**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.



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**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.



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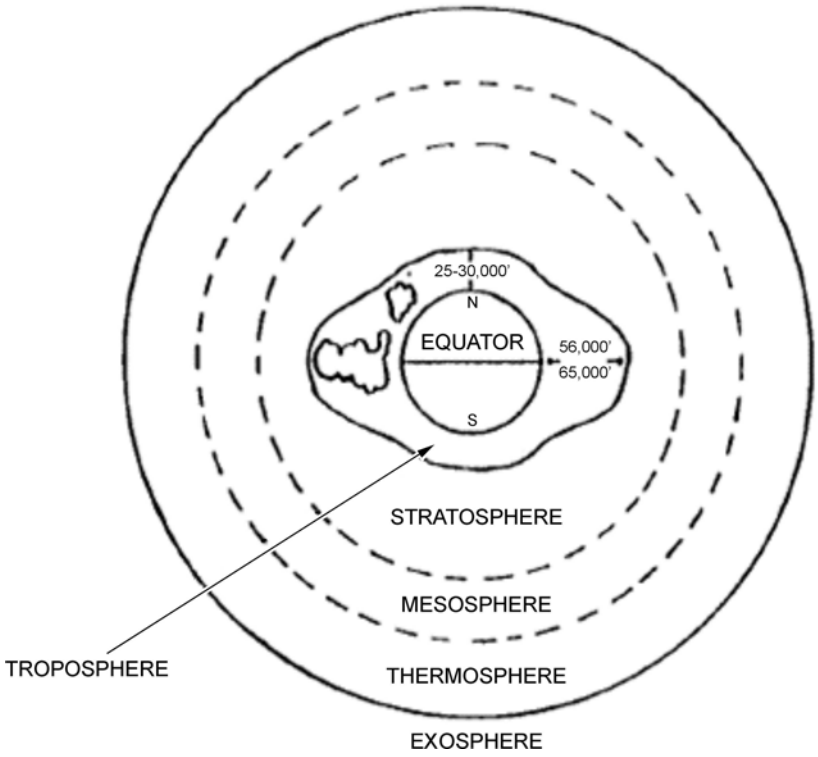
**Teaching point 2** **Illustrate the Divisions of the Atmosphere**

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 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.



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**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.

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**CONFIRMATION OF TEACHING POINT 2**

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**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.



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**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.



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**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.



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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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