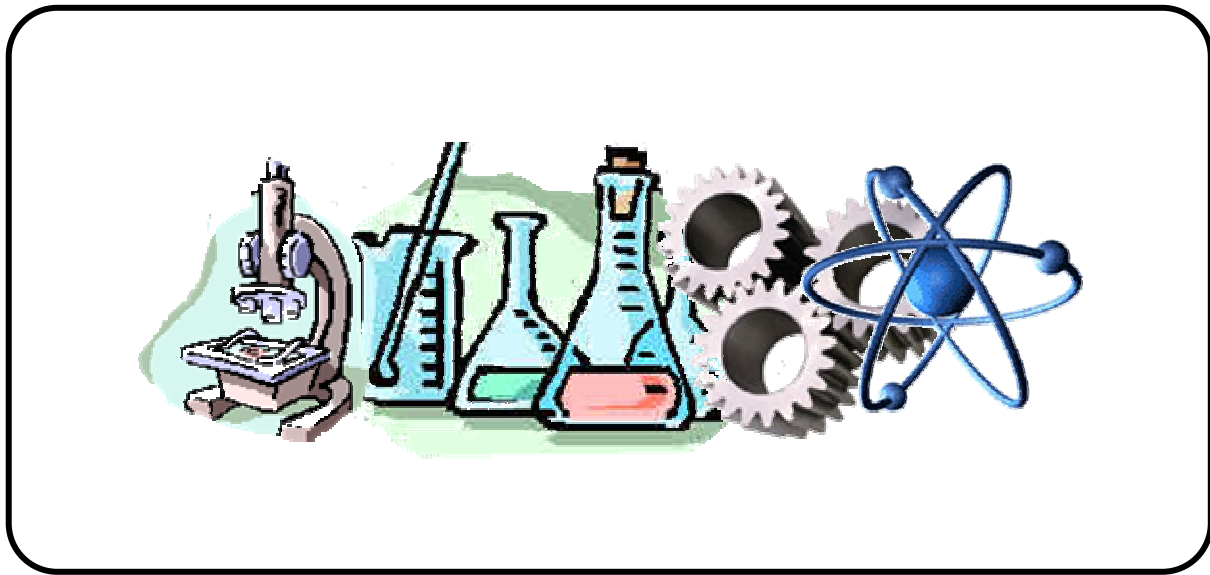


# Project EASE

(Effective and Alternative Secondary Education)

## *INTEGRATED SCIENCE I*



## MODULE 14



**BUREAU OF SECONDARY EDUCATION**

Department of Education  
DepED Complex, Meralco Avenue  
Pasig City



# Module 14

## The Earth's Atmosphere



### *What this module is about*

You have learned facts about the earth's lithosphere and hydrosphere in your last module. This module presents knowledge about the earth's gaseous envelope - the atmosphere. It includes the following lessons:

- **Lesson 1 - The Earth's Grid System**
- **Lesson 2 - The Earth's Atmosphere**
- **Lesson 3 - The Layers of the Earth's Atmosphere**
- **Lesson 4 - The Changes in the Earth's Atmosphere**



### *What you are expected to learn*

After going through the module, you are expected to:

1. explain the importance of the coordinate system in locating places on earth;
2. describe the composition of the earth's atmosphere;
3. identify the different layers of the earth's atmosphere; and
4. enumerate and describe the changes in the earth's atmosphere.



### *How to learn from this module*

Here's a simple guide for you in going about the module:

1. Read the instructions carefully.
2. Follow the instructions very carefully.
3. Answer the pre-test in order to determine how much you know about the lessons in this module.
4. Check your answers with the given answer key at the end of this module.
5. Read each lesson and do activities that are provided for you.

6. Perform all the activities diligently to help and guide you in understanding the topic.
7. Take the self-tests after each lesson to determine how much you understood the topic.
8. Answer the posttest to measure how much you have gained from the lessons.

**Good Luck and have fun!**



## *What to do before (Pretest)*

### **A. Direction: Encircle the correct answer.**

1. An imaginary line that divides the places on the earth in an EAST-WEST direction is the:
  - a. equator
  - b. latitude
  - c. longitude
  - d. prime meridian
2. The Great Circle is also known as the
  - a. equator
  - b. latitude
  - c. longitude
  - d. prime meridian
3. The 180° meridian is also called
  - a. equator
  - b. latitude
  - c. longitude
  - d. prime meridian
4. An imaginary line that divides the places on the earth in an NORTH-SOUTH direction is the:
  - a. equator
  - b. latitude
  - c. longitude
  - d. prime meridian
5. Which of the following statements describes the temperature in the troposphere and stratosphere?
  - a. The troposphere is hotter than the stratosphere
  - b. The stratosphere is hotter than the troposphere
  - c. Low temperature exists in the troposphere and stratosphere.
  - d. The temperature in the troposphere is equal to the temperature of the stratosphere.

6. Arrange the following layers of the atmosphere from the earth's reference.
- |                         |                  |
|-------------------------|------------------|
| <b>A</b> - ozone layer  | a. A – B – C - D |
| <b>B</b> – stratosphere | b. B – C – D - A |
| <b>C</b> – troposphere  | c. C – D – A - B |
| <b>D</b> - mesosphere   | d. C – A - B – D |
7. What part of the atmosphere has no weather disturbance?  
a. ozone layer   b. stratosphere   c. troposphere   d. mesosphere
8. Which part of the atmosphere protects us from harmful ultraviolet rays?  
a. ozone layer   b. stratosphere   c. troposphere   d. mesosphere
9. There are \_\_\_\_\_ seasons on earth.  
a. one (1)   b. two (2)   c. three (3)   d. four (4)
10. The earth's axis is inclined at \_\_\_\_\_  
a. 25.5°   b. 24.5°   c. 23.5°   d. 22.5°

**B. Match Column A with Column B**

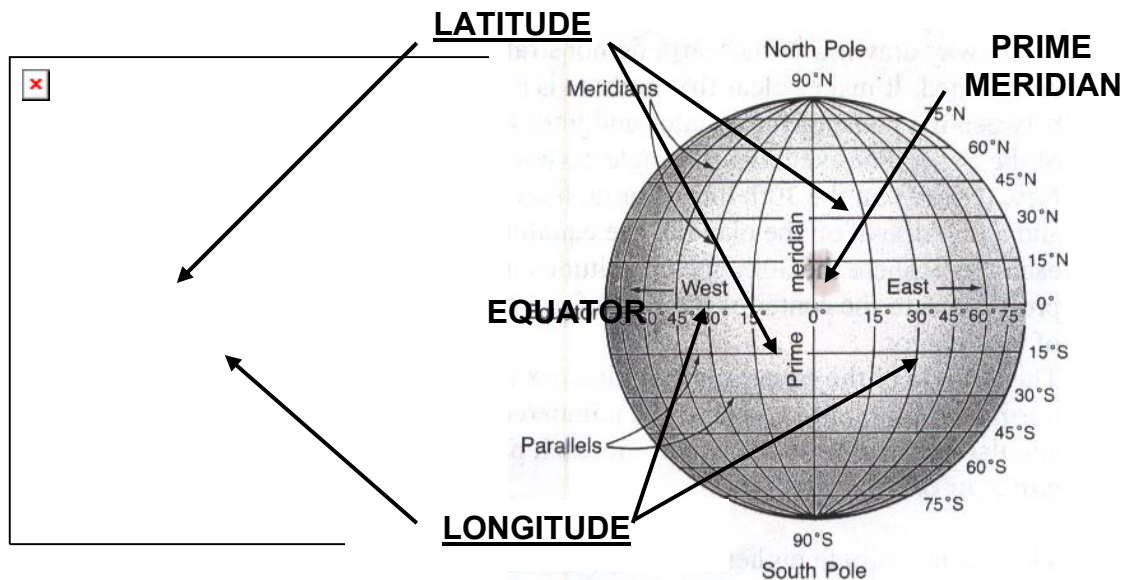
- | <b>COLUMN A</b>    | <b>COLUMN B</b>                                                                                                     |
|--------------------|---------------------------------------------------------------------------------------------------------------------|
| 1. atmosphere      | a. layer of the atmosphere that is characterized by an increase in temperature due to the concentration of ozone    |
| 2. troposphere     | b. lowermost layer of the atmosphere that is characterized by a decrease in temperature with height                 |
| 3. stratosphere    | c. layer of the atmosphere that is immediately above the stratosphere                                               |
| 4. ozone layer     | d. it is called the "blanket of air"                                                                                |
| 5. mesosphere      | e. it is the state of the atmosphere at a particular place during a short period of time                            |
| 6. air pollution   | f. it is caused by the earth-sun relationship                                                                       |
| 7. weather         | g. it is the condition of the atmosphere at a particular location over a long period of time                        |
| 8. climate         | h. formed through the process of precipitation                                                                      |
| 9. season          | i. it is the warming of the earth's surface                                                                         |
| 10. global warming | j. it involves the release into the atmosphere of gases, finely divided solids, or finely dispersed liquid aerosols |



Key to answers on page 29

## Lesson 1 The Earth's Grid System

**Earth's grid or coordinate system** can be described and determined by means of the position or location of any place on the Earth's surface.



The two reference points in locating the places on earth are the equator and the prime meridian.

The **equator** is also called the great circle around the Earth that is equidistant from the geographic poles and lies in a plane perpendicular to the Earth's axis. It divides the Earth into the Northern and Southern hemispheres and forms the imaginary reference line on the Earth's surface from which latitude is considered. It is the line with 0° latitude

The **prime meridian** is the imaginary line used to indicate 0° longitude that passes through Greenwich and terminates at the North and South poles. It is measured in degrees, minutes, and seconds. It is used as the reference for all other meridians of longitude, which are numbered east or west of it. This also serves as the basis for the world's standard time zone system.

**Latitude** is a measurement on a globe or map of location north or south of the equator. It is measured in degrees, minutes, and seconds. The greatest possible latitudes are 90° N and 90° S. Different latitudinal positions on maps or globes, equidistant circles are plotted and drawn parallel to the equator and each other. These are known as the parallels, or parallels of latitude.

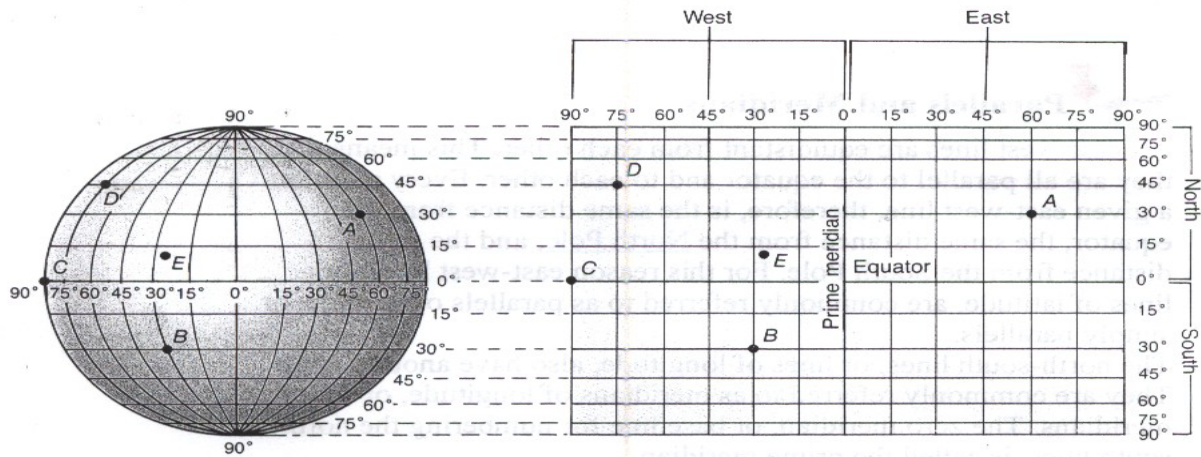
**Longitude** is a measurement of location east or west of the prime meridian at Greenwich. It is the amount of arc created by drawing first a line from the center of the Earth to the intersection of the equator and the prime meridian and then another line from the

center of the earth to any point elsewhere on the Equator. Longitude is measured 180° both east and west of the prime meridian. To locate longitudinal positions on a globe or map, meridians are plotted and drawn from pole to pole where they meet. The distance per degree of longitude at the Equator is about 111.32 km (69.18 miles) and at the poles, 0. The combination of meridians of longitude and parallels of latitude establishes a framework or grid by means of which exact positions can be determined in reference to the prime meridian and the Equator.



*What you will do*  
**Activity 1.1**

Based on the discussion, identify the points (latitude and longitude) plotted on the coordinate system. The first two points are identified for you. Write your answers on the table provided for:



Points on the Globe	Parallel Latitudes	Parallel Longitudes
<b>A</b>	30°N	60°E
<b>B</b>	30°S	30°W
<b>C</b>		
<b>D</b>		
<b>E</b>		

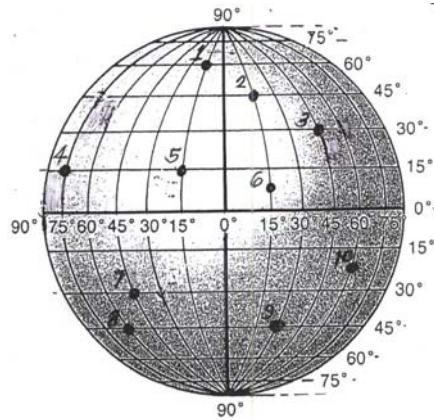


**Key to answers on page 29**



*What you will do*  
**Self-Test 1.1**

Study the diagram below. Identify the parts that are shown in the diagram. Fill up the table below.



POINTS ON THE GLOBE	PARALLEL OF LATITUDES	PARALLEL OF LONGITUDES
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		



Key to answers on page 29

## Lesson 2 The Earth's Atmosphere

This lesson will guide you in understanding the earth's atmosphere - the place on earth that is vital to our existence. It will help you examine the ocean of air in which we all must live.

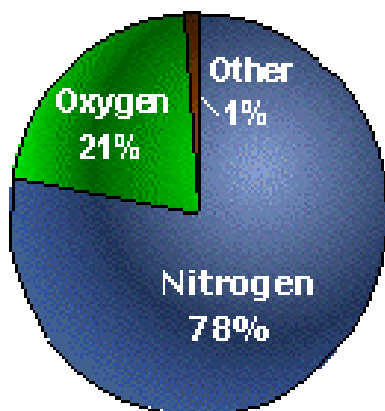
The atmosphere, solar energy and our planet's magnetic fields support life on Earth. The atmosphere absorbs the energy from the Sun, recycles water and other chemicals, and works with the electrical and magnetic forces to provide a moderate climate. The atmosphere also protects us from high-energy radiation and the frigid vacuum of space.

### The Earth's Atmosphere

The earth is a terrestrial body whose solid surface, abundant waters, and oxygen-rich atmosphere have combined to create conditions suitable for life.

The earth is surrounded by a blanket of air that we call **atmosphere**. The atmosphere is considered in terms of layers, or regions, arranged like spherical shells above the surface of the Earth. It reaches over 560 kilometers (348 miles) from the surface of the Earth, so we are only able to see what occurs fairly close to the ground. Early attempts at studying the nature of the atmosphere used clues from the weather, the beautiful multi-colored sunsets and sunrises, and the twinkling of stars. With the use of sensitive instruments from space, we are able to get a better view of our atmosphere.

### Composition of the Atmosphere



Gas	Percent by Volume
Nitrogen, N <sub>2</sub>	78.084
Oxygen, O <sub>2</sub>	20.946
Argon, Ar	0.934
Carbon dioxide, CO <sub>2</sub>	0.033
Ne	0.001818
H <sub>2</sub>	.000524
CH <sub>4</sub>	0.002
Kr	0.000114
H <sub>2</sub>	0.00005
N <sub>2</sub> O	0.00005
Xe	0.0000087



The atmosphere is primarily composed of nitrogen ( $N_2$ , 78%), oxygen ( $O_2$ , 21%), and argon (Ar, 1%). A myriad of other very influential components are also present which include the "greenhouse" gases or ozone (0 - 0.01%), carbon dioxide ( $CO_2$ , 0.033%). (Refer to Table)

The atmosphere extends from the surface of the Earth to heights of thousands of kilometers, where it gradually merges with the solar wind. The composition of the atmosphere as measured by its mean density (the average mass per unit volume) is more or less constant with height to altitudes of about 100 kilometers. This state of approximate uniformity arises as a result of motion and as a consequence of the high frequency with which molecules of a particular species are involved in collisions with their neighbors. A representative oxygen molecule,  $O_2$ , for example, encounters a nitrogen molecule,  $N_2$ , on average once every  $10^{-9}$  second at the surface. Even at heights of 100 kilometers, where the density of air molecules is much lower, the encounter time is still comparatively brief, about  $10^{-3}$  second. A force imparted to one molecule is rapidly transferred to all. The atmosphere tends to behave as though it were composed of a single molecular species with an effective molecular mass set by its mean composition. The bulk of the lower atmosphere is composed of  $N_2$  and  $O_2$ , with relative abundances of, respectively, 0.78 and 0.21. The region above 100 kilometers is referred to as the **heterosphere**, a name intended to emphasize the importance of the change in composition as a function of altitude. In the same vein, the region lower than 100 kilometers was given the name **homosphere**.



## *What you will do* Activity 2.1

Choose any set of jumbled letters. Arrange the letters to form word/s that is/are described by the following sentences.

gonar      parethomse      genortin      therosphere      smehporeoh

1. The place on earth that is vital to life
2. The gas which consists 78% of this place on earth. (see No. 1)
3. The part of the atmosphere where the bulk of the lower atmosphere composed of  $N_2$  and  $O_2$  is \_\_\_\_\_.
4. The region in the atmosphere where it is below 100 km.
5. What gas composed 1% of the atmosphere?

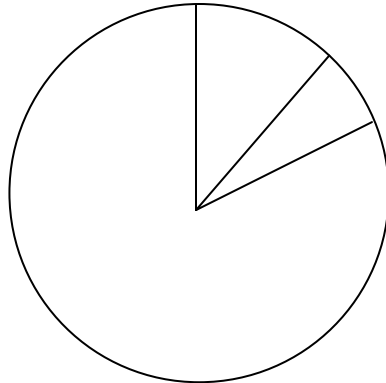


Key to answers on page 30



*What you will do*  
Self-Test 2.1

Label each division in the circle based on the percentage of gasses present in the earth's atmosphere.



Key to answers on page 30

### Lesson 3 The Layers of Earth's Atmosphere

This lesson will focus on the different layers of the earth's atmosphere. To help you understand and visualize these layers, study the diagram below:



The envelope of gas surrounding the Earth changes from the ground up. Four distinct layers have been identified using temperature changes, chemical composition, movement, and density. However, there are no distinct lines or boundaries where one layer ends and the other begins.

The **mesosphere** is the "Middle sphere" and is the coldest layer of the atmosphere. There are very few gases available in this layer to absorb the heat from the sun. The mesopause is the upper boundary for this layer.

The **stratosphere** extends from the top of the tropopause to about 50 km (31 miles). The temperature begins to increase in this layer because it contains the highest concentration of ozone. Ozone absorbs the sun's heat and also protects us from the harmful ultraviolet rays of the sun. The stratosphere is ideal for jets to travel in because they are above the weather and the air is so "thin" that it offers little resistance to the aircraft. There is no weather in this layer because there is no water vapor. The stratopause is the upper boundary for this layer.

Although the greenhouse effect and the **ozone layer** both protect life on earth, they are very different. While the greenhouse effect lets sunshine in and prevents the heat from escaping, the ozone layer prevents harmful ultraviolet radiation from entering the atmosphere. Ultraviolet radiation from the sun is what causes sunburns and skin cancer. The layer of gaseous ozone in the upper atmosphere that blocks radiation is what we call the ozone layer.

In the stratosphere, ozone is distributed all over the globe. It exists at concentrations that would be deadly in the troposphere, which extends from the Earth's surface to about 7 miles up. The ozone layer is not a thin band of concentrated gas. The ozone layer in the stratosphere extends from about 7 miles up to about 30 miles.

The **troposphere** is the lowest layer of the atmosphere where all weather occurs. It is the only layer that has both the moisture and instability necessary to produce clouds. The troposphere extends upward about 6 km (3.7 miles) at the poles, and as much as 16 km (10 miles) at the equator. The temperature decreases as one goes higher up. The tropopause, a transition zone between the troposphere and the stratosphere, is where the jet streams are found.



## *What you will do* Self-Test 3.1

Identify the following: Write your answer on the space provided before the number:

- \_\_\_\_\_ 1. The “blanket of air” on earth’s layer
- \_\_\_\_\_ 2. The lowermost layer of the atmosphere that is characterized by a decrease in temperature with height
- \_\_\_\_\_ 3. The layer of the atmosphere that is characterized by an increase in temperature due to the concentration of ozone
- \_\_\_\_\_ 4. The layer of the atmosphere that is immediately above the stratosphere
- \_\_\_\_\_ 5. The two factors that are considered in determining the layers of the atmosphere



Key to answers on page 30

## **Lesson 4 The Changes in the Earth’s Atmosphere**

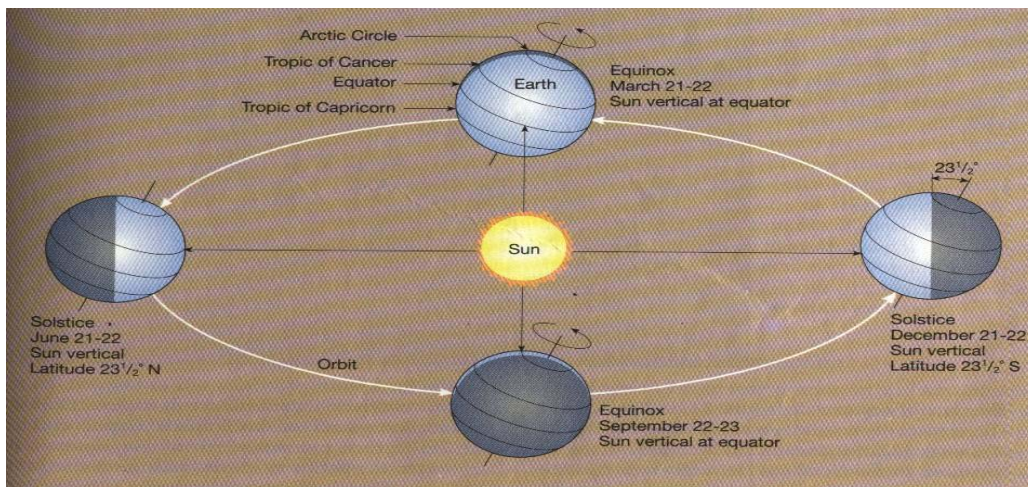
Imagine that you are living 100 years ago. The air today is not as clean as it was 100 years ago. Years have passed and the age of industrialism and rise of technology gave rise to this changing earth. Each year a huge amount of wastes is generated.

This lesson will help you understand how these changes affect the environment particularly the air. This will help you answer the following basic questions:

1. What causes the seasons?
2. How is air heated?
3. What factors control the different temperature of the earth?

**The following paragraph discusses what causes seasons**

**Season** is caused by the earth-sun relationship. It is any of four divisions of the year according to consistent annual changes in the weather. The seasons—winter, spring, summer, and autumn—are commonly regarded in the Northern Hemisphere as beginning on the winter solstice, December 22 or 23; the vernal equinox, March 20 or 21; the summer solstice, June 21 or 22; and the autumnal equinox, September 22 or 23. At the **equinoxes**, the days and nights are equal in length; at the **winter solstice** the day is the year's shortest, and at the **summer solstice**, the day is the year's longest. (See Figure 4.1)

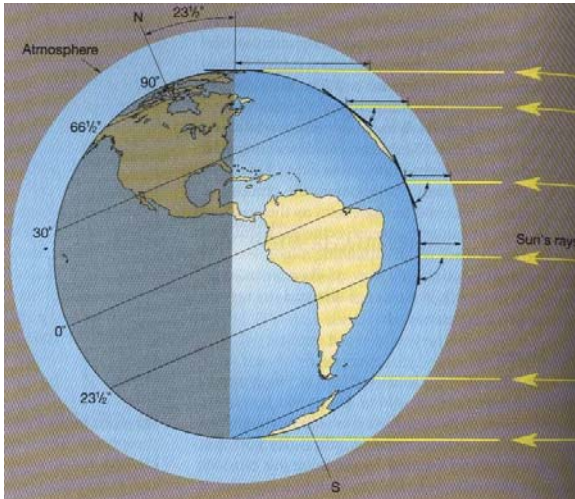


**Figure 4.1:** The Earth-Sun relationships

Each year the earth experiences changes in its radiation budget, in the distribution of heat input into the atmosphere and in the course of the seasonal migration of the Sun between 23°N and 23°S. This is a result of seasonal change.

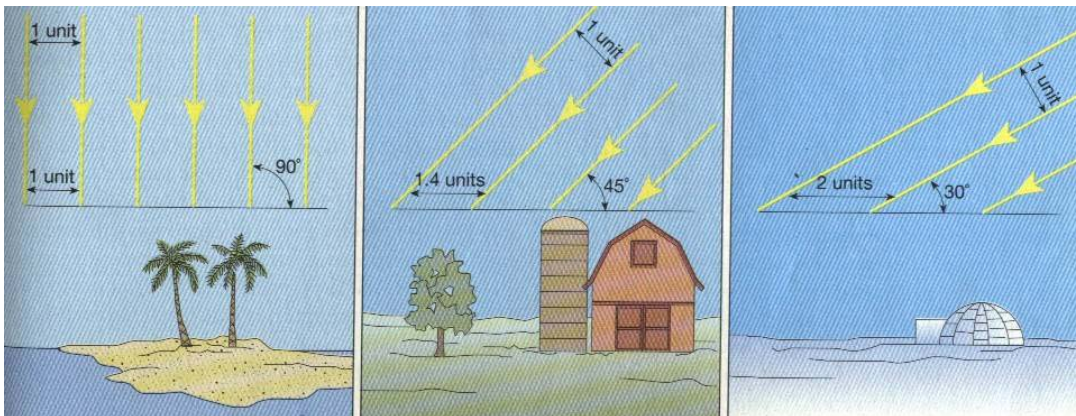
Why is there variation in season? The gradual change in daylight that occurs throughout the year accounts for this difference. (See Figure 4.2)





**Figure 4.2:** Rays striking at a low angle travel through more of the atmosphere than rays striking at a higher angle and therefore are subjected to greater depletion due to reflection of sunlight.

The seasonal variation in the altitude of the sun affects the amount of energy received at the earth's surface in two ways. First, when the sun is directly overhead ( $90^\circ$  angle), the solar rays are most concentrated. The lower the angle, the more spread out and less intense is the solar radiation that reaches the surface. (See Fig. 4.3). Second, the rays of the sun determine the amount of atmosphere the rays must travel. (See Fig. 4.2). This accounts for the fact that the midday sun can be blinding, while the setting sun can be a sight to behold.



**Figure 4.3** Changes in the sun angle cause variations in the amount of solar energy reaching the earth's surface. The higher the angle, the more intense the solar radiation.

## Weather and Climate

### Weather

Does it amaze you how the weather influences your life? Most conversations begin or end with comments about the weather. **Weather** is the state of the atmosphere at a particular place during a short period of time. It involves such atmospheric phenomena as temperature, humidity, precipitation (type and amount), air pressure, wind, and cloud cover. Weather differs from climate in that the latter is the synthesis of weather conditions that have prevailed over a given area during a long time period—generally 30 years. Weather occurs in the troposphere. Although weather is largely confined to the troposphere, phenomena of the higher regions of the atmosphere such as jet streams and upper-air waves significantly affect sea-level atmospheric-pressure patterns—the so-called highs and lows—and thereby the weather conditions at the terrestrial surface. Manifestations of such weather-affecting interactions between the ocean and the atmosphere are what scientists call the El Niño and La Niña.


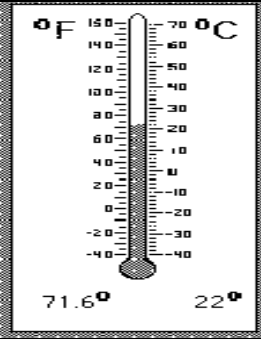
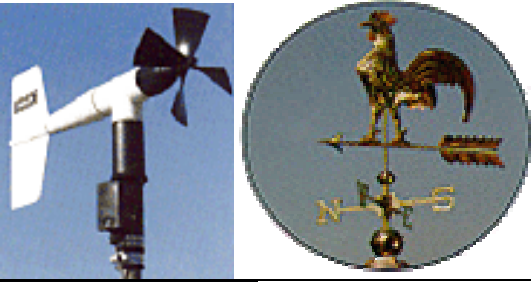
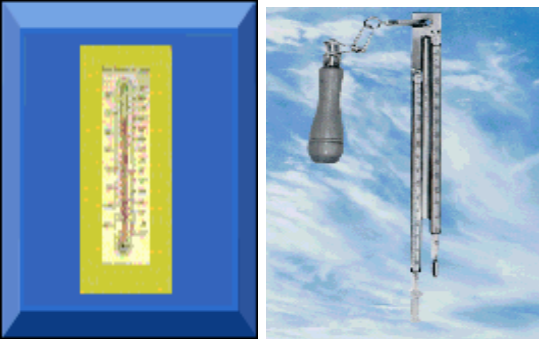

### Climate

**Climate** is the condition of the atmosphere at a particular location over a long period of time; it is the long-term summation of the atmospheric elements (and their variations) that, over short time periods, constitute weather. These elements are solar radiation, temperature, humidity, precipitation (type, frequency, and amount), atmospheric pressure, and wind (speed and direction). To the general public the word retains the meaning of expected or habitual weather, which is heavily dependent on place and time of year. Climate is now perceived as part of a larger system that includes the atmosphere but also the hydrosphere (all liquid and frozen surface waters), the lithosphere (all solid land surfaces, including the ocean floors), the biosphere (all living things), and such extraterrestrial factors as the Sun.


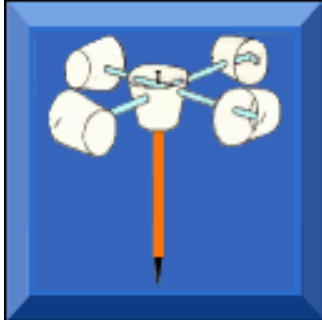
### Methodology of weather forecasting.

Weather forecasting includes predictions of changes on the earth's surface caused by atmospheric conditions. When people wait under a shelter for a downpour to end, they are making a very short-range weather forecast. They are assuming, based on past experiences that such hard rain usually does not last very long. In short-term predictions the challenge for the forecaster is to improve on what the layperson can do. For years, developed a method called nowcasting. In this method, radar and satellite observations of local atmospheric conditions are processed and displayed rapidly by computers to project weather several hours in advance. The PHILIPPINE ATMOSPHERIC GEOPHYSICAL AND ASTRONOMICAL SERVICES AUTHORITY (**PAGASA**) is an agency that measure and predict atmospheric conditions for large areas by computer. Using models that apply their accumulated expert knowledge quickly, accurately, and in a statistically valid form, meteorologists are now capable of making forecasts objectively. As a consequence, the same results are produced time after time from the same data inputs, with all analysis accomplished mathematically.

Forecasters in weather forecasting use the following weather tools.

Uses of Weather Tools	Picture of Tools/ Instruments
<p>Rain Gauge - a tool used to measure the amount of precipitation that falls. The precipitation is collected in a container with a ruler to show the amount.</p>	
<p>Thermometer - an instrument used to measure temperatures. Mercury inside the thermometer rises or falls as it expands or contracts from changes in temperature.</p>	
<p>Wind Vane - A tool used to measure the direction the wind is blowing.</p>	
<p>Barometer - A tool used to measure the atmospheric (air) pressure which is then used to forecast the weather. Low pressure is associated with bad weather (Low = Lousy) and high pressure is associated with good weather (High = Heavenly)</p>	
<p>Hygrometer - A tool used to measure the amount of humidity or moisture in the air. The higher the humidity, the more moisture is in the air</p>	



<p>Anemometer - A tool used to measure wind speed.</p>	
<p>Small cups spin - record the speed of the wind. The faster the cups spin, the harder the wind blows.</p>	

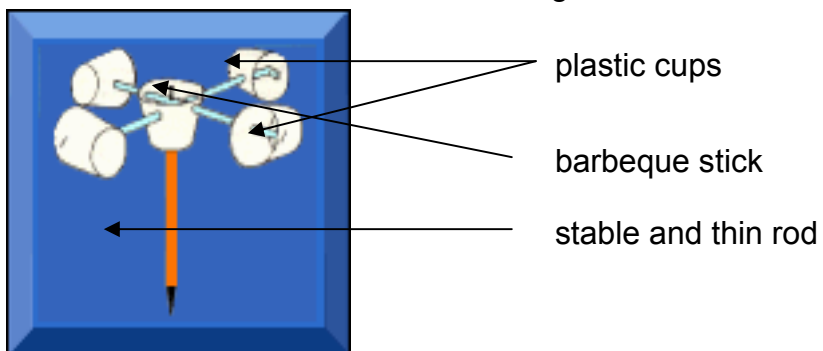


*What you will do*  
**Activity 4.1**

**Forecast the weather up to 48 hours using an improvised anemometer (small cups spin)**

A. Make your own anemometer:

1. Gather the materials: 5 small plastic cups, barbecue sticks and thin rod.
2. Assemble the materials as shown in the diagram:

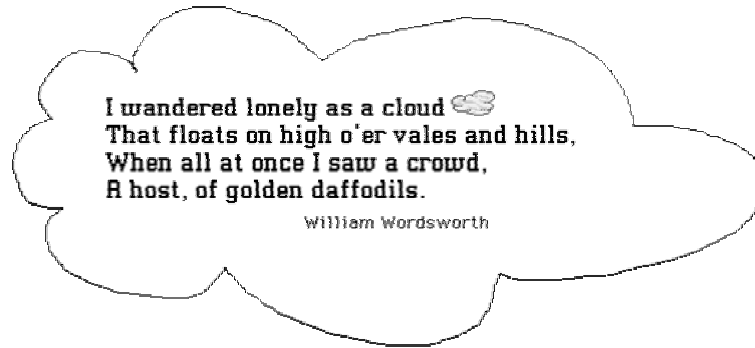


- B. Try your improvised anemometer. Place it outside the house where there is enough wind. Install it in a way that it can't be thrown by the strong wind.
- C. Observe the movement of the instrument.
- D. From your observation, tell what the weather is.

- E. Forecast the weather for two days.
- F. Verify your answers by watching TV for weather reports.

**Changes brought about by weather and climate:**

Are you familiar with this poem?



Clouds are made of small droplets of water or bits of ice that are spread out from each other. Rain falls when the drops get too big and heavy to stay in the cloud. There are three main kinds of clouds. What are these?



*What you will do*  
**Activity 4.2**

Directions

- Look outside and see if there are any clouds in the sky today.
- Draw pictures of the clouds
- Tell what the weather is like.
- Using the pictures, find the cloud that most closely matches those you have seen and drawn.
- Compare your drawing with the pictures of the clouds below.
- Write down the name of the cloud.

Draw the clouds here:

Describe the weather today:

## Different Kinds of Clouds

### Cirrus Clouds



Can you see the "halo" in this picture? The person taking the picture blocked out the sun with his fist so that he could get the picture. The halo is caused by **cirrus** clouds. The bright spot on the left is a "sun dog."



**Cirrus**(meaning "curl") clouds are very high, wispy clouds made of ice. Even in the summer, cirrus clouds are made of ice because it is cold high above Earth.

## Cumulus Clouds



**Cumulus** (meaning "heap") clouds are the large clouds that sometimes look like huge puffs of cotton. Sometimes these clouds look like animals or familiar things. It is fun to use your imagination to make up stories about the clouds.



Sometimes cumulus clouds get dark gray and rain or hail falls from them. They are then called **cumulonimbus** clouds. These clouds often produce lightning and thunder. **Nimbus** always tells us that a cloud brings rain.

## Stratus Clouds



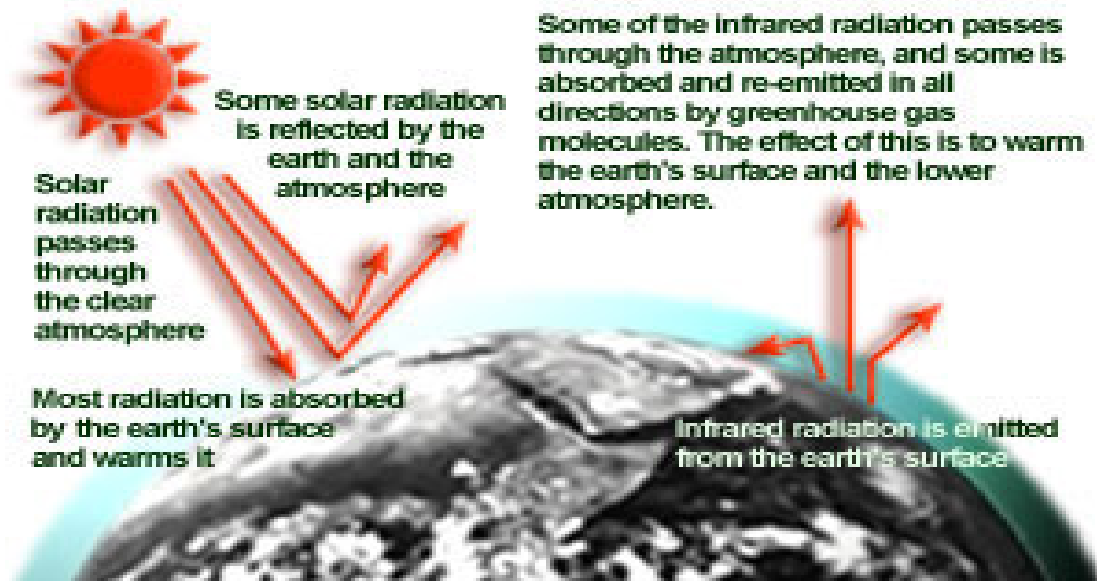
**Stratus** (meaning "stretched out") clouds are made up of low layers of clouds that usually cover the whole sky and blot out the sun. These clouds bring gray days. When rain falls from them, they are called **nimbostratus** clouds.

## The Greenhouse Effect

**Greenhouse effect** is the warming of the earth's surface and lower atmosphere that tends to intensify with an increase in atmospheric carbon dioxide. The atmosphere allows a large percentage of the rays of visible light from the sun to reach the earth's surface and heat it. A part of this energy is reradiated by the earth's surface in the form of long-wave infrared radiation, much of which is absorbed by molecules of carbon dioxide and water vapor in the atmosphere and which is reflected back to the surface as heat. This is roughly analogous to the effect produced by the glass panes of a greenhouse, which transmit sunlight in the visible range but hold in heat. The trapping of this infrared radiation causes the earth's surface and lower atmospheric layers to warm to a higher temperature than would otherwise be the case. Without this greenhouse heating, the earth's average temperature would be only about  $-73^{\circ}\text{C}$  ( $-100^{\circ}\text{F}$ ); even the oceans would be frozen under such conditions. Owing to the rise in atmospheric carbon dioxide caused by modern industrial societies' widespread combustion of fossil fuels (coal, oil, and natural gas), the greenhouse effect on earth may be intensified and long-term climatic changes may result. An increase in atmospheric concentrations of other trace gases such as chlorofluorocarbons (Freons), nitrous oxide, and methane, due again largely to human activity, may also aggravate greenhouse conditions. A growing number of scientists have predicted that significant alterations in climate patterns will be seen by the turn of the century. They estimate that global average temperatures could increase by as much as  $5^{\circ}\text{C}$  ( $9^{\circ}\text{F}$ ) by the middle of the 21st century. Such global warming would cause the polar ice caps and mountain glaciers to melt rapidly and result in appreciably higher coastal waters. The rise in global temperature would also produce new patterns and extremes of drought and rainfall, seriously disrupting food production in certain regions.

**Global warming** is a potential increase in average global atmospheric temperatures resulting from the greenhouse effect.

## The Greenhouse Effect



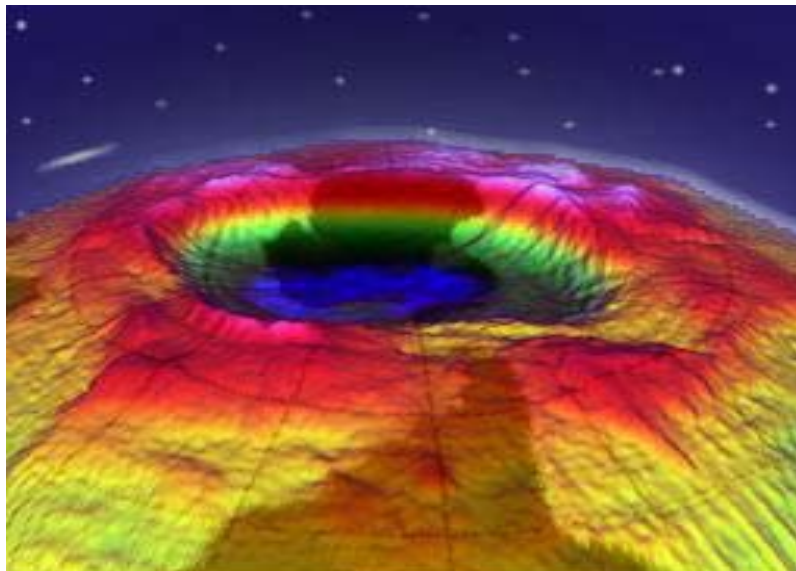
Source: U.S. Environmental Protection Agency, 2002

## The Ozone Hole

The ozone layer is not of the same thickness all around the Earth. The ozone hole refers to areas of the ozone layer that are so thin that cannot block as much radiation as thicker parts. When the ozone layer thins to 50 percent of its normal thickness, that area is called an ozone hole.

The ozone hole is caused by the breakdown of certain chlorine and/or bromine compounds (called chlorofluorocarbons (CFCs) or halons). These compounds are commonly used as a coolant in refrigerators and air conditioners, in foam manufacturing and as fire extinguishing agents.

Ground-level ozone, often called smog, is a harmful air pollutant that irritates the lungs and damages the leaves of plants. The difference between the ozone in the ozone layer and harmful ground-level ozone is the location of the ozone in relation to people, plants and animals. Ozone in the ozone layer is so high above ground that it cannot reach people, plants and animals and cannot harm them. However, ozone at ground level is close enough to breathe.



## Air Pollution

**Air pollution** involves the release into the atmosphere of gases, finely divided solids, or finely dispersed liquid aerosols at rates that exceed the capacity of the atmosphere to dissipate them or to dispose of them through incorporation into solid or liquid layers of the biosphere. Air pollution results from a variety of causes, not all of which are within human control. Air pollution may affect humans directly, causing a smarting of the eyes or coughing. Pollution continued to increase as a result of the increased number of motor vehicles. Exhaust fumes from the engines of automobiles contain a number of polluting



substances, including carbon monoxide and a variety of complex hydrocarbons, nitrogen oxides, and other compounds. When acted upon by sunlight, these substances undergo a change in composition producing the brown, photochemical smog. Efforts to reduce pollution from automobile engines and to develop pollution-free engines may eventually eliminate the more serious air pollution problems. Air pollution has a serious effect and has caused respiratory distress, particularly in children, elderly people, and those suffering from respiratory diseases.

### **Sources of air pollutants**

The two main sources of pollutants in urban areas are transportation (predominantly automobiles) and fuel combustion in stationary sources, including residential, commercial, and industrial heating and cooling and coal-burning power plants. Motor vehicles produce high levels of carbon monoxides (CO) and a major source of hydrocarbons (HC) and nitrogen oxides (NO<sub>x</sub>). Whereas, fuel combustion in stationary sources is the dominant source of sulfur dioxide (SO<sub>2</sub>).

### **Carbon Dioxide**

**Carbon dioxide (CO<sub>2</sub>)** is one of the major pollutants in the atmosphere. Major sources of CO<sub>2</sub> are fossil fuels burning and deforestation. CO<sub>2</sub> is a good transmitter of sunlight, but partially restricts infrared radiation going back from the earth into space. This produces the so-called greenhouse effect that prevents a drastic cooling of the Earth during the night. Increasing the amount of CO<sub>2</sub> in the atmosphere reinforces this effect and is expected to result in a warming of the Earth's surface. Currently carbon dioxide is responsible for 57% of the global warming trend. Nitrogen oxides contribute most of the atmospheric contaminants.

### **NO<sub>x</sub> - nitric oxide (NO) and nitrogen dioxide (NO<sub>2</sub>)**

- Natural component of the Earth's atmosphere
- Important in the formation of both acid precipitation and photochemical smog (ozone), and causes nitrogen loading.
- Comes from the burning of biomass and fossil fuels
- 30 to 50 million tons per year from human activities, and natural 10 to 20 million tons per year
- Average residence time in the atmosphere is days
- Has a role in reducing stratospheric ozone

### **N<sub>2</sub>O - nitrous oxide**

- Natural component of the Earth's atmosphere
- Important in the greenhouse effect and causes nitrogen loading
- Human inputs 6 million tons per year, and 19 million tons per year by nature
- Residence time in the atmosphere about 170 years
- 1700 (285 parts per billion), 1990 (310 parts per billion), 2030 (340 parts per billion)
- Comes from nitrogen based fertilizers, deforestation, and biomass burning

## Sulfur and chlorofluorocarbons (CFCs)

Sulfur dioxide is produced by combustion of sulfur-containing fuels, such as coal and fuel oils. Also, in the process of producing sulfuric acid and in metallurgical process involving ores that contain sulfur. Sulfur oxides can injure man, plants and materials. At sufficiently high concentrations, sulfur dioxide irritates the upper respiratory tract of human beings because the potential effect of sulfur dioxide is to make breathing more difficult by causing the finer air tubes of the lung to constrict. Almost 60% of the  $\text{SO}_2$  emissions are released by tall smoke stacks, enabling the emissions to travel long distances. As emissions of sulfur dioxide and nitric oxide from stationary sources are transported long distances by winds, they form secondary pollutants such as nitrogen dioxide, nitric acid vapor, and droplets containing solutions of sulfuric acid, sulfate, and nitrate salts. These chemicals descend to the earth's surface in wet form as rain or snow and in dry form as gases fog, dew, or solid particles. This is known as acid deposition or acid rain.

## Chlorofluorocarbons (CFCs)

**CFCs** are lowering the average concentration of ozone in the stratosphere. Chlorofluorocarbons move up to the stratosphere gradually over several decades. Under high energy ultra violet (UV) radiation, they break down and release chlorine atoms, which speed up the breakdown of **ozone ( $\text{O}_3$ )** into **oxygen gas ( $\text{O}_2$ )**.

Chlorofluorocarbons, also known as Freons, are greenhouse gases that contribute to global warming. Photochemical air pollution is commonly referred to as "smog". Smog, a contraction of the words smoke and fog, has been caused throughout recorded history by water condensing on smoke particles, usually from burning coal. With the introduction of petroleum to replace coal economies in countries, photochemical smog has become predominant in many cities, which are located in sunny, warm, and dry climates with many motor vehicles. The worst episodes of photochemical smog tend to occur in summer.

## Smog

**Photochemical smog** is created by burning coal and heavy oil that contain sulfur impurities in power plants, industrial plants, etc. The smog consists mostly of a mixture of sulfur dioxide and fog. Suspended droplets of sulfuric acid are formed from some of the sulfur dioxide, and a variety of suspended solid particles. Smog's unpleasant properties result from the irradiation by sunlight of hydrocarbons caused primarily by unburned gasoline emitted by automobiles and other combustion sources. The products of photochemical reactions includes organic particles, **ozone**, aldehydes, ketones, peroxyacetyl nitrate, organic acids, and other oxidants. Ozone is a gas created by nitrogen dioxide or nitric oxide when exposed to sunlight. Ozone causes eye irritation, impaired lung function, and damage to trees and crops. Another form of smog is called industrial smog.



*What you will do*



## Self-Test 4.1

**Direction: Draw a line that connects the statement on the left with the statement on the right:**

- |                                                                                                                                  |                                   |
|----------------------------------------------------------------------------------------------------------------------------------|-----------------------------------|
| 1. It is the layer of the atmosphere that is characterized by an increase in temperature due to the concentration of ozone       | a. atmosphere                     |
| 2. It is the lowermost layer of the atmosphere that is characterized by a decrease in temperature with height                    | b. troposphere<br>c. stratosphere |
| 3. It is the layer of the atmosphere that is immediately above the stratosphere                                                  | d. ionosphere                     |
| 4. It is called the "blanket of air"                                                                                             | e. ozone layer                    |
| 5. It is the state of the atmosphere at a particular place during a short period of time                                         | f. mesosphere<br>g. thermosphere  |
| 6. It is caused by the earth-sun relationship                                                                                    | h. air pollution                  |
| 7. It is the condition of the atmosphere at a particular location over a long period of time                                     | i. weather                        |
| 8. It is formed through the process of precipitation                                                                             | J. climate                        |
| 9. It is the warming of the earth's surface                                                                                      | K. season                         |
| 10. It involves the release into the atmosphere of gases, finely divided solids, or finely dispersed liquid aerosols             | L. global warming                 |
| 11. It is a tool used to measure the amount of precipitation that falls.                                                         | m. small cups spin                |
| 12. It is a/an instrument used to measure temperatures. Mercury inside the thermometer rises or falls as it expands or contracts | n. rain gauge<br>o. hygrometer    |

- from changes in temperature.
13. It is a tool used to measure the direction the wind
14. It is a tool used to measure the atmospheric (air) pressure which is then used to forecast the weather.
15. It is a tool used to measure the amount of humidity or moisture in the air. The higher the humidity, the more moisture is in the air
16. It is a tool used to tell wind speed.
17. These are very high, wispy clouds made of ice. Even in the summer, cirrus clouds are made of ice because it is cold high above Earth.
18. These are large clouds; look like huge puffs of cotton. Sometimes these clouds look like animals or familiar things.
19. These clouds tell us that it will rain
20. These clouds are made up of low layers of clouds that usually cover the whole sky and blot out the sun.
- p. barometer
- q. anemometer
- r. thermometer
- s. stratus clouds
- t. nimbus clouds
- u. cumulus clouds
- v. cirrus clouds
- w. rain
- x. wind vane



Key to answers on page 30



## *Let's summarize*

### 1. Earth's grid or coordinate system

- **Latitude** is a measurement on a globe or map of location north or south of the equator. It is measured in degrees, minutes, and seconds
- **Longitude** is a measurement of location east or west of the prime meridian at Greenwich. It is the amount of arc created by drawing first a line from the center of the Earth to the intersection of the equator and the prime meridian and then another line from the center of the earth to any point elsewhere on the Equator.

### 2. Composition of the Atmosphere

The atmosphere is primarily composed of:

Nitrogen (N<sub>2</sub>, 78%),

Oxygen (O<sub>2</sub>, 21%),

Argon (Ar, 1%).

A myriad of other very influential components are also present which include the water (H<sub>2</sub>O, 0 - 7%), "greenhouse" gases or Ozone (0 - 0.01%), Carbon Dioxide (CO<sub>2</sub>, 0.01-0.1%),

### 3. Layers of the Earth's Atmosphere

- The **mesosphere** is the "Middle sphere" and is the coldest layer of the atmosphere.
- The **stratosphere** extends from the top of the tropopause to about 50 km (31 miles). The temperature begins to increase in this layer because it contains the highest concentration of ozone.
- The **ozone layer** both protect life on earth. The layer of gaseous ozone in the upper atmosphere that blocks radiation.
- The **troposphere** is the lowest layer of the atmosphere where all weather occurs.

### 4. Changes in the Atmosphere:

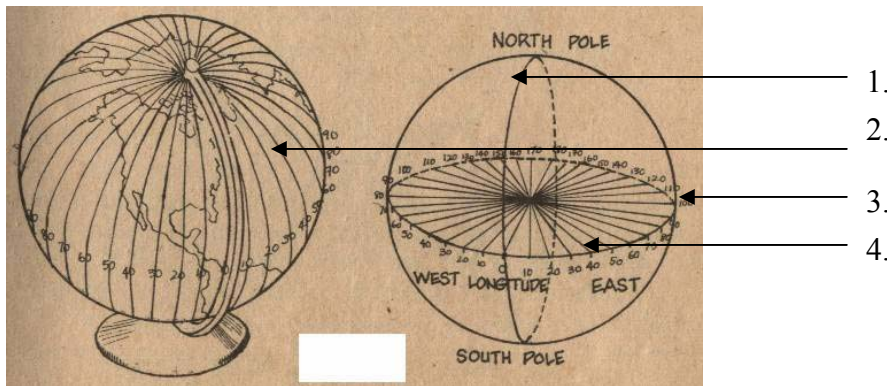
- **Season** is caused by the earth-sun relationship. It is any of four divisions of the year according to consistent annual changes in the weather.
- **Weather** is the state of the atmosphere at a particular place during a short period of time.
- **Climate** is the condition of the atmosphere at a particular location over a long period of time. Climatic change is due to the following factors:
  - **Greenhouse effect** is the warming of the earth's surface and lower atmosphere that tends to intensify with an increase in atmospheric carbon dioxide. The atmosphere allows a large percentage of the rays of visible light from the sun to reach the earth's surface and heat it.
  - **Global warming** is a potential increase in average global atmospheric temperatures resulting from the greenhouse effect.
  - **Air pollution** involves the release into the atmosphere of gases, finely divided solids, or finely dispersed liquid aerosols at rates that exceed the capacity of the atmosphere to dissipate them or to dispose of them.



## Posttest

Follow the instructions given in each number:

1 – 4. Label the diagram as to the different parts of the earth:



5. The earth is tilted by \_\_\_\_\_.
6. The earth is covered by a blanket of air called the \_\_\_\_\_.
- 7 – 9. Enumerate the layers of the earth's atmosphere according to decreasing temperature.
10. The warming of the earth's atmosphere due to the presence of too much carbon dioxide is called \_\_\_\_\_.
- 11 – 12. What are some changes in the earth's atmosphere?
- 13 – 16. Give at least three (3) air pollutants.
17. An imaginary line that divides the earth in an EAST-WEST direction is the:  
a. Equator      b. latitude      c. longitude      d. prime meridian
18. The Great Circle is also known as the  
a. Equator      b. latitude      c. longitude      d. prime meridian
19. The 180° meridian is also called  
a. Equator      b. latitude      c. longitude      d. prime meridian
20. An imaginary line that divides the earth in a NORTH-SOUTH direction is the:  
a. Equator      b. latitude      c. longitude      d. prime meridian

21. Which of the following statement describes the temperature in the troposphere and stratosphere?
- a. The troposphere is hotter than the stratosphere
  - b. The stratosphere is hotter than the troposphere
  - c. Low temperature exists in the troposphere and stratosphere.
  - d. The temperature in the troposphere is equal to the temperature of the stratosphere.
22. Arrange the following layers of the atmosphere from the earth's reference.
- |                         |                  |
|-------------------------|------------------|
| <b>A</b> - ozone layer  | a. A – B – C - D |
| <b>B</b> – stratosphere | b. B – C – D - A |
| <b>C</b> – troposphere  | c. C – D – A - B |
| <b>D</b> - mesosphere   | d. C – A - B – D |
23. What part of the atmosphere has no weather disturbance?
- a. ozone layer   b. stratosphere   c. troposphere   d. mesosphere
24. Which part of the atmosphere protects us from harmful ultraviolet rays?
- a. ozone layer   b. stratosphere   c. troposphere   d. mesosphere
25. There are \_\_\_\_\_ seasons on earth.
- a. one (1)   b. two (2)   c. three (3)   d. four (4)



Key to answers on page 30



## Key to Answers

- Pre-test:** A. 1. c  
2. a  
3. d  
4. b  
5. a  
6. d  
7. b  
8. a  
9. d  
10. c
- B. 1. d  
2. b  
3. c  
4. a  
5. c  
6. j  
7. e  
8. g  
9. f  
10. i.

### Activity 1.1:

POINTS ON THE GLOBE	PARALLEL OF LATITUDES	PARALLEL OF LONGITUDES
A	30°N	60°E
B	30°S	30°W
C	0°	90°W
D	45°N	75°W
E	10°N	25°W

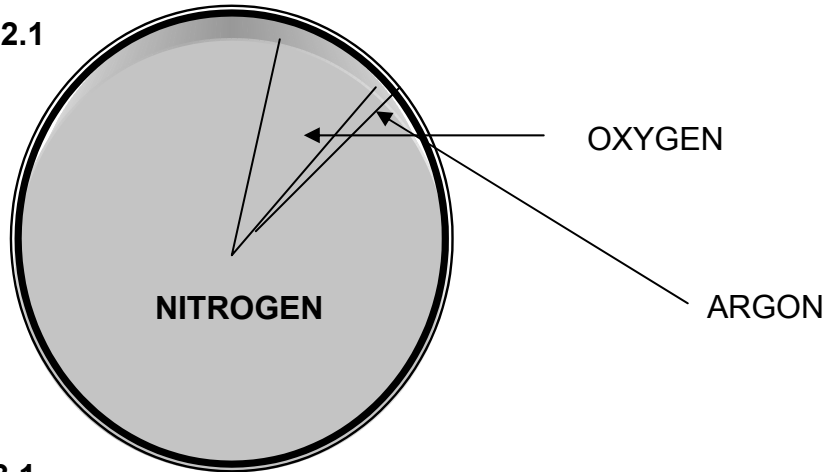
### Self-Test 1.1

POINTS ON THE GLOBE	PARALLEL OF LATITUDES	PARALLEL OF LONGITUDES
1	60°N	15°W
2	45°N	15°E
3	30°N	45°E
4	75°N	15°W
5	15°N	15°W
6	7.5°N	7.5°E
7	30°S	45°W
8	60°S	45°W
9	45°S	30°W
10	22.5°S	60°E

### Activity 2.1

- |                 |                      |                    |                       |                      |
|-----------------|----------------------|--------------------|-----------------------|----------------------|
| gonar           | parethomse           | genortin           | therosphere           | smehporeoh           |
| <b>5. argon</b> | <b>1. atmosphere</b> | <b>2. nitrogen</b> | <b>3. troposphere</b> | <b>4. mesosphere</b> |

### Self- Test 2.1



### Self-Test 3.1

1. atmosphere
2. troposphere
3. ozone layer
4. mesosphere
5. altitude and temperature

### Self – Test 4.1

- |       |       |
|-------|-------|
| 1. e  | 11. n |
| 2. b  | 12. r |
| 3. f  | 13. x |
| 4. a  | 14. p |
| 5. l  | 15. o |
| 6. k  | 16. q |
| 7. d  | 17. c |
| 8. w  | 18. u |
| 9. l  | 19. t |
| 10. h | 20. s |

### Posttest:

- |                   |                                                                        |       |
|-------------------|------------------------------------------------------------------------|-------|
| 1. longitude      | 8. stratosphere                                                        | 19. a |
| 2. prime meridian | 9. ozone layer                                                         | 20. b |
| 3. equator        | 10. mesosphere                                                         | 21. a |
| 4. latitude       | 11. greenhouse effect                                                  | 22. d |
| 5. 23.5°          | 12 – 14. season, weather, climate                                      | 23. b |
| 6. atmosphere     | 15 – 17. CFCs, CO, CO <sub>2</sub> , NO <sub>x</sub> , SO <sub>2</sub> | 24. a |

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