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.

Unofficial convenience copy of A-CR-CCP-803/PF-001, cached 2026-11-08 from https://app.cadets.gc.ca/cadet-publications/A-CR-CCP-803-PF-001/A-CR-CCP-803-PF-001.pdf.
Verify against the official publication.

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



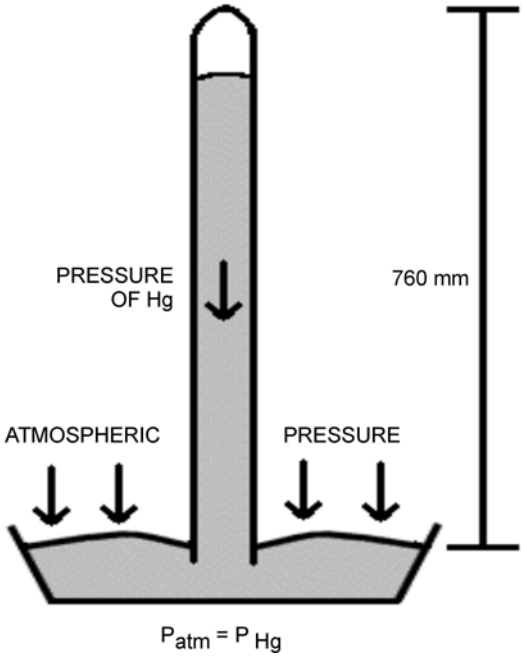
Show slide of Annex J.

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.

Unofficial convenience copy of A-CR-CCP-803/PF-001, cached 2026-11-08 from https://app.cadets.gc.ca/cadet-publications/A-CR-CCP-803-PF-001/A-CR-CCP-803-PF-001.pdf.
Verify against the official publication.



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 1 Barometer

Pressure Systems

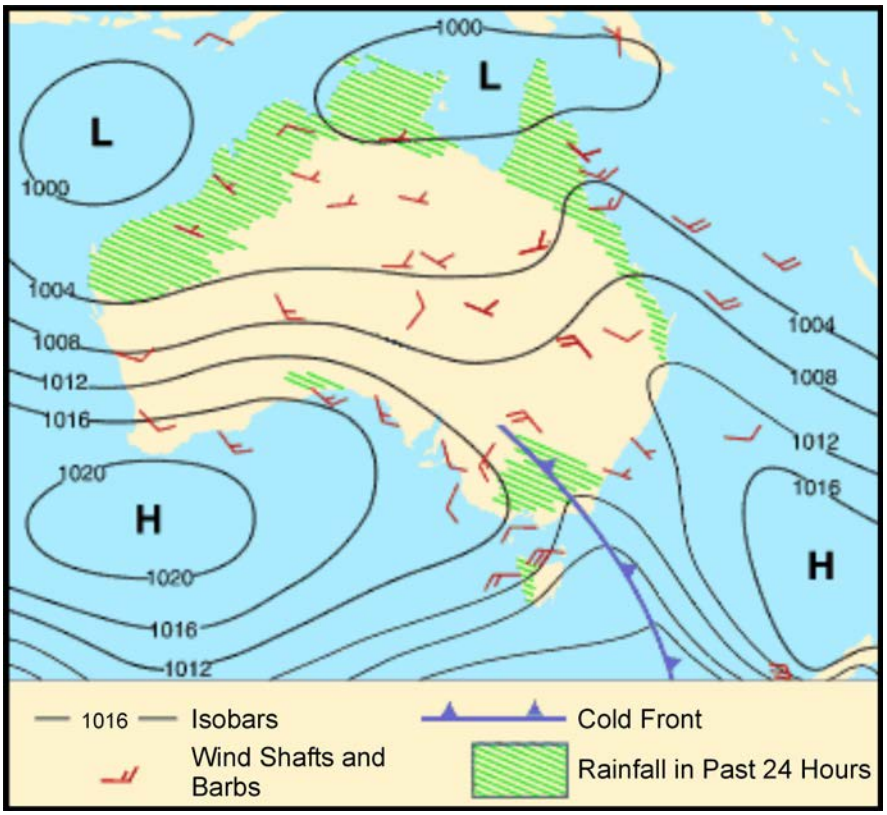
There are pressure reading stations all over North America. Each station will send its readings to a main forecasting office, which will plot the information on a weather map.



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.

Unofficial convenience copy of A-CR-CCP-803/PF-001, cached 2026-11-08 from https://app.cadets.gc.ca/cadet-publications/A-CR-CCP-803-PF-001/A-CR-CCP-803-PF-001.pdf.
Verify against the official publication.



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 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.

Unofficial convenience copy of A-CR-CCP-803/PF-001, cached 2026-11-08 from https://app.cadets.gc.ca/cadet-publications/A-CR-CCP-803-PF-001/A-CR-CCP-803-PF-001.pdf.
Verify against the official publication.

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.

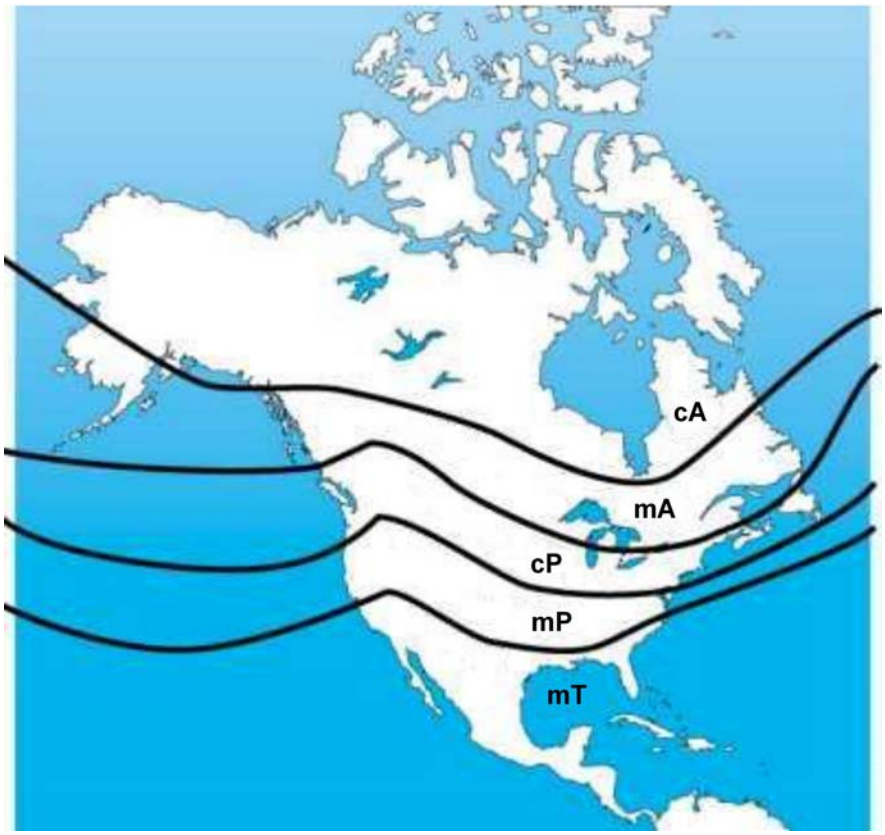
An air mass may be defined as a large section of the troposphere with uniform properties of temperature and moisture along the horizontal plane. This means that if a horizontal cross-section was taken of an air mass, one would see layers within the air mass where the temperature and the amount of moisture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

Unofficial convenience copy of A-CR-CCP-803/PF-001, cached 2026-11-08 from https://app.cadets.gc.ca/cadet-publications/A-CR-CCP-803-PF-001/A-CR-CCP-803-PF-001.pdf.
Verify against the official publication.



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 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).

Unofficial convenience copy of A-CR-CCP-803/PF-001, cached 2026-11-08 from https://app.cadets.gc.ca/cadet-publications/A-CR-CCP-803-PF-001/A-CR-CCP-803-PF-001.pdf.
Verify against the official publication.

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.

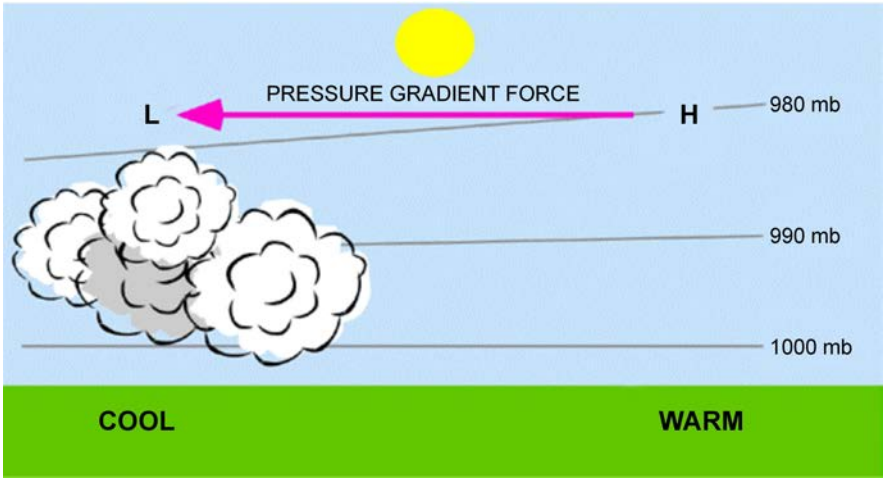


Show slide of Annex M.

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.

Unofficial convenience copy of A-CR-CCP-803/PF-001, cached 2026-11-08 from https://app.cadets.gc.ca/cadet-publications/A-CR-CCP-803-PF-001/A-CR-CCP-803-PF-001.pdf.
Verify against the official publication.



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 4 Pressure Gradient

Land and Sea Breezes

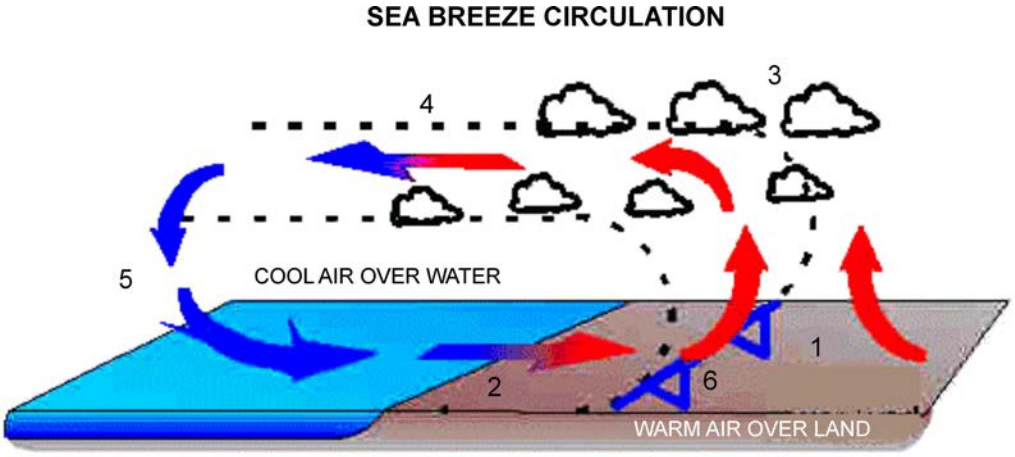
Land and sea breezes are caused by the differences in temperature over land and water.



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.

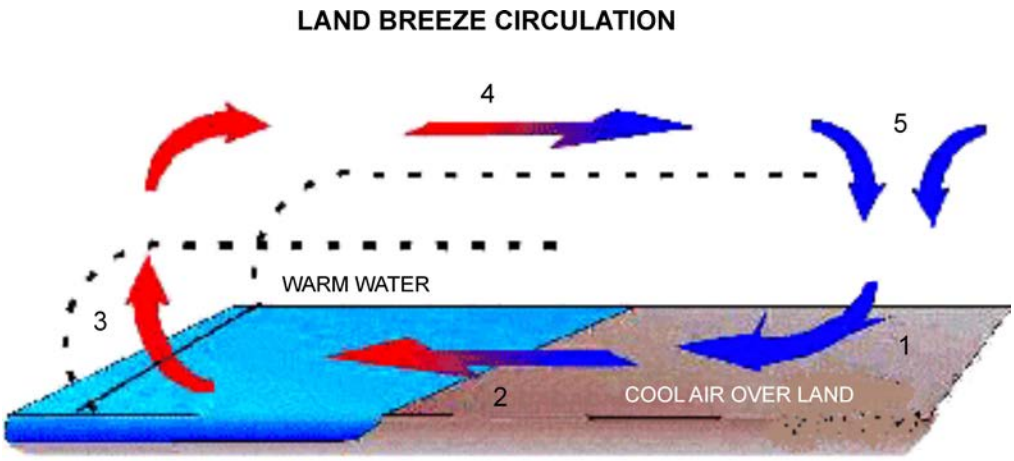


The Weather Doctor, K. C. Heidron, PhD, 1993, Sea and Land Breezes, Copyright 1998 by K. C. Heidron PhD. Retrieved April 7, 2008 from http://www.islandnet.com/~see/weather/elements/seabrz.htm

Figure 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.

Unofficial convenience copy of A-CR-CCP-803/PF-001, cached 2026-11-08 from https://app.cadets.gc.ca/cadet-publications/A-CR-CCP-803-PF-001/A-CR-CCP-803-PF-001.pdf.
Verify against the official publication.



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 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?

Unofficial convenience copy of A-CR-CCP-803/PF-001, cached 2026-11-08 from https://app.cadets.gc.ca/cadet-publications/A-CR-CCP-803-PF-001/A-CR-CCP-803-PF-001.pdf.
Verify against the official publication.

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?

Unofficial convenience copy of A-CR-CCP-803/PF-001, cached 2026-11-08 from https://app.cadets.gc.ca/cadet-publications/A-CR-CCP-803-PF-001/A-CR-CCP-803-PF-001.pdf.
Verify against the official publication.

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.

Unofficial convenience copy of A-CR-CCP-803/PF-001, cached 2026-11-08 from https://app.cadets.gc.ca/cadet-publications/A-CR-CCP-803-PF-001/A-CR-CCP-803-PF-001.pdf.
Verify against the official publication.

THIS PAGE INTENTIONALLY LEFT BLANK

Unofficial convenience copy of A-CR-CCP-803/PF-001, cached 2026-11-08 from https://app.cadets.gc.ca/cadet-publications/A-CR-CCP-803-PF-001/A-CR-CCP-803-PF-001.pdf.
Verify against the official publication.