National Defence Défense nationale

ROYAL CANADIAN AIR CADETS

BOOK 2 OF 2

PROFICIENCY LEVEL THREE INSTRUCTIONAL GUIDES

(ENGLISH)

(Supersedes A-CR-CCP-803/PF-001 dated 2015-09-01)

Cette publication est disponible en français sous le numéro A-CR-CCP-803/PF-002.

Issued on Authority of the Chief of the Defence Staff

Canada

National Defence / Défense nationale

A-CR-CCP-803/PF-001

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OPI: D Cdts & JCR 4 – Senior Staff Officer Youth Programs Development **2016-09-14**

Canada

LIST OF EFFECTIVE PAGES

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On a changed page, the portion of the text affected by the latest change is indicated by a vertical line in the margin of the page. Changes to illustrations by miniature pointing hands, or black vertical lines.

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FOREWORD AND PREFACE

1. **Issuing Authority.** This Instructional Guide (IG) A-CR-CCP-803/PF-001 was developed under the authority of the Director Cadets and Junior Canadian Rangers, and issued on the authority of the Chief of Defence Staff.

2. **Development.** Development of this IG was in accordance with the performance oriented concept of training outlined in the A-P9-050 Series, Canadian Forces Individual Training and Education System, with modifications to meet the needs of the Canadian Cadet Organization.

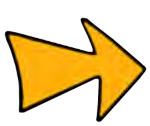
3. **Purpose of the IG.** The IG is to be used by Royal Canadian Air Cadet Squadrons in conjunction with other resources to conduct the Proficiency Level Three Program. The IG provides instructors with the base means from which to deliver training. Individual IGs are to be reviewed in conjunction with the Lesson Specifications (LSs) found in A-CR-CCP-803/PG-001, *Royal Canadian Air Cadet Proficiency Level Three Qualification Standard and Plan*, Chapter 4, before instructing, so that each instructor can adequately plan for and prepare each lesson. Instructors may be required to develop instructional materials to support training in addition to any that may be provided, eg, posters, videos, handouts, models, etc, supplemental to training control and support documents. Suggested instructional activities are included in most IGs to maximize learning and fun. Instructors are also encouraged to modify and/or enhance the activities, as long as they continue to contribute to enabling objective achievement.

4. **Use of the IG.** Throughout these instructional guides, a series of information boxes are used to highlight information; they include:

Note to the Instructor.

Key information to pass along to cadets.

Refer to the following CF regulations and policies.



Points of interest or special instructions the instructor should pass along to cadets.

5. **Suggested Changes.** Suggested changes to this document may be sent directly to cadettraining@canada.ca.

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CHAPTER 11

PO X20 – PARTICIPATE IN CANADIAN FORCES (CAF) FAMILIARIZATION ACTIVITIES

COMMON TRAINING

ALL TRAINING LEVELS

INSTRUCTIONAL GUIDE
CANADIAN ARMED FORCES
(CAF) FAMILIARIZATION

PO X20 – PARTICIPATE IN CAF FAMILIARIZATION

Total Time:

For the following EOs, refer to the lesson specifications located in A-CR-CCP-801/PG-001, *Royal Canadian Air Cadets Proficiency Level One Qualification Standard and Plan*:

- MX20.01A – Participate in a CAF Activity,
- MX20.01B – Participate in a CAF Familiarization Tour,
- MX20.01E – Attend a CAF Presentation,
- MX20.01F – Attend a CAF Commemorative Ceremony, and
- CX20.01 – Participate in CAF Familiarization Activities.

For the following EOs, refer to the instructional guides located in A-CR-CCP-801/PF-001, *Royal Canadian Air Cadets Proficiency Level One Instructional Guides*:

- MX20.01C – Fire the C7 Rifle,
- MX20.01D – Participate in a Mess Dinner,
- MX20.01G – Participate in CAF Familiarization Video Activities, and
- MX20.01H – Participate in CAF Familiarization Learning Stations.

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CHAPTER 12

PO 331 – DESCRIBE PRINCIPLES OF FLIGHT

ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL THREE

INSTRUCTIONAL GUIDE

SECTION 1

EO M331.01 – DESCRIBE AIRCRAFT STABILITY

Total Time:	60 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-803/PG-001, Chapter 4. Specific uses for said resources are identified throughout the instructional guide within the TP for which they are required.

Review the lesson content and become familiar with the material prior to delivering the lesson.

Set up the four stations as described in Annex A.

Create slide of Annex B.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

An in-class activity was chosen for TP 1 as it is an interactive way to introduce aircraft stability.

An interactive lecture was chosen for TPs 2–5 to review axes of rotation and introduce stability about the axes.

INTRODUCTION

REVIEW

N/A.

OBJECTIVES

By the end of this lesson the cadet shall have described aircraft stability.

IMPORTANCE

It is important for cadets to describe aircraft stability so that they understand why aircraft are designed with certain features. Cadets will also understand how an aircraft will react when flying through turbulent weather or when it is put through aggressive manoeuvres.

Teaching Point 1 | **Demonstrate the Characteristics of Stability**

Time: 15 min | Method: In-Class Activity

CHARACTERISTICS OF STABILITY

Stability. The tendency of an aircraft in flight to remain in straight, level, upright flight and to return to this attitude, if displaced, without corrective action by the pilot.

Static Stability. The initial tendency of an aircraft to return to its original attitude, if displaced.

Dynamic Stability. The overall tendency of an aircraft to return to its original attitude.

Positive Stability. The aircraft is able to return to its original attitude without any corrective measure.

Neutral Stability. The aircraft will remain in the new attitude of flight after being displaced, neither returning to its original attitude, nor continuing to move away.

Negative Stability. The aircraft will continue moving away from its original attitude after being displaced.

ACTIVITY

Time: 10 min

OBJECTIVE

The objective of this activity is to provide a tactile method of illustrating the different types of aircraft stability.

RESOURCES

- Tennis ball,
- Three marbles,
- Table,
- Tape, and
- Two bowls.

ACTIVITY LAYOUT

Set up four stations IAW Annex A.

ACTIVITY INSTRUCTIONS

1. Divide the cadets into four groups of equal size.
2. Assign each group to a station.
3. Have each group perform the activity at each station.
4. After the cadets have been to all stations, ask the cadets what they observed.

SAFETY

N/A.

CONFIRMATION OF TEACHING POINT 1

The cadets' participation in the stability activity will serve as confirmation of this TP.

Teaching Point 2	**Review the Axes of an Aircraft**
Time: 10 min	Method: Interactive Lecture

AXES OF THE AIRCRAFT

> Present the slide located at Annex B to the cadets.
>
> Demonstrate each axis with the model aircraft.

Each axis is an imaginary straight line which runs through the aircraft in a particular direction. All three axes intersect at the centre of gravity.

> Ask the cadets what the three axes of an aircraft are.

Longitudinal Axis and Roll

This axis runs the length of the aircraft from the tip of the nose to the end of the empennage. Movement around this axis is roll.

> Ask the cadets which control surface controls roll.

Lateral Axis and Pitch

This axis runs through the aircrafts' wings, from wing tip to wing tip. Movement around this axis is pitch.

> Ask the cadets which control surface controls pitch.

Normal (Vertical) Axis and Yaw

This axis runs through the aircraft vertically top to bottom. Movement about this axis is yaw.

Ask the cadets which control surface controls yaw.

Have the cadets make a paper airplane, marking each of the axes. Have them hold their airplanes in the air while you call out a movement (eg, roll) which they will demonstrate individually using their airplanes.

CONFIRMATION OF TEACHING POINT 2

The cadets' participation in the paper airplane activity will serve as the confirmation of this lesson.

Teaching Point 3	**Explain Longitudinal Stability**
Time: 10 min	Method: Interactive Lecture

LONGITUDINAL STABILITY

Longitudinal stability is stability around the lateral axis and is known as pitch stability. To achieve longitudinal stability, aircraft are designed to be nose heavy if loaded correctly.

Two principle factors influence longitudinal stability:

- the horizontal stabilizer, and
- the centre of gravity.

The Effects of the Horizontal Stabilizer

The horizontal stabilizer is located at the tail end of the aircraft. Its function is similar to a counterweight at the end of a lever. When the nose of the aircraft is pushed up, this will force the tail down. Since the stabilizer now meets the airflow at a higher angle of attack, it will now produce more lift. This extra lift will counter the initial disturbance.

Use the model airplane to demonstrate the effects of the horizontal stabilizer.

The Effects of the Centre of Gravity

The centre of gravity is an important factor in aircraft stability. Every aircraft has a naturally occurring centre of gravity which is inherent in its design. As the aircraft is loaded, the position of the centre of gravity can change. If this change is drastic, it can have an adverse affect on the stability of an aircraft.

Use the model airplane to demonstrate a forward centre of gravity.

If the centre of gravity is too far forward, it will produce a nose-down tendency. This will force the pilot to use excessive back pressure on the controls to maintain normal flight. If left uncorrected, the aircraft will speed up and lose altitude.

If the centre of gravity is too far aft, it will produce a nose-up tendency. This will force the pilot to use excessive forward pressure on the controls to maintain normal flight. Uncorrected, the aircraft will slow down and eventually stall.

Use the model airplane to demonstrate an aft centre of gravity.

CONFIRMATION OF TEACHING POINT 3

QUESTIONS

Q1. What is longitudinal stability?

Q2. What does the horizontal stabilizer act like?

Q3. What is the danger of an aft centre of gravity?

ANTICIPATED ANSWERS

A1. Stability around the lateral axis.

A2. A counterweight at the end of a lever.

A3. Stall.

Teaching Point 4	**Explain Lateral Stability**
Time: 10 min	Method: Interactive Lecture

LATERAL STABILITY

Lateral stability is stability around the longitudinal axis and is called roll stability. To achieve lateral stability certain design features are built into the aircraft. Three of these design features are:

- dihedral,
- sweepback, and
- keel effect.

The Effects of Dihedral and Anhedral

Dihedral is the angle that the wings make with the horizontal plane. As one looks at an aircraft from the front, the wings will slowly angle away from the ground so that the wing tip is higher than the wing root.

This assists the aircraft in maintaining lateral stability by changing the angle that the leading edge makes with the airflow.

When an aircraft with dihedral wings is forced in to a side-slipping motion, the down-going wing will meet the airflow at a right angle. This will increase the lift produced on that wing, forcing it back into place.

> Use the model airplane to demonstrate dihedral.
>
> Some aircraft have been designed with a negative dihedral, also known as anhedral. Anhedral acts opposite to dihedral, creating less stability. Usually found in aircraft with both sweepback and keel effect.

The Effects of Sweepback

Similar to the dihedral, sweepback is a design feature where the wings sweep back instead of protruding straight out from the fuselage.

This assists the aircraft in maintaining lateral stability by changing the angle that the leading edge makes with the airflow.

When an aircraft with sweepback is forced into a slipping motion, the down going wing will meet the airflow at a right angle. This will increase the lift produced by that wing forcing it back into place.

> Use the model airplane to demonstrate sweepback.

Keel Effect

While dihedral and sweepback are usually found on low-wing aircraft, high-wing aircraft have stability built-in. Since the bulk of the aircraft is below the plane of the wings, it acts as a keel. When a wing is forced up by a disturbance, the fuselage acts like a pendulum swinging the aircraft back into position.

> Use the model airplane to demonstrate keel effect.

CONFIRMATION OF TEACHING POINT 4

QUESTIONS

Q1. What is lateral stability?

Q2. What are three design features which provide lateral stability?

Q3. How does keel effect work?

ANTICIPATED ANSWERS

A1. Lateral stability is stability around the longitudinal axis.

A2. Dihedral, sweepback, and keel effect.

A3. When a wing is forced up by a disturbance, the fuselage acts like a pendulum swinging the aircraft back into position.

Teaching Point 5	**Explain Directional Stability and the Effects of the Fin**
Time: 5 min	Method: Interactive Lecture

DIRECTIONAL STABILITY

Directional stability is stability around the vertical or normal axis. The principle factor influencing directional stability is the vertical tail surface, or fin.

The Effects of the Fin

Aircraft, specifically airplanes, have a tendency of always flying head-on into the relative airflow. This tendency, called weather vaning, is a direct result of the vertical tail fin. If the aircraft yaws away from its course, the airflow strikes the fin from the side, forcing it back into position.

This will only work if the side area of the aircraft is greater aft of the centre of gravity than the area forward of the centre of gravity.

Use the model airplane to demonstrate the effects of the fin.

CONFIRMATION OF TEACHING POINT 5

QUESTIONS

Q1. What is directional stability?

Q2. What is the principle factor influencing directional stability?

Q3. What is the effect of the fin?

ANTICIPATED ANSWERS

A1. Directional stability is stability around the vertical or normal axis.

A2. The principle factor influencing directional stability is the vertical tail surface, or fin.

A3. If the airplane yaws away from its course, the airflow strikes the fin from the side, forcing it back into position.

END OF LESSON CONFIRMATION

QUESTIONS

Q1. What is dynamic stability?

Q2. What is the danger of an aft centre of gravity?

Q3. What are three design features which provide lateral stability?

ANTICIPATED ANSWERS

A1. The overall tendency of an aircraft to return to its original position.

A2. Stall.

A3. Dihedral, sweepback, and keel effect.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

This EO is assessed IAW Chapter 3, Annex B, Aviation Subjects–Combined Assessment PC.

CLOSING STATEMENT

Aircraft, airplanes in particular, require a lot of stability in order to operate safely. All airplanes have stability designed into them. Commercial and private airplanes tend to have positive stability, while military fighters tend to have neutral or negative stability.

INSTRUCTOR NOTES/REMARKS

If EO C331.01 (Review Principles of Flight, Section 2) is chosen as a complementary period, it should be scheduled prior to this EO.

When developing activities for the mandatory familiarization flying/elemental training day, it is recommended that the cadet be given the opportunity to identify and describe the stability of the aircraft.

REFERENCES

C3-116 (ISBN 0-9680390-5-7) MacDonald, A. F., & Peppler, I. L. (2000). *From the Ground Up: Millennium Edition*. Ottawa, ON: Aviation Publishers Co. Limited.

C3-229 (ISBN 0-521-02128-6) Abzug, M. J., & Larrabee, E. E. (2002). *Airplane Stability and Control* (Second Edition). Cambridge, England: Cambridge University Press.

ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL THREE

INSTRUCTIONAL GUIDE

SECTION 2

EO C331.01 – REVIEW PRINCIPLES OF FLIGHT

Total Time:	30 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-803/PG-001, Chapter 4. Specific uses for said resources are identified throughout the instructional guide within the TP for which they are required.

Review the lesson content and become familiar with the material prior to delivering the lesson.

Make copies of the handout located at Annex C for each cadet.

Make a slide of Annex C.

Bring a model airplane.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

An in-class activity was chosen for this lesson as an interactive way for the cadets to review the three axes of an aircraft and control surfaces.

INTRODUCTION

REVIEW

N/A.

OBJECTIVES

By the end of this lesson the cadet shall have reviewed principles of flight.

IMPORTANCE

It is important for cadets to review the principles of flight as a basis for learning new knowledge and skills. Comprehension of the basic principles of flight will enhance any familiarization flying activity.

Teaching Point 1	Review the Three Axes of an Aircraft
Time: 5 min	Method: In-Class Activity

ACTIVITY

OBJECTIVE

The objective of this activity is to review the three axes of an aircraft.

RESOURCES

- Handout located at Annex C,
- Slide of Annex C, and
- Overhead projector.

ACTIVITY LAYOUT

Arrange the classroom to allow for small group work.

ACTIVITY INSTRUCTIONS

1. Divide the cadets into groups of no more than four.
2. Distribute handout to each group.
3. Have the cadets label the diagram.
4. Have a cadet from each group move to another group and cross-check their answers. Have the cadets return to their group when done.
5. Project the slide onto a screen or wall.
6. Have a representative from three of the groups label one of the axes on the projected slide.

SAFETY

N/A.

CONFIRMATION OF TEACHING POINT 1

The cadets' participation in the in-class activity will serve as confirmation of this TP.

Teaching Point 2 — **As a Member of a Group, Have the Cadet Describe a Control Surface and its Effects on Attitudes and Movements**

Time: 20 min — Method: In-Class Activity

ACTIVITY

OBJECTIVE

The objective of this activity is review control surfaces and their effects on attitudes and movements.

RESOURCES

- Model airplane,
- Flip chart paper, and
- Flip chart markers.

ACTIVITY LAYOUT

Arrange the classroom to allow for small group work.

ACTIVITY INSTRUCTIONS

1. Divide the cadets into equal groups.
2. Assign each group a control surface (rudder, aileron, or elevator).
3. Have the cadets illustrate, in the fullest detail possible, the control surface assigned to their group. Allow the cadets 10 minutes to complete their illustration.
4. Have the cadets post their group's illustration on the wall. Have the cadets conduct a gallery walk for five minutes.
5. With the remaining five minutes, lead the cadets in a discussion on each of the control surfaces. Use the model airplane for demonstration purposes.

SAFETY

N/A.

CONFIRMATION OF TEACHING POINT 2

The cadets' participation in the in-class activity will serve as confirmation of this TP.

END OF LESSON CONFIRMATION

The cadets' participation in the activity in TP 2 will serve as confirmation of this lesson.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

N/A.

CLOSING STATEMENT

A review of principles of flight is important for understanding higher level material. Cadets who wish to pursue training in aviation must have a solid understanding of how aircraft fly.

INSTRUCTOR NOTES/REMARKS

If this complementary EO is chosen, it should be scheduled before any other EOs from this PO.

REFERENCES

C3-116 (ISBN 0-9680390-5-7) MacDonald, A. F., & Peppler, I. L. (2000). *From the Ground Up: Millennium Edition*. Ottawa, ON: Aviation Publishers Co. Limited.

ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL THREE

INSTRUCTIONAL GUIDE

SECTION 3

EO C331.02 – READ PITOT STATIC INSTRUMENTS

Total Time:	60 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-803/PG-001, Chapter 4. Specific uses for said resources are identified throughout the instructional guide within the TP for which they are required.

Review the lesson content and become familiar with the material prior to delivering the lesson.

Photocopy the worksheets located at Annexes D, F, and H for each cadet.

Create OHPs of the answer keys located at Annexes E, G, and I.

Construct a working model of each of the pitot static instruments IAW Annex J.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

An interactive lecture was chosen for TPs 1 to 4 to introduce pitot static instruments.

An in-class activity was chosen for TP 5 as an interactive way to confirm the cadets' comprehension of pitot static instruments.

INTRODUCTION

REVIEW

N/A.

OBJECTIVES

By the end of this lesson the cadet shall be expected to read the airspeed indicator (ASI), altimeter, and vertical speed indicator (VSI).

IMPORTANCE

It is important for the cadets to be able to read pitot static instruments so that they are aware of what is happening in the aircraft while participating in familiarization flying or using a flight simulator.

Teaching Point 1	Explain That the Basic Instruments of an Aircraft Rely on the Pitot Source and the Static Port as Sources of Information
Time: 10 min	Method: Interactive Lecture

BASIC INSTRUMENTS OF AN AIRCRAFT

There are two main sources from which the pitot static instruments receive information. The first of these is the pitot source and the second is the static source.

Pitot and Static Sources Provide Information for the ASI

The pitot source on a light aircraft is usually a pitot tube which is attached to the nose or wing of the aircraft. The information from the pitot source goes directly to the ASI, which then translates the pressure into airspeed. Since the pitot source is facing forward, it acts as an intake for air. Therefore the faster the aircraft is moving, the greater the pressure at the pitot source, which in turn means the higher the reading on the ASI.

The ASI also receives information from the static source. This information will allow the ASI to compensate for changes in the air pressure when at different altitudes.

Static Port Provides Information for the Altimeter

The static port is a small vent on the side of the aircraft. This senses the surrounding pressure of the air and feeds it to the altimeter. The static port relies on changes in air pressure to work. For example, as the aircraft increases in altitude, the air pressure decreases. This causes the altimeter to indicate a higher altitude.

Static Port Provides Information for the VSI

The static port also provides information to the VSI. As the aircraft changes its altitude, the VSI will indicate the rate of change. This reading is based on the rate at which the surrounding air pressure is changing.

The ASI is the only pitot static instrument which receives pressure from both sources.

CONFIRMATION OF TEACHING POINT 1

QUESTIONS

Q1. Which is the only instrument that uses the pitot source?

Q2. Where on a light aircraft is the pitot source usually located?

Q3. How does pressure affect the altimeter?

ANTICIPATED ANSWERS

A1. ASI.

A2. The pitot source is usually attached to the nose or wing.

A3. As pressure decreases, the indicated altitude on the altimeter will increase.

Teaching Point 2	**Explain How to Read an ASI**
Time: 10 min	Method: Interactive Lecture

READ THE AIRSPEED INDICATOR (ASI)

Reading the ASI is straightforward, and is nearly the same as reading a speedometer in a car. There is one needle and it points to the speed at which the aircraft is travelling. The biggest difference between the speedometer and the ASI is that the ASI has a colour code lining the speed scale.

Each of these arcs represent a speed range for certain flying conditions. The three colours common to all ASIs are:

- green,
- yellow, and
- red.

North American Powered Parachute Federation, "Flight Instruments". Retrieved October 30, 2007, from http://www.nappf.com/nappf_flight_instruments.htm

Figure 12-3-1 Airspeed Indicator

Normal Operating Range

The green arc indicates safe and normal flying speeds. During normal flying the pilot will modify engine power and pitch attitude so that the airspeed flown is somewhere within the green arc. This does not apply for the early part of takeoff or the last part of landing, and may not apply during aerobatic manoeuvres.

Cautionary Range

The yellow arc indicates the cautionary speed range. The aircraft can fly safely at speeds in the yellow arc range, but only if manoeuvres are kept small and gentle. Aggressive manoeuvres at speeds in the yellow arc can cause structural damage to the aircraft.

Never Exceed Speed

The red line indicates the maximum speed that the aircraft should be flown at under any circumstances. If the airspeed exceeds the red line speed, then the aircraft has to be grounded and undergo a structural inspection. Exceeding the red line may cause structural damage.

Units of Measurement

When reading the ASI, it is very important to know what units of measurement are used. In most ASIs, the unit of measurement is knots indicated airspeed (KIAS). In slower aircraft ASIs may use miles per hour (mph) as the unit of measurement. The difference between the two units is that one nautical mile (used for KIAS) is 6 080 feet, whereas one statute mile is 5 280 feet.

ACTIVITY

Time: 5 min

OBJECTIVE

The objective of this activity is for the cadet to practice reading an ASI.

RESOURCES

- ASI worksheet located at Annex D, and
- OHP of the answer key located at Annex E.

ACTIVITY LAYOUT

N/A.

ACTIVITY INSTRUCTIONS

1. Divide the cadets into pairs.
2. Distribute the ASI worksheet to each cadet.
3. Allow the cadets two to three minutes to complete the worksheet.
4. Allow the cadets two minutes to share and review answers with their partner.
5. Show the OHP of the answer key.

SAFETY

N/A.

CONFIRMATION OF TEACHING POINT 2

The cadets' participation in the activity will serve as the confirmation of this TP.

Teaching Point 3	**Explain How to Read an Altimeter**
Time: 10 min	Method: Interactive Lecture

READ AN ALTIMETER

The altimeter is the instrument which tells the pilot how high above sea level (ASL) the aircraft is. In North America the altimeter measures in feet ASL.

Units of Measurement

Every altimeter has at least three hands: one long, one short and stubby, and one long and thin with a triangle on the end.

North American Powered Parachute Federation, "Flight Instruments". Retrieved October 30, 2007, from http://www.nappf.com/nappf_flight_instruments.htm

Figure 12-3-2 The Altimeter

The long hand measures altitude in hundreds of feet ASL. This is the fastest moving hand of the three and a change in altitude will make it move.

The short hand measures altitude in thousands of feet ASL. This hand moves slowly as the altitude changes. Every time the long hand goes through a 360-degree rotation, the short hand will move to the next number on the dial.

The third hand is the thinnest and the slowest moving. It measures altitude in tens of thousands of feet ASL. As the short hand goes through a 360-degree rotation the short hand will move to the next number indicating ten thousand, twenty thousand, thirty thousand feet ASL and so on.

Pressure Sub-Scale

On the right hand side of the altimeter, there is a sub-scale. This sub-scale is used to adjust the altimeter to account for differences in the pressure of the surrounding air. The altimeter is sensitive to air pressure, and readings will change as pressure changes. Pilots have to be diligent and ensure that the sub-scale is set properly.

Field Elevation Versus Pressure Altitude

The sub-scale relies on pressure altitude to calibrate the altimeter. Pressure altitude is the perceived altitude based on the current air pressure. If this information is not available, pilots can set their altimeter to the elevation of the airfield, called field elevation. This will set the altimeter sub-scale to the proper reading.

Height Above Sea Level (ASL)/Above Ground Level (AGL)

The altimeter is designed to be used relative to sea level and is used on long flights where the ground changes in elevation. When arriving and departing an airport, all procedures are followed relative to the height above the ground. This is known as height AGL.

Reading an altimeter is very similar to reading an analog clock. Every time the second hand passes 12, the minute hand advances to the next minute. Every time the minute hand passes 12, the hour hand advances to the next hour. The altimeter works the same way.

ACTIVITY

Time: 5 min

OBJECTIVE

The objective of this activity is to allow the cadet to practice reading an altimeter.

RESOURCES

- Altimeter worksheet located at Annex F, and
- OHP of the answer key located at Annex G.

ACTIVITY LAYOUT

N/A.

ACTIVITY INSTRUCTIONS

1. Distribute the altimeter worksheet to each cadet.
2. Using the first two questions as examples, show the cadets how to read the altimeter.
3. Have the cadets complete the worksheet with a partner.
4. Show the OHP of the answer key.

SAFETY

N/A.

CONFIRMATION OF TEACHING POINT 3

The cadets' participation in the activity will serve as the confirmation of this TP.

Teaching Point 4	**Explain How to Read a VSI**
Time: 10 min	Method: Interactive Lecture

READ A VERTICAL SPEED INDICATOR (VSI)

The VSI is an instrument, which measures the rate at which the aircraft is changing altitude.

Units of Measurement

The VSI is different than the altimeter in that the altimeter measures the exact height ASL, whereas the VSI measures how fast the aircraft is gaining or losing altitude in feet per minute.

Positive/Negative Rates of Climb

The VSI is divided in half, top and bottom. Both halves are measured in increments of 100 feet, represented by the numbers 1–10 or 1–20. When the needle on the VSI is pointed to the number 1, it means 100 feet per minute. The top half is a positive rate of change in altitude or rate of climb, while the bottom half is a negative rate of change in altitude or rate of descent.

North American Powered Parachute Federation, "Flight Instruments". Retrieved October 30, 2007, from http://www.nappf.com/nappf_flight_instruments.htm

Figure 12-3-3 The Vertical Speed Indicator

ACTIVITY

Time: 5 min

OBJECTIVE

The objective of this activity is to allow the cadet to practice reading the VSI.

RESOURCES

- VSI worksheet located at Annex H, and
- OHP of the answer key located at Annex I.

ACTIVITY LAYOUT

N/A.

ACTIVITY INSTRUCTIONS

1. Distribute VSI worksheet to each cadet.
2. Have the cadets to complete the worksheet.
3. Show the OHP of the answer key.

SAFETY

N/A.

CONFIRMATION OF TEACHING POINT 4

The cadets' participation in the activity will serve as the confirmation of this TP.

Teaching Point 5	**Have the Cadet Read Pitot Static Instruments**
Time: 10 min	Method: In-Class Activity

ACTIVITY

OBJECTIVE

The objective of this activity is for the cadet to practice reading pitot static instruments.

RESOURCES

- One working model of each of the pitot static instruments, including:
  - ASI,
  - Altimeter, and
  - VSI; and
- Questions located at Annex K.

ACTIVITY LAYOUT

N/A.

ACTIVITY INSTRUCTIONS

1. Divide the cadets into two teams.
2. Set one model at a time (in no particular order) and allow each team five seconds to read the instrument.
3. Alternate which team answers. The teams get one point for every correct answer that they give.
4. If a team cannot correctly answer the question within five seconds then the other team can steal the point.
5. The team which answers the most questions correctly wins.

SAFETY

N/A.

CONFIRMATION OF TEACHING POINT 5

The cadets' participation in the activity will serve as the confirmation of this TP.

END OF LESSON CONFIRMATION

The cadets' participation in each of the activities will serve as the confirmation of this lesson.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

N/A.

CLOSING STATEMENT

Knowing how to read the pitot static instruments is essential in order to fly an aircraft. Even if a pilot is not flying under IFR conditions, these three instruments are required in order to safely operate the aircraft. They also allow the pilot to coordinate with other pilots and ATS to ensure traffic avoidance or to fly circuits at an aerodrome.

INSTRUCTOR NOTES/REMARKS

N/A.

REFERENCES

C3-116 (ISBN 0-9680390-5-7) MacDonald, A. F., & Peppler, I. L. (2000). *From the Ground Up: Millennium Edition*. Ottawa, ON: Aviation Publishers Co. Limited.

C3-139 (ISBN 0-7715511-5-0) Transport Canada. (1999). *Flight Training Manual: 4th Edition Revised*. Ottawa, ON: Transport Canada.

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ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL THREE

INSTRUCTIONAL GUIDE

SECTION 4

EO C331.03 – IDENTIFY ASPECTS OF HELICOPTER AERODYNAMICS

Total Time:	30 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-803/PG-001, Chapter 4. Specific uses for said resources are identified throughout the instructional guide within the TP for which they are required.

Review the lesson content and become familiar with the material prior to delivering the lesson.

Create slides of Annexes L and M.

Bring a model helicopter to class. If possible use a radio-controlled helicopter to illustrate helicopter aerodynamics.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

An interactive lecture was chosen for this lesson to introduce the cadets to aspects of helicopter aerodynamics.

INTRODUCTION

REVIEW

N/A.

OBJECTIVES

By the end of this lesson the cadet shall be expected to identify aspects of helicopter aerodynamics.

IMPORTANCE

It is important for cadets to identify aspects of helicopter aerodynamics so that they can appreciate the differences between airplanes and helicopters.

Teaching Point 1 **Describe the Main Rotor of a Helicopter**

Time: 15 min Method: Interactive Lecture

THE MAIN ROTOR OF A HELICOPTER

Helicopters, like airplanes, have airfoils. Unlike airplanes, which have fixed airfoils (wings), the airfoils of a helicopter are not in a fixed position. The airfoils on a helicopter are called rotor blades, which are attached to a rotating point on the top of the helicopter's airframe. The whole assembly is referred to as the main rotor or rotor system.

The terms "fixed wing" (airplane) and "rotary wing" (helicopter) are derived from the physical differences between airplane and helicopter airfoils.

Use the model of the helicopter to illustrate each of the following points. If possible, a radio-controlled helicopter model should be used as it will dynamically illustrate the concepts of rotor thrust and rotor drag.

Rotor Systems

The rotor systems of a helicopter incorporate many parts. Three of the basic parts are:

- the rotor blades,
- the rotor head, and
- the drive shaft.

The rotor blades are attached to the rotor head. The rotor head sits on top of the drive shaft. As the drive shaft spins, it moves the blades through the air.

As the blades spin, they act like the wings of an airplane. The shape of the rotor blade is symmetrical, meaning that the top of the blade is shaped the same as the bottom of the blade. As each blade passes through the air, the airflow over the blade creates lift using the same principles of a wing.

In order for a helicopter to move in a horizontal direction, the rotor system must be angled in the direction of travel. This changes the angle of the plane in which the blades rotate, and the rotor blades act the same as propellers.

Flying a helicopter is complicated. Once the angle of the plane of rotation has been changed, the amount of lift being produced will no longer be enough to maintain the helicopter's altitude. The pilot must apply more power in order to counteract this. The total lift force required to maintain the helicopter's altitude and forward motion is referred to as total rotor thrust.

Rotor Drag

Rotor drag is the opposite of rotor thrust. It is commonly known as torque, and acts opposite to the direction that each blade travels. Rotor drag attempts to slow down the rotation of the blades and an increase in engine power is required to maintain the speed of the blades. If the force of rotor drag is stronger than the rotor thrust, then the torque causes the body of the helicopter to rotate instead of the blades.

Rotor drag should not be confused with aerodynamic drag.

Aerodynamic drag is a force that acts on the body of the aircraft as it moves through the air. It acts opposite to thrust (see the four forces acting on an aircraft).

Factors Influencing Rotor Thrust

There are four factors that influence rotor thrust, including:

- **Air Density.** As the rotor blades pass through the air, the reaction between the air molecules and the surface of the blade produces lift. More air molecules will create a stronger reaction. One may state that more lift is produced in higher density air vice lower density air because dense air has more molecules. Air density can decrease with increases in temperature or decreases in pressure.
- **Rotor Revolutions per Minute (rpm).** An increase in rotor rpm increases the total rotor thrust, while a decrease in rotor rpm decreases the total rotor thrust.
- **Blade (Pitch) Angle.** An increase in the blade angle increases the total rotor thrust, while a decrease in the blade angle decreases the total rotor thrust. This is similar to the effects of pitch on an airplane's wings.
- **Disc Area.** Disc area is the total area in which the rotor blades rotate and is determined by the length of the rotor blades. The larger the disc area is, the higher the total rotor thrust will be. This follows the same principle with airplanes, where the larger the wing area, the more lift is produced.

CONFIRMATION OF TEACHING POINT 1

QUESTIONS

Q1. What are the three basic parts of a rotor system?

Q2. Which force acts opposite to rotor thrust?

Q3. How does disc area influence rotor thrust?

ANTICIPATED ANSWERS

A1. The rotor blades, rotor head, and drive shaft.

A2. Rotor drag.

A3. The larger the disc area is, the higher the total rotor thrust will be.

Teaching Point 2	**Describe the Anti-Torque Rotor of a Helicopter**
Time: 5 min	Method: Interactive Lecture

THE ANTI-TORQUE ROTOR

Show slide of Annex L.

Location on the Airframe

The anti-torque rotor is a smaller version of the main rotor. It is mounted vertically at the end of the tail. Most helicopters have an anti-torque rotor that sits in the right side of the tail, although some designs have the anti-torque rotor mounted on the left side or built into the tail assembly.

Airforce Imagery, 2008, CH-149 Cyclone. Copyright 2006 by Sikorsky Aircraft Corporation. Retrieved April 9, 2008, from http://www.airforceimagery.forces.gc.ca/netpub/server.np?find&catalog=casimages&template=detail2_e.np&field=itemid&op=matches&value=3018&site=casimages

Figure 12-4-1 Location of Anti-Torque Rotor

Function

The function of the anti-torque rotor is to counteract the torque produced by the main rotor. Without the anti-torque rotor, the rotation of the main rotor would transfer to the airframe and rotate the airframe instead of the rotor blades. By installing the anti-torque rotor, the airframe stays relatively still while the rotor blades rotate above the airframe. The anti-torque rotor serves to control movement around the vertical axis of the helicopter.

Power Source

The anti-torque rotor receives power from the main engine through a drive shaft which runs the length of the tail assembly.

CONFIRMATION OF TEACHING POINT 2

QUESTIONS

Q1. Where is the anti-torque rotor normally located?

Q2. What are the functions of the anti-torque rotor?

Q3. How does the anti-torque rotor receive power?

ANTICIPATED ANSWERS

A1. It is mounted vertically at the end of the tail.

A2. The functions of the anti-torque rotor are to counteract the torque produced by the main rotor and to control movement around the vertical axis.

A3. The anti-torque rotor receives power from the main engine through a drive shaft, which runs the length of the tail assembly.

Teaching Point 3	**Explain the Control Inputs of a Helicopter**
Time: 5 min	Method: Interactive Lecture

CONTROL INPUTS OF A HELICOPTER

There are three primary control inputs of a helicopter. They differ from the control inputs of an airplane in some ways, but are similar in others. The three primary control inputs are:

- collective,
- cyclic, and
- pedals.

Show slide of Annex M.

Collective

The collective is an arm lever located on the left side of the pilot's seat (in most helicopters the pilot sits on the right side of the cockpit). The collective controls the angle of attack of the rotor blades which will affect the amount of lift produced. Pulling up on the collective will increase the angle of attack, producing more lift. Pushing down on the collective will decrease the angle of attack, producing less lift.

At the end of the collective is a throttle. The throttle on a helicopter is a twist-style grip. The throttle controls the rpm of the blades. An increase in rpm will increase the amount of lift produced and the speed at which the helicopter travels.

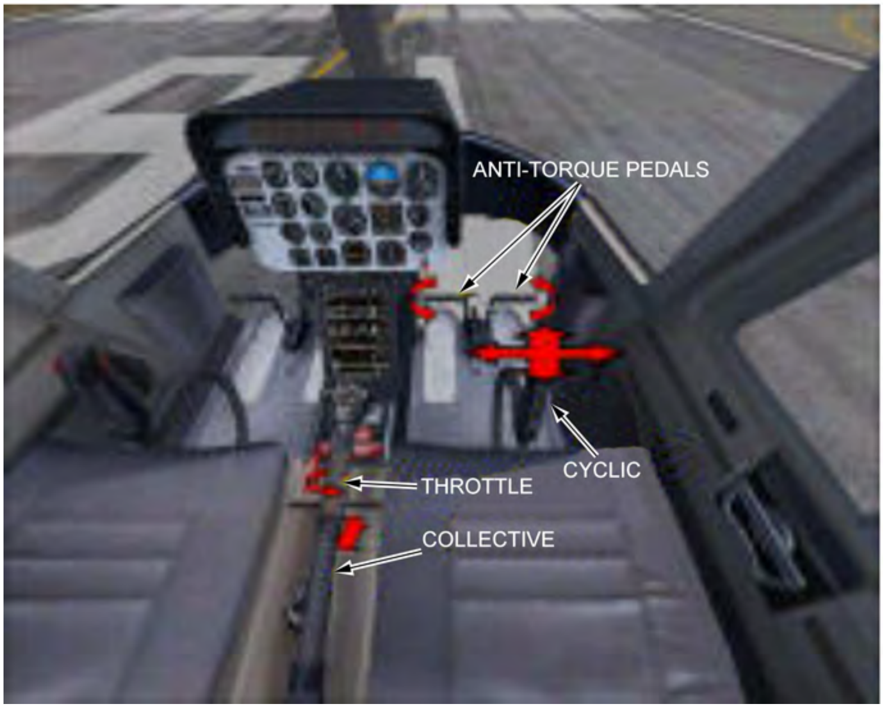
It is important to remember that the rotors act in the same way as both the wings and the propeller of an airplane. They produce the lift and the thrust. The same happens for movements forward, backward and to the right.

Cyclic

In a helicopter, the control column is known as the cyclic. The cyclic controls the angle of the plane in which the rotor blades move. Moving the cyclic left will angle the rotation of the blades left. Maintaining that angle long enough will move the helicopter to the left.

Pedals

The pedals in a helicopter cockpit are similar to rudder pedals. They control the anti-torque rotor, providing directional stability. They also control which direction the nose of the helicopter is pointed. One of the unique capabilities of a helicopter is that the nose can be pointed in a different direction than the direction of travel. This provides the helicopter increased manoeuvrability.



AVSIM Online, by S. Cartwright, 2004, Helicopter Tutorial. Copyright 2004 by AVSIM Online. Retrieved April 8, 2008, from http://www.avsim.com/pages/0604/heli/helitutorial.htm

Figure 12-4-2 Helicopter Control Inputs

CONFIRMATION OF TEACHING POINT 3

QUESTIONS

Q1. What does the collective control?

Q2. What does the cyclic control?

Q3. What do the pedals control?

ANTICIPATED ANSWERS

A1. The angle of attack of the rotor blades.

A2. The angle of the plane in which the rotor blades move.

A3. They control the anti-torque rotor, providing directional stability. They also control which direction the nose of the helicopter is pointed.

END OF LESSON CONFIRMATION

QUESTIONS

Q1. How do the main rotor systems produce lift?

Q2. What is the function of the anti-torque rotor?

Q3. What is one of the unique capabilities of helicopters?

ANTICIPATED ANSWERS

A1. As each blade passes through the air, the airflow over the blade creates lift using the same principles as a wing.

A2. The function of the anti-torque rotor is to counteract the torque produced by the main rotor.

A3. One of the unique capabilities of a helicopter is that the nose can be pointed in a different direction than the direction of travel.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

N/A.

CLOSING STATEMENT

Helicopters are flown using very different applications of Newtonian physics. Certain parts of the helicopter are similar to airplanes but have different functions. These differences make the helicopter a more manoeuvrable aircraft and more challenging to fly.

INSTRUCTOR NOTES/REMARKS

It is recommended that this EO be scheduled with EO C331.05 (Tour a Local Aviation Facility, A-CR-CCP-803/PG-001, Chapter 4, Section 13) if helicopters are present at the facility.

If the squadron has the opportunity to participate in familiarization flights in a helicopter, this EO should be conducted at that time.

REFERENCES

C3-249 (ISBN 978-1-56027-649-4) Wagtendok, W. J. (2006). *Principles of Helicopter Flight: Second US Edition*. Newcastle, WA: Aviation Supplies & Academics, Inc.

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ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL THREE

INSTRUCTIONAL GUIDE

SECTION 5

EO C331.04 – DEMONSTRATE ATTITUDES AND MOVEMENTS IN A FLIGHT SIMULATOR

Total Time:	90 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-803/PG-001, Chapter 4. Specific uses for said resources are identified throughout the instructional guide within the TP for which they are required.

Review the lesson content and become familiar with the material prior to delivering the lesson.

Create a scenario for the computer simulator IAW the manual provided with the software. The guidelines for this scenario should be using a local airport, no weather, and a starting altitude of 5 500 feet ASL.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

An interactive lecture was chosen for TPs 1 and 2 to give direction on procedures and present basic or background information about flight simulation.

A simulation was chosen for TP 3 as it is an interactive way to allow the cadet to experience attitudes and movements in a safe, controlled environment. This activity contributes to the development of principles of flight skills and knowledge in a fun and challenging setting.

INTRODUCTION

REVIEW

N/A.

OBJECTIVES

By the end of this lesson the cadet shall be expected to demonstrate attitudes and movements and read pitot static instruments in a flight simulator.

IMPORTANCE

It is important for cadets to apply this knowledge in a flight simulator to enhance the learning value of attitudes and movements. This will also serve as a solid foundation for any cadet who participates in flight training in the future.

Teaching Point 1 — **Explain Safety Considerations Related to the Location or Design of the Flight Simulator**

Time: 5 min — Method: Interactive Lecture

Arrange the cadets so they can hear the safety briefing prior to using the flight simulator.

This briefing is being conducted to pass on safety considerations for use of the flight simulator. The actual content of the briefing will vary by region and squadron based on the squadron's assets, the location of the assets, and other environmental factors. The following should be covered:

- DND regulations concerning the appropriate use of computers, including:
  - CATO 11-07 (Internet Acceptable Use – Cadet Program),
  - DAOD 6001 (Internet),
  - Regional Orders, and
  - Squadron Standing Orders;
- location of the nearest fire exit in case of fire;
- awareness of any moving parts of the simulator; and
- proper entry and exit techniques to avoid damage to assets.

CONFIRMATION OF TEACHING POINT 1

Confirmation of this TP will depend on the actual content covered.

Teaching Point 2 — **Explain How to Manipulate the Necessary Control Inputs and the Location of Necessary Instruments**

Time: 15 min — Method: Interactive Lecture

CONTROL COLUMN OR YOKE

Using a control column or yoke in a flight simulator is preferable. Accordingly, the following will need to be adjusted if a control column is used instead.

The control yoke is located directly in front of the pilot in the centre of the pilot's side of the instrument panel. The control yoke is very much like the steering wheel of a car, both in look and function. The yoke is designed to move on two planes of motion.

The first plane of motion is left and right. The standard yoke will usually move to approximately 45 degrees left or right of centre when moved like a steering wheel. This motion is what controls the ailerons of the simulated airplane. To roll left, turn the wheel left. To roll right, turn the wheel right. Remember, this must be used as well as the rudder in order to properly turn the aircraft.

The control yoke also moves back and forth. The steering column of the yoke moves in and out of the main assembly. This controls the elevator of the simulated aircraft. To pitch up, pull back (towards the pilot). To pitch down, push forward (away from the pilot).

Pitch will change your altitude, but more importantly your airspeed.

RUDDER PEDALS

On the floor of the simulator there are two pedals. If you push forward on the left pedal, the right one moves back and vice versa. These pedals control the rudder of the simulated aircraft. To yaw left, push on the left pedal. To yaw right, push on the right pedal.

Rudder pedals move in different directions so pressure must be taken off the opposite pedal in order for the movement to take place.

LOCATION OF INSTRUMENTS

The instruments of the simulated aircraft will be displayed in front of the pilot, laid out on what is called an instrument panel. The three instruments that are of significance are the pitot static instruments: the airspeed indicator (ASI), vertical speed indicator (VSI), and altimeter. They are usually located just above the control yoke in a cluster of six instruments.

ASI. The ASI is located on the top row of the instrument panel on the far left.

VSI. The VSI is located on the bottom row of the instrument panel on the far right.

Altimeter. The altimeter is located on the top row of the instrument panel on the far right, just above the VSI.

"Design a Virtual Cockpit Instrument Panel", Ngee Ann Polytechnic, 2007. Retrieved October 31, 2007, from http://www.learnerstogether.net/avionics-project-design-problem-based-learning/56

Figure 12-5-1 Cessna Flight Instrument Panel

There is no need to go in to any detail about the other three instruments located in the diagram.

CONFIRMATION OF TEACHING POINT 2

QUESTIONS

Q1. Where is the control yoke located?

Q2. Where are the pitot static instruments located?

Q3. How is pitch controlled?

ANTICIPATED ANSWERS

A1. In front of the pilot centred on the instrument panel.

A2. Clustered together, just above the control yoke.

A3. By moving the yoke towards or away from the pilot.

Teaching Point 3	Supervise the Cadets as They Practice Attitudes and Movements Using the Flight Simulator
Time: 60 min	Method: Simulation

ACTIVITY

OBJECTIVE

The objective of this activity is to allow the cadet to practice attitudes and movements and witness their effect on the pitot static instruments.

RESOURCES

- Computer flight simulator (Microsoft flight simulator, computer, control yoke, and rudder pedals), and
- Scenario using local airport, no weather, and a starting altitude of 5 500 feet ASL.

ACTIVITY LAYOUT

This will depend on the location of the simulator.

ACTIVITY INSTRUCTIONS

1. Start the simulator with the scenario created prior to the lesson.
2. Allow the cadets to take turns in the simulator, practicing attitudes and movements.
3. Each cadet should be given an equal amount of time. This means that the 60 minutes should be divided as evenly as possible by the number of cadets in the class.
4. If a cadet is quickly grasping the concepts, move on to the next cadet. This will allow some flexibility in the event a cadet does not grasp the concepts quickly.

SAFETY

N/A.

CONFIRMATION OF TEACHING POINT 3

The cadets' participation in this activity will serve as confirmation of this TP.

END OF LESSON CONFIRMATION

The cadets' participation in the flight simulator, practicing attitudes and movements, will serve as confirmation of this lesson.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

N/A.

CLOSING STATEMENT

It has been stated by many flight instructors that a significant difference can be seen in the skill quality of students who used a flight simulator compared to those who did not. The military is a large user of computer-based flight simulators, as are Air Canada and WestJet. Cadets are encouraged to train on flight simulators as it will enhance their preparation for future flight training.

INSTRUCTOR NOTES/REMARKS

Concurrent activities may be required based on the number of simulators available.

All staff should be familiar with the operation of the flight simulator prior to the EO. This will better prepare them to troubleshoot and instruct.

REFERENCES

C3-139 (ISBN 0-7715511-5-0) Transport Canada. (1999). *Flight Training Manual: 4th Edition Revised*. Ottawa, ON: Transport Canada.

C3-156 *Computerized Aircraft Simulation Center*. (2007). Retrieved October 2, 2007, from http://www.regions.cadets.forces.gc.ca/pac/aircad/flight/casc_lessons_e.asp.

THE FOUR STATIONS

Station 1: Tennis Ball – Dynamic and Static Stability

This station should be set up in an area of the classroom where there will be a six-foot (2-metre) length of unobstructed floor space. Place a piece of tape on the floor to mark the starting position. Place a tennis ball on the piece of tape.

1. Have the cadet pick up the ball to shoulder height (thus displacing it from its original position) and then drop it back on to the floor.
2. Have the cadet observe the tennis ball as it bounces.
3. The initial bounce is the static stability, while the remaining bounces reflect dynamic stability.

Station 2: Marble With Bowl – Positive Stability

In the centre of the table place the bowl, right-side up. Place a marble in the centre of the bowl.

1. Have the cadet push the marble with their finger to just below the lip of the bowl.
2. Allow the marble to fall back to the bottom of the bowl.
3. Observe the results.
4. The end result is that the marble will return to its original place; positive stability.

Station 3: Marble on Flat Level Surface – Neutral Stability

Place a marble on one end of a table.

1. Have the cadet gently push the marble towards the other end of the surface.
2. Observe the marble as it rolls and then stops.
3. The marble is now in a new position, neither moving further away nor moving back to its starting place.

Station 4: Marble With Bowl – Negative Stability

This station should be set up on a table. In the centre of the table, place a bowl, upside down. Place a marble on top of the bowl.

1. Have the cadet gently push the marble towards the edge of the bowl's base.
2. Watch as the marble continues to move away from its starting place. This is negative stability.
3. Have the cadets chase after the marble and replace it. Replacing the marble is not part of the demonstration of negative stability.

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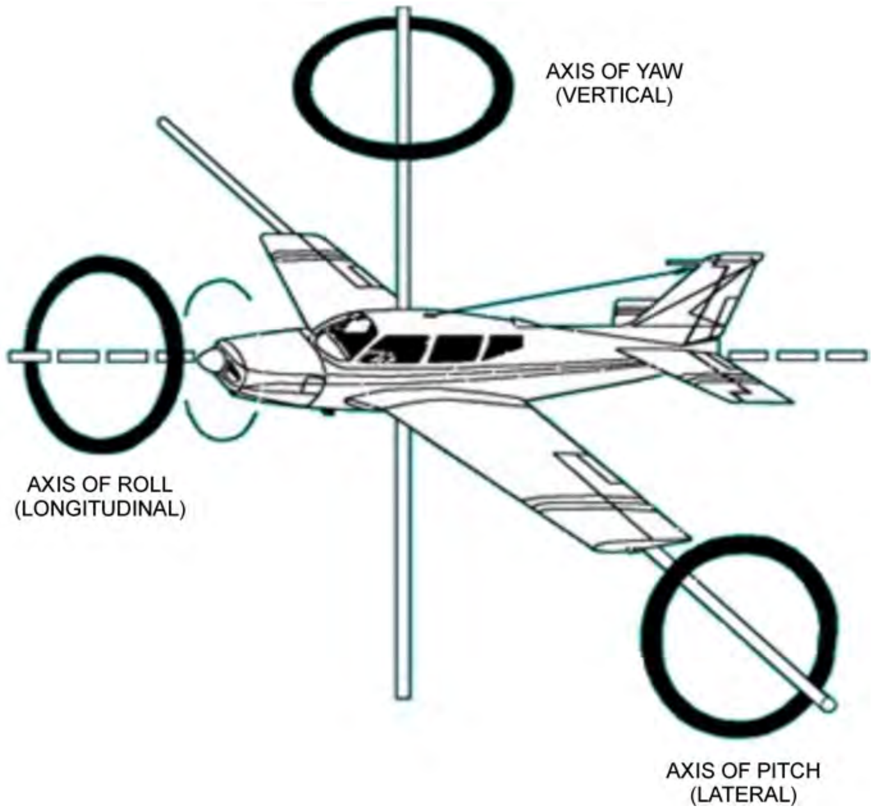
CONTROL SURFACES



"Start Flying", Controlling the Aircraft, (2007). Retrieved October 24, 2007, from http://www.startflying.com/new%20site/controlling_aircraft.htm

Figure 12B-1 Axes of Rotation

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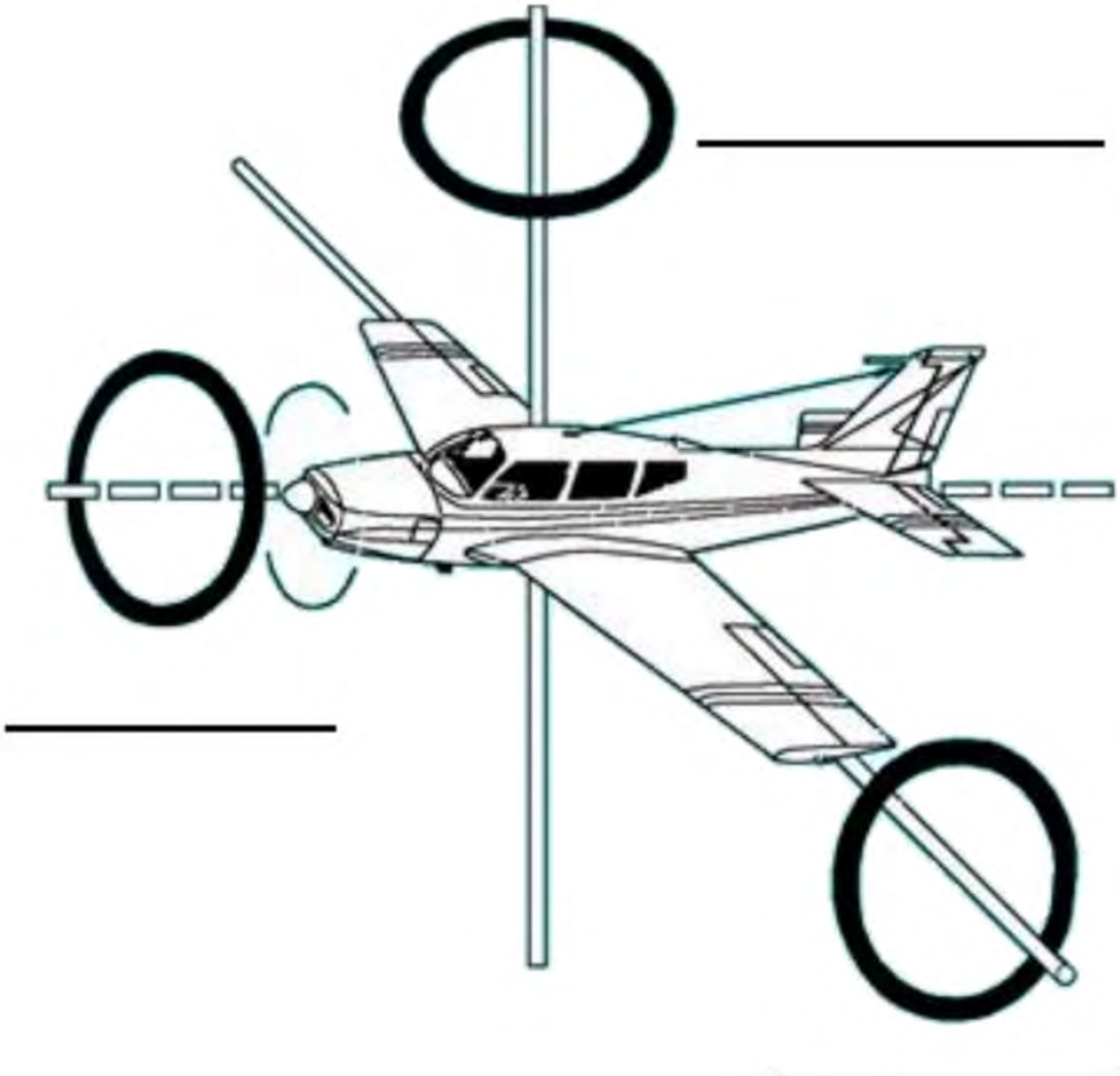
AXES OF ROTATION



"Controlling the Aircraft", Start Flying, (2007). Retrieved October 24, 2007, from http://www.startflying.com/new%20site/controlling_aircraft.htm

Figure 12C-1 Axes of Rotation

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ASI WORKSHEET

Director Cadets 3, 2008, Ottawa, ON: Department of National Defence

Figure 12D-1 ASI Worksheet

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ASI ANSWER KEY

30 KNOTS

50 KNOTS

170 KNOTS

98 KNOTS

120 KNOTS

65 KNOTS

Director Cadets 3, 2008, Ottawa, ON: Department of National Defence

Figure 12E-1 ASI Answer Key

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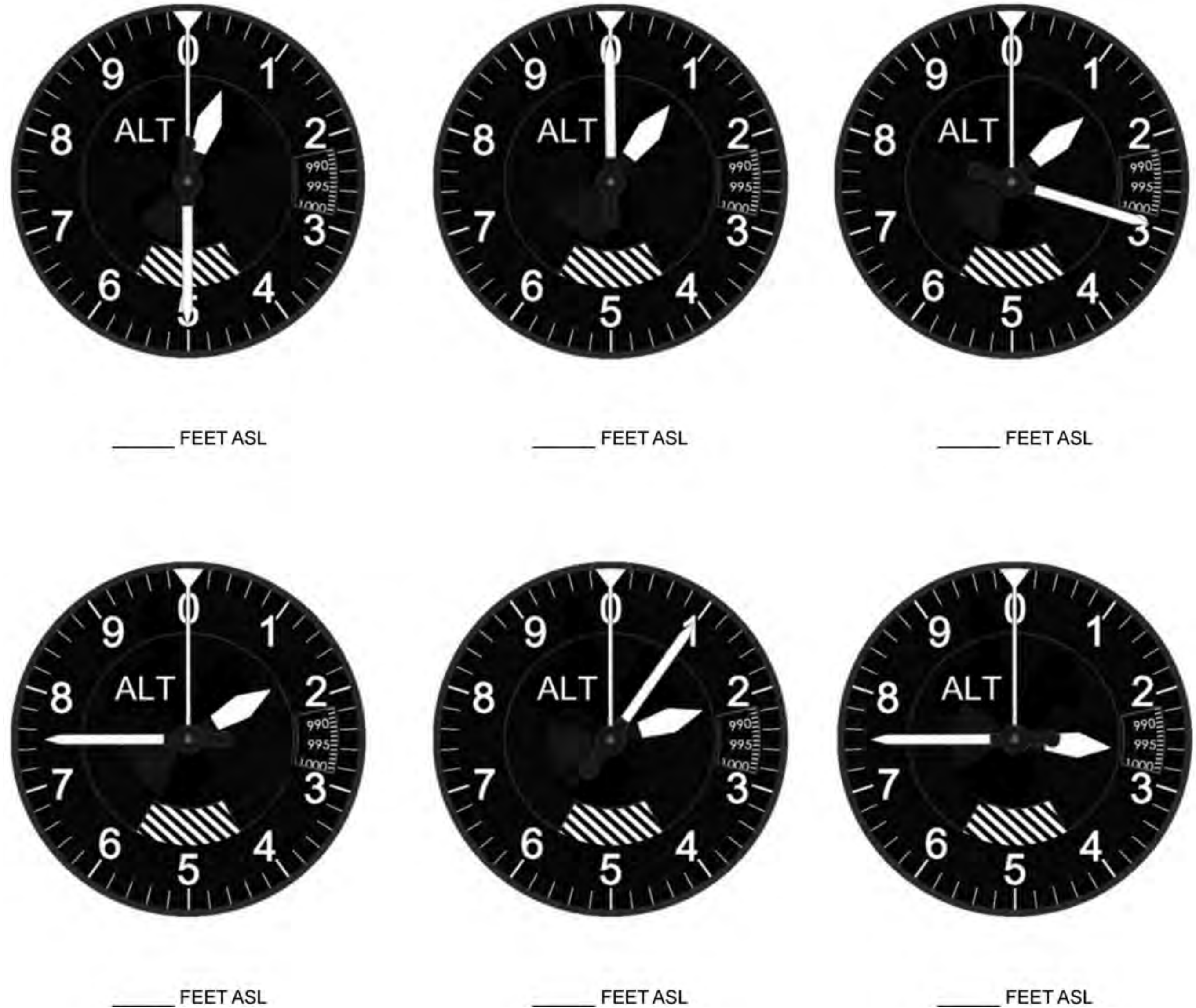
ALTIMETER WORKSHEET



Director Cadets 3, 2008, Ottawa, ON: Department of National Defence

Figure 12F-1 Altimeter Worksheet

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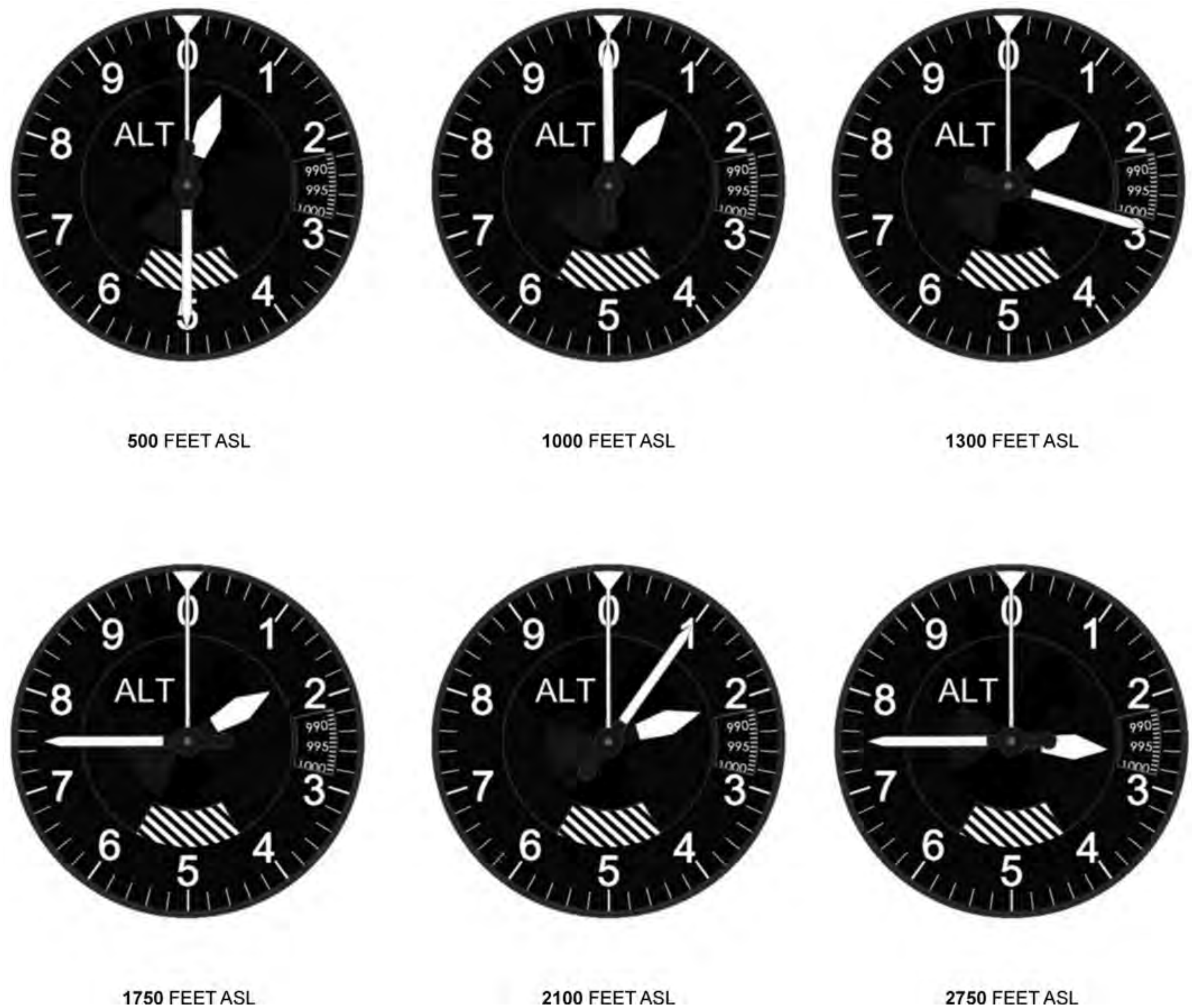
ALTIMETER ANSWER KEY



Director Cadets 3, 2007, Ottawa, ON: Department of National Defence

Figure 12G-1 Altimeter Answer Key

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VSI WORKSHEET

_____ FEET PER MINUTE

_____ FEET PER MINUTE

_____ FEET PER MINUTE

_____ FEET PER MINUTE

_____ FEET PER MINUTE

_____ FEET PER MINUTE

Director Cadets 3, 2007, Ottawa, ON: Department of National Defence

Figure 12H-1 VSI Worksheet

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VSI ANSWER KEY

0 FEET PER MINUTE

+200 FEET PER MINUTE

+700 FEET PER MINUTE

-50 FEET PER MINUTE

-400 FEET PER MINUTE

-800 FEET PER MINUTE

Director Cadets 3, 2007, Ottawa, ON: Department of National Defence

Figure 12I-1 VSI Answer Sheet

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INSTRUCTIONS FOR CREATION OF PITOT STATIC INSTRUCTIONAL AIDS

RESOURCES

- One sheet of Bristol board per training aid,
- One brass Acco fastener per training aid,
- Pencil,
- Compass from a geometry set,
- Ruler or straight edge,
- Coloured markers, and
- Poster board for making dial hands.

INSTRUCTIONS – ASI

1. Draw a representation of an ASI centred on the Bristol board. This will include all of the numbers and coloured arcs/lines. Use figures located at Annex D as guides for layout.
2. Colour in the arcs and lines with the appropriate colours for the green arc, yellow arc and red line. Colouring in the white arc is optional as it is not covered in PO S331.
3. Cut out a dial hand from the poster board.
4. Attach the dial hand to the centre of the representation using the brass Acco fastener.
5. Ensure that the hand can move when needed, but there is enough friction to keep them from moving on their own.

INSTRUCTIONS – ALTIMETER

1. Draw a representation of an altimeter's face centred on the Bristol board. This will include all of the numbers and graduated lines in between the numbers. Use figures located at Annex F as guides for layout.
2. Cut dial hands from the poster board to represent the hands of an altimeter.
3. Colour in the altimeter. To add variety of colour, use yellow and black for the polygon shape under the hands pivot point.
4. Attach the hands to the centre of the altimeter representation using the brass Acco fastener.
5. Ensure that the hands can move when needed, but there is enough friction to keep them from moving on their own.

INSTRUCTIONS – VSI

1. Draw a representation of a VSI centred on the Bristol board. This will include all of the numbers on the positive and negative scales. Ensure that zero is located on the left side. Use the figures located in Annex G as guides for layout.
2. Colour in the VSI.
3. Cut out a dial hand from poster board and attach it to the centre of the representation using the brass Acco fastener.
4. Ensure that the hand can move when needed, but there is enough friction to keep it from moving on its own.

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TRIVIAL PURSUIT QUESTIONS

These are suggested questions that can be used for the Trivial Pursuit game in TP 5. The instructor is able to modify this list in any way. When asking a question, first set the specific training aid to the desired reading. Then allow the team whose turn it is to provide an answer. Be sure to rotate instruments every question.

ASI QUESTIONS

For each question, set the ASI training aid to the desired value. These can be asked in any order desired.

1. 125 KIAS
2. 65 KIAS
3. 40 KIAS
4. 50 KIAS
5. 75 KIAS
6. 180 KIAS
7. 210 KIAS
8. 98 KIAS
9. 110 KIAS
10. 55 KIAS

ALTIMETER QUESTIONS

For each question, set the altimeter training aid to the desired value. These can be asked in any order desired.

1. 8 900 feet ASL
2. 1 300 feet ASL
3. 2 600 feet ASL
4. 11 000 feet ASL
5. 7 500 feet ASL
6. 1 250 feet ASL
7. 600 feet ASL
8. 400 feet ASL
9. 300 feet ASL
10. 1 000 feet ASL

VSI QUESTIONS

For each question, set the VSI training aid to the desired value. These can be asked in any order desired.

1. +200 feet per minute
2. +300 feet per minute
3. +150 feet per minute

4. +500 feet per minute
5. +800 feet per minute
6. -1 000 feet per minute
7. -250 feet per minute
8. -400 feet per minute
9. -900 feet per minute
10. -1 200 feet per minute

LOCATION OF ANTI-TORQUE ROTOR

Airforce Imagery, 2008, CH-149 Cyclone. Copyright 2006 by Sikorsky Aircraft Corporation. Retrieved April 9, 2008, from http://www.airforceimagery.forces.gc.ca/netpub/server.np?find&catalog=casimages&template=detail2_e.np&field=itemid&op=matches&value=3018&site=casimages

Figure 12L-1 Location of Anti-Torque Rotor

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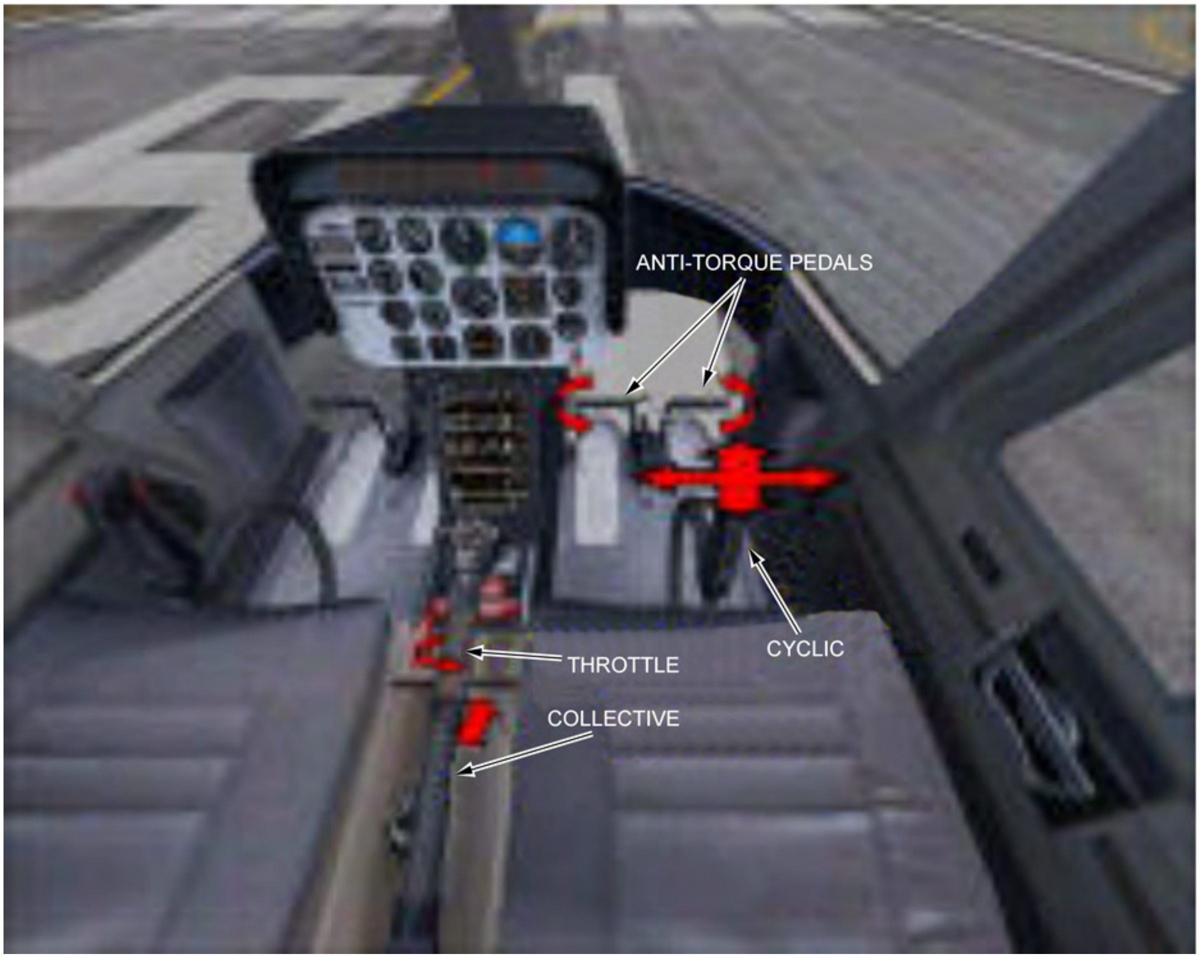
HELICOPTER CONTROL INPUTS



AVSIM Online, by S. Cartwright, 2004, Helicopter Tutorial, Copyright 2004 by AVSIM Online. Retrieved April 8, 2008, from http://www.avsim.com/pages/0604/heli/helitutorial.htm

Figure 12M-1 Helicopter Control Inputs

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CHAPTER 13

PO 336 – IDENTIFY METEOROLOGICAL CONDITIONS

ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL THREE

INSTRUCTIONAL GUIDE

SECTION 1

EO M336.01 – DESCRIBE PROPERTIES OF THE ATMOSPHERE

Total Time:	30 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-803/PG-001, Chapter 4. Specific uses for said resources are identified throughout the instructional guide within the TP for which they are required.

Review the lesson content and become familiar with the material prior to delivering the lesson.

Create a slide of the divisions of the atmosphere located at Annex A.

Bring resources needed for demonstration in TP 2.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

An interactive lecture was chosen for this lesson to introduce the cadet to the properties of the atmosphere.

INTRODUCTION

REVIEW

N/A.

OBJECTIVES

By the end of this lesson the cadet shall have described properties of the atmosphere.

IMPORTANCE

It is important for cadets to describe properties of the atmosphere to enhance their understanding of how weather conditions are created.

Teaching Point 1	**Describe the Composition of the Atmosphere**
Time: 5 min	Method: Interactive Lecture

COMPOSITION OF THE ATMOSPHERE

The atmosphere is composed of a mixture of invisible gases. These gases make up the majority of the atmosphere. There are also small particles of dust and debris in the lower levels of the atmosphere.

The Breakdown of the Major Gases

At altitudes of up to 250 000 feet above sea level (ASL), the atmosphere is composed primarily of nitrogen, oxygen, argon, carbon dioxide, hydrogen, water vapour, and several other gases. Each of these gases comprises a certain percentage of the atmosphere.

- **Nitrogen.** Nitrogen is the most abundant gas by percentage of the atmosphere at 78 percent.
- **Oxygen.** Oxygen is the second most abundant gas by percentage of the atmosphere at 21 percent.
- **Other.** The rest of the gases make up approximately 1 percent of the atmosphere.

The Importance of Water Vapour

Water vapour is found only in the lower layers of the atmosphere. The amount of water in the atmosphere is never constant, but it is the most important of the gases from the standpoint of weather. It can change from a gas into water droplets or ice crystals and is responsible for the formation of clouds.

CONFIRMATION OF TEACHING POINT 1

QUESTIONS

Q1. How much of the atmosphere is composed of nitrogen?

Q2. How much of the atmosphere is composed of oxygen?

Q3. From the standpoint of weather, which gas is the most important?

ANTICIPATED ANSWERS

A1. 78 percent.

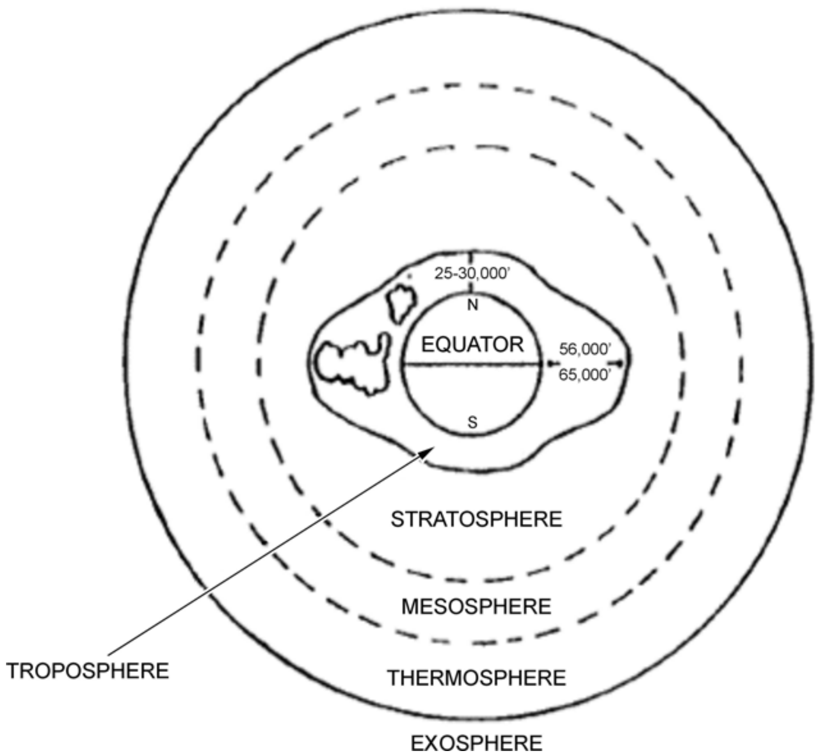
A2. 21 percent.

A3. Water vapour.

Teaching Point 2 **Illustrate the Divisions of the Atmosphere**

Time: 10 min Method: Interactive Lecture

DIVISIONS OF THE ATMOSPHERE



A. F. MacDonald and I. L. Peppler, From the Ground Up, Aviation Publishers Co. Limited (p. 123)

Figure 13-1-1 The Four Layers of the Atmosphere

The atmosphere is divided into four distinct layers which surround the earth for many hundreds of miles. These layers are the:

- troposphere,
- stratosphere,
- mesospehere, and
- thermosphere.

The exosphere is not actually a layer of the atmosphere; it is actually the first vestiges of outer space.

Show the slide located at Annex A.

Illustrate each layer of the atmosphere using the tennis ball or small globe and the clear plastic bowls. Place the tennis ball on a table, and as you introduce a new layer of the atmosphere, place a plastic bowl over the tennis ball.

The Troposphere

The troposphere is the lowest layer of the atmosphere. The troposphere starts at ground level and extends to varying heights ASL (see Figure 13-1-1). Within the troposphere air pressure, density and temperature decrease with altitude. Temperature will drop to a low of -56 degrees Celsius. Most weather occurs in this layer of the atmosphere due to the presence of water vapour as well as strong vertical currents caused by terrestrial radiation. Terrestrial radiation causes the troposphere to extend to varying altitudes. There is more radiation at the equator than at the poles.

The phenomenon known as the jet stream exists in the upper parts of the troposphere.

The top of the troposphere is known as the tropopause, which acts as a boundary between the troposphere and the stratosphere.

The Stratosphere

The stratosphere extends 50 000 feet upwards from the tropopause. The pressure continues to decrease in the stratosphere. The temperature will gradually rise to 0 degrees Celsius. It is in the stratosphere that the bulk of the ozone layer exists. This prevents the more harmful solar radiation from reaching the earth's surface, which explains the rise in temperature.

The top of the stratosphere is called the stratopause, which acts as a boundary between the stratosphere and the mesosphere.

The Mesosphere

The mesosphere is characterized by a decrease in temperature. The temperature will reach a low of -100 degrees Celsius at 275 000 feet ASL. It is in the mesosphere that meteorites will usually burn up.

The top of the mesosphere is known as the mesopause, which acts as a boundary between the mesosphere and the thermosphere.

The Thermosphere

The highest of the four layers, the thermosphere is so named due to its intense temperatures. This is the first layer to be affected by solar radiation and what few oxygen molecules there are in this layer will absorb a high amount of that radiation. The actual temperature will vary depending on solar activity, but it can exceed 15 000 degrees Celsius.

CONFIRMATION OF TEACHING POINT 2

QUESTIONS

Q1. Name the four layers of the atmosphere.

Q2. In which layer does most weather occur?

Q3. In which layer is the ozone layer found?

ANTICIPATED ANSWERS

A1. Troposphere, stratosphere, mesosphere, and thermosphere.

A2. The troposphere.

A3. The stratosphere.

Teaching Point 3	Explain International Civil Aviation Organization (ICAO) Standard Atmosphere
Time: 5 min	Method: Interactive Lecture

ICAO STANDARD ATMOSPHERE

The decrease in temperature, pressure and density with altitude is not constant, but varies with local conditions. For the purposes of aviation, it is required that an international standard be set. Different regions have different standards.

The Basis of ICAO Standards in North America

The ICAO standard for North America is based on the summer and winter averages for 40 degrees north latitude. These averages include air pressure, air density and air temperature.

The Assumptions for Standard Atmosphere in North America

ICAO standards for North America assume the following conditions:

- the air is a perfectly dry gas;
- a mean sea level pressure of 29.92 inches of mercury;
- a mean sea level temperature of 15 degrees Celsius; and
- temperature decreases with altitude at a rate of 1.98 degrees Celsius per 1 000 feet.

CONFIRMATION OF TEACHING POINT 3

QUESTIONS

Q1. Why is there an international standard atmosphere?

Q2. What is the basis for ICAO standard atmosphere in North America?

Q3. What are the four assumptions used in the ICAO standard atmosphere for North America?

ANTICIPATED ANSWERS

A1. The decrease in temperature, pressure and density with altitude is not constant, but varies with local conditions.

A2. The ICAO standard for North America is based on the summer and winter averages for 40 degrees north latitude.

A3. ICAO standards for North America assume the following conditions:

- the air is a perfectly dry gas;
- a mean sea level pressure of 29.92 inches of mercury;
- a mean sea level temperature of 15 degrees Celsius; and
- the rate at which temperature decreases with altitude is 1.98 degrees Celsius per 1 000 feet.

Teaching Point 4 — **Explain the Properties of the Atmosphere**

Time: 5 min — Method: Interactive Lecture

PROPERTIES OF THE ATMOSPHERE

The properties of the atmosphere allow for various weather conditions. There are three principle properties:

- **Mobility.** This property is the ability of the air to move from one place to another. This is especially important as it explains why an air mass that forms over the arctic may affect places in the south.
- **Capacity for Expansion.** The most important of the three properties. Air is forced to rise for various reasons. As the air pressure decreases, the air will expand and cool. This cooling may be enough for condensation to occur and clouds to form, creating precipitation.
- **Capacity for Compression.** The opposite of expansion, compression occurs when the air has cooled and becomes denser. The air will sink, decreasing in volume and increasing in temperature.

Factors Affecting the Properties of the Atmosphere

There are three factors which affect the properties of the atmosphere: temperature, density and pressure. Temperature changes air density which creates the vertical movement of the air, causing expansion and compression. The vertical movement creates pressure differences, which causes mobility across the surface as the air moves horizontally to fill gaps left by air that has moved vertically.

CONFIRMATION OF TEACHING POINT 4

QUESTIONS

Q1. What are the three properties of the atmosphere?

Q2. Which is the most important property of the atmosphere?

Q3. What are the three factors affecting the properties of the atmosphere?

ANTICIPATED ANSWERS

A1. Mobility, capacity for expansion and capacity for compression.

A2. Capacity for expansion.

A3. Temperature, density and pressure.

END OF LESSON CONFIRMATION

QUESTIONS

Q1. Name the four layers of the atmosphere.

Q2. Why is there an international standard atmosphere?

Q3. Which is the most important property of the atmosphere?

ANTICIPATED ANSWERS

A1. Troposphere, stratosphere, mesosphere, and thermosphere.

A2. The decrease in temperature, pressure, and density with altitude is not constant, but varies with local conditions.

A3. Capacity for expansion.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

This EO is assessed IAW A-CR-CCP-803/PG-001, Chapter 3, Annex B, Aviation Subjects – Combined Assessment PC.

CLOSING STATEMENT

Understanding why weather occurs will allow the cadet to anticipate what could happen to the flying conditions in the near future. This will be useful for all areas of life from flight planning to deciding whether or not to take an umbrella.

INSTRUCTOR NOTES/REMARKS

N/A.

REFERENCES

C3-116 (ISBN 0-9680390-5-7) MacDonald, A. F., & Peppler, I. L. (2000). *From the Ground Up: Millennium Edition*. Ottawa, ON: Aviation Publishers Co. Limited.

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ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL THREE

INSTRUCTIONAL GUIDE

SECTION 2

EO M336.02 – EXPLAIN THE FORMATION OF CLOUDS

Total Time:	30 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-803/PG-001, Chapter 4. Specific uses for said resources are identified throughout the instructional guide within the TP for which they are required.

Review the lesson content and become familiar with the material prior to delivering the lesson.

Create slides of Annexes B to I.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

An interactive lecture was chosen for this lesson to introduce the concepts of cloud formation.

INTRODUCTION

REVIEW

N/A.

OBJECTIVES

By the end of this lesson the cadet shall have explained the formation of clouds.

IMPORTANCE

It is important for cadets to know how clouds form as it will enhance their knowledge of meteorology and their ability to predict weather.

Teaching Point 1	**Explain Cloud Classification**
Time: 5 min	Method: Interactive Lecture

CLOUD CLASSIFICATION

Clouds are classified based on type of formation and cloud height.

Types of Formation

There are two main types of cloud formations:

Show slide of Annex B.

- **Cumulus.** Cumulus clouds are formed by air that is unstable. They are cottony or puffy, and are seen mostly during warmer seasons. Cumulus clouds may develop into storm clouds.

"Victoria Weather", by UVic, School-Based Weather Station Network.
Retrieved November 1, 2007, from http://www.victoriaweather.ca/clouds

Figure 13-2-1 Cumulus Cloud

- **Stratus.** Stratus clouds are formed in air that is stable. They are flat and can be seen year round, but are associated with colder temperatures.

Show slide of Annex C.

"Victoria Weather", by UVic, School-Based Weather Station Network.
Retrieved November 1, 2007, from http://www.victoriaweather.ca/clouds

Figure 13-2-2 Stratus Cloud

Cloud Height

Clouds are also classified based on their height above ground level (AGL). There are four main categories:

- **Low Clouds.** The bases of low clouds range from the surface to a height of 6 500 feet AGL. Low clouds are composed of water droplets and sometimes ice crystals. Low clouds use the word stratus as either a prefix (eg, stratocumulus) or a suffix (eg, nimbostratus).
- **Middle Clouds.** The bases of middle clouds range from 6 500 to 23 000 feet AGL. They are composed of ice crystals or water droplets, which may be at temperatures above 0 degrees Celsius. Middle clouds use the prefix of "alto" (eg, altocumulus).
- **High Clouds.** The bases of high clouds range from 16 500 to 45 000 feet, with an average of 25 000 feet in the temperate regions of the earth. High clouds are composed of ice crystals. High clouds use the prefix of "cirrus" or "cirro" (eg, cirrocumulus).
- **Clouds of Vertical Development.** The base of these clouds may be as low as 1 500 feet AGL and may rise as high as the lower reaches of the stratosphere. They may appear as isolated clouds or may be seen embedded in layers of clouds. Clouds of vertical development are associated with thunderstorms and other phenomena which occur during the summer months.

Show slide of Annex D.

The following chart includes a brief description of the more common cloud types.

Cloud Name	Cloud Family	Cloud Description
Cirrus	High	High, thin, wispy clouds blown by high winds into long streamers. Cirrus clouds usually move across the sky from west to east. They generally indicate pleasant weather.
Cirrocumulus	High	Appear as small, round white puffs. The small ripples in the cirrocumulus sometimes resemble the scales of a fish. A sky with cirrocumulus clouds is sometimes referred to as a “mackerel sky.”
Altocumulus	Middle	Appear as grey, puffy masses, sometimes in parallel waves or bands. The appearance of these clouds on a warm, humid summer morning often means thunderstorms will occur by late afternoon.
Altostratus	Middle	A grey or blue-grey layer cloud that typically covers the entire sky. In the thinner areas of the cloud, the sun may be dimly visible as a round disk. This cloud appears lighter than stratus clouds.
Stratus	Low	Uniform grey layer cloud that often covers the entire sky. They resemble fog that does not reach the ground. Usually no precipitation falls from stratus clouds, but sometimes they may drizzle.
Nimbostratus	Low	Dark grey layer clouds associated with continuously falling rain or snow. They often produce precipitation that is usually light to moderate.
Stratocumulus	Low	A series of rounded masses that form a layer cloud. This type of cloud is usually thin enough for the sky to be seen through breaks.
Cumulus	Vertical Development	Puffy clouds, which are thick, round, and lumpy. They sometimes look like pieces of floating cotton. They usually have flat bases and round tops.
Cumulonimbus	Vertical Development	Thunderstorm clouds that form if cumulus clouds continue to build. Violent vertical air currents, hail, lightning, and thunder are associated with the cumulonimbus clouds.

Director Cadets 3, 2007, Ottawa, ON: Department of National Defence

Figure 13-2-3 Common Clouds

CONFIRMATION OF TEACHING POINT 1

QUESTIONS

Q1. How are clouds classified?

Q2. What are the two types of cloud formations?

Q3. What are the four categories of cloud height?

ANTICIPATED ANSWERS

A1. By type of formation and height.

A2. Cumulus and stratus.

A3. Low clouds, middle clouds, high clouds and clouds of vertical development.

Teaching Point 2	**Explain Air Stability**
Time: 5 min	Method: Interactive Lecture

AIR STABILITY

At the surface, the normal flow of air is horizontal. Disturbances may occur, which will cause vertical currents of air to develop. This is normally caused by a change in temperature. If the air that is displaced resists the change, then it is said to be stable. If it does not resist the change then it is unstable. When air rises, it expands and cools.

Stable Air. If a mass of rising air is cooler than the air that it comes in contact with, then it will sink back to its original position. Stable air may have the following affects on flight characteristics:

- poor low-level visibility (fog may occur),
- stratus type cloud,
- steady precipitation,
- steady winds, which can change greatly with height, and
- smooth flying conditions.

Unstable Air. If a mass of rising air is still warmer than the new air around it, then the air mass will continue to rise. Unstable air may have the following affects on flight characteristics:

- good visibility (except in precipitation),
- cumulus type cloud,
- showery precipitation,
- gusty winds, and
- moderate to severe turbulence.

CONFIRMATION OF TEACHING POINT 2

QUESTIONS

Q1. What may create vertical currents?

Q2. What is stable air?

Q3. What is unstable air?

ANTICIPATED ANSWERS

A1. A change in temperature.

A2. When a mass of rising air is cooler than the air that it comes in contact with, then it will sink back to its original position.

A3. When a mass of rising air is warmer than the new air around it, then the air mass will continue to rise.

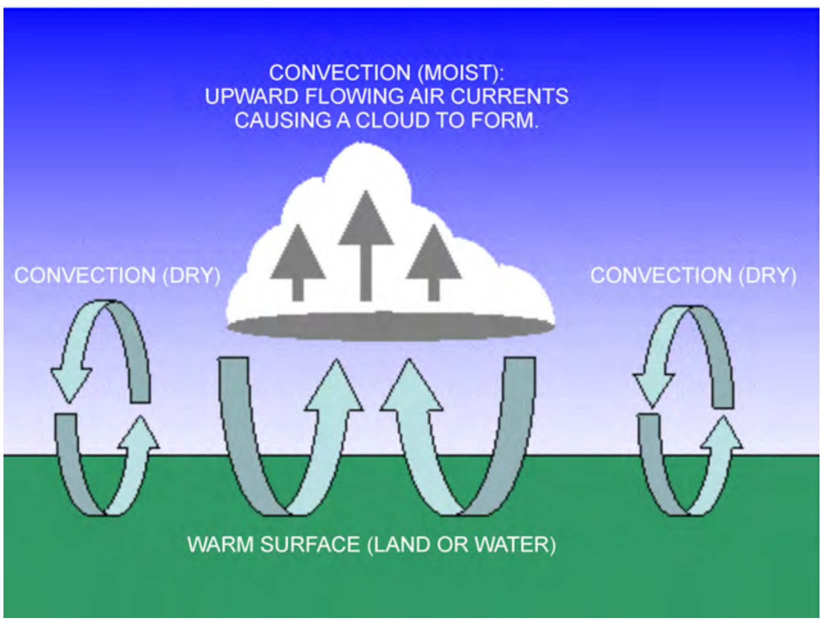
Teaching Point 3	**Explain Lifting Agents**
Time: 10 min	Method: Interactive Lecture

LIFTING AGENTS

Rising currents of air affect many weather conditions. There are five conditions that provide the lift required to initiate rising currents of air.

Show slides of Annexes E to I as applicable.

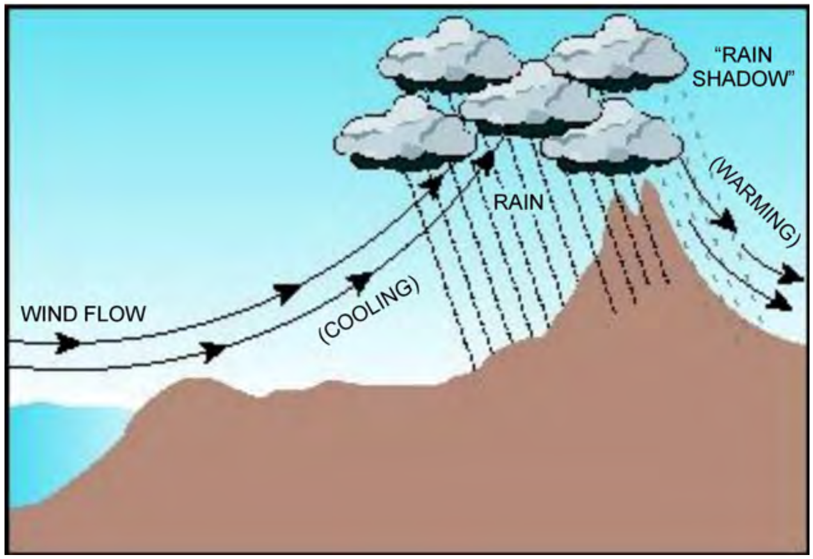
Convection. The air is heated through contact with the earth's surface. As the sun heats the surface of the earth, the air in contact with the surface warms up, rises, and expands. Convection may also occur when air moves over a warmer surface and is heated by advection.



WeatherQuestions.com, 2007, What is Convection. Copyright 2007 by WeatherStreet. Retrieved March 17, 2008, from http://www.weatherquestions.com/What_is_convection.htm

Figure 13-2-4 Convection

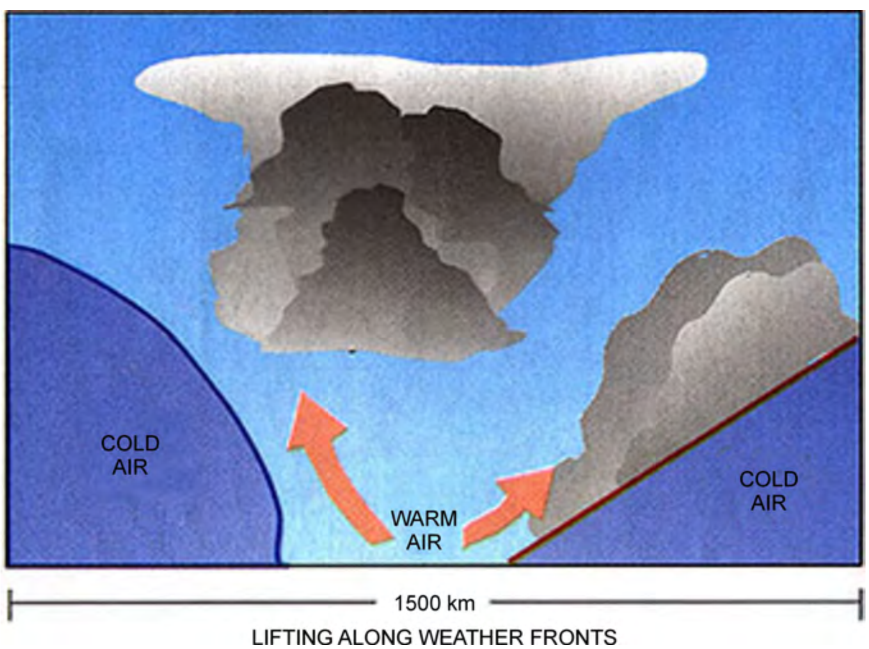
Orographic Lift. Orographic lift occurs when the sloping terrain forces the air upward. This process can be exaggerated if the air mass is already.



Water Encyclopedia, by G. H. Taylor, 2007, Water as a Climate Moderator. Copyright 2007 by Advameg. Retrieved March 17, 2008, from http://www.waterencyclopedia.com/Ce-Cr/Climate-Moderator-Water-as-a.html

Figure 13-2-5 Orographic Lift

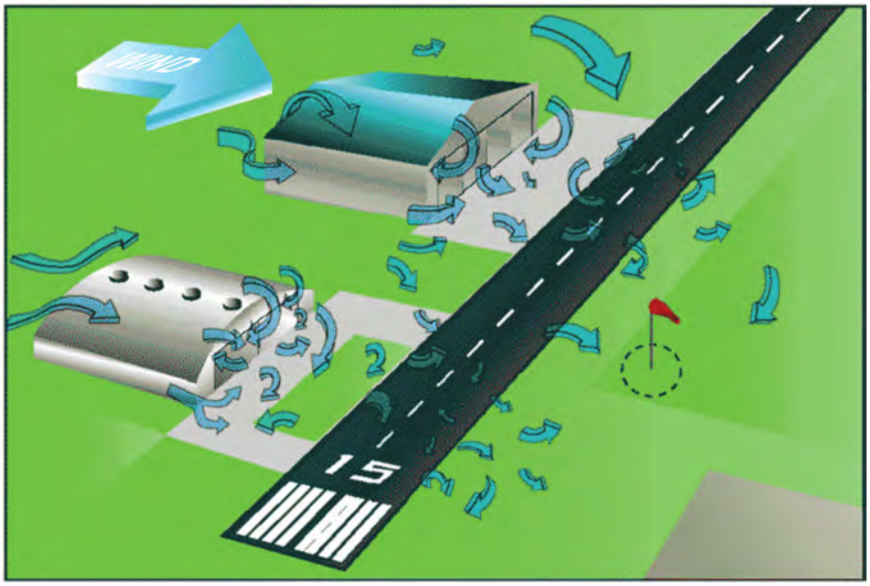
Frontal Lift. When different air masses meet, the warmer air is forced upwards by the denser cold air. This process may be exaggerated if the warm air mass becomes unstable.



Federation of American Scientists, by N. M. Short, Sr, 2007, Atmospheric Circulation: Weather Systems. Copyright 2007by FAS. Retrieved March 17, 2008, from http://www.fas.org/irp/imint/docs/rst/Sect14/Sect14_1c.html

Figure 13-2-6 Frontal Lift

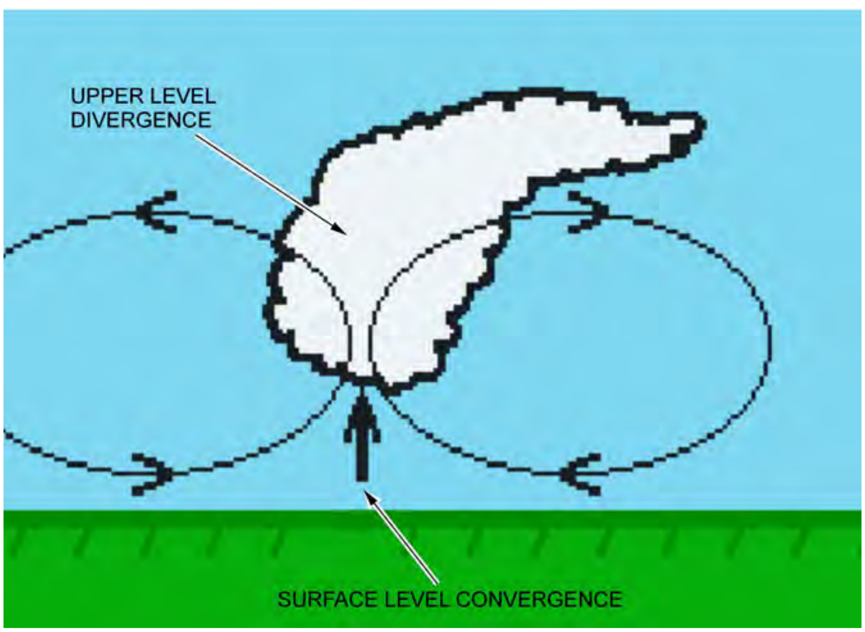
Mechanical Turbulence. Air moving over the ground may be affected by terrain that is not as pronounced as mountains. Forests, buildings, large ditches and quarries also affect the air through friction. This friction causes eddies, which are usually confined to the first few thousand feet of the troposphere. This process may be exaggerated if the air mass becomes or is already unstable.



Free Online Private Pilot Ground School, 2006, Aviation Weather–Principles. Copyright 2006. Retrieved March 17, 2008, from http://www.free-online-private-pilot-ground-school.com/Aviation-Weather-Principles.html

Figure 13-2-7 Mechanical Turbulence: Man-Made

Convergence. In a low pressure system, the wind blows toward the centre of the system. The excess air that collects here is forced upward to higher altitudes.



The Weather Doctor, by K. C. Heidron, PhD, 2002, What Goes Up: Part 3 Convergence and Divergence. Retrieved March 17, 2008, from http://www.islandnet.com/~see/weather/elements/whatgoesup3.htm

Figure 13-2-8 Convergence

CONFIRMATION OF TEACHING POINT 3

QUESTIONS

Q1. Explain how convection (as a source of lift) occurs.

Q2. Explain orographic lift.

Q3. Explain frontal lift.

ANTICIPATED ANSWERS

A1. Convection is caused by heating of the air that is in contact with the surface of the earth.

A2. Orographic lift occurs when the sloping terrain forces the air upward.

A3. When different air masses meet, the warmer air is forced upward by the denser cold air. This process may be exaggerated if the warm air mass becomes unstable.

Teaching Point 4	Describe Cloud Formation
Time: 5 min	Method: Interactive Lecture

CLOUD FORMATION

Clouds are formed by the lifting agents and air stability.

Clouds are formed in two ways. Either the temperature drops to the saturation point of the air or the temperature is constant but the amount of water in the air increases.

Relating Lifting Agents to Air Stability

Each of the lifting agents described have an effect on, or is affected by, air stability. Convection, for example, is normally associated with unstable air since heat causes the convection, and is also a source of instability in the air.

Another example would be orographic lift, which is usually associated with stable air. After the air has been forced up by the terrain, it cools and becomes dense. The effect is similar to positive stability in an airplane.

Relating Air Stability to Types of Formation

Air stability will have a direct affect on cloud formation. Clouds created in stable air will form as stratus-type clouds. Clouds formed in unstable air will form as cumulus-type clouds.

CONFIRMATION OF TEACHING POINT 4

QUESTIONS

Q1. What are the two ways in which a cloud forms?

Q2. How does orographic lift relate to air stability?

Q3. What cloud type will form in stable air?

ANTICIPATED ANSWERS

A1. Either the temperature drops to the saturation point of the air or the temperature is constant but the amount of water in the air increases.

A2. After the air has been forced up by the terrain, it cools and becomes dense. The effect is similar to positive stability in an airplane.

A3. Clouds created in stable air will form as stratus-type clouds.

END OF LESSON CONFIRMATION

QUESTIONS

Q1. What are the two types of cloud formation?

Q2. Define unstable air.

Q3. What cloud type will form in unstable air?

ANTICIPATED ANSWERS

A1. Cumulus and stratus.

A2. When a mass of rising air is warmer than the new air around it, then the air mass will continue to rise.

A3. Clouds created in unstable air will form as cumulus-type clouds.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

This EO is assessed IAW A-CR-CCP-803/PG-001, Chapter 3, Annex B, Aviation Subjects – Combined Assessment PC.

CLOSING STATEMENT

Knowing how a cloud is formed will help predict the weather conditions that may exist. Conversely, knowing the weather conditions will assist in determining what clouds will form later in the day, and it may be possible to predict what the weather for the day will be.

INSTRUCTOR NOTES/REMARKS

N/A.

REFERENCES

A3-044 CFACM 2-700 Air Command. (2001). *Air Command Weather Manual*. Ottawa, ON: Department of National Defence.

C3-116 (ISBN 0-9680390-5-7) MacDonald, A. F., & Peppler, I. L. (2000). *From the Ground Up: Millennium Edition*. Ottawa, ON: Aviation Publishers Co. Limited.

ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL THREE

INSTRUCTIONAL GUIDE

SECTION 3

EO M336.03 – EXPLAIN THE EFFECTS OF AIR PRESSURE ON WEATHER

Total Time:	30 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-803/PG-001, Chapter 4. Specific uses for said resources are identified throughout the instructional guide within the TP for which they are required.

Review the lesson content and become familiar with the material prior to delivering the lesson.

Create slides of Annexes J to O.

Photocopy handouts of Annex P for each cadet.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

An interactive lecture was chosen for this lesson to introduce the cadets to the effects of air pressure.

INTRODUCTION

REVIEW

N/A.

OBJECTIVES

By the end of this lesson the cadet shall have explained the effects of air pressure on weather.

IMPORTANCE

It is important for cadets to explain the effects of air pressure on weather in order to appreciate patterns of weather and the movement of air.

Teaching Point 1 | **Explain the Polar Front Theory**

Time: 10 min | Method: Interactive Lecture

Certain terms used in this document are meant to be relative; they may not necessarily have a fixed value. For example, low pressure system does not necessarily mean that the pressure of the air is lower than mean sea level. It means that the air pressure in that system is lower than the air pressure around the system.

POLAR FRONT THEORY

The Polar Front theory was conceived by Norwegian meteorologists, who claimed that the interaction between the consistently high pressure area over the Arctic (and Antarctic) and the relatively lower pressure areas over the lower latitudes may provide force to the movement of air.

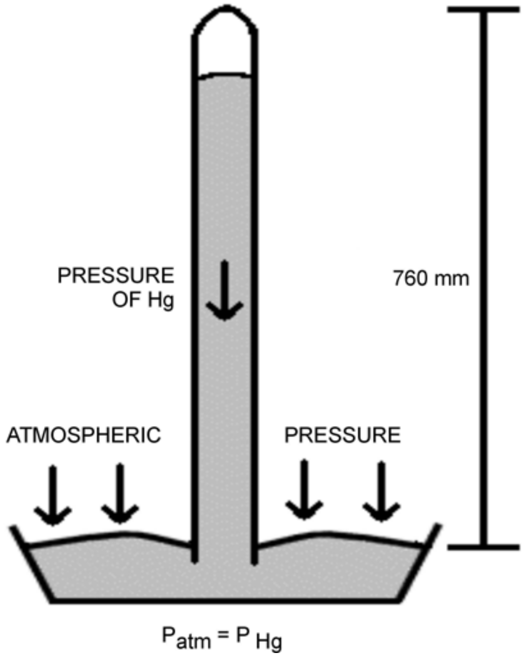
Definition of Atmospheric Pressure

Show slide of Annex J.

Atmospheric Pressure. The pressure of the atmosphere at any point due to the weight of the overlying air. Pressure at the surface of the earth is normally measured using a mercury barometer and is expressed in mm of mercury (mm Hg) or inches of mercury ("Hg). The barometer is essentially an upside-down graduated, test tube that is partially immersed in a bowl of mercury. As the pressure of the air over the bowl increases, the mercury is forced further up the test tube, providing a higher reading.

Pressure is a force and, in meteorological work, it is common to use hectopascals (hPa) to measure pressure. One hectopascal is 1 000 dynes (a unit of force) of force exerted on a 1 cm^2 area.

The average pressure of the atmosphere at sea level is normally expressed as 760 mm Hg (29.92 "Hg), which is the same as 1013.2 hPa. Public radio and television weather broadcasts (such as the Weather Network or Environment Canada) will express pressure in kilopascals (kPa). One kPa is equal to 10 hPa, so that 1013.2 hPa would be equal 101.32 kPa.



Chemistry Tutorial Notes, Department of Chemistry, Texas A&M University, 2006, Properties of Gases, Copyright 2006 by Texas A&M University. Retrieved April 4, 2008 from http://www.chem.tamu.edu/class/majors/tutorialnotefiles/pressure.htm

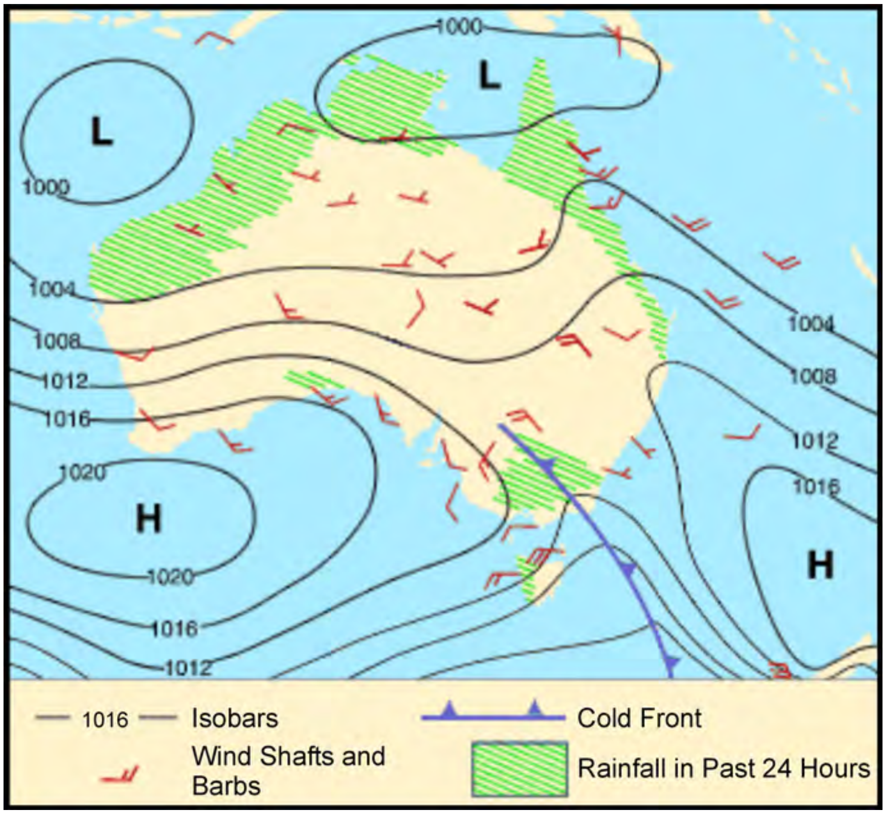
Figure 13-3-1 Barometer

Pressure Systems

There are pressure reading stations all over North America. Each station will send its readings to a main forecasting office, which will plot the information on a weather map.

Show slide of Annex K.

- **Isobars.** Areas of like pressure are joined by lines called isobars (from Greek *isos* [same] and *baros* [weight]). On a weather map, isobars will look similar to contour lines found on a topographical map. The isobars form roughly concentric circles, each circle being four hPa different than the circles before and after it. Groups of isobars will indicate areas of relatively high pressure, or relatively low pressure.



Australian Government, Bureau of Meteorlogy, 2008, Air Masses and Weather Maps, Copyright 2008 by Commonwealth of Australia, Bureau of Meteorology. Retrieved April 7, 2008 from http://www.bom.gov.au/info/ftweather/page_7.shtml

Figure 13-3-2 Isobars on a Weather Map

- **Low Pressure Areas.** Low pressure areas (often called lows, cyclones, or depressions) are areas of relatively lower pressure, with the lowest pressure in the centre. Lows will normally move in an easterly direction at an average rate of 800 km per day during the summer and 1 100 km per day in the winter. Lows are associated with thunderstorms and tornadoes, and do not stay in one place for very long. In the northern hemisphere, air moves around a low pressure in a counter-clockwise direction.
- **High Pressure Areas.** High pressure areas (often called anti-cyclones) are areas of relatively higher pressure, with the highest pressure in the centre. Winds are usually light and variable. High pressure areas move very slowly, sometimes staying stationary for days at a time. In the northern hemisphere, air moves around a high in a clockwise direction.

An Air Mass Over the Polar Regions

Polar air is typically cold and dry.

An Air Mass Over the Equatorial Regions

The air over the equator is tropical, therefore warm and moist.

Movement at the Polar Front

The transition zone between the polar air and the equatorial air is known as the polar front. Due to the differences in the properties of the two air masses, many depressions (low pressure areas) form along the polar front. The cold air moves from north-east to south-west in the northern hemisphere, while the warm air moves in the opposite direction. The result is constant instability as the cold air bulges south and the warm air bulges north. The cold air moves faster than the warm air and eventually envelopes it.

The movement of the air at the polar front is thought to be a cause for the circulation of air in the troposphere.

CONFIRMATION OF TEACHING POINT 1

QUESTIONS

Q1. What is a hectopascal?

Q2. Which direction does the air move around a low pressure in the northern hemisphere?

Q3. What is the transition zone between the polar air and the tropical air known as?

ANTICIPATED ANSWERS

A1. One hectopascal is 1 000 dynes of force exerted on a 1 cm^2 area.

A2. Counter-clockwise.

A3. Polar front.

Teaching Point 2	**Explain That the Properties (eg, Pressure) of an Air Mass are Taken From the Area Over Which it Forms**
Time: 5 min	Method: Interactive Lecture

PROPERTIES OF AN AIR MASS

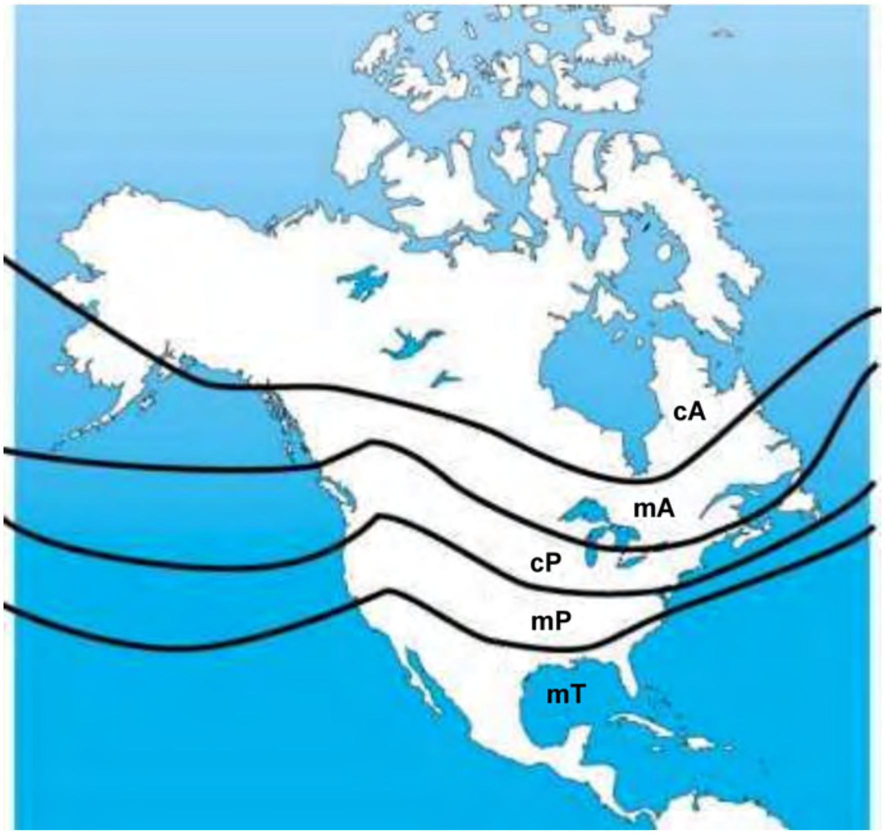
Weather forecasts used to be based solely on the existence and movement of pressure systems. Meteorologists currently base their predictions on the properties of air masses, of which pressure is only one factor.

An air mass may be defined as a large section of the troposphere with uniform properties of temperature and moisture along the horizontal plane. This means that if a horizontal cross-section was taken of an air mass, one would see layers within the air mass where the temperature and the amount of moisture would be the same throughout.

An air mass will take on the properties of the surface over which it has formed. An air mass, which has formed over the Arctic would be cold and dry, while one, which formed over the Gulf of Mexico would be warm and moist.

Air masses may be described as:

- **Continental Air Mass.** Since the air mass formed over land, this will be a dry air mass.
- **Maritime Air Mass.** Since the air mass formed over water, this will be a moist air mass.
- **Arctic Air Mass.** Since the air mass formed over the Arctic, this will be a cold air mass.
- **Polar Air Mass.** Since the air mass formed over the Polar region, this will be a cool air mass.
- **Tropical Air Mass.** Since the air mass formed over the Tropical region, this will be a warm air mass.



Meteorological Service of Canada, 2004, Frontal Systems, Copyright 2004 by Environment Canada. Retrieved April 7, 2008 from http://www.qc.ec.gc.ca/meteo/Documentation/Front_e.html

Figure 13-3-3 North American Air Masses

Show slide of Annex L.

These types of air masses are usually combined to describe the properties of temperature and moisture. For example, over Atlantic Canada one might find a maritime polar air mass, which will be cool and moist. Meanwhile prairie winters usually see continental polar or continental arctic, which will be either cool and dry or cold and dry. The five air masses in North America indicated in Figure 13-3-3 include:

- Continental Arctic (cA),
- Maritime Arctic (mA),
- Continental Polar (cP),
- Maritime Polar (mP), and
- Maritime Tropical (mT).

CONFIRMATION OF TEACHING POINT 2

QUESTIONS

Q1. What is the definition of an air mass?

Q2. Where does an air mass obtain its properties from?

Q3. What are five air masses in North America?

ANTICIPATED ANSWERS

A1. An air mass may be defined as a large section of the troposphere with uniform properties of temperature and moisture along the horizontal plane.

A2. An air mass will take on the properties of the surface over which it has formed.

A3. Continental air mass, maritime air mass, arctic air mass, polar air mass, and tropical air mass.

Teaching Point 3	**Explain the Creation of Wind**
Time: 5 min	Method: Interactive Lecture

WIND

Wind is a major factor in flight planning and flight characteristics. Pilots must constantly be aware of the direction and speed of wind during all parts of the flight, but especially during the landing sequence.

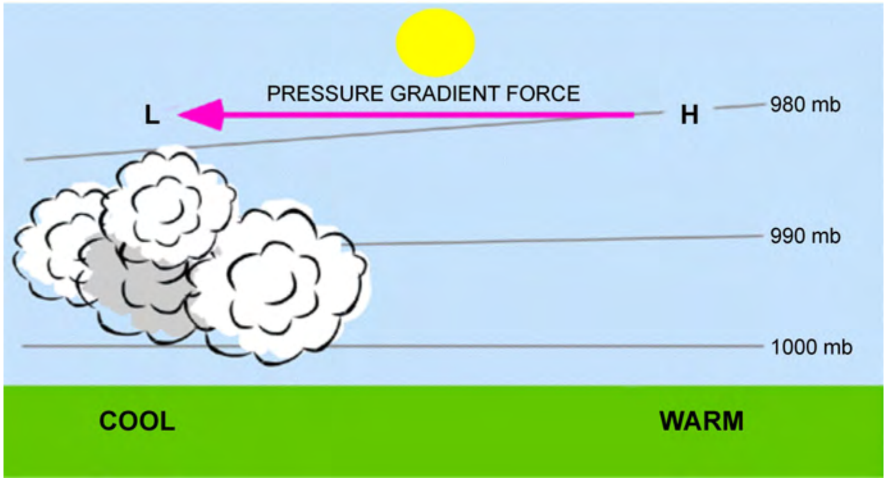
The Definition of Wind

Wind. The horizontal movement of air within the atmosphere. Wind normally moves parallel to the isobars of a pressure system. Since isobars are not straight lines, this means that the wind direction will vary at different locations along the pressure system. Wind also moves in different directions based on whether the pressure is a low or high system.

Show slide of Annex M.

Pressure Gradient

The pressure gradient is the rate of change of pressure over a given distance measured at right angles to the isobars. If the isobars are very close together, the rate of change will be steep and the wind speed will be strong. If the isobars are far apart, the rate of change will be shallow and the wind speed will be weak.



PhysicalGeography.net, Dr. M. Pidwirny, University of British Columbia Okanagan, 2007, Introduction to the Atmosphere, Copyright 2007 by M. Pidwirny. Retrieved April 7, 2008 from http://www.physicalgeography.net/fundamentals/7o.html

Figure 13-3-4 Pressure Gradient

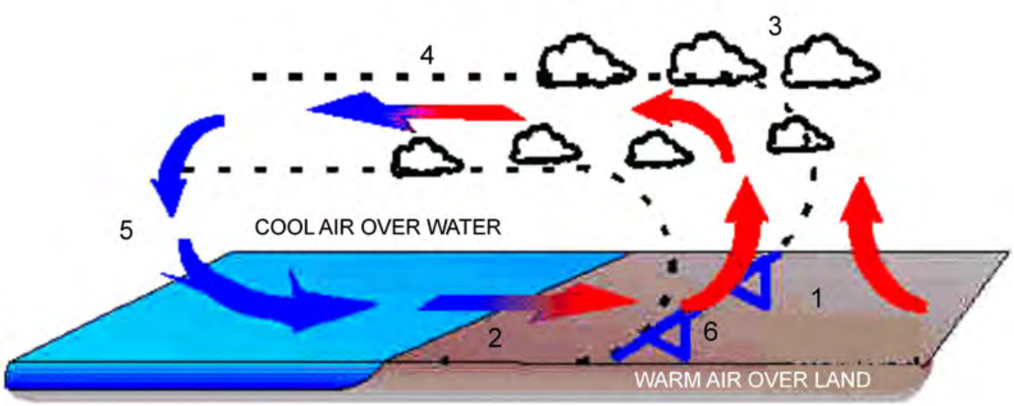
Land and Sea Breezes

Land and sea breezes are caused by the differences in temperature over land and water.

Show slides of Annexes N and O.

Note that the term breeze is used here as a technical term and has no bearing on wind strength.

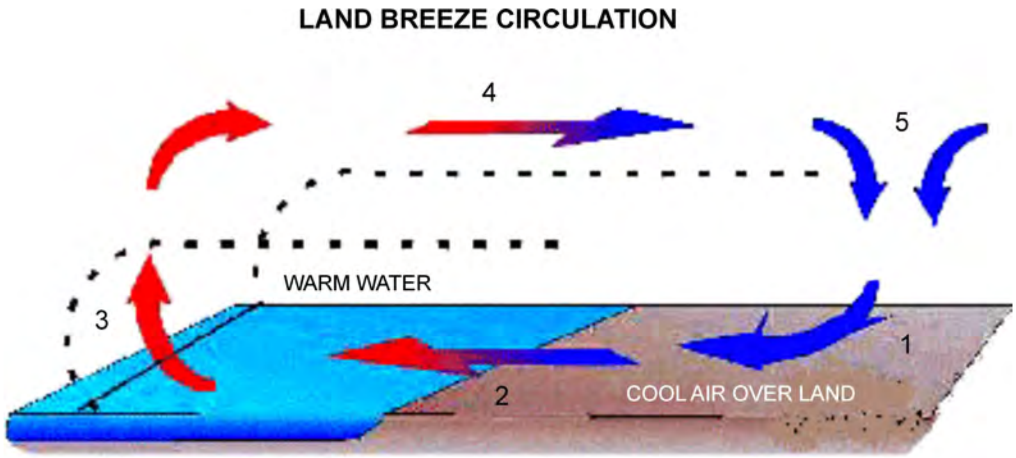
The sea breeze occurs during the day when the land heats up more rapidly than the water. This creates a lower pressure area over the land. The pressure gradient caused by this change is usually steep enough to create a wind from the water.



The Weather Doctor, K. C. Heidron, PhD, 1993, Sea and Land Breezes, Copyright 1998 by K. C. Heidron PhD. Retrieved April 7, 2008 from http://www.islandnet.com/~see/weather/elements/seabrz.htm

Figure 13-3-5 Sea Breeze

The land breeze occurs at night when the land cools down faster than the water. This creates a higher pressure over the land. The pressure gradient now moves the air from the land to the water.



The Weather Doctor, K. C. Heidron, PhD, 1993, Sea and Land Breezes, Copyright 1998 by K. C. Heidron PhD. Retrieved April 7, 2008 from http://www.islandnet.com/~see/weather/elements/seabrz.htm

Figure 13-3-6 Land Breeze

Land and sea breezes are local and affect a small area only.

Diurnal Variation

Surface winds are generally stronger during the day than at night. This is due to the heating processes, which occur during the day, creating vertical currents and pressure gradients. At night, when the heating processes cease, the vertical currents diminish and the pressure gradients become shallower.

Coriolis Force

As air moves from a high pressure system to a low pressure system, the air will not flow directly from one to the other. The rotation of the earth causes a deflection to the right (in the northern hemisphere). This force is known as Coriolis Force. Coriolis Force also explains why air moves clockwise around a high, and counter-clockwise around a low pressure system.

Veering and Backing

Veering is a change in wind direction clockwise relative to the cardinal points of a compass while backing is a change in wind direction counter-clockwise. For example, when the wind veers it will increase in direction from 090 degrees to 100 degrees; when it backs it will decrease in direction from 100 degrees to 090 degrees.

Veering and backing normally occur with changes in altitude. An increase in altitude will normally see a veer in wind direction and an increase in wind speed. A decrease in altitude will normally see a backing in wind direction and a decrease in wind speed. These changes are due to an increase in friction with the surface of the earth in the lower altitudes, and a decrease is friction in the higher altitudes.

CONFIRMATION OF TEACHING POINT 3

QUESTIONS

Q1. Define pressure gradient.

Q2. Why do sea breezes occur?

Q3. What is veering?

ANTICIPATED ANSWERS

A1. Pressure gradient is the rate of change of pressure over a given distance measured at right angles to the isobars.

A2. Sea breezes occur during the day when the land heats up more rapidly than the water, creating a lower pressure over the land.

A3. Veering is a change in wind direction clockwise relative to the cardinal points of a compass.

Teaching Point 4	Explain the Relationship Between Pressure Systems, and Wind Strength and Direction
Time: 5 min	Method: Interactive Lecture

RELATIONSHIP BETWEEN PRESSURE SYSTEMS AND WIND

Pressure and wind are interrelated, with one being the cause of the other.

Low Pressure Areas

Low pressure areas are the cause of all air movement as described by the Polar Front theory. Wind blows in a counter-clockwise direction around the low, and inwards to the centre of the system. Wind tends to be strong in a low as the pressure gradient is relatively steep causing the system to move fast over the ground. Low pressure systems are generally associated with brief periods of poor weather, as the inward flow of air acts as a vacuum.

High Pressure Areas

The wind in a high pressure areas blows in a clockwise direction around the high and outwards from the centre of the system. Wind tends to be weak in a high as the pressure gradient is normally relatively shallow causing the system to move slowly over the ground. High pressure systems are usually associated with fair weather, as the outward flow of air acts as a shield against bad weather.

CONFIRMATION OF TEACHING POINT 4

QUESTIONS

Q1. What direction does the wind blow around a low pressure system in the northern hemisphere?

Q2. What direction does the wind blow around a high pressure system in the northern hemisphere?

ANTICIPATED ANSWERS

A1. Counter-clockwise and inwards.

A2. Clockwise and outwards.

END OF LESSON CONFIRMATION

QUESTIONS

Q1. What is the transition zone between the polar air and the tropical air known as?

Q2. What is the definition of an air mass?

Q3. Why do sea breezes occur?

ANTICIPATED ANSWERS

A1. Polar front.

A2. An air mass may be defined as a large section of the troposphere with uniform properties of temperature and moisture along the horizontal plane.

A3. Sea breezes occur during the day when the land heats up more rapidly than the water, creating a lower pressure over the land.

Distribute handout of Annex P.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

This EO is assessed IAW A-CR-CCP-803/PG-001, Chapter 3, Annex B, Aviation Subjects – Combined Assessment PC.

CLOSING STATEMENT

Air pressure has a significant affect on weather around the world. Low pressure systems create movement of air, which circulates the air masses around the world. The air masses are the source of the actual weather conditions that we are exposed to.

INSTRUCTOR NOTES/REMARKS

N/A.

REFERENCES

C3-116 (ISBN 0-9680390-5-7) MacDonald, A. F., & Peppler, I. L. (2000). *From the Ground Up: Millennium Edition*. Ottawa, ON: Aviation Publishers Co. Limited.

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ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL THREE

INSTRUCTIONAL GUIDE

SECTION 4

EO M336.04 – EXPLAIN THE EFFECTS OF HUMIDITY AND TEMPERATURE ON WEATHER

Total Time: 60 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-803/PG-001, Chapter 4. Specific uses for said resources are identified throughout the instructional guide within the TP for which they are required.

Review the lesson content and become familiar with the material prior to delivering the lesson.

Gather the resources required for the in-class activity in TP 3.

Create slides of Annex Q.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

An interactive lecture was chosen for TPs 1, 2, 4, and 5 to introduce temperature, humidity and precipitation to the cadets.

An in-class activity was chosen for TP 3 as an interactive way to provoke thought about temperature and humidity.

INTRODUCTION

REVIEW

N/A.

OBJECTIVES

By the end of this lesson the cadet shall be expected to explain the effects of temperature and humidity on weather.

IMPORTANCE

It is important for cadets to be able to explain the effects of temperature and humidity on weather as it will allow the cadet to make more informed decisions about activities in the field, in aviation or whether to wear a raincoat.

Teaching Point 1	**Explain Humidity**
Time: 10 min	Method: Interactive Lecture

HUMIDITY

Humidity is a representation of the moisture or water vapour, which is present in an air mass. While water vapour is a small percentage of the overall atmosphere, it is the only gas which can change into a solid or a liquid in ordinary atmospheric conditions. It is this characteristic which causes most weather to develop.

The moisture in an air mass originates from a body of water over which the air mass forms or passes. This body of water may be a pond or an ocean. The size of the body of water determines how much water is available for the air mass to collect, while the rate of evaporation will determine how much of that water is collected by the air mass. Water may exist in the atmosphere in two forms: invisible (gaseous) or visible (water droplets [liquid] or ice crystals [solid]).

Condensation

Condensation is a process by which a gas changes into a liquid by becoming denser. This is usually caused by a cooling process. The air is cooled to a certain temperature at which the water vapour will condense into water.

Sublimation

Sublimation is a process by which a gas changes into a solid without first becoming a liquid. This is usually caused by freezing. Sublimation occurs whenever snow, ice or hail fall from the sky. This process usually occurs in the winter, but may occur during exceptional summer storms.

Dew Point

Dew point is the temperature to which unsaturated air must be cooled, at a constant pressure, in order to become saturated. The temperature and dew point are responsible for the creation of clouds and precipitation. If the difference between the temperature and the dew point is small, then the air is considered to be nearly saturated and a small drop in temperature will see the formation of clouds or precipitation.

Relative Humidity

Relative humidity is the ratio of the actual amount of water present in the air compared to the amount of water which the same volume of air would hold if it were saturated. Temperature and pressure must remain the same, otherwise the relative humidity will change. Saturated air will have a relative humidity of 100 percent, while perfectly dry air will have a relative humidity of zero percent.

CONFIRMATION OF TEACHING POINT 1

QUESTIONS

Q1. Define condensation.

Q2. Define dew point.

Q3. Define relative humidity.

ANTICIPATED ANSWERS

A1. Condensation is a process by which a gas changes into a liquid by becoming denser.

A2. Dew point is the temperature to which unsaturated air must be cooled, at a constant pressure, in order to become saturated.

A3. Relative humidity is the ratio of the actual amount of water present in the air compared to the amount of water which the same volume of air would hold if it were saturated.

Teaching Point 2	**Explain Temperature**
Time: 15 min	Method: Interactive Lecture

TEMPERATURE

Temperature represents the amount of heat in a given object, such as the human body or air. Temperature is measured using a thermometer. In aviation weather reports, temperature is normally expressed in degrees Celsius.

The Source

The source of the energy which warms the earth and its atmosphere is the sun. Solar radiation is transmitted to the earth and its atmosphere. Some of the solar radiation is absorbed by the stratosphere, while the rest passes through to be absorbed by the earth's surface. The earth then radiates heat into the troposphere through terrestrial radiation. It is terrestrial radiation that heats the troposphere, and is why the further one gets from the surface of the earth, the lower the temperature will be in the troposphere.

The atmosphere is heated from below not from above.

Diurnal Variation

During the day, the solar radiation exceeds the terrestrial radiation and the surface of the earth becomes warmer. At night, solar radiation ceases, and the terrestrial radiation causes the surface of the earth to cool. This is called diurnal variation and causes the heating and cooling of the atmosphere.

Seasonal Variation

The axis around which the earth rotates is tilted compared to the plane of orbit around the sun. The result is that the amount of solar radiation that strikes the surface of the earth varies from season to season. In the northern hemisphere, the months of June, July, and August are warm, while the months of December, January, and February are cold.

The Heating Process

Air is a poor conductor of heat. The following are four processes which assist in getting warm air into the higher levels of the atmosphere:

- **Convection.** Air over a warm surface becomes buoyant and rises, allowing cooler air to move into the vacant location. This vertical current of air distributes the heat to the higher levels.
- **Advection.** Horizontal movement of cool air over a warm surface allows the cool air to be heated from below.
- **Turbulence.** Turbulence created as the result of friction with the surface of the earth causes a mixing process which moves the heated air to other areas of the atmosphere.
- **Compression.** There are instances where air masses are forced down, such as air moving down the leeward side of a mountain. The air pressure increases as the air mass moves further down, compressing the air mass. This compression forces the particles together, creating heat. This phenomenon is also called subsidence.

The Cooling Process

Since the atmosphere is heated from below, the temperature usually decreases with altitude. The rate of temperature change is known as a lapse rate. The lapse rate is only a guideline as there is a variation in air masses and cooling processes. The following are three main cooling processes:

- **Radiation Cooling.** At night the temperature of the earth decreases with terrestrial radiation and cools the air in contact with the ground. Radiation cooling only affects the lower few thousand feet of the atmosphere.
- **Advection Cooling.** Air from a warm region moves over a cold region and cools the air.
- **Adiabatic Process.** As air is warmed it will begin to rise and as it rises it will expand and cool. In a rising current of air, the temperature decreases at a rate that is entirely independent of the surrounding, non-rising air.

CONFIRMATION OF TEACHING POINT 2

QUESTIONS

Q1. How is the atmosphere heated?

Q2. Identify the four heating processes.

Q3. Identify the three cooling processes.

ANTICIPATED ANSWERS

A1. The atmosphere is heated from below not from above.

A2. Convection, advection, turbulence, and compression.

A3. Radiation cooling, advection cooling, and adiabatic process.

Teaching Point 3 **Describe the Effects of Temperature on Relative Humidity**

Time: 10 min Method: In-Class Activity

THE EFFECTS OF TEMPERATURE ON RELATIVE HUMIDITY

Temperature will affect the relative humidity of an air mass by changing the volume of the air mass.

As the temperature of the air mass increases, the air mass will expand increasing the volume of the mass. The result is that the relative humidity will decrease, as the air mass has a higher capacity for water. This assumes that there is no change in the amount of water in the air mass.

As the temperature of the air mass decreases, the air mass will contract, decreasing the volume of the mass. The result is that the relative humidity will increase, as the air mass has a lower capacity for water. This assumes that there is no change in the amount of water in the air mass.

ACTIVITY

OBJECTIVE

The objective of this activity is to illustrate the effects of temperature on relative humidity.

RESOURCES

- Water,
- Paper towel,
- One small plastic cup per cadet, and
- One large plastic cup per cadet.

ACTIVITY LAYOUT

N/A.

ACTIVITY INSTRUCTIONS

1. Distribute one small cup and one large cup to each cadet.
2. Fill each small cup three quarters full of water. This will represent an air mass with a relative humidity of 75 percent.
3. Have the cadet pour the water from the small cup into the large cup. The large cup represents the results of increasing the temperature of the air mass.
4. Have the cadets estimate the percentage of the large cup which now contains water.
5. Fill the large cup of water to 80 percent. This will represent the continued evaporation of water from all sources into the air mass.
6. Have the cadets pour the large cup into the small cup. This will represent the results of cooling the air mass to the dew point. The water that does not fit into the small cup is the precipitation.
7. Have the cadets clean up the water.

SAFETY

N/A.

CONFIRMATION OF TEACHING POINT 3

The cadets' participation in the relative humidity activity will serve as the confirmation of this TP.

Teaching Point 4	**Explain the Effects of Temperature and Humidity on Weather**
Time: 5 min	Method: Interactive Lecture

THE EFFECTS OF TEMPERATURE AND HUMIDITY ON WEATHER

Temperature and humidity have a major effect on the weather. Together they will determine cloud formation and precipitation.

Dew Point

The temperature of the air mass will change during the heating and cooling processes. As the temperature nears the dew point, the air will become more saturated. This increases the relative humidity and allows clouds to form.

Relative Humidity

As the relative humidity increases, the weight of the air mass also increases. When the dew point is reached, the air will become saturated, and clouds will form. Once the air mass has reached 100 percent relative humidity, any addition of water or drop in temperature will cause precipitation.

Precipitation

Precipitation may be solid or liquid, depending on the temperature of the air mass. Snow will occur if the air mass has a temperature below freezing. Rain will occur in an air mass which has a temperature above freezing. The temperature in the air mass will change with altitude, so that the water may freeze at higher levels of the air mass. Frozen precipitation such as hail and even snow has been seen in the summer months.

CONFIRMATION OF TEACHING POINT 4

QUESTIONS

Q1. What is the effect of dew point on weather?

Q2. How does relative humidity affect the creation of precipitation?

Q3. How is it possible for hail or snow to occur in the summer months?

ANTICIPATED ANSWERS

A1. As the temperature nears the dew point, the air will become more saturated.

A2. Once the air mass has reached 100 percent relative humidity, any addition of water or drop in temperature will cause precipitation.

A3. The temperature in the air mass will change with altitude, so water may freeze at higher levels of the air mass.

Teaching Point 5	**Explain Types of Precipitation**
Time: 10 min	Method: Interactive Lecture

TYPES OF PRECIPITATION

Show slides of figures located at Annex Q.

There are seven main categories of precipitation listed by the World Meteorological Organization (WMO). Each one is created depending on temperature and cloud type. Types of precipitation include:

- **Drizzle.** Precipitation in the form of small water droplets which appear to float. In temperatures near freezing, water droplets may freeze on contact with objects. This is known as freezing drizzle.

- **Rain.** Precipitation in the form of large water droplets. Freezing rain will occur when water droplets, which have retained their liquid form in freezing conditions, make contact with an object and freeze.
- **Hail.** Formed in clouds, which have strong vertical currents (such as thunderstorms), hail is the result of a water droplet which has been prevented from exiting the cloud by the vertical currents, until it has reached a particular mass. The stronger the vertical currents, the larger the hailstones. Softball-sized hailstones have been seen in the Prairies and tropical areas, where large thunderstorms commonly occur. The hailstone in Figure 13-4-1 has a circumference of 47.63 cm (18.75 inches) and weighs almost 1 kg (2 pounds).

UCAR Communications, Staff Notes Monthly, 2003, One Hail of a Storm, Copyright 2003 by University of Carolina. Retrieved April 2, 2008, from http://www.ucar.edu/communications/staffnotes/0308/hail.html

Figure 13-4-1 Hailstone

- **Snow Pellets.** If the water region where the cloud is receiving water from is shallow, then the droplet will not form the hard shell that a hailstone would have. The pellet falls as a soft pellet of snow.

Climber.org, by S. Eckert, 2006. Graupel–Snow Pellets, Lighter and Smaller Than Hail, Copyright 2006 by Climber.org. Retrieved April 2, 2008, from http://www.climber.org/TripReports/2006/1473.html

Figure 13-4-2 Snow Pellets

- **Snow.** Snow is the result of sublimation. Flakes are an agglomeration of ice crystals and are usually in the shape of a hexagon or star.

Neatorama, 2007, Snow-donut. Copyright 2007 by Neatorama. Retrieved April 2, 2008, from http://www.neatorama.cachefly.net/images/2007-03/snow-donut.jpg

Figure 13-4-3 Snow Doughnut

- **Ice Prisms.** Created in stable air masses at very low temperatures. Ice prisms are tiny ice crystals in the form of needles. They can form with or without clouds. Sometimes confused with ice fog.

Ohio Weather Library, by B. Plonka, 2008, Unusual Weather. Copyright 2008 by Ohio Weather Library. Retrieved April 2, 2008, from http://www.owlinc.org/unusualweatherpg7.html

Figure 13-4-4 Ice Prisms

- **Ice Pellets.** Ice pellets are raindrops, which are frozen before contacting an object (as opposed to freezing rain, which freezes after contact with an object). They generally rebound after striking the ground.

CONFIRMATION OF TEACHING POINT 5

QUESTIONS

Q1. What are the seven types of precipitation?

Q2. What process creates snow?

Q3. What is the difference between ice pellets and freezing rain?

ANTICIPATED ANSWERS

A1. Drizzle, rain, hail, snow pellets, snow, ice prisms and ice pellets.

A2. Sublimation.

A3. Ice pellets freeze before contacting an object while freezing rain freezes after contact.

END OF LESSON CONFIRMATION

QUESTIONS

Q1. Define dew point.

Q2. Explain how the atmosphere is heated.

Q3. Explain the effect of dew point on weather.

ANTICIPATED ANSWERS

A1. Dew point is the temperature to which unsaturated air must be cooled, at a constant pressure, in order for it to become saturated.

A2. The atmosphere is heated from below not from above.

A3. As the temperature nears the dew point, the air will become more saturated.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

This EO is assessed IAW A-CR-CCP-803/PG-001, Chapter 3, Annex B, Aviation Subjects – Combined Assessment PC.

CLOSING STATEMENT

Weather is an amazing aspect of nature, which has a great impact on how we live our lives. Being aware of what causes weather will assist cadets in making decisions about outdoors activities.

INSTRUCTOR NOTES/REMARKS

Video resources are available for purchase through flight training centres or aviation supply websites. These videos may be used to augment instruction.

REFERENCES

C3-116 (ISBN 0-9680390-5-7) MacDonald, A. F., & Peppler, I. L. (2000). *From the Ground Up: Millennium Edition*. Ottawa, ON: Aviation Publishers Co. Limited.

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ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL THREE

INSTRUCTIONAL GUIDE

SECTION 5

EO C336.01 – READ AN AVIATION ROUTINE WEATHER REPORT (METAR)

Total Time:	60 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-803/PG-001, Chapter 4. Specific uses for said resources are identified throughout the instructional guide within the TP for which they are required.

Review the lesson content and become familiar with the material prior to delivering the lesson.

Gather sample METARs from the NavCanada aviation weather website.

Create a slide of Annex R.

Photocopy Annex S for each cadet.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

An interactive lecture was chosen for TPs 1 and 2 to introduce the cadets to a METAR.

An in-class activity was chosen for TP 3 as an interactive way for the cadets to practice reading a METAR.

INTRODUCTION

REVIEW

N/A.

OBJECTIVES

By the end of this lesson the cadet shall have read a METAR.

IMPORTANCE

It is important for cadets to read a METAR as it will enable them to determine weather conditions for flying in the local area.

Teaching Point 1 | **Describe a METAR**

Time: 10 min | Method: Interactive Lecture

Weather is a major factor in aviation. Pilots must constantly watch the weather around them as weather will effect the way an aircraft operates. In particular, pilots must review the weather prior to going flying to decide whether it is safe to fly.

Show the slide of examples located at Annex R.

DEFINITION

METAR is the name given to the international meteorological code used in aviation routine weather reports. These reports describe the existing weather conditions at a specific time and location. In other words, the METAR is a snapshot of the current weather; it is not a forecast.

FREQUENCY OF REPORTS

Normally, METAR observations are taken and disseminated on an hourly basis. METARs are only valid for the time that they are issued, not for the hour in between reports. METARS are normally issued every hour, on the hour as weather does not normally change much in an hour.

SPECIAL WEATHER REPORTS (SPECI)

There are times when the weather may change drastically in a short period of time. When this happens a SPECI is issued. SPECIs can be issued at any time. They will normally follow the last METAR issued and in sequence from oldest to newest as more SPECIs are issued. SPECIs use the same code as a METAR, but will start with SPECI.

WHERE METARS ARE AVAILABLE

METARs can be found at several locations. The three most common locations are:

- NavCanada's aviation weather website,
- a Flight Services Station (FSS),
- a Flight Information Centre (normally accessed by phone).

CONFIRMATION OF TEACHING POINT 1

QUESTIONS

Q1. What does a METAR describe?

Q2. How often is a METAR observation normally issued?

Q3. Why is a SPECI issued?

ANTICIPATED ANSWERS

A1. The existing weather conditions at a specific time and location.

A2. METARS are normally issued every hour, on the hour.

A3. When the weather may change drastically in a short period of time.

Teaching Point 2	**Review Terminology Used in METARs**
Time: 25 min	Method: Interactive Lecture

TERMINOLOGY USED IN METARS

Indicate on the slide of Annex R each of the following groupings as they are covered.

METAR is a code used in aviation weather reporting. This code is based on the World Meteorological Organization's (WMO) standards and conventions. A METAR is organized into sections with each section always showing in the same order.

Report Type

The report name is given in the first line of the text. The name will show as either METAR or SPECI.

Station Indicator

Each weather reporting station in Canada is assigned a four letter identifier, starting with the letter C. The remaining three letters are an abbreviation of the reporting station, where the first letter identifies what type of station it is.

An example would be CYOW for the reporting station at Ottawa/MacDonald-Cartier International Airport. The C means the station is Canadian, the Y means the station is co-located with an airport, and OW is the airport identifier.

Date and Time of Observation

The date and time of the observation are given in a six-digit grouping, based on universal coordinated time (UTC). The first two digits signify the day of the current month, while the last four digits signify the time of the day. The official time of the observation is given for all METAR reports that do not deviate more than 10 minutes from the top of the hour. SPECIs will have the time reported to the exact minute.

For example, a METAR will show as: 091000Z, which means that the observation was taken on the ninth day of the month at 1000 hrs UTC (or within 10 minutes of that hour).

For example, a SPECI will show as: 091036Z, which means that a significant change in weather was observed on the ninth day of the month at 1036 hrs UTC.

Report Modifier

This field may contain two possible codes: AUTO or CCA. AUTO indicates that the report is primarily based on observations from an automated weather observation station (AWOS). CCA is used to indicate corrected reports, where the first correction is CCA, the second is CCB, and so on. Both AUTO and CCA may be found in the same report.

Wind

This group reports the two-minute average wind direction and speed. Direction is always three digits, given degrees true but rounded off to the nearest 10 degrees. Speed is normally two digits, and is given in knots (nautical miles per hour or kt). A reading of 00000 kt indicates calm winds.

For example, 35016 will read as: winds are 350 degrees true (rounded off) at 16 kts.

If gust conditions exist, the direction and speed will be followed by a G and the maximum gust strength. A gust must be 5 knots stronger than the 10-minute average wind speed.

For example, 35016G25 will read as: winds are 350 degrees true at 16 kts gusting to 25 kts.

Prevailing Visibility

Prevailing visibility is the average visibility at the reporting station. The prevailing visibility is reported in statute miles (sm) or fractions of a statute mile.

Runway Visual Range

This is only included if the prevailing visibility is less than 1 sm, or the runway visual range is less than 6 000 feet. This group will start with an R, then the runway number (eg, 06) and position (eg, L for left, R for right, C for centre), followed by the runway visual range in hundreds of feet. This is based on a 10-minute average.

For example, R06L/1000V2400FT/U will read as: the minimum runway visual range for runway 06 left is 1 000 feet and the maximum is 2 400 feet with an upward trend.

Present Weather

This section indicates the current weather phenomena at the reporting station. This may include precipitation, obscuration, or other phenomena. This section will include all phenomena that exist, varying the length of the section between reports.

Each phenomenon is represented by a code, which may be two to nine characters in length. Each code may include one or both of the following prefixes:

- **Intensity.** (-) indicates light, (+) indicates heavy, and no symbol indicates moderate.
- **Proximity.** Used primarily with precipitation or tornadoes, VC will precede certain phenomena meaning that they are in the vicinity (5 sm) of the station, but not actually at the station.

Distribute the handout located at Annex S.

For example, VCFZRABLSN+SNVA would translate to: In the vicinity of the airport there is freezing rain, blowing snow, heavy snow, and volcanic ash.

The abbreviations used for present weather are a mixture of English and French root words. FZ comes from freezing, while BR comes from brumé (mist), and FU comes from fumée (smoke).

Sky Conditions

This group reports the sky condition for layers aloft. The group will include how much of the sky is covered measured in oktas (eighth of the sky) and the height of the clouds in hundreds of feet above ground level (AGL). The sky cover is represented by an abbreviation related to how many oktas of the sky are covered.

- SKC = sky clear, no cloud present.
- FEW = few, greater than zero to two eighths cloud cover.
- SCT = scattered, three eighths to four eighths cloud cover.
- BKN = broken, five eighths to less than eight eighths cloud cover.
- OVC = overcast, eight eighths cloud cover.
- CLR = clear, clear below 10 000 feet AGL.

Cloud height is represented by a three digit number, which when multiplied by one hundred equals the actual height AGL. There will be one entry for every layer of cloud.

For example, SCT025 would translate to: scattered cloud at 2 500 feet AGL.

Temperature and Dewpoint

This group reports the air temperature and dewpoint temperature, rounded to the nearest whole degree Celsius. A negative value will be preceded by (M). A (/) will separate the two values.

Altimeter Setting

This group reports the altimeter setting at the reporting station in inches of mercury. The group starts with (A), which will be followed by four digits, which directly relate to the actual value of the altimeter setting. Place a decimal after the second digit in order to read this group.

For example, A3006 would translate to: altimeter setting is 30.06 inches of mercury.

Remarks

This group will usually include cloud types in each layer as well as opacity, general weather remarks, and sea level pressure measured in hectopascals. The sea level pressure will always be the last entry in a METAR, prefaced by SLP. Sea level pressure is translated by either adding a 9 or a 10 in front of the value given. The goal is to make the number as close to 1 000 as possible.

For example, SLP 123 would translate to: sea level pressure is 1012.3 hPa.

For example, SLP 998 would translate to: sea level pressure is 999.8 hPa.

SLP actually represents the station pressure or the theoretical sea level pressure at the reporting station.

CONFIRMATION OF TEACHING POINT 2

QUESTIONS

Q1. How are date and time expressed in a METAR?

Q2. What does the present weather section indicate?

Q3. What is the last entry of a METAR?

ANTICIPATED ANSWERS

A1. The date and time of the observation are given in a six-digit grouping, based on universal coordinated time (UTC).

A2. This section indicates the current weather phenomena at the reporting station.

A3. The sea level pressure will always be the last entry in a METAR.

Teaching Point 3	**Demonstrate and Have the Cadets Read a METAR**
Time: 15 min	Method: In-Class Activity

ACTIVITY

OBJECTIVE

The objective of this activity is for the cadets to read a METAR.

RESOURCES

Five or six examples of METARs.

ACTIVITY LAYOUT

Arrange the classroom to enable both individual and small-group work.

ACTIVITY INSTRUCTIONS

1. Project a sample METAR and demonstrate reading it.
2. Distribute examples of METARs.
3. Have the cadets work in pairs to decipher a METAR in three minutes.
4. Correct the cadets' work.
5. Have the cadets work in pairs to decipher a second METAR in two minutes.
6. Correct the cadets' work.
7. Repeat Steps 5. and 6. as often as possible until examples are exhausted.

SAFETY

N/A.

CONFIRMATION OF TEACHING POINT 3

The cadets' participation in the METAR reading activity will serve as the confirmation of this TP.

END OF LESSON CONFIRMATION

The cadets' participation in reading METAR will serve as the confirmation of this lesson.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

N/A.

CLOSING STATEMENT

Reading a METAR is a skill which can be transferred to many other outdoor activities. The code used may also be found in aviation forecasts, which cover larger areas. This can be used for camping trips, trip planning and checking to see if your flight the next morning will be delayed.

INSTRUCTOR NOTES/REMARKS

Recent METARs can be found at http://www.flightplanning.navcanada.ca/cgi-bin/CreePage.pl?Langue=anglais &NoSession=NS_Inconnu?Page=forecast-observation&TypeDoc=html. Click on the METAR/TAF icon and then enter the airport name or identifier.

REFERENCES

C2-044 Transport Canada. (2007). *Aeronautical Information Manual*. Retrieved October 2, 2007, from http://tc.gc.ca/publications/EN/TP14371/PDF/HR/TP14371E.PDF.

C3-116 (ISBN 0-9680390-5-7) MacDonald, A. F., & Peppler, I. L. (2000). *From the Ground Up: Millennium Edition*. Ottawa, ON: Aviation Publishers Co. Limited.

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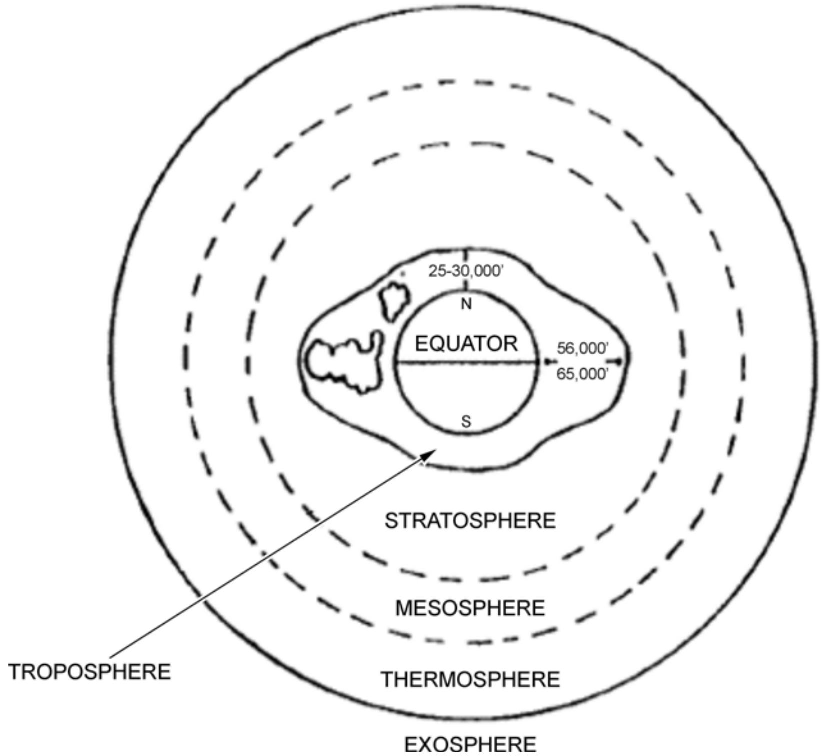
DIVISIONS OF THE ATMOSPHERE



A. F. MacDonald and I. L. Peppler, From the Ground Up, Aviation Publishers Co. Limited (p. 123)

Figure 13A-1 The Four Layers of the Atmosphere

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CUMULUS CLOUD

"Victoria Weather", by UVic, School-Based Weather Station Network. Retrieved November 1, 2007, from http://www.victoriaweather.ca/clouds

Figure 13B-1 Cumulus Cloud

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STRATUS CLOUD

“Victoria Weather”, by UVic, School-Based Weather Station Network. Retrieved November 1, 2007, from http://www.victoriaweather.ca/clouds

Figure 13C-1 Stratus Cloud

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COMMON CLOUDS

Cloud Name	Cloud Family	Cloud Description
Cirrus	High	High, thin, wispy clouds blown by high winds into long streamers. Cirrus clouds usually move across the sky from west to east. They generally indicate pleasant weather.
Cirrocumulus	High	Appears as small, round white puffs. The small ripples in the cirrocumulus sometimes resemble the scales of a fish. A sky with cirrocumulus clouds is sometimes referred to as a “mackerel sky”.
Altocumulus	Middle	Appear as grey, puffy masses, sometimes in parallel waves or bands. The appearance of these clouds on a warm, humid summer morning often means thunderstorms will occur by late afternoon.
Altostratus	Middle	A grey or blue-grey layer cloud that typically covers the entire sky. In the thinner areas of the cloud, the sun may be dimly visible as a round disk. This cloud appears lighter than stratus clouds.
Stratus	Low	Uniform grey layer cloud that often covers the entire sky. They resemble fog that does not reach the ground. Usually no precipitation falls from stratus clouds, but sometimes they may drizzle.
Nimbostratus	Low	Dark grey layer clouds associated with continuously falling rain or snow. They often produce precipitation that is usually light to moderate.
Stratocumulus	Low	A series of round mass that form a layer cloud. This type of cloud is usually thin enough for the sky to be seen through breaks.
Cumulus	Vertical Development	Puffy clouds, which are thick, round, and lumpy. They sometimes look like pieces of floating cotton. They usually have flat bases and round tops.
Cumulonimbus	Vertical Development	Thunderstorm clouds that form if cumulus clouds continue to build. Violent vertical air currents, hail, lightning, and thunder are associated with the cumulonimbus clouds.

Director Cadets 3, 2007, Ottawa, ON: Department of National Defence

Figure 13D-1 Common Clouds

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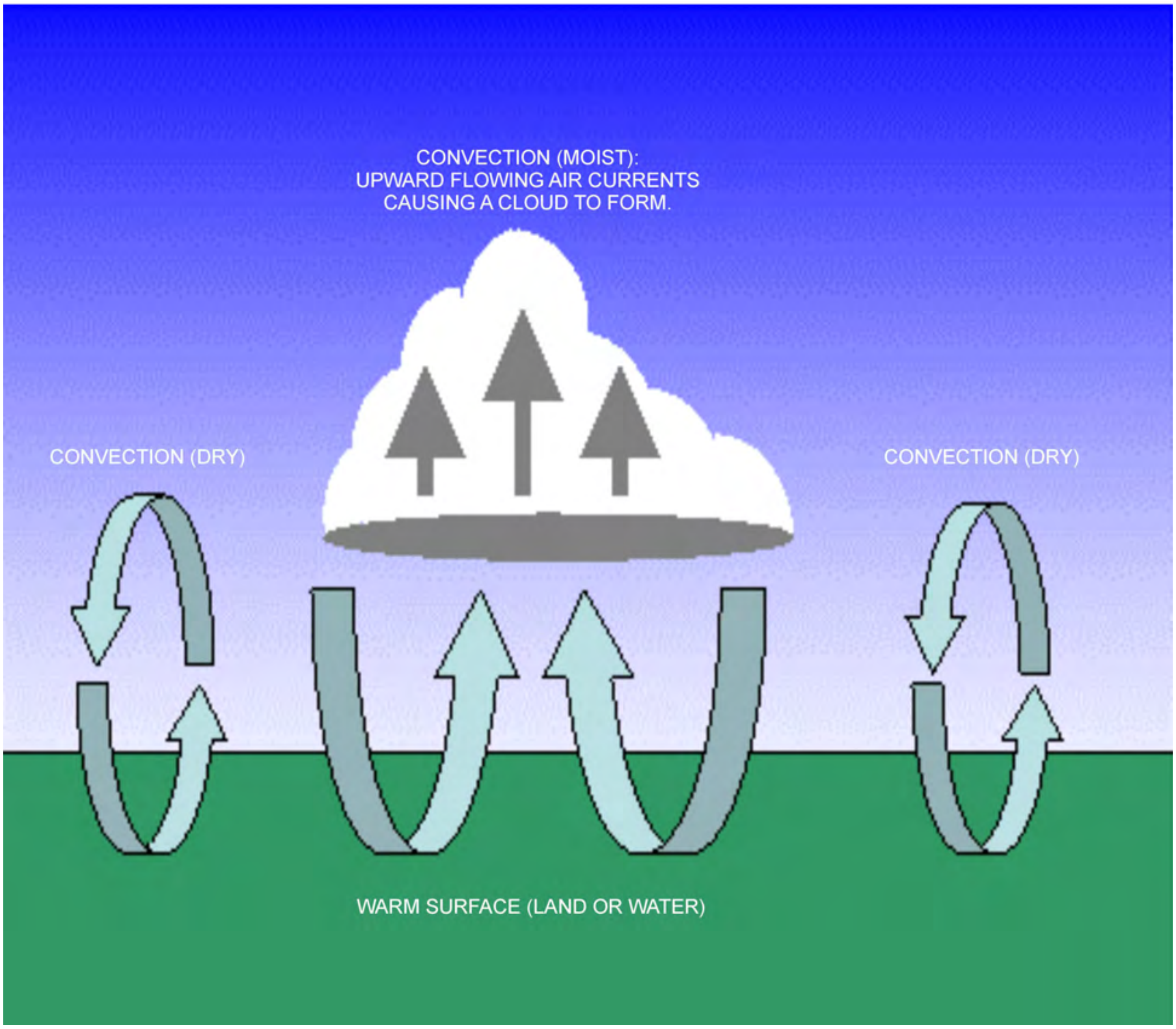
CONVECTION



WeatherQuestions.com, 2007, What is Convection. Copyright 2007 by WeatherStreet.
Retrieved March 17, 2008, from http://www.weatherquestions.com/What_is_convection.htm

Figure 13E-1 Convection

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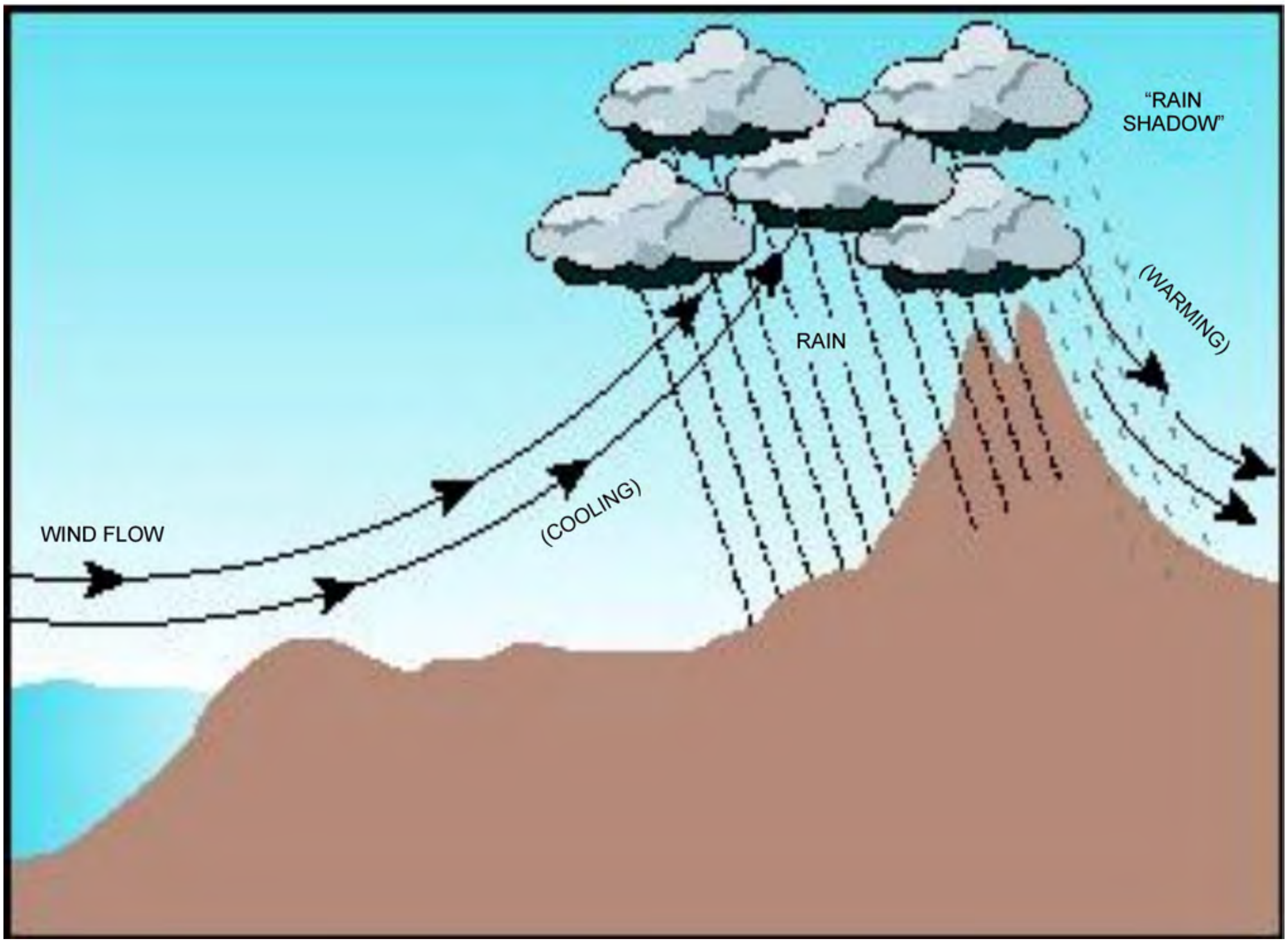
OROGRAPHIC LIFT



Water Encyclopedia, by G. H. Taylor, 2007, Water as a Climate Moderator. Copyright 2007by Advameg. Retrieved March 17, 2008, from http://www.waterencyclopedia.com/Ce-Cr/Climate-Moderator-Water-as-a.html

Figure 13F-1 Orographic Lift

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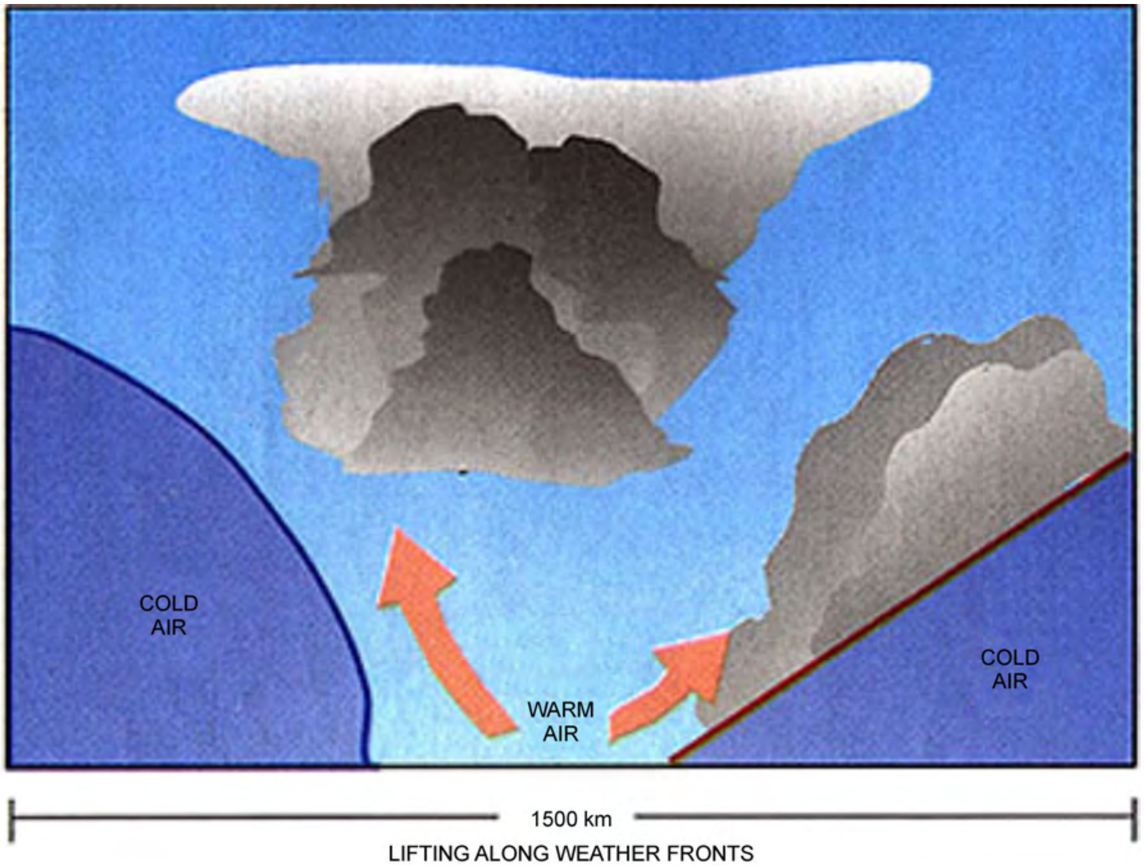
FRONTAL LIFT



Federation of American Scientists, by N. M. Short, Sr, 2007, Atmospheric Circulation: Weather Systems. Copyright 2007 by FAS. Retrieved March 17, 2008, from http://www.fas.org/irp/imint/docs/rst/Sect14/Sect14_1c.html

Figure 13G-1 Frontal Lift

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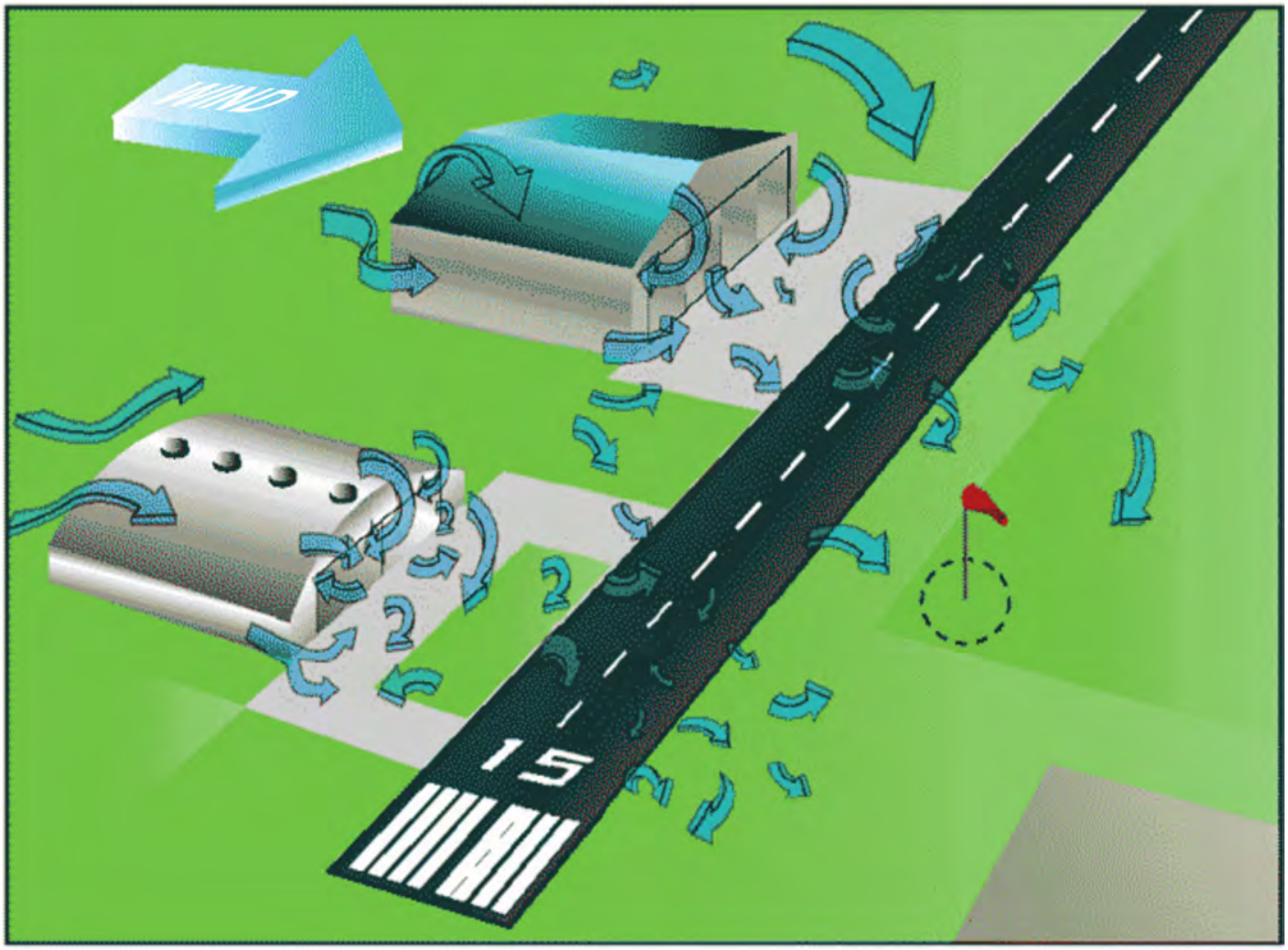
MECHANICAL TURBULENCE: MAN-MADE



Free Online Private Pilot Ground School, 2006, Aviation Weather–Principles. Copyright 2006. Retrieved March 17, 2008, from http://www.free-online-private-pilot-ground-school.com/Aviation-Weather-Principles.html

Figure 13H-1 Mechanical Turbulence: Man-Made

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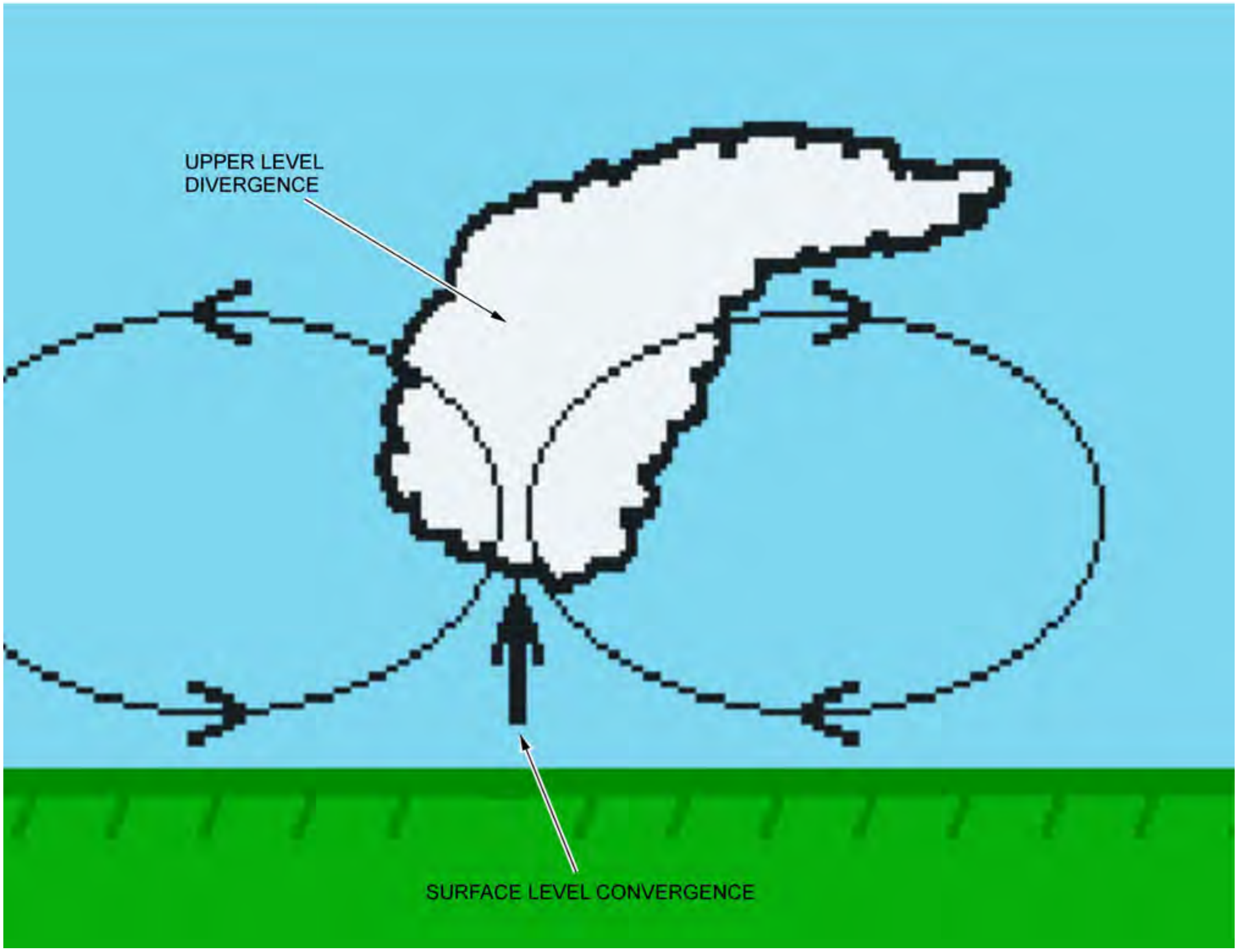
CONVERGENCE



The Weather Doctor, by K. C. Heidron, PhD, 2002, What Goes Up: Part 3 Convergence and Divergence. Retrieved March 17, 2008, from http://www.islandnet.com/~see/weather/elements/whatgoesup3.htm

Figure 13I-1 Convergence

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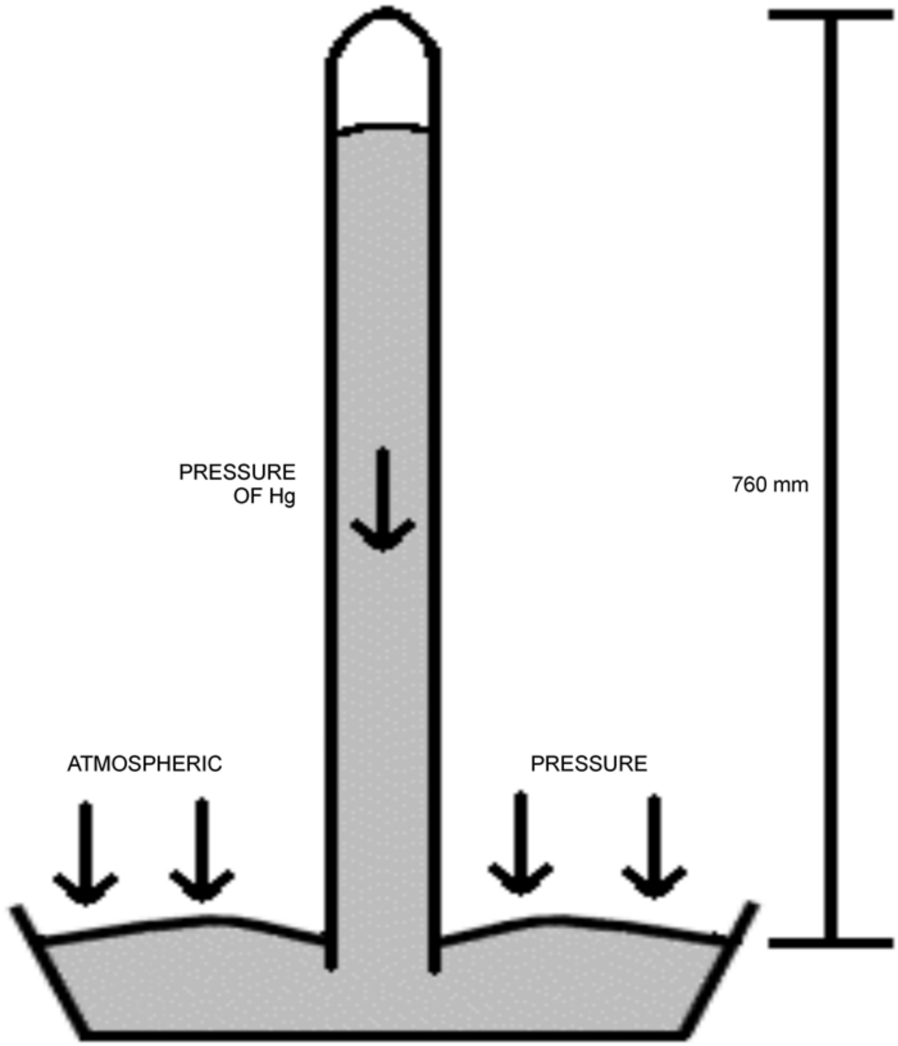
BAROMETER



$P_{atm} = P_{Hg}$

Chemistry Tutorial Notes, Department of Chemistry, Texas A&M University, 2006, Properties of Gases, Copyright 2006 by Texas A&M University. Retrieved April 4, 2008 from http://www.chem.tamu.edu/class/majors/tutorialnotefiles/pressure.htm

Figure 13J-1 Barometer

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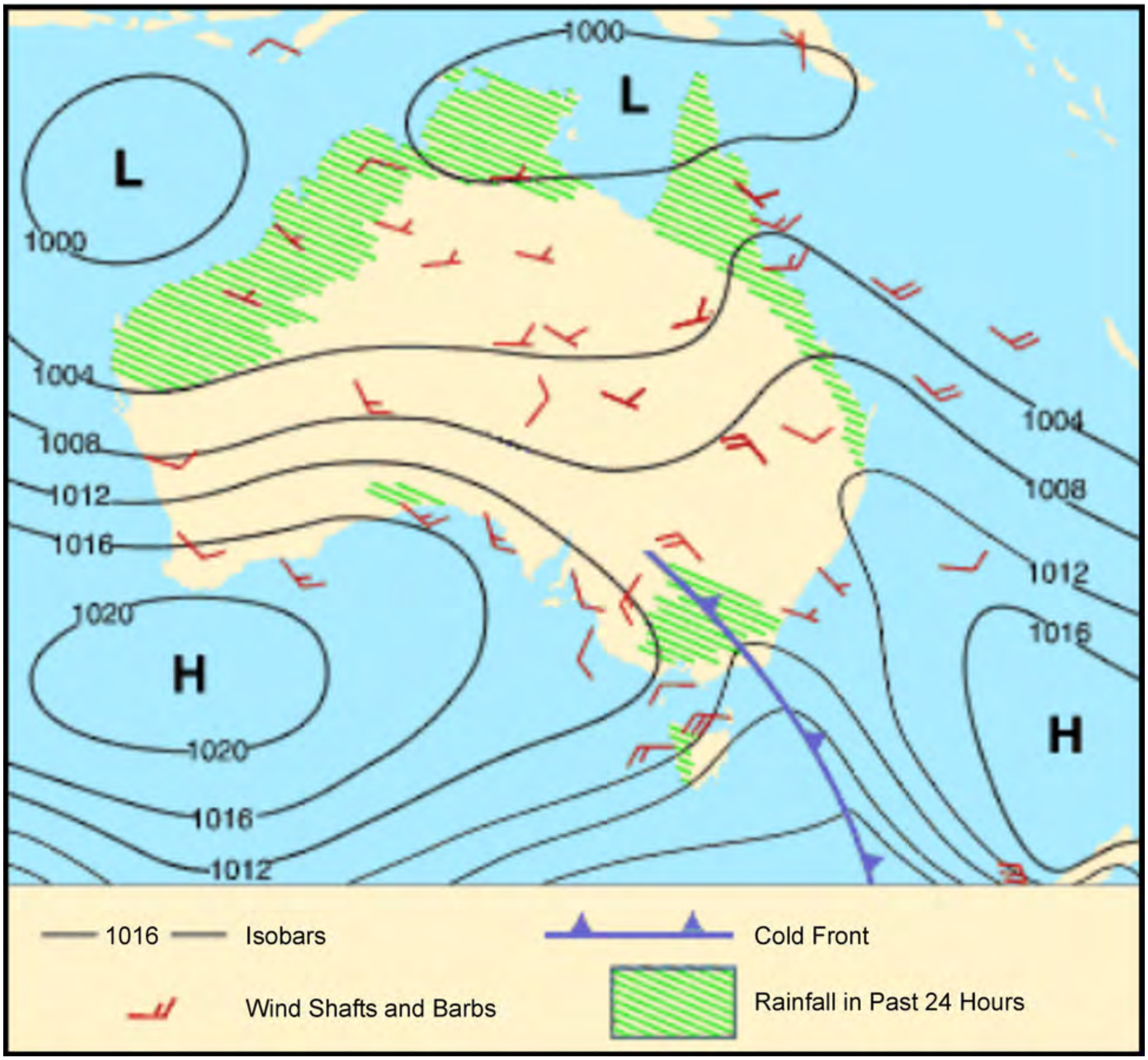
ISOBARS ON A WEATHER MAP



Australian Government, Bureau of Meteorology, 2008, Air Masses and Weather Maps, Copyright 2008 by Commonwealth of Australia, Bureau of Meteorology. Retrieved April 7, 2008 from http://www.bom.gov.au/info/ftweather/page_7.shtml

Figure 13K-1 Isobars on a Weather Map

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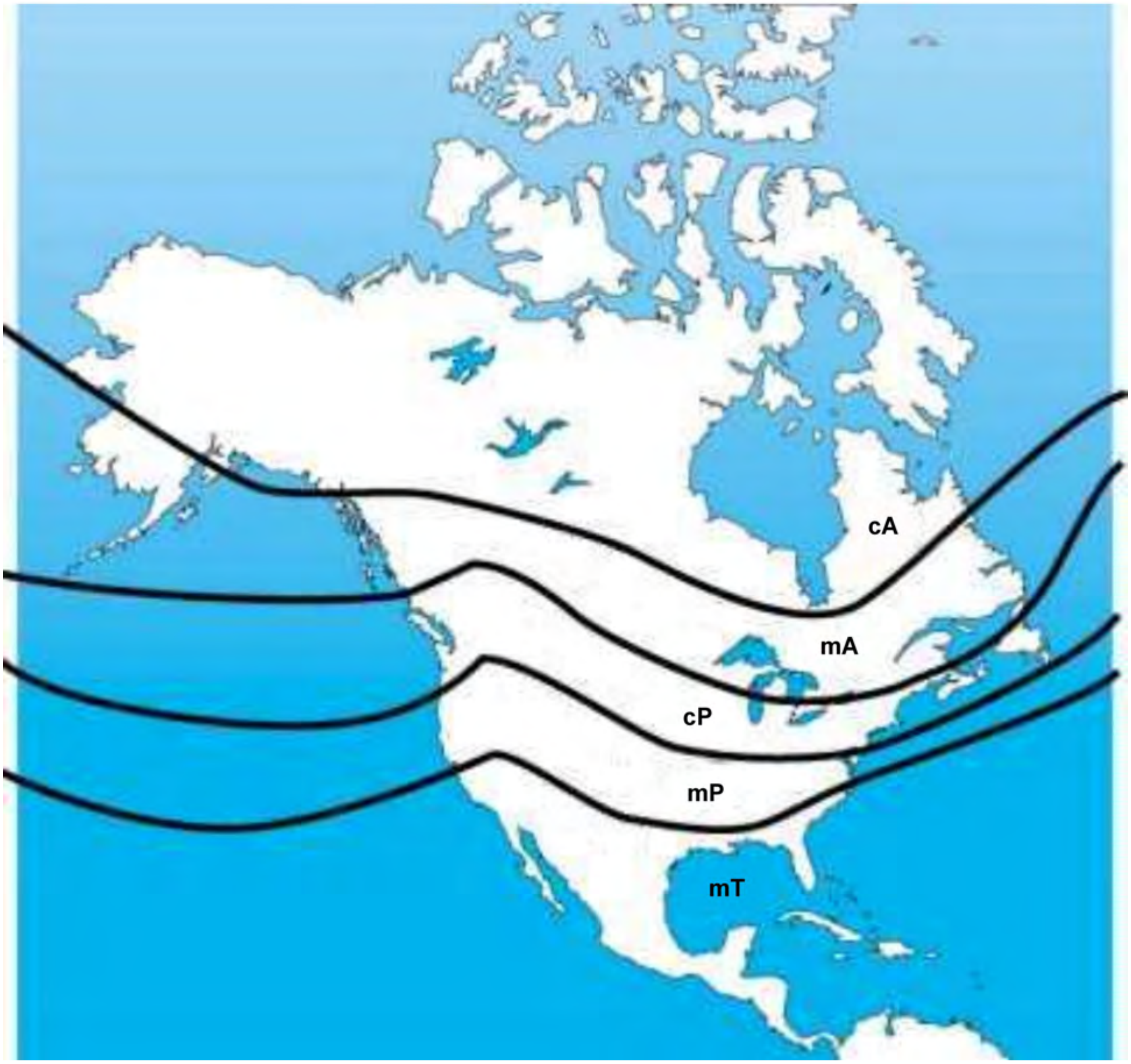
NORTH AMERICAN AIR MASSES



Meteorological Service of Canada, 2004, Frontal Systems, Copyright 2004 by Environment Canada. Retrieved April 7, 2008 from http://www.qc.ec.gc.ca/meteo/Documentation/Front_e.html

Figure 13L-1 North American Air Masses

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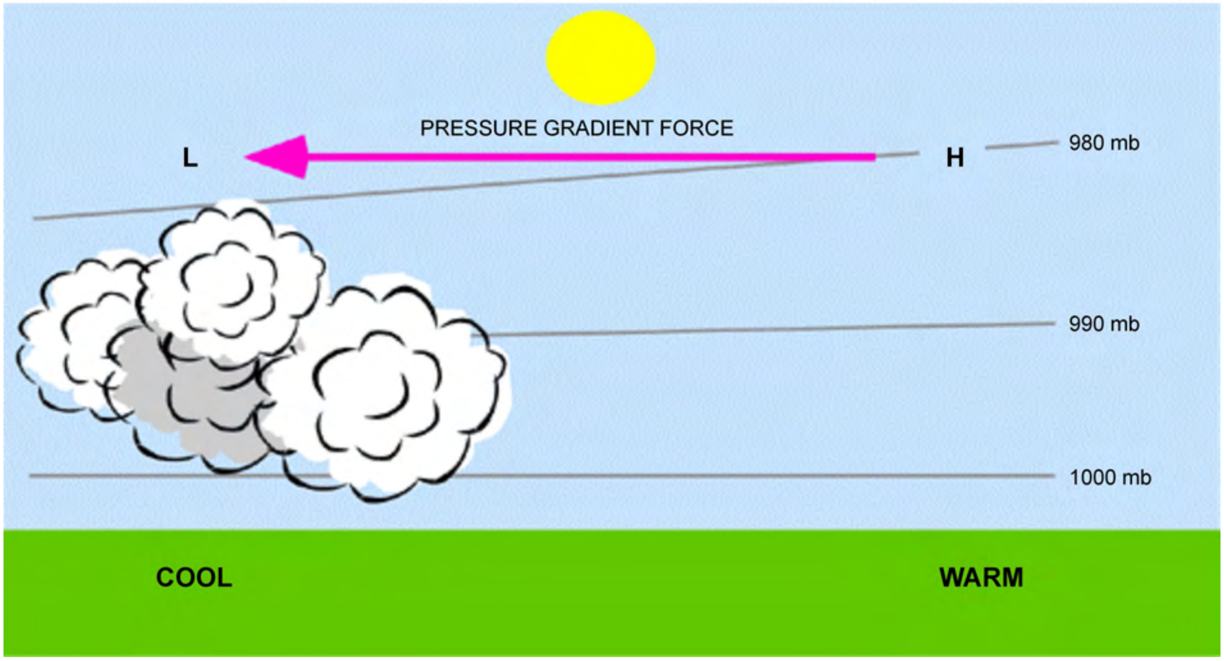
PRESSURE GRADIENT



PhysicalGeography.net, Dr. M. Pidwirny, University of British Columbia Okanagan, 2007, Introduction to the Atmosphere, Copyright 2007 by M. Pidwirny. Retrieved April 7, 2008 from http://www.physicalgeography.net/fundamentals/7o.html

Figure 13M-1 Pressure Gradient

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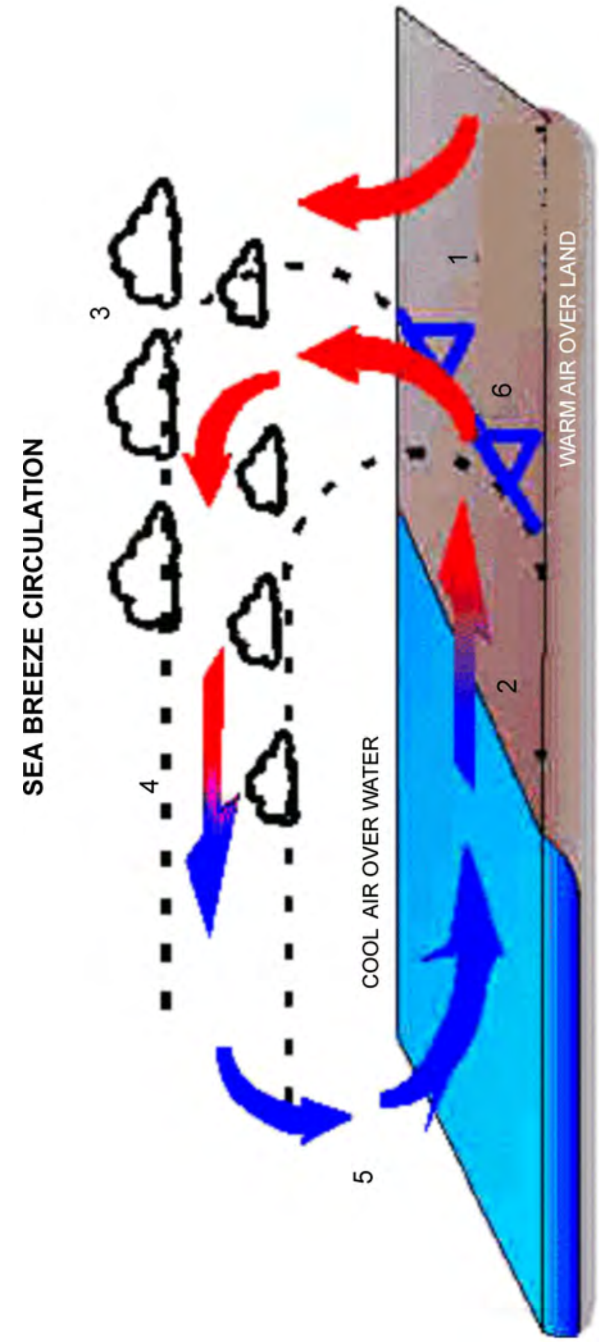
SEA BREEZE



The Weather Doctor, K. C. Heidron, PhD, 1993, Sea and Land Breezes, Copyright 1998 by K. C. Heidron PhD. Retrieved April 7, 2008 from http://www.islandnet.com/~see/weather/elements/seabrz.htm

Figure 13N-1 Sea Breeze

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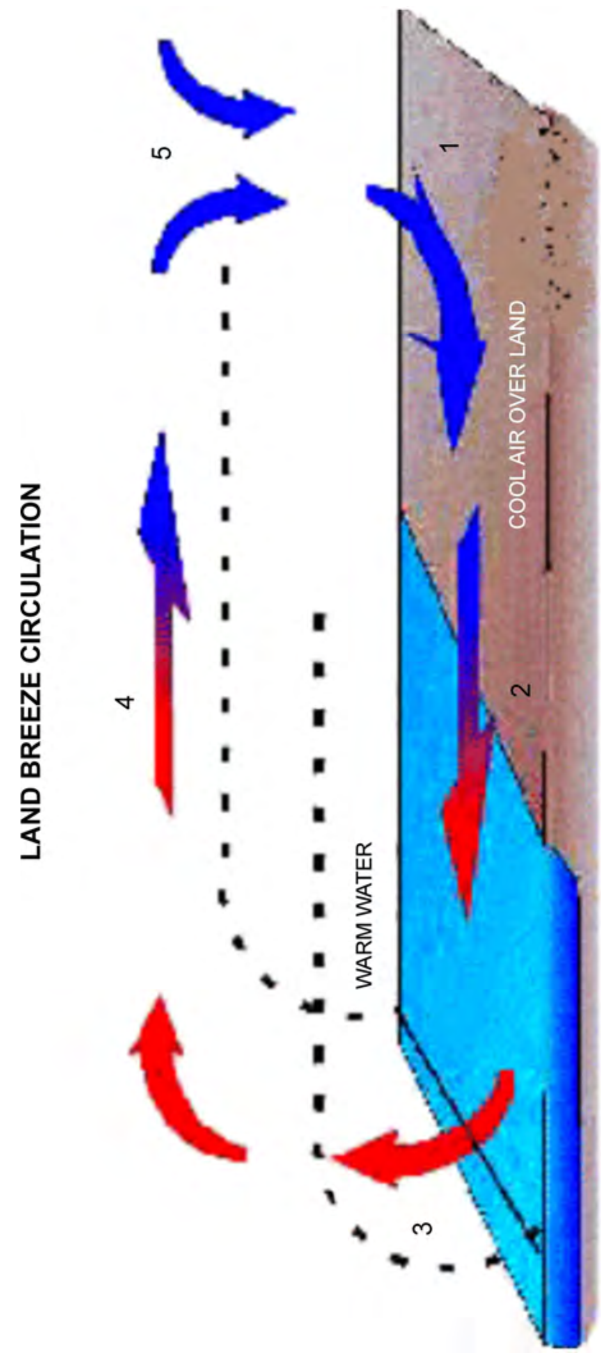
LAND BREEZE



The Weather Doctor, K. C. Heidron, PhD, 1993, Sea and Land Breezes, Copyright 1998 by K. C. Heidron PhD. Retrieved April 7, 2008 from http://www.islandnet.com/~see/weather/elements/seabrz.htm

Figure 13O-1 Land Breeze

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DEFINITIONS

Atmospheric Pressure. The pressure of the atmosphere at any point due to the weight of the overlying air.

Isobars. Areas of like pressure are joined by lines called isobars (from Greek *isos* [same] and *baros* [weight]).

Low Pressure Areas. Low pressure areas (often called lows, cyclones, or depressions) are areas of relatively lower pressure, with the lowest pressure in the centre.

High Pressure Areas. High pressure areas (often called anti-cyclones) are areas of relatively higher pressure, with the highest pressure in the centre.

Continental Air Mass. Air mass will be dry as it formed over land.

Maritime Air Mass. Air mass will be moist as it formed over water.

Arctic Air Mass. Air mass will be cold as it formed over the Arctic.

Polar Air Mass. Air mass will be cool as it formed over the Polar region.

Tropical Air Mass. Air mass will be warm as it formed over the Tropical region.

Wind. The horizontal movement of air within the atmosphere.

Pressure Gradient. The rate of change of pressure over a given distance measured at right angles to the isobars.

Sea Breeze. Occurs during the day when the land heats up more rapidly than the water.

Land Breeze. Occurs at night when the land cools down faster than the water.

Diurnal Variation. This is due to the heating processes which occur during the day, creating vertical currents and pressure gradients. At night, when the heating processes cease, the vertical currents diminish and the pressure gradients become shallower.

Coriolis Force. The rotation of the earth causes a deflection to the right (in the northern hemisphere). Coriolis Force also explains why air moves clockwise around a high, and counter-clockwise around a low pressure system.

Veering and Backing. Veering is a change in wind direction clockwise relative to the cardinal points of a compass while backing is a change in wind direction counter-clockwise caused by friction with the earth's surface.

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TYPES OF PRECIPITATION

UCAR Communications, Staff Notes Monthly, 2003, One Hail of a Storm, Copyright 2003 by University of Carolina. Retrieved April 2, 2008, from http://www.ucar.edu/communications/staffnotes/0308/hail.html

Figure 13Q-1 Hailstone

Climber.org, by S. Eckert, 2006, Graupel–Snow Pellets, Lighter and Smaller Than Hail, Copyright 2006 by Climber.org. Retrieved April 2, 2008, from http://www.climber.org/TripReports/2006/1473.html

Figure 13Q-2 Snow Pellets

Neatorama, 2007, Snow-donut. Copyright 2007 by Neatorama. Retrieved April 2, 2008, from http://www.neatorama.cachefly.net/images/2007-03/snow-donut.jpg

Figure 13Q-3 Snow Doughnut

Ohio Weather Library, B. Plonka, 2008. Unusual Weather. Copyright 2008 by Ohio Weather Library. Retrieved April 2, 2008 from http://www.owlinc.org/unusualweatherpg7.html

Figure 13Q-4 Ice Prisms

SAMPLE METAR AND SPECI

METAR CYHZ 111700Z 28009G16KT 15SM FEW250 00/M11 A2990 RMK CS0 SLP134=

METAR CYHZ 111800Z 29015KT 15SM FEW250 01/M10 A2989 RMK CI0 SLP128=

METAR CYHZ 111900Z 30008KT 15SM FEW250 02/M12 A2987 RMK CI0 SLP123=

SPECI CYYJ 111744Z CCA 23019G24KT 20SM -SHRA BKN014 BKN030 BKN120 09/07 RMK SC5SC1AC1=

SPECI CYYJ 111744Z 23019G24KT 20SM -RA BKN014 BKN030 BKN120 09/07 RMK SC5SC1AC1=

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WORLD METEOROLOGICAL ORGANIZATION CODE FOR PRESENT WEATHER

QUALIFIER					WEATHER PHENOMENA			
INTENSITY or PROXIMITY 1	**DESCRIPTOR 2**		**PRECIPITATION 3**		**OBSCURATION 4**		**OTHER 5**	
Note: Precipitation intensity refers to all forms combined.	**MI**	Shallow	**DZ**	Drizzle	**BR**	Mist (Vis ≥ 5/8 SM)	**PO**	Dust/sand Whirls (Dust Devils)
	BC	Patches	**RA**	Rain	**FG**	Fog (Vis < 5/8 SM)	**SQ**	Squalls
	PR	Partial	**SN**	Snow	**FU**	Smoke (Vis ≤ 6 SM)	**+FC**	Tornado or Waterspout
	DR	Drifting	**SG**	Snow Grains				
- Light	**BL**	Blowing	**IC**	Ice Crystals (Vis = 6 SM)	**DU**	Dust (Vis ≤ 6 SM)	**FC**	Funnel Cloud
	SH	Shower(s)						
Moderate (no qualifier)	**TS**	Thunderstorm	**PL**	Ice Pellets	**SA**	Sand (Vis ≤ 6 SM)	**SS**	Sandstorm (Vis < 5/8 SM) (+SS Vis < 516 SM)
			GR	Hail				
+Heavy	**FZ**	Freezing	**GS**	Snow Pellets	**HZ**	Haze (Vis ≤ 6 SM)	**DS**	Dust storm (Vis < 5/8 SM) (+DS Vis < 516 SM)
VC In the vicinity			**UP**	Unknown precipitation (AWOS only)	**VA**	Volcanic Ash (with any visibility)		

Transport Canada, Aeronautical Information Manual, Transport Canada (p. 145)

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CHAPTER 14

PO 337 – DEMONSTRATE AIR NAVIGATION SKILLS

ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL THREE

INSTRUCTIONAL GUIDE

SECTION 1

EO M337.01 – MEASURE DISTANCE ALONG A ROUTE

Total Time:	30 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-803/PG-001, Chapter 4. Specific uses for said resources are identified throughout the instructional guide within the TP for which they are required.

Review the lesson content and become familiar with the material prior to delivering the lesson.

Create a slide of the terms located at Annex A.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

An interactive lecture was chosen for TPs 1 and 2 to introduce basic air navigation terms and types of air navigation.

Demonstration and performance was chosen for TP 3 as it allows the instructor to explain and demonstrate measuring distances while providing an opportunity for the cadet to practice this skill under supervision.

INTRODUCTION

REVIEW

N/A.

OBJECTIVES

By the end of this lesson the cadet shall have measured distance along a route.

IMPORTANCE

It is important for cadets to learn to measure distance along a route since it is an important skill in all types of navigation. Cadets may travel and being able to determine the distance between points is important. A cadet who continues with flight training will use this skill during flight planning.

Teaching Point 1	**Define Air Navigation Terms**
Time: 5 min	Method: Interactive Lecture

AIR NAVIGATION TERMS

Show the slide of the terms located at Annex A.

There are several key terms that must be understood.

Graticule. A three-dimensional geometrical pattern of intersecting circles. Envision the black lines on a basketball, or a globe with only the black lines.

Latitude. Parallels of latitude are imaginary circles on the earth's surface, which lie parallel to the equator. Latitude measures 90 degrees north and 90 degrees south of the equator. Parallels of latitude make up half of the earth's graticule. Latitude is measured in degrees (°), minutes ('), and seconds (").

Longitude. Meridians of longitude are imaginary circles on the earth's surface, which intersect at the true or geographic poles, and join the poles of the earth together. Longitude measures 180 degrees west and 180 degrees east of the prime meridian (0 degrees), which passes through Greenwich, England. Meridians of longitude make up the other half of the earth's graticule. Longitude is measured in degrees (°), minutes ('), and seconds (").

Nautical Miles. A nautical mile (nm) is 6 080 feet and is the average length of one minute of latitude.

Statute Miles. A statute mile is 5 280 feet.

Scale. Scale on a map is the relationship between a unit of distance on the chart to the distance on the earth that the unit represents. For example, a scale of 1 : 250 means that one inch on the map is equal to 250 inches on the ground.

VNC. A visual flight rules (VFR) navigation chart (VNC) is a chart used primarily for visual navigation, at low altitudes (below 18 000 feet) and slower speeds (less than 300 knots). A VNC has a scale of 1 : 500 000, or one inch to eight miles.

CONFIRMATION OF TEACHING POINT 1

QUESTIONS

Q1. What is a graticule?

Q2. How many nautical miles are in one minute of latitude?

Q3. How many feet are in a statute mile?

ANTICIPATED ANSWERS

A1. A three-dimensional geometrical pattern of intersecting circles.

A2. One.

A3. 5 280 feet.

Teaching Point 2	**Identify and Describe Types of Navigation**
Time: 5 min	Method: Interactive Lecture

TYPES OF NAVIGATION

There are several methods of navigation used by pilots to find their way from place to place. Four of the more common methods used include:

- pilotage,
- dead reckoning,
- inertial navigation, and
- satellite navigation.

Pilotage. This method of navigation is by reference to landmarks only. This is similar to orienteering.

Dead Reckoning. This method of navigation uses predetermined vectors of wind and true airspeed, precalculated heading and groundspeed, and estimated time of arrival. This is the most common method used by private pilots.

Inertial Navigation. This method of navigation is through use of gyroscopic equipment and electronic computers to provide a continuous display of position. This equipment is built into the aircraft.

Satellite Navigation. This method uses position and guidance systems, which transmit to and receive information from orbiting satellites. The global positioning system (GPS) is the most commonly used satellite system with many new aircraft having complex units built into the instrument panel.

CONFIRMATION OF TEACHING POINT 2

QUESTIONS

Q1. What is pilotage?

Q2. Which is the most common navigation method used by private pilots?

Q3. What is the most commonly used satellite navigation system?

ANTICIPATED ANSWERS

A1. This method is navigation by reference to landmarks only.

A2. Dead reckoning.

A3. GPS.

Teaching Point 3 | **Demonstrate and Have the Cadet Determine the Distance Between Two Predetermined Points Along a Route**

Time: 15 min | Method: Demonstration and Performance

MEASURING DISTANCE

International Civil Aviation Organization (ICAO) Ruler

The ICAO ruler is a simple straight edge with four measuring scales embossed into it. The scale used depends on the type of map and unit of measurement desired. For a VNC, the scale would be 1 : 500 000. Since all distances in aviation are given in nm, this is the measurement used when determining distance.

Place the ruler on the map, with the starting point at zero. Be sure to use the 1 : 500 000 side and the nm scale. Adjust the ruler so that the destination point is on the same edge as the start point, and measure across. The value found on the nm scale is the distance between the two points.

Map Scale

The distance can also be measured using the map scale. On the reverse side of the map legend there is a graduated scale for that map. It will show nm, statute miles, and km. Take a piece of paper and line it up on the map between the two points. Use a pencil to mark where the two points are on the paper. Line the paper up with the graduated scale, on the nm line, and determine the distance. If the distance on the map is greater than the graduated scale, simply mark off the end of the graduated scale on the paper, shift the paper down so that the new mark is set to zero and remeasure. Depending on the length of the route, some basic math may be required as the paper may have to be readjusted.

Remember that the distance between minutes of latitude is one nm. This means that if two points are directly north or south of each other, count up the number of minutes of latitude between them and this equals the distance.

ACTIVITY

OBJECTIVE

The objective of this activity is to determine the distance between two points along a route.

RESOURCES

- ICAO ruler,
- VNC,
- Pencil, and
- Eraser.

ACTIVITY LAYOUT

Desks are to be arranged so that cadets can work in pairs.

ACTIVITY INSTRUCTIONS

1. Distribute one VNC to each pair of cadets.

2. Distribute one ICAO ruler to each pair of cadets.
3. Using two predetermined points, demonstrate to the cadets how to use the ICAO ruler.
4. Provide the cadets with a second set of predetermined points.
5. Have the cadets measure the distance between these two points using the ICAO ruler.
6. Provide the cadets with two more sets of points and allow them to practice.
7. If time permits, demonstrate to the cadets how to measure the distance using the scale of the map.
8. Have the cadets use the scale of the map to determine the distances of the previously used sets of points. Confirm with the results of the ICAO ruler.

SAFETY

N/A.

CONFIRMATION OF TEACHING POINT 3

The cadets' participation in the measuring activity will serve as confirmation of this TP

END OF LESSON CONFIRMATION

The cadets' participation in the activity in TP 3 will serve as confirmation of this EO.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

This EO is assessed IAW Chapter 3, Annex B, Aviation Subjects – Combined Assessment PC.

CLOSING STATEMENT

Measuring a distance along a route is very useful in aviation as well as other methods of travel. Being aware of scale and knowing how to use that information will ensure efficient trip planning.

INSTRUCTOR NOTES/REMARKS

VNCs and ICAO rulers can be ordered through the Area Cadet Officer (ACO), purchased at a local flight training centre, or ordered online at NavCanada (www.navcanada.ca).

EO C337.02 (Practice Air Navigation Skills, Section 4) may be conducted to provide extra practice of the skills learned in this EO.

REFERENCES

C3-116 (ISBN 0-9680390-5-7) MacDonald, A. F., & Peppler, I. L. (2000). *From the Ground Up: Millennium Edition*. Ottawa, ON: Aviation Publishers Co. Limited.

C3-139 (ISBN 0-7715511-5-0) Transport Canada. (1999). *Flight Training Manual: 4th Edition Revised*. Ottawa, ON: Transport Canada.

ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL THREE

INSTRUCTIONAL GUIDE

SECTION 2

EO M337.02 – DETERMINE A POSITION ON A VISUAL FLIGHT RULES (VFR) NAVIGATIONAL CHART (VNC)

Total Time:	30 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-803/PG-001, Chapter 4. Specific uses for said resources are identified throughout the instructional guide within the TP for which they are required.

Review the lesson content and become familiar with the material prior to delivering the lesson.

Create a list of predetermined coordinates that correspond to airports on the VNC to be used in TP 3.

Create a list of locations to be used in TP 4.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

An interactive lecture was chosen for TPs 1 and 2 to introduce basic air navigation terms.

Demonstration and performance was chosen for TPs 3 and 4 as it allows the instructor to explain and demonstrate determining positions and coordinates while providing an opportunity for the cadet to practice under supervision.

INTRODUCTION

REVIEW

N/A.

OBJECTIVES

By the end of this lesson the cadet shall have determined a position on a VNC.

IMPORTANCE

It is important for cadets to be able to determine a position on a VNC as this is a transferable skill in any type of navigation which uses maps that have a graticule.

Teaching Point 1 | **Explain that the Earth is Divided Into Sections by an Imaginary Grid System Called a Graticule**

Time: 5 min | Method: Interactive Lecture

GRATICULE

A graticule is a three-dimensional geometrical pattern of intersecting circles. Envision the black lines on a basketball, or a globe with only the black lines. When applied to the earth, either on a globe or a map, we refer to these intersecting lines as parallels of latitude and meridians of longitude.

Parallels of Latitude

Parallels of latitude are a series of concentric circles, which measure north and south. The baseline for measuring is the equator, which is 0 degrees of latitude. As one travels away from the equator the degree of latitude becomes larger, to a maximum of 90 degrees north or south. The southern borders of Canada's Prairie Provinces lie on the 49th parallel of latitude, and are therefore at 49 degrees north latitude. Latitude is expressed in degrees (°), minutes ('), and seconds ("). Though the terms are similar, latitude is not a measurement of time and is actually related to distance. One minute of latitude is equal to one nautical mile (nm).

Meridians of Longitude

Meridians of longitude are a series of circles, which measure east and west. The baseline for measuring is the prime meridian, which runs north to south through Greenwich, England. The prime meridian is 0 degrees of longitude. As one travels away from the prime meridian the degree of longitude becomes larger, to a maximum of 180 degrees east or west. Many meridians of longitude pass through Canada, with one being made famous by the Tragically Hip song "Hundredth Meridian". Longitude is expressed in degrees (°), minutes ('), and seconds ("). Longitude is not a measurement of time, but there is a relationship between time and longitude.

The Equator

The equator is the only parallel of latitude, which divides the earth into two equal halves. It is expressed as 0 degrees of latitude and is the dividing line between the northern and southern hemispheres.

The Prime Meridian

The prime meridian is one half of a circle, which will divide the earth into two equal halves. The other half is the International Date Line. The prime meridian is expressed as 0 degrees of longitude, while the International Date Line is expressed as 180 degrees of longitude. Both lines divide the earth into the western and eastern hemispheres.

CONFIRMATION OF TEACHING POINT 1

QUESTIONS

Q1. What is a graticule?

Q2. Which directions do parallels of latitude measure?

Q3. Which directions do meridians of longitude measure?

ANTICIPATED ANSWERS

A1. A graticule is a three-dimensional geometrical pattern of intersecting circles.

A2. Parallels of latitude measure north and south from the equator.

A3. Meridians of longitude measure east and west from the prime meridian.

Teaching Point 2	**Explain Geographical Coordinates**
Time: 5 min	Method: Interactive Lecture

GEOGRAPHICAL COORDINATES

The locations of cities, towns, and airports may be designated by their geographical coordinates. These coordinates express where a parallel of latitude intersects with a meridian of longitude. This is similar in principle to the X-and Y-axis on a graph.

Units of Measurement

Both latitude and longitude use the same units of measurement: degrees, minutes, and seconds. There are 60 seconds in a minute and 60 minutes in a degree. For latitude, this means that one degree is equal to 60 nm.

Sequencing

When expressing geographical coordinates, latitude is always shown first and longitude second. Whenever possible, coordinates should be given in the greatest detail. This means using degrees, minutes and seconds of latitude and longitude. The more precise the coordinates, the easier it will be to find a location.

Examples of coordinates include:

- Penticton Airport: N 49° 27' 47" W 119° 36' 08"
- Red Deer Airport: N 52° 10' 43" W 113° 53' 35"
- St. Jean Airport: N 45° 17' 40" W 73° 16' 52"
- Debert Airport: N 45° 25' 07" W 63° 27' 28"

CONFIRMATION OF TEACHING POINT 2

QUESTIONS

Q1. What are geographical coordinates used for?

Q2. How are geographical coordinates expressed?

Q3. What is an example of a coordinate?

ANTICIPATED ANSWERS

A1. Designating the location of cities, towns, and airports.

A2. Latitude is always shown first, longitude second.

A3. Answers may vary. Use examples in TP 2 as a guide.

Teaching Point 3 **Given a Set of Coordinates, Demonstrate and Have the Cadet Determine the Location of an Airport**

Time: 10 min Method: Demonstration and Performance

ACTIVITY

OBJECTIVE

The objective of this activity is to determine the location of an airport using coordinates.

RESOURCES

- Paper,
- Tape or adhesive putty,
- VNC, and
- Predetermined sets of coordinates for airports.

ACTIVITY LAYOUT

Arrange the classroom so that each pair may work with a VNC.

ACTIVITY INSTRUCTIONS

1. Divide the cadets into pairs.
2. Write three sets of coordinates on the whiteboard and cover them with paper.
3. Distribute one VNC to each pair of cadets.
4. Uncover the first set of coordinates, and demonstrate how to find the airport.
5. Have the cadets find the airport at those coordinates. Assist as necessary.
6. Uncover the second set of coordinates and repeat step five.
7. Uncover the third set of coordinates and repeat step five.

SAFETY

N/A.

CONFIRMATION OF TEACHING POINT 3

The cadets’ participation in the locating an airport activity will serve as confirmation of this TP.

Teaching Point 4 | **Demonstrate and Have the Cadet Determine the Coordinates of a Given Location on a Map**

Time: 5 min | Method: Demonstration and Performance

ACTIVITY

OBJECTIVE

The objective of this activity is to determine the coordinates of a given location on a map.

RESOURCES

- Paper,
- Tape or adhesive putty,
- VNC, and
- Predetermined locations on a map.

ACTIVITY LAYOUT

Arrange the classroom so that each pair may work with a VNC.

ACTIVITY INSTRUCTIONS

1. Divide the cadets into pairs.
2. Write two locations on the whiteboard and cover with paper.
3. Distribute one VNC to each pair of cadets.
4. Choose a location on the map and demonstrate how to determine the coordinates.
5. Uncover the first location. Assist cadets by giving them general directions (eg, trace a line with their fingers northeast of city X).
6. Have the cadets determine the coordinates of that location. Assist as necessary.
7. Uncover the second set of coordinates and repeat step five and six.

SAFETY

N/A.

CONFIRMATION OF TEACHING POINT 4

The cadets’ participation in the determining coordinates activity will serve as confirmation of this TP.

END OF LESSON CONFIRMATION

The cadets’ participation in the activities in TPs 3 and 4 will serve as confirmation of this lesson.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

This EO is assessed IAW Chapter 3, Annex B, Aviation Subjects – Combined Assessment PC.

CLOSING STATEMENT

Determining a location on a map is a very useful skill that cadets may use throughout life, not just in aviation. This skill can transfer to survival, outdoor sports, or travel of any kind.

INSTRUCTOR NOTES/REMARKS

VNCs can be ordered through your Area Cadet Officer (ACO), purchased at a local flight training centre, or ordered online at NavCanada.

EO C337.02 (Practice Air Navigation Skills, Section 4) may be conducted to provide extra practice of the skills learned in this EO.

REFERENCES

C3-116 (ISBN 0-9680390-5-7) MacDonald, A. F., & Peppler, I. L. (2000). *From the Ground Up: Millennium Edition*. Ottawa, ON: Aviation Publishers Co. Limited.

C3-139 (ISBN 0-7715511-5-0) Transport Canada. (1999). *Flight Training Manual: 4th Edition Revised*. Ottawa, ON: Transport Canada.

ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL THREE

INSTRUCTIONAL GUIDE

SECTION 3

EO C337.01 – OPERATE A RADIO FOR AVIATION TRANSMISSION

Total Time:	30 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-803/PG-001, Chapter 4. Specific uses for said resources are identified throughout the instructional guide within the TP for which they are required.

Review the lesson content and become familiar with the material prior to delivering the lesson.

Create several scripts using the examples located at Annex B as a guide.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

An in-class activity was chosen for TP 1 as an interactive way to review the phonetic alphabet.

Demonstration and performance was chosen for TPs 2 and 3 as it allows the instructor to explain and demonstrate operating a radio while providing an opportunity for the cadet to practice radio transmissions under supervision.

INTRODUCTION

REVIEW

N/A.

OBJECTIVES

By the end of this lesson the cadet shall have operated a radio for aviation transmissions.

IMPORTANCE

It is important for cadets to be able to operate a radio for aviation transmissions as it will improve their verbal communication skills and add to their comprehension and enjoyment of familiarization flights.

Teaching Point 1 | **Review the Phonetic Alphabet and Numbers**

Time: 5 min | Method: In-Class Activity

ACTIVITY

OBJECTIVE

The objective of this activity is to review the phonetic alphabet and numbers.

RESOURCES

N/A.

ACTIVITY LAYOUT

N/A.

ACTIVITY INSTRUCTIONS

1. Write the phonetic alphabet and numbers on the whiteboard or flip chart.
2. Have each cadet spell out their first and last name using the phonetic alphabet.
3. Have each cadet count from 1 to 5 or from 5 to 10 using the phonetic numbers.

SAFETY

N/A.

CONFIRMATION OF TEACHING POINT 1

The cadets' participation in the phonetics activity will serve as confirmation of TP 1.

Teaching Point 2 | **Explain, Demonstrate and Have the Cadet Practice Operating a Radio to Communicate the Arrival of an Aircraft**

Time: 10 min | Method: Demonstration and Performance

Arrival messages are transmitted in order to communicate intentions, clearances and instructions. An airport can be a busy place, with many aircraft arriving and departing in short spans of time. This can cause confusion if proper communication is not practiced.

There are normally four parts to a radio message, including:

1. the call-up,
2. the reply,
3. the message, and
4. the acknowledgement or ending.

All parts of the message should be clear, concise and in phonetics where appropriate.

ACTIVITY

Time: 5 min

OBJECTIVE

The objective of this activity is to demonstrate and have the cadet perform operating a radio to communicate the arrival of an aircraft.

RESOURCES

- Hand-held radio, and
- Script of phrases.

ACTIVITY LAYOUT

Arrange the classroom to facilitate small group work over a short distance.

ACTIVITY INSTRUCTIONS

1. Divide the cadets into pairs.
2. Distribute one radio and a script located at Annex B, page 14B-1 to each cadet.
3. Demonstrate the four parts of a radio message that communicate the arrival of an aircraft.
4. Have the cadets practice operating a radio to communicate the arrival of an aircraft.

SAFETY

N/A.

CONFIRMATION OF TEACHING POINT 2

The cadets' participation in the radio activity for communicating the arrival of an aircraft activity will serve as the confirmation of this TP.

Teaching Point 3	**Explain, Demonstrate and Have the Cadet Practice Operating a Radio to Communicate the Departure of an Aircraft**
Time: 10 min	Method: Demonstration and Performance

Departure messages are transmitted in order to communicate intentions, clearances and instructions.

All parts of the message should be clear, concise and in phonetics where appropriate.

ACTIVITY

Time: 5 min

OBJECTIVE

The objective of this activity is to demonstrate and have the cadet perform operating a radio to communicate the departure of an aircraft.

RESOURCES

- Hand-held radio, and
- Script of phrases.

ACTIVITY LAYOUT

Arrange the classroom to facilitate small group work over a small distance.

ACTIVITY INSTRUCTIONS

1. Divide the cadets into pairs.
2. Distribute one radio and a script located at Annex B, page 14B-2 to each cadet.
3. Demonstrate the four parts of a radio message that communicate the departure of an aircraft.
4. Have the cadets practice operating a radio to communicate the departure of an aircraft.

SAFETY

N/A.

CONFIRMATION OF TEACHING POINT 3

The cadets' participation in the operation of a radio for communicating the departure of an aircraft activity will serve as the confirmation of this TP.

END OF LESSON CONFIRMATION

The cadets' participation in the operation of a radio for aviation transmission activities will serve as the confirmation of this lesson.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

N/A.

CLOSING STATEMENT

Proper communication over the radio is essential. Some messages may contain a large amount of information that must be transmitted in a brief message. This skill will assist in developing effective verbal communication while using a radio.

INSTRUCTOR NOTES/REMARKS

Depending on available resources, this EO may be conducted on the familiarization flying day in cooperation with the Technical Training Establishment (TTE).

REFERENCES

C3-116 (ISBN 0-9680390-5-7) MacDonald, A. F., & Peppler, I. L. (2000). *From the Ground Up: Millennium Edition*. Ottawa, ON: Aviation Publishers Co. Limited.

C3-182 *Study Guide for the Radiotelephone Operator's Restricted Certificate (Aeronautical)*. (1990). Retrieved October 23, 2007, from http://www.ic.gc.ca/epic/site/smt-gst.nsf/en/sf01397e.html.

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ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL THREE

INSTRUCTIONAL GUIDE

SECTION 4

EO C337.02 – PRACTICE AIR NAVIGATION SKILLS

Total Time:	30 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-803/PG-001, Chapter 4. Specific uses for said resources are identified throughout the instructional guide within the TP for which they are required.

Review the lesson content and become familiar with the material prior to delivering the lesson.

Develop a list of points and coordinates for airports to be used in TP 1.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

A practical activity was chosen for this lesson so that the cadets may further develop skills learned in EO M337.01 (Measure Distance Along a Route, Section 1) and EO M337.02 (Determine a Position on a Visual Flight Rules [VFR] Navigational Chart [VNC], Section 2).

INTRODUCTION

REVIEW

N/A.

OBJECTIVES

By the end of this lesson the cadet shall have practiced air navigation skills.

IMPORTANCE

It is important for cadets to practice air navigation skills as each cadet may find an opportunity to use these skills in any trip planning, whether aviation based or not.

Teaching Point 1 — **Practice Air Navigation Skills**

Time: 25 min — Method: Practical Activity

The following activities are designed to be conducted concurrently. Some cadets may need to practice measuring distance along a route, while others may need to practice determining position on a Visual Flight Rules (VFR) Navigation Chart (VNC). Determine which cadets need practice with which skill, and then divide the cadets accordingly. Cadets working on different activities may share the same map to lessen the strain on resources.

ACTIVITY

OBJECTIVE

The objective of this activity is to practice measuring distance along a route.

RESOURCES

- Predetermined points,
- VNC,
- International Civil Aviation Organization (ICAO) Ruler,
- Pencil, and
- Eraser.

ACTIVITY LAYOUT

The classroom should be arranged to facilitate individual and group work, depending on the skill level of each cadet.

ACTIVITY INSTRUCTIONS

1. Divide the cadets into pairs based on the activity that they will participate in. Two cadets working on different activities may be paired up to use the same map if needed.
2. Distribute one VNC and one ICAO ruler to each pair of cadets.
3. Using two predetermined points, demonstrate to the cadets how to use the ICAO ruler.
4. Provide the cadets with a second set of predetermined points.
5. Have the cadets measure the distance between these two points using the ICAO ruler.
6. Provide the cadets with two more sets of points and allow them to practice.
7. If time permits, demonstrate to the cadets how to measure the distance using the scale of the map.
8. Have the cadets use the scale of the map to determine the distances of the previously used sets of points. Cross-check with the results of the ICAO ruler.

SAFETY

N/A.

ACTIVITY

OBJECTIVE

The objective of this activity is to practice determining position on a VNC.

RESOURCES

- Paper,
- Tape or adhesive putty,
- VNC, and
- Predetermined sets of coordinates for airports.

ACTIVITY LAYOUT

The classroom should be arranged to facilitate individual and group work, depending on the skill level of each cadet.

ACTIVITY INSTRUCTIONS

1. Write three sets of coordinates on the whiteboard and cover with paper.
2. Divide the cadets into pairs based on the activity that they will participate in. Two cadets working on different activities may be paired up to use the same map if needed.
3. Distribute one VNC to each pair of cadets. Cadets who wish to work independently may still share a map.
4. Uncover the first set of coordinates.
5. Have the cadets find the airport at those coordinates. Assist as necessary.
6. Uncover the second set of coordinates and repeat step four.
7. Uncover the third set of coordinates and repeat step four.

SAFETY

N/A.

CONFIRMATION OF TEACHING POINT 1

The cadets' participation in the activities in TP 1 will serve as confirmation of this TP.

END OF LESSON CONFIRMATION

The cadets' practicing measuring distance along a route and determining position on a VNC will serve as confirmation of this lesson.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

N/A.

CLOSING STATEMENT

Measuring distance and determining position on a map are transferable skills to any other method of travel.

INSTRUCTOR NOTES/REMARKS

This EO is designed to complement EO M337.01 (Measure Distance Along a Route, Section 1) and EO M337.02 (Determine a Position on a Visual Flight Rules [VFR] Navigational Chart [VNC], Section 2) as extra time to practice the skills.

REFERENCES

N/A.

AIR NAVIGATION TERMS

Graticule. A three-dimensional geometrical pattern of intersecting circles. Envision the black lines on a basketball, or a globe with only the black lines.

Latitude. Parallels of latitude are imaginary circles on the earth's surface, which lie parallel to the equator. Latitude measures 90 degrees north and 90 degrees south of the equator. Parallels of latitude make up half of the earth's graticule. Latitude is measured in degrees (°), minutes ('), and seconds (").

Longitude. Meridians of longitude are imaginary circles on the earth's surface, which intersect at the true or geographic poles, and join the poles of the earth together. Longitude measures 180 degrees west and 180 degrees east of the prime meridian (0 degrees), which passes through Greenwich, England. Meridians of longitude make up the other half of the earth's graticule. Longitude is measured in degrees (°), minutes ('), and seconds (").

Nautical Miles. A nautical mile (nm) is 6 080 feet and is the average length of one minute of latitude.

Statute Miles. A statute mile is 5 280 feet.

Scale. Scale on a map is the relationship between a unit of distance on the chart to the distance on the earth that the unit represents. For example, a scale of 1 : 250 means that one inch on the map is equal to 250 inches on the ground.

VNC. A visual flight rules (VFR) navigation chart (VNC) is a chart used primarily for visual navigation, at low altitudes (below 18 000 feet) and slower speeds (less than 300 knots). A VNC has a scale of 1 : 500 000, or one inch to eight miles.

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EXAMPLES OF ARRIVAL AND DEPARTURE COMMUNICATIONS

Arrival

1.	The call-up:	Schefferville Radio This is Piper Foxtrot Alfa Bravo Charlie Over
2.	The reply:	Piper Foxtrot Alfa Bravo Charlie This is Schefferville Radio Go ahead Over
3.	The message:	Schefferville Radio This is Piper Foxtrot Alfa Bravo Charlie Four miles at one thousand Landing Schefferville Over
		Piper Foxtrot Alfa Bravo Charlie This is Schefferville Radio Roger Wind – one six zero at one five Altimeter – two niner niner seven Over
4.	The acknowledgement:	Schefferville Radio This is Piper Foxtrot Alfa Bravo Charlie Roger

Departure

1.	The call-up:	Schefferville Radio This is Piper Foxtrot Alfa Bravo Charlie Over
2.	The reply:	Piper Foxtrot Alfa Bravo Charlie This is Schefferville Radio Go ahead Over
3.	The message:	Schefferville Radio This is Piper Foxtrot Alfa Bravo Charlie Holding short of runway Tree Tree on Alfa Ready for takeoff Over
		Piper Foxtrot Alfa Bravo Charlie This is Schefferville Radio Proceed at your discretion Wind – three two zero at one zero Over
4.	The acknowledgement:	Schefferville Radio Piper Foxtrot Alfa Bravo Charlie Roger

CHAPTER 15

PO 340 – IDENTIFY ASPECTS OF SPACE EXPLORATION

ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL THREE

INSTRUCTIONAL GUIDE

SECTION 1

EO M340.01 – IDENTIFY CANADIAN ASTRONAUTS

Total Time:	30 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-803/PG-001, Chapter 4. Specific uses for said resources are identified throughout the instructional guide within the TP for which they are required.

Review the lesson content and become familiar with the material prior to delivering the lesson.

Choose two astronauts to be the focus of this lesson.

Retrieve current information about the chosen astronauts from the annexes and update with information from the reference.

Create a slide of each astronaut's photograph.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

An interactive lecture was chosen for this lesson to orient the cadets to Canadian astronauts, to generate interest in Canada's space program, and to emphasize the teaching points.

INTRODUCTION

REVIEW

N/A.

OBJECTIVES

By the end of this lesson the cadet shall have identified Canadian astronauts.

IMPORTANCE

It is important for cadets to identify Canadian astronauts so that they can become familiar with the Canadian space program. The hard work that astronauts perform will illustrate the Air Force motto: Per Ardua ad Astra, as well as the rewards that can be achieved by men and women who accept the challenge of the stars.

Teaching Point 1	**Identify Canadian Astronauts**
Time: 10 min	Method: Interactive Lecture

Training of Canada's astronauts began in 1983 and Canada's first astronaut, Marc Garneau, visited space in October 1984, when, among many other mission accomplishments, the Canada Experiment (CANEX) payload performed important experiments. Those early CANEX experiments were:

- Auroral Photography Experiment (APE),
- Radiation Monitoring Equipment (RME), and
- Thermoluminiscent Dosimeter (TLD).

Since that time both the astronaut cadre and Canada's space program have grown. Some astronauts have retired after brilliant careers and new members have joined the team. Some of Canada's astronauts include:

- Marc Garneau (Canada's first astronaut),
- Roberta Bondar (Canada's first woman astronaut),
- Steve MacLean,
- Chris Hadfield,
- Robert Thirsk,
- Bjarni Tryggvason,
- David Williams, and
- Julie Payette.

Show the cadets the slides of photographs located at Annexes A to H.

Using information retrieved from the reference, identify the Canadian astronaut who most recently made his or her first space journey.

CONFIRMATION OF TEACHING POINT 1

QUESTIONS

Q1. In what year did training of Canada's astronauts begin?

Q2. When did Canada's first astronaut visit space?

Q3. Who was Canada's first astronaut?

ANTICIPATED ANSWERS

A1. 1983.

A2. October 1984.

A3. Marc Garneau.

Teaching Point 2 — **Discuss the Professional and Personal Profiles of Two Canadian Astronauts**

Time: 15 min — Method: Interactive Lecture

Discuss the following information about the two chosen astronauts, using information located at the respective annexes or retrieved from the reference, to include:

a. missions undertaken,

b. place and date of birth,

c. education,

d. professional experience,

e. special honours, and

f. affiliations.

CONFIRMATION OF TEACHING POINT 2

QUESTIONS

Q1. In what missions did these astronauts take part?

Q2. What part did these astronauts play on these missions?

Q3. What education and experience did these astronauts bring to the missions?

ANTICIPATED ANSWERS

A1. As per lesson content in TP 2.

A2. As per lesson content in TP 2.

A3. As per lesson content in TP 2.

END OF LESSON CONFIRMATION

QUESTIONS

Q1. Which Canadian astronaut most recently made his or her first space journey?

Q2. Who was Canada’s first astronaut?

Q3. Who was Canada’s first woman astronaut?

ANTICIPATED ANSWERS

A1. As per lesson content in TP 1.

A2. Marc Garneau.

A3. Roberta Bondar.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

N/A.

CLOSING STATEMENT

Space missions have a short history and a vast future. Cadets can stay current with the space program by frequently visiting websites of the Canadian Space Agency (CSA), the US National Aeronautics and Space Administration (NASA) and websites of other organizations such as the European Space Agency (ESA).

INSTRUCTOR NOTES/REMARKS

The instructor shall obtain the latest biographical information for this EO. This material must be updated each year to reflect the Canadian Space Agency's recent activities.

A list shall be kept of astronauts that cadets have focused on to prevent repetition, since other lessons, such as EO C340.01 (Identify Canadian Astronauts, Section 3), may introduce other astronauts in the future.

REFERENCES

C3-238 Canadian Space Agency. (2008). *Canadian Space Agency*. Retrieved February 9, 2008, from http://www.space.gc.ca/asc/eng/default.asp.

ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL THREE

INSTRUCTIONAL GUIDE

SECTION 2

EO M340.02 – DISCUSS THE HISTORY OF MANNED SPACE EXPLORATION

Total Time:	30 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-803/PG-001, Chapter 4. Specific uses for said resources are identified throughout the instructional guide within the TP for which they are required.

Review the lesson content and become familiar with the material prior to delivering the lesson.

Create slides of figures located at Annexes I to L.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

An interactive lecture was chosen for this lesson to orient the cadets, generate interest, present background material, and clarify the history of manned space exploration.

INTRODUCTION

REVIEW

N/A.

OBJECTIVES

By the end of this lesson the cadet shall have discussed the history of manned space exploration.

IMPORTANCE

It is important for cadets to learn about the history of manned space exploration because in the near future, space exploration will become increasingly significant as developing technologies and resource depletion move humanity's focus beyond earth.

Teaching Point 1 — **Discuss the Mercury Program**

Time: 5 min — Method: Interactive Lecture

Show the cadets the early manned space exploration timeline located at Annex I.

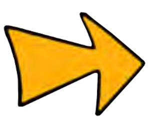
On May 5, 1961, America's first astronaut, Alan Shepard, blasted into space on a Redstone rocket. His history-making suborbital flight was in a one-man capsule named Freedom 7, which was only two metres long and less than two metres in diameter.

Show the cadets Figure 15I-1.

OBJECTIVES OF THE MERCURY PROGRAM

Specific studies and tests conducted by the US government and industry, culminating in 1958, indicated the feasibility of manned space flight. The objectives of the Mercury program, as stated at the time of project commencement in November 1958, were:

- place a manned spacecraft in orbital flight around the earth;
- investigate man's performance capabilities and his ability to function in the environment of space; and
- recover the man and the spacecraft safely.



The 1983 movie *The Right Stuff* is based on the story of the Mercury program.

HISTORY OF THE MERCURY PROGRAM

The US' first manned space flight project was successfully accomplished in less than five years, which saw more than 2 000 000 people from major government agencies and the aerospace industry combine their skills, initiative and experience into a national effort.

In this period, six manned space flights were accomplished as part of a 25-flight program. These manned space flights were accomplished with complete pilot safety and without change to the basic Mercury objectives.

It was shown that man could function ably as a pilot-engineer-experimenter without undesirable reactions or deteriorations of normal body functions for periods up to 34 hours of weightless flight. Directing this large and fast moving project required the development of a management structure and operating mode that satisfied the requirement to mould the many different entities into a workable structure.

Timeline of the Mercury Program

- October 1, 1958 National Aeronautics and Space Administration (NASA) created

- November 26, 1958 Mercury program announced
- December 4, 1959 Launch of Sam (a monkey) on Little Joe 2
- April 9, 1959 NASA names the seven Mercury astronauts
- January 21, 1960 Launch of Miss Sam (a monkey) on Little Joe IB
- January 31, 1961 Launch of Ham (a chimpanzee) on Mercury Redstone 2
- May 5, 1961 Launch of Alan Shepard in Freedom 7 (suborbital)
- July 21, 1961 Launch of Gus Grissom in Liberty 7 (suborbital)
- November 29, 1961 Launch of Enos (a chimpanzee) on Mercury Atlas 5 (orbital)
- January 3, 1962 Gemini program formally conceived
- February 20, 1962 Launch of John Glenn in Friendship 7, first American human orbital flight
- May 24, 1962 Launch of Scott Carpenter in Aurora 7
- October 3, 1962 Launch of Walter Schirra in Sigma 7
- May 15, 1963 Launch of Gordon Cooper in Faith 7, the final mission of the Mercury program

CONFIRMATION OF TEACHING POINT 1

QUESTIONS

Q1. Who was America's first astronaut to go into space?

Q2. Which movie portrays the Mercury program?

Q3. How many manned missions were there in the Mercury program?

ANTICIPATED ANSWERS

A1. Alan Shepard.

A2. *The Right Stuff*.

A3. Six.

Teaching Point 2 | **Discuss the Gemini Program**

Time: 5 min | Method: Interactive Lecture

Show the cadets the early manned space exploration timeline located at Annex I.

OBJECTIVES OF THE GEMINI PROGRAM

The Gemini program was a necessary intermediate step between the Mercury program and the Apollo program. It had four objectives:

- to subject astronauts to long duration flights – a requirement for projected later trips to the moon or deeper space;

- to develop effective methods for rendezvous and docking with other orbiting vehicles and to manoeuvre the docked vehicles in space;
- to perfect methods of re-entry and landing spacecraft at a pre-selected ground landing point; and
- to gain additional information concerning the effects of weightlessness on crew members and to record the physiological reactions of crew members during longer duration flights.

HISTORY OF THE GEMINI PROGRAM

On May 25, 1961, three weeks after Mercury astronaut Alan Shepard became the first American in space, President John F. Kennedy announced the goal to send astronauts to the moon before the end of the decade. To facilitate this goal, NASA expanded the existing manned space flight program in December 1961 to include the development of a two-man spacecraft. The program was officially designated Gemini on January 3, 1962.

Gemini, to a large degree, was the work of a Canadian – James Arthur Chamberlin of Kamloops, British Columbia, a mechanical engineer educated at the University of Toronto. Having served as the chief engineer for the Mercury program, Chamberlin was selected to be Gemini's Project Manager.

Show the cadets Figure 15J-1.

Gemini was named after the third constellation of the Zodiac and its twin stars, Castor and Pollux, because of its two-man crew.

Show the cadets Figure 15J-2.

Gemini consisted of 12 flights, including two unmanned flight tests of the equipment:

- March 23, 1965 — Gemini III – First manned Gemini flight completed three orbits
- June 03–07, 1965 — Gemini IV – First American Extravehicular Activity (EVA)
- August 21–29, 1965 — Gemini V – First use of fuel cells for electrical power
- December 04–18, 1965 — Gemini VII – First rendezvous in space, with Gemini VI-A
- December 15–16, 1965 — Gemini VI-A – First rendezvous in space, with Gemini VII

Show the cadets Figure 15J-3.

- March 16, 1966 — Gemini VIII – First docking with another (unmanned) spacecraft by astronauts Neil Armstrong and David Scott
- June 03–06, 1966 — Gemini IX-A – Three rendezvous and two hours of EVA
- July 18–21, 1966 — Gemini X – Rendezvoused with target vehicle and EVA
- September 12–15, 1966 — Gemini XI – Gemini record altitude of 1 189.3 km
- November 11–15, 1966 — Gemini XII – Final Gemini flight: rendezvous, docking, EVA

CONFIRMATION OF TEACHING POINT 2

QUESTIONS

Q1. Who was the Gemini Project Manager?

Q2. How many astronauts were on a Gemini flight?

Q3. Which astronauts accomplished the first docking with another space vehicle?

ANTICIPATED ANSWERS

A1. James Arthur Chamberlin of Kamloops, British Columbia.

A2. Two.

A3. The Gemini crew of Neil Armstrong and David Scott.

Teaching Point 3	**Discuss the Apollo Program**
Time: 5 min	Method: Interactive Lecture

Show the cadets the early manned space exploration timeline located at Annex I.

July 20, 1969: "Houston, Tranquility Base here. The Eagle has landed." were the famous first words spoken from the moon.

OBJECTIVES OF THE APOLLO PROGRAM

The Apollo's program objectives went beyond landing Americans on the moon and returning them safely to earth. The objectives also included:

- establishing the technology to meet other national interests in space;
- achieving pre-eminence in space for the United States;
- carrying out a program of scientific exploration of the moon; and
- developing man's capability to work in the lunar environment.

HISTORY OF THE APOLLO PROGRAM

The Apollo program was the work of Owen E. Maynard of Sarnia, Ontario, chief of the systems engineering division in the Apollo Spacecraft Program Office. He was previously chief of the Lunar Module engineering office in the Apollo Program Office at the Manned Spacecraft Center in Houston. Maynard held an aeronautical engineering degree from the University of Toronto. His years at NASA were rewarded on July 20, 1969, when Apollo 11 commander Neil Armstrong stepped out of the lunar module (LM) and took one small step in the Sea of Tranquility, calling it a giant leap for mankind. Maynard remained in charge of Apollo systems engineering until he left NASA in 1970 following the successful achievement of Kennedy's lunar landing goal. Thereafter he returned to private industry.

Show the cadets Figure 15K-1.

The Apollo program used the Saturn family of launch vehicles. The command, service and lunar module made a small package, dwarfed at the top of the giant launch vehicle.

Show the cadets Figure 15K-2.

The command module (CM) was small for three men to spend 8 days, 3 hours and 18 minutes in it. On the *Apollo 11* journey of July, 1969, the three men were Neil Armstrong (commander), Michael Collins (CM pilot) and Edwin (Buzz) Aldrin Jr. (LM pilot).

Show the cadets Figure 15K-3.

Six of the Apollo missions, *Apollos 11, 12, and 14–17*, landed on the moon, studying soil mechanics, meteoroids, seismic activity, heat flow, lunar ranging, magnetic fields and solar wind.

Apollos 7 and 9 tested spacecraft in earth orbit; *Apollo 10* orbited the moon as the dress rehearsal for the first landing. An oxygen tank explosion forced *Apollo 13* to scrub its landing, but the can-do problem-solving of the crew and mission control – and Maynard's systems engineering group – turned the mission into what was called a successful failure.

The 1995 movie *Apollo 13* is based on the story of the 1970 mission to the moon.

Apollo Flight Summary

- October 1968 *Apollo 7* – Earth orbit
- December 1968 *Apollo 8* – Ten lunar orbits

- March 1969 *Apollo 9* – First manned flight of lunar module
- May 1969 *Apollo 10* – Dress rehearsal for Moon landing
- July 20 1969 *Apollo 11* – First lunar landing mission (on the Sea of Tranquility)
- November 1969 *Apollo 12* – Second lunar landing (on the Ocean of Storms)
- April 1970 *Apollo 13* – Mission aborted after an on-board explosion
- January 1971 *Apollo 14* – Third lunar landing (at Fra Mauro)
- July 1971 *Apollo 15* – Fourth lunar landing (in the Hadley Apennine region)
- April 1972 *Apollo 16* – Fifth lunar landing (on the Descartes highlands)
- December 1972 *Apollo 17* – Last lunar landing (on the Taurus Littrow highlands)

CONFIRMATION OF TEACHING POINT 3

QUESTIONS

Q1. Which family of launch vehicles were used for Project Apollo?

Q2. Who was chief of systems engineering for the Apollo Project?

Q3. What was the date of Apollo's first manned moon landing?

ANTICIPATED ANSWERS

A1. The Saturn family.

A2. Owen E. Maynard of Sarnia, Ontario.

A3. July 20, 1969.

Teaching Point 4	**Discuss the Russian Manned Space Program**
Time: 10 min	Method: Interactive Lecture

The Mir space station, which was shared by Russian cosmonauts and American astronauts, was a continuation of the Soviet space program. Construction of Mir began in 1986, before the Soviet Union was disbanded. Mir was preceded by many years of Soviet space development which included, among many other programs, the Vostok missions, the Soyuz missions and the Salyut space station.

VOSTOK

The Vostok program (Восто́к, translated as "East") was a Soviet human spaceflight project that succeeded in putting a person into earth's orbit for the first time.

Show the cadets Figure 15L-1.

Vostok manned record-breaking flights included:

- April 12, 1961 *Vostok-1* – First man in space (Yuri Gagarin)

- August 6, 1961 *Vostok-2* – First full day in space
- August 11, 1962 *Vostok-3* – First of two simultaneous manned spacecraft
- August 12, 1962 *Vostok-4* – Second of two simultaneous manned spacecraft
- June 14, 1963 *Vostok-5* – Longest solo orbital flight
- June 16, 1963 *Vostok-6* – First woman in space (Valentina Tereshkova)

SOYUZ

The Soyuz program (meaning "Union") is a human spaceflight program that was initiated by the Soviet Union in the early 1960s. It was originally part of a moon landing program intended to put a Soviet cosmonaut on the moon. Both the Soyuz spacecraft and the Soyuz launch vehicle were part of this program, which later became the responsibility of the Russian Federal Space Agency.

The Soyuz program produced many experimental variants, but its development is commonly divided into three historical parts:

- Early era: *Soyuz-1 to Soyuz-9* (1966–1970),
- Salyut era: *Soyuz-10 to Soyuz T-14* (1971–1985), and
- Mir era: *Soyuz T-15 to Soyuz TM-30* (1986–2000).

Unlike the one-man Vostok spacecraft, the first three-seat Soyuz was able to conduct active manoeuvring, orbital rendezvous and docking. These features would all have been necessary for a flight around the moon or for a lunar expedition. In the early plans for circumlunar flight, the Soyuz was to be a three-part spacecraft assembled in the low-earth orbit from parts delivered by separate launch vehicles. This plan was later abandoned in favour of a two-launch and, later, a single-launch method.

In 1971, a three-seat Soyuz delivered two crews to the first Salyut space station. Disaster struck when the first Salyut crew returned from orbit. The sudden depressurization of the re-entry capsule killed all three cosmonauts. As a result of this tragedy, the designers introduced protective pressure suits, but at the expense of room for one crewmember. Two-seat Soyuz spacecraft then continued ferrying the crews to the Salyut and Almaz space stations.

SALYUT AND MIR SPACE STATIONS

First-Generation Salyut Stations (1964–1977)

First-generation Salyut space stations had one docking port and could not be resupplied or refuelled. The stations were launched unmanned and later occupied by crews. There were two types: Almaz military stations and Salyut civilian stations. To Western observers, both types were Salyut stations, including:

- 1971 *Salyut-1* – First space station (civilian)
- 1973 *Salyut-2* – First Almaz station (military, failure)
- 1974–75 *Salyut-3* – Almaz station (military)
- 1974–77 *Salyut-4* – Civilian space station
- 1976–77 *Salyut-5* – Last Almaz station (military)

Show the cadets Figures 15L-2 and 15L-3.

Second-Generation Stations (1977–1985)

Second-generation Russian space stations included:

- 1977–1982 *Salyut-6* – Civilian
- 1982–1991 *Salyut-7* – Civilian (last staffed in 1986)

With the second-generation stations, the Soviet space station program evolved from short-duration to long-duration stays. Visiting crews relieved the monotony of a long stay in space.

Salyut-6 Key Facts

Highlights of the *Salyut-6* era include:

- The station received 16 cosmonaut crews, including six long-duration crews. The longest stay time for a *Salyut-6* crew was 185 days. The first *Salyut-6* long-duration crew stayed in orbit for 96 days, beating the 84-day world record for space endurance established in 1974 by the last American Skylab crew.
- The station hosted cosmonauts from Hungary, Poland, Romania, Cuba, Mongolia, Vietnam and East Germany.
- Twelve freighter spacecraft delivered equipment, supplies and fuel.

Show the cadets Figure 15L-3 and 15L-4.

Salyut-7 Key Facts

Highlights of the *Salyut-7* era include:

- *Salyut-7*, a near twin of *Salyut-6*, was home to 10 cosmonaut crews, including six long-duration crews. The longest stay time was 237 days.
- Cosmonauts from France and India worked aboard the station, as did the first female Russian space traveller since 1963.
- Thirteen freighter spacecraft delivered equipment, supplies, and fuel to *Salyut-7*.
- Two experimental transport logistics spacecraft, Cosmos 1443 and Cosmos 1686, docked with *Salyut-7*. Cosmos 1686 was a transitional vehicle, a transport logistics spacecraft redesigned to serve as an experimental space station module.
- *Salyut-7* was abandoned in 1986 and re-entered earth's atmosphere, burning up over Argentina in February, 1991.

Mir

Mir was a third-generation Russian space station which, after 1992, was shared with the US.

Mir means peace and community in Russian. The Mir space station contributed to world peace by hosting international scientists and American astronauts. It also supported a community of humans in orbit and symbolized the commonwealth of the Russian people.

Mir was constructed in orbit by connecting different modules, each launched separately from 1986 – 1996. During the Shuttle-Mir Program, Russia's Mir combined its capabilities with America's space shuttles. The orbiting Mir provided a large and liveable scientific laboratory in space. The visiting space shuttles provided transportation and supplies, as well as temporary enlargements of living and working areas, creating history's largest spacecraft.

Show the cadets Figures 15L-5 and 15L-6.

Magnificent to behold through the windows of a space shuttle, *Mir* was as big as six school buses. Inside, it looked more like a cramped labyrinth, crowded with hoses, cables and scientific instruments – as well as articles of everyday life, such as photos, children's drawings, books and a guitar. *Mir* commonly housed three crew members, but it supported as many as six, for up to a month. Except for two short periods, *Mir* was continuously occupied until August 1999.

The journey of the 15-year-old Russian space station ended March 23, 2001, as *Mir* re-entered the Earth's atmosphere near Nadi, Fiji and fell into the South Pacific. Despite its inconveniences, many cosmonauts and astronauts grew to love *Mir*, comparing it to a living being with qualities, needs and eccentricities.

CONFIRMATION OF TEACHING POINT 4

QUESTIONS

Q1. Which Salyut space stations were considered to be second generation?

Q2. What does *Mir* mean in Russian?

Q3. Who were the first man and woman in space?

ANTICIPATED ANSWERS

A1. *Salyut-6* and *Salyut-7*.

A2. Peace and community.

A3. Yuri Gagarin and Valentina Tereshkova, respectively.

END OF LESSON CONFIRMATION

QUESTIONS

Q1. Who was America's first astronaut to go into space?

Q2. When did *Apollo 11* land on the moon?

Q3. Who was chief of systems engineering for the Apollo Project?

ANTICIPATED ANSWERS

A1. Alan Shepard.

A2. July 20, 1969.

A3. Owen E. Maynard of Sarnia, Ontario.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

N/A.

CLOSING STATEMENT

Space exploration has taken great courage and ingenuity on the part of many people. Space exploration and the space race have changed the world for the better through international cooperation and promoting technological advancement.

INSTRUCTOR NOTES/REMARKS

N/A.

REFERENCES

(ISBN 978-0-75662-227-5) Graham, I. (2006). *Space Travel*. New York, NY: DK Publishing, Inc.

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ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL THREE

INSTRUCTIONAL GUIDE

SECTION 3

EO C340.01 – IDENTIFY CANADIAN ASTRONAUTS

Total Time:	60 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-803/PG-001, Chapter 4. Specific uses for said resources are identified throughout the instructional guide within the TP for which they are required.

Review the lesson content and become familiar with the material prior to delivering the lesson.

Retrieve current information located at Annexes A to H in the instructional guide for EO M340.01 (Identify Canadian Astronauts, Section 1) or from the reference.

Create a slide of each astronaut's photograph from the same annexes.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

An interactive lecture was chosen for this lesson to orient the cadets to Canadian astronauts, to generate interest in Canada's space program, and to emphasize the teaching points.

INTRODUCTION

REVIEW

N/A.

OBJECTIVES

By the end of this lesson the cadet shall have identified Canadian astronauts.

IMPORTANCE

It is important for cadets to identify Canadian astronauts so that they can become familiar with the Canadian space program. The hard work that astronauts perform will illustrate the Air Force motto: *Per Ardua ad Astra*, as well as the rewards that can be achieved by men and women who accept the challenge of the stars.

Teaching Point 1 | **Discuss the Professional and Personal Profiles of Canadian Astronauts**

Time: 50 min | Method: Interactive Lecture

Ensure that astronauts covered in EO M340.01 (Identify Canadian Astronauts, Section 1) are not included in this lesson.

Discuss the following information about the remaining astronauts, using the information located at the respective annexes in the instructional guide for EO M340.01 (Identify Canadian Astronauts, Section 1) or retrieved from the reference, to include:

a. missions undertaken,

b. place and date of birth,

c. education,

d. professional experience,

e. special honours, and

f. affiliations.

CONFIRMATION OF TEACHING POINT 1

The cadets' participation in the interactive lecture will serve as the confirmation of this TP.

END OF LESSON CONFIRMATION

QUESTIONS

Q1. In what missions did these astronauts take part?

Q2. What role did these astronauts play on these missions?

Q3. What education and experience did these astronauts bring to the missions?

ANTICIPATED ANSWERS

A1. As per lesson content.

A2. As per lesson content.

A3. As per lesson content.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

N/A.

CLOSING STATEMENT

Space missions have a short history and a vast future. Cadets can stay current with the space program by frequently visiting websites of the Canadian Space Agency (CSA), the US National Aeronautics and Space Administration (NASA) and other organizations such as the European Space Agency (ESA).

INSTRUCTOR NOTES/REMARKS

The instructor shall obtain the latest biographical information for this EO. This material must be updated each year to reflect the Canadian Space Agency's recent activities.

A list shall be kept of astronauts that cadets have focused on to prevent repetition.

REFERENCES

C3-238 Canadian Space Agency. (2008). *Canadian Space Agency*. Retrieved February 9, 2008, from http://www.space.gc.ca/asc/eng/default.asp.

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ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL THREE

INSTRUCTIONAL GUIDE

SECTION 4

EO C340.02 – DISCUSS THE CANADIAN SPACE PROGRAM

Total Time:	30 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-803/PG-001, Chapter 4. Specific uses for said resources are identified throughout the instructional guide within the TP for which they are required.

Review the lesson content and become familiar with the material prior to delivering the lesson.

Create slides of Annexes M and N.

Photocopy Annex O for each cadet.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

An interactive lecture was chosen for this lesson to orient the cadets to the Canadian space program and to generate interest.

INTRODUCTION

REVIEW

N/A.

OBJECTIVES

By the end of this lesson the cadet shall have discussed the Canadian space program.

IMPORTANCE

It is important for cadets to learn about the Canadian space program so they know that Canada participates in space exploration. The Canadian Space Agency (CSA) and its partners are leading the world in research involving space technologies. This information may also generate interest in the many scientific and technical careers involved in the exploration of space.

Teaching Point 1 **Describe Canada's Involvement in Space Technologies**

Time: 10 min Method: Interactive Lecture

Show slide of Annex M.

CANADA'S INVOLVEMENT IN SPACE TECHNOLOGIES

The CSA headquarters is located at the John H. Chapman Space Centre in Saint-Hubert, Que. Canada is involved in many aspects of space exploration. Canadian scientists and researchers are particularly interested with the development and testing of space technologies.

Canadian Space Agency, 2008, Canadian Space Agency Logo. Retrieved April 14, 2008, from http://upload.wikimedia.org/wikipedia/en/0/01/Canadian_Space_Agency_logo.png

Figure 15-4-1 CSA Logo

The David Florida Laboratory (DFL)

The David Florida Laboratory is Canada's world-class spacecraft assembly, integration and testing centre. Named in honour of one of Canada's pioneers in space research, C. David Florida, it is located west of Ottawa, Ont. The laboratory is maintained by the CSA. On a fee-for-service basis, the DFL is available for use by Canadian and foreign aerospace and telecommunication companies and organizations for testing hardware to be used in space. Since its creation in September 1972, DFL has made substantial contributions to satellite communications and remote sensing in Canada and continues to play an essential role in our space program.

The Canadian Analogue Research Network (CARN)

CARN is the organization that uses Canadian sites for field studies. These analogue sites approximate conditions that may exist or have existed on Mars and other planetary bodies such as the moon and the Solar System's icy moons.

They provide a unique opportunity to investigate geological and biological processes and hypothesize about planetary bodies. Analogue sites can be used to develop and test specific technology and to understand how to explore and live on other planets. The following are the first three CARN sites selected in 2005:

- Haughton-Mars Project Research Station, Devon Island, Nunavut, 75° 22' N, 89° 41' W;

- McGill Artic Research Station, Axel Heiberg Island, Nunavut, 79° 26’ N, 90° 46’ W; and
- Pavilion Lake, B.C., 50° 51’ N, 121° 44’ W.

It is envisioned that CARN will expand in future years with the inclusion of other selected sites.

Partnerships With the CSA

The CSA, formed in 1989, has many partners including international space agencies, industry, post-secondary researchers and educational projects.

One example of the CSA’s partnership with international space agencies is the CSA’s participation in the International Space Station (ISS). These partners include space agencies from Europe, Japan, Russia and the United States. All of these agencies have sent astronauts to the ISS and they each have ground crews and researchers that support each element of the project.

Industrial partners with the CSA include various Canadian technology companies. MD Robotics is one partner best known for developing and building the first Canadarm. MD Robotics is the prime contractor for the Mobile Servicing System, a sophisticated robotic system critical to assembly, maintenance and servicing of the ISS.

Another technology partner is EMS Technologies, Canada, Ltd. They are a leading provider of wireless, satellite and broadband communication products. EMS Technologies hardware has flown on more than 200 spacecraft.

Many partners of the CSA come from academic institutions. Most of these institutions have a space technology research faculty and their students may be granted money from the CSA to conduct their studies. These schools include the University of British Columbia and the University of Toronto.

The CSA takes great pride in their partnership with educational projects. CSA has a Youth Outreach Group which develops and organizes special educational projects for teachers and youth. CSA believes that students in primary and secondary schools are Canada’s next generation of space explorers and researchers. Some of these students are given opportunities to pursue their studies and begin a career in science and technology.

For more information on the CSA and its Youth Outreach Group, access their website at www.space.gc.ca.

CONFIRMATION OF TEACHING POINT 1

QUESTIONS

Q1. Where is DFL located?

Q2. Analogue sites are used to develop what?

Q3. List some CSA international partners.

ANTICIPATED ANSWERS

A1. It is located west of Ottawa, Ont.

A2. Analogue sites can be used to develop and test specific space technology.

A3. Space agencies from Europe, Japan, Russia and the United States.

Teaching Point 2 **Describe CSA Missions**

Time: 15 min Method: Interactive Lecture

CSA MISSIONS

CSA has participated in many space missions with its partners. Canadian astronauts or Canadian technology has gone into space with agencies from the United States, Russia, Europe and Japan. There are four basic types of CSA missions.

Telecommunications

Canada is the second largest country on earth and finding ways to communicate over great distances is a challenge. Telecommunication satellites are the most economical way to connect Canadian communities. Being able to keep all places in the country connected with advanced telecommunication services assists every Canadian in competing in the global marketplace. These telecommunication satellites assist search and rescue teams, provide ships and aircraft with geopositioning information, and connect instructors with classrooms across the country.

Ask cadets to list instances where they have probably used telecommunication satellites (eg, long distance cell phone conversations, satellite TV, etc).

Canada's most famous telecommunication satellites are the ANIK series, which were launched in the 1980s, 1990s and as recently as 2004.

Earth Observation

Ask cadets to list ideas about what satellites are seeing when they look at the earth.

Canada's earth-observation initiatives enhance our understanding of the planet and its environment. By observing the earth from space, essential information about oceans, ice, land environments and the atmosphere is gathered. Earth-observation satellites collect data that assist scientists monitoring and protecting the environment and managing resources. Some earth-observation satellites gather data that is used by the government to ensure the safety and security of Canadians. Satellite imagery and expertise is also used for global humanitarian efforts. Some examples of earth-observation satellites include:

Radarsat-1. Launched in 1995, Radarsat-1 provides the world with an operational radar satellite system capable of the timely delivery of large amounts of data. Radarsat-1 quickly acquires images of the earth day or night, in all weather conditions and through cloud cover, smoke and haze.

Envisat. Launched in 2002, Envisat collects specific data for the scientific community in order to better understand climatic processes. Data is collected on ocean-atmosphere heat exchange, interaction between the atmosphere and land or ice surfaces and the composition of the atmosphere and its associated chemical processes. This data helps scientists improve climate models.

Cloudsat. Launched in 2006, Cloudsat gathers new data and improve our knowledge of clouds and their effect on climate. Traditional satellites studying the atmosphere can portray the cloud surface accurately, but are limited to a two-dimensional representation of cloud cover. No data has been available on cloud thickness that would help determine the volume and quantity of water, snow, or ice that clouds contain. Cloudsat was developed by National Aeronautics and Space Administration (NASA) in partnership with the CSA.

Radarsat-2. Launched in 2007, Radarsat-2 is Canada's next generation commercial satellite and offers powerful technical advancements. Radarsat-2 has higher resolution cameras and better discrimination of surface types than Radarsat-1. Radarsat-2 will enhance marine surveillance, ice monitoring, disaster management, environmental monitoring, resource management and mapping in Canada and around the world.

Space Exploration

The CSA is involved with exploring space. Canadian astronauts have been on many missions in various space shuttles and continue to investigate the solar system one small step at a time.

Have the cadets name Canadian astronauts.

Canada is renowned for the exceptional instruments in its science satellites. Some of these satellites collect data that will expand our understanding of the origin, formation, structure and evolution of celestial bodies and the universe.

Another example of the CSA exploring space is the use of Canadian technology in various Martian missions. A Canadian weather station was delivered to an arctic region on Mars in 2008. The instruments measure pressure and temperature, and assess local climate patterns as well as dust, clouds and fog in the lower atmosphere.

Canadians are developing integrated communications networks that will be needed to run a successful international mission on Mars. This will enable Canadians to play a key communications role in future manned exploration to the Red Planet and beyond.

The CSA is supporting a study that focuses on the development of biological air filters for maintaining air quality in a closed system. This research may be used for life support systems and will be crucial for any long duration space exploration missions.

Space Medicine

Show slide of Annex N.

Space medicine combines many medical specialties to examine the effects of spaceflight on humans and prevent problems associated with living in a unique, isolated, and extreme environment like space. The CSA has a medical department called the Operational Space Medicine (OSM) Group. It is responsible for the health and safety of Canadian astronauts. Studies have shown that the longer an astronaut remains in space, the more changes will take place in the body. While in space many of these changes tend not to be problematic. It is on their return to earth where the effects of living in space are felt. Some examples of effects may be reduced blood volume, diminished reflexes, loss of bone mass and radiation-induced health problems. OSM group is studying many of these changes to try to overcome them in order to send astronauts on longer flights.

Canadian Space Agency, 2008, Operational Space Medicine Logo. Retrieved April 14, 2008, from http://www.space.gc.ca/asc/eng/astronauts/osm_crest.asp

Figure 15-4-2 OSM Logo

Ask cadets if they think that space medicine will help people on earth and how that will happen.

CONFIRMATION OF TEACHING POINT 2

QUESTIONS

Q1. Why are telecommunication satellites so important to the CSA?

Q2. How can earth-observation satellites assist scientists monitoring and protecting the environment and managing resources?

Q3. Name the CSAs medical group.

ANTICIPATED ANSWERS

A1. Telecommunication satellites are the most economical way to connect Canadian communities.

A2. By collecting data.

A3. OSM Group.

END OF LESSON CONFIRMATION

QUESTIONS

Q1. Where are the three CARN sites in Canada?

Q2. What are the four basic types of missions that CSA participates in?

Q3. Where was a Canadian weather station delivered in 2008?

ANTICIPATED ANSWERS

A1. Devon Island, Nunavut, Axel Heiberg Island, Nunavut, and Pavilion Lake, B.C.

A2. Telecommunications, earth observation, space exploration and space medicine.

A3. To an arctic region on Mars.

Distribute Annex O to each cadet.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

N/A.

CLOSING STATEMENT

Even without any domestic launch capabilities of our own, Canadians have made a large impact on space exploration. There are many scientific and technical careers involved in the exploration of space and the CSA and its partners are leading the world in research involving space technologies.

INSTRUCTOR NOTES/REMARKS

This material must be updated each year to reflect CSA progress.

REFERENCES

C3-238 Canadian Space Agency. (2008). *Canadian Space Agency*. Retrieved February 9, 2008, from http://www.space.gc.ca/asc/eng/default.asp.

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ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL THREE

INSTRUCTIONAL GUIDE

SECTION 5

EO C340.03 – DISCUSS UNMANNED SPACE EXPLORATION

Total Time:	60 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-803/PG-001, Chapter 4. Specific uses for said resources are identified throughout the instructional guide within the TP for which they are required.

Review the lesson content and become familiar with the material prior to delivering the lesson.

Create slides of figures located at Annexes P to S.

Photocopy the handout of page 15Q-4 for each cadet.

Photocopy the *Moons* video worksheet located at page 15S-1.

Cue the video *Moons*.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

An interactive lecture was chosen for this lesson to orient the cadets to unmanned space exploration, generate interest, and emphasize the teaching points.

INTRODUCTION

REVIEW

N/A.

OBJECTIVES

By the end of this lesson the cadet shall have discussed unmanned space exploration.

IMPORTANCE

It is important for cadets to learn about unmanned space exploration because it will become increasingly significant as developing technologies and resource depletion move humanity's focus beyond Earth.

Teaching Point 1 | **Describe the History of Earth Satellites**

Time: 15 min | Method: Interactive Lecture

DEVELOPMENT OF LAUNCH CAPABILITY

To achieve a low earth orbit an object must accelerate to 8 000 m/s. This was first done in 1957 by two liquid-propellant rockets: the Soviet R-7 and America's Jupiter-C.

In 1898, Konstantin Tsiolkovsky (1857–1935), proposed the idea of space exploration by rocket. In 1903, Tsiolkovsky suggested the use of liquid propellants for rockets in order to achieve greater range. For his ideas, careful research and great vision, Tsiolkovsky has been called the father of modern astronautics.

Astronautics. The science of space travel.

Early in the 20th century, an American, Robert Goddard (1882–1945), conducted practical experiments in rocketry with solid-propellant rockets.

In 1919, Goddard published a pamphlet, *A Method of Reaching Extreme Altitudes*. This was a mathematical analysis of what is today called the meteorological sounding rocket.

Goddard became convinced that a rocket could be better propelled by liquid fuel than by solid fuel. Fuel and oxygen tanks, turbines and combustion chambers would be needed. Goddard achieved the first successful flight with a liquid-propellant rocket on March 16, 1926. The rocket flew for only two and a half seconds, climbed 12.5 m and landed 56 m away in a cabbage patch. Goddard's gasoline rocket was the forerunner of modern rocketry.

Goddard's experiments in liquid-propellant rockets continued for many years. His rockets became bigger, flew higher and carried more cargo. For his achievements, Robert Goddard has been called the father of modern rocketry.

Show the cadets Figures 15P-1 and 15P-2. Point out the major components of the liquid-fuelled rocket in Figure 15P-1 corresponding to the parts listed in Figure 15P-2.

SOVIET SPUTNIK MISSION

On October 4, 1957, just 12 years after Goddard's death, the world was stunned by the news of an Earth-orbiting artificial satellite launched by the Soviet Union. Sputnik-1 was the first successful entry in a race for space. Sputnik-1 was a very simple machine. Its mission was to orbit and send repetitive radio signals.

Show the cadets Figures 15P-3 and 15P-4.

The Soviet scientists and engineers launched Sputnik-1 into a low earth orbit by the use of a modified R-7 two-stage rocket. It was the first entirely successful R-7 flight. The R-7 was developed by the military as a means of delivering warhead payloads across vast distances. Such a vehicle was perceived to be necessary for national defence.

Show the cadets Figures 15P-5 and 15P-6.

UNITED STATES' EXPLORER MISSION

A few months after the launch of Sputnik-1 the United States followed with a satellite of its own, Explorer-1, designed and built by the Jet Propulsion Laboratory (JPL) of the California Institute of Technology. This satellite was launched into orbit by the US Army on January 31, 1958, using a Jupiter-C rocket, which was also developed with warheads in mind. In addition to a radio transmitter, Explorer-1 had a scientific instrumentation package designed and built by Dr. James Van Allen of the State University of Iowa. The instruments were designed to measure the intensity of cosmic radiation in space.

The discovery of the Van Allen Belts by the Explorer satellites was considered to be one of the outstanding discoveries of the International Geophysical Year (1958).

The Jupiter-C launcher was a three-stage rocket. Before the successful launch of Explorer-1, the Jupiter-C was used to loft payloads to various altitudes.

Show the cadets the flight history of Jupiter-C located at Annex P. Point out the work that preceded the successful launch of Explorer-1.

More Jupiter-C history can be found at website http://history.nasa.gov/sputnik/expinfo.html

The three-stage Jupiter-C, with Explorer-1 mounted on top, was over 21 m (71 feet) high.

Show the cadets Figures 15P-7 and 15P-8.

Nine months after the launch of Explorer-1, in October 1958, the United States formally organized its space program by creating the National Aeronautics and Space Administration (NASA). NASA became a civilian agency with the goal of peaceful exploration of space for the benefit of all humankind.

CONFIRMATION OF TEACHING POINT 1

QUESTIONS

Q1. Who has been called the father of modern astronautics?

Q2. Who has been called the father of modern rocketry?

Q3. When was NASA created?

ANTICIPATED ANSWERS

A1. Konstantin Tsiolkovsky has been called the father of modern astronautics.

A2. Robert Goddard has been called the father of modern rocketry.

A3. October 1958.

Teaching Point 2	**Describe the Twin Voyager Spacecraft**
Time: 20 min	Method: Interactive Lecture

THE TWIN VOYAGER SPACECRAFT

The twin spacecraft Voyager-1 and Voyager-2 were launched by NASA in the summer of 1977 from Cape Canaveral, Florida. The Voyagers were to conduct close-up studies of Jupiter, Saturn, Saturn's rings and the larger moons of the two planets. To accomplish their two-planet mission, the spacecraft were built to last five years. As the mission went on, and with the successful achievement of all its objectives, the additional flybys of the two outermost giant planets, Uranus and Neptune, also proved possible.

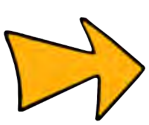
The Planetary Voyage

As the spacecraft flew across the solar system their two-planet mission became four. Their five-year lifetimes stretched to 12 and then to 30 years.

The Voyager mission was designed to take advantage of a rare geometric arrangement of the outer planets in the late 1970s and the 1980s, which allowed for a four-planet tour with minimum propellant and time.

Eventually, Voyager-1 and Voyager-2 would explore all four outer planets of the solar system, 48 of their moons and the unique systems of rings and magnetic fields those planets possess. Had the Voyager mission ended after the Jupiter and Saturn flybys, it still would have provided the material to rewrite astronomy textbooks. Having doubled their itineraries, the Voyagers returned information over the years that has revolutionized the science of planetary astronomy, helping to resolve key questions while raising new ones about the origin and evolution of the planets in our solar system.

Show the cadets Figure 15Q-1.



The layout of Jupiter, Saturn, Uranus and Neptune shown in Figure 15Q-1, which occurs about every 175 years, allows a spacecraft to swing from one planet to the next without the need for large on-board propulsion systems. The flyby of each planet bends the spacecraft's flight path and increases its velocity enough to send it to the next destination. By using this "gravity assist" technique, first demonstrated with NASA's Mariner-10 Venus/Mercury mission in 1973–74, the flight time to Neptune was reduced from 30 years to 12.

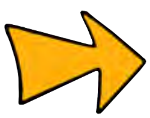
Show the cadets Figure 15Q-2.

The original Voyager mission to Jupiter and Saturn sent Voyager-1 to Jupiter on March 5, 1979 and Saturn on November 12, 1980, followed by Voyager-2 to Jupiter on July 9, 1979, and Saturn on August 25, 1981. The two spacecraft's paths differed in that:

- Voyager-1's trajectory was designed to send the spacecraft close to Saturn's large moon, Titan, and behind Saturn's rings.
- Voyager-2 was aimed to fly by Saturn at a point that would automatically send the spacecraft in the direction of Uranus.

After Voyager-2's successful Saturn encounter, it was shown that the spacecraft would likely be able to fly to Uranus with all instruments operating. Subsequently, NASA also authorized the Neptune leg of the mission, which was renamed the Voyager Neptune Interstellar Mission. Voyager-2 encountered Uranus on January 24, 1986, returning detailed photos and other data about the planet, its moons, magnetic field and dark rings.

Voyager-1 continues outward, conducting studies in space beyond the outer planets. Eventually, its instruments may be the first of any spacecraft to sense the heliopause.



The heliopause is the boundary between the end of the Sun's magnetic influence and the beginning of interstellar space.

After Voyager-2's closest approach to Neptune on August 25, 1989, the spacecraft flew a course taking it into interstellar space. Reflecting the Voyagers' new destinations, the project is now known as the Voyager Interstellar Mission.

The Voyager Interstellar Mission (VIM)

The heliopause is the boundary between the solar and the interstellar winds. This is a definitive and unambiguous frontier that the Voyagers will approach and pass through.

Show the cadets Figure 15Q-3.

Voyager-1 crossed the solar wind termination shock in December 2004 and entered into the heliosheath, the turbulent region leading up to the heliopause. The Voyagers should cross the heliopause 10 to 20 years after reaching the termination shock. In 2007, Voyager-2 was observing preshock phenomena, indicating that it was close to the termination shock.

The solar wind termination shock is where the 1 600 000 km/h solar wind slows to about 400 000 km/h on contact with the interstellar winds.

When the Voyagers cross the heliopause, hopefully while the spacecraft are still able to send science data to Earth, they will be in interstellar space. Once Voyager is in interstellar space, it will be immersed in matter that came from explosions of nearby stars.

Show the cadets Figure 15Q-4.

Both spacecraft will continue to study ultraviolet sources among the stars, and the fields and particles instruments aboard the Voyagers will continue to explore the boundary between the sun's influence and interstellar space. The Voyagers are expected to return valuable data for at least another decade. Communications will be maintained until the Voyagers' power sources can no longer supply enough electrical energy to power critical subsystems.

The Voyagers have enough electrical power and thruster fuel to operate until at least 2020. By that time, Voyager-1 will be 19.9 billion km (12.4 billion miles) from the sun and Voyager 2 will be 16.9 billion km (10.5 billion miles) away. The Voyagers are destined – perhaps eternally – to wander the Milky Way.

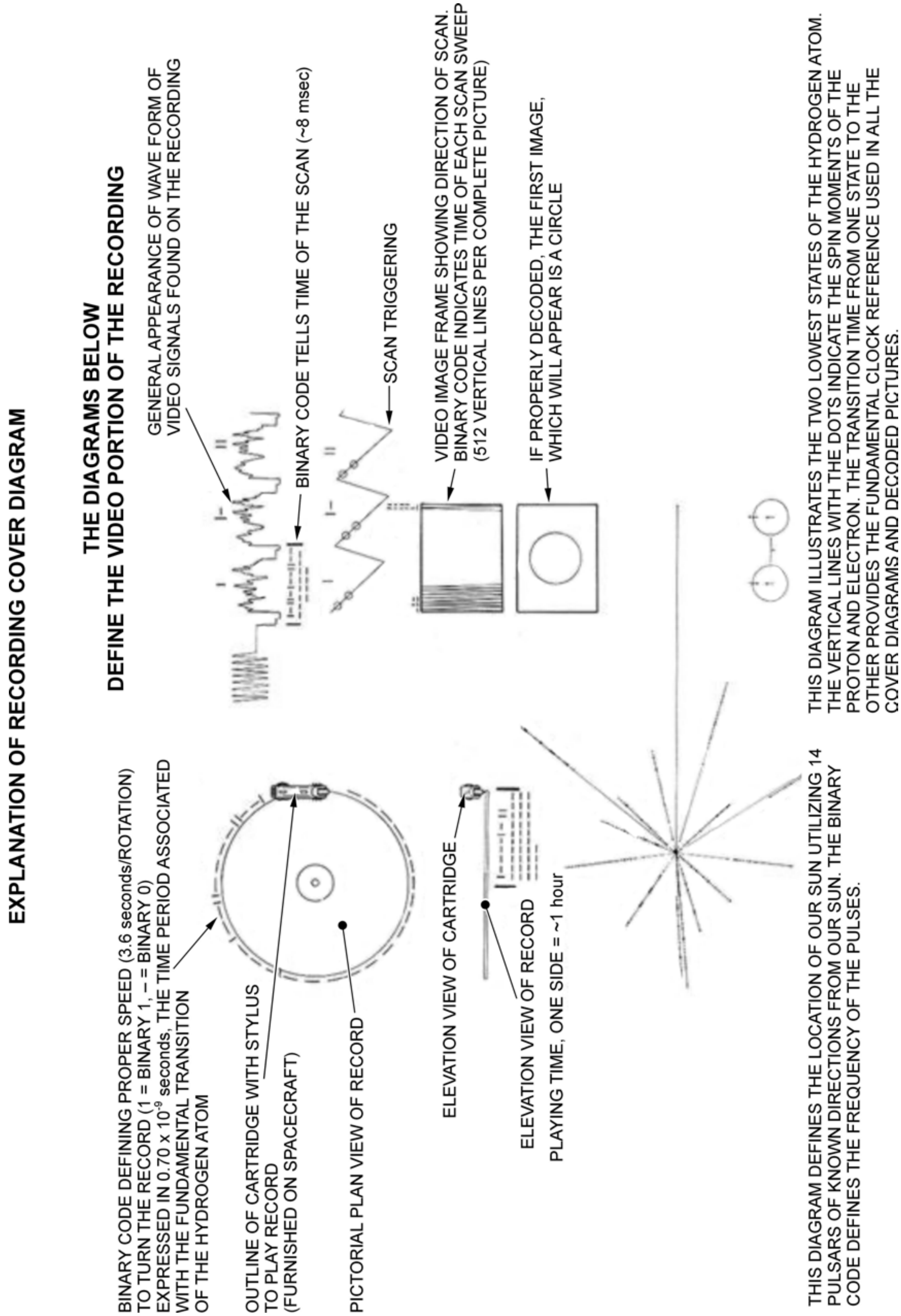
For current distances of the Voyagers, check mission weekly reports at NASA website http://voyager.jpl.nasa.gov/mission/weekly-reports/index.htm.

The Golden Record

Show the cadets Figure 15Q-5.

NASA placed a message on board Voyager-1 and -2 intended to communicate a story of our world to any extraterrestrials that find the spacecraft. A phonograph record – a 30 cm gold-plated copper disk containing sounds and images selected to portray the diversity of life and culture on Earth, carries the Voyager message. Instructions, in symbolic language, explain the origin of the spacecraft and indicate how the record is to be played. Once the Voyager spacecraft left the solar system (by 1990, both were already beyond the orbit of Pluto), they were in empty space with only the solar wind for company. It will be 40 000 years before they make a close approach to any other planetary system.

Explain symbols of the recording cover diagram as shown in Figure 15-5-1. This is information that extraterrestrials would need to understand the golden record.



"Voyager: The Intersteller Mission", by NASA, 2003, The Golden Record. Retrieved April 8, 2008, from http://voyager.jpl.nasa.gov/spacecraft/goldenrec1.html

Figure 15-5-1 Key to the Golden Record

CONFIRMATION OF TEACHING POINT 2

QUESTIONS

Q1. In what year were the two Voyager spacecraft launched?

Q2. Which Voyager spacecraft visited Saturn?

Q3. For whom was the golden record prepared?

ANTICIPATED ANSWERS

A1. 1977.

A2. Both of them: Voyager-1 in November 1980 and Voyager-2 in August 1981.

A3. Extraterrestrials.

Teaching Point 3	**Describe Unmanned Space Exploration**
Time: 20 min	Method: Interactive Lecture

MISSIONS TO PLANETS WITHIN THE SOLAR SYSTEM

Launched on March 2, 1972, Pioneer-10 was the first spacecraft to travel through the asteroid belt, make direct observations and obtain close-up images of Jupiter. During its Jupiter encounter, Pioneer-10 imaged the planet and its moons and took measurements of Jupiter's magnetic field, atmosphere and interior. These measurements of the environment near Jupiter were crucial in designing later spacecraft.

Pioneer-10 ended its successful mission on March 31,1997. Pioneer-10's weak signal continued to be tracked by the NASA's Deep Space Network as part of an advanced concept study of communication technology in support of NASA's future interstellar probe mission. The power source on Pioneer-10 finally failed in 2003. Pioneer-10 will continue into interstellar space, heading for the red star Aldebaran, which forms the eye of Taurus (The Bull). It will take Pioneer-10 over 2 million years to reach Aldebaran.

THE PHOENIX MARS MISSION

Show the cadets Figure 15R-1.

The Phoenix Mars Lander is the first spacecraft designed to visit a polar region of Mars at ground level. Its mission is to explore the soil and atmosphere of the polar regions of Mars to determine if the environment could be hospitable to life.

Show the cadets Figures 15R-2, 15R-3 and 15R-4.

Phoenix was launched from the Kennedy Space Center on August 3, 2007, to land near the northern polar cap of Mars on May 25, 2008, in an area known as Vastitas Borealis. At 125 km (78 miles) above the surface, Phoenix entered the thin Martian atmosphere. It slowed itself down by using atmospheric friction. A heat shield protected the lander from the extreme temperatures generated during entry.

Show the cadets Figures 15R-5, 15R-6 and 15R-7.

Antennas located on the back of the shell which encases the lander are used to communicate with one of three spacecraft currently orbiting Mars. These orbiters relay signals and landing info to Earth.

Mission Characteristics

In the continuing search for water on Mars, the polar regions are attractive because water ice has been found there. The Phoenix landing site was chosen farther north than previous missions, at a latitude equivalent to that of northern Canada, between 65 and 72 degrees north latitude.

To study Martian atmospheric processes, Phoenix was designed to scan the atmosphere up to 20 km (12.4 miles) in altitude, to obtain data about the formation, duration and movement of clouds, fog, and dust plumes. This capability includes temperature and pressure sensors.

Show the cadets Figure 15R-1. Point out the robotic arm.

Phoenix is equipped with a 2.35 m robotic arm to dig for clues about the history of water on Mars. Although the Phoenix mission will not be capable of moving about on Mars, the Phoenix Lander is designed to investigate by scooping up samples for analysis by its on-board chemistry set. This analysis includes whether the soil is salty, alkaline, and/or oxidizing, and then tests for complex organic molecules necessary for life.

Why would we search for water? Water is a key clue to the most critical scientific questions about Mars. Water is a precursor for life as we know it, a potential resource for human explorers and a major agent of climate and geology.

Canada's Lidar Weather Station

Canada's contribution to the Phoenix mission was a meteorological station that records the daily weather of the Martian northern plains using temperature, wind and pressure sensors, as well as a light detection and ranging (lidar) instrument. The weather station helps improve models of the Martian climate and predict future weather processes, paving the way for future exploration missions. Resembling a brilliant green laser, the lidar probes what is known as the "boundary layer" of the Martian atmosphere (the turbulent layer of the atmosphere about 7–10 km above the surface) and provides information about the structure, composition and optical properties of clouds, fog and dust in the lower atmosphere (up to 20 km above the landing site).

THE CASSINI-HUYGENS MISSION TO SATURN

Four NASA spacecraft have been sent to explore Saturn. Pioneer-11 was first to fly past Saturn in 1979. Voyager-1 flew past a year later, followed by its twin, Voyager-2, in 1981. The fourth spacecraft to visit Saturn was Cassini-Huygens.

ACTIVITY

Time: 10 min

OBJECTIVE

The objective of this activity is to have cadets learn an astrophysicist's perspective of the Cassini-Huygens mission.

RESOURCES

- Five-minute video *Moons* (Reference C3-251),
- Laptop computer,
- Multimedia projector, and
- Projection screen.

ACTIVITY LAYOUT

N/A.

ACTIVITY INSTRUCTIONS

1. Distribute the *Moons* video worksheet located at Annex S.
2. Have the cadets read all the questions before the video is started.
3. Have the cadets fill out the worksheet as they watch *Moons*.
4. Correct the answers on the worksheet using the answer key located at Annex T.

SAFETY

N/A.

Mission Summary

Cassini is the fourth spacecraft to explore Saturn, but the first to explore the Saturnian system of rings and moons from orbit. Cassini carried the Huygens probe to explore the atmosphere of Titan, one of Saturn's more than 60 moons.

Cassini-Huygens' journey to Saturn began on October 15, 1997. The spacecraft was sent to Venus for the first of four planetary gravity assists designed to boost Cassini-Huygens toward Saturn. The spacecraft entered orbit around Saturn on June 30, 2004 and immediately began sending back intriguing images and data.

Show the cadets Figure 15S-1. Point out the Saturnian moons in Figure 15S-1, with particular attention to Titan near the right side of the picture.

Saturn has the most extensive and complex ring system in our solar system. It is made up of billions of particles of ice and rock, ranging in size from grains of sugar to houses. The rings travel at varying speeds. There are hundreds of individual rings, which are believed pieces of shattered moons, comets and asteroids. Each of the billions of ring particles orbit the planet on their own path.

Huygens' Descent to Titan

The Huygens probe was released from the Cassini probe and dove into the thick atmosphere of Titan in January 2005. The sophisticated instruments on both spacecraft provided scientists with data and images of this mysterious region of our solar system.

Show the cadets Figures 15S-2 and 15S-3.

It was discovered that Saturn's orange moon, Titan, has hundreds of times more liquid hydrocarbons than all the known oil and natural gas reserves on Earth. The hydrocarbons rain from the sky, collecting in vast deposits that form lakes and dunes. Individual lakes have more oil than the entire Earth.

Cassini Orbiter Flybys

Cassini-Huygens looped around the Sun twice. On the first orbit it flew close behind Venus in its solar orbit, where it received a gravity assist. The next orbit provided two gravity assists from a second flyby of Venus in June 1999 and of Earth in August 1999. With these three gravity assist boosts, Cassini-Huygens had enough orbital momentum to reach the outer Solar System. One last gravity assist manoeuvre from Jupiter on December 30, 2000 gave Cassini-Huygens the final thrust of energy it needed to reach Saturn. The mission arrived at Saturn in July 2004.

Cassini orbited Saturn for four years, sending back data to Earth. Cassini completed 75 orbits of the ringed planet, 44 close flybys of the mysterious moon Titan, and numerous flybys of Saturn's other icy moons. During a flyby of Saturn's moon Enceladus, it was discovered that there is so much liquid water under Enceladus' frozen surface that it erupts at 400 m per second in geysers that rise into space. Flying at 15 km per second, Cassini passed through the watery plumes at an altitude of 200 km.

Show the cadets Figures 15S-4 and 15S-5.

Whether these and other facts about the Saturnian system turn out to be useful to humans remains to be seen; the European Space Agency states that there is more work left to be done for future scientists.

CONFIRMATION OF TEACHING POINT 3

QUESTIONS

Q1. What is the mission of the Phoenix lander?

Q2. Will the Phoenix mission be capable of moving about on Mars?

Q3. Why would we search for water on Mars, Titan or Enceladus?

ANTICIPATED ANSWERS

A1. To explore the soil and atmosphere of the polar regions of Mars to determine if the environment could be hospitable to life.

A2. No.

A3. Water is a precursor for life as we know it, a potential resource for human explorers and a major agent of climate and geology.

END OF LESSON CONFIRMATION

QUESTIONS

Q1. What year was Sputnik-1 launched into space?

Q2. What outstanding discovery of the International Geophysical Year did Explorer provide?

Q3. What type of assist did Cassini-Huygens use four times to accelerate?

ANTICIPATED ANSWERS

A1. 1957.

A2. The Van Allen Belts.

A3. Gravity assist.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

N/A.

CLOSING STATEMENT

The half-century from the launch of Sputnik in late 1957 to Huygen's Titan descent in early 2005 saw remarkable accomplishments in space exploration. These were possible due to technological advances and a tenacious refusal to accept defeat despite setbacks.

INSTRUCTOR NOTES/REMARKS

TP 2 must be updated each year to reflect current events.

Model kits of spacecraft may be purchased online as training aids.

REFERENCES

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C3-251 European Space Agency. (2008). ESA: Multimedia Gallery Videos. *Moons*. Retrieved April 5, 2008, from http://www.esa.int/esa-mmg/mmg.pl?mission=Cassini-Huygens&type=V.

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ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL THREE

INSTRUCTIONAL GUIDE

SECTION 6

EO C340.04 – DESCRIBE ELEMENTS OF THE NIGHT SKY

Total Time:	30 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-803/PG-001, Chapter 4. Specific uses for said resources are identified throughout the instructional guide within the TP for which they are required.

Review the lesson content and become familiar with the material prior to delivering the lesson.

Create slides of Figures 15U-1 to 15U-4.

Visit the National Research Council (NRC) website (Reference C3-221) and retrieve a planisphere star chart, make one copy for each cadet. Prepare one planisphere for use in TP1.

Photocopy Annex V for each cadet.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

An interactive lecture was chosen for this lesson to orient the cadets to elements of the night sky, to generate interest and emphasize the teaching points.

INTRODUCTION

REVIEW

N/A.

OBJECTIVES

By the end of this lesson the cadet shall have described elements of the night sky.

IMPORTANCE

It is important for cadets to be able to describe the elements of the night sky so they may apply the knowledge acquired while viewing the night sky or during online stargazing. These activities may generate interest in astronomy.

Teaching Point 1	**Describe Fixed Elements of the Night Sky**
Time: 15 min	Method: Interactive Lecture

VISIBLE STARS

Stars are large spherical bodies, many times the size of Earth, composed of hydrogen and heavy elements that are compressed and heated by the pressure of gravitation. This heat and pressure causes nuclear reactions, which make the star visible. A star's gravity then compresses the ongoing nuclear explosion, which prevents the star from disintegrating.

Although the smallest stars are many times larger than Earth, they are so far from Earth that, except for the Sun, they appear as mere luminous points. Their great distance also makes them appear fixed in the sky even though each star is actually moving in a vast orbit around the centre of the galaxy.

> Star brightness is called magnitude. The lower the magnitude, the brighter the object. The brightest star visible in the night sky is Sirius, classified as a magnitude of −1.

Presently, the scale of visibility ranges from a faint magnitude 30, which are objects that can be detected by the Hubble Space Telescope, to a bright magnitude -27 which corresponds with the Sun. On this scale, the Sun is 16 trillion times brighter than a magnitude 6 star.

Ancient peoples imagined patterns using individual stars. One of the most useful and easily identifiable patterns uses seven bright stars: Alkaid, Mizar, Alioth, Megrez, Phekda, Merak and Dubhe. Together these stars form the Big Dipper, which is part of the constellation Ursa Major.

> Show the cadets Figure 15U-1.

In the mid-northern hemisphere, the Big Dipper can be seen at any time of the year and at any time of night from everywhere in Canada. The Big Dipper is the most prominent stellar configuration in the night sky. It can easily be identified by untrained observers, making it the ideal reference point for finding other elements of the night sky.

The Big Dipper swings around the sky as the Earth rotates through day and night, so it appears in different orientations. Every 24 hours it circles the North Star (Polaris).

> Show the cadets Figure 15U-2.

> Show the cadets Figure 15U-3.

CONSTELLATIONS

Constellations are patterns of stars partitioned and named long ago by our ancestors.

Of the 88 constellations recognized by the International Astronomical Union approximately one quarter of these are in the southern sky and not visible from mid-northern latitudes. About half of the remaining constellations are faint and hard to distinguish.

Hand out Annex U to each cadet.

Many of the visible and well-known constellations are shown in this handout. All constellations, including Ursa Major (the Big Dipper), circle the sky every 24 hours, with Polaris – the North Star – at the centre of the circle.

A planisphere may be used to locate constellations by holding it so the time of year is at the top. This represents the orientation of the constellations as seen at midnight. Remember that the constellations swing around Polaris once every 24 hours and also once every 12 months. A planisphere is only correct at midnight. At midnight, the stars at the top of the planisphere will be in front of an observer facing north and the stars at the bottom of the planisphere will be in front of an observer facing south.

Distribute the two parts of a planisphere retrieved from the NRC website http://www.nrc-cnrc.gc.ca/docs/education/planisphere_e.pdf to each cadet. Demonstrate how to assemble a planisphere using a prepared copy.

ACTIVITY

Time: 5 min

OBJECTIVE

The objective of this activity is to have the cadets use the Big Dipper to locate other elements of the night sky.

RESOURCES

Handout of Figure 15U-4 showing the seasonal locations of the constellations in the night sky.

ACTIVITY LAYOUT

N/A.

ACTIVITY INSTRUCTIONS

1. Have the cadets rotate their handout so that today's date is located at the top (midnight tonight).
2. Have the cadets find the Big Dipper in Ursa Major.
3. When all cadets have found Ursa Major, have them find Polaris (at centre).

4. When all cadets have found Polaris, have them find the star Sirius in the constellation Canis Major (about July 5 position near the rim).
5. Have the cadets locate their own sign of the Zodiac (hint: midnight on their birthday).

SAFETY

N/A.

CONFIRMATION OF TEACHING POINT 1

The cadets' participation in this activity will serve as the confirmation of this TP.

Teaching Point 2	**Describe Moving Objects of the Night Sky**
Time: 10 min	Method: Interactive Lecture

SATELLITES

There are many moving lights in the sky, including aircraft and satellites. A satellite is any celestial body orbiting the earth, but most satellites that are large enough to be seen from the surface of the Earth are man-made. Aircraft have a flashing white light to identify their position as well as red and green wing tip lights, while man-made satellites orbiting the Earth are star-like and do not twinkle. They appear to shine with a steady white glow due to sunlight reflecting off the metal surfaces. Satellites are more prominent during the spring and summer when the Earth's shadow is lower in the sky. Sightings are greater just after dark and drop off close to midnight. Satellites move in a linear fashion at a regular pace, though most observers tend to view their motion as wavy or jerky. Some of these orbiting objects are inhabited by people.

To find the International Space Station (ISS) or any space shuttle, go to NASA's website http://spaceflight.nasa.gov/realdata/sightings/. Select your location from the menu and find out where to look in the sky.

Show the cadets Figure 15V-1.

The times that the spacecraft will be visible are listed. The NASA website uses the following format:

THE FOLLOWING ISS SIGHTINGS ARE POSSIBLE FROM FRI FEB 08 TO WED FEB 20

SATELLITE	LOCAL DATE/TIME	DURATION (MIN)	MAX ELEV (DEG)	APPROACH (DEG-DIR)	DEPARTURE (DEG-DIR)
ISS	Fri Feb 08/07:04 PM	2	51	20 above WNW	51 above N

HUMANSPACEFLIGHT: Sighting opportunities by NASA, 2003. Retrieved February 8, 2008, from http://spaceflight.nasa.gov/realdata/sightings/

Figure 15-6-1 Building the ISS

The first column lists the spacecraft; the second column gives the date and time of the viewing. The third column shows how long the viewing will be possible. The fourth column shows the maximum height above the horizon that the spacecraft will be seen. The fifth column shows the direction in which the spacecraft will first appear and the final column shows the direction in which it will be last visible.

Hand out Annex V to each cadet.

PLANETS

The easiest way to observe planets is to know when and where to expect them. This information is readily available on astronomical calendars, observer handbooks and most astronomy resource books or can be easily found on the internet.

Planet	Magnitude	Description
Mercury	0	Mercury is only visible for a few weeks each year because of its orbit. It is yellow and can be seen just after sunset or just before sunrise.
Venus	−4	Venus is visible in the early evening or the early morning for several months each year. It cannot be seen more than four hours after sunset or before sunrise. Venus appears white and is very bright.
Mars	−3 to 1	Because the distance from Earth varies, so does the apparent brightness of Mars. It appears to be a rusty colour due to the light reflecting off the red planet. Mars travels across half the sky in one year, making it interesting to track.
Jupiter	−2 to −3	Jupiter is brighter than most stars but is still not as bright as Venus. Jupiter appears creamy white and can occasionally be seen all night long.
Saturn	0	Saturn is often mistaken for a star since its brightness matches that of some of the brighter stars. Saturn appears as a pale yellow orb.
Uranus	6	Uranus has a distinct blue-green hue.
Neptune	8	Neptune appears to be approximately the same size of Uranus, though it has a deeper blue hue. They can be differentiated by their position in the sky.

Five planets are visible to the naked eye: Mercury, Venus, Mars, Jupiter and Saturn. Uranus and Neptune must be viewed through binoculars or a telescope.

Planets, like satellites, do not twinkle. Remember, the higher the brightness magnitude, the dimmer the planet – just like stars.

CONFIRMATION OF TEACHING POINT 2

QUESTIONS

Q1. What is a satellite?

Q2. When is the planet Venus visible?

Q3. How many planets are visible to the naked eye?

ANTICIPATED ANSWERS

A1. A satellite is any celestial body orbiting the earth.

A2. Venus is visible in the early-evening or the early-morning.

A3. Five.

END OF LESSON CONFIRMATION

QUESTIONS

Q1. What makes stars visible?

Q2. What are constellations?

Q3. What is the easiest way to observe planets?

ANTICIPATED ANSWERS

A1. Sustained nuclear reactions caused by the pressure and heat of gravity.

A2. Constellations are patterns of stars partitioned and named long ago by our ancestors.

A3. The easiest way to observe planets is to know when and where to expect them.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

N/A.

CLOSING STATEMENT

Knowledge about elements of the night sky is useful when viewing the night sky or during online stargazing. Recognizing these elements will enhance the enjoyment of amateur astronomy.

INSTRUCTOR NOTES/REMARKS

This EO may be conducted with EO C390.09 (Identify Elements of the Night Sky, Chapter 18, Section 14).

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C3-221 National Research Council of Canada. (2007). *Explore the Night Sky*. Retrieved December 3, 2007, from http://www.nrc-cnrc.gc.ca/eng/education/astronomy/constellations/html.html.

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ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL THREE

INSTRUCTIONAL GUIDE

SECTION 7

EO C340.05 – SIMULATE LIFE IN SPACE

Total Time:	90 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-803/PG-001, Chapter 4. Specific uses for said resources are identified throughout the instructional guide within the TP for which they are required.

Review the lesson content and become familiar with the material prior to delivering the lesson.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

A practical activity was chosen for TP 1 as it is an interactive way to allow cadets to experience some aspects of life in space. This activity contributes to the development of knowledge of life in space in a fun and challenging setting.

An in-class activity was chosen for TPs 2 and 3 as it is an interactive way to provoke thought and simulate some of the challenges of living in space.

INTRODUCTION

REVIEW

N/A.

OBJECTIVES

By the end of this lesson, the cadet shall have experienced simulated aspects of life in space.

IMPORTANCE

It is important for cadets to realize the challenges of living in a space environment in order to understand the Canadian Space Program. A space environment requires many considerations for the human body to exist comfortably including eating, washing, and working.

Teaching Point 1 **Explain the Medical Effects of Weightlessness**

Time: 35 min Method: Practical Activity

MEDICAL EFFECTS OF WEIGHTLESSNESS

On Earth, gravity pulls everything down. Thus, the lower torso and legs carry the weight of the body. In space, because of zero gravity, astronauts float and the legs are not used to support the body.

In space, the lower back and leg muscles are affected the same way as muscles that have been in a cast for a while. Muscles become flabby and lose tone and mass and the astronaut experiences “bird leg syndrome”. “Bird leg syndrome”, called muscular atrophy, makes the limbs thinner. The bones also become weaker because of the loss of minerals like calcium, potassium, and sodium.

The weightlessness of space also affects the cardiovascular system. On Earth, because of gravity, blood naturally pools in the legs, forcing the heart to pump against gravity to supply enough blood to the brain. In space, the heart acts the same as it would on Earth. However, because there is no gravity, the blood rushes to the torso and head. In space the astronaut experiences “puffy face syndrome”. The veins in the neck and face stand out more, and the eyes become red and swollen.

Astronauts try to lessen “puffy face” and “bird leg” syndromes by exercising as often as possible. Astronauts must exercise at least two hours every day to keep their muscles healthy. Astronauts use exercise machines to work both the lower and the upper body muscles. They use a series of straps and restraints to remain secure against the exercise equipment.

ACTIVITY

Time: 25 min

OBJECTIVE

The objective of this activity is to have the cadets simulate exercises that astronauts must perform to maintain bone density and muscle mass when living in a space environment.

RESOURCES

N/A.

ACTIVITY LAYOUT

N/A.

ACTIVITY INSTRUCTIONS

1. Have the cadets stretch for two minutes.
2. Have the cadets alternate between running on the spot and jumping jacks for eight minutes.
3. Have the cadets stretch for two minutes.
4. Have the cadets brainstorm and design exercises that will allow astronauts to keep a set of muscle groups fit in a weightless environment.

SAFETY

N/A.

CONFIRMATION OF TEACHING POINT 1

QUESTIONS

Q1. What do astronauts use to exercise?

Q2. What happens to an astronaut in zero gravity?

Q3. How is the cardiovascular system affected in space?

ANTICIPATED ANSWERS

A1. Astronauts use exercise machines to work both the lower and the upper body muscles.

A2. Astronauts float and their legs are not used to support the body.

A3. Due to the lack of gravity the blood rushes to the torso and head.

Teaching Point 2	**Explain the Challenges of Living in Space**
Time: 30 min	Method: In-Class Activity

CHALLENGES OF LIVING IN SPACE

Washing Hands With Rinseless Soap

In space, astronauts cannot wash with water, as water is very difficult to contain in a zero gravity environment. If water drops were left floating in the space vehicle, they could cause serious problems with the equipment. Astronauts use rinseless soap during space missions to clean themselves. Rinseless soap applies easily, the same way as regular soap or hair shampoo, and does not require water to be effective. The alcohol in the rinseless soap kills bacteria.

Sampling Space Food

There are many factors to consider when astronauts live in a space environment and one of these is food. The preparation of the food itself requires special considerations. Storage and transport require the product to be lightweight and have a long shelf life without refrigeration. Weight is critical during a space mission due to transport cost and efficiency. Some methods of food preparation and storage include freeze-drying, retort packing at 125 degrees Celsius, vacuum packing, and dehydrating. Preservation of taste and texture can be difficult with some of these methods. An example of space food is freeze-dried ice cream or strawberries.

Have the cadets feel how light the package of space freeze-dried ice cream or strawberries are by allowing them to hold the wrapped product.

Some dehydrated foods require rehydration, such as macaroni and cheese or spaghetti. The water is kept contained during the transfer from reservoir to food package to avoid loss. An oven is provided in the space shuttle and the space station to heat foods to the proper temperature.

Condiments such as ketchup, mustard, and mayonnaise are provided. Salt and pepper are available, but only in a liquid form, because astronauts cannot sprinkle salt and pepper on their food. The salt and pepper would simply float away. The particles could clog air vents, contaminate equipment or enter an astronaut’s eyes, mouth, or nose.

Astronauts eat three meals a day – breakfast, lunch and dinner. Nutritionists ensure the food astronauts eat provides a balanced supply of vitamins and minerals. Caloric requirements differ for different astronauts. For instance, a small astronaut weighing approximately 54 kg would require only about 1900 calories a day, while a large astronaut weighing 100 kg would require about 3200 calories a day.

There are many foods an astronaut can choose from, such as:

- fruits,
- nuts,
- peanut butter,
- chicken,
- beef,
- seafood,
- candy, and
- brownies.

Possible drinks include:

- coffee,
- tea,
- orange juice,
- fruit punches, and
- lemonade.

As on earth, space food comes in packages that must be disposed of. Astronauts must dispose of the packages in a trash compactor inside the space shuttle when they are finished eating. Some packaging actually prevents food from floating away. Food packages are designed to be flexible, easy to use and to maximize space when being stowed or disposed of.

ACTIVITY

Time: 20 min

OBJECTIVE

The objective of this activity is to have the cadets simulate how astronauts wash and eat in space.

RESOURCES

- Freeze-dried strawberries,
- Other freeze-dried fruit as available,
- Freeze-dried ice cream, and
- Rinseless soap.

ACTIVITY LAYOUT

N/A.

ACTIVITY INSTRUCTIONS

1. Divide the cadets into groups of three.
2. Distribute rinseless soap to each group of cadets.
3. Have the cadets wash their hands.
4. Distribute a package of freeze-dried ice cream and strawberries to each group of cadets.
5. Have the cadets taste the freeze-dried ice cream and strawberries.

SAFETY

- Warn cadets and staff that are lactose intolerant that the ice cream contains milk products.
- Warn cadets and staff with an allergy to strawberries that the freeze-dried strawberries are real strawberries.

CONFIRMATION OF TEACHING POINT 2

QUESTIONS

Q1. Why are dehydrated foods used by astronauts for some of their meals?

Q2. What do astronauts use to wash their hands and hair?

Q3. Why would salt and pepper be a problem in a space environment?

ANTICIPATED ANSWERS

A1. Dehydrating food is used to reduces weight and increases shelf life.

A2. They use rinseless soap and shampoo.

A3. The grains of salt or pepper could clog air vents, contaminate equipment or enter an astronaut's eyes, mouth, or nose.

Teaching Point 3	**Have the Cadets Simulate Working in Space by Installing a Nut on a Bolt Wearing Two Pairs of Thick Work Gloves**
Time: 20 min	Method: In-Class Activity

Working in zero gravity is a challenge. Often, the only resistance felt by astronauts is the spacesuit itself. In weightless space, any movement in any direction encounters Newton's Third Law and causes an equal force in the opposite direction. For example, when turning a bolt, the force applied in any direction results in an equal force in the opposite direction. Astronauts must attach themselves to, or hold on to, any object to work on it so that they can control the opposite reactive effect.

Newton's Third Law: for every action there is an equal and opposite reaction.

Spacesuits introduce constraints on movement because they are bulky and, being pressurized, they are stiff. The pressure in an astronaut's spacesuit is 4.3 pounds per square inch (psi). That is less than one-third of the pressure of Earth's atmosphere at sea level (14.7 psi). The air pressure outside an airplane flying at 35 000 feet is near 4.3 psi. It is also about the same as the extra pressure that keeps a football inflated, and like a football, the suit is hard to bend.

Pressure is especially noticeable when wearing gloves. Spacesuit gloves are designed so that there is little pressure when the hand is at rest, but resistance can be felt when the hand is open. This makes manipulating objects difficult when working in the spacesuit.

Tools used in a space environment must be two to three times larger than normal because the gloves are bulky and make manipulating the regular-sized tools difficult. In space, it becomes difficult to do tasks that would be easy to do on Earth. Small details like threading nuts onto bolts require more effort and, worse, dropped objects can be hazardous as they continuously float around and may damage other instruments, controls, or surfaces.

ACTIVITY

Time: 15 min

OBJECTIVE

The objective of this activity is to have the cadets simulate what astronauts do to manipulate objects in a space environment.

RESOURCES

- Work gloves, and
- 1/2-inch National Coarse nuts and bolts.

ACTIVITY LAYOUT

N/A.

ACTIVITY INSTRUCTIONS

1. Divide the cadets into groups of six.
2. Give each group of cadets two pair of gloves and a bolt and a nut.
3. Have one cadet from each group put on two pairs of work gloves and try to pick up the bolt.
4. Put the nut in the cadets' gloved hand and ask the cadet to put the nut on the bolt.
5. Have each cadet perform Steps 3. and 4.

SAFETY

N/A.

CONFIRMATION OF TEACHING POINT 3

QUESTIONS

Q1. What are some of the constraints of the spacesuit?

Q2. What law of motion applies to moving in space?

Q3. Why are tools used in space two to three times larger than tools used on Earth?

ANTICIPATED ANSWERS

A1. A spacesuit is suit is stiff because it is pressurized and it is bulky.

A2. Newton's Third Law of motion: for every action there is an equal and opposite reaction.

A3. Spacesuit gloves are stiff and bulky, which restricts the ability to manipulate smaller objects.

END OF LESSON CONFIRMATION

The cadets' participation in all the activities will serve as the confirmation of this lesson.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

N/A.

CLOSING STATEMENT

Astronauts living in a space environment face many challenges, even in simple things such as washing and eating. With careful planning and consideration of these challenges, life in space can be comfortable and fun.

INSTRUCTOR NOTES/REMARKS

N/A.

REFERENCES

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ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL THREE

INSTRUCTIONAL GUIDE

SECTION 8

EO C340.06 – LAUNCH A WATER ROCKET

Total Time:	90 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-803/PG-001, Chapter 4. Specific uses for said resources are identified throughout the instructional guide within the TP for which they are required.

Review the lesson content and become familiar with the material prior to delivering the lesson.

Construct a launching pad as shown at Annex W.

Prepare a string guidance system as shown at Annex X.

Photocopy Annex Y for each cadet.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

A practical activity was chosen for TPs 1 and 2 as it is an interactive way to introduce cadets to water rockets. This activity contributes to the understanding of rocketry in a fun and challenging setting.

A group discussion was chosen for TP 3 as it allows the cadets to interact with their peers and share their knowledge, experiences, opinions, and feelings about water rockets.

INTRODUCTION

REVIEW

N/A.

OBJECTIVES

By the end of this lesson the cadet, as a member of a group, shall have constructed and launched a water rocket.

IMPORTANCE

It is important for cadets to launch a water rocket so that they can experience the difference that a higher exhaust pressure makes in rocket flight, compared with using an effervescing tablet for power as was done in EO M140.01 (Build and Launch a Model Rocket, A-CR-CCP-801/PF-001, Chapter 13, Section 1).

Teaching Point 1	**Supervise the Cadets constructing a Water Rocket**
Time: 20 min	Method: Practical Activity

Supervise the cadets as they construct a water rocket, to include:

1. fuselage,
2. stabilizing fins,
3. nose cone,
4. centre of gravity trimming, and
5. decorations.

ACTIVITY

OBJECTIVE

The object of this activity is to have the cadets construct a water rocket, which will fly under its own self-contained power.

RESOURCES

- One-litre plastic pop bottles with caps removed,
- Construction paper,
- Scissors,
- Glue,
- Putty or modelling clay,
- Packing tape, and
- Instructions for constructing a water rocket.

ACTIVITY LAYOUT

Cadets shall be organized in groups of no more than four, working together at one table, with all the resources required to build a water rocket.

ACTIVITY INSTRUCTIONS

1. Give each cadet a copy of Annex Y.
2. Explain the instructions located at Annex Y.
3. Each group will construct a water rocket in the manner depicted in Figure 15Y-1.

SAFETY

N/A.

CONFIRMATION OF TEACHING POINT 1

The cadets' participation in the activity will serve as the confirmation of this TP.

Teaching Point 2	Supervise the Cadets Launching a Water Rocket
Time: 50 min	Method: Practical Activity

ACTIVITY

OBJECTIVE

The objective of this activity is to have each group of cadets launch a water rocket constructed in TP 1 and experimentally determine its flight characteristics.

RESOURCES

- Water rockets constructed in TP 1,
- Air pump with pressure gauge,
- Launch pad,
- Drinking straws,
- Packing tape,
- 3-mm string, and
- Safety glasses.

ACTIVITY LAYOUT

1. The CO shall select an outdoor area with controlled access for this training, at least 10 m by 20 m.
2. The string guidance system shall be secured to a suitable tower and the launch pad.
3. Place the launch pad in the centre of the launch area.
4. Anchor the launch pad securely in place.

ACTIVITY INSTRUCTIONS

1. Have one group of cadets place their water rocket, quarter filled with water, on the launch pad.
2. Ensure other cadets stand back 5 m; if necessary, rope off the launch site.
3. After the water rocket is attached to the launcher, have one cadet pump air into the rocket to more than 344 kPa (50 psi) pressure.
4. When pressurization is complete, all cadets shall stand behind the launch control officer.
5. Before conducting the countdown, ensure that the guidance system area is clear.
6. Have one cadet launch the water rocket by pulling the launch release cord.

7. Repeat this process for each group.

8. When all water rockets have been launched, have the cadets retrieve their water rockets.

SAFETY

- Safety glasses must be worn by all cadets and staff during this activity.
- In case of a misfire, the instructor shall ensure that no one approaches the launch pad until the instructor has removed the misfired water rocket.

CONFIRMATION OF TEACHING POINT 2

The cadets' participation in launching a water rocket will serve as the confirmation of this TP.

Teaching Point 3 **Conduct an Activity Debriefing**

Time: 10 min Method: Group Discussion

BACKGROUND KNOWLEDGE

The point of the group discussion is to draw the following information from the group using the tips for answering/facilitating discussion and the suggested questions provided.

Characteristics of the Successful Launches

The forces acting upon the cadets' water rockets in flight are those acting upon any aircraft:

- gravity,
- thrust,
- drag, and
- lift, which is minimal in this case unless the water rocket is provided with an airfoil.

Drag and lift are atmospheric forces that result from air coming in contact with the body of the water rocket.

There are many propellants used in rocketry, resulting in a variety of exhaust pressures and velocities. The greater the exhaust pressure, the higher the exhaust velocity. The rocket's power is increased as exhaust velocity of the propellant increases.

When launching a water rocket, there is a difference that a higher exhaust pressure makes in rocket flight, compared with using an effervescing tablet for power as was done in EO M140.01 (Build and Launch a Model Rocket, A-CR-CCP-801/PF-001, Chapter 13, Section 1). Since the water rocket launched in this lesson is heavier when filled with propellant, it may start slower, but the greater mass of the propellant may allow it to attain even greater speeds and distances.

Rocket Behaviour Under Newton's Laws

First Law. Every object in motion tends to remain in motion until an external force is applied to it.

Second Law. The direction of acceleration is the same as the direction of the force. Therefore, since the reactive force pushes upwards against the bottle as the water is directed downwards, the force acting upon the water rocket is also directed upwards.

Third Law. For every action there is an equal and opposite reaction. Therefore, matter such as water particles escaping outward from the rear nozzle will push upon the body of the water rocket.

GROUP DISCUSSION

TIPS FOR ANSWERING/FACILITATING DISCUSSION

- Establish ground rules for discussion, eg, everyone should listen respectfully; don't interrupt; only one person speaks at a time; no one's ideas should be made fun of; you can disagree with ideas but not with the person; try to understand others as much as you hope they understand you; etc.
- Sit the group in a circle, making sure all cadets can be seen by everyone else.
- Ask questions that will provoke thought; in other words avoid questions with yes or no answers.
- Manage time by ensuring the cadets stay on topic.
- Listen and respond in a way that indicates you have heard and understood the cadet. This can be done by paraphrasing their ideas.
- Give the cadets time to respond to your questions.
- Ensure every cadet has an opportunity to participate. One option is to go around the group and have each cadet answer the question with a short answer. Cadets must also have the option to pass if they wish.
- Additional questions should be prepared ahead of time.

SUGGESTED QUESTIONS

Q1. Which rocket was heavier? The water rocket or the film canister rocket in Proficiency Level One?

Q2. Which rocket flew further?

Q3. Which rocket flew faster?

Q4. How might increased pressure or an increased volume of propellant affect the rocket?

Other questions and answers will develop throughout the group discussion. The group discussion should not be limited to only those suggested.

Reinforce those answers given and comments made during the group discussion, ensuring the teaching point has been covered.

CONFIRMATION OF TEACHING POINT 3

The cadets' participation in the group discussion will serve as the confirmation of this TP.

END OF LESSON CONFIRMATION

The cadets' participation in launching the water rocket and in the group discussion will serve as the confirmation of this lesson.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

N/A.

CLOSING STATEMENT

There are many propellants used in rocketry, resulting in a variety of exhaust pressures and velocities. The greater the exhaust pressure, the higher the exhaust velocity. The rocket's power is increased as exhaust velocity of the propellant increases.

INSTRUCTOR NOTES/REMARKS

Prior to this lesson, instructors shall prepare a launching platform and guidance system as shown at Annexes W and X or reference C3-016.

The launching pad should be saved for future training.

Each group shall be allowed a number of attempts to achieve a successful launch.

If a suitable location for this launching water rockets is not available at the squadron's LHQ, that part of the lesson can be carried out as part of a field exercise.

REFERENCES

C3-016 EG-2003-01-108-HQ NASA. (2003). *Rockets: A Teacher's Guide With Activities in Science, Mathematics, and Technology*. Washington, DC: NASA.

ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL THREE

INSTRUCTIONAL GUIDE

SECTION 9

EO C340.07 – IDENTIFY GLOBAL POSITION SYSTEM (GPS) COMPONENTS

Total Time:	60 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-803/PG-001, Chapter 4. Specific uses for said resources are identified throughout the instructional guide within the TP for which they are required.

Review the lesson content and become familiar with the material prior to delivering the lesson.

Retrieve current information from reference C3-243 and update the lesson as required.

Create slides of figures located at Annexes Z to AB.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

An interactive lecture was chosen for this lesson to orient the cadets to GPS components, to generate interest, and emphasize the teaching points.

INTRODUCTION

REVIEW

N/A.

OBJECTIVES

By the end of this lesson the cadet shall be have identified GPS components.

IMPORTANCE

It is important for cadets to be able to identify GPS components so that they will clearly understand the operation and capabilities of GPS when it is used in the field or in an aircraft.

Teaching Point 1	**Explain How the GPS Operates**
Time: 25 min	Method: Interactive Lecture

In 1870, an American named Edward Everett Hale suggested a system of four satellites be placed in a circumpolar orbit to provide a global positioning service. This idea was published as a story called *The Brick Moon* in a series of installments in Boston's Atlantic Monthly magazine in 1870 and 1871.

> The complete *The Brick Moon* is available at the University of Virginia Library at website http://etext.virginia.edu/toc/modeng/public/HalBric.html.

THE THREE COMPONENTS OF GPS

There are multiple positioning systems that use satellites, including the Russian military's Glonass system and the US military's Navstar system. This lesson describes Navstar, but both systems share the same principles in data transmission and positioning methods, though other details such as orbits differ. Other systems existing or planned include those belonging to Japan and the European Union.

Today's GPS represents a considerable advance from Hale's brick moon idea. It has three components:

- orbiting satellites,
- earthbound control stations, and
- receivers that can be anywhere – earthbound, flying or orbiting.

Satellites

The space segment of GPS consists of 24 operational satellites in six orbital planes (four satellites in each plane). The spacing of the satellites are arranged so that a minimum of five satellites are in view from every point on the globe at any time. The satellites orbit at an altitude of 20 200 km. That altitude, clear of the atmosphere, means that satellites will orbit according to very simple mathematics. Although all the satellites are at the same altitude and their six orbits do cross, the satellites do not collide because they are carefully synchronized.

Control Stations

The control segment of GPS consists of five monitor stations and three ground antennas located around the world. A Master Control Station (MCS) is located at Schriever Air Force Base (AFB) in Colorado. The monitor stations passively track all satellites, gathering information to be processed at the MCS to determine satellite orbits and to update each satellite's navigation message. Updated information is transmitted to each satellite via the ground antennas.

Receivers

The user segment of GPS consists of antennas and receiver-processors that provide positioning, velocity, and precise timing to the user. There is a wide variety of receivers.

Individuals may purchase GPS handsets that are available through commercial retailers. Equipped with these GPS receivers, users can accurately locate where they are and easily navigate to where they want to go, whether walking, driving, flying, or boating. GPS receivers have become a mainstay of transportation systems worldwide, providing navigation for aviation, ground, and maritime operations. Disaster relief and emergency services depend upon GPS receivers for location and timing capabilities in their life-saving missions. Everyday activities such as banking, mobile phone operations, and even the control of power grids, are facilitated by the accurate timing provided by GPS receivers. Farmers, surveyors, geologists and countless others perform their work more efficiently, safely, economically, and accurately using the free and open signals of the GPS satellites.

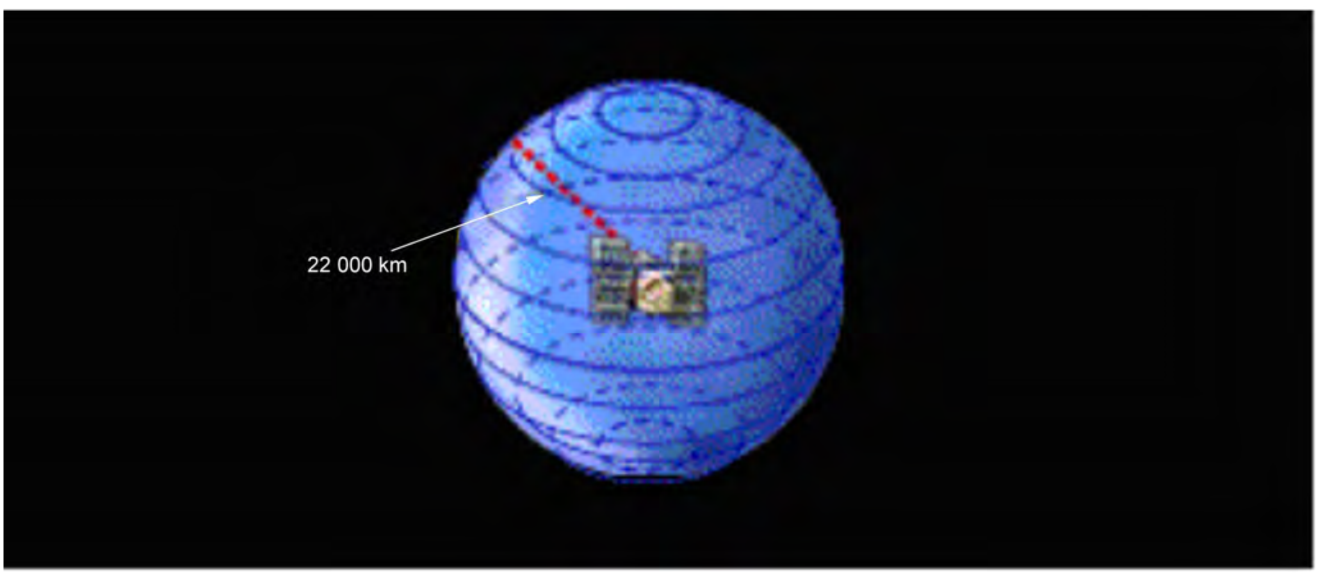
TRILATERATION FROM THREE SATELLITES

Since angles are not used in the computation, trilateration is a more accurate term than the popular term triangulation. However, the term triangulation is used by most people. For the purposes of this lesson, the two terms are interchangeable.

The principle behind GPS is the use of satellites in space as reference points for describing locations on earth. By very accurately measuring distance from three satellites a position can be trilaterated anywhere on or over the earth.

Show the cadets Figure 15Z-1.

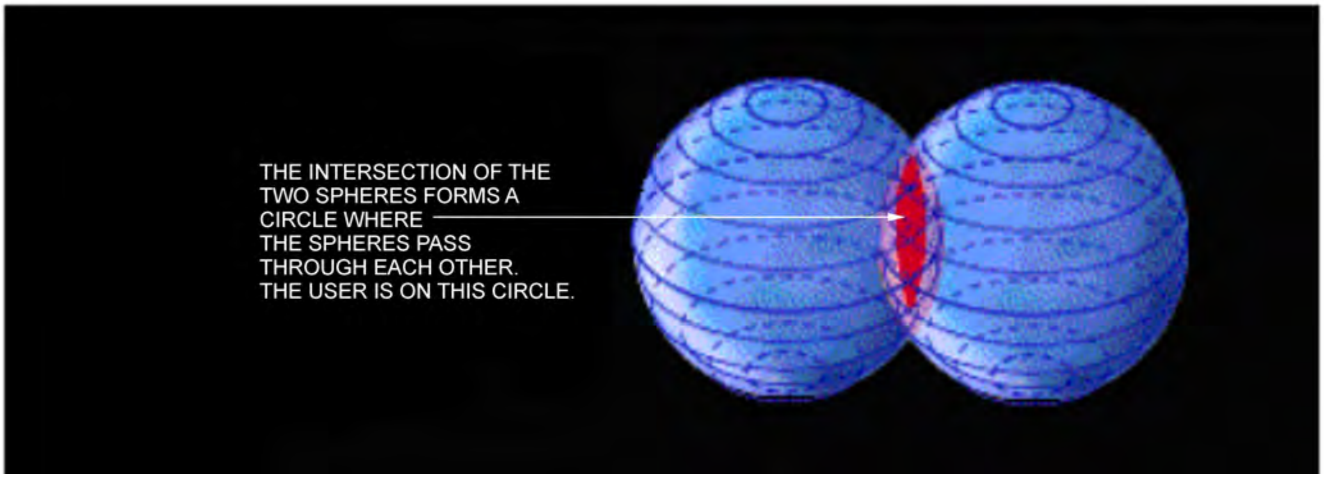
A single measurement of distance from a satellite might find the distance to be 22 000 km. Knowing that this location is 22 000 km from a particular satellite narrows down all the possible locations one could be, to the surface of a sphere that is centered on this satellite and has a radius of 22 000 km.



"GPS Tutorial", Trimple Navigation Limited, 2008, How GPS Works? Copyright 2008 by Trimple Navigation Limited. Retrieved April 11, 2008, from http://www.trimble.com/gps/howgps-triangulating.shtml

Figure 15-9-1 First Trilateration

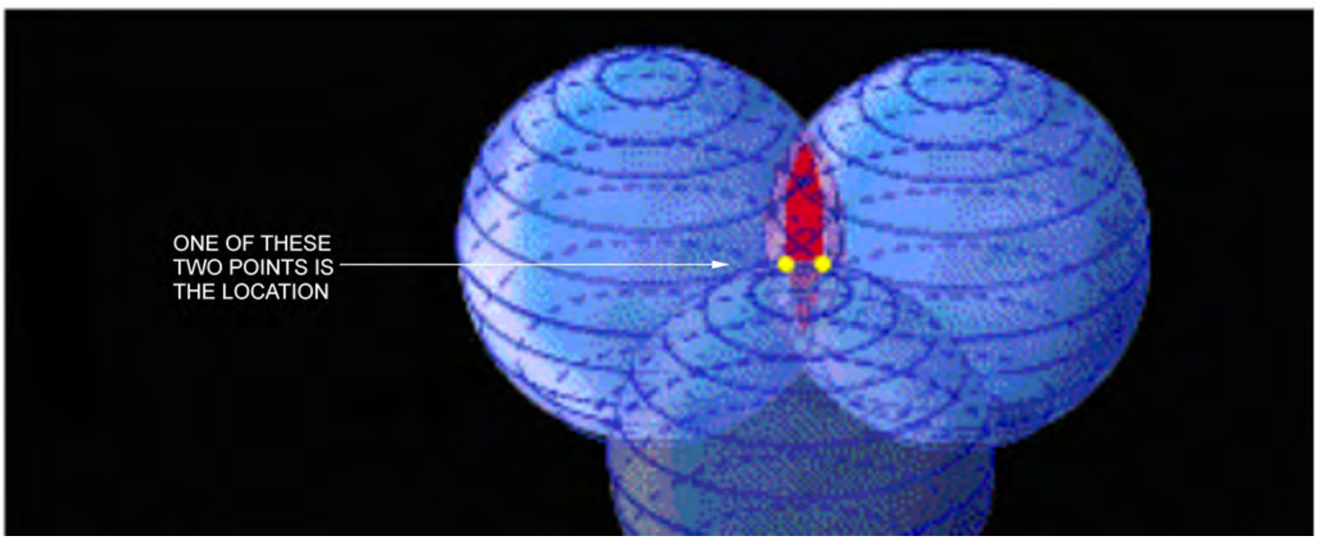
If a second measurement shows this same location to be 23 000 km from a second satellite, it is not only on the first sphere but also on a sphere 23 000 km from the second satellite. The location must be somewhere on the circle where these two spheres intersect.



"GPS Tutorial", Trimple Navigation Limited, 2008, How GPS Works? Copyright 2008 by Trimple Navigation Limited. Retrieved April 11, 2008, from http://www.trimble.com/gps/howgps-triangulating.shtml

Figure 15-9-2 Second Trilateration

If a third measurement shows the same location to be 24 000 km from a third satellite, it is not only on the first sphere and the second sphere, but also on another sphere that is 24 000 km from the third satellite. This narrows the location down to the two points where the 24 000 km sphere intersects with the circle formed by the intersection of the first two spheres.



"GPS Tutorial", Trimple Navigation Limited, 2008, How GPS Works? Copyright 2008 by Trimple Navigation Limited. Retrieved April 11, 2008, from http://www.trimble.com/gps/howgps-triangulating.shtml

Figure 15-9-3 Third Trilateration

From three satellites a location can be determined to be one of just two points in space – only one of which will usually be on the surface of the earth or at the correct altitude above it. To decide which of those two points is the true location, a fourth trilateration measurement is necessary. However, one of the two points may be a ridiculous answer (either too far from Earth or moving at an impossible velocity) and so can be rejected without further measurement.

TIMING RADIO SIGNALS

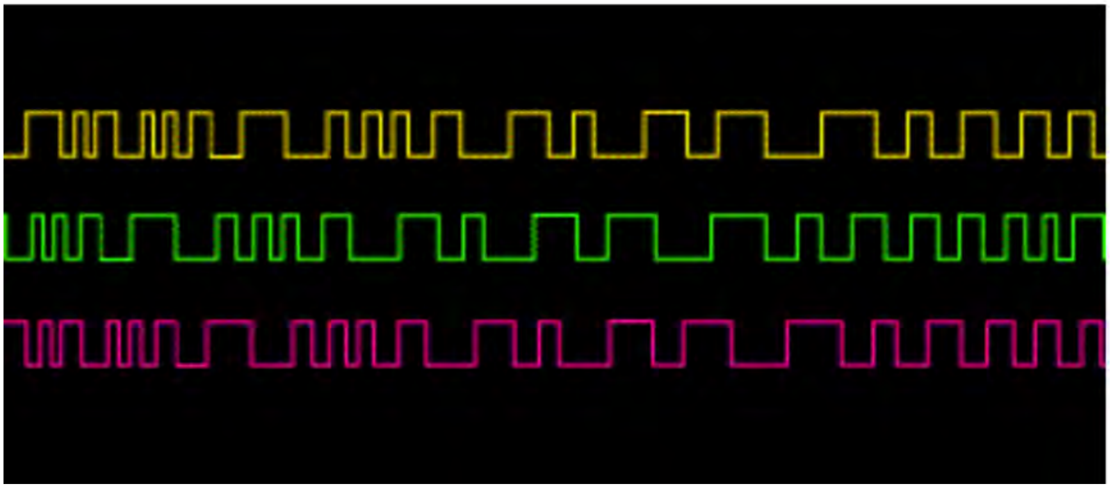
Show the cadets Figures 15AA-1 and 15AA-2.

Distance to a satellite is determined by measuring how long a radio signal takes to travel from that satellite to the user's receiver. By comparing how long it takes the satellite's coded signal to arrive at the user's receiver, compared to the receiver's internal clock, the travel time can be determined. Finally, comparing that measured travel time to the speed of light gives the distance.

"GPS Tutorial", Trimple Navigation Limited, 2008, How GPS Works? Copyright 2008 by Trimple Navigation Limited. Retrieved April 11, 2008, from http://www.trimble.com/gps/howgps-triangulating.shtml

Figure 15-9-4 Travelling Down

Each GPS satellite transmits a coded waveform radio signal (somewhat like those shown in Figure 15-9-5). Notice that the individual pulses, or waves, are of different shapes. This allows the receiver to recognize individual pulses. GPS receivers generate waveforms that are identical to those transmitted by the satellite, for the receiver's internal use. To calculate the travel time of the radio signal from the GPS satellite, the GPS receiver measures how much time the received satellite waveform is behind its own identical internal waveform. It does this by comparing synchronization of its own internal waveforms with that of the waveforms received from each satellite.

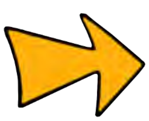


"GPS Tutorial", Trimple Navigation Limited, 2008, How GPS Works? Copyright 2008 by Trimple Navigation Limited. Retrieved April 11, 2008, from http://www.trimble.com/gps/howgps-triangulating.shtml

Figure 15-9-5 Coded Signals

Of course, this system requires perfect synchronization. All three of the GPS components – satellites, control stations and receivers – have excellent timekeeping ability.

Show the cadets The Challenge of Timing slide located at Annex AA.



Timing is tricky.

Precise clocks are needed to measure travel time.

The travel time from a satellite directly overhead is about 0.06 seconds.

The time required to synchronize the receiver's internal coded pulses with the satellite's coded pulses is equal to the travel time.

Distance to the satellite is equal to travel time multiplied by the speed of light.

As well as extremely accurate internal timing, the GPS receiver must have one last critical piece of information – the exact time on the satellite's clock. The speed of light is so great, and the travel time of the radio signal is so short, that the clock in the GPS satellite and the clock in the GPS receiver must be synchronized perfectly. This requirement, given the degree of accuracy necessary, is a formidable challenge. The method that was used to accomplish this feat involves high-speed computer processing combined with data from a fourth GPS satellite.

ACTIVITY

Time: 10 min

OBJECTIVE

The objective of this activity is to have the cadets experience the precision of GPS.

RESOURCES

- One hand-held GPS receiver, and
- Paper and pencil/pen.

ACTIVITY LAYOUT

Training area suitable for drill.

ACTIVITY INSTRUCTIONS

1. Designate a right marker.
2. Face the right marker south.
3. Have the remaining cadets fall in single file and perform a right dress.
4. Give the marker a hand-held GPS receiver.
5. Have the marker call out the coordinates shown on the GPS receiver and pass the receiver to the next cadet.
6. Write down the marker's coordinates.
7. Repeat Steps 5. and 6. for each cadet in the file.
8. List the coordinates on a whiteboard or flip chart.
9. Have the cadets examine the listed coordinates to determine:
   (a) How many seconds did the longitude change from one end of the file to the other?
   (b) How many seconds did the longitude change per cadet, on average?

SAFETY

N/A.

CONFIRMATION OF TEACHING POINT 1

QUESTIONS

Q1. What are the three components of the GPS?

Q2. How many satellites does it take to mathematically establish a location?

Q3. How is distance to a single satellite determined?

ANTICIPATED ANSWERS

A1. Satellites, control stations and receivers.

A2. Four.

A3. By measuring how long a radio signal takes to travel from that satellite to the user's receiver.

Teaching Point 2	**Describe the Constellation of 24 GPS Satellites**
Time: 5 min	Method: Interactive Lecture

THE CONSTELLATION OF 24 GPS SATELLITES

There are more than 24 GPS satellites in orbit. Satellites are constantly being moved or replaced, either temporarily or permanently. However, at any given time, 24 of the satellites are in service.

ORBIT CHARACTERISTICS

The 24 GPS satellites' circular 20 200 km orbits are inclined 55 degrees with respect to Earth's equator. The satellites complete an orbit every 12 hours and rise 4 minutes earlier each day, which adds up to 24 hours in a year. This is necessary because Earth orbits the Sun once a year and, to keep accurate time, the satellite must not change orbital position in the course of a year, relative to the stars.

STATION-KEEPING MANOEUVRES

Once per year each satellite requires a station-keeping manoeuvre, also referred to as repositioning, to move the satellite back to its original orbital position. The satellites have a tendency to drift from their assigned orbital positions. One reason for this is the gravitational pull of the Earth, Moon and Sun. These manoeuvres require, on average, 12 hours of unusable time for each satellite.

ON-BOARD GPS EQUIPMENT

In addition to the radio transmitters required to communicate with the user's GPS receivers on at least two separate frequencies, a GPS satellite will usually also have:

- accurate clocks and computers for generation of coded timing signals,
- radio receivers and transmitters to communicate with the earth-based MCS,
- antennas for the radio equipment,
- rocket thrusters for orbital location and attitude adjustments,
- propellant tanks for the thrusters engines,
- computers for controlling the thrusters engines,
- solar panels to power on-board electrical equipment, and
- batteries for storing the electrical power.

CONFIRMATION OF TEACHING POINT 2

QUESTIONS

Q1. How many GPS satellites are in orbit?

Q2. What is the shape of a GPS satellite orbit?

Q3. What is a station-keeping manoeuvre for?

ANTICIPATED ANSWERS

A1. More than 24.

A2. Circular.

A3. To move the satellite back to its original orbital position after it drifts.

Teaching Point 3	**Describe the Network of Earth-Based Control Stations**
Time: 5 min	Method: Interactive Lecture

THE NETWORK OF EARTH-BASED CONTROL STATIONS

The GPS satellite orbits are exact and the satellites are constantly monitored. Radar is used to check each satellite's exact altitude, position and speed. Errors are called "ephemeris errors" because they affect the satellite's orbit or "ephemeris." These errors are caused by gravitational pulls from the moon and sun and by the pressure of solar radiation on the satellites. The errors are usually very slight but they must be corrected to achieve the required accuracy.

Show the cadets Figure 15AA-1.

The control component of GPS consists of five monitor stations, three ground antennas and one MCS. The monitor stations passively track all satellites in view, accumulating ranging data. This information is passed to the MCS where it is processed to determine satellite orbits and to update each satellite's navigation message. Updated information is transmitted to each satellite via the ground antennas.

FIVE MONITOR STATIONS

The five monitor stations are located at:

- Hawaii, in the eastern Pacific Ocean,
- Kwajalein, in the western Pacific Ocean's Marshall Islands east of Hawaii,
- Ascension Island, in the south Atlantic Ocean,
- Diego Garcia, in the Indian Ocean, and
- Colorado Springs, in central USA.

THREE GROUND ANTENNAS

The three ground antennas are at Ascension Island, Diego Garcia and Kwajalein. These are necessary for transmitting control signals from the MCS to the satellites.

THE MASTER CONTROL STATION (MCS)

The MCS is located at the US Schriever AFB in Colorado. Only the MCS communicates with the GPS satellites, using the three ground antennas at Ascension Island, Diego Garcia and Kwajalein.

CONFIRMATION OF TEACHING POINT 3

QUESTIONS

Q1. In which US state is the MCS located?

Q2. What do monitor stations do?

Q3. Name the location of one ground antenna.

ANTICIPATED ANSWERS

A1. Colorado.

A2. The monitor stations passively track all satellites in view, accumulating ranging data.

A3. Ascension Island, Diego Garcia, or Kwajalein.

Teaching Point 4	**Describe the User Receivers**
Time: 15 min	Method: Interactive Lecture

GPS USER RECEIVERS

By obtaining a GPS receiver, users automatically get the use of the space component and the control components of the system. GPS receivers are designed and built to interact correctly with the space and control components of GPS. All GPS receivers have an almanac programmed into their computers that tells them where in the sky each satellite is, moment by moment. It only remains to measure how far away the satellites are and then the receiver can calculate its own location.

TIME CORRECTION FOR THE USER RECEIVER

As well as extremely accurate timing, the GPS receiver must have one critical piece of information to measure the distance to a satellite – the exact time on the satellite's clock. The speed of light is so great, and the travel time of the radio signal is so short, that the clock in the GPS satellite and the clock in the GPS receiver must be synchronized perfectly. This requirement, and the degree of accuracy necessary, is a formidable challenge. The method that was used to accomplish this feat involves high-speed computer processing combined with additional data from a fourth GPS satellite.

If the GPS receiver's clocks and the GPS satellite's clocks are perfectly synchronized to universal time, then all the satellite ranges would intersect at a single point (which is the position of the receiver). With imperfect clocks such as those found in the real world, a measurement taken from a fourth GPS satellite, done as a crosscheck, will not intersect with the first three. Since any offset from universal time will affect all measurements equally, the GPS receiver's computer searches for a single correction factor. The correction factor that the receiver must find is the one that it can subtract from all its timing measurements to cause them to intersect at a single point – the location of the receiver. This solution is accomplished by high-speed computing. Once the correction factor is found, the receiver will know not only its own location, but also the precise time on all the satellite's clocks.

USER RECEIVER APPLICATIONS

Many uses for GPS have been found, but there are five main categories: locating, navigating, tracking, mapping, and timing.

Locating

The first and most obvious application of GPS receivers is the determination of a position or location. A GPS receiver is the first positioning system to offer highly precise location data for any point on the planet, in any weather. That alone would be enough to qualify it as an important tool, but GPS accuracy makes it useful in special applications.

Besides just identifying a location, an exact reference locator is sometimes needed for extremely precise scientific work. When a GPS receiver was used to measure Mount Everest, the data collected improved past work, but also revealed that the mountain is getting taller.

Navigating

By providing more precise navigation tools and accurate landing systems, a GPS receiver not only makes flying safer, but also more efficient. With precise point-to-point navigation, a GPS receiver saves fuel and extends an aircraft's range by ensuring pilots do not stray from the most direct routes to their destinations.

Tracking

Tracking is the process of monitoring something as it moves from one location to another. Commerce relies on fleets of vehicles to deliver goods and services either across a city or across a nation. Effective fleet management has important implications, such as telling a customer when a package will arrive, spacing buses for the best-scheduled service, directing the nearest ambulance to an accident, or helping tankers avoid hazards.

A GPS receiver used in conjunction with communication links and computers can provide the backbone for systems tailored to applications in agriculture, mass transit, urban delivery, public safety, and vessel and vehicle tracking. So it is no surprise that police, ambulance, and fire departments have adopted GPS to pinpoint both the location of the emergency and the location of the nearest response vehicle on a computer map. With this clear visual picture of the situation, dispatchers can react immediately and confidently.

Mapping

Using a GPS receiver to survey and map precisely saves time and money. A GPS receiver makes it possible for a single surveyor to accomplish in a day what used to take weeks with an entire team. Even at that faster speed surveyors can do their work with a higher level of accuracy than was possible without a GPS receiver.

Mapping is the art and science of using a GPS receiver to locate items, then create maps and models of everything in the world: mountains, rivers, forests and other landforms, roads, routes, and city streets as well as precious minerals and resources.

> *The Longitude of Greenwich* describes some of the problems that prevent GPS technology from meshing perfectly with the standard maps that are used throughout the world. Even Britain's Royal Observatory was stumped. Details of this Prime Meridian location puzzle can be found at the Royal Observatory website http://www.nmm.ac.uk/server/show/conWebDoc.416.

The accuracy of GPS receivers can reveal serious problems with standard mapping methods and that can cause problems that are not easy to solve. One case involves the Prime Meridian.

The problem: Why does a GPS receiver operating on the zero meridian at Greenwich indicate a longitude differing by about 100 m from zero?

> Show the cadets Figure 15AB-1.

The Prime Meridian was defined, in classical navigation and map-making, to be the line of longitude passing through Greenwich in England. All other lines of longitude were measured relative to this meridian, which was originally established to be 0 degrees. That was how the International Date Line came to be on the opposite side of the earth, at 180 degrees longitude in the middle of the Pacific Ocean.

However, longitudes, latitudes and heights in the system that the GPS uses are all measured relative to a theoretical spheroid that best fits mean sea level over the whole globe. While this represents a level of accuracy that was unavailable to previous generations of cartographers (map-makers), the difference of 100 m in the location of the Prime Meridian obviously poses a problem for today's surveyors and cartographers.

When using a GPS receiver in conjunction with standard maps, it is possible to find significant conflicts between the two systems. The information from a GPS receiver will be precisely accurate, but the information it provides can be confusing when used with a standard map.

Timing

Although a GPS receiver is well known for navigation, tracking, and mapping, it is also used to disseminate precise time, time intervals, and frequency. Time is a valuable resource and knowing the exact time is more valuable still. Knowing that a group of timed events is perfectly synchronized is often very important. A GPS receiver makes synchronization and coordination easy and reliable.

There are three fundamental ways time is used. As a universal marker, time tells us when things happened or when they will happen. As a way to synchronize people, events and other types of signals, time helps keep the world on schedule. As a way to tell how long things last, time provides and accurate, unambiguous sense of duration.

CONFIRMATION OF TEACHING POINT 4

QUESTIONS

Q1. What critical piece of information does a GPS receiver need to find to calculate its position?

Q2. What are the five main categories of GPS applications?

Q3. Why must a GPS receiver always calculate a correction factor for its internal clock?

ANTICIPATED ANSWERS

A1. The exact time on the satellite's clock.

A2. Locating, navigating, tracking, mapping, and timing.

A3. All clocks are imperfect and the GPS must have time that is perfectly synchronized with the GPS satellite.

END OF LESSON CONFIRMATION

QUESTIONS

Q1. What are the three components of the GPS?

Q2. How many GPS satellites are in orbit?

Q3. In which US state is the MCS located?

ANTICIPATED ANSWERS

A1. Satellites, control stations, and receivers.

A2. More than 24.

A3. Colorado.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

N/A.

CLOSING STATEMENT

Few pieces of information are as useful as a clear and precise description of one's location. GPS describes location, trajectory and speed of any object of interest, making GPS service invaluable to transportation, industry and commerce – as well as leisure pursuits.

INSTRUCTOR NOTES/REMARKS

N/A.

REFERENCES

A2-041 B-GL-382-005/PT-001 Canadian Forces. (2006). *Maps, Field Sketching, Compasses and the Global Positioning System*. Ottawa, ON: Department of National Defence.

C3-243 US Naval Observatory. (2008). *USNO GPS Timing Operations*. Retrieved February 10, 2008, from http://tycho.usno.navy.mil/gps.html.

C3-244 Trimble Navigation Limited. (2006). *GPS Tutorial*. Retrieved February 10, 2008, from http://www.trimble.com/gps/index.shtml.

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ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL THREE

INSTRUCTIONAL GUIDE

SECTION 10

EO C340.08 – DESCRIBE ASPECTS OF THE INTERNATIONAL SPACE STATION (ISS)

Total Time:	30 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-803/PG-001, Chapter 4. Specific uses for said resources are identified throughout the instructional guide within the TP for which they are required.

Review the lesson content and become familiar with the material prior to delivering the lesson.

Create a slide of Annex AC.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

An interactive lecture was chosen for this lesson to orient the cadets to aspects of the ISS, to generate interest, and emphasize the teaching points.

INTRODUCTION

REVIEW

N/A.

OBJECTIVES

By the end of this lesson the cadet shall have described aspects of the ISS.

IMPORTANCE

It is important for cadets to describe aspects of the ISS in order to understand the scope of international cooperation involved, the size of the project and the mission capability of the ISS.

Teaching Point 1 | **Describe the Major Components of the ISS**

Time: 15 min | Method: Interactive Lecture

MAJOR COMPONENTS OF THE ISS

The ISS is a large-scale project which requires international cooperation. Major contributors include the United States through National Aeronautics and Space Administration (NASA); Canada through the Canadian Space Agency (CSA); Britain, France, Germany, and Spain through the European Space Agency (ESA); Italy through the Italian Space Agency; Japan through Tsukuba Space Centre; and Russia through Roscosmos.

Each of these contributors has been responsible for the funding and construction of the major components of the ISS.

Construction of the ISS was started in 1998 and is scheduled to be completed by 2010.

Images of the ISS and its individual modules can be viewed at the NASA website. Each of the modules described here are cylindrical in shape and are connected either to each other or to one of the nodes.

Show slide of Annex AC. If a model is available, it should be used as well.

National Aeronautical and Space Administration, STS-118 Build the Station, Build the Future, NASA (p. 54)

Figure 15-10-1 Space Shuttle *Endeavour* (STS-118) After Undocking From the ISS

Zarya

Zarya (sunrise) was the first module of the ISS to be launched. It was also the first Russian contribution. The module is used primarily for storage, though its original purpose was to provide power, communications and orientation control while waiting for the Zvezda module.

Unity

The Unity Node is a connecting passageway to living and work areas of the ISS. This was the second ISS module and the first US contribution.

Zvezda

The Zvezda Service Module serves as the cornerstone for the first habitable sections of the ISS. The module provided the early living quarters, life support, electrical power distribution, data processing, flight control system and propulsion system. Launched in July 2000, this module has already undergone updates to both hardware and software. This was the second Russian contribution to the ISS.

Harmony

The Harmony Node increases the living and workspace of the ISS by 500 cubic metres. It is a passageway between the three station science facilities (Destiny, Kibo and Columbus), and provides a platform for the Multi-Purpose Logistics Modules, the transfer vehicle, the mating adaptor for the shuttle, and the Canadarm2. This was a US contribution.

Destiny

Destiny is the US laboratory attached to the ISS. Destiny's interior is modular in design so that as mission requirements change, modules can be added or removed. At maximum capacity, Destiny is expected to hold 13 experiments focusing on human life sciences, materials research, Terran observations and commercial applications.

One feature of Destiny which has affected life on earth already is its window. From here, high quality photos and videos of earth can be taken, such as those used for BBC's documentary productions *Blue Planet* and *Planet Earth*.

Multi-Purpose Logistics Modules (MPLMs)

Three MPLMs were constructed by the Italian Space Agency to assist in the transportation of materiel to and from the ISS. The modules are pressurized and are designed to be carried inside the shuttle bay during launch and recovery. Once in space, the shuttle will dock with the ISS and use its Canadarm to transfer the MPLM to a docking port on the ISS. Crew from the ISS will transfer goods to and from the MPLM. Once the transfer is complete the MPLM will return to earth onboard the shuttle.

The three MPLMs are named after famous Italians:

- MPLM Leonardo, named after Leonardo da Vinci;
- MPLM Donato, named after Donato di Niccolo Di Betto Bardi (aka Donatello);
- MPLM Rafaello, named after Rafaello Sanzio (aka Raphael).

Kibo

A Japanese contribution, Kibo (hope) is a scientific research facility. It includes two laboratory facilities, two logistics modules, a Remote Manipulator System, and an Inter-Orbit Communication System. Experiments in Kibo focus on space medicine, biology, Terran observations, material production, biotechnology and communications research.

Columbus

Built in Germany, Columbus is the ESA's largest contribution to the ISS. Columbus is a research laboratory which will expand the research facilities of the ISS. It is attached to the Harmony Node, as well as the Destiny and Kibo research labs. Experiments focus on life sciences, materials sciences, fluid physics, and other research in a weightless environment which cannot be conducted on earth.

Two unique aspects of Columbus include:

- remote access to experiments, allowing researchers on earth to coordinate with the station crew to conduct experiments; and
- the ability to conduct experiments in the vacuum of space at any of the four exterior mounting platforms.

Automated Transfer Vehicles (ATVs)

In 2008, the ESA started construction on the first of at least seven ATVs. The ATV is designed to be an unpiloted cargo carrier, which will supply the ISS with liquid and dry cargo as well as gases. It has a substantially greater cargo capacity than the Russian *Progress* cargo carrier, which currently delivers cargo to the ISS. Its secondary duty is as a garbage scow, collecting garbage from the ISS.

The Mobile Servicing System (MSS)

The MSS is a robotic system that plays a key role in the assembly and maintenance of the ISS. It moves equipment and supplies around the exterior of the station, supports astronauts during extravehicular activity (EVA), and services instruments and modules attached to the ISS.

The MSS is composed of three parts, all contributed by Canada. They are:

- **Canadarm 2.** The next generation of the Canadarm located in the space shuttle, Canadarm 2 has improved agility, increased size and capabilities, and is not fixed to one position.
- **Mobile Base System.** The mobile base system is a work platform, which moves along rails attached to the outside of the ISS. This provides the Canadarm 2 with lateral mobility along the main trusses of the ISS.
- **Special Purpose Dexterous Manipulator (Dextre).** Dextre is a two armed robot, which may be attached to the Canadarm 2. Its purpose is to handle delicate assembly tasks currently conducted by astronauts.

CONFIRMATION OF TEACHING POINT 1

QUESTIONS

Q1. Which was the first ISS module to be launched?

Q2. Which three modules are research facilities on the ISS?

Q3. What is Canada’s contribution to the construction of the ISS?

ANTICIPATED ANSWERS

A1. Zarya.

A2. Destiny, Kibo and Columbus.

A3. The MSS.

Teaching Point 2	**Discuss ISS Missions**
Time: 10 min	Method: Interactive Lecture

ISS MISSIONS

The main role of the ISS is to be a research facility. Once construction of the ISS is complete, scientists from the various contributing space agencies will be able to conduct hundreds of experiments from many fields of study.

Materials International Space Station Experiment (MISSE)

The MISSE will test the durability of hundreds of samples ranging from lubricants to solar cell technologies. The samples are better engineered to withstand the Sun, extreme temperatures and other elements. They will be attached to the exterior of the ISS, taking them outside of the protection of the Earth's atmosphere. By examining how the materials fare in space, researchers will be able to develop new materials for use in spacecraft as well as make materials that can last longer on Earth.

One example of where this research will be used on Earth is in exterior paint. Materials in space are subjected to more ultra-violet radiation (responsible for paint degradation) than materials on Earth. By applying the knowledge gained in these experiments, paint producers can create paint, which will last longer.

Minus Eighty Degrees Celsius Laboratory Freezer for ISS (MELFI)

MELFI is a large freezer onboard the ISS. It uses nitrogen gas (N_2) as the freezing agent. The purpose of MELFI is to store biological and life sciences samples at controlled temperatures. These temperatures range from 10 degrees Celsius to 99 degrees below 0 Celsius. Samples may include blood, urine, or plants.

Synchronized Position Hold, Engage, Reorient, Experimental Satellites (SPHERES)

SPHERES are spherical satellites the size of a bowling ball. They will be used inside the ISS to test a set of instructions which will be used by spacecraft performing autonomous rendezvous and docking manoeuvers. Three free-flying SPHERES will perform formation flying inside the cabin of the ISS. Each of these satellites is self-contained with power, propulsion, computers and navigation equipment. The results of this study will be used for satellite servicing, vehicle assembly and determining formations for spacecraft to fly.

Online Viewing of ISS Missions on NASA TV

It is possible to view the ISS missions through online streaming video at the NASA website. Most of the video is archived footage, however live footage is aired during scheduled broadcasts. NASA TV is accessible on the NASA website at http://www.nasa.gov.

CONFIRMATION OF TEACHING POINT 2

QUESTIONS

Q1. What will researchers be able to do with the data gained from MISSE?

Q2. What will the results of SPHERES be used for?

Q3. Where can one go to view NASA TV?

ANTICIPATED ANSWERS

A1. Researchers will be able to develop new materials for use in spacecraft as well as make materials that can last longer on earth.

A2. The results of this study will be used for satellite servicing, vehicle assembly and determining formations for spacecraft to fly.

A3. NASA TV is accessible on the NASA website at http://www.nasa.gov.

END OF LESSON CONFIRMATION

QUESTIONS

Q1. What are the two Russian contributions to the ISS?

Q2. Which Italian contribution will be used to assist the space shuttle in delivering cargo to the ISS?

Q3. Which two vehicles, other than the space shuttle, are used for transporting goods to and from the ISS?

ANTICIPATED ANSWERS

A1. Zarya and Zvezda modules.

A2. The MPLMs (Leonardo, Donato, and Raffaello).

A3. The Russian *Progress* and the ATVs.

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

N/A.

CLOSING STATEMENT

The ISS is a major step forward for humanity. Not only does it allow for scientific research of space, but it represents collaboration between the different nations of man. Resources that may otherwise be used in conflict are being used to further humanity's knowledge and abilities.

INSTRUCTOR NOTES/REMARKS

A model of the ISS would make an ideal visual aid for this lesson. Scale models may be purchased through online sources or ordered at the local hobby store.

In lieu of a model, a large poster would make a great visual aid. Images and multimedia are available through online sources, including NASA.

REFERENCES

C3-245 NASA. (2008). *International Space Station*. Retrieved February 10, 2008, from http://www.nasa.gov/mission_pages/station/main/index.html.

C3-246 NASA. (2008). *NASA TV*. Retrieved February 12, 2008, from http://www.nasa.gov/multimedia/nasatv/index.html.

ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL THREE

INSTRUCTIONAL GUIDE

SECTION 11

EO C340.10 – IDENTIFY ONLINE STARGAZING PROGRAMS

Total Time:	30 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-803/PG-001, Chapter 4. Specific uses for said resources are identified throughout the instructional guide within the TP for which they are required.

Review the lesson content and become familiar with the material prior to delivering the lesson.

Visit the SkyView and SKY-MAP.ORG websites and navigate through the various databases presented.

Create slides of Annexes AD and AE.

Photocopy the handout located at Annex AF for each cadet.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

An interactive lecture was chosen for this lesson to orient the cadets, generate interest, present background material, and clarify online stargazing.

INTRODUCTION

REVIEW

N/A.

OBJECTIVES

By the end of this lesson the cadet should be expected to identify two online stargazing programs.

IMPORTANCE

It is important for cadets to identify online stargazing programs because online stargazing supports amateur astronomy. When weather and background light make outdoor viewing impossible, these programs make stargazing possible.

Teaching Point 1	**Discuss NASA's SkyView**
Time: 5 min	Method: Interactive Lecture

NASA'S SKYVIEW

SkyView is a virtual observatory on the Internet, which generates images of any part of the sky.

SkyView takes observations that other astronomers have made and uses them to create an image of the celestial target of interest. The user must specify which survey or surveys to use.

How to Access SkyView

Show the cadets Figure 15AD-1.

1. Type the URL http://skyview.gsfc.nasa.gov/ in the address field on the Internet.
2. On the SkyView home page, select the Non-Astronomers page using a blue button found halfway down the page, on the left side of the screen.

Show the cadets Figure 15AD-2.

3. Choose the SkyView Query Form button. Access an interactive form to select the desired view of the sky. There are, at a minimum, two required parameters:
   (a) the celestial coordinates of the sky to be viewed or the object's name, and
   (b) the database to be accessed for creating the view.

The celestial coordinate system describes an object's position as right ascension and declination.

Right Ascension. This is comparable to longitude on the earth, but measured in hours, minutes and seconds.

Declination. This is comparable to latitude on the earth, measured in degrees.

The easiest way to determine coordinates is to visit SKY-MAP.ORG; details of which are explained in the next TP. If the desired target is known, put it in the SkyView Query Form.

Show the cadets Figure 15AD-3.

NGC 4030, a galaxy in the constellation Virgo, was entered as the target in the text box, the image returned is shown in Figure 15AD-3.

The target is the object or area of interest – the name or position of a star, galaxy or nebula, or perhaps the coordinate position of some newly discovered object. Specify the position as a target name, for example, 3C273, M31 or ‘Crab Nebula’, or by using celestial coordinates.

SkyView cannot be used to look at images of objects in our solar system such as planets, asteroids or comets. SkyView is for deep space only.

SkyView’s Non-Astronomers Page

Show the cadets Figure 15AD-4.

With SkyView, one can look at the sky in many different wavelengths of light. This includes the optical light that people see, along with the invisible radio, infrared, X-ray and gamma-ray data. Different kinds of objects show up in these different regimes; that is, the sky looks very different at radio wavelengths than in the optical. The Non-Astronomers page discusses each in turn, working down from the most energetic radiation, gamma-ray, through visible light and down to the radio spectrum.

The table shown in the Non-Astronomers page gives a quick overview of what can be seen in each regime and suggests a survey and image size for each. These suggested sizes are generally quite close to the defaults, which are useful for cadets who have no image size preference.

Databases accessible from SkyView are explained on the Non-Astronomers page, and include:

- EGRET >100 MeV Gamma-ray wavelengths
- PSPC 2Deg-Int X-ray wavelength
- EUVE 83 Extreme Ultraviolet (EUV) wavelength
- DSS Optical wavelength
- 2MASS K, or IRIS 100 Infrared (IR) wavelength
- FIRST or 1420 MHz Radio wavelength

While not all cadets will want to pursue these various databases, those that do will find adequate explanations on the Non-Astronomers page. Cadets should be encouraged to take advantage of NASA’s explanations of the databases and how to use them.

CONFIRMATION OF TEACHING POINT 1

QUESTIONS

Q1. What is NASA's SkyView?

Q2. Where can more information about operating SkyView be found?

Q3. What two parameters are required to operate SkyView?

ANTICIPATED ANSWERS

A1. SkyView is a virtual observatory on the Internet, which generates images of any part of the sky.

A2. On SkyView's Non-Astronomers page.

A3. The coordinates of the sky to be viewed and the database to be accessed.

Teaching Point 2	**Discuss SKY-MAP.ORG**
Time: 5 min	Method: Interactive Lecture

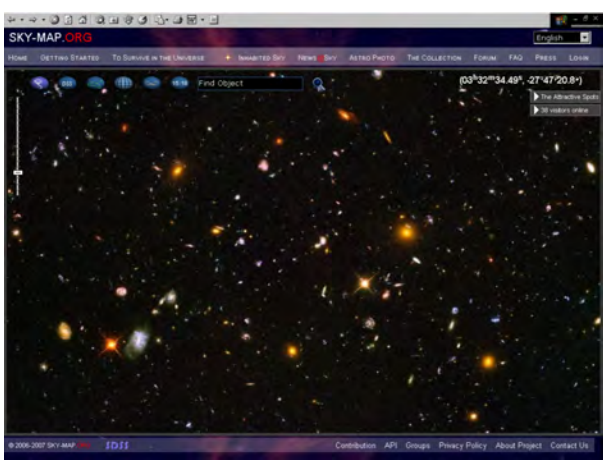
SKY-MAP.ORG

SKY-MAP.ORG is an interactive information-management system, which encompasses the entire universe. The basic element of the system is a detailed map of the sky that depicts more than half a billion celestial objects. Instructions are provided on the display. No additional instructions are necessary to browse the map or change its scale.

By using the smallest scale, the whole sky can be viewed at once. Using the largest scale, tiny areas with distant and extremely dim celestial objects, such as distant galaxies, can be viewed – courtesy of the Hubble Space Telescope (HST).

Purpose

SKY-MAP.ORG, according to its Ontario-based creators, is an attempt to show the beauty of the universe to everybody – to small children and their parents, the amateur astronomer and the professional astrophysicist.



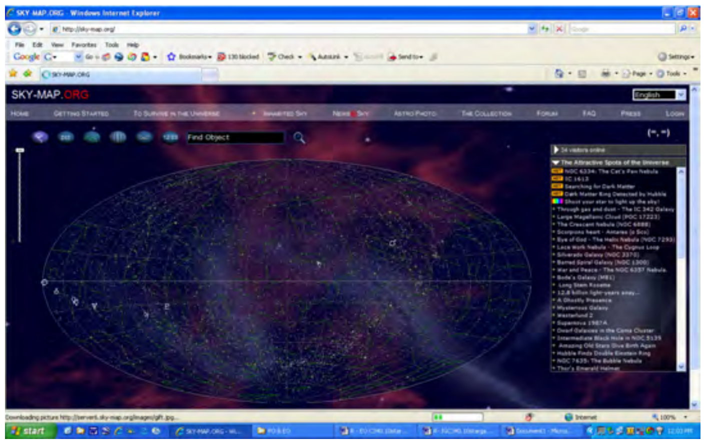
SKY-MAP.ORG, 2008, "SKY-MAP.ORG". Retrieved March 19, 2008, from http://sky-map.org/

Figure 15-11-1 The View From the Hubble Space Telescope

Show the cadets Figure 15AE-1.

How to Access SKY-MAP.ORG

1. Type http://sky-map.org in the address field on the Internet.
2. On the first screen presented, click on the "Home" button above the top of the star-field and the full universe, seen from Earth, will be shown.



SKY-MAP.ORG, 2008, "SKY-MAP.ORG". Retrieved March 19, 2008, from http://sky-map.org/

Figure 15-11-2 SKY-MAP.ORG Home Page

Show the cadets Figure 15AE-2.

CONFIRMATION OF TEACHING POINT 2

QUESTIONS

Q1. What is SKY-MAP.ORG?

Q2. Where are operating instructions for SKY-MAP.ORG found?

Q3. Where is SKY-MAP.ORG based?

ANTICIPATED ANSWERS

A1. SKY-MAP.ORG is an interactive information-management system which encompasses the entire outer space.

A2. Instructions are provided on the display.

A3. Ontario.

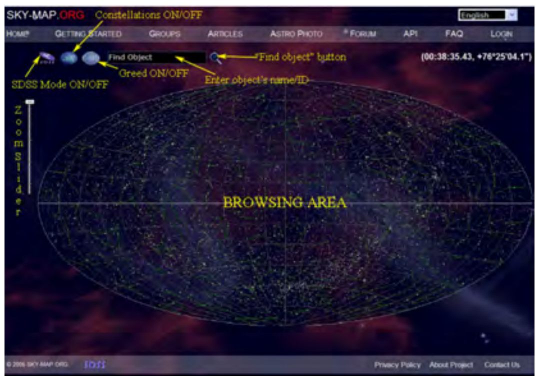
Teaching Point 3 | **Explain the SKY-MAP.ORG User Interface**

Time: 15 min | Method: Interactive Lecture

THE SKY-MAP.ORG USER INTERFACE

When using SKY-MAP.ORG, the browsing area of the screen portrays the selected view of the sky.

Show the cadets Figure 15AE-3.



SKY-MAP.ORG, 2008, "SKY-MAP.ORG". Retrieved March 19, 2008, from http://sky-map.org/

Figure 15-11-3 SKY-MAP.ORG Instruction Page

PROGRAM CONTROL FEATURES

Placing the mouse cursor over a button without clicking reveals the purpose of the control button at the top of the browsing area. As the program becomes more sophisticated, new buttons will be added. The basic controls needed to navigate are shown in Figure 15-11-3. The "Home" button returns the program to the home page showing the entire night sky as seen from the Solar system.

SKY-MAP.ORG offers two different browsing modes:

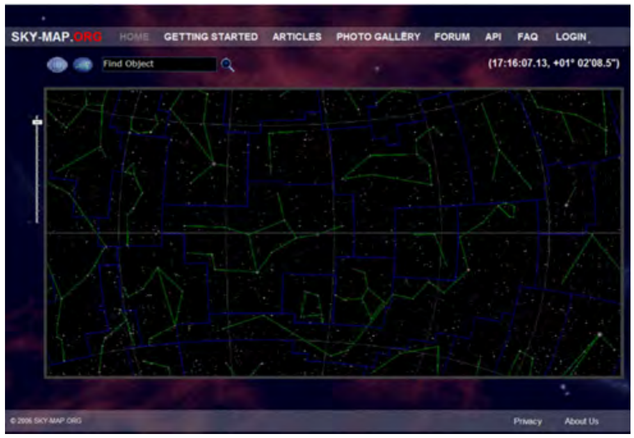
- Normal Mode, and
- Sloan Digital Sky Survey (SDSS) Mode.

Normal Mode

Show the cadets Figure 15AE-4.

The image in this figure shows the sky in Normal Mode. When in Normal Mode, SKY-MAP.ORG can access various databases to display the desired fields of view.

In the example shown, a planar projection of the whole sky is seen. Pointing the mouse at any object inside the browsing area will cause an information window to automatically appear, providing basic scientific data about the object. Left-clicking on the zoom slider causes the scale of the sky map to be changed, thereby altering the detail of the browsing area.



SKY-MAP.ORG, 2008, "SKY-MAP.ORG". Retrieved March 19, 2008, from http://sky-map.org/

Figure 15-11-4 SKY-MAP.ORG Normal Mode

In this figure, the scale has been changed to a higher magnification so that only a portion of the sky can be viewed. The scale can be enlarged again using the zoom slider, to view very faint objects.

An Object's Basic Information Window (BIW)

If the mouse cursor is close enough to an object (or on an object), its BIW appears, showing the data about the object. The basic data includes ID, names, constellations, exact coordinates, distances from Earth and apparent magnitudes. Left-clicking once while the BIW is still open, causes the object page to open. An object page contains detailed information about its star. In addition an object page displays all photo images where the star is present, articles and all external links about the star.

To view the stars at this moment, use the button provided with the correct time shown. When the button is pushed, the program asks for the user's location. When the user enters the name of the closest town or the latitude and longitude, the star field that is overhead will be presented. This feature only works in Normal Mode, not in SDSS Mode.

SDSS MODE

Show the cadets Figure 15AE-5.

This figure shows a view of the browsing area in SDSS mode. In this case, SKY-MAP.ORG has found galaxy NGC 4030 in constellation Virgo. NGC 4030 is at celestial coordinates:

- Right ascension: 12 hours 00 minutes 23.40 seconds
- Declination: -01°06'03.0"

SKY-MAP.ORG, 2008, "SKY-MAP.ORG". Retrieved March 19, 2008, from http://sky-map.org/

Figure 15-11-5 Spiral Galaxy in SDSS Mode

When online, the photographic plate can be found by entering the name NGC 4030 into the "Find Object" text box or by entering the coordinates as right ascension followed by a comma and then declination. If coordinates are entered, however, considerable magnification must be applied to see NGC 4030. At this scale, it is only magnitude 0, appearing as a bright star.

Star brightness is called magnitude. The lower the magnitude, the brighter the object. The brightest star visible in the night sky is Sirius, classified as a magnitude of −1.

Sirius, the brightest star, is found at coordinates 06 45 08.90, -16 42 58.0 in Normal Mode. SDSS does not currently cover this part of the sky, but many astro photos of Sirius can be located through Sirius' BIW.

Navigating in Normal Mode

Normal Mode uses a drag-and-drop operation to shift the sky in the browsing area. To move the browsing area, place the mouse in the browsing area without pointing at any object. Press and hold the left button of the mouse and move the mouse – the star field will move with the mouse cursor.

There are about 500 million stars in the databases. Only a small amount of these stars can be displayed simultaneously in the browsing area at any given period of time. Faint celestial objects (the less bright stars) can be viewed by increasing the scale of the map.

Show the cadets Figure 15AE-6.

This figure is a view, at a large scale, corresponding to high magnification, at the right ascension and declination coordinates shown near the top right corner of the screen.

SKY-MAP.ORG, 2006, "SKY-MAP.ORG". Retrieved March 19, 2008, from http://sky-map.org/

Figure 15-11-6 Magnitude 19 in Virgo

In the example there are only two stars present in the browsing area. Both objects have a magnitude close to 19. That means these two stars can only be seen with powerful telescopes.

Photo Gallery

From the main menu, the photo gallery page with photo images can be accessed. The photo gallery index is a view similar to Figure 15AE-7.

SKY-MAP.ORG, 2006, "SKY-MAP.ORG". Retrieved March 19, 2008, from http://sky-map.org/

Figure 15-11-7 SKY-MAP.ORG Photo Gallery

Show the cadets Figure 15AE-7.

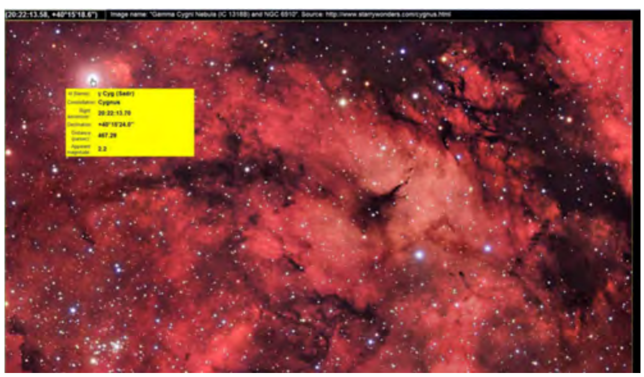
Each field with yellow borders determines the boundaries of a star field photograph. When the mouse cursor is inside these boundaries, a minimized version of the photograph appears near the pointer. If the mouse cursor points to the area where fields meet, the photographs of all the fields will be displayed. For example, in this figure, the mouse points to the intersection of three different fields. The user can see the minimized versions of all three images. Left-clicking the mouse will change the mode to "Select Image" as shown in the next figure.

Show the cadets Figure 15AE-8.

SKY-MAP.ORG, 2006, "SKY-MAP.ORG". Retrieved March 19, 2008, from http://sky-map.org/

Figure 15-11-8 Image Selection

Clicking on the desired image in Figure 8 will load it as shown in Figure 15-11-9.



SKY-MAP.ORG, 2006, "SKY-MAP.ORG". Retrieved March 19, 2008, from http://sky-map.org/

Figure 15-11-9 Gamma Cygni Nebula Image Selected

Show the cadets Figure 15AE-9.

Pointing the mouse on an object on the photograph causes the object's BIW to open exactly the same way as it did in the browsing area. Left-clicking on the object loads the object's page. The current coordinates of the mouse will be shown, with the original source directly above it.

CATALOGUES AND DATABASES AVAILABLE FOR ACCESS

Infrared Astronomical Satellite (IRAS) Sky Survey

The IRAS conducted a survey of 98 percent of the sky from low Earth orbit during a ten-month period from January to November 1983. The purpose of the survey was to produce an extremely reliable catalogue of infrared point sources at a sensitivity that was unobtainable from within the Earth's atmosphere. The stability of the orbiting IRAS infrared detectors allowed the viewing of extended, or non-point-like, astronomical sources with the IRAS survey data.

H-ALPHA SKY SURVEY

H-alpha is a particular frequency of radiation associated with hydrogen atoms. Hydrogen is the primary component of celestial nebulae. H-alpha can indicate the shape and size of a gas cloud.

Astro Photo Survey

SKY-MAP.ORG's Astro Photo Survey is a collection of astronomical photos. Credit is usually given at the top of the individual photo so that the user knows where it originated.

Sloan Digital Sky Survey (SDSS)

Simply put, the SDSS is the most ambitious astronomical survey ever undertaken. When completed, it will provide detailed optical images covering more than a quarter of the sky, and a three-dimensional map of about a million galaxies and quasars, which are extremely bright, mysterious objects. As the survey progresses, the data is released to the scientific community and general public in annual increments.

The SDSS uses a dedicated, 2.5-metre telescope on Apache Point, New Mexico, equipped with two powerful special-purpose instruments. The 120-megapixel camera can image 1.5 square degrees of sky at a time, about eight times the area of the full moon. A pair of spectrographs fed by optical fibres measure spectra of (and hence distances to) more than 600 galaxies and quasars in a single observation. A custom-designed set of software data pipelines keeps pace with the enormous data flow from the telescope.

This data, as well as more catalogues and additional databases, will be added from time to time to the list of images that SKY-MAP.ORG can access.

Give each cadet a copy of the Astronomy Basics handout located at Annex AF.

CONFIRMATION OF TEACHING POINT 3

QUESTIONS

Q1. What are the two modes that SKY-MAP.ORG can operate in?

Q2. In the SKY-MAP.ORG Photo Gallery, what marks the boundaries of a star field photograph?

Q3. What can be entered into the "Find Object" text box to select a target object?

ANTICIPATED ANSWERS

A1. Normal Mode and SDSS Mode.

A2. Yellow borders.

A3. The object's name or the object's celestial coordinates.

END OF LESSON CONFIRMATION

QUESTIONS

Q1. Where is SKY-MAP.ORG based?

Q2. What two parameters are required to operate NASA's SkyView?

Q3. When completed, approximately how much of the sky will be mapped in SDSS Mode?

ANTICIPATED ANSWERS

A1. Ontario.

A2. The coordinates of the sky to be viewed and the database to be accessed.

A3. When completed, it will provide detailed optical images covering more than a quarter of the sky.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

N/A.

CLOSING STATEMENT

Industrialization and the growth of cities has made viewing the sky difficult for the majority of Canadians but online stargazing provides an alternative way to pursue this interesting hobby.

INSTRUCTOR NOTES/REMARKS

N/A.

REFERENCES

C3-230 ET.SKY-MAP. (2008). *SKY-MAP.ORG*. Retrieved February 8, 2008, from http://sky-map.org/.

C3-231 NASA HEASARC. (2008). *SkyView*. Retrieved February 8, 2008, from http://skyview.gsfc.nasa.gov/.

ASTRONAUT MARC GARNEAU

Canadian Space Agency, 2008, Image Gallery: Marc Garneau (STS-97). Retrieved March 2, 2008, from http://www.espace.gc.ca/asc/app/gallery/results2.asp?session=&image_id=garrneau-01

Figure 15A-1 Astronaut Marc Garneau

ASTRONAUT MARC GARNEAU

Marc Garneau was a Captain (Navy) in the Canadian Forces and was Canada's first astronaut.

MISSIONS

A veteran of three space flights (STS-41G in 1984, STS-77 in 1996 and STS-97 in 2000), Marc Garneau has logged over 677 hours in space.

STS-41G

Mission: Earth Radiation Budget Satellite (ERBS).

Space Shuttle: *Challenger*.

Launched: October 5, 1984 at 7:03:00 a.m. EDT.

Landed: October 13, 1984 at 12:26:33 p.m. EDT.

Mission Duration: 8 days.

Orbit Altitude: 218 nautical miles.

This was the first flight to include two women, Sally Ride and Kathryn Sullivan. Sullivan was the first American woman to walk in space. The ERBS was deployed less than nine hours into the flight. As well, the Office of Space and Terrestrial Applications-3 (OSTA-3) carried three experiments in the payload bay. Components of Orbital Refueling System (ORS) were connected, demonstrating it is possible to refuel satellites in orbit.

Other payloads were:

- Large Format Camera (LFC),
- IMAX Camera, flying for the third time, and
- Canadian Experiments (CANEX), including:
  - Auroral Photography Experiment (APE),
  - Radiation Monitoring Equipment (RME), and
  - Thermoluminiscent Dosimeter (TLD).

STS-77

Mission: SPACEHAB; SPARTAN Inflatable Antenna Experiment (IAE).

Space Shuttle: *Endeavour*.

Launched: May 19, 1996, 6:30:00 a.m. EDT.

Landed: May 29, 1996, 7:09:18 a.m. EDT.

Mission Duration: 10 days.

Orbit Altitude: 153 nautical miles.

The fourth shuttle flight of 1996 was highlighted by four rendezvous activities with two different payloads. Primary payloads, all located in the cargo bay, were the SPACEHAB-4 pressurized research module, the IAE mounted on a Spartan 207 free-flyer and a suite of four technology demonstration experiments known as Technology Experiments for Advancing Missions in Space (TEAMS).

Using the Canadarm, the Spartan free-flyer (a platform for experiments) was deployed with the 60 kg (132 lbs) IAE antenna structure inflated to its full size of 15 m (50 feet) in diameter–about the size of a tennis court.

Potential benefits of inflatable antennas over conventional rigid structures include their lower development costs, greater reliability, and lower mass and volume requiring less stowage space and potentially a smaller launch vehicle.

TEAMS experiments were:

- Global Positioning System (GPS) Attitude and Navigation Experiment (GANE),
- Vented Tank Resupply Experiment (VTRE), and
- Liquid Metal Thermal Experiment (LMTE).

Aquatic Research Facility (ARF) experiments also took place. This was a joint Canadian Space Agency/NASA project that allowed investigation of a wide range of small aquatic species, including starfish, mussels and sea urchins.

STS-97

Mission: International Space Station Assembly Flight 4A.

Space Shuttle: *Endeavour*.

Launched: November 30, 2000, 10:06 p.m. EST.

Landed: December 11, 2000, 6:04 p.m. EST.

Mission Duration: 11 days.

Orbit Altitude: 200 nautical miles.

During their 11-day mission, the astronauts completed three spacewalks and extravehicular activities (EVAs), to:

- deliver and connect the first set of solar arrays to the International Space Station (ISS);
- prepare a docking port for arrival of the US Laboratory Destiny;
- install Floating Potential Probes to measure electrical potential surrounding the station;
- install a camera cable outside the Unity module; and
- transfer supplies, equipment and refuse between *Endeavour* and the station.

On flight day three, *Endeavour* was linked to the ISS while orbiting 200 nautical miles above northeast Kazakhstan. Extravehicular mobility units (EMUs), the Simplified Aid for EVA Rescue (SAFER) units, the Canadarm Remote Manipulator System (RMS), the Orbiter Space Vision System (OSVS) and the Orbiter Docking System (ODS) were all checked. Also, an ODS camera was installed.

From inside *Endeavour*, Mission Specialist Marc Garneau used the Canadarm RMS to remove the P6 truss from the payload bay, manoeuvring it into an overnight park position to warm its components. Shuttle astronauts moved through Endeavour’s docking tunnel and opened the hatch to the ISS docking port to leave supplies and computer hardware on the doorstep of the station. On flight day four, the crew entered the Unity module for the first time.

On flight day eight, the STS-97 crew paid the first visit to the Expedition One crew residing in the space station. Until then the shuttle and the station had kept one hatch closed to maintain respective atmospheric pressures, allowing the shuttle crew to conduct their spacewalks and mission goals. After a welcome ceremony and briefing, the eight spacefarers conducted structural tests of the station and its solar arrays, transferred equipment, supplies and refuse back and forth between the spacecraft.

On flight day nine, the two crews completed final transfers of supplies to the station and other items to be returned to earth. The *Endeavour* crew bade farewell to the Expedition One crew at 10:51 a.m. EST and closed the hatches between the spacecraft. After being docked together for 6 days, 23 hours and 13 minutes, *Endeavour* undocked from the station and made an hour-long, tail-first circle of the station. The undocking took place 204 nautical miles above the border of Kazakhstan and China. The final separation burn took place near the northeast coast of South America.

PLACE AND DATE OF BIRTH

Born February 23, 1949 in Quebec City.

EDUCATION

Marc Garneau's education includes:

- Early education in Quebec City, Saint-Jean-sur-Richelieu in Quebec and in London, England;
- Bachelor of Science degree in Engineering Physics from the Royal Military College of Kingston in 1970;
- Doctorate in Electrical Engineering from the Imperial College of Science and Technology, London, England, in 1973; and
- Attended the Canadian Forces Command and Staff College of Toronto in 1982–1983.

PROFESSIONAL EXPERIENCE

Marc Garneau was a Combat Systems Engineer in HMCS Algonquin from 1974 to 1976. While serving as an instructor in naval weapon systems at the Canadian Forces Fleet School in Halifax in 1976–77, he designed a simulator for use in training weapons officers in the use of missile systems aboard Tribal class destroyers. He served as Project Engineer in naval weapon systems in Ottawa from 1977 to 1980. Garneau returned to Halifax with the Naval Engineering Unit, which troubleshoots and performs trials on ship-fitted equipment, and he helped develop an aircraft-towed target system for the scoring of naval gunnery accuracy. Promoted to Commander in 1982 while at Staff College, Garneau was transferred to Ottawa in 1983 to become design authority for naval communications and electronic warfare equipment and systems. In January 1986, he was promoted to Captain. Garneau retired from the Navy in 1989.

In February 2001, Marc Garneau was appointed Executive Vice President of the Canadian Space Agency. He was subsequently appointed President of the Canadian Space Agency, effective November 22, 2001. He resigned from this position on November 28, 2005, to run for office in a federal election.

SPECIAL HONOURS

Marc Garneau's special honours include:

- Athlone Fellowship,
- National Research Council (NRC) Bursary,
- National Honourary Patron of Hope Air and Project North Star,
- President of the Board of the McGill Chamber Orchestra,
- Officer of the Order of Canada,
- promoted Companion of the Order of Canada,
- named Chancellor of Carleton University,
- recipient of the Prix Montfort en sciences,
- recipient of the Queen Elizabeth II Golden Jubilee Medal,

- recipient of the NASA Exceptional Service Medal,
- recipient of the NASA Space Flight Medals (1984, 1996, 2000),
- recipient of the Canadian Forces Decoration (military),
- co-recipient of the F. W. (Casey) Baldwin Award,
- awarded honourary advanced degrees from:
  - University of Ottawa,
  - Collège militaire royal de Saint-Jean,
  - Université Laval,
  - Technical University of Nova Scotia,
  - Royal Military College,
  - York University, and
  - University of Lethbridge.

AFFILIATIONS

Marc Garneau’s affiliations include:

- honorary Fellow of the Canadian Aeronautics and Space Institute,
- member of the Association of Professional Engineers of Nova Scotia,
- member of the Navy League of Canada,
- honorary Member of the Canadian Society of Aviation Medicine, and
- member of the International Academy of Astronautics.

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ASTRONAUT ROBERTA BONDAR

Canadian Space Agency, 2008, Image Gallery: Roberta Lynn Bondar. Retrieved March 2, 2008, from http://www.space.gc.ca/asc/app/gallery/gallery/hight/cd_01_11.JPG

Figure 15B-1 Astronaut Roberta Bondar

ASTRONAUT ROBERTA BONDAR

Roberta Bondar enjoys flying, hot air ballooning, canoeing, biking, target shooting (rifle, handgun), fishing, cross-country skiing and hiking.

MISSIONS

In early 1990, Roberta Bondar was designated a prime Payload Specialist for the first International Microgravity Laboratory Mission (IML-1).

STS-42

Mission: IML-1.

Space Shuttle: *Discovery*.

Launched: January 22, 1992, 9:52:33 a.m. EST.

Landed: January 30, 1992, 8:07:17 a.m. PST.

Mission Duration: 8 days.

Orbit Altitude: 163 nautical miles.

The primary payload for STS-42 was the IML-1, making its first flight and using the pressurized Spacelab module. The international crew was divided into two teams for around-the-clock research on the human nervous system's adaptation to low gravity and the effects of microgravity on other life forms such as shrimp eggs, lentil seedlings, fruit fly eggs and bacteria. Materials processing experiments were also conducted, including crystal growth from a variety of substances such as enzymes, mercury iodide and a virus.

Other experiments during STS-42 were:

- Gelation of Sols: Applied Microgravity Research-1 (GOSAMR-1),
- IMAX camera,
- Investigations into Polymer Membrane Processing (IPMP),
- Radiation Monitoring Experiment III (RME III), and
- Shuttle Student Involvement Program (SSIP) experiments.

PLACE AND DATE OF BIRTH

Born December 4, 1945 in Sault Ste. Marie, Ont.

EDUCATION

Roberta Bondar's education includes:

- Elementary and secondary school in Sault Ste. Marie, Ont.,
- BSc in zoology and agriculture from the University of Guelph,
- MSc in experimental pathology from the University of Western Ontario,
- Doctorate in neurobiology from the University of Toronto,
- Doctor of Medicine from McMaster University, and
- Certification in scuba diving and parachuting.

PROFESSIONAL EXPERIENCE

Roberta Bondar was a neurologist and a clinical and basic science researcher in the nervous system. As an undergraduate student she worked for six years for the federal Fisheries and Forestry Department on genetics of the spruce budworm with reference to the visual system. After internship in internal medicine at Toronto General Hospital, she completed post-graduate medical training in neurology at the University of Western Ontario and in neuro-ophthalmology at Tuft's New England Medical Center (Boston) and at the Playfair Neuroscience Unit of Toronto Western Hospital. Bondar was appointed assistant professor of medicine (neurology) in 1982–84 at McMaster University. She specialized in carotid and transcranial ultrasound at the Pacific Vascular Institute, in Seattle, in 1988.

Bondar was one of the six Canadian astronauts selected in December, 1983 and she began astronaut training in February, 1984. In 1985 she was named chairperson of the Canadian Life Sciences Subcommittee for Space Station. She served as a member of the Ontario Premier's Council on Science and Technology. She was a Civil Aviation medical examiner and a member of the scientific staff of Sunnybrook Health Science Centre. As an astronaut, she has conducted research into blood flow in the brain during microgravity, lower body negative pressure and various pathological states.

Roberta Bondar left the Canadian Space Agency effective September 4, 1992, to pursue her research.

SPECIAL HONOURS

Roberta Bondar's special honours include:

- recipient of Ontario Graduate Fellowship,
- recipient of National Research Council (NRC) Scholarship,
- recipient of NRC Postdoctorate Fellowship,
- recipient of Ontario Ministry of Health Fellowship,
- recipient of Medical Research Council Fellowship,
- recipient of Career Scientist Award from the Ontario Ministry of Health,
- honourary member of Zonta International,
- honourary member Canadian Federation of University Women,
- recipient of Vanier Award from the Jaycees of Canada,
- co-recipient of the F. W. (Casey) Baldwin Award,
- honourary life member of Girl Guides of Canada,
- recipient of Senior Fellowship from Ryerson Polytechnical Institute, Toronto, and
- recipient of honourary degrees from:
    - Mount Allison University,
    - Mount St. Vincent University,
    - University of Guelph,
    - Lakehead University,
    - Algoma College,
    - Laurentian University,
    - Saint Mary's University,

- McMaster University,
- University of Regina,
- University of Calgary,
- University of Ottawa, and
- University of Toronto.

AFFILIATIONS

Roberta Bondar’s affiliations include:

- Fellow of the Royal College of Physicians and Surgeons of Canada,
- American Academy of Neurology,
- Canadian Neurological Society,
- Canadian Aeronautics and Space Institute,
- Canadian Society of Aerospace Medicine,
- College of Physicians and Surgeons of Ontario,
- Canadian Stroke Society,
- Aerospace Medical Association,
- Albuquerque Aerostat Ascension Association, and
- American Society for Gravitational and Space Biology.

ASTRONAUT STEVE MACLEAN

Canadian Space Agency, 2008, Image Gallery: Steve MacLean. Retrieved March 2, 2008, from http://www.espace.gc.ca/asc/app/gallery/results1.asp?session=

Figure 15C-1 Astronaut Steve MacLean

ASTRONAUT STEVE MACLEAN

Selected as one of the first six Canadian astronauts in December 1983, Steve MacLean began astronaut training in February 1984. From 1987 to 1993 he was the Program Manager for the Advanced Space Vision System (ASVS), a computer-based camera system designed to provide guidance data that enhances the control of both Canadarm and Canadarm2. From 1988 to 1991 he also assumed the role of Astronaut Advisor to the Strategic Technologies in Automation and Robotics (STEAR) Program.

MISSIONS

STS-52

Mission: U.S. Microgravity Payload-1 (USMP-1); Laser Geodynamic Satellite II (LAGEOS II).

Space Shuttle: Columbia.

Launched: October 22, 1992, 1:09:39 p.m. EDT.

Landed: November 1, 1992, 9:05:53 a.m. EST.

Mission Duration: 9 days.

Orbit Altitude: 163 nautical miles.

The primary mission objectives were the deployment of the LAGEOS-II, a joint effort between NASA and the Italian Space Agency (ASI), and also operation of the USMP-1.

In addition to LAGEOS II and USMP-1, other mission objectives included:

- Canadian experiments, CANEX-2, located in both the orbiter's cargo bay and mid-deck, consisting of:
  - Space Vision System (SVS),
  - Materials Exposure in Low-Earth Orbit (MELEO),
  - Queen's University Experiment in Liquid-Metal Diffusion (QUELD),
  - Phase Partitioning in Liquids (PARLIQ),
  - Sun Photospectrometer Earth Atmosphere Measurement-2 (SPEAM-2),
  - Orbiter Glow-2 (OGLOW-2),
  - Space Adaptation Tests and Observations (SATO), and
  - A small, specially marked satellite, the Canadian Target Assembly, which was deployed on day nine to support SVS experiments; and
- three independent sensors provided by the European Space Agency, including:
  - Modular Star Sensor,
  - Yaw Earth Sensor, and
  - Low Altitude Conical Earth Sensor.

STS-115

Mission: Installation of the P3/P4 truss arrays on the International Space Station.

Space Shuttle: Atlantis.

Launched: September 9, 2006 at 11:15 a.m. EDT.

Landed: September 21, 2006 at 6:21 a.m. EDT.

Mission Duration: 12 days.

Orbit Altitude: 122 nautical miles.

The STS-115 crew delivered and installed the P3/P4 truss arrays on the ISS. Three spacewalks were carried out to put the new P3/P4 truss in service. Spacewalkers, including Steve MacLean, connected power cables and activated gear readying the P3/P4, and its unfurled solar arrays, for power generation.

The STS-115 and Expedition 13 crews utilized both shuttle and station robotic arms, Canadarm and Canadarm2, during installation activities.

PLACE AND DATE OF BIRTH

Born December 14, 1954, in Ottawa, Ont.

EDUCATION

Steve MacLean's education includes:

- Primary and secondary school in Ottawa,
- Bachelor of Science (Honours) in Physics in 1977 from York University, and
- Doctorate in Physics in 1983 from York University.

PROFESSIONAL EXPERIENCE

From 1974 until 1976 Steve MacLean worked in sports administration and public relations at York University, and competed with the Canadian National Gymnastics Team from 1976 to 1977. He taught part-time at York University, from 1980 until 1983, and then became a visiting scholar at Stanford University. As a laser physicist, MacLean's research included work on electro-optics, laser-induced fluorescence of particles and crystals, and multi-photon laser spectroscopy.

MacLean was the Chief Science Advisor for the International Space Station from 1993 until 1994, when he was appointed Director General of the Canadian Astronaut Program for a two-year period.

In August 1996, MacLean began mission specialist training at the Johnson Space Center in Houston, Texas. After successfully completing basic training in 1998, he continued with advanced training while fulfilling technical duties in the NASA Astronaut Office Robotics Branch. Later, MacLean served as CapCom (Capsule Communicator) for both the ISS Program and the Shuttle Program at the Johnson Space Center.

In 2007, MacLean was Chief Astronaut for the CSA, coordinating the astronaut activities from CSA headquarters.

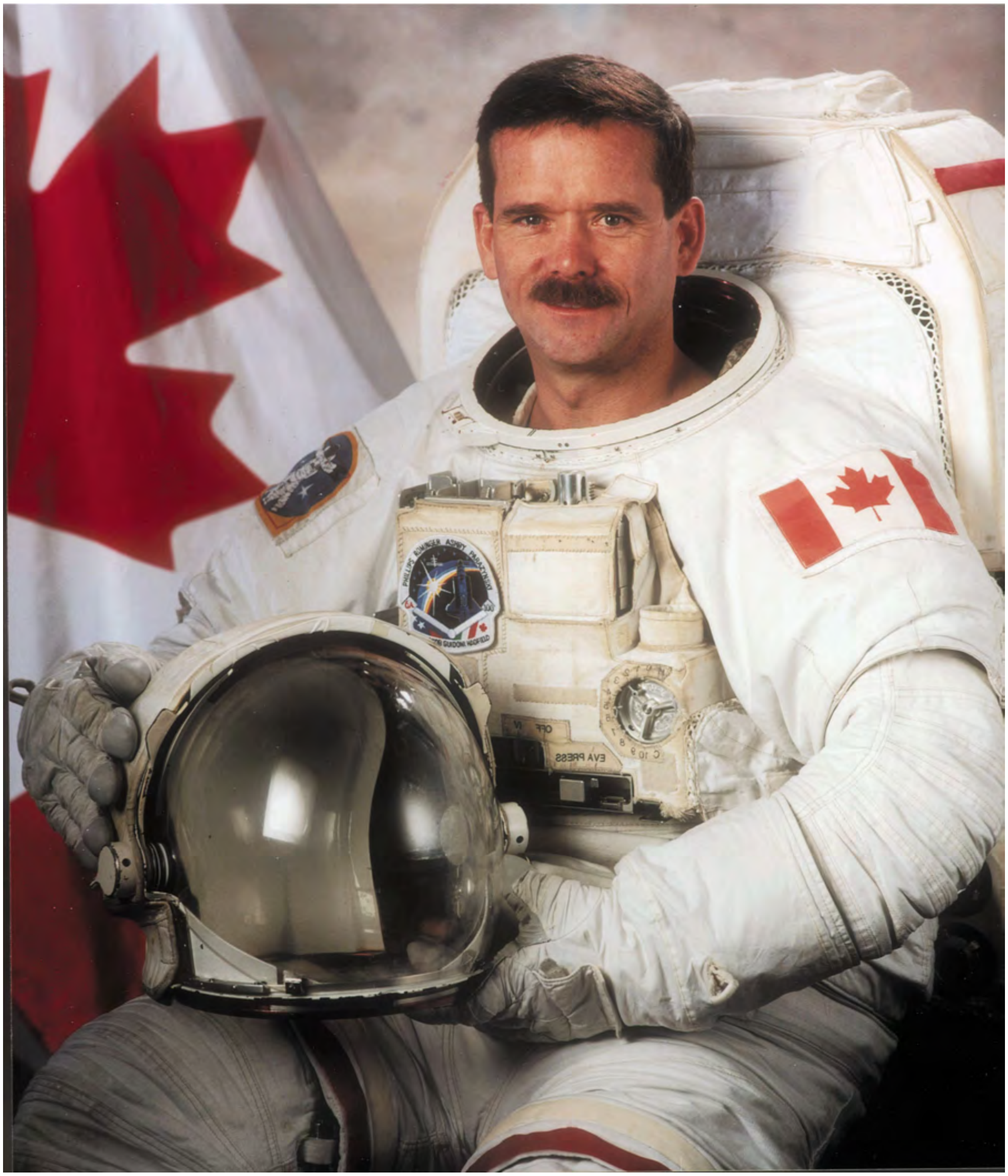
SPECIAL HONOURS

Steve MacLean's special honours include:

- recipient of the President's Award (Murray G. Ross Award) at York University,
- recipient of a Natural Sciences and Engineering Research Council of Canada (NSERC) Postgraduate Scholarship,
- recipient of two Ontario Graduate Scholarships,
- recipient of a NSERC Postdoctoral Fellowship, and
- recipient of honorary advanced degrees from:
    - Collège militaire royal de Saint-Jean in Que.,

- York University in Toronto, and
- Acadia University in Wolfville.

ASTRONAUT CHRIS HADFIELD



Canadian Space Agency, 2008, Image Gallery: Chris Hadfield. Retrieved March 2, 2008, from http://www.espace.gc.ca/asc/app/gallery/results1.asp?session=&search=0&ListAbsolutePage=8&root_categories=0&categories_0=0&keywords=Chris|Hadfield&images=ON

Figure 15D-1 Astronaut Chris Hadfield

ASTRONAUT CHRIS HADFIELD

In June 1992, Chris Hadfield was selected to become one of four new Canadian astronauts from a field of 5 330 applicants. He was assigned by the CSA to the NASA Johnson Space Center in Houston, Texas, in August of the same year where he addressed technical and safety issues for Shuttle Operations Development, contributed to the development of the glass shuttle cockpit, and supported shuttle launches at the Kennedy Space Center in Florida. In addition, Hadfield was NASA's Chief CapCom, the voice of mission control to astronauts in orbit, for 25 space shuttle missions. From 1996 to 2000, he represented CSA astronauts and coordinated their activities as the Chief Astronaut for the CSA.

From 2001 to 2003, Hadfield was the Director of Operations for NASA at the Yuri Gagarin Cosmonaut Training Centre (GCTC) in Star City, Russia. His work included coordination and direction of all ISS crew activities in Russia and oversight of training and crew support staff, as well as policy negotiation with the Russian Space Program and other international partners. He also trained and became fully qualified as a flight engineer cosmonaut in the Soyuz TMA spacecraft to perform spacewalks in the Russian Orlan spacesuit.

Hadfield is a civilian CSA astronaut, having retired as a Colonel from the Canadian Forces in 2003 after 25 years of military service. He was Chief of Robotics for the NASA Astronaut Office at the Johnson Space Center in Houston, Texas from 2003 to 2006, and then Chief of International Space Station Operations.

MISSIONS

STS-74

Mission: Second Shuttle-Mir Docking.

Space Shuttle: Atlantis.

Launched: November 12, 1995 at 7:30:43 a.m. EST.

Landed: November 20, 1995 at 12:01:27 p.m. EST.

Mission Duration: 8 days.

Orbit Altitude: 213 nautical miles.

This mission illustrated the international flavour of the space station effort in both the hardware and the crew. Hardware in the payload bay included:

- Canadian built Remote Manipulator System (RMS) arm,
- U.S. built Orbiter Docking System (ODS),
- Russian-Built Docking Module (DM) and solar array, and
- US/Russian built solar array.

Chris Hadfield was the fourth Canadian to fly on a shuttle but the first Canadian mission specialist. Awaiting Atlantis aboard Mir, were two Russian cosmonauts and a German cosmonaut, along with Russian and European Space Agency research samples and equipment.

On flight day three, Hadfield operated the Canadarm RMS to lift the DM from its stowed position and moved it to within five inches above the ODS in the forward part of the bay. ODS was flown on all Shuttle-Mir docking flights and served as a passageway between two spacecraft. Steering jets were then fired to push Atlantis against the DM. Once mating was confirmed, the Canadarm ungrappled from the DM and hatches between the DM and the ODS were opened.

The manual phase of rendezvous began when Atlantis was about 800 m from Mir. At 51.8 m from Mir, the approach was halted while Mir was manoeuvred into alignment for docking. After permission from flight directors in Moscow and Houston, Atlantis was moved to 9.1 m from Mir and then halted momentarily again to make final adjustments. The key camera for final approach was an elbow camera on the shuttle's Canadarm RMS.

Hatches between Mir and Atlantis were opened at 4:02 a.m. EST, November 15. Control of the DM was transferred to the Mir 20 crew. During mated operations, nearly 453.6 kg of water was transferred to Mir. Numerous experiment samples, including blood, urine and saliva, were moved to the orbiter for return to earth. The shuttle crew also brought gifts, including Canadian maple sugar candies and a guitar (second guitar on Mir). Lithium hydroxide canisters – a late addition – were transferred to Mir in case the faulty environmental control system failed again and the station's air needed to be "scrubbed" clean. The two spacecraft separated on November 18 and Atlantis began the journey home.

STS-100

Mission: International Space Station Assembly Flight 6A.

Space Shuttle: *Endeavour*.

Launched: April 19, 2001, 2:40:42 p.m. EDT.

Landed: May 1, 2001, 9:10:42 p.m. PDT.

Mission Duration: 12 days.

Docking with the ISS occurred at 9:59 a.m. EDT April 21. The advanced robotic arm, called Canadarm2, was attached to a pallet on the outside of the U.S. Destiny Lab. It was later directed to walk off the pallet and grab onto an electrical grapple fixture on Destiny that would provide data, power and telemetry to the arm. Days later the arm was used to hand off the cradle, on which it rested inside Endeavour's payload bay during launch, to the orbiter's arm. The exchange of the cradle from the station's Mobile Servicing System (MMS) Canadarm2 to the shuttle's RMS Canadarm marked the first ever robotic-to-robotic transfer in space.

As the astronauts rewired power and data connections for the arm, the backup power circuit failed to respond to commands from station flight engineer Susan Helms, who was operating from a workstation inside Destiny. Disconnecting and reconnecting the cables at the base of the arm resolved the situation and the redundant power path to the arm was then completed.

Other crew activities during the mission included attaching a UHF antenna on the outside of the station and inside, calibrating the Space Vision System – an alignment aid for operating the robotic arm – plus helping repair the space station's treadmill and also filming for IMAX.

ISS Trouble in Space

Computer problems surfaced late on April 24 when flight controllers for the station experienced a loss of command and control computer No. 1, one of three computers on board for systems management. The result was a loss of communication and data transfer between the space station Flight Control Room in Houston and the station.

Communication was routed through *Endeavour*, which enabled the station crew and flight controllers to talk to one another. No computer problems were encountered on *Endeavour*. Activities involving the Canadarm2 RMS were postponed.

Station flight engineer Susan Helms, using a laptop computer, was able to restore the ground's ability to monitor and send commands to the station's US systems. Through the laptop, data from the station computers could be transmitted to the ground for analysis and investigation of the problems.

Computer restoration continued successfully, especially C&C number three. C&C number one was found to have a failed hard drive. It was replaced by a backup payload computer.

Ground controllers successfully synchronized timers on all on-board computers and investigated an error in the software load that might have caused the computer problem. With one operational C&C computer in Destiny and a back-up laptop in Unity, the undocking procedure for Raffaello was given the go-ahead.

Endeavour undocked from the space station April 29, fired a separation burn and headed for home.

PLACE AND DATE OF BIRTH

Born August 29, 1959, in Sarnia and raised in Milton, Ont.

EDUCATION

Chris Hadfield's education includes:

- Graduate as an Ontario Scholar from Milton District High School,
- Bachelor degree in mechanical engineering (with honours) from RMC,
- Post-graduate research at the University of Waterloo, and
- Master of Science (aviation systems) from the University of Tennessee.

PROFESSIONAL EXPERIENCE

In total, Chris Hadfield has flown over 70 different types of aircraft. Raised on a corn farm in southern Ontario, he became interested in flying at a young age. As an air cadet, he won a glider pilot scholarship at age 15 and a power scholarship at age 16. He also taught skiing and ski racing part- and full-time for 10 years.

Hadfield underwent basic flight training in Portage La Prairie, Man., for which he was named top pilot in 1980. In 1983, he took honours as the overall top graduate from Basic Jet Training in Moose Jaw, Sask. and, in 1984–1985, he trained as a fighter pilot in Cold Lake, Alta. on CF-5s and CF-18s. For the next three years Hadfield flew CF-18s for the North American Aerospace Defence Command (NORAD) with 425 Squadron, during which time he flew the first CF-18 intercept of a Soviet "Bear" aircraft. He attended the United States Air Force (USAF) Test Pilot School at Edwards Air Force Base, in California and, upon graduation, served as an exchange officer with the US Navy at Strike Test Directorate at the Patuxent River Naval Air Station.

Colonel Hadfield's military accomplishments from 1989 to 1992 included:

- testing the F/A-18 and A-7 aircraft;
- completing the first military flight of F/A-18 enhanced performance engines;
- developing a new handling qualities rating scale for high angle-of-attack test;
- participating in the F/A-18 out-of-control recovery test program;
- performing research with NASA on pitch control margin simulation and flight; and
- piloting the first flight test of the National Aerospace Plane external-burning hydrogen propulsion engine.

SPECIAL HONOURS

Chris Hadfield's special honours include:

- recipient of Liethen-Tittle Award 1988 (top pilot graduate of the USAF Test Pilot School),
- recipient of U.S. Navy Test Pilot of the Year (1991),
- recipient of honorary Doctorate of Engineering from the Royal Military College (1996),
- recipient of Member of the Order of Ontario (1996),
- recipient of honorary Doctorate of Laws from Trent University (1999),

- recipient of Vanier Award (2001),
- recipient of Meritorious Service Cross (2001),
- recipient of NASA Exceptional Service Medal (2002),
- recipient of Queen Elizabeth II Golden Jubilee Medal (2003),
- inducted into Canada's Aviation Hall of Fame (2005), and
- commemorated on Royal Canadian Mint silver and gold coins for his spacewalk to install Canadarm2 on the ISS (2006).

AFFILIATIONS

Chris Hadfield's affiliations include:

- Royal Military College Club,
- Society of Experimental Test Pilots,
- Canadian Aeronautics and Space Institute,
- Honourary Patron of Lambton College,
- Trustee of Lakefield College School,
- Board member of the International Space School Foundation, and
- Executive with the Association of Space Explorers.

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ASTRONAUT BOB THIRSK

Canadian Space Agency, 2008, Image Gallery: Bob Thirsk. Retrieved March 2,2008, from http://www.space.gc.ca/asc/app/gallery/results2.asp?session=&image_id=Thrisk-1001

Figure 15E-1 Astronaut Robert (Bob) Thirsk

ASTRONAUT BOB THIRSK

In June and July 1996, Thirsk flew as a payload specialist aboard space shuttle mission STS-78, the Life and Microgravity Spacelab (LMS) mission. During this 17-day flight aboard Columbia, he and his six crewmates performed 43 international experiments devoted to life science and materials science.

In 2008, Thirsk was assigned to a long-duration flight as a member of Expedition 19 on the ISS, with duties that include robotic operations and conducting scientific experiments on behalf of Canadian and international researchers.

MISSIONS:

STS-78

Mission: LMS.

Space Shuttle: Columbia.

Launched: June 20, 1996, 10:49:00 a.m. EDT.

Landed: July 7, 1996, 8:36:45 a.m. EDT.

Mission Duration: 17 days.

Orbit Altitude: 150 nautical miles.

Mission Highlights

Five space agencies (NASA, European Space Agency, French Space Agency, Canadian Space Agency, and Italian Space Agency) and research scientists from 10 countries worked together on primary payload experiments of LMS. More than 40 experiments flown were grouped into two areas:

- life sciences, which included human physiology and space biology; and
- microgravity science, which included basic fluid physics investigations, advanced semiconductor and metal alloy materials processing and medical research in protein crystal growth.

Regarding STS-78, NASA observed:

Canadian Space Agency astronaut Bob Thirsk was uniquely qualified for this mission. A bio-medical engineer and a medical doctor, his knowledge and expertise reached into many areas, notably in the physiological adaptations that occur in weightlessness as well as in microgravity experimentation relating to materials processing and fluid physics.

Since 1983, when he was selected to become an astronaut, Bob Thirsk has accumulated 16 years of operational experience. He first trained as back-up Payload Specialist to Marc Garneau for Mission 41-G in October 1984. He was an investigator for three experiments that flew on previous Spacelab missions and was an alternate Payload Specialist on the IML-1 Mission.

One of the most common physiological changes astronauts must live with in a weightless environment is the redistribution of body fluids which can cause discomfort or problems in space or upon returning to earth. Thirsk was leader of an international team investigating this shift of body fluids in weightlessness and its effects on the body's venous system. He has designed an experimental antigravity suit, a pressure suit he believes will help astronauts readapt to life back on earth.

During STS-78, Bob Thirsk participated in a number of experiments in life and microgravity sciences. Like the other six astronauts, he was both subject and researcher for several life sciences investigations. He had a major role in Canada's Torso Rotation Experiment (TRE), designed by McGill University and sponsored by the Canadian Space Agency. TRE related eye/head/body movements to the symptoms of motion sickness that many astronauts experience. Thirsk was also involved in four muscle physiology experiments. Studies on previous missions have revealed a loss of muscle mass, biochemical changes in the muscle that oppose gravity and changes in the performance of certain muscle groups that bear weight and support the skeleton.

Dr. Thirsk had a strong interest in the lung function experiment whose goal was to explain the large differences in the ventilation and the perfusion (blood flow) to the top and bottom of the lung.

Bob Thirsk also participated in one microgravity science experiment, the Protein Crystallization Facility Experiment. The astronauts crystallized large proteins (such as DNA, RNA or viruses) that were analysed back on earth. The goal was to better understand the interactions within and between proteins and, eventually, to design better drugs to inhibit or improve certain effects.

The Columbia orbiter itself played a key part in tests to support raising the Hubble Space Telescope (HST) to a higher orbit during HST's second servicing mission. Columbia's vernier Reaction Control System jets were gently pulsed to boost the orbiter's altitude without jarring payloads. Raising the orbiter Columbia very gently, provided experience used to inform orbiter *Discovery's* later mission STS-82 how to raise HST's orbit without impacting its solar arrays. During STS-82 in February 1997, orbiter *Discovery* did indeed fire its manoeuvring jets several times to successfully boost HST to an orbit eight nautical miles higher.

PLACE AND DATE OF BIRTH

Born August 17, 1953, in New Westminster, B.C.

EDUCATION

Robert Thirsk's education includes:

- Primary and secondary schools in B.C., Alta., and Man.,
- BSc degree in Mechanical Engineering from the University of Calgary,
- MSc in Mechanical Engineering from the Massachusetts Institute of Technology (MIT),
- Doctorate of Medicine from McGill University, and
- Master of Business Administration from the MIT Sloan School of Management.

PROFESSIONAL EXPERIENCE

Robert Thirsk was in the family medicine residency program at the Queen Elizabeth Hospital in Montréal when he was selected in December 1983 for the Canadian Astronaut Program. He began astronaut training in February 1984 and served as backup payload specialist to Marc Garneau for the October 1984 space shuttle mission STS-41G.

Thirsk has been involved in various CSA projects including parabolic flight campaigns and mission planning. He served as crew commander for two space mission simulations: the seven-day CAPSULS mission in 1994, at Defence Research and Development Canada in Toronto, and the 11-day NEEMO 7 undersea mission in 2004 at the National Undersea Research Center in Key Largo, Florida. He also led an international research team investigating the effect of weightlessness on the heart and blood vessels.

In 1998, Thirsk was assigned by the CSA to NASA's Johnson Space Center in Houston to pursue mission specialist training. This training program involves advanced instruction on both shuttle and space station systems, extravehicular activity (EVA), robotic operations, and the Russian language. Within the NASA Astronaut Office, Thirsk serves as a capsule communicator (CapCom) for the International ISS program. CapComs participate in actual and simulated space missions as a communication link between the ground team at Mission Control and the astronauts in orbit. CapComs speak directly with the space station crew and assist with technical planning for the mission and last minute troubleshooting.

In 2004, Thirsk trained at the Yuri Gagarin Cosmonaut Training Centre near Moscow and became certified as a Flight Engineer for the Soyuz spacecraft. He served as backup Flight Engineer to European Space Agency (ESA) astronaut Roberto Vittori for the Soyuz 10S taxi mission to the ISS in April 2005. During the 10-day mission, Thirsk worked as Crew Interface Coordinator (European CapCom) at the Columbus Control Centre in Germany. Thirsk then returned to the Johnson Space Center in Houston to begin ISS Expedition crew training.

Further to Thirsk's CapCom training and experience for NASA missions, in 2007 he underwent Eurocom (European capsule communicator) training in Germany to support the European Space Agency's (ESA) Columbus Control Centre (COL-CC). The COL-CC provides command and control for the Columbus laboratory which was carried into orbit on February 7, 2008, by STS-122.

SPECIAL HONOURS

Bob Thirsk's special honours include:

- recipient of the Association of Professional Engineers, Geologists and Geophysicists of Alberta Gold Medal,
- recipient of the University of Calgary Distinguished Alumni Award,
- recipient of the Gold Medal of the Professional Engineers of Ontario, and
- honorary membership in the College of Physicians and Surgeons of British Columbia.

AFFILIATIONS

Bob Thirsk's affiliations include:

- Professional Engineers of Ontario,
- Canadian College of Family Physicians,
- Canadian Aeronautics and Space Institute,
- Aerospace Medical Association,
- Colleges of Physicians and Surgeons of Ontario and of British Columbia, and
- Canadian Foundation for the International Space University.

ASTRONAUT BJARNI TRYGGVASON

Canadian Space Agency, 2008, Image Gallery: Bjarni Tryggvason. Retrieved March 2, 2008, from http://www.space.gc.ca/asc/app/gallery/results2.asp?session=&image_id=astronaut

Figure 15F-1 Astronaut Bjarni Tryggvason

ASTRONAUT BJARNI TRYGGVASON

Bjarni Tryggvason is an airline transport rated pilot with more than 4 500 hours of flight experience and 1 800 hours as a flight instructor. He is active in aerobatic flight including time on the Tutor jet trainer with the Canadian Forces. He enjoys jogging, skiing and general fitness. He has two children.

MISSIONS

STS-85

Mission: Cryogenic Infrared Spectrometers and Telescopes for the Atmosphere-Shuttle Pallet Satellite-2 (CRISTA-SPAS-02).

Space Shuttle: *Discovery*.

Launched: August 7, 1997, 10:41:00 a.m. EDT.

Landed: August 19, 1997, 7:07:59 a.m. EDT.

Mission Duration: 12 days.

Orbit Altitude: 150 nautical miles.

STS-85 carried a complement of payloads in the cargo bay that focused on Mission to Planet Earth objectives as well as preparations for ISS assembly:

- the Japanese Manipulator Flight Development (MFD),
- the Technology Applications and Science-01 (TAS-1),
- the International Extreme Ultraviolet Hitchhiker-02 (IEH-02), and
- CRISTA-SPAS-02.

This was the second flight of CRISTA-SPAS payload. CRISTA-SPAS-02 represented the fourth mission in a cooperative venture between the German Space Agency (DARA) and NASA. The payload included three telescopes and four spectrometers, deployed on flight day one, to gather data about earth's middle atmosphere. After more than 200 hours of free flight, CRISTA-SPAS-02 was retrieved on August 16. The three CRISTA telescopes collected 38 full atmospheric profiles of the middle atmosphere. A total of 22 sounding rockets and 40 balloons were launched to provide correlating data.

A complementary instrument, the Middle Atmosphere High Resolution Spectrograph Investigation (MAHRSI), provided additional data. This new information from STS-85 combined with that from the first CRISTA-SPAS flight (STS-66 in1994) was used to yield new insight into the distribution of ozone in earth's atmosphere. Once science operations were complete, CRISTA-SPAS was used in a simulation exercise to prepare for the first ISS assembly flight, STS-88.

TAS-1 was a Hitchhiker payload carrying eight experiments designed to demonstrate faster, better and cheaper avionics and processes. All these experiments were completed successfully:

- Solar Constant Experiment (SOLCON),
- Infrared Spectral Imaging Radiometer (ISIR),
- Shuttle Laster Altimeter (SLA),
- Critical Viscosity of Xenon (CVX),
- Space Experiment Module (SEM),
- Two Phase Flow (TPF),

- Cryogenic Flight Experiment (CFE), and
- Stand Alone Acceleration Measurement Device and the Wide Band Stand Alone Acceleration Measurement Device (SAAMD/WBSAAMD).

MFD was designed to evaluate use of the Small Fine Arm that will be part of the future Japanese Experiment Module's Remote Manipulator System on ISS. Despite some glitches, MFD completed a series of exercises by the crew on orbit as well as operators on ground. Two unrelated Japanese experiments, Two-Phase Fluid Loop Experiment (TPFLEX) and Evaluation of Space Environment and Effects on Materials (ESEM), were mounted near the Small Fine Arm in the payload bay.

IEH-02 was flying a second time and consisted of four experiments–all with the common objective of investigating solar extreme ultraviolet (EUV) flux and EUV emissions of the Jupiter/Io plasma torus system:

- Solar Extreme Ultraviolet Hitchhiker-2 (SEH),
- Ultraviolet Spectrography Telescope for Astronomical Research (UVSTAR),
- Distribution and Automation Technology Advancement - Colorado Hitchhiker and Student Experiment of Solar Radiation (DATA-CHASER), and
- Shuttle Glow Experiment-5 and -6.

Payloads inside the cabin included:

- Protein Crystal Growth - Single locker Thermal Enclosure System (PCG-STES),
- Midcourse Space Experiment (MSX),
- Shuttle Ionospheric Modification with Pulsed Local Exhaust (SIMPLEX),
- Southwest Ultraviolet Imaging System (SWUIS), used to observe the Hale-Bopp comet,
- two Get Away Special (GAS) payloads,
- Biological Research in Canisters-10 (BRIC-10), one in a series of flights,
- Solid Surface Combustion Experiment (SSCE), and
- Bioreactor Demonstration System-3 (BDS-3), a cell-biology research payload that had flown previously. On this flight, BDS was used for growing colon cancer cells to a larger size than can be achieved on earth.

The crew also worked with the Orbiter Space Vision System (OSVS), which will be used during ISS assembly. OSVS features series of dots, strategically placed on various payload and vehicle structures, which permit precise alignment and pointing capability.

PLACE AND DATE OF BIRTH

Born September 21, 1945, in Reykjavik, Iceland.

EDUCATION

Bjarni Tryggvason's education includes:

- Primary school in N.S. and B.C.,
- High school in Richmond, B.C.,
- BASc in Engineering Physics from the University of British Columbia, and
- completed postgraduate work in engineering with specialization in applied mathematics and fluid dynamics at the University of Western Ontario.

PROFESSIONAL EXPERIENCE

Bjarni Tryggvason was a meteorologist with the cloud physics group at the Meteorlogic Service Canada (formerly the Atmospheric Environment Service) in Toronto in 1972 and 1973. After that, he served as a research associate in industrial aerodynamics at the Boundary Layer Wind Tunnel Laboratory at the University of Western Ontario from 1974 to 1979.

Tryggvason was a guest research associate at Kyoto University, in Kyoto, Japan, in 1979 and at James Cook University of North Queensland, in Townsville, Australia in 1980. He was a lecturer in Applied Mathematics at the University of Western Ontario from 1980 to 1982.

From 1982 to 1984, Tryggvason was a research officer at the Low Speed Aerodynamics Laboratory at the National Research Council of Canada (NRC) and was a lecturer at the University of Ottawa and at Carleton University from 1982 to 1992.

Selected as one of the original six Canadian astronauts in December 1983, Tryggvason trained as a backup payload specialist for the CANEX-2 set of experiments, which flew on Mission STS-52 in October 1992. He was also the project engineer for the Space Vision System Target Spacecraft, which was deployed during that mission.

Tryggvason also served as the principal investigator for the following projects:

- development of the Large Motion Isolation Mount (LMIM), which flew numerous times on NASA KC-135 and DC-9 aircraft,
- Microgravity vibration Isolation Mount (MIM), which operated on the Russian space station, Mir, from April 1996 until January 1998 to support several Canadian and US experiments in material science and fluid physics, and
- the MIM-2 which flew on STS-85 in August 1997.

He was the originator and technical director during the early development phase of the Microgravity Vibration Isolation Subsystem (MVIS), which the CSA developed for the European Space Agency Fluid Science Laboratory for the ISS.

On August 7, 1997, Tryggvason flew as a payload specialist aboard Space Shuttle *Discovery* on Mission STS-85. His primary role was to test MIM-2 and perform fluid science experiments designed to examine sensitivity to spacecraft vibrations, in order to develop a better understanding of the need for systems such as the MIM on the ISS and to study the effect vibrations have on the many experiments performed on the ISS.

In August 1998, Tryggvason was invited to take part in NASA mission specialist training held at the Johnson Space Center in Houston, Texas. His class underwent two years of physical and academic training and was the first group of astronauts to be trained as both mission specialists for the space shuttle and as potential crewmembers for the ISS.

Following completion of mission specialist training, Tryggvason's NASA duties included serving as a crew representative for the Shuttle Avionics Integration Laboratory (SAIL), which is used to test shuttle flight software prior to onboard use. He also supported integrated simulations on the ISS Training Facility at the Johnson Space Center in Houston, Texas, and served as a CSA representative on the NASA Microgravity Measurement Working Group and on the ISS Microgravity Analytic Integration Team.

From mid 2001 to 2003, Tryggvason worked in the private sector while on leave from the CSA. He returned to work at the CSA in 2004. He has held the position of visiting professor at the University of Western Ontario. He has written more than 50 published papers and holds three patents.

SPECIAL HONOURS

Bjarni Tryggvason's special honours include:

- recipient of the Canadian Space Agency Innovators Award,
- recipient of the Order of the Falcon from Iceland,
- recipient of the NASA Space Flight Medal, and
- recipient of the Doctorate of Philosophy (honoris causa) degrees, from:
    - University of Iceland, and
    - University of Western Ontario.

AFFILIATIONS

Bjarni Tryggvason's affiliations include the Canadian Aeronautics and Space Institute.

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ASTRONAUT DAVE WILLIAMS

Canadian Space Agency, 2008, Image Gallery: Dave Williams. Retrieved March 2, 2008, from http://spaceflight.nasa.gov/gallery/images/shuttle/sts-118/html/jsc2001-00190.html

Figure 15G-1 Astronaut Dave Williams

ASTRONAUT DAVE WILLIAMS

Dave Williams is married and has two children. He enjoys flying, scuba diving, hiking, sailing, kayaking, canoeing, downhill and cross-country skiing.

MISSIONS

STS-90

Mission: Neurolab (the final Spacelab mission).

Space Shuttle: Columbia.

Launched: April 17, 1998, 2:19:00 p.m. EDT.

Landed: May 3, 1998, 12:08:59 p.m. EDT.

Mission Duration: 16 days.

Orbit Altitude: 150 nautical miles.

The launch of Columbia was postponed on April 16 for 24 hours due to difficulty with one of Columbia's two network signal processors, which format data and voice communications between the ground and the space shuttle. The network signal processor 2 was replaced, and Columbia lifted off on April 17.

Mission Highlights

Neurolab's 26 experiments targeted one of the most complex and least understood parts of the human body – the nervous system. The primary goals were to conduct basic research in neurosciences and expand understanding of how the nervous system develops and functions in space. Test subjects were crew members, rats, mice, crickets, snails and two kinds of fish. This was a cooperative effort of the Canadian Space Agency and several other national space agencies, including ESA (European Space Agency), NASA (USA), CNES (France), DARA (Germany) and NASDA (Japan). Most experiments were conducted in the pressurized Spacelab long module located in Columbia's X bay. This was the 16th and last scheduled flight of the ESA-developed Spacelab module although the Spacelab pallets continued to be used on the ISS.

STS-118

Launch: Aug. 8, 2007, 6:36 p.m. EDT.

Landed: Aug. 21, 2007,12:33 p.m. EDT.

Orbiter: *Endeavour*.

Mission Number: STS-118.

Mission Duration: 12 days, 17 hours, 55 minutes.

Altitude: 122 nautical miles.

Primary Payload: 22nd station flight (13A.1), S5 Truss.

Dave Williams was a mission specialist on STS-118, the 22nd flight to the ISS and the 20th flight for *Endeavour*. During the mission, the crew successfully added truss segment S5, a new gyroscope and an external stowage platform to the ISS.

Show the cadets Figure 15G-2.

The mission successfully activated a new system that enables docked shuttles to draw electrical power from the ISS to extend visits to the outpost. Williams took part in three of the four spacewalks – the highest number of spacewalks performed in a single mission. He spent 17 hours and 47 minutes outside – a Canadian record. *Endeavour* carried 2 280 kg of equipment and supplies to the station and returned to earth with 1 800 kilograms of hardware and used equipment. Travelling 8.5 million km in space, the STS-118 mission was completed in 12 days, 17 hours, 55 minutes, and 34 seconds.

PLACE AND DATE OF BIRTH

Born May 16, 1954, in Saskatoon, Sask.

EDUCATION

Dave Williams' education includes:

- High school in Beaconsfield, Que.,
- BSc (Biology) from McGill University,
- MSc (Physiology) from McGill University,
- Doctorate of Medicine from the Faculty of Medicine, McGill University,
- Master of Surgery from the Faculty of Medicine, McGill University, and
- Completed a residency in family practice in the Faculty of Medicine, University of Ottawa.

PROFESSIONAL EXPERIENCE

Dave Williams pursued postgraduate studies in advanced invertebrate physiology at the Friday Harbour Laboratories at the University of Washington, Seattle, but his interests shifted to vertebrate neurophysiology when, for his master's thesis, he became involved in basic science research on how adrenal steroid hormones modify the regulation of sleep-wake cycles. While working in the Neurophysiological Laboratories at the Allan Memorial Institute for Psychiatry, Williams assisted in clinical studies of slow wave potentials within the central nervous system.

Williams served as an emergency physician with the Emergency Associates of Kitchener-Waterloo and as the medical director of the Westmount Urgent Care Clinic. Subsequently, he became the director of the Department of Emergency Services at Sunnybrook Health Science Centre and assistant professor of Surgery at the University of Toronto.

In June 1992, the CSA selected Williams as one of four successful candidates from a field of 5 330 applicants to begin astronaut training. He completed basic training and, in May 1993, was appointed manager of the Missions and Space Medicine Group within the Canadian Astronaut Program. His assignments included supervising the implementation of operational space medicine activities for the Canadian Astronaut Program Space Unit Life Simulation (CAPSULS) Project.

In January 1995, Williams was selected to join the international class of NASA mission specialist astronaut candidates. He reported to the Johnson Space Center (JSC) in March 1995, for a year of training and evaluation. Following the successful completion of this training in May 1996, he was assigned to the Payloads and Habitability Branch of the NASA Astronaut Office.

From July 1998, until September 2002, Dave Williams held the position of Director of the Space and Life Sciences Directorate at the Johnson Space Center in Houston, Texas. With this appointment, he became the first non-American to hold a senior management position within NASA. He concurrently held a six-month position as the first deputy associated administrator for crew health and safety in the Office of Space Flight at NASA Headquarters in 2001.

In addition to these assignments, Dave Williams continued to take part in astronaut training to maintain and further develop his skills. In October 2001, he became an aquanaut through his participation in the joint NASA-NOAA (National Oceanic and Atmospheric Administration) NEEMO 1 mission, a training exercise held in Aquarius, the world's only underwater research laboratory located 5.6 km off the shores of Key Largo, Florida. During this seven-day exercise, Williams became the first Canadian to have lived and worked in space and in the ocean.

In 2006, Dave Williams took the lead of NEEMO 9 as the crew commander of this mission, dedicated to assess new ways to deliver medical care to a remote location, as in a long space flight.

SPECIAL HONOURS

Dave Williams' special honours include:

- Academic awards:
  - recipient of the A.S. Hill Bursary, McGill University (1980),
  - recipient of the Walter Hoare Bursary, McGill University (1981),
  - recipient of the J.W. McConnell Award, McGill University (1981 to 1983),
  - Faculty Scholar (1982), Faculty of Medicine, McGill University,
  - University Scholar (1983), Faculty of Medicine, McGill University,
  - recipient of the Psychiatry Prize, Wood Gold Medal,
  - Dean's Honour List, Physiology Department, McGill University (1983), and
  - recipient of Second prize (1986, 1987, 1988) for participation in the University of Toronto Emergency Medicine Research Papers Program;
- recipient of the Commonwealth Certificate of Thanks and the Commonwealth Recognition Award for contributions to the Royal Life Saving Society of Canada,
- recipient of the NASA Space Flight Medal,
- recipient of the Melbourne W. Boynton Award, American Astronautical Society (1999),
- recipient of the Ramon y Cajal Institute of Neurobiology, Spanish Council for Scientific Research (CSIC) Bronze Medal for contribution to neuroscience during Mission STS-90 (1999),
- recipient of the Rotary National Award for Space Achievement (2000),
- recipient of the NASA Outstanding Leadership Medal (2002),
- Patron of the International Life Saving Federation (2002),
- Spokesperson for the Life Saving Society Canada,
- Honorary Ambassador of the SmartRisk Foundation,
- NASA JSC Space and Life Sciences Directorate Special Professional Achievement Award (2003) for the implementation of the Automatic External Defibrillator Program that has saved several lives at the NASA Johnson Space Center, and
- Honorary Doctor of Laws, University of Saskatchewan (2004).

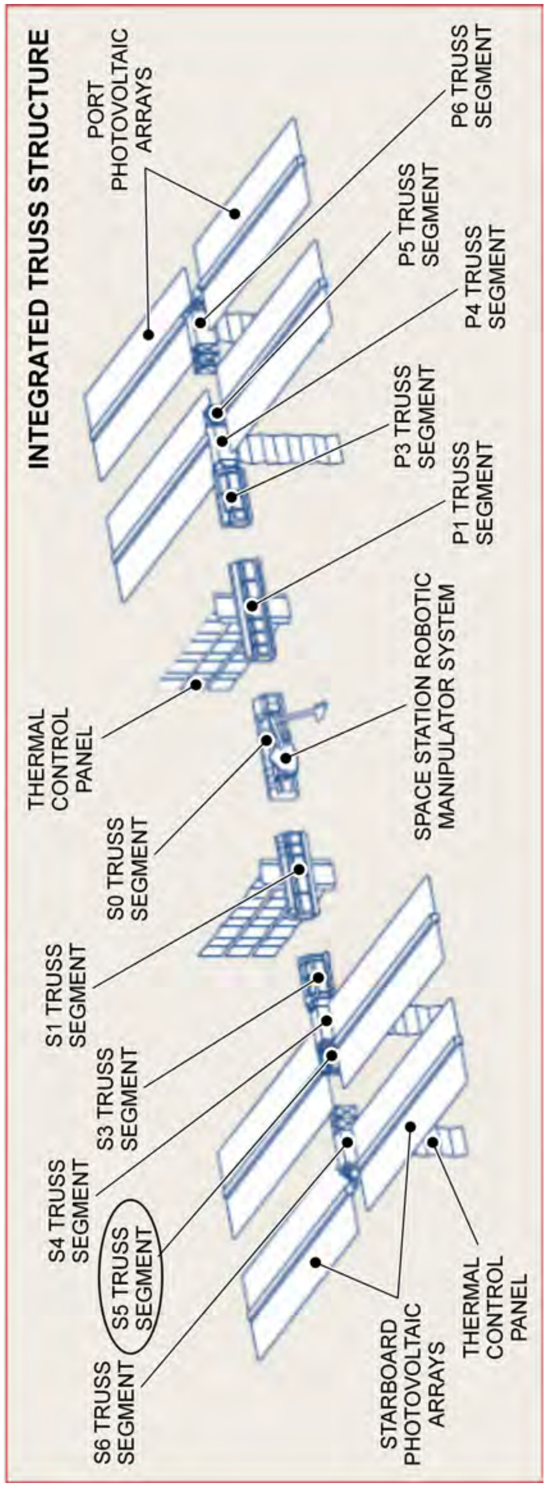
AFFILIATIONS

Dave Williams' affiliations include:

- Member of the College of Physicians of Ontario,
- Member of Ontario Medical Association,
- Member of the Canadian Association of Emergency Physicians,
- Member of the Undersea and Hyperbaric Medicine Society, and
- Member of the Aerospace Medical Association.

Past affiliations include:

- Society for Neuroscience,
- New York Academy of Science, and
- Montreal Physiological Society.



Canadian Space Agency, 2007, Missions: STS-118 Mission Overview. Retrieved March 2, 2008, from http://www.space.gc.ca/asc/eng/missions/sts-118/overview.asp

Figure 15G-2 Integrated Truss S5

ASTRONAUT JULIE PAYETTE

Canadian Space Agency, 2008, Astronauts: Julie Payette Biography. Retrieved March 2, 2008, from http://www.space.gc.ca/asc/eng/astronauts/biopayette.asp

Figure 15H-1 Astronaut Julie Payette

ASTRONAUT JULIE PAYETTE

Julie Payette enjoys running, skiing, racquet sports and scuba diving. She has a commercial pilot licence with float rating. Fluent in French and English, she can converse in Spanish, Italian, Russian and German. She plays the piano and has sung with the Orchestre symphonique de Montréal, the Piacere Vocale in Basel, Switzerland and the Tafelmusik Baroque Orchestra in Toronto. She is married and has two children.

MISSIONS

STS-96

Mission: Second International Space Station Flight.

Space Shuttle: Discovery.

Launched: May 27, 1999, 6:49:42 a.m. EDT.

Landed: June 6, 1999, 2:02:43 a.m. EDT.

Mission Duration: 10 days.

Orbit Altitude: 173 nautical miles.

Mission Highlights

All major objectives were accomplished during the mission. On May 29th, *Discovery* made the first docking to the ISS as it flew over the Russian-Kazakh border.

The 45th space walk in space shuttle history and the fourth of the ISS era took place during this mission. Astronauts transferred a US-built crane called the orbital transfer device and parts of the Russian crane Strela from the shuttle's payload bay and attached them to locations on the outside of the station. The astronauts also installed two new portable foot restraints, which will fit both American and Russian space boots, and they attached three bags filled with tools and handrails for use during future assembly operations.

The crew transferred 3 567 pounds of material, including clothing, sleeping bags, spare parts, medical equipment, supplies, hardware and about 84 gallons of water, to the interior of the station. The astronauts also installed parts of a wireless strain gauge system to help engineers track the effects of adding modules to the station throughout its assembly.

The astronauts spent a total of 79 hours, 30 minutes inside the station. Before departure, a series of 17 pulses of Discovery's reaction control system jets boosted the station to an orbit of approximately 246 statute miles. After spending 5 days, 18 hours and 17 minutes linked to the station, *Discovery* undocked at 6:39 p.m. EDT. Discovery's jets fired to move to a distance of about 400 feet for a 2-1/2 lap fly-around during which the crew made a detailed photographic record of the ISS.

After the fly-around, mission specialist Julie Payette deployed the Starshine satellite from the orbiter's cargo bay. The spherical, reflective object entered an orbit two miles below *Discovery*. The small probe became instantly visible from Earth as part of a project allowing more than 25 000 students from 18 countries to track its progress. Other payloads included the Shuttle Vibration Forces experiment and the Integrated Vehicle Health Monitoring for the Human Exploration and Development of Space (HEDS) Technology Demonstration.

PLACE AND DATE OF BIRTH

Born October 20, 1963, in Montréal, Que.

EDUCATION

Julie Payette's education includes:

- primary and secondary school in Montréal, Que.,

- International Baccalaureate from United World College of the Atlantic in Wales, UK,
- Bachelor of Engineering, Electrical cum laude from McGill University, Montréal, and
- Master of Applied Science, Computer Engineering, from the University of Toronto.

PROFESSIONAL EXPERIENCE

Before joining the space program, Julie Payette conducted research in computer systems, natural language processing and automatic speech recognition.

Her previous employment included:

- system engineer with IBM Canada (1986–1988),
- research assistant at the University of Toronto (1988–1990),
- visiting scientist at the IBM Research Laboratory, in Zurich, Switzerland (1991),
- research engineer with BNR/Northern in Montréal (1992), and
- in June 1992, the Canadian Space Agency selected Ms. Payette from 5 330 applicants to become one of four astronauts.

After her basic training in Canada, she worked as a technical advisor for the Mobile Servicing System (MSS Canadarm2), an advanced robotics system contributed by Canada to the ISS. In preparation for a space mission assignment, Payette obtained her commercial pilot license, studied Russian and logged 120 hours as a research operator on board reduced gravity aircraft. In April 1996, Payette was certified as a one-atmosphere, deep-sea diving suit operator. Payette obtained her military pilot captaincy on the CT-114 Tutor jet at the Canadian Forces Base in Moose Jaw, Sask. in February 1996. She obtained her military instrument rating in 1997. She has logged more than 1 200 hours of flight time.

Payette reported to the NASA Johnson Space Center in Houston, Texas in August 1996. She completed initial astronaut training in April 1998 and was assigned to work on technical issues in robotics for the Astronaut Office. In the spring of 1999, she visited the ISS aboard STS-96.

From September 1999, to December 2002, Payette was assigned to represent the astronaut corps at the European and Russian space agencies where she supervised procedure development, equipment verification and space hardware processing for the ISS Program.

After January 2003, Payette worked as a CapCom (Spacecraft Communicator) at Mission Control Center in Houston and was Lead CapCom for Space Shuttle mission STS-121 in 2006. The CapCom is responsible for all communications between ground controllers and the astronauts in flight.

SPECIAL HONOURS

Julie Payette’s special honours include:

- recipient of a scholarship to attend the Atlantic College in Wales, UK,
- recipient of a Greville-Smith Scholarship (highest undergraduate award at McGill University),
- McGill University Faculty Scholar (1983–1986),
- recipient of a Natural Sciences and Engineering Research Council of Canada (NSERC) Scholarship,
- recipient of a Massey College Fellowship,
- recipient of the Canadian Council of Professional Engineers Exceptional Achievement Award,
- recipient of the Chevalier de l’Ordre de la Pléiade de la francophonie,
- Ordre national du Québec,

- recipient of honorary Degrees from:
  - Queen’s University,
  - University of Ottawa,
  - Simon Fraser University,
  - Université Laval,
  - University of Regina,
  - Royal Roads University,
  - University of Toronto,
  - University of Victoria,
  - Nipissing University,
  - McGill University,
  - Mount Saint Vincent University,
  - McMaster University,
  - University of Lethbridge,
  - Mount Allison University, and
  - University of Alberta.

AFFILIATIONS

Julie Payette’s affiliations include:

- Member of l’Ordre des Ingénieurs du Québec,
- Fellow of the Canadian Academy of Engineering,
- Queen’s University Board of Directors,
- Former Governor-in-Council for NSERC, and
- Les Amies d’affaires du Ritz.

EARLY MANNED SPACE EXPLORATION TIMELINE

MERCURY PROGRAM

- October 1, 1958 National Aeronautics and Space Administration (NASA) created
- November 26, 1958 Mercury program announced
- December 4, 1959 Launch of Sam (a monkey) on Little Joe 2
- April 9, 1959 NASA names the seven Mercury astronauts
- January 21, 1960 Launch of Miss Sam (a monkey) on Little Joe IB
- January 31, 1961 Launch of Ham (a chimpanzee) on Mercury Redstone 2
- **May 5, 1961 Launch of Alan Shepard in Freedom 7 (suborbital)**
- July 21, 1961 Launch of Gus Grissom in Liberty 7 (suborbital)
- November 29, 1961 Launch of Enos (a chimpanzee) on Mercury Atlas 5 (orbital)
- January 3, 1962 Gemini program formally conceived
- **February 20, 1962 Launch of John Glenn in Friendship 7, first American human orbital flight**
- May 24, 1962 Launch of Scott Carpenter in Aurora 7
- October 3, 1962 Launch of Walter Schirra in Sigma 7
- May 15, 1963 Launch of Gordon Cooper in Faith 7, the final Mercury mission

GEMINI PROGRAM

- March 23, 1965. Gemini III. First manned Gemini flight completed three orbits
- June 03–07, 1965. Gemini IV. First American Extra Vehicular Activity (EVA)
- August 21–29, 1965. Gemini V. First use of fuel cells for electrical power
- **December 04, 1965.** Gemini VII**. First rendezvous in space, with Gemini VI-A**
- December 15, 1965. Gemini VI-A. First rendezvous in space, with Gemini VII
- **March 16, 1966.** Gemini VIII**. First docking with another (unmanned) spacecraft**
- June 03–06, 1966. Gemini IX-A. Three rendezvous and two hours of EVA
- July 18–21, 1966. Gemini X. Rendezvoused with target vehicle and EVA
- September 12, 1966. Gemini XI. Gemini record altitude of 1 189.3 km
- November 11, 1966. Gemini XII. Final Gemini flight: rendezvous, docking, EVA

APOLLO PROGRAM

- October, 1968 Apollo 7. Earth orbit
- **December,1968 Apollo 8. Ten lunar orbits**
- March, 1969 Apollo 9. First manned flight of lunar module
- May, 1969 Apollo 10. Dress rehearsal for Moon landing
- **July 20, 1969 Apollo 11. First lunar landing mission (on the Sea of Tranquility)**
- November, 1969 Apollo 12. Second lunar landing (on the Ocean of Storms)

- April, 1970 Apollo 13. Mission aborted after an on-board explosion
- January, 1971 Apollo 14. Third lunar landing (at Fra Mauro)
- July, 1971 Apollo 15. Fourth lunar landing (in the Hadley Apennine region)
- April, 1972 Apollo 16. Fifth lunar landing (on the Descartes highlands)
- December, 1972 Apollo 17. Last lunar landing (on theTaurus Littrow highlands)

NASA 40th Anniversary of the Mercury 7, by T. Gray, 2001. Retrieved March 5, 2008, from http://history.nasa.gov/40thmerc7/shepard.htm

Figure 15I-1 Alan B. Shepard

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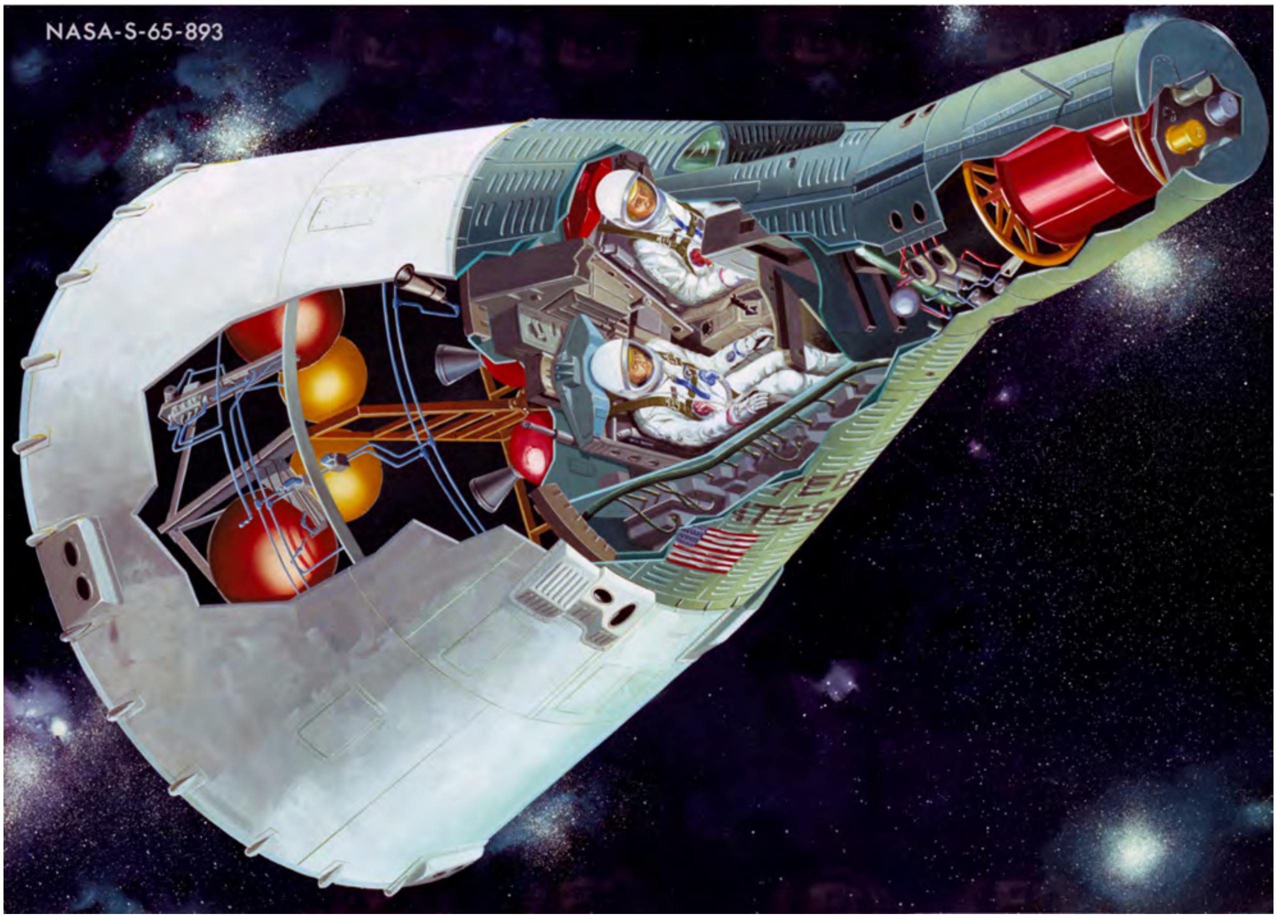
GEMINI PROGRAM

"Friendship 7: Biographies", by C. Gainor, 2007, James A. Chamberlin. Retrieved December 1, 2007, from http://history.nasa.gov/friendship7/pages/bios.html

Figure 15J-1 James A. Chamberlin



NASA Gemini: Stepping Stone to the Moon--40 Years Later. Retrieved March 5, 2008, from http://www.nasa.gov/mission_pages/gemini/index.html

Figure 15J-2 Gemini Capsule Cutaway

NASA Gemini: Stepping Stone to the Moon--40 Years Later. Retrieved March 5, 2008, from http://www.nasa.gov/mission_pages/gemini/index.html

Figure 15J-3 Gemini VII Seen From Gemini VI-A

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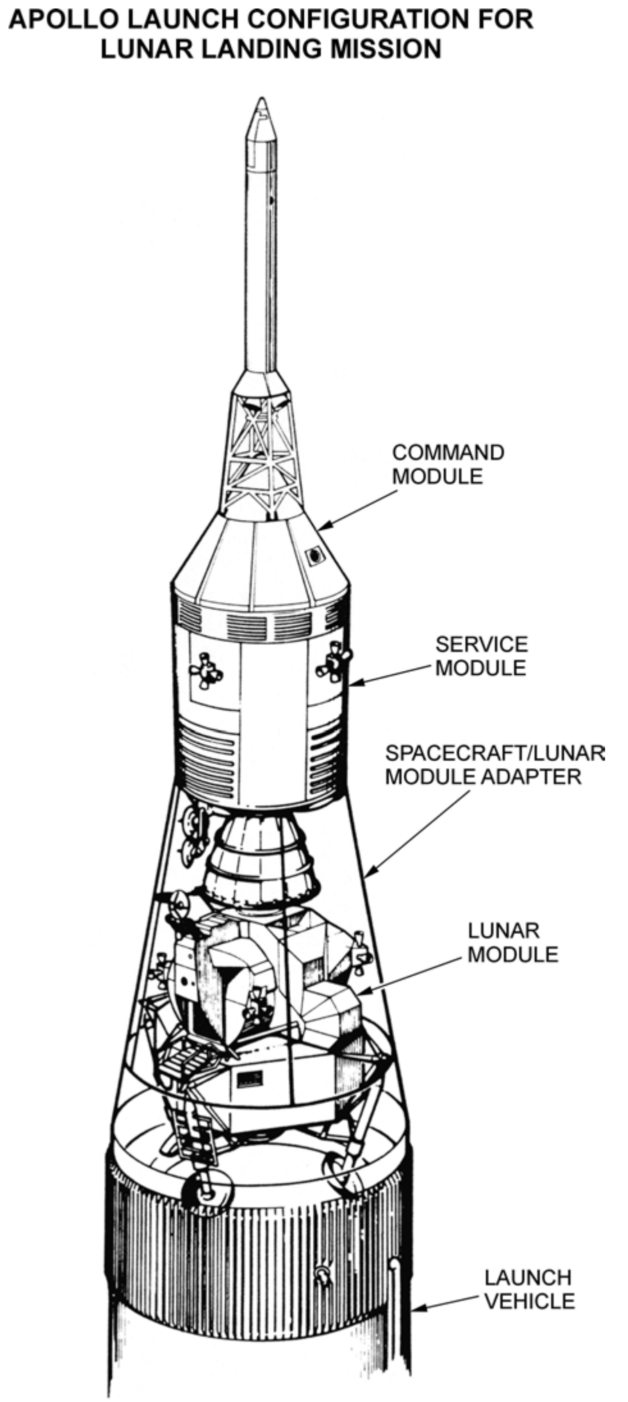
APOLLO PROGRAM

“Great Images in NASA”, 2002, GPN-2000-000629. Retrieved December 1, 2007, from http://grin.hq.nasa.gov/ABSTRACTS/GPN-2000-001053.html

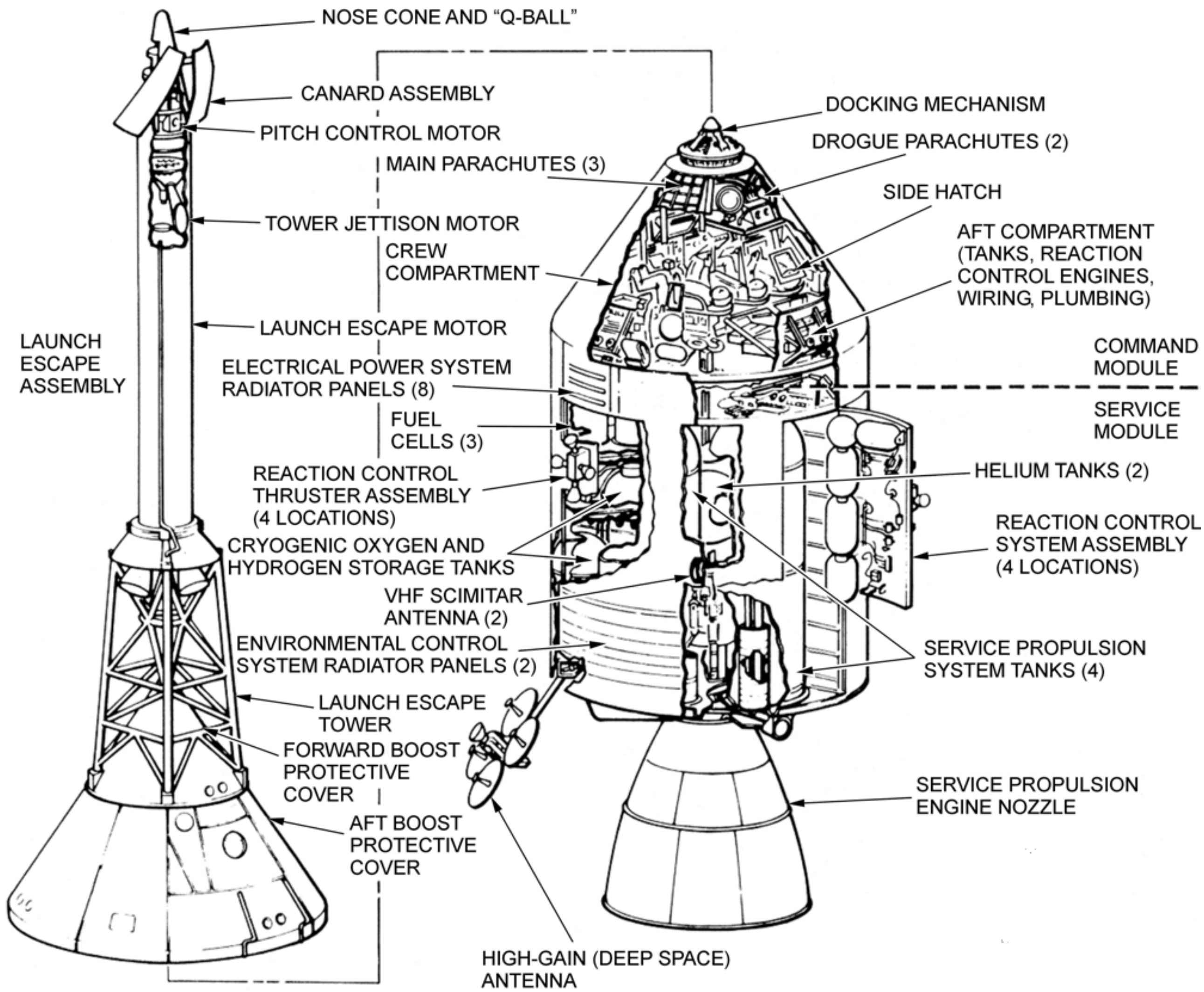
Figure 15K-1 Launching Apollo 11



Project Apollo Drawings and Technical Diagrams, NASA History Division, 2007. Retrieved March 5, 2008, from http://www.hq.nasa.gov/office/pao/History/diagrams/apollo.html

Figure 15K-2 In the Nose Cone

APOLLO COMMAND AND SERVICE MODULES AND LAUNCH ESCAPE SYSTEM



Project Apollo Drawings and Technical Diagrams, NASA History Division, 2007. Retrieved March 5, 2008, from http://www.hq.nasa.gov/office/pao/History/diagrams/apollo.html

Figure 15K-3 Modules Revealed

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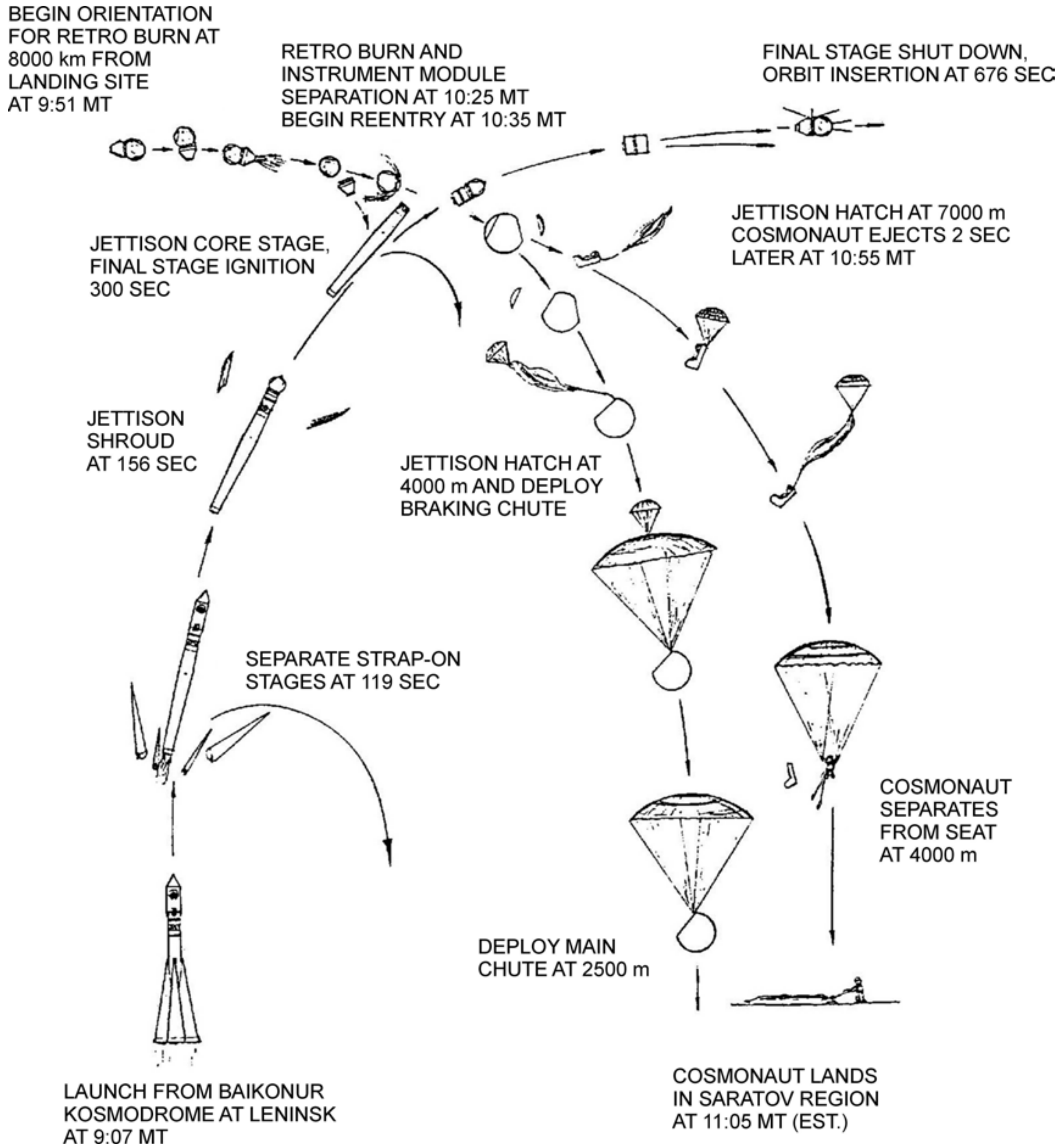
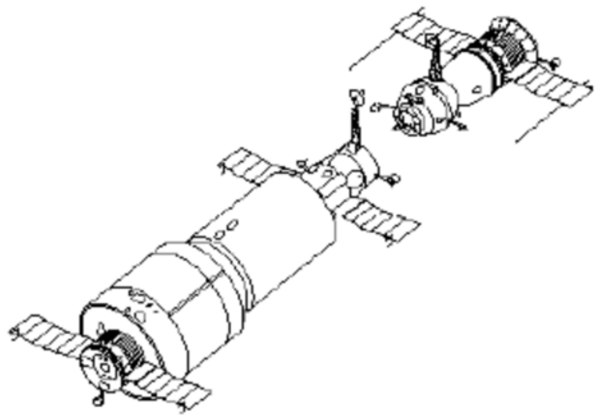
VOSTOK PROGRAM



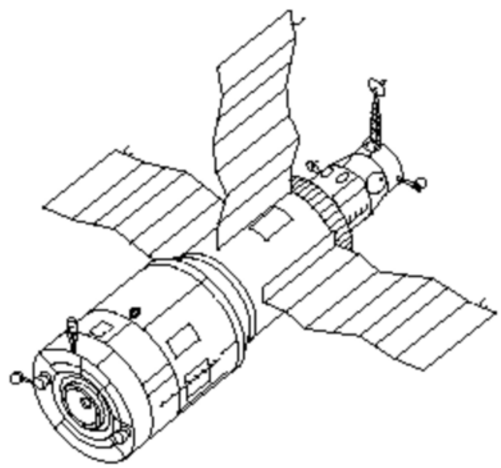
"Great Images in NASA", 2002, GPN-2002-000224. Retrieved December 1, 2007, from http://grin.hq.nasa.gov/ABSTRACTS/GPN-2000-001053.html

Figure 15L-1 Vostok-1 Historic First Manned Spacefight



"NASA Facts", 1997, International Space Station: Russian Space Stations. Retrieved December 1, 2007, from http://spaceflight.nasa.gov/history/shuttle-mir/spacecraft/to-s-mir.htm

Figure 15L-2 Salyut-1 Station With a Soyuz About to Dock

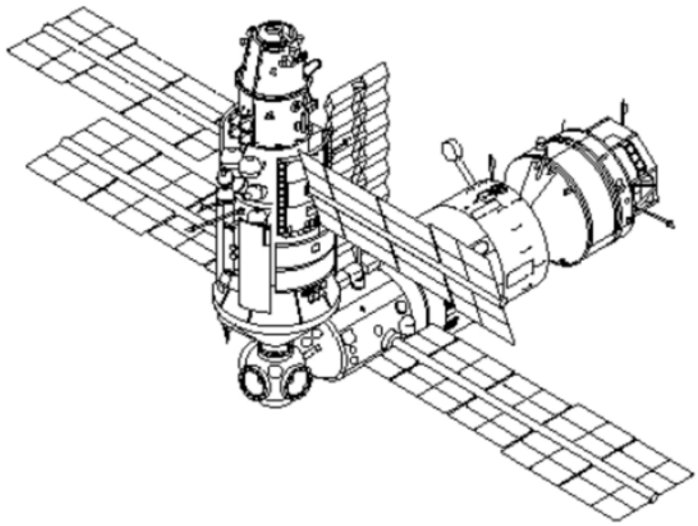


"NASA Facts", 1997, International Space Station: Russian Space Stations. Retrieved December 1, 2007, from http://spaceflight.nasa.gov/history/shuttle-mir/spacecraft/to-s-mir.htm

Figure 15L-3 Salyut-6 (1977–1982)

"Wikipedia", 2007, Salyut Program. Retrieved November 30, 2007, from http://en.wikipedia.org/wiki/Image:Salyut_7_from_Soyuz_T-13.jpg

Figure 15L-4 Salyut-7



"NASA Facts", 1997, International Space Station: Russian Space Stations. Retrieved December 1, 2007, from http://spaceflight.nasa.gov/history/shuttle-mir/spacecraft/to-s-mir.htm

Figure 15L-5 Mir Space Station

NASA "Multimedia Photo Gallery", 1998, STS 89. Retrieved December 2, 2007, from http://spaceflight.nasa.gov/history/shuttle-mir/spacecraft/s-mir.htm

Figure 15L-6 The Mir Space Station and Earth

CSA LOGO

Canadian Space Agency, 2008, Canadian Space Agency Logo. Retrieved April 14, 2008, from http://upload.wikimedia.org/wikipedia/en/0/01/Canadian_Space_Agency_logo.png

Figure 15M-1 CSA Logo

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OSM LOGO

Canadian Space Agency, 2008, Operational Space Medicine Logo. Retrieved April 14, 2008, from http://www.space.gc.ca/asc/eng/astronauts/osm_crest.asp

Figure 15N-1 OSM Logo

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CANADIAN SPACE PROGRAM

CANADA'S INVOLVEMENT IN SPACE TECHNOLOGIES

The CSA headquarters is located at the John H. Chapman Space Centre in Saint-Hubert, Que. Canada is involved in many aspects of space exploration. Canadian scientists and researchers are particularly interested with the development and testing of space technologies.

The David Florida Laboratory (DFL). The David Florida Laboratory is Canada's world-class spacecraft assembly, integration and testing centre.

The Canadian Analogue Research Network (CARN). CARN is the organization that uses Canadian sites for field studies. These analogue sites approximate conditions that may exist or have existed on Mars and other planetary bodies such as the moon and the Solar System's icy moons.

Partnerships With the Canadian Space Agency (CSA). The CSA has many partners including international space agencies, industry, post-secondary researchers and educational projects.

CSA MISSIONS

CSA has participated in many space missions with its partners. Canadian astronauts or Canadian technology has gone into space with agencies from the United States, Russia, Europe and Japan. There have been four basic types of CSA missions:

Telecommunications. Being able to keep all places in the country connected with advanced telecommunication services assists every Canadian in competing in the global marketplace.

Earth Observation. Canada's earth-observation initiatives enhance our understanding of the planet and its environment. By observing the earth from space, essential information on oceans, ice, land environments and the atmosphere is gathered.

Space Exploration. Canadian astronauts have been on many missions in various space shuttles. Canada is renowned for the exceptional instruments in its science satellites which collect data that will expand our understanding of the origin, formation, structure and evolution of celestial bodies and the universe.

Space Medicine. Space medicine combines many medical specialties to examine the effects of spaceflight on humans and prevent problems associated with living in a unique, isolated, and extreme environment like space.

For more information about the Canadian space program visit www.space.gc.ca.

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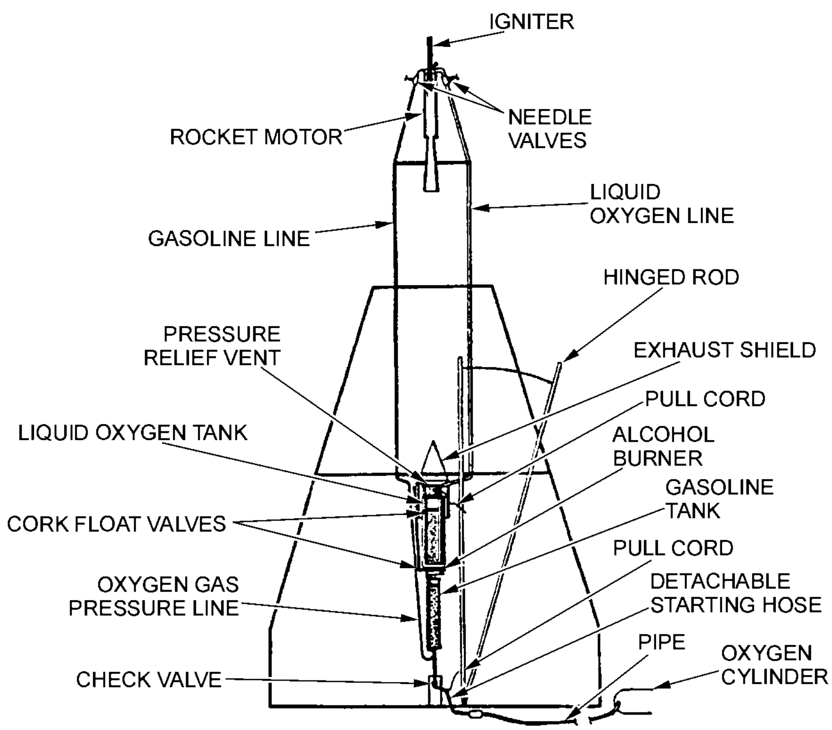
SPACE FLIGHT HISTORY

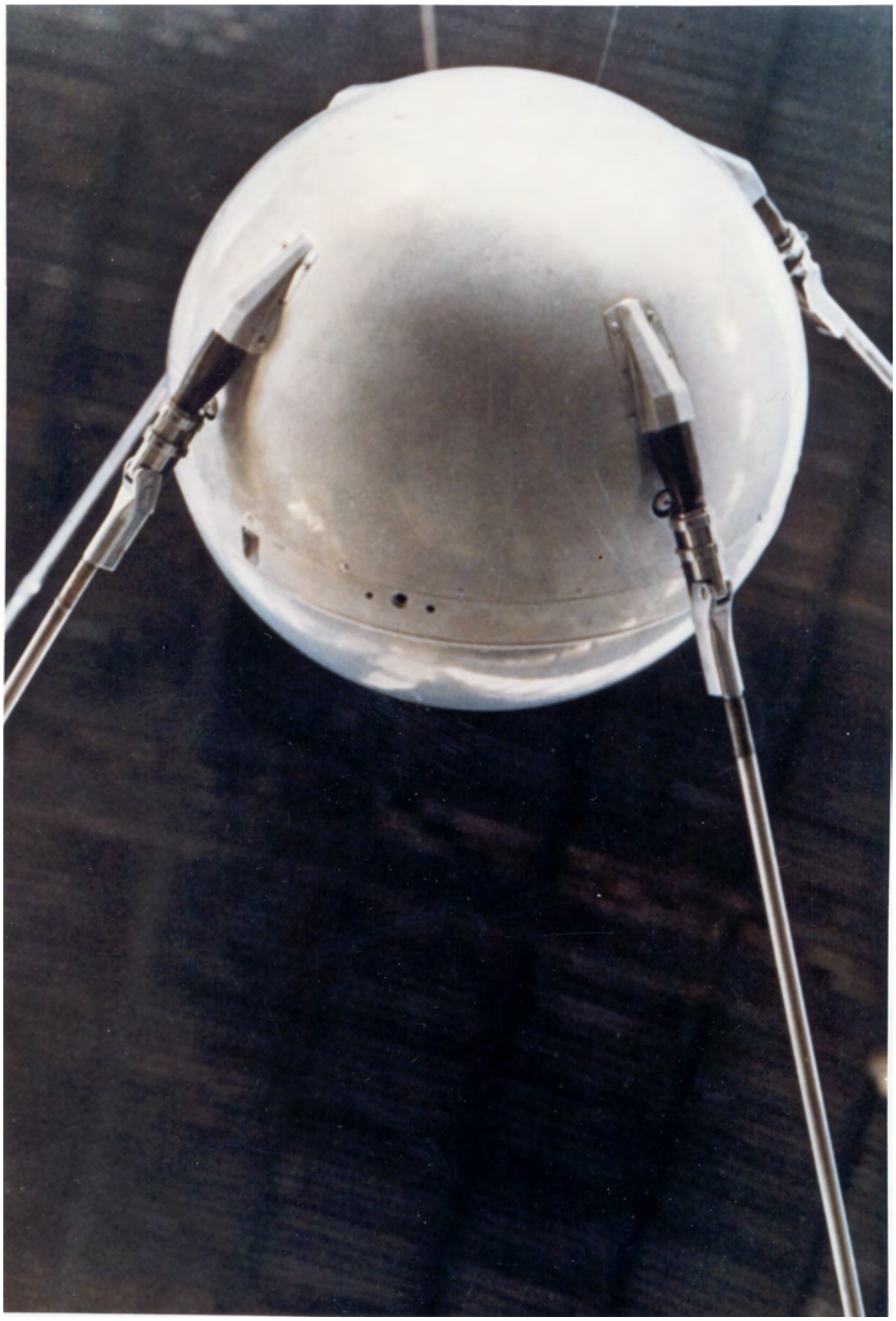
"A Beginner's Guide to Rockets", Rocket Gallery. Retrieved March 24, 2007, from http://exploration.grc.nasa.gov/education/rocket/gallery.html

Figure 15P-1 Dr. Robert Goddard, Father of Modern Rocketry



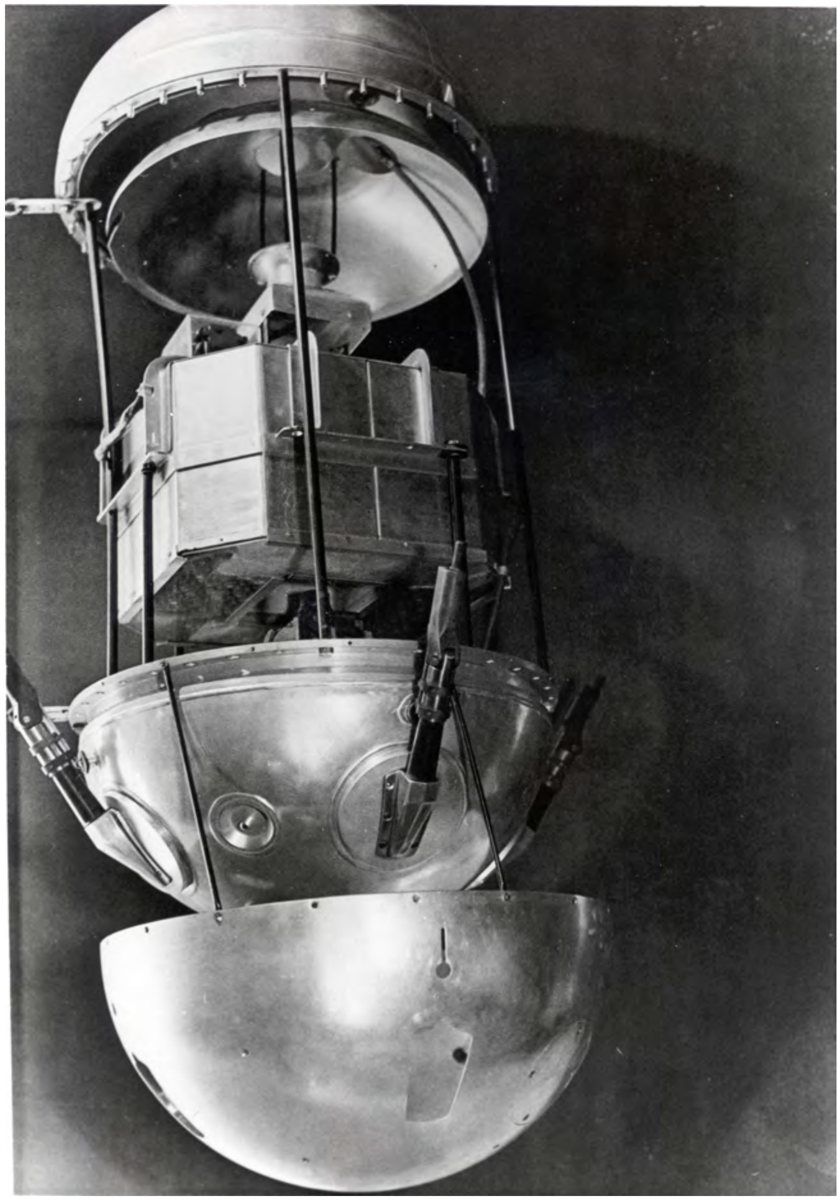
"Rockets", A Brief History of Rockets. Retrieved March 24, 2007, from http://www.grc.nasa.gov/WWW/K-12/TRC/Rockets/history_of_rockets.html

Figure 15P-2 Goddard's 1926 Rocket



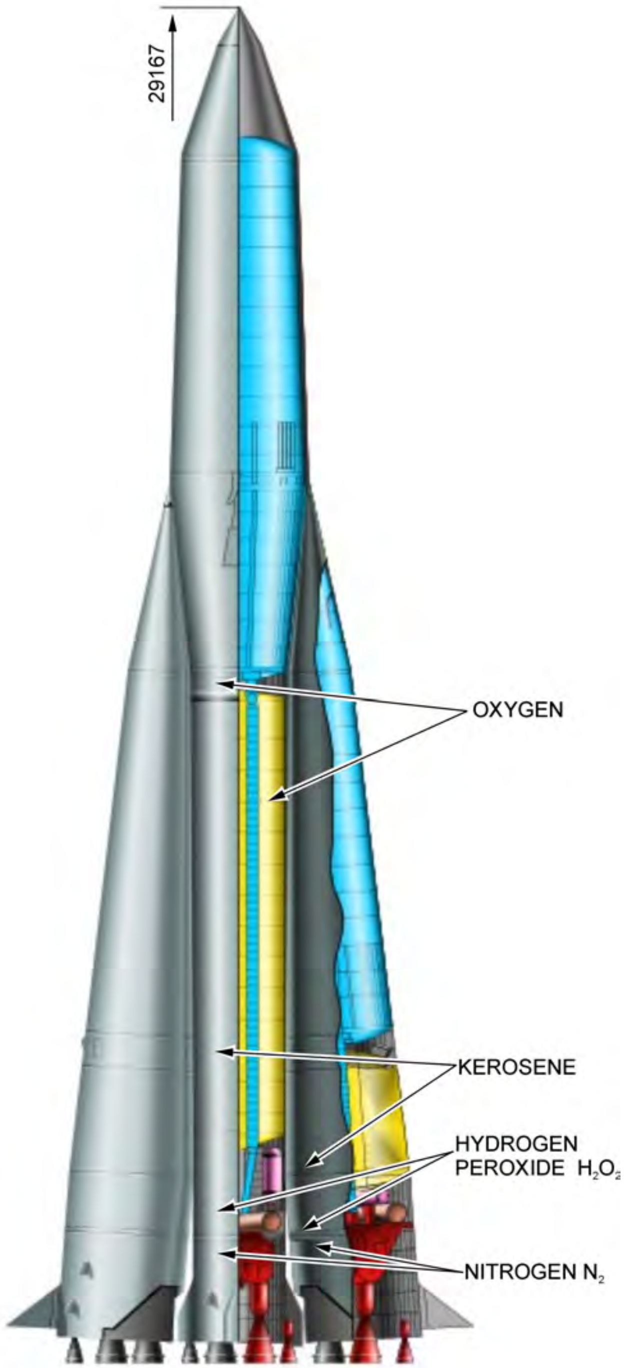
"Sputnik: The Fiftieth Anniversary", 2007, Photo Gallery. Retrieved November 29, 2007, from http://www.history.nasa.gov/sputnik/gallerysput.html

Figure 15P-3 Sputnik



"Sputnik: The Fiftieth Anniversary", 2007, Photo Gallery. Retrieved November 29, 2007, from http://www.history.nasa.gov/sputnik/gallerysput.html

Figure 15P-4 Sputnik Revealed



"Roscosmos", Space Programs Rocket Families R-7. Retrieved March 25, 2007, from http://www.roscosmos.ru/Roket1Show.asp?RoketID=8

Figure 15P-5 Sputnik's R-7 Rocket

"Russian Space Web", 2007, Rockets. Retrieved December 2, 2007, from http://www.russianspaceweb.com/r7.html

Figure 15P-6 Two-Stage R-7 Rocket Modified for Sputnik-1

Flight History JUPITER-C (three-stage configuration):

September 20, 1956: Lofted a payload to an altitude of 1 095 km and a range of 5 313 km from Cape Canaveral, Florida.

May 15, 1957: Lofted a nose cone to an altitude of 563 km and a range of 1 143 km.

August 8, 1957: Lofted a 1/3-scale Jupiter nose cone to an altitude of 459 km and a range of 2 141 km.

January 31, 1958: Orbited Explorer-1 satellite.

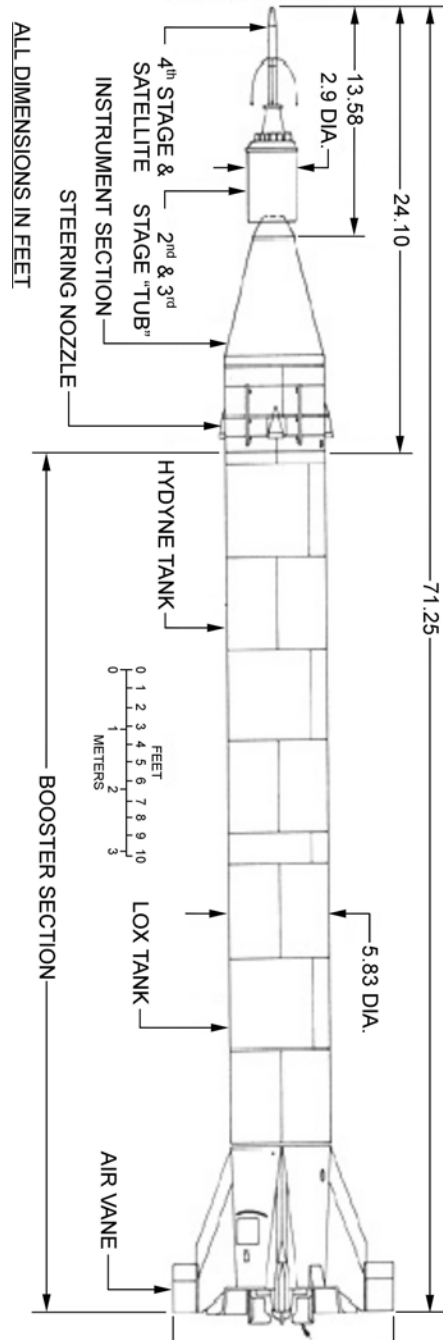
March 5, 1958: Attempted orbit of Explorer-II failed because fourth stage did not ignite.

March 26, 1958: Orbited Explorer-III satellite.

July 26,1958: Orbited Explorer-IV satellite.

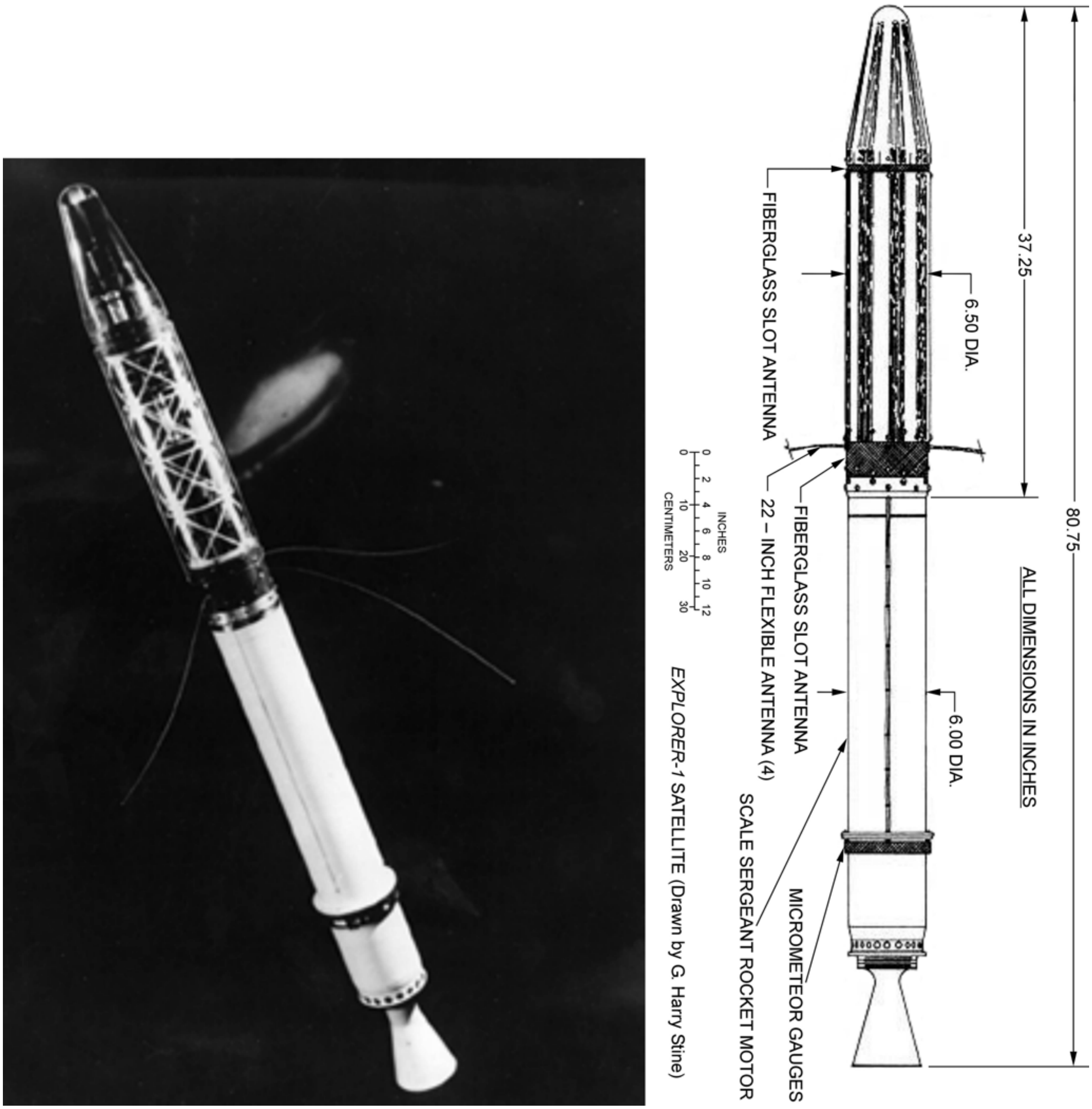
August 24,1958: Attempted orbit of Explorer-V satellite failed because booster collided with second stage after separation, causing the upper stage firing angle to be off.

October 23, 1958: Attempted orbit of inflatable Beacon satellite failed when second stage separated prematurely from booster.



"Sputnik: The Fiftieth Anniversary", Sputnik and The Dawn of the Space Age. Retrieved March 25, 2007, from http://history.nasa.gov/sputnik/expinfo.html

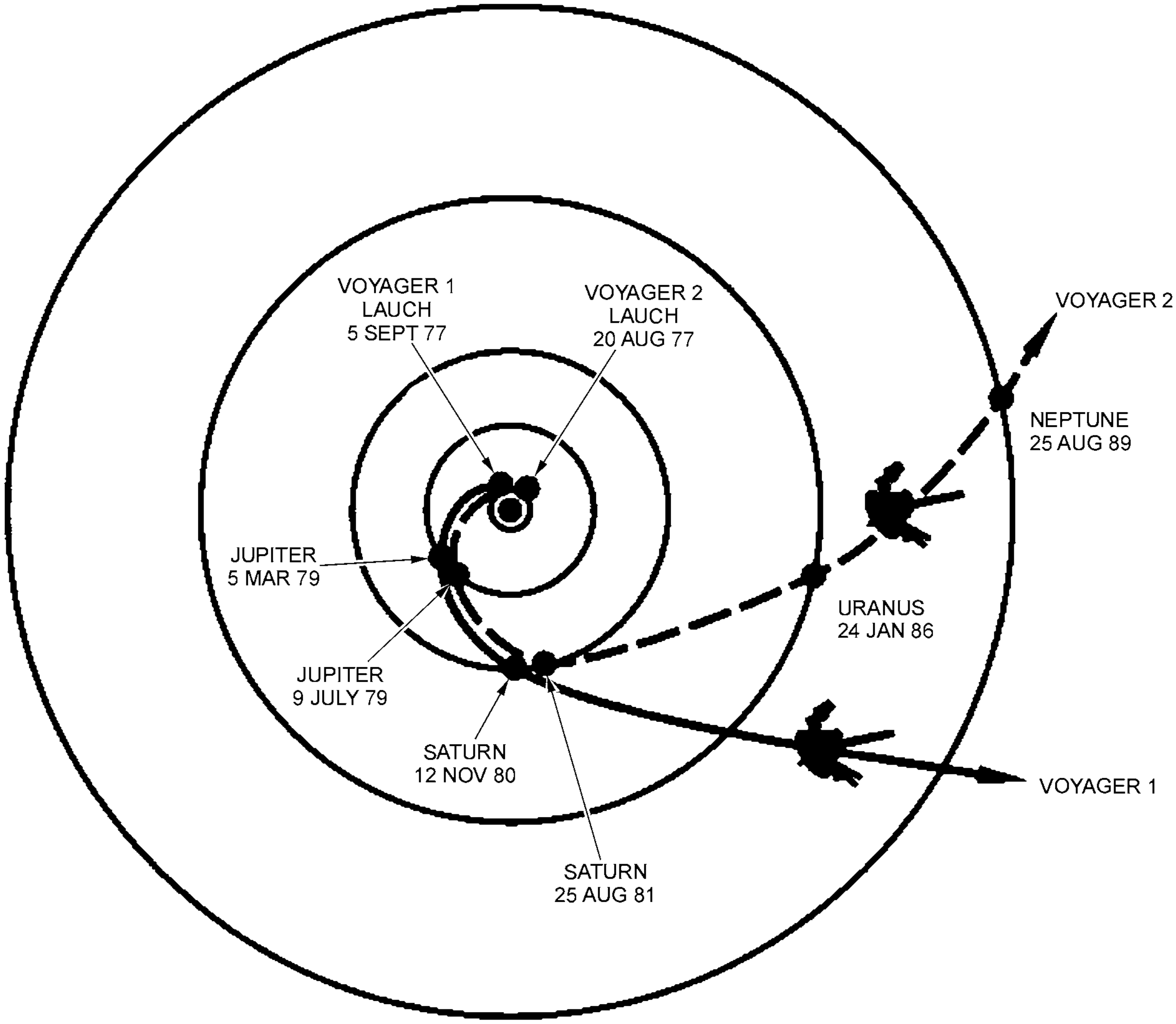
Figure 15P-7 Jupiter-C and Explorer 1



"Sputnik: The Fiftieth Anniversary", Sputnik and The Dawn of the Space Age.
Retrieved March 25, 2007, from http://history.nasa.gov/sputnik/expinfo.html

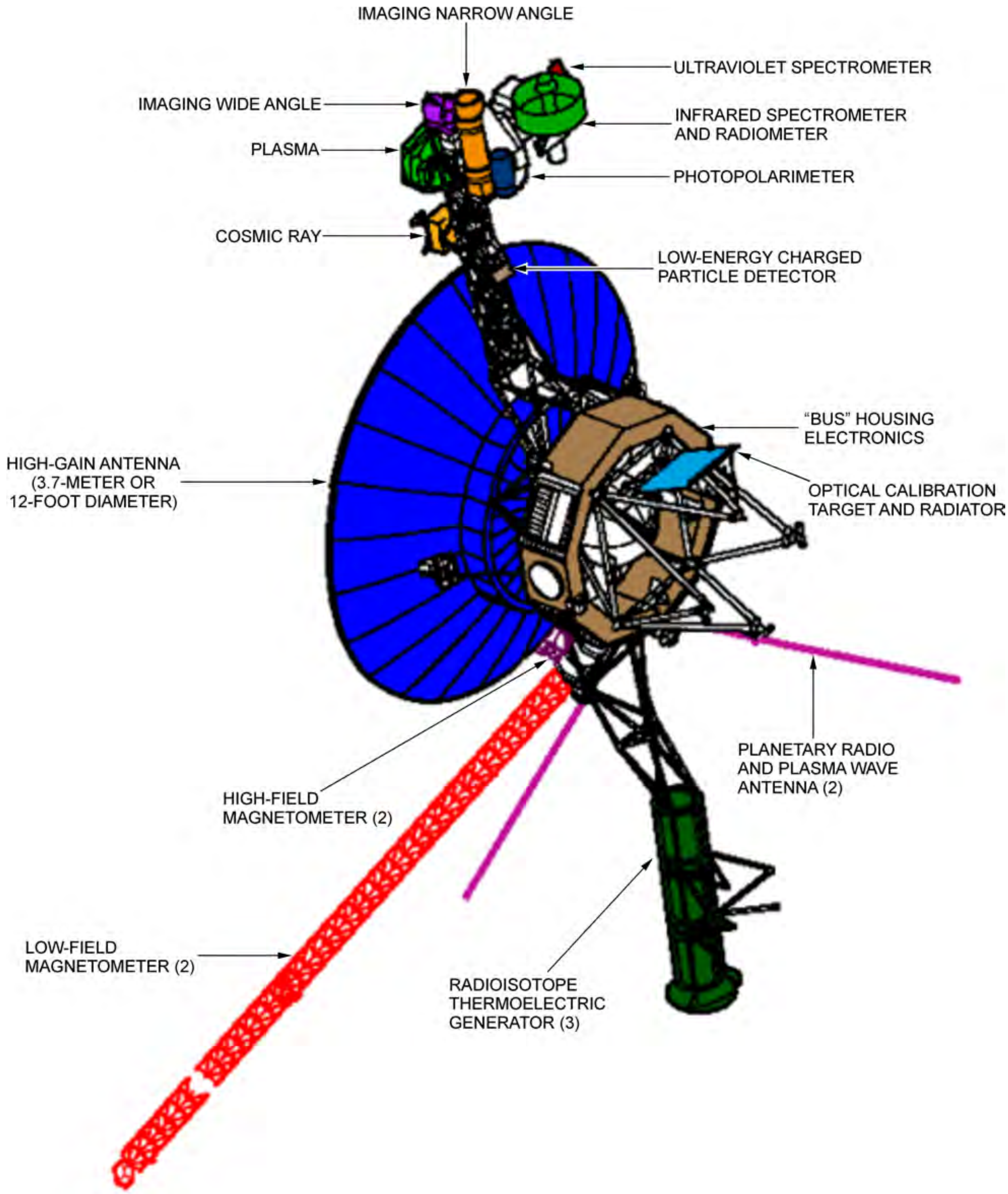
Figure 15P-8 Explorer 1

INTERSTELLAR MISSION



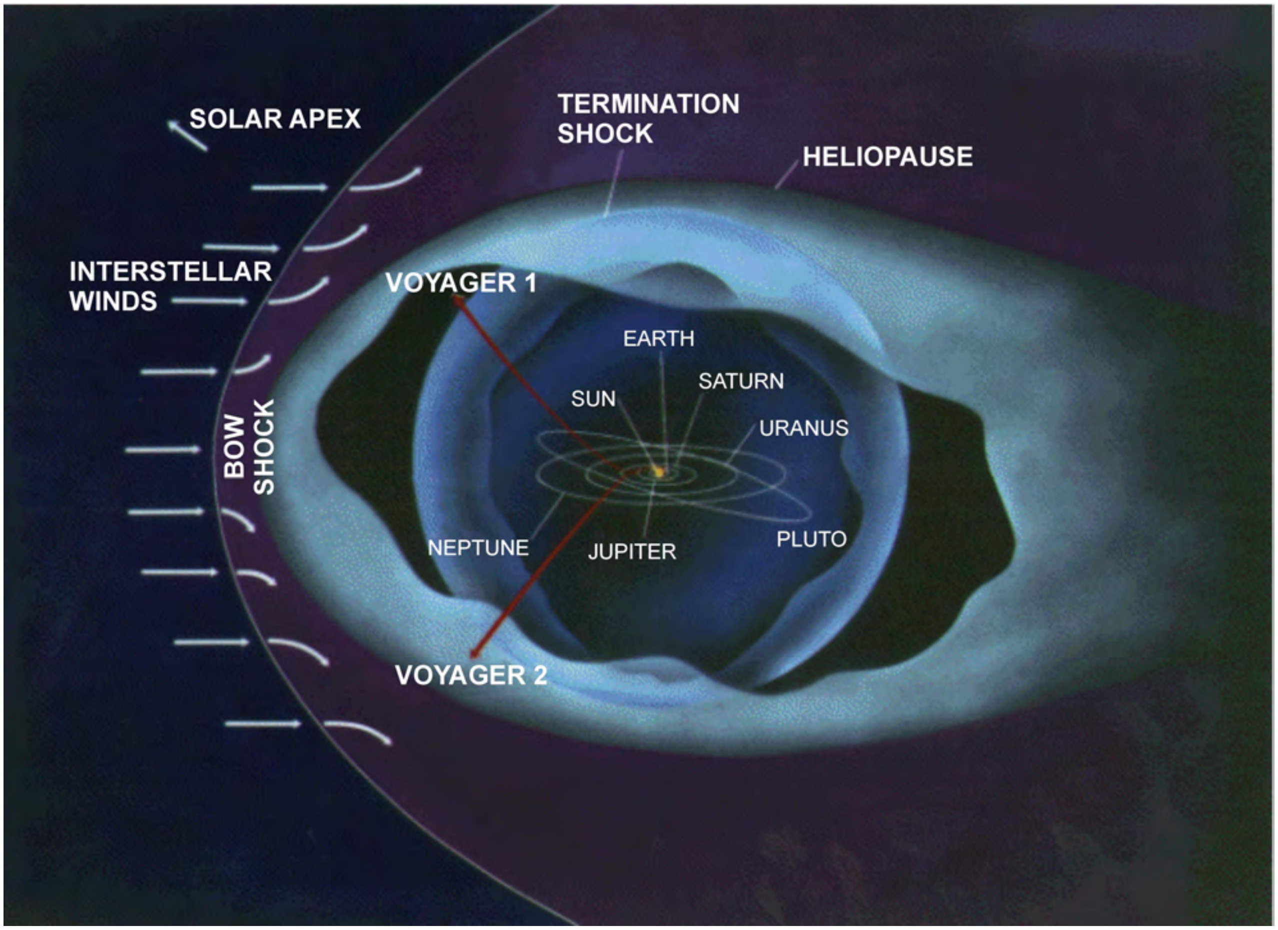
"Voyager: The Intersteller Mission", by NASA, 2004, Planetary Voyage.
Retrieved April 8, 2008, from http://voyager.jpl.nasa.gov/science/heliocentric.html

Figure 15Q-1 Planetary Voyage



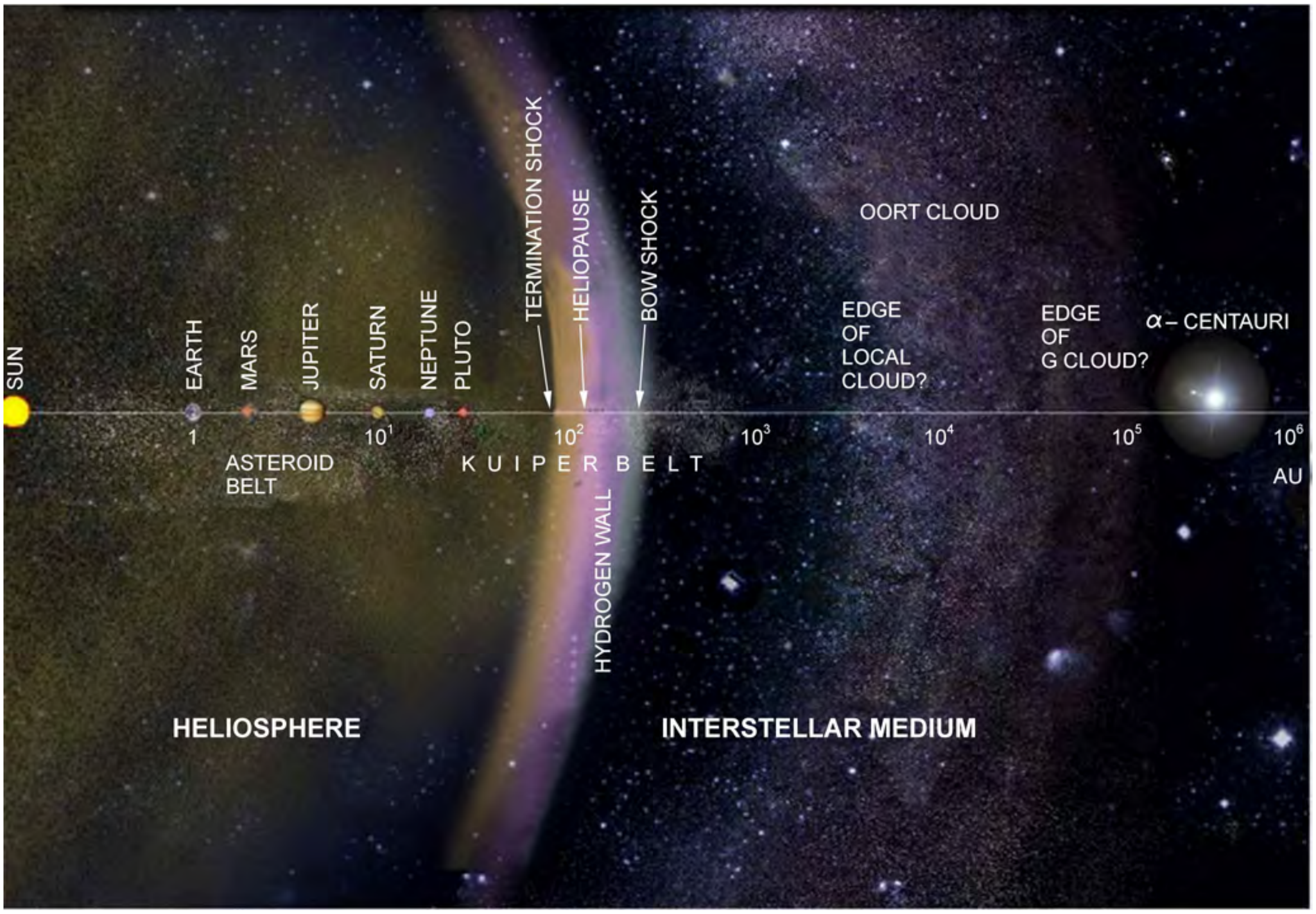
"Voyager: The Intersteller Mission", by NASA, 2004, Voyager Spacecraft. Retrieved April 8, 2008, from http://voyager.jpl.nasa.gov/spacecraft/instruments.html

Figure 15Q-2 Voyager Configuration



"Voyager: The Intersteller Mission", by NASA, 2007, Overview. Retrieved April 8, 2008, from http://voyager.jpl.nasa.gov/mission/mission.html

Figure 15Q-3 Voyager Interstellar Mission

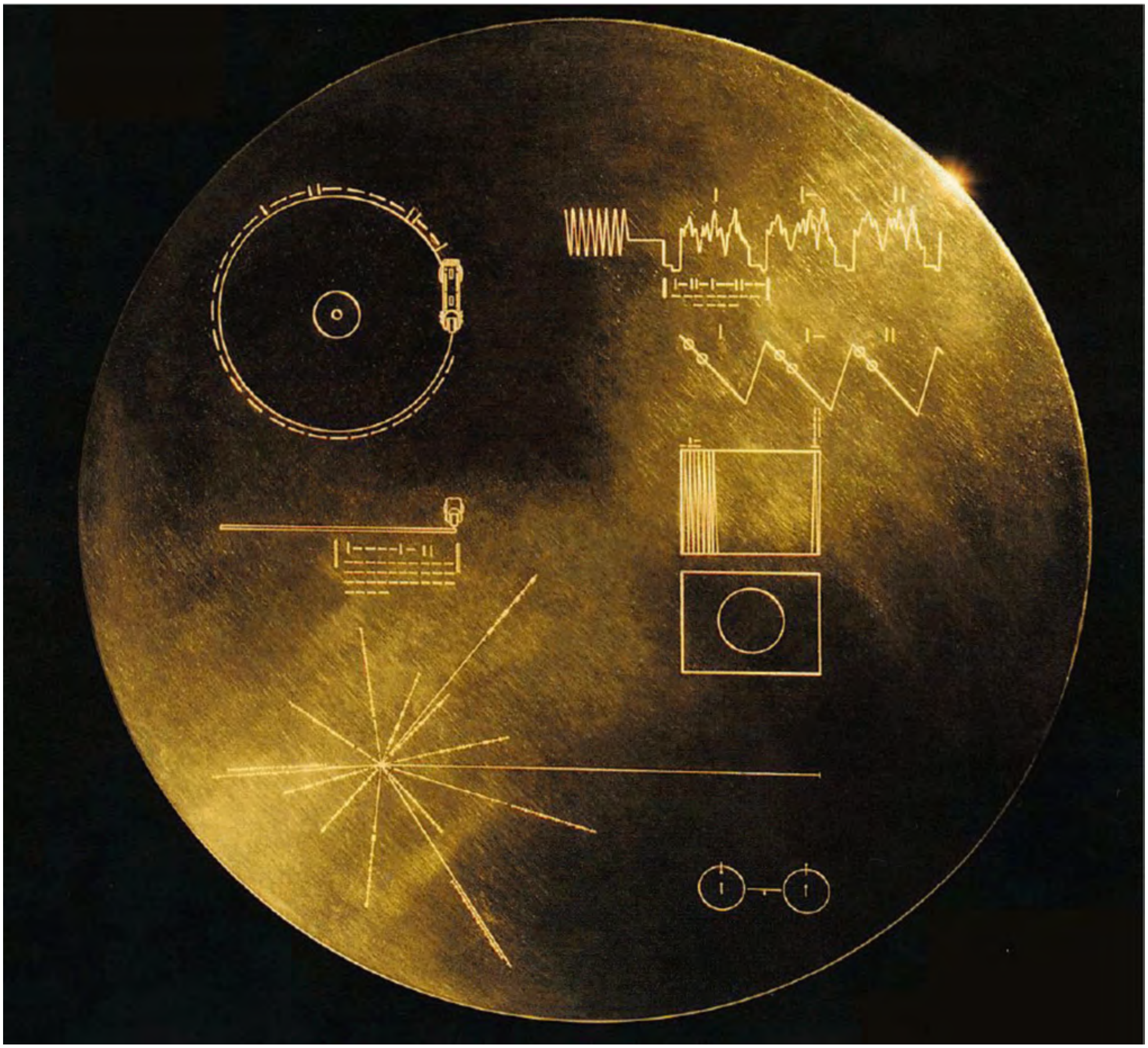


"Voyager: The Intersteller Mission", by NASA, 2004, Did You Know: Interesting Facts About the Voyager Mission. Retrieved April 8, 2008, from http://voyager.jpl.nasa.gov/mission/didyouknow.html

Figure 15Q-4 Sol's Heliopause

For current distances of the Voyagers, cadets can check mission weekly reports at NASA website http://voyager.jpl.nasa.gov/mission/weekly-reports/index.htm.

The distance from earth to the sun (approximately 149 598 000 km – this dimension is not perfectly stable) is said to be one astronomical unit (AU). Such a huge unit of measure is useful when dealing with astronomical dimensions. The vertical dimension shown in Figure 15Q-4 is therefore approximately 5 AU. The horizontal dimension, however, includes all the space between earth's sun, Sol, and Alpha Centauri – Sol's closest neighbour – 277 600 AU. To cover this vast space, the horizontal scale was altered so that it increases as the viewer moves from left to right. The scale changes are marked on the central horizontal line, as 10^1,10^2,10^3 10^4,10^5 and 10^6. This means that the distance between each pair of marks on the horizontal line is ten times larger than the distance between the preceding pairs of marks. That is, Saturn's orbit is only 10 AU from the sun, 10^3 is one thousand AU from the sun, while 10^6 is one million AU from the sun – well past Alpha Centauri. This method (logarithmic representation) is necessary for representing astronomical distances.



"Voyager: The Intersteller Mission", by NASA, 2003, The Golden Record. Retrieved April 8, 2008, from http://voyager.jpl.nasa.gov/spacecraft/goldenrec1.html

Figure 15Q-5 The Golden Record

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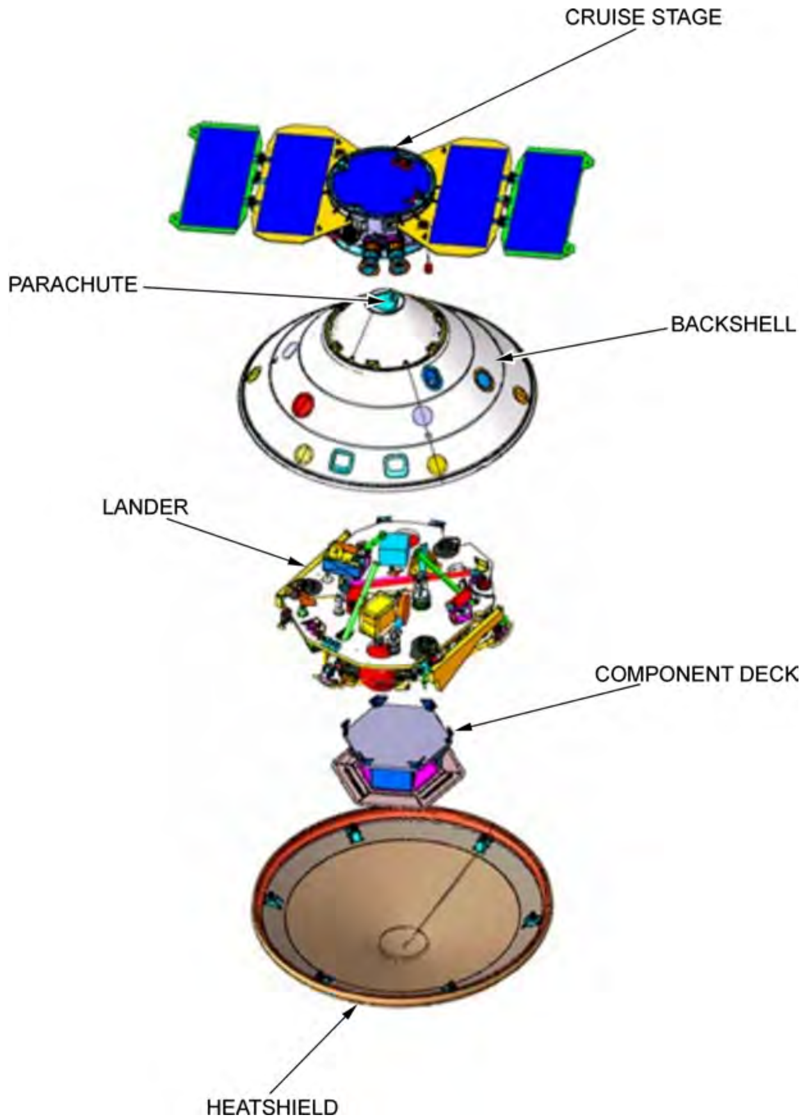
MARS MISSION

"Phoenix Mars Mission", by NASA, 2008, The Spacecraft. Retrieved April 6, 2008 from http://phoenix.lpl.arizona.edu/images.php?gID=301&cID=1

Figure 15R-1 Phoenix Mars Lander



"Phoenix Mars Mission", by NASA, 2008, The Spacecraft. Retrieved April 6, 2008, from http://phoenix.lpl.arizona.edu/images.php?gID=301&cID=1

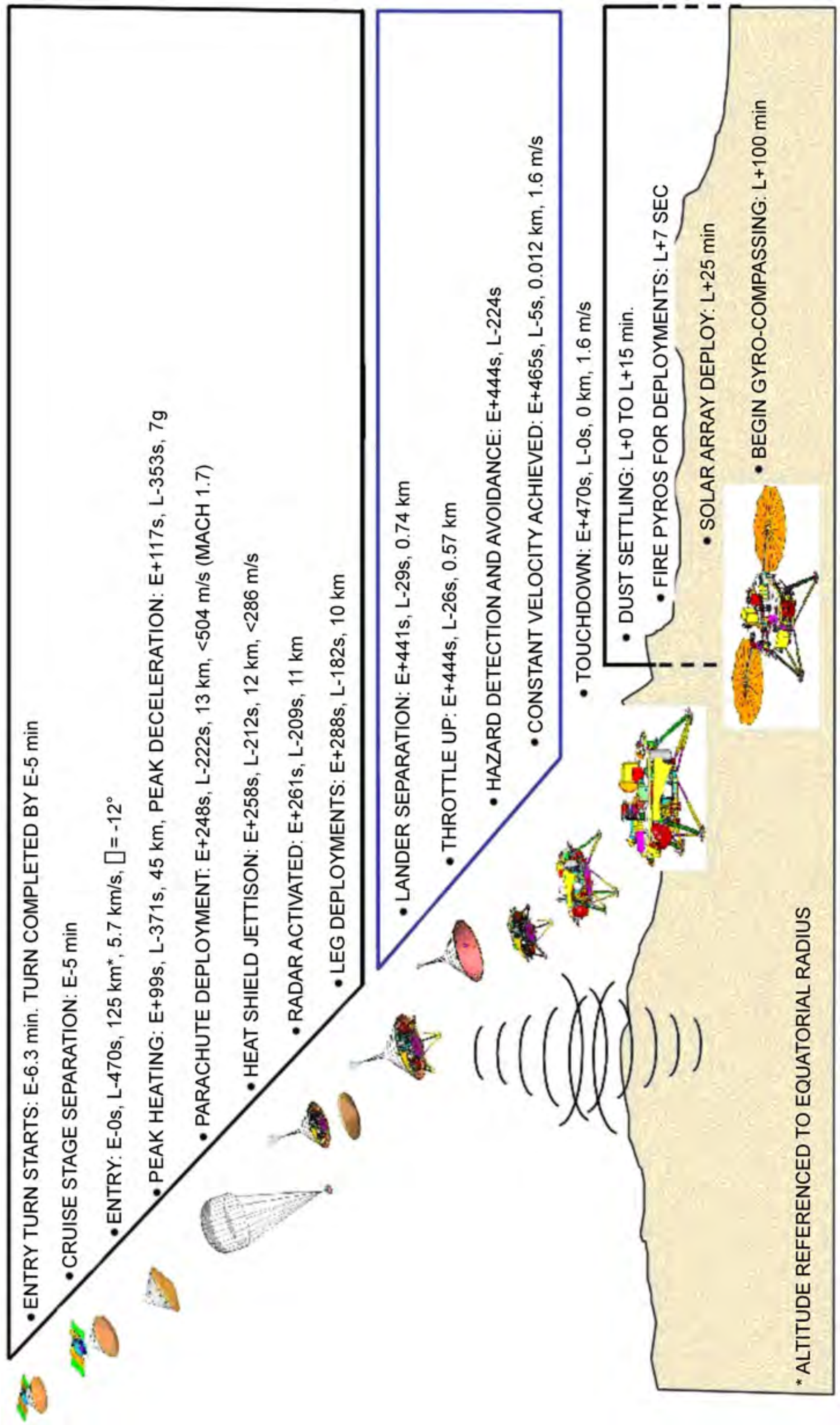
Figure 15R-2 Phoenix Revealed

"Phoenix Mars Mission", by NASA, 2008, The Spacecraft. Retrieved April 6, 2008, from http://phoenix.lpl.arizona.edu/images.php?gID=301&cID=1

Figure 15R-3 Testing the Spacecraft

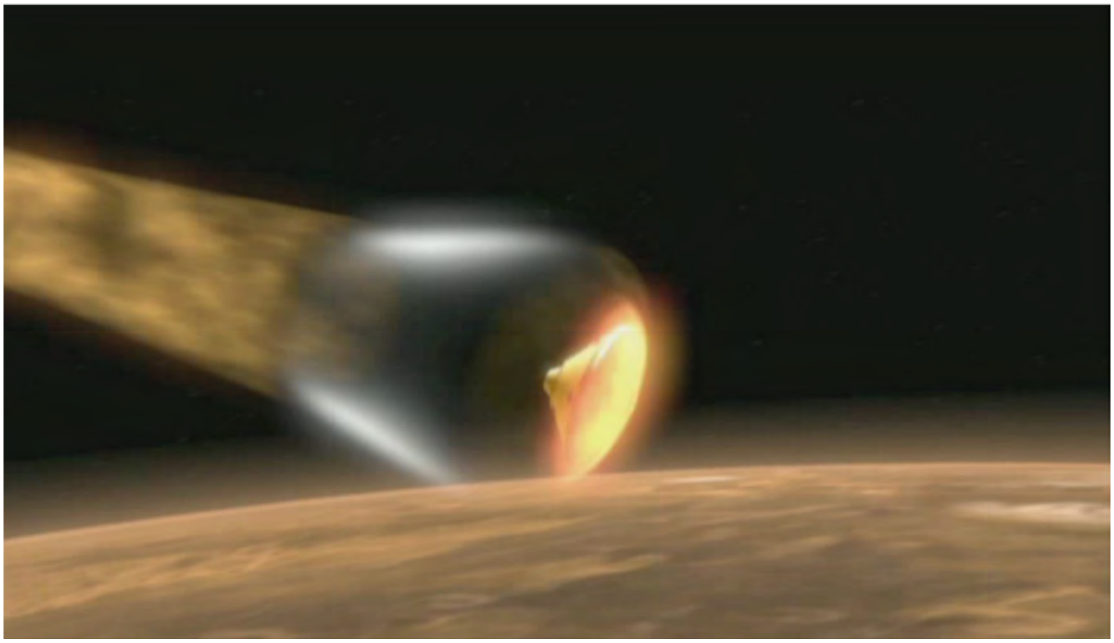
"Phoenix Mars Mission", by NASA 2008, The Spacecraft. Retrieved April 6, 2008, from http://phoenix.lpl.arizona.edu/images.php?gID=301&cID=1

Figure 15R-4 Jettisoning the Cruise Stage at Entry Minus 5 Min



"Phoenix Mars Mission", by NASA, 2008, The Spacecraft. Retrieved April 6, 2008 from http://phoenix.lpl.arizona.edu/images.php?gID=301&cID=1

Figure 15R-5 Phoenix Arriving



"Phoenix Mars Mission", by NASA, 2008, The Spacecraft. Retrieved April 6, 2008 from http://phoenix.lpl.arizona.edu/images.php?gID=301&cID=1

Figure 15R-6 Entering the Martian Atmosphere at Entry Plus 99 Seconds

"Phoenix Mars Mission", by NASA, 2008, The Spacecraft. Retrieved April 6, 2008 from http://phoenix.lpl.arizona.edu/images.php?gID=301&cID=1

Figure 15R-7 Powered Landing on Mars at Entry Plus 470 Seconds

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MOONS VIDEO WORKSHEET

Notes: 1. The information is encountered in the same order as the questions.

2. Read the questions carefully before beginning the MOONS video.

QUESTIONS

1. How long ago do scientists think that Earth's moon was formed? ________________________________

2. How many years did NASA's Galileo probe spend exploring Jupiter's moons? ________________________________

3. What lies under Europa's frozen crust? ________________________________

4. What year did the European Space agency launch Cassini-Huygens? ________________________________

5. How long did it take the Cassini-Huygens probe to travel to Saturn? ________________________________

6. What kind of scientist is the narrator, Athena Coustenis? ________________________________

7. What is Saturn's most distant moon? ________________________________

8. What year did Jean-Dominique Cassini discover Saturn's moon Iapetus? ________________________________

9. Half of Iapetus is dark as coal; what is the other half? ________________________________

10. What runs around the equator of Iapetus? ________________________________

11. What is the largest moon of Saturn? ________________________________

12. What year did the Cassini spacecraft release the Huygens probe to visit Titan? ________________________________

13. How long did Huygens operate on Titan's surface? ________________________________

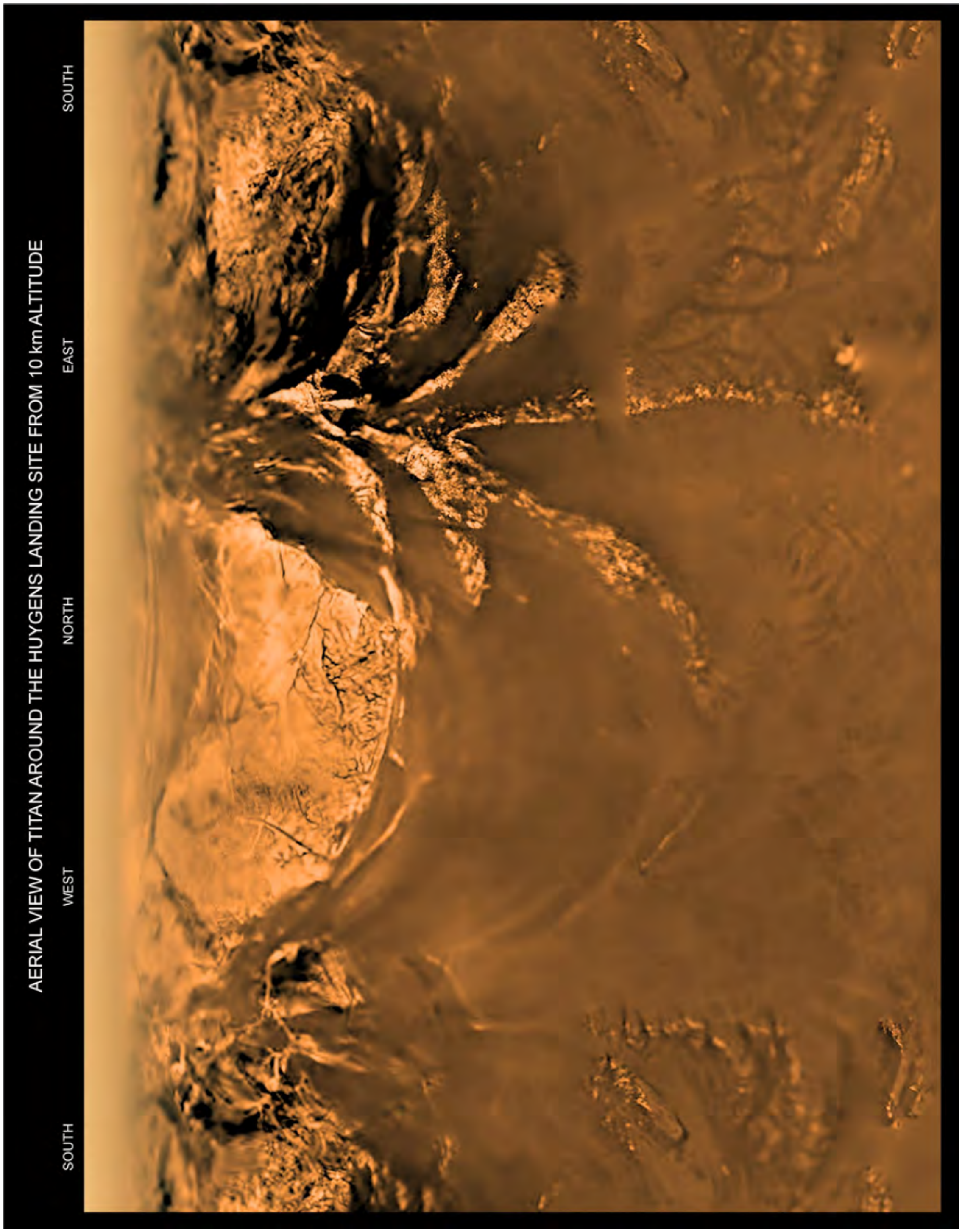
While on final approach for its September 2007 close encounter with Saturn's moon, Iapetus, Cassini spun around to take in a sweeping view of the Saturn System. Iapetus (1 468 km, or 912 miles across) is the only major moon of Saturn with a significant inclination to its orbit. From the other major satellites, the rings would appear nearly edge-on, but from Iapetus, the rings usually appear at a tilt, as seen here.

Moons visible in this image: **Dione** (1 126 km diameter) at center left, **Enceladus** (505 km diameter) near the left side ansa (or ring edge), **Mimas** (397 km diameter) a speck against the ring shadows on Saturn's western limb, **Rhea** (1 528 km diameter) against the bluish backdrop of the northern hemisphere, **Tethys** (1 071 km diameter) near the right ansa, and **Titan** (5 150 km diameter) near lower right.

The images were obtained on September 10, 2007, at a distance of approximately 3.3 million km from Saturn at a sun-Saturn-spacecraft, or phase, angle of 33 degrees. Image scale is about 195 km per pixel on the planet.

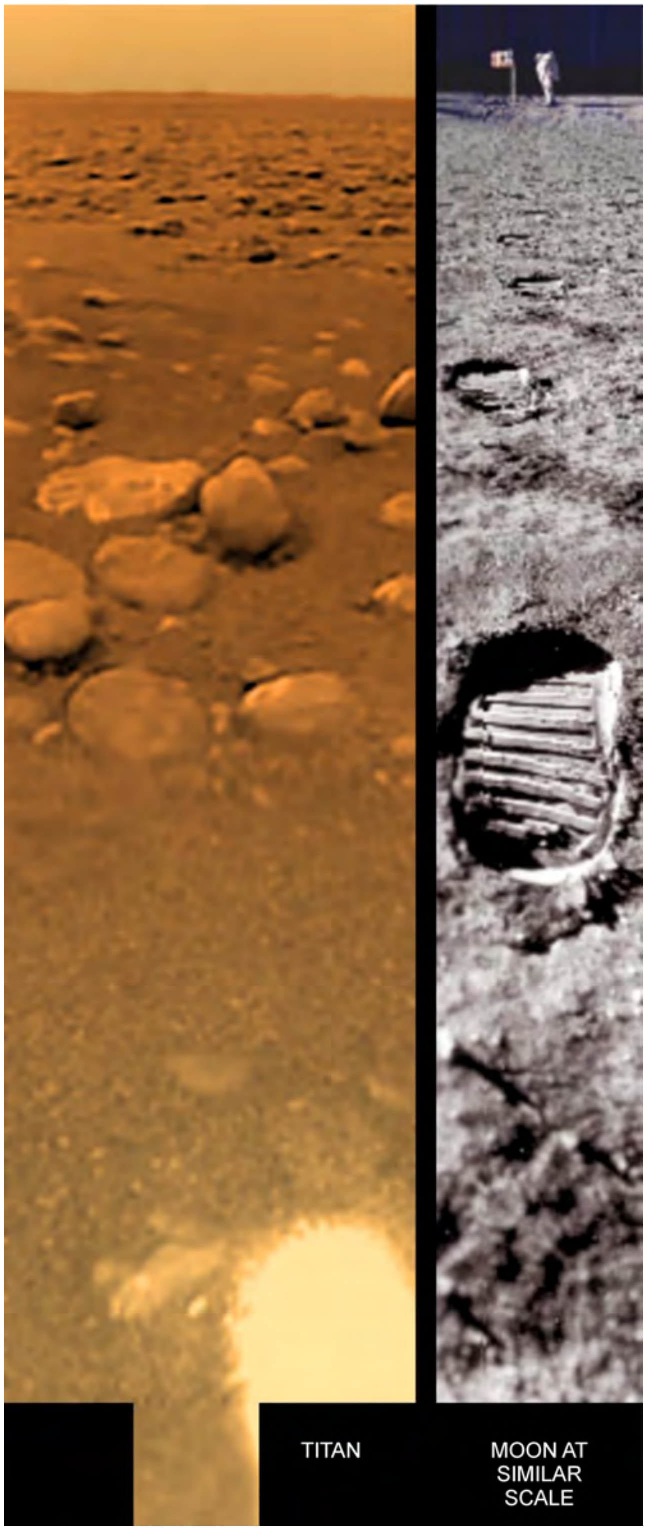
"JPL PHOTOJOURNAL", by NASA, 2007, PIA08387: The View from Iapetus. Retrieved April 6, 2008, from http://photojournal.jpl.nasa.gov/catalog/PIA08387

Figure 15S-1 Saturn, Enceladus and Titan



ESA Multimedia Gallery, 2008, Mercator Projection of Huygens's View. Retrieved April 6, 2008, from http://www.esa.int/esa-mmg/mmg.pl?b=b&keyword=titan%20huygens&single=y&start=25&size=b

Figure 15S-2 Huygen's Descent



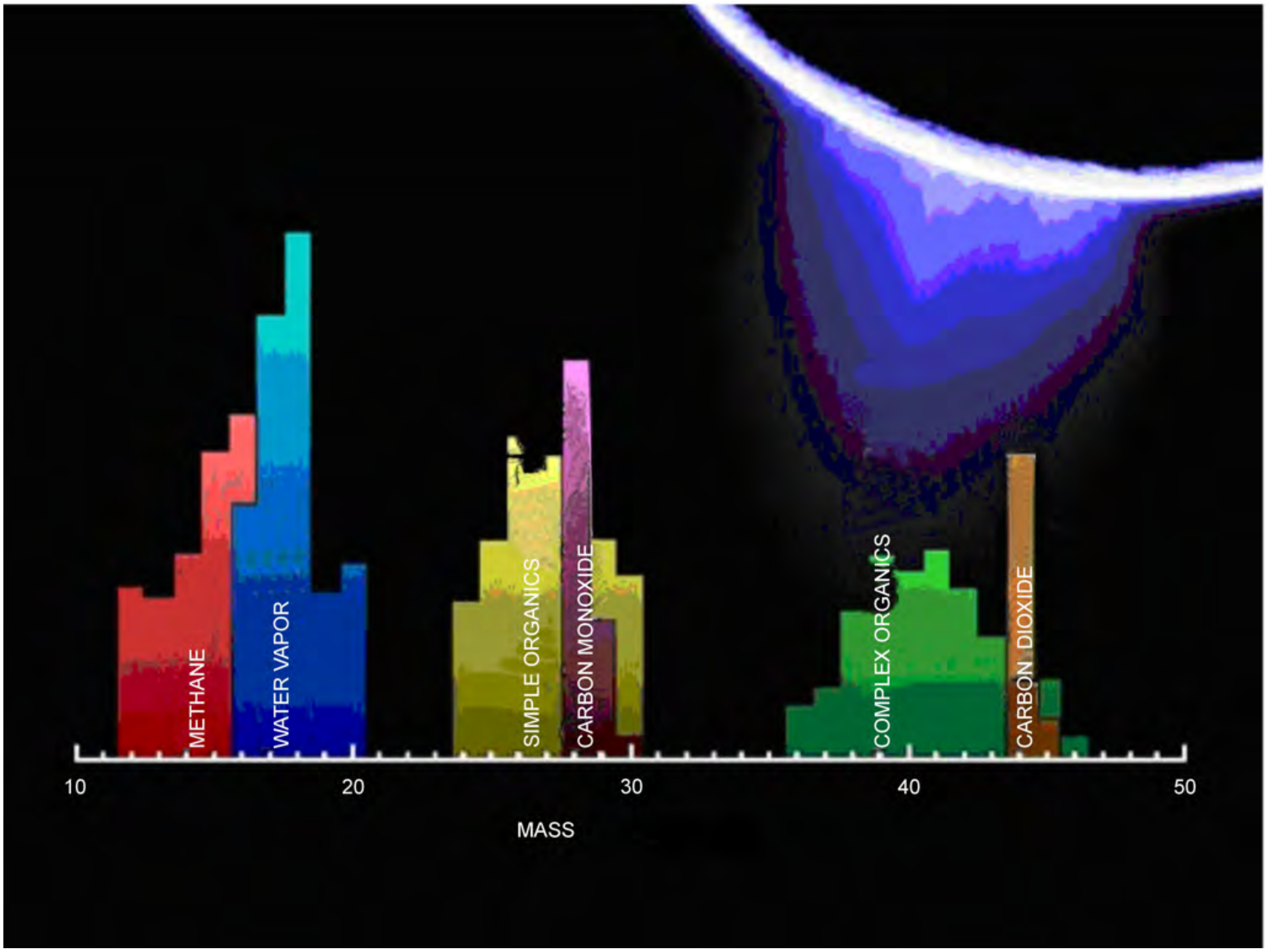
"ESA Multimedia Gallery", 2008, Titan's Surface. Retrieved April 6, 2008, from http://www.esa.int/esa-mmg/mmg.pl?b=b&keyword=titan%20huygens&start=3

Figure 15S-3 Huygen's Resting Place

"JPL Cassini-Huygens Mission to Saturn & Titan", 2008, Jet Blue. Retrieved April 6, 2008, from http://saturn.jpl.nasa.gov/multimedia/images/image-details.cfm?imageID=2779

Figure 15S-4 The Fountains of Enceladus

Enceladus [en-SELL-ah-dus] is one of the innermost moons of Saturn. Enceladus reflects almost 100 percent of the sunlight that strikes it. Parts of Enceladus show craters 35 km in diameter. Other areas show regions with no craters indicating major resurfacing events in the geologically recent past. There are fissures, plains, corrugated terrain and other crustal deformations. All of this indicates that the interior of the moon may be liquid today, even though it should have frozen eons ago. It is postulated that Enceladus is heated by a tidal mechanism. It is disturbed in its orbit by Saturn's gravitational field and by the large neighbouring satellites Tethys and Dione. Enceladus reflects so much sunlight that its surface temperature is only -201 degrees C (-330 degrees F).



"Cassini: Unlocking Saturn's Secrets", NASA, 2008, Enceladus Plume Neutral Mass Spectrum. Retrieved April 6, 2008, from http://www.nasa.gov/mission_pages/cassini/multimedia/pia10356.html

Figure 15S-5 Composition of Enceladus' Water Plumes

ANSWERS TO *MOONS* VIDEO WORKSHEET

1. How long ago do scientists think that Earth's moon was formed? **4.5 billion years**
2. How many years did NASA's Galileo probe spend exploring Jupiter's moons? **8 years**
3. What lies under Europa's frozen crust? **A liquid ocean**
4. What year did the European Space agency launch Cassini-Huygens? **1997**
5. How long did it take the Cassini-Huygens probe to travel to Saturn? **7 years**
6. What kind of scientist is the narrator, Athena Coustenis? **Astrophysicist**
7. What is Saturn's most distant moon? **Phoebe**
8. What year did Jean-Dominique Cassini discover Saturn's moon Iapetus? **1671**
9. Half of Iapetus is dark as coal; what is the other half? **Bright as snow**
10. What runs around the equator of Iapetus? **An icy ridge**
11. What is the largest moon of Saturn? **Titan**
12. What year did the Cassini spacecraft release the Huygens probe to visit Titan? **2005**
13. How long did Huygens operate on Titan's surface? **Barely a few minutes**

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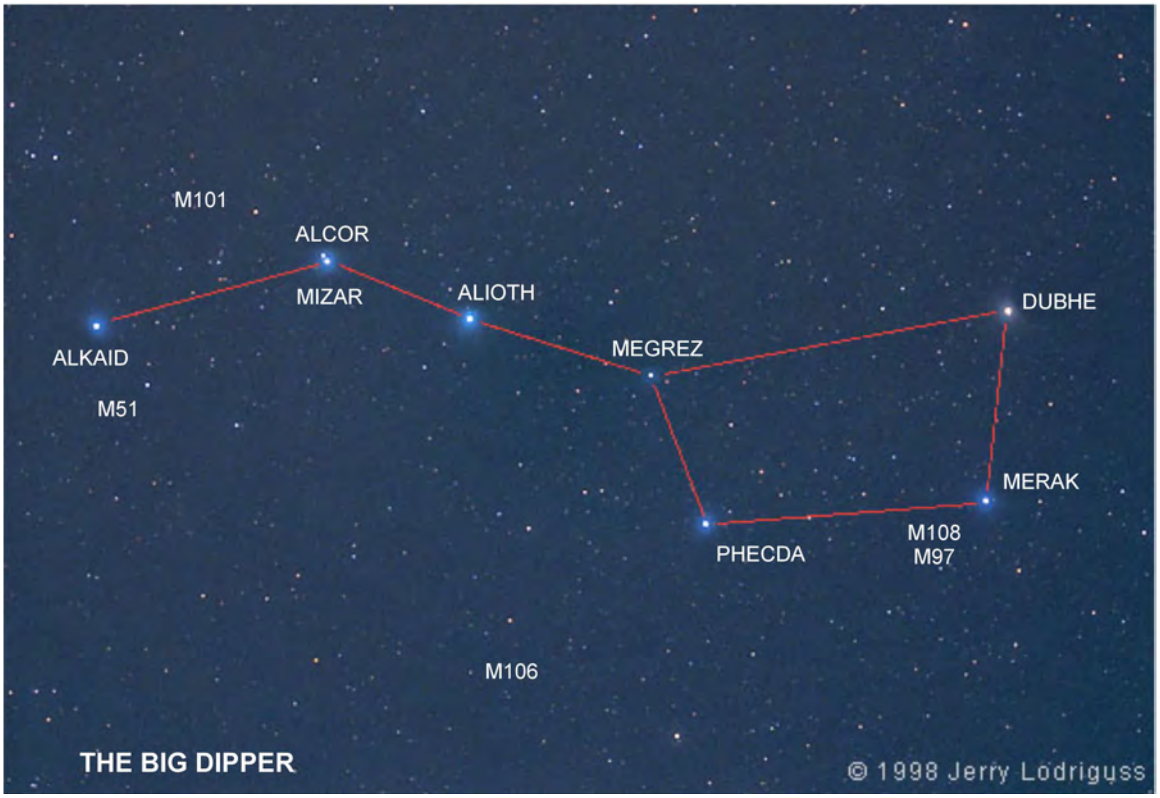
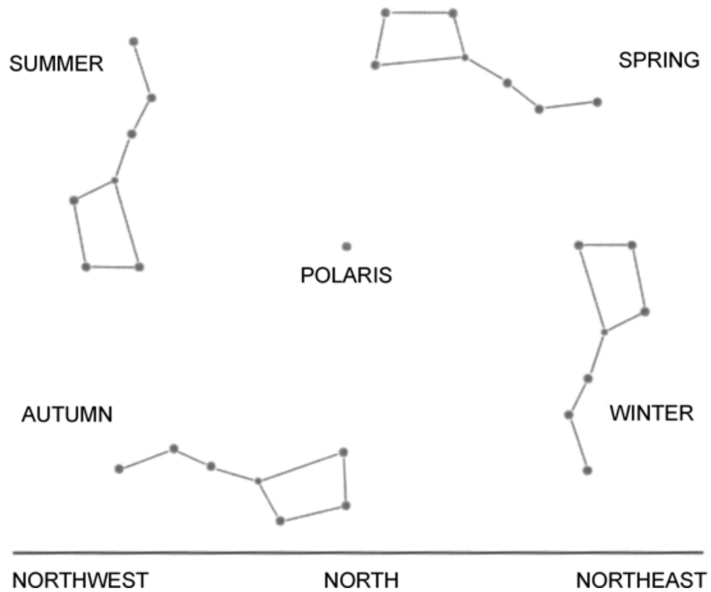
CONSTELLATIONS



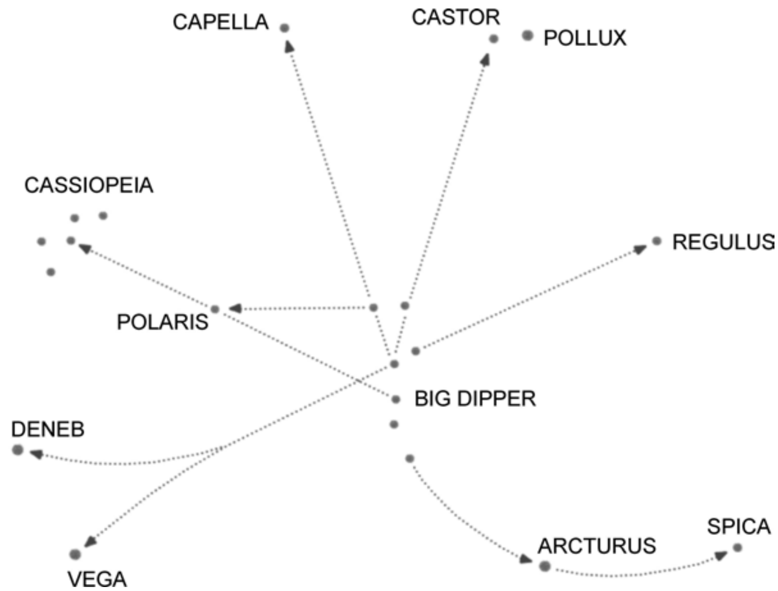
Catching the Light: Astrophotography by Jerry Lodriguss, 1998. Retrieved March 1, 2008, from http://www.astropix.com/HTML/C_SPRING/BIGDIP.HTM

Figure 15U-1 The Big Dipper in Constellation Ursa Major



T. Dickinson, NightWatch: A Practical Guide to Viewing the Universe, Firefly Books Ltd. (p. 31)

Figure 15U-2 Orientations of the Big Dipper



T. Dickinson, NightWatch: A Practical Guide to Viewing the Universe, Firefly Books Ltd. (p. 31)

Figure 15U-3 Big Dipper as the Key to the Night Sky

Constellations, by National Research Council of Canada. Retrieved March 1, 2008, from http://www.nrc-cnrc.gc.ca/docs/education/planisphere_e.pdf

Figure 15U-4 Constellations

Constellations are patterns of stars partitioned and named long ago by our ancestors. Of the 88 constellations recognized by the International Astronomical Union approximately one quarter of these are in the southern sky and not visible from mid-northern latitudes. About half of the remaining constellations are faint and hard to distinguish. Many of the visible and well-known constellations are shown in this handout. All constellations, including Ursa Major (the Big Dipper), circle the sky every 24 hours, with Polaris – the North Star – at the centre of the circle.

SIGHTING OPPORTUNITIES

On February 8, 2008, the space shuttle Atlantis, flying mission STS-122, was delivering the European Space Agency's (ESA) Columbus Laboratory module to the International Space Station (ISS). This momentous event brought the ESA's Columbus Control Center in Oberpfaffenhofen, Germany online for the first time. Coincidentally, the Progress P28 supply ship had just arrived from the Baikonur Cosmodrome in Kazakhstan the previous day to replace Progress P27 which was then de-orbited to burn up in the earth's atmosphere. The sighting opportunities listed below show not only the ISS and Atlantis, but also a last glimpse of Progress P27 before final re-entry.

ONLY DAYS WITH SIGHTING OPPORTUNITIES ARE LISTED
THE FOLLOWING SHUTTLE SIGHTINGS ARE POSSIBLE FROM FRI FEB 08 TO SUN FEB 24

SATELLITE	LOCAL DATE/TIME	DURATION (MIN)	MAX ELEV (DEG)	APPROACH (DEG-DIR)	DEPARTURE (DEG-DIR)
SHUTTLE	Fri Feb 08/07:17 PM	< 1	24	18 above WNW	24 above NW

ONLY DAYS WITH SIGHTING OPPORTUNITIES ARE LISTED
THE FOLLOWING PROGRESS SIGHTINGS ARE POSSIBLE FROM FRI FEB 08 TO SAT FEB 16

SATELLITE	LOCAL DATE/TIME	DURATION (MIN)	MAX ELEV (DEG)	APPROACH (DEG-DIR)	DEPARTURE (DEG-DIR)
PROGRESS	Fri Feb 08/07:14 PM	1	48	20 above WNW	48 above NNW

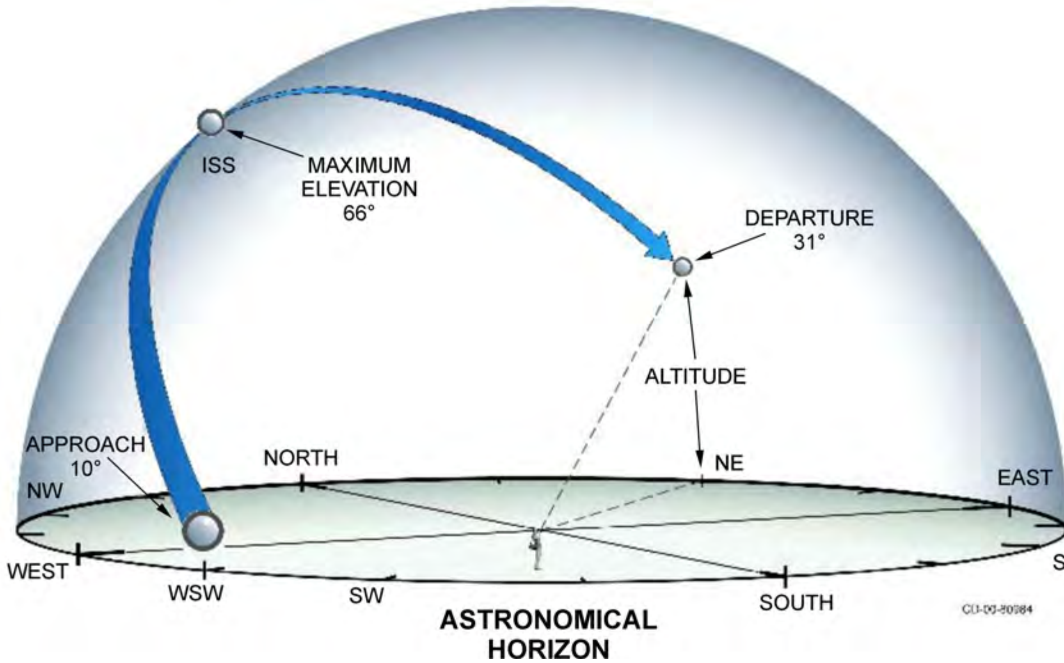
THE FOLLOWING ISS SIGHTINGS ARE POSSIBLE FROM FRI FEB 08 TO WED FEB 20

SATELLITE	LOCAL DATE/TIME	DURATION (MIN)	MAX ELEV (DEG)	APPROACH (DEG-DIR)	DEPARTURE (DEG-DIR)
ISS	Fri Feb 08/07:04 PM	2	51	20 above WNW	51 above N

HUMANSPACEFLIGHT: Sighting Opportunities by NASA, 2003. Retrieved February 8, 2008, from http://spaceflight.nasa.gov/realdata/sightings/

Figure 15V-1 Sighting Opportunities

SATELLITE	LOCAL DATE/TIME	DURATION (MIN)	MAX ELEV (DEG)	APPROACH (DEG-DIR)	DEPARTURE (DEG-DIR)
ISS	Tue Nov 14/06:22 AM	4	66	10 above WSW	31 above NE



HUMANSPACEFLIGHT: Sighting Opportunities by NASA, 2003. Retrieved March 1, 2008, from http://spaceflight.nasa.gov/realdata/sightings/GIF/large_sighting.jpg

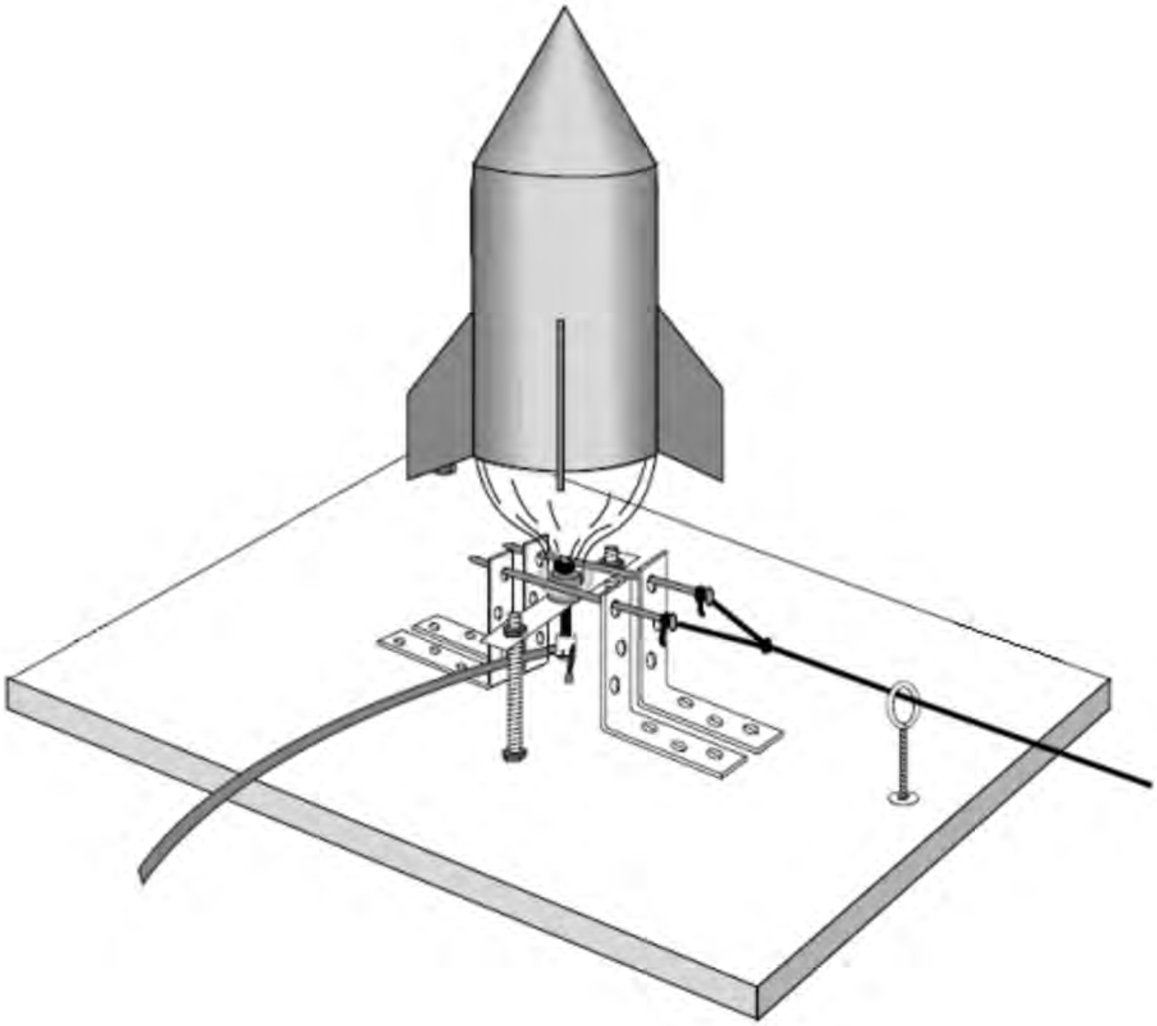
Figure 15V-2 Morning ISS Sighting

Viewing Tips

For best results, observers should look in the direction and at the elevation shown in the second column at the time listed. Telescopes are not practical because of the speed of the orbiting vehicles. However, a good pair of field binoculars may reveal some detail of the structural shape of the spacecraft. On a regular basis, the space shuttle must get rid of excess supply and waste water by dumping them overboard through water spray nozzles. Viewing the shuttle at these times through binoculars or a telescope can reveal an even more spectacular view of the spacecraft and the ice crystals that form as the water is sprayed overboard. Although you can sometimes use a flight timeline to find out when scheduled dumps occur, NASA TV is more accurate. Check the sightings list to see if a sighting opportunity and water dump overlap.

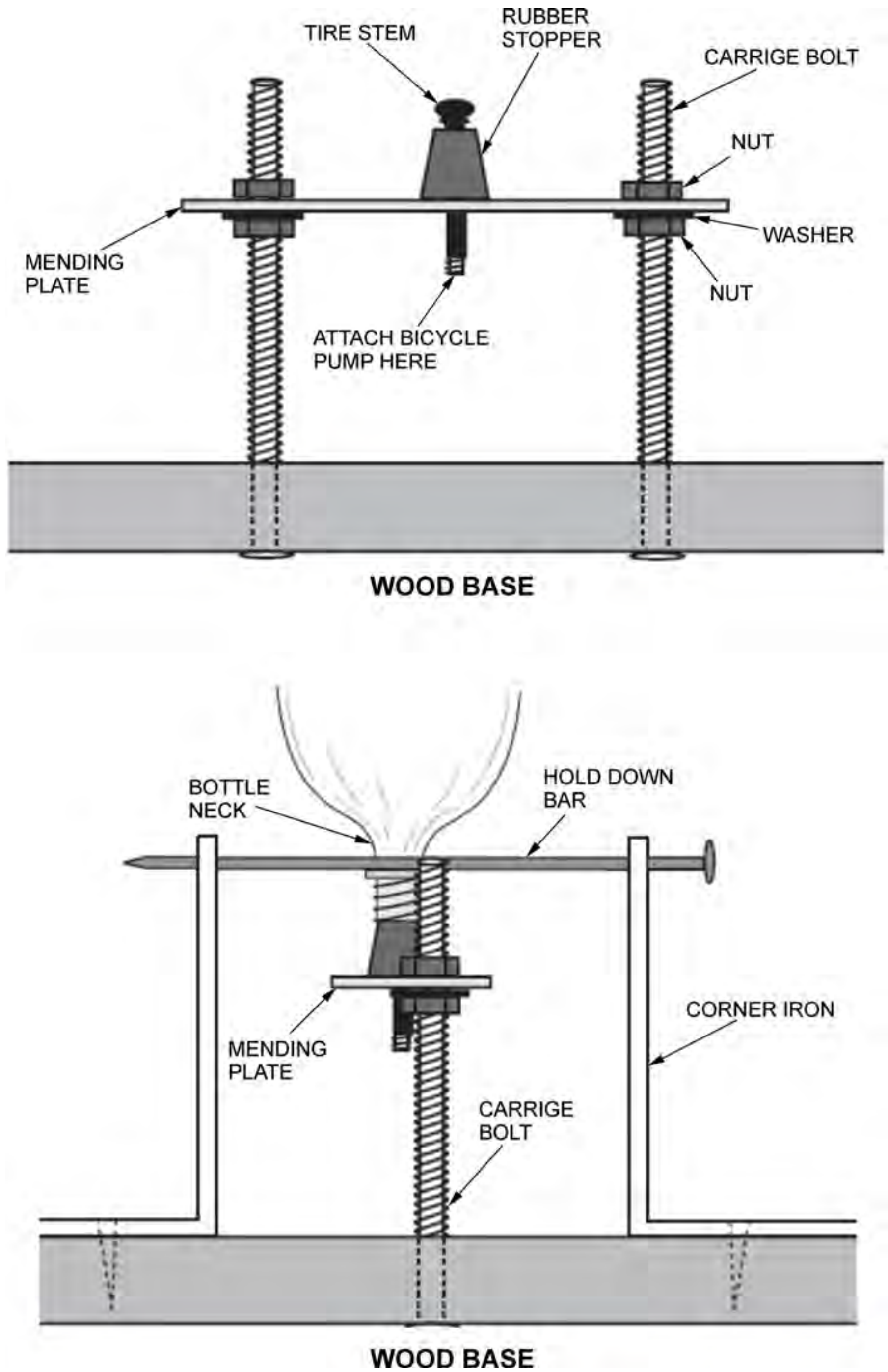
Shuttle/station docking missions provide an exciting opportunity to see a double pass. On the day or two days before docking and after undocking, the shuttle and station will appear to be chasing each other across the night sky. They will follow the same flight path varying by only a few minutes. If the distance is close enough, they will actually appear in the sky at the same time.

LAUNCHING PLATFORMS



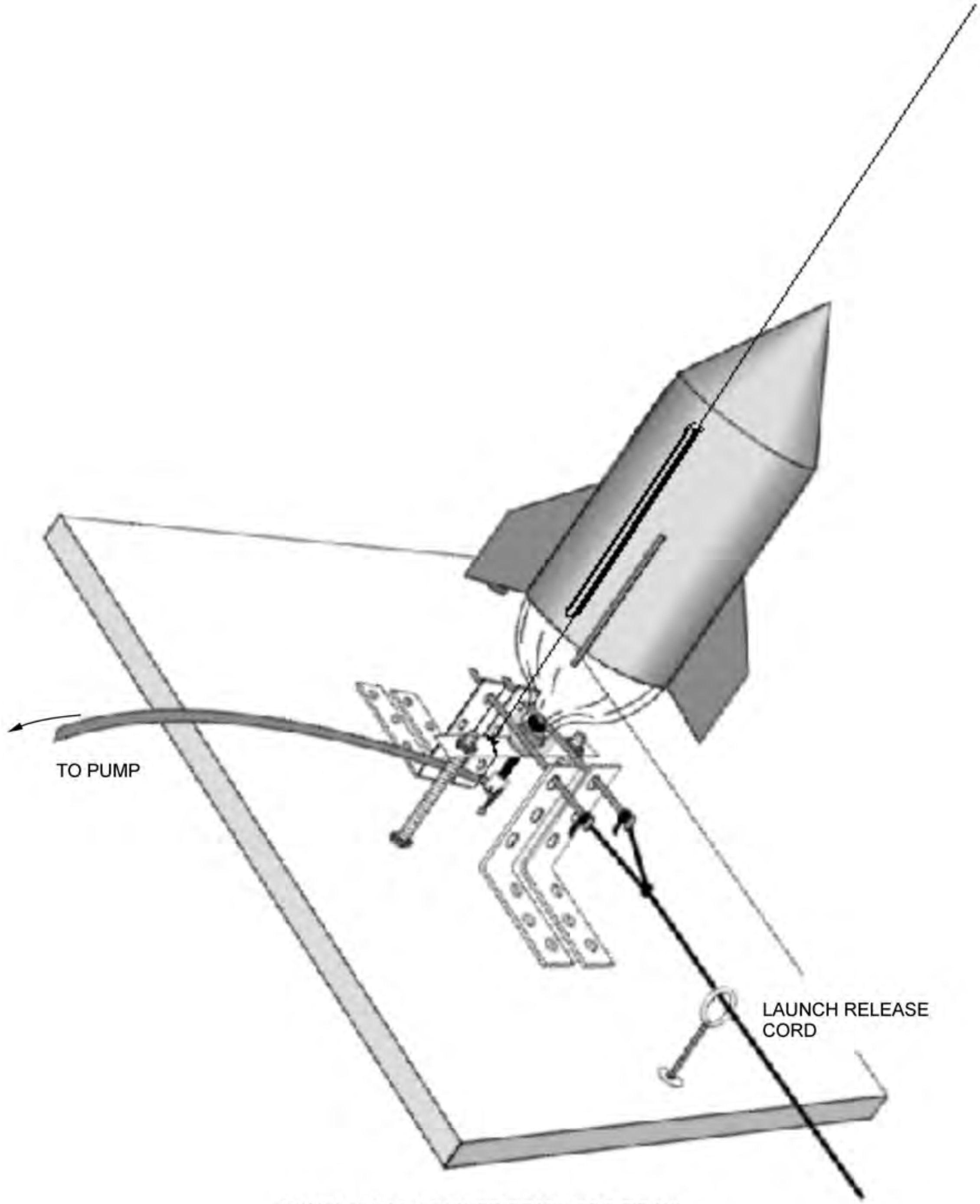
"Rockets: A Teacher's Guide with Activities in Science, Mathematics, and Technology", by NASA, 2003, Bottle Rocket Launcher. Retrieved April 12, 2008, from http://www.nasa.gov/pdf/153405main_Rockets.Guide.Bottle.Rocket.Launcher.pdf

Figure 15W-1 Parts of the Launch Pad



"Rockets: A Teacher's Guide with Activities in Science, Mathematics, and Technology", by NASA, 2003, Bottle Rocket Launcher. Retrieved April 12, 2008, from http://www.nasa.gov/pdf/153405main_Rockets.Guide.Bottle.Rocket.Launcher.pdf

Figure 15W-2 Details of the Launch Pad



COMPLETED LAUNCHER READY FOR FIRING

"Rockets: A Teacher's Guide with Activities in Science, Mathematics, and Technology", by NASA, 2003, Bottle Rocket Launcher. Retrieved April 12, 2008, from http://www.nasa.gov/pdf/153405main_Rockets.Guide.Bottle.Rocket.Launcher.pdf

Figure 15W-3 Launch Time

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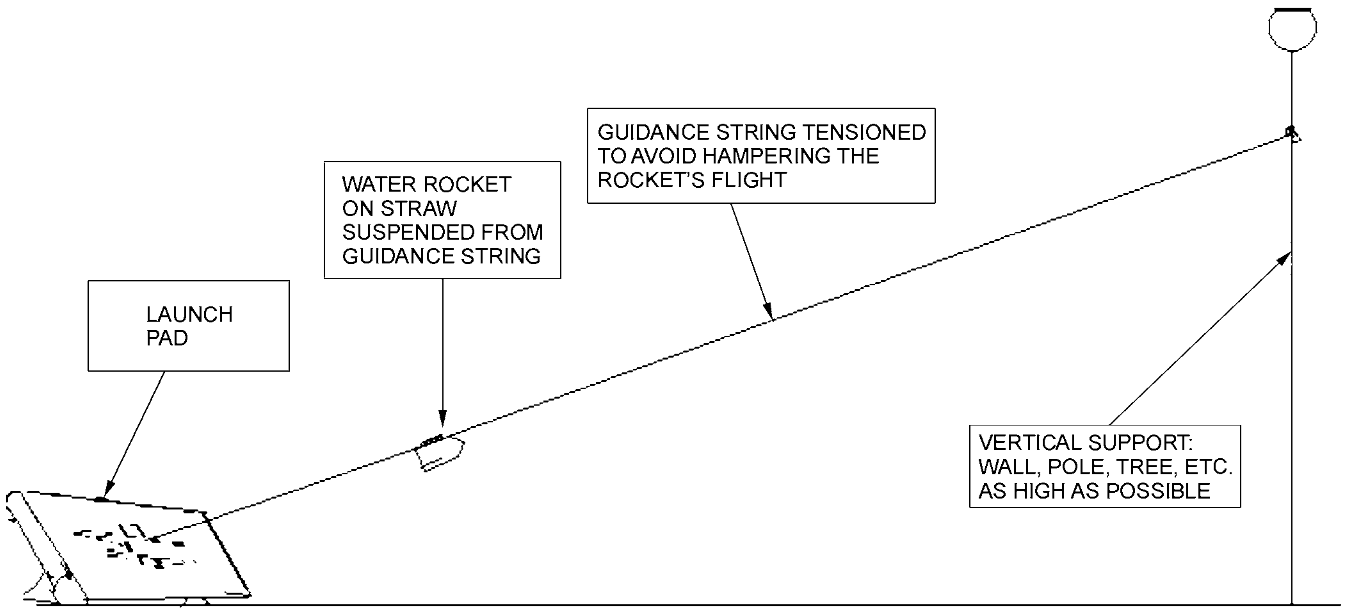
GUIDANCE SYSTEM



Director Cadets 3, 2008, Ottawa, ON: Department of National Defence

Figure 15X-1 String Guidance System

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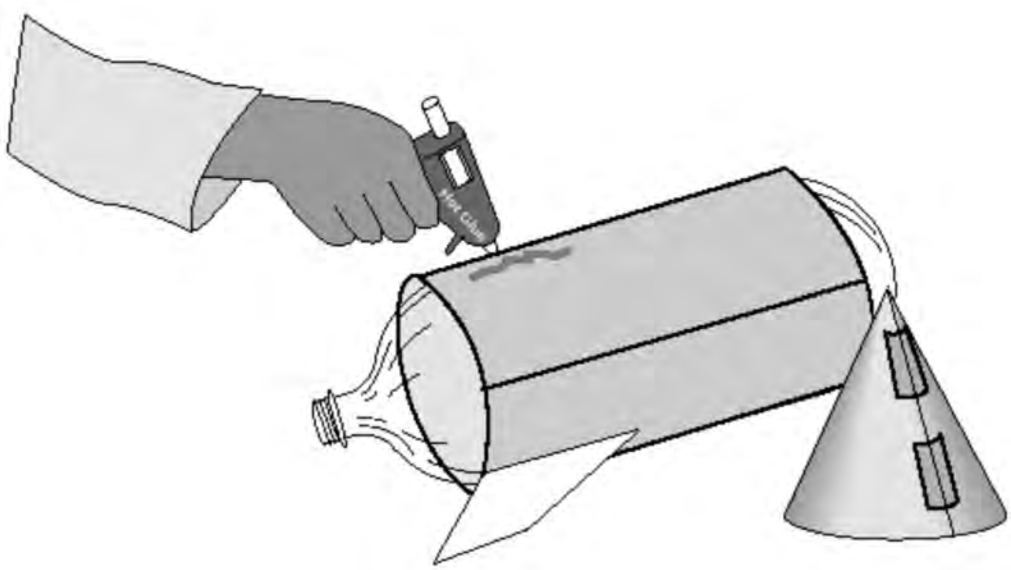
BUILDING A WATER ROCKET

Materials Required:

- One-litre soft-drink bottles with caps,
- Construction paper,
- Tape,
- Glue,
- Drill and bits, and
- Putty or modelling clay.

Hints For Construction:

- Do not allow glue to touch the plastic bottle as this may weaken the plastic and cause failure.
- Wrap and tape a tube of poster-board around the bottle.
- Cut out several fins of any shape and glue them to the tube.
- Form a nose cone and hold it together with tape or glue.
- Press a wad of modeling clay into the top of the nose cone for stability, if required.
- Tape the nose cone to upper end of bottle.
- Decorate your rocket.



"Rockets: A Teacher's Guide with Activities in Science, Mathematics, and Technology", by NASA, 2003, Bottle Rocket Launcher. Retrieved April 12, 2008, from http://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/Bottle_Rocket_Launcher.html

Figure 15Y-1 Building a Water Rocket

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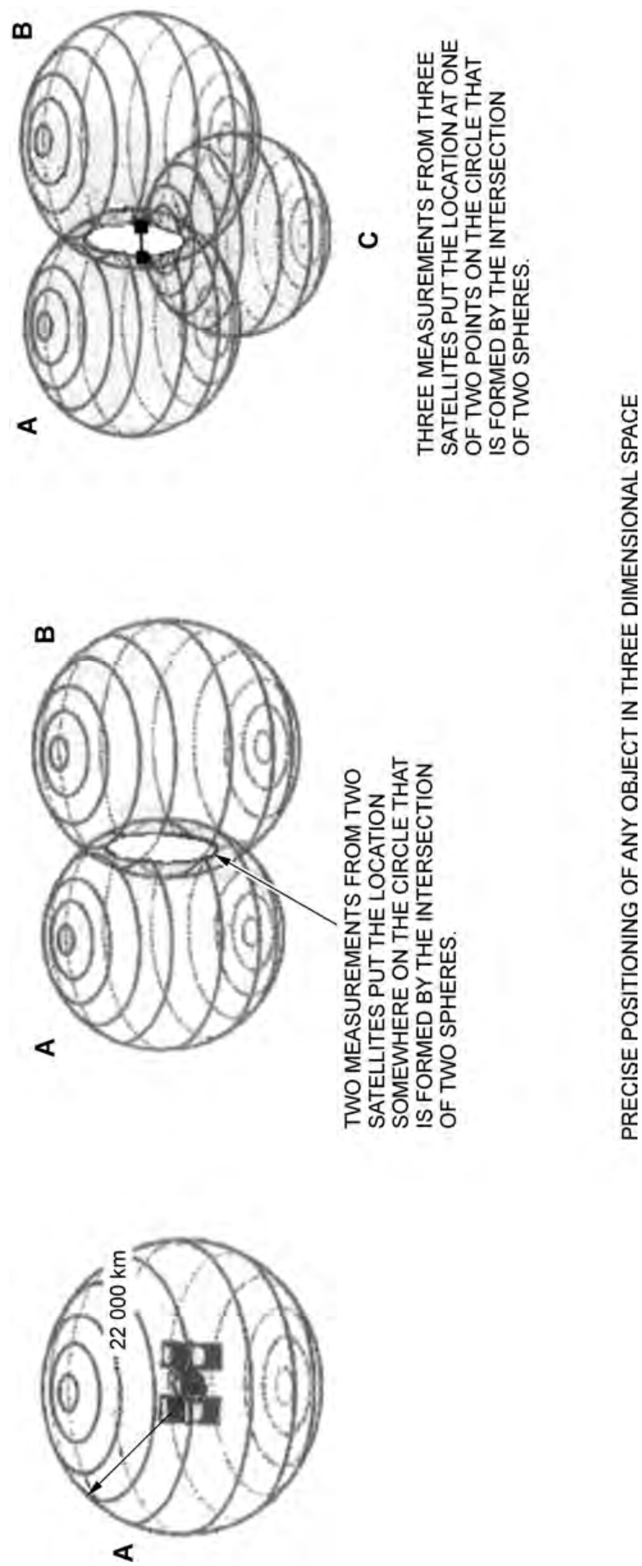
TRILATERATION



Canadian Forces, Maps, Field Sketching, Compasses and the Global Positioning System, Department of National Defence (p. 86)

Figure 15Z-1 Trilateration

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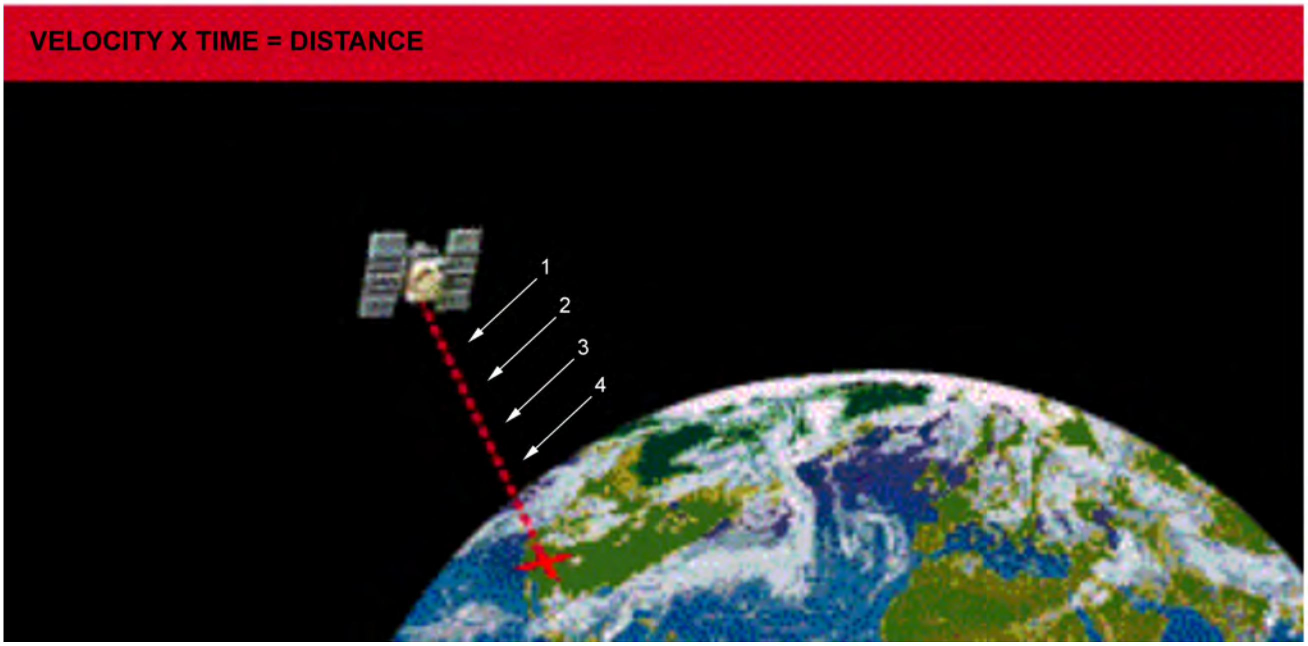
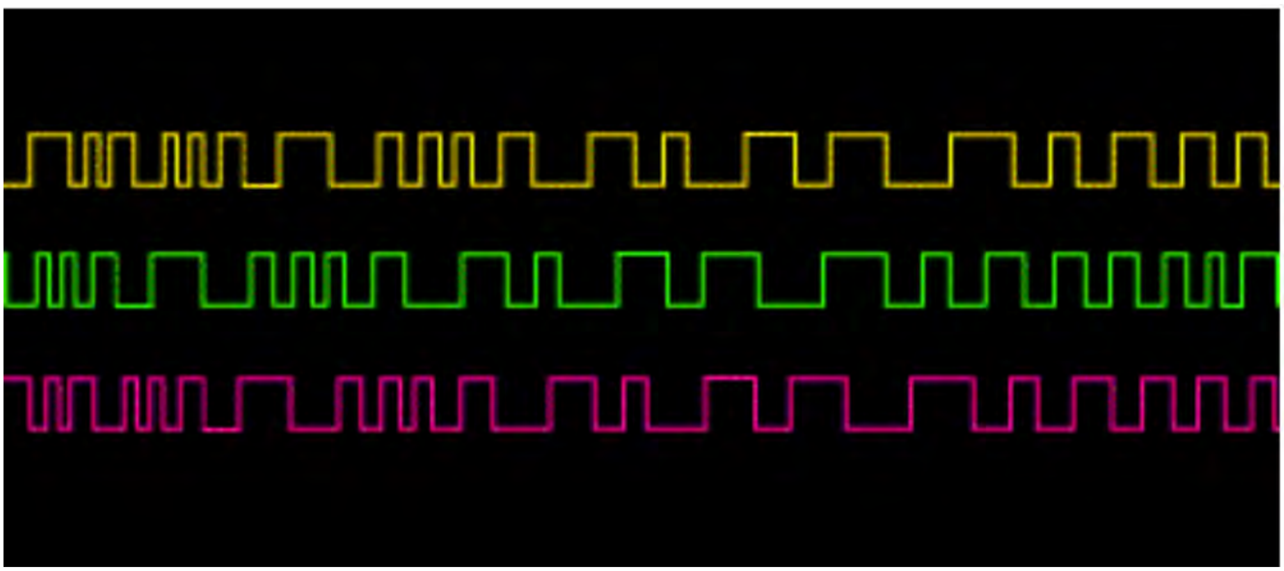
GPS SATELLITES



"GPS Tutorial", Trimple Navigation Limited, 2008, How GPS Works? Copyright 2008 by Trimple Navigation Limited. Retrieved April 11, 2008, from http://www.trimble.com/gps/howgps-triangulating.shtml

Figure 15AA-1 Travelling Down



"GPS Tutorial", Trimple Navigation Limited, 2008, How GPS Works? Copyright 2008 by Trimple Navigation Limited. Retrieved April 11, 2008, from http://www.trimble.com/gps/howgps-triangulating.shtml

Figure 15AA-2 Coded Signals

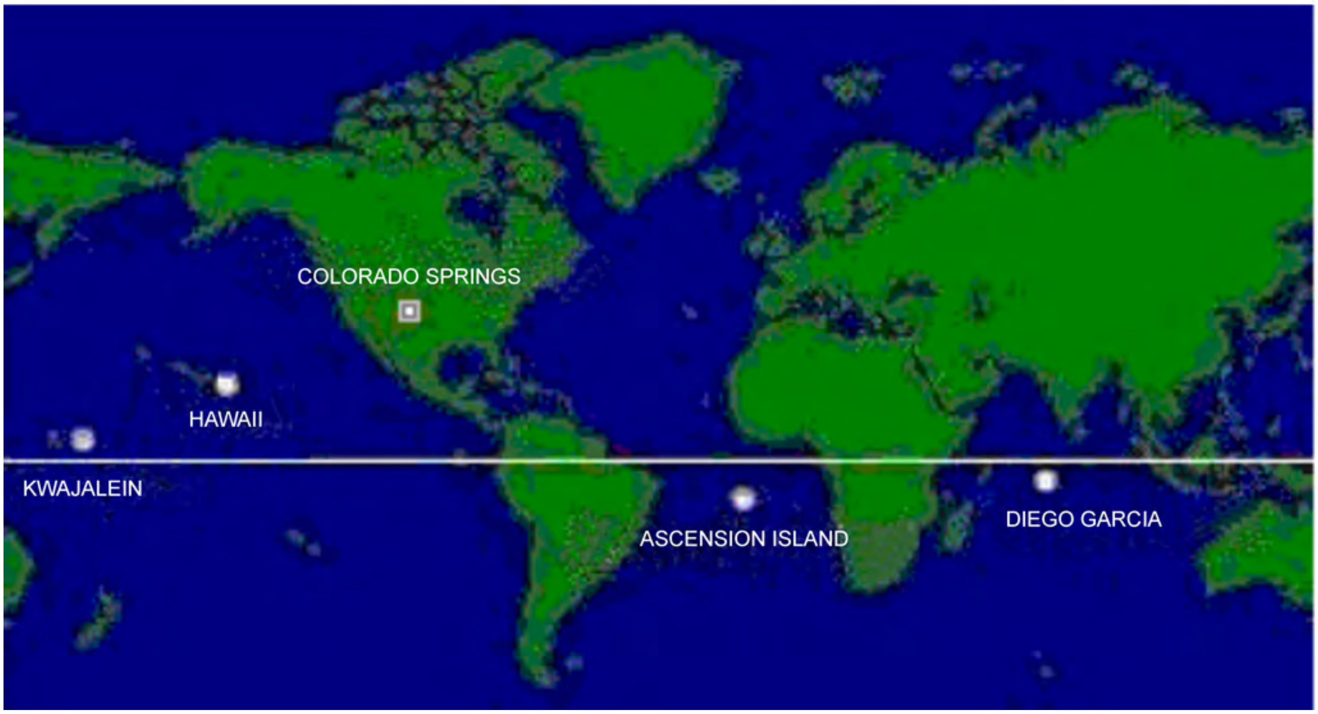
THE CHALLENGE OF TIMING

Timing is tricky.

Precise clocks are needed to measure travel time.

The travel time from a satellite directly overhead is about <u>0.06</u> seconds.

The time required to synchronize the receiver's internal coded pulses with the satellite's coded pulses is equal to the travel time.



"GPS Control Segment", Millennium Telecomm Corp (MTC), Control Stations, Copyright 2007 by Phoenix Tree Technology Corp. Retrieved April 15, 2008, from http://ufindit.com/GPS-stations.asp

Figure 15AA-3 GPS Control and Monitoring Stations

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THE MERIDIAN LINE LASER, OLD ROYAL OBSERVATORY, GREENWICH

NMM Royal Observatory, 2008, Meridian Line. Retrieved April 11, 2008, from http://www.nmm.ac.uk/server/show/nav.2904

Figure 15AB-1 The Meridian Line Laser, Old Royal Observatory, Greenwich

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SPACE SHUTTLE *ENDEAVOUR* (STS-118) AFTER UNDOCKING FROM THE ISS

National Aeronautical and Space Administration, STS-118 Build the Station, Build the Future, NASA (p. 54)

Figure 15AC-1 Space Shuttle *Endeavour* (STS-118) After Undocking From the ISS

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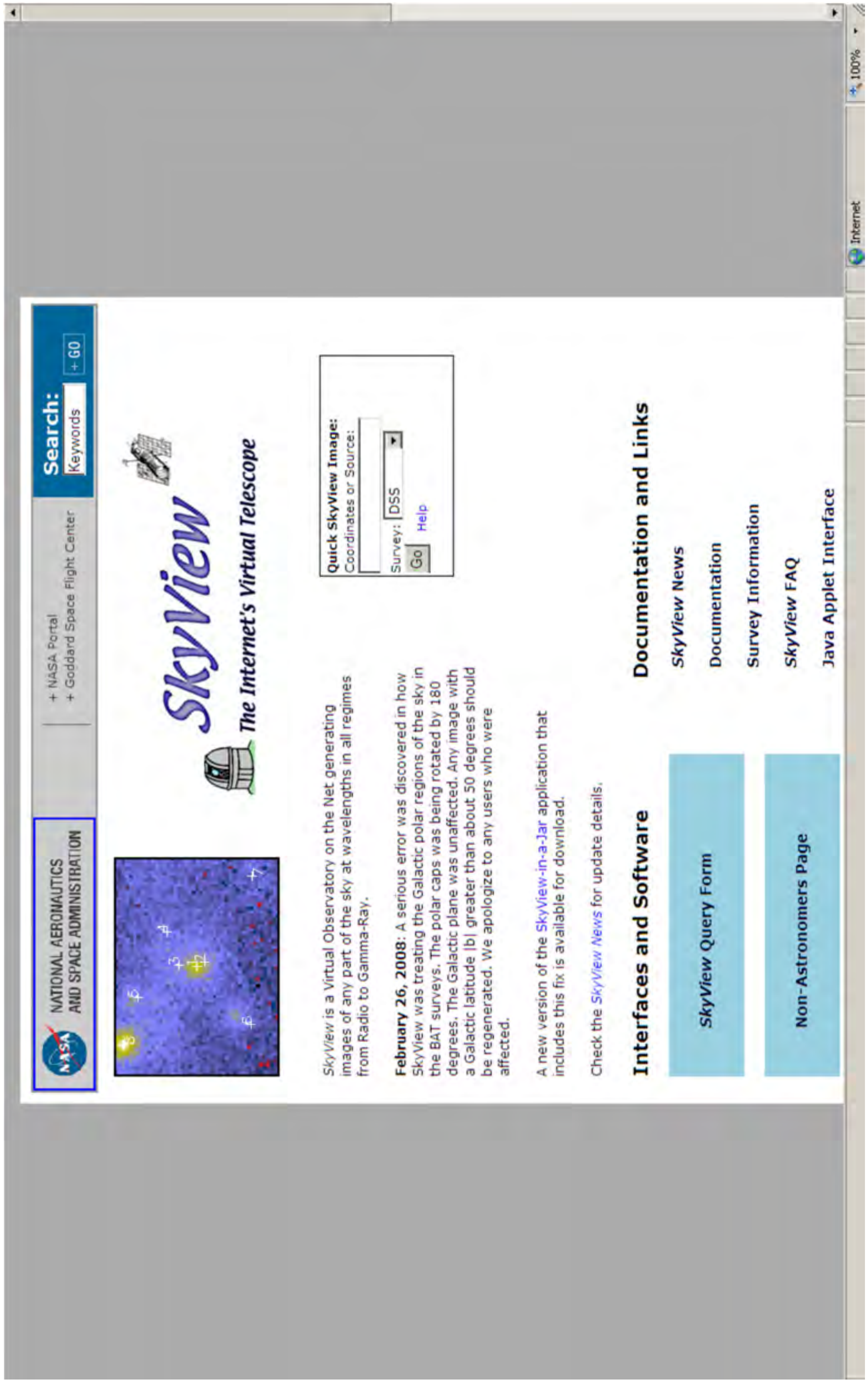
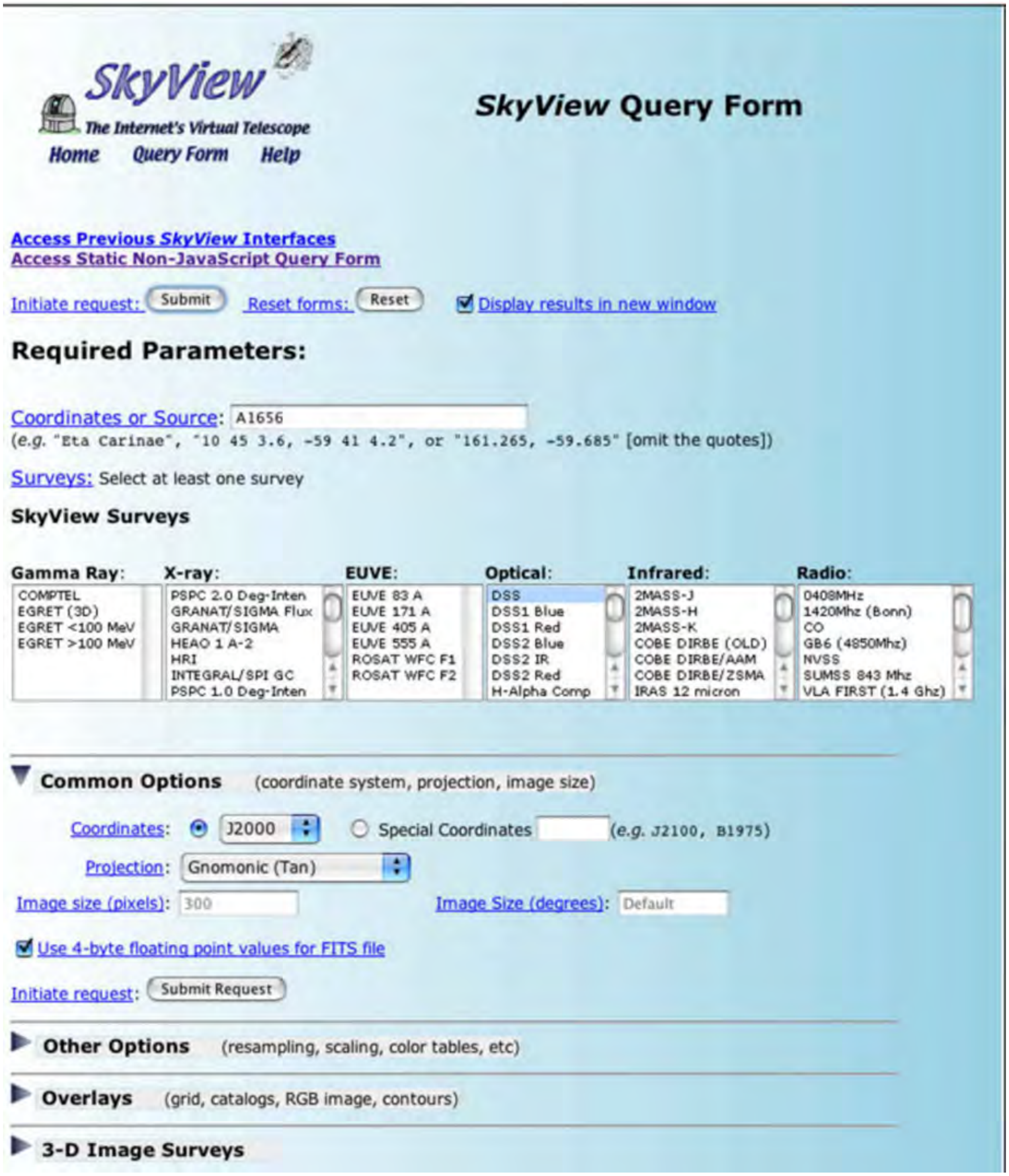
SKYVIEW



NASA SkyView, 2008, "SkyView: The Internet's Virtual Telescope". Retrieved March 19, 2008, from http://skyview.gsfc.nasa.gov/

Figure 15AD-1 SkyView Home Page


SkyView
The Internet's Virtual Telescope
Home Query Form Help

SkyView Query Form

Access Previous SkyView Interfaces
Access Static Non-JavaScript Query Form

Initiate request: Submit Reset forms: Reset ☑ Display results in new window

Required Parameters:

Coordinates or Source: A1656
(e.g. "Eta Carinae", "10 45 3.6, -59 41 4.2", or "161.265, -59.685" [omit the quotes])

Surveys: Select at least one survey

SkyView Surveys

Gamma Ray:	X-ray:	EUVE:	Optical:	Infrared:	Radio:
COMPTEL	PSPC 2.0 Deg-Inten	EUVE 83 A	DSS	2MASS-J	0408MHz
EGRET (3D)	GRANAT/SIGMA Flux	EUVE 171 A	DSS1 Blue	2MASS-H	1420Mhz (Bonn)
EGRET <100 MeV	GRANAT/SIGMA	EUVE 405 A	DSS1 Red	2MASS-K	CO
EGRET >100 MeV	HEAO 1 A-2	EUVE 555 A	DSS2 Blue	COBE DIRBE (OLD)	GB6 (4850Mhz)
	HRI	ROSAT WFC F1	DSS2 IR	COBE DIRBE/AAM	NVSS
	INTEGRAL/SPI GC	ROSAT WFC F2	DSS2 Red	COBE DIRBE/ZSMA	SUMSS 843 Mhz
	PSPC 1.0 Deg-Inten		H-Alpha Comp	IRAS 12 micron	VLA FIRST (1.4 Ghz)

▼ Common Options (coordinate system, projection, image size)

Coordinates: ◉ J2000 ○ Special Coordinates (e.g. J2100, B1975)

Projection: Gnomonic (Tan)

Image size (pixels): 300 Image Size (degrees): Default

☑ Use 4-byte floating point values for FITS file

Initiate request: Submit Request

▶ Other Options (resampling, scaling, color tables, etc)

▶ Overlays (grid, catalogs, RGB image, contours)

▶ 3-D Image Surveys

NASA SkyView, 2008, "SkyView: The Internet's Virtual Telescope". Retrieved March 19, 2008, from http://skyview.gsfc.nasa.gov/

Figure 15AD-2 SkyView Query Form

SkyView
The Internet's Virtual Telescope
Home Query Form Help

***SkyView* Images**

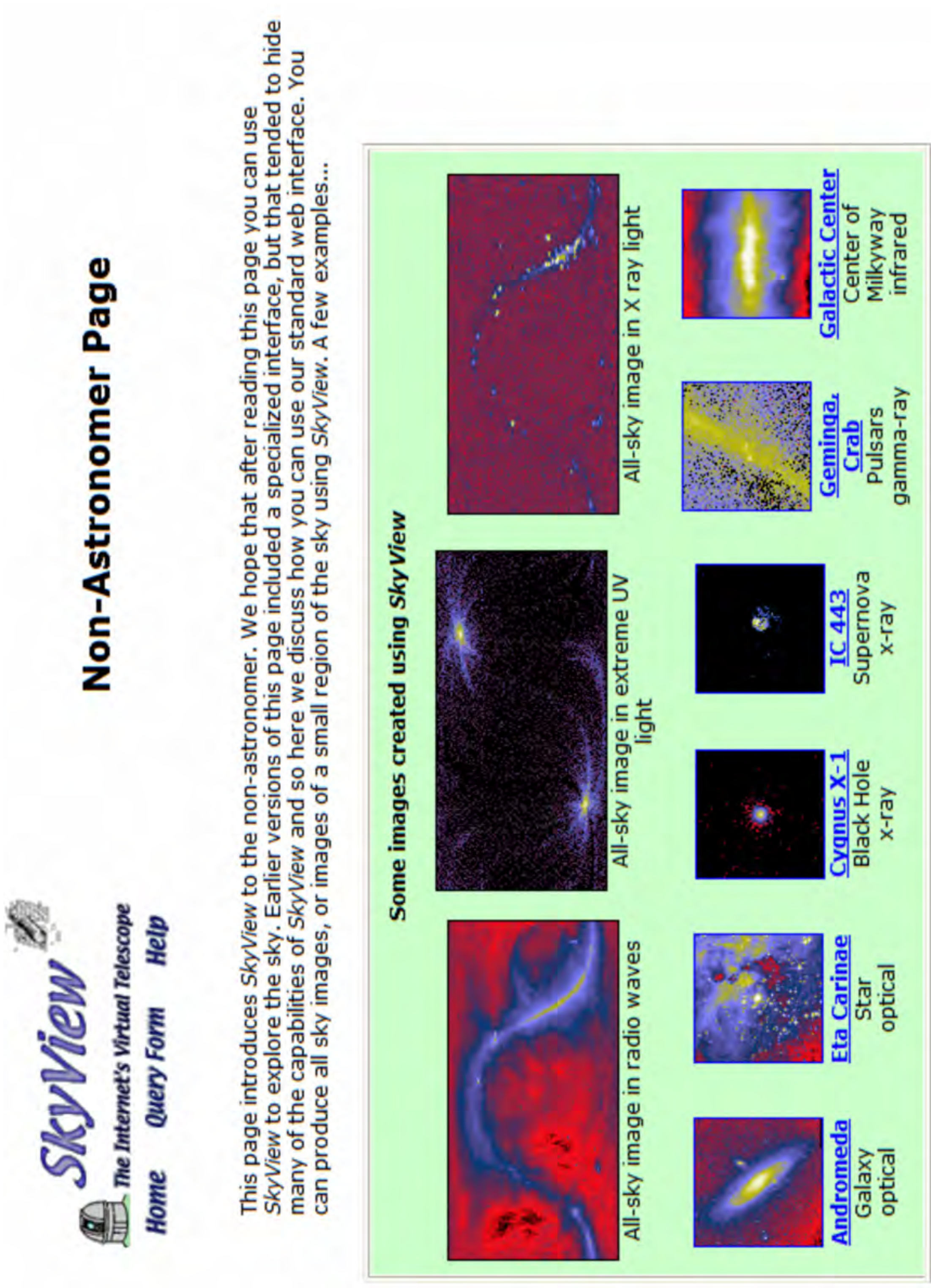
Digitized Sky Survey: Original Digitized Sky Survey

X, Y: 273,3 -> J2000.0: 12 00 09.78 -01 10 10.0

Image color table:	
Image scaling:	Log, values range from 4406.0 to 18483.0
Image size(degrees):	0.14166666 x 0.14166666
Image size(pixels):	300 x 300
Requested Center:	NGC 4030
Coordinate System:	J2000.0
Map projection:	TanProjecter

NASA SkyView, 2008, "SkyView: The Internet's Virtual Telescope". Retrieved March 19, 2008, from http://skyview.gsfc.nasa.gov/

Figure 15AD-3 SkyView Image



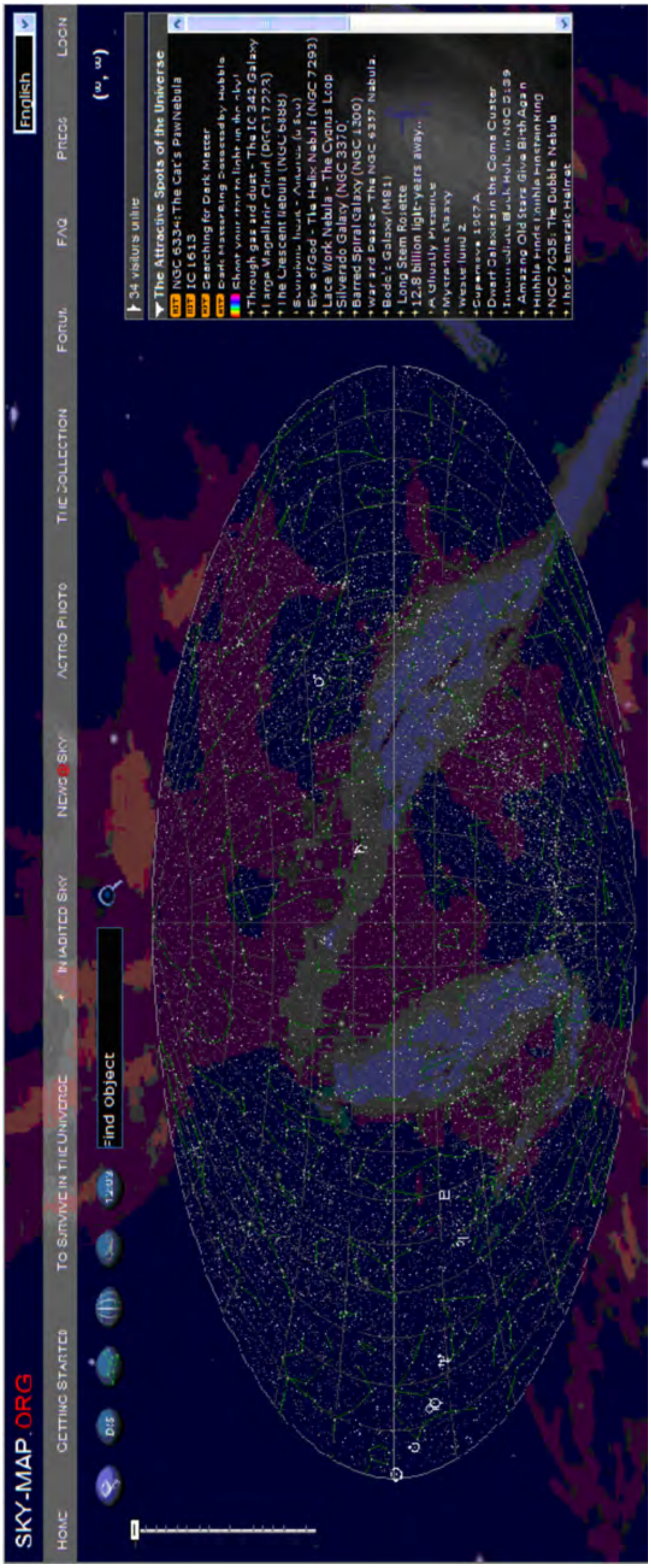
NASA SkyView, 2008, "SkyView: The Internet's Virtual Telescope". Retrieved March 19, 2008, from http://skyview.gsfc.nasa.gov/

Figure 15AD-4 SkyView Non-Astronomers Page

SKY-MAP.ORG

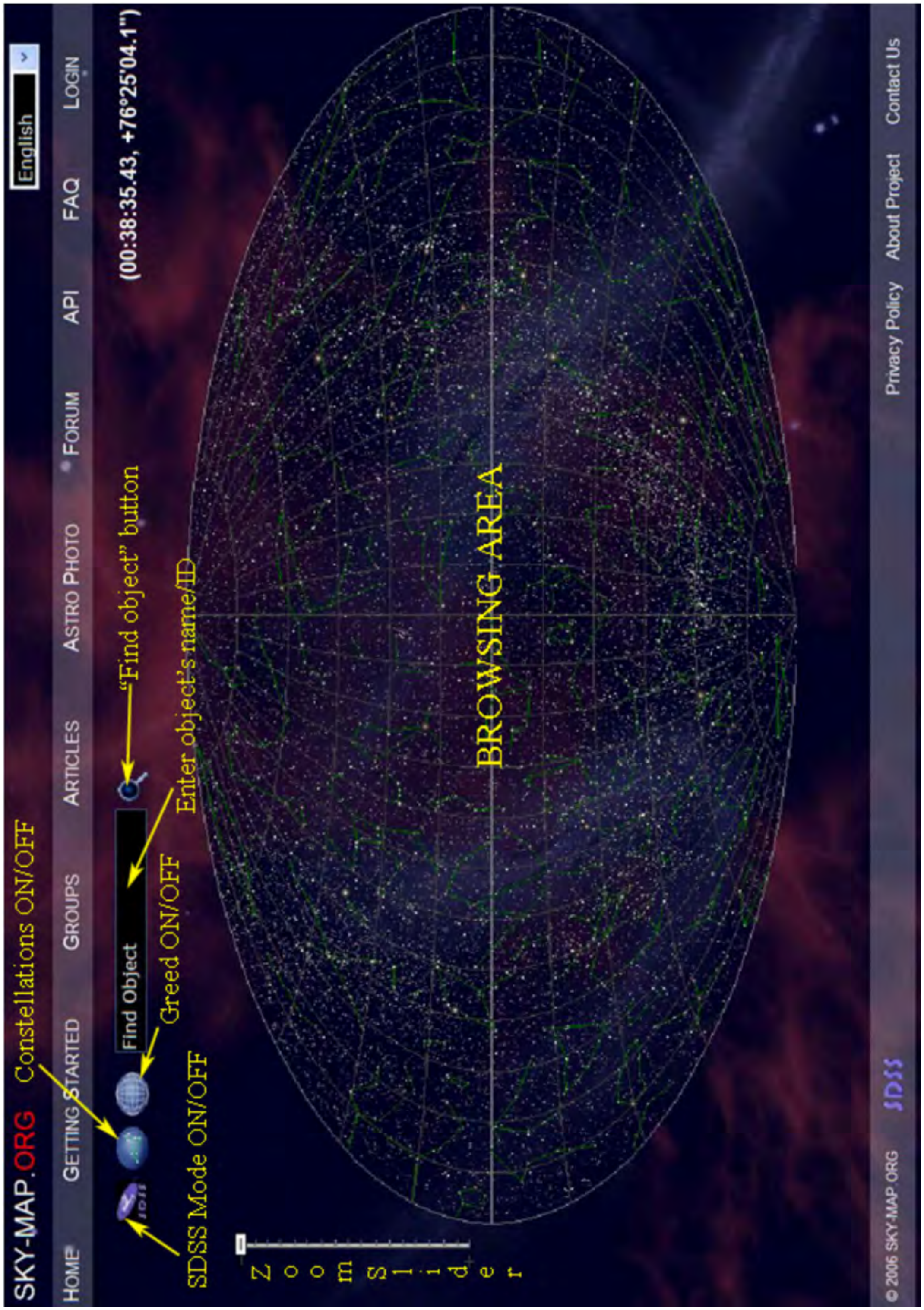
SKY-MAP.ORG, 2008, "SKY-MAP.ORG". Retrieved March 19, 2008, from http://sky-map.org/

Figure 15AE-1 The View From the Hubble Space Telescope



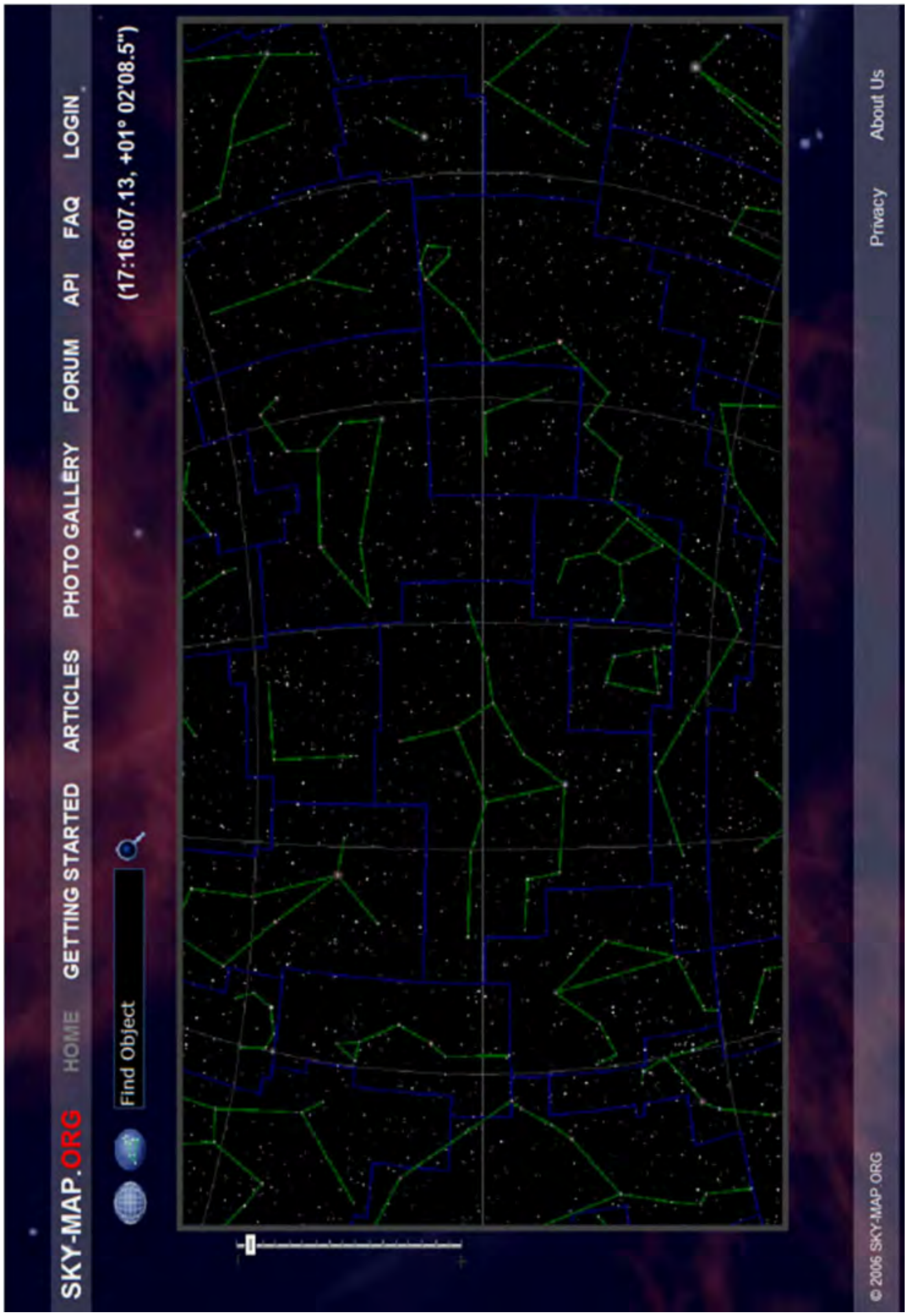
SKY-MAP.ORG, 2008, "SKY-MAP.ORG". Retrieved March 19, 2008, from http://sky-map.org/

Figure 15AE-2 SKY-MAP.ORG Home Page



SKY-MAP.ORG, 2008, "SKY-MAP.ORG". Retrieved March 19, 2008, from http://sky-map.org/

Figure 15AE-3 SKY-MAP.ORG Instruction Page

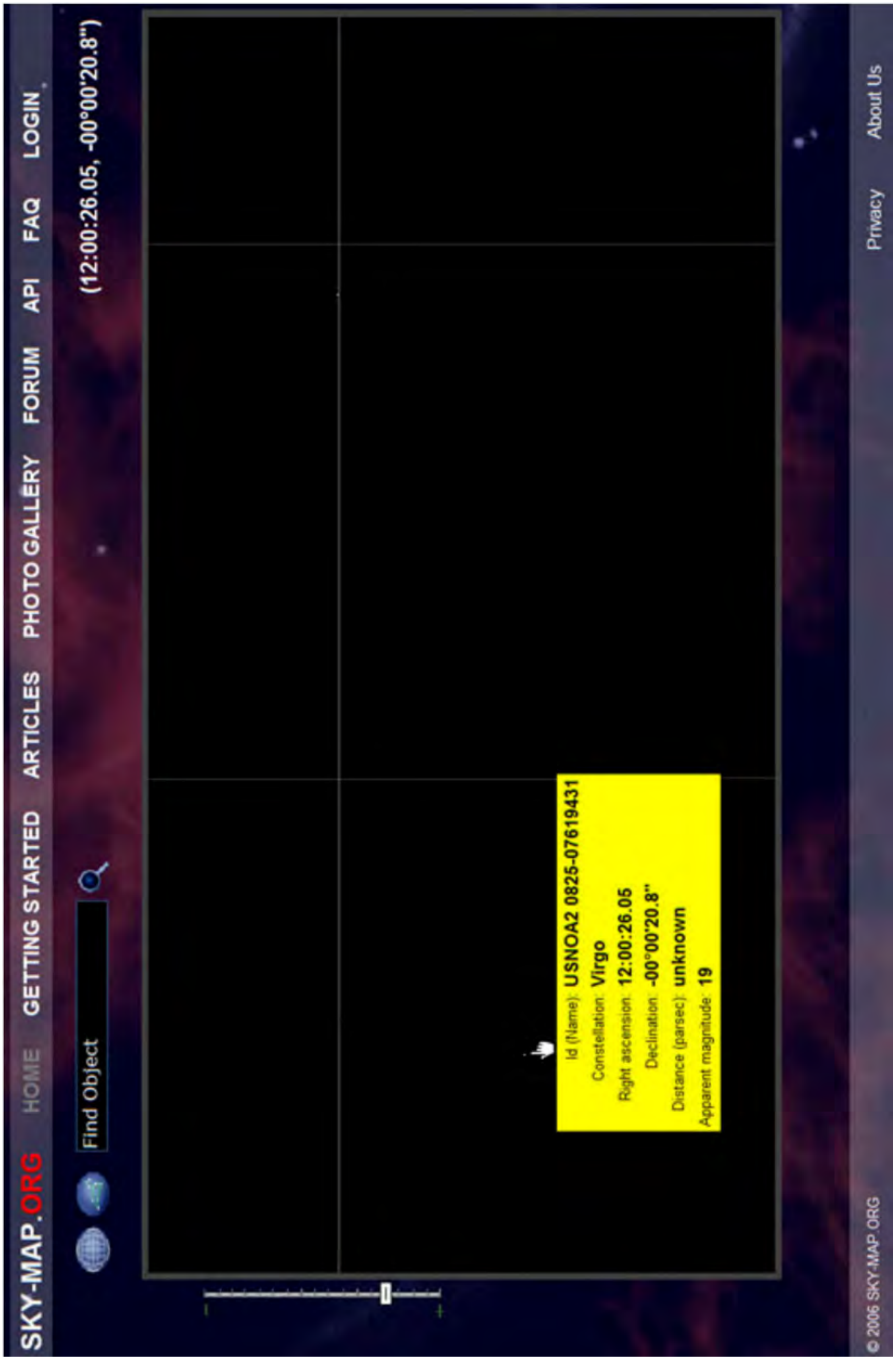


SKY-MAP.ORG, 2008, "SKY-MAP.ORG". Retrieved March 19, 2008, from http://sky-map.org/

Figure 15AE-4 SKY-MAP.ORG Normal Mode

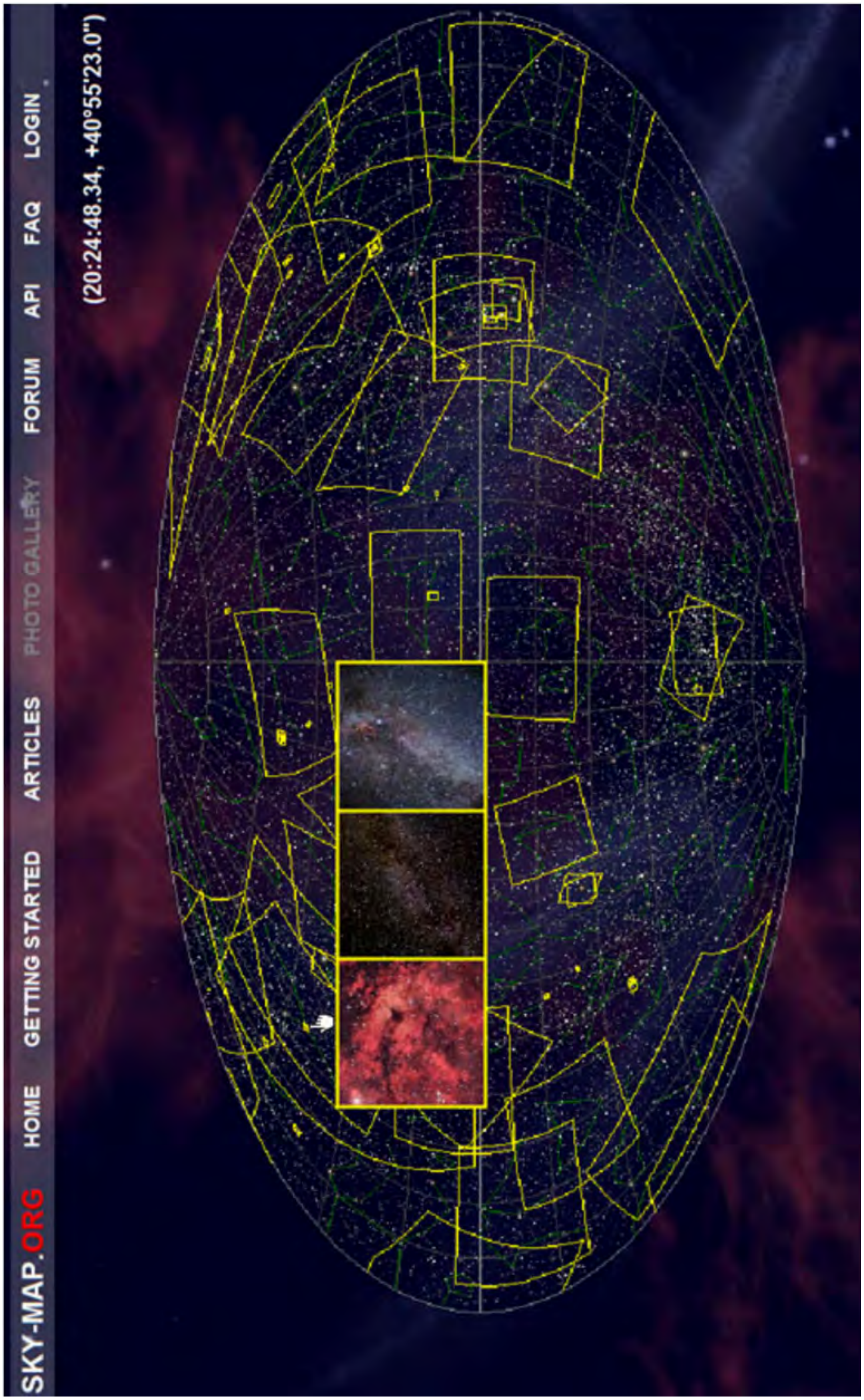
SKY-MAP.ORG, 2008, "SKY-MAP.ORG". Retrieved March 19, 2008, from http://sky-map.org/

Figure 15AE-5 Spiral Galaxy in SDSS Mode



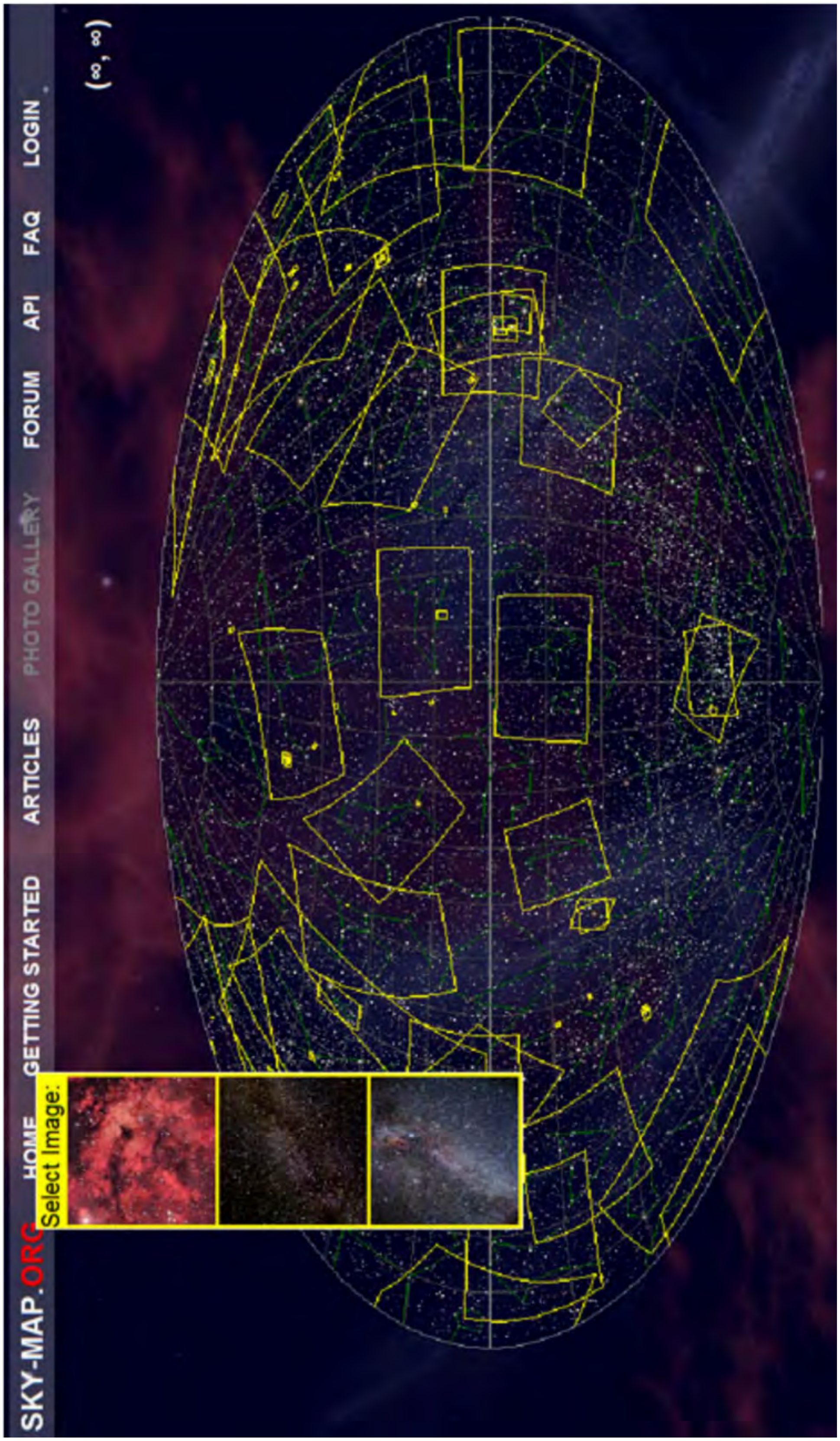
SKY-MAP.ORG, 2006, "SKY-MAP.ORG". Retrieved March 19, 2008, from http://sky-map.org/

Figure 15AE-6 Magnitude 19 in Virgo



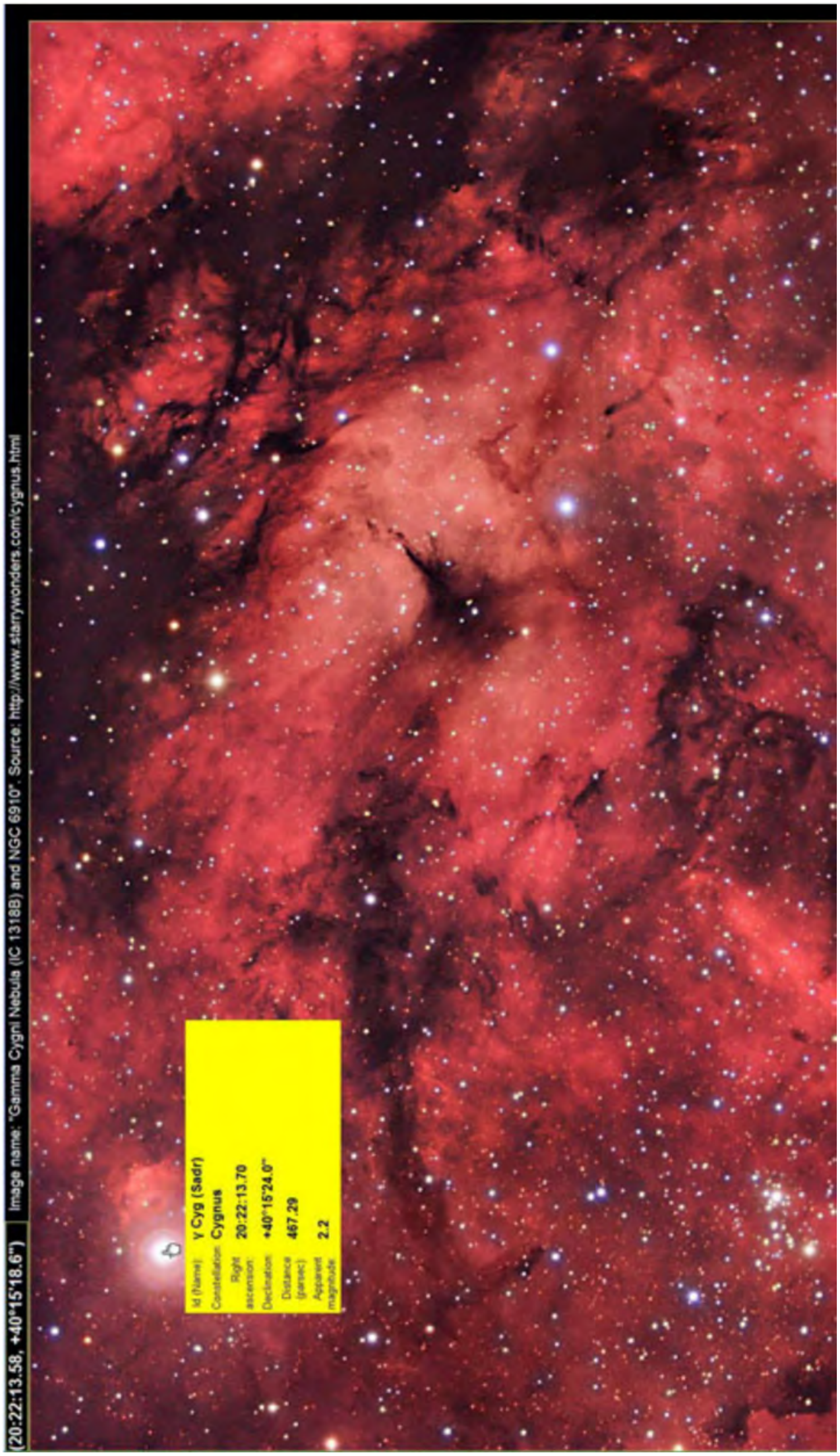
SKY-MAP.ORG, 2006, “SKY-MAP.ORG”. Retrieved March 19, 2008, from http://sky-map.org/

Figure 15AE-7 SKY-MAP.ORG Photo Gallery



SKY-MAP.ORG, 2006, "SKY-MAP.ORG". Retrieved March 19, 2008, from http://sky-map.org/

Figure 15AE-8 Image Selection



SKY-MAP.ORG, 2006, "SKY-MAP.ORG". Retrieved March 19, 2008, from http://sky-map.org/

Figure 15AE-9 Gamma Cygni Nebula Image Selected

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ASTRONOMY BASICS

For background information regarding many aspects of astronomy, Canada's National Research Council (NRC) Herzberg Institute of Astrophysics (NRC-HIA) offers Astronomy Basics at http://hia-iha.nrc-cnrc.gc.ca/public/astr_e.html.

Astronomy Websites of Interest

- Sloan Digital Sky Survey (SDSS) at http://www.sdss.org/background/
- SKY-MAP.ORG at http://sky-map.org/
- NASA's SkyView at http://skyview.gsfc.nasa.gov/
- NASA satellite sighting opportunities data at http://spaceflight.nasa.gov/realdata/sightings/
- Explore the Night Sky with Canada's National Research Council at http://www.nrc-cnrc.gc.ca/eng/education/astronomy/constellations/html.html

HINTS FROM THE LESSON EO C340.10 IDENTIFY ONLINE STARGAZING PROGRAMS

In this lesson SKY-MAP.ORG found galaxy NGC 4030 in constellation Virgo.

NGC 4030 is at celestial coordinates:

- Right ascension: 12 hours 00 minutes 23.40 seconds
- Declination: -01°06'03.0"

When online, this photographic plate can be found by entering the name NGC 4030 into the "Find Object" text box or by entering the coordinates as right ascension followed by a comma and then declination.

This celestial coordinate data is entered into the "Find Object" text box as one data field: 12 00 23.40, -01 06 03.0.

If coordinates are entered, however, considerable magnification must be applied to see NGC 4030. At this scale, it is magnitude 0 in the real sky, appearing as a bright star.

Star brightness is called magnitude. The lower the magnitude, the brighter the object. The brightest star visible in the night sky is Sirius, classified as magnitude −1.

Sirius, the brightest star, is found at coordinates 06 45 08.90, -16 42 58.0 in Normal Mode.

SDSS does not yet cover this part of the sky, but many astro photos of Sirius can be located through Sirius' Basic Information Window (BIW) by clicking on Sirius when its BIW is open.

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CHAPTER 16

PO 360 – RECOGNIZE ASPECTS OF AERODROME OPERATIONS

ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL THREE

INSTRUCTIONAL GUIDE

SECTION 1

EO C360.01 – IDENTIFY TYPES OF AERODROMES

Total Time: 30 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-803/PG-001, Chapter 4. Specific uses for said resources are identified throughout the instructional guide within the TP for which they are required.

Review the lesson content and become familiar with the material prior to delivering the lesson.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

An interactive lecture was chosen for this lesson to review, clarify, emphasize and summarize the types of aerodromes.

INTRODUCTION

REVIEW

Review the following from EO M160.01 (Identify Major Aerodrome Components, A-CR-CCP-801/PF-001, Chapter 14, Section 1):

- an aerodrome is any area of land or water designed for the arrival, departure and movement of aircraft; and
- an airport is an aerodrome that possesses a certificate stating it has met all of the airport safety standards.

OBJECTIVES

By the end of this lesson the cadet shall have identified types of aerodromes.

IMPORTANCE

It is important for the cadets to be able to differentiate types of aerodromes. Aerodrome type is critical as it directly affects all aspects of operations at the aerodrome. The aerodrome type dictates operational requirements in terms of facilities, equipment and human resources.

Teaching Point 1 **Review the Definitions of Aerodrome and Airport**

Time: 5 min Method: Interactive Lecture

AERODROME

An aerodrome is defined by the Aeronautics Act (1985) as:

“Any area of land, water (including the frozen surface thereof) or other supporting surface used, designed, prepared, equipped or set apart for use either in whole or in part for the arrival, departure, movement or servicing of aircraft and includes any buildings, installations and equipment situated thereon or associated therewith.”

Any area designated or set aside for aircraft to use can be considered an aerodrome.

AIRPORT

An airport is an aerodrome for which a certificate has been issued under Subsection 302 of the Canadian Aviation Regulations (CARs). This is done by ensuring the site is inspected periodically for compliance with Transport Canada standards. Certified aerodromes must also maintain an Airport Operations Manual and conduct operations in accordance with the manual.

An aerodrome that has been certified by Transport Canada is considered an airport.

There are three situations in which an aerodrome must be certified. They include:

- an aerodrome located within the built-up area of a city or town;
- a land aerodrome used for scheduled passenger service; or
- any aerodrome that the Minister of Transportation (the Minister) deems to be of public interest.

The only exemptions are:

- military aerodromes, and
- aerodromes for which the Minister has written an exemption.

CONFIRMATION OF TEACHING POINT 1

QUESTIONS

Q1. What is an aerodrome?

Q2. What is an airport?

Q3. When must an aerodrome be certified?

ANTICIPATED ANSWERS

A1. Any area designed, prepared, equipped or set apart for aircraft to use.

A2. An aerodrome that has been certified by Transport Canada.

A3. An aerodrome must be certified if:

- it is located within the built-up area of a city or town;
- it is a land aerodrome used for scheduled passenger service; or
- the Minister of Transportation deems it to be in the public interest.

Teaching Point 2	**Explain Types of Aerodromes**
Time: 5 min	Method: Interactive Lecture

PUBLIC AERODROMES

A public aerodrome is open to the general public for use and does not require prior permission from the aerodrome operator. Most airports operated by any level of government (municipal, provincial, or federal), are open for public use.

PRIVATE AERODROMES

A private aerodrome may have restrictions on its use, depending on the aerodrome operator. Examples of restrictions include:

- specific aircraft types (eg, ultralights, gliders),
- club members,
- company aircraft, and
- friends.

Prior Notice Required (PNR)

If an aerodrome is listed as PNR, then the aircraft operator must notify (contact) the aerodrome operator before using the aerodrome. This allows the aerodrome operator to provide the most current information on the aerodrome to the aircraft operator.

Prior Permission Required (PPR)

If an aerodrome is listed as PPR, then the aircraft operator must receive permission from the aerodrome operator before using the aerodrome. All military aerodromes are listed as PPR for civilian aircraft.

If an aircraft is in distress (experiencing an emergency), any aerodrome may be used for a safe landing – public or private.

CONFIRMATION OF TEACHING POINT 2

QUESTIONS

Q1. What is a public aerodrome?

Q2. What does PNR stand for?

Q3. What does PPR stand for?

ANTICIPATED ANSWERS

A1. An aerodrome that is open to the general public and does not require permission in advance from the aerodrome operator to use.

A2. Prior Notice Required.

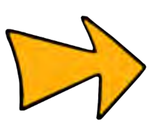
A3. Prior Permission Required.

Teaching Point 3	**Explain Canadian Military Aerodromes**
Time: 5 min	Method: Interactive Lecture

All Canadian military aerodromes require PPR for civilian aircraft, except in the case of an emergency. PPRs may be obtained on an "as needed" basis, or for recurring use by way of a written agreement. Authority to grant the PPR rests with the base/wing commander, although that authority is often delegated further to the base/wing operations officer. Before approving a PPR, the base/wing commander will take into account such factors as:

- impact on flying operations,
- air traffic congestion,
- ramp space availability,
- security risks,
- administrative and technical facilities, and
- competition with civil facilities.

For further details on authorization for civil aircraft to use Canadian military aerodromes, refer to CFAO 55-6 *Authorization for Civil Aircraft to use DND Aerodromes*.



As the operational tempo increases at most Canadian military aerodromes, it is growing more difficult for civilian operators to get permission to land or operate.

As a result of Canada's participation in the British Commonwealth Air Training Plan (BCATP) during WWII, many air bases were built across the country, all with a very similar design (three runways, arranged in a triangle). As the military began disposing of these air bases after the war, many municipalities took over their operations and have kept them operational. In other cases, the air bases were simply abandoned, and in a few cases, private operators took them over.

CONFIRMATION OF TEACHING POINT 3

QUESTIONS

Q1. What do civilian aircraft require prior to landing at a Canadian military aerodrome?

Q2. Why did the military build many air bases during WWII?

ANTICIPATED ANSWERS

A1. Permission.

A2. Due to Canada's participation in the BCATP.

Teaching Point 4	**Explain Types of Civilian Aerodromes**
Time: 10 min	Method: Interactive Lecture

PRIVATE AERODROMES

The most common type of aerodrome in Canada is a private aerodrome (often called a farmer's field). Usually consisting of just a single grass runway, these aerodromes can be found in almost every part of the country, often just miles apart. They are primarily used by the owners of light single-engine aircraft. Usually, the owner lives at the aerodrome, making it very convenient to go flying.

These aerodromes generally offer little to no service to visiting aircraft, and are usually listed as PPR or PNR. They are not certified.

MUNICIPAL AERODROMES

Many municipalities in Canada (large towns and small cities) are involved in the operation of an aerodrome located in (or just outside) the city limits. These aerodromes usually have a hard-surface runway and provide year-round operations. Generally, a municipal aerodrome is for public use.

A municipal aerodrome typically provides the following types of services:

- aircraft storage,
- fuel sales, and
- a multi-purpose terminal building.

Small aviation businesses may operate from a municipal aerodrome. They may include any of the following:

- flight training unit (FTU),
- air charter operator, and
- aviation maintenance facility.

REGIONAL AERODROMES

An aerodrome can be considered to be a regional airport if:

- it has scheduled passenger traffic;
- it is not a national, provincial, or territorial capital; and
- it has a scheduled passenger traffic volume of less than 200 000 passengers per year for three consecutive years.

Regional airports often serve as the starting/ending point in a passenger's air travel. Passengers prefer to fly from the closest regional airport to their home, especially for domestic flights.

INTERNATIONAL AERODROMES

International airports form the backbone of a country's air transportation system. Many flights that originate from a regional airport terminate at an international airport, where passengers can make connections to other regional airports domestically or to international destinations.

At most international airports, cargo flights are more frequent than at a regional airport.

International airports serve 94 percent of the total annual passenger/cargo traffic in Canada.

CONFIRMATION OF TEACHING POINT 4

QUESTIONS

Q1. Who is the main user of a private aerodrome?

Q2. What types of services are generally offered at a municipal aerodrome?

Q3. What types of aviation businesses may be found at a municipal aerodrome?

ANTICIPATED ANSWERS

A1. Owners of small single-engine aircraft.

A2. The following services are generally offered at a municipal aerodrome:

- aircraft storage,
- fuel sales, and
- multi-purpose terminal building.

A3. The following aviation businesses may be found at a municipal aerodrome:

- flight training unit (FTU),
- air charter operator, and
- aviation maintenance facility.

END OF LESSON CONFIRMATION

QUESTIONS

Q1. What is an aerodrome?

Q2. What do civilian aircraft require prior to landing at a military aerodrome?

Q3. Who is the main user of a private aerodrome?

ANTICIPATED ANSWERS

A1. Any area designed, prepared, equipped or set apart for aircraft to use.

A2. Permission.

A3. Owners of small single-engine aircraft.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

N/A.

CLOSING STATEMENT

Knowing the different types of aerodromes forms the basis of aerodrome operations. The similarities and differences between the different types of aerodromes is a key aspect of appreciating the operational requirements of the aerodrome. This is particularly true when it comes to discerning the requirements for facilities, equipment, and human resources.

INSTRUCTOR NOTES/REMARKS

N/A.

REFERENCES

C2-044 Transport Canada. (2007). *Aeronautical Information Manual*. Retrieved October 2, 2007, from http://www.tc.gc.ca/publications/EN/TP14371/PDF/HR/TP14371E.PDF.

C3-147 NAV CANADA. (2007). *Canadian Airport Charts*. Retrieved October 9, 2007, from http://www.navcanada.ca/ContentDefinitionFiles/Publications/AeronauticalInfoProducts/CanadianAirportCharts/CanadianAirportCharts_current.pdf.

C3-148 (ISBN 0-9739866-0-3) Syme, E. R., & Wells, A. T. (2005). *Airport Development, Management and Operations in Canada: Second Edition*. Barrie, ON: Aviation Education Services.

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ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL THREE

INSTRUCTIONAL GUIDE

SECTION 2

EO C360.02 – EXPLAIN ASPECTS OF AERODROME LIGHTING

Total Time:	30 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-803/PG-001, Chapter 4. Specific uses for said resources are identified throughout the instructional guide within the TP for which they are required.

Review the lesson content and become familiar with the material prior to delivering the lesson.

Photocopy the handout located at Annex A for each cadet.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

An interactive lecture was chosen for this lesson to clarify, emphasize and summarize aspects of aerodrome lighting.

INTRODUCTION

REVIEW

N/A.

OBJECTIVES

By the end of this lesson the cadet shall have explained aspects of aerodrome lighting.

IMPORTANCE

It is important for the cadets to know about aerodrome lighting as most aerodromes have some form of lighting in place. Lights indicate the edges of the movement areas and are inspected daily by aerodrome personnel. Approach lighting systems occupy significant space and care must be taken not to cause damage when working near them.

Teaching Point 1 **Explain Manoeuvring Lighting**

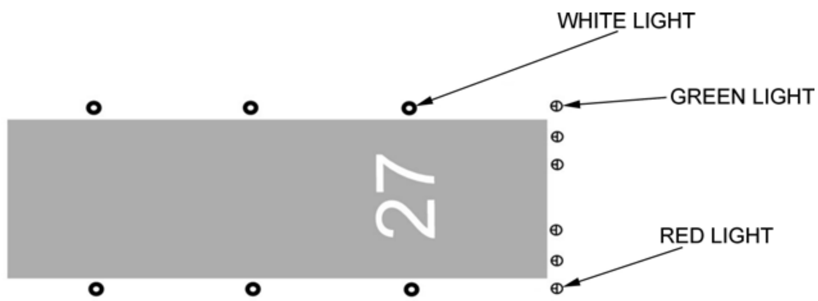
Time: 20 min Method: Interactive Lecture

MANOEUVRING LIGHTING

Runway Lighting

Edge lights are located along the runway. These lights are white in colour (white light bulb with a clear lens) and provide assistance in identifying the edge of the runway. The lights are spaced evenly along each edge with no more than 60 m (200 feet) between the lights. Each row of lights is the same distance from the runway centreline and may be located along the edge of the runway or no more than 1.5 m away from the edge, except in areas that experience significant accumulations of snow. In areas that experience significant accumulations of snow, edge lights may be placed up to 3 m from the runway edge.

The edge lights that cross the beginning of a runway are green while the lights at the end of a runway are red. This is accomplished by using a two-colour filter under the lens. The red side is located on the runway side so that when an aircraft is on the runway looking at the light, a red light is visible. The green filter is on the other side so that when the aircraft is approaching the runway, a green light is visible.



Director Cadets 3, 2007, Ottawa, ON: Department of National Defence

Figure 16-2-1 Runway Lighting

Taxiway Lighting

Edge lights are placed along taxiways in the same way edge lights are placed along runways. The maximum spacing remains at 60 m (200 feet) and will be closer together along a curved section than along a straight section. Taxiway edge lights are blue in colour. The blue colour is created by using a blue lens instead of a clear lens.

Where a taxiway intersects a runway, two blue lights are placed on each side of the taxiway, adjacent to the runway, to indicate the intersection.

Apron Lighting

Apron edge lights are yellow in colour (created by using a yellow lens). Where a taxiway intersects an apron, two yellow lights are placed on each side of the taxiway, adjacent to the apron, to indicate the intersection.

Light Location	Colour
Runway Edge Lights	White
Taxiway Edge Lights	Blue
Apron Edge Lights	Yellow
Runway/Taxiway Intersection	Two blue
Taxiway/Apron Intersection	Two yellow
Runway Threshold (end of runway side)	Red
Runway Threshold (start of runway side)	Green

Director Cadets 3, 2007, Ottawa, ON: Department of National Defence

Figure 16-2-2 Runway Lighting Colours

Unserviceable Area Markings

Certain ground markings indicate the status of aerodromes and pilots are required to comply with these markings.

A large cross, either white or yellow and at least 6.1 m in length, displayed at each end of a runway or taxiway indicates that that runway or taxiway is unserviceable. For night operations, any unserviceable portion of a runway is closed off by placing red lights at right angles to the centerline across both ends. In addition, the runway lights for the unserviceable area are turned off.

If an unserviceable portion of any manoeuvring area or taxiway is small enough that it can be bypassed by an aircraft with safety, red flags are used to outline the area. At night, the area is marked with red lights – sometimes flashing.

Approach Lighting System (ALS)

An ALS provides additional guidance to aid a pilot in finding the beginning of the runway during periods of low visibility. These lights are used as part of an instrument landing system (ILS) and aid the pilot in transitioning from the instrument portion of the approach to the visual portion.

The aerodrome operator must ensure that the systems are working properly by inspecting them on a regular basis. During the winter, the snow around the systems must be cleared to keep them visible.

CONFIRMATION OF TEACHING POINT 1

QUESTIONS

Q1. What colour are runway edge lights?

Q2. What colour are taxiway edge lights?

Q3. What colour are apron edge lights?

ANTICIPATED ANSWERS

A1. White.

A2. Blue.

A3. Yellow.

Teaching Point 2	**Explain Navigational Lighting**
Time: 5 min	Method: Interactive Lecture

AERODROME BEACON

An aerodrome beacon helps a pilot locate an aerodrome amidst all the other ground lights of a community. The beacon is a white light, visible for about ten nautical miles on a clear night, that rotates at a constant speed producing highly visible light flashes at regular intervals of about 2 – 3 seconds. The aerodrome beacon operates continuously during the night.

OBSTRUCTION LIGHTING

Obstruction lights are used to mark tall buildings and towers that might be flight hazards. These may be red lights that are either steady or flashing or they may be flashing white strobe lights.

CONFIRMATION OF TEACHING POINT 2

QUESTIONS

Q1. Why are aerodrome beacon lights used ?

Q2. How can an aerodrome beacon be recognized?

Q3. What are the possible colours of obstruction lights?

ANTICIPATED ANSWERS

A1. To help a pilot to locate an aerodrome amidst all the other ground lights of a community.

A2. An aerodrome beacon is a white light that rotates at a constant speed every 2 – 3 seconds.

A3. Red, either steady or flashing, or a flashing white strobe light.

END OF LESSON CONFIRMATION

QUESTIONS

Q1. What colour are runway edge lights?

Q2. What colour are taxiway edge lights?

Q3. How can an aerodrome beacon be recognized?

ANTICIPATED ANSWERS

A1. White.

A2. Blue.

A3. An aerodrome beacon is a white light that rotates at a constant speed every 2 – 3 seconds.

Hand out copies of Annex A to each cadet.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

N/A.

CLOSING STATEMENT

Aerodrome lighting can be complex systems that are crucial to the safe operation of the aerodrome. Personnel must know what the lights represent. Lighting systems are inspected daily to keep them in operational condition.

INSTRUCTOR NOTES/REMARKS

N/A.

REFERENCES

C2-044 Transport Canada. (2007). *Aeronautical Information Manual*. Retrieved October 2, 2007, from http://www.tc.gc.ca/publications/EN/TP14371/PDF/HR/TP14371E.PDF.

C3-116 (ISBN 0-9680390-5-7) MacDonald, A. F., & Peppler, I. L. (2000). *From the Ground Up: Millennium Edition*. Ottawa, ON: Aviation Publishers Co. Limited.

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ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL THREE

INSTRUCTIONAL GUIDE

SECTION 3

EO C360.03 – CONSTRUCT A MODEL OF THE AIRSPACE AT AN AERODROME

Total Time:	90 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-803/PG-001, Chapter 4. Specific uses for said resources are identified throughout the instructional guide within the TP for which they are required.

Review the lesson content and become familiar with the material prior to delivering the lesson.

Photocopy the handouts located at Annexes B to D for each cadet.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

An interactive lecture was chosen for TPs 1–3 to introduce the parts of the Canadian Domestic Airspace (CDA).

An in-class activity was chosen for TP 4 as an interactive way to reinforce concepts of the CDA.

INTRODUCTION

REVIEW

N/A.

OBJECTIVES

By the end of this lesson the cadet shall have constructed a model of the airspace at an aerodrome.

IMPORTANCE

It is important for the cadets to know about the CDA system as each airspace classification has a set of requirements and operating rules that make it unique. By understanding and adhering to these rules, pilots, ground crew, and aerodrome operations staff can operate safely.

Teaching Point 1 — **Explain Parts of the Canadian Domestic Airspace (CDA) System**

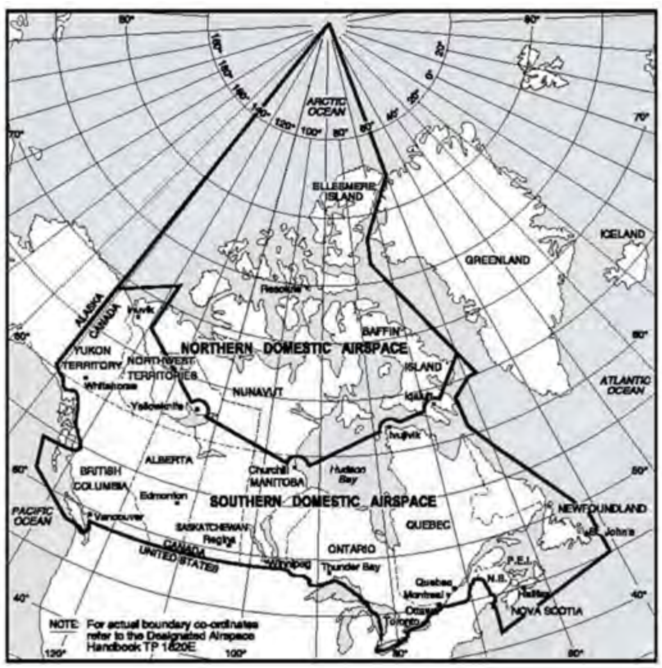
Time: 10 min — Method: Interactive Lecture

Distribute photocopies of Annex B to the cadets.

CDA

CDA includes all airspace over Canadian land mass, the Canadian Arctic, Canadian Archipelago (group of islands) and those areas of the high seas within the airspace boundaries.

CDA is geographically divided into the Northern Domestic Airspace (NDA) and the Southern Domestic Airspace (SDA) (as illustrated in Figure 16-3-1). CDA is also divided vertically into high and low level airspace (as illustrated in Figure 16-3-2).



Aeronautical Information Manual, Ottawa, ON: Her Majesty the Queen in Right of Canada (p. 182)

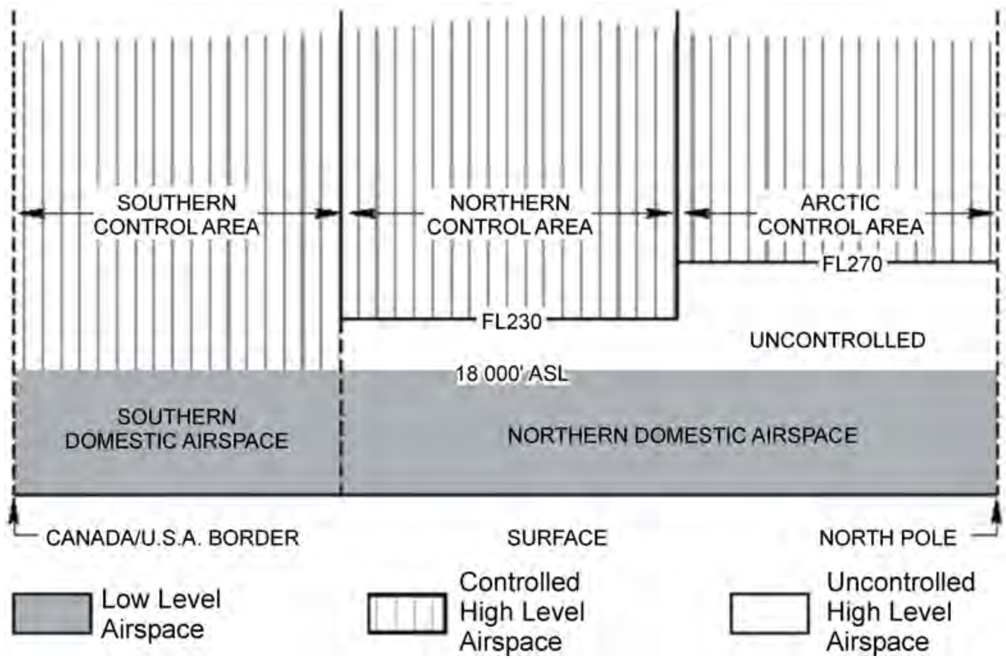
Figure 16-3-1 Boundaries of CDA, NDA, and SDA

NDA

The magnetic north pole is located near the centre of the NDA. Near the pole, the lines of magnetic force dip downwards, almost becoming vertical. This causes the horizontal compass needle to produce unreliable readings. In this region, runway headings are given in degrees true, and true track (the direction the aircraft is travelling) is used to determine cruising altitudes.

SDA

In the SDA, further away from the magnetic north pole, compass readings are reliable as the lines of magnetic force become horizontal. In this region, runway headings are given in degrees magnetic, and magnetic track is used to determine cruising altitudes.



Aeronautical Information Manual, Ottawa, ON: Her Majesty the Queen in Right of Canada (p. 184)

Figure 16-3-2 Vertical Divisions of Airspace

High Level Airspace

High level airspace consists of all airspace above 18 000 feet above sea level (ASL). Aircraft operating in this airspace must be operating in accordance with instrument flight rules (IFR); these are rules that govern the procedures for conducting flight under instrument meteorological conditions (IMC). Traffic operating in accordance with visual flight rules (VFR), which govern the procedures for conducting flight under visual conditions, is excluded from high level airspace.

This is the airspace in which the en route portions of most flights by the following aircraft occur:

- commercial passenger and cargo jets (eg, Boeing 767, Airbus 340), and
- business jets (eg, Citation, LearJet).

Low Level Airspace

Low level airspace consists of all airspace below 18 000 feet ASL. This is the airspace used by general aviation and most commercial turbo-prop aircraft. This is the general classification of airspace used for takeoffs and landings.

CONFIRMATION OF TEACHING POINT 1

QUESTIONS

Q1. How is CDA geographically divided?

Q2. How is CDA vertically divided?

Q3. Low level airspace is the airspace below what altitude?

ANTICIPATED ANSWERS

A1. Northern and Southern Domestic Airspace.

A2. High and low level airspace.

A3. Below 18 000 feet ASL.

Teaching Point 2	**Explain Types of Airspace**
Time: 10 min	Method: Interactive Lecture

CONTROLLED AIRSPACE

Controlled airspace is the airspace in which air traffic control service is provided. Depending on the specific classification of the airspace, some or all aircraft may be subject to air traffic control. Types of low level controlled airspace include:

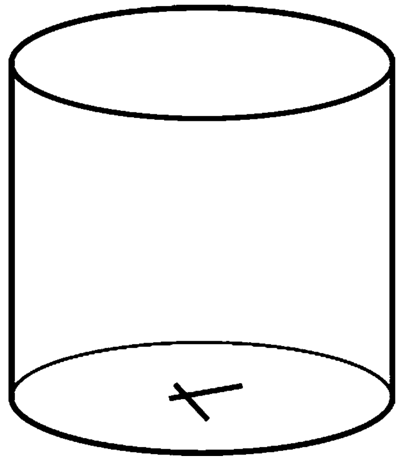
- low level airways,
- control zones,
- terminal control areas,
- transition areas,
- control area extensions, and
- military terminal control areas.

Control Zones (CZs)

CZs are designated around certain aerodromes to keep IFR aircraft within controlled airspace during approaches and to facilitate the control of VFR and IFR traffic. CZs vary in size, with the most common radii being three, five, or seven nautical miles. They are usually capped at 3 000 feet above aerodrome elevation (AAE). CZs will be classified as B, C, D or E depending on the classification of the surrounding airspace.

Military CZs usually have a 10 nautical mile radius and are capped at 6 000 feet AAE.

One can visualize a CZ as a vertical cylinder, with the base of the cylinder centred on the aerodrome (as illustrated in Figure 16-3-3).



Director Cadets 3, 2007, Ottawa, ON: Department of National Defence

Figure 16-3-3 A Control Zone

Terminal Control Areas (TCAs)

TCAs are established at high volume traffic aerodromes to provide an IFR control service to arriving, departing and en route aircraft. The TCA operating rules are established by the classification of the airspace. These rules are based on the level of ATC service that is appropriate for the number and type of aircraft using the airspace as well as the nature of the operations being conducted.

A TCA expands the controlled airspace surrounding a major aerodrome.

Transition Areas

Transition areas are established when it is necessary to provide additional controlled airspace for the IFR operations, specifically to control all of the airspace used by aircraft during takeoff and landing. Transition areas are of defined dimensions, generally based at 700 feet above ground level (AGL), and extend upwards to the base of overlying controlled airspace. The area provided around an aerodrome will normally be a 15 nautical mile radius of the aerodrome centre.

> The airspace surrounding an aerodrome is best visualized as an "upside down wedding cake" (as illustrated in Figure 16-3-4).

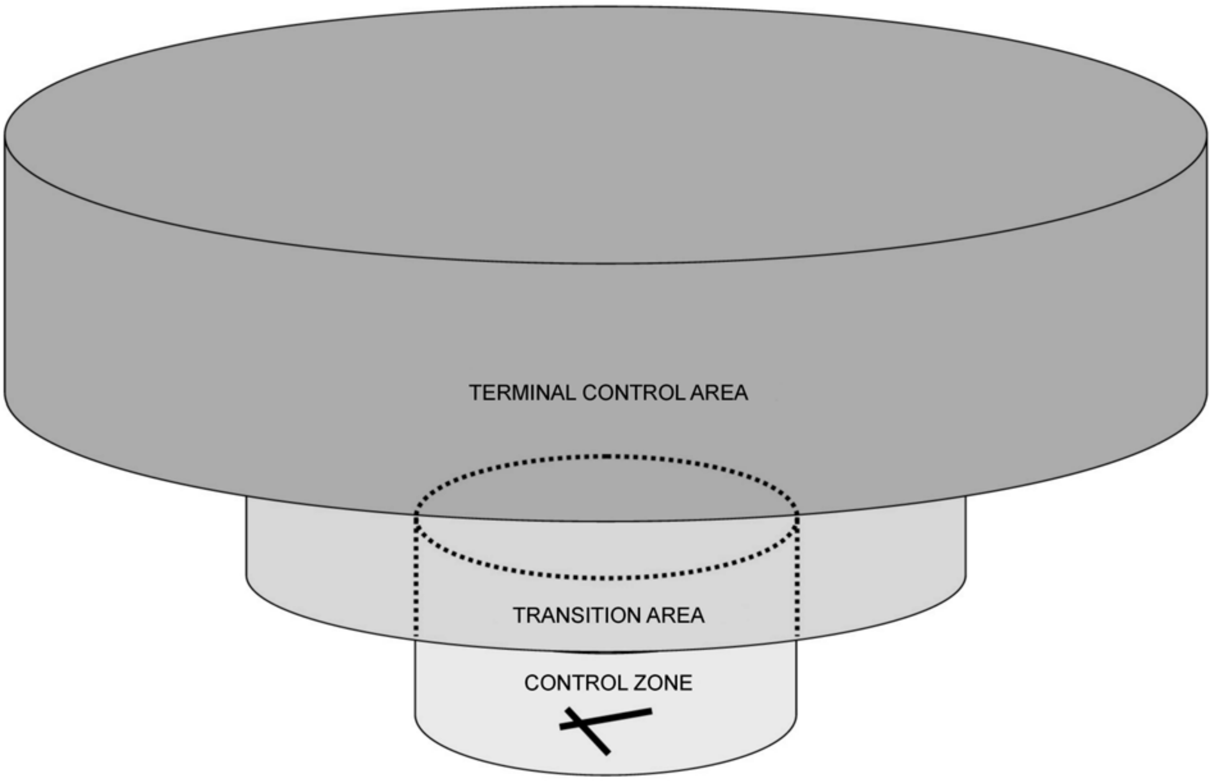


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Figure 16-3-4 Control Zone, Terminal Control Area, and Transition Area

CONFIRMATION OF TEACHING POINT 2

QUESTIONS

Q1. What is the typical radius of a CZ?

Q2. Where are TCAs established?

Q3. At what height does a transition area usually begin?

ANTICIPATED ANSWERS

A1. Three, five, or seven nautical miles (10 nautical miles for a military control zone).

A2. At high volume traffic aerodromes.

A3. At 700 feet AGL.

Teaching Point 3	**Explain Classes of Airspace**
Time: 10 min	Method: Interactive Lecture

AIRSPACE CLASSIFICATIONS

CDA is divided into seven classes, each identified by a single letter: A, B, C, D, E, F, or G. Flight within each class is governed by specific rules applicable to that class.

Class A

Class A airspace is designated where an operational need exists to exclude VFR aircraft. All operations must be conducted under IFR and are subject to Air Traffic Control (ATC) clearances and instructions. An ATC clearance gives authorization to proceed within controlled airspace and an ATC instruction is a directive issued by an ATC unit for air traffic control purposes.

All high level controlled airspace is designated as Class A.

Class B

Class B airspace is designated where an operational need exists to provide air traffic control service to IFR and to control VFR aircraft.

All low level controlled airspace above 12 500 feet ASL or at and above the minimum en route altitude (MEA), whichever is higher, up to but not including 18 000 feet ASL will be Class B airspace. Control zones and associated terminal control areas may also be classified as Class B airspace.

Class C

Class C airspace is controlled airspace in which both IFR and VFR flights are permitted.

Airspace classified as Class C becomes Class E airspace when the appropriate ATC unit is not in operation. Terminal control areas and associated control zones may be classified as Class C airspace.

Class D

Class D airspace is controlled airspace in which both IFR and VFR flights are permitted, but VFR flights must establish two-way communication with the appropriate ATC agency prior to entering the airspace.

Airspace classified as Class D becomes Class E airspace when the appropriate ATC unit is not in operation. A terminal control area and associated control zone could be classified as Class D airspace.

Class E

Class E airspace is designated where an operational need exists for controlled airspace but does not meet the requirements for Class A, B, C, or D.

Low level airways, control area extensions, transition areas, or control zones established without an operating control tower may be classified as Class E airspace.

Class F

Class F airspace is an area in which activities must be restricted, or limitations imposed upon aircraft operations that are not a part of those activities. Typical uses for Class F airspace include:

- military practice areas,
- fire-bombing,
- parachute jumping,
- flight training,
- soaring,
- hang gliders, and
- air shows.

Class F airspace is sometimes known as special use airspace. It may be classified as Class F advisory, or as Class F restricted, and can be controlled airspace, uncontrolled airspace, or a combination of both.

Class G

Class G airspace is airspace that has not been designated Class A, B, C, D, E or F and in which ATC has neither the authority or responsibility for exercising control over air traffic.

To help the cadets remember:

- Classes A to E are controlled airspace,
- Class F may be controlled or uncontrolled, and
- Class G airspace is uncontrolled.

The difference between Class C and Class D is that an ATC clearance is needed to enter Class C, but two-way communication is all you need to enter Class D.

Distribute photocopies of Annex C to the cadets.

CONFIRMATION OF TEACHING POINT 3

QUESTIONS

Q1. What happens to Class C airspace when the ATC unit is not in operation?

Q2. What is another name for Class F airspace?

Q3. Which airspace is uncontrolled?

ANTICIPATED ANSWERS

A1. It becomes Class E airspace.

A2. Special use airspace.

A3. Class G airspace.

Teaching Point 4	**Have the Cadet, as a Member of a Group of No More Than Four, Construct a Model of the Airspace at an Aerodrome**
Time: 55 min	Method: In-Class Activity

ACTIVITY

OBJECTIVE

The objective of this activity is for the cadet to construct a model of the airspace at an aerodrome.

RESOURCES

- Checklist located at Annex D.

- Coloured construction paper,
- Transparent tape,
- Scissors,
- Coloured markers, and
- Glue.

Other materials may be used in addition to this list if available. The amount of materials that are needed will depend on class size and the number of groups.

ACTIVITY LAYOUT

Group the tables/desks together to form a large work surface to support the base of the model.

ACTIVITY INSTRUCTIONS

1. Distribute the checklist located at Annex D to each cadet.
2. Divide the cadets into groups of four.
3. Inform the cadets of the materials available for them to use.
4. Inform the cadets they are all to start with a base of two large pieces of construction paper taped together.
5. Have each group create their own model aerodrome airspace using the checklist located at Annex D, ensuring all the required components are included.

While it is not important for the model to be built exactly to scale, care should be taken to construct items that are the correct size, relative to the other components of the aerodrome.

While cadets are encouraged to be creative with the materials provided, recommend the following:

- Brown or green paper should be used for the base.
- Black or grey paper should be used for pavement.
- Airspace can be created by cutting a strip of construction paper and taping the ends together to create a cylinder.
- Airspace areas can be stacked vertically by cutting and taping a circle of construction paper to the cylinders.
- Different colours of paper should be used for each classification of airspace.
- Coloured markers can be used for adding specific details to components.
- Groups that finish early can improve their model by adding a second aerodrome to the model with airspace that overlaps the first aerodrome's airspace, creating an irregular shape for the airspace areas.

SAFETY

N/A.

CONFIRMATION OF TEACHING POINT 4

The cadets’ participation in the activity will serve as the confirmation of this TP.

END OF LESSON CONFIRMATION

The cadets’ participation in the construction of a model of the airspace at an aerodrome will serve as the confirmation of this lesson.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

N/A.

CLOSING STATEMENT

Each airspace classification has a set of requirements and operating rules that make it unique. These rules allow pilots, ground crew, and aerodrome operations staff to operate safely.

INSTRUCTOR NOTES/REMARKS

N/A.

REFERENCES

C2-044 Transport Canada. (2007). *Aeronautical Information Manual*. Retrieved October 2, 2007, from http://www.tc.gc.ca/publications/EN/TP14371/PDF/HR/TP14371E.PDF.

ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL THREE

INSTRUCTIONAL GUIDE

SECTION 4

EO C360.04 – IDENTIFY HOW EQUIPMENT IS USED AT AN AERODROME

Total Time:	30 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-803/PG-001, Chapter 4. Specific uses for said resources are identified throughout the instructional guide within the TP for which they are required.

Review the lesson content and become familiar with the material prior to delivering the lesson.

Create slides of figures located at Annex E.

Photocopy the activity sheet located at Annex F for each cadet.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

An interactive lecture was chosen for this lesson to clarify, emphasize and summarize the equipment used at an aerodrome.

INTRODUCTION

REVIEW

N/A.

OBJECTIVES

By the end of this lesson the cadet shall have identified how equipment is used at an aerodrome.

IMPORTANCE

It is important for the cadets to be able to identify the equipment at an aerodrome and how it is used to understand aerodrome operations. At most aerodromes each vehicle has a specific purpose and, to carry out specialized tasks, certain vehicles have additional equipment added to them.

Teaching Point 1	**Explain How Trucks Are Used at an Aerodrome**
Time: 15 min	Method: Interactive Lecture

One of the most common vehicles found at an aerodrome is a truck. The trucks found at an aerodrome can be broken down into three general categories:

- pickup truck,
- dump truck, and
- specialty truck.

Show the cadets Figures 16E-1, 16E-2 and 16E-3.

INSPECTIONS

Throughout the course of the day, aerodrome operations staff must conduct inspections of the following areas:

- runways,
- taxiways,
- aprons, and
- roads.

Most of the time, the only equipment required to conduct these inspections is a vehicle with a rotating amber beacon and a two-way radio. A car is usually the most economical vehicle for this kind of task.

While most of the regular inspections at an aerodrome can be conducted using a car, pickup trucks are required for some specific inspections. Specifically, the guidelines for conducting runway friction testing require the use of a pickup truck when using a portable decelerometer (a device that measures deceleration).

A pickup truck transports tools and equipment required to correct deficiencies more easily than a car.

There may also be areas of the aerodrome that need inspections, but that do not have proper roads. In these cases, a four-wheel drive pickup truck may be required to safely reach these areas.

MAINTENANCE

Pickup trucks are used extensively for ongoing maintenance tasks around an aerodrome. They are well-suited to carry the tools and equipment necessary to perform maintenance. Typical maintenance tasks that might be carried out include:

- replacement and repair of lights,
- fence repairs,
- sign repairs, and
- minor pavement and turf repairs.

CONSTRUCTION

During construction at an aerodrome, trucks of all shapes and sizes will be used. Flatbed trucks deliver materials and equipment to the site, as well as move them around the facilities. Dump trucks will be used wherever excavations or earth moving occurs. Pickup trucks will be used to move people, smaller tools and equipment around.

While most of these vehicles will not be owned by the aerodrome, the aerodrome operator will be responsible for ensuring that drivers are properly trained, that the vehicles are properly equipped (eg, two-way radio, rotating amber beacon/strobe light), and that the vehicles move about the aerodrome in a safe and efficient manner.

SNOW REMOVAL

At most Canadian aerodromes, winter is a busy time of year for trucks. All of the snow that falls on the movement areas and the road system has to be cleared in a timely manner to allow operations to continue with minimal disruption.

> Show the cadets Figure 16E-4.

Snowplows are often attached to large trucks. Even pickup trucks can have a plow blade attached for clearing small areas. Piles of snow that accumulate can be moved using dump trucks. Dump trucks or pickup trucks may have hoppers in the back that can be used for spreading chemicals for melting ice or grit to increase traction.

PLATFORMS FOR SPECIALTY EQUIPMENT

Many specialized vehicles at an aerodrome are basic truck frames with the addition of special equipment. Examples of these include:

> Show the cadets Figure 16E-5.

- de-icing trucks,
- fuel delivery,
- air stairs,
- rapid response emergency vehicles, and
- ground servicing equipment (eg, catering truck).

> Show the cadets Figure 16E-6.

ACTIVITY

Time: 5 min

OBJECTIVE

The objective of this activity is to have the cadets match the vehicle pictures with the correct name and purpose.

RESOURCES

- Aerodrome vehicle handout located at Annex F, and
- Pen/pencil.

ACTIVITY LAYOUT

N/A.

ACTIVITY INSTRUCTIONS

1. Distribute the handout located at Annex F.
2. Have the cadets complete the handout.
3. Provide assistance and guidance as required.
4. Correct the answers as a group using Annex G.

SAFETY

N/A.

CONFIRMATION OF TEACHING POINT 1

The cadets' participation in the activity will serve as the confirmation of this TP.

Teaching Point 2	**Describe Runway Maintenance Equipment and How it is Used at an Aerodrome**
Time: 5 min	Method: Interactive Lecture

There are several important pieces of equipment that are used extensively at aerodromes: sweepers, snowplows and snow blowers.

Equipment designed for aerodrome use is usually designed to be mounted on a special chassis. The chassis has a standardized mounting bracket and common hydraulic connections which allow different types of equipment to be mounted, depending on the task to be done.

SWEEPERS

Sweepers come in three main configurations:

- self-propelled,
- front mounted, and
- towed.

Show the cadets Figure 16E-7.

When there has been a light accumulation of snow or slush but not enough to require a snowplow, a sweeper can be used. Sweepers remove debris such as dirt or sand, to prevent foreign object damage (FOD) to propellers or turbine engines.

The rotating brush has bristles made of stainless steel or synthetic materials (usually nylon or polypropylene). Steel bristles cut through ice and snow effectively and synthetic bristles move wet snow or slush well.

Some sweepers have hot air blowers, which direct a steady stream of hot air onto the surface being swept. In addition to blowing away any small particles left behind by the brush, the hot air can melt small ice deposits.

SNOWPLOWS

Any aerodrome that expects snow will have a snowplow, either owned by the aerodrome, or contracted by a third party. A snowplow is the most effective way to remove snow from aircraft movement areas.

Show the cadets Figures 16E-8 and 16E-9.

SNOW BLOWERS

When a snowplow pushes snow to the side of a runway, it creates a pile of snow known as a windrow. The preferred method of removing the windrow is with a snow blower. The snow blower can move along the edge of the runway blowing the snow in the windrow over the runway edge lights and away from the runway.

Show the cadets Figures 16E-10 and 16E-11.

Similar to sweepers, snow blowers can be front mounted, rear mounted or self-propelled. The large self-propelled versions have two engines: one for driving, and the other for powering the snow blower. Rear mounted blowers are commonly attached to tractors.

CONFIRMATION OF TEACHING POINT 2

QUESTIONS

Q1. What configurations do sweepers come in?

Q2. What are the differences between a highway snowplow and an aerodrome snowplow?

Q3. What is the primary purpose of a snow blower at an aerodrome?

ANTICIPATED ANSWERS

A1. Self-propelled, front mounted or towed.

A2. An aerodrome snowplow has a wider blade that is reversible (two-way).

A3. Removing windrows left behind by snowplows.

Teaching Point 3	**Describe Refuelling Equipment at an Aerodrome**
Time: 5 min	Method: Interactive Lecture

STATIONARY REFUELLING EQUIPMENT

At most public aerodromes, aviation fuel is available for purchase from the aerodrome operator, or from a third party (or parties at a large aerodrome). Fuel is dispensed in two main ways: from a stationary location or from a mobile refueller. A stationary refuelling system is made up of three main components: tanks, pumps and hoses.

Show the cadets Figures 16E-12 and 16E-13.

MOBILE REFUELLING EQUIPMENT

At a large aerodrome, or at an aerodrome with large aircraft, a stationary refuelling system is not a viable option. In these cases, refuelling is carried out by mobile refuelling equipment that brings fuel to the aircraft.

Show the cadets Figure 16E-14.

Commonly, the fuel is stored in large tanks in a remote location (known as a fuel farm) at the aerodrome. The mobile tanker is filled from the bulk tanks, driven to the aircraft and refuelling is carried out. The tanker can then move on to the next aircraft and repeat the process. When the tanker no longer carries enough fuel to service the next aircraft, it returns to the bulk tank and is refilled.

CONFIRMATION OF TEACHING POINT 3

QUESTIONS

Q1. What are the two main ways that fuel is dispensed to aircraft?

Q2. What is the name of the remote location where fuel is stored for mobile refuelling?

Q3. What are the three main components of a refuelling system?

ANTICIPATED ANSWERS

A1. From a stationary location or from a mobile refueller.

A2. A fuel farm.

A3. Tanks, pumps and hoses.

END OF LESSON CONFIRMATION

QUESTIONS

Q1. What are three types of equipment used at an aerodrome?

Q2. Where is fuel stored at an aerodrome?

Q3. For inspection of which aerodrome facilities is a car usually the most economical vehicle?

ANTICIPATED ANSWERS

A1. Sweepers, snowplows and snow blowers.

A2. At a fuel farm.

A3. Runways, taxiways, aprons, and roads.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

N/A.

CLOSING STATEMENT

It is important for the cadets to be able to identify the equipment at an aerodrome and how it is used. Each piece of equipment has a specific purpose, and is outfitted with specialized equipment to help it perform the required tasks.

INSTRUCTOR NOTES/REMARKS

N/A.

REFERENCES

C3-148 (ISBN 0-9739866-0-3) Syme, E. R., & Wells, A. T. (2005). *Airport Development, Management and Operations in Canada: Second Edition*. Barrie, ON: Aviation Education Services.

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ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL THREE

INSTRUCTIONAL GUIDE

SECTION 5

EO C360.05 – IDENTIFY ASPECTS OF EMERGENCY RESPONSE AND AERODROME SECURITY

Total Time:	30 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-803/PG-001, Chapter 4. Specific uses for said resources are identified throughout the instructional guide within the TP for which they are required.

Review the lesson content and become familiar with the material prior to delivering the lesson.

Review the mandate of the Canadian Air Transport Security Authority (CATSA) at website reference C3-098 and update the information presented in the guide if necessary.

Obtain and photocopy an updated list of permitted and prohibited carry-on items from http://www.catsa-acsta.gc.ca for each cadet.

Create a slide of Annex H.

Photocopy the Aerodrome Security Definitions located at Annex I for each cadet.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

An interactive lecture was chosen for this lesson to clarify, emphasize and summarize aircraft and aerodrome emergencies, security, the role of CATSA, and types of screening at an aerodrome.

INTRODUCTION

REVIEW

N/A.

OBJECTIVES

By the end of this lesson the cadet shall have identified aspects of emergency response and security at aerodromes.

IMPORTANCE

It is important for cadets to understand the operational requirements of aerodrome emergency response and security. Recognizing the role of CATSA and the types of screening performed will be relevant to cadets who travel through major Canadian aerodromes.

Teaching Point 1	**Discuss Aircraft Emergencies**
Time: 5 min	Method: Interactive Lecture

AIRCRAFT RESCUE AND FIRE FIGHTING (ARFF)

The primary responsibility of an ARFF service is to provide an escape route for the evacuation of passengers and crew when needed. This service is also known as:

- Crash, Fire and Rescue (CFR), and
- Emergency Response Services (ERS).

ARFF VEHICLES

ARFF must be able to respond within a specific time frame, carry the types and volumes of specified extinguishing agents (water and foam) and be able to dispense the agents.

Show the cadets Figure 16H-1.

ARFF vehicles are similar to standard fire trucks, but have been built specifically for aerodromes. They can handle rough terrain while accelerating quickly to their top speed. The use of turrets to dispense water and foam allows the operator to drive to the edge of the fire and begin dispensing extinguishing agents immediately. Two turrets (nose and roof) are standard equipment and are controlled by the operator inside the cabin. A turret can be combined with a piercing device on the end of a boom. This boom can be extended to the aircraft to create an opening in the aircraft skin and an extinguishing agent can then be delivered directly into the aircraft.

STANDBY REQUESTS

Local Standby. The level of response when an aircraft has or is suspected to have an operational defect that would cause serious difficulty for the aircraft to achieve a safe landing.

Full Emergency Standby. The level of response when an aircraft has or is suspected to have an operational defect that affects normal flight operations to the extent that there is possibility of an accident.

ON-SITE CRASHES

If a crash occurs at an aerodrome, the primary role of the ARFF service is to suppress any fire and provide a safe evacuation route out of the aircraft for the passengers. Many ARFF departments also include paramedics, vehicles and equipment to provide first aid and triage services to the passengers. In the event of a major crash, additional resources from the local area may be required.

OFF-SITE CRASHES

If an aircraft crash occurs near an aerodrome with ARFF, the ARFF services from that aerodrome may be dispatched to the scene. If ARFF services from an aerodrome are not readily available, local fire departments and paramedics will respond. Most aircraft crashes occur during takeoff and landing; the ERS for the municipalities surrounding an aerodrome, such as fire, paramedics and police services, will be prepared to respond to an off-site crash. ERS personnel receive special training on aircraft firefighting and passenger rescue techniques.

JOINT RESPONSES

Aerodromes with ARFF services may have an agreement with the surrounding municipalities to assist in off-site aircraft crashes. The agreement may also cover non-aviation related emergencies near the aerodrome. An example of this would be a fuel tanker crash and fire on a nearby highway. The foam extinguishing agent dispensed by ARFF vehicles can control this type of fire.

CONFIRMATION OF TEACHING POINT 1

QUESTIONS

Q1. What does ARFF stand for?

Q2. How do ARFF vehicles dispense water and/or foam?

Q3. When do most aircraft crashes occur?

ANTICIPATED ANSWERS

A1. Aircraft Rescue and Fire Fighting.

A2. Through turrets.

A3. During takeoff and landing.

Teaching Point 2	**Discuss Aerodrome Emergencies**
Time: 5 min	Method: Interactive Lecture

AERODROME EMERGENCIES

In addition to aircraft emergencies, the aerodrome's emergency plan should include other non-aviation emergencies. Where possible, the ARFF unit is the responding agency. In other cases, local ERS such as fire, paramedics and police would respond. In all cases, simulated emergency exercises are held to test the emergency plan and provide training opportunities for all personnel.

Building Fires

A fire in a terminal building at a large aerodrome would be handled much the same way as a fire in any large building with lots of people (such as a shopping mall). In addition to fire extinguishers throughout the building (designed to put out and control small fires) there are usually water pipes, hoses and standpipe connections. As with any emergency in a location with large numbers of people, preparations to deal with injuries and casualties are necessary.

Bomb Threats

The emergency plan includes a section on bomb threats, both in the terminal and on-board an aircraft. In the terminal, suspicious or unattended baggage is treated seriously. Large international airports usually have personnel and equipment on site to respond. Many state-of-the-art baggage screening systems have isolation chambers that suspicious baggage can be routed to. This chamber is designed to contain an explosion and prevent injuries and damage.

In Canada, making a false declaration that could jeopardize the safety or security of an aircraft or aerodrome can result in a fine up to $5 000.

Medical Crises

Heart attacks, panic attacks and allergic reactions are common in areas where large numbers of people congregate. Large aerodromes have paramedics on site to deal with medical crises. Small aerodromes must ensure that aerodrome personnel have the appropriate first aid qualifications and training to deal with common crises until paramedics can arrive. Advances in technology have resulted in the development of Automated External Defibrillators (AEDs). These machines make it possible for non-medical personnel to restore heart rhythms to help save lives.

CONFIRMATION OF TEACHING POINT 2

QUESTIONS

Q1. Who can help aerodrome ARFF units respond to emergencies?

Q2. How much could you be fined for making a false declaration that jeopardizes safety or security?

Q3. What machine can help increase the survival rate of heart attack victims?

ANTICIPATED ANSWERS

A1. Local ERS.

A2. $5 000.

A3. AED.

Teaching Point 3	**Explain Components of Aerodrome Site Security**
Time: 5 min	Method: Interactive Lecture

AERODROME SECURITY DEFINITIONS

Hand out a copy of Annex I to each cadet.

Restricted Area. A portion of an aerodrome where access is only granted to authorized persons.

Restricted Area Access Point. A location in a security barrier at which a control system is in place that controls access to a restricted area from a non-restricted area.

Screening. The checking, identification, observation, inspection or authorized search of persons, goods and other things in the possession or control of persons.

Security Barrier. A physical structure or natural feature used to prevent or deter access by unauthorized persons to a restricted area.

Sterile Area. A restricted area, including any passenger loading bridges attached to it. It is used to separate passengers who have been screened, or are exempt from screening, and other authorized persons from unauthorized persons at the aerodrome.

RESTRICTED AREAS

All aircraft movement areas (runways, taxiways and aprons) are restricted areas and only those who are authorized have access to these areas. Restricted areas also exist inside the terminal building. The area used by passengers between the time they are screened and the time they board the aircraft is a restricted area (specifically a sterile area). Other areas inside the terminal building that will be a restricted area include:

- aerodrome and airline operations,
- baggage-handling areas,
- ATC, and
- emergency response.

FENCES

The fences most commonly used as security measures at an aerodrome are chain-link fences erected around the perimeter of the aircraft movement areas. Access through the fence is provided by gates for vehicles and people or through buildings adjacent to the movement areas.

GATES

The gates found in aerodrome fencing can be categorized in several ways: routine, emergency, or occasional access points and vehicle or personnel access points. Additionally, they can be operated manually or mechanically. Gates designed to be operated mechanically should also be able to be opened manually in case of electrical failure. In all cases, a gate that remains open can become a major security problem.

CONFIRMATION OF TEACHING POINT 3

QUESTIONS

Q1. What is a restricted area?

Q2. In addition to identity, what must be confirmed prior to allowing access to a restricted area?

Q3. How can gates be operated?

ANTICIPATED ANSWERS

A1. A portion of an aerodrome where access is only granted to authorized persons.

A2. Authorization.

A3. Manually or mechanically.

Teaching Point 4	Explain Security Requirements at Different Types of Aerodromes
Time: 5 min	Method: Interactive Lecture

INTERNATIONAL AND REGIONAL AERODROMES

The security requirements at international and regional aerodromes are governed by Part Three–Aerodrome Security of the Canadian Aviation Security Regulations (CASR). It details identity verification systems and restricted area pass control. CASR Part Three requires that:

- access to restricted areas be controlled by an identity verification system;
- restricted area passes are only issued to those that require them on an ongoing basis, and deactivated when they are no longer required; and
- restricted areas can only be accessed through a restricted area access point.

MUNICIPAL AND PRIVATE AERODROMES

The measures that are implemented depend on the resources available, the types of security risks expected by the aerodrome operator and the level of risk that the aerodrome operator is willing to accept. Most aerodromes of this type will implement measures such as fences, gates, signs and locked doors to prevent unauthorized persons from inadvertently accessing restricted areas. Aerodromes with more resources and those that anticipate a higher degree of security related risks and incidents will implement more formal and stringent procedures.

CONFIRMATION OF TEACHING POINT 4

QUESTIONS

Q1. What part of the CASR pertains only to international and regional airports?

Q2. How can access to restricted areas be controlled?

Q3. Where can a restricted area be accessed?

ANTICIPATED ANSWERS

A1. CASR Part Three – Aerodrome Security.

A2. By an identity verification system.

A3. At a restricted area access point.

Teaching Point 5	Explain the Role of the Canadian Air Transport Security Authority (CATSA)
Time: 5 min	Method: Interactive Lecture

CANADIAN AIR TRANSPORT SECURITY AUTHORITY (CATSA)

CATSA's mandate is to protect the public by securing critical elements of the air transportation system as assigned by the government. CATSA was established in April 2002 as part of a comprehensive aviation security initiative. It is a crown corporation that reports to Parliament through the Minister of Transportation. CATSA's many responsibilities include pre-board screening of passengers and their belongings (PBS), hold baggage screening (HBS) and non-passenger screening (NPS).

Updated information on the role and mandate of CATSA can be found at http://www.catsa-acsta.gc.ca.

Pre-Board Screening (PBS)

Distribute the list of permitted and prohibited carry-on items. The list of prohibited items and dangerous goods changes from time to time. An updated list can be obtained from http://www.catsa-acsta.gc.ca/english/travel_voyage/list.shtml.

Passengers and carry-on baggage must pass through screening devices before entering the sterile area. These devices provide a way for screening officers to identify passengers and baggage that should be subjected to a more thorough search. Objects that are not permissible can also be identified with these devices. Passengers and baggage may also be selected at random for a more in-depth search.

Hold Baggage Screening (HBS)

HBS is the screening of checked baggage using explosives detection systems at aerodromes. In 2006 CATSA announced full deployment of HBS at 89 airports across Canada. This state-of-the-art baggage system is multi-level and involves the screening of all checked baggage. HBS is in effect for all domestic and international flights.

Non-Passenger Screening (NPS)

CATSA screens individuals, goods and possessions requiring access to the restricted areas at aerodromes where it is responsible for screening services. Flight crews and airport workers such as caterers, maintenance workers and baggage handlers are randomly selected for screening at Canada's 29 largest airports. Over 1 000 screenings of non-passengers and any goods or possessions occur nationally, at random, on a daily basis.

CONFIRMATION OF TEACHING POINT 5

QUESTIONS

Q1. What does PBS stand for?

Q2. What does HBS stand for?

Q3. What does NPS stand for?

ANTICIPATED ANSWERS

A1. Pre-board Screening.

A2. Hold Baggage Screening.

A3. Non-passenger Screening.

END OF LESSON CONFIRMATION

QUESTIONS

Q1. What are two common types of extinguishing agents carried by ARFF vehicles?

Q2. What is a restricted area?

Q3. What are three types of medical crises that are common where large numbers of people congregate?

ANTICIPATED ANSWERS

A1. Water and foam.

A2. A portion of an aerodrome where access is only granted to authorized persons.

A3. Heart attacks, panic attacks and allergic reactions.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

N/A.

CLOSING STATEMENT

Emergency response and aerodrome security are both necessary to ensure the safety of the travelling public. Both of these areas are complex, with challenges and solutions constantly evolving.

INSTRUCTOR NOTES/REMARKS

N/A.

REFERENCES

C2-044 Transport Canada. (2007). *Aeronautical Information Manual*. Retrieved October 2, 2007, from http://www.tc.gc.ca/publications/EN/TP14371/PDF/HR/TP14371E.PDF.

C3-098 Canadian Air Transport Security Authority. (2007). *Mandate*. Retrieved October 10, 2007, from http://www.catsa-acsta.gc.ca/English/about_propos/mandat.shtml.

C3-148 (ISBN 0-9739866-0-3) Syme, E. R., & Wells, A. T. (2005). *Airport Development, Management and Operations in Canada: Second Edition*. Barrie, ON: Aviation Education Services.

ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL THREE

INSTRUCTIONAL GUIDE

SECTION 6

EO C360.06 – EXPLAIN ASPECTS OF AIR TRAFFIC SERVICES (ATS)

Total Time:	30 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-803/PG-001, Chapter 4. Specific uses for said resources are identified throughout the instructional guide within the TP for which they are required.

Review the lesson content and become familiar with the material prior to delivering the lesson.

Photocopy the handouts located at Annexes J and K for each cadet.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

An interactive lecture was chosen for TPs 1 and 3 to clarify, emphasize and summarize aspects of ATS.

An in-class activity was chosen for TP 2 as this is an interactive way to reinforce the difference between ATC clearances and ATC instructions.

INTRODUCTION

REVIEW

N/A.

OBJECTIVES

By the end of this lesson the cadet shall have explained aspects of ATS.

IMPORTANCE

It is important for cadets to know that ATS is the provision of control and information services and that it is required to maintain a safe and efficient air transport system. Personnel working at an aerodrome need to be aware of the types of services provided at the aerodrome and to be prepared to communicate with the appropriate ATS unit to ensure smooth and safe operations.

Teaching Point 1	**Explain Types of ATS**
Time: 10 min	Method: Interactive Lecture

AIR TRAFFIC SERVICES (ATS)

A wide variety of services are provided to pilots and aircraft. Control and information services are both included in this category.

Air Traffic Control (ATC)

ATC service has been established primarily for the prevention of collisions and the efficient flow of traffic. The provision of ATC service will take precedence over the provision of flight information services. ATC service ensures separation between aircraft, especially those that are operating under instrument meteorological conditions (IMC). ATC service is provided to aircraft during all phases of flight and on the ground at busy aerodromes.

Information Services

Information that could be relevant to the safety of a flight is provided to pilots as it becomes available. Sometimes, ATC service suggestions are included. It is up to the pilot to make decisions based on a suggestion. Information provided includes:

- severe weather conditions along the proposed route of flight,
- changes in the serviceability of navigation aids,
- weather conditions reported or forecasted at destination or alternate aerodromes,
- changes in the serviceability of navigation aids,
- condition of airports and associated facilities, and
- other items considered pertinent to the safety of the flight.

Advisory Services

At uncontrolled aerodromes, the information listed below is provided by advisory services (if appropriate) during initial aerodrome advisory communications:

- active or preferred runway,
- wind direction and speed,
- air traffic that warrants attention,
- vehicle traffic,
- wake turbulence cautionary,
- aerodrome conditions,
- weather conditions, and
- additional information of interest for the safety of flight.

Alerting Services

When an aircraft declares an emergency, alerting services notifies the appropriate agency to provide emergency standby services. If an aircraft becomes overdue, search and rescue (SAR) agencies can be notified. Alerting a responsible authority of any unlawful interference (hijack), bomb threat or inability to communicate is also included in this service.

Briefing Services

Briefing services, provided by flight service specialists, consult on meteorological and aeronautical information to assist pilots in pre-flight planning. The flight service specialist adapts meteorological information, including satellite and radar imagery, to fit the needs of flight crew members and operations personnel and provides consultation and advice on special weather problems.

Notice to Airmen (NOTAM) Services

NOTAM services collect information from pilots, aerodrome operators and aeronautical facilities operators and distribute as required and requested. This includes Runway Surface Condition (RSC) reports and Canadian Runway Friction Index (CRFI) information.

Distribute photocopies of Annex J to the cadets.

CONFIRMATION OF TEACHING POINT 1

QUESTIONS

Q1. What type of ATS has priority over provision of flight information services?

Q2. What type of service provides such information as active or preferred runway, wind direction and speed, air traffic and vehicle traffic?

Q3. What type of service assists pilots with flight planning?

ANTICIPATED ANSWERS

A1. ATC service.

A2. Advisory service.

A3. Briefing service.

Teaching Point 2	**Explain the Difference Between an ATC Clearance and an ATC Instruction**
Time: 10 min	Method: In-Class Activity

ACTIVITY

OBJECTIVE

The objective of this activity is to allow the cadets to explain the difference between an ATC clearance and an ATC instruction.

RESOURCES

- One sheet of paper for each cadet, and

- Pens/pencils.

ACTIVITY LAYOUT

N/A.

ACTIVITY INSTRUCTIONS

1. Distribute one handout of Annex K to each cadet.
2. Organize the cadets into groups of four.
3. Explain to the cadets the following definitions:

   (a) **ATC Clearance.** An authorization from ATC for a pilot to proceed with a specific action (eg, takeoff or landing) or along a specific route.

> Whenever an ATC clearance is received and accepted by the pilot, compliance shall be made with the clearance. If a clearance is not acceptable, the pilot should immediately inform ATC of this fact as acknowledgement of the clearance alone will be taken by a controller as indicating acceptance. A clearance will be identified by the use of the word "clear" in its contents. Example of clearances are:
>
> "You are cleared to the circuit".
>
> "You are cleared for take off on runway two niner".

   (b) **ATC Instruction.** A directive from ATC to do something specific (eg, maintain 5 000 feet).

> A pilot shall comply with an ATC instruction that is directed to and received by the pilot, provided the safety of the aircraft is not jeopardized. An instruction will always be worded in such a manner as to be readily identified, although the word "instruct" will seldom be included. Pilots shall comply with and acknowledge receipt of all ATC instructions directed to and received by them. An example of an instruction would be:
>
> "Hold on taxiway".
>
> "Climb to and maintain one three thousand".

4. Have each group write down examples of ATC clearances or an ATC instructions that might be given to a person operating an aircraft at an aerodrome.
5. Read out each group's ATC clearance/instruction and have the class identify it as a clearance or instruction.
6. Continue until all of the ATC clearances/instructions have been read or time runs out.

SAFETY

N/A.

CONFIRMATION OF TEACHING POINT 2

The cadets' participation in the ATC clearance and ATC instruction activity will serve as the confirmation of this TP.

Teaching Point 3	Explain the Functions of ATC
Time: 5 min	Method: Interactive Lecture

AREA CONTROL CENTRES (ACCS)

Area control service is provided by ACCs to flights operating within specified control areas. These areas typically consist of high level airspace and serve aircraft operating in the en route phase of flight. Information and advisory services are provided when workloads permit.

TERMINAL CONTROL UNITS (TCUS)

Terminal control service is provided by TCUs to flights operating within specified control areas surrounding major aerodromes. The primary purpose is to provide arrival and departure control to aircraft as they transition from the takeoff or landing phase to the en route phase. This type of ATC unit is responsible for sequencing aircraft to ensure an efficient flow of traffic to and from an aerodrome.

CONTROL TOWERS

Control towers are located at busy aerodromes to provide ATC services to aircraft during takeoff and landing. Control of aircraft on the ground is also provided. Workloads in most control towers do not usually permit the provision of information and advisory services so aircraft will obtain the required information from another ATS unit on a different frequency or by telephone before making contact with the control tower.

FLIGHT SERVICE STATIONS (FSSS)

FSSs provide information, advisory, alerting, briefing and NOTAM services. FSSs are responsible for large areas and provide service for all of the aerodromes in their area. Remote communications systems allow flight service specialists to communicate via radio to aircraft and vehicles hundreds of kilometres away.

FSSs are the initial point of contact for pilots during the pre-flight planning stage. They play a key role in the collection and distribution of NOTAMs. FSSs can be contacted by pilots via radio when in the air (and on the ground where remote communications facilities exist) or by telephone.

Vehicle control service at uncontrolled aerodromes with a mandatory frequency is provided by a FSS. The FSS may be hundreds of kilometres away and providing this service to multiple aerodromes. Personnel operating vehicles at aerodromes in this situation must pay close attention to this fact and be very clear and concise about their intentions and location.

CONFIRMATION OF TEACHING POINT 3

QUESTIONS

Q1. Which unit provides control to aircraft and vehicles on the ground at busy aerodromes?

Q2. Which unit provides control services to aircraft arriving and departing a controlled aerodrome?

Q3. Which unit plays a key role in the provision of NOTAM services?

ANTICIPATED ANSWERS

A1. Control tower.

A2. TCU.

A3. FSS.

END OF LESSON CONFIRMATION

QUESTIONS

Q1. What type of ATS has priority over the provision of flight information services?

Q2. Which ATC communication must a pilot obey provided the safety of the aircraft is not jeopardized?

Q3. What type of service assists pilots with flight planning?

ANTICIPATED ANSWERS

A1. ATC.

A2. An ATC instruction.

A3. Briefing service.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

N/A.

CLOSING STATEMENT

ATS provides the control and information services that support safe operation at busy aerodromes. Personnel working at an aerodrome need to be aware of the types of services provided at the aerodrome and be prepared to communicate with the appropriate ATS unit.

INSTRUCTOR NOTES/REMARKS

N/A.

REFERENCES

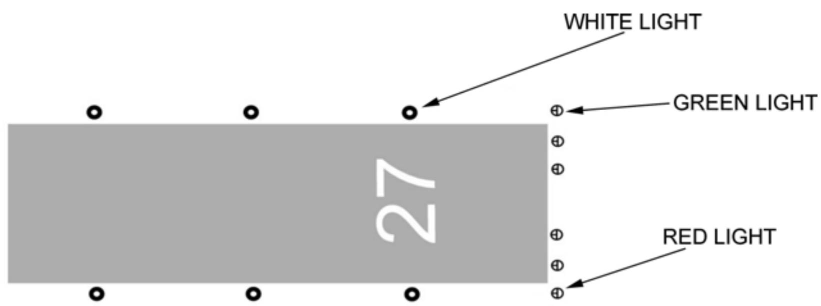
C2-044 Transport Canada. (2007). *Aeronautical Information Manual*. Retrieved October 2, 2007, from http://www.tc.gc.ca/publications/EN/TP14371/PDF/HR/TP14371E.PDF.

MANOEUVRING LIGHTING

RUNWAY LIGHTING

Edge lights are located along the runway. These lights are white in colour (white light bulb with a clear lens) and provide assistance in identifying the edge of the runway. The lights are spaced evenly along each edge with no more than 60 m (200 feet) between the lights. Each row of lights is the same distance from the runway centreline and may be located along the edge of the runway or no more than 1.5 m away from the edge, except in areas that experience significant accumulations of snow. In areas that experience significant accumulations of snow, edge lights may be placed up to 3 m from the runway edge.

The edge lights that cross the beginning of a runway are green while the lights at the end of a runway are red. This is accomplished by using a two-colour filter under the lens. The red side is located on the runway side so that when an aircraft is on the runway looking at the light, a red light is visible. The green filter is on the other side so that when the aircraft is approaching the runway, a green light is visible.



Director Cadets 3, 2007, Ottawa, ON: Department of National Defence

Figure 16A-1 Runway Lighting

TAXIWAY LIGHTING

Edge lights are placed along taxiways in the same way edge lights are placed along runways. The maximum spacing remains at 60 m (200 feet) and will be closer together along a curved section than along a straight section. Taxiway edge lights are blue in colour. The blue colour is created by using a blue lens instead of a clear lens.

Where a taxiway intersects a runway, two blue lights are placed on each side of the taxiway, adjacent to the runway, to indicate the intersection.

APRON LIGHTING

Apron edge lights are yellow in colour (created by using a yellow lens). Where a taxiway intersects an apron, two yellow lights are placed on each side of the taxiway, adjacent to the apron, to indicate the intersection.

Light Location	**Colour**
Runway Edge Lights	White
Taxiway Edge Lights	Blue
Apron Edge Lights	Yellow
Runway/Taxiway Intersection	Two blue
Taxiway/Apron Intersection	Two yellow
Runway Threshold (end of runway side)	Red
Runway Threshold (start of runway side)	Green

Director Cadets 3, 2007, Ottawa, ON: Department of National Defence

Figure 16A-2 Runway Lighting Colours

UNSERVICEABLE AREA MARKINGS

Certain ground markings indicate the status of aerodromes and pilots are required to comply with these markings.

A large cross, either white or yellow and at least 6.1 m in length, displayed at each end of a runway or taxiway indicates that that runway or taxiway is unserviceable. For night operations, any unserviceable portion of a runway is closed off by placing red lights at right angles to the centerline across both ends. In addition, the runway lights for the unserviceable area are turned off.

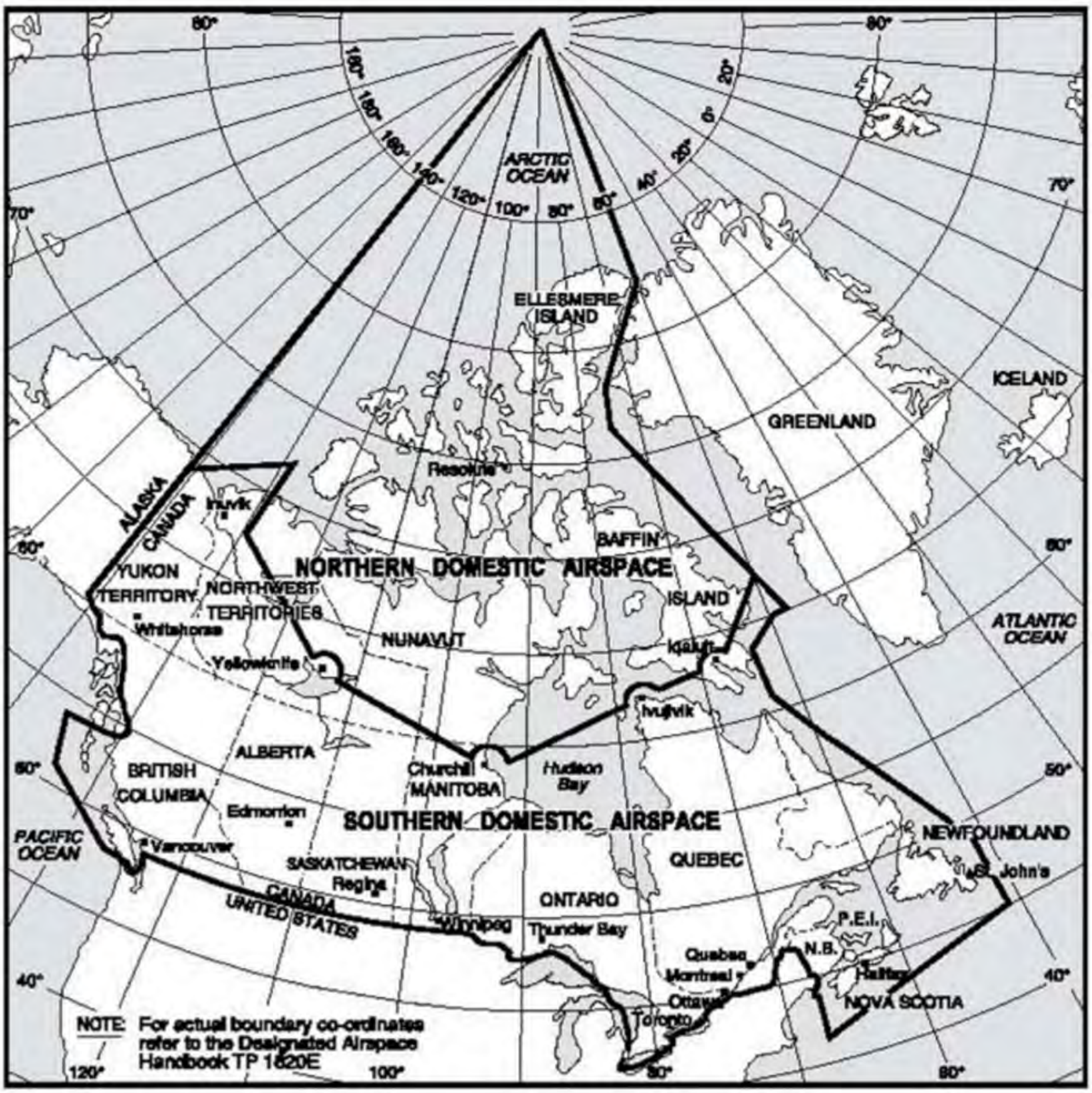
If an unserviceable portion of any manoeuvring area or taxiway is small enough that it can be bypassed by an aircraft with safety, red flags are used to outline the area. At night, the area is marked with red lights – sometimes flashing.

APPROACH LIGHTING SYSTEM (ALS)

An ALS provides additional guidance to aid a pilot in finding the beginning of the runway during periods of low visibility. These lights are used as part of an instrument landing system (ILS) and aid the pilot in transitioning from the instrument portion of the approach to the visual portion.

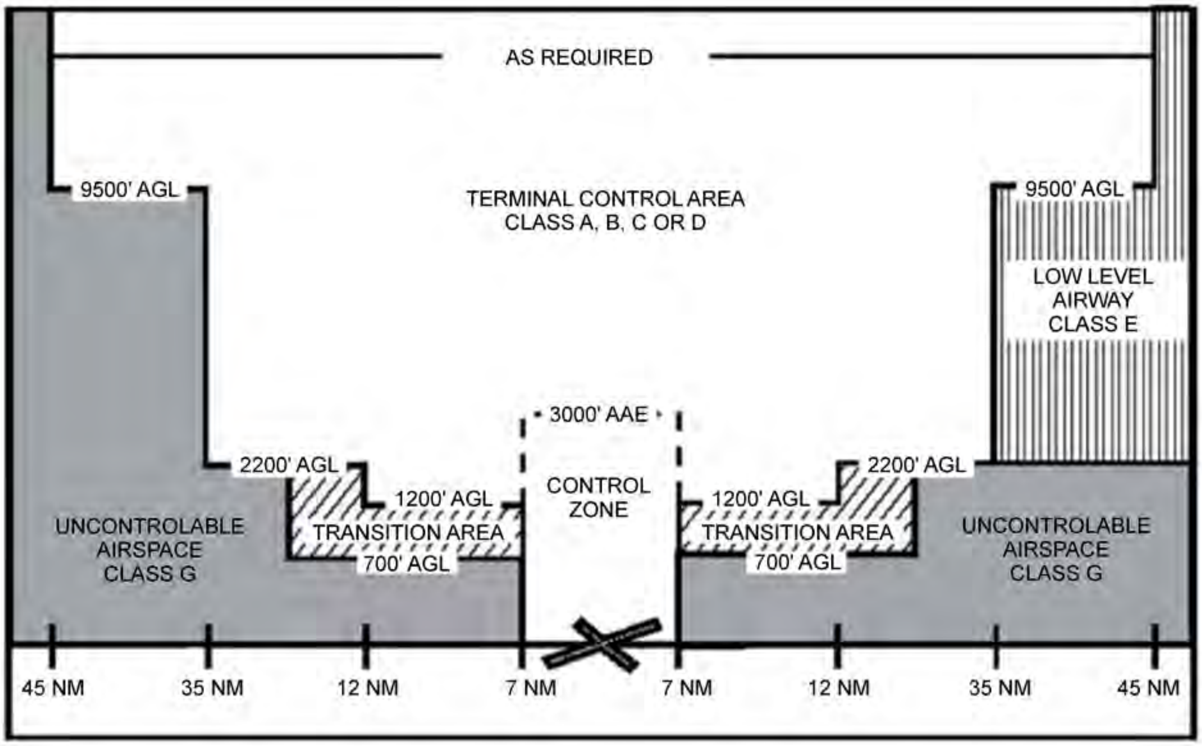
The aerodrome operator must ensure that the systems are working properly by inspecting them on a regular basis. During the winter, the snow around the systems must be cleared to keep them visible.

CANADIAN DOMESTIC AIRSPACE



Aeronautical Information Manual, Ottawa, ON: Her Majesty the Queen in Right of Canada (p. 182)

Figure 16B-1 Boundaries of CDA, NDA, and SDA



Aeronautical Information Manual, Ottawa, ON: Her Majesty the Queen in Right of Canada (p. 186)

Figure 16B-2 Typical Airspace Surrounding an Aerodrome

AIRSPACE CLASSIFICATIONS

CDA is divided into seven classes, each identified by a single letter: A, B, C, D, E, F, or G. Flight within each class is governed by specific rules applicable to that class.

CLASS A

Class A airspace is designated where an operational need exists to exclude VFR aircraft. All operations must be conducted under IFR and are subject to Air Traffic Control (ATC) clearances and instructions. An ATC clearance gives authorization to proceed within controlled airspace and an ATC instruction is a directive issued by an ATC unit for air traffic control purposes.

All high level controlled airspace is designated as Class A.

CLASS B

Class B airspace is designated where an operational need exists to provide air traffic control service to IFR and to control VFR aircraft.

All low level controlled airspace above 12 500 feet ASL or at and above the minimum en route altitude (MEA), whichever is higher, up to but not including 18 000 feet ASL will be Class B airspace. Control zones and associated terminal control areas may also be classified as Class B airspace.

CLASS C

Class C airspace is controlled airspace in which both IFR and VFR flights are permitted.

Airspace classified as Class C becomes Class E airspace when the appropriate ATC unit is not in operation. Terminal control areas and associated control zones may be classified as Class C airspace.

CLASS D

Class D airspace is controlled airspace in which both IFR and VFR flights are permitted, but VFR flights must establish two-way communication with the appropriate ATC agency prior to entering the airspace.

Airspace classified as Class D becomes Class E airspace when the appropriate ATC unit is not in operation. A terminal control area and associated control zone could be classified as Class D airspace.

CLASS E

Class E airspace is designated where an operational need exists for controlled airspace but does not meet the requirements for Class A, B, C, or D.

Low level airways, control area extensions, transition areas, or control zones established without an operating control tower may be classified as Class E airspace.

CLASS F

Class F airspace is an area in which activities must be restricted, or limitations imposed upon aircraft operations that are not a part of those activities. Typical uses for Class F airspace include:

- military practice areas,
- fire-bombing,
- parachute jumping,
- flight training,
- soaring,
- hang gliders, and

- air shows.

Class F airspace is sometimes known as special use airspace. It may be classified as Class F advisory, or as Class F restricted, and can be controlled airspace, uncontrolled airspace, or a combination of both.

CLASS G

Class G airspace is airspace that has not been designated Class A, B, C, D, E or F and in which ATC has neither the authority or responsibility for exercising control over air traffic.

To help remember:

- Classes A to E are controlled airspace,
- Class F may be controlled or uncontrolled, and
- Class G airspace is uncontrolled.

The difference between Class C and Class D is that an ATC clearance is needed to enter Class C, but two-way communication is all you need to enter Class D.

AIRSPACE MODEL CONSTRUCTION CHECKLIST

Use this as a guide to ensure that your model has all the required components. As you add each component to the model, you can check it off the list. If you add something to the model that is not on the list below, write it in the extra spaces provided.

Primary runway

Secondary runway

Control zone

Terminal control area

Transition area

____

____

____

____

____

____

____

____

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VEHICLES USED AT AN AERODROME

Enfield Auto Body, Major Clients and Services. Retrieved November 15, 2007, from http://www.enfieldautobody.com/majorclients.htm

Figure 16E-1 Pickup Truck Used at an Aerodrome

NRRA, Airport Vehicles. Retrieved November 15, 2007, from http://www.nrairport.com/equipment/airport_vehicles.htm

Figure 16E-2 Dump Truck Used at an Aerodrome

Bosserman Aviation Equipment, New Refuelers. Retrieved November 19, 2007, from http://www.bossermanaviationequip.com/refuelers.htm

Figure 16E-3 Mobile Tanker Used at an Aerodrome

Sioux Gateway Airport, Photo Gallery. Retrieved November 15, 2007, from http://www.flysiouxgateway.com/index.php/gallery/image_full/107/

Figure 16E-4 A Snowplow Used at an Aerodrome

Chisholm/Hibbing, 2007, Airport Deicing Service, Copyright 2007 by Chisholm/Hibbing Airport. Retrieved November 15, 2007, from http://www.hibbingairport.com/services/deicer.php

Figure 16E-5 A De-Icing Truck Used at an Aerodrome

Stinar Corporation, Stinar Lavatory and Water Trucks. Retrieved November 19, 2007, from http://www.stinar.com/lav_water_trucks.shtml

Figure 16E-6 A Ground Servicing Truck (Potable Water) Used at an Aerodrome

NRRA, Airport Vehicles. Retrieved November 15, 2007, from http://www.nrairport.com/equipment/airport_vehicles.htm

Figure 16E-7 Front Mounted Sweeper

Viking Cives, Photo Gallery. Retrieved November 16, 2007, from http://vcl.vikingcives.com/ViewPage.aspx?pg=35

Figure 16E-8 One-Way Snowplow Blade Mounted on a Truck

Patria, Airport Equipment. Retrieved November 16, 2007, from http://patria.fi/products/PatriaProductsPublic/search.aspx?selectedcategory=CD498

Figure 16E-9 Two-Way Snowplow Blade Mounted on a Special Chassis

NRRA, Airport Vehicles. Retrieved November 15, 2007, from http://www.nrairport.com/equipment/airport_vehicles.htm

Figure 16E-10 Front Mounted Snow Blower (Mounted on a Tractor)

Eagle Airfield, Used Equipment Inventory. Retrieved November 16, 2007, from http://www.eagleairfield.com/Used.html

Figure 16E-11 Self-Propelled Snow Blower

Velcon Canada, 2003, Engineered Products and Systems, Copyright 2003 by Velcon Canada.
Retrieved November 19, 2007, from http://www.velconcanada.ca/specialprojects.html

Figure 16E-12 Above Ground Tank and Refuelling Cabinet

Velcon Canada, 2003, Engineered Products and Systems, Copyright 2003 by Velcon Canada. Retrieved November 19, 2007, from http://www.velconcanada.ca/specialprojects.html

Figure 16E-13 Refuelling Cabinet

Bosserman Aviation Equipment, New Refuelers. Retrieved November 19, 2007, from http://www.bossermanaviationequip.com/refuelers.htm

Figure 16E-14 Mobile Tanker

VEHICLE IDENTIFICATION

Match the pictures with the most correct name or purpose. Each picture has a matching name and a matching purpose. Not all names or purposes have a matching picture.

A

B

C

D

E

F

Name

________ Pickup truck

________ Snowplow

________ Fire truck

________ De-icing truck

________ Ground servicing truck

________ Mobile tanker

________ Dump truck

________ Aircraft tow tractor

________ Snow blower

Purpose

________ Push snow.

________ Respond to aircraft emergencies.

________ Spray aircraft to remove/prevent ice.

________ Move aircraft around on apron.

________ Blow snow.

________ Deliver supplies to aircraft on the apron.

________ General aerodrome use.

________ Carry loads of snow and grit.

________ Deliver fuel to aircraft.

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ANSWER KEY

A

B

C

D

E

F

	Name
F	Pickup truck
B	Snowplow
	Fire truck
D	De-icing truck
C	Ground servicing truck
A	Mobile tanker
E	Dump truck
	Aircraft tow tractor
	Snow blower

	Purpose
B	Push snow.
	Respond to aircraft emergencies.
D	Spray aircraft to remove/prevent ice.
	Move aircraft around on apron.
	Blow snow.
C	Deliver supplies to aircraft on the apron.
F	General aerodrome use.
E	Carry loads of snow and grit.
A	Deliver fuel to aircraft.

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ARFF TRUCK

Oshkosh Truck Corporation, 2007, Striker 4500, Copyright 2007 by Oshkosh Truck Corporation. Retrieved November 28, 2007, from http://www.oshkoshtruck.com/pdf/Oshkosh_Striker4500.pdf

Figure 16H-1 ARFF Truck

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AERODROME SECURITY DEFINITIONS

Restricted Area. A portion of an aerodrome where access is only granted to authorized persons.

Restricted Area Access Point. A location in a security barrier at which a control system is in place that controls access to a restricted area from a non-restricted area.

Screening. The checking, identification, observation, inspection or authorized search of persons, goods and other things in the possession or control of persons.

Security Barrier. A physical structure or natural feature used to prevent or deter access by unauthorized persons to a restricted area.

Sterile Area. A restricted area, including any passenger loading bridges attached to it. It is used to separate passengers who have been screened, or are exempt from screening, and other authorized persons from unauthorized persons at the aerodrome.

RESTRICTED AREAS

All aircraft movement areas (runways, taxiways and aprons) are restricted areas and only those who are authorized have access to these areas. Restricted areas also exist inside the terminal building. The area used by passengers between the time they are screened and the time they board the aircraft is a restricted area (specifically a sterile area). Other areas inside the terminal building that will be a restricted area include:

- aerodrome and airline operations,
- baggage-handling areas,
- ATC, and
- emergency response.

FENCES

The fences most commonly used as security measures at an aerodrome are chain-link fences erected around the perimeter of the aircraft movement areas. Access through the fence is provided by gates for vehicles and people or through buildings adjacent to the movement areas.

GATES

The gates found in aerodrome fencing can be categorized in several ways: routine, emergency, or occasional access points and vehicle or personnel access points. Additionally, they can be operated manually or mechanically. Gates designed to be operated mechanically should also be able to be opened manually in case of electrical failure. In all cases, a gate that remains open can become a major security problem.

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EXAMPLE OF A NOTAM FILE

Aerodrome NOTAM file CYYZ

070620 CYYZ TORONTO/LESTER B.PEARSON INTL
CYYZ RWY 15L/33R CLSD DUE CONST DLY 1230/2230 0711291230 TIL 0711302230

061070 CYYZ TORONTO/LESTER B.PEARSON INTL
CYYZ THR 23 DISPLACED 685 FT (200 FT BEYOND PUB DISPLACEMENT OF 485 FT) DUE OBST 615 FT NE OF THR 23, 38 FT AGL, 592 MSL. MARKED BY ORANGE MARKERS AND WING BAR LGT EITHER SIDE OF RWY. FOR RWY 23 DEP, ACFT REQUIRING FULL LEN MUST NOTIFY GROUND CTL UPON INITIAL CTC.
DECLARED DIST:
RWY 05: TORA 11120 TODA 11435 ASDA 11120 LDA 10985
RWY 23: TORA 11120 TODA 12120 ASDA 11120 LDA 10435
CAP 4 ILS OR NDB RWY 23 TCH TO READ 45 FT VICE 55 FT
TIL APRX 0712312000

070270 CYYZ TORONTO/LESTER B.PEARSON INTL
CYYZ CRANE 7353 FT BFR THR 15L AND 131 FT LEFT EXTENDED RWY CL, 115 FT AGL 686 MSL LGTD, 1100/2100 DLY 0706091100/0711032100 AND 1200/2200 DLY 0711041200 TIL 0712072200

070449 CYYZ TORONTO/LESTER B.PEARSON INTL
CYYZ AMEND PUB:
6 SMOKE STACKS WITHIN AN AREA BOUNDED BY 434449N 794048W 434448N 794046W 434446N 794049W 434447N 794050W TO POINT OF ORIGIN (CENTRED APRX 5 NM NNW AD) 215 FT AGL 811 MSL.
LGTD, NOT PAINTED

070584 CYYZ TORONTO/LESTER B.PEARSON INTL
CYYZ PARKING AREAS: TML 1:
TAXILANE 9E AND 9W CLSD.
NEW TAXILANE 10 OPN 246 FT/75 M EAST OF TAXILANE 9,
EQUIPPED WITH CL LGT.
UNLGTD OUTER LOOP JOINING TAXILANE 9 TO 10 PAINTED WITH DASHED CL AND RESTRICTED TO ACFT WINGSPAN 118 FT /35.9 M OR LESS.
TIL APRX 0711292000

070592 CYYZ TORONTO/LESTER B.PEARSON INTL
CYYZ CAT III APCH 06L NOT AUTH PENDING INITIAL CERTIFICATION TIL 0802191700

Nav Canada, AWWS - NOTAM Page. Retrieved November 29, 2007, from http://www.flightplanning.navcanada.ca/cgi-bin/CreePage.pl?Langue=anglais&NoSession=NS_Inconnu&Page=Fore-obs%2Fnotam&TypeDoc=htmls

Figure 16J-1 A NOTAM File

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AIR TRAFFIC CONTROL CLEARANCES AND INSTRUCTIONS

Whenever an ATC clearance is received and accepted by the pilot, compliance shall be made with the clearance. If a clearance is not acceptable, the pilot should immediately inform ATC of this fact as acknowledgement of the clearance alone will be taken by a controller as indicating acceptance. A clearance will be identified by the use of the word “clear” in its contents. Example of clearances are:

“You are cleared to the circuit”.

“You are cleared for take off on runway two niner”.

EXAMPLE OF AN ATC CLEARANCE

“Cleared for takeoff on runway zero four.”

Write down an example of an ATC Clearance:

A pilot shall comply with an ATC instruction that is directed to and received by the pilot, provided the safety of the aircraft is not jeopardized. An instruction will always be worded in such a manner as to be readily identified, although the word “instruct” will seldom be included. Pilots shall comply with and acknowledge receipt of all ATC instructions directed to and received by them. An example of an instruction would be:

“Hold on taxiway”.

“Climb to and maintain one three thousand”.

EXAMPLE OF AN ATC INSTRUCTION

“Hold short of taxiway.”

Write down an example of an ATC Instruction:

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CHAPTER 17

PO 370 – RECOGNIZE ASPECTS OF AIRCRAFT MANUFACTURING AND MAINTENANCE

ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL THREE

INSTRUCTIONAL GUIDE

SECTION 1

EO M370.01 – IDENTIFY COMPONENTS OF THE PITOT STATIC SYSTEM

Total Time:	30 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-803/PG-001, Chapter 4. Specific uses for said resources are identified throughout the instructional guide within the TP for which they are required.

Review the lesson content and become familiar with the material prior to delivering the lesson.

Create slides of Annexes A and B.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

An interactive lecture was chosen for this lesson to review, clarify, emphasize, and summarize the pitot static system.

INTRODUCTION

REVIEW

N/A.

OBJECTIVES

By the end of this lesson the cadet shall have identified components of the pitot static system used in aircraft.

IMPORTANCE

It is important for cadets to identify components of the pitot static system because it is an important part of most aircraft. Familiarity with this system will allow cadets to gain an understanding of this common aircraft feature as it applies to both manufacturing and maintenance of aircraft.

Teaching Point 1	**Explain the Pitot Static System**
Time: 10 min	Method: Interactive Lecture

Flight instruments enable an aircraft to be operated with maximum performance and safety. One set of flight instruments, those of the pitot static system, measure and utilize air pressure.

Show the cadets Figure 17A-1.

There are two major parts of the pitot static system:

- the static pressure vent and lines, and
- the pitot pressure, also called impact pressure, chamber and lines.

The static pressure line provides the source of ambient (normal outside) air pressure for the operation of the altimeter, vertical speed indicator, and airspeed indicator, while the pitot pressure, or impact pressure line provides impact pressure to the airspeed indicator. The airspeed indicator is the only instrument that requires both air pressures.

STATIC VENT

The static vent is located where the air flowing past the aircraft will not disturb air pressure. This will vary with each model of aircraft. The static vent provides undisturbed air pressure for the static line.

The openings of the static vent must be checked during the pre-flight inspection to ensure that they are free from obstructions. Blocked or partially blocked openings should be cleaned by a certified mechanic. Blowing into these openings is not recommended because this could damage the instruments.

STATIC LINE

The static line is a hollow tube. Since the static line is vented to the free undisturbed air by the static vent, air pressure in the static line will change as the air pressure around the aircraft changes. As the aircraft gains altitude, air pressure in the static line will drop. This pressure change is transmitted through the static line to the instruments which utilize static air pressure. These instruments include the:

- altimeter,
- vertical speed indicator, and
- airspeed indicator.

PITOT PRESSURE CHAMBER

In the pitot static system, the impact air pressure (air striking the airplane because of its forward motion) is taken from a pitot tube. It is mounted in a location that provides minimum disturbance or turbulence caused by the motion of the aircraft through the air. Often, a pitot tube cover is placed over the pitot tube when the aircraft is parked to prevent foreign objects, such as insects, from entering the pitot static system. It is important that the pitot tube cover, if used, is removed prior to takeoff.

As the aircraft moves through the air, the impact pressure on the open pitot tube affects the pressure in the pitot pressure chamber. Any change of pitot (impact) pressure in the pitot pressure chamber is transmitted through a line connected to the airspeed indicator, which uses impact pressure for its operation.

In some aircraft, the static pressure is obtained at the same location as the pitot pressure. This is done by using a hybrid pitot-static tube. In a pitot-static tube, the static vent is combined with the impact tube. The effects are the same.

Show the cadets Figure 17A-2.

The opening of the pitot tube must be checked during the pre-flight inspection to assure that it is free from obstructions. Blocked or partially blocked openings should be cleaned by a certified mechanic. Blowing into these openings is not recommended because this could damage the instruments.

PITOT LINE

Any change of pressure in the pitot chamber is transmitted through a pitot line (a hollow tube) to the airspeed indicator, which uses impact pressure as well as static pressure for its operation.

OPERATION OF THE PITOT STATIC SYSTEM

As described above, the pitot static system of chambers and lines delivers two types of air pressure to flight instruments:

- static pressure, and
- pitot pressure.

When flight instruments are calibrated correctly, they will measure the air pressure that is delivered to them, relative to air pressure at sea level as well as impact pressure relative to static pressure. By measuring the air pressures in the static pressure and impact pressure lines, the calibrated instruments will present useful information about the aircraft's position to the pilot.

Pitot static instrument error will almost always indicate blockage of the pitot tube, the static port, or both.

CONFIRMATION OF TEACHING POINT 1

QUESTIONS

Q1. What is the pitot static system used for?

Q2. How is static pressure change delivered to the instruments?

Q3. Which instrument measures pitot (impact) pressure?

ANTICIPATED ANSWERS

A1. For operating instruments that measure and use air pressure.

A2. It is delivered through lines.

A3. The airspeed indicator.

Teaching Point 2 — **Explain Instruments of the Pitot Static System**

Time: 15 min — Method: Interactive Lecture

AIRSPEED INDICATOR

Show the cadets Figures 17B-1 and 17B-2.

The airspeed indicator is a sensitive, differential pressure gauge, which measures and shows the difference between pitot, or impact, pressure and static pressure. These two pressures will be equal when the airplane is parked on the ground in calm air. When the aircraft moves through the air, the pressure in the pitot line becomes greater than the pressure in the static line. This difference in pressure is registered by the airspeed pointer on the face of the instrument, which is calibrated in miles per hour, knots, or both.

As the pressure in the pitot tube and pitot line increases, the diaphragm in the airspeed indicator expands. The diaphragm will then maintain its size while the impact pressure is stable. As the impact pressure decreases, the diaphragm contracts accordingly. This expansion and contraction of the diaphragm is reflected in the readout of the airspeed indicator via a system of gears and shafts.

Prior to takeoff, the airspeed indicator should read zero unless there is a strong wind blowing directly into the pitot tube.

VERTICAL SPEED INDICATOR

Show the cadets Figures 17B-3 and 17B-4.

The vertical speed indicator (VSI), sometimes called a vertical velocity indicator (VVI), indicates whether the airplane is climbing, descending, or in level flight. The rate of climb or descent is indicated in thousands of feet per minute. If properly calibrated, the VSI indicates zero in level flight.

Although the VSI operates solely from static pressure, it measures pressure difference; the pressure now relative to the pressure a moment ago. It contains a diaphragm with connecting linkage and gearing to the indicator pointer inside an airtight case. The inside of the diaphragm is connected directly to the static line of the pitot static system. The area outside the diaphragm, which is inside the instrument case, is also connected to the static line, but through a restricted orifice (calibrated leak).

Both the diaphragm and the case receive air from the static line at existing atmospheric pressure. When the airplane is on the ground or in level flight, the pressures inside the diaphragm and the instrument case remain the same and the pointer indicates zero.

However, when the aircraft climbs or descends, the pressure inside the diaphragm changes immediately, but due to the metering action of the restricted passage, the case pressure remains higher or lower for a short time, causing the diaphragm to contract or expand. This causes a pressure difference that is relative to climb rate and is indicated on the instrument needle as a climb or descent.

ALTIMETER

Show the cadets Figures 17B-5 and 17B-6.

The altimeter measures the height of the aircraft above sea level. Since it is the only instrument that gives altitude information, the altimeter is one of the most vital instruments in the aircraft. However, the altimeter is calibrated with respect to standard atmospheric conditions, while air will actually seldom meet those standard conditions. Variations in atmospheric pressure and temperature will introduce errors into the altimeter's measurements. To use the altimeter effectively, its operation and how atmospheric pressure and temperature affect it must be thoroughly understood.

A stack of sealed aneroid wafers comprises the main component of the altimeter. Aneroid wafers expand and contract with changes in atmospheric pressure, in this case, pressure from the static source. The mechanical linkage translates these changes into pointer movements on the indicator.

The pressure altimeter is an adaptation of an aneroid barometer that measures the pressure of the atmosphere at the level where the altimeter is located and presents it as an altitude indication in feet instead of simple air pressure, as a barometer would. The altimeter uses static pressure as its source of operation. Air is denser at sea level than aloft, so as altitude increases, atmospheric pressure decreases. This difference in pressure at various levels causes the altimeter to indicate changes in altitude.

Since altimeters are calibrated with respect to standard atmospheric conditions as described above, it is necessary to adjust altimeters to non-standard static pressures that result from weather fronts. For example, if flying from a high-pressure area to a low-pressure area without adjusting the altimeter, the actual altitude of the aircraft would be LOWER than the indicated altitude because the altimeter was originally set to compensate for a non-standard high air pressure. Arriving in the low-pressure area, it must be reset to compensate for a non-standard low air pressure.

An old saying, "High to low, look out below" is a way of remembering which condition is most dangerous. When flying from a low-pressure area to a high-pressure area without adjusting the altimeter, the actual altitude of the airplane is HIGHER than the indicated altitude because the altimeter was originally set to compensate for a non-standard low air pressure. Arriving in the high-pressure area, it must be reset to compensate for a non-standard high air pressure.

CONFIRMATION OF TEACHING POINT 2

QUESTIONS

Q1. What does an airspeed indicator measure?

Q2. What does a vertical speed indicator measure?

Q3. What does an altimeter measure?

ANTICIPATED ANSWERS

A1. The difference between static pressure and pitot, or impact, pressure.

A2. The difference between static air pressure now and static air pressure a moment ago.

A3. The difference between static air pressure and a standard air pressure, usually at sea level.

END OF LESSON CONFIRMATION

QUESTIONS

Q1. Which flight instrument measures pitot, or impact pressure?

Q2. Why are pitot tube covers used?

Q3. What is the difference between a pitot tube and a pitot-static tube?

ANTICIPATED ANSWERS

A1. The airspeed indicator.

A2. To prevent blockage of the pitot tube when the aircraft is parked.

A3. A pitot-static tube is a combination of a pitot tube with a static vent.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

N/A.

CLOSING STATEMENT

The pitot static system, which is based on different air pressures, is found on most aircraft. Understanding how the system works allows a pilot or mechanic to use instruments correctly and to diagnose problems that are encountered with pitot static systems.

INSTRUCTOR NOTES/REMARKS

N/A.

REFERENCES

C3-116 (ISBN 0-9680390-5-7) MacDonald, A. F., & Peppler, I. L. (2000). *From the Ground Up: Millennium Edition*. Ottawa, ON: Aviation Publishers Co. Limited.

ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL THREE

INSTRUCTIONAL GUIDE

SECTION 2

EO M370.02 – IDENTIFY AIRCRAFT MANUFACTURERS

Total Time:	30 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-803/PG-001, Chapter 4. Specific uses for said resources are identified throughout the instructional guide within the TP for which they are required.

Review the lesson content and become familiar with the material prior to delivering the lesson.

Update the information located at Annexes C to I using the reference.

Create slides of Annexes C to I.

Prepare the video *Viking Video Profile*. This will be shown in TP 1.

Create slides of aircraft located at Annexes C to H with titles blocked out for use in TP 3.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

An interactive lecture was chosen for TPs 1 and 2 to orient the cadets to aircraft manufacturing companies, give an overview of them and to generate interest.

An in-class activity was chosen for TP 3 as it is an interactive way to allow cadets to test their ability to identify aircraft manufacturers.

INTRODUCTION

REVIEW

N/A.

OBJECTIVES

By the end of this lesson the cadet shall have identified manufacturers of light and heavy aircraft that are commonly found at Canadian aerodromes.

IMPORTANCE

It is important for cadets to identify manufacturers of aircraft as this will enhance their enjoyment of aviation and will help them identify aircraft they observe at Canadian aerodromes.

Teaching Point 1	**Discuss Manufacturers of Light Aircraft**
Time: 15 min	Method: Interactive Lecture

CESSNA AIRCRAFT COMPANY

The Cessna Aircraft Company traces its history to June 1911, when Clyde Cessna, a farmer in Rago, Kansas, built a wood-and-fabric plane and became the first person to build and fly an aircraft between the Mississippi River and the Rocky Mountains.

Over the years since 1911, Cessna has produced many different types of aircraft and many of the models had variations.

Show the cadets the list of Cessna aircraft located at Annex C.

A rented Cessna 172 Skyhawk is often used for air cadet familiarization flying exercises.

Show the cadets Figures 17C-2 to 17C-5, identifying each type of aircraft. Mention that the Cessna 305 is used as a glider tow plane in the Air Cadet Gliding Program.

DIAMOND AIRCRAFT INDUSTRIES

The Diamond story began in 1981 when Hoffmann Flugzeugbau was founded in Friesach, Austria, to produce the newly certified H36 Dimona motorglider. In 1992, the company, then known as Dimona Aircraft, established a full production facility in London, Ont., with a view to supplying the US market with its new aircraft. Later, after modifying its name to Diamond, the company grew into an international manufacturer with over 46 000 sq m of modern production facilities, over 800 employees, five distinct product lines, and facilities on three continents. The company's operation at the London, Ont. airport has over 23 000 sq m of state-of-the-art production facilities to design, build and test aircraft.

Diamond produces a variety of aircraft types, including:

- DA20, a single-engine propeller-driven aircraft,
- DA42, a twin-engine propeller-driven aircraft, and
- D-JET, a single-engine gas turbine fanjet.

Show the cadets the figures located at Annex D, identifying each type of aircraft.

PIPER AIRCRAFT, INC

Originally founded as the Taylor Brothers Aircraft Manufacturing Company in September 1927, the company was renamed Taylor Brothers Aircraft Corporation in April of 1928 and then Piper Aircraft Corporation in November 1937.

Now located at Vero Beach, Florida, Piper's manufacturing capabilities cover a wide variety of fabrication, assembly, paint and inspection processes. The company also designs and builds its own tooling. Piper's engineering design work is also comprehensive, with separate engineering groups responsible for aircraft certification, production support, customer service engineering, product development, engineering administration and test operations.

Show the cadets the figures located at Annex E, identifying each type of aircraft.

VIKING AIR

Viking Air is a manufacturing, maintenance and leasing company located at the Victoria International Airport in Sidney, B.C.

Viking Air, although a very small company by Canadian aviation standards, purchased the type certificates for seven de Havilland heritage aircraft, giving Viking the exclusive right to re-start production for any of these seven de Havilland Canada aircraft types.

Viking Air holds the Type Certificates for the following de Havilland aircraft:

- DHC-1 Chipmunk,
- DHC-2 Beaver,
- DHC-3 Otter,
- DHC-4 Caribou,
- DHC-5 Buffalo,
- DHC-6 Twin Otter, and
- DHC-7 Dash 7.

The DHC-6 Twin Otter and DHC-2 Beaver remain popular in commercial aviation, while the DHC-5 Buffalo continues to serve the CF in a Search and Rescue capacity.

Show the cadets the figures located at Annex F, identifying each type of aircraft.

Show the cadets the six-minute video *Viking Video Profile* (Reference C3-203).

CONFIRMATION OF TEACHING POINT 1

Participation in the aircraft identification activity at the end of this lesson will serve as the confirmation of TP 1.

Teaching Point 2	**Discuss Manufacturers of Heavy Aircraft**
Time: 5 min	Method: Interactive Lecture

AIRBUS

Airbus is one of the world's two leading aircraft manufacturers. The company employs 57 000 people and produces a comprehensive range of heavy commercial aircraft.

Manufacturing, production and sub-assembly of parts for Airbus aircraft are distributed around 16 sites in Europe, with final assembly in Toulouse, France and Hamburg, Germany. Airbus draws on a global network of more than 1 500 suppliers in over 30 countries.

There are also centres for engineering design, sales and customer support in North America; and sales and customer support centres in Japan and China. Airbus has a joint engineering centre in Russia with Kaskol, a Russian aircraft manufacturer.

Around the world, Airbus has 5 spare parts centres, 160 field sites, 3 training centres in Toulouse, Miami and Beijing and one A320 maintenance training centre in Hamburg. Airbus has an agreement with CAE (formerly Canadian Aviation Electronics Ltd.) to provide Airbus-approved training courses in many other sites around the world.

Show the cadets the figures located at Annex G, identifying each type of aircraft.

THE BOEING COMPANY

Headquartered in Chicago, Illinois, Boeing employs more than 150 000 people across the United States and in 70 other countries, with major operations in the Puget Sound area of Washington State, southern California and St. Louis, Missouri.

For more than a century, Boeing has produced a vast number of aircraft types. Some Boeing aircraft had historical significance that extended well beyond aviation; they actually changed the world. For example, America entered the age of jet transport on July 15, 1954, when the Boeing 707 prototype, the model

367-80, made its maiden flight from Renton Field, south of Seattle, Washington. Forerunner of the more than 14 000 Boeing jetliners built afterwards, the prototype, nicknamed the “Dash 80,” served 18 years as a flying test laboratory before it was turned over to the Smithsonian Air and Space Museum in May 1972. The Boeing 707 was a very successful aircraft type.

Show the cadets the Figure 17H-1.

Other popular Boeing aircraft, that are commonly seen, include the:

- Boeing 737,
- Boeing 747,
- Boeing 767, and
- Boeing 777.

Show the cadets the remaining figures located at Annex H, identifying each type of aircraft.

Different aircraft are suitable for different routes, depending on such things as traffic volume. A large carrier such as Air Canada requires a variety of aircraft to suit a variety of applications.

Show the cadets Figure 17I-1.

CONFIRMATION OF TEACHING POINT 2

Participation in the aircraft identification activity at the end of this lesson will serve as the confirmation of TP 2.

Teaching Point 3 — **Conduct an Activity to Allow the Cadets to Test Their Ability to Identify Aircraft Manufacturers**

Time: 5 min — Method: In-Class Activity

ACTIVITY

OBJECTIVE

The objective of this activity is to give the cadets an opportunity to test their ability to identify aircraft manufacturers.

RESOURCES

Pictures of aircraft located at Annexes C to H, with titles blocked out (with sticky notes).

ACTIVITY LAYOUT

N/A.

ACTIVITY INSTRUCTIONS

1. Divide the cadets into two teams on opposite sides of the room.
2. Display a picture of an aircraft discussed during this lesson.
3. Have one team attempt to identify the aircraft and its manufacturer in 10 seconds.
4. Award one point for the aircraft's name and another for the manufacturer.
5. If the first team is unable to name the aircraft or its manufacturer, the second team may try.
6. Award two points for successful aircraft or manufacturer naming by the second team.
7. Alternate the successive pictures and opportunities between the two teams.
8. The team with the most points after five minutes is the winner.

SAFETY

N/A.

CONFIRMATION OF TEACHING POINT 3

Participation in the activity will serve as the confirmation of TP 3.

END OF LESSON CONFIRMATION

Participation in the aircraft identification activity will serve as the confirmation of this lesson.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

N/A.

CLOSING STATEMENT

Aircraft manufacturers, like their product lines, are constantly changing. To make aircraft that can compete in sophisticated markets, the organizations themselves must improve to meet the ever-evolving competition.

INSTRUCTOR NOTES/REMARKS

The manufacturers and the aircraft included in this lesson were chosen because cadets frequently encounter these aircraft. Time limitations prevented more manufacturers and aircraft from being included.

REFERENCES

C3-232 Cessna Aircraft Company. (2008). *Welcome to Cessna.com*. Retrieved February 8, 2008, from http://cessna.com/.

C3-233 Diamond Aircraft Industries. (2008). *Diamond Aircraft*. Retrieved February 8, 2008, from http://www.diamondair.com/mainpage.php.

C3-234 Piper Aircraft, Inc. (2008) *Piper: Freedom of Flight*. Retrieved February 8, 2008, from http://www.newpiper.com/.

C3-235 Viking Air. (2008). *Viking*. Retrieved February 8, 2008, from http://www.vikingair.com/.

C3-236 Airbus. (2008). *Airbus*. Retrieved February 8, 2008, from http://www.airbus.com/en/.

C3-237 Boeing. (2008). *Boeing*. Retrieved February 8, 2008, from http://www.boeing.com/.

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ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL THREE

INSTRUCTIONAL GUIDE

SECTION 3

EO M370.03 – DESCRIBE ROUTINE AIRCRAFT INSPECTION PROCEDURES

Total Time:	30 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-803/PG-001, Chapter 4. Specific uses for said resources are identified throughout the instructional guide within the TP for which they are required.

Review the lesson content and become familiar with the material prior to delivering the lesson.

Create a slide of Annex J.

Photocopy handout of Annex J for each cadet.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

An interactive lecture was chosen for this lesson to orient the cadets to routine aircraft inspections, give an overview of them, and to generate interest.

INTRODUCTION

REVIEW

IAW EO M370.01 (Identify Components of the Pitot Static System, Section 1), the cadet will review the purpose and importance of pitot tubes and static pressure vents.

OBJECTIVES

By the end of this lesson the cadet shall be expected to describe routine aircraft inspection procedures.

IMPORTANCE

It is important for cadets to be able to describe routine aircraft inspection procedures so they may appreciate the attention that must be given to safety in aviation.

Teaching Point 1 **Describe the Pilot's Inspection Prior to Flight**

Time: 10 min Method: Interactive Lecture

An aircraft operating in Canada is subject to inspections that allow the aircraft to operate safely. There are two main types of inspections:

1. inspections performed by the pilot prior to flight, and
2. inspections performed by a certified Aircraft Maintenance Engineer (AME) at designated intervals appropriate to the aircraft.

This inspection overview and all others described in this instructional guide are examples only. Always refer to and follow the recommendations of the manufacturer when carrying out any inspections and procedures. Individual models of aircraft may have special procedures and inspection guidelines that will vary from those described here.

PILOT'S INSPECTION PRIOR TO FLIGHT

Prior to every flight, a pilot completes a thorough inspection of the aircraft.

Overall Appearance of the Aircraft

The pilot stands a short distance away from the aircraft and observes the general overall appearance of the aircraft, looking for obvious defects. This is important because it may indicate large defects that could affect aerodynamics.

Before beginning the walk-around inspection, enter the cockpit and ensure that the aircraft is prepared for inspection, ensuring:

- battery and ignition switches are OFF,
- control locks are REMOVED, and
- landing gear switch is in the gear DOWN position.

Fuselage/Empennage

Inspection of the fuselage/empennage will include:

- baggage compartment: contents properly arranged and secured,
- static air pressure vents: free from obstructions,
- pitot tube: free from obstructions – cover REMOVED,
- conditions of the aircraft covering: missing or loose rivets, cracks, tears, etc.,
- anti-collision and navigation lights: condition,
- avionics antennas: cracks, oil or dirt, proper mounting and damage,
- wheel and tires: cuts, bruises, excessive wear, and proper inflation,
- oleo shock absorber and shock strut: proper inflation and cleanliness,
- wheel well and fairing: general condition and secure,
- limit and position switches: cleanliness and secure, and

- ground safety lock: REMOVED.

Wings

Inspection of the wings will include:

- control surface locks: REMOVED,
- control surfaces: dents, cracks, excess play, condition of hinge pins and bolts,
- covering: missing or loose rivets, cracks, tears, etc,
- wing tip and navigation light: wing tip and light secure and undamaged,
- landing light: condition, cleanliness, secure, and
- stall warning vane: freedom of movement.

Prior to inspection, turn the master switch ON so that the stall warning signal can be checked when the vane is deflected.

Fuel

Inspection of the aircraft fuel systems will include:

- fuel quantity in tank: type and amount of fuel visually checked,
- fuel tank filler cap and fairing covers secure,
- fuel tank vents: clear of obstructions,
- drain valve: free of contaminants (drain fuel into a container to check), and
- drain cocks: operating properly without drips.

Engine/Propeller

Inspection of the engine/propeller will include:

- engine oil quantity: oil sump filled and filler cap and dipstick secured,
- general condition and evidence of fuel and oil leaks,
- cowling, access doors, and cowl flaps: condition checked and all secure,
- carburetor air filter: clean and secure,
- exhaust stacks: no cracks and studs tight,
- spark plugs: terminals secure and clean,
- engine mount: cracks and mounts secure,
- main fuel strainer: free of water or sediment (drain fuel into a container to check),
- cowling and baffle: seals snug and in place for proper engine cooling,
- propeller and spinner: security, oil leakage and condition. No deep nicks or scratches, and
- ground area under the propeller: free of loose stones, cinders, etc.

Instruments Check

Check all instruments for proper reading and, where applicable, fluid levels.

Emergency Locator Transmitter (ELT)

Inspection of the ELT to ensure:

- it is mounted securely,
- tight connections,
- general condition (no corrosion),
- antenna secure,
- annual recertification completed and current,
- battery not time-expired, and
- ELT switch in ARMED position.

Seat Belts

Check that seat belts are secure and in good condition. Secure seat belts in unoccupied seats.

Doors and Windows

Close and secure doors, windows and canopy top.

CONFIRMATION OF TEACHING POINT 1

QUESTIONS

Q1. When does a pilot perform an inspection of the aircraft?

Q2. When does an AME perform an inspection of the aircraft?

Q3. What is an ELT?

ANTICIPATED ANSWERS

A1. Prior to flight.

A2. At designated intervals appropriate to the aircraft.

A3. Emergency Locator Transmitter.

Teaching Point 2	**Describe the Pilot's Cockpit Check Prior to Flight**
Time: 10 min	Method: Interactive Lecture

PILOT'S COCKPIT CHECK PRIOR TO FLIGHT

A systematic and careful cockpit check will be carried out prior to flight. It is extremely important to carry out a thorough pre-flight inspection. Small clues indicating a malfunctioning or damaged component may easily be missed in a hurried pre-flight check. Be vigilant after maintenance, painting or a modification job has been performed on the airplane. It is possible for components to be reinstalled incorrectly.

Written Checklist for the Specific Aircraft Type

The cockpit check will be made deliberately without haste using a written checklist. A definite sequence will be followed, moving clockwise around the cockpit. Each control will be touched and named aloud. Always work from a written checklist, not a memorized list, no matter how small the aircraft.

Show the cadets the slide of Figure 17J-1.

There are many checklists relating to the various phases in the operation of an aircraft: pre-flight, before starting engines, before taxiing, engine run-up, before takeoff, takeoff and climb, cruise, descent, before landing, aborted landing, after landing and after shutdown, as well as checklists relating to emergency situations. Larger aircraft use them all. Whenever checklists are required for an aircraft, they must be used during all phases of the aircraft's operation to which they apply.

Run-Up of the Engine(s)

Position the aircraft into the wind when running up the engine(s) for engine cooling. Open and close the throttle slowly while checking operation, to include:

- oil pressure and temperature,
- RPM at full throttle,
- magneto operation,
- instruments, to include:
  - voltmeter,
  - ammeter,
  - manifold pressure gauge,
  - fuel pressure gauge,
  - tachometer,
  - vacuum, and
  - other instruments as shown on the written checklist;
- carburetor heat,
- fuel mixture control,
- idling speed,
- working engine temperature, and
- other parameters as shown on the written checklist.

Switches

Check switch positions for takeoff as per written checklist (eg, magneto ON, generator ON, anti-collision beacon ON, navigation lights ON, etc).

Flaps Set for Takeoff

Adjust the flaps to the takeoff position when ready for takeoff.

Control Surface Operation

Check freedom of all controls, to include:

- ailerons,

- elevators, and
- rudders.

While moving the control column and rudder pedals, check that the control surfaces are responding in the proper direction of travel. This check is particularly important if the aircraft has undergone maintenance.

ACTIVITY

Time: 5 min

OBJECTIVE

The objective of this activity is to allow the cadets to experience completing a pilot checklist.

RESOURCES

Photocopies of Annex J for each cadet.

ACTIVITY LAYOUT

N/A.

ACTIVITY INSTRUCTIONS

1. Give each cadet a photocopy of Figure 17J-1.
2. Divide the cadets into pairs.
3. Have one cadet, acting as pilot in command (PIC), call out the checklist steps for Pre-flight Inspection Cockpit.
4. Have the second cadet, acting as co-pilot, repeat commands and act out the procedure in any manner that the PIC deems appropriate.
5. Have the cadets trade roles and have the new PIC call out the checklist steps for Before Takeoff.
6. Have the new co-pilot repeat commands and act out the procedure.

SAFETY

N/A.

CONFIRMATION OF TEACHING POINT 2

QUESTIONS

Q1. What is used to guide a cockpit check?

Q2. Why is it important to be vigilant after maintenance, painting or a modification job has been performed on the airplane?

Q3. Why position the aircraft into the wind when running up the engine(s)?

ANTICIPATED ANSWERS

A1. A written checklist.

A2. It is possible for components to be reinstalled incorrectly.

A3. For engine cooling.

Teaching Point 3 — **Discuss an Aircraft's Required Inspections**

Time: 5 min — Method: Interactive Lecture

AN AIRCRAFT'S REQUIRED INSPECTIONS

Certificate of Airworthiness (C of A)

A Transport Canada (TC) C of A can be issued for an aircraft, which fully complies with all standards of airworthiness certification (for its applicable type).

TC regulations require that an aircraft carry its C of A on every flight.

Annual Airworthiness Information Report (AAIR)

The owner of a Canadian aircraft, other than an ultralight aeroplane, must submit an AAIR using the prescribed report form. The aircraft owner will complete the annual report by entering all data required and signing the certification to vouch that the information supplied is correct.

Approved Maintenance Schedules

All Canadian aircraft, other than ultralight or hang gliders, shall be maintained in accordance with an approved maintenance schedule, approved by the Minister of Transport, which meets the Aircraft Equipment and Maintenance Standard.

Approved maintenance schedules shall:

- be based upon data obtained from an approved maintenance review board (MRB) report; or
- where no current MRB report exists, be based upon data obtained from:
  - the current recommendations of the aircraft manufacturer,
  - a maintenance schedule approved by the Minister for use by another operator, or
  - any other data acceptable to the Minister.

CONFIRMATION OF TEACHING POINT 3

QUESTIONS

Q1. When can a C of A be issued?

Q2. How often must an AAIR be submitted?

Q3. Who approves a maintenance schedule?

ANTICIPATED ANSWERS

A1. When an aircraft fully complies with all standards of airworthiness certification (for its applicable type).

A2. Annually.

A3. The Minister of Transport.

END OF LESSON CONFIRMATION

QUESTIONS

Q1. When does a pilot perform an inspection of the aircraft?

Q2. What is used to guide a cockpit check?

Q3. What requires an aircraft to carry its C of A on every flight?

ANTICIPATED ANSWERS

A1. Prior to flight.

A2. A written checklist.

A3. TC regulations.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

N/A.

CLOSING STATEMENT

Safety in aviation requires attention to detail and it can only be successful through careful planning and preparation.

INSTRUCTOR NOTES/REMARKS

N/A.

REFERENCES

C3-116 (ISBN 0-9680390-5-7) MacDonald, A. F., & Peppler, I. L. (2000). *From the Ground Up: Millennium edition*. Ottawa, ON: Aviation Publishers Co. Limited.

ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL THREE

INSTRUCTIONAL GUIDE

SECTION 4

EO C370.01 – IDENTIFY TASKS REQUIRED TO MAINTAIN AIRCRAFT

Total Time:	30 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-803/PG-001, Chapter 4. Specific uses for said resources are identified throughout the instructional guide within the TP for which they are required.

Review the lesson content and become familiar with the material prior to delivering the lesson.

Photocopy handouts located at Annexes K to M for each cadet.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

An interactive lecture was chosen for this lesson to review, clarify, emphasize and summarize the tasks required to maintain aircraft.

INTRODUCTION

REVIEW

N/A.

OBJECTIVES

By the end of this lesson the cadet shall have identified tasks required to maintain aircraft.

IMPORTANCE

It is important for cadets to identify tasks required to maintain aircraft so that they will have an appreciation for the aircraft maintenance industry, including an understanding of safety requirements.

Teaching Point 1	**Discuss Aircraft Maintenance Work**
Time: 10 min	Method: Interactive Lecture

During the early days of aviation it was discovered that flying posed safety hazards. As aviation matured, organizations were formed to develop and enforce safety procedures. Faster aircraft and increasing air traffic became essential parts of Canadian commerce and industry. Air regulations have developed to keep pace with technological and social changes. Each regulation has a purpose and was put in place with the intention of supporting safe aviation.

MAINTENANCE CERTIFICATION

Aircraft maintenance in Canada is regulated by the Canadian Aviation Regulations (CARs). CARs are a compilation of regulatory requirements designed to enhance both safety and the competitiveness of the Canadian aviation industry. Parts I–VIII of the CARs correspond to eight broad areas of aviation:

- Part I – General Provisions,
- Part II – Aircraft Identification and Registration,
- Part III – Aerodromes, Airports and Heliports,
- Part IV – Personnel Licensing and Training,
- Part V – Airworthiness,
- Part VI – General Operating and Flight Rules,
- Part VII – Commercial Air Services, and
- Part VIII – Air Navigation Services.

EXAMPLES OF MAINTENANCE REQUIRING CERTIFICATION

CARs Part V – Airworthiness and Part VI – General Operating and Flight Rules, include the regulations for aircraft maintenance and elementary work. Generally, maintenance done on an aircraft in Canada must be followed by a maintenance release signed by a licensed aircraft maintenance engineer (AME) before the aircraft can be flown. Certain routine tasks have been designated as elementary work and do not require an AME's signature. Instead, the aircraft owner or appointee must record the work done in the aircraft's technical record, such as the journey logbook and technical logbooks.

A maintenance release signed by an AME is required for activities such as:

- modifying, repairing or replacing structural airframe parts;
- overhauling the engine;
- re-contouring or straightening a propeller blade;
- repairing avionics; and
- welding fuel tanks.

CONFIRMATION OF TEACHING POINT 1

QUESTIONS

Q1. What does the acronym CARs mean in Canadian aviation?

Q2. What does the acronym AME mean in Canadian aviation?

Q3. Who must sign a maintenance release?

ANTICIPATED ANSWERS

A1. Canadian Aviation Regulations.

A2. Aircraft Maintenance Engineer.

A3. An AME.

Teaching Point 2 | **Discuss Elementary Work**

Time: 15 min | Method: Individual Activity

Although performing and recording elementary work is less restrictive by aviation standards, it is still very rigorous by typical standards in such fields as private automobile maintenance. To understand aviation maintenance, cadets must recognize the difference between flying at hundreds of km/h at thousands of feet above the ground and parking a stalled car on the shoulder of the road when a fan belt breaks.

SPECIFIC TASKS DESIGNATED AS ELEMENTARY WORK

The difference between maintenance requiring a maintenance release and elementary work has been made easy to recognize in CAR Part VI, Standard 625, Appendix A–Elementary Work.

Elementary work task listings include 29 specific items that cover many routine activities including, under specified circumstances, changing engine oil, changing spark plugs, removing and replacing glider wings and tail surfaces, checking and replacing batteries, changing light bulbs, repairing upholstery, etc.

Distribute a copy of Annex K to each cadet.

The CARs carefully limit the activities in elementary work. For example, checking tire pressures over 100 psi is not elementary work and will require a maintenance release.

RECORDING ELEMENTARY WORK

Elementary work performed on light aircraft is recorded in the aircraft's technical record. The entry in the technical record of the work performed must be signed by the person who performed the work. Since aviation maintenance is a safety consideration, the accurate recording of all maintenance is important. Aircraft logbooks are often the first documents to be collected by investigators in the event of an accident.

Transport Canada (TC) regulations stipulate that all maintenance must be logged before the aircraft is flown.

Distribute Annexes L and M to each cadet.

ACTIVITY

Time: 5 min

OBJECTIVE

The objective of this activity is to familiarize the cadets with recording elementary work.

RESOURCES

Handouts of Annexes L and M.

ACTIVITY LAYOUT

N/A.

ACTIVITY INSTRUCTIONS

1. Demonstrate how to fill out the logbook pages as per the examples located at Annex M.
2. Have each cadet fill in the top line of their blank journey logbook flight record at Annex L to show a fictitious flight from CNT7 (Picton, Ont.) to CYSN (Welland, Ont.), establishing a history for an imaginary aircraft. Except for the date, the details of that data line should look similar to the 26 Aug 07 data line entered by M. Calvert and shown at Annex M.
3. Upon arrival at Welland, have each cadet record the addition of a litre of engine oil and adjustment of tire pressure in their logbook pages, as well as two other items of elementary work selected from the list located at Annex K.
4. If cadets do not complete all this work in the time, have them complete it after class. Ensure that the flight details and the engine oil addition are recorded correctly.

SAFETY

N/A.

CONFIRMATION OF TEACHING POINT 2

The cadets' participation in the activity will serve as the confirmation of this TP.

END OF LESSON CONFIRMATION

QUESTIONS

Q1. Who must sign a maintenance release?

Q2. What tasks may be performed on an aircraft without a maintenance release?

Q3. How many specific tasks has TC designated as elementary work?

ANTICIPATED ANSWERS

A1. An AME.

A2. Tasks designated as elementary work by the TC CARs.

A3. 29.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

N/A.

CLOSING STATEMENT

Aircraft maintenance is a critical part of aviation and of Canadian transportation, commerce and industry. Professionally performed, aircraft maintenance serves the requirements of both safety and efficiency.

INSTRUCTOR NOTES/REMARKS

N/A.

REFERENCES

C3-096 (ISBN 1715-7382) Transport Canada. (2006). *Aeronautical Information Manual*. Ottawa, ON: Her Majesty the Queen in Right of Canada.

C3-210 (ISBN 0-660-62327-7) Transport Canada. (2003). *Aircraft Journey Log*. Ottawa, ON: Her Majesty the Queen in Right of Canada.

C3-211 (ISBN 0-660-19017-6) Transport Canada. (2005). *Airframe Log*. Ottawa, ON.

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ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL THREE

INSTRUCTIONAL GUIDE

SECTION 5

EO C370.02 – DESCRIBE MATERIALS USED IN AIRCRAFT CONSTRUCTION

Total Time:	30 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-803/PG-001, Chapter 4. Specific uses for said resources are identified throughout the instructional guide within the TP for which they are required.

Review the lesson content and become familiar with the material prior to delivering the lesson.

Create slides of figures located at Annexes N to P.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

An interactive lecture was chosen for this lesson to review, clarify, emphasize and summarize materials used in aircraft construction.

INTRODUCTION

REVIEW

N/A.

OBJECTIVES

By the end of this lesson the cadet shall be expected to describe materials used in aircraft construction.

IMPORTANCE

It is important for cadets to learn about materials used in aircraft construction as it will enhance their understanding of the materials used to build aircraft and why they are chosen.

Teaching Point 1	**Describe Wood and Fabrics Used in Aircraft Construction**
Time: 5 min	Method: Interactive Lecture

WOOD

Although wood was used for the first airplanes because of its high strength and low weight, the cost of manpower needed for wood construction and maintenance has caused wood to be almost entirely replaced by other materials, particularly metal.

Species of Wood

If wood is used, it must be carefully selected to meet aviation requirements. Aircraft grade Sitka spruce, sometimes referred to as Airplane spruce, is the preferred reference wood for aviation because of its uniformity, strength and shock-resistance.

Assessment of Wood

If other wood is substituted for aircraft grade Sitka spruce, the replacement wood must meet the same requirements.

Laminated wood is constructed of two or more layers of wood that are bonded together with a glue or resin.

Assessing wood requires the examination of many characteristics such as grain, knots and pitch pockets. A defect might make a piece of wood unusable.

FABRIC

Organic Fabric

Early aircraft were constructed using organic fabrics, such as linen, for the skin of the fuselage and wings. The earliest builders did not use any process to increase the strength of the material. The material was not airtight and it loosened and wrinkled with changes in humidity. Soon, rubberized and varnished coatings came into use to improve the fabric. Later, cotton fibres dissolved in nitric acid were used to make a dope that was worked into the fabric to produce a more durable finish.

Show the cadets the Black Maria, an example of fabric construction, at Annex N.

The Black Maria can be seen today in the National Aviation Museum in Ottawa, ON.

The next step in fabric improvement was to paint enamel over the doped fabric. It cracked and peeled with time, so aluminum powder was blended into the paint. The aluminum powder pigmentation proved very effective in blocking harmful sunlight and reflecting heat away from the fabric.

Other improvements in doping followed, but eventually advances in chemical technology led to new finishes on durable synthetic materials. Although various high grades of cotton are still sometimes used, man-made inorganic fabrics have become the most popular fabric for covering an aircraft.

Inorganic Fabric

Polyester fibres, woven into cloth with different weights are sold under various trade names. Other inorganic fibres include fibreglass and composites.

CONFIRMATION OF TEACHING POINT 1

QUESTIONS

Q1. Why has wood been used less for modern aircraft?

Q2. What species is the preferred reference wood for aircraft construction?

Q3. What is laminated wood?

ANTICIPATED ANSWERS

A1. Wood construction has high costs for manpower.

A2. The reference species is Sitka spruce.

A3. Laminated wood is constructed of two or more layers of wood that are bonded together with a glue or resin.

Teaching Point 2	**Describe Composites Used in Aircraft Construction**
Time: 15 min	Method: Interactive Lecture

COMPOSITE CONSTRUCTION

> The term composite in this lesson refers to a combination of two or more materials that differ in composition or form. Composite is sometimes used to mean any synthetic building material.

Composite structures differ from metallic structures in important ways: excellent elastic properties, high strength combined with light weight and the ability to be customized in strength and stiffness. The fundamental nature of many composites comes from the characteristics of a strong fibre cloth imbedded in a resin.

Fibreglass

Fibreglass is made from strands of silica glass that are spun together and woven into cloth. Fibreglass weighs more and has less strength than most other composite fibres. However, improved matrix materials now allow fibreglass to be used in advanced composite aviation applications.

> A matrix is any material that sticks other materials together.

There are different types of glass used in fibreglass: E-glass, which has a high resistance to electric current, and S-glass, which has a higher tensile strength, meaning that the fabric made from it resists tearing.

Aramid

Aramid is a polymer. A polymer is composed of one or more large molecules that are formed from repeated units of smaller molecules.

Ask the cadets to name all the applications they are aware of for Kevlar® .

The best-known aramid material is Kevlar®, which has a tensile strength approximately four times greater then the best aluminum alloy. This cloth material is used in many applications where great strength is needed: canoes, body armour and helicopter rotors. Aramid is ideal for aircraft parts that are subject to high stress and vibration. The aramid's flexibility allows it to twist and bend in flight, absorbing much of the stress. In contrast, a metal aircraft part would develop fatigue and stress cracks sooner under the same conditions.

Carbon/Graphite

The term carbon is often used interchangeably with the term graphite; however, they are not quite the same material. Carbon fibres are formed at 1315 degrees Celsius (2400 degrees Fahrenheit), but graphite fibres are produced only above 1900 degrees Celsius (3450 degrees Fahrenheit). As well, their actual carbon content differs – but both carbon and graphite materials have high compressive strength and stiffness.

Carbon molecules will form long strings that are extremely tough (this is what makes diamonds so strong). These minute hair-like strands of carbon (a very common and inexpensive element) are, per unit of weight, many times stronger than steel. Individual carbon fibres are flexible, rather than stiff, and bend easily despite having high tensile strength. To stiffen the fibres, cross-directional layers are immersed in a matrix material such as epoxy plastic.

The term epoxy refers to a substance derived from an epoxide. An epoxide is a carbon compound containing an oxygen atom bonded in a triangular arrangement to two carbon atoms. So, an epoxy matrix is itself carbon-based, as are the fibres that it binds.

Show the cadets Figure 17O-1.

The passenger cabin of airliners must be pressurized so that passengers will not have to wear oxygen masks during flight. The large two-level cabin of the A380 Airbus requires a bulkhead (wall) to keep this pressurized air from leaking into the unpressurized tail section. Airbus' facility in Stade, Germany specializes in the design and production of carbon fibre reinforced plastic (CFRP) components and the A380 rear pressure bulkhead was produced there.

Ceramic

Ceramic fibre is a form of glass fibre designed for use in high temperature applications. It can withstand temperatures approaching 1650 degrees Celsius (3000 degrees Fahrenheit), making it effective for use around engines and exhaust systems.

Show the cadets Figure 17O-2.

Ceramic's disadvantages include both weight and expense, but sometimes no other known material will do the job. One of the most famous applications of ceramic is the Thermal Protection System used on the space shuttle. The properties of aluminum demand that the maximum temperature of the shuttle's structure be kept below 175 degrees Celsius (350 degrees Fahrenheit) during operations. Heating during re-entry (in other words, heating caused by friction with the air) creates surface temperatures high above this level and in many places will push the temperature well above the melting point of aluminum (660 degrees Celsius or 1220 degrees Fahrenheit).

Underneath its protective layer of tiles and other materials, the space shuttle has an ordinary aluminum construction, similar to many large aircraft.

Show the cadets Figure 17O-3.

A space shuttle's Thermal Protection System is very complex and it contains highly sophisticated materials. Thousands of tiles of various sizes and shapes cover a large percentage of the space shuttle's exterior surface. There are two main types of silica ceramic tiles used on the space shuttle:

- **Low-Temperature Reusable Surface Insulation (LRSI).** LRSI tiles cover relatively low-temperature areas of one of the shuttles, the Columbia, where the maximum surface temperature runs between 370 and 650 degrees Celsius (700 and 1200 degrees Fahrenheit), primarily on the upper surface of fuselage around the cockpit. These tiles have a white ceramic coating that reflects solar radiation while in space, keeping the Columbia cool.

Show the cadets Figure 17O-4.

- **High-Temperature Reusable Surface Insulation (HRSI).** HRSI tiles cover areas where the maximum surface temperature runs between 650 and 1260 degrees Celsius (1200 and 2300 degrees Fahrenheit). They have a black ceramic coating, which helps them radiate heat during re-entry.

Both LRSI and HRSI tiles are manufactured from the same material and their primary difference is the coating.

A different and even more sophisticated material, Reinforced Carbon-Carbon (RCC), is used for the nose cone and leading edges of the space shuttle. It is a composite material consisting of carbon fibre reinforcement in a matrix of graphite, often with a silicon carbide coating to prevent oxidation.

CONFIRMATION OF TEACHING POINT 2

QUESTIONS

Q1. What type of glass is used in fibreglass strands?

Q2. What is best known aramid material?

Q3. What method is used to stiffen carbon fibre materials?

ANTICIPATED ANSWERS

A1. Silica glass.

A2. Kevlar®.

A3. Immersing cross-directional layers of carbon fibres in a matrix compound such as epoxy plastic.

Teaching Point 3	**Describe Metals Used in Aircraft Construction**
Time: 5 min	Method: Interactive Lecture

METALS USED IN AIRCRAFT CONSTRUCTION

Aluminum

Pure aluminum lacks sufficient strength to be used for aircraft construction. However, its strength increases considerably when it is alloyed or mixed with other compatible metals. For example, when aluminum is mixed with copper or zinc, the resultant aluminum alloy is as strong as steel, with only one-third the weight. As well, the corrosion resistance possessed by the aluminum carries over to the newly formed alloy.

Alclad®

Most external aircraft surfaces are made of clad aluminum. Alclad® consists of a pure aluminum coating rolled onto the surface of heat-treated aluminum alloy. The thickness of the aluminum coating is approximately five percent of the alloy thickness, on each side of the alloy sheet. This clad surface greatly increases the corrosion resistance of the aluminum alloy. However, if the aluminum coating is penetrated, corrosion can attack the alloy within.

Magnesium

Magnesium is one of the lightest metals with sufficient strength and suitable working characteristics for use in aircraft structures. In its pure form it lacks sufficient strength, but like aluminum, mixing it with other metals to create an alloy produces strength characteristics that make magnesium useful.

Titanium

Titanium and its alloys are lightweight metals with very high strength. Pure titanium weighs only half as much as stainless steel and is soft and ductile. Titanium's alloys have excellent corrosion resistance, particularly to salt water.

Show the cadets Figure 17P-1 and Figure 17P-2.

Stainless Steel

Stainless steel is a classification of corrosion-resistant steel that contain large amounts of chromium and nickel. It is well suited to high-temperature applications such as firewalls and exhaust system components.

CONFIRMATION OF TEACHING POINT 3

QUESTIONS

Q1. Why is pure aluminum unsuitable for use in aircraft components?

Q2. What three characteristics make titanium useful for aircraft components?

Q3. What two metals are mixed with steel to make stainless steel?

ANTICIPATED ANSWERS

A1. Pure aluminum lacks sufficient strength.

A2. Titanium alloys have high strength, are lightweight and are resistant to corrosion.

A3. Steel is mixed with chromium and nickel.

END OF LESSON CONFIRMATION

QUESTIONS

Q1. What species is the reference wood for aircraft construction?

Q2. What is the name used to commonly identify aramid material?

Q3. What two metals are mixed with steel to make stainless steel?

ANTICIPATED ANSWERS

A1. The reference wood is Sitka spruce.

A2. Aramid is commonly called Kevlar®.

A3. Steel is mixed with chromium and nickel.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

N/A.

CLOSING STATEMENT

Materials used in aircraft construction have evolved and improved since the earliest construction and the rate of change is accelerating. Advances in associated technologies are continually integrated with aircraft construction as aircraft become larger, more powerful and more complex.

INSTRUCTOR NOTES/REMARKS

N/A.

REFERENCES

C3-136 (ISBN 0-88487-207-6) Sanderson Training Systems. (2001). *A&P Technician Airframe Textbook*. Englewood, CO: Jeppesen Sanderson Inc.

ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL THREE

INSTRUCTIONAL GUIDE

SECTION 6

EO C370.03 – IDENTIFY BASIC POWER TOOLS USED IN AIRCRAFT MANUFACTURING AND MAINTENANCE

Total Time:	30 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-803/PG-001, Chapter 4. Specific uses for said resources are identified throughout the instructional guide within the TP for which they are required.

Review the lesson content and become familiar with the material prior to delivering the lesson.

Create slides of figures located at Annexes Q to S.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

An interactive lecture was chosen for TPs 1–3 to identify basic power tools used in aircraft manufacturing and maintenance and to give an overview of them.

An in-class activity was chosen for TP 4 as it is an interactive way to confirm the cadets' comprehension of the material.

INTRODUCTION

REVIEW

N/A.

OBJECTIVES

By the end of this lesson the cadet will have identified basic power tools used in aircraft manufacturing and maintenance.

IMPORTANCE

It is important for the cadets to know about basic power tools used in aircraft manufacturing and maintenance because this will enhance their knowledge of aircraft construction and the aviation maintenance field.

Teaching Point 1	**Describe the Characteristics and Methods of Application for Power Hand Tools Used With Aircraft**
Time: 5 min	Method: Interactive Lecture

POWER HAND TOOLS

Power hand tools were originally developed to speed up work. However, some hand tools have improved to the point that they allow a novice to produce a degree of precision and excellence that was previously only attainable by expert master craftsmen.

Power hand tools also create safety concerns. Their power allows them to do a lot of damage in a very short time and their power also makes them hard to control. A twisting or reciprocating power tool can easily cause the user to lose their balance when it is first applied to the work piece. This loss of balance can result in damage to the work piece and injuries to the worker.

Show the cadets the slide of each tool at Annex Q, as they are discussed.

Drill. If there were no restrictions on technician's space or movement, there would only need to be one type of drill. However, when working in and around aircraft, drill requirements become more complex, which has given rise to various types and shapes of drills, to include:

- electric,
- pneumatic,
- right angle,
- flexible drive right angle,
- flexible drive straight, and
- long drill bit.

The drills in Figure 17Q-1 look like dentists' tools because the functions are similar. Aircraft construction and maintenance has very confined, hard-to-reach spaces that need to be worked on and worked in.

Electric hand drills can perform a number of tasks. They can drill small round holes using drill bits and they can drill large round holes using hole saw bits. There are many specialty attachments, such as screwdriver bits and sanding disks.

Reciprocating Saw. A reciprocating saw is used to make rough cuts. Reciprocating saw blades are easily replaced. They come in a variety of grades for different materials and cutting speeds. When blades are worn, they are recycled appropriately and replaced.

Sander. A disk sander is used to trim curved cuts in sheet metal, wood or plastic after they have been rough cut. Disks for sanders are easily replaced and they come in a variety of grades and materials for different applications. When worn they are discarded.

CONFIRMATION OF TEACHING POINT 1

QUESTIONS

Q1. Why are there many different styles of drills?

Q2. What is a reciprocating saw used for?

Q3. What materials can a disk sander be used for?

ANTICIPATED ANSWERS

A1. Drills have to be used in confined, hard-to-reach spaces.

A2. It is used to make rough cuts.

A3. A disk sander can be used on metal, wood or plastic.

Teaching Point 2	Describe the Characteristics and Methods of Application for Shop Equipment Used With Aircraft
Time: 5 min	Method: Interactive Lecture

Aircraft are characterized by smooth curved and rounded streamlined shapes intended to reduce turbulence and drag. To form the skin of the aircraft into these shapes, sheet metals must be formed very carefully. A number of tools have developed, which allow fast, accurate metal cutting and forming.

Sheet metal gauges are numbered so that the thicker materials have lower designation numbers. Therefore, 12 gauge metals are thicker than 24 gauge metals.

Show the cadets the slide of each tool at Annex R, as they are discussed.

FORMING TOOLS

Bar Folding Machine. A bar folding machine is used to bend the edges of relatively light sheet metal stock, up to 22 gauge thickness.

Cornice Brake. Cornice brakes, or leaf brakes as they are sometimes called, are used for bending sheet metal of a wide range of thicknesses, including heavier materials up to 12 gauge.

Slip Roll Former. A slip roll former is used to make gentle bends and to fabricate parts such as contoured fuselage skin.

COMPOUND CURVE TOOLS

Mechanical Compound Curve Tools. Large volumes of smaller compound curve components can be fabricated in a hydropress, which uses a rubber blanket and water pressure to form the component from a carefully shaped die.

Manual Compound Curve Tools. Sandbags and hammers are often used when only one compound curve component is to be formed.

CUTTING TOOLS

Squaring Shear. A squaring shear is used to make straight cuts across sheet metal.

Scroll Shear. Scroll shears are used to make irregular cuts on the inside of a sheet of metal without cutting through to the edge.

Band Saw. A band saw is used for cutting curved lines in metal, wood or plastic. The blade speed can be varied for each material.

Drill Press. A drill press is used to increase accuracy and straightness beyond what a hand-held drill can accomplish.

Lathe. A lathe is used for spinning objects so that they can be cut into a circular shape. A lathe makes circular objects in the way that a drill press makes circular holes.

Rotary Punch Press. A rotary punch press is used to punch holes or make circular cuts in metal parts.

CONFIRMATION OF TEACHING POINT 2

QUESTIONS

Q1. What are scroll shears used for?

Q2. What is another name for a cornice break?

Q3. What are two tools used to make components with compound curves?

ANTICIPATED ANSWERS

A1. Scroll shears are used to make irregular cuts on the inside of a sheet of metal without cutting through to the edge.

A2. A cornice break is also called a leaf break.

A3. A hydropress or a sandbag and hammer can be used for compound curves.

Teaching Point 3	Describe the Characteristics and Methods of Application for Fastening Tools and Associated Fasteners Used With Aircraft
Time: 5 min	Method: Interactive Lecture

Show the cadets the slide of each tool at Annex S, as they are discussed.

FASTENING TOOLS

Rivet Gun. Most rivets in aircraft construction are driven by a rivet gun. This is because a rivet gun is fast and can get into tight spaces. However, a rivet gun does less perfect riveting than a compression riveting tool.

Lighter rivet guns are used for placing rivets with small diameter shanks and heavier rivet guns are used for rivets with large shanks.

Rivet Cutter. Rivet cutters have holes for common-size rivet shank diameters. If a rivet is too long for the intended application, the rivet cutter is used to shorten the shank length. To reduce stocking requirements, some shops only stock rivets with long shanks and then cut them to the desired length. A rivet cutter has holes for common shank diameters and leaves that can be selected for the desired shank length.

Bucking Bar. Bucking bars are placed against the opposite end of the rivet from the rivet gun or hammer during the riveting operation. The rivet is flattened between the bucking bar and the hammer or rivet gun. The bucking bar gets its name from the way it bucks, or jumps, on the end of the rivet. There are many shapes and sizes of bucking bars and one of the important challenges of this work begins with the careful selection of the correct bucking bar. It must clear the structure and yet fit perfectly squarely on the end of the rivet.

Squeezer. A squeezer, or compression riveter, is used in place of a rivet gun or hammer. The squeezer is fast and produces a more uniform riveting shape than either hammers or rivet guns, but a squeezer can only operate on easily accessible locations near the edge of the material.

ASSOCIATED FASTENERS

Rivet. Rivets have been used since sheet metal was first used in aircraft construction and they remain the single most common aircraft fastener. Rivets change in dimension to fill their hole during riveting. This makes for a very solid attachment. The rivet part number designation conveys much information, including the style of rivet head, the material it is made from, the shank diameter and the shank length.

CONFIRMATION OF TEACHING POINT 3

QUESTIONS

Q1. What tool places most aircraft rivets?

Q2. What tool is fastest and produces the best rivet shapes?

Q3. How did the bucking bar get its name?

ANTICIPATED ANSWERS

A1. The rivet gun.

A2. The compression riveting tool, sometimes referred to as a squeezer.

A3. Bucking bars are called that because of the way they buck, or jump, during riveting.

Teaching Point 4	**Conduct a Tool Identification Activity**
Time: 10 min	Method: In-Class Activity

ACTIVITY

OBJECTIVE

The objective of this activity is to give the cadets an opportunity to test their knowledge of basic power tools used in aircraft manufacturing and maintenance.

RESOURCES

Pictures of shop tools located at Annexes Q to S, with titles blocked out (with sticky notes).

ACTIVITY LAYOUT

N/A.

ACTIVITY INSTRUCTIONS

1. Divide the cadets into two teams on opposite sides of the room.
2. Display a picture of a shop tool.
3. Have one team attempt to identify the tool and its use in 10 seconds.
4. Award one point for the tool's name and another for the tool's use.
5. If the first team is unable to name the tool or its use, offer an opportunity to the second team.
6. Award two points for successful tool or application naming by the second team.
7. Alternate the successive pictures and opportunities between the two teams.
8. The team with the most points after 10 minutes is the winner.

SAFETY

N/A.

CONFIRMATION OF TEACHING POINT 4

The cadets' participation in the activity will serve as the confirmation of this TP.

END OF LESSON CONFIRMATION

The cadets' participation in the tool identification activity will serve as the confirmation of this lesson.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

N/A.

CLOSING STATEMENT

Tools and equipment used in aircraft manufacturing and maintenance have developed over the years to increase the speed of the work to be done and to allow a more consistent product. The variety of these tools presents both a challenge and an opportunity to aviation technicians.

INSTRUCTOR NOTES/REMARKS

N/A.

REFERENCES

C3-136 (ISBN 0-88487-207-6) Sanderson Training Systems. (2001). *A&P Technician Airframe Textbook*. Englewood, CO: Jeppesen Sanderson Inc.

C3-137 (ISBN 0-88487-203-3) Sanderson Training Systems. (2000). *A&P Technician General Textbook*. Englewood, CO: Jeppesen Sanderson Inc.

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ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL THREE

INSTRUCTIONAL GUIDE

SECTION 7

EO C370.04 – CONSTRUCT AN ALUMINUM MODEL BIPLANE

Total Time:	360 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-803/PG-001, Chapter 4. Specific uses for said resources are identified throughout the instructional guide within the TP for which they are required.

Review the lesson content and become familiar with the material prior to delivering the lesson.

View reference C3-160 *Building the B.C. Air Originals Biplane* DVD.

Photocopy all templates and construct one set of wood jigs and wood templates located at Annex T for the cadets. Make Mylar templates of Figures 17T-1 and 17T-2. Using these templates and wood jigs, create parts for two aluminum model biplanes.

Assemble one aluminum model biplane for demonstration purposes, as shown at Annex AG.

Assemble one part for each assembly line.

Photocopy assembly line instructions at Annexes U to AF for each assembly line.

Photocopy one set of final assembly plans at Annex AG for each cadet.

Set up the classroom for the first set of assembly lines outlined in TP 1.

The workstations using power tools for cutting and tapering wood require supervisors.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

A practical activity was chosen for this lesson as it is an interactive way to introduce cadets to aluminum model biplane construction in a safe, controlled environment. This activity contributes to the development of these skills and knowledge in a fun and challenging setting.

INTRODUCTION

REVIEW

N/A.

OBJECTIVES

By the end of this lesson the cadet shall have constructed an aluminum model biplane.

IMPORTANCE

It is important for cadets to construct an aluminum model biplane because it will allow them to learn about mass production. The aircraft manufacturing industry employs precision mass production techniques to produce modern aircraft.

Teaching Point 1	**Explain and Prepare Mass Production of Aluminum Model Biplane Parts**
Time: 70 min	Method: Practical Activity

Show the cadets a completed aluminum model biplane.

At the beginning of the 20th century, vehicles were produced one at a time in a manner that today would be called customized. An American named Ransome Eli Olds applied the idea of an assembly line to produce his 1901 Curved Dash Oldsmobile in greater numbers. Henry Ford then improved the assembly line so that his 1914 Model T Ford was assembled in 93 minutes, thus making it possible for the majority of people to afford an automobile.

The Wright brother’s 1903 Flyer was produced in a customized manner as well, but Olds’ methods were soon applied to aeronautical manufacture when the Wright Aircraft Company was formed in Dayton, Ohio in 1909. Although the mass market for aircraft was slower to grow than the market for automobiles, World War I prompted the United States government to order thousands of aircraft.

Mass production is not limited to large assemblies. It can also be applied to production of models.

Production of parts for the aluminum model biplane will be carried out using a simple assembly line. However, final assembly will be by customization so that each cadet can make a unique model using mass-produced parts.

Show the cadets the parts needed for one aluminum model biplane as well as the templates, tools and raw materials that will be used in mass production.

This EO is intended to introduce the cadets to the methods of mass production. All the parts for the aluminum model biplane will be fabricated by cadets working in assembly lines. However, this cannot be one big assembly line. There are more than 30 pieces, but because each part is very simple, the assembly lines are small and also simple. Some parts must be fabricated first, since other assemblies require them. To begin the process, start as many of the following 13 assembly lines as resources permit, providing work for each cadet:

- raw aluminum material assembly line (described at Annex U),
- wood assembly line (Annex V),
- aluminum billet assembly line (Annex W),
- aluminum panel shearing assembly line (Annex X) using billets from the previous line,
- cardboard insert assembly line (Annex Y),
- wire station assembly line (Annex Z), and
- drill station assembly line for bottle caps (Annex AA).

As soon as these assembly lines have produced materials for stock, the fuselage assembly line, the top wing assembly line, the empennage assembly line and the propeller assembly line can be formed to begin those processes.

Except for certain assembly lines, such as the Wood Assembly Line and the Drill Assembly Line, the cadets will be seated at their tables or desks within proximity of each other so that materials can be passed on for processing. For example, once a cadet with the template has marked an aluminum billet with the shape of the horizontal stabilizer, the billet must be passed on to the next cadet with scissors to be cut out. This is also the case with cardboard inserts. All such work takes place at a desk or table.

Beyond the initial start-up phase, timings for other assembly lines cannot be predicted since this depends on the speed at which individual lines work and the parts for aluminum model biplanes are made. As well, additional manpower may have to be provided for assembly lines that cannot keep up; any cadet can do this work but some cadets will be faster than others. The instructor is expected to balance manpower as work progresses.

To allow for spare parts, an additional 10 per cent of parts should be made above the amounts required. This is due to inevitable losses as a result of poor workmanship. Make enough parts so that each cadet can assemble at least one aluminum model biplane. If some cadets finish ahead of others, they can make additional models or be assigned to making additional parts for additional models.

ACTIVITY

Time: 65 min

OBJECTIVE

Two objectives of this activity are for the cadets in each work group to set up their work area and also for the cadets to learn to mass produce the parts for aluminum model biplanes.

RESOURCES

- Instructions for constructing an aluminum model biplane,
- Example parts for each assembly line,
- Templates for constructing aluminum model biplane parts,
- Mechanic's gloves,
- Aluminum cans (36 per cadet),
- Softwood, 20 mm thick (fence boards),
- Bottle caps (ten per cadet),
- Corrugated cardboard,
- Tape (masking),
- Glue (two-part epoxy),
- Poster board (thin cardboard not corrugated),
- Mylar,
- Copper-coated welding rod or music wire (two sizes 1/16 inch and 3/32 inch),
- Ball-peen hammer,
- Pliers,
- Flat screwdriver,
- Rasp,
- Hand stapler,
- Staple gun,
- Push-pin,
- Hot glue gun,
- Awl,
- Wire cutter,
- Box knife,
- Scissors,
- Ruler,
- Felt-tipped pen,
- Needle-nose pliers,
- Adjustable wrench,
- Electric hand drill, and
- Hole saw bits (2-3/4 inch and 1-7/8 inch).

ACTIVITY LAYOUT

- Arrange assembly lines as shown in the layout figures located at Annexes U to AA.

- Provide a shop environment for the wood assembly line.

ACTIVITY INSTRUCTIONS

1. Organize the cadets into the work groups described at Annexes U to AA, providing them with wood jigs and prefabricated wood templates constructed from the templates in reference C3-146, or those located at Annex T, as required.

2. Assembly line assignments include:
   Raw Aluminum Material Assembly Line (Annex U)
   Prepare aluminum billets from aluminum cans by:

   (a) washing the aluminum cans and removing the pull tabs;

   (b) removing the bottom from one can per biplane (parts B-1 to stock);

   (c) removing the bottom from one can per biplane leaving 2-inch tops (parts B-3 to stock); and

   (d) removing the top and bottom from fifteen cans per biplane (raw blanks to stock).
   Wood Assembly Line (Annex V)
   Produce wood rounds for aluminum model biplane fuselages by:

   (a) cutting 3/4 inch thick rounds (2-3/4 inch and 1-7/8 inch diameters); and

   (b) tapering wood rounds 10 degrees to create F-1 and F-2.
   Aluminum Billet Assembly Line (Annex W)
   Cut cans vertically on the nutrition label (blanks).
   Aluminum Panel Shearing Assembly Line (Annex X)
   Using raw aluminum billets from stock, fabricate the following parts:

   (a) aluminum panels (dimensions 2-5/8 inch by 8-1/8 inch) for under-wing panels, and

   (b) aluminum panels (dimensions 3-5/8 inch by 8-1/8 inch) for wing panels bent 90 degrees on the1/8 inch edge.
   Cardboard Insert Assembly Line (Annex Y)
   Fabricate the following parts from corrugated cardboard sheets:

   (a) cardboard inserts for Bottom Wing (BWC) 7-1/4 inch by 2-5/8 inch,

   (b) cardboard inserts for Bottom Wing (BWAS) 6-1/2 inch by 3/4 inch,

   (c) cardboard inserts for Top Wing (TWC) 18-1/4 inch by 2-3/4 inch,

   (d) cardboard inserts for Top Wing (TWAS) 18-1/4 inch by 3/4 inch,

   (e) cardboard inserts for Horizontal Stabilizer (HS) from Template No. 8, and

   (f) cardboard inserts for Vertical Stabilizers (VS) from Templates No. 9/10.
   Wire Station Assembly Line (Annex Z)
   Fabricate the following parts from wire stock:

   (a) 3/32-inch welding rods 7-3/4 inches long and bend landing gear wire,

   (b) 1/16-inch welding rods 6-3/4 inches and bend landing gear support wire,

   (c) 3/32-inch wire 15-3/4 inches long for wing spars, and

   (d) 3/32-inch wire 18 inches long for propeller shaft.
   Drill Station Assembly Line (Annex AA)
   Perform the following operations:

(a) Drill a 3/32-inch hole in the centre of bottle caps for wheels.

(b) Drill a 3/32-inch hole in the centre of can B-1 for front fuselage.

(c) Drill a 3/32-inch hole in the centre of can P-2 for propeller.

(d) Drill a 3/32-inch hole in the centre of can P-1 for propeller face.

(e) Enlarge holes A, B and C in fuselage assembly to 3/32 inch.

(f) Enlarge hole D in fuselage assembly to 1/16 inch.

(g) Enlarge holes E and F in fuselage assembly to 10-24 bolt size, as required.

(h) Enlarge eight bolt holes in top wing for 10-24 bolts as required.

(i) Enlarge four bolt holes for 10-24 bolts in bottom wing as required.

3. Inform the cadets that they will be rotated among the workstations.

4. Assign the cadets to workstations.

5. Have each work group produce units for prototype assembly as well as stock for assembly line start-up in subsequent mass production sessions.

6. When sufficient parts have been fabricated for building more than two aluminum model biplanes, halt production and, as a demonstration in front of the class, assemble a prototype aluminum model biplane by combining the fuselage, upper wing and empennage. Do not attach propeller or landing gear at this stage.

SAFETY

- Supervised assembly lines, including the hole-saw station and the rasp station, will be used by one cadet at a time. Each of the supervised stations, using electric power tools, must be constantly supervised.
- Before beginning, ensure each cadet can perform the activity safely.
- Cadets shall wear mechanic's gloves while working with sharp materials.

CONFIRMATION OF TEACHING POINT 1

The cadets' participation in the activity will serve as the confirmation of this TP.

Teaching Point 2	Demonstrate, Explain and Have the Cadets Manufacture the Parts for Aluminum Model Biplanes
Time: 120 min	Method: Practical Activity

ACTIVITY

OBJECTIVE

The objective of this activity is to have the cadets experience mass production of various aluminum model biplane parts at a variety of workstations.

RESOURCES

- Instructions for constructing an aluminum model biplane,

- Templates for constructing aluminum model biplane parts,
- Mechanic's gloves (one pair per cadet),
- Empty aluminum beverage cans (36 per cadet),
- Bottle caps (ten per cadet),
- Corrugated cardboard,
- Tape,
- Glue (two-part epoxy),
- Poster board (thin cardboard not corrugated),
- Mylar,
- Copper-coated welding rod or music wire (two sizes 1/16 inch and 3/32 inch),
- Ball-peen hammer,
- Pliers,
- Flat screwdriver,
- Hand stapler,
- Staple gun,
- Push-pin,
- Hot glue gun,
- Awl,
- Wire cutters,
- Box knife,
- Scissors,
- Ruler,
- Felt-tipped pen,
- Needle-nose pliers,
- Adjustable wrench,
- Electric hand drill, and
- Hole saw bits (2-3/4 inch and 1-7/8 inch).

ACTIVITY LAYOUT

A classroom with desks or tables for work groups with assignments.

Assembly lines can be combined to work together if space and manpower permit. Lines should be selected and set up based on resources such as cadet manpower, working area and also manufactured parts that are available from previous work sessions. For example, the Top Wing assembly line cannot begin without the aluminum panels and cardboard panels provided by previous assembly lines. However, the Top Wing Assembly Line (Annex AD) can operate concurrently with the Aluminum Panel Shearing Assembly Line (Annex X) and the Cardboard Insert Assembly Line (Annex Y) if space and manpower permit.

ACTIVITY INSTRUCTIONS

1. Assign cadets to workstations.

2. In addition to the work groups and assembly lines already used, if still required, the following work groups and assembly lines will be established as manpower becomes available:
Aluminum Rear Fuselage Assembly Line (Annex AB)
Fabricate the rear fuselage from the following parts:

    (a) raw billets from scissor station,

    (b) softwood parts F-1 from stock,

    (c) softwood parts F-2 from stock, and

    (d) fabricated rear fuselages from assembly stations 1–6.

    Fuselage and Bottom Wing Assembly Line (Annex AC)
    Combine parts B-1, B-2, wood rounds and staples to make fuselages and bottom wings.
    Top Wing Assembly Line (Annex AD)
    To fabricate top wings:

    (a) combine cardboard parts TWC, TWAS and three pre-bent aluminum panels dimensions of 3-5/8 inch by 8-1/8 inch to form top wing (all from stock);

    (b) insert panels (dimensions of 2-5/8 inch by 8-1/8 inch) under wing (from stock);

    (c) staple top wing (ten staples); and

    (d) apply Wing Bolt Hole Placement Template (WBHPT) to top of top wing and with a push-pin, make eight holes for bolts in the top wing (top wing to stock).

    Empennage Assembly Line (Annex AE)
    Fabricate the empennage by combining the following parts:

    (a) aluminum horizontal stabilizer – Bottom,

    (b) aluminum horizontal stabilizer – Top Right,

    (c) aluminum horizontal stabilizer – Top Left,

    (d) cardboard insert HS – Horizontal Stabilizer, and

    (e) cardboard insert VS – Vertical Stabilizer.

    Propeller Assembly Line (Annex AF)
    Fabricate the fan propeller by combining the following parts:

    (a) aluminum propeller, and

    (b) aluminum propeller cover.

3. Inform each work group of the number of parts they will make.

4. As each work group completes fabrication of a particular part, have the cadets produce other parts until all parts required are in stock.

5. Ensure that each cadet fabricates a variety of parts.

SAFETY

- Supervised assembly lines, including the hole-saw station and the rasp station, will be used by one cadet at a time. Each of the supervised stations, using electric power tools, must be constantly supervised.

- Before beginning, ensure each cadet can perform the activity safely.
- Cadets shall wear mechanic's gloves while working with sharp materials.

CONFIRMATION OF TEACHING POINT 2

The cadets' participation in the activity will serve as the confirmation of this TP.

Teaching Point 3 **Demonstrate, Explain and Have the Cadet Construct an Aluminum Model Biplane**

Time: 150 min Method: Practical Activity

ACTIVITY

OBJECTIVE

The objective of this activity is to have the cadet assemble an aluminum model biplane.

RESOURCES

- One complete set of parts for one aluminum model biplane per cadet,
- Instructions for assembling an aluminum model biplane parts located at Annex AG,
- Tape (masking),
- Glue, and
- Tools, to include:
  - ball-peen hammer,
  - pliers,
  - flat screwdriver,
  - hand stapler,
  - staple gun,
  - glue gun,
  - awl,
  - wire cutters,
  - box knife,
  - scissors,
  - ruler,
  - felt-tipped pen,
  - needle-nose pliers, and
  - adjustable wrench.

ACTIVITY LAYOUT

N/A.

ACTIVITY INSTRUCTIONS

1. Divide the cadets into groups of four.
2. Demonstrate the assembly of the aluminum model biplane.
3. Ensure that every cadet is ready to proceed before moving to the next step in the assembly.
4. Assist each cadet with installation of landing gear to prevent tearing the aluminum fuselage.

SAFETY

Cadets shall wear mechanic's gloves while working with sharp material.

CONFIRMATION OF TEACHING POINT 3

The cadets' participation in the activity will serve as the confirmation of this TP.

END OF LESSON CONFIRMATION

The cadets' participation in aluminum model biplane parts fabrication and aluminum model biplane assembly will serve as the confirmation of this lesson.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

N/A.

CLOSING STATEMENT

Construction of an aluminum model biplane using mass production of parts demonstrates one of the ways that society produces large volumes of equipment, including increasingly complex aircraft.

INSTRUCTOR NOTES/REMARKS

Templates, models and spare parts should be preserved for future training years.

Scheduling this lesson as a weekend activity will reduce preparation and cleanup.

Before beginning the instruction of this EO the instructor shall be familiar with the aluminum model biplane assembly techniques shown at references C3-146 and C3-160.

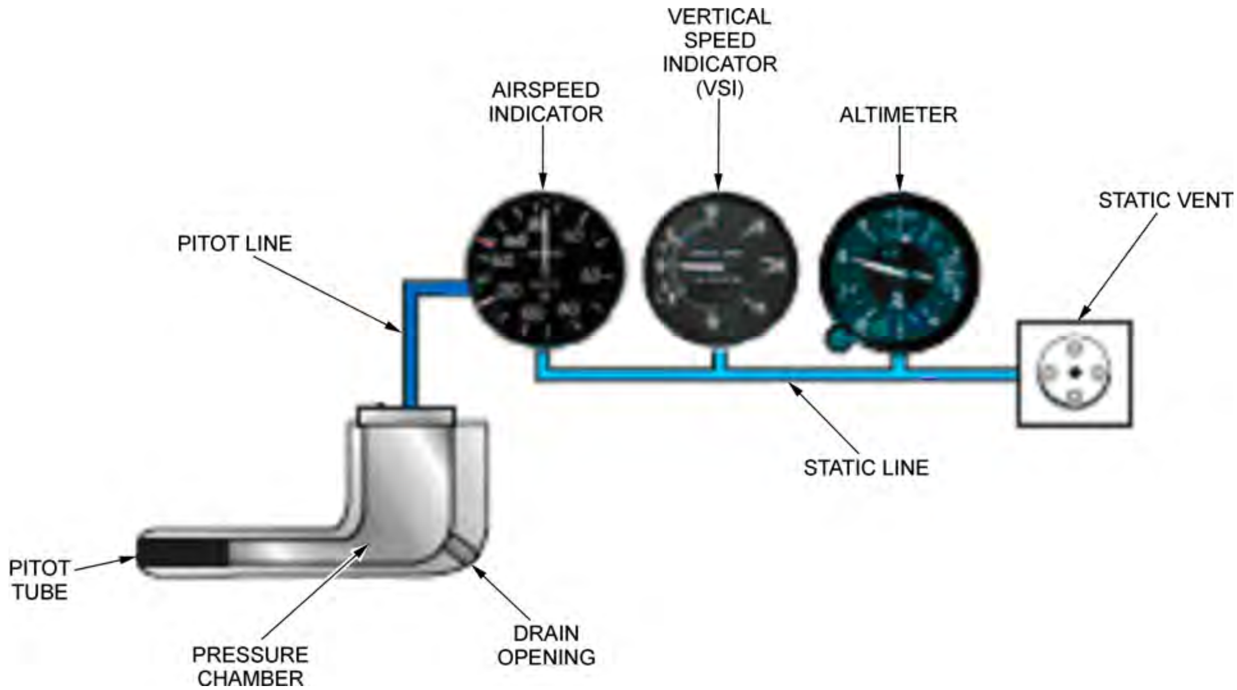
This lesson may be conducted over a number of separate sessions.

REFERENCES

C3-146 Mathis, D. P. (2005). *Step by Step Construction Plans: Classic Biplane*. Helena, MT: BC Air Originals.

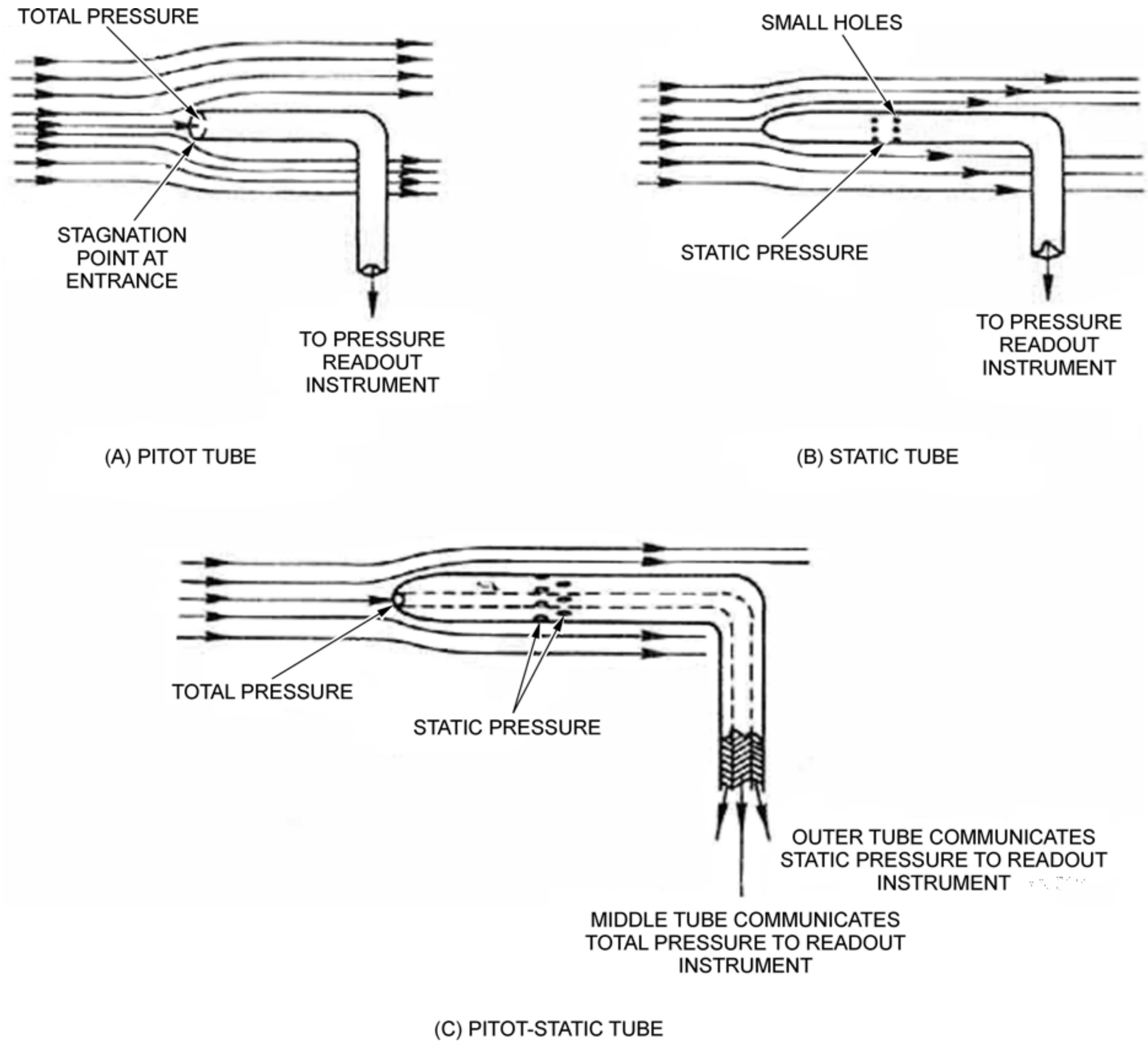
C3-160 Mathis, D. P. (2007). *Building the B.C. Air Originals Biplane*. Helena, MT: B.C. Air Originals.

PITOT STATIC SYSTEM AND TUBES



Pilot's Handbook of Aeronautical Knowledge, "Flight Instruments", 2003, United States Department of Transportation Federal Aviation Administration Flight Standards Service. Retrieved March 6, 2008, from http://www.faa.gov/library/manuals/aviation/pilot_handbook/

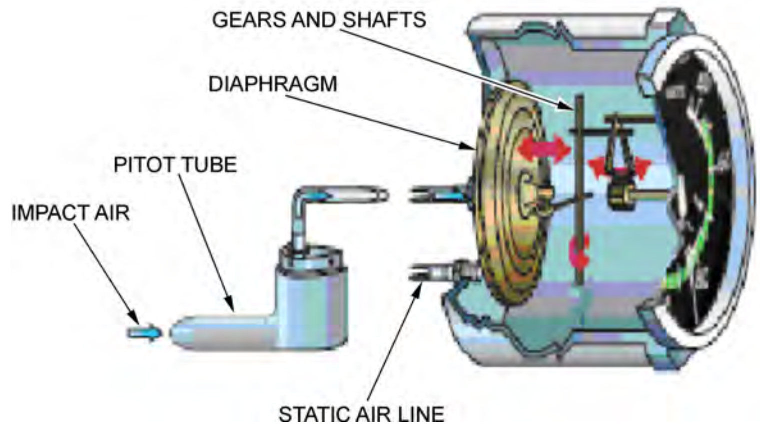
Figure 17A-1 The Pitot Static System



NASA SP-367 Introduction to the Aerodynamics of Flight by T. A. Talay (1975), "Ideal Fluid Flow". Retrieved March 6, 2008, from http://history.nasa.gov/SP-367/chapt3.htm#f27

Figure 17A-2 Pitot Tubes, Static Tubes and Pitot Static Tubes

INDICATORS

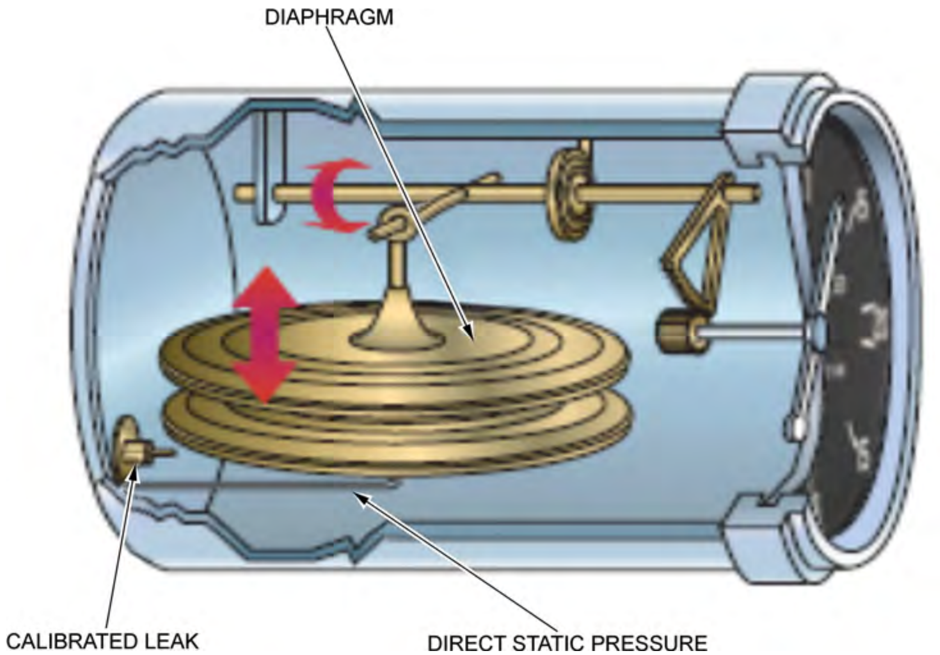


Pilot's Handbook of Aeronautical Knowledge, "Flight Instruments", 2003, United States Department of Transportation Federal Aviation Administration Flight Standards Service. Retrieved March 6, 2008, from http://www.faa.gov/library/manuals/aviation/pilot_handbook/

Figure 17B-1 Airspeed Indicator

North American Powered Parachute Federation, "Flight Instruments". Retrieved October 30, 2007, from http://www.nappf.com/nappf_flight_instruments.htm

Figure 17B-2 Airspeed Indicator Face

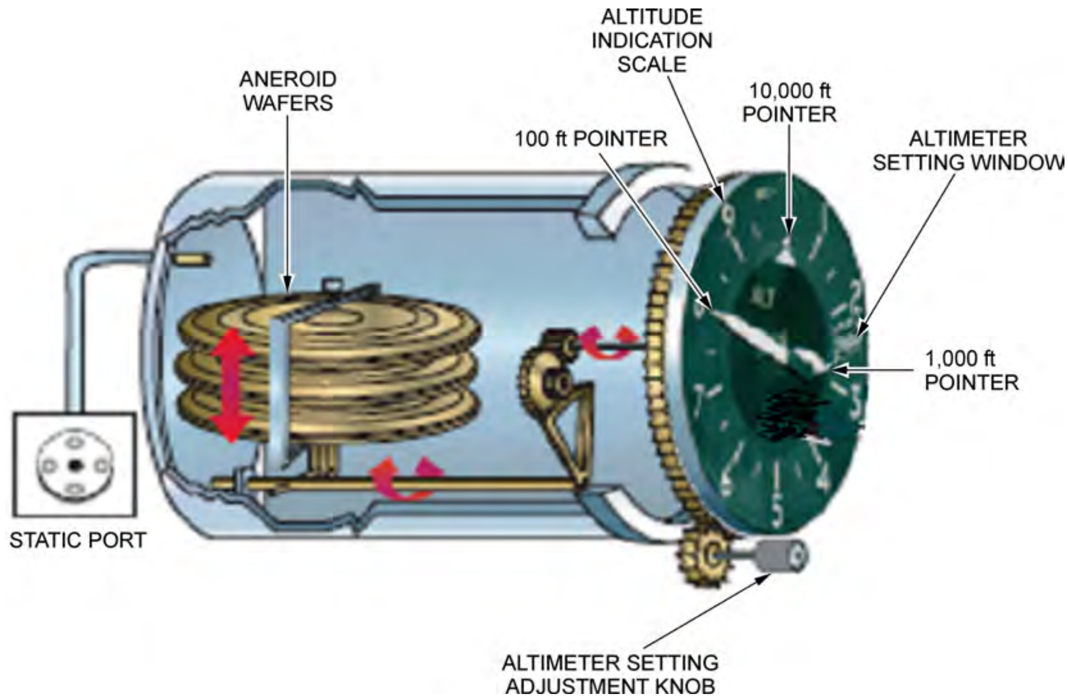


Pilot's Handbook of Aeronautical Knowledge, "Flight Instruments", 2003, United States Department of Transportation Federal Aviation Administration Flight Standards Service. Retrieved March 6, 2008, from http://www.faa.gov/library/manuals/aviation/pilot_handbook/

Figure 17B-3 Vertical Speed Indicator Parts

North American Powered Parachute Federation, "Flight Instruments". Retrieved October 30, 2007, from http://www.nappf.com/nappf_flight_instruments.htm

Figure 17B-4 Vertical Speed Indicator Face



Pilot's Handbook of Aeronautical Knowledge, "Flight Instruments", 2003, United States Department of Transportation Federal Aviation Administration Flight Standards Service. Retrieved March 6, 2008, from http://www.faa.gov/library/manuals/aviation/pilot_handbook/

Figure 17B-5 Altimeter Parts

North American Powered Parachute Federation, "Flight Instruments". Retrieved October 30, 2007, from http://www.nappf.com/nappf_flight_instruments.htm

Figure 17B-6 Altimeter Face

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TYPES OF CESSNA AIRCRAFT

Cessna NGP
Cessna CH-1 Helicopter
Cessna A
Cessna BA
Cessna AW
Cessna AT-17 Bobcat
Cessna C-34 Airmaster
Cessna T-37
Cessna 120
Cessna 140
Cessna 150 Commuter, Patroller & Aerobat
Cessna 152
Cessna 160
Cessna 162 Skycatcher
Cessna 165 Airmaster
Cessna 170
Cessna 172 Skyhawk, T-41 Mescalero
Cessna 175 Skylark
Cessna 177 Cardinal
Cessna 180 Skywagon
Cessna 182 Skylane
Cessna 185 Skywagon
Cessna 187
Cessna 188 AGwagon, AGpickup, AGtruck, and AGhusky
Cessna 190
Cessna 195
Cessna 205 Super Skywagon
Cessna 206 Stationair & Super Skylane
Cessna 207 Skywagon, Stationair 7 & 8
Cessna 208 Caravan
Cessna 210 Centurion
Cessna 303
Cessna 305 Bird Dog
Cessna 310
Cessna 320 Skynight
Cessna 335
Cessna 336 Skymaster, O-2 Skymaster
Cessna 337 Skymaster
Cessna 340
Cessna 350 formerly the Columbia 350
Cessna 400 formerly the Columbia 400
Cessna 401 Utiliner and Businessliner
Cessna 402 Utiliner and Businessliner
Cessna 404 Titan II
Cessna 406 Caravan II
Cessna 411
Cessna 414 Chancellor
Cessna 421 Golden Eagle
Cessna 425 Conquest I
Cessna 441 Conquest II
Cessna 500 Citation I
Cessna 501 Citation ISP
Cessna 510 Citation Mustang
Cessna 525 Citation Jet, CJ1, CJ1+
Cessna 525A CJ2, CJ2+
Cessna 525B CJ3
Cessna 550 Citation II, Cessna Citation Bravo
Cessna 551 Citation IISP
Cessna S550 Citation SII
Cessna 560 Citation V, Citation Ultra, Citation Encore, Citation Encore+
Cessna Citation 560XL Excel, XLS, XLS+
Cessna 620
Cessna 650 Citation III, Citation VI, Citation VII
Cessna 680 Citation Sovereign
Cessna 750 Citation X
Cessna 850 Citation Columbus

Wikimedia Commons by Adrian Pingstone, 2005, "Cessna 172G". Retrieved March 10, 2008, from http://en.wikipedia.org/wiki/Image:Cessna.f172g.g-bgmp.arp.jpg

Figure 17C-1 Cessna 172 Skyhawk

Cessna.com: Our Aircraft, 2008, "Amphibian Cessna Caravan". Retrieved March 16, 2008, from http://caravanamphib.cessna.com/#

Figure 17C-2 Cessna 208 Caravan Amphibian

Wikimedia Commons by Adrian Pingstone, 2005, "Cessna 404". Retrieved March 10, 2008, from http://en.wikipedia.org/wiki/Cessna_404

Figure 17C-3 Cessna 404 Titan II

Cessna emedia, 2008, "Citation image gallery". Retrieved March 16, 2008, from http://cessna.com/news/gallery/index.php?model=mustang

Figure 17C-4 Cessna 510 Citation Mustang

RCA OPS (PAC), 2005, "Aircraft operating instructions Cessna 305 aircraft". Retrieved March 16, 2008, from http://www.regions.cadets.forces.gc.ca/pac/rgs/doc/L19%20AOIs%201%20Jun%2006%20-%20Complete%20version.pdf

Figure 17C-5 Cessna 305 (L-19 Bird Dog)

DIAMOND

Diamond Aircraft: The Ultimate Fleet, 2008, "DA20 Eclipse". Retrieved March 16, 2008, from http://www.diamondair.com/aircraft.php

Figure 17D-1 Diamond DA20 Eclipse

Diamond Aircraft: The Ultimate Fleet, 2008, "DA42 Twin". Retrieved March 16, 2008, from http://www.diamondair.com/aircraft.php

Figure 17D-2 Diamond DA42 Twin Star

Diamond Aircraft D-Jet, 2006, "D-Jet: The features". Retrieved March 16, 2008 from http://www.diamond-air.at/fileadmin/uploads/files/productfacts/d-jet/D_JETbrochure.pdf

Figure 17D-3 Diamond D-Jet

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PIPER

Piper Aircraft Inc., 2008, "Piper freedom of flight: Heritage" at website Retrieved March 16, 2008, from http://www.piper.com/company/heritage.asp

Figure 17E-1 Forerunner of the Piper Cub

Controller, "1979 Piper Aztec F", Copyright 2008 by Sandhills Publishing Company. Retrieved March 16, 2008, from http://www.controller.com/listings/aircraft-for-sale/PIPER-AZTEC-F/1979-PIPER-AZTEC-F/1126249.htm?guid=450D7ACC60104829A0081C4C7E88EFED

Figure 17E-2 Piper Aztek on Final

Piper Freedom of Flight "Piper unveils the revolutionary piperjet" Retrieved March 12, 2008, from http://www.prnewswire.com/mnr/carlisle/25816/

Figure 17E-3 Piper Jet

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VIKING AIR (DE HAVILLAND ORIGINAL PRODUCTS)

"Canada's Air Force", Image Gallery photo search (2007). Retrieved March 8, 2008, from http://www.airforce.forces.gc.ca/site/imagery/search_e.asp

Figure 17F-1 de Havilland DHC-6 Twin Otter (CC-138 Twin Otter)

Viking Air A New Beginning for a Canadian Legend, 2008, DHC-2T Turbo Beaver. Retrieved March 16, 2008, from http://www.vikingair.com/content.aspx?id=270#

Figure 17F-2 de Havilland DHC-2T Turbo Beaver

"Canada's Air Force", Image Gallery photo search (2007). Retrieved March 8, 2008, from http://www.airforce.forces.gc.ca/site/imagery/search_e.asp

Figure 17F-3 de Havilland DHC 5 Buffalo (CC-115 Buffalo)

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AIRBUS

Wikimedia Commons by Adrian Pingstone, 2005, "Airbus A300B4-603". Retrieved March 10, 2008, from http://en.wikipedia.org/wiki/Image:Luft.a300b4.d-aias.750pix..jpg

Figure 17G-1 Airbus A300

Wikimedia Commons by Adrian Pingstone, 2005, "Airbus A310-200". Retrieved March 10, 2008, from http://en.wikipedia.org/wiki/Image:Fedex.a310-200.n420fe.arp.jpg

Figure 17G-2 Airbus A310

Air Canada: Our Fleet, 2007, "Airbus A320-200 (320)". Retrieved March 16, 2008, from http://www.aircanada.com/en/about/fleet/a320-200xm.html

Figure 17G-3 Airbus A320

Air Canada: Our Fleet, 2007, "Airbus A330-300 (333)". Retrieved March 16, 2008, from http://www.aircanada.com/en/about/fleet/a330-300.html

Figure 17G-4 Airbus A330

Air Canada: Our Fleet, 2007, "Airbus A340-300 (343)". Retrieved March 16, 2008, from http://www.aircanada.com/en/about/fleet/a340-300.html

Figure 17G-5 Airbus A340

Airbus Multimedia Library Images, 2007, "The A380". Retrieved March 16, 2008, from http://www.airbus.com/store/photolibrary/AIRCRAFT/AIRBUS/A380/att00009804/media_object_image_lowres_A380_touchdown

Figure 17G-6 Airbus A380

THE BOEING COMPANY

Boeing Commercial Airplanes: Out of Production, "707". Copyright 2008. Retrieved March 16, 2008, from http://www.boeing.com/commercial/gallery/707-04.html

Figure 17H-1 Dash-80 First Boeing 707

Air Canada: Historical Fleet, 2007, "737-200". Retrieved March 16, 2008, from http://www.aircanada.com/shared/images/common/fleet/pictures/737b.jpg

Figure 17H-2 Boeing 737

Air Canada: Historical Fleet, 2007, "747-400". Retrieved March 16, 2008, from http://www.aircanada.com/shared/images/common/fleet/pictures/747combi.jpg

Figure 17H-3 Boeing 747

Air Canada: Our Fleet, 2007, "767-300". Retrieved March 16, 2008, from http://www.aircanada.com/en/about/fleet/b767-300er.html

Figure 17H-4 Boeing 767

Air Canada: Our Fleet, 2007, “777-300ER”. Retrieved March 16, 2008, from http://www.aircanada.com/en/about/fleet/77W.html

Figure 17H-5 Boeing 777

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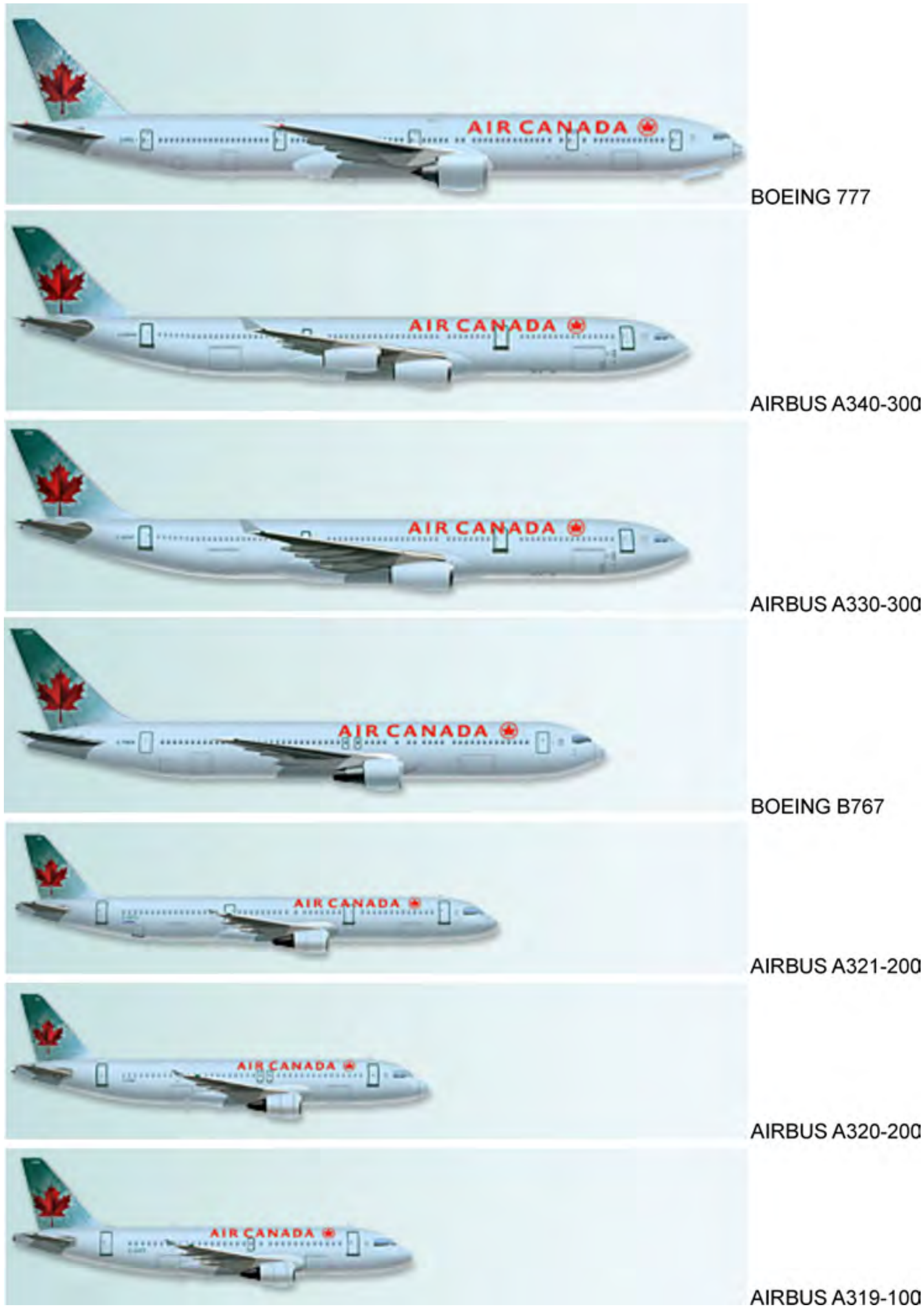
AIR CANADA'S FLEET



Air Canada, 2008, "Our Fleet". Retrieved March 16, 2008, from http://www.aircanada.com/en/about/fleet/

Figure 17I-1 Air Canada Fleet Comparison

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SKYHAWK CHECKLIST

Cessna 172 Preflight

Preflight Inspection Cockpit

Aircraft docs (ARROW)	Check
Weight & Balance	Check
Parking Brake	Set
Control wheel lock	Remove
Hobbs/Tach	Check/Remove
Ignition	Off
Avionics Power Switch	Off
Master Switch	On
Fuel quantity indicators	Check
Pitot Heat	On
Avionics Master Switch	On
Avionics Cooling Fan	Audible
Avionics Master Switch	Off
Static Pressure Alt Src Valve	Off
Annunciator Panel Switch	Test
Annunciator's Illuminate	Check
Annunciator Panel Switch	Off
Flaps	Extend
Pitot Heat	Off
Master Switch	Off
Pitot Tube	Test for Heat
Fuel shutoff valve	On (In)

Fuselage and Empenage

Baggage Door	Closed & Locked
Rivets	Check
Rudder Gust Lock	Remove
Tail Tie-Down	Disconnect
Control surfaces	Free & Secure
Trim Tab	Check Security
Antennas	Check Security

Right wing

Wing tie-down	Disconnect
Aileron	Free and Secure
Flaps	Secure
Main wheel tire	Inflated/Cond
Brakes	Not Leaking
Fuel tank sump	Sample
Fuel Quantity	Check
Fuel Filler cap	Secure

Nose

Engine oil level	Check
Fuel strainer	Sample
Propeller and spinner	Check
Alternator belt	Check
Air intake	Check
Carburetor air filter	Check
Landing lights	Check
Nose wheel strut & tire	Check
Nose-Tie down	Disconnect
Static source opening	Check

Left Wing

Wing tie-down	Disconnect
Aileron	Free and Secure
Flaps	Secure
Main wheel tire	Inflated/Cond
Brakes	Not Leaking
Fuel tank vent open	Check
Fuel tank sump	Sample
Fuel Quantity	Check
Fuel Filler cap	Secure
Pitot tube	Uncover and Check
Stall warning	Check
Landing/Taxi Light(s)	Clean/Cond

Before starting engine

Preflight inspection	Complete
Passenger Briefing	Complete
Seats, belts	Adjust & Lock
Doors	Closed & Locked
Brakes	Test & Set
Circuit breakers	Check In
Electrical Equip/Autopilot	Off
Avionics Power Switch	Off
Fuel Selector Valve	Both
Fuel shutoff valve	On (In)

Starting Engine

Throttle	Open 1/4 inch
Mixture	Rich (IN)
Carb heat	Cold (IN)
Prime	As required; locked
Aux Fuel Pump	On
Propeller area	Clear
Master Switch	On
Beacon	On
Ignition	Start
Throttle	Adjust 1000 rpm
Oil Pressure	Check normal
Aux Fuel Pump	Off
Avionics Master Switch	On
Radios	On

Cessna 172 In Flight

Transponder	Standby
Flaps	Up
Ammeter	Check
Heading Indicator	Set
ATIS/AWOS/ASOS	Obtain
Altimeter	Set
Autopilot	Engage
Flight Controls	Move Against AP
Autopilot	Disconnect (Sound)
Departure &Taxi Clrnce	Contact

Before Takeoff

Parking brake	Set
Cabin doors	Closed & Locked
Seats, belts	Adjust & Lock
Flight controls	Free & Correct
Instruments (4)	Set
Fuel Quantity	Check
Fuel Shutoff Valve	On
Mixture	Rich (IN)
Fuel Selector Valve	Both
Elevator Trim	Set for TAKEOFF
Throttle	1800 rpm
Magnetos	Check
Suction gage	Check
Engine Instruments	Check
Ammeter	Check
Mixture	Set for Density Alt
Carb heat	On
Annunciator Panel	Clear
Throttle	1000 rpm
Throttle Friction Lock	Adjust
Strobe Lights	On
Radios/Avionics	Set
Autopilot	Off
Flaps	Set for Takeoff (0°-10°)
Parking Brake	Release
Windows	Closed

Takeoff

Flaps	Up
Carb heat	Cold (In)
Transponder	Altitude
Trim	set for TAKEOFF
Throttle	Full
Tach, oil, airspeed	Check
Elevator	Lift at 55 KIAS
Climb	70-80 KIAS

Cruise

Pitch	Set
Throttle	As required
Trim	Set
Mixture	Adjust

Pre-landing checklist

Fuel selector	On
Mixture	Rich
Carb Heat	On
Seatbelts	Fastened

Approach

Flight instruments	Ckd & Set
Radios	Checked
ATIS	Checked
Carb Heat	On (Out)
Mixture	Rich
Landing light	On
Airspeed	65-75 KIAS (Flaps Up) 60-70 KIAS (Flaps Dn)

After landing

Flaps	Up
Carb Heat	Cold (In)
Transponder	Standby
Landing light	Off

Parking

Avionics	Off
Electrical	Off
Throttle	1000 RPM
Mixture	Cut-off
Ignition switch	Off
Master switch	Off

Securing the aircraft

Control Lock	Install
Hobbs/Tach	Record
Door/Window	Secure
Tie-downs	Secure

Comm Freq

ATIS	
Ground	
Tower	
Club	
Fuel	

International Flying Club, 2005, "Cessna 172 Preflight Cessna 172 In Flight". Retrieved March 17, 2008, from http://www.internationalflyingclub.org/docs/c172-chklist.pdf

Figure 17J-1 Skyhawk Checklist

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ELEMENTARY WORK TASK LISTINGS FROM STANDARD 625 APPENDIX A – ELEMENTARY WORK, CANADIAN AVIATION REGULATIONS PART VI – GENERAL OPERATING AND FLIGHT RULES

1. fabric patches measuring not more than 15 cm (6 in) in any direction and not requiring rib stitching or the removal of control surfaces or structural parts, on small privately operated aircraft;
2. removal and replacement of tires, wheels, landing skids or skid shoes, not requiring separation of any hydraulic lines, on small privately operated aircraft;
3. removal and replacement of skis on fixed landing gear, not requiring separation of any hydraulic lines, on small privately operated aircraft;
4. repair of non-structural fairings, cover plates and cowlings, on small privately operated aircraft;
5. cleaning and replacement of spark plugs, on small privately operated aircraft;
6. checking of cylinder compression, on small privately operated aircraft;
7. cleaning or changing of fuel, oil, and air filters, on small privately operated aircraft;
8. draining and replenishing engine oil, on small privately operated aircraft;
9. checking the electrolyte level and specific gravity of lead acid batteries, on small privately operated aircraft;
10. adjustment of generator or alternator drive belt tension, on small privately operated aircraft;
11. cleaning of balloon burner nozzles;
12. removal and replacement of balloon baskets, burners and gas tanks that are designed for rapid change in service;
13. removal and replacement of glider wings and tail surfaces that are designed for quick assembly;
14. repair of upholstery, trim and cabin furnishings;
15. removal and replacement of role equipment designed for rapid removal and replacement;
16. removal and replacement of passenger seat belts and harnesses;
17. removal and replacement of fuses, light bulbs and reflectors;
18. removal and replacement of avionics components that are rack mounted or otherwise designed for rapid removal and replacement, where the work does not require testing other than an operational check;
19. removal and replacement of aircraft batteries;
20. removal and replacement of co-pilot control levers, wheels, pedals and pedal guard plates that are designed for rapid removal and replacement, on other than transport category aircraft;
21. opening and closing of non-structural access panels;
22. removal and replacement of cabin doors on unpressurized aircraft, where the door is designed for rapid removal and replacement;
23. removal, replacement and repositioning of non structural partitions in the passenger cabin;
24. inspection and continuity checking of self-sealing chip detectors;
25. removal and replacement of induction system anti-icing baffles, scoops and deflectors that are designed for rapid removal and replacement;

26. removal, cleaning, replacement and adjustment of external components of chemical dispersal systems that are designed for rapid removal and replacement;

27. deactivating or securing inoperative systems in accordance with sections 605.09 or 605.10 of the CARs, including the installation of devices specifically intended for system deactivation, where the work does not involve disassembly, the installation of parts, or testing other than operational checks;

28. checking and adjusting air pressure in helicopter floats, and aircraft tires having an operating pressure below 100 psi, except on aircraft operated under CAR 704 and CAR 705; and

29. repetitive visual inspections or operational checks (including inspections and tests required by airworthiness directives) not involving disassembly or the use of visual aids, performed out of phase with the aircraft's scheduled check cycle at intervals of less than 100 hours air time, provided the tasks are also included in the most frequent scheduled maintenance check.

JOURNEY LOG FLIGHT RECORD

Section 1: Record of maintenance and elementary work 1

Date / /	Total air time	Total landings/cycle	Details of task	Signature	AME or AMO/ACA

Transport Canada, Airframe Log, Minister of Transport (p. 1)

Figure 17L-1 Airframe Logbook Page 1

FLIGHT RECORD — DOSSIER DE VOL

Date	Crew - Équipage	Journey - Route		Record of time - Fiche de temps				Other - Autre			Maintenance		
1 __/__/__	2 Pilot / Copilot Pilote / Copilote	3 From De	4 To À	5 Up Décollage	6 Down Atterissage	7 Air time Temps-air	8 TTSN**	9	10	11	12 Defects Défectuosités	13 Rectification	14 Signature
	Totals brought forward Totaux reportés	→											
15 →	(Brought forward) (Reporté)	Next scheduled maintenance: Prochaine maintenance planifiée:				Due: Échéance:			(hr / cycles / date)* (h / cycles / date)*		Next scheduled maintenance: Prochaine maintenance planifiée:	Due: Échéance: .... (hr / cycles / date)* (h / cycles / date)*	(Carry forward) (Reporter) →

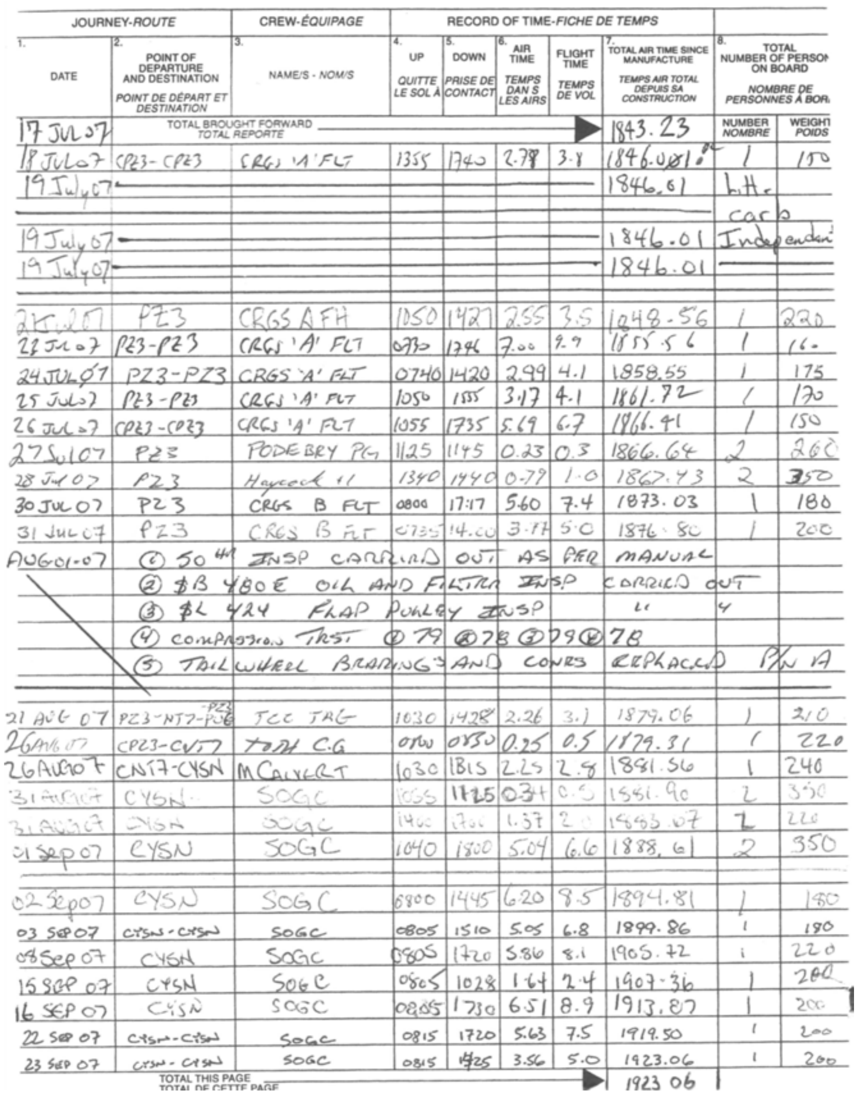
*Delete where inapplicable — Supprimer si ce n'est pas applicable

**Total time since new — Temps total depuis neuf

Transport Canada, Aircraft Journey Log, Minister of Transport (p. 1)

Figure 17L-2 Journey Logbook Flight Record Page 2

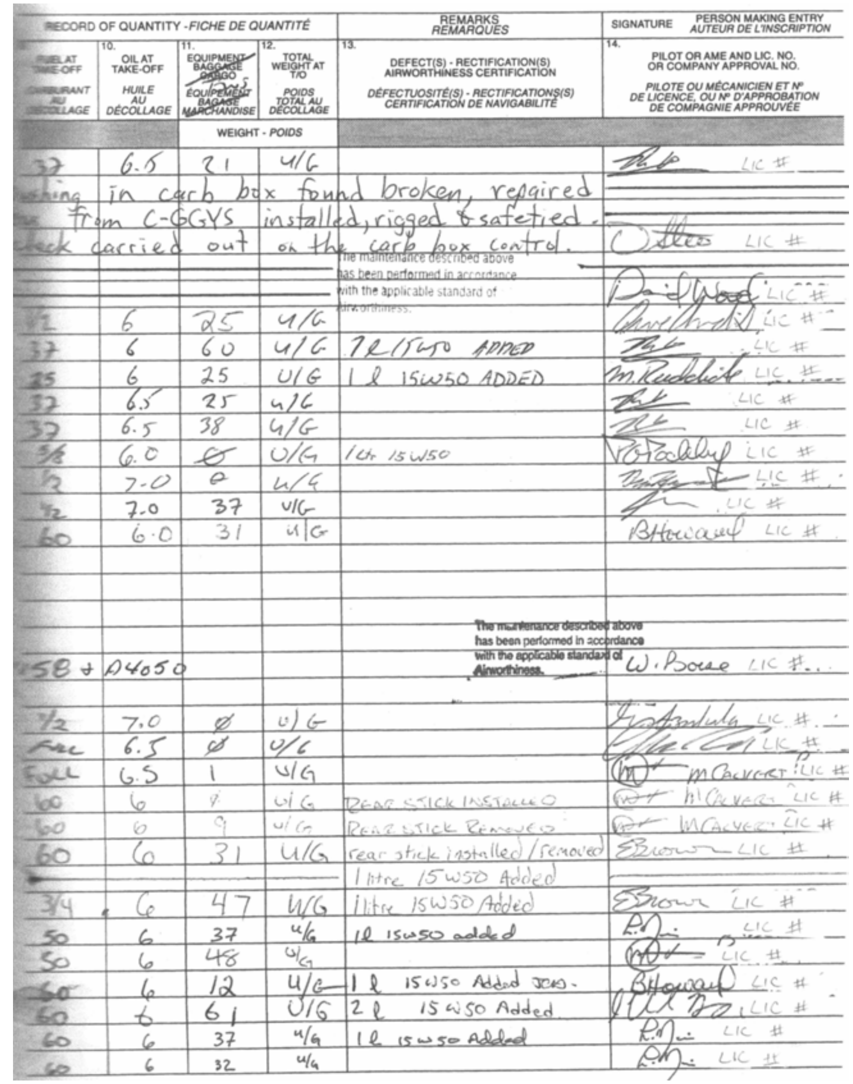
JOURNEY LOGBOOK



1. DATE	2. POINT OF DEPARTURE AND DESTINATION / POINT DE DÉPART ET DESTINATION	3. NAME/S - NOM/S	4. UP / QUITTE LE SOL À	5. DOWN / PRISE DE CONTACT	6. AIR TIME / TEMPS DANS LES AIRS	FLIGHT TIME / TEMPS DE VOL	7. TOTAL AIR TIME SINCE MANUFACTURE / TEMPS AIR TOTAL DEPUIS SA CONSTRUCTION	8. NUMBER / NOMBRE	WEIGHT / POIDS
17 JUL 07	TOTAL BROUGHT FORWARD / TOTAL REPORTÉ						1843.23		
18 JUL 07	CPZ3-CPZ3	CRGS 'A' FLT	1355	1740	2.78	3.8	1846.01	1	150
19 July 07							1846.01	L.H. carb	
19 July 07							1846.01	Independent	
19 July 07							1846.01		
21 Jul 07	PZ3	CRGS AFH	1050	1427	2.55	3.5	1848.56	1	220
22 Jul 07	PZ3-PZ3	CRGS 'A' FLT	0730	1746	7.00	9.7	1855.56	1	160
24 JUL 07	PZ3-PZ3	CRGS 'A' FLT	0740	1420	2.99	4.1	1858.55	1	175
25 Jul 07	PZ3-PZ3	CRGS 'A' FLT	1050	1555	3.17	4.1	1861.72	1	170
26 Jul 07	CPZ3-CPZ3	CRGS 'A' FLT	1055	1735	5.69	6.7	1866.41	1	150
27 Jul 07	PZ3	PODEBRY PG	1125	1145	0.23	0.3	1866.64	2	260
28 Jul 07	PZ3	Haycock 11	1340	1440	0.79	1.0	1867.43	2	350
30 JUL 07	PZ3	CRGS B FLT	0800	17:17	5.60	7.4	1873.03	1	180
31 JUL 07	PZ3	CRGS B FLT	0735	14.00	3.77	5.0	1876.80	1	200
AUG 01-07	(1) 50 HR INSP CARRIED OUT AS PER MANUAL								
	(2) #B 480E OIL AND FILTER INSP CARRIED OUT								
	(3) #L 424 FLAP PULLEY INSP " "								
	(4) COMPRESSION TEST (1) 79 (2) 78 (3) 79 (4) 78								
	(5) TAILWHEEL BEARINGS AND CONES REPLACED P/N A								
21 AUG 07	PZ3-NT7-PZ3	TCC TAG	1030	1428	2.26	3.1	1879.06	1	210
26 AUG 07	CPZ3-CNT7	TOPH C.G	0710	0930	0.25	0.5	1879.31	1	220
26 AUG 07	CNT7-CYSN	M CALVERT	1030	1815	2.25	2.8	1881.56	1	240
31 AUG 07	CYSN	SOGC	1055	1125	0.34	0.5	1881.90	2	350
31 AUG 07	CYSN	SOGC	1400	1700	1.37	2.0	1883.07	2	220
01 SEP 07	CYSN	SOGC	1040	1800	5.04	6.6	1888.61	2	350
02 Sep 07	CYSN	SOGC	0800	1445	6.20	8.5	1894.81	1	180
03 SEP 07	CYSN-CYSN	SOGC	0805	1510	5.05	6.8	1899.86	1	190
08 Sep 07	CYSN	SOGC	0805	1720	5.86	8.1	1905.72	1	220
15 SEP 07	CYSN	SOGC	0805	1028	1.64	2.4	1907.36	1	200
16 SEP 07	CYSN	SOGC	0805	1730	6.51	8.9	1913.87	1	200
22 SEP 07	CYSN-CYSN	SOGC	0815	1720	5.63	7.5	1919.50	1	200
23 SEP 07	CYSN-CYSN	SOGC	0815	1425	3.56	5.0	1923.06	1	200
	TOTAL THIS PAGE / TOTAL DE CETTE PAGE						1923.06		

Director Cadets 3, 2007, Ottawa, ON: Department of National Defence

Figure 17M-3 Example of Journey Logbook First Page



FUEL AT TAKE-OFF / CARBURANT AU DÉCOLLAGE	10. OIL AT TAKE-OFF / HUILE AU DÉCOLLAGE	11. EQUIPMENT BAGGAGE CARGO / ÉQUIPEMENT BAGAGE MARCHANDISE	12. TOTAL WEIGHT AT T/O / POIDS TOTAL AU DÉCOLLAGE	13. DEFECT(S) - RECTIFICATION(S) AIRWORTHINESS CERTIFICATION / DÉFECTUOSITÉ(S) - RECTIFICATION(S) CERTIFICATION DE NAVIGABILITÉ	14. PILOT OR AME AND LIC. NO. OR COMPANY APPROVAL NO. / PILOTE OU MÉCANICIEN ET Nº DE LICENCE, OU Nº D'APPROBATION DE COMPAGNIE APPROUVÉE
37	6.5	21	U/G		LIC #
…hing in carb box found broken, repaired from C-GGYS installed, rigged & safetied. …eck carried out on the carb box control. The maintenance described above has been performed in accordance with the applicable standard of airworthiness.					LIC #
					LIC #
1/2	6	25	U/G		LIC #
37	6	60	U/G	1 L 15W50 ADDED	LIC #
25	6	25	U/G	1 L 15W50 ADDED	M Ruddick LIC #
37	6.5	25	U/G		LIC #
37	6.5	38	U/G		LIC #
3/8	6.0	Ø	U/G	1 L 15W50	LIC #
1/2	7.0	Ø	U/G		LIC #
1/2	7.0	37	U/G		LIC #
60	6.0	31	U/G		BHoward LIC #
58 + A4050				The maintenance described above has been performed in accordance with the applicable standard of Airworthiness.	W. Bowe LIC #
1/2	7.0	Ø	U/G		LIC #
FULL	6.5	Ø	U/G		LIC #
FULL	6.5	1	U/G		M Calvert LIC #
60	6	9	U/G	REAR STICK INSTALLED	M Calvert LIC #
60	6	9	U/G	REAR STICK REMOVED	M Calvert LIC #
60	6	31	U/G	rear stick installed / removed. 1 litre 15W50 Added	E Brown LIC #
3/4	6	47	U/G	1 litre 15W50 Added	E Brown LIC #
50	6	37	U/G	1 L 15W50 added	LIC #
50	6	48	U/G		LIC #
60	6	12	U/G	1 L 15W50 Added	BHoward LIC #
60	6	61	U/G	2 L 15W50 Added	LIC #
60	6	37	U/G	1 L 15W50 Added	LIC #
60	6	32	U/G		LIC #

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Figure 17M-4 Example of Journey Logbook Second Page

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WOODEN AIRCRAFT

"The Aviation History Online Museum", 2007, Aircraft: Sopwith Triplane. Retrieved November 25, 2007, from http://www.aviation-history.com/sopwith/triplane.htm

Figure 17N-1 The Black Maria Sopwith Triplane

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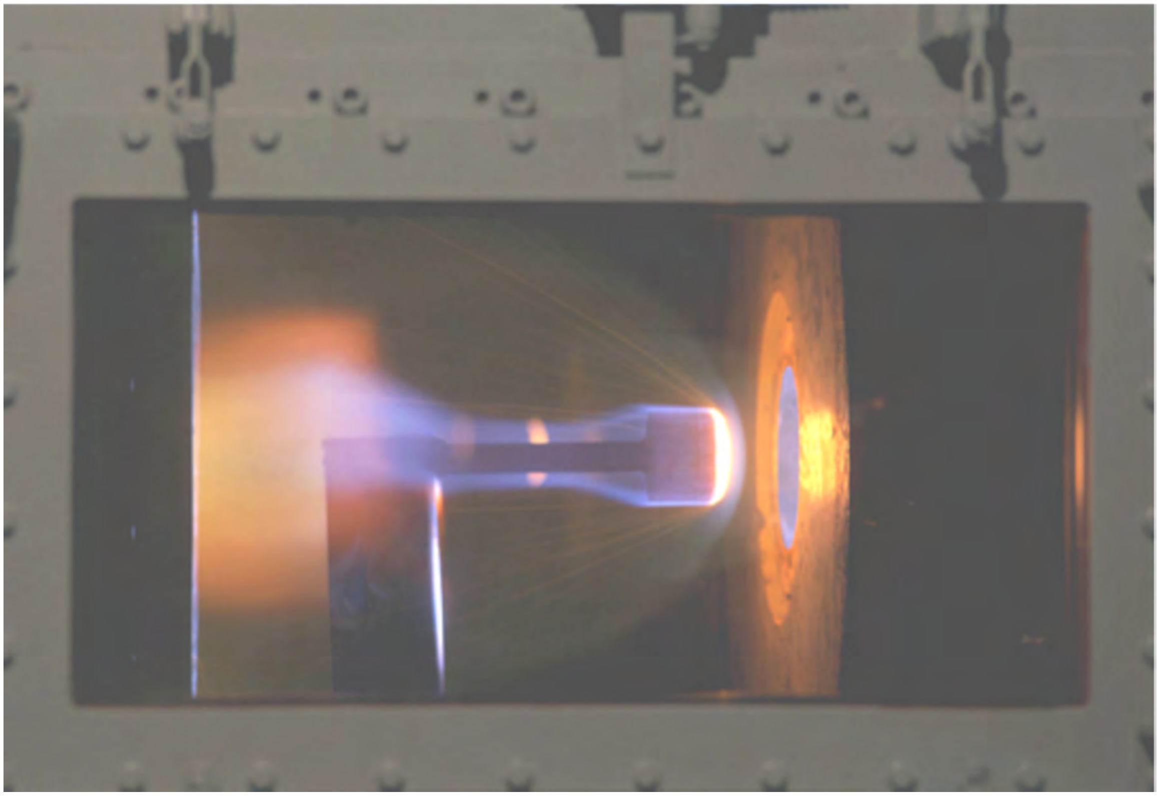
COMPOSITE MATERIALS USED IN AIRCRAFT CONSTRUCTION

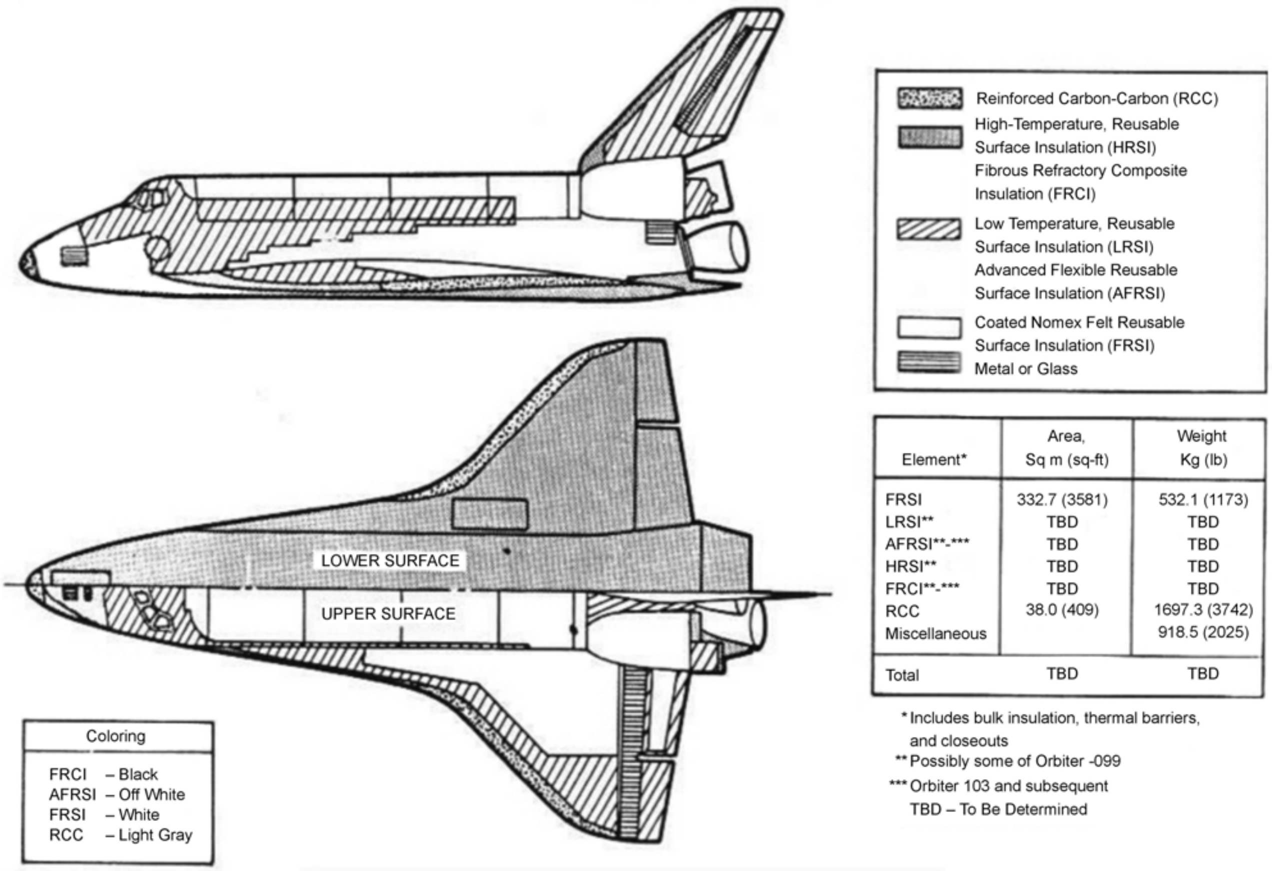
"A380 Navigator", 2007, Manufacturing Process. Retrieved November 24, 2007, from http://events.airbus.com/A380/Default2.aspx?ArtId=644

Figure 17O-1 A380 Rear Pressure Bulkhead



"US Centennial of Flight Commission", 2004, Shuttle Thermal Protection System. Retrieved November 25, 2007, from http://www.centennialofflight.gov/essay/Evolution_of_Technology/TPS/Tech41.htm

Figure 17O-2 Testing Thermal Insulation in a Wind Tunnel

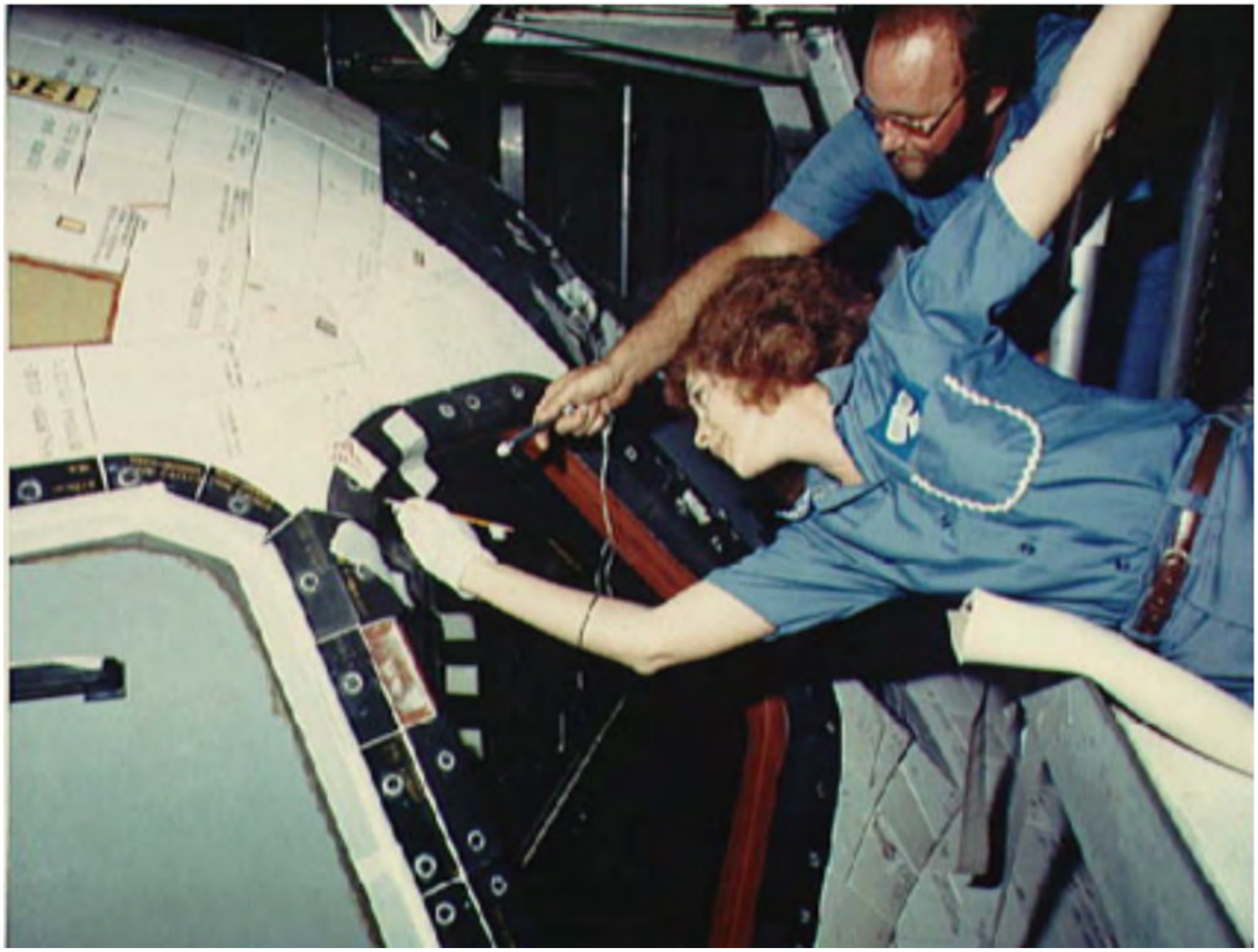


Element*	Area, Sq m (sq-ft)	Weight Kg (lb)
FRSI	332.7 (3581)	532.1 (1173)
LRSI**	TBD	TBD
AFRSI**-***	TBD	TBD
HRSI**	TBD	TBD
FRCI**-***	TBD	TBD
RCC	38.0 (409)	1697.3 (3742)
Miscellaneous		918.5 (2025)
Total	TBD	TBD

* Includes bulk insulation, thermal barriers, and closeouts
** Possibly some of Orbiter -099
*** Orbiter 103 and subsequent
TBD – To Be Determined

"US Centennial of Flight Commission", 2004, Shuttle Thermal Protection System. Retrieved November 25, 2007, from http://www.centennialofflight.gov/essay/Evolution_of_Technology/TPS/Tech41.htm

Figure 17O-3 Orbiter Thermal Protection System



"US Centennial of Flight Commission", 2004, Shuttle Thermal Protection System. Retrieved November 25, 2007, from http://www.centennialofflight.gov/essay/Evolution_of_Technology/TPS/Tech41.htm

Figure 17O-4 Repairing TPS on Columbia

METAL USED IN AIRCRAFT CONSTRUCTION

"A380 Navigator", 2007, Manufacturing Process. Retrieved November 24, 2007, from http://events.airbus.com/A380/Default2.aspx?ArtId=644

Figure 17P-1 Titanium Pylon for an A380 Airbus Engine

"A380 Navigator", 2007, Manufacturing Process. Retrieved November 24, 2007, from http://events.airbus.com/A3

Figure 17P-2 Empty Pylons on an A380 Airbus

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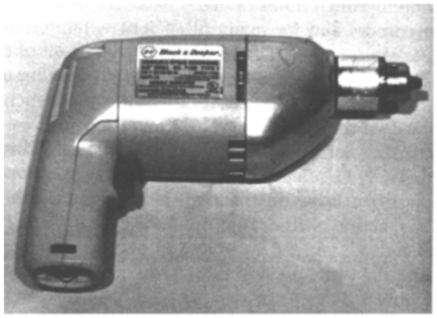
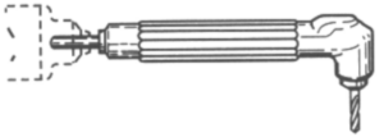
POWER TOOLS



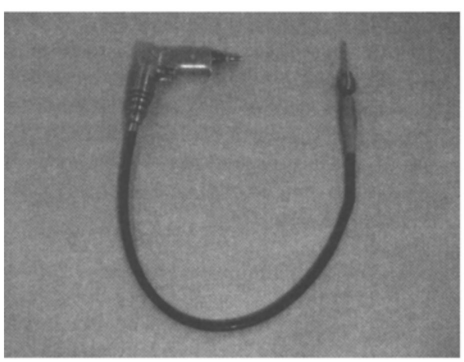
ELECTRIC

PNEUMATIC

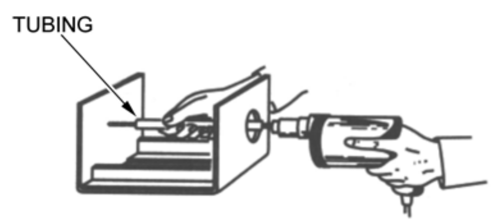


RIGHT ANGLE

FLEXIBLE DRIVE RIGHT ANGLE



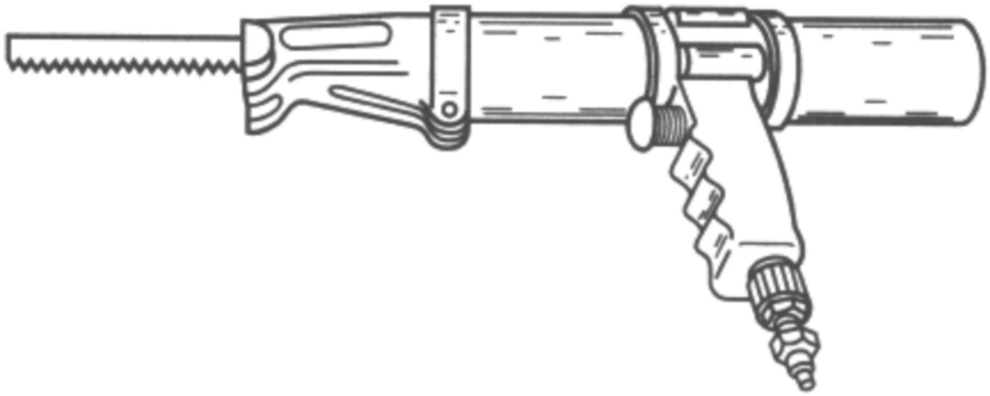
FLEXIBLE DRIVE STRAIGHT



LONG DRILL BIT APPLICATION

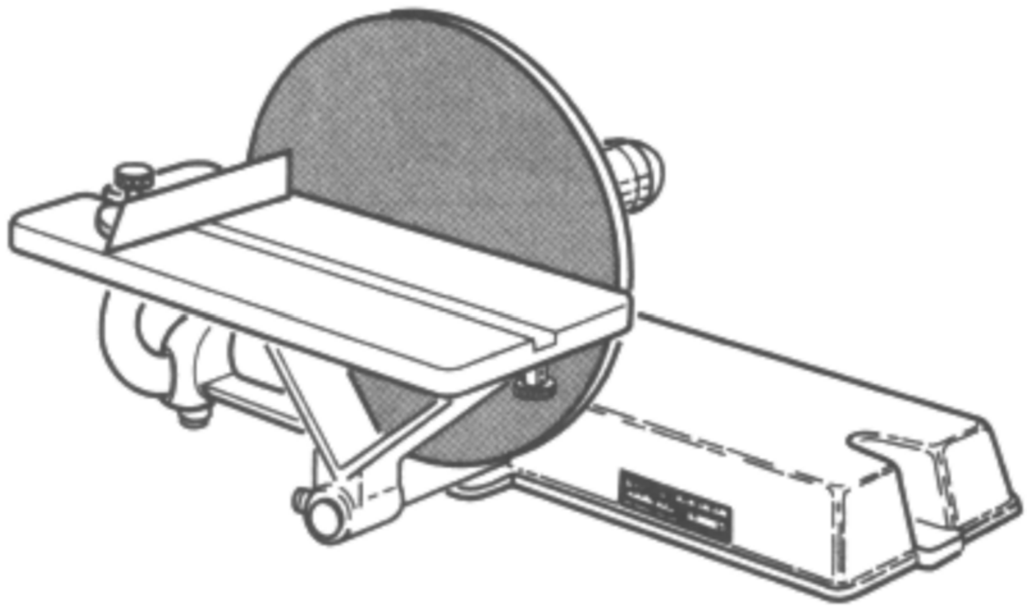
A&P Technician Airframe Textbook, Sanderson Training Systems (pp. 2-24 to 2-26)

Figure 17Q-1 Various Drill Types



A&P Technician Airframe Textbook, Sanderson Training Systems (pp. 2-19)

Figure 17Q-2 Reciprocating Saw



A&P Technician Airframe Textbook, Sanderson Training Systems (pp. 2-24)

Figure 17Q-3 Disk Sander

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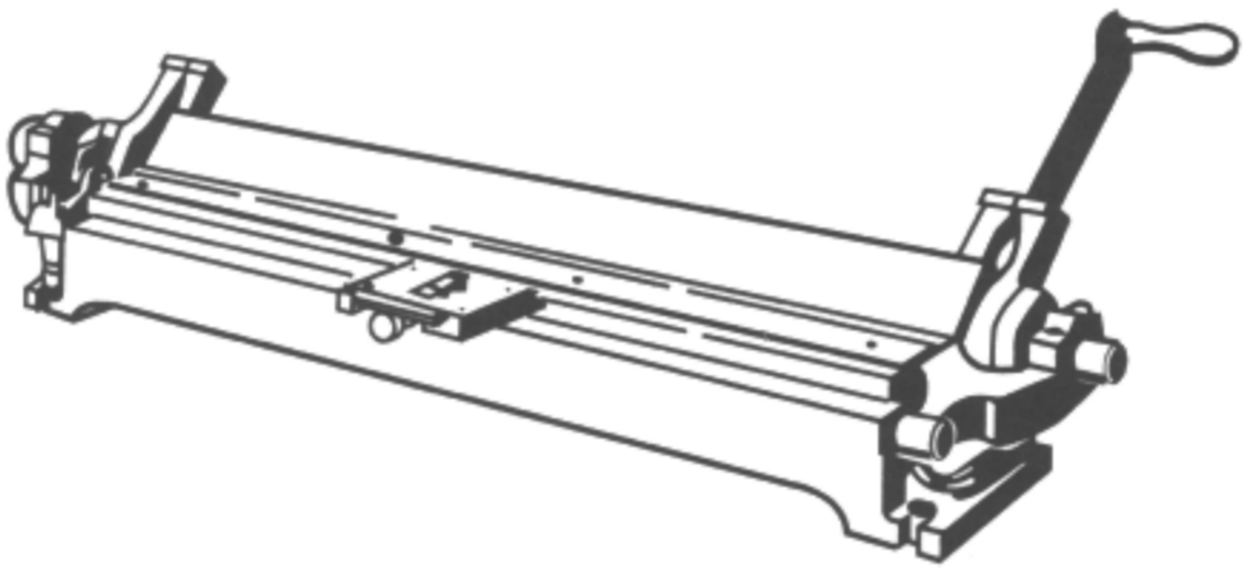
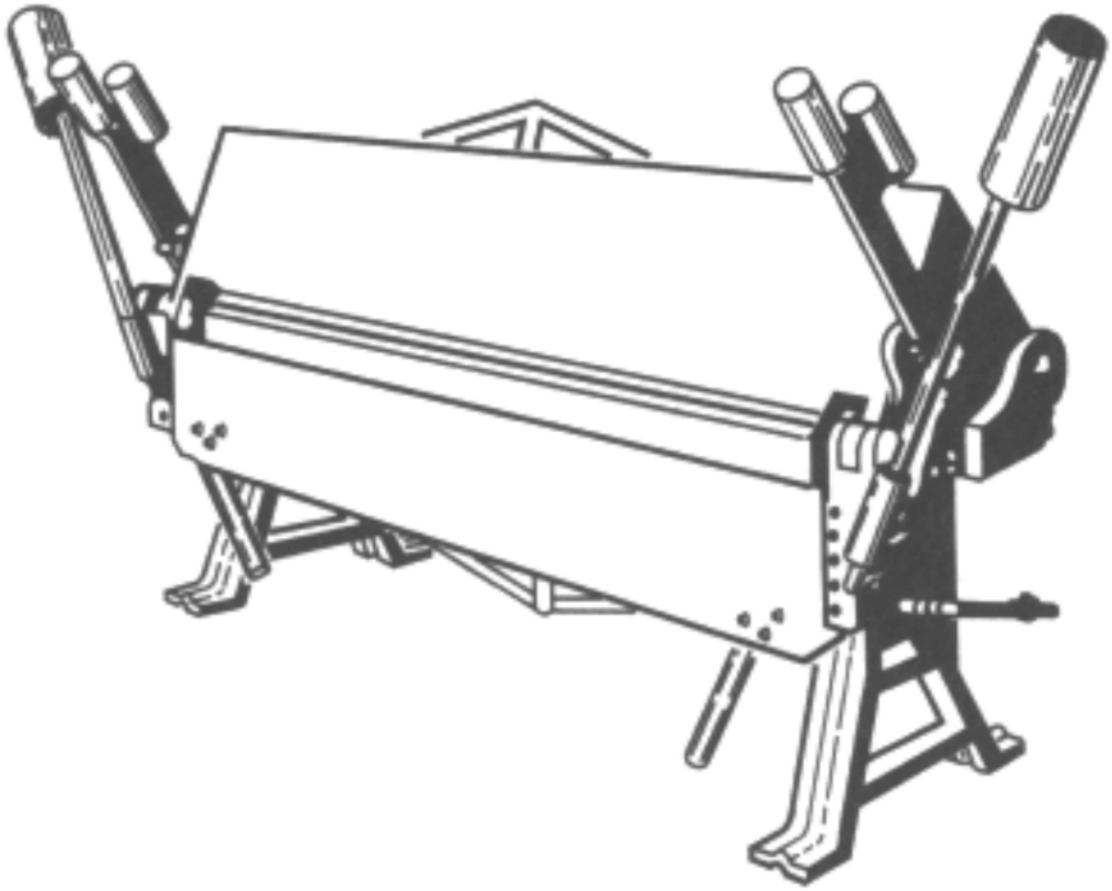
FORMING AND CUTTING TOOLS



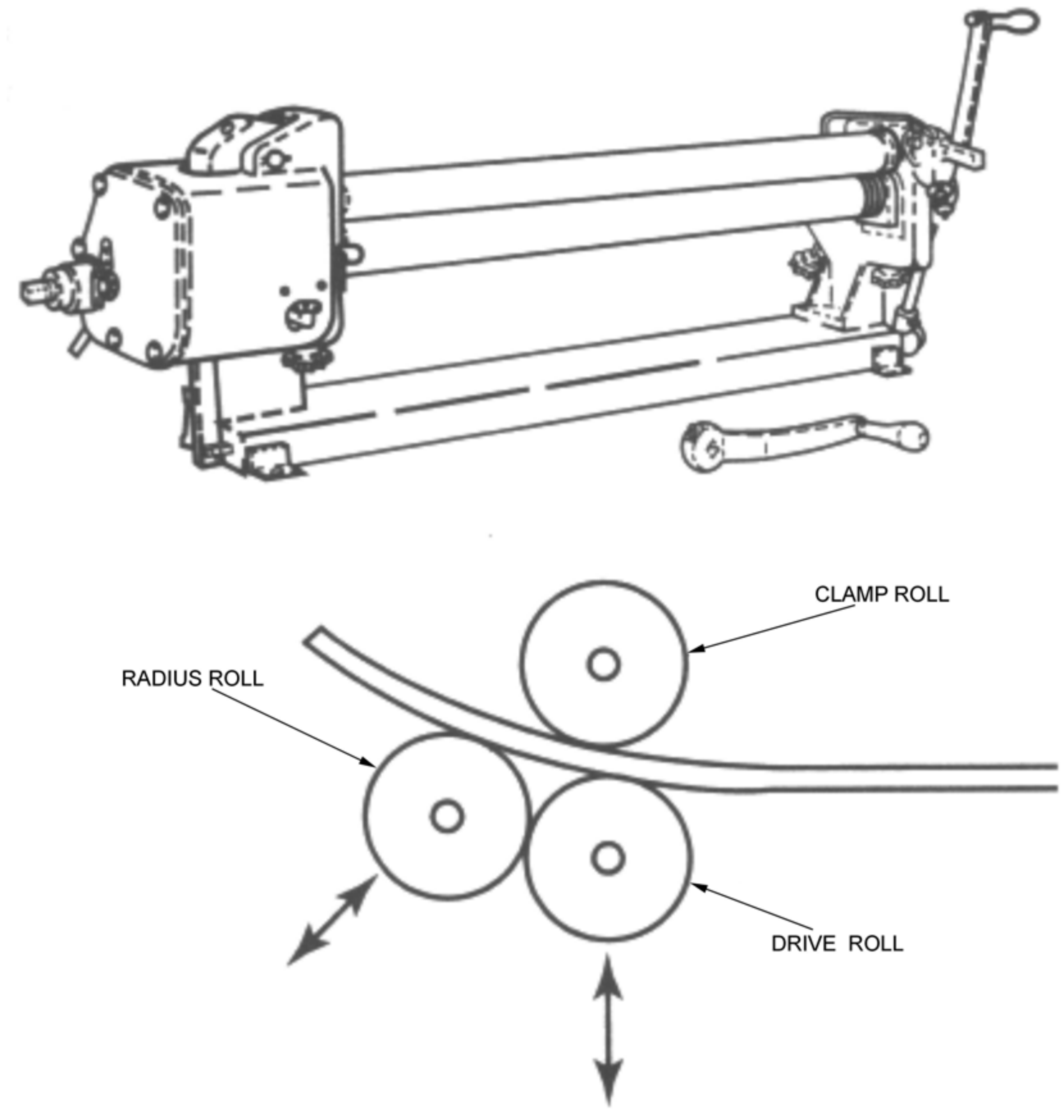
A&P Technician Airframe Textbook, Sanderson Training Systems (pp. 2-30)

Figure 17R-1 Bar Folding Machine



A&P Technician Airframe Textbook, Sanderson Training Systems (pp. 2-29)

Figure 17R-2 Cornice Break

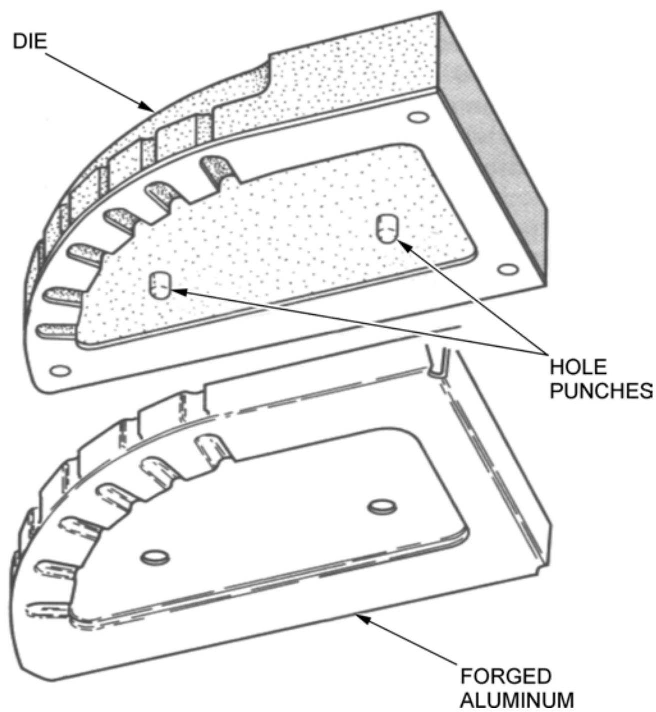


A&P Technician Airframe Textbook, Sanderson Training Systems (pp. 2-31)

Figure 17R-3 Slip Roll Former

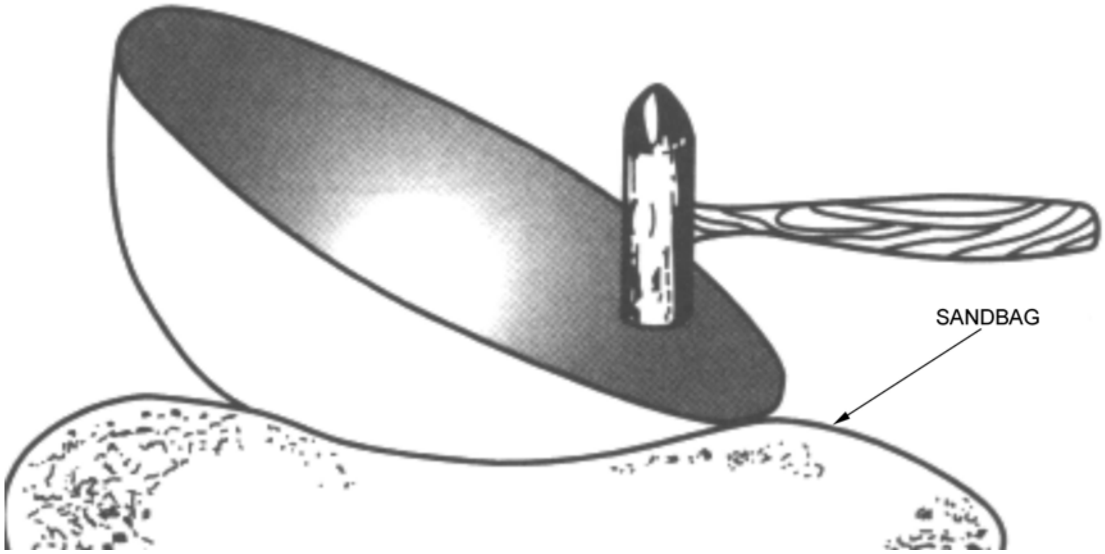
Triway YangZhong International Trade Company, Hydropress. Retrieved November 17, 2007, from http://www.nantex-triway.com/equipment.htm

Figure 17R-4 Hydropress



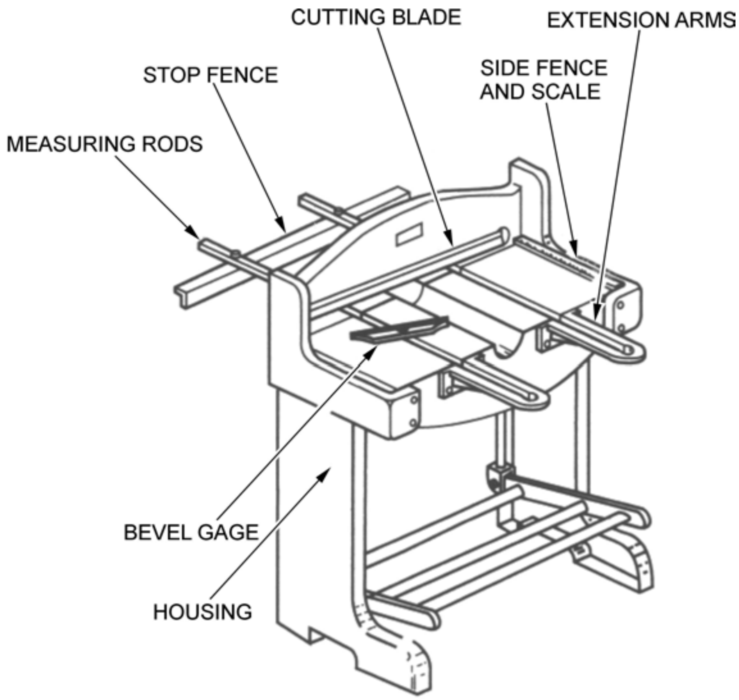
A&P Technician Airframe Textbook, Sanderson Training Systems (pp. 2-32)

Figure 17R-5 Hydropress Die With Forged Aluminum Product



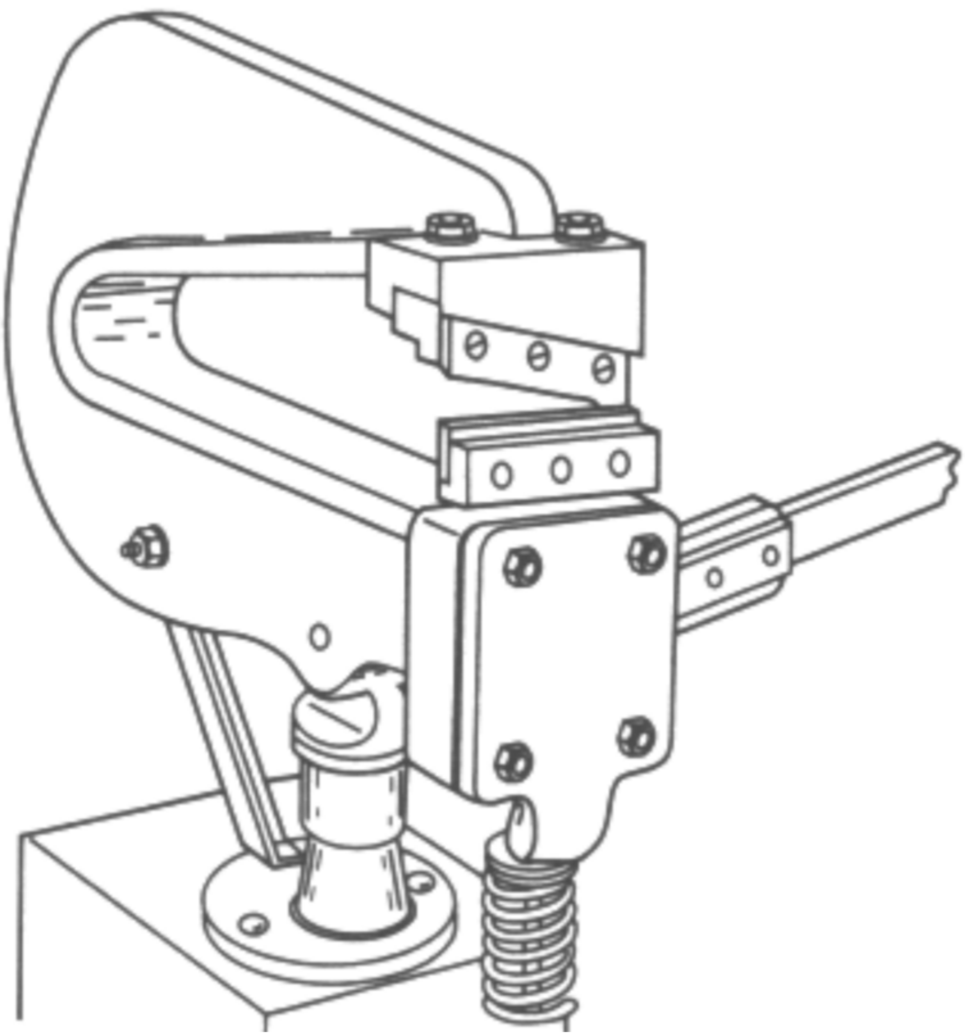
A&P Technician Airframe Textbook, Sanderson Training Systems (pp. 2-32)

Figure 17R-6 Sandbag Forming



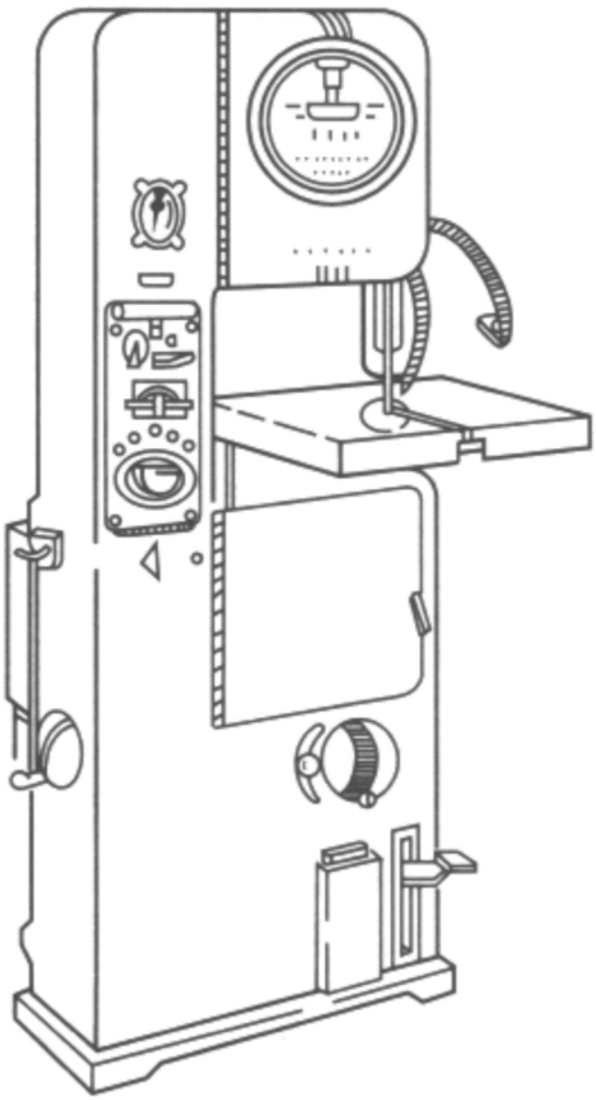
A&P Technician Airframe Textbook, Sanderson Training Systems (pp. 2-22)

Figure 17R-7 Squaring Shear



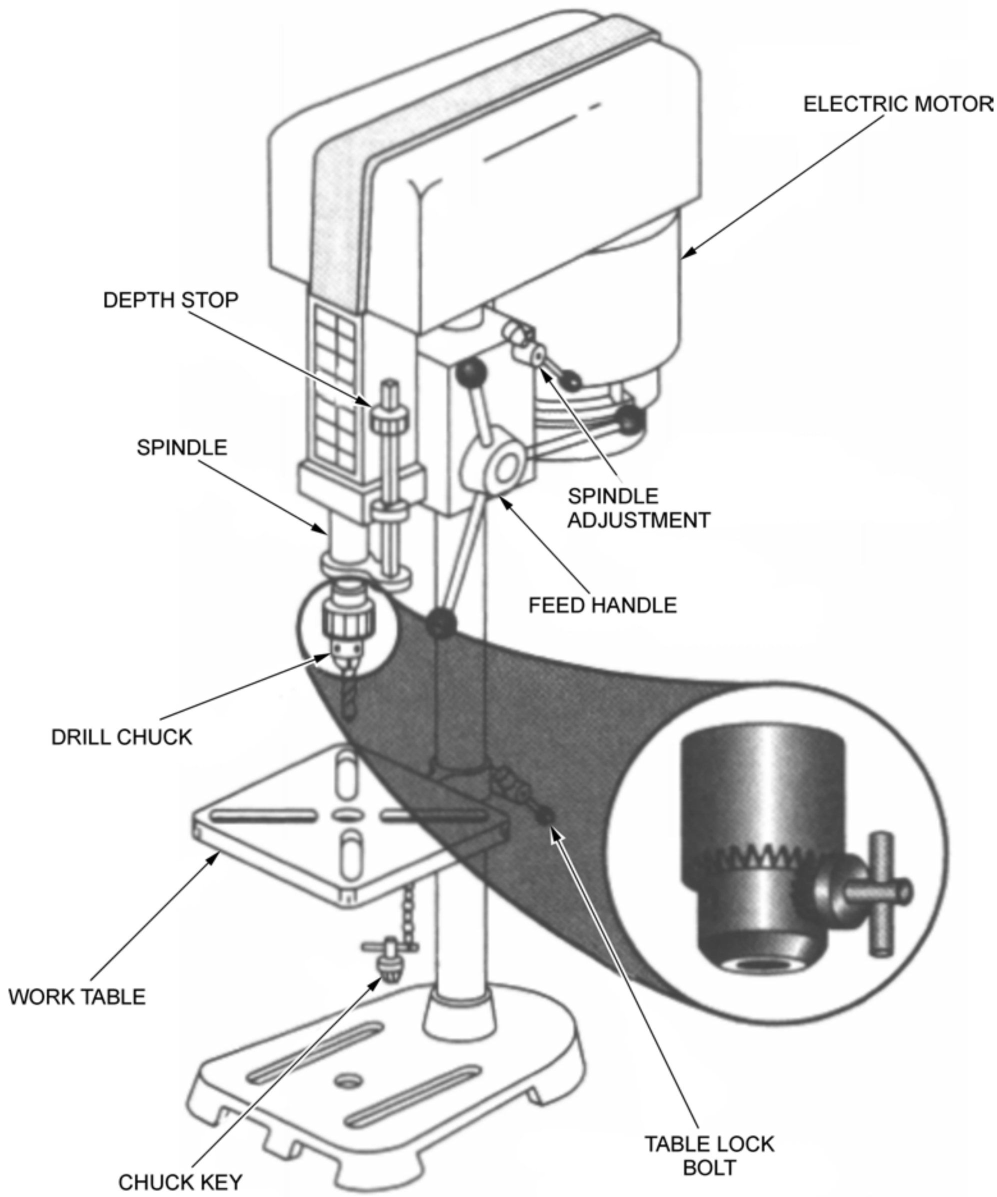
A&P Technician Airframe Textbook, Sanderson Training Systems (pp. 2-24)

Figure 17R-8 Scroll Shears



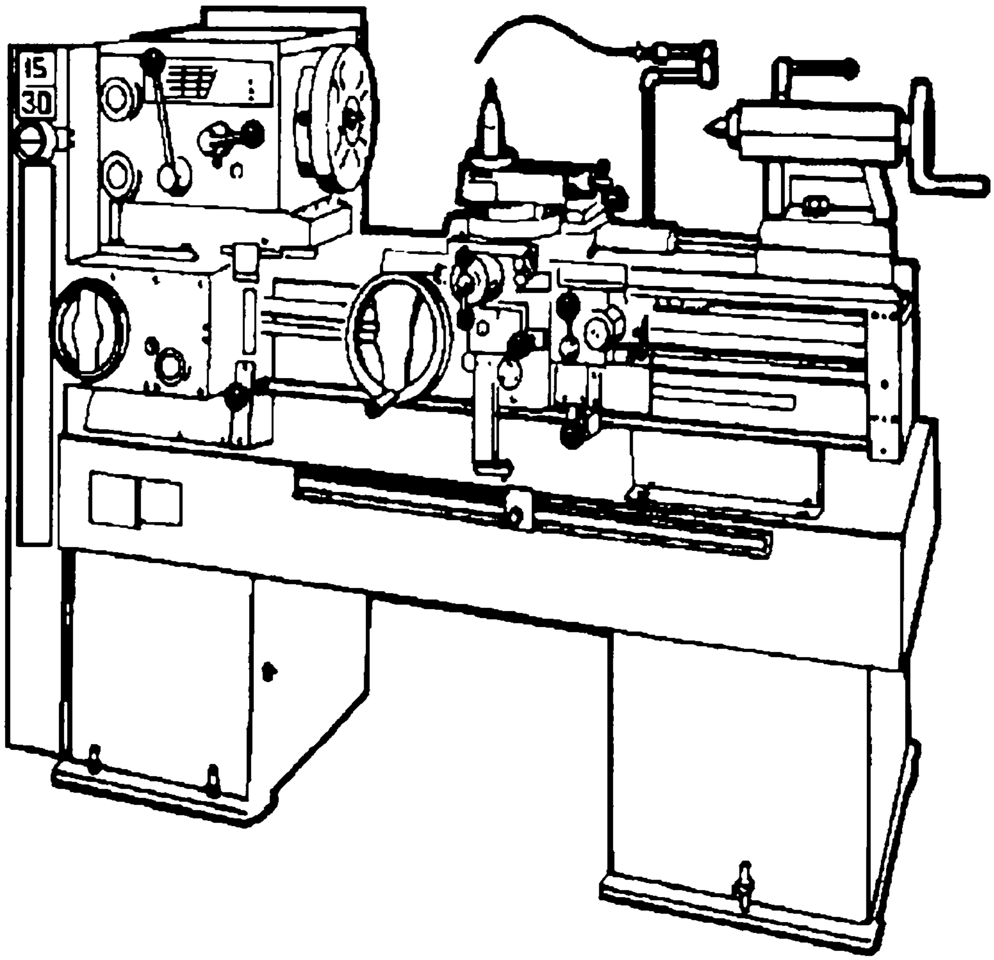
A&P Technician Airframe Textbook, Sanderson Training Systems (pp. 2-23)

Figure 17R-9 Band Saw



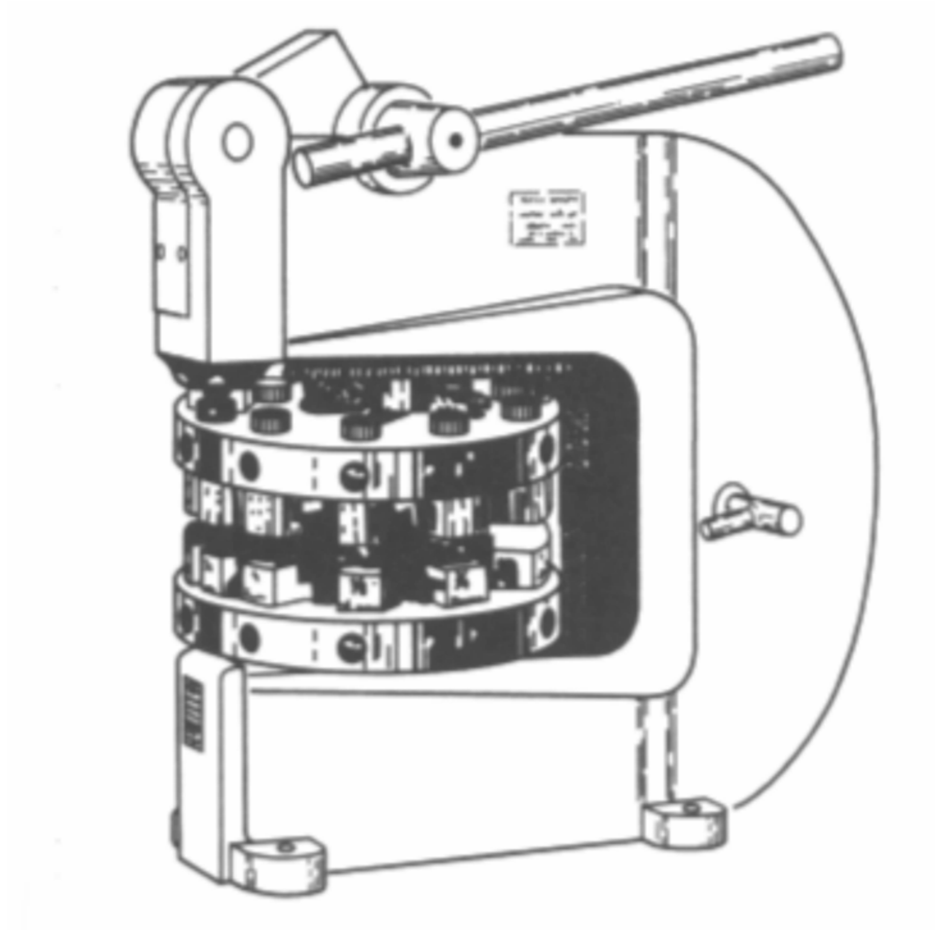
A&P Technician Airframe Textbook, Sanderson Training Systems (pp. 2-26)

Figure 17R-10 Drill Press



Fundamentals of Machine Tools, Headquarters Department of the Army Washington DC ,1996, Training Circular No. 9-524. Retrieved November 23, 2007, from http://metalworking.com/tutorials/army-TC-9-524/TOC.pdf

Figure 17R-11 Metal Lathe



A&P Technician Airframe Textbook, Sanderson Training Systems (pp. 2-23)

Figure 17R-12 Rotary Punch

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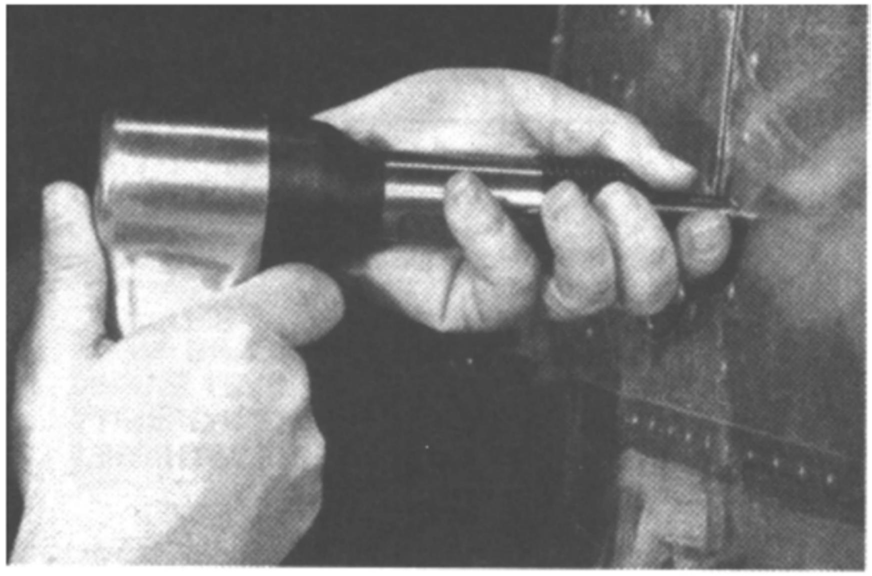
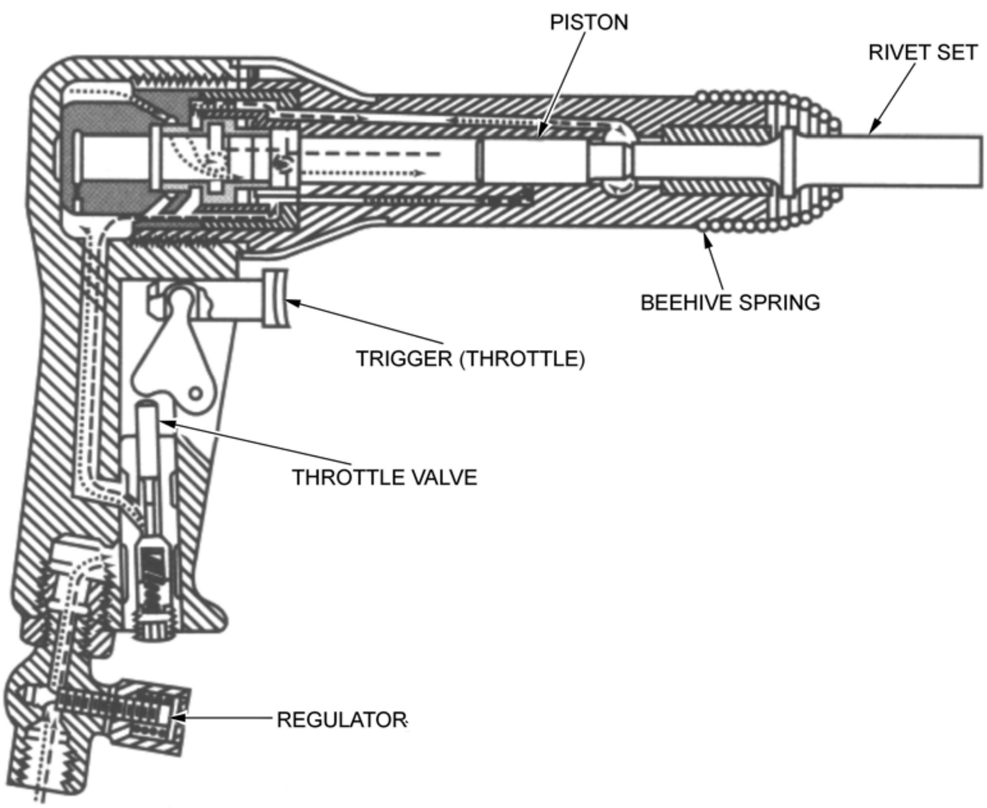
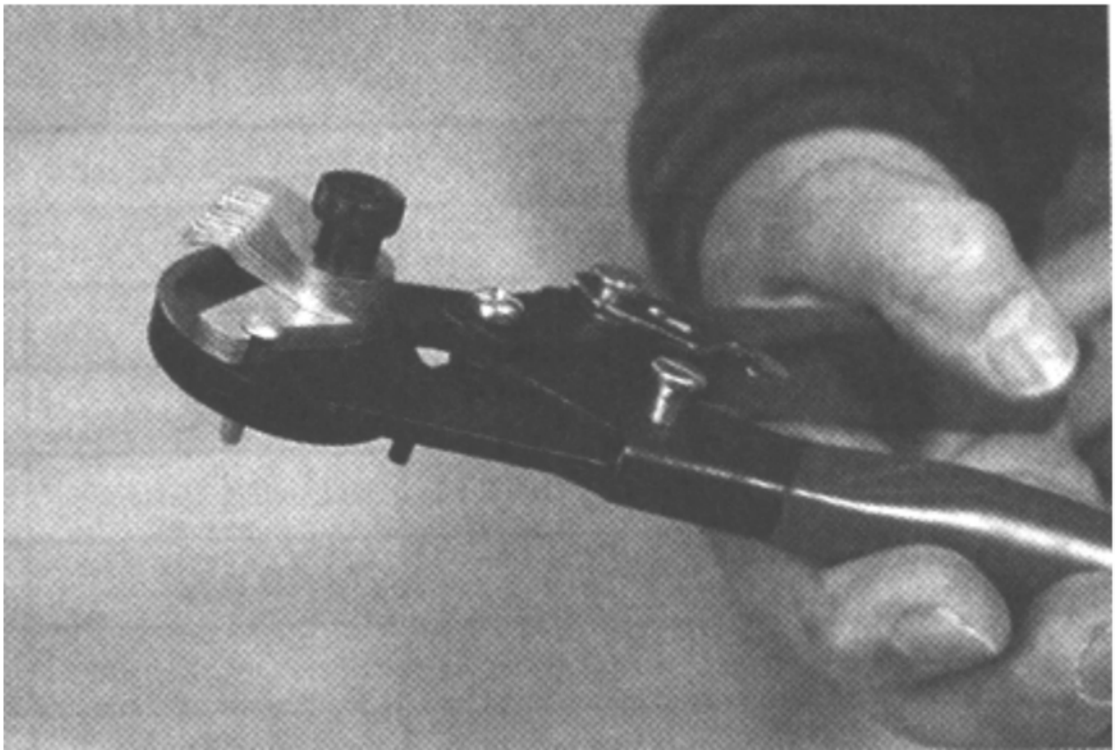
FASTENING TOOLS





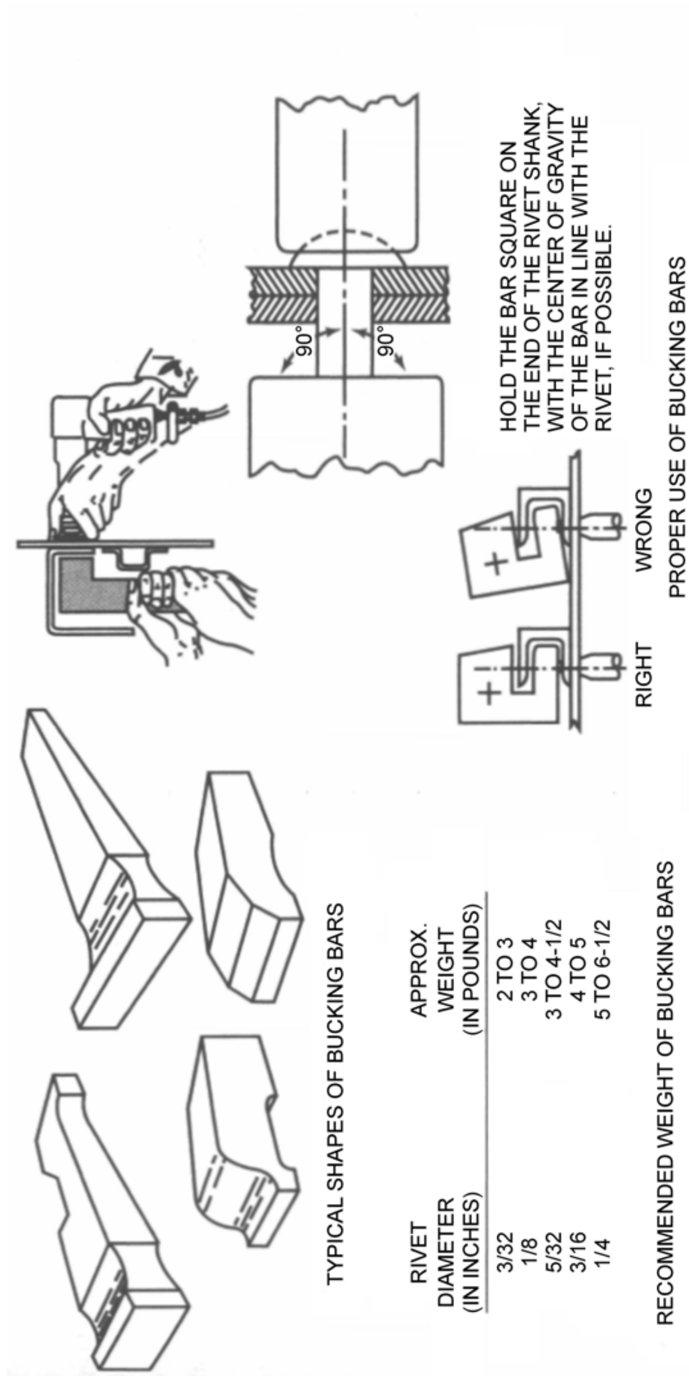
A&P Technician Airframe Textbook, Sanderson Training Systems (pp. 2-63 and 2-66)

Figure 17S-1 Rivet Gun



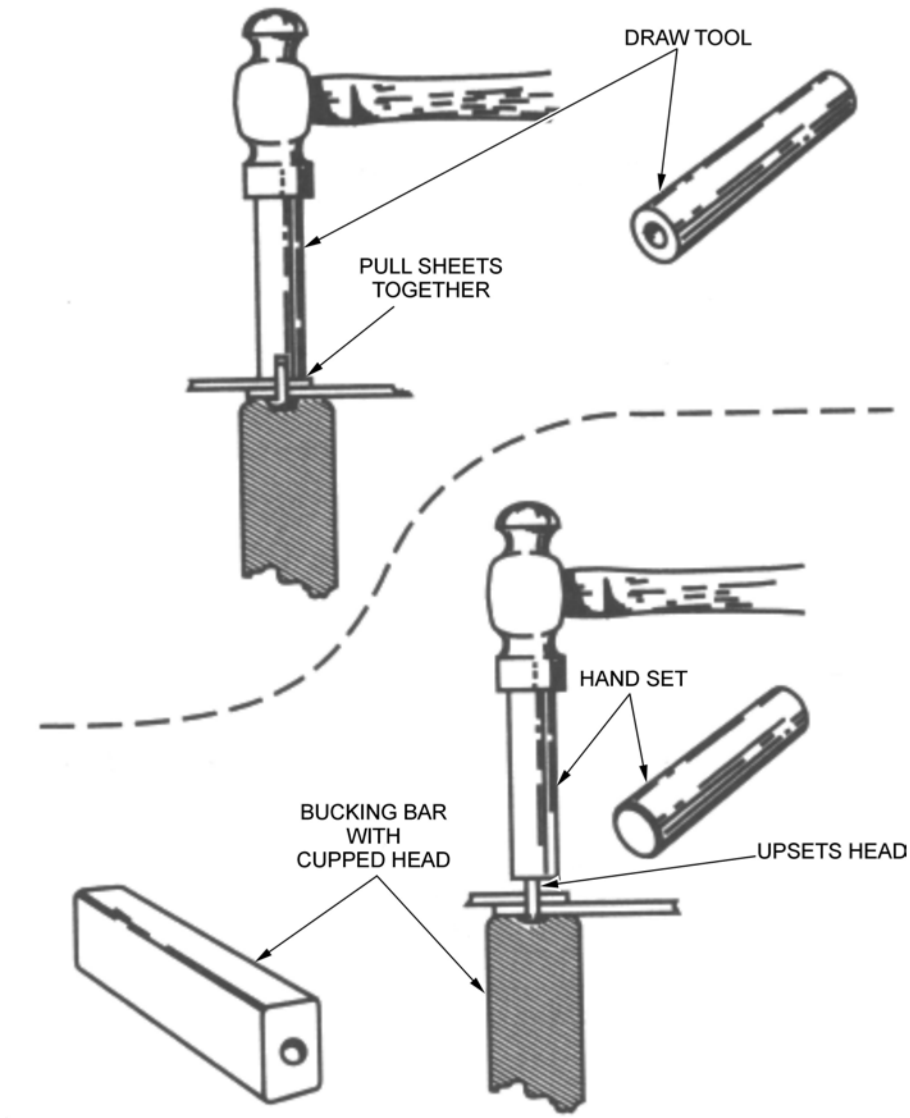
A&P Technician Airframe Textbook, Sanderson Training Systems (pp. 2-53)

Figure 17S-2 Rivet Cutter



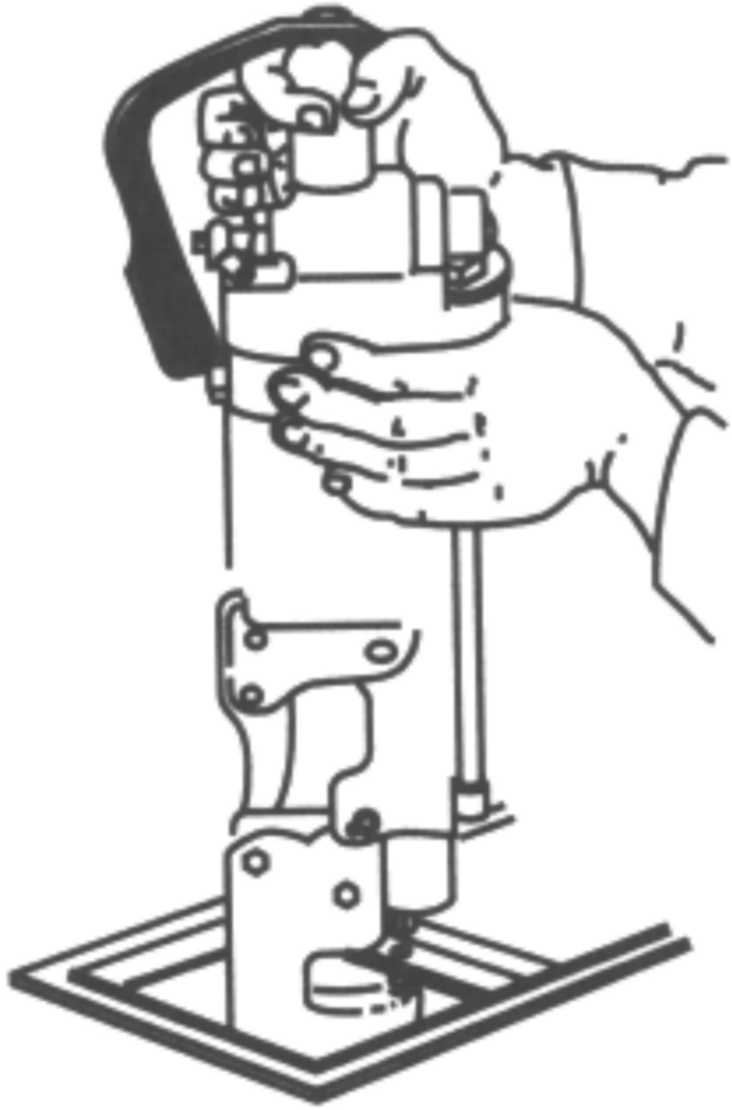
A&P Technician Airframe Textbook, Sanderson Training Systems (pp. 2-65)

Figure 17S-3 Bucking Bars



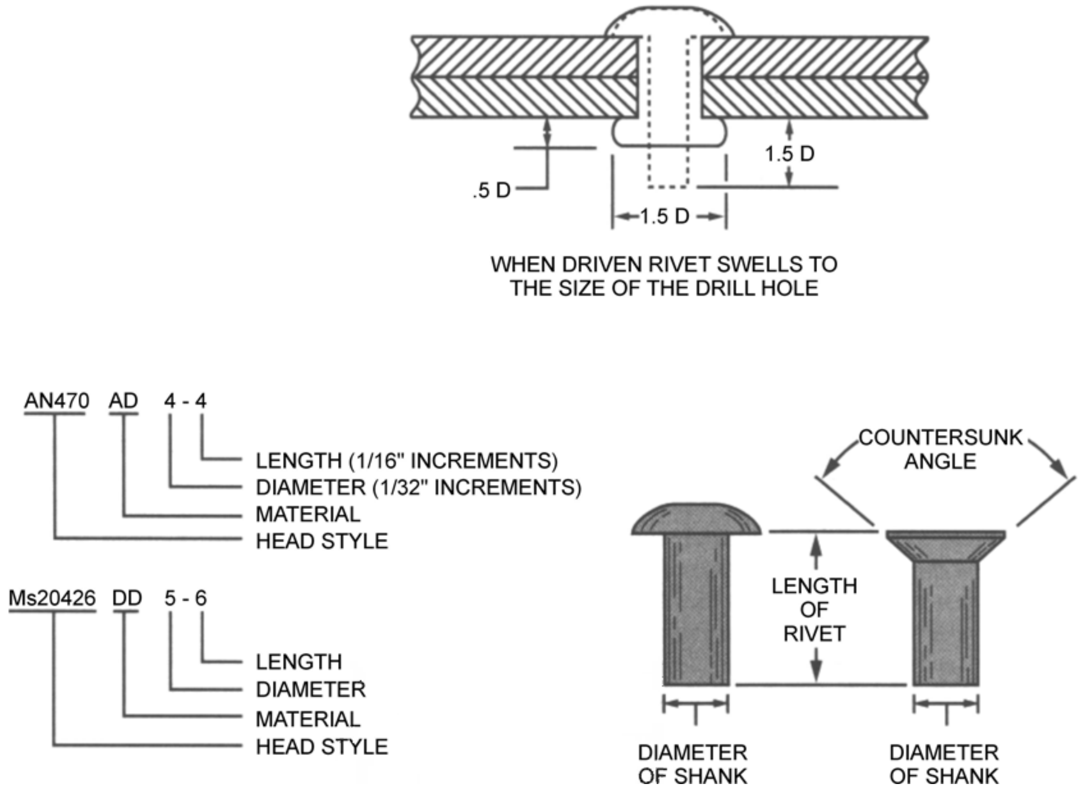
A&P Technician Airframe Textbook, Sanderson Training Systems (pp. 2-61)

Figure 17S-4 Hand Riveting



A&P Technician Airframe Textbook, Sanderson Training Systems (pp. 2-61)

Figure 17S-5 Squeezer



A&P Technician Airframe Textbook, Sanderson Training Systems (pp. 2-36)

Figure 17S-6 Rivet Applications, Dimensions and Designations

TOOLS AND MATERIALS REQUIRED TO CONSTRUCT AN ALUMINUM MODEL BIPLANE

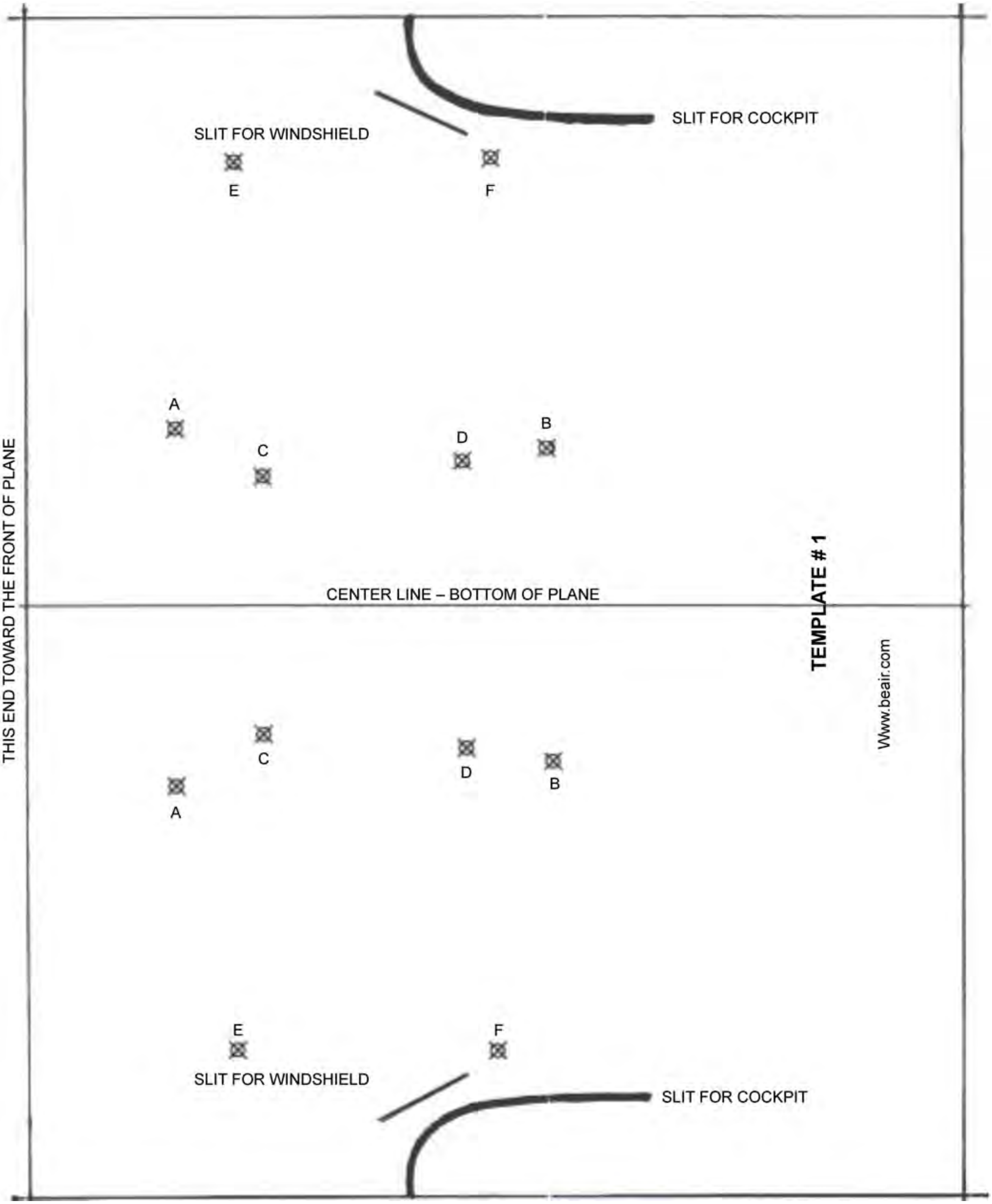
Tools

- Mechanic's gloves,
- Ball-peen hammer,
- Pliers,
- Flat screwdriver,
- Rasp,
- Hand stapler,
- Staple gun,
- Push-pin,
- Hot glue gun,
- Awl,
- Wire cutters,
- Box knife,
- Scissors,
- Ruler,
- Felt-tipped pen,
- Needle-nose pliers,
- Adjustable wrench,
- Electric hand drill,
- Hole saw 2-3/4 inch bits, and
- Hole saw 1-7/8 inch bits.

Materials

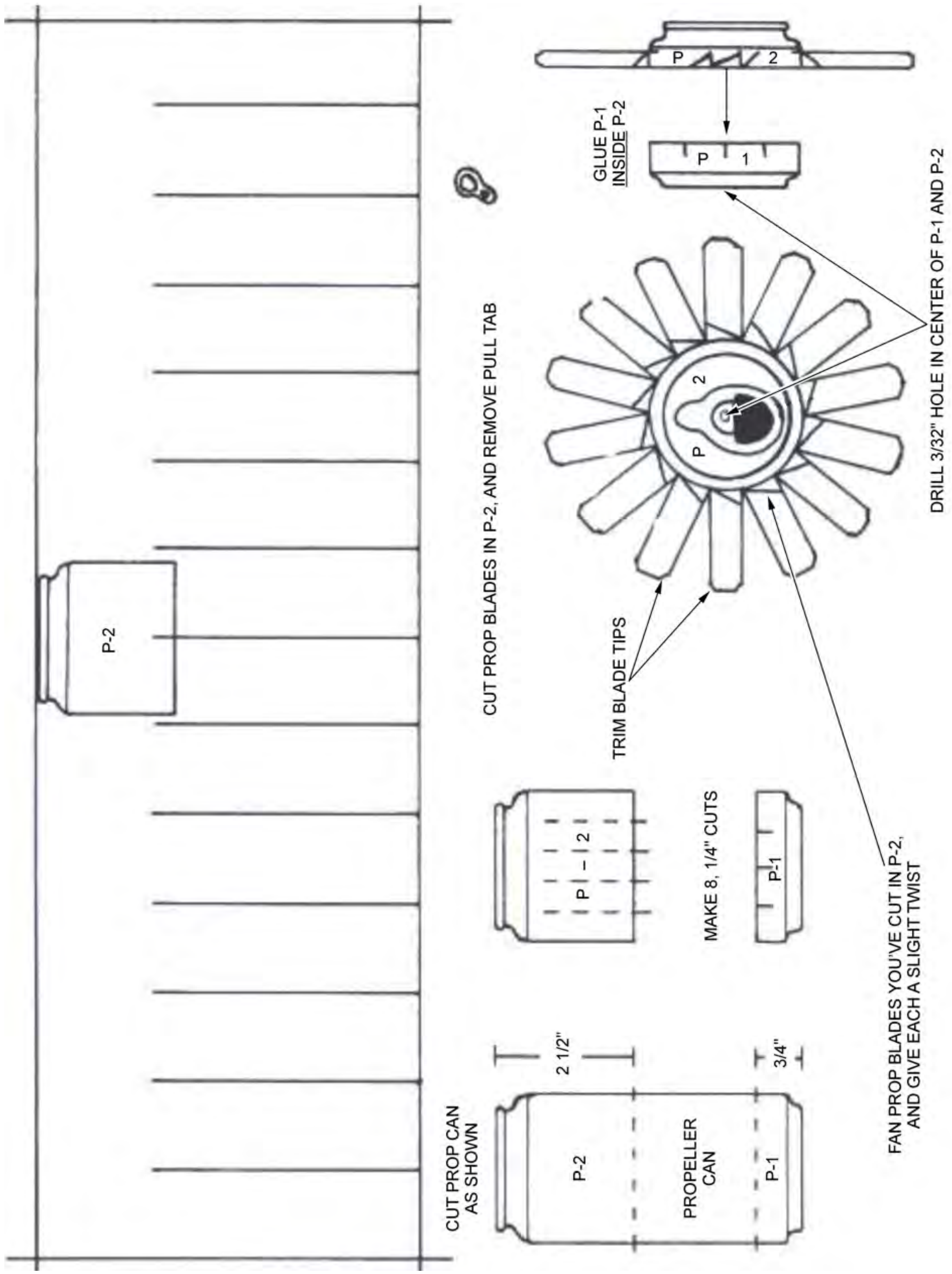
- Empty aluminum beverage cans (36 per cadet),
- Softwood, 20 mm thick (fence boards),
- Bottle caps (ten per cadet),
- Corrugated cardboard,
- Poster board,
- Tape (masking),
- Glue,
- Mylar,
- Copper-coated welding rod (2 sizes 1/16 inch and 3/32 inch),
- Cap nuts or toothpaste tube caps (two per aluminum model biplane),
- Bolts, 2-1/2 inch 10-24, with nuts (four per aluminum model biplane),

- Bolts, 3-1/2 inch 10-24, with nuts (eight per aluminum model biplane), and
- Wire clip (speed nut) to fit the copper coated welding rod (two per aluminum model biplane).



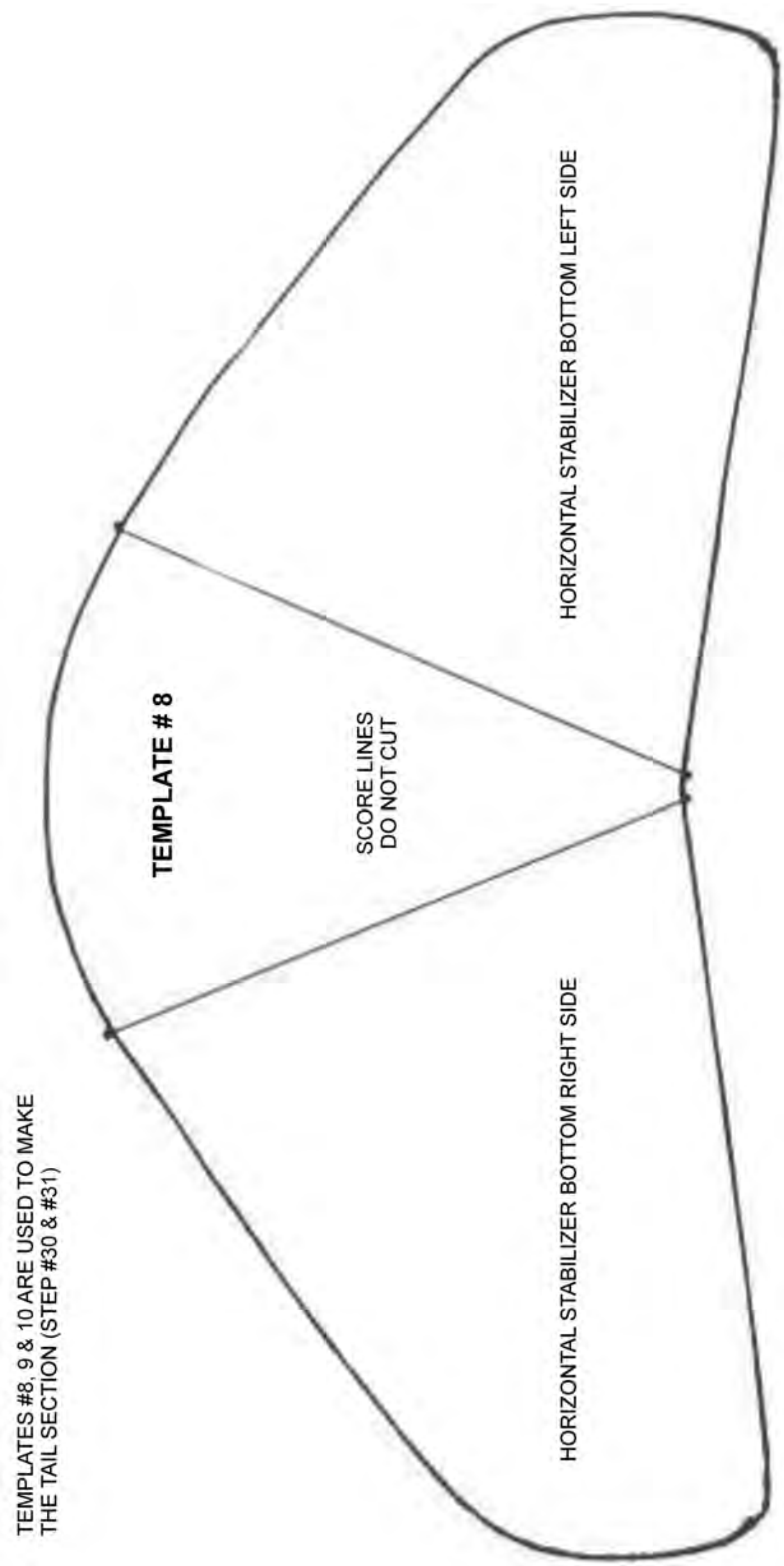
D. P. Mathis, Building the B.C. Air Originals Biplane, B.C. Air Originals (p. 3)

Figure 17T-1 Fuselage Template



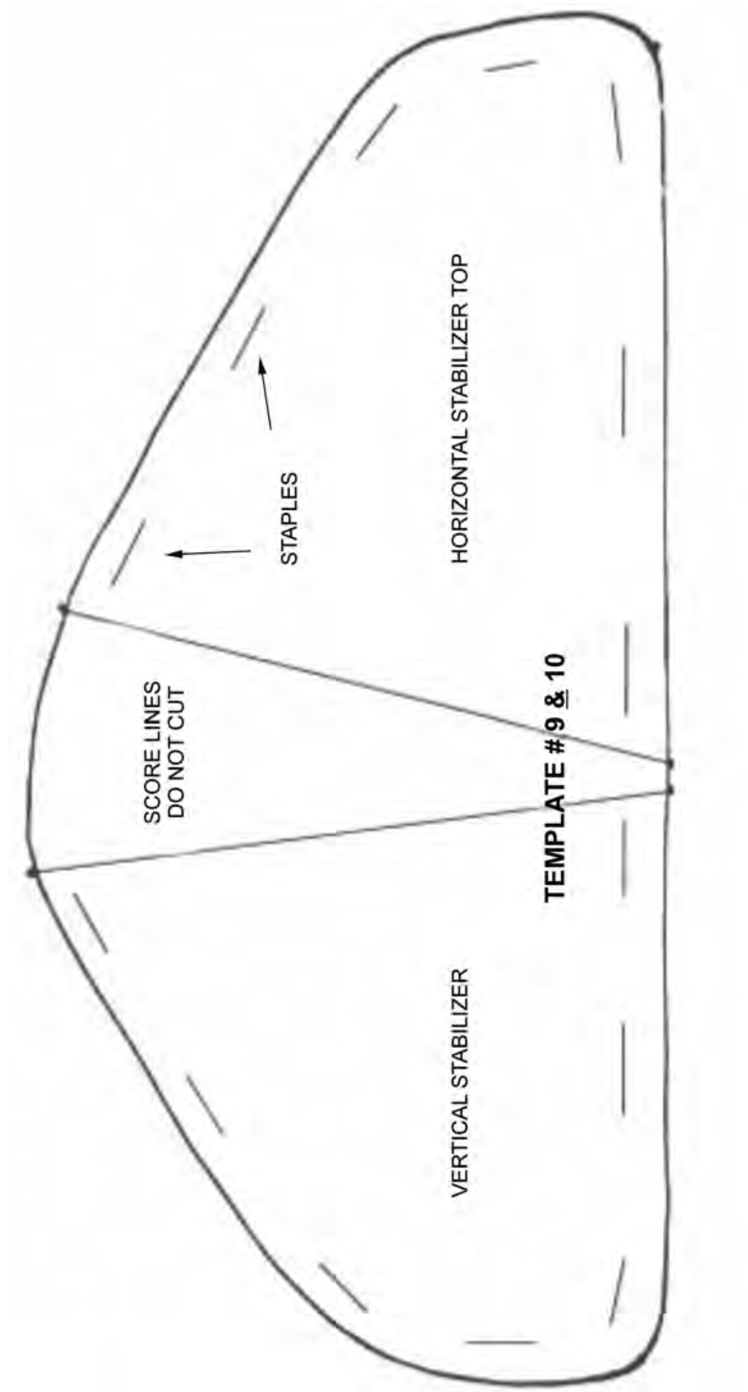
D. P. Mathis, Building the B.C. Air Originals Biplane, B.C. Air Originals (p. 21)

Figure 17T-2 Fuselage Template



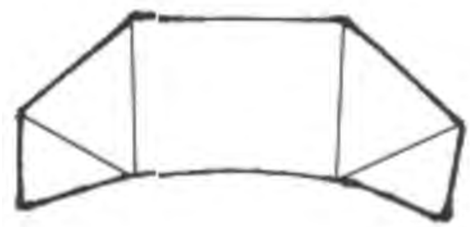
D. P. Mathis, Building the B.C. Air Originals Biplane, B.C. Air Originals (p. 20)

Figure 17T-3 Horizontal Stabilizer Bottom Template



D. P. Mathis, Building the B.C. Air Originals Biplane, B.C. Air Originals (p. 20)

Figure 17T-4 Left and Right Vertical Stabilizer Template



D. P. Mathis, Building the B.C. Air Originals Biplane, B.C. Air Originals (p. 20)

Figure 17T-5 Windshield Template

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RAW ALUMINUM MATERIAL ASSEMBLY LINE

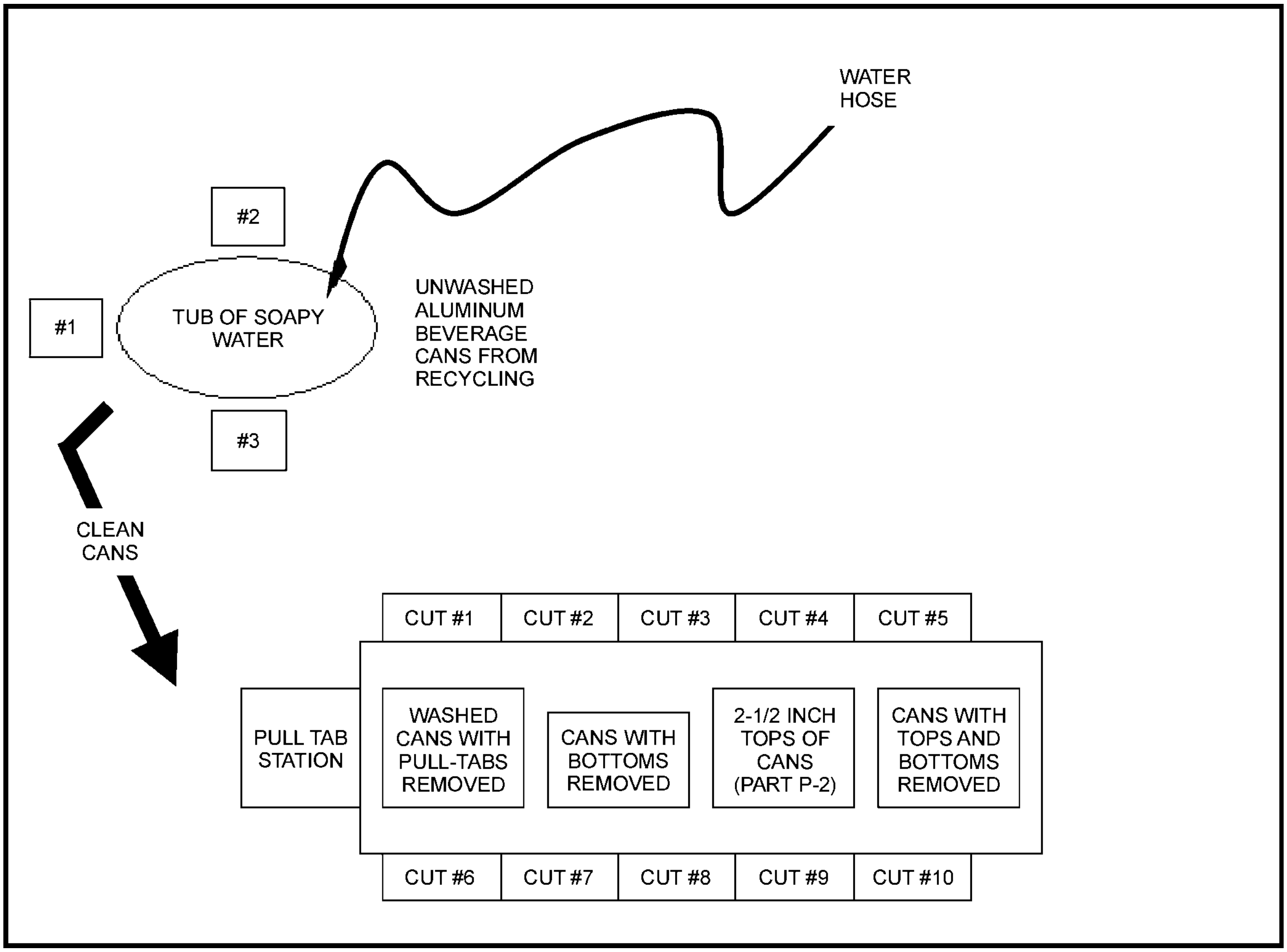

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Figure 17U-1 Raw Aluminum Material Assembly Line

1. Wash 17 cans.
2. Remove pull-tabs from all cans.
3. Cut tops and bottoms from 15 cans using box knives (to stock as raw material) (Figure 17U-2).
4. Cut bottom from one can (can B-1 to stock for fuselage) (Figure 17U-3).
5. Cut one 2-1/2-inch top from can for propeller (can-top P2 to stock) (Figure 17U-4).
6. Cut one 3/4-inch bottom from can for propeller cover (can bottom P1 to stock).

D. P. Mathis, Building the B.C. Air Originals Biplane, B.C. Air Originals (p. 5)

Figure 17U-2 Unended Can

D. P. Mathis, Building the B.C. Air Originals Biplane, B.C. Air Originals (p. 5)

Figure 17U-3 Bottomless Can

D. P. Mathis, Building the B.C. Air Originals Biplane, B.C. Air Originals (p. 5)

Figure 17U-4 Can Top P-2

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WOOD ASSEMBLY LINE

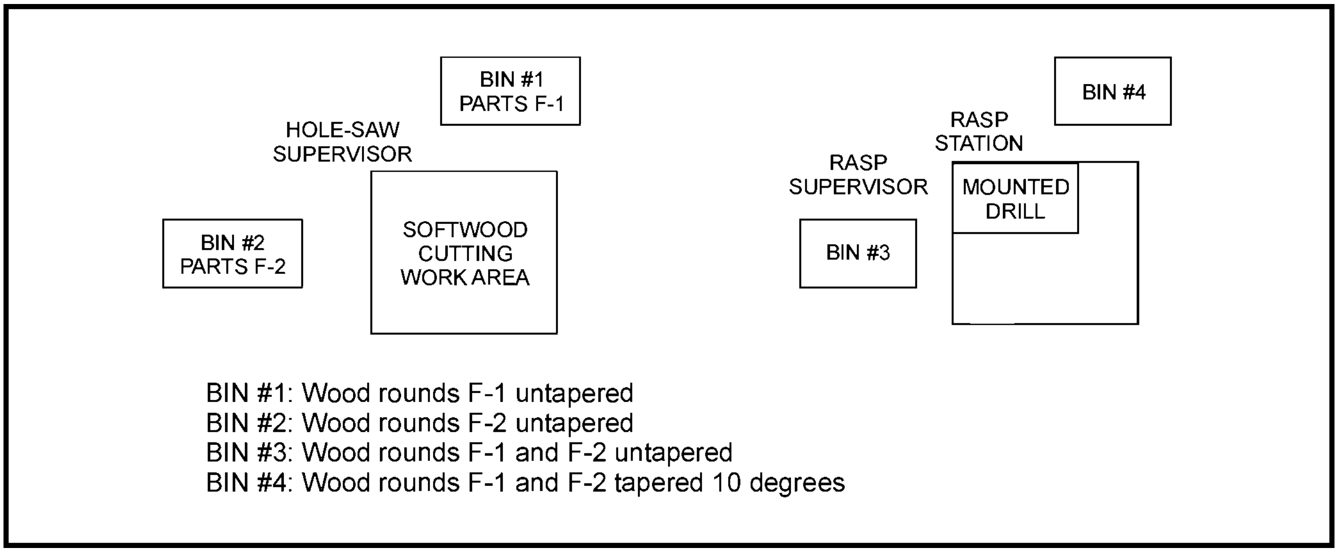

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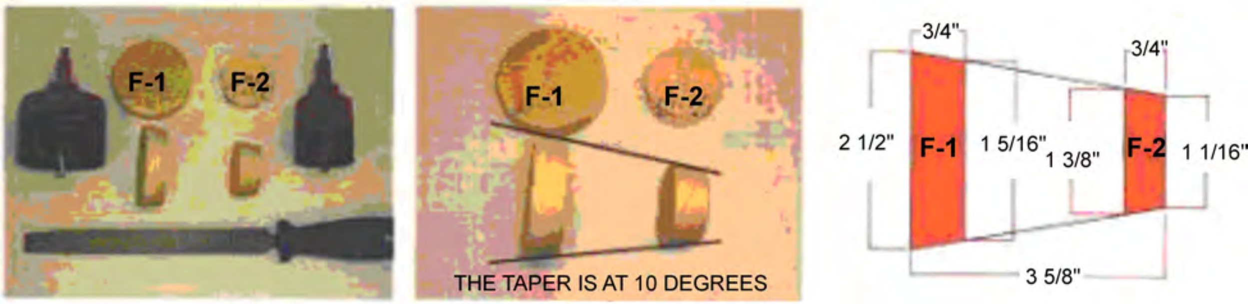
Figure 17V-1 Wood Assembly Line

For each aluminum model biplane to be constructed:

1. Cut one 3/4 inch thick softwood round 2-1/2 inch diameter for F-1.
2. Cut one 3/4 inch thick softwood round 1-5/8 inch diameter for F-2.
3. Place bolt through hole in centre of wood round.
4. Place nut on bolt and tighten.
5. Place bolt with wood round in electric drill.
6. Use the drill to spin the wood round (F-1) and use the rasp to taper the edge to 10 degrees (to stock as F-1).
7. Use the drill to spin the wood round (F-2) and use the rasp to taper the edge to 10 degrees (to stock as F-2).



D. P. Mathis, Building the B.C. Air Originals Biplane, B.C. Air Originals (p. 4)

Figure 17V-2 Steps to Make Rear Fuselage Parts

ALUMINUM BILLET ASSEMBLY LINE

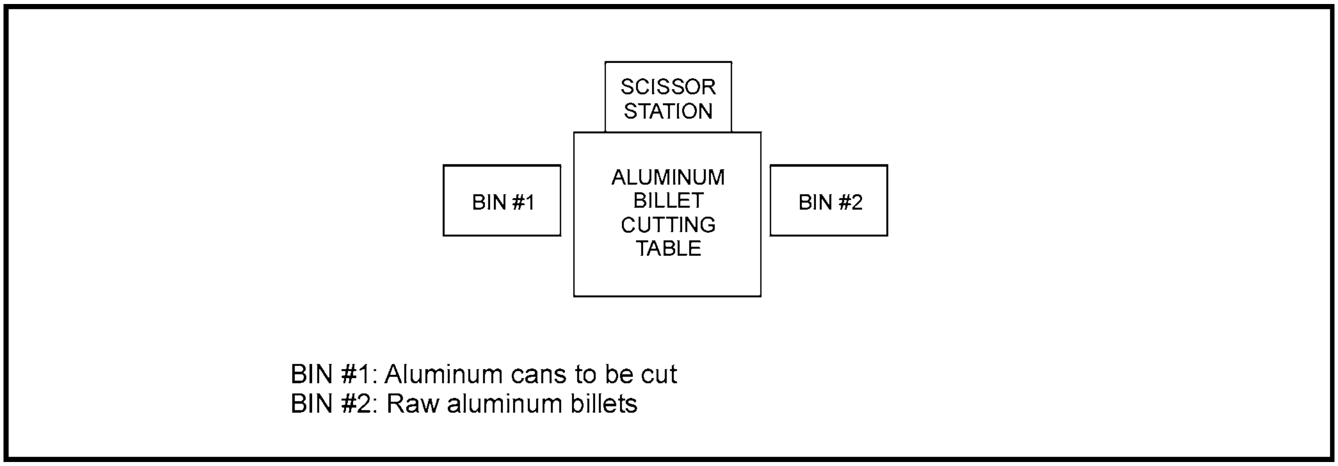


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Figure 17W-1 Aluminum Billet Assembly Line

For each aluminum model biplane to be constructed:

1. Cut 15 unended cans vertically through the nutrition label.
2. Do not attempt to flatten cans (to stock as raw billets).

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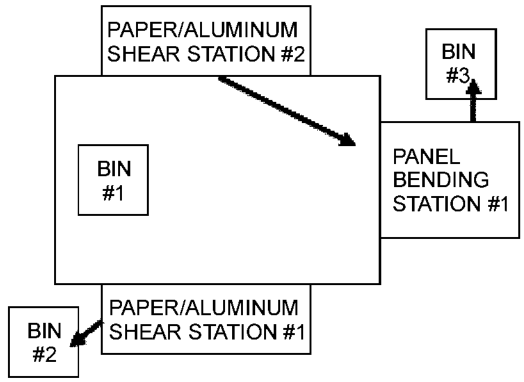
ALUMINUM PANEL SHEARING ASSEMBLY LINE



BIN #1: Raw aluminum billets from stock
BIN #2: Aluminum billets (dimensions of 2-5/8 inch by 8-1/8 inch) for under-wing panels
BIN #3: Aluminum billets (dimensions of 3-5/8 inch by 8-1/8 inch) for wing panels bent to 90 degrees on the 1/8-inch edge

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Figure 17X-1 Aluminum Panel Shearing Assembly Line

For each aluminum model biplane to be constructed:

1. Cut five billets to dimensions of 3-5/8 inch by 8-1/8 inch for wing panels (Figure 17X-2).
2. Bend these wing panels edges down 90 degrees on each 8-1/8 inch edge (to stock).
3. Cut five cans to dimensions of 2-5/8 inch by 8-1/8 inch for under-wing panels (Figure 17X-3) (to stock).

D. P. Mathis, Building the B.C. Air Originals Biplane, B.C. Air Originals (p. 5)

Figure 17X-2 Wing Top Panels

D. P. Mathis, Building the B.C. Air Originals Biplane, B.C. Air Originals (p. 5)

Figure 17X-3 Under-Wing Panels

CARDBOARD INSERT ASSEMBLY LINE

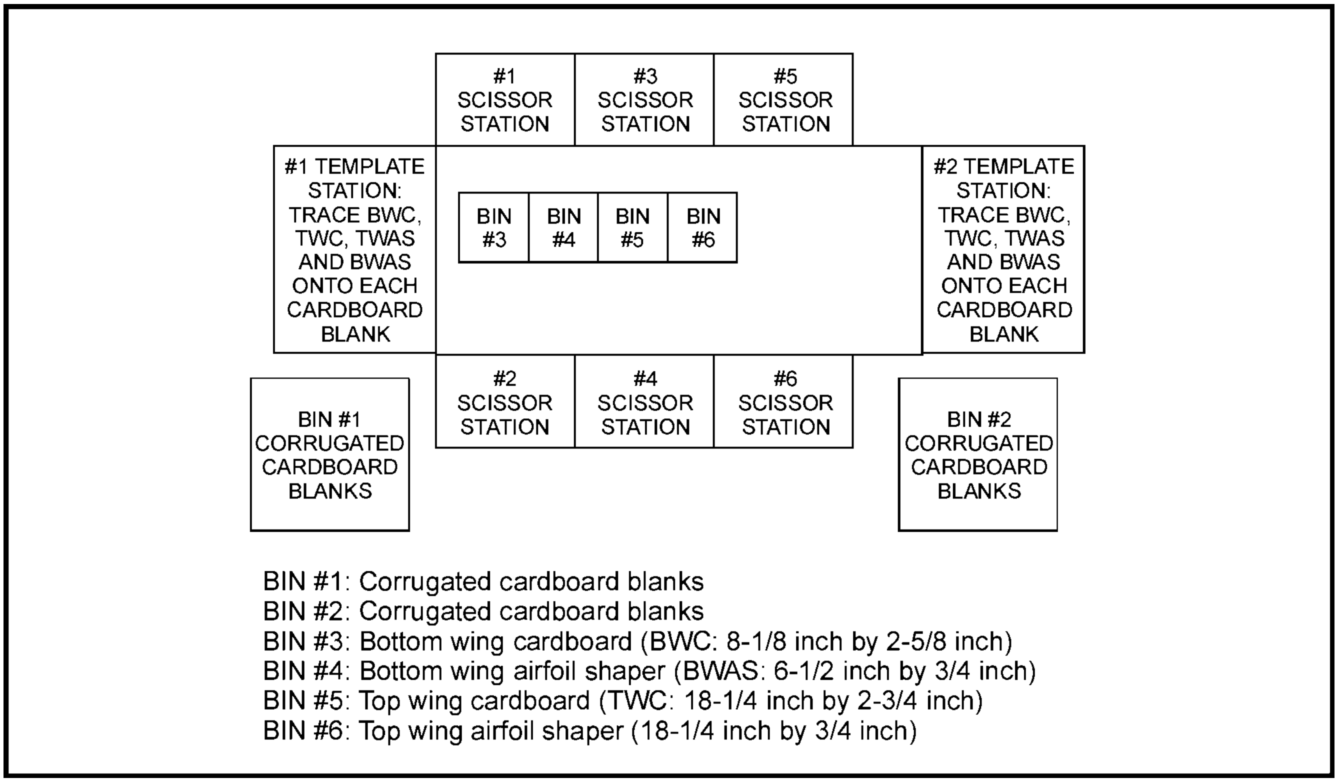

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Figure 17Y-1 Cardboard Insert Assembly Line

For each aluminum model biplane to be constructed, cut and place into stock:

1. two bottom wing cardboard sections (BWC) 8-1/8 inch by 2-5/8 inch,
2. two cardboard bottom wing airfoil sections (BWAS) 6-1/2 inch by 3/4 inch,
3. two top wing cardboard sections (TWC) 18-1/4 inch by 2-3/4 inch, and
4. two cardboard top wing airfoil sections (TWAS) 18-1/4 inch by 3/4 inch.

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WIRE STATION ASSEMBLY LINE

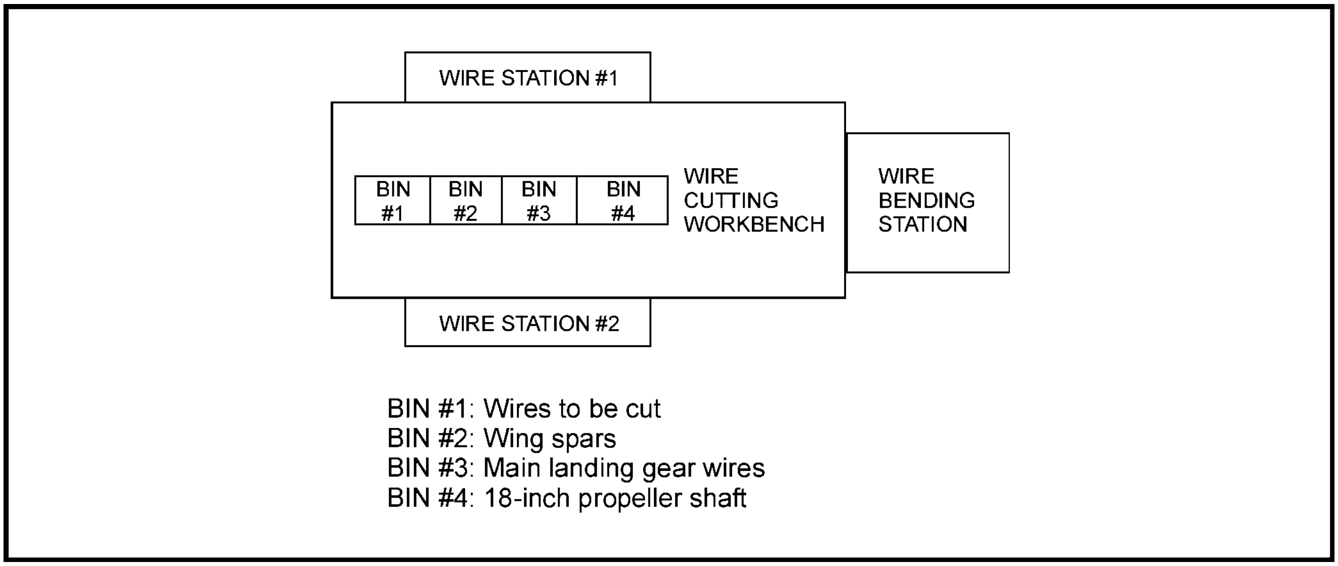

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Figure 17Z-1 Wire Station Assembly Line

For each aluminum model biplane to be constructed:

1. Cut two pieces of 3/32-inch wire 15-3/4 inches long (to stock for wing spars).
2. Cut one piece of 3/32-inch wire 18 inches long (to stock for propeller shaft).
3. Cut one piece of 3/32-inch wire 7-3/4 inches long (for main landing gear).
4. Bend the wire that is 7-3/4 inches long to main landing gear shape (Figure 17Z-2) (to stock).

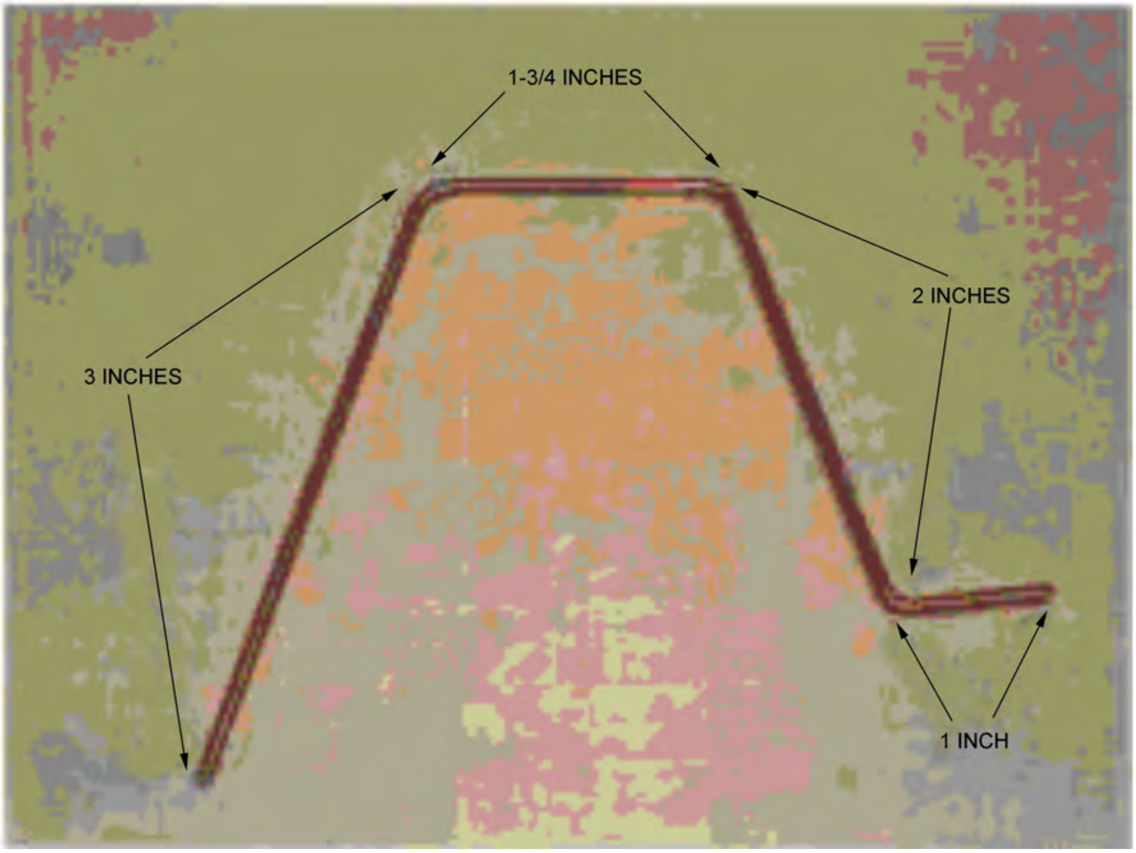

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Figure 17Z-2 First Bends of the Landing Gear

DRILL STATION ASSEMBLY LINE

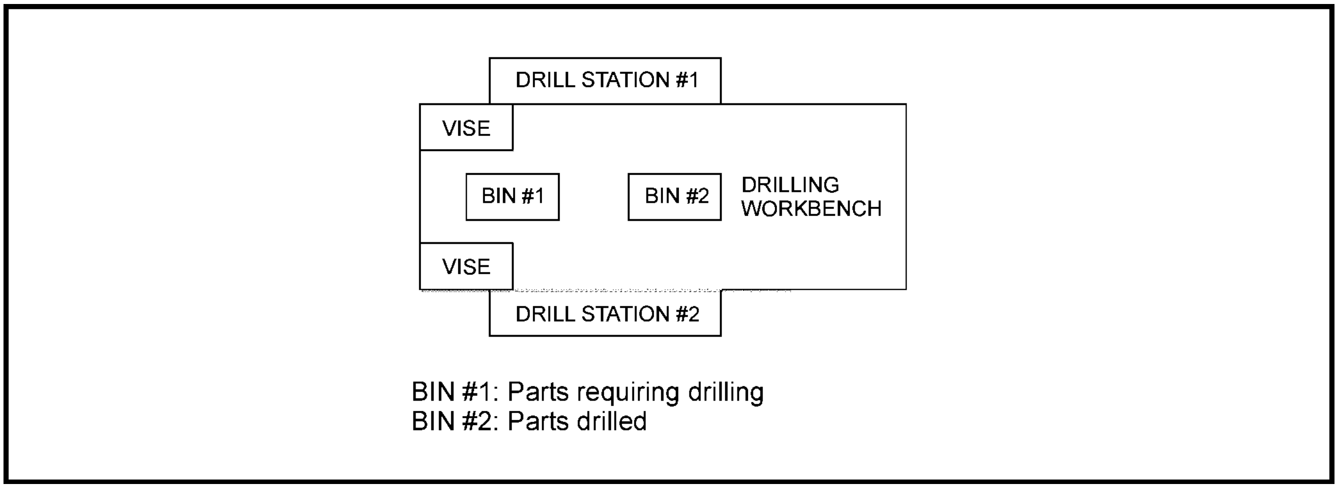

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Figure 17AA-1 Drill Station Assembly Line

For each aluminum model biplane to be constructed:

1. Drill a 3/32-inch hole in the centre of four bottle caps (to stock for wheels).
2. Drill a 3/32-inch hole in the centre of one can B-1 (Figure 17AA-2) (to stock for front fuselage).
3. Drill a 3/32-inch hole in the centre of one can P-2 (to stock for propeller).
4. Drill a 3/32-inch hole in the centre of one can P-1 (to stock for propeller face).
5. Get fuselage from stock.
6. Enlarge holes A, B and C in fuselage assembly to 3/32 inch (fuselage from stock).
7. Enlarge hole D in fuselage assembly to 1/16 inch (fuselage from stock).
8. Enlarge holes E and F in fuselage assembly to bolt size, as required.
9. Get top wing from stock.
10. Enlarge eight bolt holes in top wing for bolts as required (return top wing to stock).
11. Get fuselage and attached bottom wing from stock.
12. Enlarge four bolt holes in bottom wing as required (return fuselage and bottom wing to stock).
13. Insert under-wing panel (dimensions 2-5/8 inch by 8-1/8 inch) into right wing.

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Figure 17AA-2 The Fuselage Centre-Line Hole

ALUMINUM REAR FUSELAGE ASSEMBLY LINE

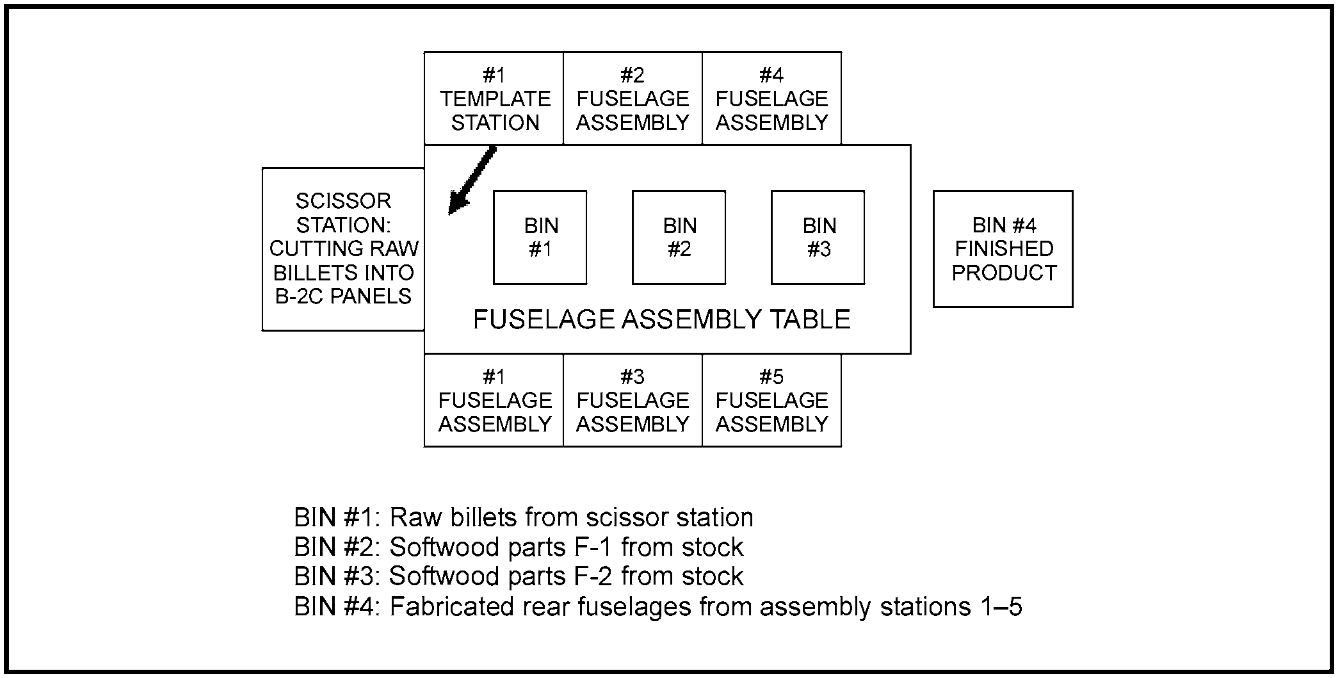

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Figure 17AB-1 Aluminum Rear Fuselage Assembly Line

For each aluminum model biplane to be constructed:

1. Mark one raw billet as B-2C rear fuselage.
2. Cut triangle from one raw billet to create B-2C rear fuselage (Figure 17AB-2) (to stock as B-2C).
3. Combine wood F1 and F2 with B-2C and staple to make rear fuselage B-2 (Figure 17AB-3) (to stock as B-2).

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Figure 17AB-2 Triangle Cut

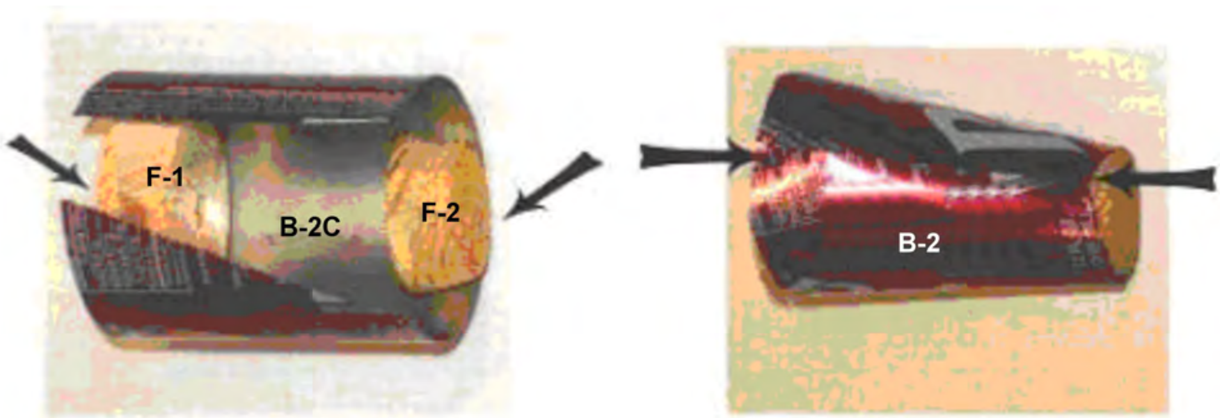

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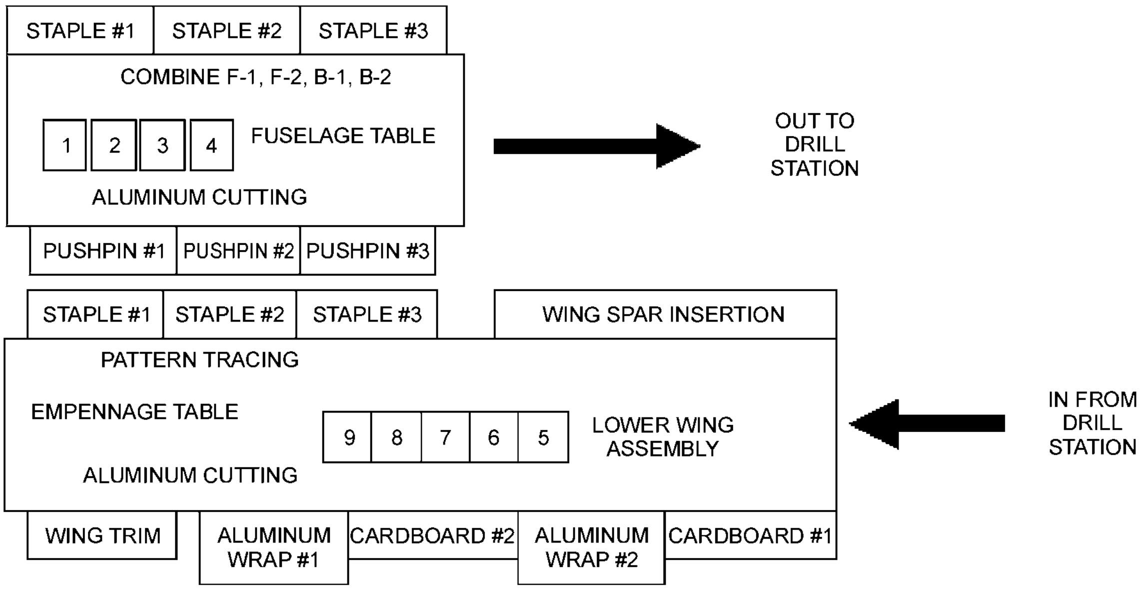
Figure 17AB-3 Completing the Rear Fuselage

FUSELAGE AND BOTTOM WING ASSEMBLY LINE



BIN #1: Wood part F-1
BIN #2: Wood part F-2
BIN #3: Aluminum part B-1
BIN #4: Aluminum part B-2
BIN #5: Drilled fuselages from drill station
BIN #6: Wing spars
BIN #7: Pre-bent aluminum panels 3-5/8 inch by 8-1/8 inch
BIN #8: Aluminum under-wing panels 2-5/8 inch by 8-1/8 inch
BIN #9: Completed fuselages with lower wing attached (to stock)

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Figure 17AC-1 Fuselage and Bottom Wing Assembly Line

For each aluminum model biplane to be constructed:

1. Combine parts F-1, F-2, B-1 and B-2 with staples to make a full fuselage (Figure 17AC-2).
2. Slide Template No. 1 over full fuselage (Figure 17AC-3).
3. Use push-pins to create holes in fuselage through Template No. 1.
4. Trace, but do not cut, the openings for the cockpit and windshield.
5. Remove Template No. 1 from fuselage (to stock for Drill Station).
6. Insert bottom wing spars in fuselage holes A and B (spars/fuselage from stock).
7. Tape cardboard parts BWC to bottom wing spars (BWC and spars from stock) (Figure 17AC-4).
8. Tape or glue cardboard part BWAS to top of BWC (BWAS/BWC from stock).
9. Repeat Steps 7. and 8. for other wing.
10. Wrap top of left bottom wing with pre-bent aluminum panel (from stock) (Figure 17AC-5).

11. Wrap top of right bottom wing with pre-bent aluminum panel (Figure 17AC-6) (from stock).
12. Insert under-wing panel (dimensions 2-5/8 inch by 8-1/8 inch) into left wing (Figure 17AC-7).
13. Insert under-wing panel (dimensions 2-5/8 inch by 8-1/8 inch) into right wing (Figure 17AC-7).
14. Staple panels (three staples) at left wing tip (Figure 17AC-8).
15. Staple panels (three staples) at right wing tip (Figure 17AC-8).
16. Trim wing tips to desired shape.
17. Make two slits for the windshield (Figure 17AC-9).
18. Trim cockpit aluminum to avoid blocking pilot hole in F-1 (Figure 17AC-10).
19. Carefully turn biplane upside down.
20. Split cockpit back in half so it will fold down and place wire insulation on cockpit edging (Figure 17AC-11).
21. Turn the Wing Bolt Hole Placement Template (WBHPT) upside down also, and apply WBHPT to the underside of the bottom wing Figure 17AC-12).
22. With a push-pin, make holes for four outer bolts in the bottom wing near the wing tips. Do not make holes near the fuselage (fuselage with bottom wing to stock).

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Figure 17AC-2 Fuselage Assembly

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Figure 17AC-3 Fuselage With Clear Mylar Template Placed Around

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Figure 17AC-4 Getting Its Wings

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Figure 17AC-5 Cladding the Wings

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Figure 17AC-6 Under the Wings

UNDERSIDE VIEW OF PLANE

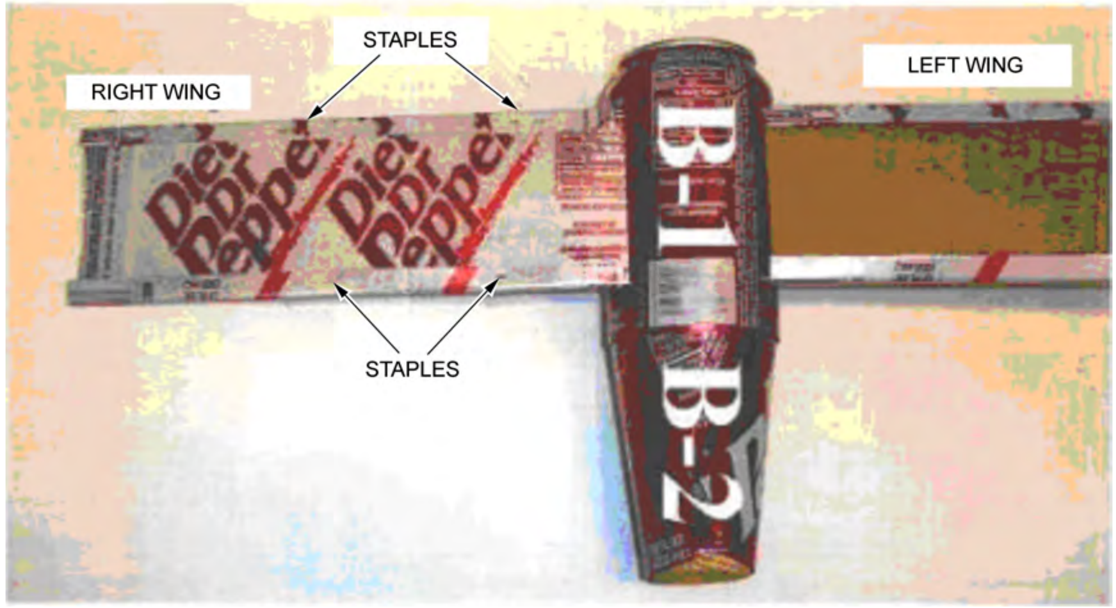

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Figure 17AC-7 Cladding the Under-wing

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Figure 17AC-8 Securing the Wing Tip

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Figure 17AC-9 Roughing the Cockpit and Windscreen

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Figure 17AC-10 Clearing the Centre Line

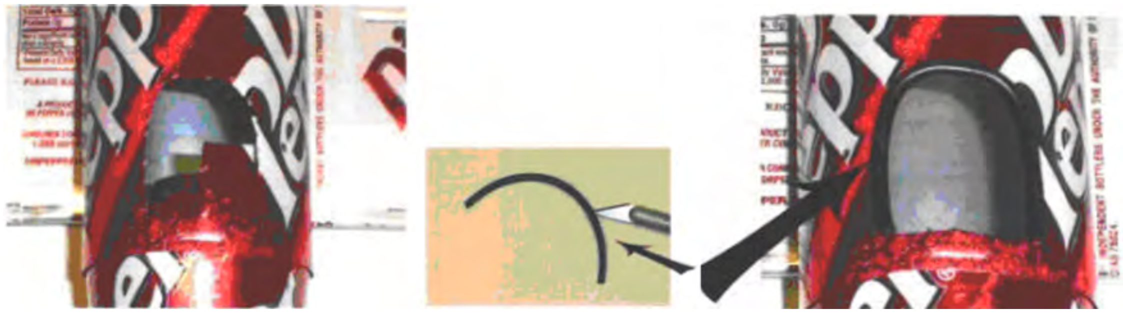

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Figure 17AC-11 Opening and Trimming the Cockpit

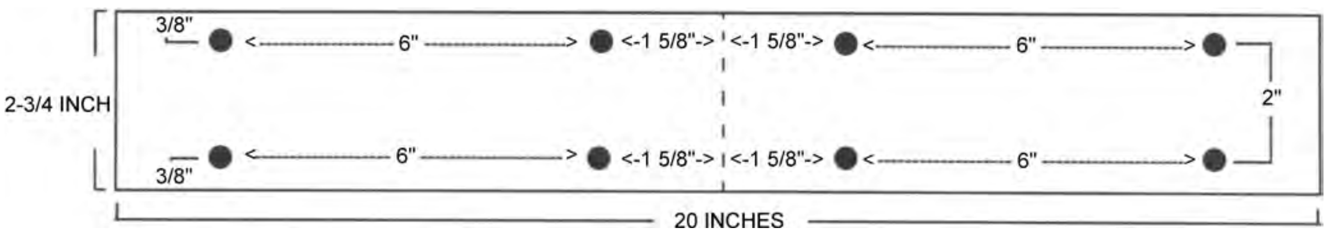

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Figure 17AC-12 Wing Bolt Hole Placement Template (WBHPT)

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TOP WING ASSEMBLY LINE

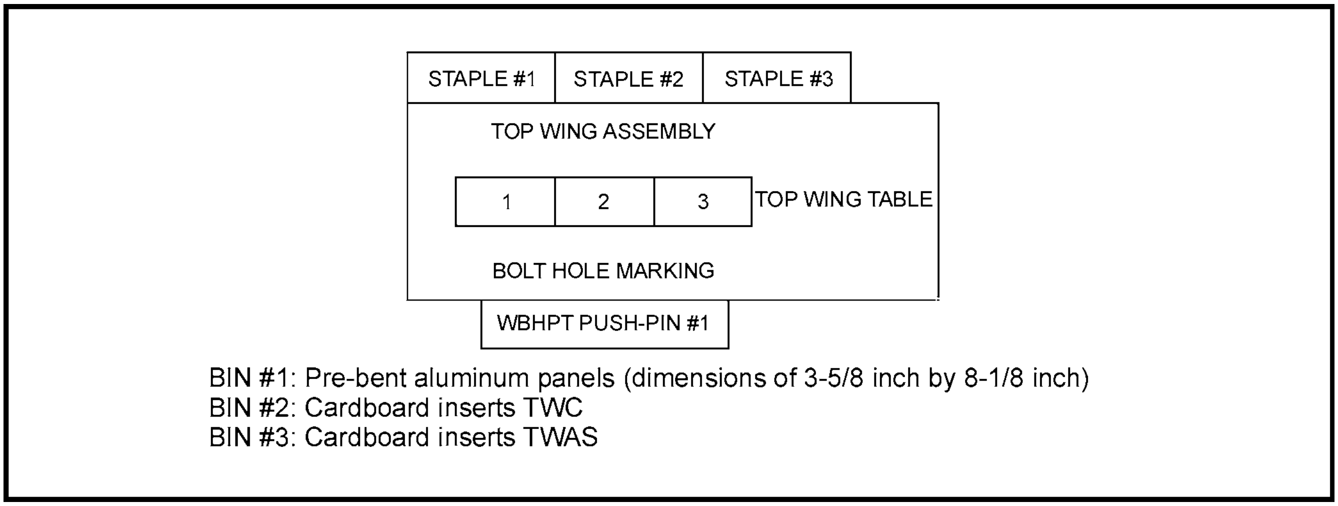

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Figure 17AD-1 Top Wing Assembly Line

For each aluminum model biplane to be constructed:

1. Combine cardboard parts TWC, TWAS and three pre-bent aluminum panels (dimensions of 3-5/8 inch by 8-1/8 inch) to form top wing (all from stock).
2. Insert panels (dimensions of 2-5/8 inch by 8-1/8 inch) under wing (from stock).
3. Staple top wing (ten staples).
4. Apply Wing Bolt Hole Placement Template (WBHPT) to top of top wing and with a push-pin, make eight holes for bolts in the top wing (top wing to stock).

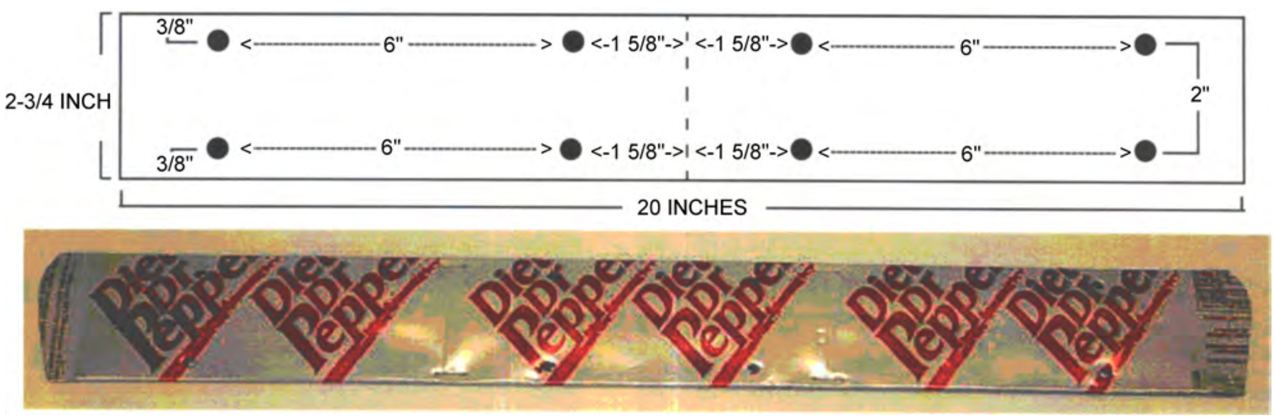

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Figure 17AD-2 Wing Bolt Hole Placement Template (WBHPT)

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EMPENNAGE ASSEMBLY LINE

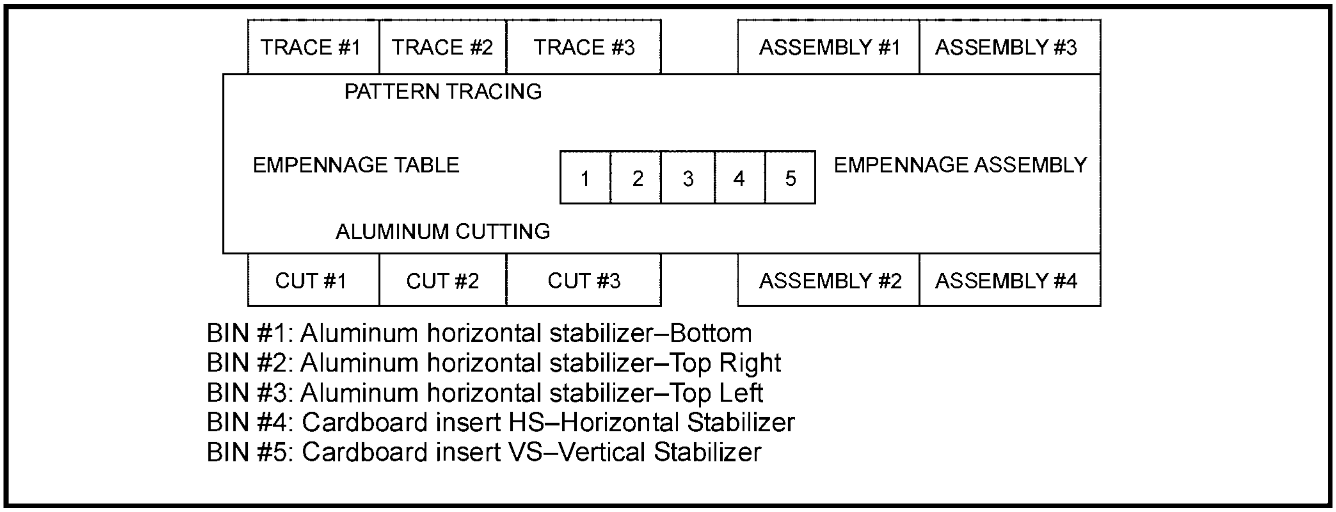

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Figure 17AE-1 Empennage Assembly Line

For each aluminum model biplane to be constructed:

1. Trace Template No. 8 onto one raw aluminum billet (from stock).
2. Cut with scissors (Figure 17AE-2).
3. Trace Template No. 9 onto one raw aluminum billet (from stock).
4. Cut with scissors one horizontal stabilizer top right (Template No. 9) (Figure 17AE-2).
5. Trace Template No. 10 onto one raw aluminum billet (from stock).
6. Cut with scissors one horizontal stabilizer top left (Template No. 10) (Figure 17AE-2).
7. Score one horizontal stabilizer bottom (Template No. 8).
8. Score one horizontal stabilizer top right (Template No. 9).
9. Score one horizontal stabilizer top left (Template No. 10).
10. Combine cardboard pieces HS and VS with aluminum parts (Figure 17AE-3), to include:
    (a) one scored horizontal stabilizer bottom (Template No. 8),
    (b) one scored horizontal stabilizer top right (Template No. 9), and
    (c) one scored horizontal stabilizer top left (Template No. 10).
11. Carefully bend the aluminum parts to form a complete empennage (Figure 17AE-4).
12. Staple the complete empennage.

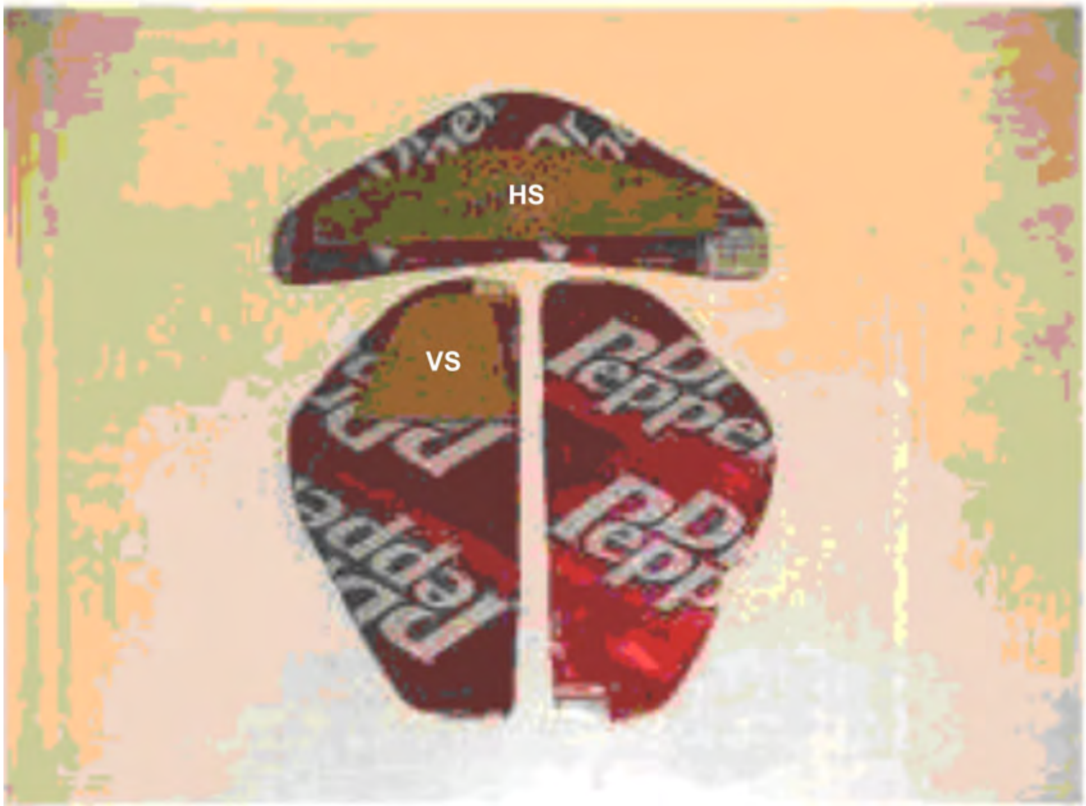

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Figure 17AE-2 Parts of the Empennage

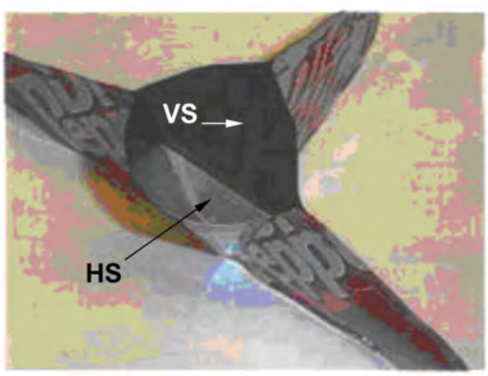

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Figure 17AE-3 Forming the Empennage

Match up the left and right Vertical Stabilizer parts and staple them together, placing staples approximately 3/8 inch from the outside edge. Insert cardboard VS between the two Vertical Stabilizer halves.

Match up the Horizontal Stabilizer parts and staple only the back end together. Insert the cardboard HS between the Horizontal Stabilizer panels.

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Figure 17AE-4 Forming the Empennage

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PROPELLER ASSEMBLY LINE

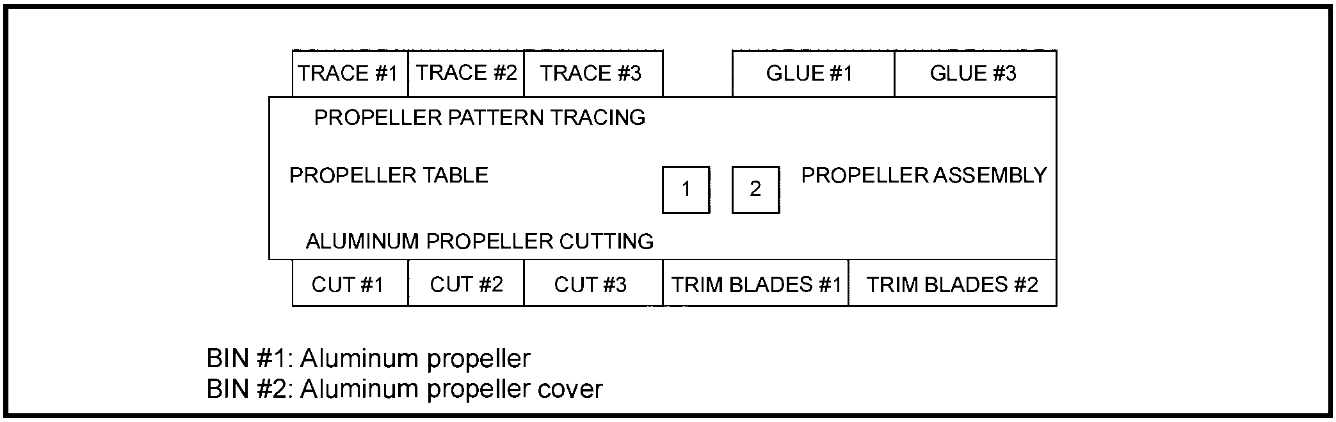

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Figure 17AF-1 Propeller Assembly Line

For each aluminum model biplane to be constructed:

1. Place fan propeller template over part P-2 (from stock) and mark propeller blades of part P-2.
2. Cut propeller blades into part P-2.
3. Bend propeller blades out from part P-2 (Figure 17AF-3).
4. Trim propeller blade tip corner edges (completed propeller to stock).

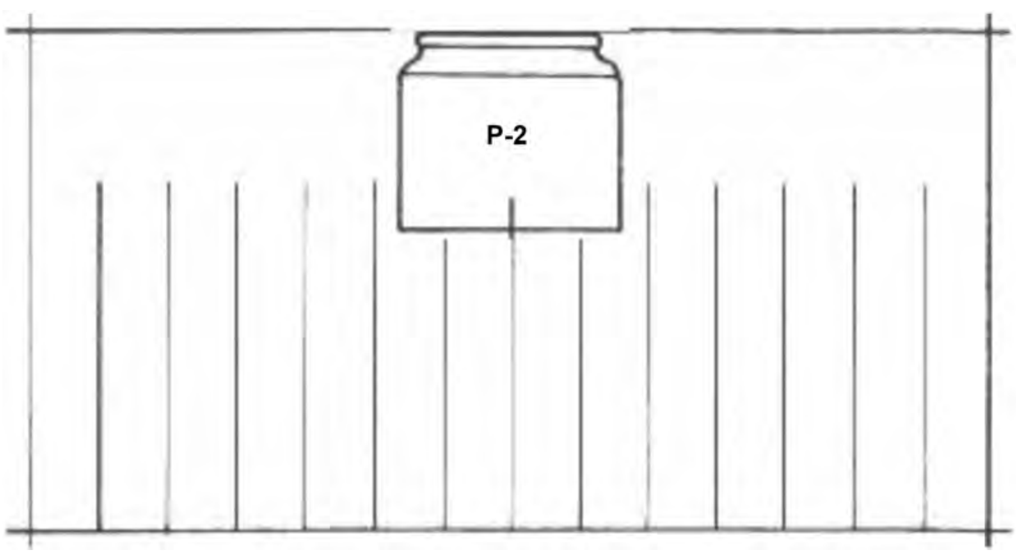

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Figure 17AF-2 Marking the Propeller

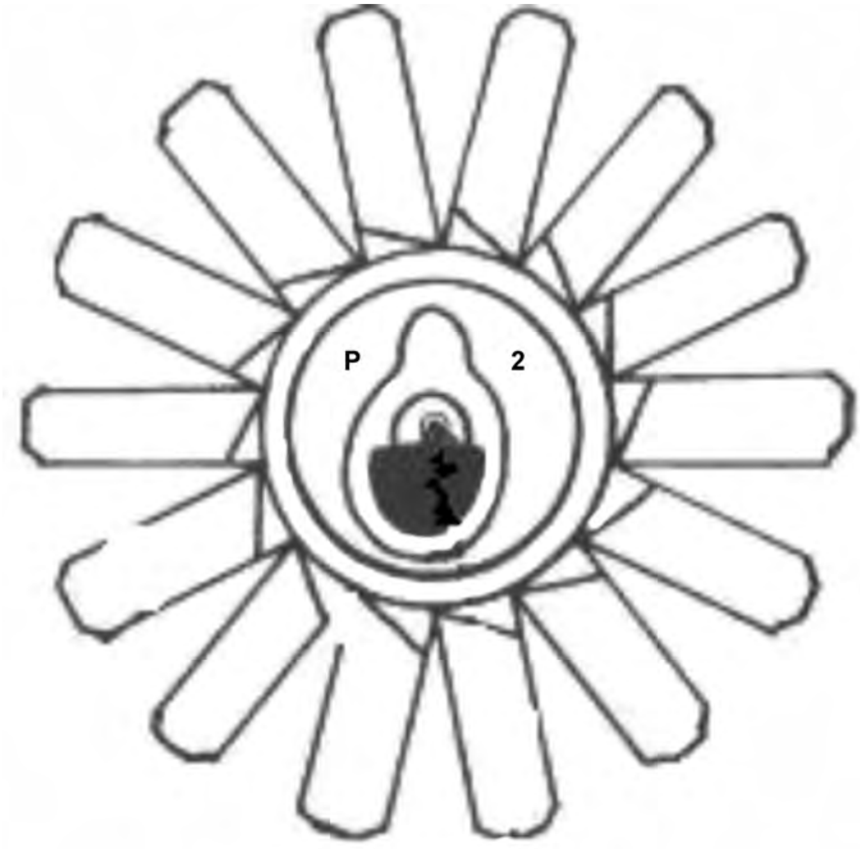

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Figure 17AF-3 Fan Propeller

FINAL ASSEMBLY

Each cadet will receive a full set of aluminum model biplane assemblies and parts, to include:

- one completed empennage assembly,
- one completed fan propeller assembly,
- one completed top wing assembly,
- one completed fuselage with bottom wing assembly,
- one landing gear wire,
- four 3-1/2-inch 10/24 bolts c/w 12 nuts to act as interplane struts,
- four 2-1/2-inch 10/24 bolts c/w eight nuts to act as cabane or centre-section struts,
- one metre of heavy-duty black thread to act as flying and landing wires,
- a length of 3/32-inch wire 18 inches long to act as the propeller shaft, and
- a length of 1/16-inch wire 6-3/4 inches long for a landing gear support wire.

1. Place four 3-1/2-inch 10/24 bolts through the outer holes in the top wing and secure snugly with a nut under the top wing and place another nut near the bottom of the bolts.

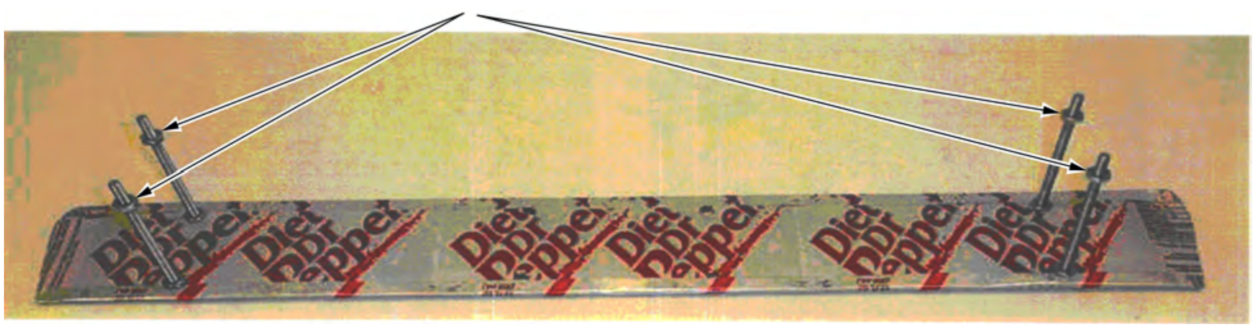

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Figure 17AG-1 Interplane Struts

2. Secure the top wing to the bottom wing by pushing the four outer bolts through the bottom wing outer holes and threading the nuts down the bolts until they touch the upper surface of the bottom wing.

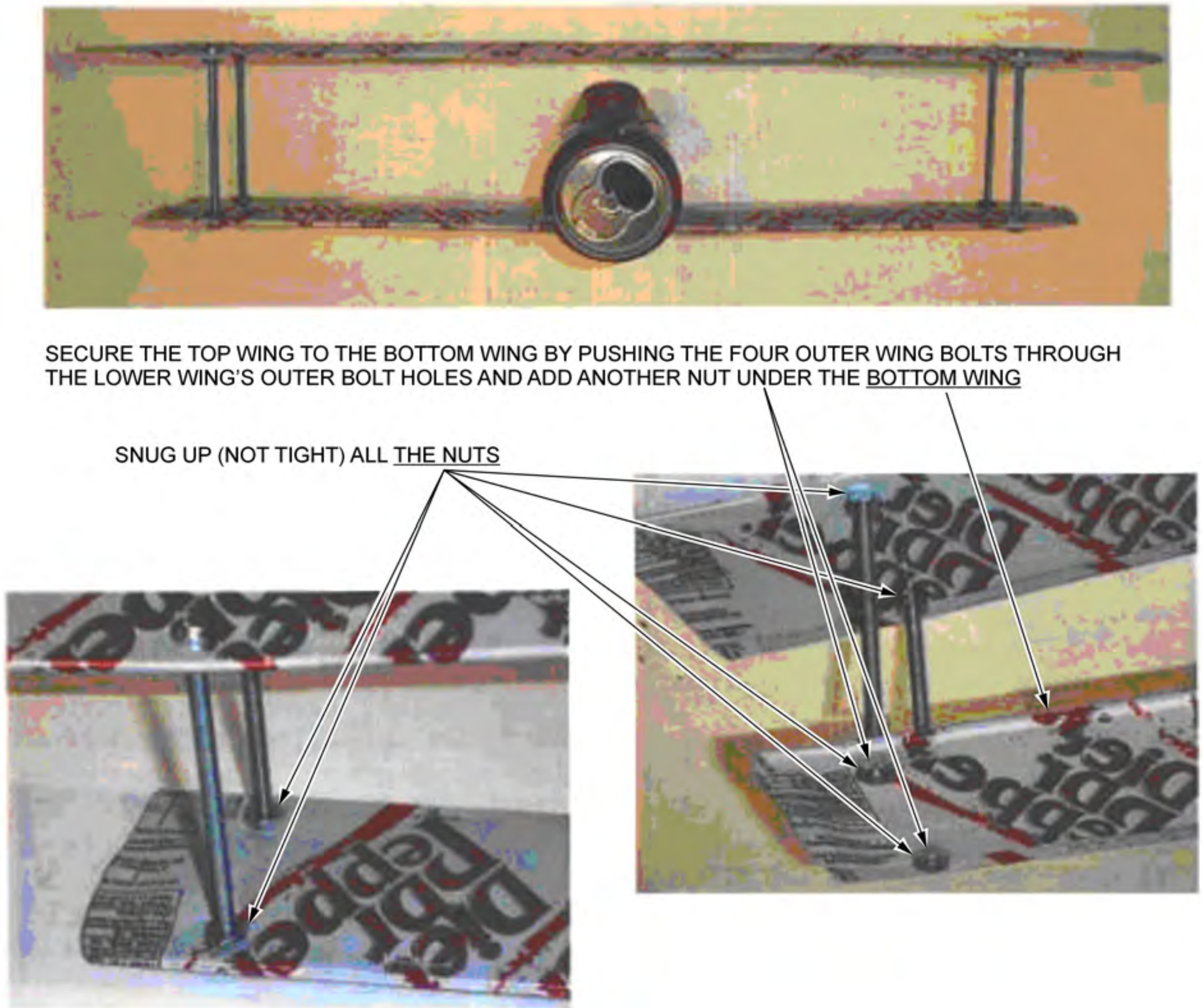

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Figure 17AG-2 Top Wing

3. Secure the top wing to the fuselage by inserting four 2-1/2-inch 10/24 bolts through the top wing and threading two nuts on the ends of the bolts; then thread the bolt ends into the two front holes E and the two back holes F in the fuselage, making the nuts snug against the underside of the top wing and also the fuselage.

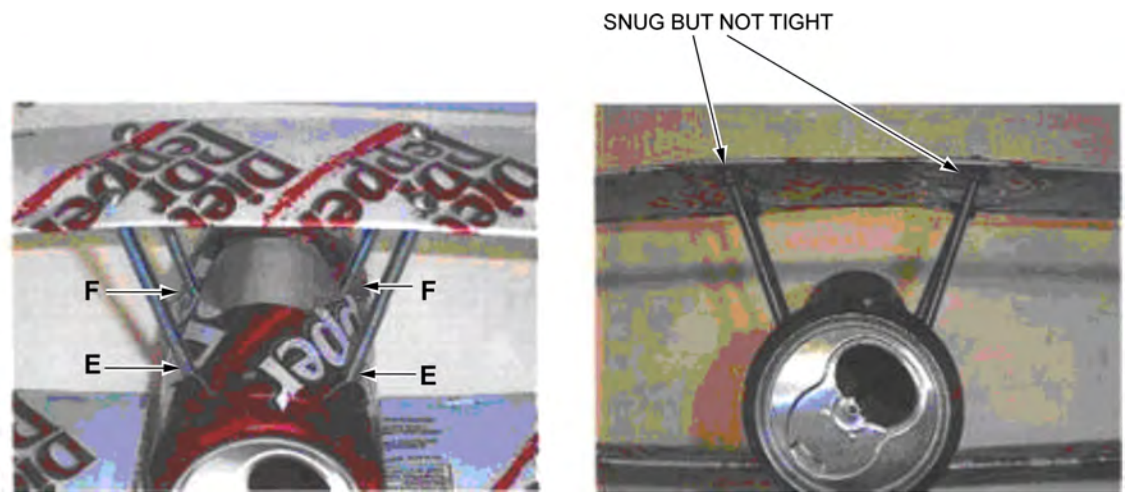

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Figure 17AG-3 Cabane Struts

4. Install the landing wires.

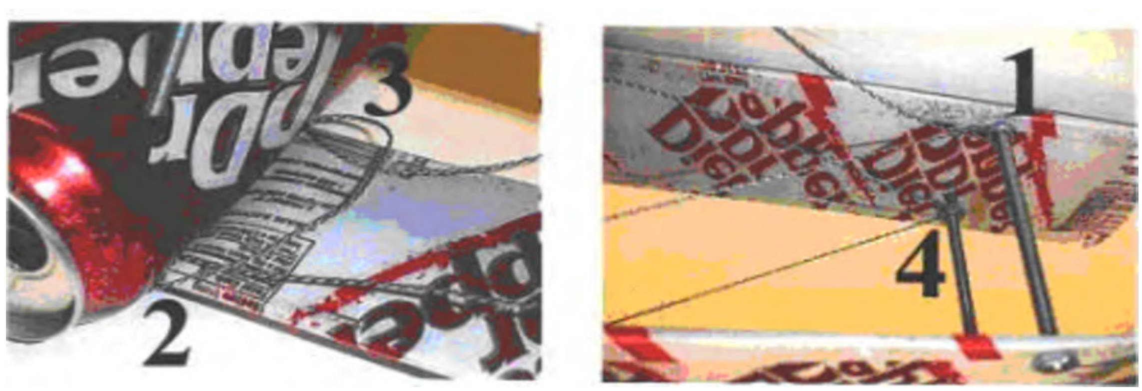

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Figure 17AG-4 Landing Wires

(a) To rig the plane, start by loosening the nut under the top wing outer front bolt (position 1 above).

(b) Wrap the line twice, between the nut and the aluminum, then tighten the nut.

(c) Now draw the line down to where the front wing spar goes into hole A in B-1 (position 2 above).

(d) Thread the line around the front wing spar, then draw it to the back wing spar (position 3 above).

(e) Thread the line around the back wing spar where it goes into hole B in B-1, then draw it up to the nut under the top wing outer back (position 4 above).

(f) Loosen this nut, wrap the line twice around the bolt between the nut and the aluminum, then tighten the nut.

(g) Repeat this on the other wing of the biplane.

5. Install the flying wires.

   (a) Loosen the outer front nut on the top of the bottom wing (position 5 below) and wrap the line twice around the bolt, between the nut and the aluminum, and then tighten the nut.

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Figure 17AG-5 Flying Wires

   (b) Draw the line up to the inner front nut on the top wing (position 6 above).

   (c) Loosen the nut, wrap the line twice around the bolt, between the nut and the aluminum, and tighten the nut.

   (d) Repeat this on the other wing of the biplane.

   (e) Loosen the outer back nut on the top of the bottom wing (position 7 above) and wrap the line twice around the bolt, between the nut and the aluminum, then tighten the nut.

   (f) Draw the line up to the inner back nut on the top wing (8). Loosen the nut and wrap the line twice around the bolt and tighten the nut.

   (g) Cut off all excess line.

   (h) Repeat this on the other wing of the biplane.

6. Insert the landing gear wire through holes C and have the instructor make the final bend.

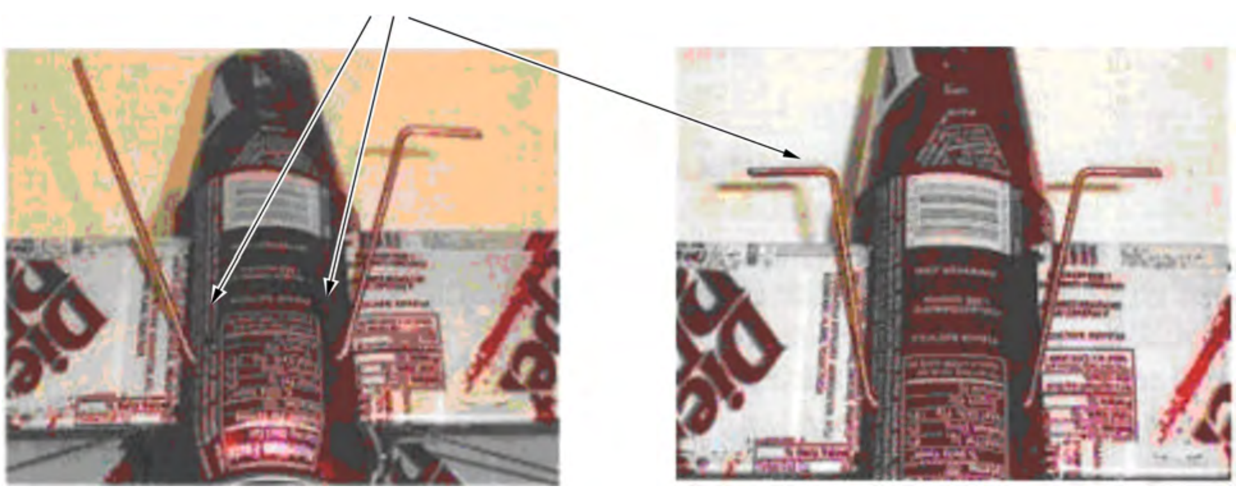

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Figure 17AG-6 Main Landing Gear

7. Bend the 1/16-inch wire that is 6-3/4 inches long into shape as a support wire.

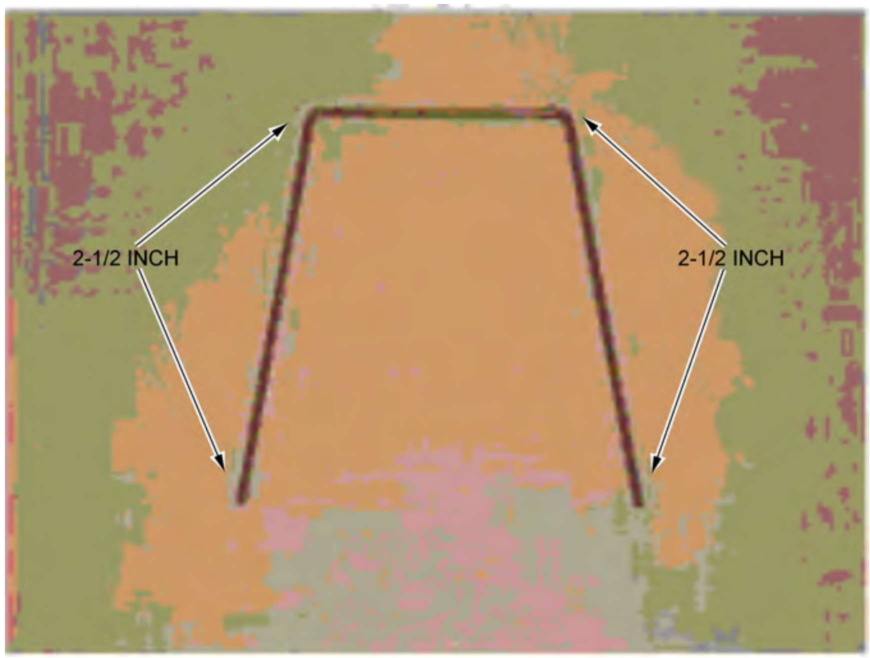

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Figure 17AG-7 Main Landing Gear Support Structure

8. Insert the support wire through holes D in the fuselage and crimp it around the main landing gear wire.

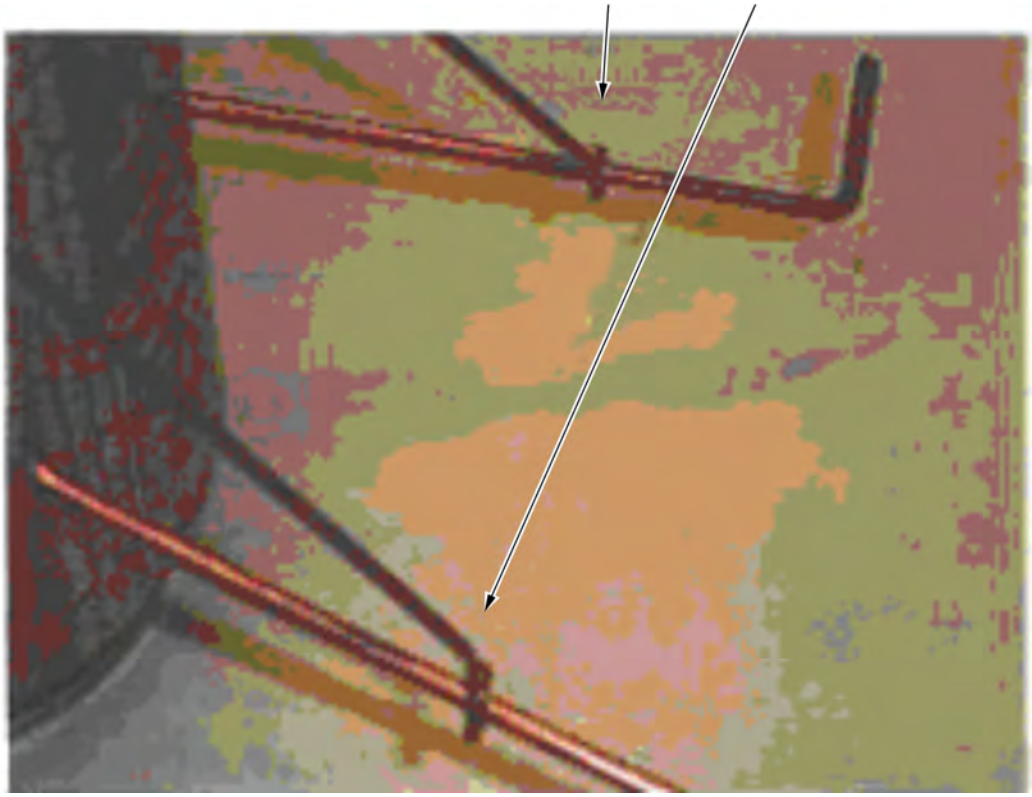

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Figure 17AG-8 Crimping the Landing Gear Support

9. To attach the empennage to the fuselage, take a piece of 3/32-inch wire 18 inches long and make a 4-inch hook on one end to make the propeller shaft:

   (a) insert the propeller shaft through the hole in the back of the empennage under the horizontal stabilizer cardboard and the smaller section of wire goes over the horizontal stabilizer cardboard; and

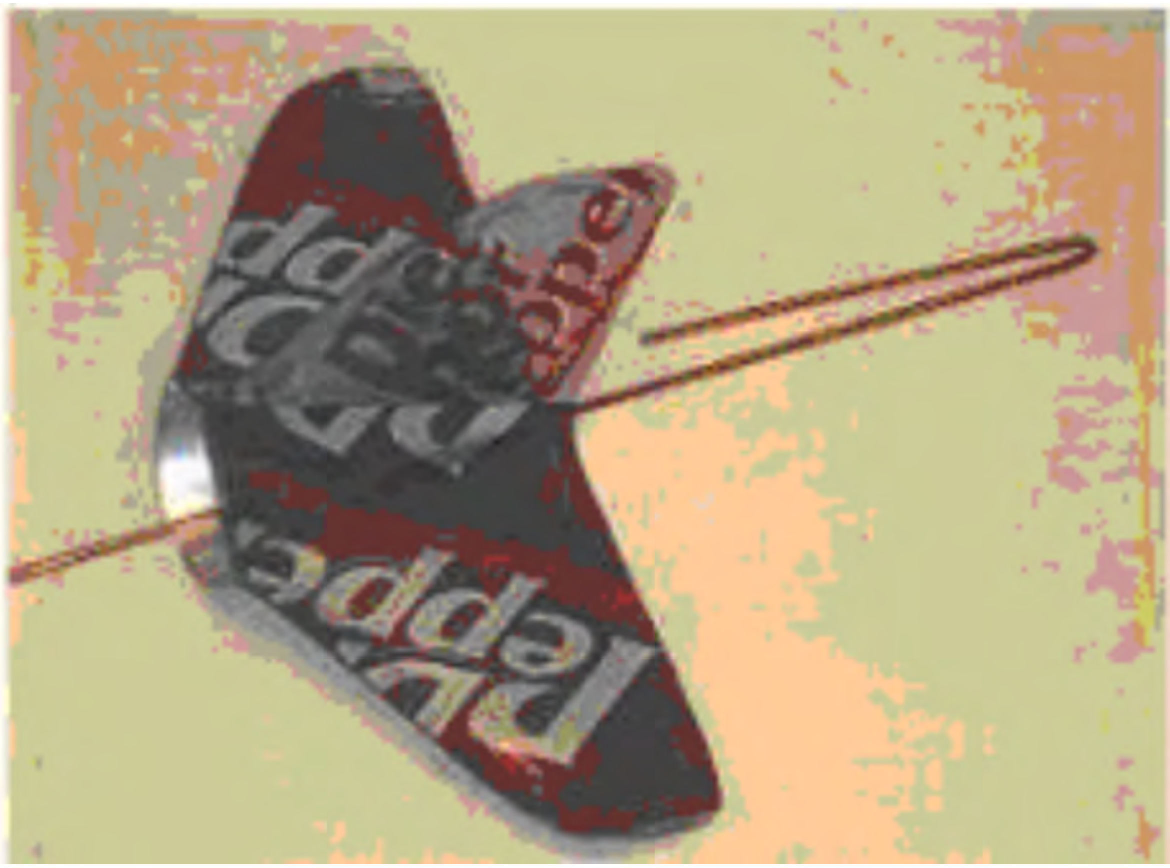

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Figure 17AG-9 Propeller Shaft Installation

   (b) insert the propeller shaft, with the empennage attached, through the pilot hole in the wood piece F-2, through the pilot hole in wood piece F-1 and through hole G in the front fuselage section part B-1. Pull the empennage over the rear of part B-2 at the rear of the fuselage. Pull the propeller shaft snug and hold it in place with a wire clip at the front of the fuselage part B-1.

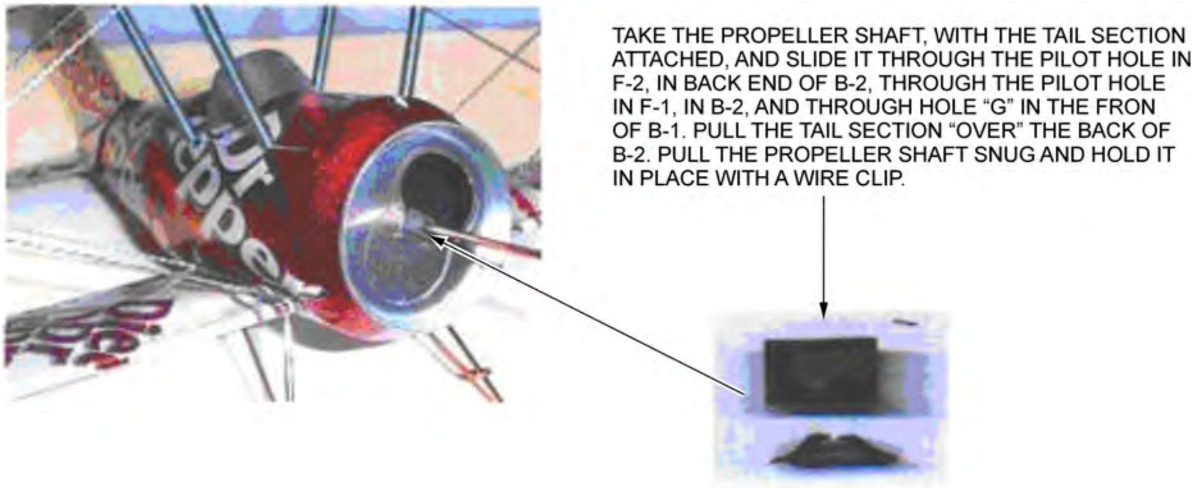

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Figure 17AG-10 Propeller Shaft Wire Clip Installation

10. To fabricate the rear skid, take a piece of 3/32-inch wire and form it into the shape shown. Drill a hole through the fuselage into the bottom of wood piece F-2. Insert and glue the tail skid into place.

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Figure 17AG-11 Tail Skid Fabrication

11. Insert two windshield tabs into their slits as shown. Glue the windshield and the cockpit rubber into place.

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Figure 17AG-12 Windscreen Installation

12. Using four bottle caps with holes through the centre, glue pairs together to make wheels as shown. Place and glue the two wheels on the main landing gear wires.

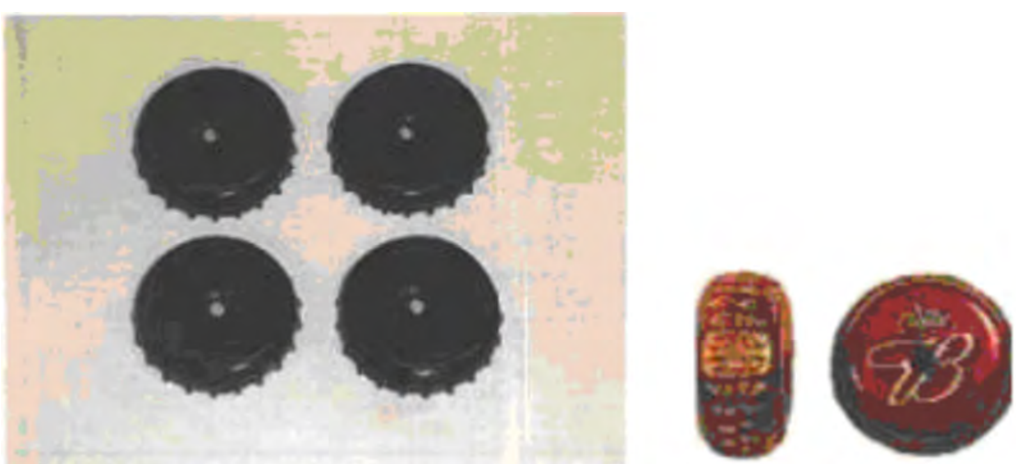

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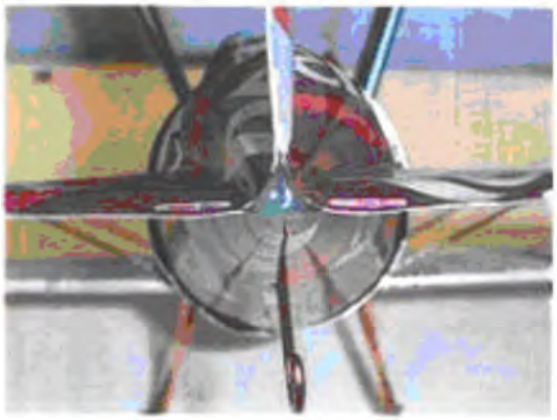
Figure 17AG-13 Bottle-Cap Wheels

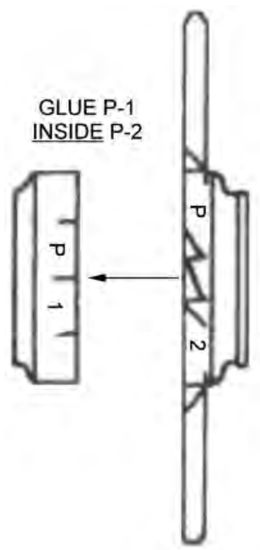
13. Fill the hole at the rear of the empennage with glue.



D. P. Mathis, Building the B.C. Air Originals Biplane, B.C. Air Originals (p. 17)

Figure 17AG-14 Tail Light

14. Attach the propeller part P-2 to the front of the fuselage by slipping it over the propeller shaft. Place the propeller cover part P-1 over the face of P-2 and glue it into place inside of P-2.



D. P. Mathis, Building the B.C. Air Originals Biplane, B.C. Air Originals (p. 21)

Figure 17AG-15 Finishing Touch

B.C. Air Originals "FAQ" Biplane. Retrieved November 19, 2007, from http://www.bcair.com/faq/index.htm

Figure 17AG-16 Aluminum Model Biplane

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CHAPTER 18

PO 390 – NAVIGATE A ROUTE USING A MAP AND COMPASS

ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL THREE

INSTRUCTIONAL GUIDE

SECTION 1

EO M390.01 – IDENTIFY PARTS OF THE COMPASS

Total Time: 30 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-803/PG-001, Chapter 4. Specific uses for said resources are identified throughout the instructional guide within the TP for which they are required.

Review the lesson content and become familiar with the material prior to delivering the lesson.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

An interactive lecture was chosen for TPs 1 and 2 to present background material and introduce the parts of a compass to the cadets.

Demonstration and performance was chosen for TP 3 as it allows the instructor to explain and demonstrate the skill the cadet is expected to acquire while providing an opportunity for the cadets to practice setting a predetermined declination under supervision.

INTRODUCTION

REVIEW

N/A.

OBJECTIVES

By the end of this lesson the cadet shall have identified the parts of the compass and set a predetermined declination.

IMPORTANCE

It is important for cadets to understand the principles on how a compass works, recognize the parts of the compass and be able to set the magnetic declination on the compass. This basic knowledge will aid the cadet in learning how to use the compass as a navigational tool.

Teaching Point 1 | **Explain the Principles Behind the Workings of a Compass**

Time: 5 min | Method: Interactive Lecture

INTRODUCTION

The compass is an important tool used in wilderness navigation. It is not a replacement for good map-reading skills; however it is a trustworthy tool to complement and complete ground navigation. A compass user must take care to be precise in compass measurements. A small error in calculation or measurement can equal a significant error in the field.

A magnetic compass remains viable as a navigational aid, even with the advent of Global Positioning System devices, because it does not require batteries and remains reliable year after year.

CHINESE FLOATING COMPASS

Director Cadets 3, Royal Canadian Army Cadet Reference Book, Department of National Defence (p. 5-33)

Figure 18-1-1 Chinese Floating Compass

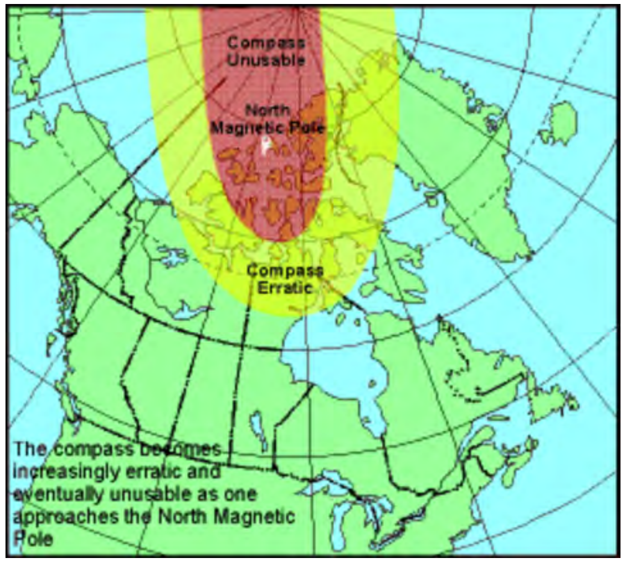
The Chinese had discovered the orienting effect of magnetite, or lodestone as early as the 4^{th} century BC. In 101 BC, Chinese ships reached the east coast of India for the first time, possibly with help from a magnetic compass. By the 10^{th} century, they had developed a floating compass for use at sea. Western Europeans had developed one by 1187, Arabs by 1220, and Scandinavians by 1300. Columbus used a magnetic compass on his first transatlantic trip in 1492.

HOW A COMPASS WORKS

Regardless of intended purpose or complexity of construction, most compasses operate on the same basic principle. A small, elongated, permanently magnetized needle is placed on a pivot so that it may rotate freely on the horizontal plane. The earth's magnetic field, which is shaped approximately like the field around a simple bar magnet, exerts forces on the compass needle causing it to rotate until it comes to rest in the same horizontal direction as the magnetic field. Over much of the earth this direction is roughly running between north and south, which accounts for the compass's importance in navigation.

The earth has a north and south magnetic pole. These magnetic poles correspond roughly with the actual geographical poles. The north magnetic pole is located (2005 estimate) at approximately 82.7 degrees N latitude and 114.4 degrees W longitude, which lies over 800 km from the north geographic pole.

The horizontal force of the magnetic field, responsible for the direction in which a compass needle is oriented, decreases in strength as one approaches the north magnetic pole. This decrease is due to the lines of force changing direction towards the vertical as they bend back into the earth at the north magnetic pole towards the south magnetic pole. The compass starts to behave erratically, and eventually as the horizontal force decreases even more, the compass becomes unusable.



Director Cadets 3, Royal Canadian Army Cadet Reference Book, Department of National Defence (p. 5-33)

Figure 18-1-2 Earth's Magnetic Field

The nature of the earth's magnetic field is such that the magnetic north pole shifts geographic position about 5–10 km per year. Natural phenomena, like earthquakes, may also shift the magnetic field.

CONFIRMATION OF TEACHING POINT 1

QUESTIONS

Q1. Why is the compass such an important navigational tool?

Q2. Approximately how far can the north magnetic pole shift in a year?

Q3. Why does a compass become less accurate the further north a person travels?

ANTICIPATED ANSWERS

A1. Over much of the earth, a compass roughly indicates the direction of true north, which accounts for the compass's importance in navigation.

A2. The magnetic north pole shifts geographic position about 5–10 km per year.

A3. The horizontal force of the magnetic field, responsible for the direction in which a compass needle is oriented, decreases in strength as one approaches the north magnetic pole. This decrease is due to the lines of force changing direction towards the vertical as they bend back into the earth at the north magnetic pole towards the south magnetic pole. The compass starts to behave erratically, and eventually as the horizontal force decreases even more, the compass becomes unusable.

Teaching Point 2 — **Identify and Describe the Parts of the Compass**

Time: 10 min — Method: Interactive Lecture

Divide the cadets into equal groups according to the number of compasses available. Starting with the compass opened, use Figures 8-1-3 and 8-1-4 to identify the parts of the compass.

PARTS OF THE COMPASS

A – Sight. Located at the top of the compass cover. Used to align on an objective when taking a bearing or to observe one along a given bearing.

B – Compass Cover. Protects the compass dial and houses the sighting mirror.

C – Sighting Mirror. Used to see the compass dial while taking a bearing.

D – Sighting Line. Used when aligning an objective or observing along a bearing.

E – Luminous Index Point. At the top of the compass dial and where a bearing is set or read from.

F – Compass Dial. Houses the magnetic needle, the orienting arrow, the meridian lines, the declination scale (on the inside) and the dial graduations (on the outside).

G – Dial Graduations. The compass dial is graduated in 2-degree divisions from 0 to 360 degrees. The dial is rotated by hand.

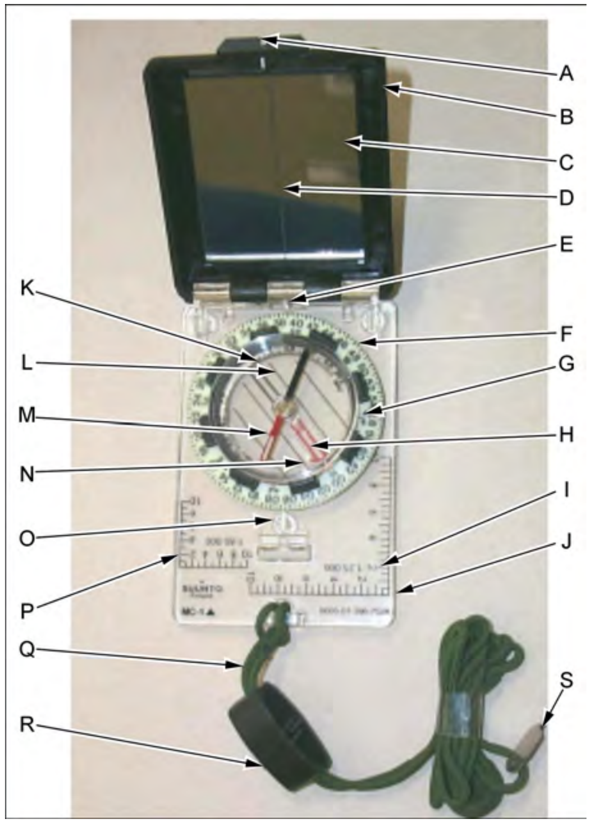
H – Orienting Arrow. The black and red orienting arrow is located inside the compass dial and is used to line up with the magnetic needle when taking a bearing on the ground. The orienting arrow is what is adjusted when the magnetic declination is set.

I – Romer 1 : 25 000. Used to measure six-figure grid references (GRs) on maps with a 1 : 25 000 scale.

J – Compass Base Plate. A clear piece of flat plastic to which the cover, dial and lanyard are attached.

K – Declination Scale. Used when adjusting the orienting arrow and while setting the magnetic declination for the map being used. It is graduated in 2-degree divisions.

L – Compass Meridian Lines. Black or red lines inside the compass dial. They are used to line up the compass dial with the grid lines (eastings) on a map.



Director Cadets 3, Royal Canadian Army Cadet Reference Book, Department of National Defence (p. 5-33)

Figure 18-1-3 Compass

M – Magnetic Needle. Spins freely and points towards magnetic north. The south end of the compass needle is black and the north end, with a luminous patch, is red.

> When the magnetic needle is lined up in the red end of the orienting arrow, the mnemonic device “Red in the Bed” is used to remember that the red end of the needle belongs in the red end of the arrow.

N – Luminous Orienting Points. There are two luminous orienting points located on either side of the red end of the orienting arrow.

O – Luminous Index Point. At the bottom of the compass dial; where a back bearing is read from.

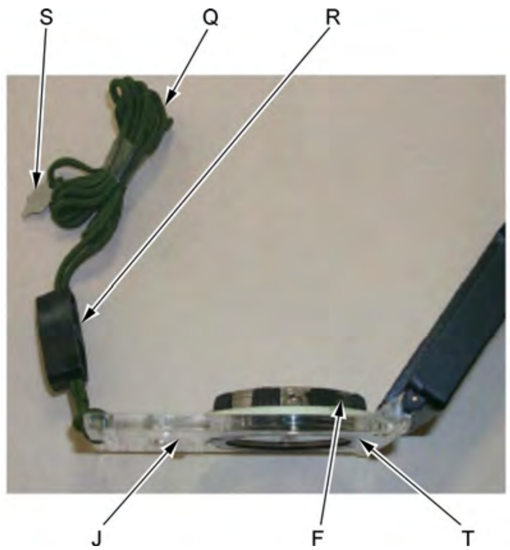
P – Romer 1 : 50 000. Used to measure six-figure GRs on maps with a 1 : 50 000 scale.

Q – Safety Cord or Lanyard. Used to fasten the compass to the wrist (never around the neck).

R – Adjustable Wrist Lock. Used to attach the compass to the wrist.

S – Screwdriver. Located at the end of the safety cord and is used to turn the screw to adjust the orienting arrow’s position on the declination scale.

T – Declination Adjusting Screw. Located on the back side of the compass dial and is used to adjust the orienting arrow’s position on the declination scale.



Director Cadets 3, Royal Canadian Army Cadet Reference Book, Department of National Defence (p. 5-34)

Figure 18-1-4 Compass

After being exposed to a strong light source, the luminous parts of the compass will glow in the dark making operating the compass at night possible.

CONFIRMATION OF TEACHING POINT 2

QUESTIONS

Q1. What is the purpose of the 1 : 25 000 and 1 : 50 000 romers?

Q2. What colour is the north end of the magnetic needle?

Q3. Where should the safety cord or lanyard of the compass never be placed?

ANTICIPATED ANSWERS

A1. The purpose of these romers is to measure six-figure GRs on maps with 1 : 25 000 and 1 : 50 000 scale respectively.

A2. The north end of the magnetic needle is red.

A3. The safety cord or lanyard of the compass should never be placed around a person's neck.

Teaching Point 3 | **Explain, Demonstrate and Have Cadets Set a Predetermined Declination**

Time: 10 min | Method: Demonstration and Performance

Explain and demonstrate setting a predetermined declination as listed below, prior to the cadets' practicing. Calculating declination may be taught in EO C390.05 (Calculate Magnetic Declination, Section 10).

Do not go into too much detail about the three norths as this material will be covered in EO M390.05 (Determine Bearings on a Map and on the Ground, Section 5).

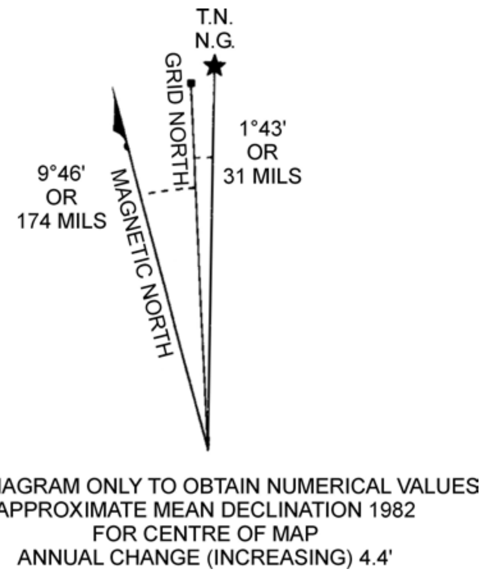
DECLINATION

Magnetic declination is the difference in bearing either between grid north and magnetic north or between true north and magnetic north. Declination will change for each topographical map and it also changes annually due to the shifting north magnetic pole.

Cadets will almost always use the magnetic declination value between grid north and magnetic north (grid declination) when navigating using a map and compass. By setting the magnetic declination on the compass, magnetic bearings are converted to grid bearings which allow bearings taken from the map to be used on the ground and vice versa.

Declination is further described by stating whether the declination is east or west of magnetic north. The declination for the map being used is calculated using the information in the declination diagram (as illustrated in Figure 18-1-5) found in the marginal information of the map.

Declinations are stated in degrees and minutes. Each degree is subdivided into 60 minutes. This is important when setting the declination as the declination scale is graduated in 2-degree divisions.



Director Cadets 3, Royal Canadian Army Cadet Reference Book, Department of National Defence (p. 5-39)

Figure 18-1-5 Declination Diagram

ADJUSTING THE DECLINATION ON A COMPASS

The compass's declination scale must be set to compensate for the difference between grid north and magnetic north. To do this we must first have the amount of declination in degrees east or west. Then, turn the compass over and look at the back of the dial.

From the zero point, using the screwdriver, turn the declination adjusting screw to the right for west and to the left for east declination (as illustrated in Figure 18-1-6). Each small black line represents two degrees of declination.

> When setting declination on a compass, it is easier to hold the screwdriver and turn the compass, especially in cold weather. The declination shall *never* be turned past the last number of the declination scale.

Director Cadets 3, 2008, Ottawa, ON: Department of National Defence

Figure 18-1-6 Declination Screw

If a person were to follow a compass bearing for one km without first adjusting for declination, for every one degree of declination, that person would be over 17 m to the left or right of their plotted bearing. This is how important declination is.

ACTIVITY

Time: 5 min

OBJECTIVE

The objective of this activity is to have cadets set magnetic declination on a compass.

RESOURCES

- Compasses, and
- Predetermined declination.

ACTIVITY LAYOUT

N/A.

ACTIVITY INSTRUCTIONS

1. Divide the cadets into groups based on the number of compasses available.
2. Give the cadets a declination value.
3. Have the cadets turn the compass over (on its back with the declination adjusting screw facing up).
4. With the other hand have the cadet grasp the screwdriver that is attached to the safety cord/lanyard.
5. Using the screwdriver, have the cadet turn the declination adjusting screw to the right for west and to the left for east declination values.
6. Check the set declination.

SAFETY

N/A.

CONFIRMATION OF TEACHING POINT 3

The cadets' participation in setting declination will serve as the confirmation of this TP.

END OF LESSON CONFIRMATION

QUESTIONS

Q1. A compass is a tool used to complement what other ground navigation skill?

Q2. What must be done to the luminous marks of the compass to make them glow?

Q3. In what direction would the declination adjusting screw be turned for an east declination value?

ANTICIPATED ANSWERS

A1. A compass is used to complement map-reading skills.

A2. The luminous marks need to be exposed to a strong light source.

A3. The declination adjusting screw would be turned to the left.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

This EO is assessed IAW A-CR-CCP-803/PG-001, Chapter 3, Annex B, Appendix 5 (390 PC).

CLOSING STATEMENT

Map and compass skills are the core of the cadets' Proficiency Level Three survival training. Being familiar with the compass and how it works is one of the bases on which the rest of the lessons are anchored.

INSTRUCTOR NOTES/REMARKS

TP 2 may need to be modified to reflect the type of compass used for the lesson.

REFERENCES

A2-036 A-CR-CCP-121/PT-001 Director Cadets 3. (2003). *Royal Canadian Army Cadet Reference Book*. Ottawa, ON: Department of National Defence.

A2-041 B-GL-382-005/PT-001 Canadian Forces. (2006). *Maps, Field Sketching, Compasses and the Global Positioning System*. Ottawa, ON: Department of National Defence.

ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL THREE

INSTRUCTIONAL GUIDE

SECTION 2

EO M390.02 – IDENTIFY MARGINAL INFORMATION AND CONVENTIONAL SIGNS

Total Time:	60 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-803/PG-001, Chapter 4. Specific uses for said resources are identified throughout the instructional guide within the TP for which they are required.

Review the lesson content and become familiar with the material prior to delivering the lesson.

Distribute topographical maps before beginning the lesson.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

An interactive lecture was chosen for TP 1 to introduce the details of marginal information to the cadet.

An in-class activity was chosen for TP 2 as it is an interactive way to introduce conventional signs to the cadet.

INTRODUCTION

REVIEW

The review for this lesson will be from EO M390.01 (Identify Parts of the Compass, Section 1).

QUESTIONS

Q1. What is the purpose of the sighting mirror?

Q2. What is the function of the meridian lines found inside the compass dial?

Q3. The mnemonic device “Red in the Bed” is used to remember what?

ANTICIPATED ANSWERS

A1. The sighting mirror is used to see the compass dial while taking a bearing.

A2. Compass meridian lines are used to line up the compass dial with the grid lines (eastings) on a map.

A3. The mnemonic device “Red in the Bed” is used to remember that the red end of magnetic needle is lined up within the red end of the orienting arrow.

OBJECTIVES

By the end of this lesson the cadet shall have to identified marginal information and conventional signs found on a topographical map.

IMPORTANCE

Cadets need to be able to identify features on the map as they relate to objects on the ground. The cadets will apply this knowledge during training where any type of map is used.

Teaching Point 1	Identify and Describe Marginal Information on a Topographical Map
Time: 20 min	Method: Interactive Lecture

MARGINAL INFORMATION

The margins provide information important to the understanding and use of the map. Before using an unfamiliar map, it is important to have a good look at the information contained in its margins. The layout and contents of the marginal information is normally in the same place for all topographical maps, but will always be found within the margins. This information includes:

Have cadets point out each piece of marginal information on a topographical map as it is being described.

Name of Map Sheet. For ease of reference the name of the map is usually a major community or district located on the map (found at the bottom centre of the margin, as well as in the top or bottom right corner).

Number of the Map and Index of Adjoining Maps. A diagram showing the position of the map sheet in relation to adjoining sheets is shown near the lower right-hand margin. The diagram shows the sheet numbers of the adjoining sheets and accentuates the sheet in hand.

Date of Map Data. Helps to indicate the amount of change that may have occurred since the map was printed (found in the bottom left corner).

Map Scale. Indicates the scale of the map, most commonly 1 : 25 000 or 1 : 50 000. Scale is used to represent distances on the map in direct relation to the ground. On a 1 : 50 000 scale map 1 cm on the map represents 50 000 cm (500 m) on the ground.

Scale Bars. Used as a measuring aid for determining distance on the map (found bottom centre below the map name). The left end of the scale bars is divided into tenths for measuring distances more accurately.

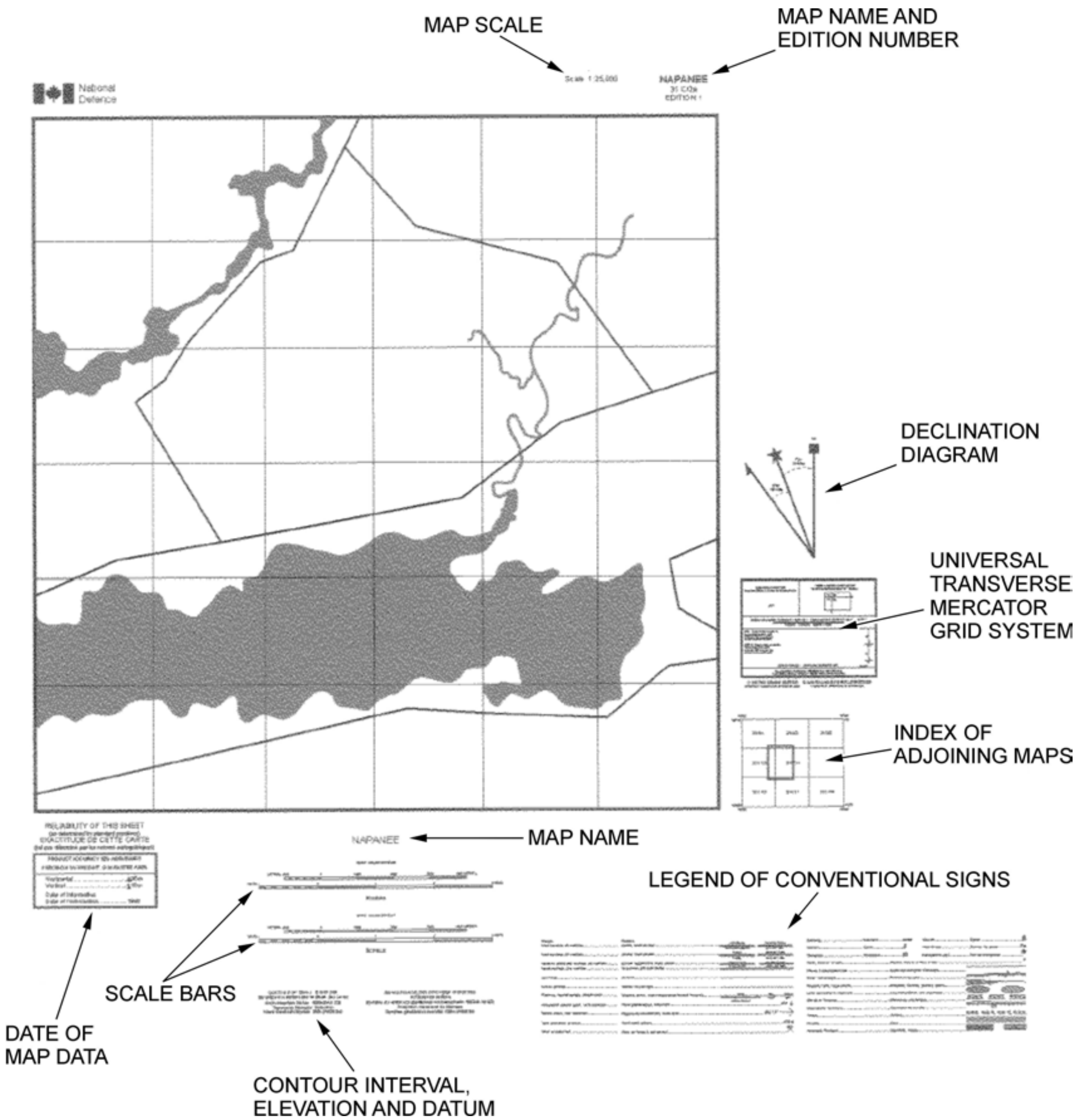
Contour Interval. Indicates the vertical (height) interval between contour lines and is given in metres or feet. The contour interval is found in the bottom margin.

Legend of Conventional Signs. A table showing the conventional signs used on the sheet in their correct colours with their descriptions is shown in the bottom or side margin, plus in a more complete list on the back of the map.

Military Index Number. The index is found in the top right corner of the map sheet and used for ordering additional maps.

Declination Diagram. Contains the information for the map on how true, grid, and magnetic north relate to each other. This information is given in the form of a diagram with explanatory notes. The diagram is in the right side margin.

Universal Transverse Mercator Grid System (UTM). The UTM grid system divides the earth's surface into zones, each covering six degrees of longitude and eight degrees of latitude. The 60 longitude bands are numbered and the 20 latitude bands are lettered. Each grid zone is one rectangle of the grid pattern, established by the bands and designated by the figures of the longitude band followed by the letter of latitude band.



Canadian Forces, Maps, Field Sketching, Compasses and the Global Positioning System, Department of National Defence (p. 11)

Figure 18-2-1 Marginal Information

Military users, refer to this map as:	SERIES **A901** MCE 320 EDITION 1

Canadian Forces, Maps, Field Sketching, Compasses and the Global Positioning System, Department of National Defence (p. 12)

Figure 18-2-2 Military Index Number

CONFIRMATION OF TEACHING POINT 1

QUESTIONS

Q1. Besides the margins, where else may the legend of conventional signs be found?

Q2. How is a map usually named?

Q3. What is the purpose of the declination diagram?

ANTICIPATED ANSWERS

A1. The legend of conventional signs may also be found on the back of the map.

A2. A map is usually named for a major community or district located on the map.

A3. The declination diagram contains the information for the map on how true, grid, and magnetic north relate to each other.

Teaching Point 2	**Conduct an Activity Where the Cadets Identify Conventional Signs by Colour**
Time: 30 min	Method: In-Class Activity

Discuss the information with the cadets prior to the commencement of the activity outlined below.

CONVENTIONAL SIGNS

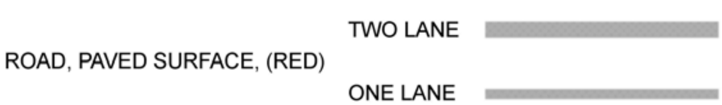
A number of symbols are used to indicate an object or item of detail that cannot be shown either by outline or by a line symbol. Most have been established through long usage and standardization agreements. The meaning of most symbols is obvious. However, if there is doubt consult the table of conventional symbols located on every map. Located on the back of most maps you will find many additional conventional signs.

Map-reading not only involves the ability to interpret the symbols shown on the map and to understand the information given in pictorial or written form, but it also involves a true understanding of the ground portrayed and an appreciation of the reliability and value of the particular map being used.

Where the symbol may have more than one meaning, the sign or symbol will be accompanied by a descriptive word (eg, tank or tower).

The use of colour aids in distinguishing details.

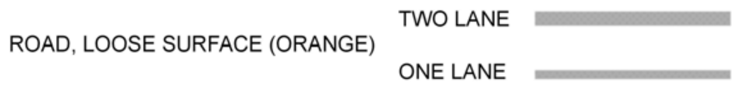
Red. Used to identify paved roads and highway numbers. Red is also used to shade in areas of urban development.



Director Cadets 3, 2008, Ottawa, ON: Department of National Defence

Figure 18-2-3 Red Conventional Signs

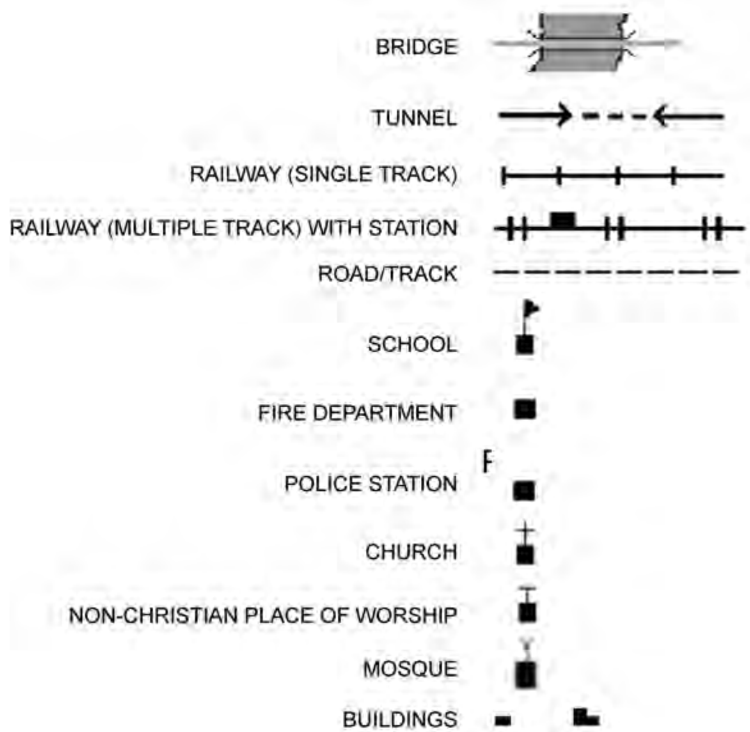
Orange. Used to represent unpaved roads.



Director Cadets 3, 2008, Ottawa, ON: Department of National Defence

Figure 18-2-4 Orange Conventional Signs

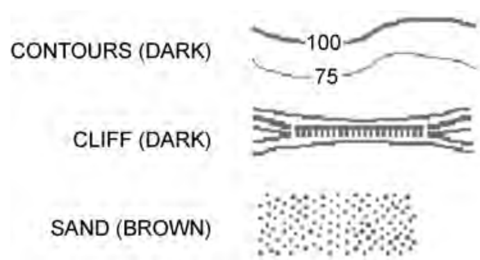
Black. Used for cultural features, toponyms (place names), some symbols and precise elevations.



Director Cadets 3, 2008, Ottawa, ON: Department of National Defence

Figure 18-2-5 Black Conventional Signs

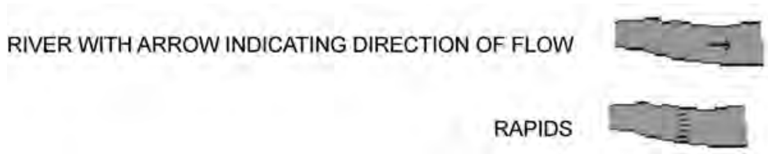
Brown. Used for contour lines, contour elevations, spot elevations, sand, cliffs, and other geographical features.



Director Cadets 3, 2008, Ottawa, ON: Department of National Defence

Figure 18-2-6 Brown Conventional Signs

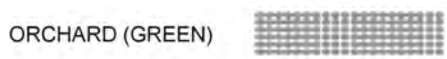
Blue. Used for water or permanent ice features (eg, rivers, lakes, swamps and ice fields), names of water features and the grid lines.



Director Cadets 3, 2008, Ottawa, ON: Department of National Defence

Figure 18-2-7 Blue Conventional Signs

Green. Used for vegetation features such as woods, orchards and vineyards.



Director Cadets 3, 2008, Ottawa, ON: Department of National Defence

Figure 18-2-8 Green Conventional Signs

White. Used to represent open fields.

Grey. Used for the legend of conventional signs on the back of the map.

Purple. Used for updates that are made over top of the original map information.

ACTIVITY

Time: 20 min

OBJECTIVE

The objective of this activity is to have the cadet identify conventional signs through the creation of a topographical map of Mapville.

RESOURCES

- Flip chart/whiteboard,
- Markers/dry erase markers, and
- Topographical maps.

ACTIVITY LAYOUT

The cadets should be seated in front of a flip chart/whiteboard with topographical maps available.

ACTIVITY INSTRUCTIONS

1. Draw a large outline of a topographical map on the flip chart/whiteboard at the front of the room.
2. Have the cadets approach the front, one at a time, and draw a conventional sign on the developing map of Mapville.
3. Have the cadets explain what the sign is for and why they chose to put it where they did. No sign may be used more than once.
4. Have cadets continue to add conventional signs until the time is used up.

Based upon the number of cadets in the class, each cadet may have to add several different conventional signs to the map.

SAFETY

N/A.

CONFIRMATION OF TEACHING POINT 2

The cadets' participation in the in-class activity will serve as confirmation of this TP.

END OF LESSON CONFIRMATION

The cadets' participation in the creation of the topographical map of Mapville will serve as confirmation of this lesson.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

This EO is assessed IAW A-CR-CCP-803/PG-001, Chapter 3, Annex B, Appendix 5 (390 PC).

CLOSING STATEMENT

Map-reading not only involves the ability to interpret the symbols shown on the map and to understand the information given in pictorial or written form, but it also involves a true understanding of the ground portrayed and an appreciation of the reliability and value of the particular map being used. This information will aid the cadet during their map and compass practical assessment.

INSTRUCTOR NOTES/REMARKS

N/A.

REFERENCES

A2-041 B-GL-382-005/PT-001 Canadian Forces. (2006). *Maps, Field Sketching, Compasses and the Global Positioning System*. Ottawa, ON: Department of National Defence.

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ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL THREE

INSTRUCTIONAL GUIDE

SECTION 3

EO M390.03 – DETERMINE GRID REFERENCES (GRS)

Total Time:	60 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-803/PG-001, Chapter 4. Specific uses for said resources are identified throughout the instructional guide within the TP for which they are required.

Review the lesson content and become familiar with the material prior to delivering the lesson.

Topographical maps are the preferred training aid for TP 2, however, the worksheet located at Annex A may be used. If required, photocopy Annex A for each cadet.

Create a slide or photocopy the training aid located at Annex B for each cadet.

Photocopy the worksheet located at Annex C for each cadet.

Based on the topographical map being used, create a list of objects for the cadets to determine six-figure GRs for, and a list of six-figure GRs for the cadets to determine what objects they represent.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

An interactive lecture was chosen for TPs 1 and 4 to introduce the grid system used to identify locations on a map.

Demonstration and performance was chosen for TPs 2, 3, 5 and 6 as it allows the instructor to explain and demonstrate determining four- and six-figure GRs and the construction and use of romers while providing an opportunity for the cadet to practice these skills under supervision.

INTRODUCTION

REVIEW

The following questions are a review of EO M390.02 (Identify Marginal Information and Conventional Signs, Section 2).

QUESTIONS

Q1. What does the contour interval on a topographical map represent?

Q2. What are conventional signs?

Q3. What is the colour green used for on topographical maps?

ANTICIPATED ANSWERS

A1. Indicates the vertical (height) interval between contour lines and is given in metres or feet.

A2. These are symbols used to indicate an object or item of detail that cannot be shown either by an outline or by a line symbol.

A3. It is used for vegetation features such as woods, orchards and vineyards.

OBJECTIVES

By the end of this lesson the cadet shall have determined four- and six-figure GRs.

IMPORTANCE

It is important for cadets to accurately determine four- and six-figure GRs in order to convey their location to others, for others to convey their location, and to plot a route on a topographical map.

Teaching Point 1	**Explain the Use of Grid Lines and GR Accuracy**
Time: 5 min	Method: Interactive Lecture

USE OF GRID LINES

Grid lines are used to convey a person's location to others and to plot a route on a topographical map using GRs.

The grid system is a network of intersecting vertical and horizontal blue lines superimposed on a topographical map. Maps are normally printed so that north is at the top of the sheet. The lines of the grid system are drawn evenly spaced, one scale kilometre apart, so that one set of lines run north-south (vertically) and the second set of lines run east-west (horizontally). The lines are assigned a sequential number and count up from the bottom left corner. The numbers are written along the edges of the map and occasionally within it. The intersecting grid lines at the lower left corner designate a grid square.

Eastings. Similar to the X-axis in mathematical graphing, eastings are a series of vertical parallel lines plotted as an overlay to the map sheet, which are drawn from top to bottom and numbered, with two digits, sequentially from west to east. They run north-south, similar to lines of longitude.

It is important to note that while eastings run parallel to each other, lines of longitude do not. The spacing between lines of longitude is widest at the equator and come together at the north and south poles. It is because of this difference that a bearing taken from a topographical map is a grid bearing, not a true bearing.

Northings. Similar to the Y-axis in mathematical graphing, northings are a series of horizontal parallel lines plotted as an overlay to the map sheet, which are drawn from left to right and numbered, with two digits, sequentially from south to north. They run east-west, the same as lines of latitude.

GR ACCURACY

A four-figure GR represents one grid square and is accurate within a 1 000 m square (1 km^2 or 1 000 000 m^2).

A six-figure GR represents one one-hundredth of a grid square and is accurate within a 100 m square (0.01 km^2 or 10 000 m^2).

CONFIRMATION OF TEACHING POINT 1

QUESTIONS

Q1. What is the grid system of a topographical map?

Q2. What is the spacing between lines of the grid system of a topographical map?

Q3. What is a northing?

ANTICIPATED ANSWERS

A1. The grid system is a network of intersecting vertical and horizontal blue lines superimposed on a topographical map.

A2. The lines of the grid system are drawn evenly spaced, 1 km apart.

A3. Similar to the Y-axis in mathematical graphing, northings are a series of horizontal parallel lines plotted as an overlay to the map sheet, which are drawn from left to right and numbered, with two digits, sequentially from south to north. They run east-west, the same as lines of latitude.

Teaching Point 2	**Explain, Demonstrate, and Have the Cadet Practice Determining a Four-Figure GR**
Time: 10 min	Method: Demonstration and Performance

For this skill lesson, it is recommended that instruction take the following format:

1. Explain and demonstrate the complete skill while cadets observe.
2. Explain and demonstrate each step required to complete the skill. Monitor cadets as they imitate each step.
3. Monitor the cadets' performance as they practice the complete skill.

Note: Assistant instructors may be used to monitor cadet performance.

Characteristics of a four-figure GR:

- Four-figure GRs will have four numerical digits derived from the numbers assigned to the eastings and northings on the map sheet.
- The numbers are listed by recording the two-digit easting followed by the two-digit northing.

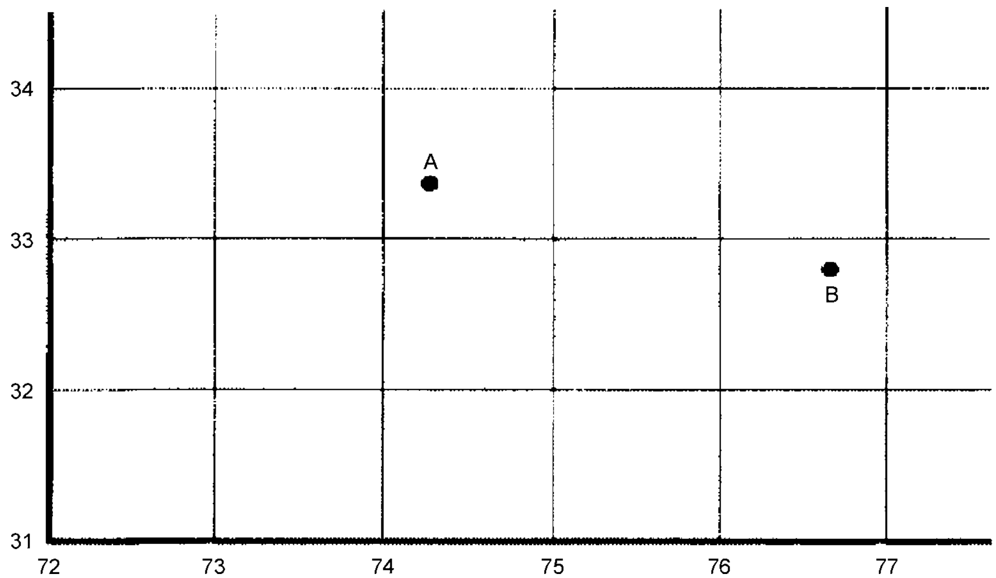
The grid lines that intersect in the bottom left corner of the grid square are used to identify that grid square.

Steps to determine a four-figure GR:

1. Confirm the correct grid square.
2. Place a finger at the bottom left corner of the map.
3. Move that finger along the bottom of the map (left to right) up to the grid line (easting) before the grid square.

4. Record the two-digit easting.
5. Place a finger at the bottom left corner of the map.
6. Move that finger along the left side of the map (bottom to top) up to the grid line (northing) before the grid square.
7. Record the two-digit northing after the two-digit easting to create the four-figure GR.
8. Confirm the four-figure GR.

In Figure 18-3-1 Building A is located at GR 7433 and Building B at GR 7632.



Canadian Forces, Maps, Field Sketching, Compasses and the Global Positioning System, Department of National Defence (p. 37)

Figure 18-3-1 Four-Figure Grid References

Steps to determine a grid square using a four-figure GR:

1. Confirm the four-figure GR.
2. Place a right-hand finger at the bottom left corner of the map.
3. Move that finger along the bottom of the map (left to right) up to the grid line (easting) numbered the same as the first two digits of the four-figure GR.
4. Place a left-hand finger at the bottom left corner of the map.
5. Move that finger along the left side of the map (bottom to top) up to the grid line (northing) numbered the same as the last two digits of the four-figure GR.
6. Move the right-hand finger up the grid line and the left-hand finger right along the grid line.
7. Where the two grid lines intersect is the bottom left corner of the grid square.
8. Confirm the correct grid square.

In Figure 18-3-1, GR 7532 represents the grid square southeast of Building A and west of Building B.

Have the cadets practice the skill either on a topographical map or the worksheet located at Annex A.

If using Annex A, check the cadets' answers using the answer key located at Annex D.

CONFIRMATION OF TEACHING POINT 2

The cadets' participation in the activity will serve as the confirmation of this TP.

Teaching Point 3 **Explain, Demonstrate, and Have the Cadet Practice Estimating a Six-Figure GR**

Time: 10 min Method: Demonstration and Performance

Using either the overhead or the handout created from Annex B, explain and demonstrate how to determine a six-figure GR. Care must be taken to ensure that all cadets understand each step before proceeding to the next step.

For this skill lesson, it is recommended that instruction takes the following format:

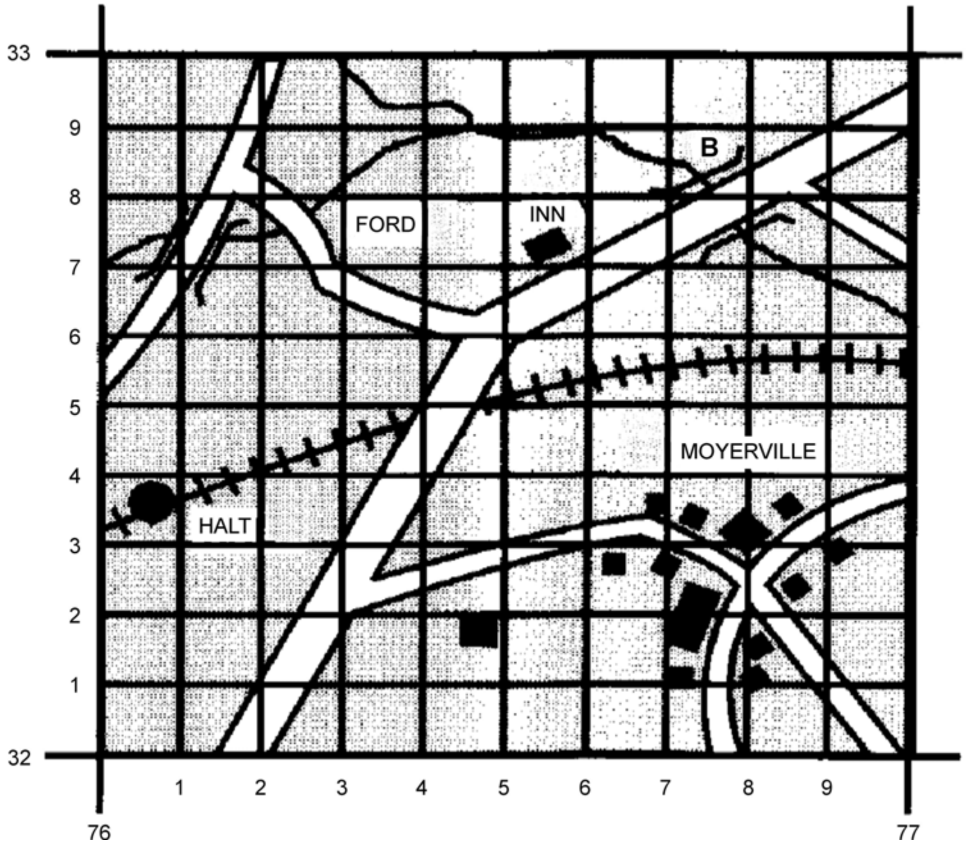
1. Explain and demonstrate the complete skill while cadets observe.
2. Explain and demonstrate each step required to complete the skill. Monitor cadets as they imitate each step.
3. Monitor the cadets' performance as they practice the complete skill.

Note: Assistant instructors may be used to monitor cadet performance.

Estimate a six-figure GR by:

1. creating an imaginary grid system to divide a grid square into 100 equally sized smaller grid squares with 10 along the bottom edge and 10 along the left-side edge (as illustrated at Figure 18-3-2);
2. noting that six-figure GRs will have six numerical digits derived from the numbers assigned to the eastings and northings on the map sheet and their estimated tenths;
3. recognizing that the numbers are listed by recording the three-digit easting followed by the three-digit northing; and
4. remembering that the grid lines that intersect in the bottom left corner of the grid square are used to identify that imaginary grid square.
   Steps to determine a six-figure GR:
   (1) Identify the object within the grid square. Note the four-figure GR.
   (2) Using the imaginary grid within the square, determine the three-digit easting by using the two digits of the easting combined with the number of tenths, measured from the left, to the line before the object.
   (3) Using the imaginary grid within the square, determine the three-digit northing by using the two digits of the northing combined with the number of tenths, measured from the bottom, to the line before the object.

(4) Combine the two sets of numbers to create the six-figure GR.



Canadian Forces, Maps, Field Sketching, Compasses and the Global Positioning System, Department of National Defence (p. 38)

Figure 18-3-2 Six-Figure Grid References

Example 1: Determine the six-figure GR for the building west of the town of Moyerville.

1. Building west of the town of Moyerville is within GR 7632.
2. 76 combined with 4 tenths creates ’764’.
3. 32 combined with 1 tenth creates ’321’.
4. Building west of the town of Moyerville is located at GR 764321.

Example 2: Determine the six-figure GR for the Inn north-north-west of the town of Moyerville.

1. The Inn at the north part of the grid square at GR 7632.
2. 76 combined with 5 tenths creates ’765’.
3. 32 combined with 7 tenths creates ’327’.
4. The Inn at the north part of the grid square is located at GR 765327.

Have the cadets complete the worksheet located at Annex C.

CONFIRMATION OF TEACHING POINT 3

The cadets' completion of the worksheet will serve as the confirmation of this TP.

Teaching Point 4 — **Define a Romer as a Device Used for Measuring a Point Within a Grid Square and Identify the Types of Romers Available for Use and Where to Find Them**

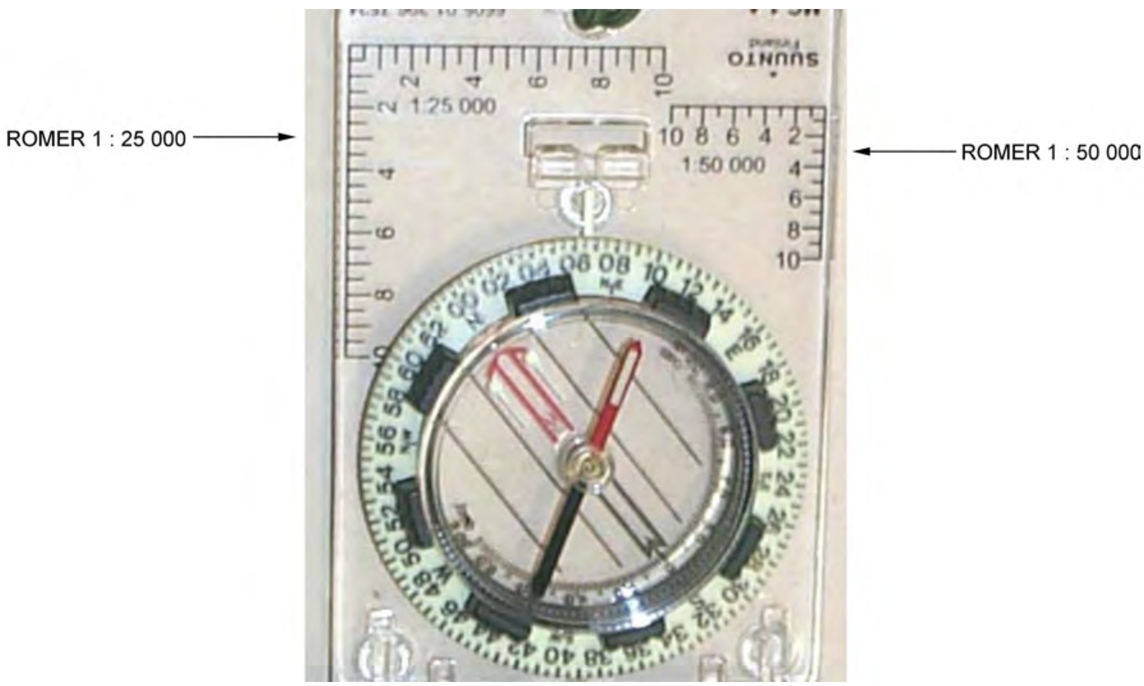
Time: 5 min — Method: Interactive Lecture

Romer. A device used for measuring a point within a grid square to determine its six-figure GR.

Romers may be purchased or created. Purchased romers include compasses and protractors. Constructed romers use a small piece of paper and the scale bars of a topographical map.

COMPASS

Many compasses include romers already printed on the compass base plate. There are commonly two romers, for use with 1 : 25 000 and 1 : 50 000 scale topographical maps.

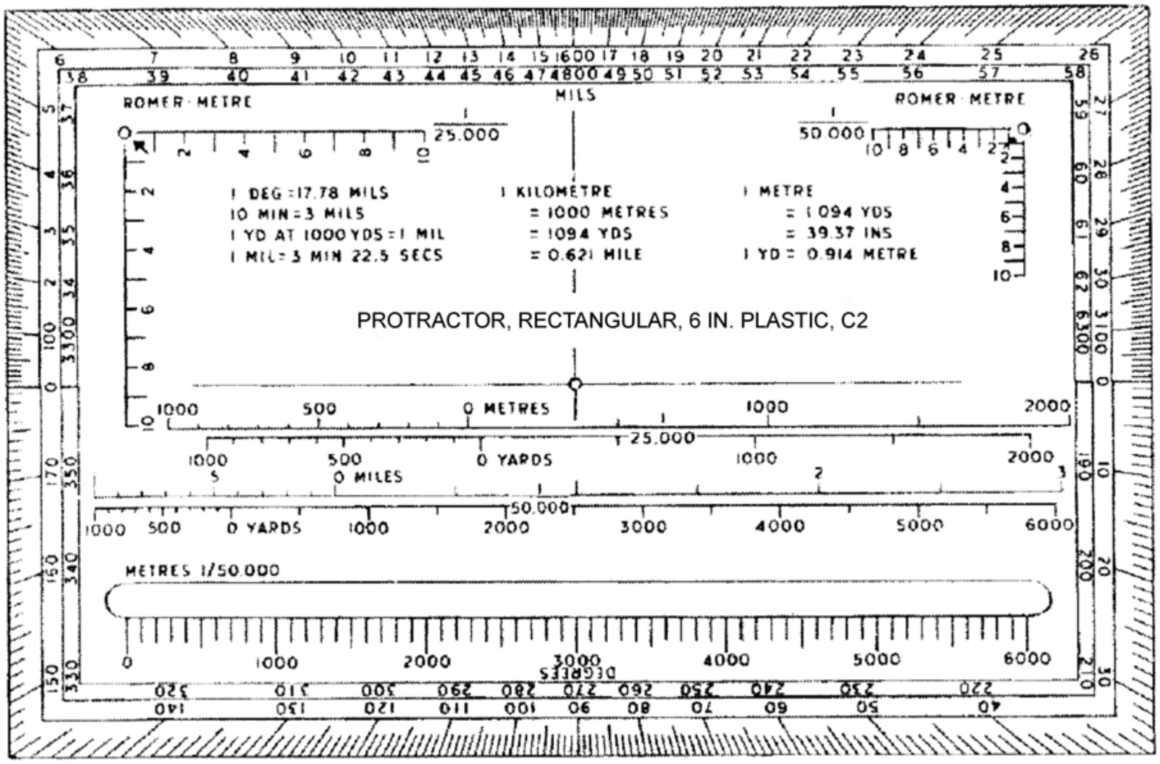


Director Cadets 3, 2008, Ottawa, ON: Department of National Defence

Figure 18-3-3 Compass

PROTRACTOR

All protractors may be used to determine a bearing on a map, however, few have romers already printed on them. The Canadian Forces has created the C2 protractor (as illustrated in Figure 18-3-4) specifically designed for use on topographical maps.

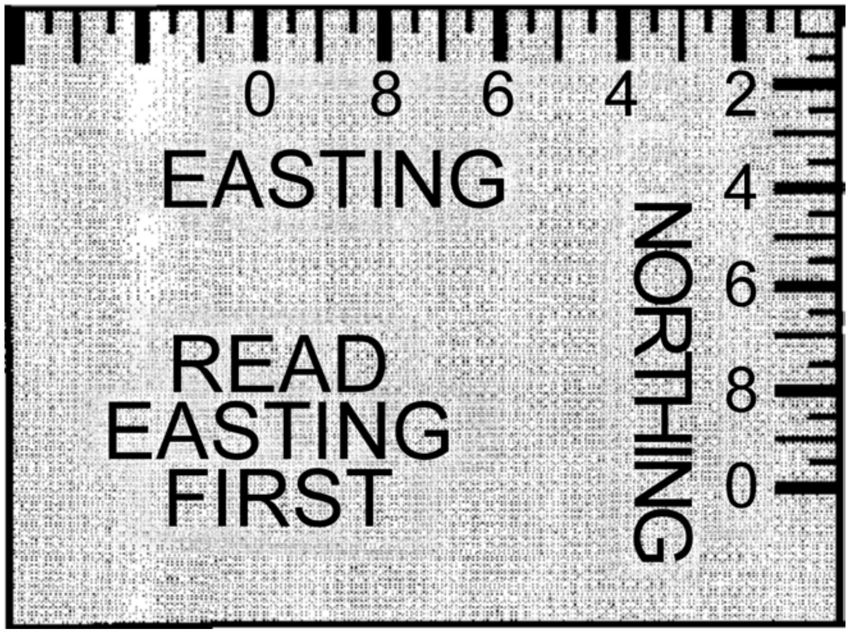


Canadian Forces, Maps, Field Sketching, Compasses and the Global Positioning System, Department of National Defence (p. 41)

Figure 18-3-4 C2 Protractor

CONSTRUCTED

A constructed romer requires a piece of paper with at least one square corner and the scale bars of the topographical map. Using the scale bars of the topographical map, a romer can be constructed as illustrated in Figure 18-3-5.



Canadian Forces, Maps, Field Sketching, Compasses and the Global Positioning System, Department of National Defence (p. 41)

Figure 18-3-5 Constructed Romer

CONFIRMATION OF TEACHING POINT 4

QUESTIONS

Q1. What is a romer?

Q2. Where are the romers on a compass found?

Q3. What two things are required to construct a romer?

ANTICIPATED ANSWERS

A1. A device used for measuring a point within a grid square to determine its six-figure GR.

A2. The romers are printed on the compass base plate.

A3. A constructed romer requires a piece of paper with at least one square corner and the scale bars of the topographical map.

Teaching Point 5 | **Explain, Demonstrate, and Have the Cadet Construct a Romer for Use in Determining Six-Figure GRs**

Time: 10 min | Method: Demonstration and Performance

Accuracy must be stressed to the cadets when constructing a romer. Have the cadets ensure that their pencils are sharp or their pens are fine tipped.

For this skill lesson, it is recommended that instruction take the following format:

1. Explain and demonstrate the complete skill while cadets observe.
2. Explain and demonstrate each step required to complete the skill. Monitor cadets as they imitate each step.
3. Monitor the cadets' performance as they practice the complete skill.

Note: Assistant instructors may be used to monitor cadet performance.

Construct a romer for determining six-figure GRs by:

1. obtaining a blank piece of paper with a square edge;
2. placing one side of the square edge along the 100-m scale bars;
3. marking off 100-m segments beginning at the corner of the paper and working outward;
4. numbering these markings from zero (at the corner of the paper) to ten; and
5. repeating Steps 2. to 4. on the adjacent edge (eg, completed romer as illustrated in Figure 18-3-5).

It is important to use the correct scale bar. The constructed romer's markings should match the grid lines of the topographical map; the side of a grid square must be equal to ten 100-m marks on each of the romer's two edges.

CONFIRMATION OF TEACHING POINT 5

The cadets' participation in the activity will serve as the confirmation of this TP.

Teaching Point 6 — **Explain, Demonstrate, and Have Cadet Practice Determining a Six-Figure GR Using a Constructed Romer**

Time: 10 min — Method: Demonstration and Performance

This TP uses all the skills from the previous TPs and it is essential that this TP not be covered until problems from the previous TPs have been corrected.

Unlike TP 3, where the cadets used the very visible 'imaginary' grid (eg, Figure 18-3-2) to determine a six-figure GR, the cadets will now be using their constructed romer from TP 5 to determine a six-figure GR and to locate objects with a six-figure GR. Much greater care and attention to detail must used by the cadets in order to ensure accuracy.

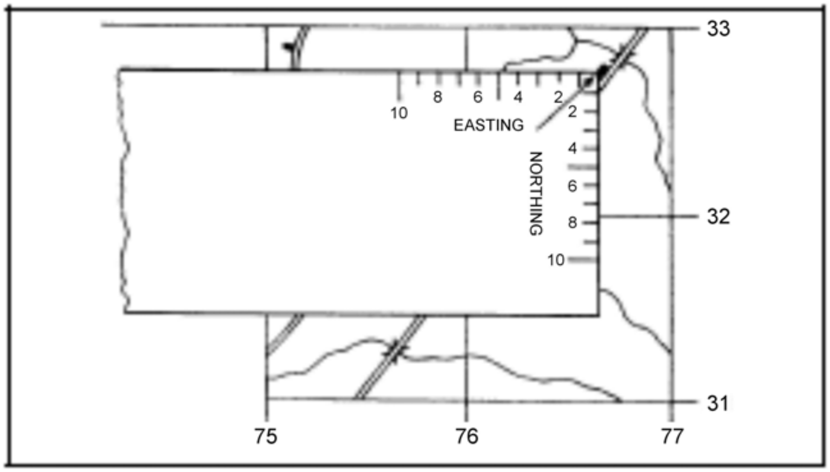
For this skill lesson, it is recommended that instruction take the following format:

1. Explain and demonstrate the complete skill while cadets observe.
2. Explain and demonstrate each step required to complete the skill. Monitor cadets as they imitate each step.
3. Monitor the cadets' performance as they practice the complete skill.

Note: Assistant instructors may be used to monitor cadet performance.

Determine a six-figure GR using a constructed romer, by:

1. placing the corner of the constructed romer on the bottom left corner of the grid square, noting the four-figure GR;
2. moving the constructed romer to the right the number of tenths required to align the romer directly to or before (never past) the conventional sign or location for which the GR is being determined;
3. reading the value along the X-axis of the romer where it crosses the easting on the map sheet (the value at this intersection becomes the value for the third digit of the six-figure GR);
4. moving the constructed romer up the number of tenths required for the corner of the romer to be positioned on or before (never past) the conventional sign or location for which the GR is being determined;
5. reading the value along the Y-axis of the romer where it crosses the northing on the map sheet (the value at this intersection becomes the value for the sixth digit of the six-figure GR); and
6. combining the two sets of digits to create the six-figure GR.



Director Cadets 3, Royal Canadian Army Cadet Reference Book, Department of National Defence (p. 5-20)

Figure 18-3-6 Using a Constructed Romer

Determine what a six-figure GR represents using a constructed romer, by:

1. determining the four-figure GR, by removing the third and sixth digits from the six-figure GR, to identify and locate the correct grid square;
2. placing the corner of the constructed romer on the bottom left corner of the grid square;
3. moving the constructed romer to the right the number of tenths, as identified by the third digit;
4. moving the constructed romer up the number of tenths, as identified by the sixth digit; and
5. determining the object (that is up and to the right from the tip of the romer).

Examples used will be from Annex C.

Example 1:

From Figure 18C-1, determine the six-figure GR for the Post Office.

1. Grid square GR 7632.
2. Four tenths to the right.
3. 76 combined with 4 tenths creates ‘764’.
4. Four tenths up.
5. 32 combined with 4 tenths creates ‘324’.
6. The Post Office is located at GR 764324.

Example 2:

From Figure 18C-1, determine the object located at GR 766323.

1. Four-figure GR is 7632.

2. Place romer at the bottom left corner of grid square 7632.
3. Move the romer to the right six tenths.
4. Move the romer up three tenths.
5. GR 766323 identifies the Train Station.

Have the cadets practice using the lists created before the lesson, of objects for the cadets to determine six-figure GRs for, and of six-figure GRs for the cadets to determine what objects they represent, on the appropriate topographical map.

CONFIRMATION OF TEACHING POINT 6

The cadets' participation in the activity will serve as the confirmation of this TP.

END OF LESSON CONFIRMATION

The cadets' participation in determining six-figure GRs will serve as the confirmation of this lesson.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

This EO is assessed IAW A-CR-CCP-803/PG-001, Chapter 3, Annex B, Appendix 5 (390 PC).

CLOSING STATEMENT

It is important for cadets to accurately determine four- and six-figure GRs in order to convey their location to others, determine where others are, and to plot a route on a topographical map. This skill will be of great benefit whenever the cadets are using topographical maps.

INSTRUCTOR NOTES/REMARKS

N/A.

REFERENCES

A2-041 B-GL-382-005/PT-001 Canadian Forces. (2006). *Maps, Field Sketching, Compasses and the Global Positioning System*. Ottawa, ON: Department of National Defence.

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ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL THREE

INSTRUCTIONAL GUIDE

SECTION 4

EO M390.04 – DETERMINE DISTANCE ON A MAP AND ON THE GROUND

Total Time:	90 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-803/PG-001, Chapter 4. Specific uses for said resources are identified throughout the instructional guide within the TP for which they are required.

Review the lesson content and become familiar with the material prior to delivering the lesson.

Create five 'point-to-point' and five 'along a route between two points' distances for the topographical map being used. Four- and six-figure grid references (GRs) should be used to designate the start and end points.

Measure and mark three 100-m pace courses. One should be on a flat trail/road, another through light bush, and the last through heavier bush, with slopes if possible. Pace courses should be wide enough to allow several cadets to use them at the same time.

Calculate personal pace for 100 m.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

Demonstration and performance was chosen for TPs 1 and 2 as it allows the instructor to explain and demonstrate measuring distances on a map and determining personal pace, while providing an opportunity for the cadet to practice these skills under supervision.

An interactive lecture was chosen for TP 3 to introduce the factors that can affect the cadets' personal pace.

A practical activity was chosen for TP 4 as it is an interactive way for the cadet to experience pacing and the factors that affect it in a safe, controlled environment. This activity contributes to the development of pacing skills and knowledge in a fun and challenging setting.

INTRODUCTION

REVIEW

The following questions are a review of EO M390.03 (Determine Grid References [GRs], Section 3).

QUESTIONS

Q1. What are eastings?

Q2. Which grid line intersection is used to represent a grid square?

Q3. What is a romer?

ANTICIPATED ANSWERS

A1. Similar to the X-axis in mathematical graphing, eastings are a series of vertical parallel lines plotted as an overlay to the map sheet, which are drawn from top to bottom and numbered, with two digits, sequentially from west to east. They run north-south, similar to lines of longitude.

A2. The grid lines that intersect in the bottom left corner of the grid square are used to identify that grid square.

A3. A device used for measuring a point within a grid square to determine its six-figure GR.

OBJECTIVES

By the end of this lesson the cadet shall have determined distance on the map and on the ground.

IMPORTANCE

It is important for cadets to be able to accurately determine distance on the map and on the ground in order to effectively use a topographical map to plot a route that will be followed on the ground.

Teaching Point 1	**Explain, Demonstrate and Have the Cadet Determine Distance on a Map**
Time: 30 min	Method: Demonstration and Performance

For this skill lesson, it is recommended that instruction take the following format:

1. Explain and demonstrate the complete skill while cadets observe.
2. Explain and demonstrate each step required to complete the skill. Monitor cadets as they imitate each step.
3. Monitor the cadets' performance as they practice the complete skill.

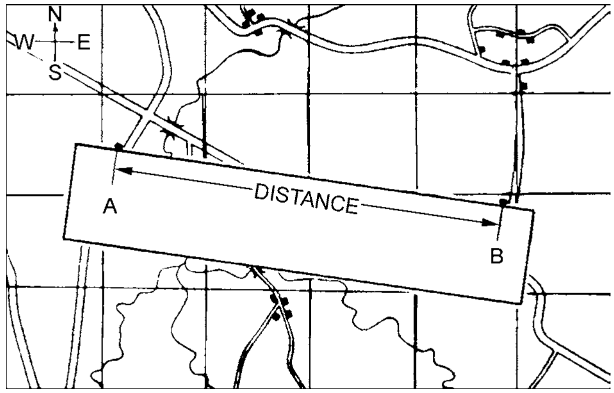
Note: Assistant instructors may be used to monitor cadet performance.

DETERMINING DISTANCE ON A MAP

Cadets can use a map to measure the distance between two points (eg, points A and B as illustrated at Figure 18-4-1) on the ground. All maps are drawn to scale; therefore, a specified distance on a map equals a specified distance on the ground. The scale of a map is printed at the top and bottom of each map (eg, scale 1 : 50 000). This means that 1 cm on the map equals 50 000 cm (500 m) on the ground.

There are two ways to determine distance on a topographical map – point-to-point and along a route.

Measuring Point-to-Point

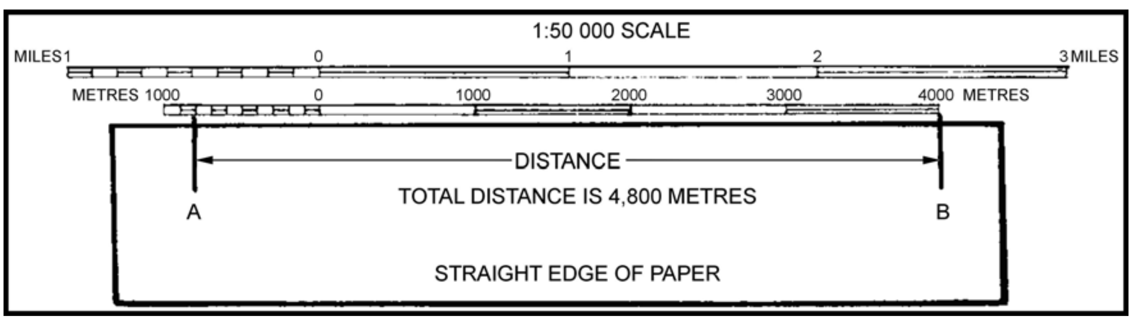


Director Cadets 3, Royal Canadian Army Cadet Reference Book, Department of National Defence (p. 5-24)

Figure 18-4-1 Measure Distance Point-to-Point

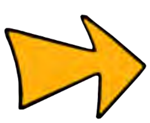
To measure a distance point-to-point:

1. Lay the straight edge of a piece of paper against the two points.
2. With a sharp pencil, mark the paper at the A (start) and B (end) points.
3. Lay the paper just under the metres scale bar with the B mark at the right end of the scale. Move the paper to the left aligning the B mark with each thousand metre mark until the A mark falls within the subdivided thousands (hundreds) to the left of the zero.
4. To calculate the total distance, add the number of thousands where the B mark is, plus the number of subdivided thousands where the A mark is to the left of the zero.



Director Cadets 3, Royal Canadian Army Cadet Reference Book, Department of National Defence (p. 5-25)

Figure 18-4-2 Calculate Distance



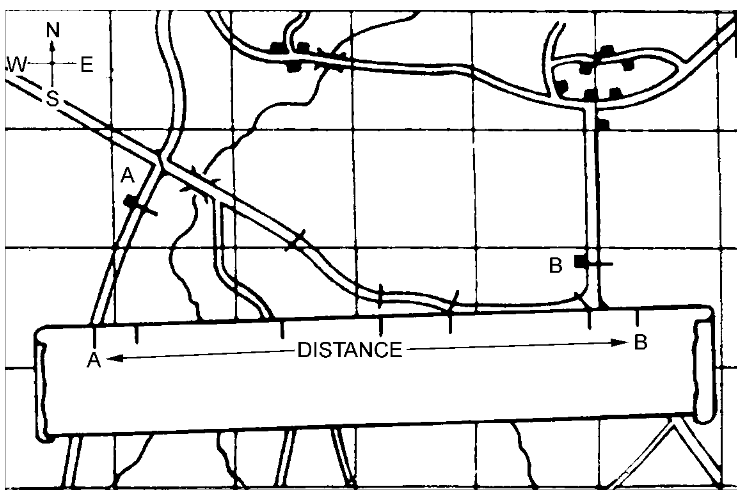
For a distance that is longer than 5 000 m, measure the first 5 000 m and mark the paper with a new line and label it ‘5 000 m’. Place the new mark at the zero or thousands mark until the A mark fits within the subdivided thousands (hundreds) bar. Add the total of that distance to the 5 000 m to create the total distance.

Measuring Along a Route Between Two Points

Sometimes cadets need to find the distance between A and B around the curves in a road along a planned route.

To measure a distance along a route between two points:

1. Lay the straight edge of a piece of paper against point A.
2. With a sharp pencil, mark point A on the paper and the map.
3. Line up the paper with the edge of the road until a curve is reached and make another mark on the paper and on the map.
4. Pivot the paper so that it continues to follow the road edge. Repeat until you reach point B.
5. Mark the paper and the map at point B.
6. Lay the paper just under the metres scale bar with the B mark at the right end of the scale. Move the paper to the left aligning the B mark with each thousand metre mark until the A mark falls within the subdivided thousands (hundreds) to the left of the zero.
7. Add the number of thousands where the B mark is, plus the number of subdivided thousands (hundreds) where the A mark is to the left of the zero, to determine the total distance.



Director Cadets 3, Royal Canadian Army Cadet Reference Book, Department of National Defence (p. 5-25)

Figure 18-4-3 Measure Distance Along a Route

ACTIVITY

Time: 15 min

OBJECTIVE

The objective of this activity is to have the cadets measure distance on a map.

RESOURCES

- Topographical map,
- Paper, and

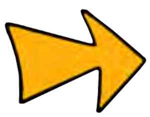
- Pencil.

ACTIVITY LAYOUT

N/A.

ACTIVITY INSTRUCTIONS

1. Divide the cadets into pairs.
2. Distribute a map to each pair.
3. Have the cadets determine the distance:
   (a) point-to-point, and
   (b) along a route.
4. Check answers.
5. Repeat Steps 3. to 4. until complete or the time is up.



All marks should be carefully erased from the map after each distance is determined.

SAFETY

N/A.

CONFIRMATION OF TEACHING POINT 1

The cadets' participation in determining distance on a map will serve as the confirmation of this TP.

Teaching Point 2	**Explain, Demonstrate and Have the Cadet Pace**
Time: 15 min	Method: Demonstration and Performance

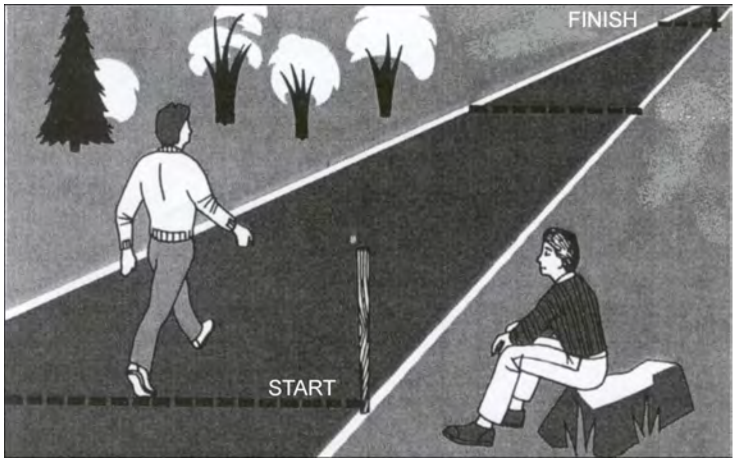
For this skill lesson, it is recommended that instruction take the following format:

1. Explain and demonstrate the complete skill while cadets observe.
2. Explain and demonstrate each step required to complete the skill. Monitor cadets as they imitate each step.
3. Monitor the cadets' performance as they practice the complete skill.

Note: Assistant instructors may be used to monitor cadet performance.

DETERMINING A PERSONAL PACE FOR 100 M

Being able to determine distance is a key skill for ground navigation. By learning how to determine distance using a personal pace, a cadet will have the skill to determine how far they have travelled, and how far they have to travel to reach their destination.



B. Kjellstrom, Be Expert With Map & Compass, Hungry Minds, Inc. (p. 53)

Figure 18-4-4 Determining Distance Using Pacing

Personal Pace. The number of paces a person walks over a distance of 100 m.

COUNTING PACES

There are two basic methods to count pace:

- count every pace (count every step); or
- count every other pace (count every left or every right step).

For example:

- count every pace: 140 paces = 100 m; or
- count every other pace: 70 paces = 100 m.

CALCULATING DISTANCE

In order to determine distance travelled, the total number of paces travelled is divided by the personal pace and multiplied by 100 m to calculate the number of metres travelled.

Formula:

$$\frac{\text{total number of paces}}{\text{personal pace}} \times 100 \text{ m} = \text{total distance travelled (m)}$$

Example:

$$\frac{140 \text{ paces}}{70} \times 100 \text{ m} = 200 \text{ m}$$

Common methods of keeping track of the number of paces travelled include:

- transferring pebbles from one pocket to another: one pebble for each 100 paces;
- using a length of cord with knots – the knotted cord is held with the hand gripping a knot and the hand is advanced one knot down the cord for every 100 paces; and

- combining the knotted cord and pebbles (eg, cord with 10 knots, pebbles transferred for each completed cord [10 knots x 100 paces each = 1000 paces/pebble]).

ACTIVITY

Time: 10 min

OBJECTIVE

The objective of this activity is to have the cadets determine their personal pace.

RESOURCES

- Calculator (one per pair of cadets),
- Paper, and
- Pen/pencil.

ACTIVITY LAYOUT

Measure a 100-m course and mark it with a clearly defined start and end point on a flat trail/road.

ACTIVITY INSTRUCTIONS

1. Have the cadets walk the pace course, counting out loud, being careful to keep an accurate count.
2. Have the cadets walk the pace course three times, noting their pace count each time.
3. Have the cadets calculate their personal pace by averaging their three pace counts.
4. Have the cadets record their personal pace.

Do not walk with someone when determining a personal pace. When people walk together, they automatically adjust their pace length to match the other person's in order to stay together.

SAFETY

Boundaries must be marked and supervised.

CONFIRMATION OF TEACHING POINT 2

The cadets' participation in determining personal pace will serve as the confirmation of this TP.

Teaching Point 3 | **Describe Factors That Affect Pacing**

Time: 5 min | Method: Interactive Lecture

FACTORS THAT AFFECT PACING

This teaching point should be presented by asking the cadets what they think could affect their personal pace. Ensure to cover any points that are not suggested by the cadets.

Factors that will affect personal pace include:

Terrain. The rougher the ground, the shorter the pace.

Slopes. Pace is shorter going uphill and longer going downhill.

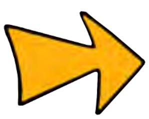
Fatigue. Will shorten a person's pace.

Equipment. Footwear with poor traction will shorten a person's pace. Carrying a heavy load will also shorten a person's pace.

Weather. Snow and rain will shorten a person's pace. The wind will increase/decrease pace length if a person is travelling with/against the wind.

Obstacles. Going around small features (eg, trees, bushes) will affect pace count unless compensated for. Compensation methods include:

- **Sidestepping.** Stepping to the side (left/right) enough paces to bypass the obstacle, pacing forward past the obstacle and sidestepping back (right/left) to return to the original line of travel. This method maintains pace accuracy, but takes time.



The paces that the cadets sidestep are not added to their total pace count.

- **Alternating sides.** In this method, the cadet alternates which side (left/right) of the obstacle they pass (eg, last obstacle was passed on the left, next will be on the right). This method is less accurate, but faster.

If obstacles are always bypassed on the same side, the line of travel will veer off in that direction unless a distant steering point (eg, tall tree, hill top, building) is used as a guide.

CONFIRMATION OF TEACHING POINT 3

QUESTIONS

Q1. How does slope affect pace?

Q2. How will weather affect pace?

Q3. What can happen if you always bypass obstacles on the same side?

ANTICIPATED ANSWERS

A1. Pace is shorter going uphill, and longer going downhill.

A2. Snow and rain will shorten a person's pace, the wind will increase/decrease pace length if a person is travelling with/against the wind.

A3. The line of travel will veer off in that direction unless a distant steering point (eg, tall tree, hill top, building) is used as a guide.

Teaching Point 4	**Demonstrate and Have the Cadet Practice Determining Distance Using the Pace-Counting Method Over Varied Terrain**
Time: 30 min	Method: Practical Activity

This activity combines the cadets' personal pace determined in TP 2 with the knowledge taught in TP 3. This allows the cadets to gain experience pacing and the effect varied terrain will have on their pace.

ACTIVITY

OBJECTIVE

The objective of this activity is to have the cadets determine their personal pace over varied terrain.

RESOURCES

- Calculator (one per pair of cadets),
- Paper, and
- Pen/pencil.

ACTIVITY LAYOUT

Measure two 100-m pace courses and mark each of them with clearly defined start and end points. One should be through light bush and the second through heavier bush, with slopes if possible.

ACTIVITY INSTRUCTIONS

1. Inform the cadets that they will be using their personal pace on two courses to determine the effect of terrain on pace.
2. Divide the cadets into two groups. Assign one group to each course.
3. Have the cadets, individually, pace the course five times, and then determine the difference between this count and their personal pace.
4. After 15 minutes, have the cadets switch courses.
5. Have the cadets, individually, pace the course five times, and then determine the difference between this count and their personal pace.
6. Have the cadets record their findings.

SAFETY

Boundaries must be marked and supervised.

CONFIRMATION OF TEACHING POINT 4

The cadets' participation in the pacing activities will serve as the confirmation of this TP.

END OF LESSON CONFIRMATION

The cadets' participation in determining distance on a map and determining their personal pace will serve as the confirmation of this lesson.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

This EO is assessed IAW A-CR-CCP-803/PG-001, Chapter 3, Annex B, Appendix 5 (390 PC).

CLOSING STATEMENT

It is important for cadets to be able to accurately determine distance on the map and on the ground in order to effectively use a topographical map to plot a route that will be followed on the ground. The skill gives the map reader confidence in their ability to know where they are at all times.

INSTRUCTOR NOTES/REMARKS

N/A.

REFERENCES

A2-041 (B-GL-382-005/PT-001) Canadian Forces. (2006). *Maps, Field Sketching, Compasses and the Global Positioning System*. Ottawa, ON: Department of National Defence.

C0-111 (ISBN 978-0-9740820-2-8) Tawrell, P. (2006). *Camping and Wilderness Survival: The Ultimate Outdoors Book* (2nd ed.). Lebanon, NH: Leonard Paul Tawrell.

C2-041 (ISBN 0-07-136110-3) Seidman, D., & Cleveland, P. (1995). *The Essential Wilderness Navigator*. Camden, ME: Ragged Mountain Press.

ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL THREE

INSTRUCTIONAL GUIDE

SECTION 5

EO M390.05 – DETERMINE BEARINGS ON A MAP AND ON THE GROUND

Total Time:	60 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-803/PG-001, Chapter 4. Specific uses for said resources are identified throughout the instructional guide within the TP for which they are required.

Review the lesson content and become familiar with the material prior to delivering the lesson.

Ensure sufficient topographical maps of the exercise area are available.

Create a list of points (designated by description and by grid reference [GR]) from the topographical map of the exercise area for the cadets to determine in TP 5.

A reconnaissance (recce) of the exercise area should be made to determine a site with several distinctive features to be used as prominent objects for the cadets to take bearings.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

An interactive lecture was chosen for TPs 1–4 to introduce the cadets to the compass, the degree system, the three norths, and bearings.

Demonstration and performance was chosen for TPs 5 and 6 as it allows the instructor to explain and demonstrate determining bearings on a map and on the ground while providing an opportunity for the cadets to practice these skills under supervision.

INTRODUCTION

REVIEW

The following questions are a review of EO M390.04 (Determine Distance on a Map and on the Ground, Section 4).

QUESTIONS

Q1. After marking a map to assist in determining distance, what should be done with the marks?

Q2. Define personal pace.

Q3. What effect does weather have on a person's pace?

ANTICIPATED ANSWERS

A1. All marks should be carefully erased from the map after each distance is determined.

A2. The number of paces a person walks over a distance of 100 m.

A3. Snow and rain will shorten a person's pace while wind will increase/decrease the pace length if a person is travelling with/against the wind.

OBJECTIVES

By the end of this lesson the cadet shall have determined bearings on a map and on the ground.

IMPORTANCE

It is important for cadets to be able to determine bearings on a map and on the ground as this is one of the key skills required to navigate using a map and compass.

Teaching Point 1 **Identify and Explain the 16 Points of a Compass**

Time: 10 min Method: Interactive Lecture

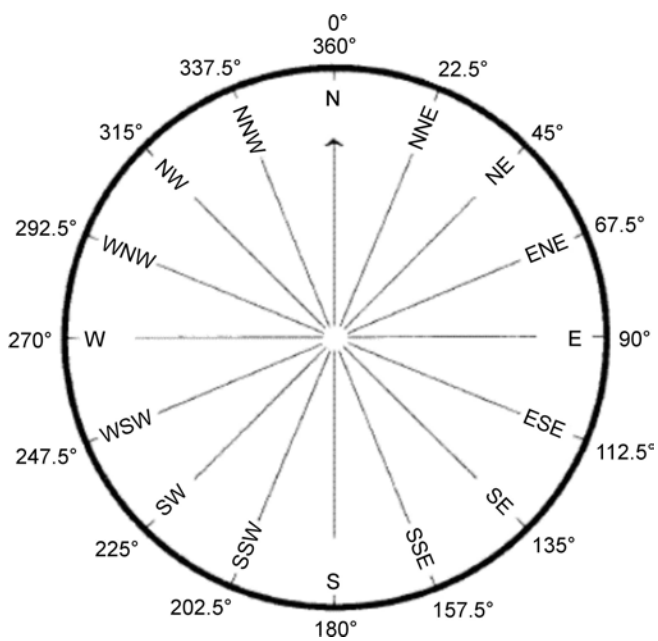


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Figure 18-5-1 Compass Rose

FOUR CARDINAL POINTS

The four cardinal points of the compass, measured at right angles clockwise from north are:

- north (N) at 0 and 360 degrees,
- east (E) at 90 degrees,
- south (S) at 180 degrees, and

- west (W) at 270 degrees.

FOUR INTER-CARDINAL POINTS

The four inter-cardinal points are located halfway between each of the cardinal points. Measured clockwise from north, they are:

- northeast (NE) at 45 degrees,
- southeast (SE) at 135 degrees,
- southwest (SW) at 225 degrees, and
- northwest (NW) at 315 degrees.

EIGHT INTERMEDIATE POINTS

The eight intermediate points are located halfway between each cardinal point and inter-cardinal point. Measured clockwise from north, they are:

- north-northeast (NNE) at 22.5 degrees,
- east-northeast (ENE) at 67.5 degrees,
- east-southeast (ESE) at 112.5 degrees,
- south-southeast (SSE) at 157.5 degrees,
- south-southwest (SSW) at 202.5 degrees,
- west-southwest (WSW) at 247.5 degrees,
- west-northwest (WNW) at 292.5 degrees, and
- north-northwest (NNW) at 237.5 degrees.

As an aid to remember the different types of points:

- cardinal points are designated by one letter;
- inter-cardinal points are designated by two letters; and
- intermediate points are designated by three letters.

CONFIRMATION OF TEACHING POINT 1

QUESTIONS

Q1. Which two degree values may be used for north?

Q2. How many inter-cardinal points are there?

Q3. Name one of the intermediate points.

ANTICIPATED ANSWERS

A1. 0 and 360 degrees.

A2. Four.

A3. Either NNE, ENE, ESE, SSE, SSW, WSW, WNW, or NNW.

Teaching Point 2 | **Explain the Degree System on a Compass**

Time: 5 min | Method: Interactive Lecture

The cardinal, inter-cardinal, and intermediate points describe directions only to within one-sixteenth of a full circle. For a more precise indication of direction it is necessary to use the sub-divisions of the circle called degrees. This measurement starts and ends at north (top) and is measured in a clockwise rotation.

Degrees. The most common method of dividing a circle is by degrees. These degrees represent 360 equal angles in a complete circle and they are represented by the symbol “°” (eg, 222°).

It is important to emphasize that degrees should always be measured clockwise and always using north as the start point.

CONFIRMATION OF TEACHING POINT 2

QUESTIONS

Q1. Degrees are measured in which direction?

Q2. What is the most common method of dividing a circle?

Q3. How many degrees are in a full circle?

ANTICIPATED ANSWERS

A1. Degrees are measured clockwise from north.

A2. Degrees.

A3. 360 degrees.

Teaching Point 3 **Identify and Explain the Three Norths**

Time: 5 min Method: Interactive Lecture

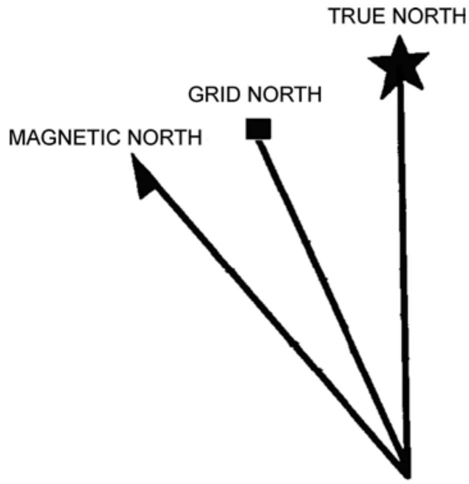

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Figure 18-5-2 The Three Norths

THE THREE NORTHS

The relationship between the three norths, especially grid and magnetic, is key to using a compass on both a map and on the ground.

True North. True north is located at the top of the earth where the geographic North Pole is located, where all lines of longitude meet. In the declination diagram on the map, true north is represented by the symbol of a star, which represents the North Star, Polaris.

Grid North. Grid north is the north indicated by the grid lines (eastings) on a topographical map. The easting lines run parallel to each other and will never meet at the geographic North Pole; because of this, grid north points off slightly from true north. In the declination diagram on the map, grid north is represented by a square, which represents a map grid.

Magnetic North. Magnetic north is the location of the north magnetic pole, where the Earth's magnetic field bends back into the Earth toward the south magnetic pole. It is located in the Canadian arctic and is different from true north. It is the direction in which the compass needle points. In the declination diagram on the map, magnetic north is represented by a needle as on a compass.

The differences between the three norths affect navigation for the map and compass user, in the form of magnetic declination. Magnetic declination is the difference in bearing either between true north and magnetic north or between grid north and magnetic north.

Cadets will normally use the magnetic declination value between grid north and magnetic north when navigating using a map and compass. By setting the magnetic declination on the compass, magnetic bearings are converted to grid bearings which allow bearings taken from the map to be used on the ground and vice versa.

CONFIRMATION OF TEACHING POINT 3

QUESTIONS

Q1. Which north is represented by a star?

Q2. Which north does a compass needle point towards?

Q3. Which magnetic declination value is most important to topographical map users?

ANTICIPATED ANSWERS

A1. True north.

A2. Magnetic north.

A3. The magnetic declination value between grid north and magnetic north.

Teaching Point 4	**Explain Bearings**
Time: 5 min	Method: Interactive Lecture

DEFINITION OF A BEARING

Bearing. A bearing is an angle that is measured clockwise, from north. It is measured in degrees and is relative to the observer.

In geometry, an angle is based on three points; a vertex, and two points, each of which designates a ray. For a bearing, the vertex is the point where the bearing is taken from, another point is north, and the last point is where the bearing is directed to. The north (either true, grid or magnetic) used identifies the type of bearing.

In ground navigation, one ray of the angle points north (usually grid north) and the other ray, known as a plotting ray, points to the object/direction.

TYPES OF BEARINGS

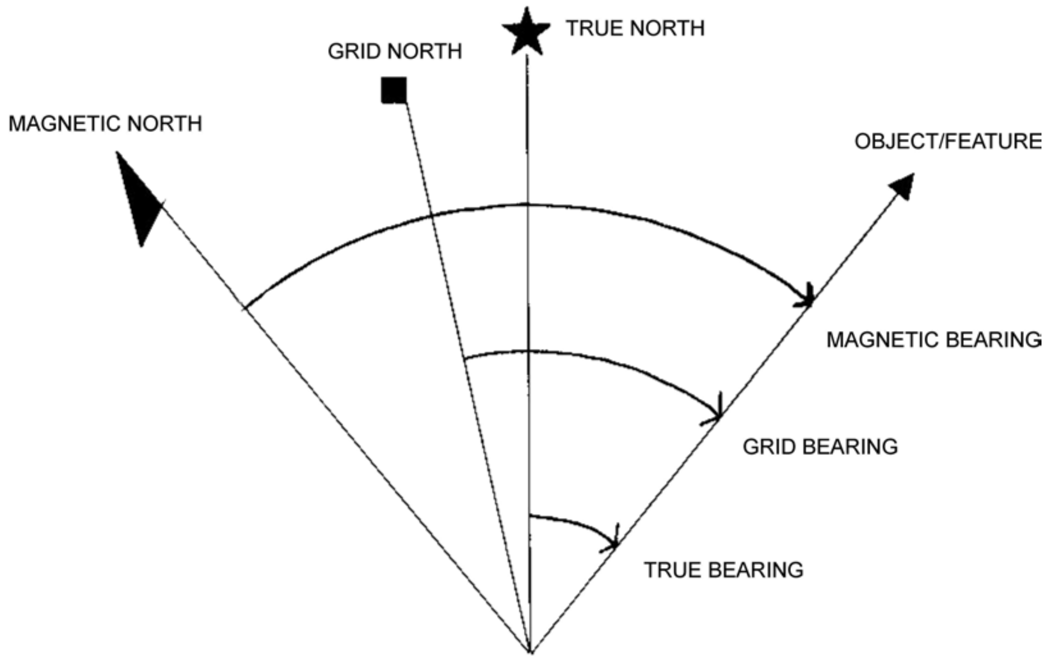

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Figure 18-5-3 Types of Bearings

True Bearings. A true bearing is a bearing measured from true north. While map users rarely use them, directions determined using the sun, moon and stars are true bearings. Global Positioning System (GPS) receivers also use true bearings.

Grid Bearings. A grid bearing is a bearing measured from grid north. The ability to determine a bearing from a map allows a map user to plan routes or activities before going into the field, and allows an easy method of communicating information about movement or location.

Magnetic Bearings. A magnetic bearing is measured from magnetic north and is measured using a compass, which either has no option of setting magnetic declination or has the magnetic declination set to zero. A magnetic bearing is a quick and efficient method of describing a route when a map is not being used.

> If a compass has its declination set to zero, bearings to objects on the ground determined by that compass are magnetic bearings. Setting the magnetic declination on a compass converts the magnetic bearings determined by that compass into grid bearings for the map being used.

Back Bearing. A back bearing is a bearing that is in exactly the opposite direction of the bearing that has been measured. A back bearing can be useful for different reasons: to return to the start location after a hike, or to calculate the bearing from an object to one's current location. The steps to calculate a back bearing are:

- if the bearing is less than 180 degrees, add 180 degrees; and
- if the bearing is greater than 180 degrees, subtract 180 degrees.

CONFIRMATION OF TEACHING POINT 4

QUESTIONS

Q1. A bearing is another name for what?

Q2. Directions determined using the sun, moon and stars are what type of bearing?

Q3. How is knowing a back bearing useful?

ANTICIPATED ANSWERS

A1. A bearing is another name for an angle.

A2. True bearings.

A3. A back bearing can be useful for different reasons: to return to the start location after a hike, or to calculate the bearing from an object to one's current location.

Teaching Point 5	Explain, Demonstrate and Have the Cadets Practice Determining a Bearing on a Map
Time: 15 min	Method: Demonstration and Performance

The ability to determine a bearing from a map allows cadets to plan routes or activities before going into the field, and allows an easy method of communicating information about movement or location. When a compass is adjusted to compensate for magnetic declination, it will allow bearings taken on the map to be used on the ground and vice versa.

For this skill lesson, it is recommended that instruction take the following format:

1. Explain and demonstrate the complete skill while cadets observe.
2. Explain and demonstrate each step required to complete the skill. Monitor cadets as they imitate each step.
3. Monitor the cadets' performance as they practice the complete skill.

Note: Assistant instructors may be employed to monitor cadet performance.

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Figure 18-5-4 Measuring a Bearing on a Map

A cadet will accidentally measure a back bearing if they determine the bearing in the wrong direction (eg, bearing from point B to point A instead of point A to point B).

Prior to measuring a bearing on a map it is good practice to first estimate the bearing by drawing a compass rose and looking at where the bearing would be on the compass rose. This serves as a good check to ensure the cadet has not accidentally measured the back bearing.

To measure a bearing on a map:

1. Set the predetermined declination on the compass.
2. Identify and mark the start (point A) and finish (point B) points on a map.
3. Draw a plotting ray from point A to point B.
4. Lay the fully opened compass with the edge of the compass base plate along the plotting ray, and the sighting arrow pointed in the direction of travel (point A to point B).
5. Hold the compass in place, rotate the compass dial so that the compass meridian lines align with the easting lines on the map, ensuring north on the dial indicates north on the map.
6. Read the number on the compass dial at the luminous index pointer.

If the bearing is taken from point B to point A, the compass will be pointing 180 degrees in exactly the opposite direction of travel wanted. This is called a back bearing.

Have the cadets practice determining bearings on a map from the list created (before the lesson) from the topographical map of the exercise area.

CONFIRMATION OF TEACHING POINT 5

The cadets' participation in determining bearings on a map will serve as the confirmation of this TP.

Teaching Point 6 — **Explain, Demonstrate, and Have Cadets Determine the Bearing of a Prominent Object**

Time: 10 min — Method: Demonstration and Performance

For this skill lesson, it is recommended that instruction take the following format:

1. Explain and demonstrate the complete skill while the cadets observe.
2. Explain and demonstrate each step required to complete the skill. Monitor the cadets as they imitate each step.
3. Monitor the cadets' performance as they practice the complete skill.

Note: Assistant instructors may be employed to monitor the cadets' performance.

A compass can be used to determine the bearing for a direction of travel and from one's current location to a prominent object. The ability to take a bearing of a prominent object also allows the cadet to look for a prominent object as a steering point when they need to follow a given bearing. A bearing is a quick and accurate method for describing the direction of travel.

A prominent object is something that is usually tall and easily recognizable (eg, church steeple, tall tree or hilltop).

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Figure 18-5-5 Determining a Bearing

After the cadets have demonstrated the skill, have them practice determining the bearings of other prominent objects. This location should be predetermined by the recce IAW the pre-lesson instructions.

To determine the bearing of a prominent object:

1. Set the predetermined declination on the compass.
2. Hold the compass at eye level and at arm's length, and turn to face the prominent object (as illustrated in Figure 18-5-5).
3. Aim at the object using the compass sight, ensuring the sighting line is in line with the index pointer.
4. Adjust the compass cover so the compass dial is seen in the sighting mirror.
5. Look in the mirror and turn the compass dial until the magnetic needle is over the orienting arrow (put the red in the bed).
6. Read the number on the compass dial at the luminous index pointer.

Inform the cadets that when taking a bearing of a prominent object they will get different readings than other cadets unless they are all using the same line of sight to that prominent object (eg, standing in the same spot).

CONFIRMATION OF TEACHING POINT 6

The cadets' participation in determining bearings on the ground will serve as the confirmation of this TP.

END OF LESSON CONFIRMATION

The cadets' participation in determining bearings on a map and on the ground will serve as the confirmation of this lesson.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

This EO is assessed IAW A-CR-CCP-803/PG-001, Chapter 3, Annex B, Appendix 5 (390 PC).

CLOSING STATEMENT

It is important for cadets to be able to determine bearings on a map and on the ground as this is one of the key skills required to navigate using a map and compass. Experience in this skill will give the cadets confidence in their ability to navigate in the field.

INSTRUCTOR NOTES/REMARKS

To preserve and reuse the maps, the maps should be covered or coated to allow the use of wet-erase markers instead of pencils or pens.

REFERENCES

A2-041 B-GL-382-005/PT-001 Canadian Forces. (2006). *Maps, Field Sketching, Compasses and the Global Positioning System*. Ottawa, ON: Department of National Defence.

ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL THREE

INSTRUCTIONAL GUIDE

SECTION 6

EO C390.01 – IDENTIFY TYPES OF MAPS

Total Time:	30 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-803/PG-001, Chapter 4. Specific uses for said resources are identified throughout the instructional guide within the TP for which they are required.

Review the lesson content and become familiar with the material prior to delivering the lesson.

Photocopy the handout located at Annex E for each cadet.

The following maps are the minimum required to instruct this lesson: topographical, orienteering, street, and road. However, as many examples of different types of maps should be collected.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

An interactive lecture was chosen for TPs 1–3 to orient the cadets to maps and present basic or background material on the purposes, types, and care of maps.

Demonstration and performance was chosen for TP 4 as it allows the instructor to explain and demonstrate folding a map while providing an opportunity for the cadets to practice folding a map under supervision.

INTRODUCTION

REVIEW

N/A.

OBJECTIVES

By the end of this lesson the cadet shall have identified types of maps.

IMPORTANCE

It is important for cadets to understand the types of maps in order to choose the appropriate map to meet their needs.

Teaching Point 1	**Explain the Purpose of a Map**
Time: 5 min	Method: Interactive Lecture

THE PURPOSE OF A MAP

Maps are designed to give the user specific information based on its type. While there are many different types of maps, there is information that is common to most types.

> The art and science of making maps is called cartography. The oldest known maps are preserved on Babylonian clay tablets from about 2300 B.C.

A MAP IS A SCALE REPRESENTATION OF THE GROUND

A map is usually drawn to scale, that is, it is a proportionately smaller representation of the area depicted. However, many maps distort key features to highlight or emphasize them on the map. For example, roads are almost always depicted wider than they would be to scale. Scales may range from 1 : 5 000 (very high detail map) to 1 : 10 000 000 (a globe or a map of the world).

A MAP USES SYMBOLS TO REPRESENT BOTH PHYSICAL AND MAN-MADE FEATURES FOUND ON THE GROUND

Many features on a map are too small to see if depicted to scale. Cartographers (map-makers) use internationally accepted symbols to represent both natural and man-made features. These symbols are commonly known as conventional signs.

Maps Identify Locations Such as Towns, Lakes, and Rivers, by Name

Locations such as towns, lakes, and rivers are identified by name. Other important features such as mountains, highways, and political boundaries are also identified.

Map Designs Reflect the Needs of the User

Map designs reflect the individual needs of the user. Urban planners need a map that shows where water, sewer, and electrical lines are located. Travellers need to get to where they want to be, whether it is within a city or across the country. Education providers need maps that show the demographics (the statistical data of a population such as age, education, etc) of the region to know where their students may be coming from. Cadets need a map that will help them navigate, whether it is planning a flight or using a compass to trek to a survival site.

CONFIRMATION OF TEACHING POINT 1

QUESTIONS

Q1. What is the purpose of a map?

Q2. Internationally accepted symbols used to represent both natural and man-made features are known as what?

Q3. Maps identify many types of locations by name. Identify three.

ANTICIPATED ANSWERS

A1. Maps are designed to give the user specific information based on its type.

A2. These symbols are commonly known as conventional signs.

A3. Locations such as towns, lakes, and rivers are identified by name. Other important features such as mountains, highways, and political boundaries are also identified.

Teaching Point 2	**Describe the Various Types of Maps**
Time: 5 min	Method: Interactive Lecture

VARIOUS TYPES OF MAPS

Maps contain information based on their type.

If the type of map is available as a training aid, it should be displayed when it is being discussed.

Topographical

This type of map is commonly used by the military. The purpose of a topographical map is to present a picture of the ground as it really exists. Topographical maps show as much detail as the scale allows, generally 1 : 25 000, 1 : 50 000, or 1 : 250 000. This is the main type of map used by cadets for ground navigation.

Orienteering

Through the International Orienteering Federation (IOF), specific rules and standards have been set for the production of orienteering maps, including colour, symbols, and scales. They are more detailed than topographical maps, with reference to vegetation and landforms.

Political

Political maps show countries, provinces, counties and other political borders. Most globes show the political boundaries of the world.

Street

Street maps are designed to help commuters and tourists locate key sites such as roads and highways, police stations, fire halls, hospitals, schools, parks and more within a metropolitan area (eg, town, city).

Road

Road maps are designed to show the roads and highways over a large area like a province or territory. They show how to travel between cities, towns, parks, etc.

Statistical

Statistical maps show statistical information such as the production levels of crops or minerals across a country.

Relief

Relief maps are a three-dimensional representation, usually of terrain. The terrain elevation is usually exaggerated by a factor between five and ten. This helps to visually recognize the terrain features.

Outline

Outline maps show large areas with only borders, and coastlines showing. They normally have a high map scale (eg, 1 : 10 000 000).

Air Photo

Air photo maps are actual pictures used in reconnaissance or to create many of the maps listed. They are the most accurate in that they show the actual area. Satellites pictures now represent the next level of air photo maps with the ability to zoom in on almost any area in the world.

CONFIRMATION OF TEACHING POINT 2

QUESTIONS

Q1. What is the main type of map used by cadets for ground navigation?

Q2. To travel from one city to another, what type of map is best?

Q3. Most maps are flat (two dimensional). What type discussed is not?

ANTICIPATED ANSWERS

A1. Topographical maps.

A2. A road map.

A3. Relief maps.

Teaching Point 3	**Describe How to Care for a Topographical Map**
Time: 5 min	Method: Interactive Lecture

HOW TO CARE FOR A TOPOGRAPHICAL MAP

Some maps produced are already waterproofed, however, most maps are not. Paper maps are expensive and may be easily damaged. Precautions must be taken to protect them from water, dirt and wind. Maps, when exposed to water, will become soggy, start to deteriorate and become very easy to tear.

Waterproofing the Map

Preparing a map for exposure to the elements is a vital step in prolonging the life of the map. Ways to prepare a map for waterproofing include:

- **Resealable Plastic Bag Method.** This method requires a large heavyweight resealable clear plastic bag and waterproof tape (eg, clear packing tape). Place the folded map into the bag with one edge at the sealed opening and an adjacent edge along one of the two sides of the bag. Cut enough tape to completely adhere to one edge of the bag from corner to corner. Stick one half of the tape along one edge of the bag that overhangs the map, from corner to corner. Flip the bag over (on to the side of the map that is not being used) and fold the tape down on itself and the other side of the bag. Fold the empty portion of the bag over the backside of the map and tape it down.
- **Contact Paper.** Sometimes called Map Tac, this is a clear plastic that has an adhesive on one side. Covering the map with contact paper will waterproof the map; however, it will become very stiff. A wet-erase marker or grease pencil will be required to write on the map. Use rubbing alcohol to remove permanent marker.
- **Chemical Coatings.** Chemical coatings are effective in waterproofing maps; however, they must be applied carefully in a well-ventilated area. They are sprayed or brushed onto the map. The coating must be allowed to fully dry before using the map.

Drying Technique

If a map gets wet, carefully open it fully and let it dry completely on a flat clean surface. If it dries when it is folded, it may stick together, ruining the map.

Only Partially Opening in a Strong Wind

A map should never be fully opened in a strong wind. It should be opened to the area being used, and refolded along the original fold lines.

Using Pencil and Erasing When Work is Complete

Use only pencil to mark your maps and erase all markings gently. Maps that are protected by plastic can be marked using wet-erase markers or grease pencils.

Storing the Map

Maps should be stored in a dry place, rolled, folded, or laid flat.

CONFIRMATION OF TEACHING POINT 3

QUESTIONS

Q1. Name the three types of waterproofing techniques discussed.

Q2. How should a map be handled in a strong wind?

Q3. Where should maps be stored?

ANTICIPATED ANSWERS

A1. Resealable plastic bag method, contact paper, and chemical coatings.

A2. It should be opened to the area being used, and refolded along the original fold lines.

A3. Maps should be stored in a dry place.

Teaching Point 4	**Explain, Demonstrate, and Have Cadets Practice Folding a Map**
Time: 10 min	Method: Demonstration and Performance

For this skill lesson, it is recommended that the instruction take the following format:

1. Explain and demonstrate folding the map.
2. Explain and demonstrate each step required to complete the skill. Monitor cadets as they imitate each step.
3. Monitor the cadets' performance as they practice the complete skill.

The cadets will use Annex E as their map. This annex also shows the steps in pictorial format.

Note: Assistant instructors may be used to monitor the cadets' performance.

The steps to fold a map:

Lay map face up (north at the top), fold map in half by bringing the top of the map sheet down to the bottom of the map sheet.

Fold the top half of the map sheet up in half again, then turn the map over and fold the bottom half to match the top half.

Fold the ends of the map in half from left to right.

Fold each of the open ends back into half again so that the map name and index to adjacent map sheet appears on the outside.

If the map is folded correctly, it should now open like an accordion in the shape of an M with the map name visible on top.

CONFIRMATION OF TEACHING POINT 4

The cadets' participation in folding a map will serve as the confirmation of this TP.

END OF LESSON CONFIRMATION

QUESTIONS

Q1. A map is usually drawn to scale. What does this mean?

Q2. What type of map should be used to travel from the Same City Museum to the Same City Zoo?

Q3. If the map is folded correctly, how should it now look?

ANTICIPATED ANSWERS

A1. A map is a proportionately smaller representation of the area depicted.

A2. A street map.

A3. The map should now open like an accordion in the shape of an M with the map name visible on top.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

N/A.

CLOSING STATEMENT

It is important for cadets to understand the types of maps in order to choose the appropriate map.

INSTRUCTOR NOTES/REMARKS

The following types of maps are the minimum required to instruct this lesson:

- topographical,
- orienteering,
- street, and
- road.

REFERENCES

A2-036 A-CR-CCP-121/PT-001 Director Cadets 3. (2003). *Royal Canadian Army Cadet Reference Book*. Ottawa, ON: Department of National Defence.

A2-041 B-GL-382-005/PT-001 Canadian Forces. (2006). *Maps, Field Sketching, Compasses and the Global Positioning System*. Ottawa, ON: Department of National Defence.

C0-007 (ISBN 0-02-029265-1) Kjellstrom, B. (1994). *Be Expert With Map and Compass: The Complete Orienteering Handbook*. New York, NY: Hungry Minds, Inc.

C2-041 (ISBN 0-07-136110-3) Seidman, D., & Cleveland, P. (1995). *The Essential Wilderness Navigator*. Camden, ME: Ragged Mountain Press.

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ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL THREE

INSTRUCTIONAL GUIDE

SECTION 7

EO C390.02 – INTERPRET CONTOUR LINES

Total Time:	30 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-803/PG-001, Chapter 4. Specific uses for said resources are identified throughout the instructional guide within the TP for which they are required.

Review the lesson content and become familiar with the material prior to delivering the lesson.

Photocopy the handouts located at Annexes F and H for each cadet.

Create slides of Annexes G and I.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

An interactive lecture was chosen for TP 1 to illustrate to the cadets how to interpret contour lines.

A practical activity was chosen for TP 2 as it is an interactive way to introduce cadets to interpreting contour lines in a safe, controlled environment. This activity contributes to the development of ground navigation skills and knowledge in a fun and challenging setting.

INTRODUCTION

REVIEW

N/A.

OBJECTIVES

By the end of this lesson the cadet shall have interpreted contour lines.

IMPORTANCE

It is important for cadets to be able to interpret contour lines in order for them to navigate through or around different elevations.

Teaching Point 1 | **Explain How Contour Lines Are Interpreted to Indicate the Shape of the Ground**

Time: 15 min | Method: Interactive Lecture

HOW CONTOUR LINES ARE INTERPRETED TO INDICATE THE SHAPE OF THE GROUND

Through learning how to interpret contour lines, cadets will be better able to understand the relationship between contour lines on the map to the features on the ground.

Relief

Relief, or elevation, is the shape of the ground on a vertical plane. Relief on a map is the representation of the height and shape of the ground in intervals of metres or feet.

There are two distinct elements in the representation of relief, including:

- **Representation of Height.** This is a fact-based representation of the height of the land and of landforms. Differences in appearance on the map (as compared to the ground) will arise from the type, density and accuracy of the information provided.
- **Representation of Shape.** This may be largely artistic, and the methods used will vary between maps.

Contour Lines and Intervals

A contour line joins points of equal elevation in relationship to sea level, and is the standard method of showing relief on topographical maps.

Contour lines are shown at a regular vertical interval. This difference in height between contours lines is called contour interval. The contour interval is always stated in the margin of the map, normally near the graphic scales.

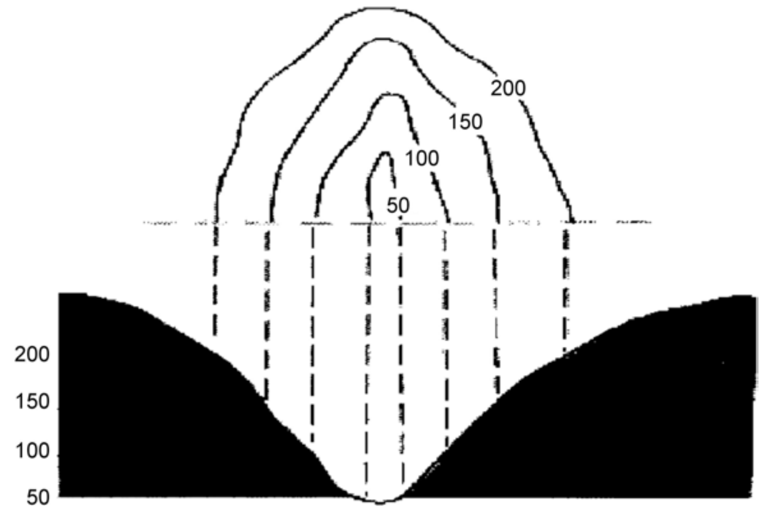
Contour lines are normally drawn as continuous brown lines. Every fourth or fifth contour line is called an "Index Contour" and is shown by a thicker brown line. This helps when reading and counting the contour lines to determine a height.

The Shape of the Ground

Interpreting contour lines provides a visualization of the shape of the ground, which is shown on the map by contour lines and contour intervals. Correct interpretation of the shape of the ground from interpreting contour lines requires practice. It is essential to study the various features, comparing the map to the ground in each case.

Types of Slopes

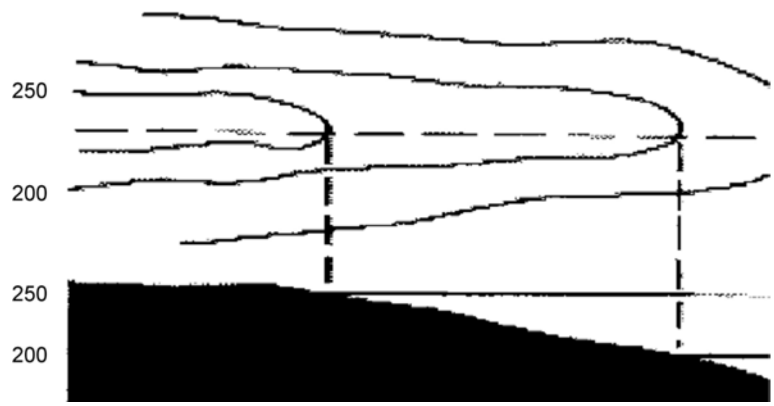
- **Steep.** Contour lines are close together. There is less distance to travel to gain or lose elevation.



Canadian Forces, Maps, Field Sketching, Compasses and the Global Positioning System, Department of National Defence (p. 32)

Figure 18-7-1 Steep Slopes

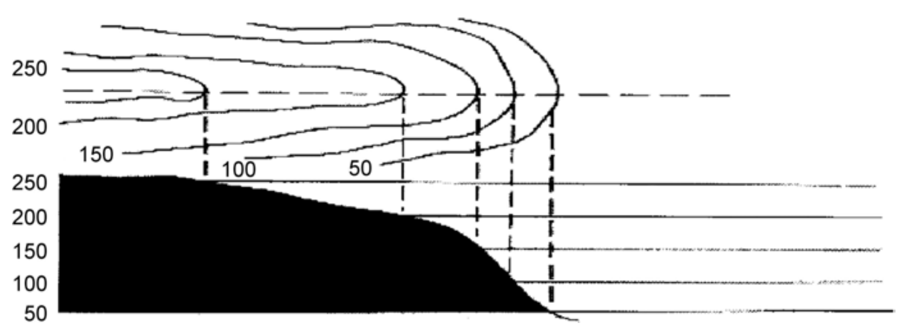
- **Gentle.** Contour lines are further apart. There is a greater distance to travel to gain or lose elevation.



Canadian Forces, Maps, Field Sketching, Compasses and the Global Positioning System, Department of National Defence (p. 32)

Figure 18-7-2 Gentle Slope

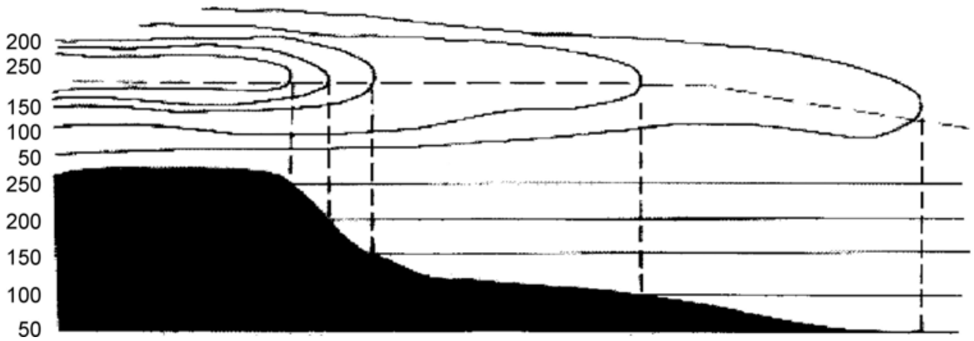
- **Uniform.** Contours are an equal distance apart. The slope remains constant in its rise/decline, whether the slope is steep or gentle.
- **Convex.** The spacing between contour lines moving down a slope decreases. The middle of the slope seems to bulge outward – appearing convex.



Canadian Forces, Maps, Field Sketching, Compasses and the Global Positioning System, Department of National Defence (p. 32)

Figure 18-7-3 Convex Slope

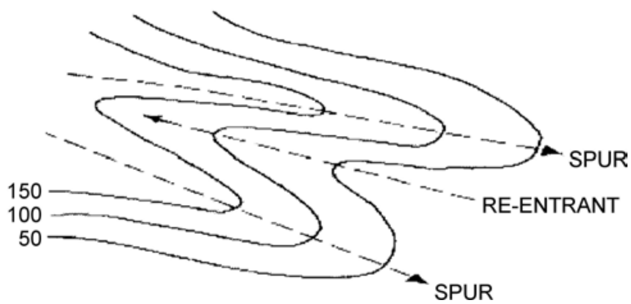
- **Concave.** The spacing of the contour lines increases towards the bottom of the slope. The middle of the slope seems to depress inward – appearing concave.



Canadian Forces, Maps, Field Sketching, Compasses and the Global Positioning System, Department of National Defence (p. 32)

Figure 18-7-4 Concave Slope

- **Spurs.** A contour feature that extends out from a slope.
- **Re-Entrants.** A contour feature that cuts back into a slope.



Canadian Forces, Maps, Field Sketching, Compasses and the Global Positioning System, Department of National Defence (p. 32)

Figure 18-7-5 Spurs and Re-Entrant

Distribute Annex F to each cadet and have them complete the worksheet. Correct the answers using the answer key located at Annex G.

CONFIRMATION OF TEACHING POINT 1

The cadets' completion of the matching contour line worksheet will serve as the confirmation of this TP.

Teaching Point 2	**Have the Cadets Interpret Contour Lines**
Time: 10 min	Method: Practical Activity

Have cadets work independently (or in small groups if it suits the needs of the class).

The cadets will choose the easiest route, based on slope as indicated by the contour lines.

ACTIVITY

OBJECTIVE

The objective of this activity is to have the cadet interpret contour lines on a map.

RESOURCES

- Contour line worksheet located at Annex H, and
- Relief version of map located at Annex I.

ACTIVITY LAYOUT

N/A.

ACTIVITY INSTRUCTIONS

1. Hand out contour line worksheet.
2. Have cadets draw a route, based on the features (especially elevations), on their map.
3. Have cadets explain why they chose their route, emphasizing the contour lines that would be traversed.
4. When cadets have finished, display the slide of Annex I and discuss the terrain and its affects on possible routes.

Inform the cadets that there is no right answer. Routes chosen can be based on many factors, such as: differing hiking abilities, fitness levels, personal preferences, etc.

SAFETY

N/A.

CONFIRMATION OF TEACHING POINT 2

The cadets' participation in the activity will serve as the confirmation of this TP.

END OF LESSON CONFIRMATION

The cadets' completion of the two contour line worksheets will serve as the confirmation of this lesson.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

N/A.

CLOSING STATEMENT

It is important for cadets to be able to interpret contour lines in order to navigate through or around differences of elevation. This skill will require practice.

INSTRUCTOR NOTES/REMARKS

N/A.

REFERENCES

A2-041 B-GL-382-005/PT-001 Canadian Forces. (2006). *Maps, Field Sketching, Compasses and the Global Positioning System*. Ottawa, ON: Department of National Defence.

ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL THREE

INSTRUCTIONAL GUIDE

SECTION 8

EO C390.03 – ORIENT A MAP BY INSPECTION

Total Time:	30 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-803/PG-001, Chapter 4. Specific uses for said resources are identified throughout the instructional guide within the TP for which they are required.

Review the lesson content and become familiar with the material prior to delivering the lesson.

Photocopy Annex J. Cut the first page along the dotted lines and post the three locations around the training area (eg, on walls, trees, etc). Ensure that the locations match the demonstration map.

Ensure sufficient topographical maps of the exercise area are available.

A recce of the exercise area should be made to determine a site where the topographical map of the exercise area may be oriented by inspection. The site chosen should have a minimum of three distinctive features to be used as prominent objects by the cadets in order to orient their maps.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

An interactive lecture was chosen for TP 1 to give the cadets an overview of the purpose of orienting a map.

Demonstration and performance was chosen for TP 2 as it allows the instructor to explain and demonstrate orienting a map by inspection while providing an opportunity for the cadets to practice the skill under supervision.

INTRODUCTION

REVIEW

N/A.

OBJECTIVES

By the end of this lesson the cadet shall have oriented a map by inspection.

IMPORTANCE

It is important for cadets to be able to orient a map by inspection in order to match the symbols on the map with the terrain it represents. It also allows the cadet to confirm or discover their approximate location on the map.

Teaching Point 1	**Explain the Purpose of Orienting a Map**
Time: 5 min	Method: Interactive Lecture

PURPOSE OF ORIENTING A MAP

Orienting a map by inspection means to rotate the map so that the map directions and map detail correspond with those on the ground. This is a simple and quick way of orienting a map, if the person's approximate location is known. If the approximate location is unknown, orienting a map by inspection is much more difficult as similar features may confuse map readers and thereby they orient themselves incorrectly. If more unique features are visible and shown on the map, it will be easier to find one's approximate location.

Orienting the map does a number of things:

- it makes it easy to relate the map to the ground;
- it helps to confirm, or possibly find, a person's approximate location; and
- when moving over a complex route, or when travelling over long distances, it helps keep a hiker on the right track.

CONFIRMATION OF TEACHING POINT 1

QUESTIONS

Q1. What is physically done to the map when it is being oriented?

Q2. What key piece of information makes orienting a map by inspection simple and quick?

Q3. Orienting the map does a number of things. Describe one.

ANTICIPATED ANSWERS

A1. The map is rotated so that the map directions and map detail correspond with those on the ground.

A2. The person's approximate location.

A3. Three possible answers include:

- it makes it easy to relate the map to the ground;
- it helps to confirm, or possibly find, a person's approximate location; and
- when moving over a complex route, or when travelling over long distances, it helps keep a hiker on the right track.

Teaching Point 2 | **Explain and Demonstrate How to Orient a Map**

Time: 20 min | Method: Demonstration and Performance

After explaining each step, demonstrate using the training aids.

After the demonstration, have the cadets orient a topographical map of the exercise area using the prominent objects they observe.

To orient a map, complete the following steps:

Identify the approximate location on the map (the ‘You’).

Select three prominent objects around your current location and find them on the map (house, church and bridge).

Rotate the map until all identified objects on the map line up with the objects located on the ground.

Ensure that all features line up with the positions on the map.

Show page 18J-2.

ACTIVITY

Time: 15 min

OBJECTIVE

The objective of this activity is to have the cadets orient a map by inspection.

RESOURCES

- Topographical map of the exercise area, and
- The cadet’s location on the map.

ACTIVITY LAYOUT

N/A.

ACTIVITY INSTRUCTIONS

1. Have cadets confirm their location on the map.
2. Have cadets select three prominent objects around their current location and find them on the map.
3. Have cadets rotate the map until all identified objects on the map line up with the objects located on the ground.
4. Ensure all features line up with the positions on the map.

SAFETY

N/A.

CONFIRMATION OF TEACHING POINT 2

The cadets' participation in the activity will serve as the confirmation of this TP.

END OF LESSON CONFIRMATION

The cadets' participation in orienting a map by inspection will serve as the confirmation of this lesson.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

N/A.

CLOSING STATEMENT

It is important for cadets to be able to orient a map by inspection in order to match the symbols on the map with the terrain it represents. It also allows the cadet to confirm or discover their approximate location on the map.

INSTRUCTOR NOTES/REMARKS

N/A.

REFERENCES

A2-041 B-GL-382-005/PT-001 Canadian Forces. (2006). *Maps, Field Sketching, Compasses and the Global Positioning System*. Ottawa, ON: Department of National Defence.

ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL THREE

INSTRUCTIONAL GUIDE

SECTION 9

EO C390.04 – ORIENT A MAP USING A COMPASS

Total Time:	30 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-803/PG-001, Chapter 4. Specific uses for said resources are identified throughout the instructional guide within the TP for which they are required.

Review the lesson content and become familiar with the material prior to delivering the lesson.

Ensure sufficient topographical maps of the exercise area are available.

Photocopy Annex K. Cut the first page along the dotted lines and post the three locations around the training area (eg, on walls, trees, etc). Ensure that the locations match the demonstration map. Ensure that the north of the demonstration map corresponds to the north of the training area, which will allow the map to be oriented with a compass.

Calculate the magnetic declination for the topographical map of the exercise area.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

An interactive lecture was chosen for TP 1 to give the cadets an overview of the purpose of orienting a map.

Demonstration and performance was chosen for TP 2 as it allows the instructor to explain and demonstrate orienting a map using a compass while providing an opportunity for the cadets to practice the skill under supervision.

INTRODUCTION

REVIEW

N/A.

OBJECTIVES

By the end of this lesson the cadet shall have oriented a map using a compass.

IMPORTANCE

It is important for cadets to orient a map using a compass in order to match the symbols on the map with the terrain it represents. It also allows the cadet to confirm or discover their approximate location on the map.

Teaching Point 1	**Explain the Purpose of Orienting a Map**
Time: 5 min	Method: Interactive Lecture

PURPOSE OF ORIENTING A MAP

Orienting a map using a compass means to rotate the map so that the north of the map matches the north of the ground. This is confirmed, visually, with the map directions and map detail corresponding with those on the ground. This is a simple and quick way of orienting a map if the person's approximate location is known. If the approximate location is unknown, orienting a map using a compass can still be done, but this does not determine the map reader's location. Similar features may confuse map readers and thereby they orient themselves incorrectly. If more unique features are visible and are shown on the map it will be easier to find one's approximate location.

Orienting the map does a number of things:

- it makes it easy to relate the map to the ground;
- it helps to confirm, or possibly find, a person's approximate location; and
- when moving over a complex route, or when travelling over long distances, it helps keep a hiker on the right track.

CONFIRMATION OF TEACHING POINT 1

QUESTIONS

Q1. What is physically done to the map when it is being oriented?

Q2. Can a map be oriented using a compass if the person's location is unknown?

Q3. Orienting the map does a number of things. Describe one.

ANTICIPATED ANSWERS

A1. The map is rotated so that the map directions and map detail correspond with those on the ground.

A2. Yes. Also, the oriented map may assist map readers in discovering their location.

A3. Three possible answers include:

- it makes it easy to relate the map to the ground;
- it helps to confirm, or possibly find, a person's approximate location; and
- when moving over a complex route, or when travelling over long distances, it helps keep a hiker on the right track.

Teaching Point 2 | **Explain, Demonstrate and Have the Cadets Practice Orienting a Map Using a Compass**

Time: 20 min | Method: Demonstration and Performance

> After explaining each step, demonstrate using the training aids.
>
> After the demonstration, the cadets will orient the topographical map of the training area.

To orient a map using a compass, complete the following steps:

1. Identify the cadet's approximate location on the map (the 'You').
2. Set the magnetic declination.
3. Set the compass dial to north.
4. Lay the compass flat on the map with the cover open.
5. Point the mirror to north (top of the map).
6. Align the compass meridian lines with the map easting lines (use the arrow beside the 'You' on the demonstration map).
7. Turn the map until the magnetic needle lines up with the orienting arrow.
8. Ensure that all features (the house, church and bridge) line up with their positions on the map.

> Show page 18K-2.

ACTIVITY

Time: 10 min

OBJECTIVE

The objective of this activity is to have the cadets orient a map using a compass.

RESOURCES

- Topographical map of the exercise area,
- Compass,
- Predetermined magnetic declination, and
- The cadet's location on the map.

ACTIVITY LAYOUT

N/A.

ACTIVITY INSTRUCTIONS

1. Have cadets confirm their location on the map.
2. Have cadets set the magnetic declination.
3. Have cadets set the compass dial to north.
4. Have cadets lay the compass flat on the map with the cover open.
5. Have cadets point the mirror to north (top of the map).
6. Have cadets align the compass meridian lines with the map easting lines.
7. Have cadets rotate the map until the magnetic needle lines up with the orienting arrow.
8. Have cadets ensure that all features line up with their positions on the map.

SAFETY

N/A.

CONFIRMATION OF TEACHING POINT 2

The cadets' participation in the activity will serve as the confirmation of this TP.

END OF LESSON CONFIRMATION

The cadets' participation in orienting a map using a compass will serve as the confirmation of this lesson.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

N/A.

CLOSING STATEMENT

It is important for cadets to orient a map using a compass in order to match the symbols on the map with the terrain it represents. It also allows the cadet to confirm or discover their approximate location on the map.

INSTRUCTOR NOTES/REMARKS

N/A.

REFERENCES

A2-041 B-GL-382-005/PT-001 Canadian Forces. (2006). *Maps, Field Sketching, Compasses and the Global Positioning System*. Ottawa, ON: Department of National Defence.

ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL THREE

INSTRUCTIONAL GUIDE

SECTION 10

EO C390.05 – CALCULATE MAGNETIC DECLINATION

Total Time:	60 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-803/PG-001, Chapter 4. Specific uses for said resources are identified throughout the instructional guide within the TP for which they are required.

Review the lesson content and become familiar with the material prior to delivering the lesson.

Photocopy the handouts located at Annexes L and N for each cadet.

Create slides of Annex M.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

An interactive lecture was chosen for TP 1 to orient the cadet to calculating magnetic declination and present basic material.

Demonstration and performance was chosen for TP 2 as it allows the instructor to explain and demonstrate calculating magnetic declination while providing an opportunity for the cadets to practice calculating magnetic declination under supervision.

An in-class activity was chosen for TP 3 as it is an interactive way to reinforce calculating magnetic declination.

INTRODUCTION

REVIEW

N/A.

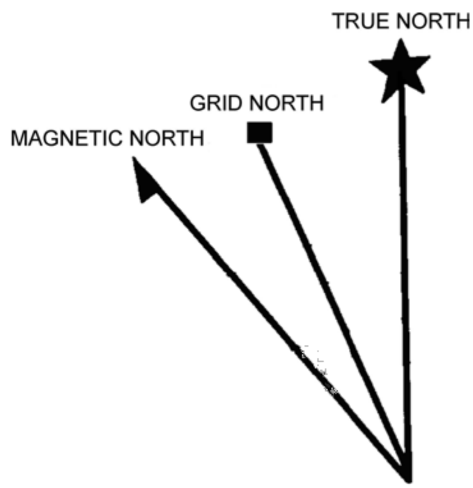
OBJECTIVES

By the end of this lesson the cadet shall have calculated magnetic declination.

IMPORTANCE

It is important for cadets to know how to calculate magnetic declination as it provides the cadet with confidence that they will arrive at their destination when navigating on a bearing. Not accounting for magnetic declination may affect navigation, as the cadet may travel off the intended route. For every one degree of magnetic declination not accounted for, a person would be approximately 17 m off for each kilometre travelled.

Teaching Point 1	Discuss the Three Norths and Magnetic Declination
Time: 5 min	Method: Interactive Lecture



Director Cadets 3, 2008, Ottawa, ON: Department of National Defence

Figure 18-10-1 The Three Norths

THE THREE NORTHS

The relationship between the three norths, especially grid and magnetic, is key to using a compass on both a map and on the ground.

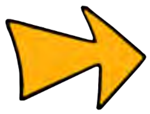
True North. True north is located at the top of the earth where the geographic North Pole is located and where all lines of longitude meet. In the declination diagram on the map, true north is represented by the symbol of a star, which represents the North Star, Polaris.

Grid North. Grid north is the north indicated by the grid lines (eastings) on a topographical map. The easting lines run parallel to each other and will never meet at the geographic North Pole; because of this, grid north points off slightly from true north. In the declination diagram on the map, grid north is represented by a square, which represents a map grid.

Magnetic North. Magnetic north is the location of the magnetic north pole, where the Earth's magnetic field bends back into the Earth toward the south magnetic pole. It is located in the Canadian arctic and is different from true north. It is the direction in which the compass needle points. In the declination diagram on the map, magnetic north is represented by a needle as on a compass.

MAGNETIC DECLINATION

The differences between the three norths affect navigation for the map and compass user, in the form of magnetic declination. Magnetic declination is the difference in bearing either between true north and magnetic north or between grid north and magnetic north.



The line of zero declination, as of 2008, runs through Baker Lake, Nunavut, Churchill, Man., and Sioux Lookout, Ont.

Cadets will normally use the magnetic declination value between grid north and magnetic north when navigating using a map and compass. By setting the magnetic declination on the compass, magnetic bearings are converted to grid bearings which allow bearings taken from the map to be used on the ground and vice versa.

CONFIRMATION OF TEACHING POINT 1

QUESTIONS

Q1. Which north is represented by a star?

Q2. Which north does a compass needle point towards?

Q3. Which magnetic declination value is most important to topographical map users?

ANTICIPATED ANSWERS

A1. True north.

A2. Magnetic north.

A3. The magnetic declination value between grid north and magnetic north.

Teaching Point 2 — **Explain, Demonstrate and Have Cadets Calculate Magnetic Declination**

Time: 15 min — Method: Demonstration and Performance

Distribute Fact Sheet located at Annex L. When using the slides from Annex M, cover the right section (the equations) and reveal each step as required. Example 1 should be used as the demonstration and Example 2 to be performed step-by-step by the cadets. If more examples are required, use the questions from the worksheet. However, Question 9 should not be used as an example, only as a question for the cadets to calculate as it involves an east/west declination switch.

For this skill lesson, it is recommended that instruction take the following format:

1. Explain and demonstrate the complete skill while cadets observe.
2. Explain and demonstrate each step required to complete the skill. Monitor cadets as they imitate each step.
3. Monitor the cadets' performance as they practice the complete skill.

Note: Assistant instructors may be employed to monitor cadet performance.

LOCATING DECLINATION DIAGRAM

Calculating current declination uses the information provided by the declination diagram on a map and the information printed directly underneath. This diagram is most often found on the right side of the map in the marginal information.

IDENTIFING THE FORMULA USED TO CALCULATE MAGNETIC DECLINATION

Several mathematical principles are used in the formula to calculate magnetic declination. Understanding of the mathematical order of operations is essential.

Formula: Grid Magnetic Angle + [(Current Year - Year of Declination Information) × (Annual Change)] = Current Declination

Grid Magnetic Angle. The angle between grid north and magnetic north, found on the declination diagram. Written in degrees and minutes.

1 degree (°) = 60 minutes ('), similar to calculating time (eg, 1 hour = 60 minutes).

This ratio is very important to remember when adjusting the grid magnetic angle to the current declination. This is where many errors occur.

Current Year. The current calendar year.

Year of Declination Information. Found below the declination diagram.

Annual Change. Found below the declination diagram and is written in minutes.

It is important that the annual change be inserted into the formula correctly:

- If annual change is **increasing**, insert into formula as a **positive** number.
- If annual change is **decreasing**, insert into formula as a **negative** number.

Current Declination. This is the result of the formula. It is the magnetic declination to be set on the compass.

West Declination. When magnetic north is west (to the left) of grid north on the declination diagram.

East Declination. When magnetic north is east (to the right) of grid north on the declination diagram.

If the current declination calculates to a negative number, an east declination changes to a west declination and vice versa.

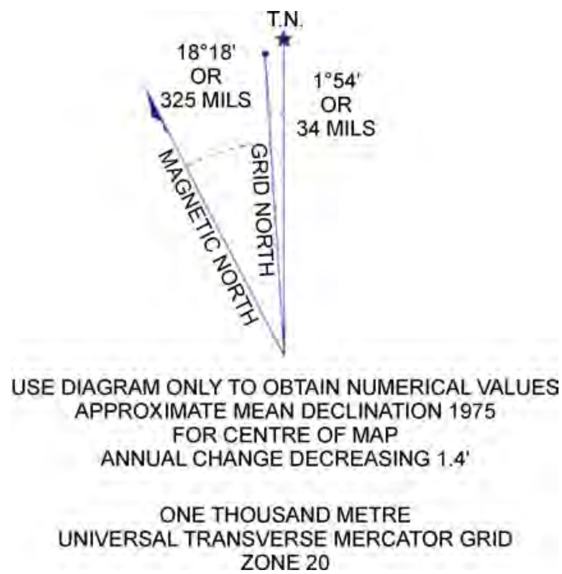
CALCULATING MAGNETIC DECLINATION

Steps to calculate magnetic declination:

1. Identify grid magnetic angle.
2. Identify current year.
3. Identify year of declination information.
4. Identify annual change.
5. Determine whether the annual change is positive or negative.
6. Input the information into the formula.
7. Solve for current declination.
8. Determine whether the magnetic declination is east or west.

Show slide of Example 1 of Calculating Magnetic Declination located at Annex M.

Example 1:



Natural Resources Canada, 2008, Topo Declination Diagram. Retrieved April 11, 2008, from http://gsc.nrcan.gc.ca/geomag/field/magdec_e.php?p=1

Figure 18-10-2 Declination Diagram

From Figure 18-10-2:

1. Grid Magnetic Angle: 18° 18'
2. Current Year: 2008 (used for this example)
3. Year of Declination Information: 1975
4. Annual Change: decreasing 1.4'
5. Decreasing means 1.4' becomes -1.4'
6. Input the information into the formula:
   18° 18' + [(2008 - 1975) x (-1.4')] = Current Declination
7. Solve for current declination.
   (a) 18° 18' + [(33) x (-1.4')] = Current Declination
   (b) 18° 18' + [-46.2'] = Current Declination
   (c) 18° 18' - 46.2' = Current Declination

Since 46.2' cannot be easily subtracted from 18° 18', 1° is converted into 60' (similar to time calculations), which converts 18° 18' to 17° 78'.

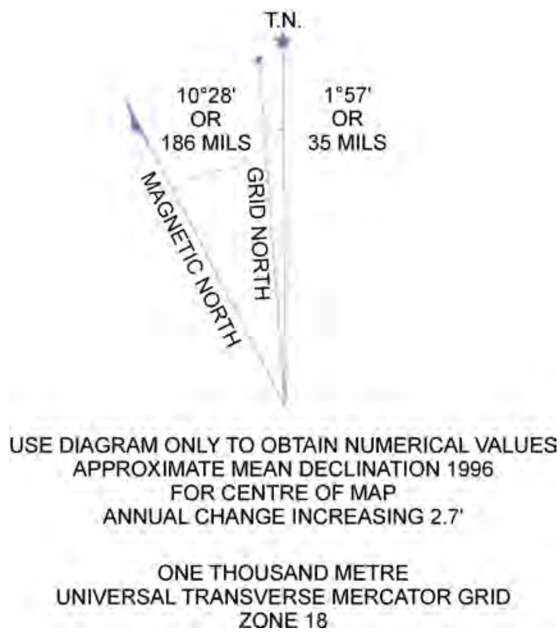
(d) 17° 78' - 46.2' = Current Declination

(e) 17° 31.8' = Current Declination

8. Since magnetic north is west of grid north and the result is positive, the magnetic declination for the topographical map in 2008 is 17° 31.8' west declination.

Show slide of Example 2 of Calculating Magnetic Declination located at Annex M.

Example 2:



Canada Centre for Mapping, Bancroft 31 F/4, Natural Resources Canada

Figure 18-10-3 Declination Diagram

From Figure 18-10-3:

1. Grid Magnetic Angle: 10° 28'

2. Current Year: 2008 (used for this example)

3. Year of Declination Information: 1996

4. Annual Change: increasing 2.7'

5. Increasing means 2.7' becomes +2.7'

6. Input the information into the formula:
10° 28' + [(2008 - 1996) x (+2.7')] = Current Declination

7. Solve for current declination.

(a) 10° 28' + [(12) x (+2.7')] = Current Declination

(b) 10° 28' + [+32.4'] = Current Declination

(c) 10° 28' + 32.4' = Current Declination

(d) 10° 60.4' = Current Declination

> Since 60.4' is greater than 1°, 60' is converted into 1° (similar to time calculations), which converts 10° 60.4' to 11° 0.4'.

(e) 11° 0.4' = Current Declination

8. Since magnetic north is west of grid north and the result is positive, the magnetic declination for the topographical map in 2008 is 11° 0.4' west declination.

CONFIRMATION OF TEACHING POINT 2

The cadets' participation in the activity will serve as the confirmation of this TP.

Teaching Point 3	**Have Cadets Calculate Magnetic Declination**
Time: 30 min	Method: In-Class Activity

ACTIVITY

OBJECTIVE

The objective of this activity is to have the cadets calculate magnetic declination.

RESOURCES

- Magnetic declination worksheet located at Annex N, and
- Pen/pencil.

ACTIVITY LAYOUT

N/A.

ACTIVITY INSTRUCTIONS

1. Distribute a worksheet to each cadet.
2. Have the cadets individually complete as many problems on the worksheet as possible in 20 minutes.
3. Correct the worksheet with the cadets using the answer key located at Annex O.
4. Answer any questions the cadets may have on calculating magnetic declination.

SAFETY

N/A.

CONFIRMATION OF TEACHING POINT 3

The cadets' participation in the in-class activity will serve as the confirmation of this TP.

END OF LESSON CONFIRMATION

The cadets' calculation of magnetic declination will serve as the confirmation of this lesson.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

N/A.

CLOSING STATEMENT

Knowing how to calculate magnetic declination provides the cadet with confidence that they will arrive at their destination when navigating on a bearing.

INSTRUCTOR NOTES/REMARKS

Cadets may use a calculator if they wish.

REFERENCES

A2-041 B-GL-382-005-PT-001 Canadian Forces. (2006). *Maps, Field Sketching, Compasses and the Global Positioning System*. Ottawa, ON: Department of National Defence.

ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL THREE

INSTRUCTIONAL GUIDE

SECTION 11

EO C390.06 – DETERMINE DIRECTION USING THE SUN

Total Time:	30 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-803/PG-001, Chapter 4. Specific uses for said resources are identified throughout the instructional guide within the TP for which they are required.

Review the lesson content and become familiar with the material prior to delivering the lesson.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

Demonstration and performance was chosen for this lesson as it allows the instructor to explain and demonstrate determining direction using the sun while providing an opportunity for the cadets to practice the skill under supervision.

INTRODUCTION

REVIEW

N/A.

OBJECTIVES

By the end of this lesson the cadet shall have determined direction using the sun.

IMPORTANCE

It is important for the cadets to be able to determine direction using the sun so in a survival situation they can navigate to and from their survival site without the aid of a compass or map.

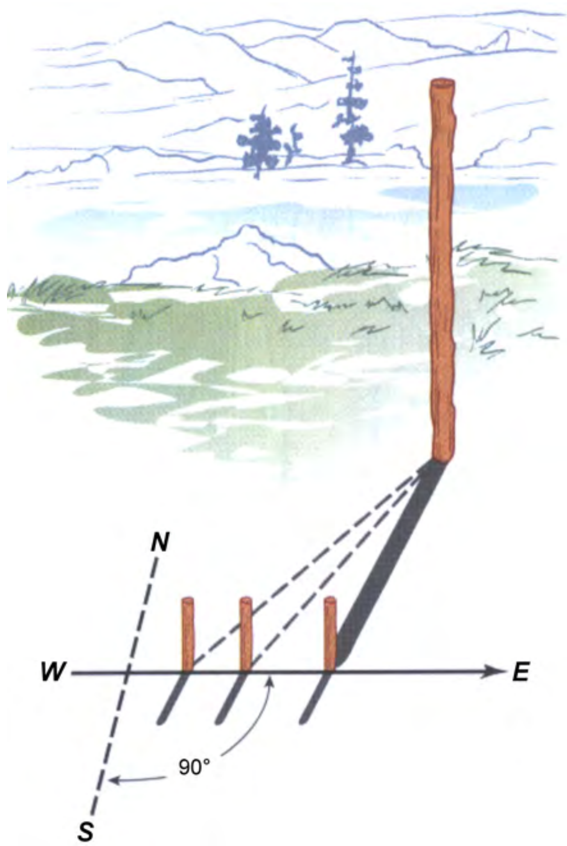
Teaching Point 1 | **Explain, Demonstrate and Have Cadets Determine Direction Using a Shadow Stick**

Time: 15 min | Method: Demonstration and Performance

DETERMINE DIRECTION USING A SHADOW STICK

In a survival situation, one may not have a map of the area, a compass or the use of a watch. On this occasion, it may be necessary to use natural guides, such as the sun to determine direction. The sun can be used to find north using a branch or stick to cast a shadow on the ground.

A shadow stick works because the sun always travels east to west, even though it may not rise at exactly 90 degrees or set at exactly 270 degrees. The tip of the shadow stick's shadow moves in the opposite direction, so the first shadow tip is always west of the second, anywhere on earth. Improvised methods are only general indicators of direction. The shadow stick is more accurate and easier to read when the stick is narrow.



National Association of Search and Rescue, Fundamentals of Search and Rescue, Jones and Bartlett Publishers, Inc. (p. 76)

Figure 18-11-1 Shadow Stick

ACTIVITY

Time: 10 min

OBJECTIVE

The objective of this activity is to have the cadets construct a shadow stick and determine direction using the sun.

RESOURCES

Stick.

ACTIVITY LAYOUT

N/A.

ACTIVITY INSTRUCTIONS

1. Divide the cadets into groups of three or four.
2. Have the cadets find a 45–60 cm straight stick.
3. Find a level vegetation-free spot. Push the 45–60 cm straight stick into the ground about 10 cm so it will remain upright, inclining it by 5–10 degrees to create a longer, bigger shadow.
4. Mark the tip of the shadow with a stone. Wait until the shadow tip moves several centimetres (10–15 minutes with a 45 cm stick).

> Use the time interval required for Step 4. to instruct TP 2.

5. Mark the position of the new shadow tip.
6. Draw a straight line from the first mark through the second mark and continue about 30 cm past it (as illustrated in Figure 18-11-1).
7. Have the instructor or a supervisor verify the bearings with a compass.

> The line drawn indicates the east–west line. The first mark made is west and the last mark made is east. A line perpendicular to the east–west line is a north–south line.

SAFETY

N/A.

CONFIRMATION OF TEACHING POINT 1

The cadets' participation in this activity will serve as the confirmation of this TP.

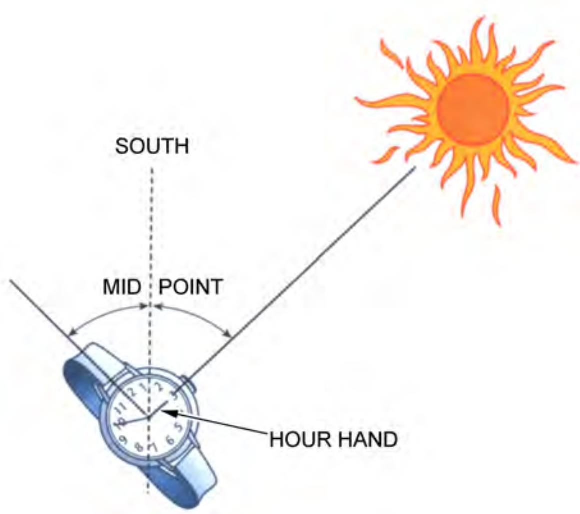
Teaching Point 2	**Explain, Demonstrate and Have Cadets Determine Direction Using an Analog Watch**
Time: 10 min	Method: Demonstration and Performance

Use an analog wall clock for demonstration purposes instead of an analog watch. Ask the cadets if any of them have an analog watch. Since digital watches are more common than analog watches, the cadets should understand that without one, they cannot use this method.

DETERMINE DIRECTION USING AN ANALOG WATCH

An analog watch can help establish direction using either standard or daylight savings time. The analog watch method is based on the principle that at noon (or 1 pm for daylight savings time) the sun is approximately due south in the northern hemisphere and approximately due north in the southern hemisphere. Using this principle, an analog watch's (with the correct time) hour hand, at noon, pointed at the sun, also points approximately due south/north. At times other than noon, bisecting the angle between the hour hand (pointing at the sun) and the 12 (or the 1 for daylight savings time) on the watch face, creates an imaginary line that points approximately due south/north.

This method becomes less accurate the closer a person is to the equator.



National Association of Search and Rescue, Fundamentals of Search and Rescue, Jones and Bartlett Publishers, Inc. (p. 76)

Figure 18-11-2 Analog Watch

ACTIVITY

Time: 5 min

OBJECTIVE

The objective of this activity is to have the cadets determine direction using an analog watch.

RESOURCES

Analog watch (with the correct time).

ACTIVITY LAYOUT

N/A.

ACTIVITY INSTRUCTIONS

1. Point the hour hand towards the sun.
2. Determine the halfway point between the hour hand and noon (or 1 pm for daylight savings time).
3. Create an imaginary line between the centre of the watch face and the halfway point (as illustrated in Figure 18-11-2).

> The imaginary line is a north–south line (points to the south in the northern hemisphere and to the north in the southern hemisphere).

SAFETY

N/A.

CONFIRMATION OF TEACHING POINT 2

The cadets' participation in this activity will serve as the confirmation of this TP.

END OF LESSON CONFIRMATION

The cadets' participation in constructing a shadow stick and determining direction using an analog watch will serve as the confirmation of this lesson.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

N/A.

CLOSING STATEMENT

It is important for the cadets to be able to determine direction using the sun so in a survival situation they can navigate to and from their survival site without the aid of a compass or map.

INSTRUCTOR NOTES/REMARKS

Sticks are to be collected by the cadets in the field.

REFERENCES

C3-002 (ISBN 0-00-653140-7) Wiseman, J. (1999). *The SAS Survival Handbook*. Hammersmith, London: HarperCollins Publishers.

ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL THREE

INSTRUCTIONAL GUIDE

SECTION 12

EO C390.07 – DETERMINE DIRECTION AT NIGHT

Total Time:	30 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-803/PG-001, Chapter 4. Specific uses for said resources are identified throughout the instructional guide within the TP for which they are required.

Review the lesson content and become familiar with the material prior to delivering the lesson.

Choose a suitable night to perform this activity by checking both a moon calendar and local weather conditions.

A sky map should be created for the date and location where the lesson will be taught. Annex P is an example created for reference of what a sky map looks like and how it is used to locate constellations. Photocopy the created sky map for each cadet.

Photocopy the handout located at Annex Q for each cadet.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

Demonstration and performance was chosen for this lesson as it allows the instructor to demonstrate determining direction at night while providing an opportunity for the cadet to practice the skill under supervision.

INTRODUCTION

REVIEW

N/A.

OBJECTIVES

By the end of this lesson the cadet shall have determined direction at night.

IMPORTANCE

It is important for the cadets to be able to navigate at night so they will have the skills to find their way in the dark. In a survival situation, being able to determine direction in the dark is a skill that can assist in being rescued.

Teaching Point 1 — **Explain, Demonstrate and Have Cadets Determine Direction Using the Moon**

Time: 10 min — Method: Demonstration and Performance

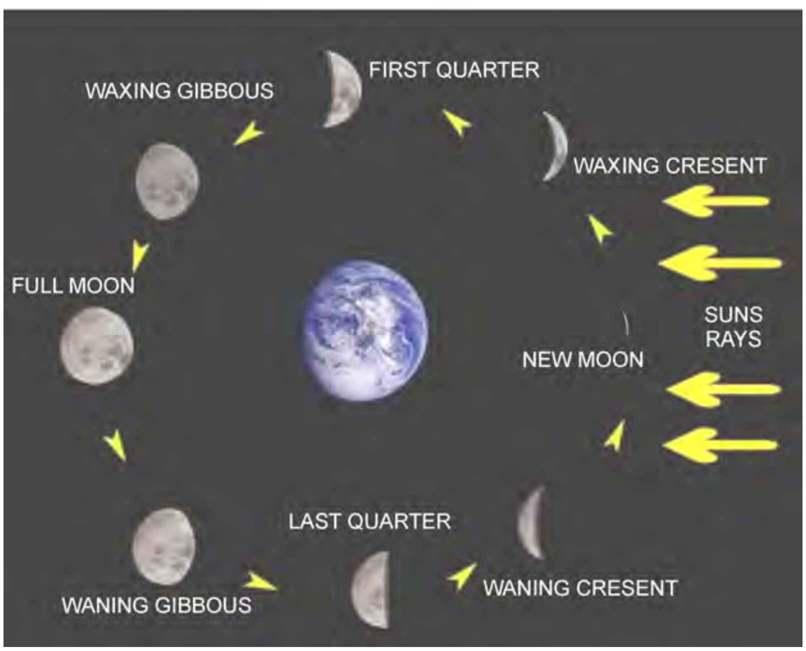
This TP must be conducted during a clear night when the moon is in one of its crescent phases. Determine the phases of the moon on a moon calendar or through the internet.

IDENTIFYING THE PHASES OF THE MOON

The phases of the moon are caused by the relative positions of the earth, sun, and moon. The moon rotates around the earth, on average, once every 27 days, 7 hours and 43 minutes.

The sun always illuminates the half of the moon facing the sun (except during lunar eclipses). When the sun and moon are on opposite sides of the earth, the moon appears “full” like a bright, round disk. When the moon is between the earth and the sun, it appears dark, a “new” moon. In between these phases, the moon’s illuminated surface appears to grow (waxing) to full, and then shrink (waning) to the next new moon.

The moon’s familiar crescent shape is formed by the shadow of the earth on the moon’s surface and always points relatively north and south in the sky.

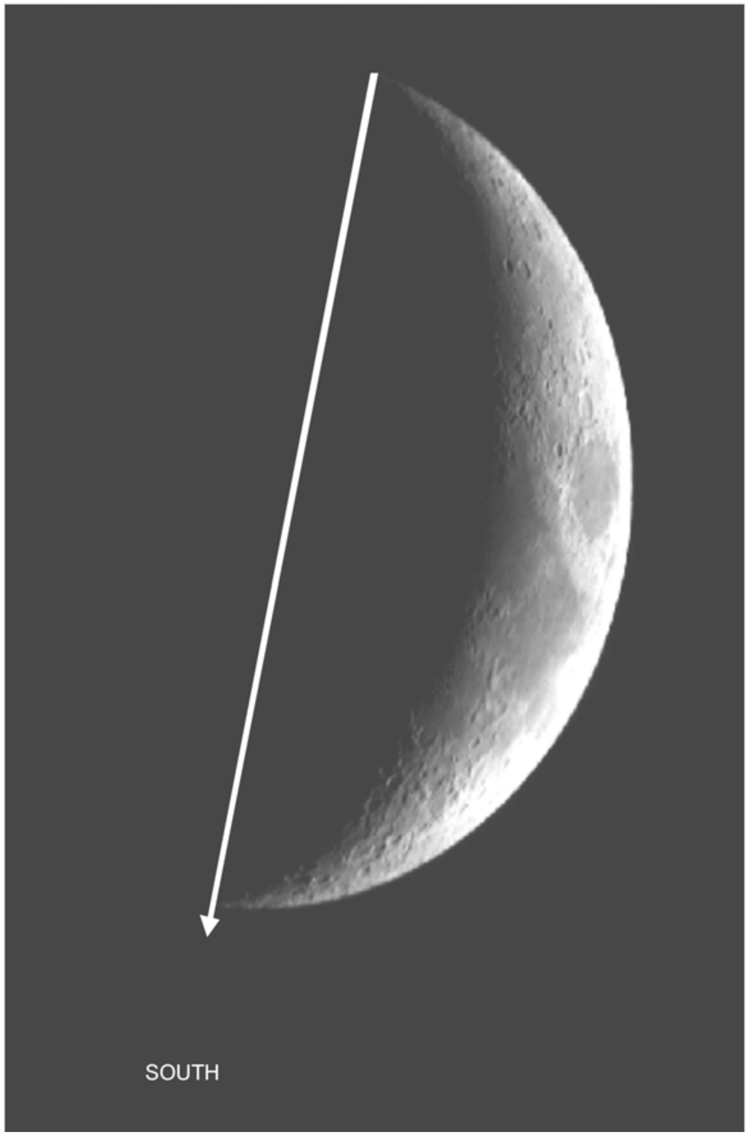


Afreshhorizon.co.uk, Copyright 2008 by A Fresh Horizon. Retrieved November 14, 2007, from http://www.afreshhorizon.co.uk/images/moon_phases.jpg

Figure 18-12-1 Moon Phases

DETERMINING SOUTH

Drop a line along the points of the crescent moon and project it to the horizon. This point on the horizon is in the general direction of south.



The Calvin College Observatory, 2001, The Crescent Moon, Copyright 2001 by The Calvin College Observatory. Retrieved November 14, 2007, from http://www.calvin.edu/academic/phys/observatory/images/moon/

Figure 18-12-2 Determining South by the Moon

This method will give a general direction of north and south.

ACTIVITY

Time: 5 min

OBJECTIVE

The objective of this activity is to have the cadets determine direction using the moon.

RESOURCES

N/A.

ACTIVITY LAYOUT

N/A.

ACTIVITY INSTRUCTIONS

Explain, demonstrate and have the cadets drop an imaginary line along the points of the crescent moon and project that line to the horizon (as illustrated in Figure 18-12-2). This point on the horizon is in the general direction of south.

SAFETY

N/A.

CONFIRMATION OF TEACHING POINT 1

The cadets' participation in the activity will serve as the confirmation of this TP.

Teaching Point 2 — **Explain, Demonstrate and Have Cadets Identify the Major Constellations Required to Find Polaris**

Time: 10 min — Method: Demonstration and Performance

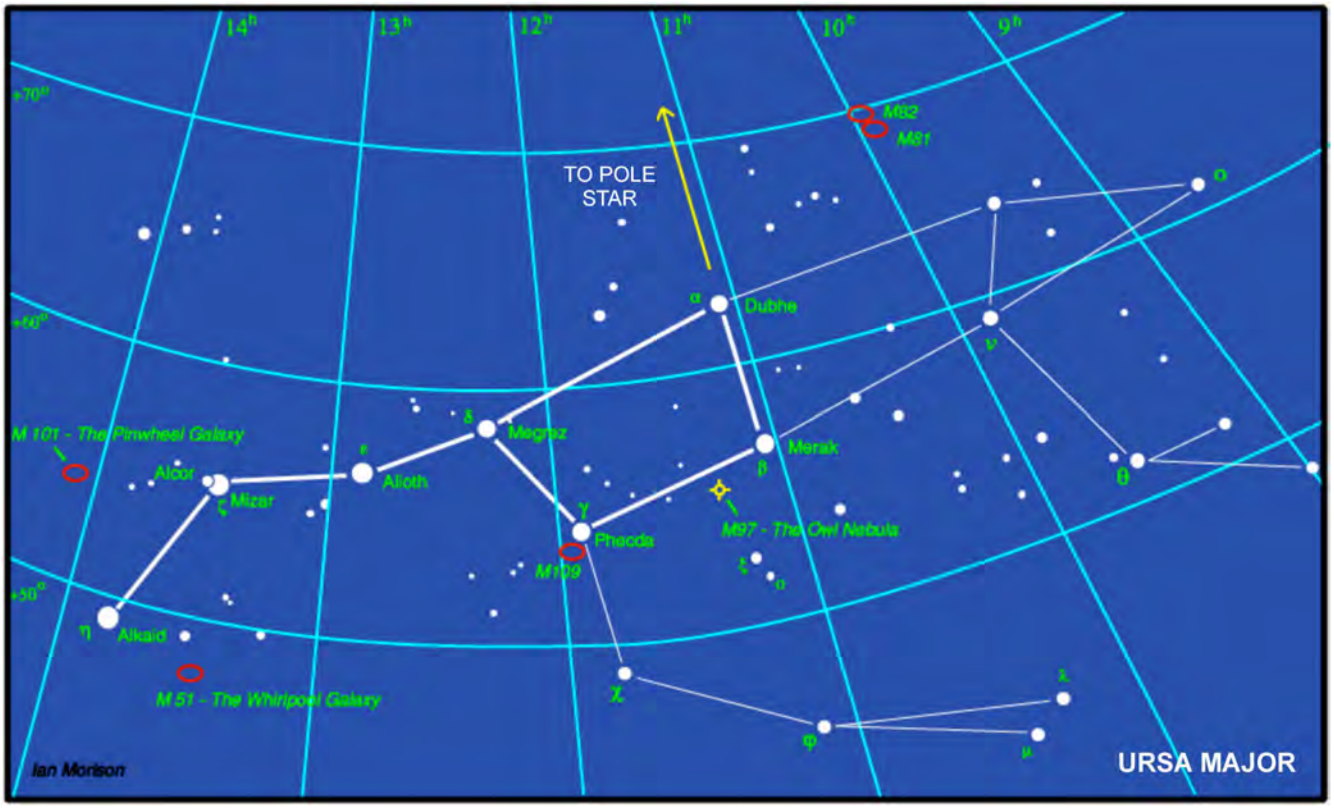
The best watching time for stars is between the moon's last quarter and the first, and three hours after sunset so the sky is dark enough to see the low intensity stars.

CONSTELLATIONS

Constellations are groupings of stars that have been given legendary or historical significance. These groups have been joined together with lines, outlining a figure or symbol, so that they may be found in the sky.

Ursa Major (Big Dipper)

Ursa Major is visible throughout most of the year in the northern hemisphere and is known as the "Great Bear" in Latin. The seven brightest stars are located in the bear's hindquarters and tail and form the well known asterism Big Dipper as it appears to form the shape of a ladle, or dipper shape. The stars Dubhe and Merak, located on the outside edge of the dipper, are also known as "The Pointer" since they point in the direction of Polaris.



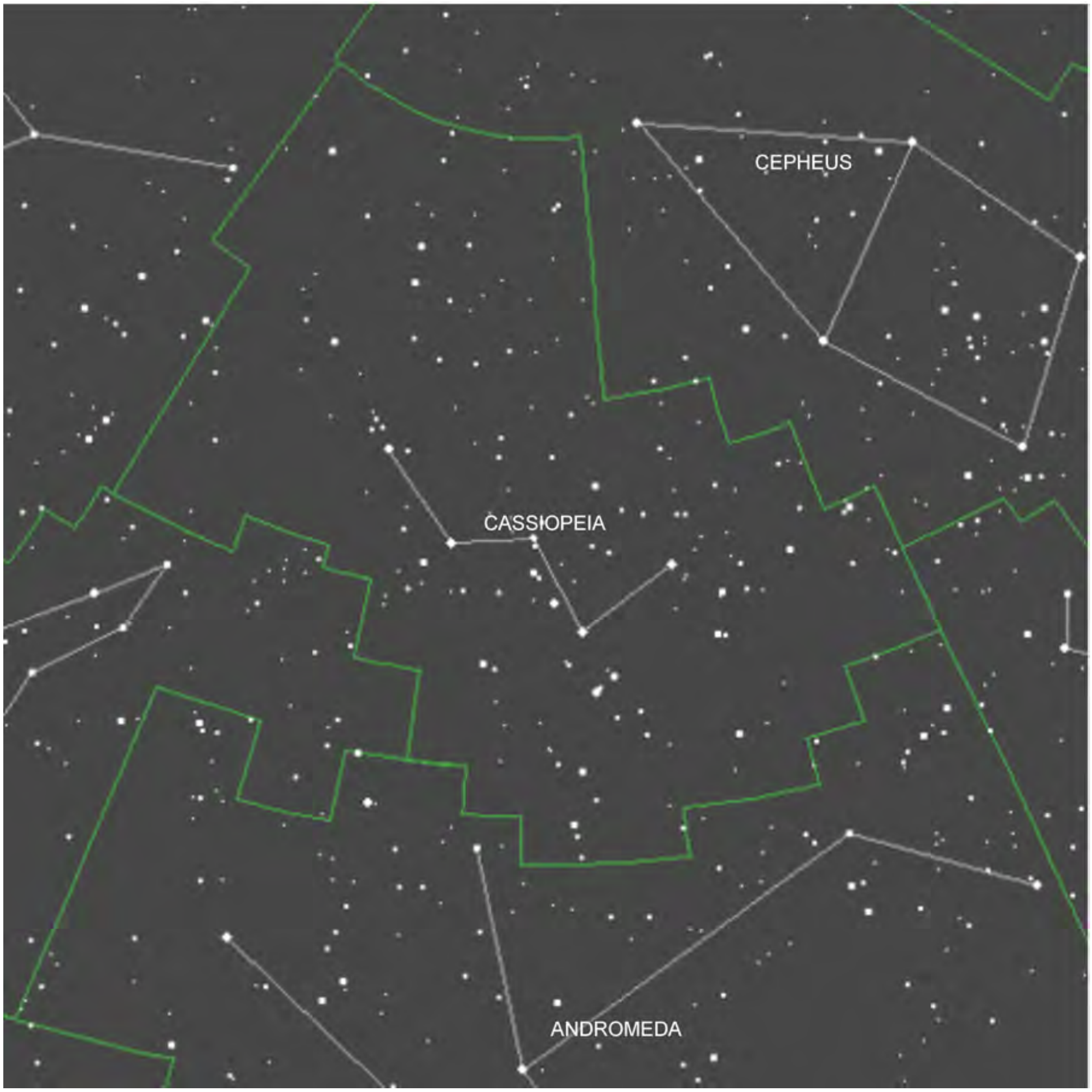
Jobrell Bank Observatory, 2006, Ursa Major, Copyright 2006 by The University of Manchester. Retrieved November 14, 2007, from http://www.jb.man.ac.uk/public/Ursamjor.jpg

Figure 18-12-3 Ursa Major

> The Big Dipper is not a constellation. It is part of Ursa Major, the Great Bear. The Big Dipper is an asterism – a recognized, but not official, grouping of stars. Some asterisms fall within a single constellation, others span across constellations.

Cassiopeia

Cassiopeia is a northern constellation which in Greek mythology represents a vain queen who boasted about her unrivalled beauty. It is made up of five stars that resemble a lopsided “M” or “W” depending on its position in the sky. Viewing the constellation as an “M”, connect the three bottom stars with an imaginary line. From the right-most star create an imaginary line straight down to find Polaris.

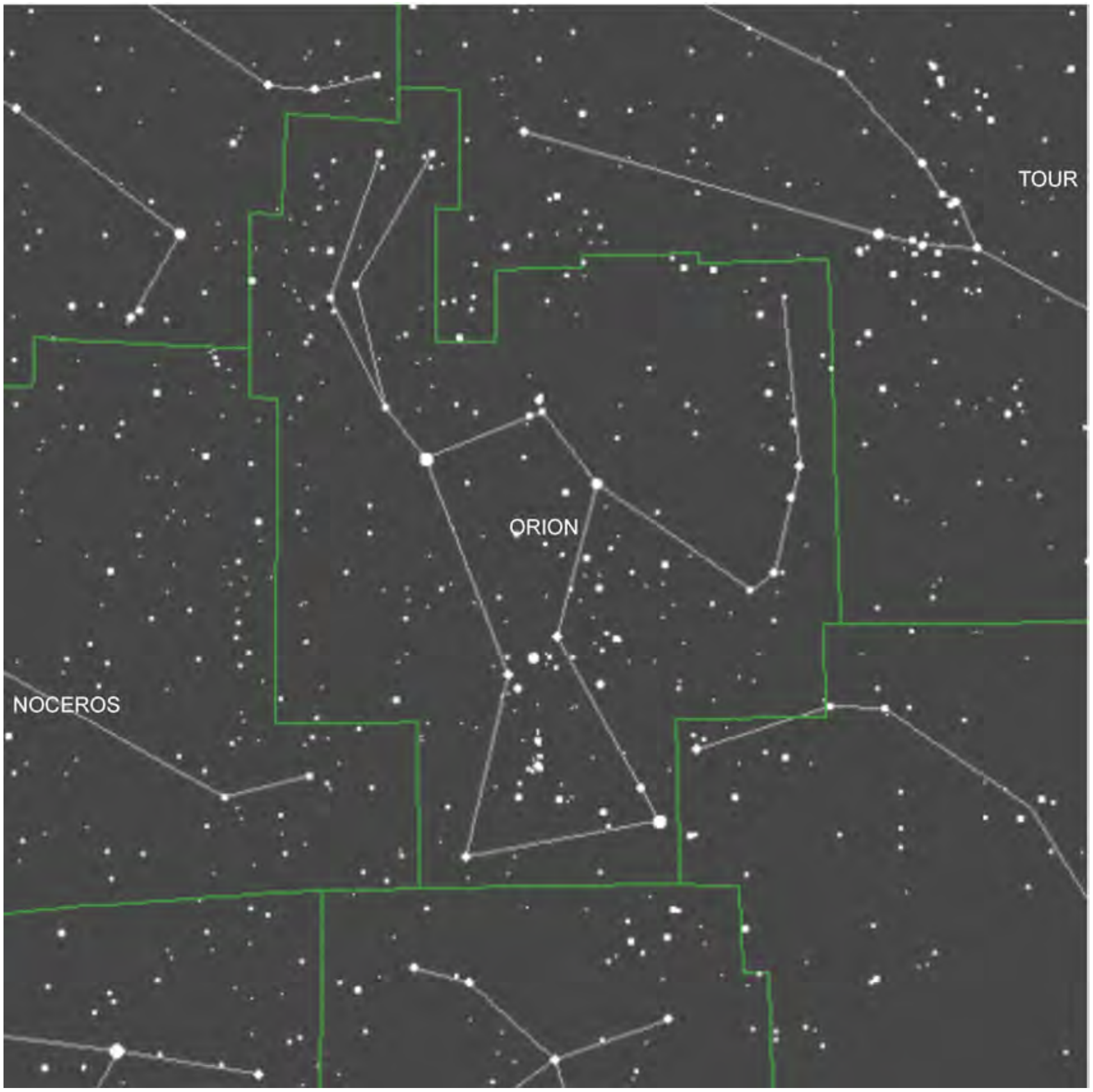


About.com, 2007, Cassiopeia, Copyright 2007 by About Inc. Retrieved November 14, 2007, from http://space.about.com/od/starsplanetsgalaxies/ig/Constellations-Pictures/cassiopeia.htm

Figure 18-12-4 Cassiopeia

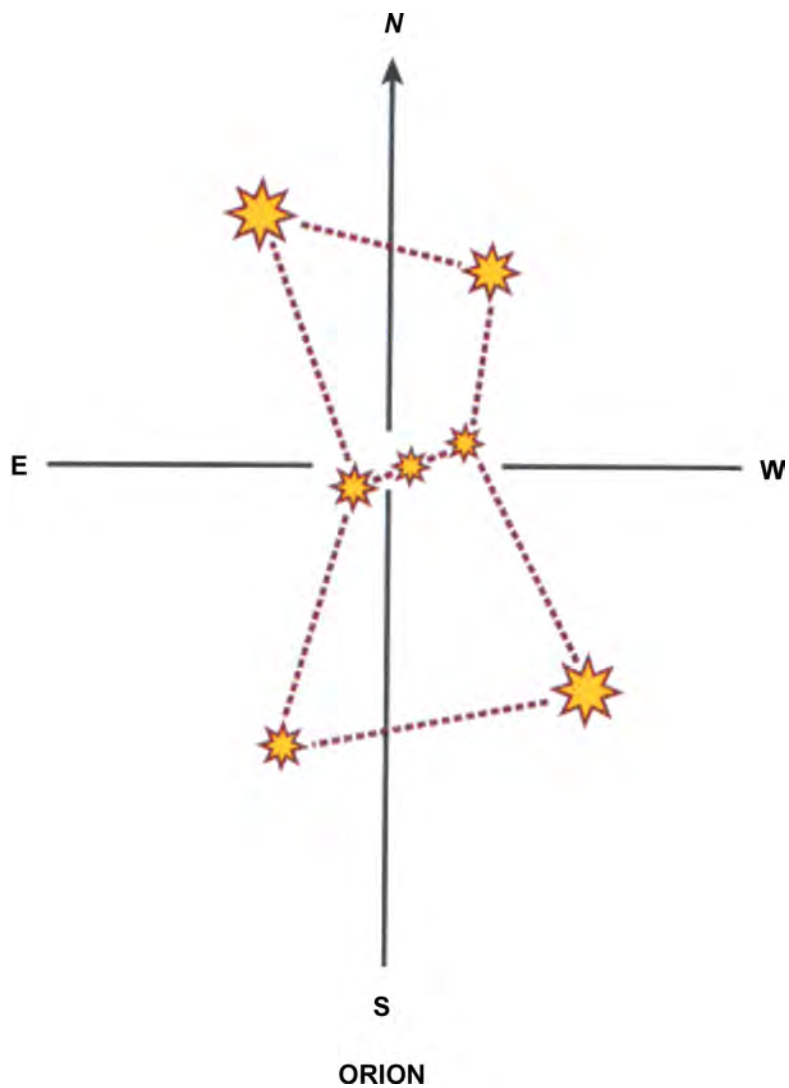
Orion

Orion is a constellation often referred to as The Hunter. It is one of the largest and most visible constellations in the sky. Its brilliant stars are found on the celestial equator and are visible throughout the world. From mid-northern latitudes, Orion is visible in the evening from November to early May and in the morning from late July to November. The constellation of Orion consists of seven stars. The three stars that are close together are the belt of the constellation. The Orion constellation, rises on the horizon due east and sets due west. At the equator it will pass directly overhead, and in the northern hemisphere it will pass south directly overhead. The top of Orion points in the direction of the Pole Star.



About.com, 2007, Orion, Copyright 2007 by About Inc. Retrieved November 14, 2007, from http://space.about.com/od/starsplanetsgalaxies/ig/Constellations-Pictures/orion.htm

Figure 18-12-5 Orion

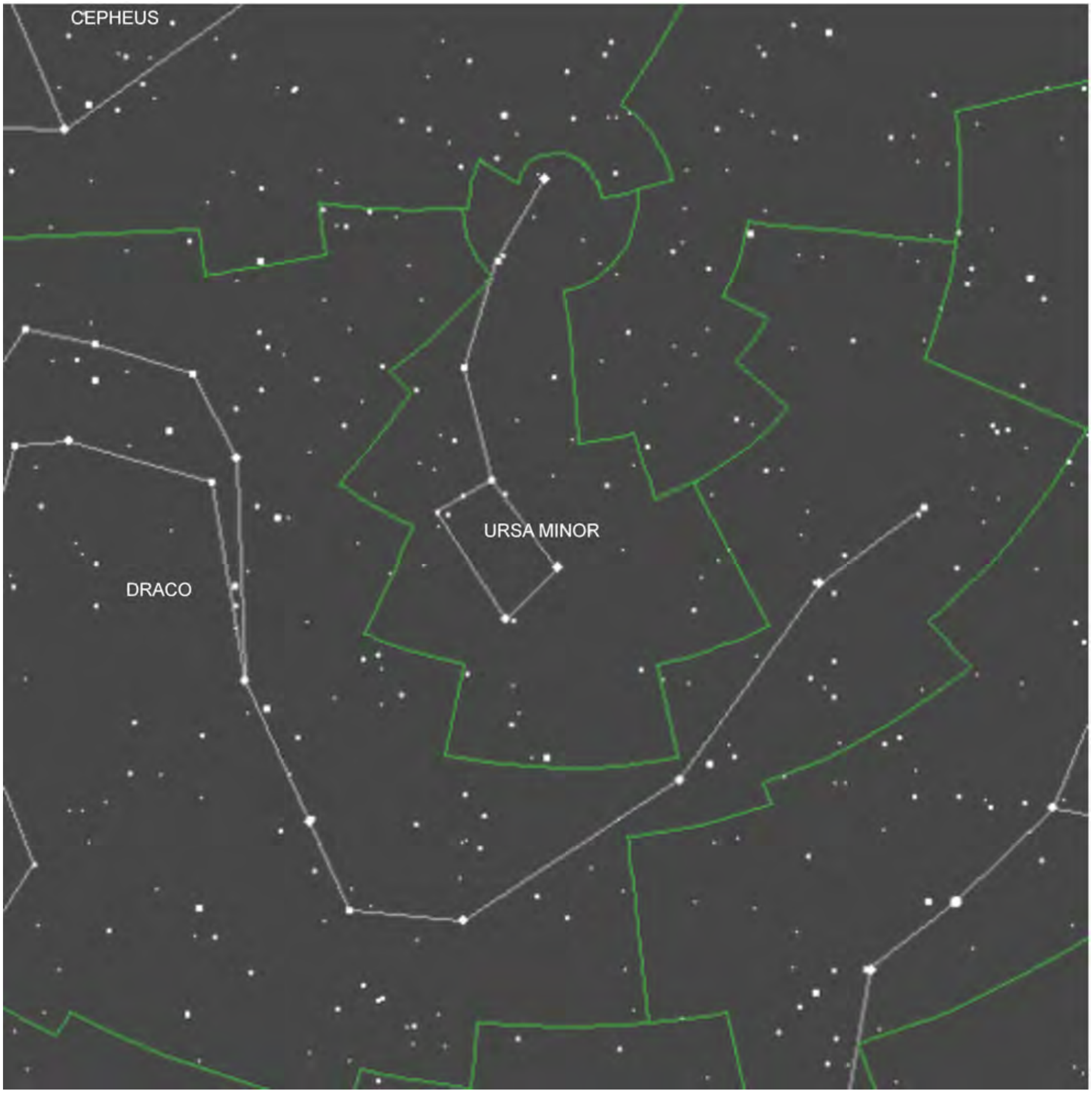


National Association of Search and Rescue, Fundamentals of Search and Rescue, Jones and Bartlett Publishers, Inc. (p. 78)

Figure 18-12-6 Orion and North

Ursa Minor (Little Dipper)

Ursa Major is a constellation in the northern hemisphere. Its name means “Little Bear” in Latin. Ursa Minor is known as Little Dipper because its seven brightest stars appear to form a ladle, or dipper shape. The star at the end of the dipper’s handle is Polaris, the North or Pole Star.



About.com, 2007, Ursa Minor, Copyright 2007 by About Inc. Retrieved November 14, 2007, from http://z.about.com/d/space/1/7/f/P/ursaminor.gif

Figure 18-12-7 Ursa Minor

ACTIVITY

Time: 5 min

OBJECTIVE

The objective of this activity is to have cadets locate various constellations.

RESOURCES

- Sky map, and
- Red-filtered flashlight.

ACTIVITY LAYOUT

N/A.

ACTIVITY INSTRUCTIONS

1. Indicate north to the cadets (use compass if necessary).
2. Hold the sky map upside-down (allowing the cadet to look at it) and overhead with the "N" on the map pointing north.

> The east and west printed on the sky map are on the opposite side of the east and west of an earth map. The reason is that when the map is held above the head, the east and west markings will then be the same as on the ground. To better read a sky map in the dark, use a flashlight with a red filter so night vision is not affected.

3. With the aid of a local sky map, have the cadets locate:
   (a) Ursa Major,
   (b) Cassiopeia,
   (c) Orion, and
   (d) Ursa Minor.

SAFETY

N/A.

CONFIRMATION OF TEACHING POINT 2

The cadets' participation in the activity will serve as the confirmation of this TP.

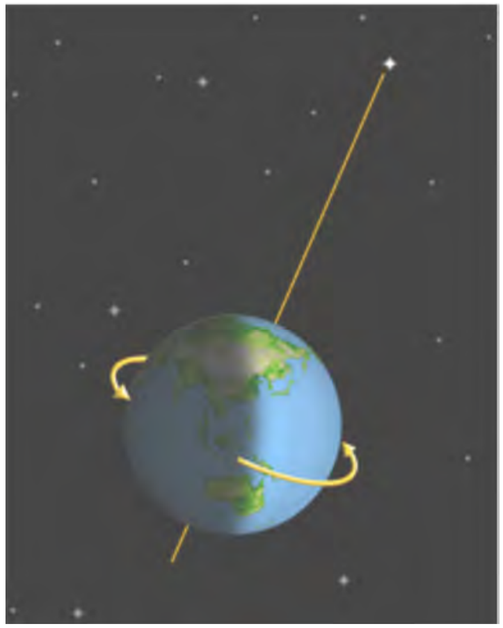
Teaching Point 3	**Explain, Demonstrate and Have Cadets Locate Polaris Using the Major Constellations Identified in TP2**
Time: 5 min	Method: Demonstration and Performance

POLARIS

Polaris is more commonly known as the North Star. It is the brightest star in the constellation Ursa Minor. It is very close to the celestial pole (0.7 degrees away from the pole rotation), making it the current Pole Star. The star lies in a direct axis above the North Pole and appears to stand almost motionless in the sky and the other stars seem to rotate around it. Polaris has been close to the actual position of north for the past 1000 years and during the course of the 21st century it will continue to close in on being in line with True North and will be closest on March 24, 2100 (almost 0.45 degrees away). After that date it will start to pull away and eventually another star will become the new Pole Star.

Locating the North Star

Polaris is located in the constellation Ursa Minor, which contains the group of stars that make up the Little Dipper (as illustrated in Figure 18-12-7). Polaris is the star in the end of the Little Dipper's handle. Often the Little Dipper is not very bright and can be challenging to find.



Lunar and Planetary Institute, 2007, Polaris, Copyright 2007 by Lunar and Planetary Institute. Retrieved November 14, 2007, from http://www.lpi.usra.edu/education/skytellers/polaris/about.shtml

Figure 18-12-8 Polaris

ACTIVITY

Time: 5 min

OBJECTIVE

The objective of this activity is to have the cadets locate Polaris.

RESOURCES

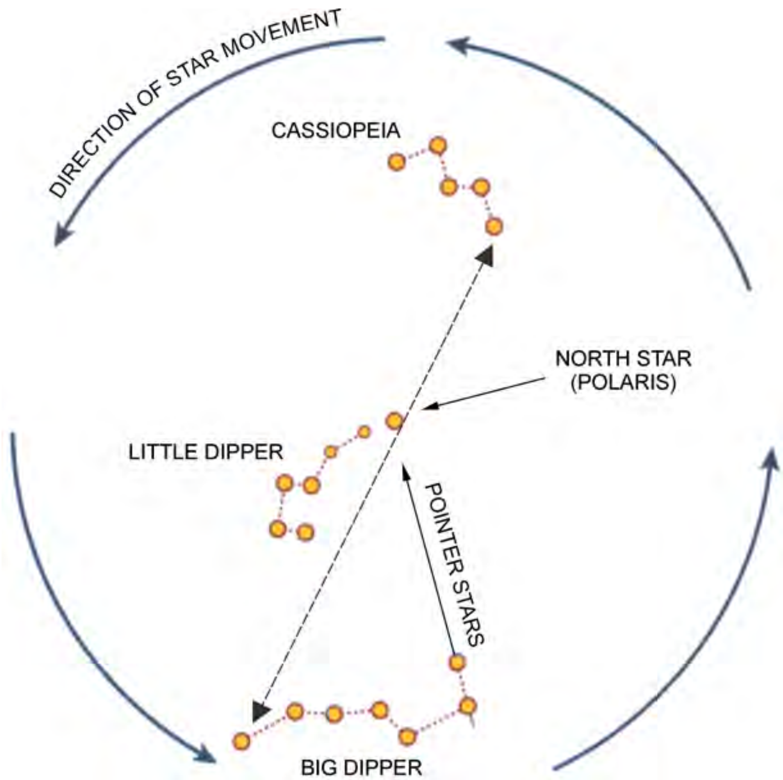
Handout located at Annex Q.

ACTIVITY LAYOUT

N/A.

ACTIVITY INSTRUCTIONS

1. Hand out copies of Annex Q to each cadet.
2. Have the cadets find the constellation Ursa Major (Big Dipper).
3. Have the cadets draw an imaginary line between the two stars (the pointers Merak and Dubhe) at the end of the big dipper's bowl as they will point toward the Pole Star. The distance to the Pole Star is about five times the distance between the pointers.



National Association of Search and Rescue, Fundamentals of Search and Rescue, Jones and Bartlett Publishers, Inc. (p. 76)

Figure 18-12-9 Finding Polaris

4. Have the cadets locate the constellation Cassiopeia, which is directly across from Ursa Major.
5. Have the cadets draw an imaginary line between the star at the end of Cassiopeia and the last star in the handle of Ursa Major (as illustrated in Figure 18-12-9). Polaris is almost equidistant between Ursa Major and Cassiopeia.

SAFETY

N/A.

CONFIRMATION OF TEACHING POINT 3

The cadets' participation in the activity will serve as the confirmation of this TP.

END OF LESSON CONFIRMATION

The cadets' participation in determining south by the phases of the moon, locating the various constellations and locating Polaris will serve as the confirmation of this lesson.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

N/A.

CLOSING STATEMENT

It is important for the cadets to be able to navigate at night so they can find their way in the dark. In a survival situation being able to determine direction in the dark is a skill that can assist in being rescued.

INSTRUCTOR NOTES/REMARKS

N/A.

REFERENCES

C0-111 (ISBN 978-0-9740820-2-8) Tawrell, P. (2006). *Camping and Wilderness Survival: The Ultimate Outdoors Book* (2nd ed.). Lebanon, NH: Leonard Paul Tawrell.

C3-002 (ISBN 0-00-653140-7) Wiseman, J. (1999). *The SAS Survival Handbook*. Hammersmith, London: HarperCollins Publishers.

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ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL THREE

INSTRUCTIONAL GUIDE

SECTION 13

EO C390.08 – USE BLAZING TECHNIQUES

Total Time:	30 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-803/PG-001, Chapter 4. Specific uses for said resources are identified throughout the instructional guide within the TP for which they are required.

Review the lesson content and become familiar with the material prior to delivering the lesson.

Blaze a route using grass and rocks for the demonstration in TP 2.

Prepare a route that is 100 m long for the cadets to use during the activity in TP 3.

Photocopy the handout located at Annex R for each cadet.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

An interactive lecture was chosen for TP 1 to present basic material on blazing.

Demonstration was chosen for TP 2 as it allows the instructor to explain and demonstrate blazing techniques.

Performance was chosen for TP 3 as it provides an opportunity for the cadet to practice blazing techniques under supervision.

INTRODUCTION

REVIEW

N/A.

OBJECTIVES

By the end of this lesson the cadet shall have used blazing techniques.

IMPORTANCE

It is important for the cadets to know how to use blazing techniques in a survival situation. Blazing techniques can be used when a cadet leaves a site to find water or build a signal fire and needs to find their way back. Blazing techniques may also help searchers find a survival site.

Teaching Point 1	**Explain the Reasons for Blazing**
Time: 5 min	Method: Interactive Lecture

REASONS FOR BLAZING

Leaving and Returning to the Site

When searching for water or finding higher ground to build a signal fire, the survivor may have to walk for a kilometre or more. Blazing will help to establish the route. If one loses their sense of direction they can follow it back to the survival site.

> Most trails are spotted (marked) coming and going so that they can be seen from both directions of travel.

Acting as a Guide to a Ground Search and Rescue (SAR) Party

Signs in the area will act as a clue to any presence or past presence and the direction markers will help rescuers follow someone's trail.

CONFIRMATION OF TEACHING POINT 1

QUESTIONS

Q1. Why are trails spotted (marked) in two directions?

Q2. What does blazing help to establish?

Q3. What do signs in the area act as a clue to?

ANTICIPATED ANSWERS

A1. Most trails are spotted (marked) coming and going so that they can be seen from both directions of travel.

A2. Blazing will help to establish the route. If one loses their sense of direction they can follow it back to the survival site.

A3. Signs in the area will act as a clue to any presence or past presence and the direction markers will help rescuers follow someone's trail.

Teaching Point 2	**Explain and Demonstrate Blazing Techniques**
Time: 10 min	Method: Demonstration

BLAZING TECHNIQUES

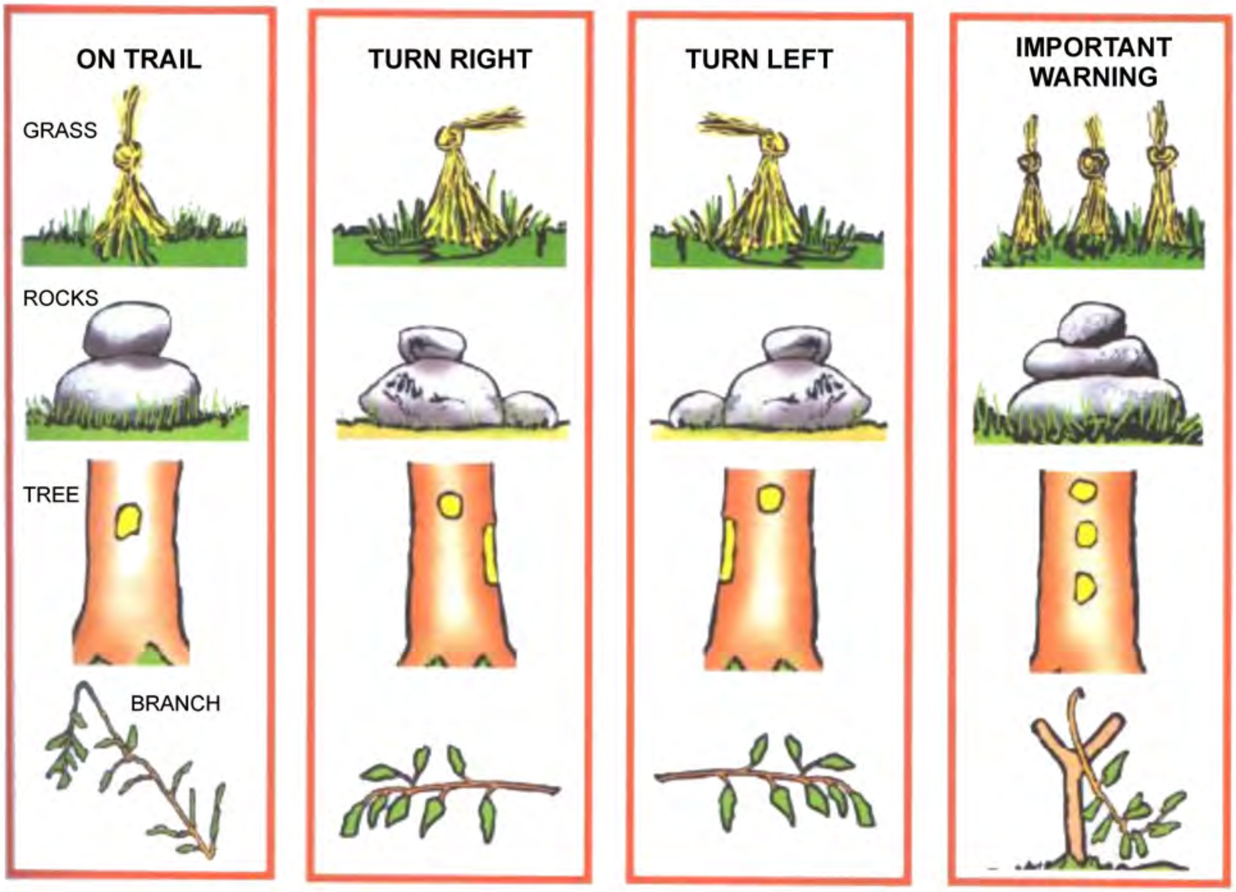
Blazing. Signals left behind if leaving the scene of a crash or moving to and from, or abandoning a survival site. These may include any of the following:

- A large arrow shape made to indicate the direction in which one is travelling. It will be visible from the air and other direction markers which can be interpreted at ground level. Direction markers could include:
  - rocks or debris placed in an arrow shape,
  - a stick left in a crooked support, with the top pointing in the direction taken,
  - grass tied in an overhand knot with the end hanging in the direction followed,
  - forked branches laid with the fork pointing in the direction followed,
  - arrowhead-shaped notches cut out of tree trunks indicating a turn,
  - small rocks set upon larger rocks, with small rocks beside, and
  - a cross of sticks or stones meaning “not this way”.
- Trail-blazing signals, not only for people to follow but to establish a route to retrace and guide someone if they lose their sense of direction.
- In case rescuers find the survival site while the lost person is away, written messages left in containers with details of planned movements. Hang them from tripods or trees and draw attention to them with markers.

Show the cadets the previously blazed trail with grass and rocks.

Allow the cadets to ask questions.

EXAMPLES OF BLAZING



P. Tawrell, Camping and Wilderness Survival: The Ultimate Outdoors Book, Paul Tawrell (p. 547)

Figure 18-13-1 Blazing Techniques

STEPS TO BLAZE A TRAIL

To blaze a trail with branches:

1. Find a route to follow for 100 m.
2. Gather branches which are already on the ground (deadfall or debris).
3. Create blazes by placing the branches along the route for 100 m.
4. At each created blaze, examine it from the point of view of returning along that trail. If necessary, create another blaze that will direct the person back along the trail.
5. Return the branches to the environment, when finished.

Demonstrate blazing with branches as the cadets observe.

CONFIRMATION OF TEACHING POINT 2

QUESTIONS

Q1. What can direction markers include?

Q2. What is blazing?

Q3. What should be left at the survival site?

ANTICIPATED ANSWERS

A1. Direction markers may include:

- rocks or debris placed in an arrow shape,
- a stick left in a crooked support, with the top pointing in the direction taken,
- grass tied in an overhand knot with the end hanging in the direction followed,
- forked branches laid with the fork pointing in the direction followed,
- arrowhead-shaped notches cut out of tree trunks indicating a turn,
- small rocks set upon larger rocks, with small rocks beside, and
- a cross of sticks or stones meaning "not this way".

A2. Signals left behind if you leave the scene of a crash or abandon a survival site.

A3. In case rescuers find the survival site while the lost person is away, written messages should be left in containers with details of planned movements.

Teaching Point 3 — **Have Cadets Blaze a Trail**

Time: 10 min — Method: Performance

Have cadets blaze a trail using branches.

ACTIVITY

OBJECTIVE

The objective of this activity is to have the cadets blaze a trail using branches.

RESOURCES

Handout of blazing techniques located at Annex R.

ACTIVITY LAYOUT

A route that is 100 m long.

ACTIVITY INSTRUCTIONS

1. Distribute the handout located at Annex R to each cadet.
2. Have the cadets:
   (a) gather branches which are already on the ground (deadfall or debris);
   (b) place the branches along the route for 100 m;
   (c) turn the branches around when returning to the starting point; and
   (d) return the branches to the environment when the activity is complete.

SAFETY

Ensure the cadets stay in the designated area during this TP.

CONFIRMATION OF TEACHING POINT 3

The cadets' participation in the activity will serve as the confirmation of this TP.

END OF LESSON CONFIRMATION

The cadets' participation in blazing a trail will serve as the confirmation of this lesson.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

N/A.

CLOSING STATEMENT

It is important for the cadets to know how to use blazing techniques in a survival situation. Blazing techniques can be used when the survivor leaves their site to find water or build a signal fire and needs to find their way back. Blazing techniques also help searchers find a survival site.

INSTRUCTOR NOTES/REMARKS

N/A.

REFERENCES

A3-016 B-GG-217-001/PT-001 Director Air Operations and Training. (1983). *Down But Not Out*. Ottawa, ON: Department of National Defence.

C0-111 (ISBN 978-0-9740820-2-8) Tawrell, P. (2006). *Camping and Wilderness Survival: The Ultimate Outdoors Book* (2nd ed.). Lebanon, NH: Leonard Paul Tawrell.

ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL THREE

INSTRUCTIONAL GUIDE

SECTION 14

EO C390.09 – IDENTIFY ELEMENTS OF THE NIGHT SKY

Total Time:	120 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-803/PG-001, Chapter 4. Specific uses for said resources are identified throughout the instructional guide within the TP for which they are required.

Review the lesson content and become familiar with the material prior to delivering the lesson.

If there are insufficient quantities of planispheres and red-filtered flashlights, divide the cadets into groups based on the quantities available.

Planispheres may be created from Figures 15U-4 and 15U-5.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

An interactive lecture was chosen for TP 1 in order to orient the cadets to the conditions required to observe the elements of the night sky.

Demonstration and performance was chosen for TP 2 as it allows the instructor to explain and demonstrate how to use a planisphere star chart while providing an opportunity for the cadets to practice the skill under supervision.

A practical activity was chosen for TP 3 as it is an interactive way to introduce the cadets to elements of the night sky. This activity contributes to the development of astronomy skills and knowledge in a fun and challenging setting.

INTRODUCTION

REVIEW

N/A.

OBJECTIVES

By the end of this lesson the cadet shall have identified elements of the night sky.

IMPORTANCE

It is important for cadets to be able to identify the elements of the night sky so they can apply the knowledge acquired in a practical setting. Observing the night sky will allow the cadets to observe the moon, planets, stars and constellations. This may also assist in overcoming the sixth and seventh enemies of survival: boredom and loneliness.

Teaching Point 1	**Describe Conditions Required to View the Elements of the Night Sky**
Time: 5 min	Method: Interactive Lecture

CLOUDS

The presence of clouds will inhibit observations of the elements of the night sky. Even partial cloud cover will make it more difficult to identify specific constellations by hiding parts of the constellation or obscuring elements used to find the constellation. It is best to observe the night sky on a cloudless night.

MOON

The moon is the brightest object in the night sky. The moon itself does not shine, it reflects sunlight. When the moon is full, its light overpowers the light of the dim stars near it. For example, looking at a small flashlight that is next to a million candlepower flashlight, the light of the smaller flashlight is not any less, but its light is overpowered by the brighter flashlight.

The best time to look for stars is between the moon's last quarter and the first quarter, three hours after sunset so the sky is dark enough to see the low intensity stars.

The moon is second only to the sun as the largest source of natural light pollution.

LIGHT POLLUTION

T. Dickinson, NightWatch: A Practical Guide to Viewing the Universe, Firefly Books Ltd. (p. 48)

Figure 18-14-1 Light Pollution's Effects

The sun and moon are the main sources of light pollution. However, artificial light pollution exists near built-up areas and makes the sky appear yellowish-gray as opposed to black. This happens because outdoor lighting illuminates the air as well as the ground. To clearly see stars at night, find a location that is free from lights. This includes individual lights, like street lights, as well as the glow that appears from built-up areas (eg, towns and cities). Figure 18-14-1 illustrates the effect of light pollution by contrasting the same section of sky with and without light pollution.

CONFIRMATION OF TEACHING POINT 1

QUESTIONS

Q1. Which natural phenomenon may inhibit the view of part or all of the night sky?

Q2. What is the second brightest object that may be seen from Earth?

Q3. What are examples of artificial light pollution?

ANTICIPATED ANSWERS

A1. Clouds.

A2. The moon.

A3. This includes individual lights, like street lights, as well as the glow that appears from built-up areas (eg, towns and cities).

Teaching Point 2 — **Explain, Demonstrate and Have the Cadets Use a Planisphere Star Chart**

Time: 10 min — Method: Demonstration and Performance

Instruct the cadets on the use of the specific planisphere star chart according to directions provided with the planisphere.

Note: Directions, for the *Firefly Planisphere: Latitude 42 deg N*, are included and may serve as an example of directions for the type of planisphere used.

Distribute one each, planisphere and red-filtered flashlight, per group of cadets and have the cadets orient their planisphere.

For this skill lesson, it is recommended that instruction take the following format:

1. Explain and demonstrate the complete skill while cadets observe.
2. Explain and demonstrate each step required to complete the skill. Monitor cadets as they imitate each step.
3. Monitor the cadets' performance as they practice the complete skill.

Note: Assistant instructors may be employed to monitor cadet performance.

Elements of the night sky can be identified with the naked eye, star charts, a planisphere star chart, binoculars or a telescope.

Planisphere Star Chart. An analog computer for calculating the position of stars. It has this name because the celestial sphere is represented on a flat plane, such as paper. Since the Earth is constantly in motion, the time of day, time of year and location influence the appearance of the sky. An individual star chart cannot accurately represent all of these combinations. This would take many different star charts. A preferable method is to use a planisphere star chart which allows the user to twist a dial to show the true position of the stars.

Steps to use the *Firefly Planisphere: Latitude 42 deg N*:

1. Find the date around the outer edge of the disk, and the time of night on the inner, movable wheel. (As illustrated in Figure 18-14-2, the planisphere is set for 10 p.m. (22h) on the evening of January 23.)

R. Scagell, Firefly Planisphere: Latitude 42 deg N, Firefly Books Ltd.

Figure 18-14-2 Step 1

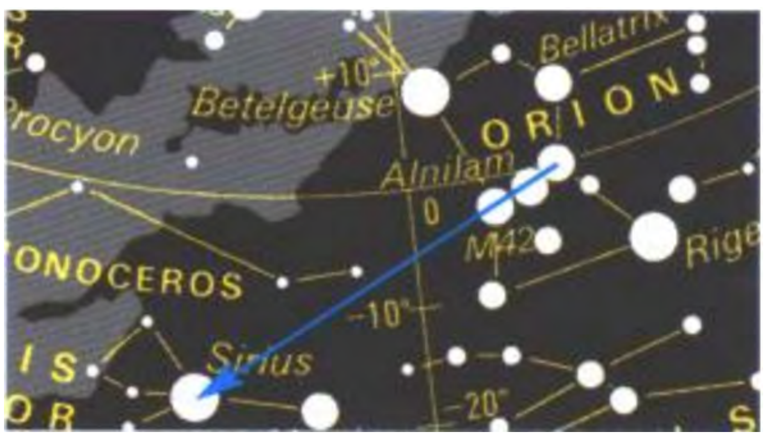
> Remember to allow for Daylight Savings Time (mid-spring to mid-fall) if it is in effect. This means subtracting one hour from the current time.

2. Hold the planisphere over your head. The oval map shows the entire sky, with the horizon around the edges of the map and the overhead point in the middle (as illustrated in Figure 18-14-3). Rotate the planisphere so that the eastern horizon, western horizon and the ‘N’ by the Midnight marker correspond with the ground.

R. Scagell, Firefly Planisphere: Latitude 42 deg N, Firefly Books Ltd.

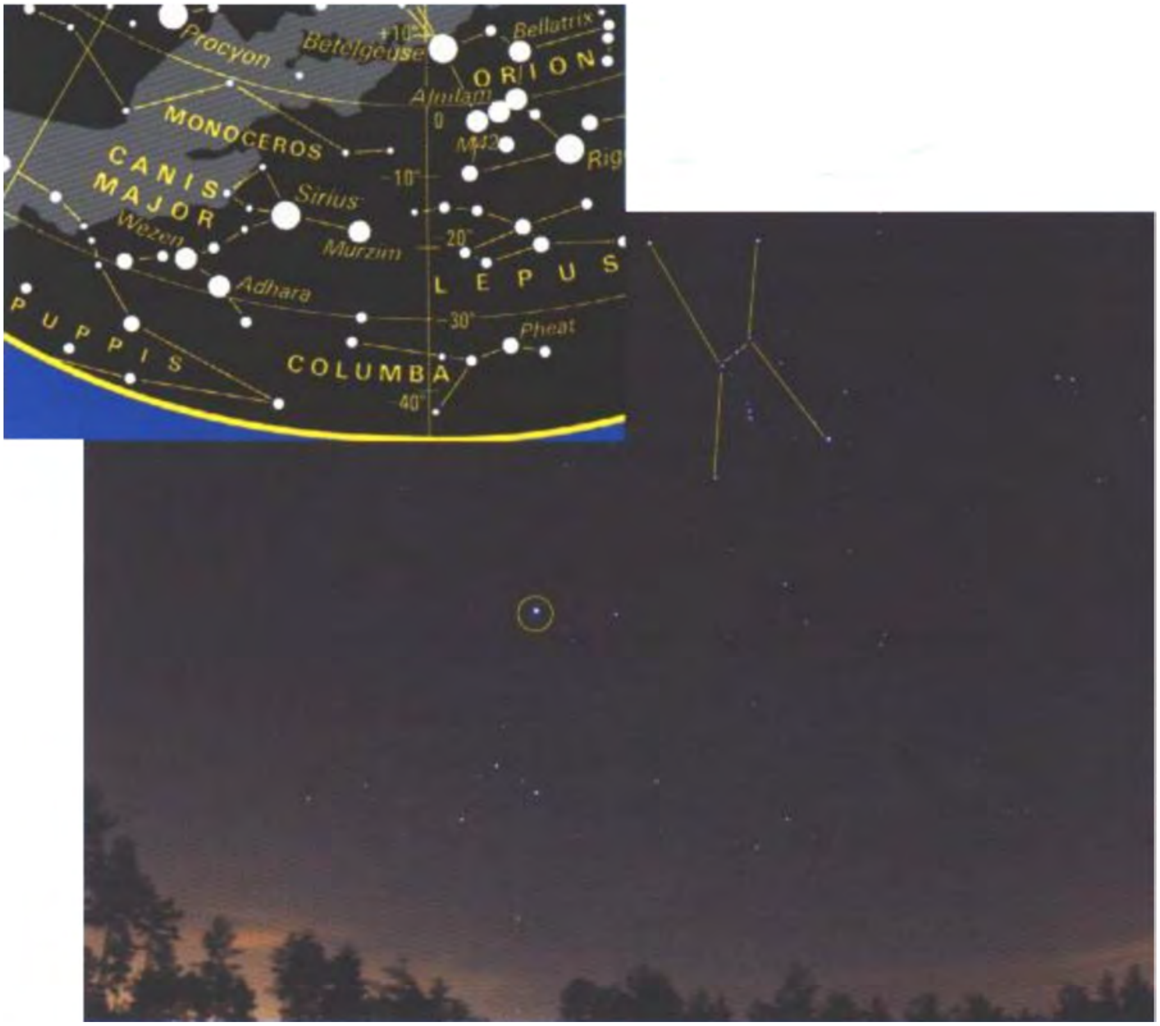
Figure 18-14-3 Step 2

3. Pick out a major constellation by its shape. Remember that the map shows the whole sky, so what looks like a small pattern on the map may cover a large area of the sky. Once one constellation is found, it is used as a guide to locate other constellations. (as illustrated in Figure 18-14-4, the three central stars of Orion, known as Orion's Belt, will be used as a pointer to Sirius in Canis Major. Figure 18-14-5 illustrates a section of the planisphere and a section of night sky with Orion marked and Sirius circled.)



R. Scagell, Firefly Planisphere: Latitude 42 deg N, Firefly Books Ltd.

Figure 18-14-4 Step 3 Locating Sirius Using Orion's Belt



R. Scagell, Firefly Planisphere: Latitude 42 deg N, Firefly Books Ltd.

Figure 18-14-5 Step 3 Sirius Located

The above example used Orion as a guide; however, Orion is visible in Canada only from approximately November to April. If Orion is not visible, choose another constellation.

CONFIRMATION OF TEACHING POINT 2

The cadets' participation in using a planisphere will serve as the confirmation of this TP.

Teaching Point 3 — **Describe and Have the Cadets Identify Elements of the Night Sky**

Time: 95 min — Method: Practical Activity

Depending on viewing opportunities, handouts may be created for the moon and Venus located at Annexes S and T.

MOON

The moon is the brightest object in the night sky. If the moon dominates the night sky making observing other elements of the night sky difficult, the opportunity should be used to observe the moon itself. While it may be a source of light pollution, when the Moon is at least half full, many features may be observed on its surface (see Annex S).

VENUS

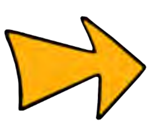
The planet Venus and the Moon are the only natural objects that can be seen while the Sun is in the sky. Venus is normally seen either around dawn or dusk depending on where it is relative to Earth in its orbit (see Annex T).

POLARIS

Polaris is more commonly known as the North Star. It is the brightest star in the constellation Ursa Minor. It is very close to the celestial pole (0.7 degrees away from the pole rotation), making it the current North Star. The star lies in a direct axis above the North Pole and appears to stand almost motionless in the sky. Other stars seem to rotate around it. Polaris has been close to the actual position of north for the past 1000 years and during the course of the 21^{st} century it will continue to close in on being in line with True North and will be closest on March 24, 2100 (approximately 0.45 degrees away). After that date it will start to pull away and eventually another star will become the new North Star.

CONSTELLATIONS

Throughout history humanity has gazed upon the stars and created patterns called constellations. These celestial groups are steeped in mythology and, in the case of the signs of the zodiac, embellished with the symbolism of astrology. One of the best known (in Canada) group of stars is known as the Big Dipper, however, it is not a constellation.



The Big Dipper is not a constellation. It is part of Ursa Major, the Great Bear. The Big Dipper is an asterism, a recognized, but not official, grouping of stars. Some asterisms fall within a single constellation; others cross constellations.

Ursa Major

Ursa Major means “Great Bear” in Latin. The seven brightest stars are located in the bear’s hindquarters and tail and form the well known asterism, the Big Dipper, as it appears to form the shape of a ladle, or dipper shape. The stars Dubhe and Merak, located on the outside edge of the dipper, are also known as “The Pointer” since they point in the direction of Polaris. Most of Ursa Major is visible year-round in Canada.

Ursa Minor

Ursa Minor means “Little Bear” in Latin. Ursa Minor is known as Little Dipper because its seven brightest stars appear to form a ladle, or dipper shape. The star at the end of the dipper’s handle is Polaris, the North or Pole Star. Ursa Minor is visible year-round in Canada.

Cassiopeia

Cassiopeia is a northern constellation which in Greek mythology represented a vain queen who boasted about her unrivalled beauty. It is made up of five stars that resemble a lopsided “M” or “W” depending on its position in the sky. It is visible year-round in Canada.

Orion

Orion is a constellation often referred to as The Hunter. It is one of the largest and most visible constellations in the sky. The constellation consists of seven stars. The three stars that are close together at the centre of the constellation are known as Orion’s Belt. Orion is visible in Canada from approximately November to April.

The Signs of the Zodiac

All of the signs of the zodiac will not be visible at the same time. This is due to the location of the signs around the celestial sphere, which means that several signs will be below the horizon at any one time.

The twelve signs of the zodiac are Aries, Taurus, Gemini, Cancer, Leo, Virgo, Libra, Scorpio, Sagittarius, Capricorn, Aquarius, and Pisces.

See Annex U for more details of the 16 constellations. Use this information to answer questions the cadets may have about these constellations.

ACTIVITY

Time: 85 min

OBJECTIVE

The objective of this activity is to have the cadets identify elements of the night sky.

RESOURCES

- Planisphere star chart, and
- Red-filtered flashlight.

ACTIVITY LAYOUT

N/A.

ACTIVITY INSTRUCTIONS

1. Have the cadets locate the Moon (if visible).
2. Have the cadets locate Venus (if visible, see Annex T).
3. Have the cadets locate Polaris (always visible).

4. Have the cadets locate Ursa Major (always visible).
5. Have the cadets locate Ursa Minor (always visible).
6. Have the cadets locate Orion (if visible).
7. Have the cadets locate Cassiopeia (always visible).
8. Have the cadets, using a planisphere, locate signs of the zodiac.

SAFETY

The site chosen for observing the night sky should be flat as the cadets will be concentrating on the sky and not where they are stepping.

CONFIRMATION OF TEACHING POINT 3

The cadets' participation in the activity will serve as the confirmation of this TP.

END OF LESSON CONFIRMATION

The cadets' identification of elements of the night sky will serve as the confirmation of this lesson.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

N/A.

CLOSING STATEMENT

Observing the night sky will allow the cadets to observe the moon, planet, star and constellations. This may assist in overcoming the sixth and seventh enemies of survival: boredom and loneliness.

INSTRUCTOR NOTES/REMARKS

It is recommended this lesson be conducted after EO C340.04 (Describe Elements of the Night Sky, Chapter 15, Section 6).

REFERENCES

C3-179 (ISBN 1-55209-302-6) Dickenson, T. (2006). *Night Watch: A Practical Guide to Viewing the Universe*. Richmond Hill, ON: Firefly Books Ltd.

C3-180 (ISBN 1-55297-853-2) Scagell, R. (2004). *Firefly Planisphere: Latitude 42 Deg N*. Toronto, ON: Firefly Books Ltd.

C3-221 National Research Council of Canada. (2007). *Explore the Night Sky*. Retrieved December 3, 2007, from http://www.nrc-cnrc.gc.ca/eng/education/astronomy/constellations/html.html.

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ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL THREE

INSTRUCTIONAL GUIDE

SECTION 15

EO C390.10 – IDENTIFY METHODS OF PREPARING AND COOKING A SMALL ANIMAL OR FISH

Total Time:	60 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-803/PG-001, Chapter 4. Specific uses for said resources are identified throughout the instructional guide within the TP for which they are required.

Review the lesson content and practice skinning a small animal or preparing a fish and cooking a small animal or fish with the equipment provided prior to delivering the lesson.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

Demonstration was chosen for this lesson as it allows the instructor to explain and demonstrate skinning a small animal, preparing a fish and cooking a small animal or fish.

INTRODUCTION

REVIEW

N/A.

OBJECTIVES

By the end of this lesson the cadet shall have identified methods of preparing and cooking a small animal or fish.

IMPORTANCE

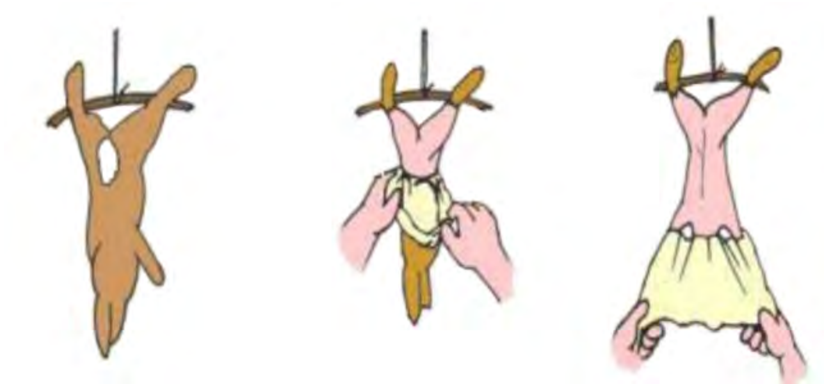
It is important for the cadets to identify the methods of preparing and cooking a small animal or fish that can be used in a survival situation. While food is the last component of the survival pattern (a person can live for weeks without eating), if it is readily available, the efforts made in catching, preparing and cooking a small animal or a fish are worthwhile. Proper preparation and cooking minimizes the chances of getting sick and helps to preserve the food.

Teaching Point 1	Explain and Demonstrate Skinning a Small Animal
Time: 15 min	Method: Demonstration

SKINNING A SMALL ANIMAL

For best results, the steps for skinning a small animal should be done in the sequence outlined below.

1. Remove urine by holding the animal's forelegs and gradually squeeze down on the body from the chest to the bowels.
2. Cut a hole in the belly area.
3. Pull the skin apart at the hole exposing the guts. Remove the guts.
4. Cut the skin around the front and hind paws and between the hind legs.
5. Hang the small animal and pull off the skin by pulling it down and over the head.
6. Cut the head off the small animal.



Note. From "Dressing", Simple Survival. Retrieved March 15, 2007, from http://www.simplesurvival.net/dressing.htm

Figure 18-15-1 Skinning a Small Animal

The guts (innards or entrails) can be used as bait or buried as the odour will attract insects and scavengers.

CONFIRMATION OF TEACHING POINT 1

QUESTIONS

Q1. How do you remove urine from the animal's body?

Q2. What area of the animal's body is first cut?

Q3. What is the last step in skinning an animal?

ANTICIPATED ANSWERS

A1. Remove the urine by holding the animal's forelegs and gradually squeeze down on the body from the chest to the bowels.

A2. The first cut is made in the belly area.

A3. Cutting the head off the small animal.

Teaching Point 2	Explain and Demonstrate Preparing a Fish
Time: 15 min	Method: Demonstration

PREPARING A FISH

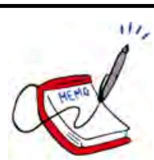
To prevent spoilage, prepare the fish as soon as possible. The innards (guts or entrails) can be used as bait or buried as the odour will attract insects and scavengers. Keep the fish cool and cook as soon as possible.

1. **Bleeding.** As soon as a fish is caught, cut its throat and allow it to bleed. Wipe the slime off the fish to make it less slippery. Do not let any slime get into your eyes as it may cause Fisherman's Conjunctivitis (pink eye). Cut out the gills (these are the flaps on both sides and just behind the fish's head) as they will quickly spoil.

2. **Gutting.** Make an incision from the anal orifice to where the throat was cut. Remove the entrails – you can use them for bait. Keep the roe, which runs down the side of the fish. It is hard in females and soft in males; it is very nutritious.

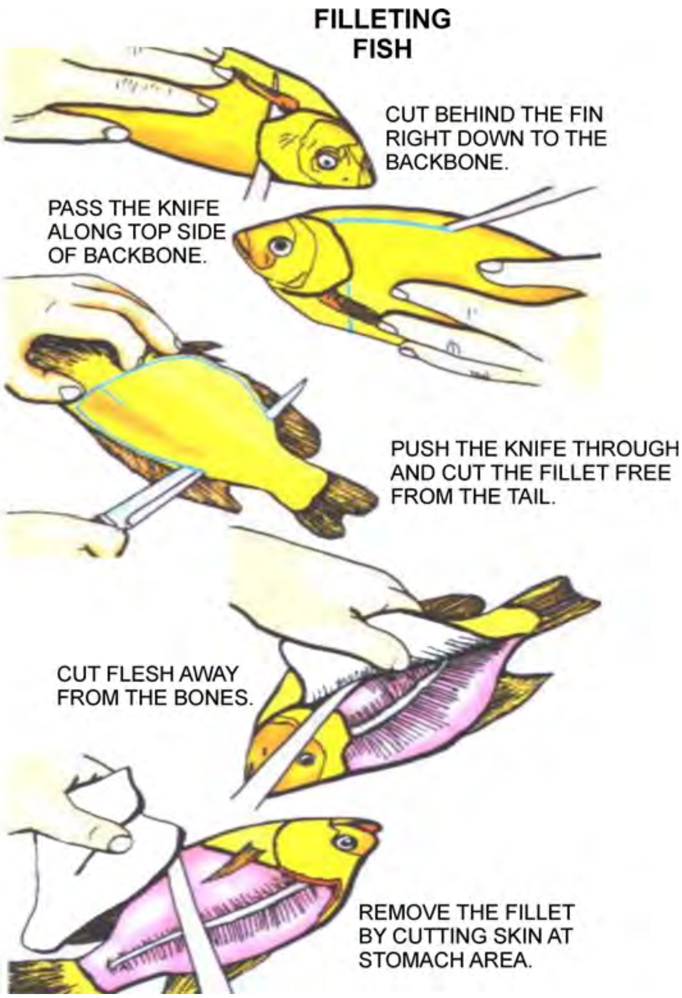
The roe of a fish are within the sexual organs (hard roe are eggs, soft roe is sperm). It is recommended that this is not explained to the cadets.

3. **Scaling.** Scaling is not necessary and fish can be cooked with scales on, but if there is time, scrape them off. Remove scales by holding the tail and pushing a dull knife across the skin at a forty-five degree angle. Draw the knife from tail to head.



Catfish have skin, not scales and should be skinned like a small animal.

4. **Filleting.** Pass the knife along the top side of the backbone. Cut behind the fin down to the backbone. Push the knife through and cut the fillet free from the tail. Cut the flesh away from the bones. Remove the fillet by cutting the skin at the stomach area.



P. Tawrell, Camping and Wilderness Survival, Paul Tawrell (p. 144)

Figure 18-15-2 Filleting a Fish

CONFIRMATION OF TEACHING POINT 2

QUESTIONS

Q1. What is done as soon as a fish is caught?

Q2. What should you do with the entrails?

Q3. What is the process for filleting?

ANTICIPATED ANSWERS

A1. As soon as a fish is caught, its throat is cut and allowed to bleed.

A2. Remove the entrails – you can use them for bait.

A3. Filleting:

(1) Pass the knife along the top side of the backbone.

(2) Cut behind the fin down to the backbone.

(3) Push the knife through and cut the fillet free from the tail.

(4) Cut the flesh away from the bones.

(5) Remove the fillet by cutting the skin at the stomach area.

Teaching Point 3	**Explain Methods of Cooking a Small Animal or Fish and Demonstrate One of the Methods**
Time: 20 min	Method: Demonstration

While only one method will be demonstrated, all three are explained.

COOKING A SMALL ANIMAL OR FISH

In addition to killing parasites and bacteria, cooking food can make it more palatable. The methods chosen for cooking a small animal or fish are based on the items one may have in a survival situation.

Practice cooking a small animal or fish before demonstrating one of the following procedures to the cadets. Prepare all materials before the start of the class. The small animals and fish prepared during the instructor's practice should be cooked using all three methods and used as examples of the finished (fully cooked) products.

GRILLING

The following are some considerations for grilling food:

- Grilling is a quick way of cooking large amounts of food but it requires a support – such as wire mesh or a grid of green sticks – rested on rocks over the embers of the fire.
- It should only be used when food is plentiful since it wastes most of the fat from the meat.
- Hot rocks beside the fire can be used as grilling surfaces.

Grilling:

1. Place the large rocks on either side of the fire for the wire mesh/green sticks to rest on.
2. Place the wire mesh/green sticks (in grid formation) on the rocks above the fire.
3. Place food on the wire mesh/green sticks and cook until the meat is no longer pink. Fresh water fish are normally germ free and may be eaten raw, however it is more palatable when cooked.

J. Wiseman, The SAS Survival Handbook, HarperCollins Publishers (p. 284)

Figure 18-15-3 Grilling

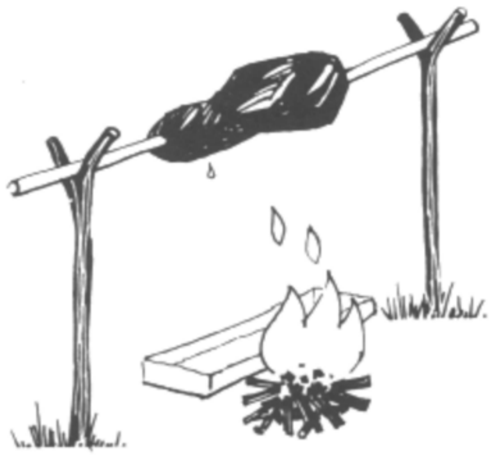
ROASTING

The following are some considerations for roasting food:

- Roasted meat cooks in its own fat.
- Continually turning the meat keeps the fat moving over the surface.
- The easiest method is to skewer the meat on a spit and turn it over the hot embers of a fire or beside a blazing fire where it is hot enough to cook.
- Roasting makes a very tasty dish but has two disadvantages:
  - Valuable fat is lost unless a drip tray is placed beneath the spit. Regularly baste the meat with fat from the tray.
  - Roasting by a fierce fire can cook and seal the outside, leaving the inner meat uncooked and harmful bacteria alive. A slow roast is preferable, and the inner meat can continue cooking after the outer meat has been cut off.

Roasting:

1. Build a spit with two Y shaped sticks and a green stick as the centrepiece.
2. Place the spit over the fire.
3. Skewer the meat and place it on the spit. Turn it over the hot embers of the fire or place the spit beside a blazing fire where it is hot enough to cook. If possible, place a drip pan under the meat to catch the fat.
4. Continue turning the meat so the fat moves over the surface.



J. Wiseman, The SAS Survival Handbook, HarperCollins Publishers (p. 284)

Figure 18-15-4 Roasting

FRYING

The following are some considerations for frying:

- Frying is an excellent way of adding variety to your diet if fat is available and you have a container in which to fry food.
- Any sheet of metal that you can fashion into a curve or give a slight lip can serve as a pan.
- In some areas, you may find a large leaf which contains enough oil that will not dry out before the cooking is done. Before you risk valuable food on them, try the leaves first. See if the leaves burn when placed over the embers. If you use a large leaf, fry only over embers, not over flames.

Frying

1. Place a flat rock, large leaf, or sheet of metal on or next to the fire. (Avoid rocks with high moisture content, they may explode when heated).
2. Let the rock or metal heat up and cook on it as you would a frying pan.

CONFIRMATION OF TEACHING POINT 3

QUESTIONS

Q1. What are three types of cooking methods?

Q2. Which type of cooking should only be used when food is plentiful?

Q3. What material can serve as a pan?

ANTICIPATED ANSWERS

A1. Grilling, roasting and frying.

A2. Grilling should only be used when food is plentiful since it wastes most of the fat from the meat.

A3. Any sheet of metal that you can fashion into a curve or give a slight lip can serve as a pan.

END OF LESSON CONFIRMATION

The cadets' participation in identifying methods of preparing and cooking a small animal or fish will serve as the confirmation of this lesson.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

N/A.

CLOSING STATEMENT

It is important for the cadets to identify the methods of preparing and cooking a small animal or fish in a survival situation because before you can eat what you have caught you have to prepare and cook it. Proper preparation and cooking minimizes the chances of getting sick and helps to preserve the food.

INSTRUCTOR NOTES/REMARKS

Cadets who feel uncomfortable with skinning a small animal do not have to participate in that portion of the class but should be present for the TP on preparing a small animal or fish.

If a rabbit or squirrel cannot be caught in a snare, it may be bought at a farmers' market or a similar venue.

If a fish cannot be caught, it may be bought at a farmers' market or a similar venue.

REFERENCES

C0-111 (ISBN 978-0-9740820-2-8) Tawrell, P. (2006). *Camping and Wilderness Survival: The Ultimate Outdoors Book* (2nd ed.). Lebanon, NH: Leonard Paul Tawrell.

C3-002 (ISBN 0-00-653140-7) Wiseman, J. (1999). *The SAS Survival Handbook*. Hammersmith, London: HarperCollins Publishers.

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ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL THREE

INSTRUCTIONAL GUIDE

SECTION 16

EO C390.11 – CONSTRUCT CAMP CRAFTS

Total Time:	120 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-803/PG-001, Chapter 4. Specific uses for said resources are identified throughout the instructional guide within the TP for which they are required.

Review the lesson content and become familiar with the material prior to delivering the lesson.

Prepare three camp crafts for demonstration purposes.

Photocopy the diagrams detailing camp craft construction for the selected camp crafts located at Annexes V to AJ for each pair of cadets.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

A practical activity was chosen for this lesson as it is an interactive way to allow the cadets to practice constructing camp crafts in a safe, controlled environment.

INTRODUCTION

REVIEW

EO C190.03 (Tie Knots and Lashings, A-CR-CCP-801/PF-001, Chapter 15, Section 9) may serve as the review for this lesson.

OBJECTIVES

By the end of this lesson the cadet shall have constructed two camp crafts.

IMPORTANCE

It is important for the cadets to be able to construct camp crafts in a survival situation so they will be able to combat both the elements and psychological factors (eg, boredom and loneliness). It is important to construct camp crafts that serve a purpose in a survival situation (eg, a fishing pole does not have a purpose if there is no water present). The amount of energy put into constructing a camp craft should be relative to its usefulness.

Teaching Point 1 **Have the Cadets, in Pairs, Construct Two Camp Crafts**

Time: 110 min Method: Practical Activity

For this skill lesson, it is recommended that the instruction take the following format:

1. Explain how the camp crafts that were prepared prior to the lesson were constructed.
2. Divide the cadets into pairs and distribute the handouts.
3. Have groups choose two camp crafts to construct.
4. Supervise the cadets as they construct camp crafts.

Cadets will choose the camp crafts they want to construct. If time allows, have each group construct a third camp craft.

CAMP CRAFTS

Two camp crafts will be chosen from the following:

- a ladder bed,
- a pack frame,
- a shower,
- a washstand,
- a drying rack,
- a tool rack,
- a camp craft for cooking, including:
  - a pot rod,
  - a swinging pot holder, or
  - a Chippewa kitchen;
- a wheelbarrow,
- a coat hanger,
- a simple bench,
- a bench with back rest,
- a camp table, or
- a friction-lock table.

ACTIVITY

Time: 100 min

OBJECTIVE

The objective of this activity is to have the cadets, in pairs, construct two camp crafts.

RESOURCES

- Knife,
- Cord,
- Axe,
- Bow saw,
- Other resources based on camp craft chosen, and
- Diagrams detailing camp craft construction (located at Annexes V to AJ).

ACTIVITY LAYOUT

N/A.

ACTIVITY INSTRUCTIONS

1. Divide the cadets into pairs and hand out diagrams detailing camp craft construction.
2. Have the cadets construct two camp crafts.
3. When camp crafts are completed, have the groups view all of the constructed crafts.
4. Do not leave camp crafts behind. Have the cadets redistribute all natural material used into the bush at the end of the lesson or exercise.

SAFETY

Tools shall be handled in a safe manner.

CONFIRMATION OF TEACHING POINT 1

The cadets' participation in the activity will serve as the confirmation of this TP.

END OF LESSON CONFIRMATION

The cadets' participation in constructing camp crafts will serve as the confirmation of this lesson.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

N/A.

CLOSING STATEMENT

It is important for the cadets to be able to construct camp crafts in a survival situation so they will be able to combat both the elements and psychological factors (eg, boredom and loneliness). It is important to construct camp crafts that serve a purpose for each survival situation (eg, a fishing pole does not have a purpose if there is no water present). The amount of energy put into constructing a camp craft should be relative to its usefulness.

INSTRUCTOR NOTES/REMARKS

Natural resources found in the field, such as fallen or dead wood, are to be used for construction.

The directives found in CATO 11-08, *Environmental Protection and Stewardship*, are to be followed during this lesson.

The more difficult camp crafts should be constructed in advance for demonstration purposes.

REFERENCES

A0-039 CATO 11-08 Director Cadets 3. (1997). *Environmental Protection and Stewardship*. Ottawa, ON: Department of National Defence.

C2-046 PioneeringProjects.org. (2004). *PioneeringProjects.org*. Retrieved February 20, 2007, from http://www.pioneeringprojects.org/projects/index.htm.

C3-002 (ISBN 0-00-653140-7) Wiseman, J. (1999). *The SAS Survival Handbook*. Hammersmith, London: HarperCollins Publishers.

ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL THREE

INSTRUCTIONAL GUIDE

SECTION 17

EO C390.12 – PERFORM MINOR FIRST AID IN A FIELD SETTING

Total Time:	120 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-803/PG-001, Chapter 4. Specific uses for said resources are identified throughout the instructional guide within the TP for which they are required.

Review the lesson content and become familiar with the material prior to delivering the lesson.

There is no requirement for a qualified first aid instructor to teach the material contained in this lesson, as the cadets are not required to qualify in first aid; however, the instructor should be a qualified first-aider.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

Demonstration and performance was chosen for TPs 1–3 and 5 as it allows the instructor to explain and demonstrate minor first aid while providing an opportunity for the cadet to practice and develop these skills under supervision.

An interactive lecture was chosen for TP 4 to introduce the cadets to the treatment of minor wounds and burns.

INTRODUCTION

REVIEW

N/A.

OBJECTIVES

By the end of this lesson the cadet shall have performed minor first aid in a field setting.

IMPORTANCE

It is important for the cadets to be able to perform the selected minor first aid skills as injuries are a common occurrence in field settings. Having a basic understanding of minor first aid will allow the cadets to take action in an emergency situation.

Teaching Point 1 **Demonstrate and Have the Cadets Perform Minor First Aid**

Time: 25 min Method: Demonstration and Performance

When performing first aid in the field there are certain considerations regardless of what the injury or illness is. The following are the first to be addressed:

- breathing problems,
- exposure,
- shock, and
- dehydration.

BREATHING PROBLEMS

Many people have died in the wilderness because they were left on their back while someone went to seek assistance. In most cases the person became unconscious and their relaxed tongue fell to the back of their throat blocking the air passage. In some cases the wounded individual vomited and it entered the lungs. In other cases blood from the nose or mouth collected in the airway and caused asphyxiation.

Placing a casualty in the recovery position is one of the basics of first aid. The recovery position protects an unconscious or injured casualty against fluid entering the lungs. If the casualty is on the snow or damp ground, a blanket or pad should be placed underneath to protect the face and reduce heat loss.

Have two assistants demonstrate each step as it is described.

The Recovery Position

The recovery position is adopted as follows:

1. Cross the casualty’s legs at the ankles, with the leg further from you on top.
2. Place the arm that is closer to you along their side and the arm further from you across their chest (as illustrated in Figure 18-17-1).

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Figure 18-17-1 Preparing the Roll

3. Support their head with one hand and grip their clothing at the waist on the far side.

4. Roll the person gently toward you, protecting their head and neck, and rest them against your knees (as illustrated in Figure 18-17-2).

W. Merry, St. John Ambulance: The Official First Aid Guide, McClelland & Stewart Inc. (p. 3)

Figure 18-17-2 Making the Roll

5. Bend their upper knee toward you to form a support (as illustrated in Figure 18-17-3).

W. Merry, St. John Ambulance: The Official First Aid Guide, McClelland & Stewart Inc. (p. 3)

Figure 18-17-3 Leg Position

6. Position their head with the chin slightly extended to keep their airway open.

7. Place the upper arm above the head to keep the casualty from rolling onto their face (as illustrated in Figure 18-17-4).

8. Place the lower arm along their back so they cannot roll onto their back.

W. Merry, St. John Ambulance: The Official First Aid Guide, McClelland & Stewart Inc. (p. 3)

Figure 18-17-4 Final Position

If the individual is conscious and having breathing problems it is best to place them in a seated position. Causalities have died because they cannot get enough air into their lungs. A person lying down cannot breathe as well as someone who is sitting up.

W. Merry, St. John Ambulance: The Official First Aid Guide, McClelland & Stewart Inc. (p. 4)

Figure 18-17-5 Semi-Sitting Position

EXPOSURE

Exposure is a common hazard in a survival situation. It occurs when a person is exposed to the elements (eg, rain, snow, wind, immersed in water) and the body starts losing heat faster than it produces it. Hypothermia occurs when the body's core temperature falls below 33.7 degrees Celsius. If a person is wet, even in a mild wind, hypothermia may occur in temperatures as high as 15 degrees Celsius.

Anyone who is sick or injured is in more danger from exposure than a healthy person. They may get hypothermia or frostbite, because their bodies are unable to produce sufficient heat. A first-aider must protect a casualty from exposure even in a warm environment.

Protecting a casualty from exposure is as simple as covering them with a sleeping bag, blanket or extra clothing. It is also necessary to place something underneath the casualty as body heat is easily lost into the ground. Keep the casualty warm and dry as an injured person is extremely sensitive to changes in temperature.

SHOCK

Shock may be present with many injuries or illnesses and is usually present in serious injuries. Shock occurs when there is inadequate organ perfusion (decreased blood flow through the organs).

The Circulatory System

The heart is a pump. The arteries and veins work like flexible hoses: carrying blood to and from every part of the body, bringing oxygen and food, and removing carbon dioxide and waste products. The food and oxygen are “burned”, keeping the body healthy and producing heat. When organs are not getting enough oxygen to work properly the signs of shock will begin to show.

Causes of Shock

Shock is caused by a drop in blood pressure. This pressure is provided by the heart and maintained by a system of veins and arteries. Several things may cause this pressure to drop; medications, prolonged rest, a variety of illnesses, and if there is a “leak” in the system from a bad cut or injury. With such a “leak”, blood flows out of the system and the pressure drops.

Signs and Symptoms of Shock

Signs and symptoms of shock include:

- pale, cool clammy skin,
- rapid pulse rate,
- rapid breathing,
- thirst,
- gasping for air,
- anxiety,
- nervousness,
- confusion, and
- decreased amounts of urine.

Shock Prevention and Treatment

> Fainting is not the same as shock. It is caused by a shortage of blood flow to the brain.

Once shock begins, it may be difficult to stop. Always expect shock in any severe injury or illness and prevent/treat it by:

- ensuring a good airway;
- controlling bleeding;
- lying the casualty down on their back, with their feet raised 20–30 cm (8–12 inches) (do not tilt the entire body if there is difficulty breathing);
- keeping the casualty warm and comfortable;
- avoiding rough handling;

- reducing pain as much as possible (eg, by splinting fractures); and
- reassuring the casualty.

DEHYDRATION

Dehydration is not usually a factor in urban first aid. In the wilderness, however, it often affects a person more than is realized.

Dehydration occurs when the body loses more water than it takes in. Dehydration is usually caused by:

- not drinking enough water;
- losing too much water through the skin by perspiration;
- losing too much water through the lungs by evaporation;
- losing water through vomiting or diarrhea; and
- frequently urinating.

A person who is working hard outdoors in a survival situation for several days with little opportunity to drink may become severely dehydrated and may show signs similar to shock. With the cold, very dry air in more northern regions, dehydration occurs more rapidly.

Signs and Symptoms of Dehydration

Signs and symptoms of dehydration include:

- thirst,
- dry tongue,
- discomfort,
- tiredness,
- nausea,
- sleepiness,
- pale, cool and clammy skin,
- faster pulse,
- pinched skin on back of hand is slow to flatten out, and
- little urine, dark in colour.

A person who drinks an adequate amount of fluids and is healthy will produce at least 1 000 ml of urine per day.

Prevention of Dehydration

Drink more water during outdoor activities. Try to drink even if there is no feeling of thirst. Remember that drinks containing caffeine are diuretics and will make one urinate more often. Although one can reduce thirst for a short time by nibbling on snow, remember that melting any amount of snow in the mouth takes an enormous amount of heat from the body and produces little water. Any water one can get, no matter how cold, will use up less body heat than eating snow.

> There are stories of people who have survived for long periods of time by drinking their own urine, but it is more likely that they survived in spite of drinking urine since urine and sea water contain large amounts of salt which draw water away from the tissues, having an overall negative effect on hydration.

ACTIVITY

Time: 10 min

OBJECTIVE

The objective of this activity is to have the cadets practice putting a casualty in the recovery position.

RESOURCES

N/A.

ACTIVITY LAYOUT

N/A.

ACTIVITY INSTRUCTIONS

1. Divide the cadets in groups of three or four.
2. Have one cadet act as the casualty, one act as the first-aider and one or two observe and assist.
3. The first-aider will put the casualty in the recovery position by:
   (a) crossing the casualty's legs at the ankles, with the leg furthest from the first-aider on top;
   (b) placing the arm closest to the first-aider along their side, the arm furthest from the first-aider across their chest;
   (c) supporting their head with one hand and grip their clothing at the waist on the far side with the other hand;
   (d) rolling the person gently toward the first-aider, protecting their head and neck, and resting them against the first-aider's knees;
   (e) bending their upper knee toward the first-aider to form a support;
   (f) positioning their head with the chin slightly extended to keep their airway open;
   (g) placing their upper arm to keep the casualty from rolling onto their face; and
   (h) placing the lower arm along their back so they cannot roll onto their back.
4. Have the cadets rotate through positions.

SAFETY

N/A.

CONFIRMATION OF TEACHING POINT 1

The cadets' participation in putting a casualty into the recovery position will serve as the confirmation of this TP.

Teaching Point 2 | **Demonstrate and Have the Cadets Practice Actions to be Taken at an Emergency Scene**

Time: 30 min | Method: Demonstration and Performance

For this skill lesson, it is recommended that the instructor take the following format:

1. Explain and demonstrate the steps in the Priority Action Approach while cadets observe.
2. Explain and demonstrate each step required to complete the skill. Monitor cadets as they imitate each step.
3. Monitor the cadets' performance as they practice the complete skill.

Note: Assistant instructors may be used to monitor the cadets' performance.

ENSURE PERSONAL SAFETY

With serious injuries it is often difficult to know how to assist. Most people react well to less serious problems. When a person gets a cut or scrape or breaks an arm, it is easy to see and understand what is wrong and handle it without emotion or confusion.

In every first aid situation, before doing anything else, a person must make sure there is no further hazard threatening oneself or the casualty. Take care of the hazard first or get the casualty away from it.

Rescuer panic usually happens when the casualty is unconscious or dazed, when there is a lot of blood or disfigurement, or when we do not know what is exactly wrong with the casualty but suspect it is quite serious. Rescuers who are panicked need to regain control of themselves before performing first aid.

FOLLOW THE STEPS IN A PRIORITY ACTION APPROACH

First aid employs the Priority Action Approach to identify and treat the most life threatening items first. Then the less critical areas are taken care of next. If the exact cause of the injury is known, either directly witnessed or the casualty is conscious and can describe the accident, there is no need to go through all the steps of the Priority Action Approach. However, if the cause is unknown it is necessary to follow a checklist of tasks.

The most common approach uses the first four letters of the alphabet as clues:

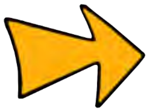
A = Airway and cervical spine

B = Breathing

C = Circulation

D = Deadly bleeds

Also, include "S" for shock, because it may be present in any serious injury or illness.



Check the level of consciousness (LOC), by talking to the casualty in a loud voice. If the casualty is unresponsive, immediately begin the Priority Action Approach.

(A) Airway and Cervical Spine. Check the airway. Is it open? Is there anything blocking the airway (eg, packed snow or blood)? Clear it. Is the tongue falling back blocking the airway? To open the airway, move the lower jaw upward without moving the neck.

W. Merry, St. John Ambulance: The Official First Aid Guide, McClelland & Stewart Inc. (p. 15)

Figure 18-17-6 Chin Lift

If there is a possibility of neck injury, immobilize the neck with a cervical or improvised collar. Ensure airway is open.

(B) Breathing. Be sure the casualty is breathing. Remember, they can only live for minutes without air. Press an ear next to their lips. Listen for breathing, feel for their breath on the ear or cheek and watch for the chest to rise and fall. If the casualty is not breathing, start rescue breathing immediately.

Rescue Breathing

With the chin lifted, as illustrated in Figure 18-17-6, place the mouth over the casualty's mouth and establish a seal. Close the nostrils and breathe into the casualty's mouth. Then lift the mouth away, permitting the casualty to exhale. The rescuer breathes 12 times each minute (15 times for a child and 20 for an infant) into the casualty's mouth.

Rescue breathing and cardiopulmonary resuscitation (CPR) are very different in purpose. Rescue breathing only addresses the casualty's breathing problems. CPR addresses both breathing and circulatory problems. CPR requires extensive practice and will not be covered in this lesson.

W. Merry, St. John Ambulance: The Official First Aid Guide, McClelland & Stewart Inc. (p. 15)

Figure 18-17-7 Breathing

(C) Circulation. Check the circulation. Is there a pulse? The pulse in the neck (carotid pulse) is the easiest to check, because it is strongest. Fingers can be slipped onto the neck without removing clothing and risking frostbite. If there is no pulse and the first-aider has CPR training, start CPR.

> Breathing and circulation go hand in hand and a casualty cannot survive without either. If there is no pulse, chances are unlikely that the casualty will be breathing. They can still have a heartbeat and not be breathing if the injuries are recent. Start rescue breathing in this situation.

W. Merry, St. John Ambulance: The Official First Aid Guide, McClelland & Stewart Inc. (p. 16)

Figure 18-17-8 Pulse

(D) Deadly Bleeds. Make sure that the casualty is not bleeding severely from somewhere unseen. While wearing latex or surgical gloves, slide a hand gently beneath the casualty then remove and look for blood on the gloves. If the casualty is bleeding severely, try to stop it. Next, feel carefully underneath the casualty for any obvious bumps, irregularities or tenderness in the spine indicating damage.

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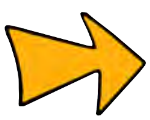
Figure 18-17-9 Bleeding

(S) Shock. Shock is a life-threatening disability. If the casualty shows or is likely to show the signs of shock, begin treatment immediately.

Shock is covered in TP 1.

Completing the Priority Action Approach should only take a couple of minutes.



First-aiders should wear latex gloves whenever they may be exposed to bodily fluids because of the increasing danger of HIV (the AIDS virus), hepatitis (A, B, C, D, and E) and other diseases. Every first aid kit should include one or more pairs of gloves. They can be obtained at a drug store, nursing station or hospital. After use, the contaminated gloves should be carefully removed and burned. Any blood that accidentally spatters onto skin must be washed off immediately with soap and water.

CONFIRMATION OF TEACHING POINT 2

The cadets' participation in completing the Priority Action Approach will serve as the confirmation of this TP.

Teaching Point 3	Demonstrate and Have the Cadets Move a Casualty to Shelter
Time: 30 min	Method: Demonstration and Performance

For this skill lesson, it is recommended that the instructor take the following format:

1. Explain and demonstrate each carry while the cadets observe.
2. Explain and demonstrate each step required to complete the skill. Monitor the cadets as they imitate each step in groups of two or three.
3. Monitor the cadets' performance as they practice the complete skill.

Note: Assistant instructors may be used to assist with carries and monitor the cadets' performance.

MOVING AND CARRYING OVER SHORT DISTANCES

Many wilderness emergencies require moving or carrying a casualty a short distance, with usually only one or two rescuers. It is difficult to carry an adult for any distance and it is easy to injure them further while carrying.

Drags

A casualty should be dragged only if they must be moved quickly out of danger, severe cold, strong winds, blowing snow or water. It is important to assess the casualty before attempting a drag because some injuries, if not yet stabilized, may be aggravated by premature movement. If there is only one rescuer, dragging may be the only means of moving a casualty.

When dragging a casualty, observe the following rules:

- Drag a casualty headfirst. This allows the head and neck to be supported and keeps the body straight.
- Keep the body in-line. The casualty's body must not twist or bend. Avoid major bumps.
- The neck should not bend sharply, nor should the head fall forward or to the side.

Steps to drag a person:

1. If possible, secure the casualty's hands before beginning the drag.
2. Reach under the casualty's body and grip their clothing just below their shoulder on either side while supporting the head and neck using the forearms.
3. Crouch or kneel and walk backwards (as illustrated in Figure 18-17-10).
4. Stop when the casualty is out of danger.

This drag is hard on the rescuer's back, so be careful.

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Figure 18-17-10 Drag

5. If the casualty's clothing pulls up too much or tears, place a shirt or jacket over their chest and bring the sleeves under their back to provide a firm grip (as illustrated in Figure 18-17-11).

> The first-aider can use cuff buttons or Velcro, mitten ties or a piece of cord to assist in this drag.

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Figure 18-17-11 Modified Drag

Tarp Drag Method

> Rarely should lifts or carries be done on snow because of the possibility of the rescuer slipping; it is safer and easier to drag a casualty on a tarp or sled.

The tarp drag method works well on snow. A rescuer may make a ramp of snow and slide a casualty onto a sled. This drag is also a good way to move a casualty onto insulating material to protect them from the cold ground or snow.

One may wish to leave the tarp under the casualty to aid in another lift. Always put the casualty into a basket stretcher with a backboard, blanket or tarp under them, as it is otherwise difficult to remove them without excessive movement.

Be careful when using the tarp drag method on sloping snow as control may be lost on a downhill slope.

Dragging a casualty on a tarp, blanket, sail, tent or large hide can be accomplished by following these steps:

1. Place the tarp next to the casualty.
2. Fold the tarp into accordion folds of about 1 m (3 feet) wide.
3. Log-roll the casualty toward the first-aider and brace them there with your knees while the first-aider use one hand to slide the folds close against their back.
4. Roll the casualty gently back onto the accordion folds.
5. Reach under the casualty and pull the folds out straight.

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Figure 18-17-12 Rolling Onto a Tarp

6. Grip the tarp and hold the casualty's head and shoulders off the ground and drag carefully.

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Figure 18-17-13 Tarp Drag

Single-Rescue Carries

Most single-rescue carries are for short distances and cannot be used to transport a casualty with major injuries. All are extremely strenuous. They are often used to transport casualties with injuries of the lower extremities but care must be taken as it is easy to cause further injuries.

Packstrap Carry

This is a quick, easy carry for very short distances. The casualty must be able to stand to get into position with their arms across the shoulders like packstraps. Bring the casualties arms across the shoulders, crossing their wrists in front. Hold their wrists while bending forward and lift the casualty’s feet off the ground. Be sure their arms are bent at the elbow.

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Figure 18-17-14 Packstrap Carry

Pickaback Carry

This familiar carry is good for short-distance transport of conscious casualties with minor injuries and may be used to carry children for long distances.

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Figure 18-17-15 Pickaback Carry

Carrying Seat

A quick and easy backpack seat to assist the pickaback system may be made with a simple loop of wide strap. It may be necessary to adjust the length once or twice for maximum comfort. This seat is best used if the casualty is lighter than the rescuer, otherwise it may put pressure on the rescuer’s neck and shoulders.

W. Merry, St. John Ambulance: The Official First Aid Guide, McClelland & Stewart Inc. (p. 23)

Figure 18-17-16 Carrying Seat With Wide Strap

CARRYING OVER LONG DISTANCES USING TWO-PERSON CARRIES

Lifting is half as strenuous if there are two rescuers; however carrying for any distance is usually not easier because two carriers must compensate for each other's movements to keep balanced. The chance of error is multiplied with each added person in a lifting team and injury to the casualty often occurs if lifts are poor. Whenever more than one person lifts, observe the following rules:

- One person must be clearly designated as the leader and be responsible for giving all of the commands.
- The partner(s) must be told exactly what is to be done and what the commands will be.
- The lift should first be practiced without the casualty or on an uninjured person.
- Rescuers should maintain eye contact while lifting.

The Fore-and-Aft Lift and Carry

This should be used only if the casualty has minor injuries. On uneven terrain, it may be the easiest method of lifting a casualty onto a stretcher or another means of transport. As it produces some pressure against the chest, it will restrict the casualty's air flow. Follow these steps:

1. If the casualty is conscious, help them sit up. If the casualty is unconscious, have a partner take the casualty's hands and pull them into the sitting position.
2. Cross the casualty's arms on their chest.
3. Crouch behind them, reach under their arms and grasp the opposite wrists.
4. Have your partner crouch between the casualty's knees, facing the casualty's feet and take a leg under each arm.
5. At the leader's signal, rise, keeping your back straight.

W. Merry, St. John Ambulance: The Official First Aid Guide, McClelland & Stewart Inc. (p. 26)

Figure 18-17-17 Fore-and-Aft Lift and Carry

Two-Hand Seat

This two-person lift and carry is good for casualties who cannot hold onto the rescuer's shoulders for support, or who are not fully alert.

1. Rescuers crouch on either side of the casualty.
2. Each rescuer will slide one hand under the casualty's thighs and lock fingers over a pad or while wearing mittens or gloves so that fingernails do not dig into each other (as illustrated in Figure 18-17-18).

W. Merry, St. John Ambulance: The Official First Aid Guide, McClelland & Stewart Inc. (p. 26)

Figure 18-17-18 Hand Grip

3. Reach across the casualty's back and grip their belt and pants at the opposite hip; the rescuers' arms are crossed (as illustrated in Figure 18-17-19).
4. Rise on command and step off with the inside foot. This supports the casualty's back; however, the fingers of the gripping hands will tire quickly.

W. Merry, St. John Ambulance: The Official First Aid Guide, McClelland & Stewart Inc. (p. 26)

Figure 18-17-19 Two-Person Lift

For longer carries, try gripping your partner's wrists rather than their fingers. If wearing mittens, gripping the wrist will be more secure than gripping the hand. If the casualty is unconscious, they may be lifted easily to a sitting position. One rescuer pulls on the casualty's hands while the other lifts and supports their head; then the rescuers move into position while supporting the casualty's head and back.

W. Merry, St. John Ambulance: The Official First Aid Guide, McClelland & Stewart Inc. (p. 26)

Figure 18-17-20 Two-Person Carry

CONFIRMATION OF TEACHING POINT 3

The cadets' participation in completing all the carries will serve as the confirmation of this TP.

Teaching Point 4 | **Have the Cadets Identify Minor Wounds and Types of Burns**

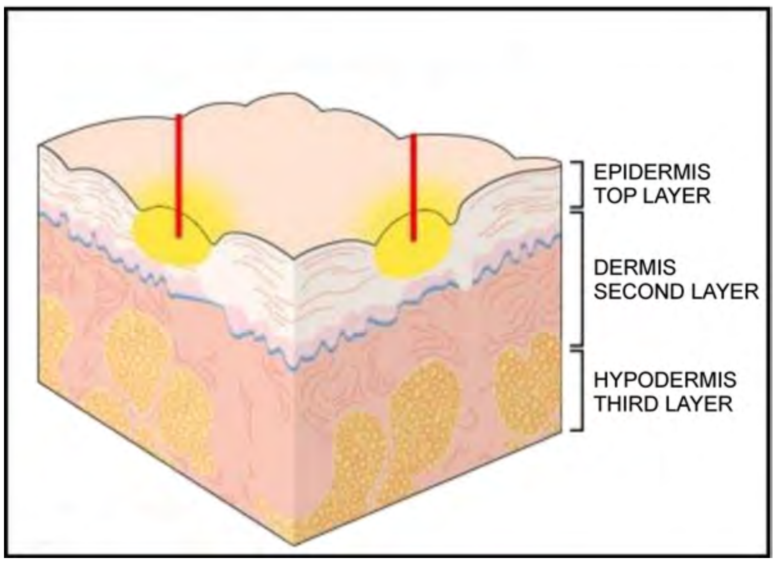
Time: 10 min | Method: Interactive Lecture

MINOR WOUNDS

Minor wounds are those that do not have severe bleeding; bleeding wounds can be internal (inside the body) or external (outside the body). Common external bleeding wounds are:

- abrasions and scrapes, and
- nicks and cuts.

There is always a risk of infection when the skin's top layer is broken. Knowing how to identify and treat minor wounds can reduce the risk of infection or aggravation.



Irishhealth.com, Copyright 2007 by Irishhealth.com. Retrieved March 17, 2007, from http://irishhealth.com/index.html?level=4&con=467

Figure 18-17-21 Layers of Skin

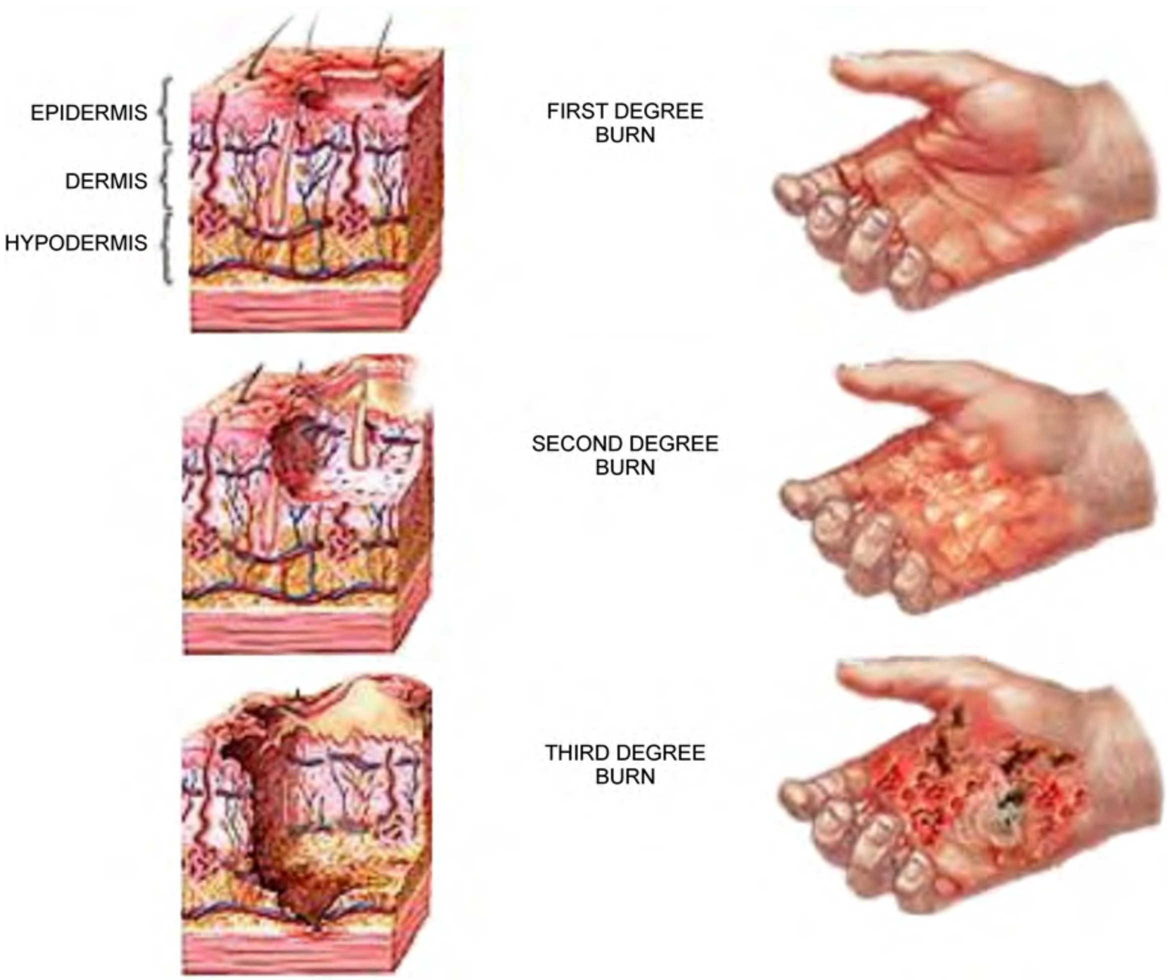
Abrasions and Scrapes. These occur on the top layer of the skin, when the skin is scraped or rubbed away. They are often painful and may bleed in small amounts.

Nicks and Cuts. Cuts are breaks in the top or second layer of the skin; there is often minor bleeding involved.

TheFatManWalking.com, Copyright 2006 by FatManWalking.com. Retrieved March 6, 2007, from http://www.thefatmanwalking.com/page/65492/;jsessionid=mni5xlvqdm9

Figure 18-17-22 Leg Scrape

TYPES OF BURNS



Medline Plus, Medical Encyclopedia, Copyright 2007 by US National Library of Medicine. Retrieved March 19, 2007, from http://www.nlm.nih.gov/medecineplus/ency/presentations/100208_4.htm

Figure 18-17-23 Types of Burns

First-Degree Burns. Called superficial burns and only affect the top layer of skin. Hot liquids, heat, and the sun are the main causes of these burns.

Signs and symptoms of a first-degree burn include:

- pinkish-reddish skin,
- slight swelling of the area,
- mild to moderate pain in the area, and
- sore, dry skin.

VisualDxHealth, 2006-2008, Sunburn, Copyright 2007 by Logical Images, Inc. Retrieved March 17, 2008, from http://www.visualdxhealth.com/images/dx/webChild/sunburn_43305_lg.jpg

Figure 18-17-24 First-Degree Burn

Sunburns are first-degree burns.

Second-Degree Burns. Affect the second layer of skin. Hot liquids, the sun, chemicals, and fire are the main causes of these burns.

Signs and symptoms of a second-degree burn include:

- raw-looking, moist skin,
- skin colouring that may range from white to cherry red,
- blisters containing clear fluid, and
- extreme pain in the area.

Sickkids.ca. Copyright 1999 by The Hospital for Sick Children. Retrieved March 6, 2007, from http:// www.sickkids.ca/plasticsurgery/section.asp?s=Burns&s ID=4489&ss=About+Burns&ssID=4496

Figure 18-17-25 Second-Degree Burn

Third-Degree Burns. Affect the third layer of skin and can extend into the muscle. Contact with extreme heat sources (eg, hot liquids and solids, direct flame, chemicals) and electricity are the main causes of these burns.

Signs and symptoms of a third-degree burn include:

- dry, leathery skin,
- pearly white, tan, grey, or charred black skin,
- blood vessels or bone may be visible,
- little or no pain (nerves are destroyed),
- breathing problems, and
- shock.

Sickkids.ca. Copyright 1999 by The Hospital for Sick Children. Retrieved March 6, 2007, from http://www.sickkids.ca/plasticsurgery/section.asp?s=Burns&s ID=4489&ss=About+Burns&ssID=4496

Figure 18-17-26 Third-Degree Burn

CONFIRMATION OF TEACHING POINT 4

QUESTIONS

Q1. Where do abrasions and scrapes occur?

Q2. What layer of the skin does first-degree burn affect and what are the main causes?

Q3. What are the main causes of third-degree burns?

ANTICIPATED ANSWERS

A1. They occur on the top layer of the skin, when the skin is scraped or rubbed away. They are often painful and may bleed in small amounts.

A2. Called superficial burns and only affect the top layer of skin. Hot liquids, heat and the sun are the main causes of these burns.

A3. Contact with extreme heat sources (eg, hot liquids and solids, direct flame, chemicals) and electricity are the main causes of these burns.

Teaching Point 5 — **Demonstrate and Have the Cadets Treat Minor Wounds and First-Degree Burns**

Time: 150 min — Method: Demonstration and Performance

For this skill lesson, it is recommended that the instructor take the following format:

1. Explain and demonstrate treating minor wounds and first-degree burns while the cadets observe.
2. Explain and demonstrate each step required to complete the skill. Monitor the cadets as they imitate each step.
3. Monitor the cadets' performance as they practice the complete skill.

Note: Assistant instructors may be used to assist with carries and to monitor the cadets' performance.

TREATMENT FOR MINOR WOUNDS

There are three basic objectives when treating abrasions, scrapes, nicks and cuts:

- to control bleeding;
- to prevent further injury; and
- to reduce the risk of infection.

Have cadets, in pairs, practice the principles of cleaning and treating a wound, using the following resources:

- gauze,
- gloves,
- scissors,
- sterile dressing, and
- tape.

Principles of cleaning and treating a minor wound to avoid infection:

1. Wash hands with soap and water and put gloves on. Do not cough or breathe directly over the wound.
2. Fully expose the wound, without touching it.
3. Gently wash loose material from the surface of the wound. Wash and dry the surrounding skin with clean dressings, cleaning the wound with clean gauze wiping from the centre of the wound to the edge of the wound (an antibiotic cream can be used on surface wounds and abrasions).
4. Cover the wound promptly with a sterile dressing.

Medline Plus, Medical Encyclopedia, Copyright 2007 by US National Library of Medicine. Retrieved March 19, 2007, from http://www.nlm.nih.gov/medecineplus/ency/presentations/100208_4.htm

Figure 18-17-27 Washing the Wound

5. Tape the dressing in place.

6. Remove and dispose of the gloves and wash your hands and any other skin area that may have been in contact with the casualty's blood.

Medline Plus, Medical Encyclopedia, Copyright 2007 by US National Library of Medicine. Retrieved March 19, 2007, from http://www.nlm.nih.gov/medecineplus/ency/presentations/100208_4.htm

Figure 18-17-28 Dressing and Taping the Wound

TREATMENT FOR FIRST-DEGREE BURNS

Have cadets, in pairs, practice the principles of cleaning and treating heat and radiation burns, using the following resources:

- gauze,
- gloves,
- scissors,
- sterile dressing, and
- tape.

Heat Burns. The most common types of burns; caused by sources of heat such as flames from stoves, lanterns, and fires. A scald is a heat burn caused by hot liquid or steam.

To treat a heat burn:

1. Immerse the burn in cool water until the pain is reduced. If it is not possible to immerse the burn in cool water, flush the burn with cool water and cover it with a clean, wet cloth.

Medline Plus, Medical Encyclopedia, Copyright 2007 by US National Library of Medicine. Retrieved March 19, 2007, from http://www.nlm.nih.gov/medecineplus/ency/presentations/100213_1.htm

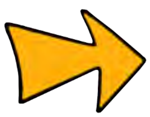
Figure 18-17-29 Cooling the Burn

2. Cover the burn with a clean, lint-free dressing.
3. Seek further medical attention, if necessary.

Medline Plus, Medical Encyclopedia, Copyright 2007 by US National Library of Medicine. Retrieved March 19, 2007, from http://www.nlm.nih.gov/medecineplus/ency/presentations/100213_1.htm

Figure 18-17-30 Dressing the Burn

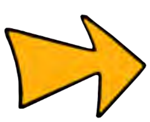
Radiation Burns (Sunburns). These are caused by over-exposure to sunlight and can be prevented by wearing sunscreen of a high sun protection factor (SPF), long sleeves, and wide-brimmed hats. Sunburns range from mild to serious.



SPF indicates the time a person using sunscreen can be exposed to sunlight before getting sunburn. For example, a person who would normally burn after 12 minutes in the sun would expect to burn after 120 minutes if protected by a sunscreen with SPF 10. The higher the SPF, the more protection sunscreen offers against ultraviolet radiation (UV).

To treat radiation burns:

1. Seek shade.
2. Gently sponge the area with cool water.
3. Cover the area with a cool wet towel.
4. Repeat as needed to relieve pain.
5. Pat the skin dry.
6. Apply medicated sunburn lotion (ointment).
7. Seek medical attention, if necessary.



Blisters caused by sunburns should not be broken. Fevers and vomiting indicate a serious sunburn and medical attention should be sought immediately.

CONFIRMATION OF TEACHING POINT 5

The cadets' participation in treating minor wounds and first-degree burns will serve as the confirmation of this TP.

END OF LESSON CONFIRMATION

The cadets' participation in placing a casualty in the recovery position, practicing the Priority Action Approach, moving a casualty to shelter and treating minor wounds and first-degree burns will serve as the confirmation of this lesson.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

N/A.

CLOSING STATEMENT

It is important for the cadets to be able to perform the selected minor first aid skills as injuries are a common occurrence in field settings. Having a basic understanding of minor first aid will allow the cadets to take action in an emergency situation.

INSTRUCTOR NOTES/REMARKS

There is no requirement for a qualified first aid instructor to teach the material contained in this lesson, as the cadets are not required to qualify in first aid; however, the instructor should be a qualified first-aider.

REFERENCES

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C2-030 (ISBN 0-7710-8250-9) Merry, W. (1994). *St. John Ambulance: The Official Wilderness First Aid Guide*. Toronto, ON: McClelland & Stewart Inc.

ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL THREE

INSTRUCTIONAL GUIDE

SECTION 18

EO C390.13 – ACT AS A MEMBER OF A GROUND SEARCH AND RESCUE (SAR) PARTY

Total Time:	120 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-803/PG-001, Chapter 4. Specific uses for said resources are identified throughout the instructional guide within the TP for which they are required.

Review the lesson content and become familiar with the material prior to delivering the lesson.

Examples of confinement methods and clues are to be created prior to the lesson.

The lost person's survival site is to be created prior to the lesson.

The briefing to be presented in TP 4 should be created based on the details of the lost person that will be found at the scenario's survival site. A sample briefing is located at Annex AK.

Additional staff will be required during TP 4 for supervision and assistance in the search.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

An interactive lecture was chosen for TP 1 to present the categories of lost persons and other general information to the cadets.

Demonstration was chosen for TPs 2 and 3 as it allows the instructor to explain and demonstrate limiting the search area and clue orientation which the cadet is expected to learn.

A practical activity was chosen for TP 4 as it is an interactive way to experience being a member of a search and rescue party. This activity contributes to the development of search and rescue skills and knowledge in a fun and challenging setting.

INTRODUCTION

REVIEW

N/A.

OBJECTIVES

By the end of this lesson the cadet, in pairs, shall have acted as a member of a ground SAR party.

IMPORTANCE

It is important for the cadets to know how a ground SAR party operates so they know what to look for when searching for a lost person. It is easier for them to plan their rescue in a survival situation.

Teaching Point 1	Explain Lost Person Behaviour and General Information
Time: 10 min	Method: Interactive Lecture

LOST PERSON BEHAVIOUR

Profiling. Recording and analyzing a person's psychological and behavioural characteristics, to assess or predict their capabilities or to assist in identifying a particular subgroup of people.

People that become lost exhibit specific traits that have been profiled from SAR statistics. These traits, if known to the SAR party, will greatly help in the search effort. While there will always be exceptions, lost persons will generally react to their situation based on these specific traits.

Children (1–3 Years)

Children will rarely be far from the point they were last seen, unless some mode of transportation is available (eg, a river, boat, vehicle). In general, children in this age group exhibit the following traits:

- unaware of the concept of being lost;
- navigation skills and sense of direction are practically non-existent;
- tend to wander aimlessly with no specific objective; and
- will seek out the most convenient location to lie down and go to sleep, for example:
  - inside a hollow log,
  - under a thick bush,
  - under an overhanging rock, or
  - under a picnic table.

Children (3–6 Years)

Children will rarely be far from the point they were last seen, unless some mode of transportation is available (eg, a river, boat, vehicle, bicycle). In general, children in this age group exhibit the following traits:

- more mobile and capable of walking further than children aged 1–3 years;
- have a concept of being lost and will generally try to return home or go back to a place they are familiar with;
- have definite interests and may be drawn away by animals, older children or just exploring;
- when tired, generally try to find a spot to sleep; and
- some have been instructed to stay away from strangers and as a result will not answer or talk to searchers when called by name.

Children (6–12 Years)

This group is much more complex than the previous groups in that they may intentionally be running away. They may also seek out some mode of transportation (eg, boat, vehicle, bicycle). In general, members of this group exhibit the following traits:

- navigational and directional skills are much more developed;
- generally oriented to their normal, familiar surroundings and become confused in a strange environment;
- may intentionally run away to avoid punishment, gain attention, or sulk;
- often will not answer when called;
- darkness usually brings on a willingness to accept help and be found;
- suffer from the same fears and problems an adult would, but with a greater sense of helplessness; and
- the circumstances of becoming lost often reflect they are being taken to an unknown environment or surroundings by parents or other adults they know.

Older Persons

Older persons have a wide variety of capabilities, but the many physical and mental conditions of this group define their behavioural characteristics. In general, members of this group exhibit the following traits:

- may be suffering from senility or Alzheimer's disease;
- may be easily attracted by something that catches their attention;
- their orientation may be to previously known environments rather than the present;
- some may have conditions that require the same type of supervision that children do;
- more lucid older persons may be more likely to over-extend and exhaust themselves rapidly, which can result in a heart attack or other fatal complications; and
- they may be hard-of-hearing or deaf which presents problems with detection.

People With Intellectual Disabilities (All Ages)

This group is very difficult to categorize due to the wide variety of disabilities; however some general behavioural characteristics are:

- they act and react in much the same way as children from the age of 6–12;
- they generally will not respond to their spoken name;
- they most often will be hidden from view as a result of fright or seeking shelter from the elements;
- many times they will stay in one place for days; and
- they usually have no physical impairments but may do nothing to help themselves.

Hikers

Hikers are one of the groups more likely to become lost and their behavioural characteristics include:

- they usually rely on trails with a set destination in mind;
- problems or complications may arise with navigation when trail conditions change or become obscure, for example:
    - a slide over the trail,

- the trail is not maintained,
- the trail is covered intermittently with snow in the spring, or
- poorly defined trail junctions;

- often hiking party members may be mismatched in abilities and one person falls behind, becomes disoriented and ultimately lost;
- cutting switchbacks (a type of road/trail used to ascend/descend a slope by using almost 180 degree turns to follow the slope at a gentler angle for ease of driving/walking) will many times lead to disorientation or going down the wrong hill or drainage; and
- they may be dependent on travel aids and trails for navigation.

GENERAL INFORMATION

Most adults and older youth do not have specific traits that may be used to predict their behaviour. The most important clue to predicting their behaviour is the reason (eg, hiking) they were in the wilderness in the first place. The following general information is relevant (to all groups) and may be used when trying to predict the behaviour of a lost person, their movements and whereabouts.

Category and Circumstances

Can a lost person be categorized? Children are different from hikers, who are different from the elderly, etc. By categorizing a lost person, the search effort may be orientated to the most likely area. The circumstances surrounding the person before they become lost contribute greatly to predicting their behaviour. Effort must be made to discover these circumstances.

Terrain

The terrain affects travel. The area should be examined for barriers, escape routes, drainages, ridges, etc. Flat terrain generally yields different travel distances (farther) than mountainous.

Weather

Weather may restrict the lost person's movement. It is also a principle contributor to hypothermia, which may affect movement and decision making. Poor weather increases the importance of the length of time a person has been lost (eg, increased risk of hypothermia) and may require increased SAR efforts.

Personality

It has a substantial effect on the lost person's ability to survive. Consider the aggressive personality versus the ponderer or pessimist.

Physical Conditions

Are the lost person's physical capabilities limited in any way? A poor physical condition means an increased susceptibility to hypothermia. It also has a direct bearing on the distance a lost person will travel.

Medical Problems

Is there any condition that could possibly precipitate abnormal behaviour? This could have a direct bearing on the distance a lost person will travel. Examples of medical problems that may affect a person's behaviour:

- weak heart,
- diabetes,
- allergies, and
- not having taken medication when needed (they do not have their prescription with them).

Through determining if the lost person is affected by any of the discussed conditions, logical assumptions may be made on their possible behaviour in order to determine the most likely area to focus the search effort.

CONFIRMATION OF TEACHING POINT 1

QUESTIONS

Q1. Where are the most likely places to find a lost child between the ages of 1–3?

Q2. Where would a hiker most likely be found?

Q3. How does weather affect the behaviour of a lost person and the need to find them?

ANTICIPATED ANSWERS

A1. Lying down/asleep inside a hollow log, under a thick bush, under an overhanging rock, or under a picnic table.

A2. On or near a trail.

A3. Weather restricts the lost person's movement and is a principle contributor to hypothermia. Poor weather increases the importance of the length of time a person has been lost (eg, increased risk of hypothermia) and may require increased SAR efforts.

Teaching Point 2 — **Explain and Demonstrate Limiting the Search Area**

Time: 20 min — Method: Demonstration

Demonstrate examples of limiting techniques, based on the types (eg, road block, track trap, string line) created (based on terrain) for the lesson, when it is being discussed.

LIMITING THE SEARCH AREA

Why Limit the Search Area?

The search area should be limited as the smaller the area, the less time that will be required to effectively cover it. In addition, fewer searchers are required, or smaller spacing can exist between party members.

Confinement. An effort made to establish a search perimeter which encompasses the lost person and beyond which the person is unlikely to pass without being detected.

Confinement Methods

Confinement methods are used to establish a perimeter around the area being searched and to detect a lost person that may wander out of the search area. Types of confinement methods include:

- **Road Block/Trail Block/Patrols.** Blocks and patrols are designed to cover the parts of the perimeter made up of roads and trails. Blocks serve to confine the search area and also inform through traffic of a search in progress. Patrols serve to cover stretches of roads and trails between the blocks.

- **Lookouts.** While aerial search has replaced the need for most fixed lookout towers, stationing lookouts on high ground is also a viable method of establishing a perimeter.
- **Track Traps.** Sections of trail or a road edge that has been brushed clear of all traces of use. Patrols would, on a regular basis, examine track traps for footprints for an indication that the lost person may have left the confinement area.
- **String Lines.** A method of confinement where a large spool of string is mounted in a backpack. As a SAR member walks through an area, the string unrolls, which is then tied by another SAR member approximately one metre (three feet) above the ground leaving a very visible perimeter. Arrows could also be placed on the string directing the lost person that comes across the string line to the closest SAR group, usually located at a road or trail block.

CONFIRMATION OF TEACHING POINT 2

QUESTIONS

Q1. Why limit the search area?

Q2. Define confinement.

Q3. What is a string line?

ANTICIPATED ANSWERS

A1. The search area should be limited as the smaller the area, the less time that will be required to effectively cover it. In addition, fewer searchers are required, or smaller spacing can exist between party members.

A2. Confinement is an effort made to establish a search perimeter which encompasses the lost person and beyond which the person is unlikely to pass without being detected.

A3. A string line is a method of confinement where a string is tied approximately one metre (three feet) above the ground leaving a very visible perimeter for the lost person.

Teaching Point 3	**Explain and Demonstrate Clue Orientation**
Time: 10 min	Method: Demonstration

Demonstrate examples of clues, based on the types (eg, footprint, food wrapper, trip plan, an eyewitness account, light flashing in the distance) created for the lesson, when it is being discussed.

CLUE ORIENTATION

Searching for clues helps discover the characteristics and possible behaviour of the lost person that are key to limiting the search area.

General Principles

The general principles of clue orientation are as follows:

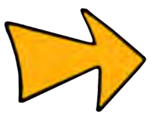
- Clue seeking is a learned skill and must be practiced to develop a sense of what is the minimum information needed to decide on how to categorize a lost person. Clues found and deciphered allow the SAR leader to orientate the search effort to the most likely area.

- Avoid forming opinions and then gathering information to support that opinion. It may limit the searcher to only accepting clues that support their opinion.
- A SAR leader gathers information from everyone, as no one person can know all the facts.
- Assemble a complete profile of the missing person and their situation and let it offer direction.

Searching for Clues

Types of clues that SAR leaders search for:

- **Physical.** Examples include footprints, food wrappers and dropped/lost items.
- **Recorded.** Examples include a trail register, summit logs and a trip plan.
- **People.** These are eyewitness accounts, the point last seen, family and friends.
- **Event.** Examples include a flashing light, a campfire or a ground-to-air signal.



The cadets should evaluate any physical clues they find for relevance. For example, a fresh candy wrapper possibly dropped by the lost person versus one that has been there for some time (dirty and weathered).

CONFIRMATION OF TEACHING POINT 3

QUESTIONS

Q1. Why is searching for clues important?

Q2. Why should a searcher avoid making an opinion and then search for clues?

Q3. Name the four types of clues.

ANTICIPATED ANSWERS

A1. Searching for clues helps discover the characteristics and possible behaviour of the lost person that are key to limiting the search area.

A2. It may limit the searcher to only accepting clues that support their opinion.

A3. The four types are: physical, recorded, people and an event.

Teaching Point 4	**Cadets, in Pairs, Will Participate in a Ground SAR Exercise**
Time: 70 min	Method: Practical Activity

Planning and preparation are key to the running of this activity. Ensure the lost person is in position before beginning the search.

ACTIVITY

OBJECTIVE

The objective of this activity is to have the cadets, in pairs, act as a member of a SAR party.

RESOURCES

- Prepared briefing,
- Compasses (one per pair),
- Two first aid kits (to be given to the anchor [end] pairs),
- Hand-held radios (one per pair),
- Spare batteries, and
- Whistle (one per cadet).

ACTIVITY LAYOUT

A large confined outdoor area.

ACTIVITY INSTRUCTIONS

1. Issue equipment, to include:
   (a) compass,
   (b) first aid kit,
   (c) hand-held radio,
   (d) spare batteries, and
   (e) whistle.
2. Give a briefing, to include:
   (a) situation,
   (b) details of the confinement area,
   (c) formation: creeping line (as when cadets do a garbage sweep),
   (d) distance between pairs: 10–20 m (30–60 ft) based on the terrain,
   (e) call signs and radio frequency to be used,
   (f) magnetic bearing (search direction),
   (g) safety bearing (if lost or disoriented), and
   (h) actions to take if the cadets discover a clue/lost person: radio in, wait for instructions.
3. Have the cadets deploy to the search start line.
4. Have the cadets respond to a radio check.
5. Begin the search.

6. Have the cadets radio in if they find a clue.
7. Have the cadets radio in if they find the lost person.
8. Have first-aid trained cadets perform first aid on simulated minor injuries of the lost person (only if designed into the scenario).
9. Have the cadets examine the (mock) survival site.
10. Have the SAR leader conduct a debriefing of the activity.
11. Have the cadets return equipment.

SAFETY

- A safety bearing shall be given to the cadets.
- Staff should be placed in the centre and at the ends of the search formation.

CONFIRMATION OF TEACHING POINT 4

The cadets' participation in the activity will serve as confirmation of this TP.

END OF LESSON CONFIRMATION

The cadets' participation in the SAR activity will serve as confirmation of this lesson.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

N/A.

CLOSING STATEMENT

Understanding how a SAR party operates, a person in a survival situation will have a better idea of knowing what is being looked for and where. If you know how to search, you should know how to be found. This information should allow the cadets to better plan for being rescued through selecting their site location, signal placement and clues known and also found.

INSTRUCTOR NOTES/REMARKS

A briefing will be conducted before the practical activity, to inlcude the scenario (eg, downed pilot, lost hiker), the confinement area, search bearing, and call signs.

The scenario's survival site should be set up prior to the activity.

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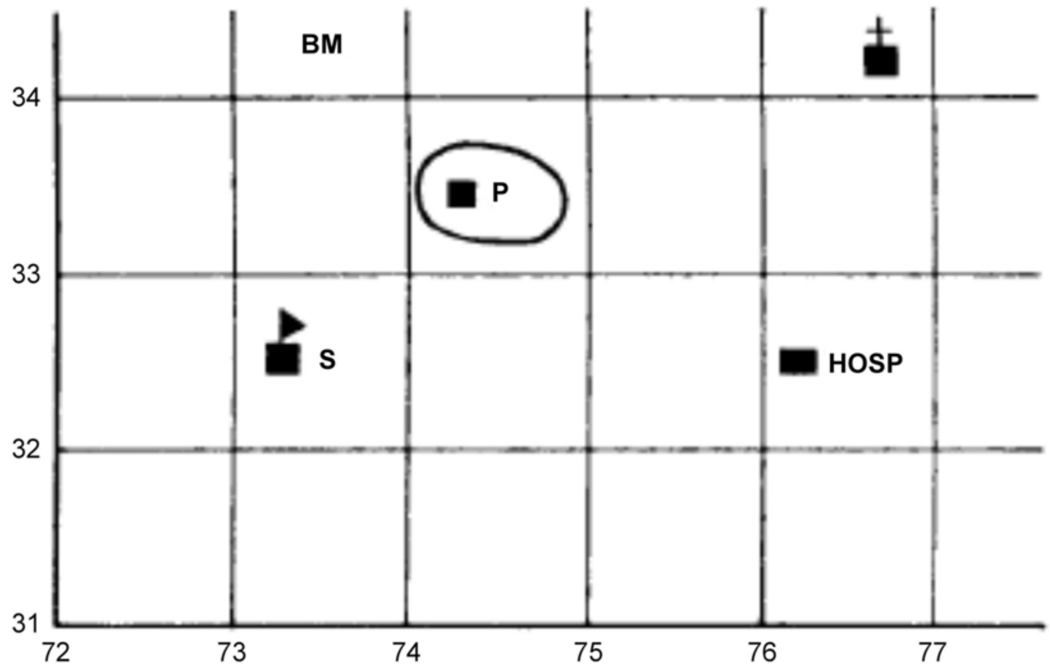
WORKSHEET FOR FOUR-FIGURE GRID REFERENCES



Determine the four-figure grid references for the following:

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Hospital: ____________

Christian Church: ____________

Bench Mark: ____________

School: ____________

Director Cadets 3, Royal Canadian Army Cadet Reference Book, Department of National Defence (p. 5-18)

Figure 18A-1 Four-Figure Grid Reference Worksheet

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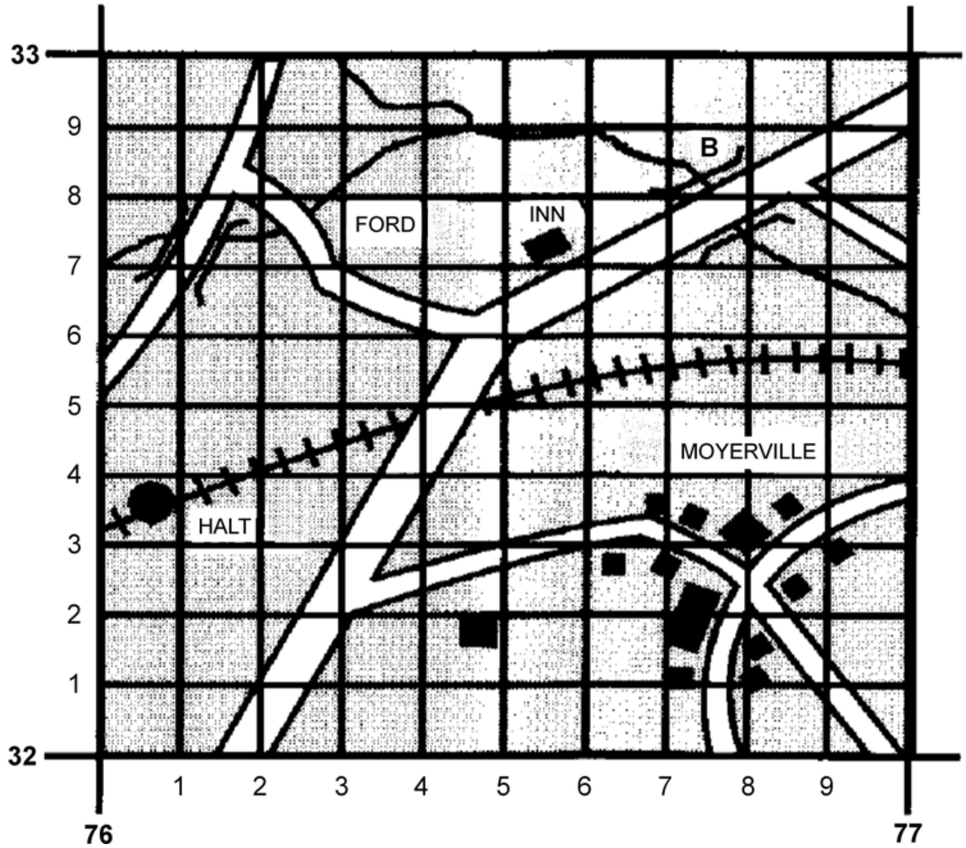
SIX-FIGURE GRID REFERENCES



Canadian Forces, Maps, Field Sketching, Compasses and the Global Positioning System, Department of National Defence (p. 38)

Figure 18B-1 Six-Figure Grid References

Steps to Determine a Six-Figure GR:

1. Identify the object within the grid square. Note the four-figure GR.
2. Using the imaginary grid within the square, determine the three-digit easting by using the two digits of the easting combined with the number of tenths, measured from the left, to the line before the object.
3. Using the imaginary grid within the square, determine the three-digit northing by using the two digits of the northing combined with the number of tenths, measured from the bottom, to the line before the object.
4. Combine the two sets of numbers to create the six-figure GR.

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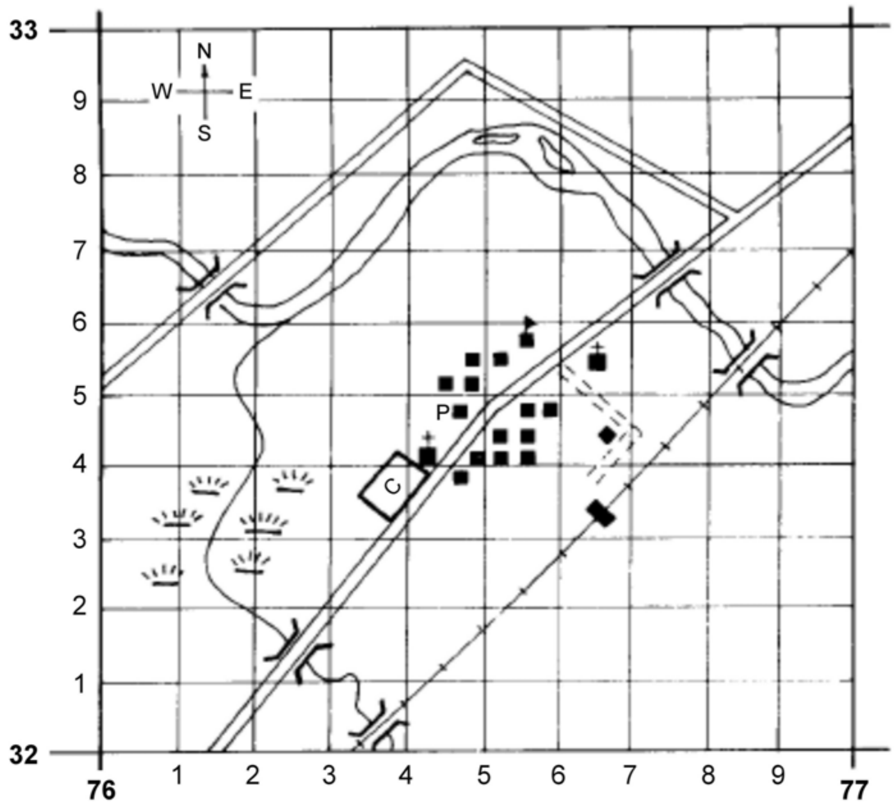
WORKSHEET FOR SIX-FIGURE GRID REFERENCES



Determine the six-figure grid references for the five bridges:

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____

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Director Cadets 3, Royal Canadian Army Cadet Reference Book, Department of National Defence (p. 5-18)

Figure 18C-1 Six-Figure Grid Reference Worksheet

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ANSWER KEY FOR WORKSHEETS AT ANNEXES A AND C

Answer Key for Worksheet for Four-Figure Grid References

Post Office:	<u>GR 7433</u>
Hospital:	<u>GR 7632</u>
Christian Church:	<u>GR 7634</u>
Bench Mark:	<u>GR 7334</u>
School:	<u>GR 7332</u>

Answer Key for Worksheet for Six-Figure Grid References

<u>GR 761326</u>

<u>GR 762321</u>

<u>GR 763320</u>

<u>GR 767326</u>

<u>GR 768325</u>

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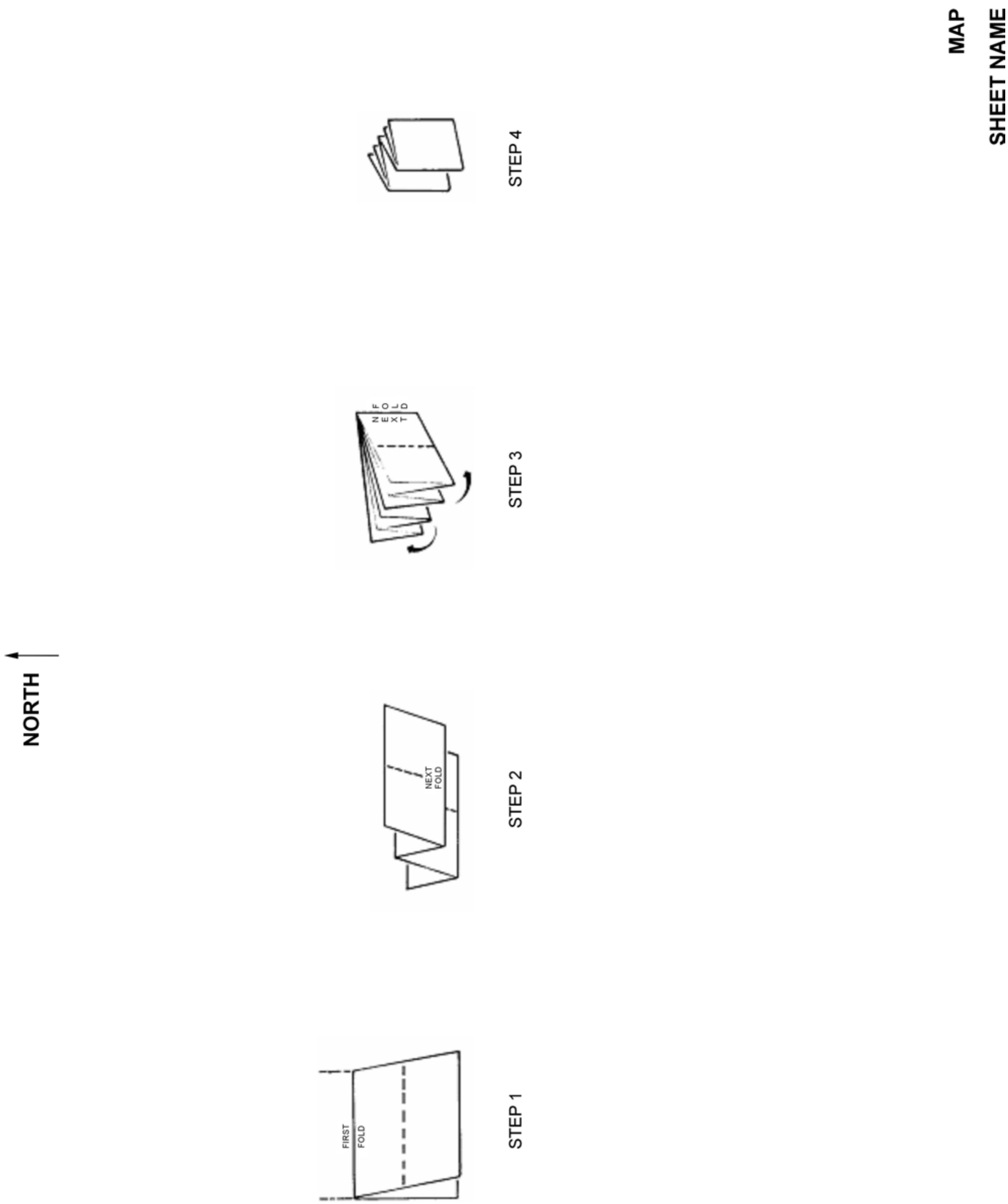
STEPS TO FOLD A MAP



Director Cadets 3, Royal Canadian Army Cadet Reference Book, Department of National Defence (p. 5-5)

Figure 18E-1 Steps to Fold a Map

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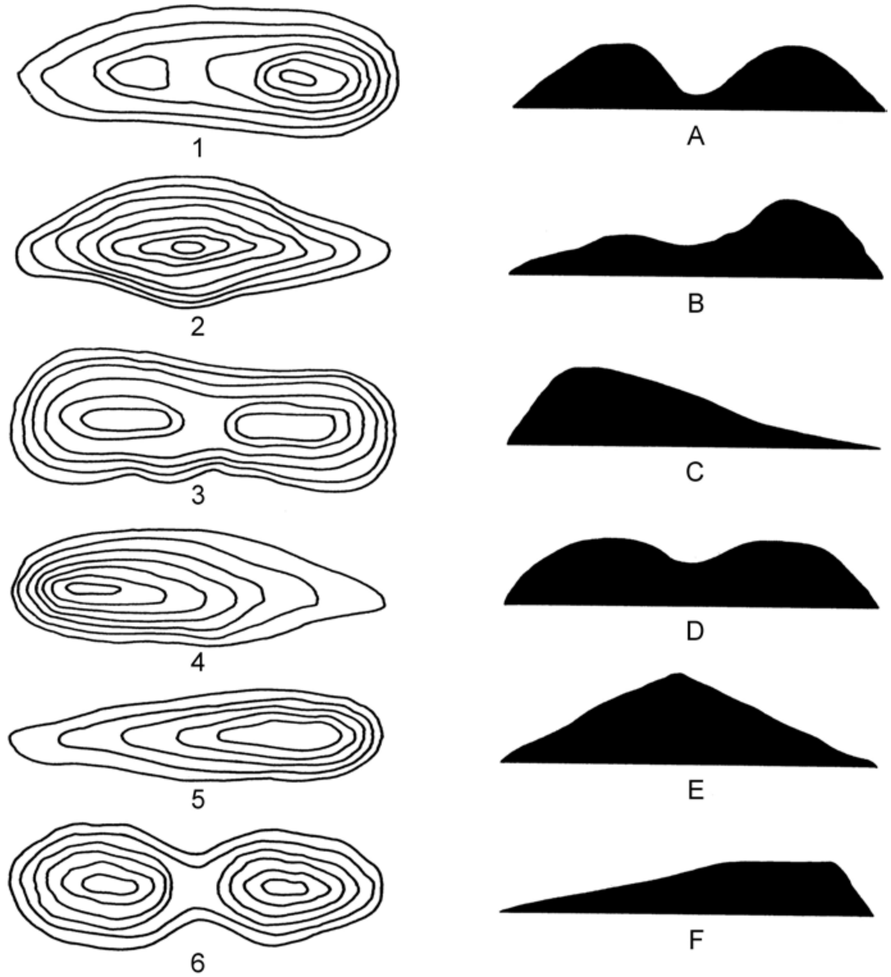
MATCH THE CONTOUR DIAGRAM ON THE LEFT TO THE APPLICABLE DEPICTION OF A LANDFORM ON THE RIGHT



1. ___
2. ___
3. ___
4. ___
5. ___
6. ___

Director Cadets 3, 2007, Ottawa, ON: Department of National Defence

Figure 18F-1 Contour Lines Matching Sheet

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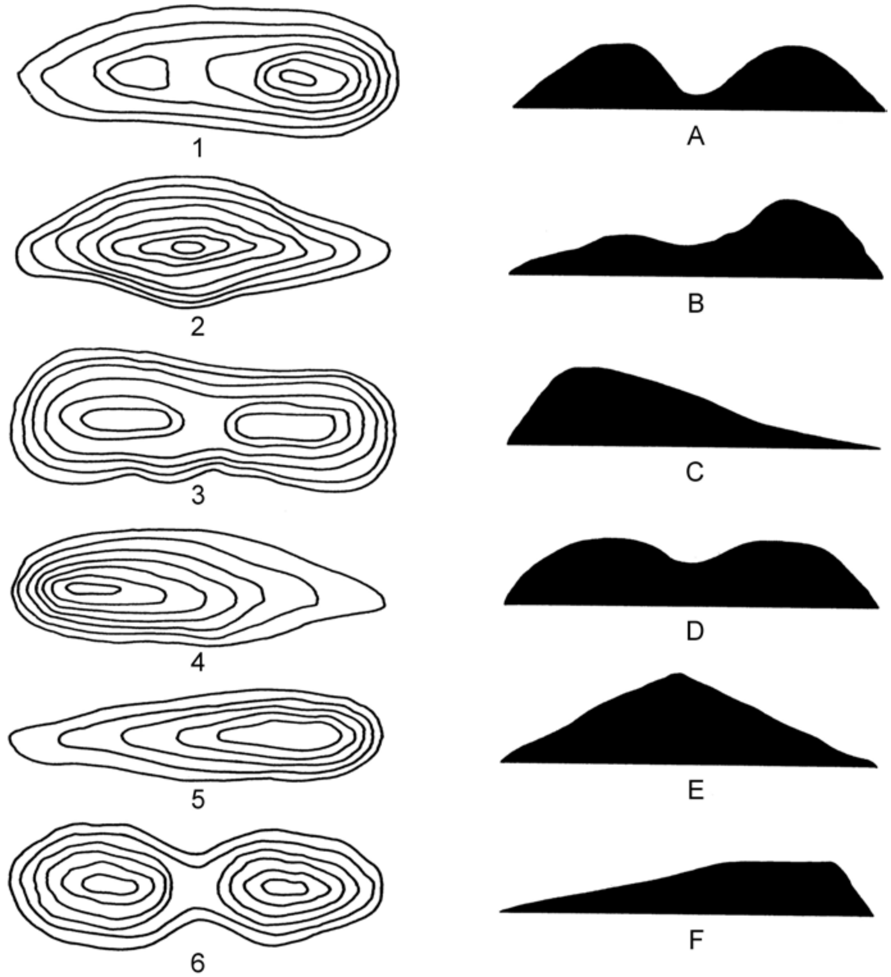
MATCH THE CONTOUR DIAGRAM ON THE LEFT TO THE APPLICABLE DEPICTION OF A LANDFORM ON THE RIGHT



1. B	4. C
2. E	5. F
3. D	6. A

Director Cadets 3, 2007, Ottawa, ON: Department of National Defence

Figure 18G-1 Contour Line Matching Answer Key

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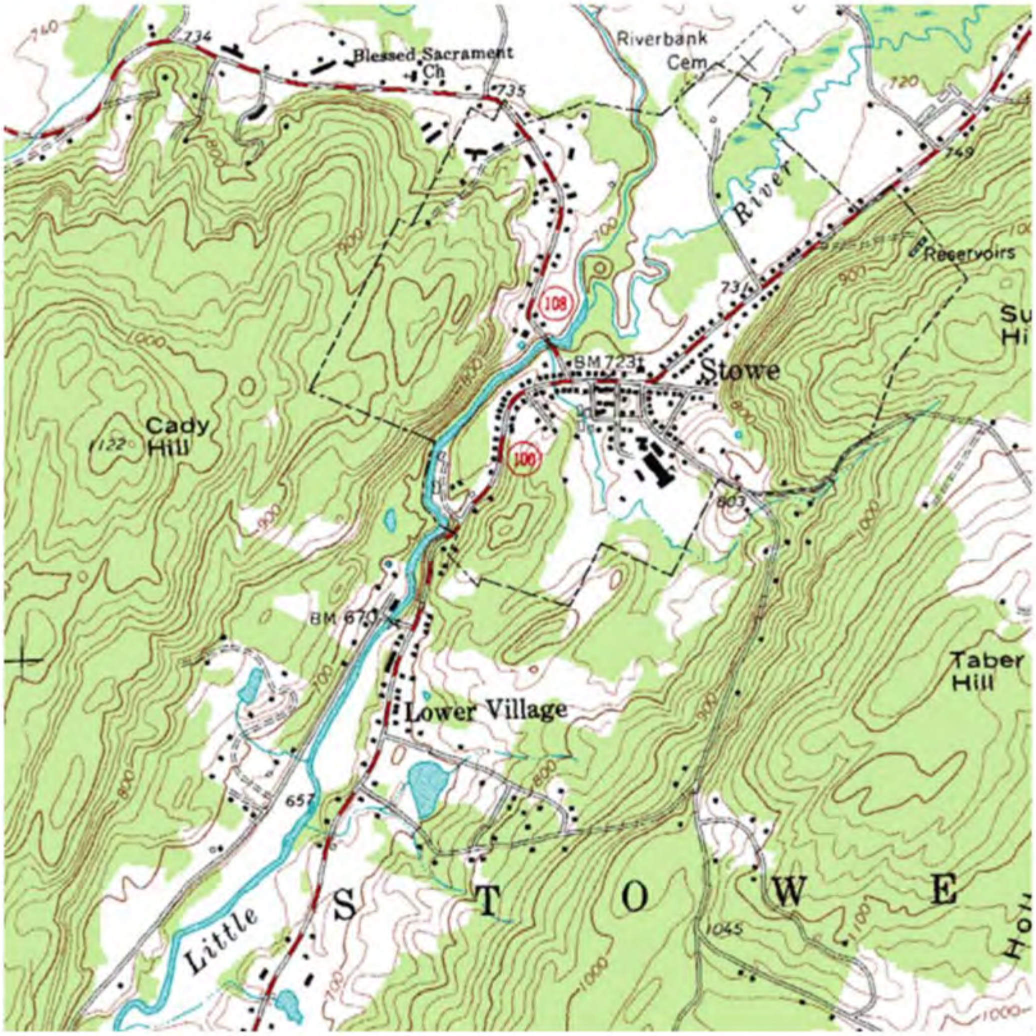
TOPOGRAPHICAL MAP EXAMPLE

Instructions: Draw a line to represent a route you would take to travel from your house on Taber Hill to the peak of Cady Hill.



Explain why you picked your route, emphasizing the contour lines you crossed over.

____

____

____

____

Wikimedia.org, 2006, Topographic Map Example. Retrieved March 26, 2008, from http://upload.wikimedia.org/wikipedia/commons/7/79/Topographic_map_example.png

Figure 18H-1 Topographical Map Example

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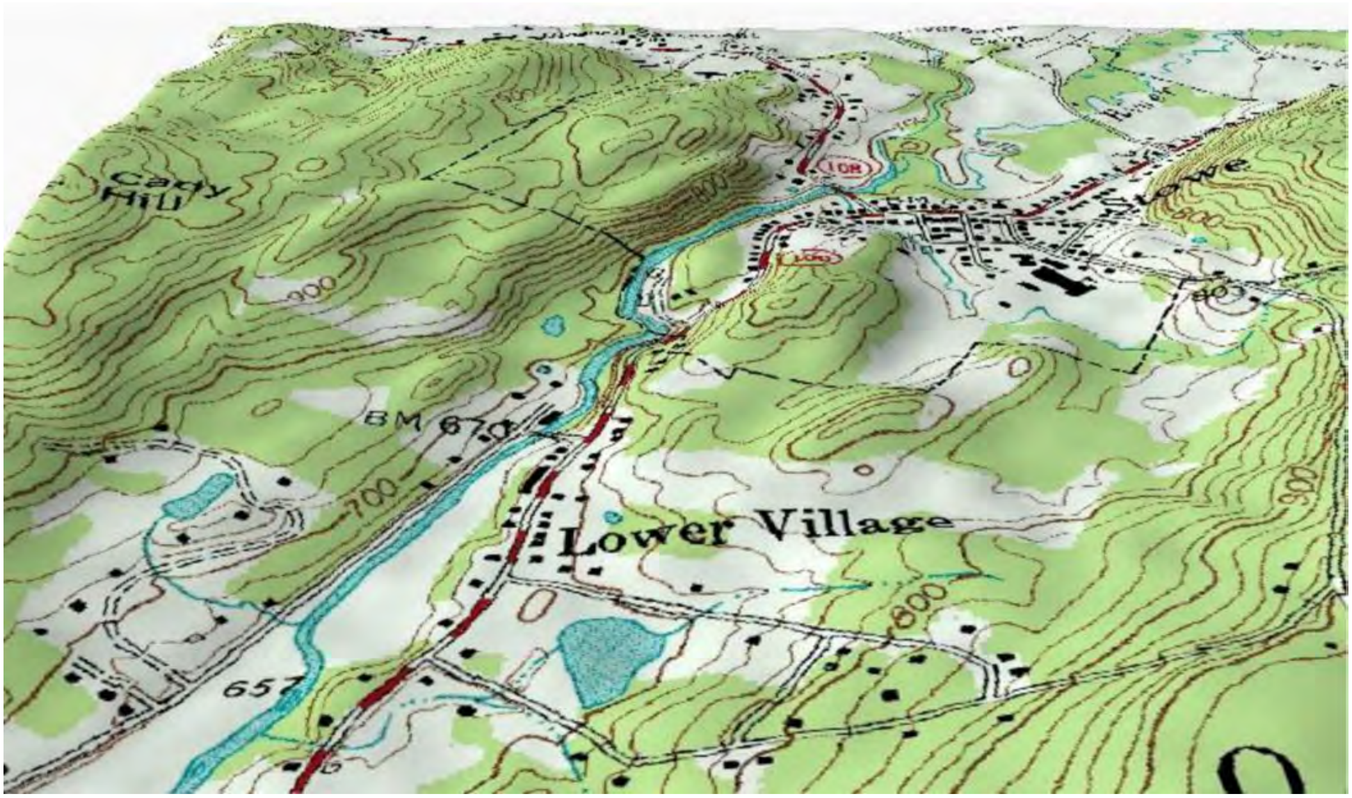
TOPOGRAPHICAL MAP EXAMPLE

Relief Version of Map at Figure 18H-1



Wikimedia.org, 2007, Topographic Relief Perspective Sample. Retrieved March 26, 2008 from http://upload.wikimedia.org/wikipedia/en/4/4c/Topographic-Relief-perspective-sample.jpg

Figure 18I-1 Topographical Relief Perspective Sample

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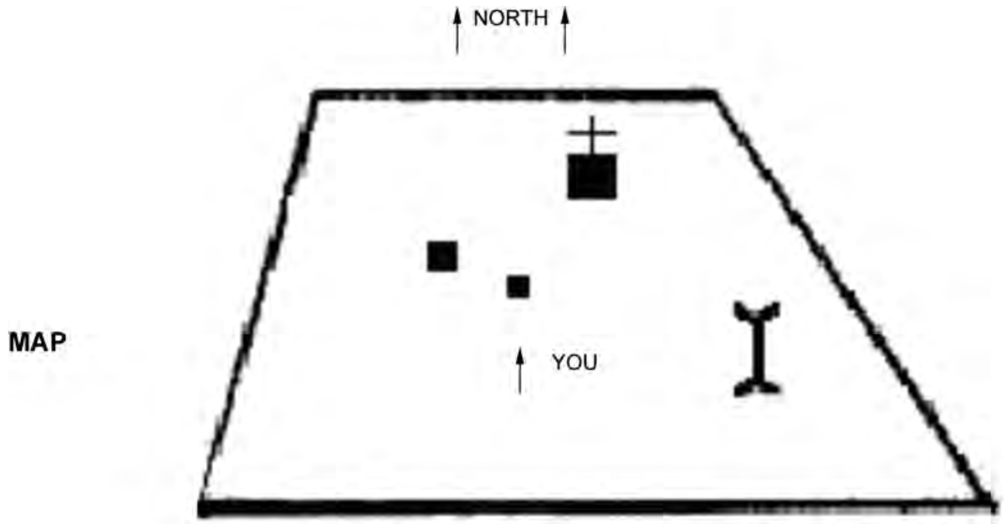
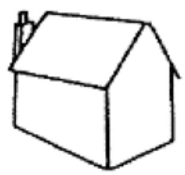
ORIENTING A MAP BY INSPECTION



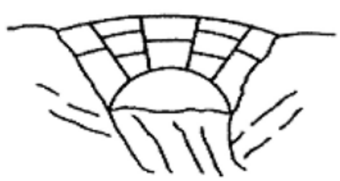
Canadian Forces, Maps, Field Sketching, Compasses and the Global Positioning System, Department of National Defence (p. 79)

Figure 18J-1 Demonstration Map

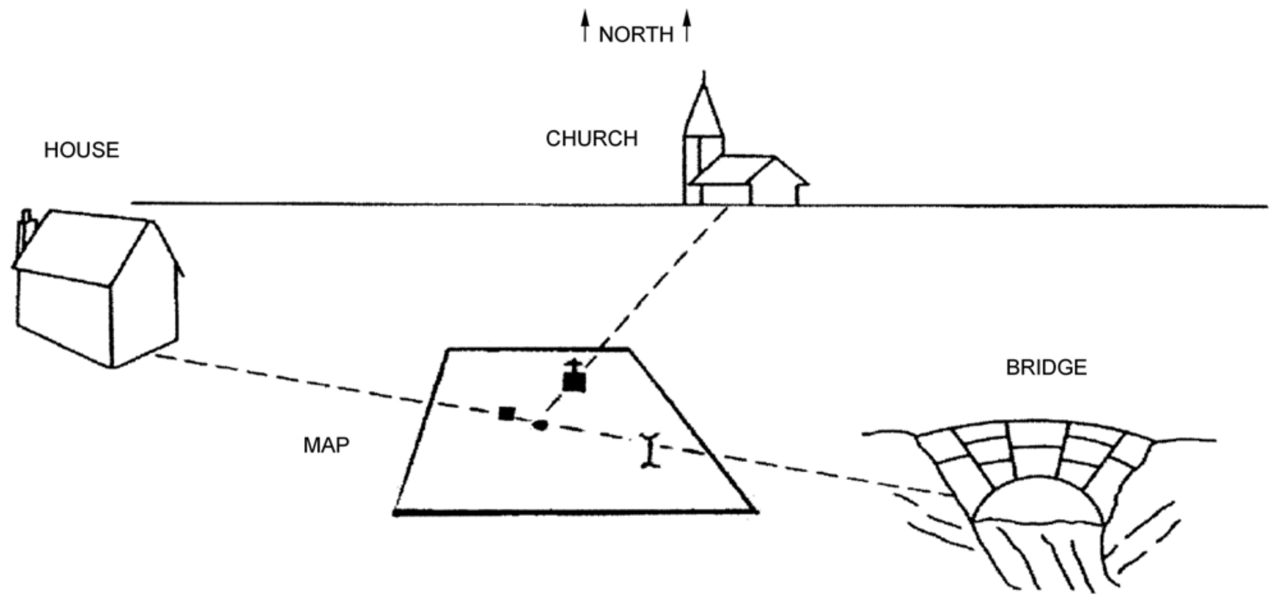


House

Church



Bridge

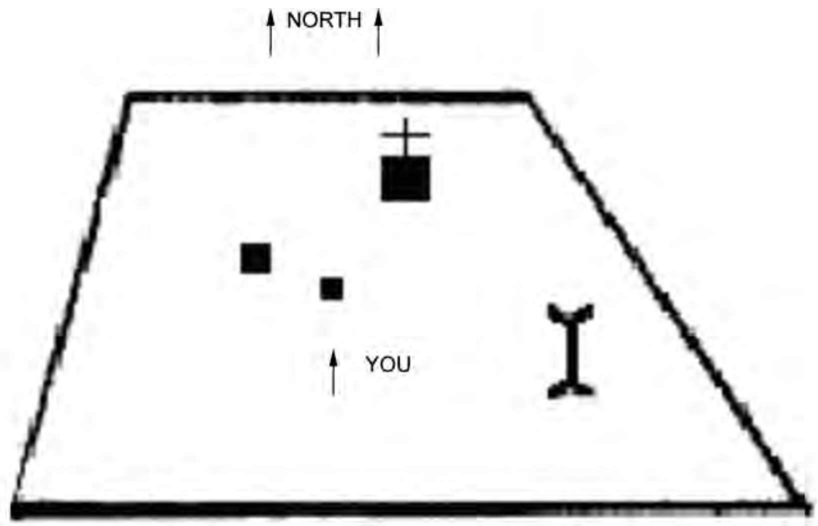


Canadian Forces, Maps, Field Sketching, Compasses and the Global Positioning System, Department of National Defence (p. 79)

Figure 18J-2 Orienting a Map by Inspection

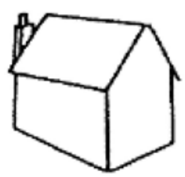
ORIENTING A MAP USING A COMPASS

MAP



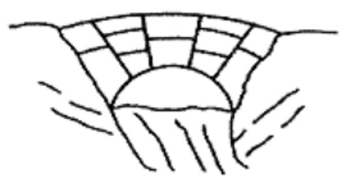
Canadian Forces, Maps, Field Sketching, Compasses and the Global Positioning System, Department of National Defence (p. 79)

Figure 18K-1 Demonstration Map

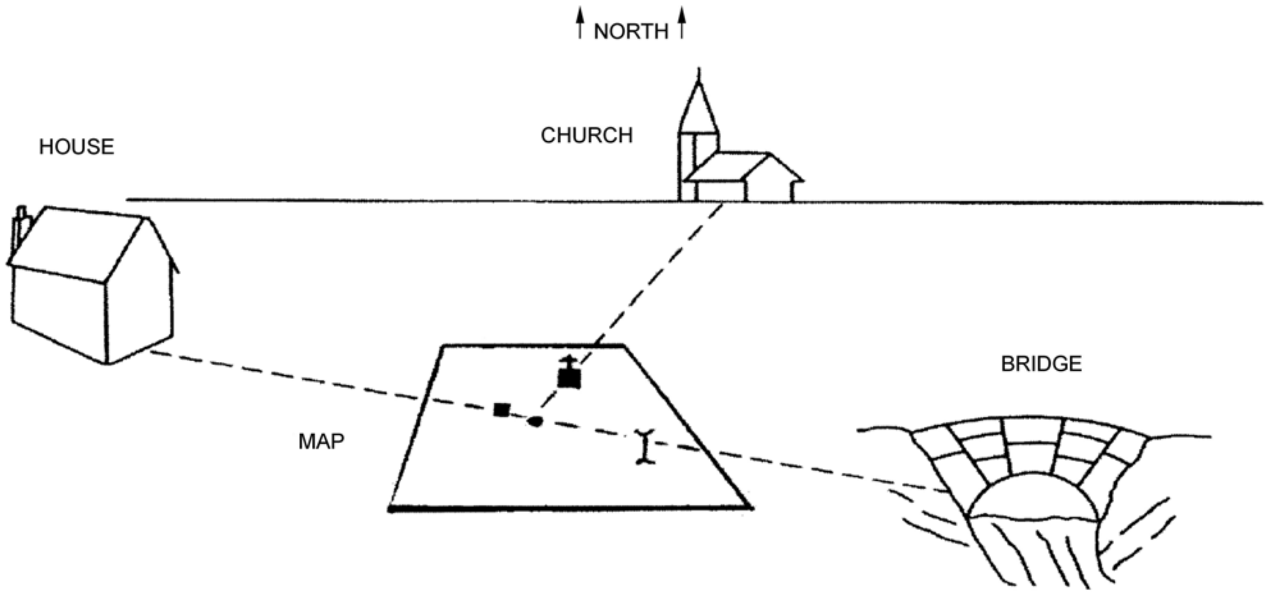


House

Church



Bridge



Canadian Forces, Maps, Field Sketching, Compasses and the Global Positioning System, Department of National Defence (p. 79)

Figure 18K-2 Orienting a Map Using a Compass

FACT SHEET: CALCULATING MAGNETIC DECLINATION

Formula: Grid Magnetic Angle + [(Current Year - Year of Declination Information) × (Annual Change)] = Current Declination

Grid Magnetic Angle. The angle between grid north and magnetic north, found on the declination diagram. Written in degrees and minutes.

1 degree (°) = 60 minutes ('), similar to calculating time (eg, 1 hour = 60 minutes).

This ratio is very important to remember when adjusting the grid magnetic angle to the current declination. This is where most errors occur.

Current Year. The current calendar year.

Year of Declination Information. Found below the declination diagram.

Annual Change. Found below the declination diagram and is written in minutes.

It is important that the annual change be inserted into the formula correctly:

- If annual change is **increasing**, insert into formula as a **positive** number.
- If annual change is **decreasing**, insert into formula as a **negative** number.

Current Declination. This is the result of the formula. It is the magnetic declination to be set on the compass.

East Declination. When magnetic north is east (to the left) of grid north on the declination diagram.

West Declination. When magnetic north is west (to the right) of grid north on the declination diagram.

If the current declination calculates to a negative number, an east declination changes to a west declination and vice versa.

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DECLINATION DIAGRAMS

EXAMPLE 1: CALCULATING MAGNETIC DECLINATION

USE DIAGRAM ONLY TO OBTAIN NUMERICAL VALUES
APPROXIMATE MEAN DECLINATION 1975
FOR CENTRE OF MAP
ANNUAL CHANGE DECREASING 1.4'

ONE THOUSAND METRE
UNIVERSAL TRANSVERSE MERCATOR GRID
ZONE 20

Grid Magnetic Angle: 18° 18'

Current Year: 2008 (used for this example)

Year of Declination Information: 1975

Annual Change: decreasing 1.4' (decreasing means 1.4' becomes -1.4')

Grid Magnetic Angle + [(Current Year - Year of Declination Information) × (Annual Change)] = Current Declination

Inputting the information into the formula:

18° 18' + [(2008 - 1975) x (-1.4')] = Current Declination

Solving for current declination.

18° 18' + [(33) x (-1.4')] = Current Declination

18° 18' + [-46.2'] = Current Declination

18° 18' - 46.2' = Current Declination

Note: Since 46.2' cannot be easily subtracted from 18° 18', 1° is converted into 60' (similar to time calculations), which converts 18° 18' to 17° 78'.

17° 78' - 46.2' = Current Declination

17° 31.8' = Current Declination

Since magnetic north is west of grid north and the result is positive, the magnetic declination for the topographical map in 2008 is 17° 31.8' west declination.

Natural Resources Canada, 2008, Topo Declination Diagram. Retrieved April 11, 2008, from http://gsc.nrcan.gc.ca/geomag/field/magdec_e.php?p=1

Figure 18M-1 Declination Diagram

EXAMPLE 2: CALCULATING MAGNETIC DECLINATION

USE DIAGRAM ONLY TO OBTAIN NUMERICAL VALUES
APPROXIMATE MEAN DECLINATION 1996
FOR CENTRE OF MAP
ANNUAL CHANGE DECREASING 2.7'

ONE THOUSAND METRE
UNIVERSAL TRANSVERSE MERCATOR GRID
ZONE 18

Grid Magnetic Angle: 10° 28'

Current Year: 2008 (used for this example)

Year of Declination Information: 1996

Annual Change: increasing 2.7'

Increasing means 2.7' becomes +2.7'

Inputting the information into the formula:

10° 28' + [(2008 - 1996) x (+2.7')] = Current Declination

Solving for current declination.

10° 28' + [(12) x (+2.7')] = Current Declination

10° 28' + [+32.4'] = Current Declination

10° 28' + 32.4' = Current Declination

10° 60.4' = Current Declination

Note: Since 60.4' is greater than 1°, 60' is converted into 1° (similar to time calculations), which converts 10° 60.4' to 11° 0.4'.

11° 0.4' = Current Declination

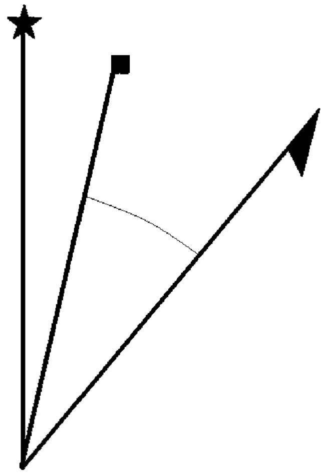
Since magnetic north is west of grid north and the result is positive, the magnetic declination for the topographical map in 2008 is 11° 0.4' west declination.

Canada Centre for Mapping, Bancroft 31 F/4, Natural Resources Canada

Figure 18M-2 Declination Diagram

MAGNETIC DECLINATION WORKSHEET

Grid Magnetic Angle + [(Current Year - Year of Declination Information) × (Annual Change)] = Current Declination



Question 1:

Grid Magnetic Angle: 10° 46'

Current Year: 2011

Year of Declination Information: 1988

Annual Change: decreasing 5.2'

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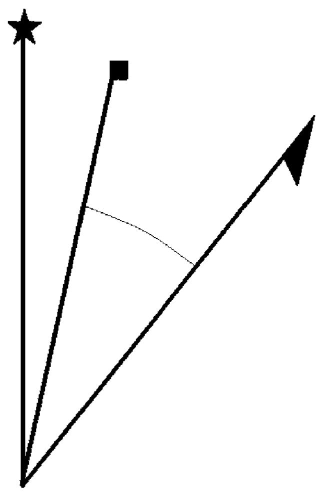
Answer: ____________ E/W declination (circle correct one)



Question 2:

Grid Magnetic Angle: 11° 2'

Current Year: 2014

Year of Declination Information: 1995

Annual Change: increasing 3.8'

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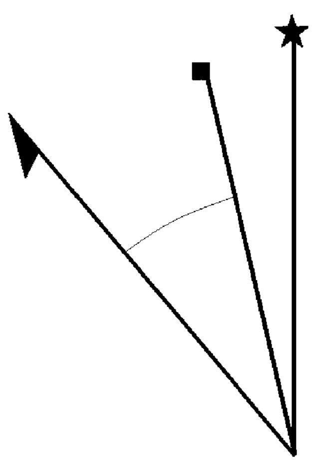
Answer: ____________ E/W declination (circle correct one)



Question 3:

Grid Magnetic Angle: 18° 43'

Current Year: 2013

Year of Declination Information: 1986

Annual Change: decreasing 6.5'

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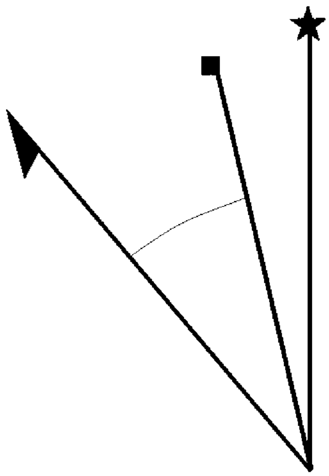
Answer: ____________ E/W declination (circle correct one)

Grid Magnetic Angle + [(Current Year - Year of Declination Information) × (Annual Change)] = Current Declination



Question 4:

Grid Magnetic Angle: 9° 14'

Current Year: 2018

Year of Declination Information: 1999

Annual Change: increasing 4.1'

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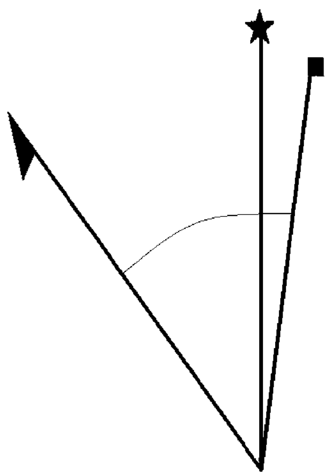
Answer: ____________ E/W declination (circle correct one)



Question 5:

Grid Magnetic Angle: 19° 35'

Current Year: 2016

Year of Declination Information: 1981

Annual Change: decreasing 5.4'

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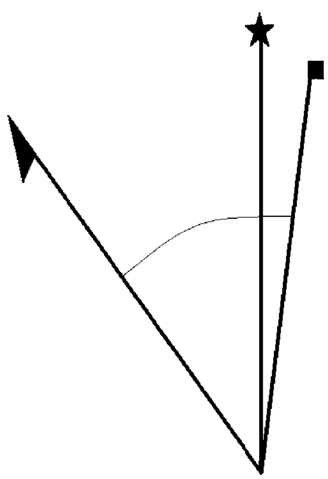
Answer: ____________ E/W declination (circle correct one)



Question 6:

Grid Magnetic Angle: 18° 22'

Current Year: 2010

Year of Declination Information: 1976

Annual Change: increasing 4.7'

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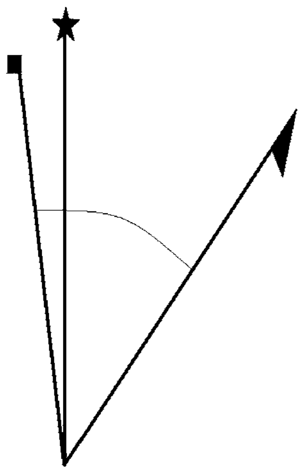
Answer: ____________ E/W declination (circle correct one)

Grid Magnetic Angle + [(Current Year - Year of Declination Information) × (Annual Change)] = Current Declination



Question 7:

Grid Magnetic Angle:	12° 34'
Current Year:	2020
Year of Declination Information:	1991
Annual Change:	increasing 1.2'

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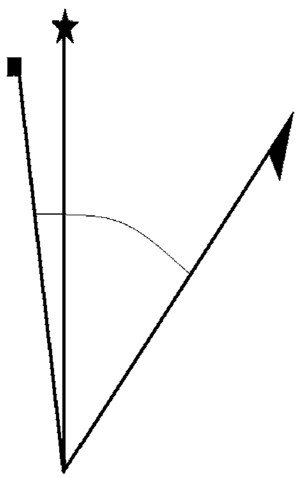
Answer: ____________ E/W declination (circle correct one)



Question 8:

Grid Magnetic Angle:	13° 21'
Current Year:	2017
Year of Declination Information:	1994
Annual Change:	decreasing 2.9'

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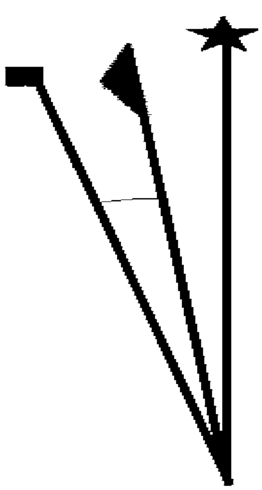
____

____

Answer: ____________ E/W declination (circle correct one)



Question 9:

Grid Magnetic Angle:	3° 16'
Current Year:	2012
Year of Declination Information:	1980
Annual Change:	decreasing 6.2'

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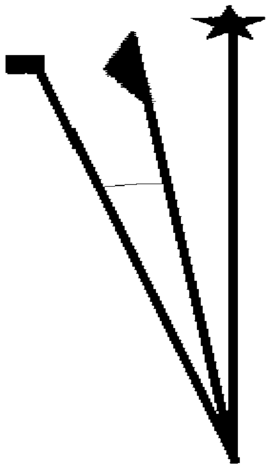
Answer: ____________ E/W declination (circle correct one)

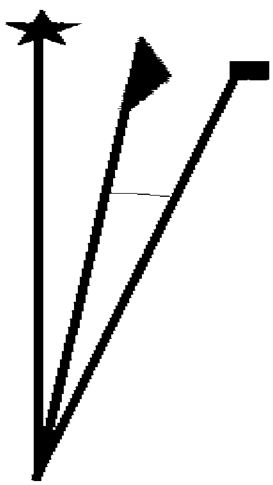
Grid Magnetic Angle + [(Current Year - Year of Declination Information) × (Annual Change)] = Current Declination



Question 10:

Grid Magnetic Angle:	4° 27'
Current Year:	2019
Year of Declination Information:	1977
Annual Change:	increasing 2.2'

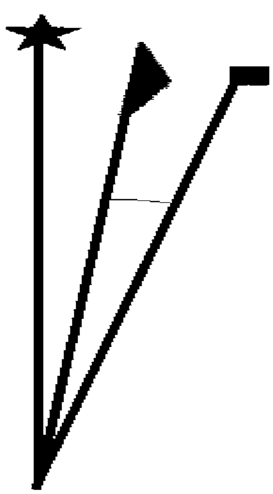
Answer: ____________ E/W declination (circle correct one)



Question 11:

Grid Magnetic Angle:	7° 7'
Current Year:	2021
Year of Declination Information:	1992
Annual Change:	increasing 5.5'

Answer: ____________ E/W declination (circle correct one)



Question 12:

Grid Magnetic Angle:	9° 36'
Current Year:	2015
Year of Declination Information:	1983
Annual Change:	decreasing 3.3'

Answer: ____________ E/W declination (circle correct one)

MAGNETIC DECLINATION WORKSHEET: ANSWER KEY

Grid Magnetic Angle + [(Current Year - Year of Declination Information) × (Annual Change)] = Current Declination

Question 1:

Grid Magnetic Angle:	10° 46'
Current Year	2011
Year of Declination Information:	1988
Annual Change:	decreasing 5.2'

10° 46' + [(2011 - 1988) × (-5.2')] = Current Declination

10° 46' + [(23) × (-5.2')] = Current Declination

10° 46' + [-119.6'] = Current Declination

10° 46' - 119.6' = Current Declination

9° 106' - 119.6' = Current Declination

8° 166' - 119.6' = Current Declination

8° 46.4' = Current Declination

Magnetic declination is 8° 46.4' east.

Question 2:

Grid Magnetic Angle:	11° 2'
Current Year:	2014
Year of Declination Information:	1995
Annual Change:	increasing 3.8'

11° 2' + [(2014 - 1995) × (+3.8')] = Current Declination

11° 2' + [(19) × (+3.8')] = Current Declination

11° 2' + [+72.2'] = Current Declination

11° 2' + 72.2' = Current Declination

11° 74.2' = Current Declination

12° 14.2' = Current Declination

Magnetic declination is 12° 14.2' east.

Question 3:

Grid Magnetic Angle:	18° 43'
Current Year:	2013
Year of Declination Information:	1986
Annual Change:	decreasing 6.5'

18° 43' + [(2013 - 1986) × (-6.5')] = Current Declination

18° 43' + [(27) × (-6.5')] = Current Declination

18° 43' + [-175.5'] = Current Declination

18° 43' - 175.5' = Current Declination

17° 103' - 175.5' = Current Declination

16° 163' - 175.5' = Current Declination

15° 223' - 175.5' = Current Declination

15° 47.5' = Current Declination

Magnetic declination is 15° 47.5' west.

Question 4:

Grid Magnetic Angle:	9° 14'
Current Year:	2018
Year of Declination Information:	1999
Annual Change:	increasing 4.1'

9° 14' + [(2018 - 1999) × (+4.1')] = Current Declination

9° 14' + [(19) × (+4.1')] = Current Declination

9° 14' + [+77.6'] = Current Declination

9° 14' + 77.6' = Current Declination

9° 91.9' = Current Declination

10° 31.9' = Current Declination

Magnetic declination is 10° 31.9' west.

Question 5:

Grid Magnetic Angle:	19° 35'
Current Year:	2016
Year of Declination Information:	1981
Annual Change:	decreasing 5.4'

19° 35' + [(2016 - 1981) × (-5.4')] = Current Declination

19° 35' + [(35) × (-5.4')] = Current Declination

19° 35' + [-189'] = Current Declination

19° 35' - 189' = Current Declination

18° 95' - 189' = Current Declination

17° 155' - 189' = Current Declination

16° 215' - 189' = Current Declination

16° 26' = Current Declination

Magnetic declination is 16° 26' west.

Question 6:

Grid Magnetic Angle:	18° 22'
Current Year:	2010
Year of Declination Information:	1976
Annual Change:	increasing 4.7'

18° 22' + [(2010 - 1976) × (+4.7')] = Current Declination

18° 22' + [(34) × (+4.7')] = Current Declination

18° 22' + [+159.8] = Current Declination

18° 22' + 159.8' = Current Declination

18° 181.8' = Current Declination

19° 121.8' = Current Declination

20° 61.8' = Current Declination

21° 1.8' = Current Declination

Magnetic declination is 21° 1.8' west.

Question 7:

Grid Magnetic Angle:	12° 34'
Current Year:	2020
Year of Declination Information:	1991
Annual Change:	increasing 1.2'

12° 34' + [(2020 - 1991) × (+1.2')] = Current Declination

12° 34' + [(29) × (+1.2')] = Current Declination

12° 34' + [+34.8'] = Current Declination

12° 34' + 34.8' = Current Declination

12° 68.8' = Current Declination

13° 8.8' = Current Declination

Magnetic declination is 13° 8.8' east.

Question 8:

Grid Magnetic Angle:	13° 21'
Current Year:	2017
Year of Declination Information:	1994
Annual Change:	decreasing 2.9'

13° 21' + [(2017 - 1994) × (-2.9')] = Current Declination

13° 21' + [(23) × (-2.9')] = Current Declination

13° 21' + [-66.7'] = Current Declination

13° 21' - 66.7' = Current Declination

12° 81' - 66.7' = Current Declination

12° 14.3' = Current Declination

Magnetic declination is 12° 14.3' east.

Question 9:

Grid Magnetic Angle:	3° 16'
Current Year:	2012
Year of Declination Information:	1980
Annual Change:	decreasing 6.2'

3° 16' + [(2012 - 1980) × (-6.2')] = Current Declination

3° 16' + [(32) × (-6.2')] = Current Declination

3° 16' + [-198.4'] = Current Declination

3° 16' - 198.4' = Current Declination

2° 76' - 198.4' = Current Declination

1° 136' - 198.4' = Current Declination

196' - 198.4' = Current Declination

-2.4' = Current Declination

Since the current declination calculated has a negative value, the east declination, as shown on the declination diagram, becomes a west declination.

Magnetic declination is 2.4' west.

Question 10:

Grid Magnetic Angle:	4° 27'
Current Year:	2019
Year of Declination Information:	1977
Annual Change:	increasing 2.2'

4° 27' + [(2019 - 1977) × (+2.2')] = Current Declination

4° 27' + [(42) × (+2.2')] = Current Declination

4° 27' + [+92.4'] = Current Declination

4° 27' + 92.4' = Current Declination

4° 119.4' = Current Declination

5° 59.4' = Current Declination

Magnetic declination is 5° 59.4' east.

Question 11:

Grid Magnetic Angle:	7° 7'
Current Year:	2021
Year of Declination Information:	1992
Annual Change:	increasing 5.5'

7° 7' + [(2021 - 1992) × (+5.5')] = Current Declination

7° 7' + [(29) × (+5.5')] = Current Declination

7° 7' + [+159.5'] = Current Declination

7° 7' + 159.5' = Current Declination

7° 166.5' = Current Declination

8° 106.5' = Current Declination

9° 46.5' = Current Declination

Magnetic declination is 9° 46.5' west.

Question 12:

Grid Magnetic Angle:	9° 36'
Current Year:	2015
Year of Declination Information:	1983
Annual Change:	decreasing 3.3'

9° 36' + [(2015 - 1983) × (-3.3')] = Current Declination

9° 36' + [(32) × (-3.3')] = Current Declination

9° 36' + [-105.6'] = Current Declination

9° 36' - 105.6' = Current Declination

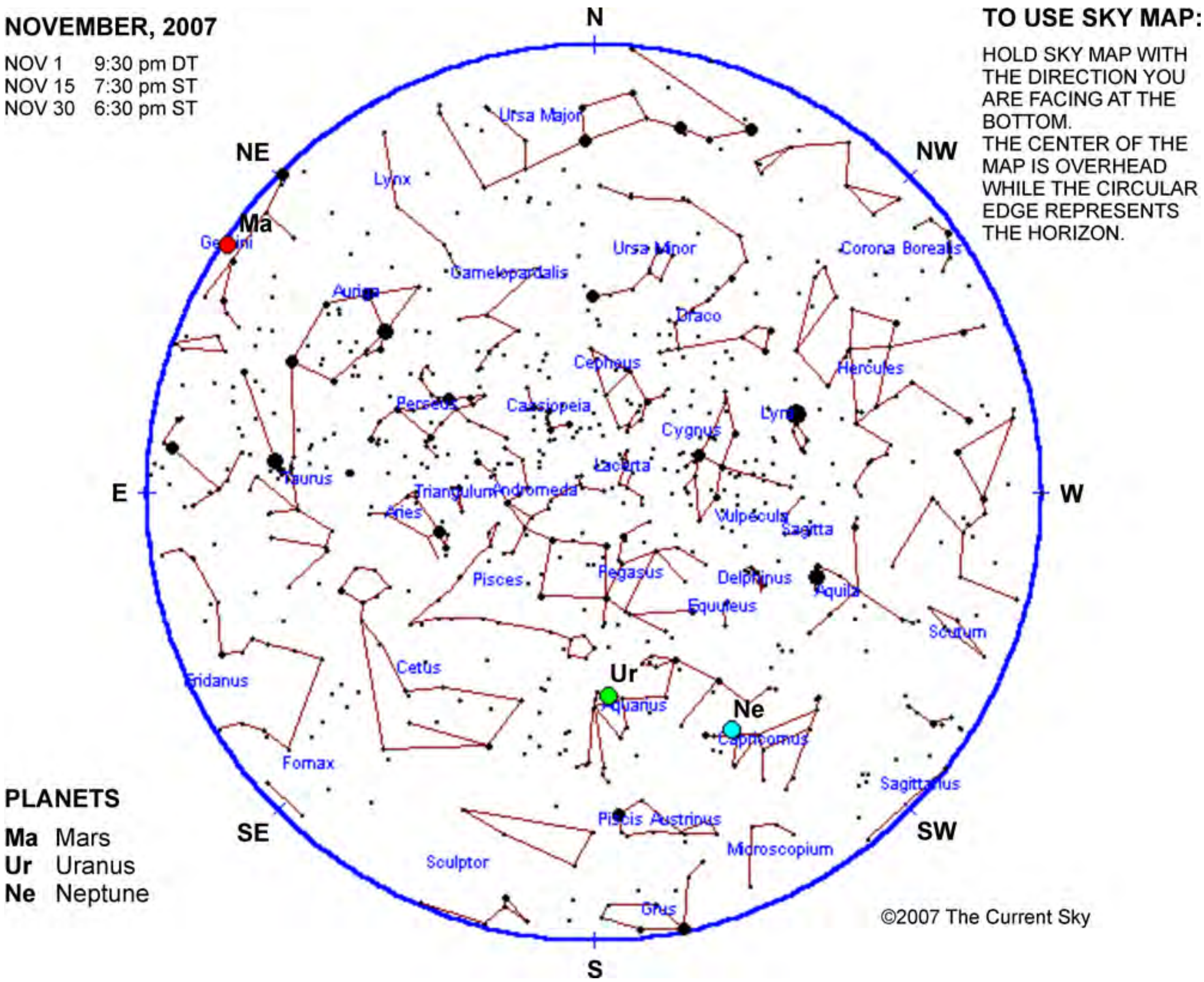
8° 96' - 105.6' = Current Declination

7° 156' - 105.6' = Current Declination

7° 50.4' = Current Declination

Magnetic declination is 7° 50.4' west.

SKY MAP



Sky Map, 2007, Sky Map for Chicago, IL, November 2007, Copyright 2007 by CyberSky 3.3.1. Retrieved November 30, 2007, from http://77illinois.homestead.com/files/astro/skypage.html

Figure 18P-1 Sky Map

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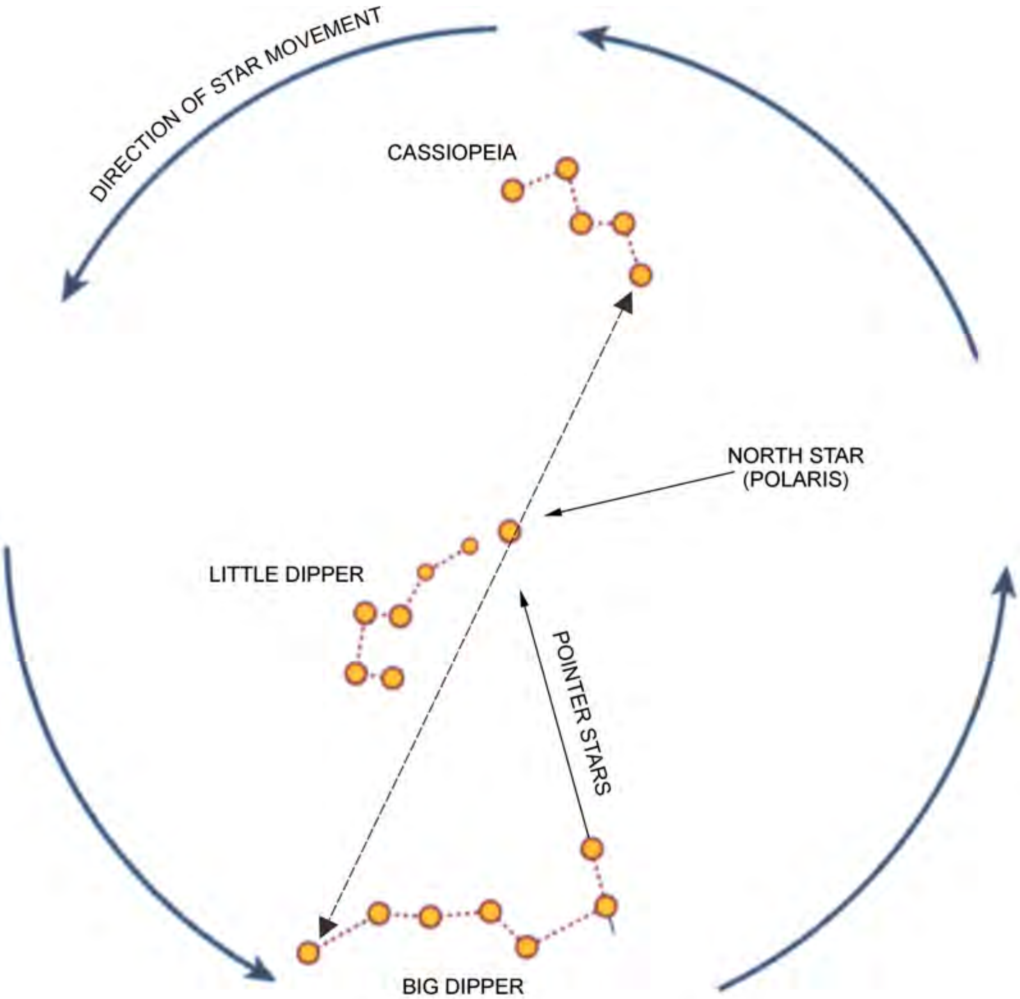
FINDING POLARIS



National Association of Search and Rescue, Fundamentals of Search and Rescue, Jones and Bartlett Publishers, Inc. Copyright 2005 by Jones and Bartlett Publishing (p. 76)

Figure 18Q-1 Finding Polaris

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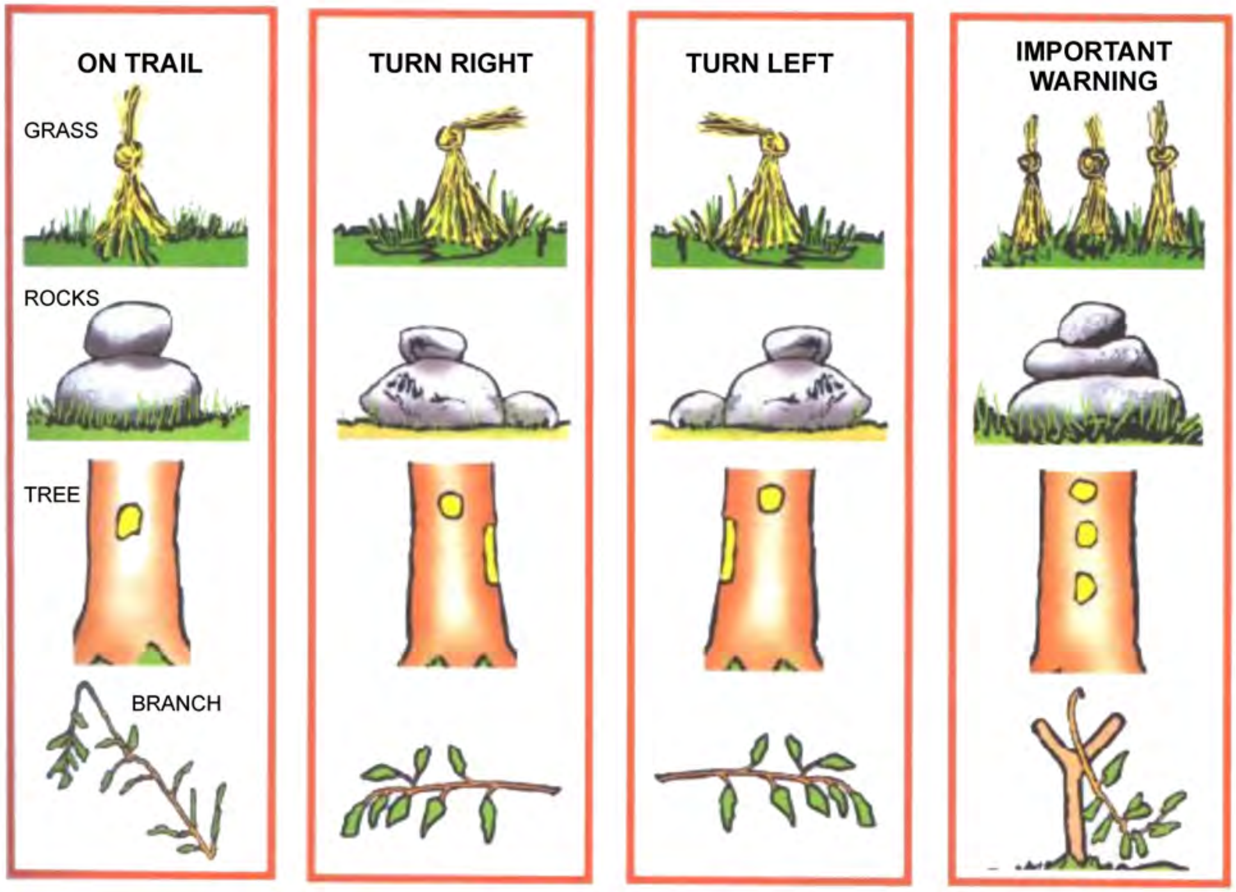
BLAZING TECHNIQUES



P. Tawrell, Camping and Wilderness Survival: The Ultimate Outdoors Book, Paul Tawrell (p. 547)

Figure 18R-1 Blazing Techniques

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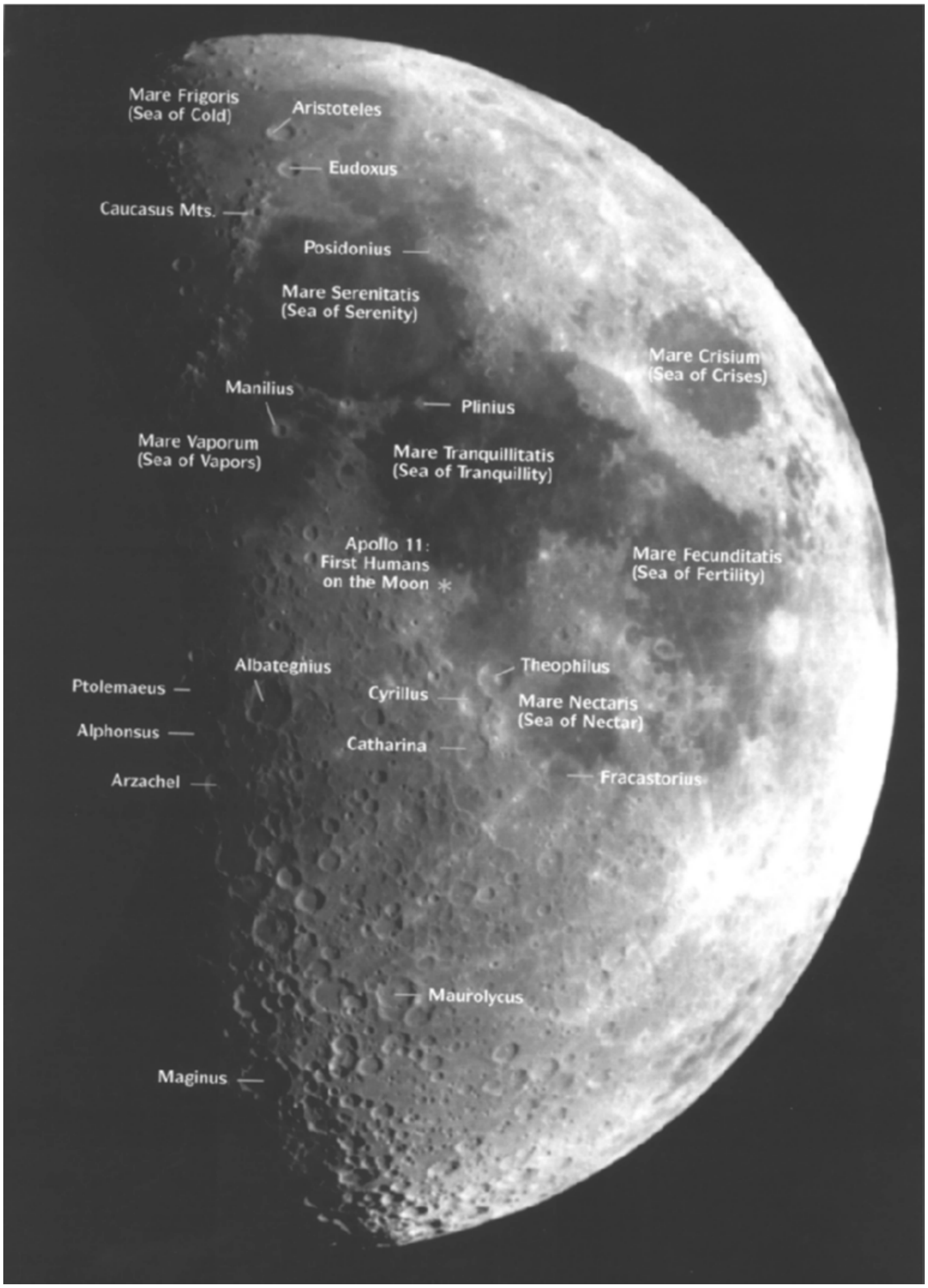
MOON QUARTERS

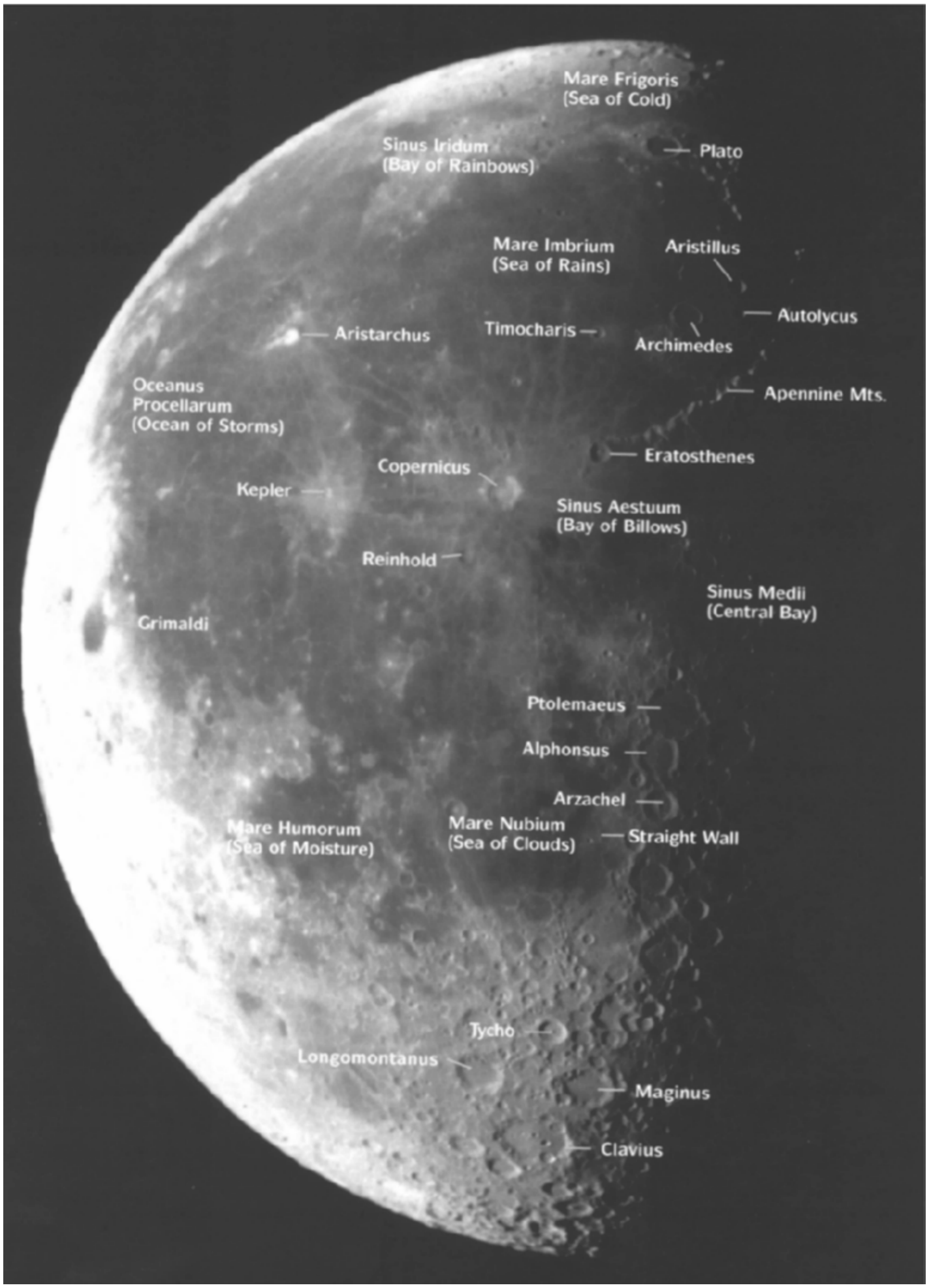
FIRST QUARTER MOON



T. Dickinson, NightWatch: A Practical Guide to Viewing the Universe, Firefly Books Ltd. (p. 141)

Figure 18S-1 The First Quarter of the Moon

LAST QUARTER MOON



T. Dickinson, NightWatch: A Practical Guide to Viewing the Universe, Firefly Books Ltd. (p. 140)

Figure 18S-2 The Last Quarter of the Moon

VENUS: PERIODS OF PROMINENT VISIBILITY

Although Venus is the brightest object in the night sky, apart from the moon, it is often close to the horizon. If possible, observe from a location with an unobstructed horizon in the specified direction.

Western Sky at Dusk

- early March 2010 to mid-September 2010
- early November 2011 to mid-May 2012
- late May 2013 to late December 2013
- early January 2015 to mid-July 2015
- mid-September 2016 to mid-March 2017
- mid-March 2018 to early September 2018

Eastern Sky at Dawn

- mid-November 2010 to mid-March 2011
- late June 2012 to late December 2012
- late January 2014 to late August 2014
- late August 2015 to mid-February 2016
- mid-April 2017 to late October 2017
- mid-November 2018 to early April 2019

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CONSTELLATIONS

<table>
<tr><th>Constellations</th><th>Description</th><th>Picture</th></tr>
<tr>
<td>Ursa Major (the Great Bear) and Ursa Minor (the Little Bear)</td>
<td>
The Great Bear was actually a beautiful nymph named Callisto. Callisto was turned into a bear by Zeus to protect her from his jealous wife Hera. One day, Callisto ran into her son, Arcas, who was hunting in the woods. Arcas raised his spear towards the bear, his mother. Zeus, watching from above, acted quickly to save his beloved, Callisto. He turned Arcas into a bear and hoisted them both into the sky by their tails. In doing so, Zeus stretched the bears' tails and they now appear that way in the sky.
The legends of some Canadian First Nations, including the Micmac and Iroquois, also identify this constellation as a bear.
Ursa Major includes the Big Dipper which is also known as "The Plough" in Europe. The Big Dipper's handle is the bear's tail, while its scoop is the bear's side.
The second star from the end of the Big Dipper's handle is really two stars. In ancient times these stars were used to test eyesight. An individual had good eyesight if they could see two distinct stars.
At the end of the Little Dipper, Ursa Minor, is the pole star, Polaris. Polaris, also known as the North Star, is about 50 times larger than the sun but it appears very faint as it is 600 light years away.
Polaris is due north and was important in early northern hemisphere navigation.
</td>
<td>

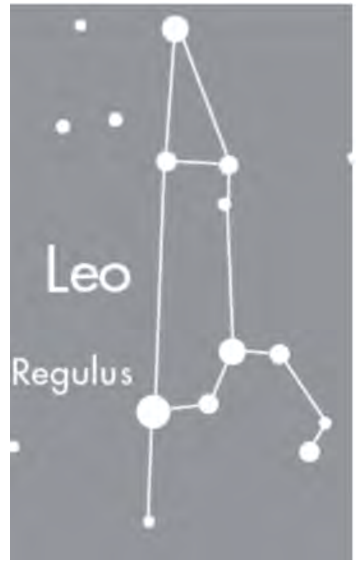

Constellations, by National Research Council of Canada. Retrieved December 3, 2007, from http://www.nrc-cnrc.gc.ca/docs/education/planisphere_e.pdf
Figure 18U-1 Ursa Major


Constellations, by National Research Council of Canada. Retrieved December 3, 2007, from http://www.nrc-cnrc.gc.ca/docs/education/planisphere_e.pdf
Figure 18U-2 Ursa Minor
</td>
</tr>
<tr>
<td>Cassiopeia (the Queen of Ethiopia)</td>
<td>
When Cassiopeia died, she was placed next to her husband, Cepheus, in the sky. Her vanity and cruelty had never been forgotten by her enemy, Poseidon, who tilted her throne as she was placed in the sky. For half the night Cassiopeia is sitting upright, but for the rest of the night she must cling to her throne as she hangs upside-down in the sky.
</td>
<td>


Constellations, by National Research Council of Canada. Retrieved December 3, 2007, from http://www.nrc-cnrc.gc.ca/docs/education/planisphere_e.pdf
Figure 18U-3 Cassiopeia
</td>
</tr>
</table>

Constellations	Description	Picture
Orion (the hunter)	Orion was a famous hunter who claimed he could kill any animal. Nothing could protect him from the scorpion that stung his heel and killed him. Orion and Scorpius are placed at opposite ends of the sky so they will not fight again. Look for a star with a fuzzy appearance just below Orion's belt as this is the Orion Nebula where baby stars are born. Betelgeuse, or the "armpit" of Orion, is a red supergiant star that is 300–400 times the diameter of the sun and is among the best candidates to become a supernova in northern skies. Betelgeuse is a variable star; its brightness varies, but on average it is the 12th brightest star in the sky.	 *Constellations, by National Research Council of Canada. Retrieved December 3, 2007, from http://www.nrc-cnrc.gc.ca/docs/education/planisphere_e.pdf* Figure 18U-4 Orion
Aries (the ram)	Aries was a magical ram who could speak, think and fly. The god Hermes gave Aries two children, Helle and Phrixus, who wanted to escape their evil stepmother. Helle fell off Aries during the escape, but Phrixus made it to safety and sacrificed Aries to show his thanks. He gave Aries' fleece to King Aeetes, who sent Draco the dragon to guard it. Eventually, Aries' Golden Fleece was stolen by Jason and the Argonauts. Aries' brightest star is Hamal, which means "the lamb." It is one of the few stars that has had its apparent size measured. Most stars are so far away they appear as just a point of light, but astronomers have measured the size of Hamal to be 0.00680 arcseconds. That is the same size as a penny would seem to be if you held it 60 km away.	 *Constellations, by National Research Council of Canada. Retrieved December 3, 2007, from http://www.nrc-cnrc.gc.ca/docs/education/planisphere_e.pdf* Figure 18U-5 Aries
Taurus (the bull)	Taurus represents a bull. When Zeus fell in love with Europa, he transformed himself into a white bull. One day, as Europa was playing near the seashore, she noticed the new white bull. She went over for a closer look, and the bull knelt down to allow her to climb up. Once she was on, the bull leapt into to the sea and swam to the island of Crete. Then Zeus changed back into human form and told Europa of his love for her. Taurus is easy to spot from the constellation Orion. Follow the three stars of Orion's belt towards the west until a bright red-orange star is encountered. This is Aldebaran, the Eye of the Bull. Nearby are five more stars that make a V with Aldebaran and trace out the face of the bull.	 *Constellations, by National Research Council of Canada. Retrieved December 3, 2007, from http://www.nrc-cnrc.gc.ca/docs/education/planisphere_e.pdf* Figure 18U-6 Taurus

Constellations	Description	Picture
Gemini (the twins)	The Twins, Castor and Pollux, were born to Leda, who was seduced by Zeus in the form of a beautiful swan. Every December, meteors appear to spray out of this constellation. This event is called the "Geminid meteor shower." Castor and Pollux, the heads of the Twins, are the two brightest stars in the constellation Gemini. Castor, "the Beaver" and Pollux, "much wine" are the 20th and 16th brightest stars in the night sky respectively.	 *Constellations, by National Research Council of Canada. Retrieved December 3, 2007, from http://www.nrc-cnrc.gc.ca/docs/education/planisphere_e.pdf* Figure 18U-7 Gemini
Cancer (the crab)	Cancer represents a crab that played a small role in the story of Hercules whose stepmother, the goddess Hera, was his mortal enemy. Hera sent the crab to try to distract Hercules who was battling the dreaded Hydra. The crab grabbed on to Hercules' toe with its claws, but Hercules just shook him off and crushed him underfoot. To thank the crab for its brave attempt, Hera placed it in the sky.	 *Constellations, by National Research Council of Canada. Retrieved December 3, 2007, from http://www.nrc-cnrc.gc.ca/docs/education/planisphere_e.pdf* Figure 18U-8 Cancer

Constellations	Description	Picture
Leo (the lion)	Leo was a lion that was sent from the moon down to Earth by Hera, the stepmother and mortal enemy of Hercules. Leo lived in a cave and would attack the people who lived nearby. Hercules was sent to fight Leo but his spears and arrows just bounced off the lion's invincible skin. Hercules finally decided to wrestle Leo and eventually managed to strangle the lion to death. Hercules then made a cloak from the lion's skin so that he could be invincible too. Regulus, the brightest star in the constellation Leo, means "the little king" in Latin. It is the 25th brightest star in our night sky and is relatively close to the Earth at a distance of 77 light years. Regulus is much brighter than our own star; it shines 350 times more brightly than the sun. The easiest way to find Leo in the sky is to look for a backwards question mark. This shape, often called The Sickle, marks the head and front paws of the lion.	 *Constellations, by National Research Council of Canada. Retrieved December 3, 2007, from http://www.nrc-cnrc.gc.ca/docs/education/planisphere_e.pdf* Figure 18U-9 Leo
Virgo (the goddess of agriculture)	To the ancient Greeks, Virgo represented Demeter, the goddess of agriculture. Demeter's daughter, Persephone, was kidnapped by Hades, the god of the underworld, and taken to be his wife. Demeter searched high and low for her daughter neglecting the crops. Eventually, Zeus persuaded Hades to release Persephone. While she was in the underworld, Persephone had eaten some pomegranate seeds and could never fully leave. Each year Persephone returns to the underworld for a time and winter occurs as the crops die and her mother mourns. When Persephone returns, her mother rejoices and the earth becomes fruitful again. The brightest star in Virgo is called Spica. It is easy to find by following the arc of the Big Dipper's handle to Arcturus and then continuing in a straight line: "Arc to Arcturus, then speed on to Spica".	 *Constellations, by National Research Council of Canada. Retrieved December 3, 2007, from http://www.nrc-cnrc.gc.ca/docs/education/planisphere_e.pdf* Figure 18U-10 Virgo

Constellations	Description	Picture
Libra (the scales)	To the ancient Babylonians, Libra represented scales or balance. This might be because the sun was in front of the stars of Libra during their autumnal equinox, when days and nights were of equal length. To the Greeks, the stars of Libra were not their own constellation but rather the claws of the scorpion Scorpio. The Romans resurrected the idea of Libra representing scales and sometimes drew Virgo holding the scales, just like the goddess of justice. The two brightest stars in Libra have interesting Arabic names: Zubenelgenubi, “the southern claw,” and Zubenelchemale, “the northern claw.”	 *Constellations, by National Research Council of Canada. Retrieved December 3, 2007, from http://www.nrc-cnrc.gc.ca/docs/education/planisphere_e.pdf* Figure 18U-11 Libra
Scorpius (the scorpion)	Scorpius represents the scorpion that killed the hunter Orion. Orion was so proud of his hunting skills that he boasted he could track down and kill any animal on earth. His claim was so outrageous that the earth trembled in rage and cracked open. Out of the crack crawled a scorpion which stung and killed Orion. Out of pity, the gods placed Orion and Scorpius on opposite sides of the sky so there could be no more trouble between them. The brightest star in Scorpius is called Antares. This star is quite red and many people mistake it for Mars.	 *Constellations, by National Research Council of Canada. Retrieved December 3, 2007, from http://www.nrc-cnrc.gc.ca/docs/education/planisphere_e.pdf* Figure 18U-12 Scorpius
Sagittarius (the archer)	Sagittarius was the ultimate archer, keen-eyed and with deadly aim. He is usually drawn as the Babylonians saw him, a centaur: half-man and half-horse. To the Greeks, though, he was a satyr: half-man and half-goat. He was the son of the pipe-playing god Pan and invented archery.	 *Constellations, by National Research Council of Canada. Retrieved December 3, 2007, from http://www.nrc-cnrc.gc.ca/docs/education/planisphere_e.pdf* Figure 18U-13 Sagittarius

Constellations	Description	Picture
Capricornus (the goat-fish)	Capricornus is one of the oldest known constellations. The ancient Babylonians called it the goat-fish and said it ruled the part of the sky from which the mighty Tigris and Euphrates rivers flowed. The Greeks also saw Capricornus as a creature that was half-goat and half-fish. They associated it with the god Pan, who had a human torso and face, but goat legs and goat horns. One story about Pan is that he jumped in the river Nile to escape the sea monster, Typhon. The part of him below the water turned into a fish, while the rest of his body remained a goat. Capricornus is a hard constellation to find because it does not have any bright stars and it never gets very high in the sky.	 *Constellations, by National Research Council of Canada. Retrieved December 3, 2007, from http://www.nrc-cnrc.gc.ca/docs/education/planisphere_e.pdf* Figure 18U-14 Capricornus
Aquarius (young man pouring water from a pitcher)	To the Babylonians, Aquarius was the ruler of all the watery constellations – Pisces, Capricornus, Piscis Austrinus and Cetus. To the Egyptians, Aquarius caused the yearly flooding of the river Nile. The Greeks personified Aquarius, drawing him as a young man pouring water from a pitcher.	 *Constellations, by National Research Council of Canada. Retrieved December 3, 2007, from http://www.nrc-cnrc.gc.ca/docs/education/planisphere_e.pdf* Figure 18U-15 Aquarius

Constellations	Description	Picture
Pisces (two fish)	Pisces represents two fish in the sky. One day, the goddess Aphrodite and her son Eros were fleeing the terrible sea monster Typhon. They hid in the rushes along the bank of the river Euphrates but could not escape. The monster was just about to attack when two fish swam up and carried Aphrodite and Eros to safety. As a reward for their help, the fish were placed in the sky as the constellation Pisces. Pisces is a hard constellation to find. The easiest way is to locate the square of Pegasus and look underneath it towards the south. A ring of stars, called the Circlet of Pisces may be seen. This represents the body of one of the fish.	 *Constellations, by National Research Council of Canada. Retrieved December 3, 2007, from http://www.nrc-cnrc.gc.ca/docs/education/planisphere_e.pdf* Figure 18U-16 Pisces

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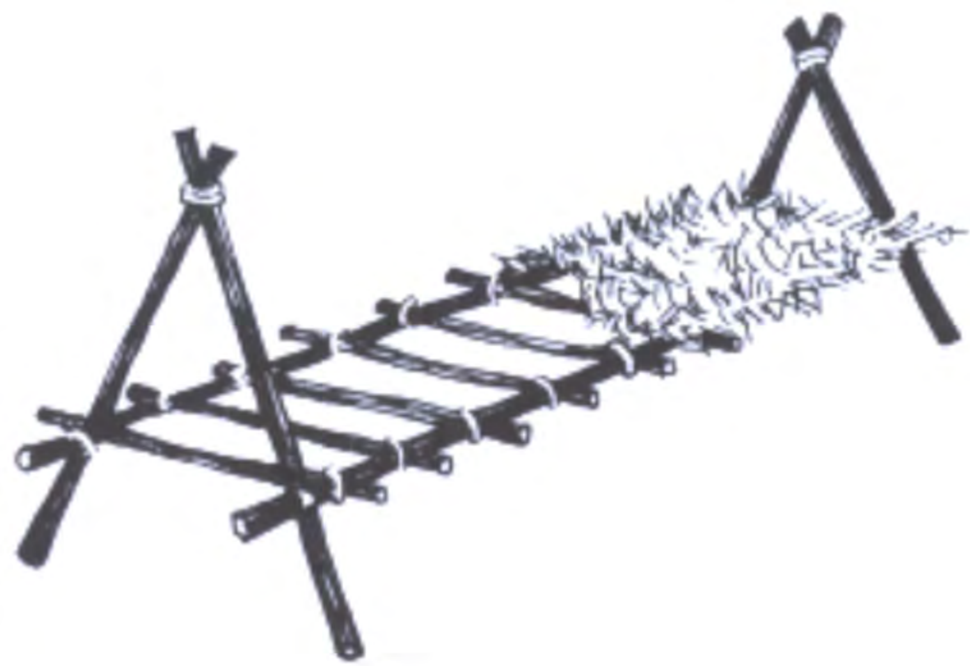
LADDER BED

Using natural resources and cord, a ladder bed can be constructed. Steps to constructing a ladder bed:

1. Collect the natural resources, including:
   (a) four poles 75–100 cm long to construct the A-frames,
   (b) two sturdy poles approximately 180 cm long to make the frame (length will depend on the height of the person), and
   (c) several crosspieces 50–60 cm long, the more flexible the better; length will depend on the width of the person.
2. Construct two A-frame supports using round lashings.
3. Attach the two frame poles to the A-frames, ensuring that the knots and wood are strong and will hold the weight of the individual.
4. Tie the crosspieces making a ladder along the frame.
5. Lay a bedding of boughs, leaves or moss, as desired. Ensure there is enough material to prevent heat from being transferred away from the body during the night.



J. Wiseman, The SAS Survival Handbook, HarperCollins Publishers (p. 309)

Figure 18V-1 Ladder Bed

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PACK FRAME

Using natural resources, cord and two straps, a pack frame can be constructed. Steps to constructing a pack frame:

1. Collect natural resources, including:
   (a) two poles to make the frame 75–100 cm long (length will depend on the height of the person),
   (b) several crosspieces 50–60 cm long, (length and number will depend on the width of the person), and
   (c) five pieces (two 15–20 cm long , two 50 cm long and one 50–60 cm long) to construct the right angle projection at the bottom.
2. Construct the ladder frame to the size of the individual.
3. Construct the right angle projection at the bottom and ensure the knots and wood are strong and will not break with a load.
4. Attach straps made from cord or from improvisation and adjust it to a comfortable position.

J. Wiseman, The SAS Survival Handbook, HarperCollins Publishers (p. 372)

Figure 18W-1 Pack Frame

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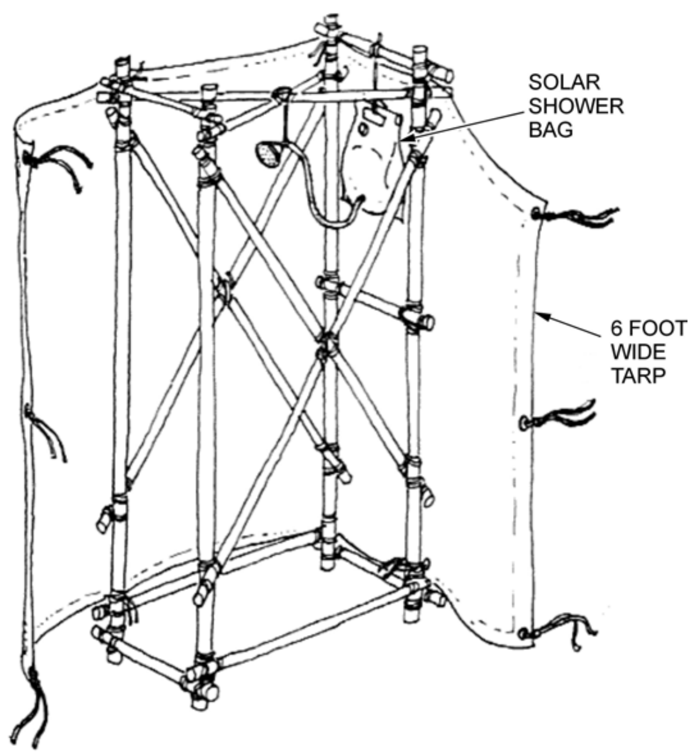
SHOWER

Using natural resources, cord, a large tarp and a shower bag or bucket; a camp shower can be constructed. Steps to constructing a shower:

1. Collect the natural resources, including:
   (a) four poles at least 180 cm in length, but may depend on the height of the person,
   (b) several poles for supports, (number and length will depend on the size of the shower being constructed and the strength of the material being used),
   (c) a tarp at least 180 cm in width and 240 cm in length, and
   (d) a shower bag or a bucket.
2. Lash the four poles at least to a square base frame and a cross-frame top.
3. Add cross-braces on two sides of the shower for support, remembering to leave one side open for accessibility.
4. Tie a large tarp with grommets to the outside of the frame and rig a latch on the open side.
5. Attach the shower bag or bucket to the top of the frame.



*PioneeringProjects.org, 2001, Camp Shower, Copyright 2001 by PioneeringProjects.org.
Retrieved November 17, 2007, from http://www.pioneeringprojects.org/projects/images/pion39.gif*

Figure 18X-1 Shower

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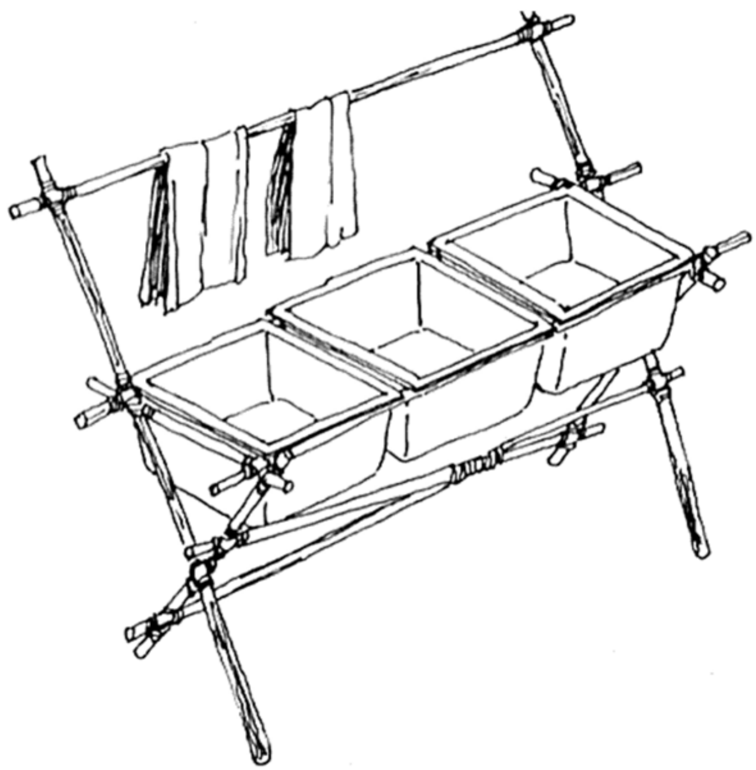
WASHSTAND

Using natural resources, cord and several wash basins or tubs, a washstand can be constructed. Steps to constructing a washstand:

1. Collect the natural resources, including:
   (a) four poles to construct the table top (the dimensions will depend on the size and number of wash basins the washstand is being constructed for),
   (b) four poles to construct the stand, two poles 180 cm in length and two 120 cm in length, and
   (c) two poles the length of the washstand to form a cross-brace at the bottom.
2. Construct a box frame for the wash basins to sit in using square lashings; use the wash basin as a measuring tool.
3. Lash two sets of poles (one pole 180 cm and the other 120 cm long) using square lashings to form the stand.
4. Lash the table top to the sides and add supports as necessary.



PioneeringProjects.org, 2001, Three Compartment Sink, Copyright 2001 by PioneeringProjects.org. Retrieved November 17, 2007, from http://www.pioneeringprojects.org/projects/images/pion33.gif

Figure 18Y-1 Washstand

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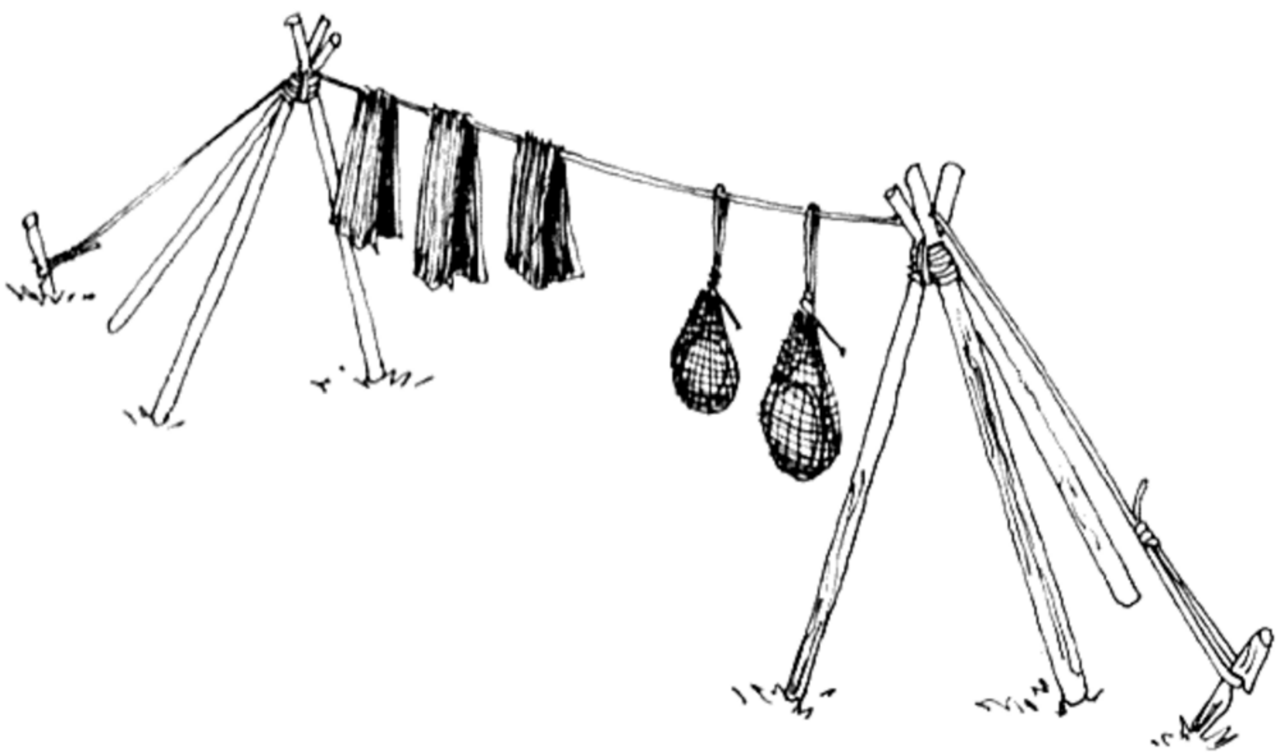
DRYING RACK

Using natural resources and cord, a drying rack can be constructed. Steps to constructing a drying rack:

1. Collect six poles 180 cm in length to construct two tripods.
2. Drive two uprights (piece of wood) into the ground and then lash a crosspiece of cord to join them across the top.
3. To ensure the structure is sturdy, add further poles lashed at an angle to form a simple ‘A’ frame at either end.
4. Attach guy wires to the two ends and peg out to keep the clothes rack on the ground in high winds. Add extra drying lines by lashing cord across the uprights.

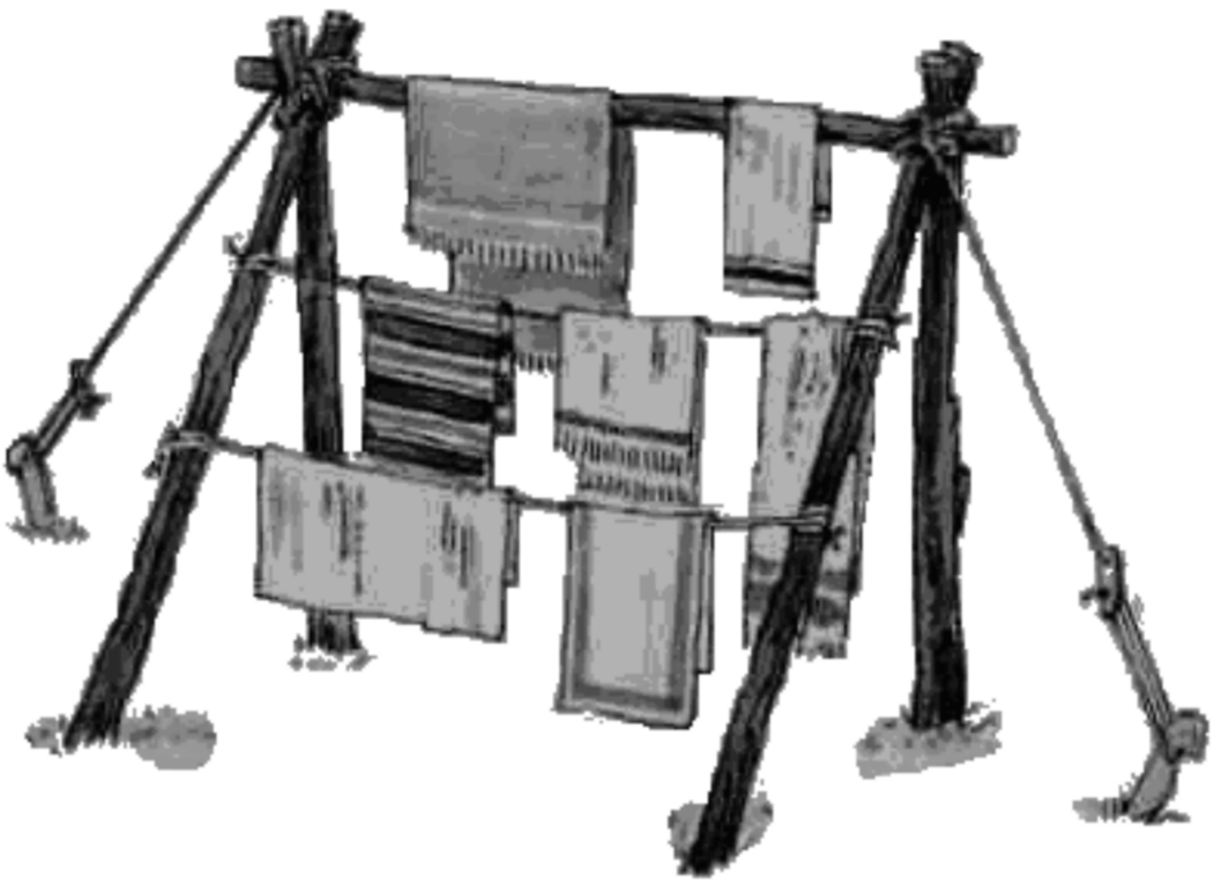
Dry clothing is essential in a survival situation to avoid exposure and possible hypothermia.



PioneeringProjects.org, 2001, Clothesline, Copyright 2001 by PioneeringProjects.org. Retrieved November 17, 2007, from http://www.pioneeringprojects.org/projects/images/pion24.gif

Figure 18Z-1 Drying Rack 1

Another option (as illustrated in Figure 18Z-2) is to build the entire frame out of wood.



PioneeringProjects.org, 2001, Drying Rack, Copyright 2001 by PioneeringProjects.org. Retrieved November 17, 2007, from http://www.pioneeringprojects.org/pioneering/index.htm

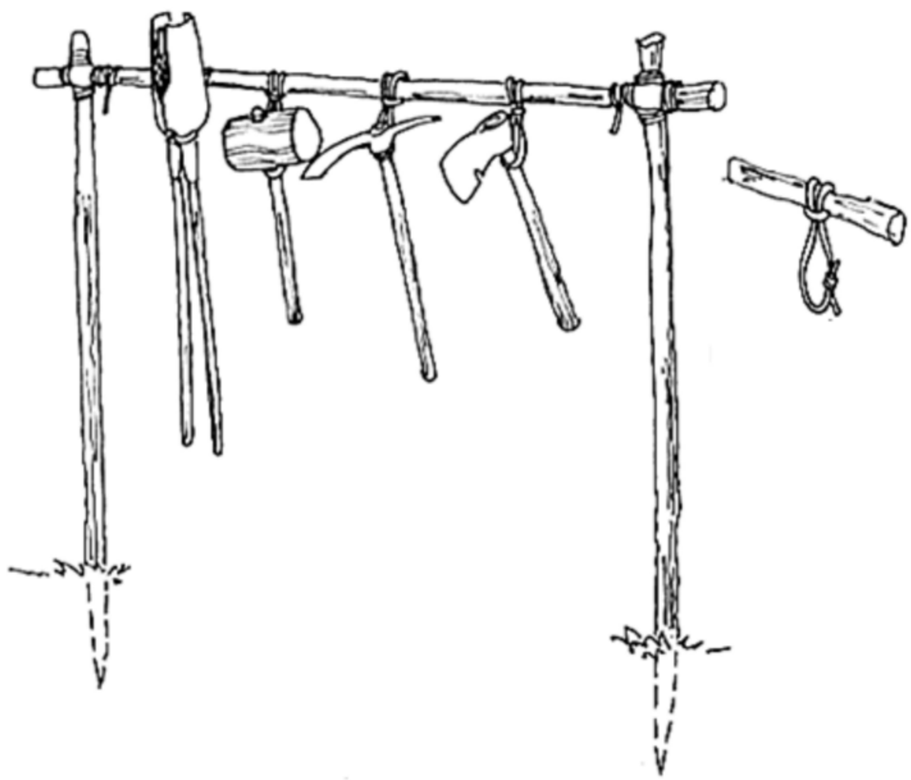
Figure 18Z-2 Drying Rack 2

TOOL RACK

Using natural resources and cord, a tool rack can be constructed. Steps to constructing a tool rack:

1. Collect the three poles 180 cm long from natural resources.
2. Drive two uprights into the ground or use two trees.
3. Lash a ridge pole between the two uprights to hang the tools from.
4. Tie pieces of cord into a loop using a reef knot and then loop it over the ridge pole (as illustrated in Figure 18AA-1).

A tool rack will keep tools off of the ground and prevent them from rusting or becoming dull too quickly. By having tools kept in one place they are less likely to go missing and site safety is increased.



PioneeringProjects.org, 2001, Tool Rack, Copyright 2001 by PioneeringProjects.org. Retrieved November 17, 2007, from http://www.pioneeringprojects.org/projects/images/pion27.gif

Figure 18AA-1 Tool Rack 1

Another example (as illustrated in Figure 18AA-2) has two crosspieces of wood for increased stability.

Scoutmaster, Knots and Pioneering, Retrieved November 18, 2007, from http://scoutmaster.typepad.com/.shared/image.html?/photos/uncategorized/chip5_copy_copy.jpg

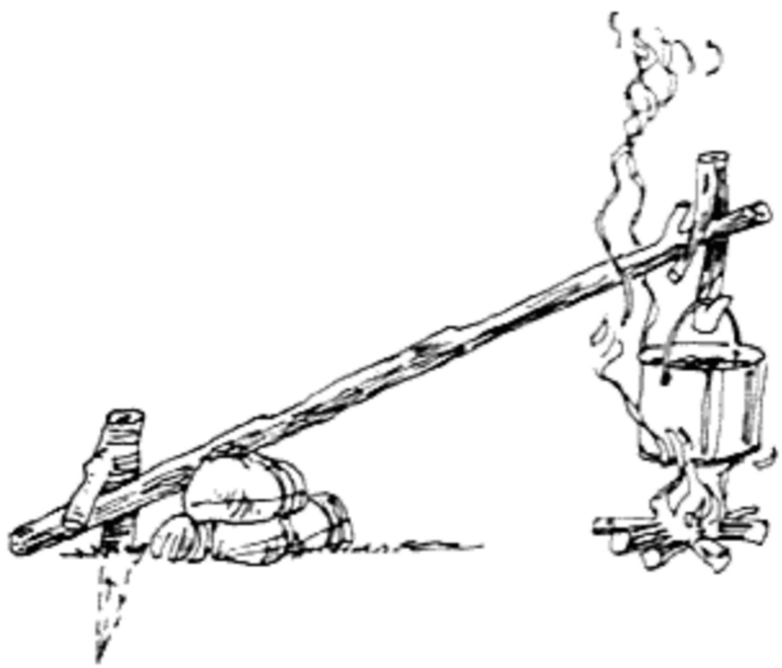
Figure 18AA-2 Tool Rack 2

CAMP CRAFTS FOR COOKING

Pot Rod

Using natural materials, cord and a pot, a pot rod for cooking over a fire can be constructed. Steps to constructing a pot rod:

1. Collect the natural resources, including:
   (a) one pole 180 cm long, and
   (b) two forked sticks, match size and shape to the pole.
2. Drive a forked stick into the ground near the fire, so that the forked part is facing down (as illustrated in Figure 18AB-1). Be careful in the placement so it does not catch on fire.
3. Pile rocks on the fire side of the forked stick and insert a long pole between the forked stick and the rocks so that the end is over the fire; add rocks to achieve the desired height.
4. Secure the pot by either lashing another forked stick (as illustrated in Figure 18AB-1) or by notching a groove so the handle stays in one spot.



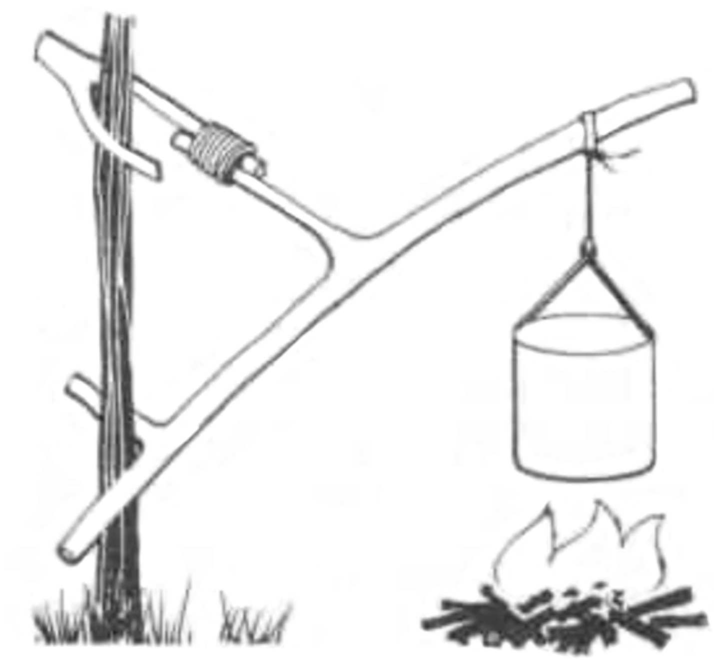
PioneeringProjects.org, 2001, Various Utensils, Copyright 2001 by PioneeringProjects.org. Retrieved November 17, 2007, from http://www.pioneeringprojects.org/projects/images/pion29.gif

Figure 18AB-1 Pot Rod

Swinging Pot Holder

Using natural materials, cord and a pot, a swinging pot holder for cooking over a fire can be constructed. A swinging pot holder is an extremely useful version of the simple pot rod. Steps to constructing a swinging pot holder:

1. Collect the natural resources, including:
   (a) one pole 150 cm long, with a forked end and another fork at the midway point,
   (b) one pole 90 cm long for an upright, and
   (c) one short stick with a fork (as illustrated in Figure 18AB-2).
2. Drive the 90-cm long upright 15 cm into the ground.
3. Lash the two forked sticks so that the forks fit in opposite directions on the upright. This will produce a cantilever action which not only maintains the height that it is set at, but will also swing freely allowing the pot to move away from the flames. Note that with a longer upright, the cooking height can be better controlled.
4. Secure the pot by either lashing another forked stick (as illustrated in Figure 18AB-2) or by notching a groove so the handle stays in one spot.



J. Wiseman, The SAS Survival Handbook, HarperCollins Publishers (p. 288)

Figure 18AB-2 Swinging Pot Holder

Chippewa Kitchen

Using natural materials and cord, a Chippewa kitchen for cooking over a fire can be constructed. A challenging camp craft, but a nice set-up for long-term cooking, the Chippewa kitchen (as illustrated in Figure 18AB-3) is constructed by the following steps:

1. Collect the natural resources, including:
   (a) eight straight poles 240-cm long and 4 cm thick,
   (b) four straight poles 50 cm long and 4 cm thick, and
   (c) poles 50-cm long to create a table top.
2. Using round lashings and four 240-cm poles, lash two sets of 'A' frames.
3. Lash two 50 cm poles to each of the 'A' frames for support.
4. Lash the two 'A' frames together with the remaining four 240-cm poles (as illustrated in Figure 18AB-3).
5. Add poles to create a table top.

Scale the kitchen to available materials or conditions as appropriate.

Scoutmaster, Knots and Pioneering. Retrieved November 18, 2007, from http://scoutmaster.typepad.com/my_weblog/2006/05/chippewa_kitche.html

Figure 18AB-3 Chippewa Kitchen

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WHEELBARROW

Using natural materials and cord, a wheelbarrow can be constructed. A wheelbarrow is a tool that assists in gathering firewood or moving heavy objects around a survival site. Steps to constructing a wheelbarrow:

1. Collect the natural resources, including:
   (a) two poles 60–100 cm long,
   (b) two poles for crosspieces,
   (c) one cross-section of a log approximately 15 cm in diameter and 4 cm thick, and
   (d) one rod matched to the size of the hole.
2. Construct the wheel from a cross-section of a small tree that has been bored out and a rod to create an axle. The wheel portion can take a lot of time to create depending on available tools.
3. Insert a rod that has been shaped to fit into the hole.
4. Make a notch into each of the longer poles to match the diameter of the rod.
5. Tightly lash the two poles with a crosspiece as close to the wheel as possible. This crosspiece will hold the wheel in place and must be very tight.
6. Lash another crosspiece near the top of the two poles for support.
7. Add other crosspieces if necessary.

Ropesandpoles.blogspot.com. Retrieved November 18, 2007, from http://ropesandpoles.blogspot.com/2006/01/camp-wheelbarrow.html

Figure 18AC-1 Wheelbarrow

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COAT HANGER

Using natural materials and cord, a coat hanger can be constructed. Good for using on a drying rack, the coat hanger is one of the easier crafts to construct. Steps to constructing a coat hanger:

1. Collect the natural resources, including:
   (a) one slightly bent pole 60 cm long, and
   (b) one forked stick approximately 15 cm long or a bent stick approximately 30 cm long.
2. Lash either a forked stick or bent stick (as illustrated in Figure 18AD-1), to the slightly bent pole.

PioneeringProjects.org, 2001, Various Utensils, Copyright 2001 by PioneeringProjects.org.
Retrieved November 17, 2007, from http://www.pioneeringprojects.org/projects/images/pion29.gif

Figure 18AD-1 Coat Hanger

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SIMPLE BENCH

Using natural materials and cord, a bench can be constructed. A simple bench can double as a tool storage area or a work bench. Steps to constructing a simple bench:

1. Collect the natural resources, including:
   (a) six sturdy logs approximately 100 cm long and 15 cm thick, and
   (b) one sturdy log approximately 150 cm long and 15 cm thick.
2. Using round lashings, create two tripod frames.
3. Attach a sturdy log to the tripod frames to sit on.

PioneeringProjects.org, 2001, Miscellaneous, Copyright 2001 by PioneeringProjects.org. Retrieved November 17, 2007, from http://www.pioneeringprojects.org/images/pioneering/Miscellaneous.JPG

Figure 18AE-1 Simple Bench

Figure 18AE-1 shows the legs as a pair instead of a tripod frame. Tripod frames are required to make the bench stable.

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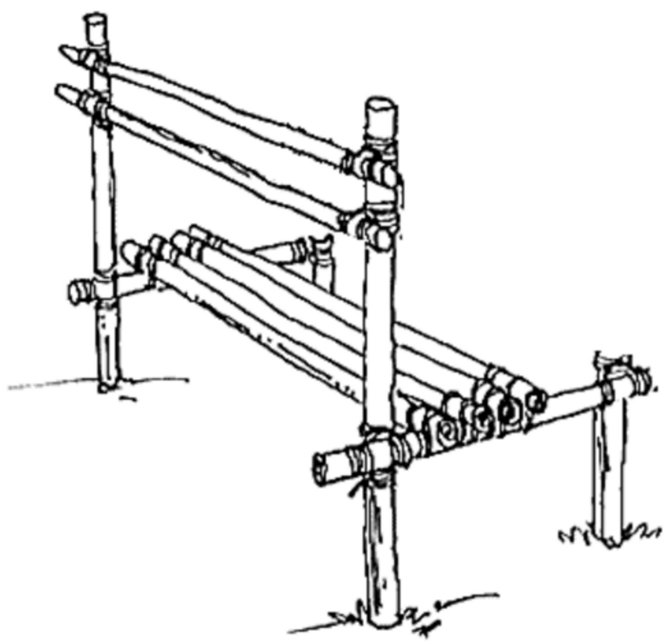
BENCH WITH BACK REST

Another example of a bench (as illustrated in Figure 18AF-1) uses more poles and has a back rest. Steps to constructing a bench with a back rest:

1. Collect the natural resources, including:
   (a) eight poles approximately 2 m each,
   (b) two poles approximately 1 m each, and
   (c) two poles approximately 0.5 m each.
2. Construct the sitting portion of the bench by attaching four long pieces of wood to the 1 m pieces, using square lashings.
3. Drive the two long and two short pieces of wood that will be used as the legs of the bench into the ground.
4. Lash the sitting portion onto the legs, using square lashings.
5. Construct the back rest using square lashings and attach it to the long legs in the ground.



PioneeringProjects.org, 2001, Bench With Back Rest, Copyright 2001 by PioneeringProjects.org. Retrieved February 20, 2007, from http://www.pioneeringprojects.org/projects/index.htm

Figure 18AF-1 Bench with Back Rest

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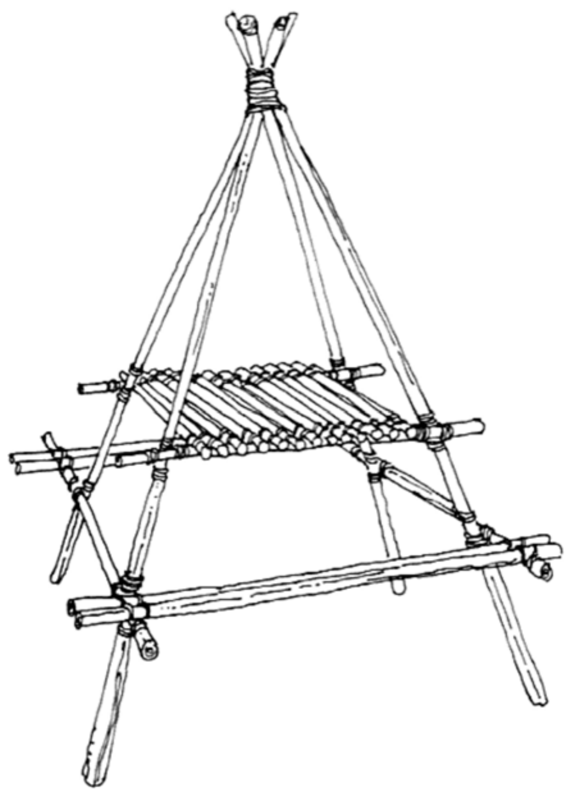
CAMP TABLE 1

Using natural materials and cord a table can be constructed (as illustrated in Figure 18AG-1). Steps to constructing a camp table:

1. Collect the natural resources, including:
   (a) four poles approximately 3 m long,
   (b) six poles approximately 2 m long,
   (c) two poles approximately 1.5 m long, and
   (d) fourteen poles approximately 0.5 m long.
2. Construct a figure-of-eight lashing around the four long pieces of wood, to make an A-frame.
3. Construct the table top, using square lashings.
4. Attach the table top portion to the long poles, using square lashings.
5. Make the sitting portion using square lashings and attach it to the long poles using square lashings.



PioneeringProjects.org, 2001, Camp Table, Copyright 2001 by PioneeringProjects.org. Retrieved November 17, 2007, from http://www.pioneeringprojects.org/projects/images/pion35.gif

Figure 18AG-1 Camp Table 1

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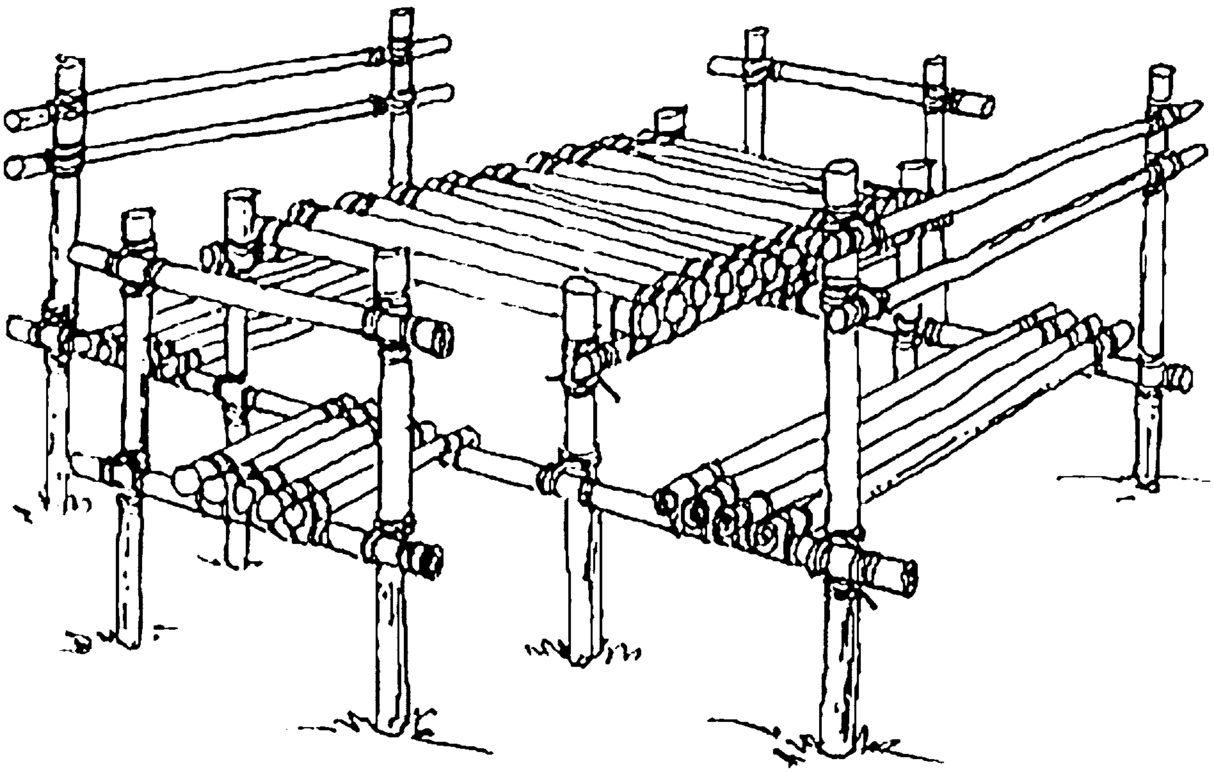
CAMP TABLE 2

An alternative to Camp Table 1, this camp table is a combination of the steps in Bench with a Back Rest combined with a variation of the steps in Camp Table 1. Steps to constructing camp table 2:

1. Collect the natural resources, including:
   (a) thirty poles approximately 1 m long,
   (b) fourteen poles approximately 2 m long,
   (c) two poles approximately 3 m long, and
   (d) ten poles approximately 0.5 m long.
2. Construct the table by lashing together the four 1-m uprights with two 1-m poles and two 2-m poles.
3. Add twelve 1-m poles as a table top.
4. Lash the two 3-m poles to either end of the table using square lashings.
5. Lash the four 1-m uprights to the end of the 3-m poles using square lashings at each end.
6. Lash eight 2-m long poles to the seat and two 2-m long poles to form the backrest.
7. Lash the five 0.5-m poles to the sides of the table and lash a 1-m long pole to the other end. Repeat on the other side.
8. Then using the 1-m long pole from Step 7., lash two 1-m uprights using square lashings. Repeat on the other side.
9. Finish the end seats by lashing the final 1-m long pole to the top to form a backrest. Repeat on the other side.

This elaborate camp craft can take many hours to build, a lot of personnel and resources are required.



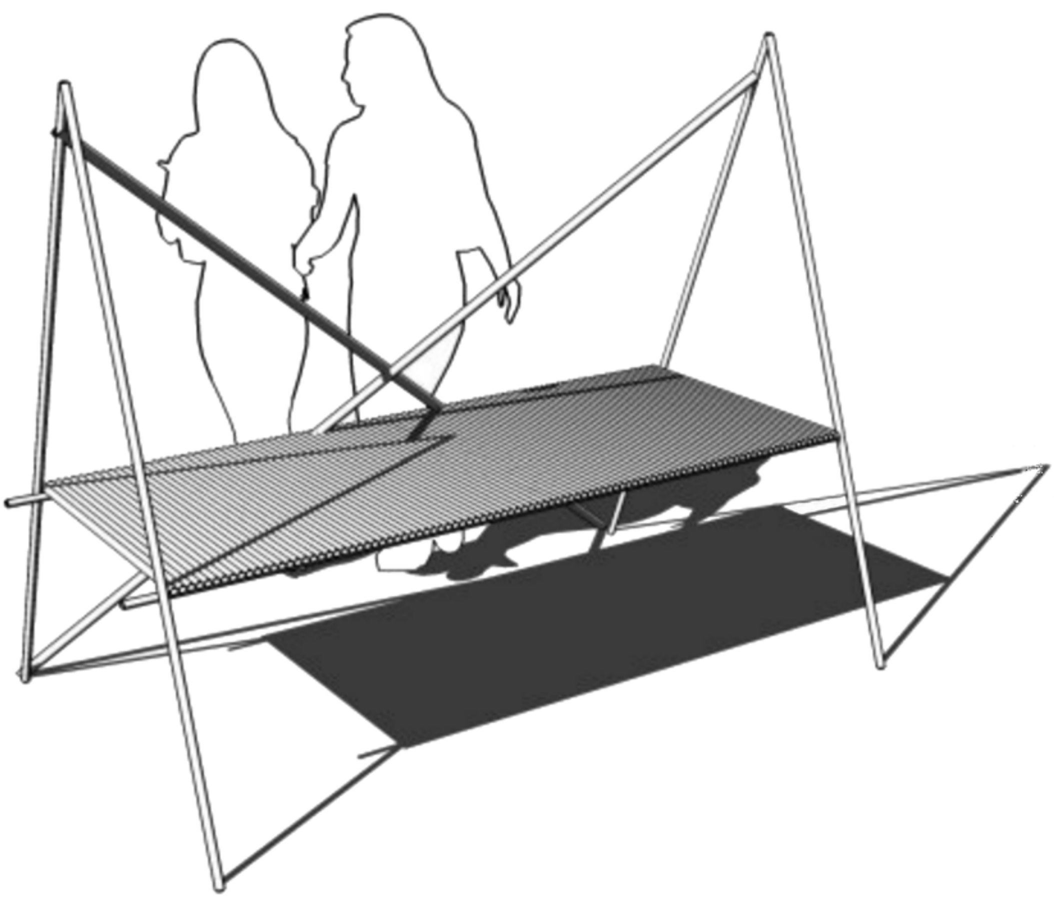
PioneeringProjects.org, 2001, Camp Table With Bench & Seat, Copyright 2001 by PioneeringProjects.org. Retrieved November 17, 2007, from http://www.pioneeringprojects.org/projects/images/pion38.gif

Figure 18AH-1 Camp Table 2

CAMP TABLE 3

Using natural materials and cord another example of a camp table (as illustrated in Figure 18AI-1).

1. Collect the natural resources, including:
   (a) two poles approximately 2 m long,
   (b) two poles approximately 2.5 m long,
   (c) two poles approximately 3 m, and
   (d) poles approximately 0.5 m long to create the table top.
2. Lash the two 2-m pole to make two 'A' frames.
3. Lash a cross-brace the two 'A' frames using two 3-m poles.
4. Lash the two 2.5-m poles to the frame to form the table top.
5. Add poles to the table top to complete the structure.



Ropesandpoles.blogspot.com. Retrieved November 18, 2007, from http://ropesandpoles.blogspot.com/2006/01/camp-table.html

Figure 18AI-1 Camp Table 3

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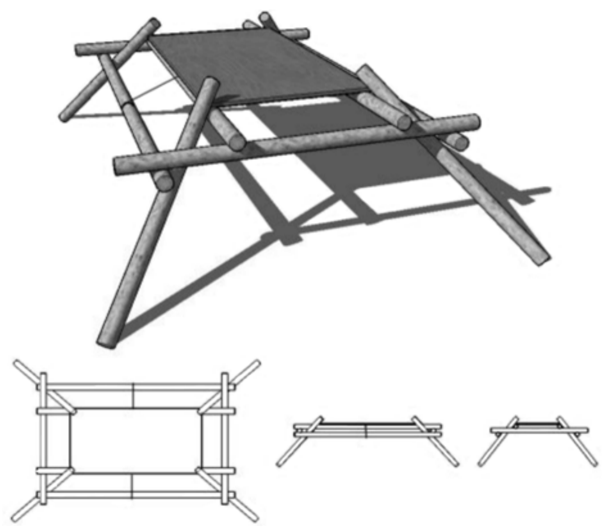
FRICTION-LOCK TABLE

Using natural resources and cord, a friction lock table can be constructed. This table only uses one piece of cord (as illustrated in Figure 18AJ-1). Friction locks the whole table together. There is one rope stopping the entire thing from spreading out and falling apart, running across the table (from left to right, under the table top). No lashings are used at all in this construction.

Steps to constructing a friction lock table:

1. Collect the natural resources, including:
   (a) four poles 180 cm in length and at least 15 cm thick, all poles used to construct this table should be of the same thickness to ensure a proper fit,
   (b) six poles 120 cm in length and at least 15 cm thick, and
   (c) natural materials to construct the tabletop.
2. Lay out the four parallel poles (the ones pointing towards the screen (as illustrated in Figure 18AJ-1) and tie together with clove hitches on each pole.
3. Lifting the two centre poles that were just tied, place the two cross-poles under these but over the outside poles.
4. Place natural materials or a piece of plywood to make a table top.
5. Lift the table (by the two outside tied poles) and hold up while the legs are inserted.



Ropesandpoles.blogspot.com. Retrieved November 18, 2007, from http://photos1.blogger.com/blogger/3732/1264/1600/friction%20lock%20tableS.jpg

Figure 18AJ-1 Friction-Lock Table

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SAMPLE BRIEFING

Situation

A 26-year-old male, Jim Grapevine, was a member of a group of hikers travelling through the park towards Hope Lake. He was lagging behind the group and was told to catch up. An hour after the group reached the lake, he still had not caught up. The group decided to look for him on their own and by nightfall, they returned to the lake without finding any sign of him. All the next day they backtracked along their trail to the point he was last seen. They searched back towards the lake, still finding no signs. After a day and a half of searching, they decided to contact the authorities. As there was no cell phone signal at the lake, they hiked the next morning to where they could make the emergency call. It has now been two days since Jim was last seen and through examining the clues we have, I have decided to concentrate the search in this area (point to the area on the map). Jim is an inexperienced hiker but very cool-headed. He has a very creative personality and was tired but in good spirits when he was last seen. He was only carrying his own gear. No other member of the group can say what he had except for a sleeping bag and clothes.

Details of the Confinement Area

A lookout has been airlifted to the top of Cloud Hill, which overlooks the area. Increasing low cloud cover will make the lookout ineffective in about two hours. The main road is being patrolled by vehicle and the Hope River is being patrolled by boat. Track traps have been set on the main trail from the lake.

Formation

The formation we will be using is the creeping line (as when cadets do a garbage sweep). Remember to move slowly so as to not get too far ahead of the other pairs.

Distance Between Pairs

Based on the type of terrain we will be encountering, the distance between pairs will be 10 m (30 ft).

Call Signs and Radio Frequency to be Used

Call signs that will be used are:

SAR leader: Sierra

Left anchor (end) team: Lima Major

Right anchor (end) team: Romeo Major

First pair to the left of the SAR leader: Lima One

Second pair to the left of the SAR leader: Lima Two

etc...

First pair to the right of the SAR leader: Romeo One

Second pair to the right of the SAR leader: Romeo Two

etc...

The radio frequency will be 6.07, check your radio now to ensure it is on the correct frequency.

Magnetic Bearing (Search Direction)

The magnetic bearing you will be searching on will be 72 degrees. It is important that you stay in your search lane and not veer into a neighbouring team’s lane. Remember your pacing techniques when bypassing obstacles. If possible, use a steering point.

Safety Bearing (If Lost or Disoriented)

If you become lost or disoriented, radio the SAR leader, who will assist you to get back on track. If you are also out of radio contact, use a magnetic bearing of 260 degrees which will bring you to Highway 43, which is being patrolled. Wait on the side of the road and flag down the patrol vehicle when you see it.

Actions to Take if the Cadets Discover a Clue/Lost Person: Radio In, Wait for Instructions

If you find a clue, stop and radio the SAR leader. Follow the instructions given. All other teams should stop and wait for instructions. Depending on the type of clue found, the search may be reoriented based on the new information.

If you find the lost person, one of you shall evaluate the situation to assess whether it is safe to approach. The other person should radio the SAR leader with the discovery and wait for instructions.

Does anyone have any questions?