**Suggested time allotment: 14 hours**

Unit 4
**MODULE**

# 1

# THE PHILIPPINE ENVIRONMENT

## Overview

Everything that we see around us makes up our environment. The landforms and bodies of water that make up the landscape, the mountains and valleys, rivers and seas; the climate, the rains brought by the monsoons, the warm, humid weather that we frequently experience; the natural resources that we make use of; every plant and animal that live around us. Truly, the environment is made up of a lot of things.

All these things that we find in our surroundings and all the natural phenomena that we observe are not due to some random luck or accident. What makes up our environment is very much related to where our country is on the globe. Or, to say it in a different way, the characteristics of our environment are determined by the location of the Philippines on the planet.

## Latitude and Longitude

Before we learn about the characteristics of our environment, let us first talk about the location of the Philippines. Where is the Philippines? The Philippines is on Earth, of course, but where exactly is it located? To answer this question, you have to learn a new skill: locating places using latitude and longitude.

# Activity 1
# Where in the world is the Philippines? (Part I)

## Objective

After performing this activity, you should be able to describe the location of the Philippines using latitude and longitude.

## What to use

globes

## What to do

1. Study the image of a globe on the right. Then get a real globe and identify the parts that are labelled in the image. Be ready to point them out when your teachers asks you.

2. After studying the globe and the image on the right, try to define “equator” in your own words. Give your own definition when your teacher asks you.

3. The “northern hemisphere” is that part of the world between the North Pole and the equator. Show the northern hemisphere on the globe when your teacher asks you.

4. Where is the “southern hemisphere”? Show the southern hemisphere on the globe when your teacher asks you.

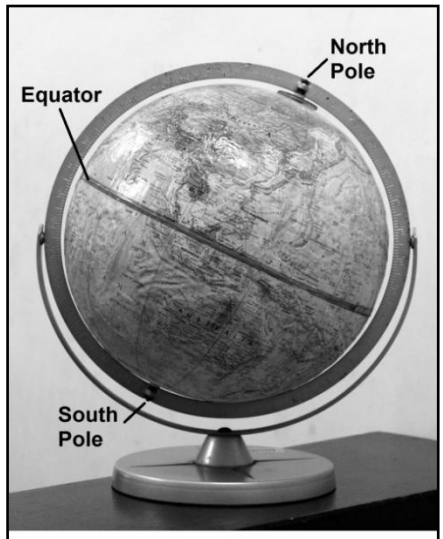



*Figure 1. What does the globe represent?*

5. Study the drawing on the right. It shows the lines of latitude.

   Q1. Describe the lines of latitude.

   Q2. Show the lines of latitude on the globe when your teacher asks you.

   Q3. The starting point for latitude is the equator. The equator is at latitude 0° (0 degree). At the North Pole, the latitude is 90°N (90 degrees north). At the South Pole, the latitude is 90°S (90 degrees south). Show the following latitudes when your teacher calls on you: 15°N; 60°N; 30°S; 45°S.

   Q4. The globe does not show all lines of latitude. If you wish to find 50°N, where should you look?

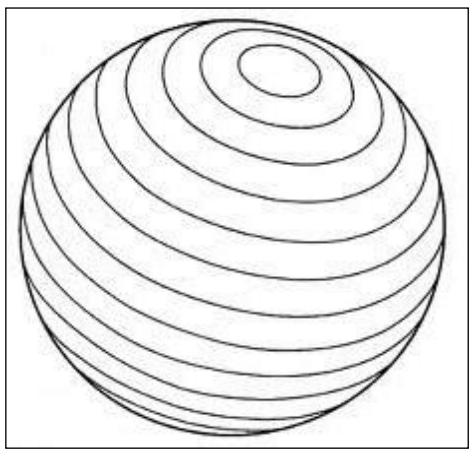


*Figure 2. What is the reference line when determining the latitude?*

6. Study the drawing on the right. It shows the lines of longitude.

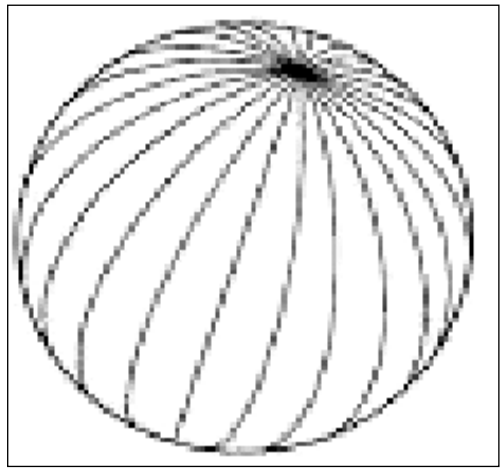


*Figure 3. What is the reference line when determining the longitude?*

Q5. Describe the lines of longitude.

Q6. Show the lines of longitude on the globe when your teacher asks you.

Q7. The starting point for longitude is the Prime Meridian. The Prime Meridian is at longitude 0°. Show the Prime Meridian on the globe when your teacher asks you.

Q8. To the right of the Prime Meridian, the longitude is written this way: 15°E (15 degrees east), 30°E (30 degrees east), and so on. To the left of the Prime Meridian, the longitude is written as 15°W (15 degrees west), 30°W (30 degrees west), and so on. On your globe, find longitude 180°. What does this longitude represent?

Q9. Not all lines of longitude are shown on a globe. If you want to find 20°W, where should you look?

Q10. The location of a place may be described by using latitude and longitude. To the nearest degree, what is the latitude and longitude of Manila?

Q11. Compared to the size of the world, Manila is just a tiny spot, and its location may be described using a pair of latitude and longitude. But how would you describe the location of an "area" such as the whole Philippines?

Now you know how to describe the location of a certain place using latitude and longitude. The lines of latitude are also known as parallels of latitude. That is because the lines of latitude are parallel to the equator and to each other. Five lines of latitude have special names. They are listed in the table below. The latitude values have been rounded off to the nearest half-degree.

| Latitude | Name |
|---|---|
| 0° | Equator |
| 23.5°N | Tropic of Cancer |
| 23.5°S | Tropic of Capricorn |
| 66.5°N | Arctic Circle |
| 66.5°S | Antarctic Circle |

Get a globe and find the Tropic of Cancer and the Tropic of Capricorn. Trace the two lines of latitude with a red chalk. The part of the world between the two chalk lines is called the tropics. Countries that are located in this zone experience a tropical climate where the annual average temperature is above 18°C.

Now, find the Arctic Circle and the Antarctic Circle on the globe. Trace them with blue chalk. Between the Tropic of Cancer and the Arctic Circle is the northern temperate zone; between the Tropic of Capricorn and the Antarctic Circle is the southern temperate zone. Countries in these zones go through four seasons – winter, spring summer, and autumn.

Finally, the areas within the Arctic Circle and Antarctic Circle are called the polar regions or frigid zones. People who choose to live in these areas have to deal with temperatures that never go above 10°C. It is cold all year round and even during the summer months, it does not feel like summer at all.

To sum up, the closer the latitude is to the equator, the warmer the climate. The closer it is to the poles, the colder. Thus, it is clear that there is a relationship between the latitude of a place and the climate it experiences, and you will find out why in the next module.

### Landmasses and Bodies of Water

Using latitude and longitude is not the only way that you can describe the location of a certain area. Another way is by identifying the landmasses and bodies of water that are found in that area. So, what are the landmasses and bodies of water that surround the Philippines? Do the following activity and get to know the surrounding geography.

## Activity 2
## Where in the world is the Philippines? (Part II)

### Objective

After performing this activity, you should be able to describe the location of the Philippines with respect to the surrounding landmasses and bodies of water.

### What to use

globe or world map

### What to do

1. Using a globe or a world map as reference, label the blank map below.

2. Your labelled map should include the following:

| A. Landmasses | B. Bodies of water |
|---|---|
| Philippine archipelago | Philippine Sea |
| Asian continent | South China Sea |
| Malay peninsula | Indian Ocean |
| Isthmus of Kra | Pacific Ocean |
| Indonesian archipelago | |
| Australian continent | |

Q1. Which bodies of water in the list are found to the west of the Philippines?

Q2. Which body of water in the list is located to the east of the Philippines?

Q3. Which large landmass is found to the north of the Philippines?

3. Be ready to show the map with your labels when your teachers asks you.

*Figure 4. Where is the Philippines in the map? Why is the Philippines called an archipelago?*

By now you can say that you really know where the Philippines is. You can now describe its location in two ways: by using latitude and longitude, and by identifying the landmasses and bodies of water that surround it. What then is the use of knowing where the Philippines is located? You will find out in the next section and also in the following module.

## Are We Lucky in the Philippines?

Planet Earth is made up of different things - air, water, plants, animals, soil, rocks, minerals, crude oil, and other fossil fuels. These things are called natural resources because they are not made by people; rather they are gathered from nature. Sunlight and wind are also natural resources. We use all these things to survive or satisfy our needs.

The Philippines is considered rich in natural resources. We have fertile, arable lands, high diversity of plant and animals, extensive coastlines, and rich mineral deposits. We have natural gas, coal, and geothermal energy. Wind and water are also harnessed for electricity generation.

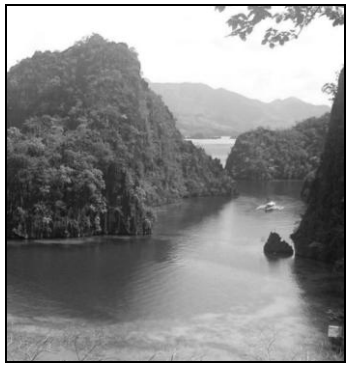


Photo: Courtesy of Kit Stephen S. Agad

Photo: Courtesy of Cecile N. Sales

http://en.wikipedia.org/wiki/File:POTW_MichelleELLA01.jpg

*Figure 5: What kind of natural resources are shown in the pictures? Do you have similar resources in your area?*

Why do we have rich natural resources? What geologic structures in the country account for these bounty? Is our location near the equator related to the presence of these natural resources?

The next lessons will help you find answers to some questions about natural resources in the country namely, rocks and minerals, water, soil, varied life forms, and energy.

- How does our latitude position affect the water, soil resources, and biodiversity in the country?
- What mineral deposits do we have in the country? Where are they located and why only in those places?
- Given our location, what energy resources are available?
- Which of our practices in using natural resources are sustainable? Which are not sustainable?

- How can we help conserve natural resources so that future generations can also enjoy them?

Hopefully, the knowledge and skills acquired in the lessons will help you value your responsibility as a productive citizen so that you can help prevent protected and vulnerable places from being mined, forests from being overcut, and natural resources like metals from ending up in a dumpsite.

## Water Resources and Biodiversity

The Philippines boasts of many different kinds of natural water forms, such as bays, rivers, lakes, falls, gulfs, straits, and swamps. Because it is made up of islands, the country's coastline (seashore) if laid end-to-end, would measure around 17.5 thousand kilometers. And you know how we are proud of our coastlines! The bodies of water and its surrounding environment not only support the survival of diverse organisms for food but are also used for other economic activities. All these you learned in *Araling Panlipunan.*

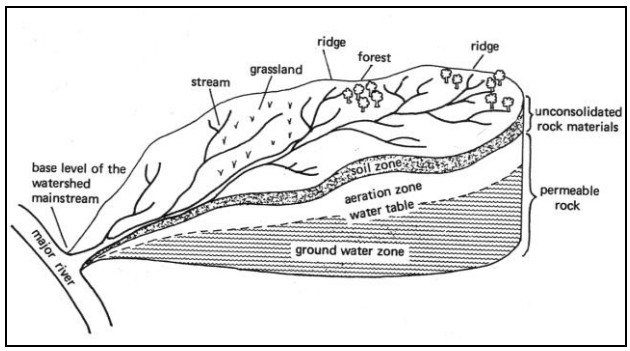
In the previous activity you identified two big bodies of water on the west and east side of the country: the Pacific Ocean in the east and south China Sea in the west (sometimes referred to as the West Philippine Sea). These bodies of water are the origin of typhoons which on the average, according to ***Philippine Atmospheric, Geophysical and Astronomical Services Administration*** (PAGASA), is about 20 a year. Typhoons and the monsoons (*amihan* and *habagat*) bring lots of rain to the Philippines.

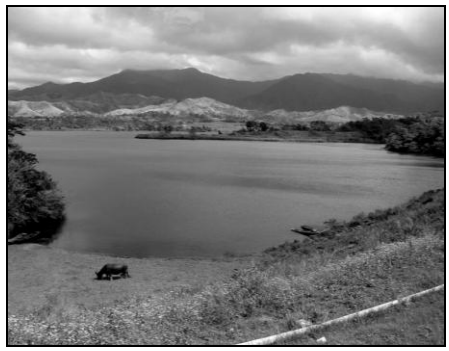
What is your association with too much rainfall? For some, rain and typhoons result in flooding, landslides, and health related-problems. But water is one of nature's gifts to us. People need fresh water for many purposes. We use water for domestic purposes, for irrigation, and for industries. We need water to generate electricity. We use water for recreation or its aesthetic value. Many resorts are located near springs, waterfalls or lakes.

Where does water in your community come from? You collect them when the rain falls or get them from the river, deep well, or spring. But where does water from rivers, lakes, and springs originate?

They come from a watershed – an area of land on a slope which drains its water into a stream and its tributaries (small streams that supply water to a main stream). This is the reason why a watershed is sometimes called a catchment area or drainage basin. It includes the surface of the land and the underground rock formation drained by the stream.

From an aerial view, drainage patterns in a watershed resemble a network similar to the branching pattern of a tree. Tributaries, similar to twigs and small branches, flow into streams, the main branch of the tree. Streams eventually empty into a large river comparable to the trunk.



http://en.wikipedia.org/wiki/File:Maria1637jf.JPG

*Figure 6. The network of streams in a watershed area is illustrated on the left and a photo of a watershed area is on the right. How does the concept "water runs downhill" apply to a watershed?*

Watersheds come in all shapes and sizes. They cross towns and provinces. In other parts of the world, they may cross national boundaries.

There are many watersheds in the Philippines basically because we have abundant rainfall. Do you know that Mt. Apo in Davao-Cotabato, Makiling-Banahaw in Laguna and Quezon, and Tiwi in Albay are watersheds? You must have heard about La Mesa Dam in Metro Manila, Pantabangan Dam in Pampanga, and Angat Dam in Bulacan. These watersheds are sources of water of many communities in the area. The Maria Cristina Falls in Iligan City is in a watershed; it is used to generate electricity. Locate these places in your map. Ask elders where the watershed is in or near your area? Observe it is used in your community.

But watersheds are not just about water. A single watershed may include combination of forest, grassland, marshes, and other habitats. Diverse organisms in the Philippines are found in these areas! Being a tropical country, the Philippines has abundant rainfall, many bodies of water, and lots of sunshine. The right temperature and abundant rainfall explain partly why our country is considered to be a mega-diverse country. This means that we have high diversity of plants and animals, both on land and in water (Philippine Clearing House Mechanism Website, 2012).

Reports show that in many islands of the Philippine archipelago, there is a high number of endemic plants and animals (endemic means found only in the Philippines). The country hosts more than 52,177 described species of which more than half is found nowhere else in the world. They say that on a per unit area basis, the Philippines shelters more diversity of life than any other country on the planet.

For now remember that the main function of a watershed is the production of a continuous water supply that would maintain the lifeforms within it and in the area fed by its stream. Later you will learn that besides supporting the survival of varied life forms, abundant water in the country is important in moderating temperature. This topic will be discussed later.

Have you ever asked yourself the following questions? If we have abundant rainfall to feed watersheds, why do we experience drought some parts of the year? What factors affect the health of a watershed? Is there a way of regulating the flow of water in watershed so that there will be enough for all throughout the year? What can people do to keep watersheds 'healthy'? Find out about these in the next activity.

# Activity 3
# What are some factors that will affect the amount of water in watersheds?

## Objective

You will design a procedure to show how a certain factor affects the amount of water that can be stored underground or released by a watershed to rivers, lakes and other bodies of water.

## What to do

1. In your group, choose one factor that you want to investigate.

    a. Vegetation cover
    b. Slope of the area
    c. Kind of soil
    d. Amount of rainfall

2. Identify the variables that you need to control and the variable that you will change.

3. Design a procedure to determine the effect of the factor you chose on watersheds.

4. Be ready to present your design in the class and to defend why you designed it that way.

## Soil Resources, Rainfall and Temperature

Recall in elementary school science that soil is formed when rocks and other materials near the Earth's surface are broken down by a number of processes collectively called weathering. You learned two types of weathering: the mechanical breaking of rocks or physical weathering, and the chemical decay of rocks or chemical weathering.

Let us review what happens to a piece of rock when left under the Sun and rain for a long time. Do the next activity.

# Activity 4
# How are soils formed from rocks?

## Objectives

1. Using the information in the table, trace the formation of soil from rocks.

2. Identify the factors acting together on rocks to form soil.

## What to use

Drawing pens

## What to do

1. Processes involved in soil formation are listed in the table below. Read the descriptions of the processes and make your own illustrations of the different processes. Draw in the designated spaces.

2. Use the descriptions and your drawings to answer the following questions.

Q1. What are the factors that act together on rocks to form soil?

Q2. What does the following sentence mean, “Soils were once rocks”?

| Processes of soil formation | Illustrations of processes |
|---|---|
| When a piece of rock is exposed to the Sun, its outer part expands (becomes bigger) because it heats up faster than the inner part (Drawing A). | Drawing A |
| On cooling, at night time, the outer part of the rock contracts or shrinks because the outer part of the rock cools faster than the inner portion (Drawing B). The process of expansion and contraction are repeated over the years and produce cracks in the rock causing the outer surface to break off. | Drawing B |
| Once broken, water enters the cracks causing some minerals to dissolve. The rock breaks apart further. (Drawing C). | Drawing C |

| Processes of soil formation | Illustrations of processes |
|---|---|
| Air also enters the cracks, and oxygen in the air combines with some elements such as iron to produce iron oxide (rust or kalawang) which is brittle and will easily peel off. In a similar way, carbon dioxide from the air reacts with water to form an acid causing the rock to soften further. Once soft and broken, bacteria and small plants start to grow in the cracks of the rock (Drawing D).<br><br>After some time, the dead plants and animals die and decay causing the formation of more acidic substances which further breaks the rocks. The dead bodies of plants and animals are acted upon by microorganism and breakdown into smaller compounds while the minerals from the rock return to the soil. | Drawing D |

Soil covers the entire Earth. Temperature, rainfall, chemical changes, and biological action act together to continuously form soil. Climate, expressed as both temperature and rainfall effects, is often considered the most powerful soil-forming factor.

Temperature controls how fast chemical reactions occur. Many reactions proceed more quickly as temperature increases. Warm-region soils are normally more developed or more mature than cold-region soils. Mature soils have more silt and clay on or near the surface. Thus, soils in the tropical areas are observed to sustain various farming activities and account for why the primary source of livelihood in the Philippines and other countries in the tropical region is their fertile land. What is the effect of very little rainfall on food production?

Climate (temperature and rainfall) is a significant factor not only in soil formation but also in sustaining diversity of plants and animals in the country. On the other hand, water also directly affects the movement of soluble soil nutrients from the top soil to deep under the ground (leaching). These nutrients may no longer be available to shallow rooted plants. Acidic rainwater may also contribute to the loss of minerals in soil resulting in low yield. So rainfall determines the kind of vegetation in an area. In turn, the degree of vegetation cover, especially in sloping areas, determines how much soil is removed. Are there ways to protect soil resources?

### Rocks and Mineral Resources

History tells us that rocks have been used by humans for more than two million years. Our ancestors lived in caves; they carved rocks and stones to make tools for hunting animals, cultivating crops, or weapons for protection. Rocks, stones, gravel, and sand were and are still used to make roads, buildings, monuments, and art objects.

http://commons.wikimedia.org/wiki/File:DirkvdM_rocks.jpg

*Figure 7. What are the features of the rocks? What environmental factors may have caused such features?*

http://en.wikipedia.org/wiki/File:Pana_Banaue_Rice_Terraces.jpg

*Figure 8. What kind of tools do you think were used to build the Rice Terraces? Why are terraces useful?*

The mining of rocks for their metal content has been considered one of the most important factors of human progress. The mining industry has raised levels of economy in some regions, in part because of the kind of metals available from the rocks in those areas.

## Activity 5
## Where are the minerals deposits in the Philippines?

Mineral deposits can be classified into two types: metallic and non-metalllic. You have already learned the symbols of some metals and nonmetals. Review them before you do the activity.

### Objectives

After performing this activity, you will be able to

1. locate the metallic mineral deposits across the country;

2. find out what geologic features are common in areas where the deposits are found;

3. give a possible reason/s for the association between metallic mineral deposits and geologic features in the country; and

4. infer why your area or region is rich or not rich in metallic mineral deposits.

## What to use

Figure 9: Metallic Deposits Map of the Philippines
Figure 10: Map of Trenches and Faults in the Philippines
Figure 11: Map of Volcanoes in the Philippines
2 pieces of plastic sheet used for book cover, same size as a book page
Marking pens (two colors, if possible)

## What to do

Part I

1. Familiarize yourself with the physical map of the Philippines. Identify specific places of interest to you in the different regions.

2. In your notebook, make a four-column table with headings similar to Table 1.

Table 1: Metallic Minerals in the Philippines and Their Location

| Metal, in Symbols (Example: Au) (1) | Metal, in Words (2) | Province/Region Where the Metals are Found (3) | Geologic Structure Near the Location of the Metallic Deposits (4) |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

3. As a group, study the Metallic Deposits Map of the Philippines. See Figure 9. In the map you will see symbols of metals. Fill in the information needed in Columns 1 and 2 of your own table.

4. Check with each other if you have correctly written the correct words for the symbol of the metals. Add as many rows as there are kinds of metals in the map.

5. Analyze the data in Table 1.

Q1. Identify five metals which are most abundant across the country. Put a number on this metal (1 for most abundant, 2 next abundant, and so on).

Q2. Record in Column 3 where the five most abundant metals are located.

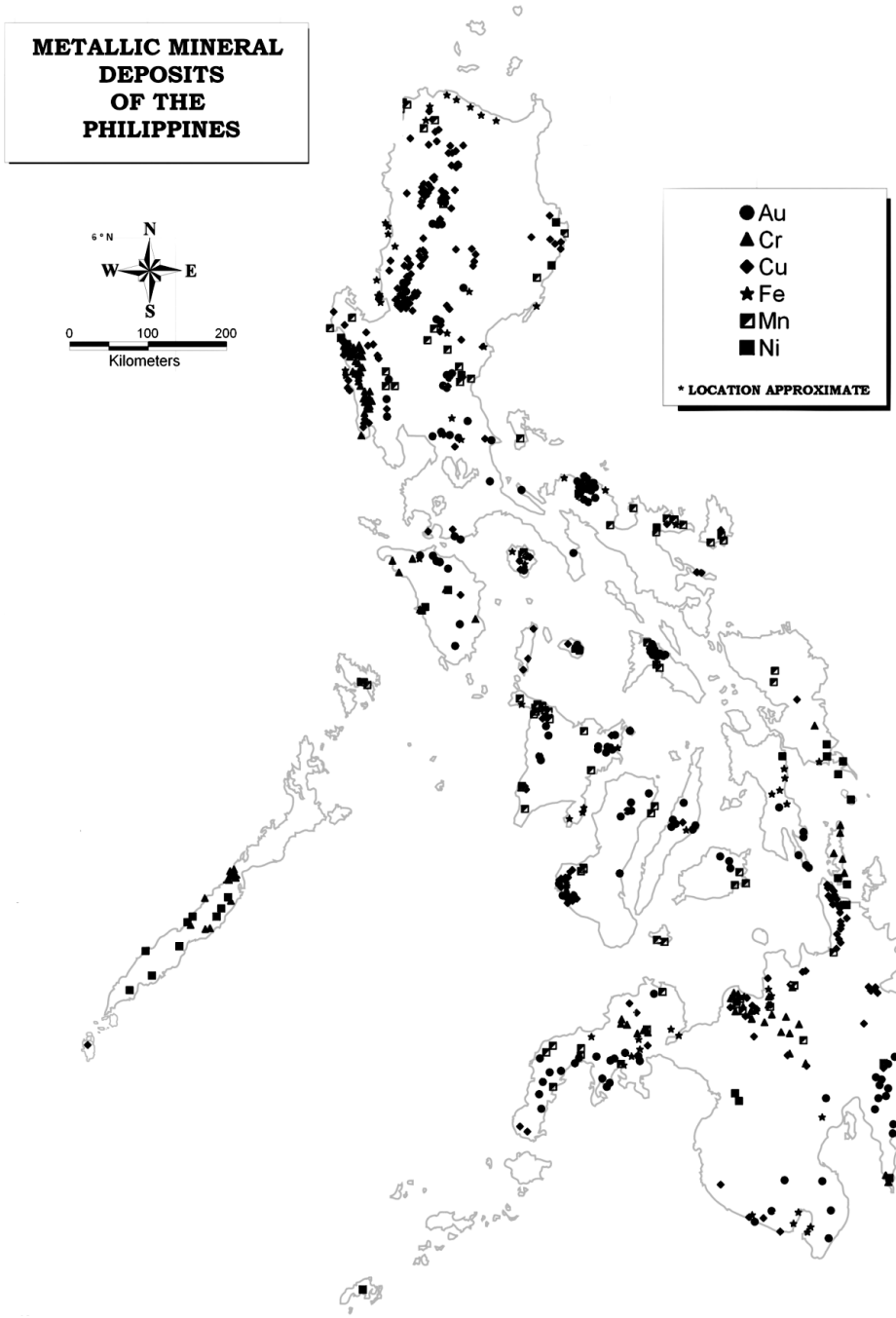



*Figure 9. Metallic Deposits in the Philippines*

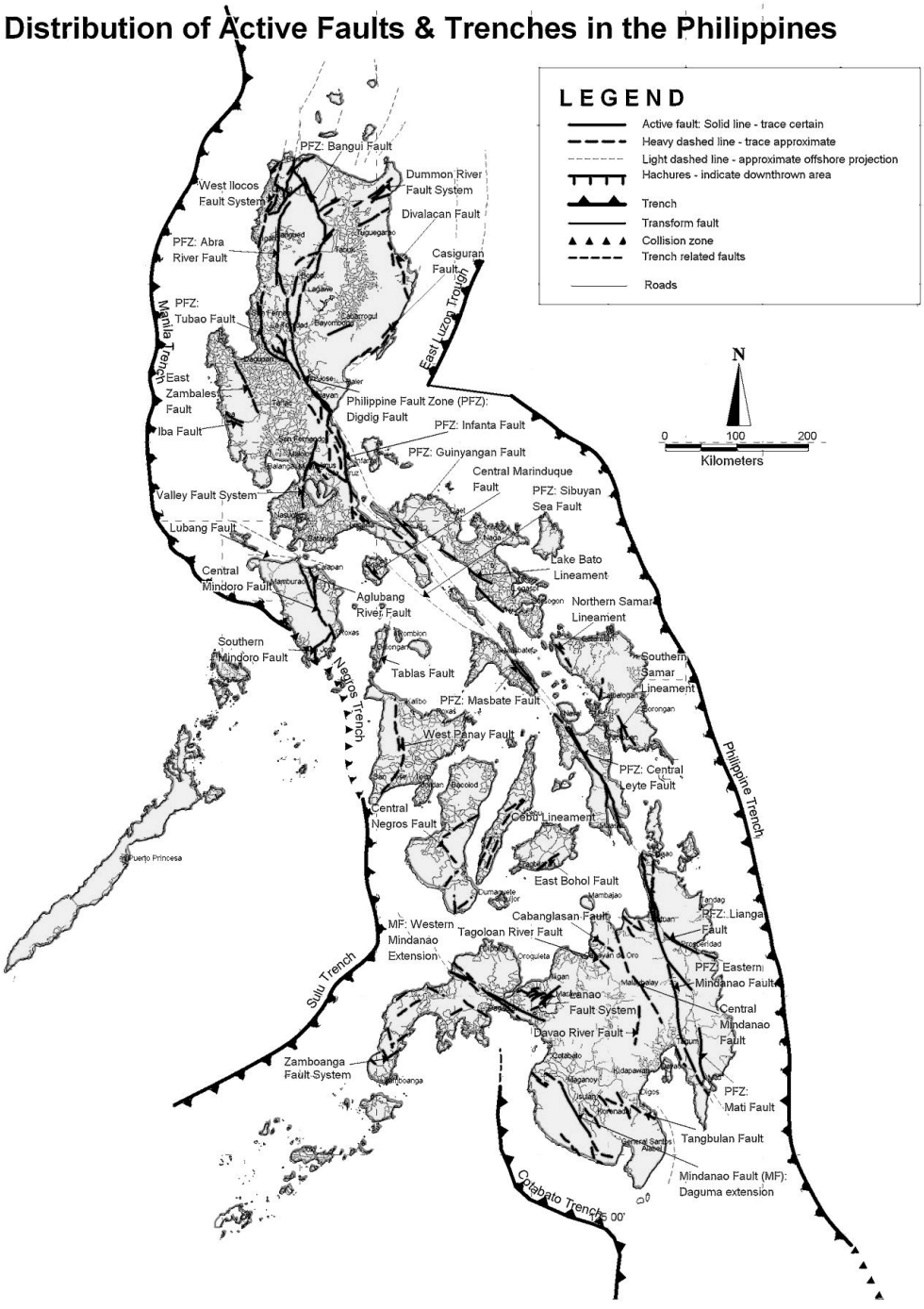



*Figure 10. Trenches and Faults in the Philippines*

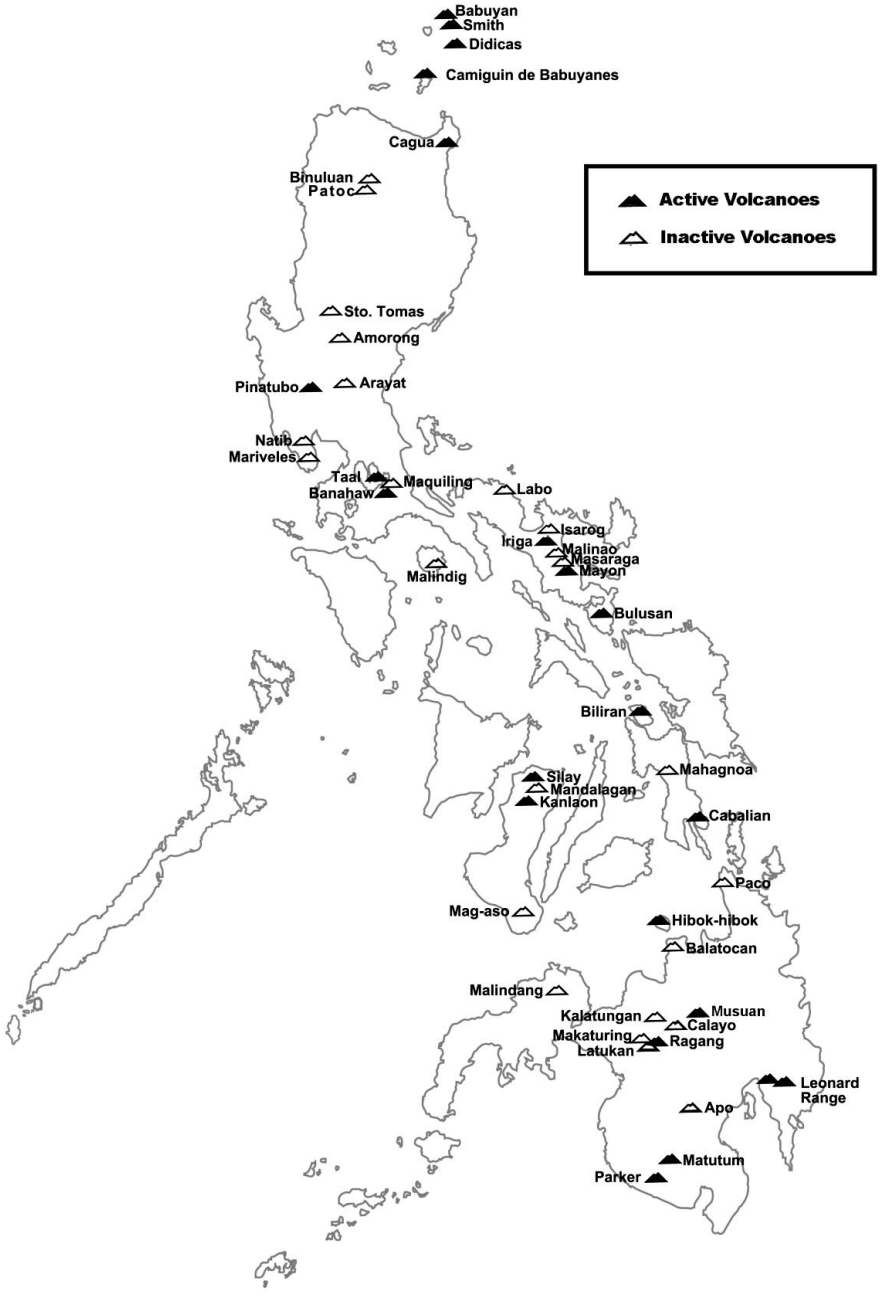



*Figure 11. Volcanoes in the Philippines*

Part II

1. Get two plastic sheets. On one sheet, trace the outlines of the trenches and faults from Figure 10. On the other sheet, trace the location of volcanoes from Figure 11.

2. Place the Trench and Fault plastic sheet over the Metallic Deposits map.

3. Place the Volcanoes plastic sheet over the two maps.
   Q3. What geologic structures are found near the location of the metallic deposits? Write trenches, faults or volcanoes in column 4 of Table 1.
   Q4. Write a statement to connect the presence of metallic deposits with trenches or volcanic areas.
   Q5. Why do you think are metallic deposits abundant in places where there are trenches or volcanoes?

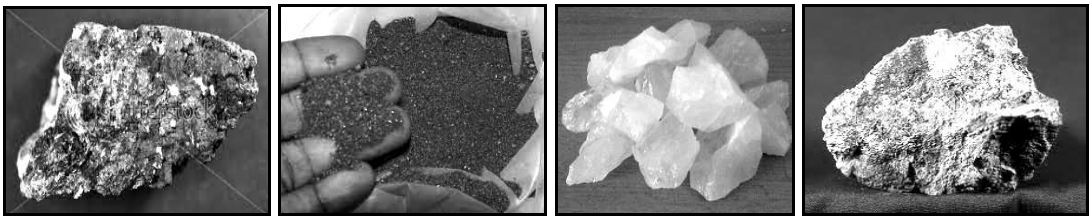
4. Look for your province in the map.
   Q6. Are there metallic deposits in your area?
   Q7. What could be reason for the presence or absence of metallic deposits in your area? You can download the detailed map of Trenches, Faults and volcanoes in the Philippines from the website of Phivolcs.
   Q8. If there are metallic deposits, what activities tell you that there are indeed deposits in or near your area/province?

The important metallic minerals found in various parts of the Philippines include gold, copper, iron, chromite (made up of chromium, iron, and other metals), nickel, cobalt, and platinum. The most productive copper and gold producers in the Philippines are found in Baguio, the province of Benguet, and in Surigao-Davao areas. Major producers of nickel are in Palawan and Surigao (DENR Website, 2012).

Metals are important. The properties of metals make them useful for specific purposes. You learned these in Quarter 1. Iron is the main material for steel bars used in buildings and road construction. Copper is used in making electrical wires. Tin is the material for milk cans and other preserved food products. Nickel is mixed with copper or other metals to form stainless cooking wares. Gold is important in making jewelry.

What other metals are you familiar with? What are the uses of aluminum? What metal is used to make GI sheets for roofing? What metals are used to make artificial arms or legs? Are metals used in chairs and other furniture? Do you know that some dentists use gold for filling teeth cavities? Look around and find how versatile metals are.

The Philippines has also varied nonmetallic resources including sand and gravel, limestone, marble, clay, and other quarry materials. Your teacher will show you a map of the nometallic deposits in the Philippines. Locate your area and determine what nonmetallic deposits are found there. How are these deposits recovered? How are they used in your community? For example: What are the uses of sand, gravel, or clay? How are marble stones used? Think of other nonmetals and their uses!



*Copper –iron ore* *Iron filings* *Quartz* *Copper ore*

*Figure 12. From the drawing, what are ores? Have you noticed that a piece of ore can have more than one kind of mineral in it?*

Do you know that the Philippines is listed as the 5th mineral country in the world, 3rd in gold reserves, 4th in copper, and 5th in nickel! The ores (mineral-bearing rocks) are processed out of the country to recover the pure metal. We buy the pure metal. Is this practice advantageous to the Philippines? Why or why not?

The richness of the Philippines in terms of mineral resources is being attributed to its location in the so-called Pacific Ring of Fire. See Figure 13. This area is associated with over 450 volcanoes (small triangles in the map) and is home to approximately 75% of the world's active volcanoes. Why are there minerals where there are volcanoes?


*Figure 13. Besides the Philippines, what other countries are in the Ring of Fire? Do you think they are also rich in mineral resources?*

Geologists (scientists who study the Earth and the processes that occur in and on it) explain that there is a continuous source of heat deep under the Earth; this melts rocks and other materials (link to usgs website) The mixture of molten or semi-molten materials is called magma. Because magma is hotter and lighter than the surrounding rocks, it rises, melting some of the rocks it passes on the way. If the magma finds a way to the surface, it will erupt as lava. Lava flow is observed in erupting volcanoes.

But the rising magma does not always reach the surface to erupt. Instead, it may slowly cool and harden beneath the volcano and form different kinds of igneous rocks. Under favourable temperature and pressure conditions, the metal-containing rocks continuously melt and redeposit, eventually forming rich-mineral veins.

Though originally scattered in very small amounts in magma, the metals are concentrated when magma convectively moves and circulates ore-bearing liquids and gases. This is the reason why metallic minerals deposits such as copper, gold, silver, lead, and zinc are associated with magmas found deep within the roots of extinct volcanoes. And as you saw in the maps, volcanoes are always near trenches and faults! You will learn more of this later.

For now you must have realized that the presence of mineral deposits in the Philippines is not by accident. It is nature's gift. If before, your association with volcanoes and trenches is danger and risk to life and property, now you know that the presence of volcanoes, trenches and other geological structures is the reason for the rich mineral deposits in the country.

The existence of volcanoes also explains why the Philippines is rich in geothermal energy (heat from the Earth). Energy resources will be discussed in the next section.

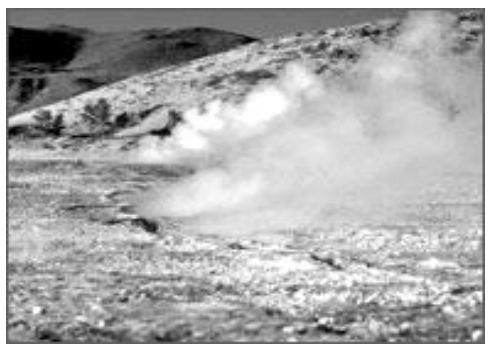
## Energy Resources

The abundance of some metal resources in the Philippines is related to geologic structures, specifically the presence of volcanoes and trenches in the country. The year-round warm temperature and availability of water are effects of our geographic location.

The tropical climate and the geological conditions also provide several possibilities to get clean and cheap energy. Do you know which energy resources are due to these factors? Were the following included in your list- solar energy, heat from the ground (geothermal energy), hydrothermal energy from falling water), wind energy, and natural gas?

Solar energy is free and inexhaustible. This energy source will be discussed in a later science subject.

Geothermal energy was briefly introduced in the lesson on mineral resources and their location. The Philippines ranked second to the United States in terms of geothermal energy deposits. Geothermal power plants are located in Banahaw-Makiling, Laguna, Tiwi in Albay, Bacman in Sorsogon, Palimpinon in Negros Occidental, Tongonan in Leyte, and Mt. Apo side of Cotabato.



http://commons.wikimedia.org/wiki/File:Hot_Spring.jpg

*Figure 14. Do you know that heat from the Earth may escape as steam in a hot spring?*

Try to locate places with geothermal power plants in your map? Does your area have geothermal energy deposits? How do you know?

Hydrothermal or hydroelectric power plants use water to generate electricity. They provide for 27% of total electricity production in the country. Ambuklao in Benguet, Mt Province, Agus in Lanao del Sur and Agus in Lanao del Norte are large hydrothermal power plants. Small hydroelectric power plants are in Caliraya, Laguna, Magat in Isabela, Loboc in Bohol, and other places. Used water from hydropower plants flows through irrigation systems. Many of the reservoir areas are used for sport activities.


Photograph courtesy of National Power Corporation, retrieved from http://www.industcards.com/hydro-philippines.htm

*Figure 15. How is water used to generate electricity?*

Again, locate places with hydroelectric power plants in your map? Does your area have hydroelectric power plants? What other uses do you have for water in these areas?

Natural gas is a form of fossil fuel, so are coal and crude oil (sometimes called petroleum). Fossil fuels were formed from plants and animals that lived on Earth millions of years ago. They are buried deep in the Earth. Natural gas and oil are taken from the deep through oil rigs while coal is extracted through mining. Fossil fuels are used to produce electricity and run vehicles and factory machines. Did you know that petroleum is the raw material for making plastics?

In the Philippines, we have coal and natural gas deposits. Coal is a black or brownish black, solid rock that can be burned. It contains about 40% non-combustible components, thus a source of air pollution when used as fuel. Coal deposits are scattered over the Philippines but the largest deposit is located in Semirara Island, Antique. Coal mines are also located in Cebu, Zamboanga Sibuguey, Albay, Surigao, and Negros Provinces.

*Figure 16. The black bands in the picture are coal deposits. Coal is not like the charcoal you use for broiling fish or barbecue. What do you think is the difference?*

Our natural gas deposits are found offshore of Palawan. Do you know where this place is? The Malampaya Deepwater Gas-to-Power Project employs 'state-of-the-art deepwater technology' to draw natural gas from deep beneath Philippine waters. The gas fuels three natural gas-fired power stations to provide 40-45% of Luzon's power

generation requirements. The Department of Energy reports that since October 2001, the Philippines has been importing less petroleum for electricity generation, providing the country foreign-exchange savings and energy security from this clean fuel.

Natural gas is considered clean fuel because when burned, it produces the least carbon dioxide, among fossil fuels. $CO_2$ is naturally present in air in small amounts. However, studies show that increase in carbon dioxide in the atmosphere results in increase in atmospheric temperature, globally. You will learn about global warming in the next module.

Did you know that in Ilocos Province, giant wind mills as shown in Figure 5 of this module are used to generate electricity. In Quirino, Ilocos Sur the electricity generated from wind mills runs a motorized sugarcane press for the community's *muscovado* sugar production? This project is a joint effort between the local farmers and local organizations with support from Japan. In Bangui, Ilocos Norte, the windmills as high as 50 meters not only help improve the tourism in Ilocos but it also provides 40% of the energy requirements for electricity in the entire province. This proves that we do not have to be dependent on fossil fuel in our country.

What do you think are the environmental conditions in Ilocos Sur and Ilocos Norte that allow them to use wind power for electricity? Do you think there are places that have these conditions? Support your answers.

## Conserving and Protecting Natural Resources

There are two types of natural resources on Earth - renewable and nonrenewable. What is the difference between these two kinds of resources?

The food people eat comes from plants and animals. Plants are replaced by new ones after each harvest. People also eat animals. Animals have the capacity to reproduce and are replaced when young animals are born. Water in a river or in a well may dry up. But when the rain comes the water is replaced. Plants, animals, and water are resources that can be replaced. They are renewable resources.

Most plants grow in top soil. Rain and floods wash away top soil. Can top soil be replaced easily? Soil comes from rocks and materials from dead plants and animals. It takes thousands of years for soil to form. Soil cannot be replaced easily, or it takes a very long time to replace. It is a nonrenewable resource.

Metals like copper, iron, and aluminum are abundant on Earth. But people are using them up fast. They have to dig deeper into the ground to get what they need. Coal, oil and natural gas (fossil fuels) were formed from plants and animals that lived on Earth millions of years ago. It takes millions of years for dead plants and animals to turn into fossil fuels. Soil, coal, oil and natural gas are nonrenewable resources.

Before you do Activity 6, think of these sentences: “Too much is taken from Earth!" and "Too much is put into Earth." You may write up a short essay about your understanding of the sentences.

# Activity 6
# How do people destroy natural resources?

## Objectives

1. Identify the effects of some human activities on natural resources.
2. Suggest ways to reduce the effects.

## What to Do

1. Study Table 2 and tell if you have observed the activities listed in your locality.

Table 2. Ways People Destroy Natural Resources

| Activities (1) | Effects on Natural Resources (2) |
|---|---|
| When roads are built, mountains are blown off using dynamite. | Damage natural habitats and/or kill plants and animals. |
| Rice fields are turned into residential or commercial centers. | |
| People cut too many trees for lumber or paper or building houses. | |
| More factories are being built to keep up with the demands of a fast growing population and industrialization. | |
| Too much mining and quarrying for the purpose of getting precious metals and stones and gravel. | |
| Some farmers use too much chemical fertilizers to replenish soil fertility. | Too much fertilizer destroys the quality of the soil and is harmful to both human and animals. |
| Plastics and other garbage are burned. | |
| Cars, trucks, and tricycles that emit dark smoke (smoke belchers) are allowed to travel. | |
| Other activities | |

2. Discuss the effects of these activities on natural resources.

3. Write the effects on the column opposite the activities. An activity may have more than one effect. Some of the effects have already been listed in the table.

4. Do you know of other activities that destroy or cause the depletion of natural resources? Add them to the list and fill the corresponding effect in column 2.

5. What can you do to conserve resources?

### Protecting Resources in Your Own Way

All resources used by humans, including fuels, metals, and building materials, come from the Earth. Many of these resources are not in endless supply. It has taken many thousands and millions of years to develop and accumulate these resources.

To conserve natural resources is to protect or use them wisely without wasting them or using them up completely. Conserving natural resources can make them last and be available for future generations. This is what sustainability of natural resources means. Each one of us should think about how to make things sustainable. Remember: The lives of future generations depend on how we use natural resources today.

## Activity 7
## Are you ready for “Make-a-Difference” Day?

This activity involves you in hands-on activities that help you learn more about reducing waste, reusing materials instead of throwing them away, recycling, composting, and conserving natural resources and energy. There are many activities that you can include: conducting a "waste-free lunch" or building art materials out of cans, bottles, and other recyclable trash. Depending on the location and nature of your school, you might want to include river cleanup, trail maintenance, or tree planting. Or, you can mix these activities with a poster making contest for use in the campaign on non-use of plastic bags for shopping and/or marketing.

### What to do

1. In your group, make a list of what is done in your school that help conserve natural resources. Discuss your list before finalizing the report.

2. Make another list of what is done in your school that do not help conserve natural resources. For example, do you still have lots of things in the trash can or on the ground? What are they? What is being done with them?

3. Come up with a one-day plan on what else can be done in school to conserve natural resources. Present your plan to the class.

4. Based on the group presentation, decide which part in the plans will be adopted or adapted to make a class plan. The plan should consider the following:
    - Easy to follow
    - Who will be responsible for making the plan happen
    - What should be done if the people responsible for making the plan happen will not or cannot do it
    - What natural resources will be conserved
    - Schedule of activities to include monitoring
    - Why you think this plan is the best idea

5. With your teacher's permission, make an appointment with your principal to present your plan and to solicit support. Maybe she might recommend the "Make-a-Difference" Day for the whole school!

Hopefully, the "Make-a-Difference" Day will engage you in a variety of environmental activities that help foster not only an appreciation for the environment and the resources it provides but also develop a life-long environmental stewardship among your age group.

## Links and Other Reading Materials

gdis.denr.gov.ph (Geohazard Map)
http://www.phivolcs.dost.gov.ph
http://www.jcmiras.net/surge/p124.htm (Geothermal power plants in the Philippines)
http://www.industcards.com/hydro-philippines.htm (Hydroelectric power plants in the Philippines)

**Suggested time allotment: 12 hours**

Unit 4
**MODULE**

# 2

# SOLAR ENERGY AND THE ATMOSPHERE

In the previous module, you learned that the presence of different natural resources in the Philippines is related to the country's location. It was also mentioned that the climate in a certain area depends on its latitude. In this module, you are going to learn more about how the location of the Philippines influences its climate and weather. To prepare you for this lesson, you must first learn about the envelope of air that surrounds the Earth where all weather events happen – the atmosphere.

## Activity 1
## What is the basis for dividing Earth's atmosphere into layers?

Earth's atmosphere is divided into five layers. What is the basis for subdividing the atmosphere?

### Objectives

You will be able to gather information about Earth's atmosphere based on a graph. Specifically, you will:

1. describe the features of each of the five layers;
2. compare the features of the five layers; and
3. explain the basis for the division of the layers of the atmosphere.

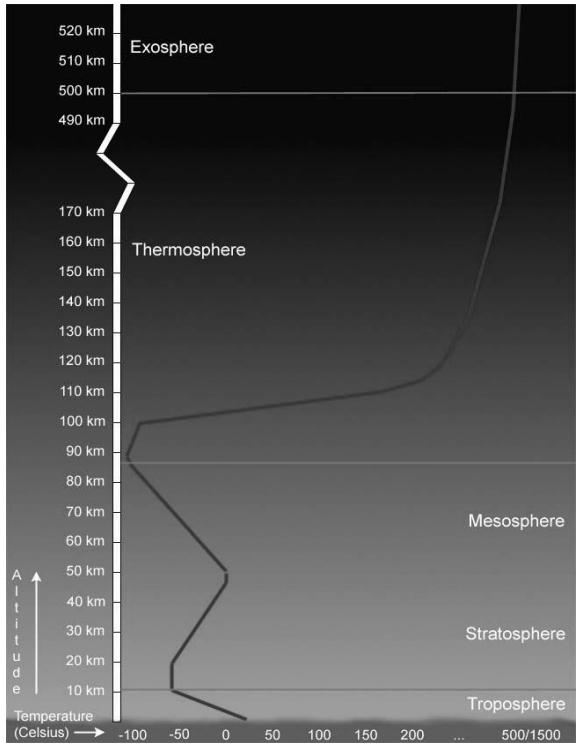



*Figure 1. What are the layers of the atmosphere?*

## What to use

- Graph in Figure 1
- A ruler, if available

## What to do

1. Study the graph.

    Q1. What are the five layers? Estimate the height of each layer.
    Q2. Describe the graph for each layer.
    Q3. In which layer is temperature increasing with increasing altitude?
    Q4. In which layer is temperature decreasing with increasing altitude?
    Q5. What is the relationship between temperature and height in the
        - troposphere?
        - stratosphere?
        - mesosphere?
        - thermosphere?
        - exosphere?
    Q6. Observe the whole graph. What is the basis for the division of Earth's atmosphere?
    Q7. From the graph, can you generalize that the higher the layer of the atmosphere (that is closer to the Sun), the hotter the temperature? Why or why not?
    Q8. What other information about Earth's atmosphere can you derive from the graph?

2. Read the succeeding paragraphs and think of a way to organize and summarize the data about the atmosphere from the graph and the information in the discussion that follows.

The *troposphere* is the layer closest to Earth's surface. The temperature just above the ground is hotter than the temperature high above. Weather occurs in the troposphere because this layer contains most of the water vapor. Remember the water cycle? Without water, there would be no clouds, rain, snow or other weather features. Air in the troposphere is constantly moving. As a result, aircraft flying through the troposphere may have a very bumpy ride – what we know as turbulence. People who have used the airplane for travelling have experienced this especially when there is a typhoon in areas where the plane passes through.

The *stratosphere* is the layer of air that extends to about 50 km from Earth's surface. Many jet aircraft fly in the stratosphere because it is very stable. It is in the stratosphere that we find the ozone layer. The ozone layer absorbs much of the Sun's harmful radiation that would otherwise be dangerous to plant and animal life.

The layer between 50 km and 80 km above the Earth's surface is called the *mesosphere.* Air in this layer is very thin and cold. Meteors or rock fragments burn up in the mesosphere.

The *thermosphere* is between 80 km and 110 km above the Earth. Space shuttles fly in this area and it is also where the auroras are found. Auroras are caused when the solar wind strikes gases in the atmosphere above the Poles. Why can we not see auroras in the Philippines?

The upper limit of our atmosphere is the *exosphere*. This layer of the atmosphere merges into space. Satellites are stationed in this area, 500 km to 1000 km from Earth.

To summarize what has been discussed: More than three quarters of Earth's atmosphere is made up of nitrogen while one fifth is oxygen. The remaining 1% is a mixture of carbon dioxide, water vapour, and ozone. These gases not only produce important weather features such as cloud and rain, but also have considerable influence on the overall climate of the Earth, through the greenhouse effect and global warming.

## What is the Greenhouse Effect?

In order to understand the greenhouse effect, you need to first understand how a real greenhouse works.

In temperate countries, a greenhouse is used to grow seedlings in the late winter and early spring and later, planted in the open field when the weather is warmer. Greenhouses also protect plants from weather phenomena such snowstorm or dust storms. In tropical countries, greenhouses are used by commercial plant growers to protect flowering and ornamental plants from harsh weather conditions and insect attack.

Greenhouses range in size from small sheds to very large buildings. They also vary in terms of types of covering materials. Some are made of glass while others are made of plastic.

*http://commons.wikimedia.org/wiki/File:Gartengew%C3%A4chshaus.JPG*

*Figure 2. Different sizes of greenhouses. How does a greenhouse work?*

# Activity 2
# Does a greenhouse retain or release heat?

## Objectives

The activity will enable you to

1. construct a model greenhouse.
2. find out if your model greenhouse retains heat
3. relate the concept of greenhouse to the increasing temperature of Earth's atmosphere.

## What to use

- 2-liter plastic soft drink bottle
- 2-plastic containers to serve as base of the bottles
- knife or scissors
- transparent tape
- two alcohol thermometers
- one reading lamp (if available), otherwise bring the setups under the Sun


## What to do

Constructing the model greenhouse

For each model greenhouse you will need a two-liter plastic soft drink container (with cap) and a shallow plastic container for the base.

1. Remove the label of the soft drink bottle but keep the cap attached.

2. Cut off carefully, the end of the bottle approximately 5-6 cm from the bottom. Dispose of the bottom piece.

3. Place the bottle with cap in the plastic base. This is your *model greenhouse.* Label it Bottle A.

4. Use scissors or knife to cut several elongated openings or vents (1.5 x 5.0 cm) on the sides of Bottle B. Leave Bottle A intact.

5. Tape a thermometer onto a piece of cardboard. Make sure that the cardboard is longer than the thermometer so that the bulb will not touch the plastic base. Make two thermometer setups, one for Bottle A and another for Bottle B. Place one thermometer setup in each bottle.

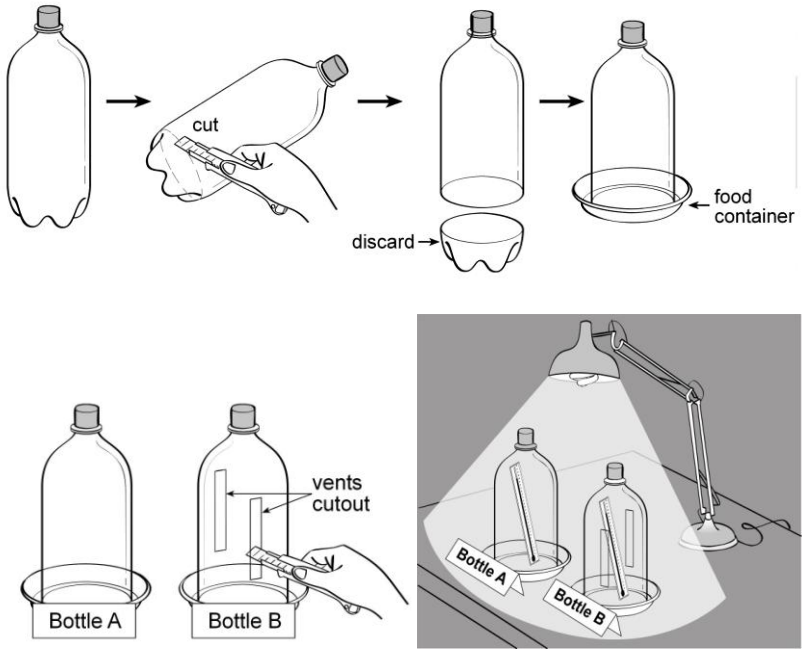



*Figure 3. How to construct a model greenhouse*

6. Place both bottles approximately 10 cm away from the lamp. DO NOT turn on the lamp yet.
   - Q1. Predict which bottle will get hotter when you turn on the light or when they are exposed to the Sun. How will you know that one bottle is hotter than the other?
   - Q2. Write down your prediction and the reason why you predicted that way.
7. Turn on the light and begin collecting data every five minutes for 25 minutes. (Note: But if you have no lamp, place the setups under the Sun. Read the temperature every 20 minutes for over two hours.)

**NOTE:**

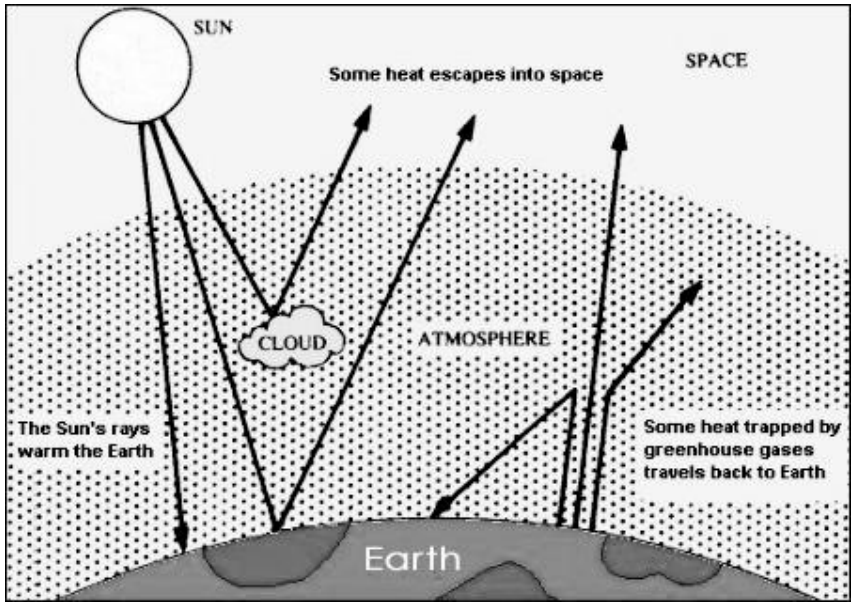
**If you have no lamp, bring the setups outside the classroom under the Sun where they will not be disturbed.**

8. Record the temperature readings of Bottle A and Bottle B in your notebook.

9. Graph your data separately for Bottles A and B.
   - Q3. What variable did you put in the x-axis? In the y-axis?
   - Q4. Why did you put these data in the x and y axes, respectively?
   - Q5. Describe the graph resulting from observations in Bottle A.
   - Q6. Describe the graph resulting from observations in Bottle B.
   - Q7. Explain the similarities in the graphs of Bottles A and B.
   - Q8. Explain the differences in the graphs of Bottles A and B.
   - Q9. Does this activity help you answer the question in the activity title: Do greenhouses retain heat? What is the evidence?

Greenhouses allow sunlight to enter but prevent heat from escaping. The transparent covering of the greenhouse allows visible light to enter without obstruction. It warms the inside of the greenhouse as energy is absorbed by the plants, soil, and other things inside the building. Air warmed by the heat inside is retained in the building by the roof and wall. The transparent covering also prevents the heat from leaving by reflecting the energy back into the walls and preventing outside winds from carrying it away.

The Earth's atmosphere is compared to a greenhouse. You know that besides nitrogen and oxygen, Earth's atmosphere contains trace gases such as carbon dioxide, water vapor, methane, and ozone. Like the glass in a greenhouse, the trace gases have a similar effect on the Sun's rays. They allow sunlight to pass through, resulting in the warming up of the Earth's surface. But they absorb the energy coming from the Earth's surface, keeping the Earth's temperature suitable for life on Earth. The process by which the Earth's atmosphere warms up is called 'greenhouse effect,' and the trace gases are referred to as 'greenhouse gases.'




*https://sites.google.com/site/glowar88/all-about-global-warming/1-what-is-global-warming*

*Figure 4. Why are greenhouse gases like the glass in the greenhouse?*

The 'greenhouse effect' is a natural process and it warms the Earth. Without the greenhouse effect, Earth would be very cold, too cold for living things, such as plants and animals.

To further understand the effect of greenhouse gases look at Figure 5. It contains some data about Venus and Earth, planets that are almost of the same size and if you remember from elementary school science, are near each other, so they are called twin planets. The composition of atmosphere and the average surface

temperature of the two planets are also given. Why is the average temperature of Venus very much higher than that of Earth? What could have caused this phenomenon?

Both Earth and Venus have carbon dioxide, a greenhouse gas, in their atmospheres. The small amount of carbon dioxide on Earth's gives the right temperature for living things to survive. With the high surface temperature of Venus due to its high carbon dioxide concentration, do you think life forms like those we know of could exist there? Why or why not?

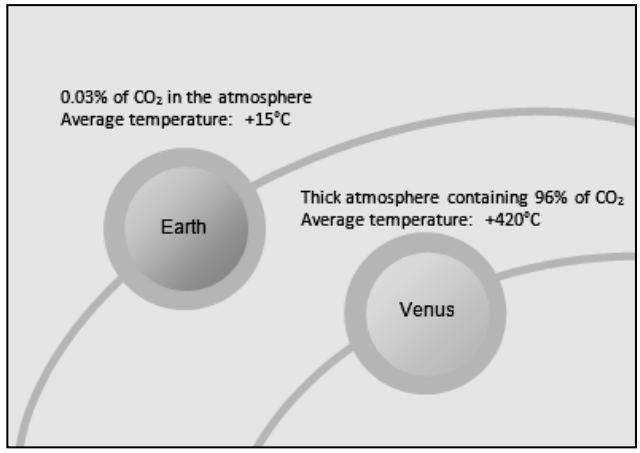


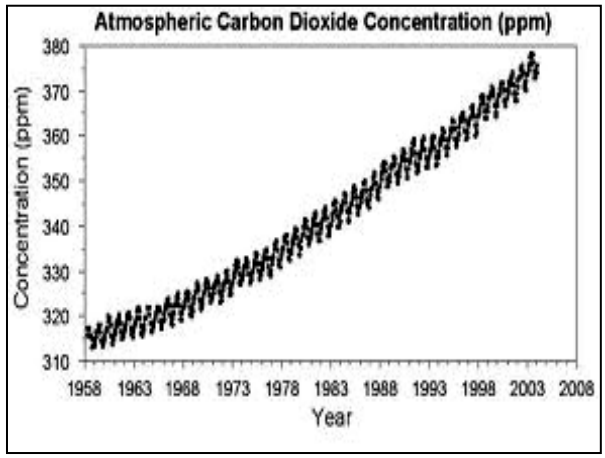

*Figure 5. What gas is present in the atmosphere of Venus that explains its high surface temperature?*

## Is Earth Getting Warmer? What is the Evidence?

Studies have shown that before 1750 (called the pre-industrialization years), carbon dioxide concentration was about 0.028 percent or 280 parts per million (ppm) by volume. The graph below shows the concentration of carbon dioxide from 1958 to 2003. What information can you derive from the graph?

Recent studies report that in 2000-2009, carbon dioxide rose by 2.0 ppm per year. In 2011, the level is higher than at any time during the last 800 thousand years. Local temperatures fluctuate naturally, over the past 50 years but the average global temperature has increased at the fastest rate in recorded history.

So what if there is increasing emission of greenhouse gases like carbon dioxide into the atmosphere? What is the problem with a small increase in carbon dioxide concentration in the atmosphere?




*http://en.wikipedia.org/wiki/File:Mauna_Loa_Carbon_Dioxide-en.svg#file*

*Figure 6. Carbon dioxide measurements in Mauna Loa Observatory, Hawaii*

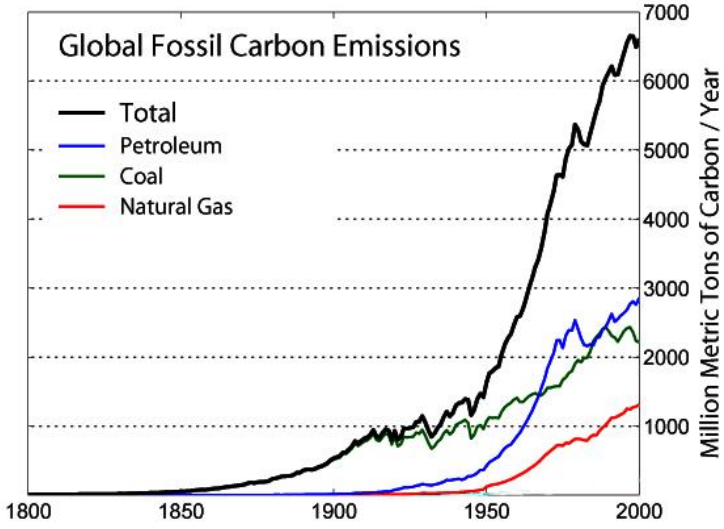
More carbon dioxide means that more heat is trapped in Earth's atmosphere. More heat cannot return back into space. More heat trapped by the carbon dioxide means a warmer Earth.

The increasing temperature phenomenon is known as 'global warming'. Global means that all countries and people around the world are affected even if that country is not a major contributor of greenhouse gases. Many scientists now agree that many human activities emit more greenhouses gases into the atmosphere, making the natural greenhouse effect stronger. Scientists are also saying that if we carry on polluting the atmosphere with greenhouse gases, it will have a dangerous effect on the Earth.

## Sources of Greenhouse Gases

Carbon dioxide is naturally produced when people and animals breathe. Plants and trees take in and use carbon dioxide to produce their own food. Volcanoes also produce carbon dioxide. Methane comes from grazing animals as they digest their food and from decaying matter in wet rice fields. Ozone is also naturally present in the stratosphere.

But human activities emit a lot of greenhouse gases into the atmosphere. Study Figure 7.




*http://en.wikipedia.org/wiki/File:Global_Carbon_Emission_by_Type.png*

*Figure 7. Does burning of fossil fuels raise the carbon dioxide concentration in the atmosphere?*

Which fossil fuel has the highest contribution to carbon dioxide concentration in the atmosphere?

What human activities use this fuel? List at least three.

Recall Module 1. What kind of fossil fuels are used in the Philippines?

Are we also contributing to the increase in carbon dioxide concentration in the atmosphere? Why or why not?

Carbon dioxide comes from the burning of fossil fuel such as coal, crude oil and natural gas. Cutting down and burning of trees releases carbon dioxide. Methane can also be released from buried waste. For example, the left-over food, garden wastes, and animal wastes collected from our homes are thrown into dumpsites. When lots of wastes are compressed and packed together, they produce methane. Coal mining also produces methane.

Another group of greenhouse gases includes the chlorofluorocarbons or CFCs for short. CFCs have been used in spray cans as propellants, in refrigerators as refrigerants, and in making foam plastics as foaming agents. They become dangerous when released into the atmosphere, depleting the ozone layer. For this reason, their use has been banned around the world.

What have you learned about the atmosphere? There are natural processes in the atmosphere that protect and sustain life on Earth. For example, the greenhouse effect keeps temperature on Earth just right for living things. For as long as the concentration of greenhouse gases are controlled, we will have no problem.

But human beings activities have emitted greenhouse gases into the atmosphere, increasing their levels to quantities that have adverse effects on people, plants, animals and the physical environment. Burning of fossil fuels, for example, has increased levels of carbon dioxide thus trapping more heat, increasing air temperature, and causing global warming. Such global phenomenon is feared to melt polar ice caps and cause flooding to low-lying areas that will result to reduction in biodiversity. It is even feared that global warming is already changing climates around the globe, causing stronger typhoons, and creating many health-related problems. You will learn more about climate change later.

## Common Atmospheric Phenomena

In the next section, you will learn two concepts that will help you understand common atmospheric phenomena: why the wind blows, why monsoons occur, and what is the so-called intertropical convergence zone. All of these are driven by the same thing: the heat of the Sun or solar energy. Thus, we begin by asking, what happens when air is heated?

# Activity 3
# What happens when air is heated?

## Objective

After this activity, you should be able to explain what happens when air is heated.

## What to use

two paper bags
candle
long straight stick
match
masking tape
chair

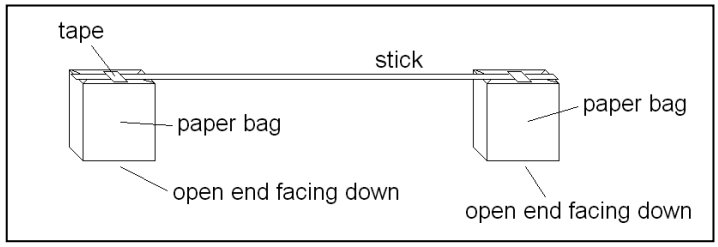



*Figure 8. Setup for Activity 3*

## What to do

1. Attach a paper bag to each end of the stick (see drawing above). The open end of each bag should be facing down.

2. Balance the stick with the paper bags on the chair (see drawing below.)

3. Make a prediction: what do you think will happen if you place a lighted candle under the open end of one of the bags?

4. Now, light the candle and place it below one of the bags. Caution: Do not place the candle too close to the paper bag. It may catch fire. Be ready with a pail of water or wet rag just in case.

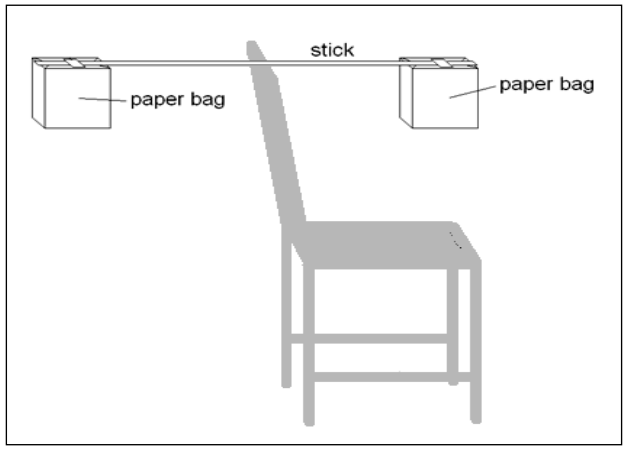



*Figure 9. Balance the stick with paper bags on a chair.*

Q1. Was your prediction accurate? Describe what happened.

Q2. Can you explain why?

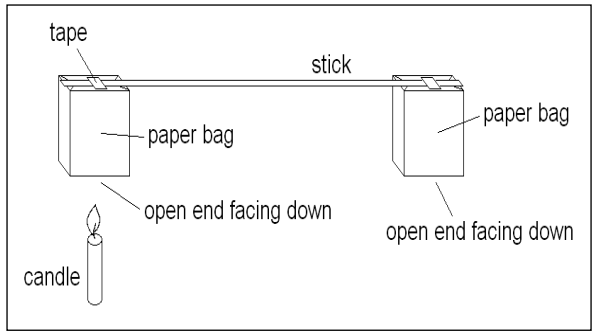



*Figure 10. What will happen when a lighted candle is placed under one of the bags?*

This is the first concept that you need to know: W*arm air rises*. Now, try to answer the following question. When warm air is rising, what is its effect on the air in the surroundings? Will the air in the surroundings stay in place? Or will it be affected in some way by the rising air? Do the following activity and find out.

# Activity 4
# What happens to the air in the surroundings as warm air rises?

## Objective

After performing this activity, you should be able to explain what happens to the air in the surroundings as warm air rises.

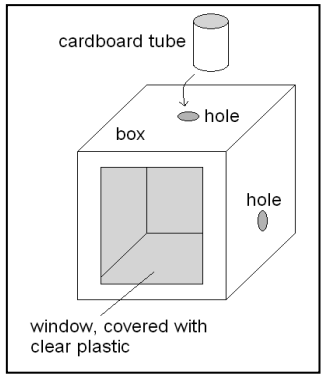



*Figure 11.*
*Setup for Activity 4*

## What to use

| | |
|---|---|
| box | candle |
| scissors | match |
| cardboard tube | smoke source |
| clear plastic | (ex. mosquito coil) |

## What to do

Pre-activity

Make two holes in the box: one hole on one side and another hole on top (see drawing). Place the cardboard tube over the hole on top and tape it in place. Make a window at the front side of the box so you can see inside. Cover the window with clear plastic to make the box airtight.

Activity proper

1. Open the box and place the candle directly below the hole on top. Light up the candle and close the box.

2. Make a prediction: What do you think will happen if you place a smoke source near the hole?

3. Now, place the smoke source near the hole.

Q1. Was your prediction accurate?

Q2. What happened?

Q3. Can you explain why?

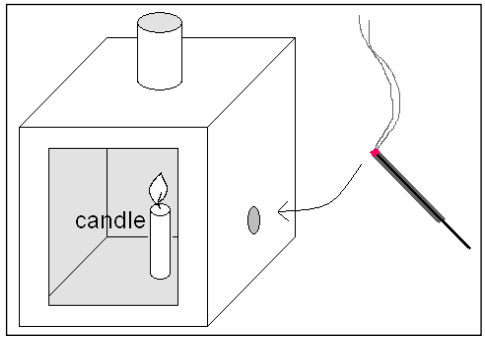



*Figure 12. What happens to the smoke when the source is placed near the hole?*

## What Makes the Air Move?

As you have seen in the activity, air in the surroundings can be affected by rising warm air. The drawing below shows how this happens. First, the air above the candle becomes warm because of the flame. What happens to this warm air? It rises. As warm air rises, what happens to the air in the surroundings? It will move toward the place where warm air is rising. But you cannot see air, how can you tell that it is moving? Did you see smoke from the mosquito coil? The movement of the smoke shows the movement of the air.

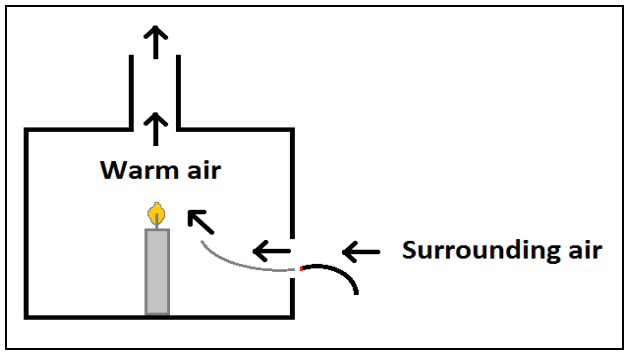



*Figure 13. Air in the surroundings move toward the place where warm air is rising.*

Let us now relate what happened in the activity to what happens in nature. During the day, the surface of the Earth becomes warm because of the Sun. Some parts of the Earth will warm up more quickly than others. Naturally, the air above the warmer surfaces will also become warm. What happens to the warm air? Just like in the activity, it will rise. How is the air in the surroundings affected? It will move toward the place where warm air is rising. This is the other concept that you need to know: *Air moves toward the place where warm air is rising*.

Whenever we feel the air moving, that means that somewhere, warm air is rising. And the air around us moves toward the place where warm air is rising. Do you remember that 'moving air' is called wind? Every time you feel the wind, it means that air is moving toward the place where warm air is rising. Strictly speaking, wind is air that is moving horizontally.

Let us use now the two concepts you have learned to explain other things. You know that the surface of the Earth is made basically of two things: land and water. When the Sun's rays strike land and water, do they heat up as fast as each other? Do land and water absorb heat from the Sun in the same way? Or is there a difference? Perform the next activity and find out.

# Activity 5
# Which warms up faster?

## Objectives

After performing this activity, you should be able to

1. compare which warms up faster: sand or water
2. compare which cools faster: sand or water
3. use the results of the activity to explain sea breeze and land breeze

## What to use

| | |
|---|---|
| 2 identical plastic containers | string |
| 2 thermometers | water |
| 2 iron stands with clamps | sand |

## What to do

1. In the shade, set up everything as shown below. The bulbs of the thermometer should be 2 cm below the surface of the water and sand.

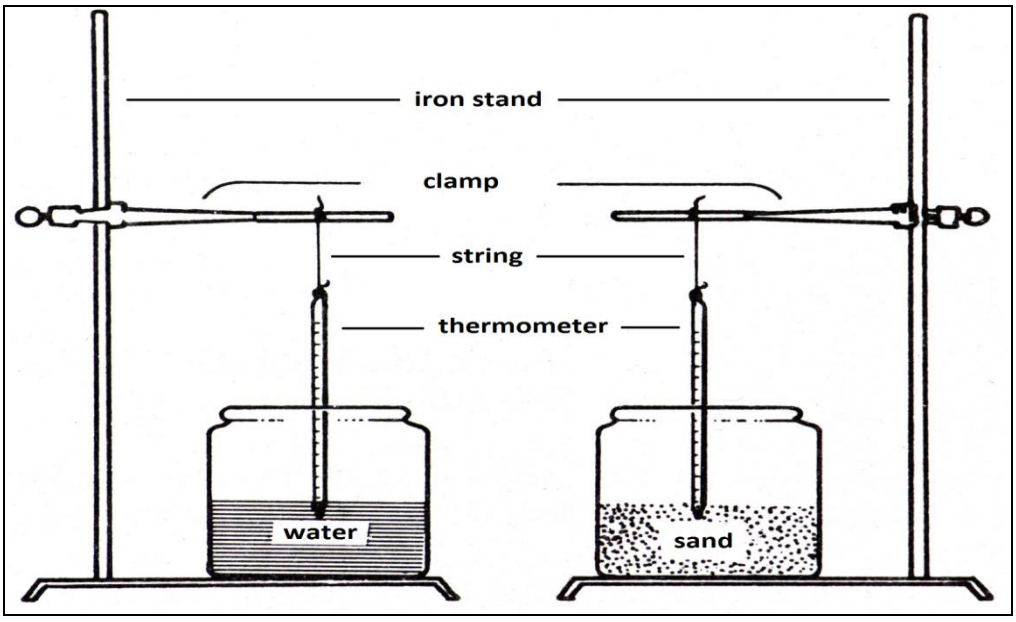



*Figure 14. Setup for Activity 5*

2. Wait for 5 minutes, then read the initial temperature of the water and sand. Record the temperature readings below.

   Initial temperature reading for water: _____
   Initial temperature reading for sand: _____

3. Now, place the setup under the Sun. Read the thermometers again and record the temperature readings in Table 1. Read every 5 minutes for 25 minutes.

Table 1. In the Sun

| Observation time (minutes) | Water | Sand |
|---|---|---|
| 0 | | |
| 5 | | |
| 10 | | |
| 15 | | |
| 20 | | |
| 25 | | |

4. After 25 minutes, bring the setup back to the shade. Read the thermometers and record the temperature readings in Table 2. Read every 5 minutes for 25 minutes.

Table 2. In the shade

| Observation time (minutes) | Water | Sand |
|---|---|---|
| 0 | | |
| 5 | | |
| 10 | | |
| 15 | | |
| 20 | | |
| 25 | | |

5. Study the data in the tables and answer the following questions.

   Q1. Which has a higher temperature after 25 minutes in the Sun, water or sand?

   Q2. After 25 minutes, how many Celsius degrees was the increase in the temperature of the water? Of the sand?

6. Make a line graph using the temperature readings taken while the setup was in the Sun.

   Q3. Based on the graph, which became hot faster, water or sand?

   Q4. What happened to the temperature of the water and sand when brought to the shade?

   Q5. How many Celsius degrees was the decrease in temperature of the water after 25 minutes? Of the sand?

7. Make a line graph using the temperature readings taken when the setup was in the shade.
   Q6. Based on the graph, which cooled down faster, water or sand?

## Sea Breeze and Land Breeze

The sand and water in the previous activity stand for land and water in real life. From the activity, you have learned that sand heats up faster than water, and that sand cools down faster than water. In the same way, when land surfaces are exposed to the Sun during the day, they heat up faster than bodies of water. At night, when the Sun has set, the land loses heat faster than bodies of water. How does this affect the air in the surroundings?

Imagine that you are standing by the sea, along the shore. During the day, the land heats up faster than the water in the sea. The air above land will then become warm ahead of the air above the sea. You know what happens to warm air: it rises. So the warmer air above the land will rise. The air above the sea will then move in to replace the rising warm air. (See drawing below.) You will then feel this moving air as a light wind—a sea breeze.

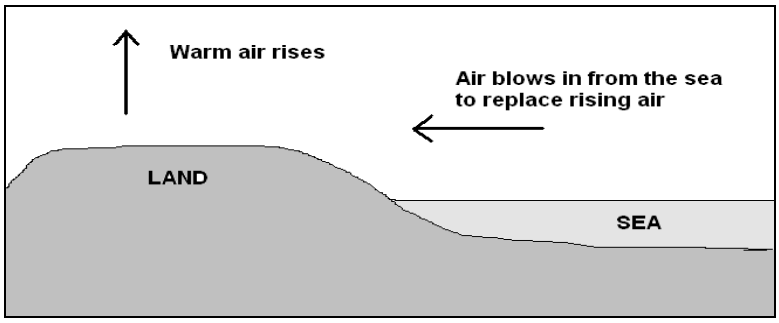



*Figure 15. When does sea breeze occur?*

What will happen at night, when the Sun is gone? The land and sea will both cool down. But the land will lose heat faster than the water in the sea. In other words, the sea will stay warm longer. This time the air above the sea will be warmer than that above land. The warm air above the sea will then rise. Air from land will move out to replace the rising warm air. (See drawing below.) This moving air or wind from land is called a land breeze.

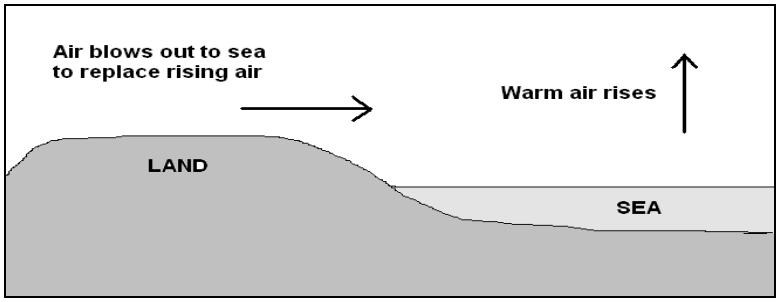



*Figure 16. When does land breeze occur?*

In the illustration above, you can see an arrow pointing upward. This represents rising warm air. The place where warm air rises is a place where air pressure is low. In other words, the place where warm air is rising is a low-pressure area. In contrast, cold air is dense and tends to sink. The place where cold air is sinking is a high-pressure area. Based on what you learned so far, in what direction does air move, from a low-pressure area to a high-pressure area or the other way around? You probably know the answer already. But the next section will make it clearer for you.

## Monsoons

Do you know what monsoons are? Many people think that monsoons are rains. They are not. Monsoons are wind systems. But these winds usually bring abundant rainfall to the country and this is probably the reason why they have been mistaken for rains. In Filipino, the monsoons are called *amihan* or *habagat*, depending on where the winds come from. Find out which is which in the following activity.

# Activity 6
# In what direction do winds blow–from high to low pressure area or vice versa?

## Objectives

After performing this activity, you should be able to

1. Interpret a map to determine direction of wind movement
2. Explain why it is cold around in December to February and warm around July.
3. Illustrate why *habagat* brings lots of rain
4. Give examples how the monsoons (*amihan* and *habagat*) affect people.

## What to use

Figure 17: Pressure and Winds in January
Figure 18: Pressure and Winds in July
pencil

## What to do

Part I.

Study Figure 17. It shows the air pressure and direction of winds in different parts of the world in January. Low-pressure areas are marked by **L** and high-pressure areas are marked by **H**. Broken lines with arrowheads show the direction of the wind.

Q1. Choose a low-pressure area and study the direction of the winds around it. Do the winds move toward the low-pressure area or away from it?

Q2. Choose a high-pressure area and study the direction of the winds around it. Do the winds move toward the high-pressure area or away from it?

Q3. In what direction do winds blow? Do winds blow from high-pressure areas to low-pressure areas? Or, from low-pressure areas to high-pressure areas?

Q4. Where is North in the map? South? West? East? Write the directions on the map.

Q5. Where is the Philippines on the map? Encircle it.

Q6. Study the wind direction near the Philippine area. From what direction does the wind blow near the Philippines in January?

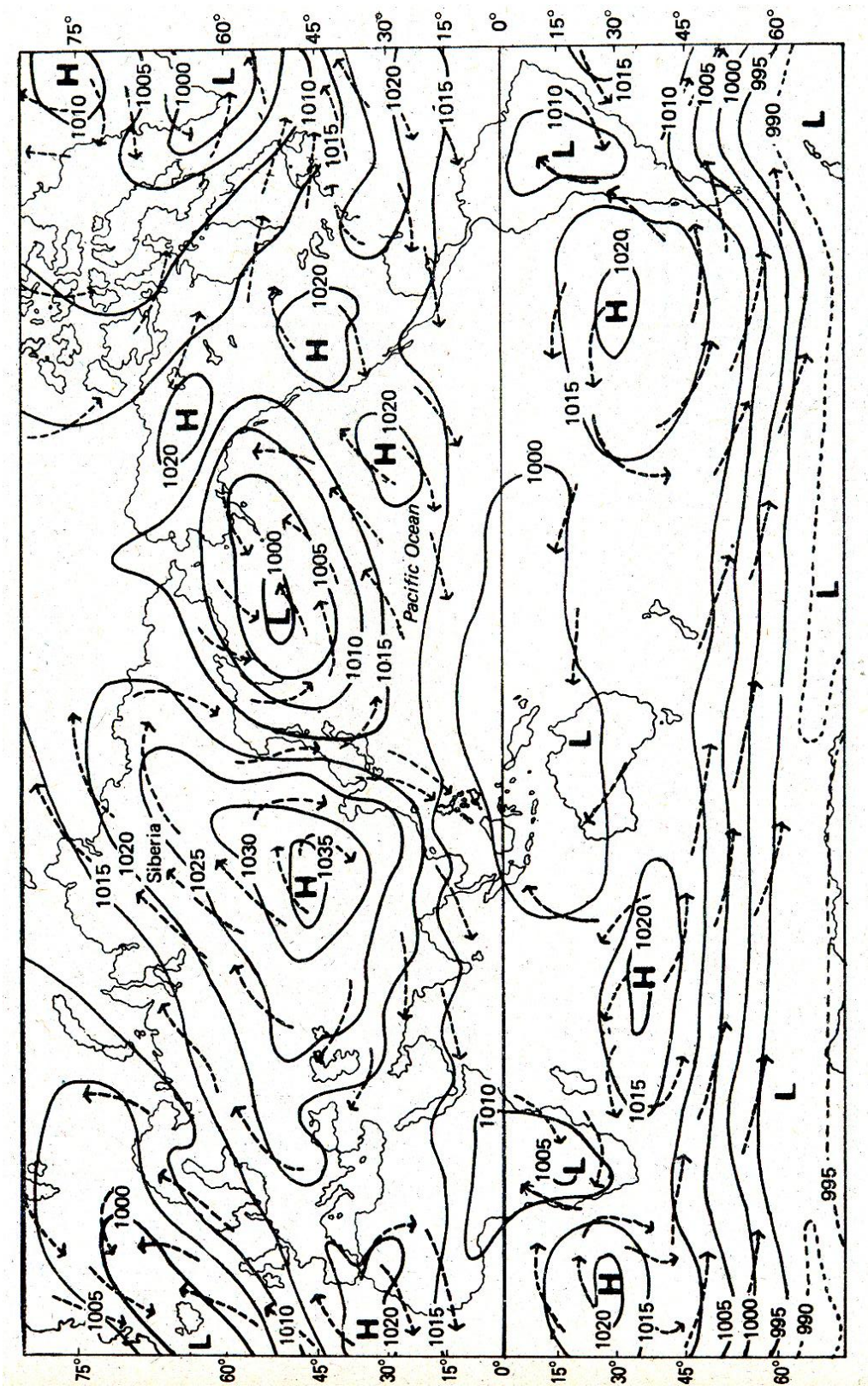



Figure 17. Pressure and Winds in January

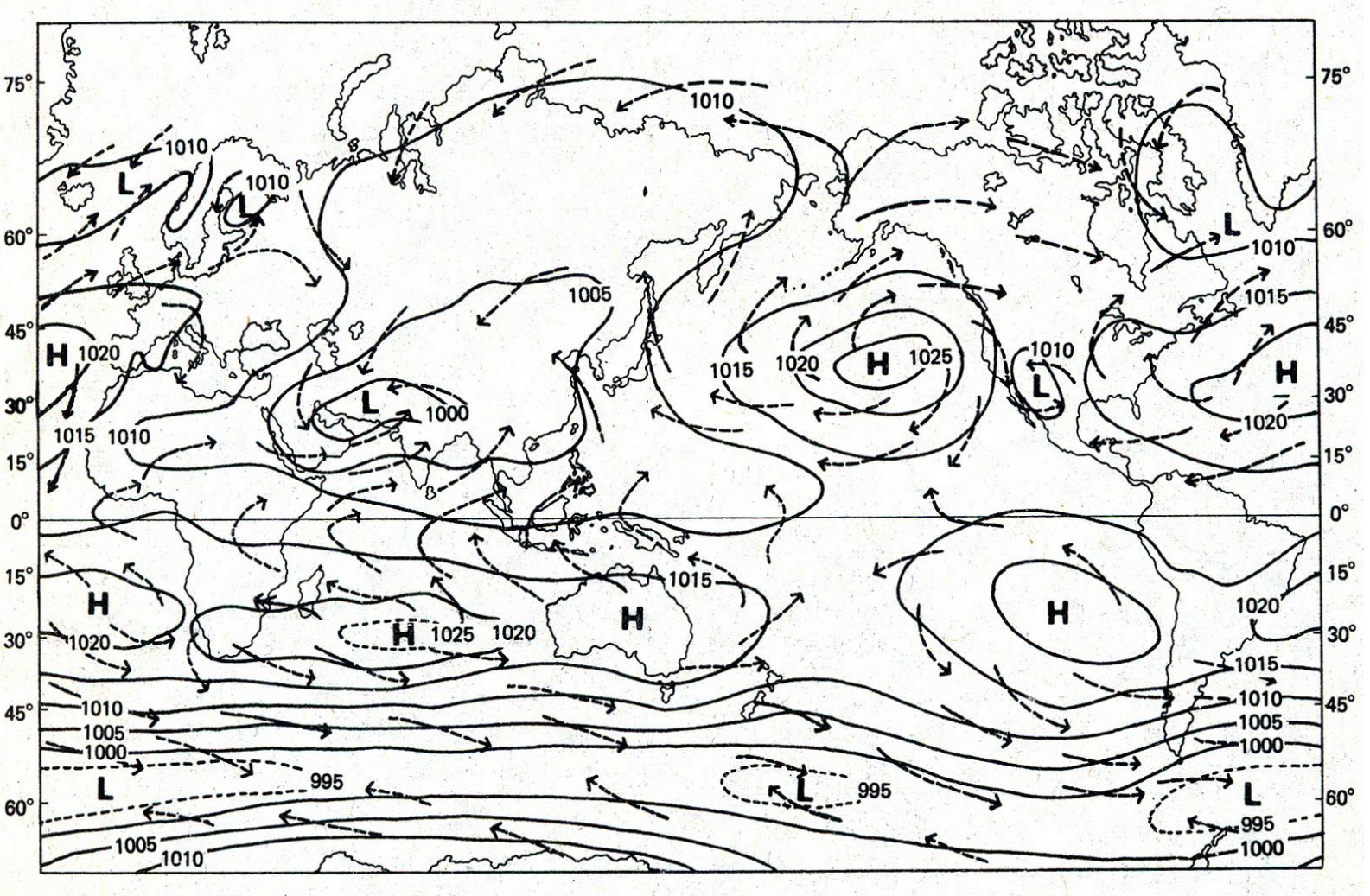



*Figure 18. Pressure and Winds in July*

Part II.

Study Figure 18. It shows the air pressure and direction of winds in different parts of the world in July.

Q7. Study the wind direction near the Philippine area. From what direction does the wind blow in the vicinity of the Philippines in July?

Figure 17 shows what happens during the colder months. The wind blows from the high-pressure area in the Asian continent toward the low-pressure area south of the Philippines. The cold air that we experience from December to February is part of this wind system. This monsoon wind is locally known as *amihan*. As you can see from Figure 17, the wind passes over some bodies of water before it reaches the Philippines. The wind picks up moisture along the way and brings rain to the eastern part of the Philippines.

Now, what happens during the warmer months? Study Figure 18 carefully. What do you observe about the low-pressure area and high-pressure area near the Philippines? They have changed places. (You will learn why in the next module.) As a result, the direction of the wind also changes. This time the wind will move from the high-pressure area in Australia to the low-pressure area in the Asian continent. This monsoon wind is locally called *habagat*. Trace the path of the *habagat* before it reaches the Philippines. Can you explain why the *habagat* brings so much rain? Which part of the Philippines does the *habagat* affect the most?

The monsoons, *habagat* and *amihan*, affect people in different ways. Try to explain the following. Why do farmers welcome the monsoons? Why are fisherfolk not so happy about the monsoons? Why do energy providers appreciate the monsoons? Why are fishpen owners worried about the monsoons? How do the monsoons affect your own town?

In the next section, you will apply the two concepts once more to explain another weather event.

## The Intertropical Convergence Zone (ITCZ)

Many people who listen to weather forecasts are confused about the intertropical convergence zone. But it is easy to understand it once you know that warm air rises, and air moves toward the place where warm air is rising. Take a look at the drawing below.

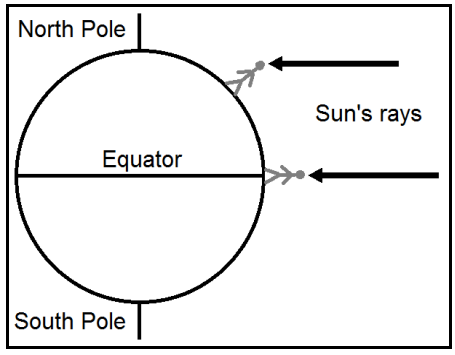



*Figure 19. Sun's rays at the equator and at a higher latitude*

Figure 19 shows the rays of the Sun at two different places at noon. Study the drawing carefully. Where would you observe the Sun directly above you? When you are at the equator? Or when you are at a higher latitude?

As you can see, the position of the Sun at midday depends on where you are. At the equator, the Sun will be directly overhead and the rays of the Sun will hit the ground directly. At a higher latitude, the Sun will be lower in the sky and the Sun's rays will strike the ground at a lower angle. Where do you think will it be warmer?

It is clear that it is warmer at the equator than anywhere else. Because of that, the air over the equator will be warmer than the air over other parts of the Earth. And you already know what happens to warm air. It rises. And when warm air rises, air in the surroundings will then move as a result.

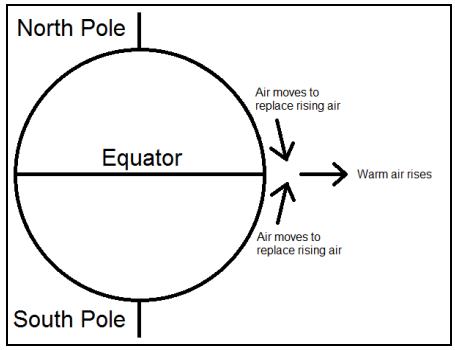



*Figure 20. How does the air move at the equator?*

As you can see from Figure 20, air from north of the equator and air from south of the equator will move toward the place where warm air is rising. Thus, the intertropical convergence zone is the place where winds in the tropics meet or converge. (Recall that the area near the equator is called the tropics.) In time the rising warm air will form clouds, which may lead to thunderstorms. Now you know why weather forecasters often blame the ITCZ for some heavy afternoon rains. The band of white clouds in the following picture shows the location of the ITCZ.

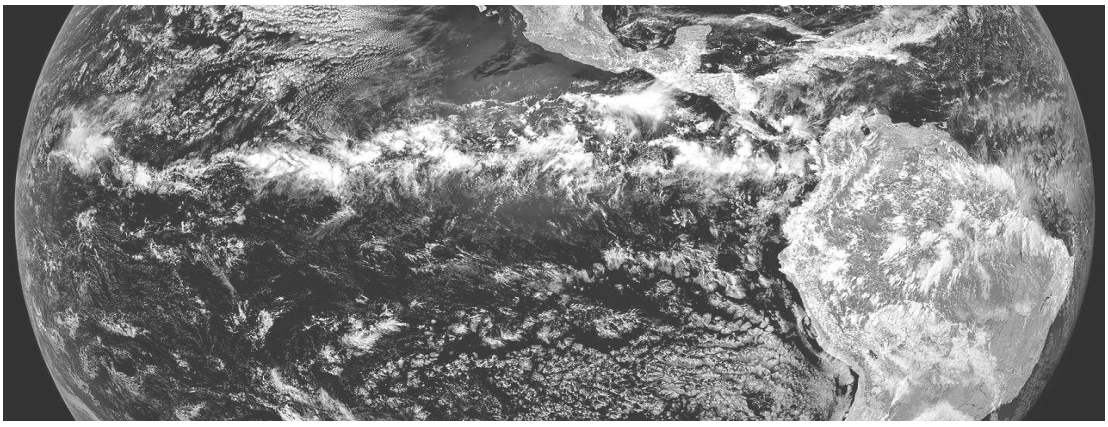


*Figure 21. Satellite photo showing the location of ITCZ*

## Summary

This module discussed global atmospheric phenomena like the greenhouse effect and global warming (including ozone depletion) that affect people, plants, animals and the physical environment around the world. And though the greenhouse effect is a natural phenomenon, there is a growing concern that human activities have emitted substances into the atmosphere that are causing changes in weather patterns at the local level.

Highlighted in this module are concepts used to explain common atmospheric phenomena: why the wind blows, why monsoons occur, and what is the so-called inter tropical convergence zone.

It is important for everyone to understand the varied atmospheric phenomena so that we can all prepare for whatever changes that occur in the environment and cope with these changes.

There are still many things to learn about the atmosphere, specifically on weather and climate. You have just been provided with the basic concepts. You will learn more as you move to Grade 8 and onwards.

**Suggested time allotment: 10 hours**

Unit 4
**MODULE**

# 3

# SEASONS AND ECLIPSES

## Overview

In Grade 6, you have learned about the major members of our solar system. Like the other planets, the Earth moves mainly in two ways: it spins on its axis and it goes around the Sun. And as the Earth revolves around the Sun, the Moon is also revolving around the Earth. Can you imagine all these "motions" happening at the same time? The amazing thing is we do not feel that the Earth is moving. In reality, the planet is speeding around the Sun at 30 kilometers each second. (The solar system is also moving around the center of the Milky Way!)

But even if we do not actually see the Earth or Moon moving, we can observe the effects of their motion. For example, because the Earth rotates, we experience day and night. As the Moon goes around the Earth, we see changes in the Moon's appearance.

In this module you will learn that the motions of the Earth and Moon have other effects. Read on and find out why.

## Seasons

In Grade 6, you tracked the weather for the whole school year. You found out that there are two seasons in the Philippines: rainy and dry. You might have noticed too that there are months of the year when it is cold and months when it is hot. The seasons follow each other regularly and you can tell in advance when it is going to be warm or cold and when it is going to be rainy or not. But can you explain why there are seasons at all? Do you know why the seasons change? The following activity will help you understand why.

# Activity 1
# Why do the seasons change?

## Objective

After performing this activity, you should be able to give one reason why the seasons change.

## What to use

Figures 1 to 5

## What to do

1. Study Figure 1 carefully. It shows the Earth at different locations along its orbit around the Sun. Note that the axis of Earth is not perpendicular to its plane of orbit; it is tilted. The letter "N" refers to the North Pole while "S" refers to the South Pole.

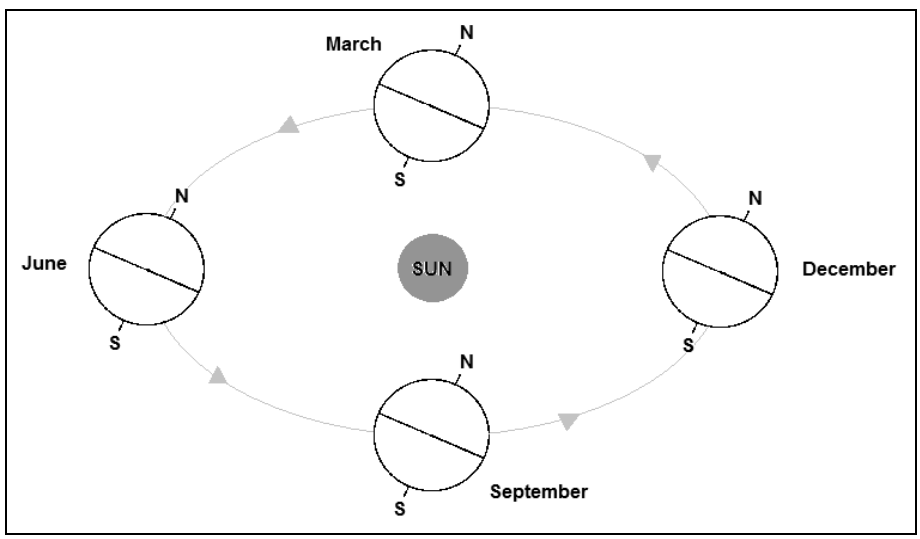



*Figure 1. The drawing shows the location of the Earth at different times of the year. Note that the axis of Earth is not vertical; it is tilted. (Not drawn to scale)*

Q1. In which month is the North Pole tilted toward the Sun– in June or December?

Q2. In which month is the North Pole tilted away from the Sun– in June or December?

2. Study Figure 2 carefully. The drawing shows how the Earth is oriented with respect to the Sun during the month of June.

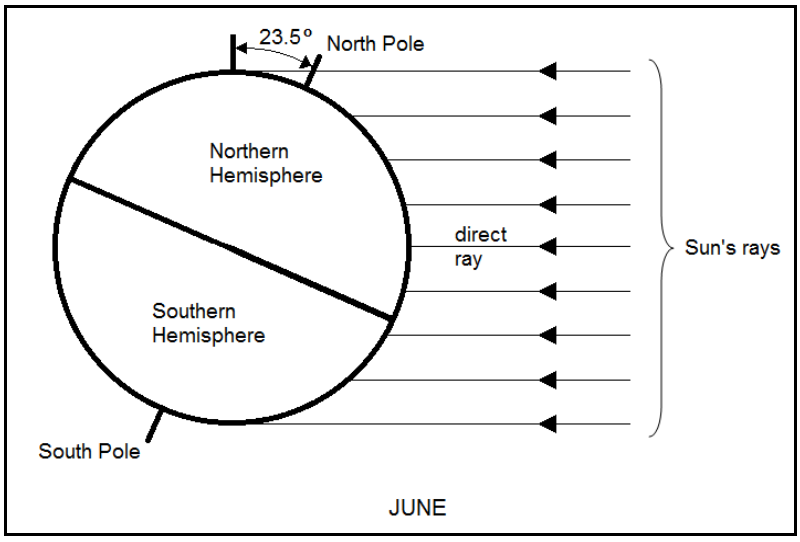



*Figure 2. Where do direct rays from the Sun fall in June?*

Q3. In June, which hemisphere receives direct rays from the Sun– the Northern Hemisphere or Southern Hemisphere?

3. Study Figure 3 carefully. The drawing shows how the Earth is oriented with respect to the Sun during the month of December.

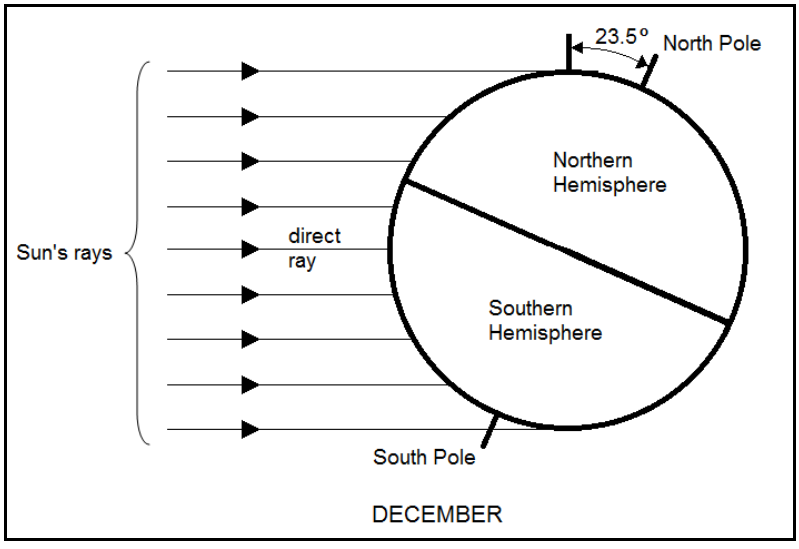



*Figure 3. Where do direct rays from the Sun fall in December?*

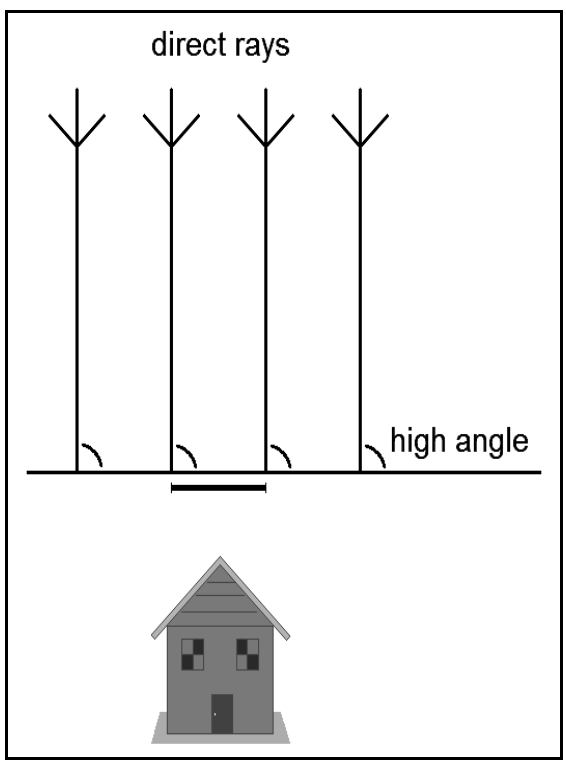
Q4. In December, which hemisphere receives direct rays from the Sun- the Northern Hemisphere or Southern Hemisphere?

Look at Figure 1 again. Note that the axis of the Earth is not perpendicular to the plane of its orbit; it is tilted from the vertical by 23.5 degrees. What is the effect of this tilt?

In June, the North Pole is tilted toward the Sun. Naturally, the Northern Hemisphere will also be tilted toward the Sun. The Northern Hemisphere will then receive direct rays from the Sun (Fig. 2). When the Sun's rays hit the ground directly, the place will become warmer than when the rays are oblique (Figures 4 and 5). This is why it is summer in the Northern Hemisphere at this time.

But the Earth is not stationary. The Earth goes around the Sun. What happens when the Earth has moved to the other side of the Sun?

After six months, in December, the North Pole will be pointing away from the Sun (Figure 1). The Northern Hemisphere will no longer receive direct rays from the Sun. The Northern Hemisphere will then experience a time of cold. For temperate countries in the Northern Hemisphere, it will be winter. In tropical Philippines, it is simply the cold season.




***What's the angle got to do with it?***

*"Direct rays" means that the rays of the Sun hit the ground at 90°. The rays are vertical or perpendicular to the ground. When the Sun's rays strike the ground at a high angle, each square meter of the ground receives a greater amount of solar energy than when the rays are inclined. The result is greater warming. (See Figure 4.)*

*On the other hand, when the Sun's rays come in at an oblique angle, each square meter of the ground will receive a lesser amount of solar energy. That's because at lower angles, solar energy will be distributed over a wider area. The place will then experience less heating up. (See Figure 5.)*

*Figure 4. In the tropics, the warm season is due to the Sun's rays hitting the ground directly. To an observer, the position of the Sun at noon will be exactly overhead.*

Which part of the Earth receives the direct rays of the Sun in December? As you can see in Figure 3, it is the South Pole that is tilted toward the Sun. This time the Sun's direct rays will fall on the Southern Hemisphere. It will then be summer in the Southern Hemisphere. Thus, when it is cold in the Northern Hemisphere, it is warm in the Southern Hemisphere.

After another six months, in June of the following year, the Earth will have made one full trip around the Sun. The Sun's direct rays will fall on the Northern Hemisphere once more. It will be warm in the Northern Hemisphere and cold in the Southern Hemisphere all over again. Thus, the seasons change because the direct rays of the Sun shift from one hemisphere to the other as the Earth goes around the Sun.

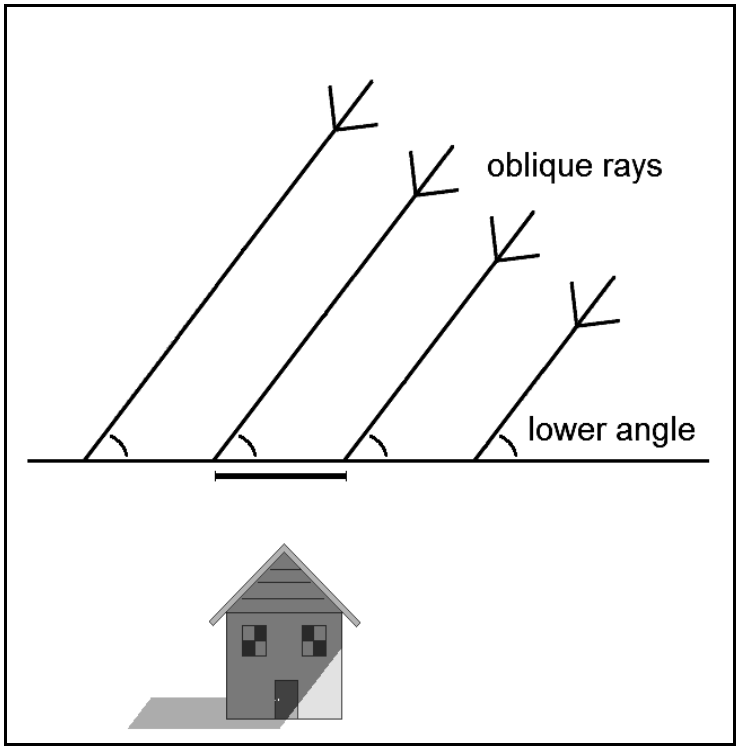



*Figure 5. The cold season is the result of the Sun's rays striking the ground at a lower angle. To an observer, the Sun at midday will not be directly above; it will be lower in the sky.*

Now you know one of the reasons why the seasons change. Sometimes the Sun's direct rays fall on the Northern Hemisphere and sometimes they fall on the Southern Hemisphere. And that is because the Earth is tilted and it goes around the Sun. There is another reason why the seasons change. Find out in the next activity.

# Activity 2
# How does the length of daytime and nighttime affect the season?

## Objectives

After performing this activity, you should be able to

1. Interpret data about sunrise and sunset to tell when daytime is long and when daytime is short;
2. Infer the effect of length of daytime and nighttime on seasons;
3. Summarize the reasons why seasons change based on Activity 1 and Activity

## What to use

Table 1

## What to do

1. Study the table below. It shows the times of sunrise and sunset on one day of each month.

Table 1: Sunrise and sunset in Manila on selected days of 2011

| Day | Sunrise | Sunset | Length of daytime |
|---|---|---|---|
| Jan 22, 2011 | 6:25 AM | 5:50 PM | 11h 25m |
| Feb 22, 2011 | 6:17 AM | 6:02 PM | 11h 45m |
| Mar 22, 2011 | 5:59 AM | 6:07 PM | 12h 08m |
| Apr 22, 2011 | 5:38 AM | 6:11 PM | 12h 33m |
| May 22, 2011 | 5:27 AM | 6:19 PM | 12h 52m |
| Jun 22, 2011 | 5:28 AM | 6:28 PM | 13h 00m |
| Jul 22, 2011 | 5:36 AM | 6:28 PM | 12h 52m |
| Aug 22, 2011 | 5:43 AM | 6:15 PM | 12h 32m |
| Sep 22, 2011 | 5:45 AM | 5:53 PM | 12h 08m |
| Oct 22, 2011 | 5:49 AM | 5:33 PM | 11h 44m |
| Nov 22, 2011 | 6:00 AM | 5:24 PM | 11h 24m |
| Dec 22, 2011 | 6:16 AM | 5:32 PM | 11h 16m |

Q1. Compare the times of sunrise from January, 2011 to December, 2011. What do you notice?

Q2. Compare the times of sunset during the same period. What do you notice?

Q3. Compare the time of sunrise on June 22, 2011 with that on December 22, 2011. On which day did the Sun rise earlier?

Q4. Compare the time of sunset on June 22, 2011 with that on December 22, 2011. On which day did the Sun set later?

Q5. When was daytime the longest?

Q6. When was daytime the shortest?

You know that there are 24 hours in a day. You probably think that daytime and nighttime are always equal. But you can infer from the activity that the length of daytime changes from month to month. When the North Pole is tilted toward the Sun, daytime will be longer than nighttime in the Northern Hemisphere.

What happens when daytime is longer than nighttime? The time of heating up during the day will be longer than the time of cooling down at night. The Northern Hemisphere steadily warms up and the result is summer. At the same time, in the Southern Hemisphere, the opposite is happening. Nights are longer than daytime. It is winter there.

But when the Earth has moved farther along its orbit, the North Pole will then be tilted away from the Sun. Nighttime will then be longer than daytime in the Northern Hemisphere. There would be a shorter time for heating up and longer time to cool down. The result is winter in the Northern Hemisphere. In tropical Philippines, it is the cold season. Meanwhile, it will be summer in the Southern Hemisphere.

At this point, you should now be able to explain why the seasons change. Your explanation should include the following things: the tilt of the Earth; its revolution around the Sun; the direct rays of the Sun, and the length of daytime. There are other factors that affect the seasons but these are the most important.

After discussing the motions of the Earth, let us now focus on the motions of another celestial object, the Moon. You have seen that the shape of the Moon appears to change from night to night. You have learned in Grade 5 that the changing phases of the Moon are due to the revolution of the Moon. The movement of the Moon also produces other phenomena which you will learn in the next section.

## Shadows and Eclipses

Do you know how shadows are formed? How about eclipses? Do you know why they occur? Do you think that shadows and eclipses are related in any way?

In this section, you will review what you know about shadows and later on perform an activity on eclipses. Afterwards, you will look at some common beliefs about eclipses and figure out if they have any scientific bases at all.

Using a shadow-play activity, your teacher will demonstrate how shadows are formed and how shadows affect the surroundings. The demonstrations should lead you to the following ideas:

- When a light source is blocked by an object, a shadow of that object is cast. The shadow will darken the object on which it falls.
- The distance of the object from the light source affects the size of its shadow. When an object is closer to the light source, its shadow will appear big. But when it is farther from the light source, its shadow is smaller.
- The occurrence of shadows is an ordinary phenomenon that you experience every day. Shadows can be seen anywhere. Sometimes, the shadow appears bigger than the original object, other times smaller.

How about in outer space? Are shadows formed there, too? How can you tell when you are here on Earth?

The next activity will help you answer these questions. The materials that you will use in the activity represent some astronomical objects in space. You will need to simulate space by making the activity area dark. Cover the windows with dark materials such as black garbage bag or dark cloth.

# Activity 3
# Are there shadows in space?

## Objective

After performing this activity, you should be able to explain how shadows are formed in space.

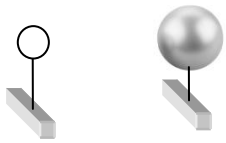
## What to use

- 1 big ball (plastic or Styrofoam ball)
- 1 small ball (diameter must be about ¼ of the big ball)
- flashlight or other light source
- 2 pieces barbecue stick (about one ruler long)
- any white paper or cardboard larger than the big ball
- Styrofoam block or block of wood as a base

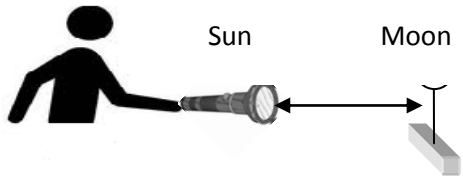
## What to do

Note: All throughout the activity, stay at the back or at the side of the flashlight as much as possible. None of your members should stay at the back of the big ball, unless specified.

1. Pierce the small ball in the middle with the barbecue stick. Then push the stick into a Styrofoam block to make it stand (see drawing on the right). The small ball represents the *Moon.* Do the same to the big ball. The big ball represents the *Earth.*

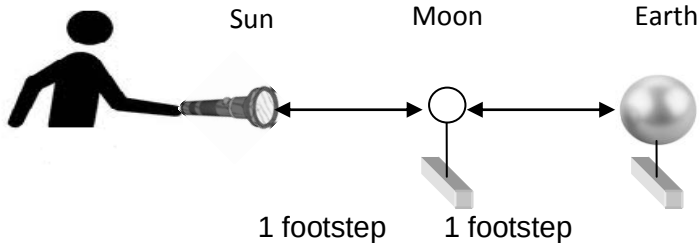


2. Hold the flashlight and shine it on the small ball (see drawing below). The distance between the flashlight and the ball is one footstep. Observe the small ball as you shine light on it. The flashlight represents the Sun.



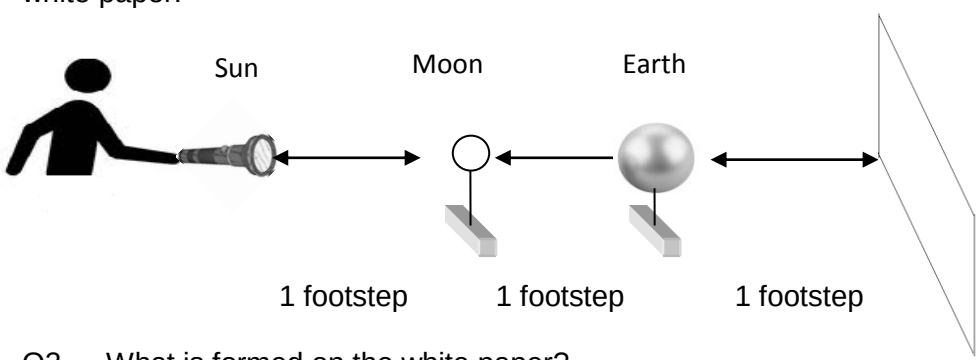

Q1. What is formed on the other side of the Moon?

3. Place the Earth one footstep away from the Moon (see drawing below). Make sure that the Sun, Moon, and Earth are along a straight line. Turn on the flashlight and observe.



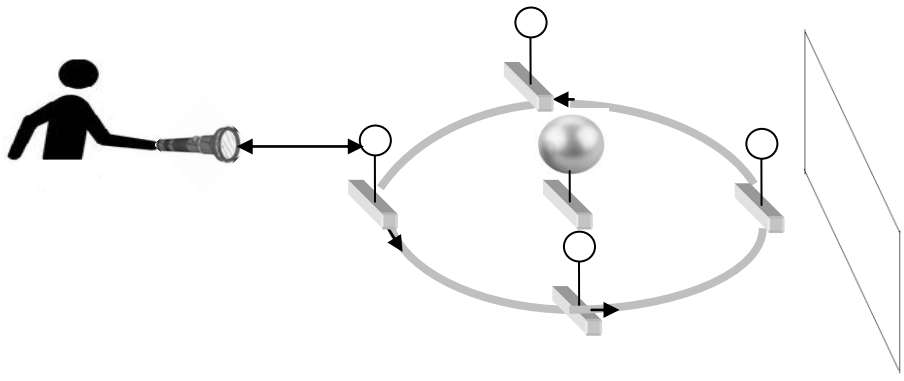

Q2. What is formed on the surface of the Earth?

4. Place the white paper one footstep away from the Earth (see drawing below). The white paper must be facing the Earth. Observe what is formed on the white paper.




Q3. What is formed on the white paper?

5. Ask a group mate to move the Moon along a circular path as shown below.



Circular path

Q4. What happens to the shadow of the Moon as you move the Moon around the Earth?

Q5. Observe the appearance of the Moon. What is the effect of the shadow of the Earth on the Moon as the Moon reaches position X (see drawing above)?

You have just simulated the formation of shadows of astronomical objects in space. The formation and darkening is exactly the same as the formation of shadows commonly seen around you. When shadows are formed on astronomical objects, a darkening effect is observed. This phenomenon is called an eclipse.

## How Do Eclipses Happen?

In the earlier grades, you learned about the members of the solar system. You know that the Sun gives off light. As the different members of the solar system move around the Sun, they block the light from the Sun and form shadows. What this means is that planets have shadows, and even their moons have shadows, too. But we cannot see the shadows that they form because we are far from them. The only shadows that we can observe are the shadows of the Moon and Earth.

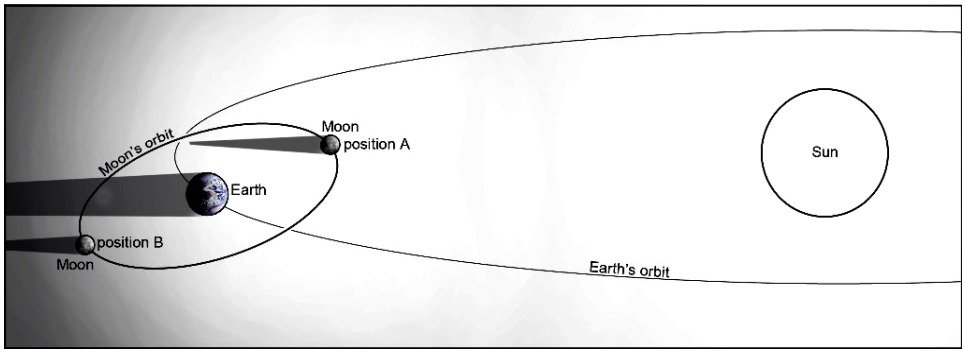



*Figure 6. Look at the shadows of the Moon and Earth. Where does the shadow of the Moon fall? Where does the shadow of the Earth fall?*

Look at Figure 6. (Note that the objects are not drawn to scale.) In the drawing, there are two Moons. Of course, you know that we only have one Moon. The figure is just showing you the Moon at two different locations as it goes around the Earth.

The figure shows where the shadows of the Moon and Earth are as viewed in space. But here on Earth, you cannot observe these shadows. Why? Look at the shadow of the Moon in positions A and B. In position A, the Moon is too high; its shadow does not fall on Earth. In position B, the Moon is too low; the shadow of the Earth does not fall on the Moon. The shadows of the Earth and Moon are cast in space. So, when can we observe these shadows? In what positions can we see these shadows? Let us look at another arrangement.

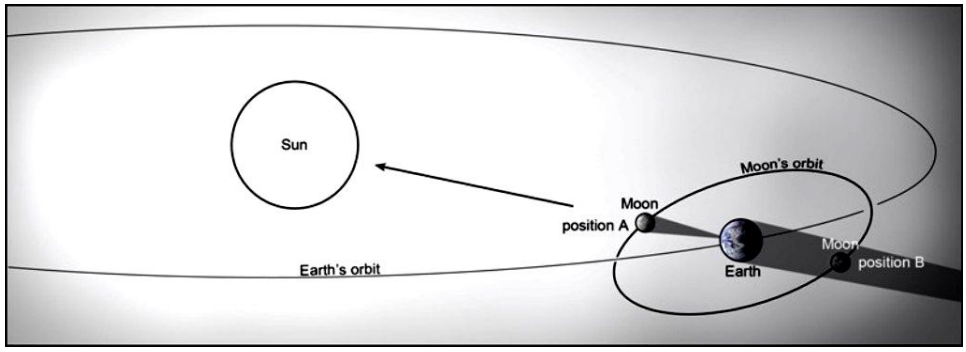



*Figure 7. When does the shadow of the Moon fall on Earth? When does Earth cast a shadow on the Moon?*

In Figure 7, the Earth has moved along its orbit, taking the Moon along. The Moon is shown in two different locations once more. Note that at these positions, the Moon is neither too high nor too low. In fact, the Moon is in a straight line between the Sun and the Earth. You can say that the three objects are perfectly aligned.

At position A, where does the shadow of the Moon fall? As you can see, the shadow of the Moon now falls on the Earth. When you are within this shadow, you will experience a **solar eclipse**. A solar eclipse occurs when the Moon comes directly between the Sun and Earth (Figure 7, position A). You have simulated this solar eclipse in Activity 3.

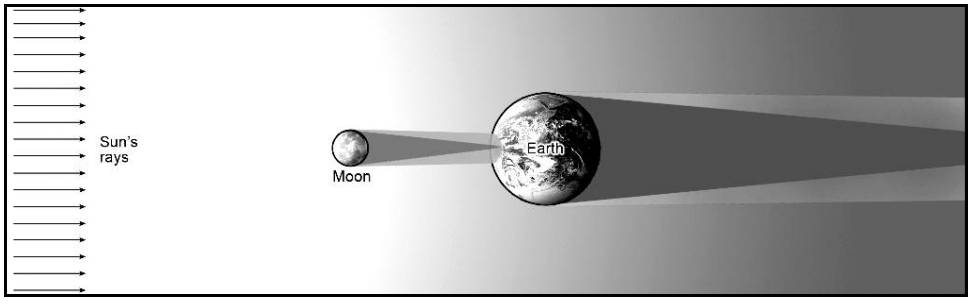



*Figure 8. Where is the Moon in relation to the Sun and Earth during a solar eclipse?*

Let us look at the Sun, Moon, and Earth in Figure 8. Look at the tip of the shadow of the Moon as it falls on Earth. Is the entire shadow of the Moon completely dark? Do you notice the unequal shading of the shadow? Actually this unequal shading is comparable to what you have observed in your simulation activity.

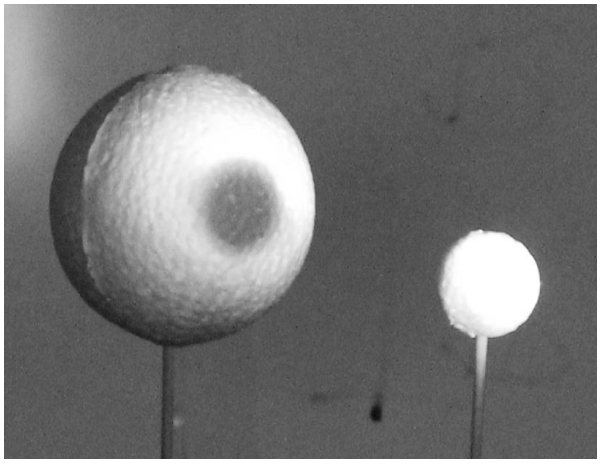


*Figure 9. Is the shadow of the small ball uniformly dark?*

Remember the shadow of the small ball (Moon) on the big ball (Earth) in your activity? It has a gray outer part and a darker inner part (Figure 9). In the case of the Moon's shadow, this gray outer region is the penumbra while the darker inner region is the umbra.

If you are standing within the umbra of the Moon's shadow, you will see the Sun disappear from your view. The surroundings appear like it is early evening. In this case, you are witnessing a total solar eclipse. In comparison, if you are in the penumbra, you will see the Sun partially covered by the Moon. There are no dramatic changes in the surroundings; there is no noticeable dimming of sunlight. In this case, you are observing a partial solar eclipse.

Let us go back to Figure 7. Look at the Moon in position B. Do you notice that at this position the Moon is also aligned with the Sun and Earth? At this position, a different type of eclipse occurs. This time, the Moon is in the shadow of the Earth. In this case, you will observe a lunar eclipse. A lunar eclipse occurs when the Moon is directly on the opposite side of the Earth as the Sun.

The occurrence of a lunar eclipse was simulated in the activity. Do you remember the small ball (Moon) in position X? You noticed that the shadow of the big ball (Earth) darkened the whole surface of the small ball. In a lunar eclipse, the shadow of the Earth also darkens the Moon (Figure 10).

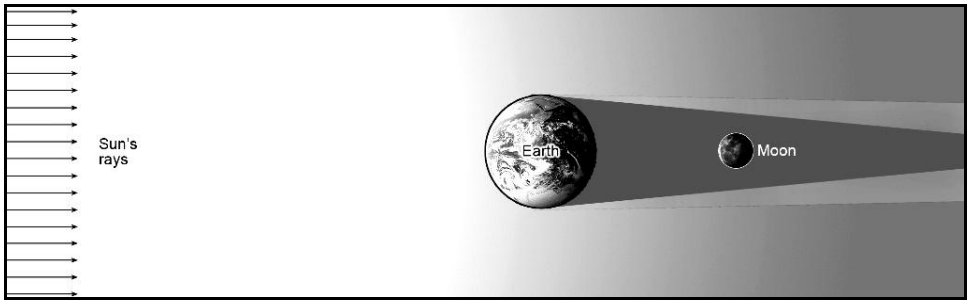



*Figure 10. Where is the Earth in relation to the Sun and Moon during a lunar eclipse?*

Focus your attention on the shadow of the Earth in Figure 10. The shadow is wider than that of the Moon. It also has an umbra and a penumbra. Which part of the Earth's shadow falls on the Moon? Is the Moon always found within the umbra?

The appearance of the Moon is dependent on its location in the Earth's shadow. When the entire Moon is within the umbra, it will look totally dark. At this time you will observe a total lunar eclipse. But when the Moon passes only through a part of the umbra, a partial lunar eclipse will be observed. A part of the Moon will look dark while the rest will be lighter.

In earlier grades, you learned that it takes about one month for the Moon to complete its trip around the Earth. If that is the case, then we should be observing monthly eclipses. In reality, eclipses do not occur every month. There are only about three solar eclipses and three lunar eclipses in a year. What could be the reason for this?

The answer lies in the orbit of the Moon. Look at the orbit of the Earth and the Moon in Figures 6 and 7. Do their orbits have the same orientations? As you can see the Moon's orbit is slightly inclined. The orbit is tilted by $5^0$ from the plane of the orbit of the Earth. As the moon moves around the Earth, it is sometimes higher or lower than the Earth. In these situations, the shadow of the Moon does not hit the surface of the Earth. Thus, no eclipses will occur. Eclipses only happen when the Moon aligns with the Sun and Earth.

### Facts, Myths, and Superstitions

Some people believe that a sudden darkening during the day (solar eclipse) brings bad luck. Others say that it is also bad luck when the Moon turns dark during a Full Moon (lunar eclipse).

Do you think these beliefs regarding eclipses are true? Let us find that out in the next activity.

# Activity 4
# Does a Bakunawa cause eclipses?

### Objective

When you finish this activity, you should be able to evaluate some beliefs about eclipses.

### What to do

1. Collect some beliefs about eclipses. You may ask older people in your family or in the community Or, you may read on some of these beliefs.

Table 2. Beliefs related to eclipses and its scientific bases

| Beliefs | Scientific explanations |
|---|---|
| | |
| | |
| | |
| | |

*Ancient Tagalogs call eclipses as laho. Others call it as eklepse (pronounced as written). Old people would tell you that during laho or eklepse, the Sun and the Moon are eaten by a big snake called Bakunawa. The only way to bring them back is to create a very loud noise. The Bakunawa gets irritated with the noise and spews out the Sun and the Moon back to the people.*

Q1. Which beliefs and practices have scientific bases? Why do you say so?

Q2. Which beliefs and practices have no scientific bases? Support your answer.

Which among the beliefs you have collected do you consider true? Do all the beliefs you have collected have scientific bases? Are the explanations of the occurrences of eclipses related to these beliefs? Are there any proofs that tell you they are true?

In science, explanations are supported with evidence. Beliefs related to eclipses, such as the Sun being swallowed by *Bakunawa* (a large animal), or the increase of harmful microorganisms during an eclipse, are passed on by adults to young children. But until now, no proof has been offered to show that they are true.

However, there are beliefs that have scientific bases. For example, it is bad to look directly at the Sun during a solar eclipse. Doing so will damage your eyes. This is true. Even if only a thin crescent of the Sun is left uncovered by the Moon, it will still be too bright for you to observe. In fact, it is 10,000 times brighter than the Full Moon and it will certainly harm your retina. So if you ever observe a solar eclipse, be ready with a solar filter or welder's goggles to protect your eyes.

Now you are an informed student on the occurrence of eclipses. The next time an eclipse occurs, your task is to explain to your family or the community the factors that cause eclipse.

## Summary

You may still be wondering why the topics *Seasons* and *Eclipses* were discussed together in a single module. The reason is that these phenomena are mainly the result of the motions of the Earth and Moon through space. As the Earth goes around the Sun, the northern and southern hemispheres are alternately exposed to the direct rays of the Sun, leading to the annual changes in seasons. And as the Moon goes around the Earth, it sometimes forms a straight line with the Sun and Earth, leading to the occurrence of eclipses. We do not directly see nor observe the motions of the Earth and Moon, but we can observe the phenomena that arise because of them.