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Science

Teacher's Guide

This instructional material was collaboratively developed and reviewed by educators from public and private schools, colleges, and/or universities. We encourage teachers and other education stakeholders to email their feedback, comments, and recommendations to the Department of Education at action@deped.gov.ph.

We value your feedback and recommendations.

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Teacher's Guide
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UNIT 1: Diversity of Materials in the Environment

Overview

This set of five modules on the Diversity of Materials in the Environment provides many opportunities for students to increase their understanding of solutions, substances and mixtures, elements and compounds, acids and bases, and metals and nonmetals, through engaging them in scientific inquiry.

There is a wide range and variety of materials on Earth. These include natural materials, those that have been made from other materials (processed or manufactured), and those which make up living things. In Grade 7, the development of ideas about materials begins with awareness of solutions, which students often encounter everyday as liquid mixtures. Further awareness of materials in terms of the components they are made of—substances, elements, compounds are taken up in Modules 2, 3, and 5. Students will also study the properties of a special group of compounds—acids and bases in Module 4.

These concepts will be encountered by the students in the contexts and life situations that they are most familiar with. It is important to recognize that the teaching of the concepts covered in this set of modules focuses more on the 'macro' view (the tangible and visible). Science education research recommends that concepts be taught, initially, at the macro level only. Explanations at the 'submicroscopic' level (atomic or molecular level) could be shared in appropriate doses enough to be processed by the students. The use of chemical symbols and equations are reserved for higher grade levels much later. The experiences gained through different activities in each module will allow students to transform the information they obtain into a form that is usable to them in their own personal and community context.

The development of the modules veers away from teaching science that is textbook-centered to that which incorporates interactive and inquiry-based learning experiences. Inquiry is essential in learning science. When students are engaged in inquiry, they describe objects and phenomena, "identify questions that can be answered through scientific investigations; design and conduct a scientific investigation; use appropriate tools and techniques to gather, analyze, and interpret data; develop descriptions, explanations, predictions, and models using evidence; think critically and logically to make the relationships between evidence and explanations; recognize and analyze alternative explanations and predictions; communicate scientific procedures and explanations; and use mathematics in all aspects of scientific inquiry" (*The National Science Education Standards*, U.S. National Research Council, 2000. p.19).

Research has shown that the use of inquiry and investigative skills develop with age. In this set of modules, the students will apply the inquiry skills they learned in earlier grades. They will plan and carry out simple science investigations. Each student will be able to participate first-hand in looking for evidence to answer questions they have posed at the beginning. They will have opportunities to gather

and interpret data as well as draw conclusions based on evidence they have gathered. They will perform fair tests by identifying variables to be changed, measured and controlled, and do repeat trials.

The teacher needs to guide and intervene throughout the process of investigation to improve the students' understanding of the concepts involved. Gradually, the students will gain more independence in looking for evidence to answer questions as they move from guided inquiry to full investigations.

It is hoped that through the use of inquiry, teachers will be able to facilitate learning of science and assess each student's developing understandings and abilities. Some activities, by themselves, can be considered as embedded assessment. There is also a pre/post test that should be administered before and after all the activities in each module have been completed. The teacher needs to analyze the results of these tests. The pretest results will indicate students' prior knowledge and alternative conceptions (if any). The posttest results will show the extent of students' comprehension of the concepts and their capacity to demonstrate needed skills. The posttest can also reveal students' misconceptions that need to be addressed in succeeding modules.

Unit 1
MODULE

1

SOLUTIONS

In this module on Solutions, the activities have been sequenced in such a way that the concepts are developed gradually from the first to the last activity. It starts with the students being acquainted with solutions found in their home. The second activity allows them to study some common characteristics of solutions—appearance, number of phases observed, ability to be dissolved in water, and ability to be filtered. In Activity 3, students begin to distinguish a saturated from an unsaturated solution through a guided investigation where they learn that there is a maximum amount of solute that can dissolve in a given amount of solvent at a certain temperature.

Key questions for this module

What common properties do solutions have?
Are solutions always liquid?
Will all solids dissolve in water?
How fast do solids dissolve in water?

The development of inquiry skills is also gradual. In Activity 1, the students will simply write observations and present their observations in table form. In the second activity, students will predict, find some patterns and draw conclusions based on the collected data in order to give some common characteristics of solutions. Students will have the opportunity to observe, measure, analyze data and consequently give generalizations when they distinguish between a saturated and an unsaturated solution in Activity 3.

Activities 4 to 6 deal with factors affecting how fast a solid solute dissolves in water. Students will perform a guided investigation where they will (1) formulate specific question(s) to a testable form; (2) formulate a hypothesis that identifies a cause and effect relationship between the dependent and independent variables; (3) select and justify a procedure to be used in answering the specific question(s); (4) identify the dependent and independent variables in the investigation; (5) carry out the procedure that includes a fair test, including controlling variables and doing repeated trials to increase accuracy and reliability; (6) make observations that are relevant to the specific question(s); (7) make measurements using appropriate

devices; (8) record and report all observations and data; (9) interpret patterns from the data gathered; (10) infer and explain relationships from the data; and (11) draw a conclusion from the results obtained, including a statement to support or reject the hypothesis.

Activity 1 — What solutions do you find in your home?!

For the TEACHER

1. Assign your students to go to a store or grocery and list the products being sold. Ask them to identify which among the products are solutions.

2. Let the students describe the products in terms of color and appearance, odor, feel, and taste (for food products).

3. They may also search their kitchen shelves and storage areas at home to identify the solutions they use at home. Let the students bring the product itself or the label of the used product.

4. Bring to class other solutions which students may not recognize as solutions. Some examples are bronze medal, brass, stainless steel utensils, sterling silver jewelry, coins, and other solutions.

Activity 2 — What are the properties of solutions?

Table 1. Data table for Activity 2

(1) Sample solid or liquid	(2) Will dissolve in ½ cup water (yes or no)	(3) Appearance	(4) Number of phases	(5) Can be separated by filtration (yes or no)	(6) Path of light (can or cannot be seen)	(7) Solution or not?
Sugar	completely	uniform	one	NO	cannot be seen	solution
Salt	completely	uniform	two	NO	cannot be seen	solution
Mongo seeds	not at all	not uniform	two	YES	can be seen	not a solution

(1) Sample solid or liquid	(2) Will dissolve in ½ cup water (yes or no)	(3) Appearance	(4) Number of phases	(5) Can be separated by filtration (yes or no)	(6) Path of light (can or cannot be seen)	(7) Solution or not?
Powdered juice	completely or partially	not uniform	two	NO or some powder left on filter paper	can be seen	colloid (not a solution)
Cooking oil	not at all	not uniform	Two layers	NO	can be seen	not a solution
Vinegar (clear type)	completely	uniform	one	NO	cannot be seen	solution
Colloidal type	completely	not uniform	one	NO	can be seen	not a solution

Note 1: In column 3, students may describe the mixture in other ways such as homogeneous or heterogeneous. They may also describe the color of the mixture.

Note 2: For salt as sample, students might observe two phases (the liquid part and some solids at the bottom of the container.) These particles may either be undissolved salt or particles of dirt from the sample used. In this case, the number of phases is *two*. However, if all of the salt dissolved, then the number of phases is *one*.

In Activity 2, students found out that a solution is formed when a solute dissolves in a solvent to form a single phase that appears uniform throughout. In a solution, the particles are too small that they cannot be seen by the unaided eye. The particles in solution are smaller than the pores of the filter paper or the cheesecloth and so these can pass through the filter.

Each part of a solution retains its characteristic properties. When a sugar solution is filtered, the filtrate tastes sweet. The sweetness of sugar is present in any part of the sugar solution.

Ordinarily, a path of light from a source cannot be seen unless the light passes through mist or through dust in the air. These particles scatter light. The path of light is visible only when the light is scattered by particles. So, when a beam of light from a flashlight is passed through a solution, the path of light is not observed because the particles are too small to scatter light. On the other hand, particles of colloids and suspensions scatter or reflect light. The scatter of visible light by particles is called **Tyndall effect**.

In Activity 2, the path of light cannot be seen in the samples which dissolved completely in water. These are solutions. So, one property of solutions is that they do not scatter light. Solutions do not exhibit Tyndall effect. However, the path of light can be observed in the samples that did not completely dissolve in water.

Based on the results of Activity 2, there are common properties that solutions have.

Some common properties of solutions:

1. **Solutions are homogeneous. They are mixtures consisting of one phase only. The components are so well mixed that all parts of the solution appear the same. A solution has the same composition and properties throughout.**

2. **The solute cannot be separated from the solvent through filtration because these are so small that they pass through the filter paper or cheesecloth.**

3. **Solutions do not scatter light. They do not exhibit Tyndall effect.**

It would be good to introduce the concept of solute and solvent after Activity 2. A solution consists of two components called the solvent and the solute. Generally, the component present in small amount is called the **solute**. The solute and the solvent dissolve in each other. Usually the solvent is the component present in greater amount. So in a sugar solution, sugar is the solute and water is the solvent.

Activity 3

What is the evidence that a solution is saturated?

Answers to Questions

Q1. The solution appears uniform throughout. It is homogeneous.
Q2. Five and ½ teaspoons of sugar were added when there was excess undissolved sugar observed remaining in the container.
Q3. Five teaspoons of sugar is the maximum amount that can dissolve in 20 mL of water.

Note: Activity 3 is done at room temperature only. The effect of temperature on solubility is not yet discussed in Grade 7. Activities 4 to 6 will deal only with the factors affecting *how fast* a solid solute dissolves in water.

While in general, solubility of solute increases as temperature is increased, it should be noted that the relationship between temperature and solubility is not simple. Faster dissolving does not necessarily mean more extensive dissolving. It is important to distinguish the effect of temperature on how fast the process of dissolving takes place from its effect on the final amount of solute that will completely dissolve.

The solubility of some solutes decreases as temperature increases. On the other hand, there are solutes that increase their solubility at higher temperatures. For some other solutes, their solubility is not affected by an increase in temperature. Since the effect of temperature on different solutes is more accurately explained using solubility curves, Grade 7 students are not expected to use these solubility curves, which will be taken up in Grade 9. The effect of temperature on the solubility of gases in liquids will also be taken up also in Grade 9.

Teacher Demonstration: Concentration of Solutions

Materials

food color (blue, yellow, or green)
medicine droppers
water
4 clear, transparent bottles
stirrer

Procedure (Part 1)

1. Label the clear, transparent bottles with numbers 1 to 4.
2. Place one drop of food color in bottle #1.
3. Add 50 mL water to the food color in bottle #1 and stir the solution.
4. Place 10 drops of food color in bottle #2.
5. Add 50 mL water to the food color in bottle #2 and stir the solution.
6. Show the class bottles #1 and #2 and ask them to differentiate the two bottles.

Procedure (Part 2)

1. Place one drop of food color in bottle #3.
2. Add 20 mL water in bottle #3 and stir the solution.
3. Place one drop of food color in bottle #4.
4. Add 100 mL water to the food color in bottle #4 and stir the solution.
5. Show the class bottles #3 and #4 and ask them to differentiate the two bottles.

After the demonstration, student should be aware that concentrated solutions can be prepared either by adding more solute and keeping the amount of solvent the same or keeping the amount of solute the same and reducing the amount of solvent.

Activities 4 to 6 focus on some factors affecting how fast a solid solute dissolves in water. These activities will allow students to perform simple investigations where they have to do the following:

1. formulate a specific question or problem to a testable form
2. formulate a **hypothesis** (the statement that gives a tentative answer or solution to the question; a possible explanation that will be proven or disproven)
3. select and justify a procedure to be used in answering the specific question
4. identify the dependent and independent variables in the investigation

   The **dependent variable** is the factor or condition that is

   - *measured* or *responding* in an experiment
   - the change or *result* that occurs due to the independent variable
   - the *"what will happen"* in an experiment

   The **independent variable** is the factor or condition that is

   - *changed* in an experiment directly caused by the experimenter
   - *manipulated* in the experiment
   - the *"what you do"* in the experiment

5. carry out the procedure that includes a fair test, which includes identifying the **control variables** (factors that are kept the same) and doing repeated trials to increase accuracy and reliability.

   > *A **fair test** is making sure that in an experiment, one factor or condition (the independent variable) affects another (the dependent variable) by keeping all other conditions constant or the same.*

6. make observations that are relevant to the specific question
7. make measurements using appropriate devices and units
8. record and report all observations and data
9. interpret patterns from the data gathered
10. infer and explain relationships from the data; and
11. draw a conclusion from the results obtained, including a statement to support or reject the hypothesis.

The teacher will demonstrate the effect of stirring, as one factor affecting how fast solids dissolve in liquids. For the other factors affecting how fast solids dissolve in water, the class can be divided into groups of 6-8 students, where different groups can address any one of the following:

a) the effect of particle size
b) the effect of temperature
c) the nature of the solute

The discussion for Grade 7 will be limited only on the factors that affecting how fast a solid solute dissolves in water based on the results of the students' investigations in this module.

Teacher Demonstration: The Effect of Stirring

1. Put one (1) teaspoon of chocolate powder in each of two different transparent drinking cups, labeled cup A and cup B, respectively.

2. Add ½ cup of water in each of the cups. Let the students observe closely.

3. Stir the mixture in cup A 10 times using a stirrer or teaspoon. Do not stir the mixture in cup B.

4. Let the students observe what happens in each cup.

5. Ask the students: what differences do you observe between cup A and cup B?

6. Let the students give the reason(s) for the results they observed.

Emphasize that stirring the solution will let the solvent particles come in contact faster with the corners and edges of solute particles. Therefore, the solute dissolves faster. Keep in mind that stirring does not affect the amount (how much) of solute that dissolves in solution. You will recall in Activity 3 that a solute remains undissolved no matter how much you stir if it is already a saturated solution.

Activity 4 Size matters!

1. Let different groups of students design and conduct an investigation to find out whether the particle size of a solid affects how fast it dissolves in water.

2. Ask students to come up with a hypothesis in a testable form.
   Example: The crushed salt dissolves faster than the uncrushed (salt which has bigger size of particles).

3. Ask students to think about how they could investigate this question using table salt. Introduce them to the idea that crushing salt will make the particle size smaller.

4. Provide measuring cups and teaspoons, water, table salt (big crystals) and crushed salt. Let them use a big cup or glass bottle to roll over table salt in order to crush it.

5. Let the students list the materials they need. Check whether the list is complete. Make sure that the following materials are listed (though the groups may ask for different amounts):

   2 clear plastic cups
   2 stirrers
   Measuring cups: ½ cup, 1 cup
   2 tablespoons of rock salt
   water

6. Check the procedure of the students. The dependent and independent variables should be identified. The control variable should also be specified and considered in the procedure to be done.

7. Let the students perform at least two trials (replicates), but it is much better if three trials or replicates are done.

Effect of Particle Size

In the discussion, ask students if their observations from the investigation support this idea that smaller pieces can dissolve faster than larger ones. They can infer that when water and salt are mixed, the particles are constantly moving within the container.

The teacher should let the students imagine that in a solution, the particles of the solute (table salt) and the solvent (water) are constantly moving. Water particles collide everywhere along the surface of the particles of table salt.

When the water particles come close to the salt particles, the collision happens more often at the corners and edges of the solid salt. At the corners and edges of the solid, the particles are more easily removed than those which are within the solid.

The container with crushed salt has much smaller particles in the solution than the container with bigger crystals of salt. So water particles could more easily surround the smaller particles of crushed salt than the surface of the big salt crystal. Therefore, the crushed salt dissolves faster. Thus, the smaller particles of salt, the easier they mix with the water.

These explanations refer to the surface area of the solute particles. The surface area is the area of the solute particles exposed to the solvent (water in this case). Since the crushed table salt has a bigger the surface area, then it dissolves faster. Therefore, crushed table salt dissolves faster than the bigger granules of salt.

Note: The term “surface area” is not used in explaining the effect of particle size to Grade 7 students since it may still be difficult for them to visualize what it means. However, showing a big whole cube and another cube of the same dimension but cut

into smaller pieces of cubes may help students visualize that the cube cut into smaller pieces has a larger surface area.

Activity 5

How fast does coffee dissolve in hot water? In cold water?

This activity will let students conduct an investigation to see how fast coffee dissolves in cold and in hot water.

1. Ask students how they make hot coffee. Ask them if they could make "cold coffee" by adding cold water or milk to the hot coffee.

2. In groups, ask them to write a hypothesis in testable form to compare how fast coffee dissolves in cold and in hot water. An example of a hypothesis is: Coffee powder dissolves faster in hot water than in cold water.

3. Give time for the students to determine which variables should be controlled. They should come up with the following variables: amount of water in each cup; amount of coffee in each cup; method of stirring; time when the solid is added to water, and how long each solution is stirred. Students should know that what differs in each cup is the temperature of the water.

   Note: You may either have each group conduct its own investigation according to the group's plans, or have a class discussion to decide on a procedure that everyone will use.

4. Let them list the materials they need as well as the amounts needed. Their list should include the following:

   2 cups hot water
   2 cups cold water
   instant coffee powder
   2 clear plastic cups
   2 stirrers
   Measuring cups: ½ cup, 1 cup
   Measuring spoons: ½ tsp, 1 tsp

6. The following procedure is one method students can use. Different ratios of coffee and water can be used since different groups are assigned to investigate the effect of temperature.

Procedure

1. Place ½ cup of cold water in a cup.
2. Place ½ cup of hot water in another cup.
3. At the same time, add ½ teaspoon of coffee to each cup.

4. Stir each solid for 10 seconds and observe.
5. Stir for another 10 seconds and observe again.

***Expected results*:** The coffee in hot water will make the color of water dark brown or black. The coffee powder will dissolve faster in hot water. In cold water, there will be some coffee particles remaining that did not dissolve. With more stirring, the coffee in the cold water may also completely dissolve in the water after some time.

Note: Coffee is used in this activity because making hot coffee is common to students and such will show how heating a liquid can affect how fast a solid dissolves.

Let the students draw diagrams or illustrations showing the stages of a solid dissolving. Ask students questions like the following:

- Does coffee dissolve faster in hot water?
- What is the best way to make "cold coffee"?

The Effect of Temperature

Most solids, like coffee powder, dissolve faster in hot water than in cold water. At higher temperature, the water particles in move faster and come in contact more frequently with the solute particles (the coffee powder).

Activity 6

Which dissolves faster in hot and in cold water? Sugar or salt?

Questions to investigate: Does salt dissolve faster in hot water than in cold water? Does sugar dissolve faster in hot water than in cold water?

1. Ask students to investigate how temperature affects how fast sugar and salt dissolve in water.

In their earlier investigations, students learned that the temperature of water affected how fast coffee dissolves in water. Ask students how they could test whether the temperature of water affects how fast salt dissolves in water. Similarly, ask them how they can test whether temperature of water affects how fast sugar dissolves in water.

2. Let the students formulate a hypothesis in testable form. For example, they can predict that both sugar and salt dissolve better in hot water than in cold water.

3. Ask the students to identify the dependent and the independent variables.

4. Give time for the students to determine which variables should be controlled. They should come up with the following variables: amount of water in each cup; amount of salt and sugar in each cup; method of stirring; time when the solid is added to water, and how long each solution is stirred. Students should recognize that what differs in each cup is the temperature of the water.

   You may ask students these questions to guide them in controlling variables:

   - Do you need to use the same amount of sugar in each sample?
   - Do you need to use the same amount of water in dissolving both sugar and salt?
   - Should the water be at the same or at different temperatures?

5. Let them list the materials they need as well as the amounts needed. Their list should include the following:

   2 cups of water
   2 cups cold water
   2 tablespoon sugar
   2 tablespoon salt
   4 plastic cups
   2 stirrers
   Measuring cups: ½ cup, 1 cup
   Measuring spoons: ½ tsp, 1 tsp

6. The following procedure is one method students can use. Different amounts of salt, sugar and water can be used depending on the planned procedure of the students.

   Hint: It is better to use a small volume of water, for example, 20 mL of water to make the time for investigation shorter.

   Sugar in hot and cold water

   a. Place 20 mL of hot water in a cup.
   b. Place 20 mL of cold water in another cup.
   c. At the same time, add 2 teaspoons of sugar to each cup.
   d. Stir the sugar in each cup for 10 seconds and observe. What happened to the sugar?
   e. Record your observations.
   f. Stir for another 10 seconds and observe again.
   g. Set aside both containers.
   h. After 5 minutes, observe closely the bottom of the container.

Salt in cold and hot water

Repeat Steps 1 to 7 with salt.

7. Discuss the results of the investigation. Ask the following questions:

    - Does temperature affect how fast sugar dissolves in water? Give the evidence based on your observations.

    - Does temperature affect how fast salt that dissolves in water? Give the evidence based on your observations.

    - Which dissolves easier in hot water: sugar or salt?

Expected results:

For sugar: Sugar dissolves faster in hot water than in cold water. Two teaspoons of sugar can completely dissolve at room temperature in three minutes. But, two teaspoons of sugar can completely dissolve at 75^{o}C in one minute and 13 seconds.

For salt: There is about the same amount of salt remaining at the bottom of both the hot and cold containers. Only a little more salt can dissolve in very hot water than in cold.

Students can conclude that temperature affects how fast sugar dissolves in water more than it affects how fast salt dissolves in water. This conclusion is based on the difference in the time needed to dissolve sugar in cold and in hot water. However, there is only a slight difference in the time needed to completely dissolve the salt in hot water than in cold water.

8. Let students use their observations to make statements about the effect of temperature on how fast salt dissolves in water as well as how fast sugar dissolves in water.

9. When all groups have completed their investigation, compare the results.

PRE/POST TEST

1. Which of the following is an example of a solution? (Choose more than one.)

   a. Vinegar
   b. Mud in water
   c. Food coloring in water
   d. Sugar dissolved in water
   e. Ice cream

   Give the reason why you think these are solutions.

2. Which statement describes the solute?

   a. It is the solid formed in solution.
   b. It is the liquid part of the solution.
   c. It is the component of a solution in smaller amount.
   d. It is the component of a solution in bigger amount.

3. Which is more concentrated, a solution containing 5 grams of salt in 10 grams of water or a solution containing 18 grams of salt in 90 grams of water? Show your calculations.

4. The label of the 200-mL rubbing alcohol that Mrs. Herrera bought shows that it contains 40% ethyl alcohol. What is the volume of ethyl alcohol does the rubbing alcohol contain? Show your calculations.

5. Joel and Ben wanted to find out how much salt is needed to make a saturated solution in 100 mL of water. Use the following data to answer the questions below the table.

Step Number	Amount of salt added	Observations
1	6 grams	After stirring, salt completely dissolved.
2	6 grams	After stirring, salt completely dissolved.
3	6 grams	After stirring, salt completely dissolved.
4	6 grams	After stirring, salt completely dissolved.
5	6 grams	After stirring, salt completely dissolved.
6	6 grams	After stirring, salt completely dissolved.
7	6 grams	After stirring, some salt is seen at the bottom of the container.

   a. Which is the solute of the solution? Which is the solvent?
   b. In which step is the solution described as saturated solution? Explain your answer.
   c. What the concentration of the solution in step 4?

6. Give one reason why people stir coffee or juice in water after they have added sugar.

7. Why do you think that it is easier to dissolve powdered brown sugar than a big whole piece or chunk of brown sugar (the size of a small ice cream cup) in water?

For items 8-10: A group of students was asked to investigate how fast sugar dissolves in cold and in hot water?

8. If this is going to be a fair test, what variables should they control?

   a. Amount of water and sugar in each cup, method of stirring, time when the solid is added to water, how long each solution is stirred.

   b. Amount of water and sugar in each cup, method of stirring, how long each solution is stirred.

   c. Amount of sugar in each cup; method of stirring, time when the solid is added to water, how long each solution is stirred.

   d. Amount of water in each cup, method of stirring, time when the solid is added to water; how long each solution is stirred.

9. What is the dependent variable (what is being measured)?

   I. The temperature of water.
   II. The amount of sugar.
   III. The length of time that sugar completely dissolves in hot water.
   IV. The length of time that sugar completely dissolves in cold water.

   a. I only
   b. II only
   c. II and III
   d. III and IV

10. What is the independent variable in the investigation?

   a. I only
   b. II and III
   c. I, II and III
   d. II, III and IV

Answer Key

1. (**a**), (**c**), (**d**); Vinegar, food coloring in water, and sugar dissolved in water are all solutions since each appears to be in one phase only (homogeneous) and transparent.

2. (**c**). The component in smaller amount is the solute. The component present in greater amount is the solvent.The solid formed in a solution is called a precipitate.

3. 5 grams salt in 10 grams water is more concentrated.
   Calculations:
   5 grams salt/10 grams water x 100% = 50% salt
   18 grams salt/90 grams water x 100% = 20% salt

4. % volume = volume solute/volume solution x 100%
   40% = volume solute/200 mL x 100 %
   volume solute = 40% x 200 mL = 80 mL ethyl alcohol

5. a. Salt is the solute; water is the solvent.
   b. The solution is saturated at step 6. The solution is saturated when all (maximum amount) of the solute was dissolved. At step 7, some salt already came out of solution and did not dissolve anymore.
   c. 24 grams/100 mL

6. Stirring will increase the movement or allows faster spreading of solute particles in the solvent. This in turn hastens the contact between the surface of the solute and the solvent particles.

7. Powdered brown sugar has more corners and edges since the particles of the powder are smaller. So there will be more particles of brown sugar that can attach or come in contact with the water, making it dissolve faster in water.
8. (**a**)

9. (**d**)

10. (**a**)

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Unit 1
MODULE

2

SUBSTANCES AND MIXTURES

In this module, students will broaden their knowledge about the different samples of matter. They will find out that *mixture* is just one of the two major classes of matter. The other of which is the *substance*. Based on differences in behavior under certain conditions, they should be able to distinguish one from the other.

Key questions for this module

How are mixtures different from substances?
How are they similar?

A series of activities will gear the students in answering the questions above. With the hope that students will find connection between the topics they have learned in the lower grade levels to the ones they are about to learn, the first activity will bring them to their past lesson on separating mixtures. Moreover, the products obtained from this activity will be the ones used for the proceeding activity which will focus on differentiating substances from mixtures. In this manner, the students will be more convinced that mixtures may be composed of substances. A culminating activity will check if they have learned the distinguishable behaviors between these classes of matter vis-à-vis their ability to design an investigation.

Skills enhanced in this module

Science Inquiry Skills	Manipulative Skills
through	
• making qualitative and quantitative observations • drawing inferences from observations • organizing and tabulating data • comparing and contrasting behaviors of substances and mixtures • classifying samples as mixtures and substances • plotting and interpreting line graphs • stating a generalization based on observations or data which are consistent in a number of trials	• observing proper behavior in the laboratory to prevent accidents and errors • using the correct technique in smelling, feeling, and tasting samples • using the correct technique in making temperature readings • setting up equipment for boiling and melting samples • constructing an improvised equipment

Activity 1

Seawater! See water and salt!

In grade 6, students have encountered several ways in separating mixtures. Most of them are techniques to separate heterogeneous mixtures such as scooping, filtration, and decantation. In this activity, they will experience a way of separating the components of a homogeneous mixture. It is important that they are aware of the kind of sample they are working with — mixture. They may review some characteristics of mixtures such as those in the table on the right. They may check the sample that they are going to use in this activity if it does have the characteristics listed in the table. The students should know that the *seawater* sample is made up of components; however, they cannot be distinguished because the sample is homogeneous. This activity will help them "see" the components of their *seawater* sample which are salt and water. They will distill the water out from the mixture and may refer to this product as *distilled water*. The remaining sample will evaporate out the rest of the water leaving salt crystals.

Characteristics of Mixtures
• may be solid, liquid or gas • may be homogeneous or heterogeneous • made up of two or more components • components may be separated/recovered by physical means such as filtration, and distillation • amount of components may vary

Important!

- Emphasize the ones written in the "Take Care!" boxes.
- Make sure to use protective eyewear at all times during the activity. Some samples may splatter when inflamed.
- Have a fire extinguisher (blanket, sand or big jar) ready at all times.

Teaching Tips

- Alternative materials
  - *Salt solution instead of seawater.* To prepare a salt solution, add about 3.0g table salt and 10 mL water. Mix well and filter undissolved particles.
  - *Broken tiles or porous pot chips instead of boiling chips.* The chips can be reused two times. After the activity, collect all the chips. Wash, dry and then keep them in a covered container.
  - *Ballpen casing and rubber hose instead of the delivery tube used for the distillation setup.*
  - *Aluminum foil instead of evaporating dish.* The foil may be shaped like a bowl and fitted around the mouth of a beaker. See Figure 2 in Student Module 2.

- *Wire gauze without the asbestos*. Simply scrape off the asbestos center of those old wire gauze, provided they are not yet worn out. Collect the asbestos and dispose of properly.

- Distillation techniques
  - Do not remove the flame from the test tube while distillation is in progress. This may cause the cold liquid to be sucked back into the hot test tube. Remove the receiving test tube first before extinguishing the flame.
  - Do not let the solution in the sample flask dry up. Remove the flame as soon as the liquid in the sample flask is only about 1 cm high from the bottom.
  - Keep the receiver in the water bath while doing the distillation. It is better to add ice to the water bath.

- You may discuss the distillation techniques above and ask the students the possible reason for such techniques. Allow the students to think or give them prompt questions that may lead them to think of the reasons.

- Let the students be the ones to assemble the distillation setup, however make sure that they have done it correctly. You may include this as an assessment.

Answers to Activity Questions

Part A

Q1. There are some small, solid crystals left.

Part B

Q2. The intensity of the yellow color flame is the same with the residue and the table salt. It is highly possible that the residue from Part A is table salt, which is sodium chloride.

Activity 2

Looks may be deceiving

In Activity 1, students have learned that mixtures, despite the homogeneity, are made up of components. These components were referred as substances. However, the word *substance* is being introduced in the module for the first time. The students may not have any idea on what a substance is. Hence, this activity will build in the students the concept of *substance* from their previous knowledge on mixtures. They will find out that the behavior of mixtures are much different than those of substances. Being so, substance is another class of matter.

This activity is divided into two parts: part A will differentiate substances and mixtures through the way the temperature changes during boiling; while in part B, these two are differentiated through how they appear/behave while they are melting. Both parts will make use of samples that appear to be identical. Part A will use the distilled water obtained in Activity 1 and seawater; while Part B will use benzoic acid and a mixture of benzoic acid and salt. They will first differentiate the samples based on appearance. They will find it difficult to identify one from the other by simply looking at them since they are homogeneous. As such, *looks may be deceiving*. Only after the activity, they will realize a way these samples may be differentiated. From here, the students will give their operational definition of substances.

It is highly encouraged to use the distilled water obtained in Activity 1 as the sample for Part A. In this manner, the students will be more convinced that mixtures may be composed of substances. Salts that were recovered from Activity 1 are still mixtures of different salts and minerals. In effect, it may be said that mixtures may also be composed of mixtures.

Reminders

- In part A, make sure the students will boil the *distilled water* sample first. In this manner, the chances of contaminating the *distilled water* may be lessened. Also, make sure the seawater sample has the same odor as distilled water. Allow the seawater to dissipate its characteristic odor by leaving the container partly covered overnight.
- In part B, make sure the samples are placed in their assigned X marks of the improvised melting dish.
- The expected results and generalization are as follows. Allow the students to come about these generalizations by themselves as you facilitate in processing their results.

Reminders

cont'd.

- During boiling, the temperature of a substance changes at first then it becomes the same, while the temperature of a mixture is different at different times.
- During melting, a substance melts completely/smoothly within a short time; while the mixtures have portions that seem to be not melting.

- Do the following after Activity 2 to emphasize that melting and boiling behavior of a substance are the same even the amount changes.
  - Boil different volumes (1 mL, 3mL, 5mL) of distilled water. Ask the students to describe the boiling behavior of distilled water in different volumes. (The behavior is the same for the different volumes of distilled water, i.e., the temperature changes at first then it becomes the same.)
  - Melt different amounts (1 scoop, 2 scoops, 3 scoops, 4 scoops) of benzoic acid. Ask the students to describe the melting behavior of benzoic acid in different amounts. (The behavior is the same for the different amounts of benzoic acid, i.e., the samples melt completely/ smoothly within a short time.)
  - Let them think of other properties that will not change with the amount of a substance (e.g., density).

Teaching Tips

- Emphasize that the samples that will be used in Part A are the products from Activity 1. Part B will not be using the ones collected from Activity 1. However, after the activity, students will infer the melting behavior of one of its products.
- The melting dish made by other classes or batches may be used. You may skip the construction of an improvised melting dish if it is already available. Other possible materials for melting dish are the metal lids of mayonnaise/marmalade jars and Piknik shoestring potato snack.
- In case some materials for Part B are not available, a video may serve as an alternative. To get a copy of this video, please access curriculum.nismed.upd.edu.ph.
- Allow students to tinker with the samples so they may be able to give a rich description for each of them. Hand lens, if available, may be used.
- Let the students assemble the setup for boiling. This will give an opportunity for the students to enhance their lab/manipulative skills. This can also be included as an assessment.
- Review techniques in the proper use of a laboratory thermometer. Make sure temperature is read at the eye level. There is no need to shake the thermometer to bring the reading to zero.

Teaching Tips

- Check how your students construct their graphs. This part is an opportunity to reinforce what they have learned about investigations in Module 1. This can be a way to check if they understand the concepts of independent and dependent variables; and if they can plot using the appropriate graph to show their results.
  - Let them identify the kind of graph (line) that best suits their data.
  - Let them identify the independent (time) and the dependent (temperature reading in ^{o}C) variables.
  - Let them plot the graph and see to it that it is correctly done.
    - The data for the x-axis must be the independent variable, while the y-axis is for the dependent variable.
    - The scale is appropriate. They should have regular intervals in their x-axis. *Since reading is done every 30 sec, you can suggest that they plot every reading they have obtained. Hence, the x-axis will have 30 sec per unit.*
    - The axes should be labelled with both quantity and units.
    - There is a descriptive title for their graph.

- Compare the data obtained by the different groups. Discuss similarities and differences among these data. Make a generalization based on the data obtained. Emphasize that this generalization was based on data that is consistent in a number of trials.

- After doing Part B of Activity 2, ask the students to describe how sodium chloride melts. Tell them that it is a substance. After some students have shared their answers, show them a video on how sodium chloride melts.

- Allow students to tinker with the samples so they may be able to give a rich description for each of them. Hand lens, if available, may be used.

- Reiterate the point that “looks can be deceiving” and may not be enough basis to classify a sample as substance or mixture.

  - Allow them to revisit what they wrote in Tables 1 and 2 in the cell labelled Appearance/Odor. Do the liquid samples look the same? (Yes.) How about the solid samples? (Yes.) Based on the appearance, can you say that the samples are the same? (Yes.)
  - Try this one too! If it is possible to freeze the samples from Activity 1, the students can compare the physical states the samples can assume. Ask them the following questions: Do they look the same? (Yes.) Right after getting the samples from the freezer, what were their physical states? (Solid.)

Teaching Tips

- After establishing that appearance, odor, physical state cannot distinguish a substance from a mixture, ask them the following questions: When you boiled these two samples, can you say that they are the same? (No, they are not anymore the same.) How about the solid samples you used in part B? (They are also not anymore the same.) Can you say that they are the same after you have observed how they behave while being melted? (No, they are not anymore the same.)
- How can boiling and melting determine if a sample is a substance or a mixture? (During boiling, the temperature of a substance changes at first then it becomes the same, while the temperature of a mixture is different at different times. During melting, a substance melts completely/ smoothly and within a short time, while the mixtures have portions that seem to be not melting.)

Answers to Activity Questions

Part A
Q1. The temperature changes at first and then it becomes the same.
Q2. A substance has the same boiling temperature.
Q3. The temperature is always changing.
Q4. A mixture has changing boiling temperature.

Part B
Q1. Benzoic acid melts completely/smoothly within a short time.
Q2. A substance melts completely/smoothly within a short time.
Q3. Some parts of the mixture have started to melt and some parts don't seem to melt.
Q4. A mixture does not melt completely/smoothly like a substance. There are some portions that seem to be not melting.

Activity
3

My unknown sample: substance or mixture?

This activity may assess two things: 1) their understanding of the distinguishable behaviors between substances and mixtures; and 2) their ability to conduct an unstructured investigation. Each student is given one unknown sample, either a solid or liquid. Refer to the table below for some samples that may be used as unknowns. They will design a procedure that will identify their unknown sample as substance or mixture. They will decide which methodology is best fitted to test their sample. This procedure may be critiqued by their fellow students but you will still be the one to give the final check and "go signal" to do the activity.

Some unknown samples that may be used in the activity

	Liquid	**Solid**
Substance	distilled water	benzoic acid
Mixture	vinegar	benzoic acid-salt*
	mineral water	benzoic acid-monosodium glutamate*
	seawater	benzoic acid-white sugar*

*The ratio between the two components is 1:1.

Answers to Activity Questions

Q1. Answers will depend on the student's unknown.
For solid unknown, determine its melting behavior to identify whether it is a substance or a mixture. A substance melts completely/smoothly, while a mixture takes longer time to completely melt.
For liquid unknown, determine its boiling behavior to identify whether it is a substance or a mixture. A substance has a constant boiling temperature, while a mixture boils at a temperature range.

Note that the method has to be repeated at least three times before the student can conclude if their unknown sample is a substance or a mixture.

PRE/POST TEST

1. You were tasked to check if the liquid sample you have is a substance or a mixture. Which among these tests is the **BEST** way to do so?

    I. Color comparison
    II. Taste comparison
    III. Boiling test
    IV. Melting test

    A. I, II, III and IV
    B. I, II and III only
    C. I, II and IV only
    D. I and III only

2. A liquid has the following properties: one-phase, colorless, boils at varying temperature. Which of the following **BEST** describes the liquid?

    A. Solution
    B. Substance
    C. Suspension
    D. Coarse mixture

3. Jill has an unopened box of a 2-meter foil labeled 100% made of aluminum. Aluminum is a substance. Jill takes just a thumb-size piece of the aluminum foil. Which of the following statements is **TRUE** about the piece of aluminum foil that Jill took compared with the rest that was left in the box?

    A. Its mass and melting behavior are different.
    B. Its mass and melting behavior are the same.
    C. The mass is different but the melting behavior is the same.
    D. The mass is the same but the melting behavior is different.

Answer Key

1. D 2. A 3. C

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Unit 1
MODULE

3

ELEMENTS AND COMPOUNDS

In this module, students will begin broadening and deepening their knowledge about substances. They will find out that substances, like mixtures, are of various kinds. Being so, like mixtures which may be classified in many ways such as *solution*, *suspension*, and *colloid*; substances may also be further classified into smaller groups, such as *elements* and *compounds*.

Key questions for this module

How are elements different from compounds?

How are they similar?

A series of activities will gear the students in answering the questions above. With the hope that students will find connection between the topics they have learned in the lower grade levels to the ones they are about to learn, the first activity will resurface some ideas from Module 2. It will begin with *compound*, for the reason that it is more comparable with mixtures in terms of the number of components they are made of. Moreover, the products obtained from this activity will serve as the examples used to introduce the next concept, which is *element*. In this manner, the students will see better the connection between compounds and elements, that is, compounds are made up of elements. The periodic table will also be introduced to familiarize the students with the elements and the periodic table per se. Two activities culminate this module which will let the students realize that these elements and compounds are found just about anywhere, even with the food they eat.

Activity 1

Water, "wat-er" you made of?

In Module 2, students have learned that substances and mixtures share some similarities such as homogeneity. All substances are homogeneous while only some mixtures are. Also, they learned that being homogeneous does not automatically say that a sample is made up of only one component. This holds true for one group of substances — the *compounds*. Compounds are homogeneous

which are also made up of components. In this activity, the students will separate components of widely used compound — water. They will learn that water is made up of the elements *hydrogen* and *oxygen*. The properties of each of these substances are different from one another.

Components of water are separated through the passage of an electric current, hence the process is termed as **electrolysis**. The students will use an improvised electrolysis apparatus. You will find below how to construct one from commonly available materials.

Reminders

- Acquaint the students with the apparatus before doing the activity. Emphasize some parts (as shown in Figure 1) because they will be mentioned in the activity procedure.
- Prepare ahead 5% NaOH. You may either use NaOH pellets or *Liquid Sosa*.
  - *NaOH pellets*. Place 100 mL distilled water in a beaker. Dissolve carefully 5 g of NaOH pellets (corrosive). Store NaOH solution in PET bottle. Label with its name, concentration and date of preparation. NaOH absorbs CO_2 from air. Its concentration could change after some time.
  - *Liquid Sosa*. Mix thoroughly 1mL liquid sosa and 20mL water.

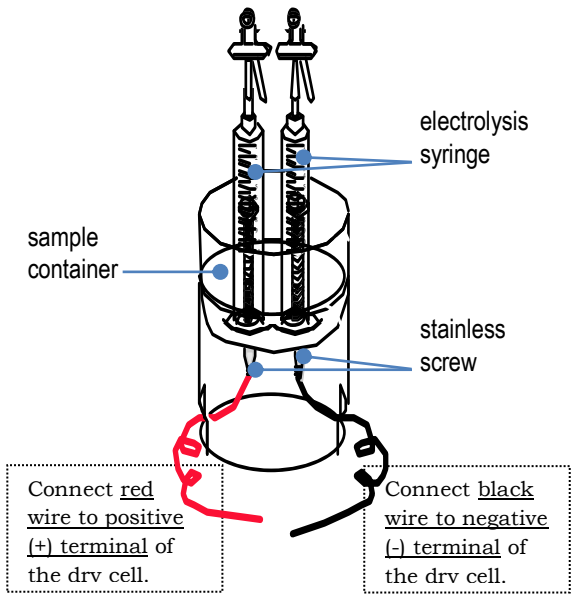


Figure 1. An improvised electrolysis

Teaching Tips

- Run down the procedure before doing the activity. Together, visualize what is supposed to be done. Have one complete setup the students can look at while emphasizing some procedures. Ask some questions as you go through each step, for example:

    - Procedure 1: What are the components of a 5% sodium hydroxide solution? (Sodium hydroxide and water.) How much in percentage is each of these components present in the said solution? (95% water and 5% sodium hydroxide.) What is the component that is of highest amount in the solution? (water.)
    - Procedure 2: What is the basic solution referred to? (5% sodium hydroxide solution) Why is it referred as a basic solution? (Sodium hydroxide is a base.)
    - Procedure 4: Here is the dry cell, where will you connect the red wire? (Positive terminal.) How about the black wire? (Negative terminal.)

- Assess your students' capability in doing the activity. If you find that the students are not yet ready to be the ones to do this, you are free to make this as a demonstration activity instead.

- Emphasize the difference in behavior of the the two products. In the presence of a flame or spark, hydrogen gives off a "pop" sound while oxygen induces a brighter spark. You may also try doing the same thing with water. Collect some water vapor in a test tube and insert a glowing stick/flame. Nothing is supposed to happen. This will let the students observe that these three exhibit different behaviors, hence are different substances.

Answers to Activity Questions

Q1. A "pop" sound was heard.

Q2. A brighter spark was observed.

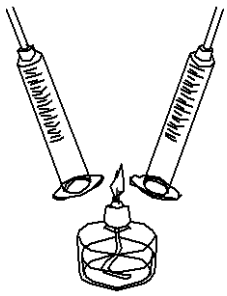
Construction of an Improvised Electrolysis Apparatus

Materials Needed

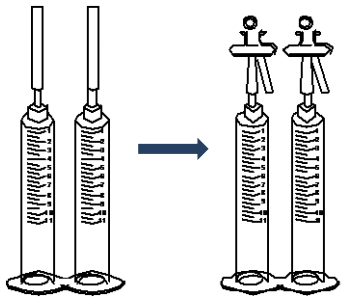
- glue
- ruler
- alcohol lamp
- stripping knife
- dry cells (1.5V)
- 2 paper clips (bulldog type)
- 3 disposable syringes (10 mL)
- 2 stainless steel screws #6 (2 x 12)
- 2 connecting wires (red and black)
- GI wire (about 6 cm, ordinary wire)
- plastic bottle (1 L, 8 cm in diameter or more), preferably thick and hard
- hard plastic straw or dextrose plastic tube (6 cm long)

Procedure (Source: Practical Work in High School Chemistry)

1. Get two disposable 10 mL syringes and remove the plungers. Attach the two syringes at the base. Using an alcohol lamp, heat the edge of the base to be attached. Refer to the figure on the right.



2. Insert each tip of the syringe inside a plastic straw about 6 m long. Bend the straw to close it and place a bulldog type paper clip on the bend to keep it in place. Refer to the figure on the right. These will serve as the “electrolysis syringes”.

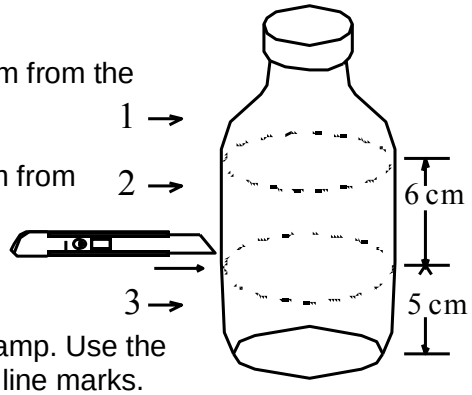


Construction of an Improvised Electrolysis Apparatus

3. Divide the plastic bottle into three portions. Mark "cutting lines" around the bottle. Refer to the figure on the right.

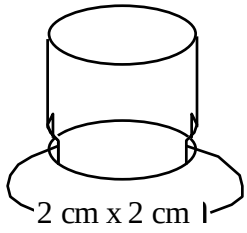
   Distance between cutting-line marks:

   - **Bottom portion** (3): about 5 cm from the bottom part of the bottle.
   - **Middle portion** (2): about 6 cm from the marked line of the bottom portion (3)

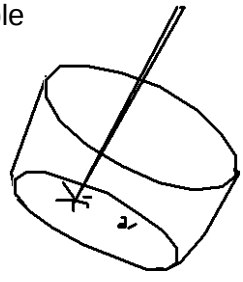


   Heat the stripping knife in an alcohol lamp. Use the hot stripping knife to cut around these line marks.

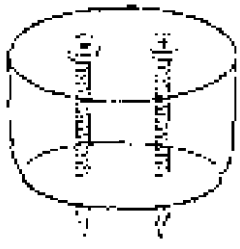
4. Use the middle portion of the bottle to make a stand for the sample container. Make two small squares measuring about 2 cm x 2 cm at opposite sides of the base. These will serve as passageway for the connecting wires.



5. Use the bottom portion of the bottle as the sample container. Measure the distance between the centers of the "electrolysis syringes". Mark this length with a line on the bottom of the cup. Then using a hot GI wire (2 mm in diameter) bore a small hole at each end of the line. The stainless screws will pass through these holes.



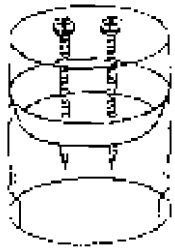
6. Insert the stainless screw through each hole by rotating it carefully until 1/4 of the nail is out at the bottom of the bottle. Refer to the figure on the right. To prevent leaks, apply glue around the stainless screws at the bottom part of the sample container.



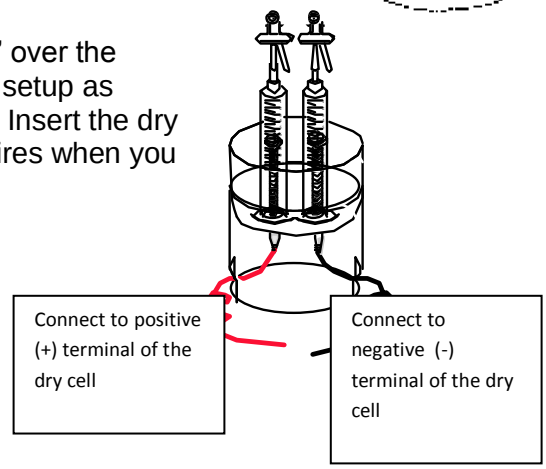
   Note: The glue should only be applied on the outside surface of the sample container.

Construction of an Improvised Electrolysis Apparatus

7. Support the sample container on the stand prepared in #3. Refer to the figure on the right.



8. Invert the "electrolysis syringes" over the stainless screws. Complete the setup as shown in the figure on the right. Insert the dry cells between the connecting wires when you are ready to do the electrolysis.



Note: This procedure is also available in http://curriculum.nismed.upd.edu.ph/2012/04/how-to-make-an-improvised-electrolysis-apparatus/

Activity 2

The periodic table: It's element-ary!

In Activity 1, they were able to generate two elements — *hydrogen* and *oxygen*. In this activity, they will find out that these two elements are just a fraction of the numerous elements currently existing. Also, that these are the substances that are homogeneous which are made up of only one component. Being so, they are said to be the "simplest form of matter".

All of the elements are systematically organized in the *periodic table*. It was described to be "amazingly" done as varied information about all of the elements are laid out in a single table. Patterns and trends are evident in the arrangement. It serves as a handy reference and as such was labelled as a chemist's tool. This tool can then be a good starting material to learn about the different elements. However, note that this is the first time for the students to formally use this tool. Being so, this activity, as it walks them through the periodic table, focuses only with the basic

information — name and symbol. Do not overwhelm them with the vast information the *periodic table* can provide. Worse, if they are required to memorize its contents. Gradually, let them realize these different information through varied activities that require its use. In that manner, they may find the *periodic table* not that complicated — it's even quite simple that it's "element-ary".

Reminders

- At this grade level, the students are not expected to have a fully-developed concept of "element." The atomic definition comes after learning about the particulate nature of matter in grade 8. Discussion at this grade level is limited to the idea that elements are the ones that make up compounds and all of these elements are listed in the Periodic Table.
- Periodic table is a tool in Chemistry that we can refer to every now and then. The more we use it, the more we get to be familiar with what it contains. Thus, there is no need to memorize such table.
- A periodic table is provided at the end page of Modules 3 and 5. The information placed there is limited to the scope of the module for this quarter. It is highly encouraged to begin with the names and symbols of the elements as they try to know what the elements are. Group number will be introduced at the latter part of the activity. Atomic numbers, at this point, will serve as a guide on how elements are sequenced in the table; it will not be defined as the number of protons of an element's atom. The latter will be discussed in grade 8 when they have already learned about the particulate nature of matter.

Teaching Tips

- Show students pictures of some elements. You may refer to some of the books and websites listed at the end page of this guide. They may give other descriptions of the elements such as physical state at standard conditions and color. If possible, use real samples.
- As an assignment, a student may choose one element and find more information about it. A poster or something similar may be done as if the student is trying to promote that element.

Answers to Activity Questions

Table 1. Name and symbol of some elements and the group number it belongs to.

Q#	Name	Symbol	Group Number (Q9)
1	beryllium	Be	2
	phosphorus	P	15
	germanium	Ge	14
	darmstatdtium	Ds	10
2	boron	B	13
	nitrogen	N	15
	fluorine	F	17
	vanadium	V	5
3	lithium	Li	1
	chlorine	Cl	17
	argon	Ar	18
	calcium	Ca	2
	manganese	Mn	7
4	iron	Fe	8
	silver	Ag	11
	mercury	Hg	12
	lead	Pb	14
5	silicon	Si	14
	magnesium	Mg	2
	gold	Au	11
6	aluminum	Al	13
	copper	Cu	11
	tin	Sn	14
	carbon	C	14
7	potassium	K	1
8	titanium	Ti	4
	barium	Ba	2

Activity 3

The "matter" on labels

Food in itself is a sample of *matter* and thereby made up of either elements, compounds or mixtures. By law, these *matter* must be written in food labels. In this activity, the students will find these *matter* on food labels. They will focus on the elements and compounds that make up the food they eat. They will be more aware of the existence of elements and compounds around them. They will find out that these elements are some of the nutrients that a food provides. These nutrients are called **minerals**. They can find them listed in the *Nutrition Facts*. Moreover, these

minerals are not added as the elements themselves. Most of the time, compounds of that element are the ones added to manufacture the food. Being so, it is the compound which is the one listed as the *Ingredient*.

Aside from the knowledge the students may gain in this activity, it is also hoped that the students acquire the habit of reading food labels. The food they eat has a major implication to their health and well-being. It is imperative then to be aware of what is taken in by the body. These are all listed in a food label. Therefore, reading food labels "matter".

Teaching Tips

- Ask the students to bring more food labels. The ones used in the activity are hoped to be only supplemental.
- As an assignment, the students can find product labels other than food such as medicine, household cleaning products, cosmetics and toiletries. They can identify elements and compounds listed on those labels.
- In the activity, the students will find out that the list of ingredients does not seem to contain those nutrients in the Nutrition Facts. The iron reported in chocolate candy is provided by the unsweetened chocolate/cocoa listed in the ingredient. This is an opportunity to emphasize that aside from knowing the name of the compound, it is an added advantage if they are familiar with the natural mineral content of the food. Some of them are listed in Table 2 of Module 3. It may also go the other way around. An ingredient is listed but does not have a counterpart in the *Nutrition Fact*. There may be two reasons for this. One is that the mineral is not that essential for health maintenance. The other is that the food product does not significantly provide that nutrient.

Answers to Activity Questions

Note: Answers below are based on those labels provided in the activity. However, it is highly encouraged that the students use additional labels for reference.

Table 3. Compounds and their constituent elements written in the food labels

Food Product	Compound	Constituent Elements
Cereal Drink	iron pyrophosphate	iron, phosphorus, oxygen
	zinc sulfate	zinc, sulfur, oxygen
Chocolate candy	sodium bicarbonate	sodium, hydrogen, carbon, oxygen
	calcium chloride	calcium, chlorine
Soy sauce	monosodium glutamate	sodium, carbon, hydrogen, nitrogen, oxygen

Activity 4

The iron-y of food fortification

Most of the minerals added to the food are in the form of compounds, for it is more easily absorbed by the body if it is in such form. Being so, rarely that the element itself is added. However, there are food products which are fortified with element *iron*.

Iron in the blood is the one responsible in carrying oxygen from the lungs to the rest of the body. For the body to function well, oxygen is critically needed. Health officials had to find ways to ascertain that there is enough iron in the food. Besides, there was a time when a lot of people were stricken with *anemia* — sickness caused by a deficiency of iron. To address this, most of the food products especially milk and cereal were required to be fortified with iron. Some food are added with compounds of iron such as ferrous sulfate, ferric pyrophosphate, and ferrous fumarate. However, addition of some of these compounds affect the taste of the food. In effect, consumers may not buy or patronize the food product. Food technologists devised other ways to add iron to food products. One of which is to manufacture a food grade iron. This is the elemental iron which was subjected into a reduction process that makes it permissible to be added to food. Being the element iron itself, properties of this substance are retained such as its ability to be attracted by a magnet.

In this activity, students will be able to recover the iron present in a food product. Emphasize though that the iron in the food is safe to eat compared to the iron that makes up the concrete nail and other products that are not meant to be ingested. Also, the ones that will be recovered from the activity should not be ingested.

Most of the equipment needed for this activity may be available in your TLE laboratory. A video (http://curriculum.nismed.upd.edu.ph/2012/04/the-iron-y-of-food/) is provided in case the materials for this activity are not easily accessible/available.

Answers to Activity Questions

Q1. There are small, black pieces or bits that are attached to the magnet.

Q2. With its attraction to the magnet, it is highly possible that the black bits recovered from the food are pieces of iron.

PRE/POST TEST

1. Which of the following statements is **TRUE**?

   A. Ferrous sulfate cannot be broken down into simpler substances.
   B. Compounds are made up of one kind of element.
   C. Water is composed of more than two elements.
   D. Compounds are more complex than elements.

2. Which of the following statements is **TRUE**?

   A. Ferrous sulfate cannot be broken down into simpler substances.
   B. Compounds are made up of one kind of element.
   C. Water is composed of more than two elements.
   D. Compounds are more complex than elements.

For questions 3 to 5. Refer to the information below. You may also refer to the periodic table. Write the symbols only.

Substance Symbol	Substance melts at	Substance boils at
Ca	850 ^{o}C	1490 ^{o}C
Cu	1083 ^{o}C	2600 ^{o}C
Fe	1540 ^{o}C	2900 ^{o}C
He	-270 ^{o}C	-269 ^{o}C
Mg	650 ^{o}C	1110 ^{o}C
NCl_3	-37 ^{o}C	71 ^{o}C
NO	-163 ^{o}C	-152 ^{o}C
Na_2CO_3	858 ^{o}C	890 ^{o}C
SiO_2	1610 ^{o}C	2230 ^{o}C

3. Which compound melts above 1000°C and boils above 2000°C?

4. Which element is gaseous at room temperature?

5. Which substance is liquid at 30°C?

Answer Key

1. D 2. B 3. SiO_2 4. He 5. NCl_3

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Unit 1
MODULE

4

ACIDS AND BASES

In this module, students will get acquainted with the properties of a group of compounds—acids and bases. They will prepare plant indicators to help them determine the acidity or basicity of common household items. Upon completion of this module, students will be able to answer the following key questions that will allow them recognize the characteristic properties of acids and bases.

Key questions for this module

How acidic or basic are common household materials?

Does water from different sources have the same acidity?

What is the effect of acid on metals?

Similar to Module 1, the activities have been developed in such a way that concepts are developed gradually from the first to the last activity. It starts with the students distinguishing between acidic and basic mixtures through the use of a plant indicator, which they will prepare. Using the plant indicator, they will determine the acidity or basicity of common household items as well as that of water from different sources. In Activity 2, students are guided to determine the pH of the solutions in Activity 1. In Activity 3, students will investigate the effect of an acid on a metal like iron. They will find out what happens after the metal has been in contact with the acidic mixture for some time.

Activity 1

How can you tell if a mixture is acidic or a basic?

This is a colorful activity that the students will enjoy. Instead of using litmus paper, which can only indicate if a sample is acidic or basic, the use of plant indicators has an advantage since these can specify a range of pH values.

This activity is divided into three parts. Part A allows the students to prepare the plant indicator and use it in Part B to determine the acidity or basicity of common household items. Similar to Part B, Part C gives the students the opportunity to test different water samples from various sources for acidity or basicity.

If you want the class to always have indicator paper available for use, then it is good to ask selected students to work on the following with the guidance of the teacher outside of their class time in Science.

Preparing an eggplant/camote acid-base indicator paper

Note: You may do this if you need to use an indicator to test samples in other science activities.

1. Pour the indicator solution prepared in Part A into a shallow plastic or ceramic container. (Do not use a metal container.)

2. Cover the entire filter or bond paper with the indicator solution by dipping the paper into the solution.

3. Air dry for about five minutes. (There is no need to air dry the paper completely at this point.)

4. Repeat procedure numbers 1 and 2 three times or until the color of the paper becomes dark.

5. Continue drying the indicator paper. When the paper is completely dry, cut the paper into small square pieces. This is your indicator paper. Keep it in a covered bottle.

6. Label the bottle properly (with name of material and date of preparation).

Background Information on Indicators

The red, purple, and blue colors of most flowers and some vegetables contain compounds called anthocyanins. A typical anthocyanin is red in acid, purple in neutral, and blue in basic solution. The eggplant extract shows yellow in a strong base since it contains anthoxanthins (colorless in acid, yellow in base) in addition to anthocyanins. Note that anthocyanins and anthoxanthins are usually present in many plants. The green color is a mixture of blue and yellow. Colors of anthocyanins in neutral to basic condition are very unstable. The purple, blue, and green colors will fade and eventually turn to yellow upon exposure to air.

Teaching Tips

Part A

- Only one of the suggested plants will be prepared by all groups in the class.
- If the other plants are available, you may assign some groups to use the other suggested plants that can be used as indicators.
- Emphasize the caution written in the "Take Care!" box.

Part C

- Instruct the students to use a wide-mouthed plastic container, about ½ liter capacity to collect water. The container for collecting water should be dipped or immersed about 6 inches or about 15 cm from the surface of the source of water.

Answers to Activity 1

Table 1. Acidic or basic nature of household materials

Sample	Color of indicator	Nature of sample
calamansi		strongly acidic
tap water (water from the faucet)		weakly acidic
distilled water		neutral
vinegar		strongly acidic
sugar in water		weakly acidic or neutral (depending on the type of water used)
baking soda		basic
baking powder		basic
soft drink (colorless)		strongly acidic
coconut water (from buko)		weakly acidic
toothpaste		basic
shampoo		basic
soap		basic

Reminder

- It is recommended that preparation for Activity 3 be started the day before Activity 2 is done. This will ensure that students have three days to observe the changes in each setup of Activity 3.

Activity 2

Color range, pH range

This activity introduces students to another method that can be used to distinguish acids from bases. It is through the use of the pH scale, which extends from 0 to 14. Students simply need to use color range given for eggplant indicator in the student module.

Teaching Tips

- If a universal indicator paper is available, it would be good to use it also and compare the pH observed with that of the plant indicator.
- The excess plant indicator can be stored in a bottle and kept in a cool dark place or inside a refrigerator.
- The pH indicated in the answers for Table 3 may not be exactly the same as the pH observed using the plant indicator prepared by the students. This is acceptable as long as the nature of the sample (acidic or basic) is the same as expected. This means that a sample of calamansi may not have exactly pH 2, but it should still be in the strongly acidic range.

Answers to Activity 2

Table 3. pH of samples from Activity 1

Sample	pH based on eggplant/*camote* indicator	Acidic or Basic
calamansi	pH 2	strongly acidic
tap water (water from the faucet)	pH 5 to 6	weakly acidic
Distilled water	around pH 7	neutral
vinegar	pH 2 to 3	strongly acidic
sugar in water	pH 6-7	weakly acidic to neutral
baking soda	pH 8 to 9	basic
baking powder	around pH 8	basic
soft drink (colorless)	pH 2 to 3	strongly acidic
coconut water (from buko)	pH 5	weakly acidic
toothpaste	pH 8 to 9	basic
shampoo	pH 8 to 9	basic
soap	pH 8 to 9	basic

Answers to Part C will depend on the sources of water, so pH will depend on the specific water sample tested by the student.

Activity 3

What happens to metals when exposed to acids?

Answers to Activity Questions

Q1. There are three different bottles for each sample of iron nail to make sure that replicate data are gathered for the setups.

Q2. At the end of 3 days, the iron nail has rust all over its sides, head, and tip.

Q3. When iron rusts, it produces a characteristic flaky red-brown solid, commonly called iron rust.

Further Explanation on Rusting of Iron

Rust is hydrated iron or iron (III) hydroxide, $Fe(OH)_3$, sometimes written as $Fe_2O_3 \cdot 3H_2O$. This layer does not securely stick to the surface of the iron. It flakes off, weakening the metal and leaving it exposed to further rusting and structural decay.

Iron forms rust upon prolonged exposure to oxygen and moisture in the air and in the presence of acid. Recall that the acid used in Activity 3 is vinegar, which is about 4.5 to 5% acetic acid.

Note that you do not need to let the students memorize the chemical formula of iron rust. It is sufficient for Grade 7 students to know that rust is hydrated iron or iron hydroxide.

PRE/POST TEST

1. Arrange the following household items: toothpaste, milk, tap water, vinegar from the most acidic to most basic?

    a. tap water, milk, toothpaste, vinegar
    b. milk, tap water, vinegar, toothpaste
    c. toothpaste, milk, tap water, vinegar
    d. vinegar, tap water, milk, toothpaste

2. Arrange the household items in question number (1) from the item with the highest pH to the one with the lowest pH.

3. Give a reason why farmers need to know how acidic or basic the soil is before they plant their crop.

4. Give at least two (2) safe ways you should practice when you handle an acid, like muriatic acid.

5. Why does “rust” form on some metallic materials?

Answer Key

1. (**d**) vinegar, tap water, milk, toothpaste

2. toothpaste, milk, tap water, vinegar

3. Any **one** of the answers below is considered correct.

   (a) Some plants grow well in acidic soil while others prefer basic soil. Farmers need to know the pH of their soil since plants will only grow in a specific pH range.
   (b) The pH also affects how much nutrients from the soil become available to plants.

4. Any **two** of the following answers is considered correct.

   (a) Do not take internally (Do not taste nor drink).
   (b) Avoid contact with eyes, nose and mouth.
   (c) Use only in well ventilated areas.
   (d) Always keep the container tightly sealed.
   (e) Do not store in a warm place.
   (f) Keep out of reach of children.

5. A metal like iron forms rust when exposed for a long time to oxygen and moisture in the air and in the presence of an acid.

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Unit 1
MODULE

5

METALS AND NONMETALS

Students are already familiar with metals. They have encountered a lot of this during their early grade levels. In fact, they use metals as one of the segregation scheme when they were starting the habit of 5Rs — reduce, reuse, recycle, recover and repair. Appearance was their primary basis when they identify metals. In this module, students will broaden their knowledge on the properties of metals. They will learn additional characteristics of metals. They will find out that these are also elements. Moreover, they will find out that not all elements exhibit such properties. Most of them have highly contrasting properties with that of metals. As such, they were referred as **nonmetals**.

Key questions for this module

How are metals different from nonmetals?

How are they similar?

A series of activities will gear the students in answering the questions above. With the hope that students will find connection between the topics they have learned in the lower grade levels to the ones they are about to learn, a simple activity on identifying the metals around them will be done. It is expected that they will be basing it on the appearance of the material. Other simple activities are interspersed within the student module to learn more properties exhibited by different metals. They will verify if such properties are truly exhibited by metals. For instance, they will bring close a magnet to different samples of metals. They will find out that not all of these properties are exhibited by metals. The main activity highlights the property that is common to all metals — electrical conductivity. It will be followed by another activity that will likewise differentiate a metal and a nonmetal.

Activity 1

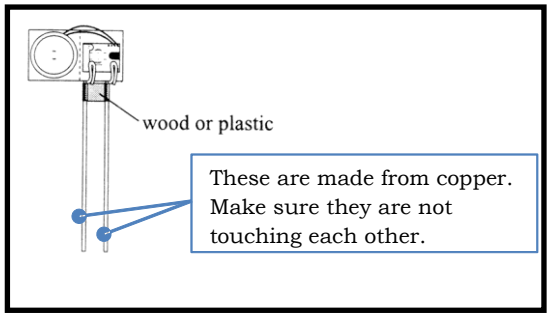
Which can conduct electricity, metals or nonmetals?

Prior to this activity, the students must have learned that metals share a number of common properties. However, not all of the metals exhibit these properties. For instance, only some metals are magnetic. The common ones are iron, nickel and cobalt.

In this activity, students will learn that there is a property that all metals possess — electrical conductivity. This is the ability of a material to allow electricity to pass through it. They will use an improvised electrical conductivity tester to check for such property. You will find below how to construct one from commonly available materials.

Reminder

- The sound (and light) indicates that a material is electrically conductive. The stem of the tester is electrically conductive. Please see figure on the right. Make sure that the tips of the conductivity tester are not touching each other especially when testing the sample material.



Teaching Tips

- Acquaint the students with the electrical conductivity tester before starting the activity. Allow them to try having the tips of the tester touch each other. Ask them about what they observe. This will help emphasize the reminder stated above.

Teaching Tips

- After processing the activity, you may go back to the reminder set for this activity. Ask the students again why they were asked not to let the tips of the electrical conductivity tester touch each other. What could be the material of the stem of the conductivity tester? (Metal.)

- The students can find other objects around them to test using the improvised electrical conductivity tester; and identify these objects if these are made up of metals or nonmetals.

- Students have to understand the concept of conductivity, that is, a material is conductive if it allows something to pass through it. In the case of electrical conductivity, it is electricity that is allowed to pass. A material may also allow heat to pass through it. In this case, the material is said to be thermally conductive. However, the concept of being thermal has not been formally introduced to the students. Being so, describe the elements that are thermally conductive as heat conductors. The term thermal conductivity is the one used for many references, so for familiarity purposes, the term is mentioned. Moreover, when they have to find the values from different references, these are referred as thermal conductivity values. During the 3rd quarter (physics), the student will learn more about conductivity.

- Show students pictures of some metals and nonmetals. You may refer to some of the books and websites listed at the end page of this guide. They may give other descriptions of the elements such as physical state at standard conditions and color. If possible, use real samples.

Answers to Activity Questions

Q1. Aluminum, copper and iron look like metals; while iodine and sulfur look like nonmetals.

Q2. Aluminum, copper and iron are electrical conductors; while iodine and sulfur are nonconductors of electricity.

Construction of an Improvised Electrical Conductivity Tester

Materials Needed

- alcohol lamp
- stripping knife
- pliers (long nose)
- musical greeting card
- insulated copper wire, 2 pcs (2.0 mm in diameter, 24 cm long);
- 2 pcs wood/chopstick (1 cm x 1 cm)
- thick iron nail, 7 cm long, 3 mm thick

Procedure

1. Using pliers and a stripping knife, remove about 6 cm of the insulation of the copper wire on one end. At the other end of the wire, remove about 15 cm of the insulation.

Fig. 1

2. Measure four 1.5 cm length on the 6 cm stripped portion of the copper wire. Mark these lengths as L1, L2, L3, and L4.

Fig. 2

3. Using a pair of pliers, completely turn L1 180o angle until its end touches the L2 side of the wire. Turn L3 opposite to L1. Lastly, bend L4 in the opposite direction so that four zigzag bends are formed. See Figure 3. Do this for both wires.

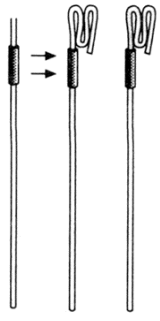


Fig. 3

Construction of an Improvised Electrical Conductivity Tester

4. Open the musical greeting card and carefully remove the integrated circuit by cutting out the paper on which the IC is attached.

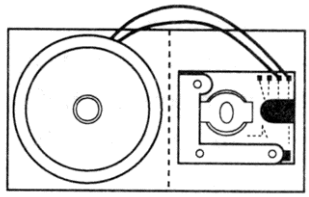


Fig. 4

5. Lift the long metal sheet of the switch part of the IC. Fold it to expose the negative (-) terminal of the switch. Retain the dry cell.

   See Figure 5.

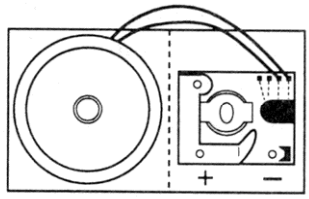


Fig. 5

6. Clip the metal electrodes on the IC, one on the positive (+) terminal and the other on the negative (-) terminal. Place a block of wood or plastic or any insulator between the two electrodes and fix it by taping. See Figure 6.

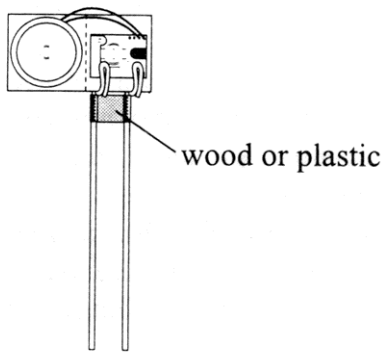


Fig. 6

Activity 2

Acidity of the oxides of metals and nonmetals

This activity reinforces the idea learned from Module 3, that is, compounds may be formed when elements combine. Hence, metals and nonmetals, being elements, may form compounds. Combining with oxygen, a metal or a nonmetal may form an **oxide**. However, the acidity differs depending on the nature of this oxide. This, again, is a defining characteristic of a metal and a nonmetal. A metal oxide is generally basic; while a nonmetal oxide is acidic.

Moreover, the activity will allow the students to apply their learning in Module 4. They will test the acidity of their samples. It is very important that they know how to interpret the color changes of the acid/base indicator. The litmus paper is suggested to be used in this activity. However, you may use other acid/base indicators that are more available in your school. You may refer to Module 4 for some of these indicators.

Answers to Activity Questions

Q1. Magnesium is a metal.

Q2. The red litmus paper changed its color to blue.

Q3. The oxide of magnesium is basic.

Q4. Sulfur is a nonmetal.

Q5. The blue litmus paper changed its color to red.

Q6. The oxide of sulfur is acidic.

PRE/POST TEST

1. Which of the following elements is most likely ductile at room temperature?

   A. Sulfur
   B. Mercury
   C. Nitrogen
   D. Aluminum

2. An element was subjected into flame and the acidity of the oxide formed was tested. Solution of this oxide turned red litmus paper to blue. Which is most likely that element?

   A. Chlorine
   B. Nickel
   C. Phosphorus
   D. Silicon

For questions 3 to 5. Refer to the information below. Write the symbols only.

Element Symbol	MP (^oC)	BP (^oC)	Electrical conductivity
Al	660	2450	Good
Br	-7	58	Poor
Ca	850	1490	Good
Cl	-101	-35	Poor
Cu	1083	2600	Good
He	-270	-269	Poor
Fe	1540	2900	Good
Pb	327	1750	Good
Mg	650	1110	Good
Hg	-39	357	Good
N	-210	-196	Poor
O	-219	-183	Poor
P	44	280	Poor
K	64	760	Good
Na	98	890	Good
S	119	445	Poor
Zn	419	906	Good

3. Which metal is liquid at room temperature?

4. Which nonmetal is liquid at room temperature?

5. List the nonmetals in order of increasing boiling point.

Answer Key

1. D
2. B
3. Hg
4. Br
5. He, N, O, Cl, Br, P, S

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UNIT 2: Living Things and Their Environment

Overview

Science is about asking questions and looking for answers.

Each of the five modules on Living Things and Their Environment for Grade 7 starts with questions that will guide students in their journey of constructing the big ideas through activities that are interspersed in the modules. The students are provided with opportunities to develop the inquiry skills as well as their critical thinking, problem solving, and communication skills.

There are five modules on Life Science:

Module 1: *From Cell to Organism*
Module 2: *Plant and Animals Cells*
Module 3: *Living Things Other than Plants and Animals*
Module 4: *Reproduction: The Continuity of Life*
Module 5: *Interactions*

These modules deal with the levels of organization and diversity of living components of the environment both at the organism and ecosystem levels; the relationships among living things, and between living things and their environment; and how living things reproduce to continue their own kind.

Most of the activities may be performed as groupwork while some may be performed individually or with a partner. It is strongly urged that students read the activities before performing them. It is also important that the students take note of the safety measures.

There is also a pre/post test that should be administered before and after all the activities in each module have been completed. The pretest results will reveal students' prior knowledge and alternative conceptions (if any). The posttest results will show the extent of students' comprehension of the concepts and their capacity to demonstrate needed skills. The posttest can also uncover students' misconceptions that need to be addressed in succeeding modules.

The K to 12 curriculum spirals and increases in difficulty at each grade level so as to provide challenges appropriate to the students' age. The tools and habits of inquiry that students will acquire will help them develop into scientifically literate and productive citizens.

Unit 2
MODULE

1

FROM CELL TO ORGANISM

In the First Quarter, the students learned that there are different materials in the environment. For this quarter, they will be introduced to the diverse kinds of living things and the processes and interactions they go through. This module deals with different kinds of living things and what they are made up of.

In the lower grades, the students have learned that the human body is made up of organ systems that work together. In turn, these organ systems are made up of organs whose functions are related with each other. For example, the heart and the blood vessels are organs that facilitate the circulation of blood and nutrients to the different parts of the body; similarly, the esophagus, stomach, and intestines work together to carry out digestion of food. The organs are made up of even smaller structures: the tissues and cells.

In this module, the students will be introduced to the concept of levels of organization in an organism. They will learn in the activity titled, "What makes up an organism?" that whatever happens to the smaller structures will affect the bigger structures and, eventually, the whole organism. Draw out from the students the idea that these structures work together to carry out specific functions to make the organism meet its basic needs and survive.

Towards the end of the module, the students will recognize that all organisms are made up of cells – the basic unit of structure and function in all living things. They will discover more about cells in Module 2.

Key questions for this module

What are organisms?

What makes them up?

Motivation

Ballpen disassembly

Below are parts of 4 different kinds of ballpens. Ask the students to identify which part belongs to which ballpen.

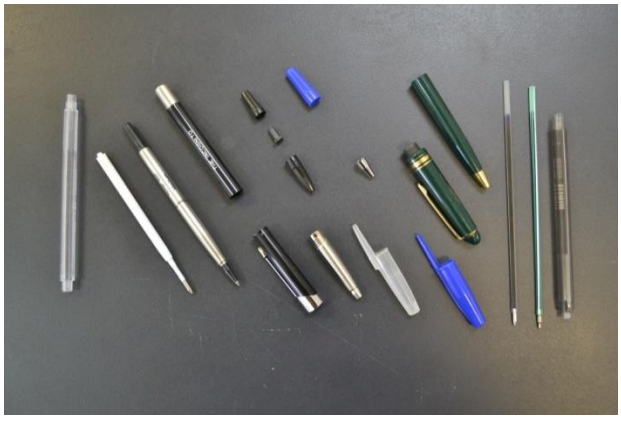

Photo: Courtesy of Michael Anthony B. Mantala

A ballpen has parts like those shown in the picture below. Ask them to identify the function of each part of the ballpen.

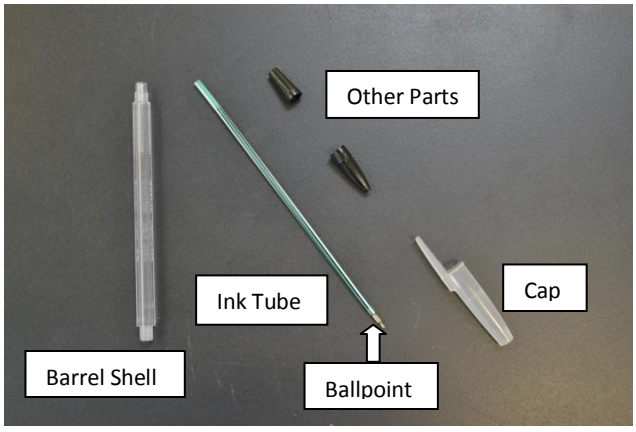

Photo: Courtesy of Michael Anthony B. Mantala

Have them take a closer look at the top picture on the next page. Ask them to identify the part of the ballpen that is missing and its function. Ask them to imagine how the ballpen will work compared to the ballpen with complete parts.

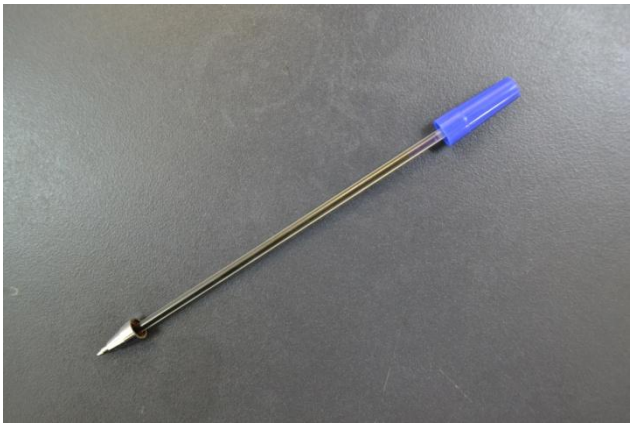

Photo: Courtesy of Michael Anthony B. Mantala

Below is a picture of a ballpen that was assembled with a part that belongs to another ballpen. Ask the students to identify the part of the ballpen that was replaced and its function. Ask them to imagine how the ballpen will work compared to the original ballpen.

Photo: Courtesy of Michael Anthony B. Mantala

In this motivation part of the lesson, you used ballpens to represent structure and function in organisms. The ballpen is made up of different parts that have specific functions; they work together to make the ballpen perform its function. Similarly, organisms are made up of parts that work together: organ systems, organs, tissues, and cells.

Of course, you can use other representations. Bear in mind though, that the use of representations has its limitations. It can help, to some extent, concretize abstract concepts like structural organization in organisms as it can also give, to some extent, misconceptions like using the ballpen as a representation for concepts the apply to living things.

That said, have them discover through a discussion that like the ballpen that is made up of different parts that work together, organ systems are made up of organs that also work together to carry out the organ system's task. Anything that happens to the small parts will certainly affect the bigger parts and, eventually, the organism.

Activity 1 What makes up an organism?

In this activity, you will ask the students to read the selection and answer the questions that follow. The activity seeks to answer the questions: 'What are organisms?' and, 'What are they made up of?'

If you have a model or a poster of a human torso, you can show it to the class and ask the students to check the parts closely. If not, you can direct the class to check Figure 2 of Module 1.

Q1. What parts of the human body do you see?

They will see that the human body is made up of different parts.

Q2. To which organ systems do these parts belong?

To answer this question, have them recall the different organ systems of the body that they have learned in the lower grades. Then, have them look at Figure 3.

Figure 3 shows some organ systems of the human body. Have them identify the parts that make up each of the organ systems. Ask them to describe how the different parts work together in an organ system. Have them imagine what happens to the organism if any of the organ systems is injured or diseased.

Q3. Can you identify these organ systems?

The organ systems shown in Figure 3 are the skeletal and respiratory systems.

Q4. How do these organ systems work together?

To answer this question, they will have to identify the functions of each of the organ systems and describe how the function of one organ system relates to the functions of the others. For example, the skeletal system, along with the muscular system, functions for movement. The bones move according to the alternating contraction and relaxation of the muscles. These movements of the skeletal and muscular systems are coordinated by the nervous system. All these happen because

of energy that comes from the nutrients transported by the circulatory system to the different parts of the body.

Organ systems are made up of functionally related organs. Figure 4 shows a model of a human heart.

Q4. Refer to Figure 4. What parts of the human heart do you see?

The human heart is made up of muscles and blood vessels: the veins and arteries. If they had advanced readings, they would probably mention auricles, ventricles, and valves in addition to what is shown in the figure. They will have more on these and other parts of the heart in higher Biology.

Q6. What do you think will happen to the heart if any of these parts were injured or diseased?

An injury to any of the parts of the heart is an injury of the heart. This means, the heart will suffer in the same way that its parts suffer.

Q7. If these parts of the heart were injured or diseased, what do you think will happen to the organism?

As you ask this question, you can also ask them if they know of relatives or acquaintances who have been diagnosed with heart ailment. They would probably mention that the person is weak and experiences chest pains or difficulty in breathing. An injury to any of the parts of the heart affects the organism – the person.

Another organ – the kidney – belongs to another organ system, the excretory system. Like the processing you did for the heart, ask the students to check out the picture of a model of a human kidney.

Q8. Refer to Figure 5. What parts of the human kidney do you see?

Like the heart, the kidneys are made up of muscles and blood vessels. Those who had advanced readings may probably mention renal cortex, medulla, and pelvis in addition to what is shown in the figure. They will have more on these and other parts of the heart in higher Biology.

Q9. What do you think will happen to the kidneys if any of these parts were injured or diseased?

An injury to any of the parts of the kidneys is an injury of the entire organ. This means, the kidneys will suffer in the same way that its parts suffer.

Q10. If these parts of the kidneys were injured or diseased what do you think will happen to the organism?

Before you ask this question, you can ask them if they know of people who have been diagnosed with kidney problems. You can also ask how these people are

coping with the disease. They will probably mention that these people are weak and have difficulty urinating or may have poor appetite. An injury to any of the parts of the kidneys affects the organism – the person.

Organs themselves are made up of even smaller parts: the tissues and cells. Guide the students through Figure 6 that shows a picture of a muscle tissue. You should be able to draw the idea that these tissues play specific tasks to keep the organs, organ systems, and the whole organism healthy.

Q11. What procedure can a medical doctor do to correct an injury the these organs?

They will answer this question using what they have learned from the interviews they made of the articles they have read.

Q12. What do you think will happen to the organs if these tissues were injured or diseased?

The organ will suffer from an injury to the tissues.

Q13. If these tissues were injured or diseased, what do you think will happen to the organ systems?

The organ systems will suffer, too.

Q14. If these tissues were injured or diseased, what do you think will happen to the organism?

The organism will suffer, too. For example, a cut on the tissues of the skin is felt by the whole organism. Anything that happens to the tissues will affect the bigger structures they make up.

Plants are also made up of organ systems: the root and shoot systems. The roots absorb water and nutrients; the shoot system moves them to the different parts of the plant.

Q15. In what ways are the functions of the organ systems of plants similar to those of animals?

Like the organ systems of animals, those of plants have parts that work together. For example, the shoot system of plants is composed of the stem, leaves, and flowers. The stem has tissues that allow for the transport of water and nutrients from the roots to the leaves. The leaves on the other hand serve as structures for photosynthesis through which, they manufacture their food. The flowers are the reproductive organs of plants.

Q16. In what ways are they different?

Plants have only two organ systems: the root and shoot systems; whereas, animals have complex organ systems that work directly with the other organ systems. For example, plants do not have a nervous system that coordinates the functions of the other organ systems of animals. Plants also do not have circulatory and respiratory systems that move oxygen and nutrients to the different parts of the body.

Figure 8 shows a picture of a flower. Flowers are the reproductive organs of plants. Together with the leaves and the stems, they make up the shoot system.

Q17. How are flowers similar to the reproductive organs of animals?

Like the reproductive organs of animals, complete flowers have male and female parts. These parts work together to bear seeds from which new plants germinate.

Q18. How are they different?

Plants can dispense with their flowers – their reproductive organs – to generate their kind for they can also reproduce asexually. Animals that reproduce sexually make use of only their reproductive organs to do so.

Q19. How do the flowers, leaves, and stems help plants meet their basic needs?

They have learned in the lower grades that plants are able to manufacture their food through photosynthesis. They use their leaves to carry out this process. The stem provides support to the leaves, flowers, and fruits. They also serve as channels for the transport of water and nutrients from the roots to the different parts of the plant. The flowers serve as their reproductive organs.

Q20. What do you think will happen to the plant if any of the parts that make up the shoot system were injured or diseased?

Anything that happens to any of the parts that make up the shoot system of pants will certainly affect the plant as well. You can ask them to cite examples to highlight this connection.

The root system is another organ system of plants. In some plants, it is made up of the primary root, the secondary roots, and the root hairs. Figure 9 shows a picture of a root tip of an orchid.

Q21. Aside from absorbing water and nutrients, what other functions do the roots serve?

Roots also provide anchorage to the plant.

Plants have tissues, too. You can peel off the skin of onion bulbs to show your students what tissues look like. Tissues of onion bulbs would look like a

transparent plastic. Roots are also made up of tissues. Figure 10 shows a model of a section of a root tip.

Tissues are made up of cells – the basic units of structure and function in organisms. All organisms are made up of cells; they are the smallest level of organization at which the properties of life can be carried out.

Q22. What do you think will happen to the roots if the tissues that make them up were injured or diseased?

Q23. If the roots were injured or diseased, what do you think will happen to the plant?

Serious damage to the root will kill the plant.

Q24. What do you think will happen to the tissues, organs, and organ systems if these cells were injured or diseased?

When cells or tissues are injured or diseased, the higher levels of organization that they make up are affected as well.

Q25. What do you think will happen to the organism?

The different parts that make up an organism each perform a specific function. Anything that happens to the smallest of parts that make up an organism will most likely affect the whole organism.

Activity 2

Levels of organization in an organism

For Activity 2, *Levels of organization in an organism*, ask the students to complete the table on page 8 of Module 1 using the information they gathered from their interviews with relatives or neighbors who have diseases affecting certain organs or who know of people who have the disease. They may also use the information from the articles that they have read in Activity 1. Have the students read the procedure for completing the table.

The activity will help the students synthesize what they have learned about what makes up an organism; it also serves as an enrichment activity. In each of the boxes that correspond to the levels of organization, have them describe how the disease affects the parts that make up each level. Opposite each level of organization, have them cut and paste pictures (they may use the pictures that come with the articles) that show how the disease affects the parts that make up the

different levels. Another option is to have them show it through drawing. After completing the table, have them present their work to class.

In the last part of Activity 2, ask the students to reflect on the question, *Are there levels of organization that are bigger than the organism?*

At the end of Module 1, the students should have learned the following big ideas:

- *Organisms are made up of parts: organ systems, organs, tissues, and cells.*
- *Whatever happens to any of these parts will affect the other parts and the whole organism.*
- *We need to keep our cells and tissues healthy to make our organs, organ systems, and the whole body healthy.*
- *To stay healthy, we need to eat nutritious foods; they include the plants in our backyard and the animals in our farm.*
- *Like us, these plants and animals are also organisms. They have basic needs that include proper care for them.*

PRE/POST TEST

1. The heart pumps blood that carries oxygen and nutrients to the different parts of the body. To which organ system does the heart belong?

   A. Circulatory
   B. Digestive
   C. Excretory
   D. Reproductive

2. Cancer starts from cells that start to grow uncontrollably fast. They destroy tissues and organs. What does this say about the effects of diseased cells on the higher levels of organization in an organism?

   A. Cancer involves only certain kinds of cells and does not affect any other kind of cell.
   B. Diseased cells affect only the next higher levels of organization that they make up – the tissues.
   C. Diseased cells damage the higher levels of organization they make up: tissues, organs, organ systems, and eventually, the whole organism.
   D. Diseased cells do not affect the other parts of an organism.

3. Each part of an organ system plays a specific function. Which of the following structures **does not** match its function?

   A. Eyes : Sight
   B. Kidneys : Respiration
   C. Heart: Circulation
   D. Stomach: Digestion

4. Flowers are the reproductive organs of plants. How are flowers different from the reproductive organs of animals?

   A. Flowers have male and female parts; animals have either male or female parts.
   B. Flowers need pollinators like bees to reproduce; animals do not.
   C. Flowers are shed from time to time; nothing is shed from animals.
   D. There is no difference between flowers and the reproductive organs of animals.

5. The organ systems of plants consist of the root and shoot systems. Why is it important for these organ systems to work together?

   A. To grow and survive
   B. To avoid pests and other animals
   C. To survive floods and strong winds
   D. To survive droughts and earthquakes

6. Which of the following differentiates organs from tissues?

   A. Organs make up tissues; tissues make up organs
   B. Tissues make up organs; cells make up tissues
   C. Organs and tissues are made up of cells.
   D. Organs and tissues make up an organ system.

7. At which smallest level of organization in an organism can the characteristics of life be carried out?

   A. Organ system
   B. Organ
   C. Tissue
   D. Cell

8. Which is the correct sequence – from biggest to smallest – of the levels of organization in an organism?

   A. Cell → Organ → Organ System → Tissue
   B. Organ → Organ System → Tissue → Cell
   C. Tissue → Cell → Organ → Organ System
   D. Organ System → Organ → Tissue → Cell

Answer Key

1. A
2. C

Note: When cancer cells metastasize, they spread to the cells of other tissues and organs. But even in the early stages, they start affecting nearby cells and tissues and making them cancerous.

3. B
4. B

Note: Some animals are hermaphroditic like the earthworms. They have both male and female parts; hence A is not the answer. Egg and sperm cells are shed from the reproductive organs of animals from time to time; hence, C is not the answer. Option B shows a difference between flowers and the reproductive organs of animals; D is not the answer.

5. A
6. B
7. D
8. D

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Unit 2
MODULE

2

PLANT AND ANIMAL CELLS

The module presents to the students discoveries about the cell based on what have been observed by scientists through the microscope. It discusses concepts that all organisms are made up of cells and that an organism can be just single-celled (unicellular) or many-celled (multicellular). Through the module they will be introduced to the cell, its parts and their functions, and similarities and differences between two kinds of cells.

Key questions for this module

Are all cells the same?

If not, in what ways are they different?

Activity 1 shows how plant and animal cells look like through the illustrations presented. Students will study and analyse these illustrations. Through these they will also be able to observe the differences in shapes of the two cells as shown by the figures presented. In the activity students will construct a Venn diagram to illustrate how it can be used to differentiate plant from animal cells.

Activity 2 is an alternate activity that students can do IF YOUR SCHOOL HAS MICROSCOPES. It will give them an opportunity to have a hands-on experience of studying plant cells using this tool. It will also demonstrate how a stain can help in making plant cells more visible under the microscope. In the activity students will also draw plant cells as seen under the light microscope**.**

Cell Parts

Start by saying that in the earlier module, you learned that organisms have organ systems composed of organs. These organs are made up of even smaller parts namely, tissues and the smallest of which are the cells. Make them recall what they have learned in Module 1 by showing them the muscle tissues, plant root tissues and the cell models they saw in the previous module. Let them identify which are the tissues or the cells. Or show and ask them whether an onion bulb, a stem, or a leaf or a leaf midrib is an organ, tissue or cell. Watch out for wrong answers like, some may still mistake tissues for cells. Make sure that they will be able to

differentiate one from the other at this point. Then, continue by asking them the essential questions.

Activity 1

Comparing plant and animal cells

You may wish to use enlarged illustrations of Figures 1 and 2 during the discussion part of the activity. Add the information that these diagrams are results of cell studies done using the more powerful electron microscope. Researchers and scientists put together all the cell parts they have seen under this type of microscope in the diagrams presented.

Give time for students to study and analyse the figures. Let them examine first the plant cell then, the animal cell. Have them describe the plant cell and its parts by asking them how each part looks like or where they are located or the number of a part present in a cell. Then, let students answer the questions.

Q1. Compare the shape of a plant cell with that of an animal cell as shown in Figures 1 and 2. *Answers may be: Plant cells are rectangular or angular or rigid in shape, while animal cells are rounded and somewhat irregular or spherical or cylindrical. Mention that there are many other shapes of animal cells according to their functions that they will study later in the next grade levels.*

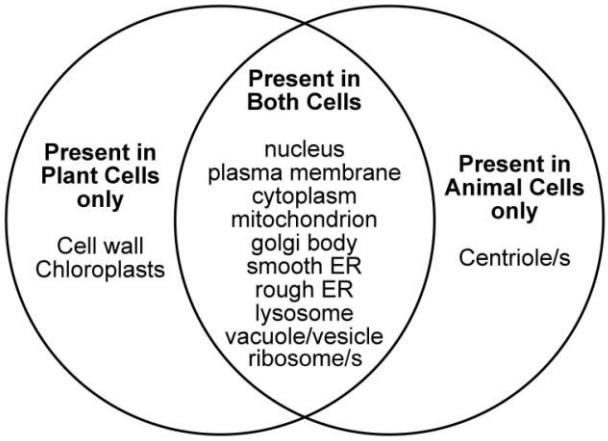
Q2. Which cell parts are found in both cells? *The nucleus, plasma membrane, cytoplasm, the mitochondrion, rough and smooth endoplasmic reticulum, Golgi body, vacuole, vesicle, ribosome/s and lysosome are common to both plant and animal cells.*

Q3. Which cell parts are present only in animal cells? *The centrioles are present in animal cells only.*

Q4. Which cell parts are present only in plant cells? *The cell wall and chloroplast are present in plant cells only.*

After students have read what a Venn diagram is, call one or two to explain if they have understood what it is. A correct explanation would be: A Venn Diagram shows relationships between and among sets or groups of objects that have something in common. It uses two circles that overlap with one another. The common things are found in the overlapping area, while the differences are in the non-overlapping areas. You can either have students make their Venn Diagram individually or by groups.

The Venn diagram that students made may look like the one below:



Come up with a system of correcting students' work. An example would be for a completely correct output like the figure above, score it 16. For any wrongly placed part or heading subtract 1 point. Take note that cell parts present only in plant or animal cells may be written either on the left or right side of the overlapping area.

Q5. Based on your observations and study of plant and animal cells, cite differences and similarities between them.

Differences between plant and animal cells:

- Plant and animal cells differ in shape and in some parts. Plant cells are rectangular or angular or rigid in shape, while animal cells are rounded and somewhat irregular.

- Plant cells have cell walls and chloroplasts which animal cells do not have. Animal cells have centrioles which plant cells do not have.

Similarity between plant and animal cells:

- Both plant and animal cells have common parts namely: the nucleus, plasma membrane, cytoplasm, the mitochondrion, rough and smooth endoplasmic reticulum, Golgi body, vacuole/vesicle, ribosomes and lysosome.

End the discussion for the activity by asking students if plant and animal cells are the only types of cells. Watch out for students who have the misconception and might think that there are only two types of cells. Clarify that cells can be of different kinds, plant or animal cells, bacteria, amoeba cells, etc. Inform them that these will be dealt with in later topics or grade levels.

Proceed with the discussion about the nucleus, plasma membrane and cytoplasm, the basic parts of the cell. The nucleus serves as the control center of the

cell. The plasma membrane is also called the cell membrane. It is semipermeable because it permits some substances but prevents others to pass through it.

Q6. What do you think will happen to the cell if the plasma membrane does not function properly? *Without the plasma membrane, any substance can go in and out the cell. The cell may be affected by the exit of needed substances or entrance of unneeded or poisonous substances that may lead to death of the cell.*

Point out the cell wall and the chloroplasts, the plant cell parts which distinguishes it from the animal cell. Mention that cell walls form the outer boundary of plant cells and are made of cellulose a tough material. Thus, cell walls serve as protective barrier.

Q7. What is the purpose of the cell wall in plants? *The cell wall being made of tough or rigid material gives shape and protection to plant cells.*

Q8. Look at Figure 1 again. Why are there several chloroplasts in the plant cell? *The chloroplast in cells of plants is where food is made. The greater the number of chloroplast in them makes them efficient in making more food for the plant.*

Some students may have read in other books that vacuoles/large or central vacuoles are only found in plant cells. Clarify that vacuoles are easily seen in plant cells because of their size. Since water also collects in the vacuoles, it pushes out into the cell wall producing turgor pressure. This turgor pressure maintains crispness of fresh vegetables.

In animals vacuoles are smaller and are called by some biologists as vesicles. Some books and other reading materials say that plant and animal cells contain vesicles that store and transport a variety of substances. In Grade 7, it is enough that students know that plant and animal cells have parts that store and transport different substances, some call them vacuoles, others vesicles.

Add too that lysosomes although rare are also found in plant cells. If animal cells have these parts to digest or breakdown unneeded or trash materials, then plant cells must have a part that can do this for them. Some biologists refer to them as plant lysosomes or the small vacuoles in plant cells.

Regarding Q9, if students cannot relate what they have learned about contents of some plant vacuoles to the harm they cause to the animals that eat them, let them recall that part of the discussion in the student material.

Q9. How would vacuoles in plants serve as defense against animals that eat them? *Vacuoles in some plants may contain poison or toxic substances. These substances can harm these animals, once eaten. So, this serve to protect them.*

The centrioles which can be found in animal cells only, are located near the nucleus. They help organize structures during cell division.

As stated in the student module, other cell parts will be dealt with in detail in the higher grades. Discuss the following information:

- Mitochondrion- converts energy in food to a form usable to the cell; will be taken up again in Grade 9
- Golgi body/apparatus – sort, modify, package and distribute cell products to where they are needed;
- Endoplasmic reticulum (ER) – carry proteins to different parts of the cell;
- Rough ER – with attached ribosomes that manufacture proteins
- Smooth ER – contains no ribosomes; makes lipids(fats)
- Ribosomes – produced in the nucleus, occurs in large numbers and can be free floating in the cytoplasm, involved in the manufacture of protein, can be attached to the ER, thus there is a rough ER; will be taken up in detail in Grade 10
- Nucleolus – the prominent round structure in the nucleus that produces ribosomes; will be dealt with in Module 4 and in Grades 11 and 12

Activity 2 Investigating plant cells

If your school has microscopes/s let students perform Activity 2 for them to be able to observe actual plant cells, the onion cells. It is a must that they do first the activities in the section on “HOW TO USE THE MICROSCOPE” for them to be able to do this activity.

In Step 2, check if students placed the piece of transparent onion skin on the slide with its non-waxy side facing up.

Check students’ record of magnification of their onion cell drawings. Some may need to go back to part “D” on “The Magnifying Power of the Microscope”.

Q10. How much are these onion cells magnified?

The answer may vary depending on the magnifying powers of the eyepiece and objective used.

Q11. In this case, why is it not good to tilt the microscope? *It is not good to tilt the microscope while viewing a wet mount. It might cause water to spill and flow into its mechanical parts. This will cause its parts to rust.*

Q12. Describe the onion cells. *The shape of onion cells are quite angular to almost rectangular. The cytoplasm appears translucent. The nucleus is easily seen as a dark spot, more or less rounded in shape and brownish or dark brown in color.*

Q13. Did you observe any change in the image of onion cell before and after staining? *Yes.*

Q14. How did the iodine solution affect the image of the onion cell? *There is a change in the clarity of the image of onion cells and its parts. The cells became more visible and the parts distinct. The nucleus is more prominent or darker and brownish in color. The cell wall is clearly seen.*

Q15. What parts of the onion cell can you identify? *Answers may vary. Usually, onion cell parts easily seen using the light microscope and iodine stain are the cell wall, cytoplasm, nucleus and sometimes plasma membrane and vacuole. Some very observant students may ask about the prominent and still darker, inner circle inside the nucleus. This is the nucleolus.*

Some other students may ask which are the chloroplasts or why they cannot see or identify the chloroplasts. Some might think and have that misconception that all plant cells contain chloroplasts. Make them recall in what part of the plant is food made. Lead them to the idea (by posing questions) that chloroplasts are not found in onion cells because onion bulbs are growing under the soil. Onion bulbs are specialized leaves that store food, so they are not photosynthesing or better are not involved in the food making process. They should be able to say that not all plant cells have chloroplasts. Only cells that produce food for the plant contain chloroplasts.

You can ask students what is the purpose of adding iodine solution to their onion cell preparation. Explain that iodine solution is used to stain cells. Have them recall their observation and answer to Q14 to confirm this.

A drawing of four onion cells must be made. Labels should include the nucleus, cytoplasm, cell wall, and the plasma membrane and nucleolus if observed. Encourage them to be honest in what they have actually seen. Drawings should be realistic, that is they must only draw what was actually observed.

Q16. Of what importance is the contribution of the microscope in the study of cells? *The microscope makes one see objects that are not seen by just using the eyes. It enables one to see enlarged images of specimens such as cells for a thorough study of their structure and thus, infer their function.*

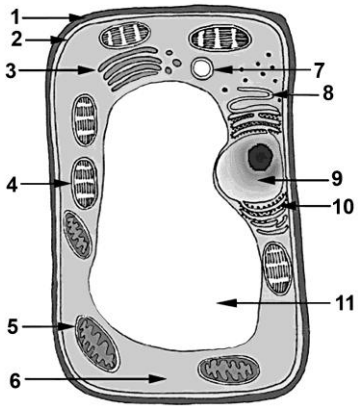
To summarize the lesson, ask some students what they have learned from it. Check if they are able to answer the essential questions found at the beginning of the module.

PRE/POST TEST

1. Which of the following parts allow different activities of the cell to happen?
   A. vacuoles
   B. lysosome
   C. cytoplasm
   D. vesicle

2. If the chloroplasts of a plant cell are damaged, which will it be unable to do?
   A. protect the cell
   B. make food for the cell
   C. excrete waste materials
   D. give instruction for cell to reproduce

Questions 3 and 4 refer to the figure next page. Use numbers in your answers.



3. Which part allows or prevents substances to go into and out of this cell?

4. What part of this cell store water and maintain its rigidity?

The table below enumerates the parts that are present or absent in two kinds of cells.

Structure	Cell A	Cell B
cell wall	×	✓
plasma membrane	✓	✓
Chloroplast	×	✓
Centriole	✓	×
nucleus	✓	✓

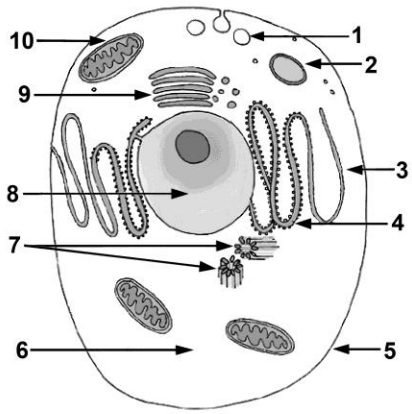
5. Which is a plant cell? Explain your answer.
6. Which is an animal cell? Explain your answer.

Use the following options to answer the next question.

I. absence of centrioles
II. irregular shape
III. presence of cell wall
IV. angular and rigid shape
V. absence of chloroplast

7. You are asked to identify an unknown slide. Which could help you identify it to be an animal cell?
   A. I and III
   B. II and V
   C. I and IV
   D. III and IV

Questions 8 to 10 are about the figure next page. Use numbers in your answers.



8. Which part of this cell function in the excretion of waste materials?
9. Which is the control center of this cell?
10. It is the part of this cell which play a role during cell division.

The following questions can be given if Activity 2 was performed:

I. Adding iodine solution to the onion cell preparation makes the cells_____.
   A. big.
   B. small.
   C. less visible.
   D. more visible.

II. Which of the following plant cell parts is not found in onion cells?
   A. chloroplast
   B. cell wall
   C. vacuole
   D. mitochondrion

Answer Key

1. C
2. B
3. 2
4. 11
5. 2 pts.– B is a plant cell because it has a cell wall and chloroplast.
   1 pt. – B is a plant cell but no explanation
   0 pt. – Wrong answer or no answer at all
6. 2 pts. – A is an animal cell because it has no cell wall and no chloroplast.
   1 pt. – A is an animal cell but no explanation.
   0 pt. – Wrong answer or no answer at all
7. B
8. 1
9. 8
10. 7

Answers to Optional Questions:

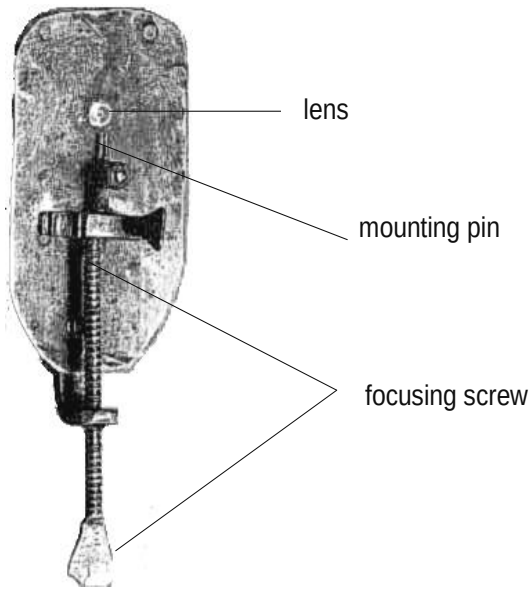
I. D
II. A

How To Use The Light Microscope

Humans are unable to see the cell, the tiniest part that make up all organisms. The microscope has made possible observation of the cell, other tiny objects and organisms.

This section will provide students with information about features and capabilities of the light microscope. Activities on the parts as well as the function of these parts will familiarize students with this important tool in learning science. The module will teach and help students develop the skill in manipulating it. This will aid them in doing a successful study of cells and other investigations in later topics and grade levels. In this section, students will also calculate how much objects are magnified under the microscope. Tips given on the proper use and care of the microscope will help schools maintain the equipment for efficient and longer use. Ultimately, the students will be able to recognize the role of microscopes in their study of objects and organisms and enable them to understand life itself.

If your school has microscopes you can give demonstrations or let your students do the activities with your supervision. Start by showing students the light microscope. You can show the figure below to give idea to the students the difference between the early microscopes and the current one being used.



Microscope constructed by Anton van Leeuwenhoek (1632-1723)
(Philippines. Department of Education. (2009). *Science and Technology II textbook*. Rev. ed. Pasig City: Instructional Materials Development Corporation)

A. Introduce students to the microscope by discussing its features and capabilities. Have students locate the different parts of the microscope using Figure 1 in the student material. Let them point out the parts as they go along

with the first part of the activity. Give emphasis too on the reminders or cautions regarding the use of the microscope.

Q1. What are the functions of the base and the arm of the microscope? *The base provides support to the microscope. The arm on the other hand supports the body tube and it is where the microscope is held.*

Q2. What have you observed about the objectives? *Answers can be: they are of different lengths, they are marked with numbers followed by x, some may say: there are three or four objectives attached to the revolving nosepiece.*

Q3. What is accomplished by turning the coarse adjustment upwards? Downwards? *Turning the coarse adjustment upwards and downwards raises and lowers the body tube with the objectives respectively. It also focuses or brings out the object to be observed.*

Mention that in some new microscopes however, this movement raises or lowers the stage.

Q4. What is the other function of the revolving nosepiece? *It facilitates the changing of objectives.*

Q5. Which connects the eyepiece to the revolving nosepiece with the objectives? *Body tube.*

Students should be able to notice that the eyepiece also may have 5x, 10x or 15x marks. Take note that the light microscope has two sets of lenses to magnify the object that is why it is also called a compound microscope. Lenses should only be cleaned with lens paper. A lens cleaning kit is also a good investment to maintain usefulness of the microscope. It can be bought in photo shops.

For Step 10, if the mirror was stored properly with the concave side facing the user the answer is No. If its position was changed, there may be a circle of light that can be seen.

Q6. What are the two functions of the eyepiece? *It is where you look through in the microscope. It also magnifies the image of the object that has been magnified by the objective.*

Q7. Describe the function of the mirror. *It reflects light up to the diaphragm, object to be observed and lenses.*

Q8. What do you notice as you change the diaphragm openings? *The size of the openings differ. The amount of light reflected also changes in that the bigger the opening, the greater is the amount of light reflected.*

Q9. What can you infer as to the function of the diaphragm? *The diaphragm regulates the amount of light reflected to the object to be viewed.*

Q10. What parts of the microscope are being connected by the inclination joint? *The arm and the base of the microscope.*

Q11. What does this movement do? *It allows one to tilt the microscope so viewing is possible while seated.*

Emphasize to students that even if tilting of the microscope can be done, it can cause water or liquids in wet mounts to spill and flow into the metal parts. This can cause rusting. The microscope can be tilted when observing dry specimens and while seated so that observing specimens will not to be tiresome.

B. Making a Wet Mount

A wet mount is a slide preparation in which the specimen is placed in a drop of water or liquid and held between a slide and a cover slip. Water improves the clarity of the image formed. Wet mounts however, cannot be stored for a long time so it is also called a temporary mount. It is important for students to learn the proper way of preparing wet mounts as they will use this in doing other investigations later. Care must be taken that bubbles will not interfere in their observation of objects or organisms.

Q12. What makes letter "e" suitable for *observation* under the microscope? *It is small and thin. Specimens must be thin and small enough to allow light to pass through for them to be viewed under the microscope.*

Q13. Describe the position of the letter as seen *under* the microscope. *The letter is inverted.*

Q14. Compare the image of the letter *as* seen under the microscope. *The image is larger or is enlarged as compared to the one using the eyes only. With the microscope, the letter also appears grainy and not in straight lines.*

Q15. To which direction does the image *move*? *It moves toward the opposite direction.*

Have the students also move the slide forward (away from them) or backward (toward them) and ask what they have observed. They should notice that the slide also moves to the opposite direction.

Q16. Why do you have to watch from the side when changing objectives? *Objectives are of different lengths. This is done to prevent accidental crashing of the objectives into the slide and breakage of objective lens, slide or cover slip.*

Q17. Why should the fine adjustment be used only with the HPO? *The HPO is longer and can easily crash into the cover slip and slide.*

Explain that the fine adjustment other than that it is longer compared to the scanner and LPO, moves slower or shorter in terms of distance as in steps of stairs which are closer to each other. The coarse adjustment in contrast moves fast and have greater distance as in steps of stairs which are little far away from each other.

Q18. In which objective/s can you see the whole letter ”e”? *It can be seen whole under the scanner.*

Have students also describe letter “e” under the LPO and HPO. Take note that only a part of the letter can be seen under the LPO. Under the HPO only a small portion can be seen. They may even need to move the slide to see that small portion of the letter.

Q19. What are the advantages of using the HPO? the disadvantages? *The advantages of using the HPO are: the image is greatly magnified, details of the letter or cell structure can be observed. Disadvantages include: reduced field of view and the whole letter or structure cannot be observed.*

Q20. In which objective is the light darker? brighter? *It is darker in the HPO than in the LPO and scanner.*

Ask students what they think of the field of view of the three objectives. They should have observed that as the magnifying power of the objectives increase the field of view decreases.

Q21. How much is the letter “e” you are now viewing under the scanner magnified? under the LPO? Under the HPO? *Answer depends on what eyepiece and objective are currently used. If the eyepiece is 10x and scanner is 5x, then it is magnified 50x or 50 times. If the eyepiece is 10x and the LPO used is 10x, then it is magnified 100x. If the eyepiece is 10x and the HPO is 40x, then it is magnified 400x.*

Q22. If a cell being observed has been magnified 200x under a 40x HPO, what is the magnifying power of the eyepiece used? *The eyepiece used is 5x.*

Q23. In what ways would the microscope contribute to the study of different objects and organisms? *The microscope gives an enlarged view of objects and organisms. Detailed studies of their complex structure and consequently their functions is possible using this equipment. It also enables one to see and observe organisms that are not visible using the unaided eye.*

Silica gel is a dessicant which absorbs water or moisture. It prevents fungal growth in microscope lenses. If you are not familiar with it, ask the Chemistry teachers in your school about it. Silica gel packs are found in newly bought appliances or in medicine and food bottles or containers.

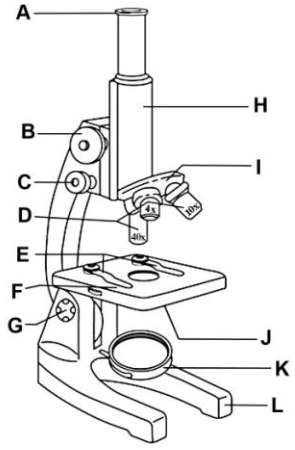
The steps given in preparing for storage and practices on care and maintenance of the microscope would develop in students responsibility in the use and giving value to this expensive yet important science tool.

PRE/POST TEST

1. Which two parts of the light microscope magnify the image of an object?

   A. eyepiece and mirror
   B. eyepiece and objectives
   C. objectives and mirror
   D. objectives and diaphragm

Use the letters in the figure next page to answer questions 2 to 4.



2. It moves the body tube and objectives up and down.

3. Which part makes possible the changing of the objectives?

4. Which part will you adjust if the onion cell you are observing under the HPO is not clear?

5. A plant cell is viewed using a 10X eyepiece and a 43x HPO. How much will the cell be magnified?

6. Which should be used to observe bacteria?

   A. 43x objective and a 10x eyepiece
   B. 60x objective with immersion oil and 10x eyepiece
   C. 60x objective and 15x eyepiece
   D. 97x objective with immersion oil and 5x objective

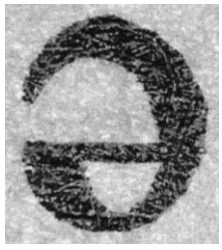
7. What is the correct way of carrying a microscope?

8. An animal cell being observed is seen at the topmost part of the field of view under the LPO. If you want to center the specimen, which direction should you move the slide?

9. Which of the following can be observed using the light microscope?

   A. acacia bark
   B. five peso coin
   C. piece of stone
   D. tip of gumamela leaf

Refer to the pictures below:



A.

B.

10. Which of the two above shows letter “e” seen under the microscope?

Answer Key

5. B
6. B
7. I
8. C
9. 430x or 430 times
10. D
11. Hold the arm by grasping it with one hand(right/left) and support the base with the other hand(left/right)hand.
12. Forward or away from me or the user
13. D
14. A

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Unit 2
MODULE

3

LIVING THINGS OTHER THAN PLANTS AND ANIMALS

This module contains activities that will introduce learners to living things other than the animals and plants they studied in Grades 3-6, or, if they have some knowledge about them already, bring such knowledge to the classroom to be shared, further added to, and organized in a useful way. They will also use a magnifying lens in their study, or even a microscope, if their school has one. Many representatives of the groups Fungi, Algae and Bacteria are quite beneficial to humans and may cause disease and harm too. The common members of these groups and most visible ones will be studied first before proceeding to members that are very small in size, needing the use of a microscope to become visible to us, hence the term ***microorganisms*** to refer to them.

Through the activities, learners will develop their inquiry skills of observing, communicating, inferring, comparing, classifying, and gathering, recording, and organizing data in a table.

More than that, they will be getting to know their immediate environment more closely so that it may be protected, conserved, and made safe and useful for their own and the community's benefit.

Advance preparation

1. Collect one kind of mushroom and lichen. You may usually find the latter on trunks of trees.
2. Buy from the market *ar-arusep* or *lato* (*Caulerpa*) or whatever seaweed is available locally. If you are in a mountainous or landlocked area, you may collect green algae or *lumot* from rocks, ponds, or even your aquarium in school.
3. Allow molds to grow on some fruit peelings (banana) or a piece of moistened bread.
4. Grow a bacterial colony on a slice of potato or *kamote* which you have dropped in boiling water for 3 minutes. Do this by getting a clean cotton bud (Q tip) wiped against your tongue or the inside of your cheek. Then streak it across the potato surface as a big letter Z. Keep this slice inside a clean, see-through plastic bag and seal with tape inside a dark cabinet for 2-3 days.

DAY 1

Activity 1

Are these also plants?

1. Recall that during the elementary grades, they learned about animals and plants---the different kinds, their characteristics and needs. Say: “Today we will examine some living things which may also be found in our environment. Ask yourself the question: ‘Are they also plants?’”

2. Distribute Activity 1 and tell them to answer Q1 to Q11 initially. Show them live specimens of mushrooms and *ar-arusep (Caulerpa)* or other edible algae found in the local market, if possible. In the absence of edible seaweed, show *lumot,* or the green scum that forms in shallow ponds or places that are always wet. Give them a few minutes to observe the specimens and write down their answers.

3. When they are done, show them a specimen of a lichen (#4 in the Student Activity). This can be collected from trunks of trees. Tell them to answer Q12 to Q14. Following are some photos of lichens from internet sources. Tell them they can use their magnifying lenses.

http://www.ppdl.purdue.edu/ppdl/weeklypics/1-12-04.html downloaded 9 March 2012

http://visual.merriam-webster.comimagesplants-gardeningplantslichenexamples-lichens.jpg

4. You may take photos of your own and project these. The ones shown here may or may not be the same kinds found in your locality. Look at trunks of trees that are in shady and moist places.

5. Then, show them the bacterial colony in the form of the letter Z on potato, the fungus on rotting banana peel or the mold on old bread, and green algae or *lumot*. Tell them to answer Q15 to Q17. Ask if they know what each is. Encourage them to use their magnifying lenses. They will see something similar to the following:

Q15. (a)

Photo by A. Encarnacion 2012

Q16. (b) Fungus on rotting banana peeling

Rotting banana peeling as seen through the naked eye

Rotting banana peeling as seen through a magnifying lens

(photos by R.L. Reyes)

Or, (c)

Old bread with mold seen through the naked eye

Old bread seen with a magnifying lens

(photos by R.L. Reyes)

and, (d)

Green algae or *lumot* in a freshwater aquarium
http://www.guitarfish.org/algae downloaded 12 March 2012

6. Conduct a discussion of the answers they wrote. Do not give them the answers, though you can confirm at the end, after eliciting answers from all, those who mentioned the correct answers.

Expected answers:

Q1. Yes, it is a plant.
Q2. Mushrooms (Correct!)
Q3. Answers will vary. Example: They have "stems" and a "crown" like miniature trees.
Q4. Yes, it is a plant.
Q5. Answers will vary. They may answer "seaweed" or the local name. (Correct!)
Q6. Because it's green.
Q7. One is green, the other is white, brown, or grey.
Q8. Both have root-like, stem-like or fruit-like parts.
Q9. Answers will vary. If they have, they may describe light brown slices of button mushrooms or pieces of black *taingang daga.* If it's seaweed, they may describe other seaweeds like *guso* on the cover of this module.
Q10. They may have eaten dishes with mushrooms or salads with seaweeds.
Q11. Answers will vary; common names are different in the different dialects.
Q12. Answers may vary; many will probably answer "plant."
Q13. Yes.
Q14. Because its color is greenish; it has leaf-like parts.
Q15. (a) The letter Z in a different color from the potato. It's white.
Q16. (b) Cottony, thread-like growth (on banana peel). Some may mention *amag* (correct).

Or, if you showed them the moldy bread,

(c) There are tiny black dots and growth like cotton. (This is also *amag.*)

Q17. Dark green, slimy stuff.

Q18-19. Answers will vary depending on what the students already know or have experienced. Elicit all the different answers then **affirm the correct ones**. It is not expected that any student would guess that the Z is a bacterial colony (Q18). Students may correctly guess Q19 (b) or (c) as *amag* which both are.

Q20. (d) May be correctly identified as *lumot.* In English the word "moss" is used but mosses are very small plants that have thin stems and grow on land. *Lumot* are actually green algae, not plants. They float in water or cling to wet rocks. They have no roots, stems or leaves.

Advance preparation for Day 2

Survey the school grounds beforehand so you know where to take them to find mushrooms, puddles or rocks with algae (*lumot*), tree trunks with lichens and whatever there is to find that is not recognizably or doubtfully a plant for Activity 2.

DAY 2

Activity 2

What other living things are found in the school grounds?

1. Distribute Activity 2. Tell them to wear their gloves; bring tweezers, tongs, or forceps; plastic bags or glass jars. Give them a maximum of 10 minutes outside. Each student need only collect **one** living thing similar to the ones you showed them yesterday or which they are not sure about being a plant.

In the grounds:

2. Bring them to shady, moist areas with decaying plant matter. Point out cottony, powdery material on decaying logs and leaves as well as green stuff on wet surfaces. Fruiting bodies of mushrooms are easy to spot and would be the obvious choice of students to collect.

3. Prompt them to get a sample of green algae (*lumot*), lichens, fuzzy or hairy patches.

Back in the classroom:

4. Allow them to describe the specimens they collected and to show their drawings (Q1) to the class. Discuss their answers to Q2, and Q3.

Expected answers:

Q1. Drawings will vary, depending on what they collected.
Q2. Answers will depend on the exact place of collection.
Q3. Answers will depend on the conditions of the place of collection, e.g., if it was collected in a moist, shady place, the specimen must need moisture to live. It may be inferred that it will not thrive under intense sunlight and dry conditions. They should also give air as a need.

5. When they have heard and seen what others have collected, tell them to answer Q4 and Q5.

Q4. Answers will vary, but they are expected to collect something they had seen the previous day in the classroom because you pointed out the places where they were to go and suggested what to collect. They may collect the same kind of living thing but of a different species or form.

6. At this point (as you discuss answers to Q4), give the names of all the organisms they observed in Activities 1 and 2: mushrooms, molds, algae, and lichens. Tell them that the Z in the potato is actually a bacterial colony from human saliva. The lichen is a combination of fungus and alga.

Allow students to group the living things they have seen so far. Ask them for their reasons for grouping together the living things. See if they see the similarities between different kinds of mushrooms and molds and the different kinds of algae (seaweeds) if they are by the sea, and *lumot*.

Q5. Their answers may include the following: Mushrooms and molds are different from plants because they are not green; they are white, grey, brown, black. They only have stem-like, fruit-like, and leaf-like parts just as plants do but their bodies are very much softer and smaller. Seaweeds may be green but they only have stem-like, fruit-like, leaf-like parts not the real parts.

7. For their homework, tell them to find reference books or search the internet for the big groups these organisms belong to based on the names you gave them. The names of the big groups are Fungi, Protists or just Algae or Seaweeds, and Monerans or just Bacteria. Lichens are combinations of a fungus and an alga. Tell them to find out the characteristics of these groups, their uses to humans and the environment, and negative effects, if any. Tell them they can give other examples they find out about in the course of their readings.

Tell that what they did (collecting specimens in the school grounds) is already part of an investigation.

8. Discuss information they gathered that may not be in agreement. Review their sources. Give them the opportunity to evaluate and judge their sources. Explain to them that through this process, their critical thinking skills will be

honed. There should not just be one source of information. Encourage them to refer to several sources.

Expected answers to questions after the activity:

Q. What are the similarities among these groups? They are close to the ground (small, e.g., the fungi and *lumot*). They need moisture to live. They grow on living things or once-living things and in fact, cause decay and decomposition, in the case of fungi.
Q. How are they different from each other? The algae are green, they make their own food, while mushrooms are white, cream, grey and get food from decaying living things. Lichens are often found on trunks of trees and are greyish green.
Q. How are these big groups different from the plants studied in Grades 3-6? These big groups are mostly smaller than plants. They have no true leaves, true roots, true stems, true flowers.

DAY 3

1. On a table like the one below, allow the students to enter the information they gathered as homework the previous day.

Expected information:

Name of living thing or organism	Big group/ Other Examples	Characteristics	Uses/ Benefits	Harmful Effects
Mushroom	Fungi / yeast, mold	Not green; cannot make its own food	Food; decomposes living matter	Some species can cause disease, e.g. athlete's foot, ringworm; some are poisonous when eaten
Green algae, e.g. *Caulerpa* or *ar-arusep,*	Protist (Algae)/ Red algae, e.g., *Kappaphycus* or *Eucheuma*	Has green, and other colors; can make their own food; some are one-celled, some are multicellular	Food for humans; food for fish in ponds	Some considered pests in aquariums and recreation beaches
Lichen	Partly fungus and partly alga	Algal part can photosynthesize; fungal part cannot	Algal part provides food for the fungal part; fungal part provides a home for the alga; acts as indicator of air pollution; lichens act as seed bed or spore bed	

Name of living thing or organism	Big group/ Other Examples	Characteristics	Uses/ Benefits	Harmful Effects
Molds	Fungi	Has root-like, stem-like, fruit-like parts; has spores	Break down once living matter into its simplest components	Responsible for spoiled food
Bacteria	Bacteria or Monera	Can be seen only when in colonies or big numbers	Making fermented products: also decomposes once-living matter	May cause disease like TB, diarrhea, pneumonia, some sexually transmitted diseases, urinary tract infection or UTI, leprosy, typhoid, rheumatic fever

2. Teach them how to list down their references. Enabling them to seek and gather information on their own is a valuable skill students need to learn. They should also be engaged in evaluating credibility of various sources and determining acceptable information. These skills are part of critical thinking.

3. Discuss disease-carrying and beneficial members of these big groups. Settle differences by evaluating their sources.

4. End the lesson by saying they have just classified certain living things under three big groups apart from the groups of Animals and Plants they have learned about in the elementary grades. Say that other members of these groups, especially the microscopic and single-celled representatives, **will be studied in the higher grades**.

5. Administer the posttest.

PRE/POST TEST

1. The green alga, *Caulerpa,* and mushrooms both have some characteristics similar to plants. What are these characteristics common to both that are also found in plants?

   I Green color for foodmaking
   II Stem-like parts
   III Spores
   IV Fruit-like parts

   A. I and II
   B. II and III
   C. I and III
   D. II and IV

2. Just like many living things, fungi have certain needs to survive. What are these needs?

   I Food
   II Air and water
   III Sunlight and soil
   IV Water

   A. I and II
   B. II and III
   C. I and III
   D. II and IV

3. Fungi cannot make their own food. What is the effect of their food getting activities?

   A. Decomposition of living things
   B. Production of starch
   C. Trapping of solar energy
   D. Release of oxygen

4. What characteristic differentiates fungi, algae and bacteria from the plants studied in Grades 3-6 aside from their small size?

   A. They do not have true roots, true leaves, true stems, fruits and flowers.
   B. Most do not make their own food unlike plants.
   C. They are at the base of the food chain while animals are at the top.
   D. They cause diseases while plants and animals have many uses.

Answer Key

1. D
2. A
3. A
4. A

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Teaching Guide for Activity 3 (for schools with microscopes)

Activity 3

What do these living things look like under the microscope?

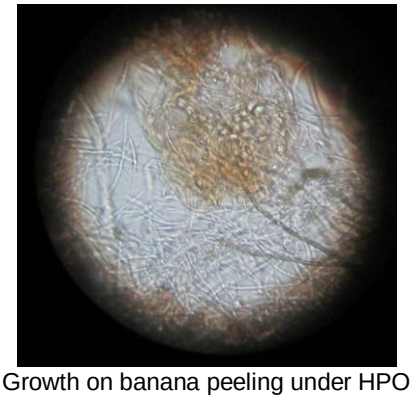
1. Distribute Activity 3. Supervise their preparation of slides. Each group should have slides of each of the specimens: banana peeling mold, bread mold, *lumot*, bacterial colony, and lichen.

2. Help them also in the manipulation of the microscope.

   For Q1, they may see something like this:

Growth on banana peeling under LPO
Photo by R Reyes

For Q2, they may see something like this:



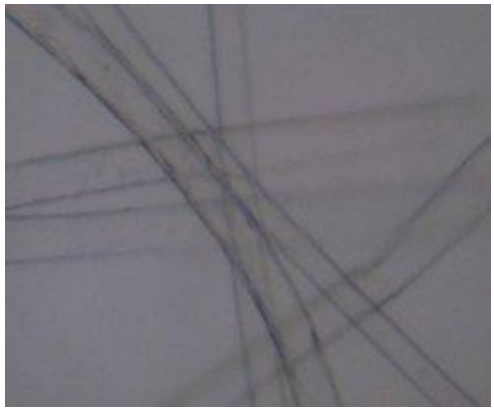
Growth on banana peeling under HPO
Photo by R Reyes

Q3. Sample answer:

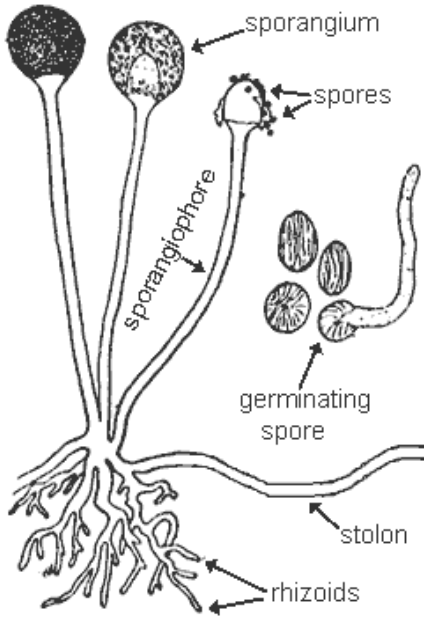
Under the LPO, I see threadlike structures and two roundish, yellowish forms.

Under the HPO, this yellowish, roundish form has smaller round things inside and a stalk or stem-like part

Q4. Show this to students and ask them to label their drawings:



Fungal **hyphae** (plural of hypha) – fine branching, colorless threads; together they form a tangled web called a **mycelium**
Source: http://www.countrysideinfo.co.uk/fungi/struct.htm downloaded 21 March 2012

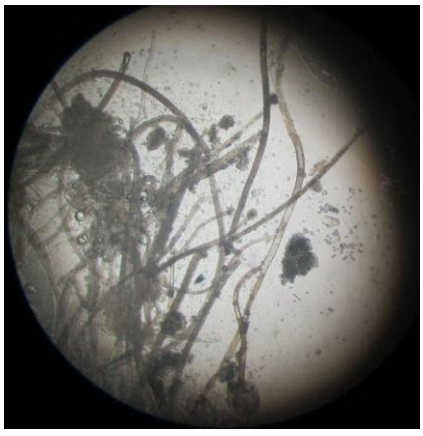


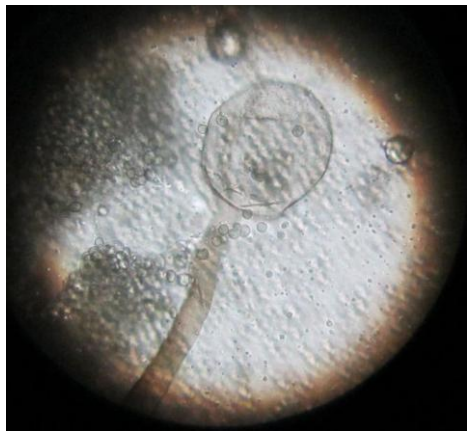
The **stolon** is a kind of hypha connecting fruiting bodies. The stemlike part is called a **sporangiophore**. The roundish yellowish shapes are **sporangia** (plural for sporangium) the structures which bear the small round **spores**. Each spore that lands in a warm, dark, moist place “germinates” and form hyphae all over again.

Source: http://www.backyardnature.net/f/bredmold.htm downloaded 21 March 2012

3. The mold on bread is similar to the mold on the old banana peeling.

LPO HPO





Example of *Lumot*

http://www.microscopyuk.org.uk/mag/indexmag.html?http://www.microscopy-uk3

Unit 2
MODULE

4

REPRODUCTION: THE CONTINUITY OF LIFE

This module discusses the different modes of reproduction in representative plants, animals, and microorganisms. Investigations in this module will help students understand the different ways that organisms reproduce. At the end of this module, students should be able to describe asexual and sexual reproduction and differentiate the offspring resulting from each mode of reproduction.

Key questions for this module

What are the different modes of reproduction?

How can we use this knowledge to grow plants?

Activity 1

Can you grow new plants from "eyes"?

In this activity, the potato is used as an example of a plant that can reproduce asexually through vegetative reproduction. The potato tuber, a specialized underground stem, is cut into pieces 2-3 days before planting to allow for the growth of the hard and waxy layer on the cut surface to prevent rapid decomposition.

If potatoes are not readily available, you may use ginger or sweet potato for this activity.

Possible answers to the developmental questions in Activity 1:

Q1. The cut pieces are planted with the eye pieces pointing upward to enable the shoots to grow faster.
Q2. Answers may vary.
Q3. One potato "eye" will yield one new shoot.

Q4. Vegetative propagation is a faster way of propagating plants. A larger number of offspring may also result in vegetative propagation. In Activity 1, several new plants were grown from one potato plant.

Ask the students if they know of other plants that can be propagated vegetatively. Students may give some of these possible answers: Some plants that can be propagated vegetatively are *kamote* (sweet potato), cassava, ginger, pineapple, and some ornamental plants.

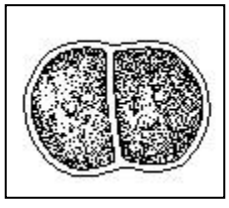
Activity 2

Can one become two?

Before discussing fission, show the class how to prepare a wet mount of *Protococcus*. The scrapings of *Protococcus* must be soaked in water three days before the cells are studied. In this way, it will be easier to separate the cells from the other algae and debris in the scrapings. To separate *Protococcus,* tease the scrapings using two dissecting needles. The *Protococcus* is a green alga that may form clusters or colonies.

Answer to the developmental questions in Activity 2:

Q5. Dividing *Protococcus* cells may look like these:



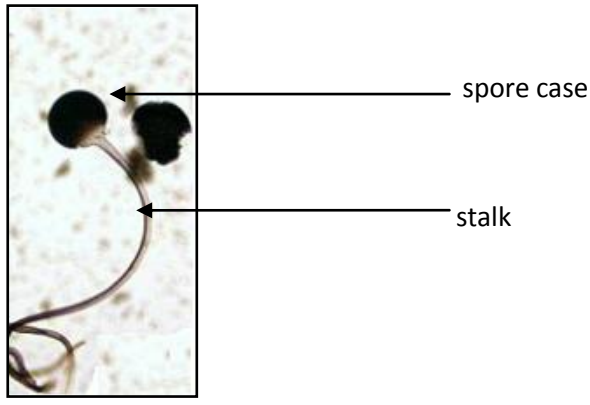
Q6. Paramecium and amoeba are two examples of unicellular organisms that reproduce through fission.

You may show students prepared slides of Paramecium undergoing fission.

Introduce budding as another type of asexual reproduction. You may show the class a slide of yeast cells. Have them describe what they see. In some cases, they may see actual budding of the yeast cells. The smaller cell is called a bud which detaches itself from the mother cell and grows into a mature cell. Ask the students if they know of other organisms that reproduce by budding. *Possible responses: hydra and sponges.*

Prepare ahead of time a bread mold culture before the discussion on spore formation as a means of asexual reproduction. Expose a piece of bread for a few days until you can observe mold growing on the bread. Spore formation is common among the molds. Using the bread mold culture, show the class where the spores are located.

If you have a microscope, you may prepare the bread mold for examination under the microscope. With a dissecting needle, get a few filaments from the culture and place them on a clean slide with a drop of water. Put a cover slip. Under the microscope, the bread mold looks like this:



Mold with spore case

Call the attention of the students to the round structures at the tip of the stalk. These are the spore cases containing the spores. You may crush one and show the spores under the microscope to give the students an idea of the size and number of spores. Ask students how important spores are. The acceptable response is: the spores, when carried by the wind to bread or fruit, can grow into a new mold.

Emphasize that proper temperature, amount of moisture, and food source are necessary for the spores to germinate. Ask the class if they know of other organisms that can reproduce by spore formation. *Possible responses*: *kabute* (mushrooms), shelf or bracket fungi, *pako* (fern).

Proceed to the discussion on asexual reproduction among animals. Reproduction through regeneration or replacement of missing parts is also possible among lower forms of animals. The bodies of sponges, hydra, and planaria can be cut into several pieces and each part can become new individuals. Point out the difference between regeneration and reproduction. Through regeneration lizards, crabs, and lobsters can replace missing parts like tails or legs but their tails or legs cannot regenerate the missing heads. In general, increased specialization in animals corresponds to a decrease in capacity for regeneration.

After providing students with a wide range of common examples of organisms that reproduce asexually, ask them to describe the offspring resulting from asexual reproduction. *Answer: Asexual reproduction gives rise to offspring that are identical to the parents.*

After the kinds of asexual reproduction have been taken up, introduce the second mode of reproduction, sexual reproduction. Emphasize that sexual reproduction involves sex cells or gametes. The female gamete is called egg cell or ovum; and the male gamete is called sperm cell. A form of sexual reproduction is

called conjugation. This is exhibited by *Spirogyra*, *Paramecium*, and bread mold. If you have a prepared slide of conjugating *Paramecium* and *Spirogyra*, you may focus them under the microscope for students to study. Use drawings if there are no prepared slides.

Sexual Reproduction in Flowering Plants

The flower is the reproductive structure in plants. Some plants have the male and the female reproductive structures in one flower. Others have separate flowers containing the male and female reproductive structures. In Activity 3, the gumamela flower will be studied.

Activity 3 Structure of a gumamela flower

At the end of this activity, the students should be able to: (1) distinguish the male and the female reproductive structures; and (2) describe the function of each structure in reproduction.

Ask each student to bring the following: gumamela flowers (1 fresh, 1 withered, and 1 gumamela bud), scalpel or razor blade. Remind the students not to play with the scalpel or razor blade.

To motivate the students, ask them what they think about flowers. What is the importance of flowers? Encourage discussion of responses. Then bring around the discussion to the biological importance of flowers. You may bring up the topic of pollination and the role of attractive flowers.

Proceed with the activity.

Answers to the developmental questions in Activity 3:

Q6. The flower is attached to the stem by a short stalk-like structure.

Q7. The sepals provide protection to the unopened flower.

Q8. The stigma of the fresh flower feels sticky.

Q9. The stigma is sticky so the pollen grains that fall on it can better adhere on it.

Q10. The answers may vary.

Q11. Pollen grains may reach the pistil through agents of pollination like insects, wind, water, and humans.

Use illustrations or drawings in describing the formation of a pollen tube so that the students will understand the process better. Talk about fertilization which occurs after pollination. Fertilization is the fusion of the nuclear contents of the egg and the sperm. From this union, a zygote results. In plants, the zygote or embryo is within the seed.

Sexual Reproduction in Humans and Animals

Sexual reproduction needs two parents, a male and a female and this involves specialized cells or gametes. The more complex species have gonads for the production of the male and female gametes. Gametes differ in form and structure. Use diagrams of the egg and sperm cells to facilitate the discussion on gametes. Emphasize that gametes are microscopic cells. The method by which the sperm comes in contact with the egg cell may be external or internal. External fertilization usually occurs in aquatic animals. In internal fertilization, specialized structures transport the sperm into the egg within the body of the female. Fertilization or the union of these gametes starts the development of the new individual.

Sexual reproduction gives rise to offspring that are a combination of the traits from its parents. Thus, the offspring differ genetically from their parents and their siblings. These genetic differences help to ensure the survival of the species in changing environmental conditions.

PRE/POST TEST

1. Which of the following structures are NOT involved in asexual reproduction?
   A. Gametes
   B. Tuber
   C. Stem
   B. Root

2. A farmer grew only one type of onion. All of the onion plants died from the same disease. What can be said of this onion plant population?
   A. Only a few plants were resistant to the disease.
   B. All of the onion plants were resistant to the disease.
   C. The onion plants were genetically identical.
   D. The onion plants were genetically different from each other.

3. A farmer wants to propagate a good variety of a crop in a way which maintained all its desirable traits. Which of the following methods should be used?
   A. Self-pollination
   B. Vegetative propagation
   C. Growing seeds produced from this variety
   D. Cross-pollinating this crop with another good variety and growing the seeds resulting from the cross

4. A sperm cell unites with an egg cell to form a zygote. Which process is taking place?
   A. Pollination
   B. Fertilization
   C. Asexual reproduction
   D. Vegetative propagation

5. In sexual reproduction, what is the source of the genetic material in a zygote?
   A. An egg cell only
   B. A sperm cell only
   C. A pollen and a sperm cell
   D. An egg cell and a sperm cell

6. Which species can produce offspring that are genetically different from their parents?
   A. A species that has few variations
   B. A species that reproduces asexually
   C. A species that reproduces sexually
   D. A species that competes with a similar species

7. What is NOT a characteristic of sexual reproduction?
   A. Gametes from two parents unite to form a zygote.
   B. Offspring are genetically identical with the parent.
   C. Offspring are different from their parents and sibling.
   D. Genetic variability of offspring help to ensure survival in changing environmental conditions.

Answer Key

1. A
2. C
3. B
4. B
5. D
6. C
7. B

References

Hwa, K. S., Sao-Ee, G., & Luan, K. S. (2010). My *pals are here! 6A science*. (International Ed.). Singapore: Marshall Cavendish.

Philippines. Department of Education. (2009). *Science and Technology II textbook*. (Rev. ed.). Pasig City: Instructional Materials Development Corporation.

Unit 2
MODULE

5

INTERACTIONS

In the lower grades, learners were introduced to the living and nonliving things that make up the environment. They have also been introduced to the different interactions that take place among organisms and between organisms and their environment; they prey on other organisms for food, they have structures that help them look for food and meet their basic needs, and they live in places where they can be safe from bigger animals.

Some interactions are beneficial; others are harmful. There are also interactions in which populations of organisms are neither benefitted nor harmed. All these interactions take place in ecosystems.

All these interactions involve energy and its transformation through trophic levels. Producers like plants convert radiant energy into chemical energy through photosynthesis. This energy is transformed to other forms in the environment as one organism feeds on another organism.

In this module, the students will discover that there are levels of organization that are beyond the level of the organism.

Key question for this module

How do organisms interaction with each other and with their environment?

How energy is transferred from one organism to the other?

Activity 1

What does it mean to be alive?

In this activity, you will ask the students to identify the components of the environment, compare the living and nonliving things, and describe how organisms interact with each other and with their environment.

Visit your school garden or a pond near your school. On a separate sheet of paper, ask the students to describe or draw the place.

Q1. What are the things that you see in your school garden or the pond?

Depending on the nature of your school garden or the pond, the students will probably see rocks, soil, water, insects, and plants.

Q2. Which of these things are living? Which of these things are nonliving?

In the sample answer to Q1, the living things include the insects and plants; the nonliving things include the rocks, soil, and water.

Q3. Observe the things that you identified as living. What do they have in common?

They will probably observe that the insects move and that both the insects and plants respond to stimuli.

Q4. Observe the things that you identified as nonliving. What do they have in common?

They will probably observe that, except for the water that is fluid, the rocks and soil are stationary; but nonliving things do not respond to stimuli

Q5. What interactions do you observe happening among the living and nonliving things?

They will probably observe small plants inhabiting the rocks; or ants making anthills.

Q6. What makes living things different from nonliving things?

Accept as many answers for this question as possible. Their answers may include properties they mentioned in answering Q3 and Q4.

Have the students observe the rocks found in the school garden or the pond. Ask them if they look like the rock shown in Figure 1 of Module 5. If so, have them use a magnifying lens to see the details of the small plants.

Q7. What do these small plants need that is provided for by the rock?

These small plants need water and nutrients. Rocks are porous and hold enough water to sustain the small plants' growth; they also contain some nutrients and minerals that the small plants need.

Q8. Where do you find these rocks that are inhabited by small plants?

Most of these rocks are found in moist places.

Q9. What other things in the environment are inhabited by these small plants? Where do you find these things?

Some of these small plants grow on concrete walls like those shown in Figure 2; others grow on the stem of trees.

Q10. Why do you find them in these places?

These places hold enough moisture and may contain some nutrients that support the growth of the small plants; they also get just enough filtered light. Direct sunlight may dry up the place and cause the small plants to wither.

Q11. Do you also see small plants growing on the fences of your school?

If yes, the reason may be similar to those mentioned in the answer for

Q12. What other living and nonliving things did you see in the school garden or the pond? Do you see them in other parts of the school? Explain your answer.

They probably will not see rocks that are inhabited by small plants in parts of the school that are dry. These small plants need enough moisture to live and grow. Accept as many answers as possible to this question.

Figure 3 shows a picture of a community of plants. Different populations of organisms that interact with each other in a given place make up a community.

Q13. Do you know of a similar place near your school where you see communities of organisms?

The answer to this question varies depending on the other places in the school that were visited by the students.

Q14. Are the things you find in your school garden or the pond the same things that you find in the backyard of your house? Explain your answer.

If the physical conditions of the school garden i.e., moist and with filtered light, are the same as the physical conditions of the backyard of the house, then more likely, they will observe similar communities of organisms.

Q15. How do living things interact with each other and with their environment?

Living things have basic needs to meet in order to survive. These basic needs: water, nutrients, sunlight (for plants), and shelter, are provided to them by their physical environment. Living things meet their basic needs through their interaction with their physical environment.

Activity 2

Housemate? Ecomates!

In this activity, the students will describe interdependence among the components of the environment, explain how organisms interact with their environment to survive, and infer what happens to organisms if their environment is not able to provide them with their basic needs.

Guide the students through the procedure. They will set up 8 different aquaria; the contents of which are provided in the chart. Should you opt to use Bromthymol Blue as an indicator for the presence of carbon dioxide, you may use the boxed procedure on the right.

On a separate sheet of paper, have the students copy Table 1. They will record their observations of changes, if any, in the things that were placed in each of the aquaria.

Preparation for Bromthymol Blue (BTB)

1. Add 0.1g Bromthymol Blue into 16ml of 0.01N NaOH
2. Mix in a small container
3. Dilute to 250mL with distilled water
4. Add 5 drops in 10mL of test sample

*Adapted from
http://www.thelabrat.com

Q16. Where did the snails and fish stay most of the time in each of the containers each day for three days? Explain your answer.

The snails and the fish in the containers that did not have plants stayed near the top of the water column most of the time. Snails and fish need oxygen to live. Without plants, their only source of oxygen is the air just above the water.

Q17. What happened to the organisms in each of the containers after three days?

It's very likely that the snails and fish in the containers that did not have plants would have already died or are very weak.

Q18. In which container/s were the organisms still alive? Which organisms are these?

It's very likely that the organisms in the containers that have plants are still alive. These organisms are the snails, fish, and even the plants.

Q19. What do you think will happen to the organisms in each of the jars when left closed for a longer period of time? Why do you think so?

After a longer period of time, the organisms that were placed in the dark would have already died. The snails, fish, and plants that were placed together in the container that was placed in strong light would have survived.

Questions 20-22 are additional questions if you used BTB.

Q20. In which container/s did you observe change in color on each day for three days?
Containers B1 and B2
Q21. Bromthymol blue changes color to yellow in the presence of carbon dioxide. Which jar/s contained carbon dioxide?
Containers B1 and B2
Q22. What explains the presence of carbon dioxide in this/these container/s?
These containers had snails and fish that give off carbon dioxide.

Q23. How do plants and animals depend on each other?

The plants give off oxygen in the presence of light. The fishes and snails need oxygen to survive. Plants need carbon dioxide given off by the fishes and snails to survive.

What the students have observed in this activity are interactions that take place in an aquarium. There are other kinds of interactions and interdependence among organisms and their environment in bigger ecosystems.

Ecological Relationships

Objective

The purpose of this section is to study the how organisms interact with other organisms in a given environment.

Teaching Tips

At a start of the lesson, explain to the students that in our environment, there plants, animals, and microorganisms (bacteria, fungi).

There are other microorganisms such as protozoa – they are single-celled organisms that have a true nucleus enclosed by a membrane. Some protozoa have animal-like behavior such as, movement (e.g., amoeba and paramecium). Some protozoa have plant-like behavior, they are able to photosynthesize, and these include the algae.

Explain to the students that a population is a group of organisms or individuals of the same kind (species) living in a given place and in a given time. Have students study figure 4 and then ask:

Q24. In figure 4 below, what populations of organisms can you observe?

Answer:

Populations of:

- Cotton stainer insect
- Dragon fly
- Fly
- Butterfly
- Praying mantis
- Different fungi
- Different plants

Each picture of an organism represents of the population of that organism, e.g., cotton stainer represents the population of the cotton stainer in the given area. A butterfly represents the population of butterflies in the area.

Explain to the students this set of populations that inhabit a certain area form a **community**. Therefore, what was shown in figure 24 in the student text is an example of a community of different populations and in turn each population is composed of one kind of organisms. You may introduce other sample of a community as shown in figure below. Different populations of organisms such as: Ducks, a representative of herons (white bird), insects, tall grasses, coconut plants, and different types of fish in water.

These populations of organisms interact among themselves. For example, ducks stay in water for food. They eat small animals living in water. This is an interaction between ducks and small animals. **Biological interactions** are the effects organisms in a community have on one another. In the environment no organism exists in absolute isolation, and thus every organism must interact with other organisms and the environment.

In the student text, Figure 25 shows fern plants growing on a trunk of a *Narra* tree. What kind of relationship do you think these two organisms have? Figure 25 shows an epiphytic fern attached itself on a trunk of a *Narra* tree **without harming** the tree. The *Narra* tree is a host that provides a place for the fern. When it rains, the ferns get nutrients from rotting leaves and other organic materials that collect at the root base of the fern plant. This relationship is called **commensalism** -- one organism benefits from the host organism, while the host organism is neither positively nor negatively affected.

Q25. What other examples can you give similar to this relationship?

Barnacles and other seashells

Barnacles on the shells of *tahong*

Barnacles on the shells of *talaba*

Photos: Courtesy of Rodolfo S. Treyes

Barnacles adhering to the shell of oyster or mussels (*talaba* or *tahong*): they are crustaceans whose adults are sedentary. The motile larvae find a suitable surface and then undergo a metamorphosis to the sedentary form. The barnacle benefits by finding a habitat where nutrients are available. In the case of lodging on the shell of other organisms living organism, barnacle populations does not hamper or enhance the survival of the animals carrying them. However, some species of barnacles are parasitic.

Orchid plants and trees

Orchid plant is an epiphytic plant species that grows on certain woody plants (trees). Orchid draws its nutrients from the atmosphere, not from the host tree. Thus the orchid has no harmful effect to the woody plant.

Another type of relationship is parasitism – one organism lives in or on another organism (the host) and consequently harms the host while it benefits.

Q26. What other example of parasitism do you know?

- Hookworms consuming blood from inside an animal's intestine.
- Tick that feed on the blood of dog

Photo: Courtesy of Rodolfo S. Treyes

Activity 3

Which eats what?

Let the students fill in the appropriate box to each of the organism.

Organisms	Q27. What organisms are involved?	Q28. What is the eater? What is eaten?	Q29. What part of the body does the eater use to get its food?
	Frog and insect	The frog is the eater. An insect is eaten by the frog.	The frog stretches its tongue to catch an insect.
 	Cat and mouse	The cat is the eater. The mouse is eaten.	Cat uses its sharp claws to catch the mouse and bitten using its sharp canine teeth.
	Spider and insect	The spider is the eater. Insect is eaten.	The spider uses its web to catch the insect.
	Mantis Student may search in the internet what the praying mantis eating. (Praying mantises eat insects and other invertebrates such as, beetles, butterflies, spiders, crickets, grasshoppers, and even spiders.)	Praying mantis Small crawling animals e.g., ants	By grabbing the prey with its front claw like legs and eating it alive.
	Bird and earthworm	The bird is the eater. The earthworm is eaten.	The bird uses its beak to get the earthworm.

Students may visit a school ground or garden to make more observations. Facilitates the students in identifying the organisms they are observing. They can search some information in the internet.

Organisms	Q30. What organisms are involved?	Q31 What is the eater? What is eaten?	Q32. How does the eater gets its food?

Explain to the students, what they have observed in this activity is predation -- an interaction in which one organism captures another and feeds on the captured organism. An animal that kills and eat other animal is called **predator**. An animal that is killed and eaten by its predator is called a **prey.** Prey animals are usually smaller and less powerful than the predator that eats it.

Energy Transfer in the Ecosystems

Plants, animals, and microorganisms eat food to get energy that enable them to move, grow, repair damaged body parts, and reproduce.

Q33. Why plants are considered producers? *Plants are capable of converting energy from the Sun into chemical energy in the form of glucose (food). The process is called **photosynthesis**, which uses water, carbon dioxide and sunlight.*

Q34. Are plants the only organisms in an ecosystems that can produce their own food? *There are also microorganisms that can photosynthesize; examples of which are shown in Figure 8.*

Q35. How do animals and humans obtain energy to keep them alive? *Humans and other animals are not capable of making their own food. They are must eat other organisms in order to obtain their energy as well as nutrients.*

Q36. In the figure 9, what are organisms being eaten? *Plants and plant parts are eaten by animals.*

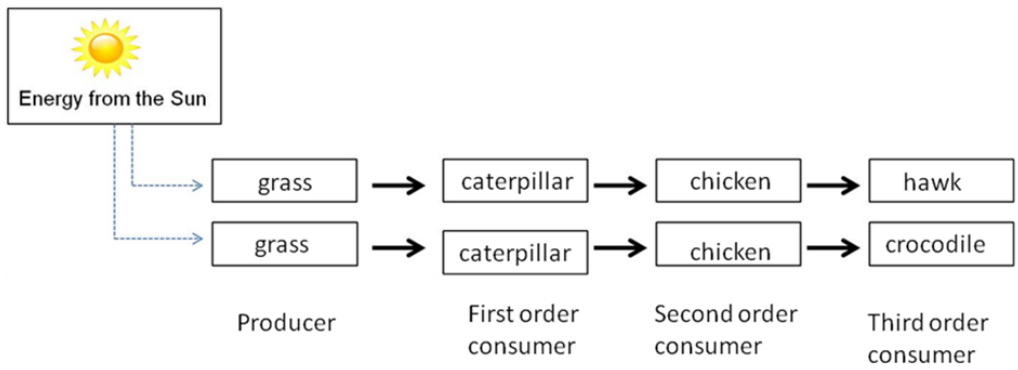
Q37. What are the eaters? *Goats, cows, caterpillar, and mouse are the eaters.*

Q38. What other organisms do you know in your area that eats only plants? *Snails, grasshoppers, horses, sheep, beetles,*

Q39. In figure 10, what organisms could provide energy to the snake and chicken? *The snake gets its energy by eating the mouse. The Chicken gets its energy by eating the caterpillar.*

Q40. Refer to figure 11 above. How does energy from the Sun reach the 3rd order consumers? Trace the flow of energy among organisms by filling up the boxes below? The arrow (⟶) pointing to the next box means "eaten by".

Answer:



Q41. List down the organisms found in your community. Classify the organisms according to the following categories:

Organism	Producer	First Order Consumer	Second Order Consumer	Third Order Consumer

Answers to this question will depend on students' data.

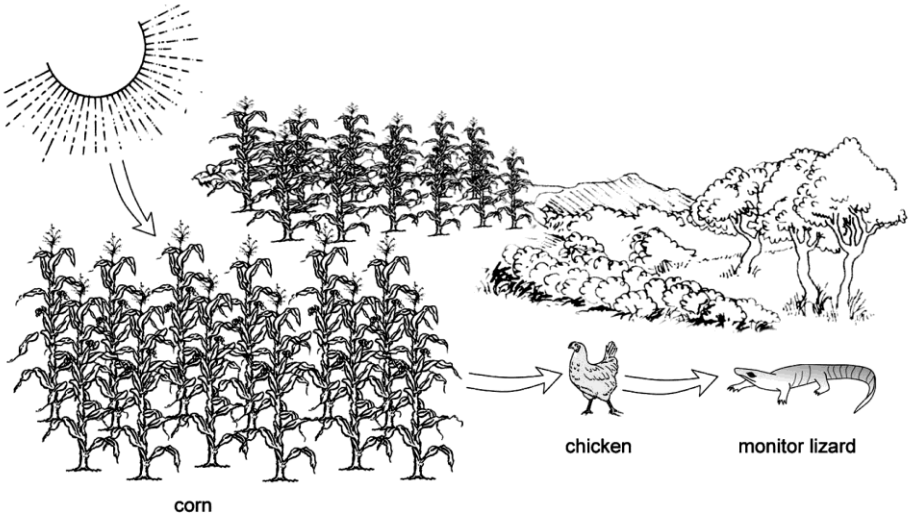
Q42. Construct a food chain using the organisms listed on the table above.

Answers to this question will depend on students' data.

Activity 4

What to do with food wastes?

Before the activity review the students about the food chain. A food chain only follows just one path as animals find food.



Food Chain

UNIT 3: Energy in Motion

Overview

The topics covered in Grade 7 deal with the relationship between motion and energy. At the end of the quarter, students should be able to realize that energy exists in different forms, energy transfers from one body to another, and that motion is the concrete manifestation that a body possesses energy.

Among the many forms of energy, *motion, heat*, *light*, *sound*, and *electrical* energy are the most common and most familiar among students. All these forms belong to kinetic energy; they are all associated with some kind of motion - the motion of waves, electrons, atoms, molecules, and objects.

In this grade level, the focus is on the sources of the different forms of energy and the different ways by which they are transferred from one place to another. Sound and light are introduced as forms of energy that are transferred by waves while heat is introduced as an energy that is transferred either by randomly moving particles, or by electromagnetic waves (radiation). Electrical energy is described as an energy that is transferred by moving electrical charges through a complete circuit.

Motion is considered to be the first topic because it is the most concrete manifestation of the abstract concept of energy. Besides, some of the concepts to be developed in this module will be useful in understanding the succeeding topics, like when students learn about the common characteristics of waves and when they relate these to the characteristics of sound and light waves.

The table below shows the general and specific topics covered in Grade 7:

Module Title	Specific Topics	Focus Questions
Motion	➢ Uniform Motion ➢ Accelerated Motion	– How do objects move?
Wave	➢ Types/Kinds of waves ➢ Common characteristics of waves	– How are waves classified? – What characteristics do waves have in common?
Sound	➢ Sources of sound ➢ Characteristics of sound	– How is sound produced? – How does sound propagate? – How do sounds differ from each other?
Light	➢ Sources of light ➢ Characteristics of light	– How is light produced? – How does light intensity vary

Module Title	Specific Topics	Focus Questions
	➢ How the eye sees color	with distance from the source? – How is color related to frequency and wavelength?
Heat	➢ Heat transfer ➢ Modes of heat transfer ➢ Conductors/insulators of heat	– When does heat transfer take place? – How does heat transfer take place?
Electricity	➢ Electrical charges ➢ Simple circuit	– How do charges behave? – How do charges carry energy?

Each topic or module contains three to five activities, mostly practical work activities, that provide students with opportunities to develop their thinking and manipulative skills. Teachers need to make sure that students are on the right track while performing the activities and are able to grasp the particular concepts involved.

Unit 3
MODULE

1

DESCRIBING MOTION

This module covers basic aspects of motion. Its aim is to enable the students to describe examples of motion along a straight line. Motion is defined as the change in position over an interval of time. Students will therefore describe motion in terms of the positions of the moving object at different points in time, or its distance travelled over a period, or its speed of travel. Furthermore, they will construct or analyze diagrams, graphs, or charts to describe whether an object is in motion or not, or moving with constant speed, or whether it is changing in speed or not.

In this module, the relevant concepts are introduced only at a basic, more conceptual and less mathematical level. But the students' understanding of these concepts will be enhanced when they continue to study about motion in the next grade levels or when they study other relevant topics in physics and in other areas.

Key questions for this module

When can we say that an object is in motion?

How do we describe the motion of an object?

This module contains four sections:

I-Where

- In this section, students will describe the position of an object with respect to a point of reference (or reference point).

Activity 1

Where is it?

- Prepare beforehand the instructions to be given to the students. The instructions should be vague to make it less helpful to the students. Examples are given below:
  a. It is right there.

b. Turn and it is there.
c. Walk slowly and you will get there.
d. It is from here to there.

- In this activity, students should be able to realize the importance of the point of reference (or reference point) and direction in describing the position of an object.
- Students may use the terms such as beside, above, below, left, right, in front of, or behind when describing the direction of an object from the reference point.
- During the processing, it should be emphasized that once the students have selected their point of reference, they can easily describe any change in the position of an object. In other words, they can easily tell whether an object is moving or not. At this point, the definition of motion, which is the change in position over time, can be introduced.

Sample answers to the questions

Q1. (Students are supposed to have a hard time in finding the object)
Q2. The instruction is not clear. There should be another object where we can refer to or compare the position of the object.
Q3. (This time, students should be able to find the object)
Q4. The distance of the object and its direction from the point of reference are included in the instruction.
Q5. A point of reference is something that seems steady that is used to compare the position of an object.
Q6. -10 m.
Q7. 5 m.
Q8. The dog is 25 meters to the left of the house
Q9. The tree is 15 meters to the right of the dog.
Q10. The initial position of the ball is at 0 m. Its final position is at 15 m.
Q11. 10 m.
Q12. 15 seconds
Q13. 7.5 meters
Q14. 12.5 seconds

Table 1

Time (sec)	Position of the ball
0	0
5	5
10	10
15	15

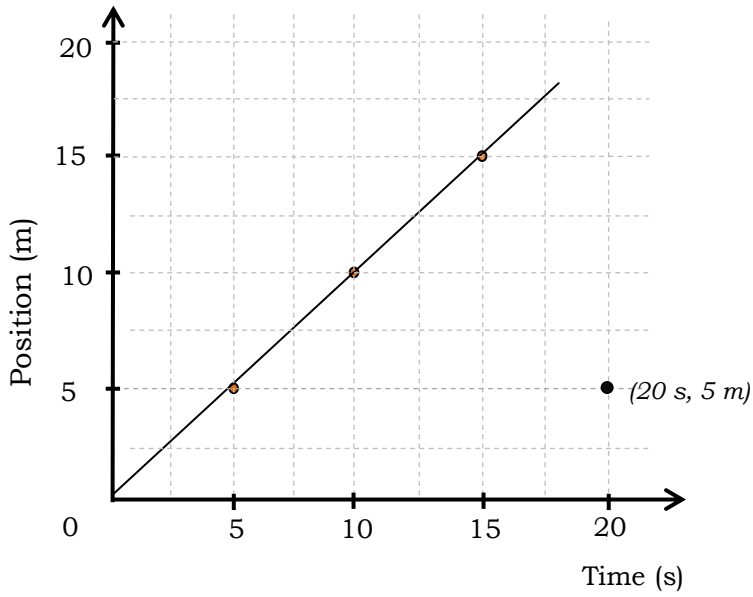


Figure 3

II-How far

- In this section, students will describe the motion of an object in terms of the distance it travelled. They will also differentiate distance from displacement.
- Since vector and scalar quantities are not yet introduced in the module, displacement will be defined as measurement of length plus direction while distance is defined as measurement of length only.
- The following questions are asked to test students' understanding of the difference between distance and displacement. Encourage the students to answer these questions or use them as points for discussion.
  - What have you noticed about the distance and the displacement in the given examples above?
    Displacement always follows a straight line. Distance does not always follow a straight line.
    Displacement measures the length of the straight line that connects the object's point of origin and its point of destination. Distance measures the length of the path travelled by the object.
  - When can displacement be equal to distance?
    When the path travelled is a straight line
  - Can displacement be greater than distance? Why?
    No, it can be shorter but it cannot be greater than the distance.
    Displacement is the shortest length between the object's point of origin and its point of destination.
  - What if the ball, the car, and the dog in the illustration go back to their starting positions, what will be their total distances? What will be their displacements?

Their total distances will increase two times (will double) but their displacements will become zero.

Activity 2 Home to school roadmap

- Allow students to work either in pairs or in small groups.
- In the absence of ruler, or meter stick, or any standard distance measuring instrument, ask students to design an alternative way to measure the distance. Check their design or device for precision.
- If the students live far from school, they can choose a nearer place as their starting point. Remind them to include in their maps the street names, reference points and precise measurements. Remind them also to stay safe while doing the activity outside the school.
- All answers to the questions depend on the students' data.

III-How fast?

- In this section, students will describe the motion of an object in terms of its speed. They will also differentiate speed from velocity (which is defined as speed plus direction) and average speed from instantaneous speed.

Activity 3 Fun Walk

- In this activity, students should be able to design ways to obtain the speed of each member of the group and decide how to use these values to determine who among them walks fastest.
- In the absence again of a standard instrument for measuring distance, students can use their previous design/device.
- Check their units of distance, time, and speed. If for example, they use meter for distance and minute for time, then their unit for speed must be meter/minute.

Sample answers to the questions

Q1. We measured the total distance travelled and time taken to travel the distance
Q2. We divided the distance travelled by the time of travel
Q3. The fastest participant was the one with the highest computed value of distance over time
Q4. The lesser the time of travel, the greater the speed of travel
Q5. The greater the distance travelled, the greater the speed of travel

Q6. They travelled with the same speed of 2m/s.

IV-How fast is the velocity changing?

- In this section, students will be introduced to the concept of acceleration.
- Since the students are dealing only with motion along a straight line, the concept of acceleration is introduced as due to the change in the speed of the moving object. During the discussion, it should be emphasized that acceleration may also be due to the change in the direction of the object. *Acceleration, by definition, is the change in velocity over a time interval,* and velocity as mentioned earlier is speed plus direction. So even if there is no change in speed but there is a change in direction, acceleration is achieved.

Activity 4

Doing detective work

- In this activity, students will analyze an example of motion wherein speed (or velocity) is changing by examining the record of the dots on a strip of paper.
- Prepare beforehand the paper strips containing dots. The dots should be arranged such that the distance between two successive dots increases uniformly, like the one shown in the module.
- However, each group can be also asked to work on a strip having different arrangement of dots. Some can be decreasing uniformly; others can be increasing or decreasing but not uniformly.
- During the discussion, emphasize *that any change in the velocity* of an object results in an acceleration. This includes change in speed (increasing speed or decreasing speed which is also called deceleration) or change in direction (although this is not discussed in the module). This is to correct the common conception among people that acceleration only refers to objects with increasing speed.

Sample answers to the questions

Q1. The distance between two successive dots increases uniformly.
Q2. The length of the strips of tape in the chart increases uniformly.
Q3. Each strip of tape provides the speed (or velocity) of the object every 1 second.
Q4. Because the length of the tape increases uniformly, it means that the speed (or velocity) of the object increases uniformly.
Q5. The change in length of the tape is constant. The change in speed is constant.
or
The length of the tape increases by the same amount in each time interval. The speed increases by the same amount in each time interval.
Q6. The object is moving with constant acceleration.
Q7. The graph is curved or parabolic.

Q8. The shape of the speed-time graph is different from the. It is a straight-line graph.
Q9. Similar to the answers in Q5 and Q6
Q10. If the arrangement of oil drops left by the car is similar to what we used in this activity, then the suspect was not telling the truth.

PRE/POST TEST

1. When is an object considered to be in motion?

I. When its position changes with respect to a point of reference.
II. When its distance changes with respect to a point of reference.
III. When its direction changes with respect to a point of reference.

A. I and II only
B. I and III only
C. II and III only
D. I, II, and III

For questions 2 and 3, refer to the table below. Data were obtained from a 200-meter dash competition.

Female Athlete	Recorded Time	Male Athlete	Recorded Time
1	26.5	1	22.4
2	26.1	2	21.9
3	25.3	3	23.0
4	26.7	4	22.6

2. Which of the following statements is/are true?

I. The male athletes are faster than the female athletes.
II. Compared to the speed of the fastest male athlete, the average speed of the fastest female athlete is slightly less.

A. I only
B. II only
C. Both I and II
D. Neither I nor II

3. How do you compute for the average speed of each athlete?

A. Multiply 200 meters by the recorded time of travel.
B. Divide 200 meters by the recorded time of travel.
C. Divide the recorded time of travel by 200 meters.
D. Divide 200 meters by twice the recorded time of travel.

4. Which of the following is true about an object that travels 5 meters to the left, then 2 meters up, then another 5 meters to the right?

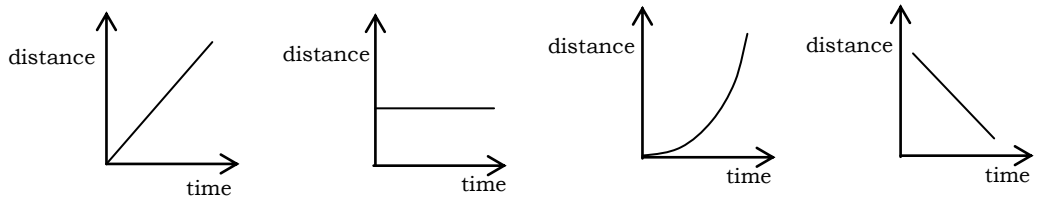
A. The displacement of the object is equal to 12 meters.
B. The total distance travelled by the object is equal to 12 meters.

C. The displacement of the object is equal to 12 meters down.
D. The total distance travelled by the object is equal to 12 meters down.

5. Which of the following statements is NOT true about the object moving with constant speed?

A. The object is not accelerating
B. The speed of the object is equal to zero.
C. The distance travelled by the object increases uniformly
D. The speed of the object remains the same all throughout the travel

6. Which of the following graphs shows that the object's motion is accelerating?



A B C D

Answer Key
1. D
2. C
3. B
4. B
5. B
6. C

Links and References

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Unit 3
MODULE

2

WAVES AROUND YOU

This module introduces the student to the study of waves and its properties. There is one warm-up activity and three principal activities designed to target key concepts about wave motion. While the lesson is generally activity-centered, the teacher must set off the lesson by facilitating the class to give examples of waves in the environment and to think about what these waves can do.

Importance of the Topics to Real Life

Sound waves, earthquake waves, waves on stretched strings, and water waves are all produced by some source of vibration. To explain many other phenomena in nature, it should be emphasized that it is important to understand concepts of wave motion.

For instance, since the Philippines is one of the countries which is a part of the Pacific Ring of Fire, it experiences frequent earthquakes due to the movements of tectonic plates or segments of the earth's crust. It is therefore important to understand how earthquake waves propagate and to know what actions are taken by scientists, particularly the geologists, to address the challenges brought by the geographical location of the Philippines.

Architects and engineers also consider concepts in wave motion in designing skyscrapers and bridges. Although these structures appear to be rigid, they actually vibrate and this fact must be taken into account in their construction.

Finally, to understand how radio and television work, concepts about the origin, nature and propagation of electromagnetic waves have to be examined.

Hints for the Teacher

1. Prepare the students for this lesson by giving a demonstration to serve as motivation.

   Demonstration Activity. Introduction to Vibrations

   1) Prepare a metal can with both lids removed.

2) Cut a rubber balloon cut and stretched it over one end of the can. Use a rubber band to hold the stretched balloon in place.
3) Put the can and its balloon end up on a table.
4) Put a small amount of salt on top of the balloon.
5) Ask a student volunteer to shout (not blow) at the can.
6) Tell the class to observe what happens to the salt. Also, invite them to place their fingers lightly on their throat while creating a sound.

Guide Questions

1. What two things are vibrating?
   (1) *The rubber balloon on the can and (2) the students' vocal cords in their throats*

2. What caused the salt to move?
   The salt is moved by the balloon's vibrations, which are ultimately caused by sound waves traveling through the air. These sound waves are generated by the vibration of the vocal chords in the throat. Tell the students they will study the details in the next activities and in a separate module on sound.

2. Do the warm up activity with the class and relate it with the demonstration activity. The demonstration and the warm-up activity aim to bring out the following pre-requisite concepts:

   (1) Waves are caused by a source of a vibration and
   (2) Waves can set objects into motion.

Guide Questions

1. What do you do when you wave your hand?
   Tell the students that they are essentially "vibrating" their hands by doing a repetitive back-and-forth or side-to-side movement with your fingers or your palm. (Encourage the students to demonstrate their personal hand waves.)

2. Think of a still lake. How would you generate water waves on the lake?
   Water waves can be generated by vibrating the surface of the water. Students can have various answers from their experiences. Tell them that the activities that they would perform will allow them to generate waves and to understand wave motion.

3. You may have to demonstrate to students how they can make periodic waves using the materials in the activities.

Objectives

After taking up this module, the students should be able to:

1. Infer that energy, like light and sound travel in the form of waves.
2. Explain how waves carry energy from one place to another.
3. Distinguish between transverse and longitudinal waves and mechanical and electromagnetic waves.
4. Create a model to demonstrate the relationship among frequency, wavelength, and wave speed.

Guide to Conducting the Principal Activities in the Module

The activities in the module are designed to be performed within the classroom. Each activity will take up one class period.

The following schedule of activities is suggested:

Session 1	Demonstration Activity Warm Up. What are waves? Activity 1. Let's Make Waves! Presentation of Group Output Discussion of the Answers to Activity 1
Session 2	Review of Key Concepts from Activity 1 Activity 2. Anatomy of a Wave Presentation of Group Output Discussion of the Answers to Activity 2
Session 3	Review of the Key Concepts from Activities 1 and 2 Activity 3. Mechanical vs. Electromagnetic Waves Discussion of the Answers to Activity 3 Summary of the Module Test Your Knowledge

Activity 1

Let's Make Waves!

What happens when waves pass by?

The students are given 30 minutes to perform the activity and to answer the questions in the activity sheet. After completing the activity, the teacher will facilitate a brief discussion of the findings.

It is best to choose three groups to present their findings on the different parts of the activity (i.e. one representative will show the work of their group on Part A only; representatives from other groups will talk about Part B and Part C respectively.)

The teacher will conclude the meeting by answering the summary part of the activity sheet with the class.

Answers to the Activity Sheet

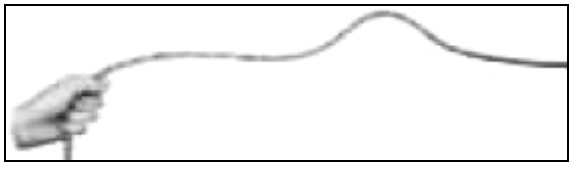
What are transverse waves?

1. Sketches showing the motion of a wave pulse at three subsequent instances (snapshots at three different times).

   Time 1

   Time 2

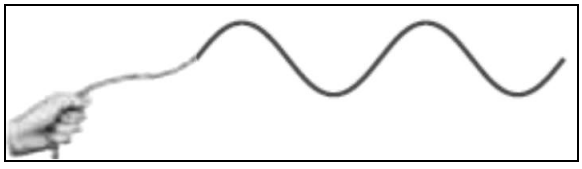
   

   Time 3

   a. What is the source of the wave pulse?
      A vibration due to a quick shake at one end of the rope
   b. Describe the motion of your hand as you create the pulse.
      A quick up and down movement
   c. Describe the motion of the pulse with respect to the source. *The pulse moved away from the source.*

2. [Sketch of the waveform or the shape of the wave created by the students.]

a. Does the wave transport the colored ribbon from its original position to the end of the rope?
No, it doesn't.
b. Describe the vibration of the colored ribbon. How does it move as waves pass by? Does it move in the same direction as the wave?
As the waves pass by, the colored ribbon moves up and down repetitively. It does not move in the same direction as the passing waves. Instead, it vibrates along the axis perpendicular to the direction of travel of the passing waves.

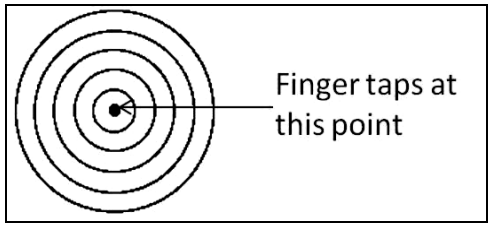
What are longitudinal waves?

1. Sketch of longitudinal waves in a coil spring.

2. [Observations on the colored ribbon tied to the coil spring.]
   a. Does the wave transport the colored ribbon from its original position to the end of the rope?
   No, it doesn't.
   b. Describe the vibration of the colored ribbon. How does it move as waves pass by?
   As the waves pass by, the colored ribbon moves back and forth repetitively. It vibrates along the axis parallel to the direction of travel of the passing waves.

What are surface waves?

1. [Sketch of the waves as seen from above the water basin.] The source of the disturbance should be marked.



2. [Observation on the paper boat.]
   a. Do the waves set the paper boat into motion? What is required to set an object into motion?
   Yes, the waves moved the paper boat. Energy is required to set and object into motion.
   b. If you exert more energy in creating periodic waves by tapping the surface with greater strength, how does this affect the movement of the paper boat?
   The wave carried more energy causing the paper boat to vibrate strongly.

3. [Observations on the figure showing water waves.]
   a. As shown in the figure, the passage of a wave across a surface of a body of water involves the motion of particles following a *circular* pattern about their original positions.
   b. Does the wave transport water molecules from the source of the vibration? Support your answer using the shown figure.
      No, the water molecules are not transported from the source of the vibration. The figure shows that the water particles merely move in circular orbits about their original positions as waves pass by.

Summary

1. Waves can be typified according to the direction of motion of the vibrating particles with respect to the direction in which the waves travel.

   a. Waves in a rope are called *transverse* waves because the individual segments of the rope vibrate *perpendicular* to the direction in which the waves travel.
   b. When each portion of a coil spring is alternatively compressed and extended, *longitudinal* waves are produced.
   c. Waves on the surface of a body of water are a combination of transverse and longitudinal waves. Each water molecule moves in a *circular* pattern as the waves pass by.

2. How do we know that waves carry energy?
   Waves can set other objects into motion.

3. What happens when waves pass by?
   Particles vibrate alternately to transport the energy of the wave.

Activity 2

Anatomy of a Wave

How can you describe waves?

The students are given 40 minutes to perform the activity and to answer the questions in the activity sheet. After completing the activity, the teacher will facilitate a brief discussion of the findings.

Before discussing the results of the activity to the class, it is useful to show a large image of a sinusoidal wave and ask the class to name the parts of the wave.

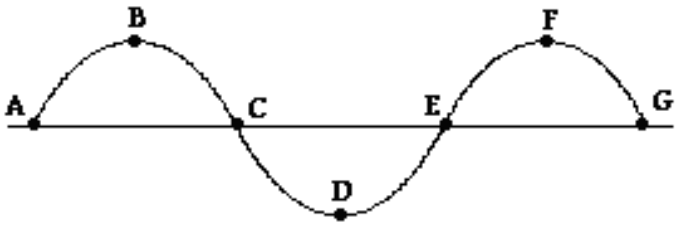
The activity has three parts so the groups may be asked to assign a different representative to discuss the result of their work to the class (i.e. those who have been chosen as presenters in Activity 1 should not be assigned again).

The teacher will conclude the meeting by answering the summary part of the activity sheet with the class.

Answers to the Activity Sheet

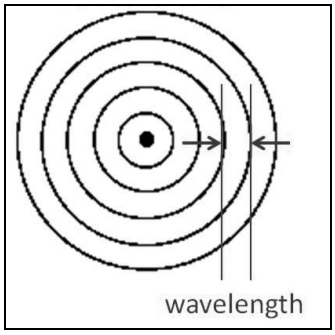
How can you measure the wavelength of a wave?

1. The **wavelength** of a wave refers to the distance between any successive identical parts of the wave. For instance, the distance from one crest to the next is equal to one full wavelength. In the following illustration, this is given by the interval B to F. Identify the other intervals that represent one full wavelength.



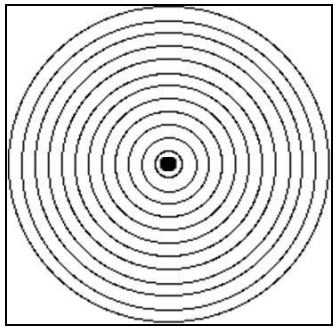
Intervals 1) A to E and 2) C to G

2. Sketch of the water waves as seen them from the above of the basin. One wavelength should be labeled in the drawing.



3. Increase the rate of the vibrations you create by tapping the surface of the water rapidly. What happens to the wavelength of the waves?
The wavelength becomes shorter.

[Sketch of the water waves as seen them from the top of the basin. Compared to the drawing in number 2, this one has shorter wavelengths.]



How can you measure the frequency of a wave?

1-3. Results are recorded in Table 1. Each group may have different answers.

Table 1. Frequency and period of the wave

Number of waves (N cycles) that passed by the ribbon in 10 seconds	**Frequency** of the waves (N cycles/10 seconds)	**Period** of the waves (seconds)
Example *15 cycles*	*15 cycles/10s = 1.5 Hz*	*1/1.5 Hz = 0.67 s*

4. If you increase the frequency of vibration by jerking the end of the rope at a faster rate, what happens to the wavelength?
The wavelength becomes shorter.

How can you measure the speed of a wave?

1-2a. Results are recorded in Table 2. Each group may have different answers.

Table 2. The speed of a wave

Estimated wavelength (meters)	**Number of waves** (N cycles) that passed by the ribbon in 10 seconds	**Frequency** of the waves (N cycles/10 seconds)	**Wave speed** (meter/second)
Example *0.5 m*	*15 cycles*	*15 cycles/10s = 1.5 Hz*	*(0.5m)*(1.5Hz) = 0.8 m/s*

Summary

1. What is the relationship between wave speed, wavelength and frequency? *They are related by the equation: wave speed = frequency x wavelength. The frequency of a wave is inversely proportional to the wavelength.*

2. Suppose you observed an anchored boat to rise and fall once every 4.0 seconds as waves whose crests are 25 meters apart pass by it.
   a. What is the frequency of the observed waves?
      The frequency of the waves is 0.25 Hz.
      Frequency = 1/period = 1/4.0 seconds = 0.25 Hz
   b. What is the speed of the waves?
      The speed of the waves is 6.3 m/s.
      Wave speed = (frequency)(wavelength) = (0.25 Hz)*(25 m) = 6.3 m/s*

Activity 3

Mechanical vs. Electrical Waves

How do waves propagate?

The students are given 30 minutes to perform the activity and to answer the questions in the activity sheet. After completing the activity, the teacher will facilitate a brief discussion of the findings.

Before discussing the results of the activity to the class, it is useful to show a set of large images of the mechanical waves, which the students were able to generate in Activity 1, and a chart of the electromagnetic spectrum which can be used by the students in answering the questions in the activity sheet. The class must be divided into small discussion groups until all of each group's members are able to complete the activity sheets. Proceed with the discussion of the answers to the class while keeping the small discussion groups intact. Before giving the correct answers, have each group announce their answers to the class.

The teacher will conclude the meeting by answering the summary part of the activity sheet with the class.

Answers to the Activity Sheet

What are mechanical waves?

1. [Identifying the **medium** of wave propagation for mechanical waves]
   a. In Activity 1 Part B, what is the medium of wave propagation?
      Coil spring
   b. In Activity 1 Part C, what is the medium of wave propagation?
      Water
2. [Characteristics of mechanical waves]
   a. How can you generate mechanical waves? *They can be generated by vibrating a medium. A medium is required because vibrating particles are needed for the wave to travel.*

3. [Application of the concept of mechanical waves to earthquakes]
   a. What do you think is the source of earthquake waves? *Earthquake waves are caused by a vibration due to colliding tectonic plates.*
   b. What is the medium of propagation of earthquake waves?
      The Earth

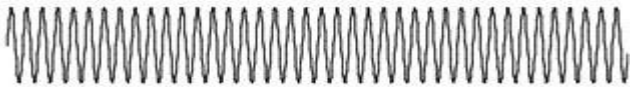
What are electromagnetic waves?

1. [Knowing the electromagnetic waves]
   1) Radio waves
   2) Microwaves
   3) Infrared waves
   4) Visible light
   5) Ultraviolet waves
   6) X-rays
   7) Gamma Rays

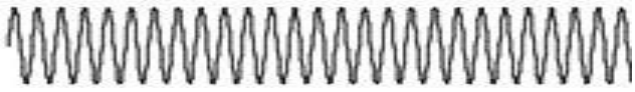
2. [Some characteristics of electromagnetic waves]

   a. Describe the relationship between frequency and wavelength of each electromagnetic wave.
      Among electromagnetic waves, the higher the frequency, the shorter the wavelength.
   b. Draw waves to represent each electromagnetic wave. Your illustrations must represent the wavelength of a wave relative to the others. For instance, gamma rays have a very small wavelength compared to the other waves in the spectrum.
      High energy electromagnetic waves have (*high*, low) frequency and (long, *short*) wavelengths.

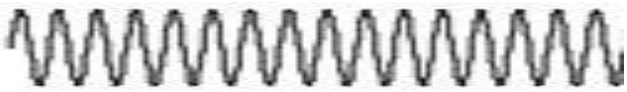
1. **Gamma Rays**



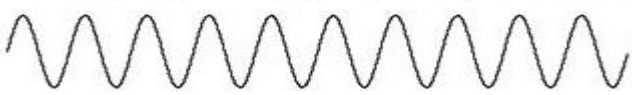
2. **X-rays**



3. **Ultraviolet Waves**



4. **Visible Light**

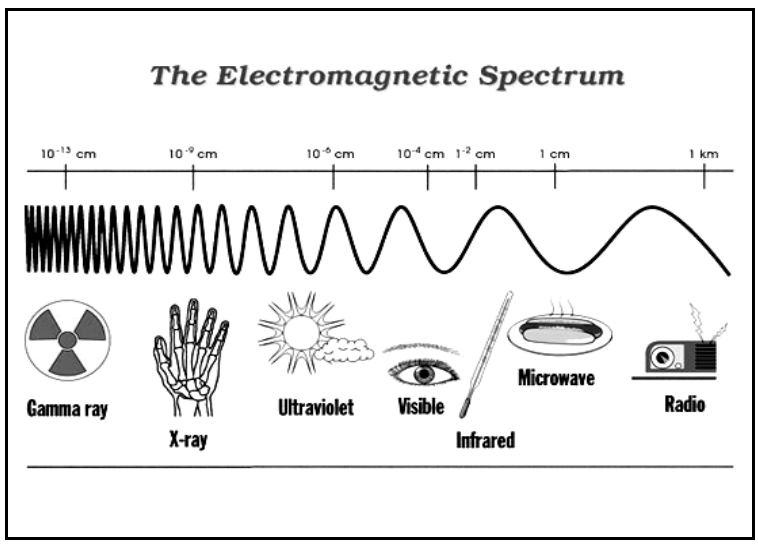


5. **Infrared Waves**

6. **Microwaves**

7. **Radio Waves**

The following image can also be used.



c. The Sun is an important source of ultraviolet (UV) waves, which is the main cause of sunburn. Sunscreen lotions are transparent to visible light but absorb most UV light. The higher a sunscreen's solar protection factor (SPF), the greater the percentage of UV light absorbed. Why are UV rays harmful to the skin compared to visible light?

   Compare the frequency and energy carried by UV waves to that of visible light.
   UV waves have higher energy and frequency compared to visible light.

Summary

1. Mechanical waves like sound, water waves, earthquake waves, and waves in a stretched string propagate through a *medium* while *electromagnetic* waves such as radio waves, visible light, and gamma rays, do not require a material medium for their passage.

Review. Waves Around You

The activities in the module are all about wave motion or the propagation of a pattern caused by a vibration. Waves transport energy from one place to another thus they can set objects into motion.

What happens when waves pass by?

Activity 1 introduced transverse waves, longitudinal waves, and surface waves. The students were able to observe the motion of a segment of the material through which the wave travels.

1. Transverse waves occur when the individual particles or segments of a medium vibrate from side to side perpendicular to the direction in which the waves travel.
2. Longitudinal waves occur when the individual particles of a medium vibrate back and forth in the direction in which the waves travel.
3. The motion of water molecules on the surface of deep water in which a wave is propagating is a combination of transverse and longitudinal displacements, with the result that molecules at the surface move in nearly circular paths. Each molecule is displaced both horizontally and vertically from its normal position.
4. While energy is transported by virtue of the moving pattern, it is important to remember that there is not net transport of matter in wave motion. The particles vibrate about a normal position and do not undergo a net motion.

How can you describe waves?

In Activity 2, the students encountered the important terms and quantities used to describe periodic waves.

1. The crest and trough refer to the highest point and lowest point of a wave pattern, respectively.
2. The amplitude of a wave is the maximum displacement of a particle of the medium on either side of its normal position when the wave passes.
3. The frequency of periodic waves is the number of waves that pass a particular point for every one second while the wavelength is the distance between adjacent crests or troughs.
4. The period is the time required for one complete wave to pass a particular point.
5. The speed of the wave refers to the distance the wave travels per unit time. It is related to the frequency of the wave and wavelength through the following equation:

$$wave\ speed = frequency\ x\ wavelength$$

How do waves propagate?

Finally, Activity 3 prompted the students to distinguish between mechanical and electromagnetic waves.

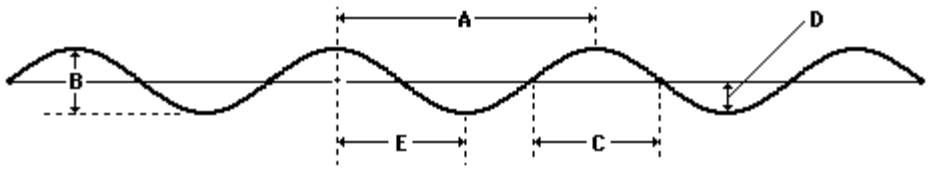
1. In mechanical waves, some physical medium is being disturbed for the wave to propagate. A wave traveling on a string would not exist without the string. Sound waves could not travel through air if there were no air molecules. With mechanical waves, what we interpret as a wave corresponds to the propagation of a disturbance through a medium.

2. On the other hand, electromagnetic waves do not require a medium to propagate; some examples of electromagnetic waves are visible light, radio waves, television signals, and x-rays.

PRE/POST TEST
(For Modules 2 to 4)

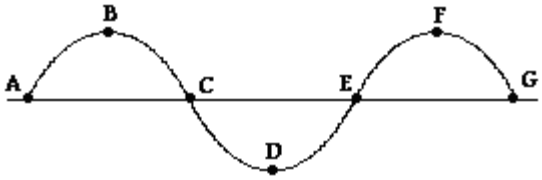
Part A: WAVES

Consider the diagram below to question 1 below



1. The amplitude of the wave in the diagram above is given by letter __.

2. Indicate the interval that represents a half wavelength.



   a. A to E
   b. B to F
   c. A to B
   d. C to E

3. Mechanical waves transport energy from one place to another through
   a. Alternately vibrating particles of the medium
   b. Particles traveling with the wave
   c. Vibrating particles and traveling particles
   d. None of the above

4. In a transverse wave, the individual particles of the medium
   a. move in circles
   b. move in ellipses
   c. move parallel to the direction of travel
   d. move perpendicular to the direction of travel

5. The higher the frequency of a wave,
   a. the lower its speed
   b. the shorter its wavelength
   c. the greater its amplitude
   d. the longer its period

6. Waves in a lake are 5.00 m in length and pass an anchored boat 1.25 s apart. The speed of the waves is
   a. 0.25 m/s
   b. 4.00 m/s
   c. 6.25 m/s
   d. impossible to find from the information given

7. Energy from the sun reaches the earth through
   a. ultraviolet waves
   b. infrared waves
   c. mechanical waves
   d. electromagnetic waves

Part B: SOUND

8. Which of the following objects will produce sound?
   a. soft objects
   b. radio stations
   c. vibrating objects
   d. objects under pressure

9. Which of the following best describes a high frequency sound? It has _____.
   a. low pitch
   b. high pitch
   c. low energy
   d. A and C

10. Compared to a thin string of the same length and tightness a thick string produces sounds of _____.
   a. the same pitch
   b. lower pitch
   c. higher pitch
   d. lower then higher pitch

11. A sound wave is a _____.
   a. longitudinal wave
   b. transverse wave
   c. standing wave
   d. shock wave

12. Which of the following is not capable of transmitting sound?
   a. air
   b. water
   c. steel
   d. a vacuum

13. Which of the following would most likely transmit sound best?
    a. Steel in cabinet
    b. Water in the ocean
    c. Air in your classroom
    d. Water in a swimming pool

Part C: LIGHT

1. Which of the following is **NOT** an electromagnetic wave?
    a. Infrared
    b. Radio
    c. Sound
    d. X ray

2. How does the wavelength of infrared (IR) compare with the wavelength of ultraviolet (UV) waves?
    a. Infrared waves have longer wavelength.
    b. Infrared waves have shorter wavelength.
    c. IR waves have the same wavelength as the UV waves.
    d. IR is not comparable in wavelength with the UV waves

3. Among all the electromagnetic waves (EM), which has the highest frequency?
    a. Infrared radiation
    b. Radio wave
    c. Ultraviolet
    d. Gamma rays

4. ROYGBIV is the basic component of white light. Which color of light carries the most energy?
    a. Blue
    b. Green
    c. Orange
    d. Red

5. Light is an electromagnetic wave. Which characteristic is common in all electromagnetic waves?
    a. amplitude
    b. frequency
    c. speed
    d. wavelength

Answer Key		
Part A	**Part B**	**Part C**
1. D	1.C	1.C
2. D	2.B	2.A
3. A	3.B	3.D
4. D	4.A	4.A
5. B	5.D	5.C
6. B	6.A	
7.D		

References and Web Links

[1] Anatomy of an electromagnetic wave. Available at: http://missionscience.nasa.gov/ems/02_anatomy.html
[2] Electromagnetic waves. Available at: http://www.colorado.edu/physics/2000/waves_particles/
[3] Hewitt, P. (2006). Conceptual Physics 10th Ed. USA: Pearson Addison-Wesley.
[4] The anatomy of a wave. Available at: http://www.physicsclassroom.com/class/waves/u10l2a.cfm
[5] The nature of a wave. Available at: http://www.physicsclassroom.com/class/waves/u10l1c.cfm

Unit 3
MODULE

3

SOUND

In this module the student will be able to explore the concept of sound. Specifically, students will be acquainted with (1) sound propagation, (2) characteristics of sound – pitch, loudness, and quality, and (3) types of sound according to quality – infrasonic, audible, & ultrasonic.

The developmental task for the students include being able to (1) demonstrate how sound is produced; (2) use the concepts of wavelength, velocity, and amplitude to describe characteristics of sound such as pitch, loudness and quality; (3) demonstrate changes in pitch and loudness using real or improvised musical instrument through fair testing; (4) explain sound production in the human voice box and how pitch, loudness and quality of sound vary from one person to another; (5) describe how organisms produce, transmit and receive sound of various frequencies (infrasonic, audible and ultrasonic sound); and (6) create harmonious music using indigenous products.

Probable Misconceptions

- Sound waves move with the medium.
- Sound can travel in vacuum.
- Sound travels fastest in gas.
- Pitch is dependent on period.

Teaching and Learning Strategies

Motivation

- The facilitator may start with elicitation of the different indigenous instruments in the locality used as musical apparatus. Ask them what particular local occasions are these used. Ask them how these instruments are played to derive from the students the concept of how sound waves are propagated.

Facilitating Learning

- Introduce activity 1 to arrive at the objectives: design a sounding box to explain and explore how sound is produced.

- Since activity 1 features not only concept attainment but also provides opportunities for learners who are artistically inclined to express their talents as well then this may be able to keep all students on task.
- Data processing may be done by group presentation and class discussion of the guide questions to probe the concept of sound propagation.
- Discussion should also be extended to cover media on which sound travel and speed of sound.
- Then introduce Activity 2: Characteristics and Properties of Sound. In this activity, the students will be able to use their sounding box to describe the characteristics of sound and compare their experimental results with that of the standard instrument (guitar).
- Data processing may be done by group presentation and class discussion of the guide questions to probe the how pitch is related to frequency.
- Extend the discussion to include types of sound (infrasonic, audible, and ultrasonic), the human ear, loudness and intensity.
- As a performance task, introduce Activity 3: Big Time Gig!. In this activity the students will be able to: (1) create musical instruments using indigenous products and (2) use these instruments to compose tunes and present in a Gig. Students may also utilize other indigenous musical instruments.
- In the quest to come up with a Gig students will be able to discover and apply the different characteristics and properties of sound. Further, they will also be able to utilize and showcase their talents through a presentation or rendition.
- Summary of the whole module may be probed by asking for insights and experiences they had during the preparation, presentation and post-presentation discussion of the rendition.

Description of Activities

- Activity 1: *My Own Sounding Box*
  (*Students will design a sounding box to explain and explore how sound is produced*)
- Activity 2: *Properties and Characteristics of Sound*
  (Using the Sound Box, students will describe the characteristics of sound through the concept of wavelength, velocity and amplitude)

- Activity 3: *Big Time Gig!!!*
  (Students will create musical instruments using indigenous products and use these instruments to compose tunes and present in a Gig. Students may also utilize other indigenous musical instruments)

Answers to Questions:

Activity 1 My Own Sounding Box

Q1. The elastic bands vibrate when plucked. Sound is produced by vibration of the elastic band.
Q2. The sound produced by each elastic band is different from the others. The thinker the band the louder the sound produced. The thicker the band, the lower the tone.
Q3. When the elastic bands are stretched then plucked, sound increases in pitch.
Q4. Highest note – thinnest, Lowest note - thickest

Activity 2 Properties and Characteristics of Sound

Q1. The rubber bands were vibrating when plucked. This resulted to produced sound. This means that sound is produced by vibration of the medium or material.
Q2. Yes. The sound produced by each elastic band is different from the others.
Q3. The thinker the band the louder the sound produced. The thicker the band the lower the tone.
Q4. To make a softer sound apply small force in plucking the rubber bands. To make a louder sound, apply greater force in plucking the rubber bands
Q5. Pitch is dependent on the thickness or thinness of the string and on the stretching of the elastics. Loudness and softness of sound, on the other hand, affected by the force exerted in plucking the elastics.
Q6. Yes.
Q7. Yes, the pitch is higher.
Q8. Shorter side – higher pitch; Longer side – lower pitch
Q9. Pitch of sound is affected by the thickness of the rubber band and the amount of stretch.
Q10. String No. 0
Q11. String No. 6
Q12. String No. 0
Q13. String No. 0
Q14. String No. 6
Q15. String No. 6
Q16. The higher the frequency, the higher the pitch.

Activity 3

Big Time Gig!!!

Big Time Gig!
Rubric Scoring

Task/ Criteria	4	3	2	1	Score
Improvised/ Localized musical instruments	• Makes use of local and indigenous materials • The improvised instruments are produce good quality sound comparable to standard musical instruments.	• Makes use of local materials only. • The improvised instruments produce good quality sound.	• Makes use of local materials only. • The improvised instruments produce fair quality sound.	• Makes use of local materials only. • The sound produced by the improvised instruments is not clear and distinct.	
Composition	The group's original composition has good melody and the lyrics provided are thematic and meaningful	The group's original composition has fair melody and the lyrics provided are thematic and meaningful	The group's original composition has fair melody and the lyrics provided are ***NOT*** thematic but meaningful	The group's original composition has fair melody and the lyrics provided are ***NEITHER*** thematic nor meaningful	
Performance	• The group was able to successfully use the improvised musical instruments in their GIG. • The group was able to provide good quality rendition or performance.	• The group was able to successfully use the improvised musical instruments in their GIG. • The group was able to provide fair rendition.	• The group was able to use the improvised musical instruments but some were out of tune • The group was able to provide fair rendition.	• The group was able to use the improvised musical instruments but MOST were out of tune • The group was able to provide fair rendition	
Cooperation and Team Work	Each one of them completed their task so as to come up with the expected output - GIG	3 out of 4 members completed their task so as to come up with the expected output - GIG	2 out of 4 completed their task so as to come up with the expected output - GIG	Only 1 out of the 4 members did his/her job	
				TOTAL	

Unit 3
MODULE

4

LIGHT

In this module the student will be able to explore the concept of light. Specifically, students will be acquainted with (1) light production and propagation, and (2) characteristics of light – intensity, brightness and color.

The developmental task for the students include being able to (1) Demonstrate how light produced by common sources differ in brightness; (2) Relate characteristics of light such as color and intensity to frequency and wavelength; (3) Design and implement an experiment that shows that light travels in a straight line; and (4) Investigate the relationship between light intensity and the distance from a light source through fair testing.

Probable Misconceptions

- Brightness is measurable.
- Brightness of light is only dependent on the distance from the light source.
- Parts of the electromagnetic spectrum have different speed as that of the visible light because these have different wavelength and frequency.
- Light bends even when travelling in a uniform medium.

Teaching and Learning Strategies

Motivation

- The facilitator may start with elicitation of the unique and indigenous light sources or lighting material in the locality aside from bubs and fluorescent lamps. Ask them to differentiate the different light sources from their place to arrive at the concept that there is variety of light sources.

Facilitating Learning

- Introduce Activity No. 1 to arrive at the objectives: (1) design a simple photometer (2) determine which chemical substances produce the brightest light; and (3) infer that brightness of light is dependent on the distance of the source.
- Since activity 1 features not only concept attainment but also provides opportunities for learners who are artistically inclined to express their talents as well then this may be able to keep all students on task.

- Data processing may be done by group presentation and class discussion of the guide questions to probe the concept of common light sources and how light is produced and propagated.
- Discussion should also be extended to cover differences and similarities of brightness and intensity.
- Introduce light as a wave, specifically as a major component of the Electromagnetic Theory of Light by James Clark Maxwell.
- Then introduce Activity No. 2: My Spectrum Wheel. In this activity the students will (1) design a spectrum wheel and (2) explore the characteristics of light such energy, frequency and wavelength.
- Data processing may be done by group presentation and class discussion of the data and results in tabular form and guide questions to the characteristics of electromagnetic spectrum.
- Extend the discussion to include dispersion as a special kind of refraction.
- Then introduce Activity No. 3: Colors of Light - Colors of Life!. In this activity the students should be able to (1) make a color spectrum wheel; (2) explore the characteristics of color lights; and (3) observe how primary colors combine to form other colors.
- Data processing may be done by group presentation and class discussion of the data and results in tabular form and guide questions to the characteristics of color spectrum.
- Extend the discussion to include dispersion as a special kind of refraction.
- As a performance task, introduce Activity No. 4: Lighting Up Straight!. In this activity the students will be able to: design an experiment given several materials to show that light travels in a straight line.
- In the quest to come up with a design, students will be able to discover and apply the different characteristics and properties of light.
- Summary of the whole module may be probed by asking for insights and experiences they had during the preparation, presentation and post-presentation discussion of their outputs.

Description of Activities

- Activity 1: Light Sources: Langis Kandila or Diwali Lights
  (*Students will explore the concept of common light sources and how light is produced by chemical substances*)
- Activity 2: *My Spectrum Wheel*
  (Students will design a spectrum wheel to explore the characteristics of electromagnetic spectrum such as intensity and relate these to frequency and wavelength)
- Activity 3*: Colors of light – color of life!*
  (Students will design a spectrum wheel to explore the characteristics of light such as color and intensity and relate these to frequency and wavelength)
- Activity 4: *Lighting Up Straight!*
  (Students will design n experiment given several materials to show that light travels in a straight line)

Answers to Questions:

Activity 1 — Light Sources: *Langis Kandila* or *Diwali Lights*

Q1. Sample Computation: *If both side of the wedge showed equal illumination when it is about 200 cm from 1, and 50 cm from 2, the distances are as 4 to 1. But as light falls off according to the square of the distance:* $(200)^2 = 40000$ *and* $(50)^2 = 2500$ *or 16 to 1.).* **Thus the candle-power of the lamp is 16.**

Q2. DL-LK1 (Canola Oil)

Q3. The farther the light source, the dimmer is the light and the lower the intensity

Activity 2 — My Spectrum Wheel

Q1. While the frequency increases, the wavelength decreases.

Q2. The product of frequency and wavelength for all spectrum regions is constant. This is equal to the speed of light in vacuum.

Q3. As the frequency is increased, the energy is also increased.

Activity 3 — Colors of Light – Colors of Life!

Q1. Violet – highest frequency, Violet – shortest wavelength

Q2. Red – lowest frequency, Red –longest wavelength

Q3. The wavelength decreases as the frequency is increased.

Q4. The product of frequency and wavelength in all color lights is constant and equal to the speed of light in vacuum.

Q5. The speed of all color light in air is constant and is equal to the speed of visible light.

Q6. White light separates in color light due to the process known as dispersion. As white light enters the air glass interface, different color light exhibit different refractive indices thus separates into the visible color lights.

Activity 4

Lighting Up Straight!

Lighting Up Straight!
Rubric Scoring

Task/ Criteria	4	3	2	1	Score
Experiment Procedure	• Steps are logically presented. • The procedure included about 5-6 steps. • All materials given to the group are utilized in the procedure	• Steps are logically presented. • The procedure included about 3-4 steps. • 75% of the materials given to the group are utilized in the procedure	• Steps are logically presented. • The procedure included about 3-4 steps. • 50% of the materials given to the group are utilized in the procedure	• Steps are logically presented. • The procedure included about 2-3 steps. • 25% of the materials given to the group are utilized in the procedure	
Result of Experiment Try-out/ Feasibility	The group has successfully attained the object to prove that light travels in a straight line using their designed procedure.	The group has attained the object to prove that light travels in a straight line using their designed procedure but there are some steps that are not very clear.	The group has partially attained the object to prove that light travels in a straight line using their designed procedure.	The group had some effort but was not able to attained the object to prove that light travels in a straight line using their designed.	
Cooperation and Team Work	Each one of them completed their task so as to come up with the expected output.	About 75% of the members completed their task so as to come up with the expected output.	About 50% of the members completed their task so as to come up with the expected output.	About 25% of the members did his/her job	
				TOTAL	

Unit 3
MODULE

5

HEAT

In the previous modules, students learned about sound and light as forms of energy that travel in waves. This time, they will study about heat which is another form of energy that travels through moving particles or through radiation. In the first activity, they will determine the condition needed for heat to transfer from one place to another and the direction by which it transfers. Then they will observe and compare the different modes of heat transfer and identify some factors that affect the transfer of heat. They will specifically investigate how the color of the surface of the material affects it ability to absorb or emit heat. Lastly, they will apply what they learned in the module to describe how each part of the thermos bottle helps in keeping its content hot or cold for a longer period of time.

The lessons covered in Module 5 are relevant to life because they help explain some of our everyday experiences with heat. Also, some of the lessons covered in this module will be picked up in the next quarter when students learn about “weather and climate”.

Key questions for this module

How is heat transferred between objects or places?

Do all objects equally conduct, absorb, or emit heat?

Heat and Thermal Energy

- At the start, students may be asked to give their own ideas about heat, based on what they learned in the lower grades or based on their everyday experiences with heat. Be aware of their misconceptions and take note of those which can be addressed by the module, like *cold is associated with lack of heat* or *heat is a substance that is in the object that makes the object warm.* Make sure to go back to them during the processing, wherever applicable.
- The difference between heat and thermal energy should be made clear to the students.

Heat is a form of energy that refers to the thermal energy that is in the process of being transferred, say between objects due to the difference in their temperature. In other words, heat is energy "in transit". It transfers from an object of higher temperature to an object of lower temperature.

Activity 1

Warm me up, cool me down

- In this activity, students will analyze changes in the temperature of the water inside the containers to answer the following questions:
  a) What is the condition needed for heat transfer to occur between the containers?
  b) In which direction does heat transfer between them?
  c) Until when will heat transfer continue to occur?
- Since students will gather data using the thermometers, make sure that they know how to use the device properly and measure temperature accurately. If needed, give them a detailed review of how to use the thermometer and take data from it. Aside from the tips on how to measure temperature accurately, the following points may also be emphasized:
  a) Handle the thermometer with care to prevent breaking.
  b) Do not hold the thermometer by its *bulb* (the lower end of the tube)
  c) Do not 'shake down' the thermometer to reset it.
  d) Do not use the thermometer to stir the water inside the containers.
  e) Do not allow the thermometer to touch the bottom of the container.
- Each group should be provided with 4 thermometers – one for each container. If ever they have only one or two thermometers, they should be advised to consider one setup at a time.
- In the absence of a laboratory thermometer, students may use their 'sense of touch' to determine the relative hotness or coldness of the water inside the containers. Just make sure that if they do, they dip their fingers with care and use a different finger for each container. Students may be allowed to perform the activity provided in the module to show them how sense of touch may give different result in their activity.

Sample data:

Table 1

Container		Temperature (°C) of Water After					
		0 min (initial)	2 mins	4 mins	6 mins	8 mins	10 mins
Setup 1	**1**-*Tap water*						
	A-*Tap water*						

Container		Temperature (°C) of Water After					
		0 min (initial)	2 mins	4 mins	6 mins	8 mins	10 mins
Setup 2	**2**-*Tap water*						
	B-*Hot water*						

* This slight increase in temperature could be due to the warmer surrounding

Answers to the questions:

Q1. *Setup 2. Setup 1*
Q2. *Setup 2.*
Q3. *For heat transfer to take place, the objects must be of different temperature.*
Q4. *Container B. Its temperature decreases after 2 minutes.*
Q5. *Container 2. Its temperature increases after 2 minutes.*
Q6.
- *Heat is transferred from Container B to container 2.*
- *Heat is transferred from object of higher temperature to an object of lower temperature.*
- *Heat is transferred from a warmer object to a cooler object.*

Q7. *In container 2, the temperature of water continuously increases while the temperature of water in container B continuously decreases. Heat transfer is continuously taking place between the containers.*
Q8. *Heat transfer will continue to take place until both objects reach the same temperature (just like in Setup1)*
Q9. *The blue line shows that the temperature decreases as time increases. This represents Container B (with higher initial temperature).*
Q10. *The red line shows that the temperature increases as time increases. This represents Container 2 (with lower initial temperature)*
Q11. *The broken line shows that container 2 and container B have already the same temperature and their temperature is still decreasing as time continues. This time, heat transfer is taking place between the container and the surrounding.*

- At this point, it is important to emphasize that heat transfer will continue to occur as long as there is a temperature difference.

Methods of Heat Transfer
Heat transfer by Conduction

Conduction takes place when the particles between objects or places that are in contact vibrate and collide at different speeds due to the difference in their temperature. The particles at a higher temperature are more energetic and thus vibrate faster than the particles at the lower temperature. When these particles collide, some of the energy from the more energetic particles is transferred to the less energetic particles, in the form of heat.

Heat transfer occurs not only in solids but also in fluids, but not all conduct heat equally. Some materials conduct heat easily; other materials conduct heat poorly. Objects that conduct heat poorly, like wood are particularly called *insulators*. There is no particular name for those materials which conduct heat easily.

One basis for determining the use of materials is by their ability to conduct heat, known as their **conductivity**. Higher conductivity means that the material is a good conductor of heat. As shown in the table below, most metals have higher conductivities; they are good conductors of heat. That's why they are generally used for products that require better heat conductivity like cooking utensils.

Table 2: List of thermal conductivities of common materials

Material	Conductivity W/(m·K)	Material	Conductivity W/(m·K)
Silver	429	Concrete	1.1
Copper	401	Water at 20°C	0.6
Gold	318	Rubber	0.16
Aluminum	237	Polypropylene plastic	0.25
Ice	2	Wood	0.04 - 0.4
Glass, ordinary	1.7	Air at 0°C	0.025

* Watt (W) is the unit of power where 1 watt is equal to 1 joule per second. 1 joule is equal to 0.24 calories.

Activity 2 Which feels colder?

* This activity is adapted from the book of Harry Sootin, entitled "Experiments with Heat"

- Motivate the students by asking them to touch or feel some objects found inside the classroom, like the metal bars or grills, the curtains, glass windows, the floor, the wooden chairs. Then ask some volunteers to share their observations to the class. Let them also try to explain their observations. Be aware of the misconceptions that students may give, such as the following:
  a) The objects have different temperatures.
  b) Some objects contain greater amount of heat than others.
  c) Some objects are naturally cooler than others.

  If ever, make sure to go back to these during the post activity discussion for clarifications.

- The first part of the activity must be done at home or in school one day ahead. In case there is no available refrigerator, students may just bring cooler with ice

cubes inside the classroom where they can place their thermometer and samples before the day ends.

- For the second part of the activity, make sure that the students read the temperature from the thermometer or touch their sample objects while these are still inside the freezer (cooler). Bringing them out may affect the result of their experiment, especially if the materials are already out for long. Also, make sure that the students feel each sample with a different finger. Lastly, make sure that each student will touch all the samples to determine their relative coldness. (Do not compare the coldness of an object with another object that is examined by another student) They can just compare their conclusions and answers to the questions with the other members of the group once they are done examining all their samples.
- During the discussion, emphasize that different objects or materials conduct heat differently. And this explains why even if they are of the same temperature, they do not feel (cold) equally. Materials with higher conductivities feel cooler than those with lower conductivities because they allow more energy to be transferred from the (warmer) finger than those with lower conductivities.

Answers to the questions:

Q1. *Answer will depend on their reading from the thermometer.*
Q2. *The temperature of the objects inside the freezer must all be the same because they are just exposed to the same condition. Their temperature must also be equal to the temperature that was read from the thermometer.*
Q3. *Yes. When my finger got in contact with the object, heat was trasferred from my finger to it.*
Q4. *Yes. Because my finger loses some amount of thermal energy (heat), so that makes me feel the object cold.*
Q5. *No, the objects did not feel equally cold. This means that the objects conduct heat differently. Some objects conduct heat more easily than the others.*
Q6. *Answers depend on the objects or materials used.*
Q7. *Answers depend on the objects or materials used. The coolest should be the best conductor.*

Heat Transfer by Convection

Heat transfer by conduction can take place in solids and in fluids. **Convection**, on the other hand, takes place only in fluids because it involves the movement of particles themselves from one place to another.

In the module, heat from the bottom part of the water is transferred to the upper part through convection. As the water gets warmer, it expands and become lighter and so it rises at the top of the cooler water. This will then be replaced by the cooler water that goes down from above, which will in turn become warmer and also will rise to the top.

Activity 3

Move me up

- Refer the students back to the conductivity table. Then ask them this question: *Is water a good conductor of heat*? When they say no, ask them again: *Then why is it that when we heat the bottom of the pan containing water, the entire water evenly gets hot so quickly?* Allow students to give their answers/opinions. Be aware of their misconceptions and make sure to go back to these during the post activity discussion. These may include be the following:
  a) The particles of the water travel faster than the particles of the solids.
  b) Heat is distributed so fast throughout the water (without mentioning how).
- Prepare the hot water prior to the activity. If available, better use an electric thermal pot for convenience. Remind the students to take extra care when pouring hot water into their containers.
- In the absence of liquid food coloring, students can use the 'water color' that they use for their arts activities. Make sure that the colored water is much cooler than the tap water.
- Remind the students not to bump the table nor shake the containers while doing the activity.
- The third and fourth steps are very crucial. Make sure that students follow them accordingly and very carefully.
- During the discussion, emphasize that following

  - This module considers convection in water only. Convection does not only take place in liquids. It also takes place in gases, like air. This will be discussed when they study about weather and climate in Earth Science.

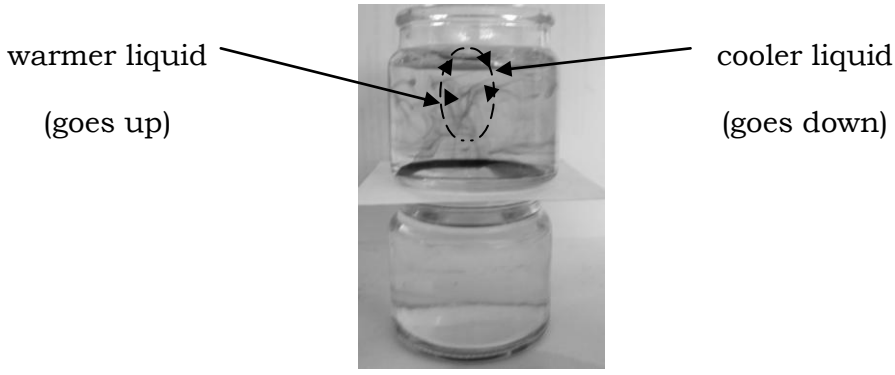
Sample answers to the questions:

Q1. *Most of the colored liquid stayed at the bottom (a small amount mixed immediately with the water).*

Q2. *When the container was placed on top of the other container with hot water, the liquid (water and food coloring) at the bottom rises slowly to the top.*

Q3. *Yes. Heat is transferred by the heated liquid that moved from the bottom to the top.*

- You can extend the discussion by asking the students to describe what happens to the cooler liquid on top.
- You can use the illustration below to discuss about **convection current**.



Q4. *Yes. The food coloring itself goes up.*
Q5. *Convection is a method by which heat is transferred through the liquid (or gas) by the movement of its particles.*
Q6. *(Students can be asked to try out this part).*

Heat Transfer by Radiation

Radiation refers to the emission of electromagnetic waves which carry energy away from the surface of the emitting body or object. In this process, no particles are involved, unlike in the processes of conduction and convection. This is why radiation can take place even in vacuum.

All objects emit and absorb radiation, known as thermal or infrared radiation. The amount of radiation emitted depends on the temperature of the emitting object. The hotter an object is, the more infrared radiation it emits.

Heat transfer by radiation takes place between objects of different temperatures, when the hotter object emits more energy than it absorbs from the cooler object and the cooler object receives more energy than it emits.

Activity 4

Keep it cold

- This is an unstructured type of activity wherein will be the one to design their own experiment based on the given situation. They will construct their own problem, write their own procedure, and gather and analyze their data to arrive at an answer to the problem.
- Not all surfaces absorb or reflect radiation equally. Some surfaces reflect or absorb radiation better than others. The aim of this activity is to enable the

students to compare the abilities of the two different surfaces to absorb or reflect radiation from the Sun or from a lighted electric bulb.

- To motivate the students, ask them of their favourite cold drinks. Then ask them how they usually make their drinks inside the container stay cold longer.

Prediction

At this point, there is no need yet to check whether their predictions are right or wrong. They should find out themselves later when they do their investigation.

Sample Design

- Testable Question: *Which container will keep the temperature of the cold milk tea longer?*

- Independent variable: *The surface of the container (dull and black surface or bright and shiny surface).*

- Controlled Variables: *The amount of the liquid, the amount of light entering the container (degree of exposure)*

- Dependent variables: *The temperature of the liquid inside the container at equal intervals of time*

Sample Answers to the Questions

Q1. *Dull black container*
Q2. *Dull black container*
Q3. *Bright shiny container*
Q4. *No.*

Activity
5

All at once

These last two tasks are applications of what the students learned so far from this module.

Task 1: What's For Dinner?

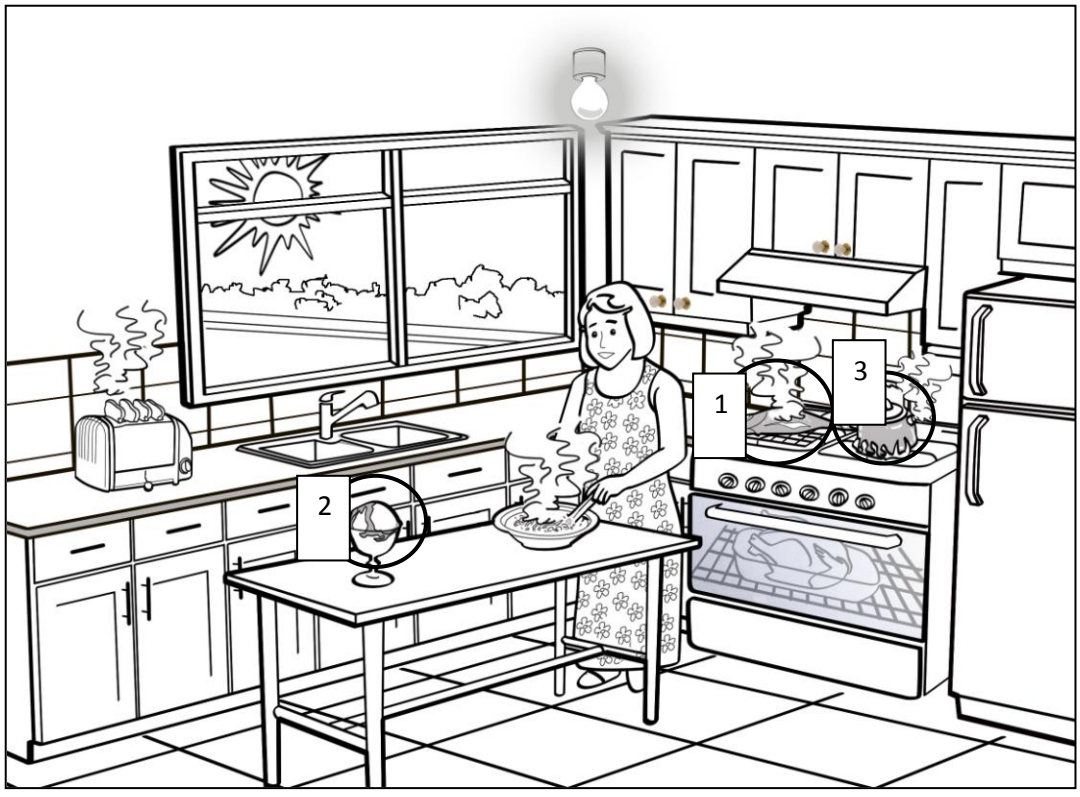


Figure 6

Sample answers

	Description	*Which object gives off heat?*	*Which object receives heat?*	*What is the method of heat transfer?*
1	broiling fish	flame	fish	conduction/ convection
2	melting ice cream	sun	Ice cream	radiation

	Description	Which object gives off heat?	Which object receives heat?	What is the method of heat transfer?
3	steam coming out of the kettle (with boiling water)	boiling water	Air above	convection

Task 2
(Adapted from: http://1e1science.files.wordpress.com/2009/08/13.pdf)

Below is a diagram showing the basic parts of the thermos bottle. Examine the parts and the different materials used. Explain how these help to keep the liquid inside either hot or cold for a longer period of time. Explain also how the methods of heat transfer are affected by each material.

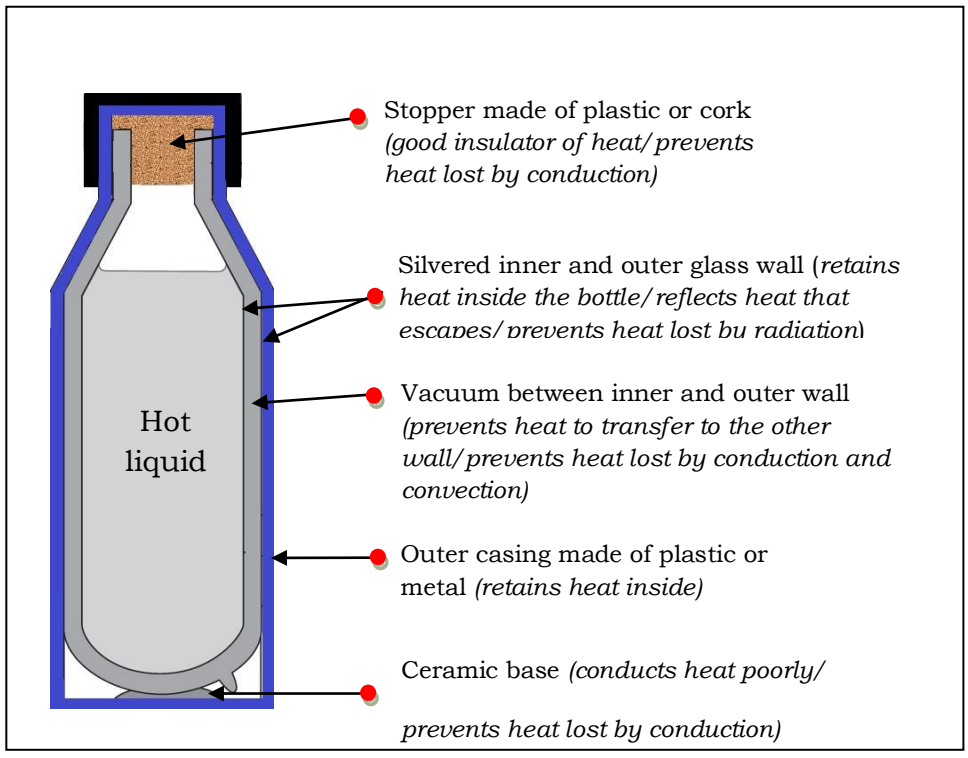


Figure 7: Parts of a thermos bottle

Summary

Below is a list of concepts or ideas developed in this module.

- Heat is a thermal energy that is in transit.
- Heat transfer takes place between objects of different temperature.
- When the object becomes warmer, it means that it gained energy. When it becomes cooler, it means that it lost energy.
- Heat energy always transfers from object of higher temperature to object of lower temperature.
- Heat can be transferred in three ways: conduction, convection, and radiation.
- Conduction takes place due to the vibrating and colliding particles of objects that are in contact. It can take place in solids, liquids, and gases but it takes place best in solids.
- Conductivity refers to the ability of the material to conduct heat. The higher the conductivity of the object, the better it conducts heat.
- Metals are mostly good conductors of heat.
- Convection takes place in fluids because their particles can move around. In convection, the heat is transferred by the particles themselves.
- During convection, warmer liquid or gas expands and goes up while cooler liquid or gas moves down.
- Heat transfer by radiation does not need particles or a medium to take place.
- Different surfaces emit or absorb heat differently. Dull and black surfaces absorb heat better than bright and shiny surfaces.

PRE/POST TEST

The illustration on the right shows a lady making a noodle soup using a pan made of metal. Use this illustration to answer the questions below:

1. How does heat travel through the pan?
   A. by radiation C. by dispersion
   B. by convection D. by conduction

2. How does heat travel through the soup?
   A. by radiation C. by dispersion
   B. by convection D. by conduction

3. In what direction does heat travel through the soup?
   A. from top to bottom C. both A and B
   B. from bottom to top D. neither A nor B

4. Which of the following explains why the lady is able to hold the handle of the pan with her bare hands?

   I. The handle is made of good insulator of heat.
   II. The handle has low thermal conductivity.
   III. The handle has high thermal expansion.

A. I and II only
B. I and III only
C. II and III only
D. I, II, and III

5. Which of the following methods of heat transfer is NOT taking place in the given situation?

A. Conduction
B. Convection
C. Radiation
D. None of them

Answer Key
1. D
2. B
3. B
4. A
5. D

Links and References

Classroom Clipart. "Marine Life." [Online image] 23 October 2003. http://classroomclipart.com/cgi-bin/kids/imageFolio.cgi?direct=Animals/Marine_Life

http://coolcosmos.ipac.caltech.edu/cosmic_classroom/light_lessons/thermal/transfer.html

Unit 3
MODULE

6

ELECTRICITY

In Module 5, students learned about heat as a form of energy that can be transferred through conduction, convection and radiation. They identified the conditions that are necessary for these processes to occur and performed activities that allowed them to investigate the different modes of heat transfer.

Here, students will learn about another form of energy which is encountered in everyday life, electricity. This is a familiar form of energy since it is the energy required to operate appliances, gadgets, and machines, to name a few. Aside from these manmade devices, the ever-present nature of electricity is demonstrated by lightning and the motion of living organisms which is made possible by electrical signals sent between cells. However, in spite of the familiar existence of electricity, many people do not know that it actually originates from the motion of charges.

In this module, students will learn about the different types of charges and perform activities that will demonstrate how objects can be charged in different ways. They will also learn the importance of grounding and the use of lightning rods. At the end of the module students will do an activity that will introduce them to simple electric circuits.

Key questions for this module

What are the different types of charges?

How can objects be charged?

What is the purpose of grounding?

How do lighting rods work?

What constitutes a complete electrical circuit?

Activity 1

Charged interactions

- Tell the students to follow the procedure described below. Take note that discharging will occur once the sticky side of the tape comes into contact with other objects. This will make it difficult for the students to perform the succeeding parts of this activity.

Sample answers

1. Is there any sign of interaction between the tape and the finger?
   The students will observe that the tape will be attracted to the finger.

2. Is there any sign of interaction between the tape and this object?
   Once again, students will observe an attraction between the tape and the object.

3. Do you observe any interaction?
   The charged tapes will tend to push each other away, i.e. they are repelling each other.

4. Drag a moistened sponge across the nonsticky side of the tapes and repeat steps 5, 6 and 8. Do you still observe any interaction?
   Interactions observed earlier will be greatly reduced or will be non-existent.

Discussion for Activity 1

Ask students to recall what they learned from previous modules about the composition of matter. Emphasize that different materials have varying atomic composition and lead them to the idea that this gives the materials different electrical properties. One of which is the ability of a material to lose or gain electrons when they come into contact with a different material through friction.

Discuss how the tape acquired a net charge when the tape was pulled vigorously from the table in activity 1. Explain that the electrons from the table's surface were transferred to the tape and lead them to the difference between the two types of charges, positive and negative. Then proceed to the description of **charging by friction**.

Through the activity you can also introduce the law of conservation of charge to the students by explaining that the negative charge acquired by the tape is equal to the positive charge left on the table.

The Law of Conservation of Charge
Charges cannot be created nor destroyed, but can be transferred from one material to another.
The total charge in a system must remain constant.

Ask students to describe the interactions they observed in the activity. You may then introduce the concept of **electric force** which acts on charges. Explain that an uncharged or **neutral** object cannot experience this force.

Let students differentiate between the interactions they observed in the activity. This will lead them to identify the two kinds of electric forces, **repulsive** and **attractive**. Then you may discuss the electrostatic law:

Electrostatic Law
Like charges repel and unlike charges attract.

Restate that electrical forces do not act on neutral objects. Then ask students to explain how the neutral objects and the finger which did not acquire an extra charge during the activity was able to interact with the charged tape. This will lead to the concept of **polarization** which can be explained by the electrostatic law. When a neutral object is placed near a charged object, the charges within the neutral object are rearranged such that the charged object attracts the opposite charges within the neutral object. The phenomenon is illustrated in Figure 3.

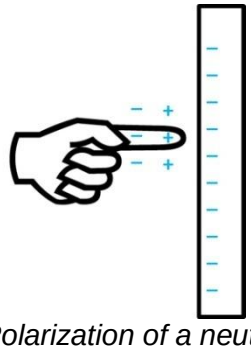


Figure 3. Polarization of a neutral object.

Let students recall what happened to the interactions after dragging a moistened sponge on the surface of the tape. They will have noticed that the interactions were gone or were greatly reduced. Ask them for possible explanations then lead them to the concept of **discharging** which is the process of removing excess charges on an object. You may then discuss **grounding** which occurs when discharging is done by means of providing a path between the charged object and a **ground**. Define the term ground as any object that can serve as an “unlimited” source of electrons so that it will be capable of removing or transferring electrons from or to a charged object in order to neutralize that object.

Conclude the discussion for the activity by asking students to explain how grounding is important for electrical devices and equipment.

Activity 2

To charge or not to charge

- Tell the students to follow the procedure accordingly. Take note that charging the balloon by rubbing it against the hair will only work when the hair is completely dry. If the hair is slightly wet, the water will prevent the transfer of electrons between the balloon and the hair.

Sample answers

Q1. *The hair will give up electrons thus the balloon will acquire a negative charge.*
Q2. *Polarization occurred in step 3. When the charged balloon was placed near the neutral soft drink can, the charges in the can were rearranged in such a way that the negative charges migrated towards the edge of the can that was farther from the balloon.*
Q3. By touching the can, a path was provided for the charges to be transferred. This is an example of grounding.
Q4. *Ideally, the soft drink can will be charged. The hand provided a path for negative charges to move away from the can thus when the hand was removed the can was left with a net charge.*
Q5. *The soft drink can has acquired a net positive charge.*

Discussion for Activity 2

Discuss the difference between conductors and insulators and let students enumerate different examples of each. Ask them to identify which materials in activity 2 are conductors and which are insulators.

Let students describe how the can was charged and introduce the process of **charging by induction**, where an object can be charged without actual contact to any other charged object.

In the next activity the students will investigate another method of charging which depends on the conductivity of the materials.

Activity 3

Pass the charge

Sample answers

Q1. Ideally, the can in the second set up will be charged since excess charges has been transferred to it from the can in the first set up.

Q2. *The contact between the cans is necessary since it is this contact that has provided a path for the charges to be transferred. This is possible because both cans are good electrical conductors.*

Q3. *The can in the second set up has acquired a net positive charge.*

Discussion for Activity 3

The charging process performed by students in Activity 3 is called **charging by conduction** which involves the contact of a charged object to a neutral object. By this time, students have already learned the three types of charging processes. In the next activity they will investigate how lightning occurs, a natural phenomenon which is essentially a result of electrical charging.

Activity 4

When lighting strikes

Ask students to use reference books or the internet to answer the following questions. Remind students to check the reliability of internet sources before using its content.

- What is a lightning?
- Where does a lightning originate?
- How 'powerful' is a lightning bolt?
- Can lightning's energy be caught stored, and used?
- How many people are killed by lightning per year?
- What can you do to prevent yourself from being struck by lightning?
- Some people have been hit by lightning many times. Why have they survived?
- How many bushfires are started by lightning strikes?
- 'Lightning never strikes twice in the same place.' Is this a myth or a fact?
- What are lightning rods? How do they function?

Discussion for Activity 4

After performing activity 5, students will be aware how much energy is involved when lightnings strike. Lead them to the idea that no matter how much

energy is available, if it cannot be controlled, it will be hard for us to use it. This will naturally lead to this question: How do we control electricity? It starts by providing a path through which charges can flow. This path is provided by an **electric circuit**. Students will investigate the necessary conditions for an electric circuit to function in the following activity.

Activity 5

Let there be light!

- Ask students to follow the following procedures. Remind them that handling electrical units should be done with extra care especially when it involves actual circuits.
  1. Work with a partner and discover the appropriate arrangements of wires, a battery and a bulb that will make the bulb light.
  2. Once you are successful in the arrangement, draw a diagram representing your circuit.
  3. Compare your output with other pairs that are successful in their arrangement.

Sample answers

Q1. *Answers will vary depending on student output.*
Q2. *Answers will vary depending on student output.*
Q3. *For the bulb to light, the circuit should be closed and must include all the necessary parts (wire, battery, and bulb).*

Discussion for Activity 5

In activity 5, students have seen that with appropriate materials and connections, they can make the bulb light up. Remind them that light is one form of energy. Ask them to recall the law of conservation of energy then lead them to the idea that energy transfer or transformation has occurred in the circuit from electrical energy to light energy. Explain that all electrical equipment and devices are based on this process of transformation, where electrical energy is converted other forms of energy. Prove this point by giving these examples:

1. Flat iron – Electrical energy to thermal energy or heat
2. Electric fan – Electrical energy to mechanical energy
3. Washing machine – electrical energy to mechanical energy.

You may then ask them to give their own examples.

PRE/POST TEST

9. What will happen when two like charges are brought together?

   A. They will repel each other.
   B. They will attract each other.
   C. They will neutralize each other.
   D. They will have no effect on each other.

10. Which of the following describes the usual way by which a material can gain a positive charge?

   A. By gaining protons
   B. By gaining electrons
   C. By losing protons
   D. By losing electrons

11. If you comb your hair and the comb becomes positively charged, what will happen to your hair?

   A. It will remain uncharged.
   B. It will be repelled by the comb.
   C. It will become positively charged.
   D. It will become negatively charged.

12. Which of the following can be attracted by a positively charged object?

   A. Another positively charged object.
   B. Any other object.
   C. A neutral object.
   D. No other object.

13. A negatively charged rod is brought near a metal can that rests on a wooden box. You touch the opposite side of the can momentarily with your finger. If you remove your finger before removing the rod, what will happen to the can?

   A. It will be discharged.
   B. Its charge will remain as it was.
   C. It will become positively charged.
   D. It will become negatively charged.

14. Is it possible to charge an electrical insulator?

   A. No, because they hinder charges from passing through them.
   B. No, because insulators have no free charges in them.
   C. Yes, because they can also conduct electricity.
   D. Yes, because electrons can be transferred between insulators through friction.

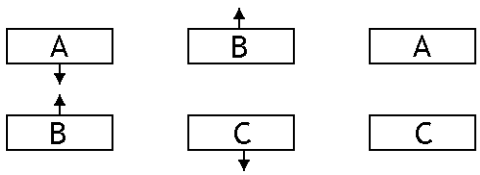
15. A charged object is brought near a metal ball that is mounted on a rubber sheet. If the metal ball acquired a negative charge after it was grounded momentarily, what must be the charge of the object that was brought near it?

A. Neutral
B. Positive
C. Negative
D. Cannot be determined from the given information alone.

16. What is really meant when we say an appliance "uses up" electricity?

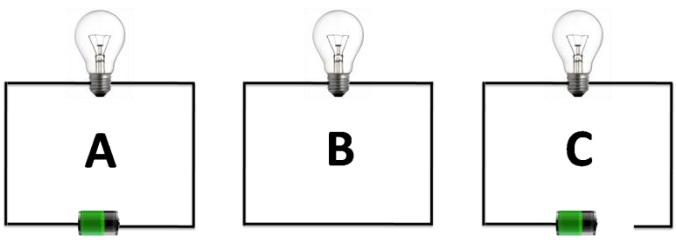
A. The current disappears.
B. The main power supply voltage is lowered.
C. Electrons are taken out of the circuit and put some where else.
D. The potential energy of electrons is changed into another form.

17. The figure shows three pairs of plates. The electrostatic force between the plates is shown for two of the pairs. If B is negative, what is the charge of A? and what kind of force exists in the third pair?



A. negative, attractive
B. negative, repulsive
C. positive, attractive
D. positive, repulsive

18. In which set-up(s) will the bulb light up?



A. A only
B. B only
C. C only
D. A, B and C

Answer Key

1. A
2. D
3. D
4. C
5. C
6. D
7. B
8. D
9. C
10. A

UNIT 4: Earth and Space

Overview

What do we want the students to learn about "Earth and Space" in Grade 7? We want students to know that whatever they observe in the environment, whether these are things or processes, are related to the location of our country on the planet. In other words, different countries have different environments because they are located in different places. For example, some countries are located near the equator while others are near the poles. Will these countries have the same climate? Obviously not! Some countries are located near bodies of water while others are surrounded by land. Which countries are more likely to experience typhoons? Some countries are located near trenches while others are not. Which countries are more likely to be hit by earthquakes? The location of a certain place will determine what we see and what happens in the environment.

There are three modules in this quarter: Module 1 is about the Philippine Environment, Module 2 is about Solar Energy and the Atmosphere, and Module 3 is on Seasons and Eclipses. The concepts and skills are presented in an integrated manner not just within the science disciplines (e.g., Life Science, Chemistry, Physics, and Earth/Environmental Sciences) but also whenever possible, across learning areas such as *Araling Panlipunan*, Mathematics, Health, Technology and Livelihood Education, and *Edukasyon sa Pagpapakatao.*

An integrated approach to teaching and learning will help students recognize the relevance of the science topics to real life. The environment is where we get the things we need and use to survive and enjoy life. What happens around also affects us, directly or indirectly, sometimes in disastrous proportions. Knowledge of what these events are and how they occur will help us prepare and cope with their negative effects or even prevent them from happening. Students will realize that many environmental phenomena are interrelated and complex in nature, so understanding that "everything is connected to everything else" will also help us get ready for unexpected events.

In each module, the first lesson starts with activities that will help students recall prerequisite concepts and skills. The understanding of these concepts and skills will be deepened through inquiry-based activities such as analyzing information on the globe, in maps, tables, graphs, and/or illustrations and discovering on their own, relationships and connections from the data gathered. The concepts learned in these modules will prepare students to tackle more abstract science concepts about Earth and space in higher grade levels.

There is a pre/post test for each module using selected-response and constructed-response questions. The result of the pre-test should guide you in focusing the lesson so that concepts already understood may already be applied to the current lesson without spending much time reviewing them. The questions in the text and pre/post test may also be used as exemplars when formulating your own test items.

Unit 4
MODULE

1

THE PHILIPPINE ENVIRONMENT

This module has two parts. The first part deals with the location of the Philippines on Earth. The second part deals with the varied resources found in the Philippines.

Key question for this module

Is there a connection between the location of our country and its natural resources (abundant water, fertile soil, diverse plants and animals, precious metal deposits, and geothermal power, to name a few)?

But before talking about our environment, the students must first learn how to locate the Philippines on the globe. There are two ways by which we can describe the location of a certain place. One is by determining its latitude and longitude. The other is by identifying the landmasses and bodies of water in the surrounding area. They will learn these in Activity 1. The activity has two parts. Part 1 will teach students how to figure out the latitude and longitude of a certain place. Part 2 will familiarize the students with the landmasses and bodies of water around the Philippines.

Latitude and Longitude

If one examines a map, one can see that there are lines that run from west to east (left to right) and lines that go from north to south (top to bottom). These are lines of latitude and longitude, respectively. They are there to help people describe the location of any place on Earth. These lines are also found on a globe, which is a better representation of the Earth.

Activity 1

Where in the world is the Philippines? (Part 1)

Activity 1 is easy to conduct. All you need are a number of globes and the activity sheets. Divide the class into groups and distribute the globes. Read the first step in "What to do" and let the students accomplish the task. (The class should perform only one step or task at a time.) After a reasonable amount of time, call on each group for their respective answers. After each group has given their answer, confirm the correct answers while guiding those who were confused into getting the right answers. Then proceed to the next number until everyone has understood everything.

Teaching Tips

1. It goes without saying that you should try out the activity before doing it in class.

2. When identifying the equator, do not let the students simply point to a segment of the equator. Ask them to trace the whole equator. Ask them to do the same when identifying the lines of latitude and lines of longitude.

3. Similarly, when identifying the northern and southern hemispheres, do not let the students simply point to a vague spot. They should use their palm in a "wiping" motion to indicate the whole extent of each hemisphere. A hemisphere is half of the globe. Pointing to a spot is misleading.
4. After the activity, the students should realize that the location of any place on Earth can be described using latitude and longitude. Conduct a sort of exercise/competition among the groups. Call out a pair of latitude and longitude, and the groups will look for the nearest city. After that exercise, do the opposite, calling out the name of a city and the groups will race to find the latitude and longitude of that city. Here are some examples that you can use.

Exercise 1: Identify the city nearest to the following rounded latitudes and longitudes.

Given: Latitude, Longitude	Answer: Nearest city
41°N, 74°W	New York
56°N, 38°E	Moscow
12°S, 77°W	Lima

Exercise 2: To the nearest whole degree, estimate the latitude and longitude of the following cities.

Given: City	Answer: Estimated latitude, longitude
Tokyo	36°N, 140°E
Melbourne	39°S, 146°E
Singapore	1°N, 104°E

5. Now that the students are familiar with the lines of latitude, discuss the relationship between latitude and climate, using a globe and the table below. The closer a country is to latitude 0° (equator), the warmer is its climate. By studying the globe, the students can give examples of countries with warm climate. These are the countries within the tropical zone, bounded by the Tropic of Cancer and Tropic of Capricorn.

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

In contrast, the farther a country is from latitude 0°, the colder is its climate. These are the countries in the polar regions, within the Arctic Circle and Antarctic Circle. And in the zone between the Tropic of Cancer and the Arctic Circle, and between the Tropic of Capricorn and the Antarctic Circle, there are countries which enjoy a temperate climate, where the seasons change from very cold to very warm. Thus, it is clear that the climate changes with latitude.

Answers to questions in Activity 1, Part I

Q1. Lines of latitude:
- are parallel to the equator and to each other
- form circles that are smaller at the poles
- do not meet

(Students should give descriptions that are based on the drawing and not on a memorized definition.)

Q2. (Let the students trace the lines of latitude on the globe.)
Q3. (Let the students show the given latitudes on the globe.)
Q4. (The teacher should guide the students in estimating the latitude.)
Q5. Lines of longitude:
- are not parallel to each other
- do not form circles
- meet at the poles (or extend from pole to pole)
- have the same length

(Students should give descriptions that are based on the drawing and not on a memorized definition.)

Q6. (Let the students trace the lines of longitude on the globe.)

Q7. (Let the students show the Prime Meridian on the globe.)

Q8. Starting at the Prime Meridian, moving 180 degrees to the east or to the west brings you to longitude 180°. Like the Prime Meridian, longitude 180° represents the boundary of the eastern hemisphere and western hemisphere. The Prime Meridian and longitude 180° are on opposite sides of the world.

Q9. (The teacher should guide the students in estimating the longitude.)

Q10. The latitude and longitude of Manila is 14°N, 121°E. This reading is approximate. It may be difficult to get exact readings from a globe, so estimates are acceptable.

Q11. Locating cities such as Manila is easy. Manila is just a "spot" on the globe. But locating a whole country like the Philippines may be challenging because the country is not a "spot," it is an "area." Since the boundary of the Philippines (or any country, for that matter) is irregular, we can simplify things by drawing a rectangle around the Philippines. So, how do you describe the location of the rectangle? One way is by getting the latitude and longitude of each corner of the rectangle. The Philippines is located within that rectangle. Can you think of another way?

Landmasses and Bodies of Water

In the next activity, students will become familiar with the location of the Philippines in terms of the surrounding bodies of water and landmasses. This is in preparation for the discussion on natural resources later on in this module, and common weather phenomena in the next module. For instance, the activity will show that the bodies of water that surround the Philippines are the sources of seasonal rain that fall on land. Water is a very important resource. It is not only used in agriculture; it is also needed to generate electricity, sustain all sorts of organisms, and form soil.

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

This activity is also easy to do. All you need are globes (to be distributed to each group) or a large world map (posted on the blackboard) as reference.

Answers to questions in Activity 2, Part II

Q1. South China Sea (called "West Philippine Sea" by the Philippine Government) and Indian Ocean

Q2. Philippine Sea and Pacific Ocean

Q3. Asian continent

Additional Information

Activity 2 (Part II) also acquaints the students with some of the landmasses near the Philippines. In the next module, the students will find out that the Asian mainland influences the movement of wind over a wide area that includes the Philippines. The occurrence of the monsoons, (*hanging habagat* and *hanging amihan*) is the result of the interactions of these landmasses and bodies of water with the atmosphere. And as the students work with the world map, they are expected to encounter some of the countries near the Philippines which are similarly located along the Ring of Fire. In later discussions in module 1, students will find out that countries found near the Ring of Fire are likely to have metallic deposits and geothermal power. Just make sure that students have a working knowledge about our location on the globe so that discussions about the environment are better understood.

Are We Lucky in the Philippines?

The four activities in this section focus on why we have varied natural resources in the Philippines, e.g., water, soil, metallic and non-metallic deposits, and energy. The discussion on water and soil will integrate the concept of biodiversity covered in Quarter 2. The characteristics of metals and nonmetals learned in Quarter 1 will help students appreciate the importance of mineral deposits. The discussion on energy in Quarter 3 will help students understand weather and other atmospheric phenomena in succeeding modules for this grade level. What will be highlighted is the fact that the natural resources found in the Philippines are due to its geographic and geologic locations.

Start the lesson by asking students what they associate with the word 'resources'. Some will give the meaning e.g., 'resources are things that can be used for support, help, or drawn on when needed". Others will give examples of resources: e.g., air, water, plants, animals, soil, rocks, minerals, crude oil, and other fossil fuels, sunlight, wind, car, houses, clothes, jewelry, and money. They can define resources as things used by people to survive or satisfy needs.

Differentiate resources made by humans and those gathered from nature. Introduce that the Philippines is considered 'rich' in natural resources. In Activity 1 Part II, students learned that the bodies of water that surround the Philippines are the sources of seasonal rain that fall on land. Students may have negative ideas about typhoons and heavy rainfall but they should realize that water is important for sustaining life.

Water Resources and Biodiversity

In elementary school science, students learned the sources of water in their community, the importance of the water cycle, the ways to use water wisely, and the effects of unwise use of water.

In this section, the focus of the discussion will be on watersheds - the area that feeds into surface and undergound waters. People know how important water is

but they do not know where the supply in the community originates. When ask where water in their community comes from, most answers would be - from the rain, river, lake, deep well, or spring. But rain does not come everyday so water must be stored in nature somewhere else.

Before doing Activity 3, provide some introduction about watersheds: what they are, where they are, and why they are important. Try asking from the local office of the National Power Corporation (NAPOCOR) the book entitled "Watersheds Sheltering Life", 2010, published by the same agency, for pictures and discussion of important watersheds in the country.

Activity 3

What are some factors that affect the amount of water in watersheds?

This activity is an example of a semi-guided/semi-structured investigation because the problem is given. It requires students to choose one variable in the list of factors that affect the condition of a watershed. Then, they design a procedure to determine the effect of that variable on the watershed.

Specifically, students will compare the amount of water that seeps through the soil 1) when there are plants and without plants, 2) during light and heavy rain, 3) given different kinds of soil-clay, loam or sandy, and 4) given different slopes/degrees of steepness of the hill or mountain.

Teaching tips

1. Review the components of an investigation discussed in Quarter 1.

2. Make sure that the design of the investigation includes a control setup and an experimental setup.

    - For the effect of vegetation on watersheds, students should be able to prepare two setups – one with grass and the other without. The following variables should be kept the same in both setups: kind and amount of soil, size of container or plot, amount of rainfall, and height of delivering water. Make sure that their materials include a receiver for the water runoff.

    - For the effect of the slope of the area: one setup should have a steep slope while the other should be gentle. The following variables should be kept the same: kind and amount of soil, size of container or plot, amount of rainfall, and height of delivering water. The setups may or may not have vegetation cover.

    - For the effect of kind of soil and amount of rainfall, what variables should be kept the same? What should be different?

3. Let students present the results of their investigations. Refer to the rubrics to help you critique student outputs.

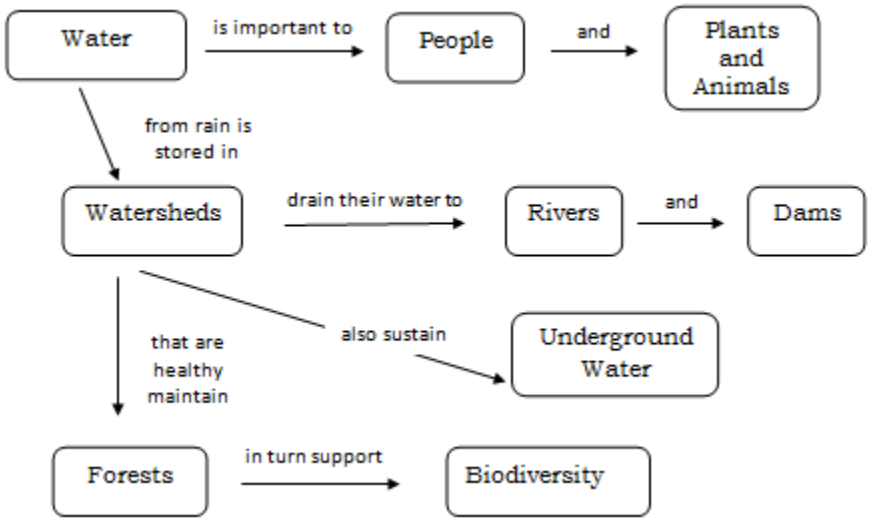
4. Summarize the discussion by using a drawing of a watershed and with arrows, trace the flow of rainwater as it falls on the ground. The following can be highlighted: Surface and underground waters are fed by healthy watersheds. Watersheds drain water to rivers, lakes, or dams that supply water for domestic and industrial uses. The presence of waterfalls or springs on the sides of mountains reveal that lots of water are collected in that watershed. Rain falling on mountain areas with vegetation seeps through the soil and collects there. Without vegetation cover, rainwater runs off to the lowland carrying topsoil. Also, abundant rainfall that occurs over days soak into soils along mountain slopes, causing landslides.

5. Ask what situation will result in lack of water supply in communities and the possible effects on people, plants, animals, and the physical environment. In a later section of this module, you will discuss ways to conserve water.

   Finally, ask: Are watersheds just about water? What other things can be found in watersheds? Relate the presence of water to high biodiversity in the Philippines. Include a discussion of endemic species in your area and tell where they are found. Note that bodies of water also moderate air temperature because water absorbs heat; this topic however, requires some chemistry concepts so do not introduce it if it does not crop up.

6. Use a concept map to point out the connections between and among concepts. Emphasize the appropriate connecting words or propositions. The arrow directs the reader to related concepts. Remember that it is NOT a concept map if there are no connecting phrases between concepts. Tell students that concept maps may vary depending on the connecting phrases between conceptual terms.

   A sample concept map may look like this:



Soil Resources, Rainfall, and Temperature

Soil is an important resource to any country. However, students will not be able to observe soil formation because it takes many years for this to happen.

This lesson enumerates what happens during weathering of rocks. It discusses the major factors that cause rocks to change over time. Students will understand the processes by illustrating them. This lesson links Science with English and Art.

Activity 4

How is soil formed from rocks?

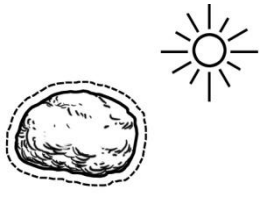
This activity highlights the fact that climate (temperature and rainfall) is a significant factor not only in soil formation but also in sustaining diversity of plants and animals in the country.

Teaching Tips

1. Try illustrating the processes yourself before the class discussion.

2. Check students' drawing by calling on some to present their outputs. Let other groups posts theirs on the wall. If there are illustrations that show misinterpretation of the processes detailed in the chart, explain these.

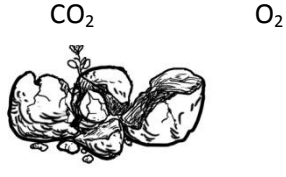
3. The illustrations may look like this:



Drawing A

Drawing B

Drawing C



Drawing D

Rocks and Mineral Resources

Start the lesson by asking what they have observed with rocks and stones from the beach, from construction sites, and other places. They can infer why some are smooth, others are rough or with sharp edges; some have beautiful colors and bands while other are plain. If you have some samples of these rocks, show these to the students.

Teacher preparation

5. Prepare big maps in advance for use in the processing of the activity (e.g., Metallic Deposits Map, Map of Volcanoes and Trenches, Ring of Fire diagram from the student module, and the Nonmetallic Deposits Map from the TG).

6. Locate the geologic structures and deposits in your community using the maps.

7. Invite a local expert to talk about the topic to add value to the lesson.

Activity 5

Where are the mineral deposits in the Philippines?

This activity presents the 'plus' side of volcanoes. It answers the question: *What mineral deposits do we have in the country? Where are they located and why are they found only in those places?* Using overlay or putting one drawing on plastic sheet over another enables students to discover the association between the presence of mineral resources (metallic ones) and geologic structures in the country such as volcanoes and trenches. Then they can infer why their area has or does not have mineral deposits.

Teaching Tips

1. This lesson may take two to three days to finish unless some preparatory works like tracing of maps on plastic sheets are assigned to students in advance.

2. Review students' knowledge of metals and nonmetals. They had lessons on this in Module 1 (Diversity of Materials in the Environment). Practice with students naming metals and nonmetals and giving their symbols. Do a game using flashcards. For example: Some cards bear the names of metals and nonmetals and students give the symbols. Other cards have symbols and students give the names.

3. After the review, let each student copy Table 1 in his or her notebook. (This could have been an assignment so as not to waste time.) Let them do the activity as a group.

4. Let students do Activity 5. Help students to learn how to manage their time. Move around the groups and see that each one is doing something e.g., one member traces the mineral map while another does the map of volcanoes and trenches. Also observe how they do the overlaying of plastics with the traced maps. Remind them to fill in the columns in the table.

5. Let the groups discuss the answers to the questions embedded in the activity before they finalize their report.

6. After the activity, post a big map of the Philippines in front of the class. When students are presenting their findings, point out on the map the location t they are discussing.

7. Let students make a generalization where metallic deposits are found. Then, elicit ideas on the uses of metals (e.g., in the softdrink industry, construction industry, at home, in school, in the farm, and other places).

8. Ask: *If metallic deposits are important to the economy of a country, why do you think is the Philippines not rich as a nation since we have lots of these?* Expect varied answers but point out the absence of technology in the country to recover the metals from the ores. What we export are the ores, then buy the metals at a high price. Here is the connection to *Araling Panlipunan.*

9. Summarize the core ideas in the activity e.g., The Philippines has metallic mineral deposits. They are found near volcanoes and trenches. These metals are used in many ways.

10. Ask student to ponder this question: *Why are minerals located where there are volcanoes or trenches?* Let students make a guess why mineral deposits are found where there are volcanoes or trenches. Do not comment on their answers at this point.
11. Introduce the topic by illustrating on the board the process describes in the module.

    There is a continuous source of heat deep under the Earth; this heat melts rocks and other materials. Water flowing between these rocks is also heated up. The mixture of molten or semi-molten materials, liquids and gases 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 crystalline 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 moves and circulates ore-bearing liquids and gases.
Metallic minerals deposits such as copper, gold, silver, lead, and zinc are associated with magmas found deep within the roots of extinct volcanoes.

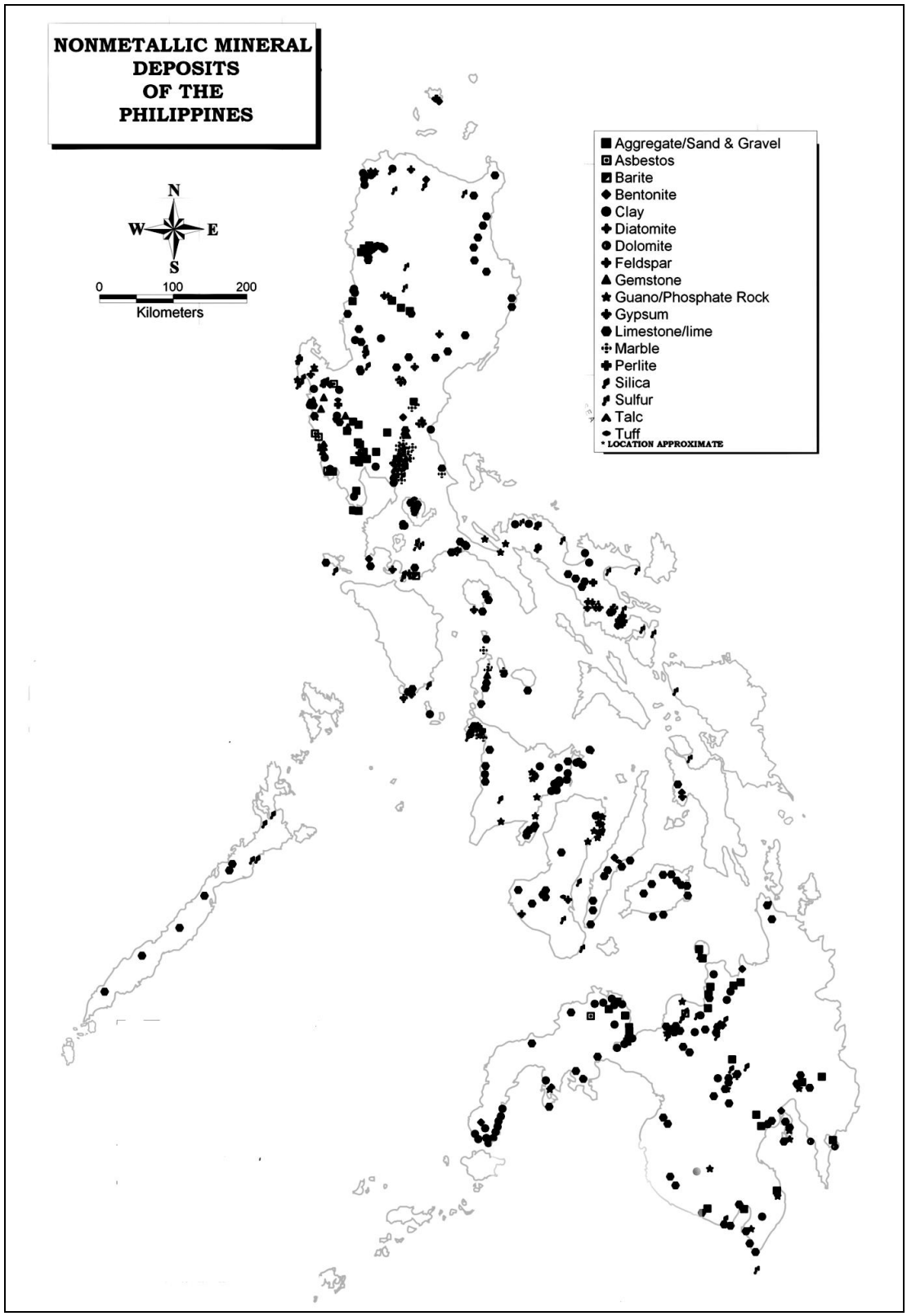
12. To reinforce their understanding, show the diagram of the Ring of Fire and ask: *Where is this Ring located?* (Around the Pacific Ocean). *What countries are found in this Ring?* (The Pacific Ring of Fire stretches for about 40 000 kilometers and touches four of the world's continents as well as several major island chains. Starting from Antarctica, it is found on the Pacific Ocean - - facing coastlines of New Zealand, Indonesia, the Philippines, Japan, Korea, China, Russia, Alaska, Canada, the United States, Mexico, Central America and South America. The world's largest volcanic region can be found along the Pacific Ring of Fire. Have you heard about Mt. Saint Helens in Washington, Mt. Pinatubo in the Philippines, Mt. Fuji in Japan, and the Paricutin Volcano in Mexico?

    Point out the location of volcanoes (shown as triangles). Mention that there are about 450 volcanoes altogether, 75% of which are active. *Why is this area called the Ring of Fire? (*There is a continuing movement of very hot magma under the ground.) *Do you think there are also mineral deposits in these countries? Why or why not?* This Ring is also famous for the occurrence of strong earthquakes and what causes them. Ask students if they have heard that Earth is made up of large plates. NOTE: The existence of volcanoes and the occurrence of earthquakes in the Ring Of Fire can be explained by plate movement. But this topic will be reserved in a later year science class because they still need to learn the prerequisite concepts.

13. *Ask: Do you still see the presence of volcanoes in the country as bad? Why or why not?* Ask for reasons why the presence of volcanoes in a place can be considered an advantage even if they result in disasters sometimes. Remind them that if people are prepared and follow Phivolcs suggestions on what to do before, during and after a volcanic eruption, negative effects are minimized or even avoided. Review the precautionary measures people should take in connection with volcanic eruptions from their lessons in elementary school science, especially if there is an active volcano in or near your area.

14. Ask students if the presence of volcanoes in the Philippines has other advantages besides their association with mineral deposits. (Answers may include fertile soils, though developed over a long time and geothermal energy resources but these will be discussed in this module when they study about energy resources.

15. Introduce the map on Nonmetallic Mineral Deposits in the Philippines. Ask students to identify the nonmetallic deposits and their location. Ask also for uses of these nonmetallic mineral deposits in their community.


NONMETALLIC MINERAL DEPOSITS OF THE PHILIPPINES
N
W
E
S
0
100
200
Kilometers
Aggregate/Sand & Gravel
Asbestos
Barite
Bentonite
Clay
Diatomite
Dolomite
Feldspar
Gemstone
Guano/Phosphate Rock
Gypsum
Limestone/lime
Marble
Perlite
Silica
Sulfur
Talc
Tuff
* LOCATION APPROXIMATE

16. End the lesson on rocks and minerals by letting students summarize the core ideas e.g., The Philippines has both metallic and nonmetallic mineral deposits. These are found in many parts of the country. They are used in different ways. In the Ring of Fire, metallic deposits are found near active or even extinct volcanoes or near trenches.

Energy Resources and Their Conservation

Besides supporting diverse life forms and providing mineral resources, 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?

Students should be assigned to read on energy resources in the Philippines ahead of the lesson. They should have information at least on the following: solar energy, heat from the ground (geothermal energy), hydrothermal energy (from falling water), wind energy, and natural gas.

Teaching Tips

1. Start the lesson by looking at our energy needs. Ask questions like these: *Why do we need energy? What are our energy sources? Where do we get energy for electricity? Or for running buses, jeeps, tractors and cars*?

2. Discuss that the Philippines is still dependent on imported oil for our domestic and industrial needs. But the presence of geologic structures or specifically the presence of volcanoes and trenches in the country and our tropical climate also provide several possibilities to get clean and cheap energy.

3. Make a table on the board to record major information about the energy resources that will be reported (e.g., advantages and disadvantages, where they are found).

4. Call some students to make their presentation or to record their data on the board.

   Crude oil or petroleum is used as fuel to run engines in factories and vehicles. As mentioned earlier they are imported so we cannot depend on petroleum forever. Moreover, use of petroleum or crude oil cause many environmental problems.
   Solar energy is free but the cost of production is expensive and requires a large area to collect them. Hydropower is also clean energy but is dependent on how much water there is in watersheds and dams.

   Geothermal energy or heat from the ground is less polluting than crude oil. But when they are taken from deep under the ground, areas that have high biodiversity are destroyed. We have coal but natural gas is the cleanest of all fossil fuels.

5. Study the location where our geothermal energy resources are found and why we have many hydrothermal power plants using the map and information in the text. Both geological and geographic reasons support the presence of these energy resources.

6. Mention that in Ilocos Province, giant windmills are used to generate electricity. In Quirino, Ilocos Sur the electricity generated from windmills 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 also provides 40% of the energy requirements for electricity in the entire province. This proves that we don't have to be dependent on fossil fuel in our country.

7. Refer to Figure 1 in this module. Ask: *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 other places that have similar conditions? Support your answers.*

8. End the day by summarizing the kinds of natural resources in the Philippines.

Conserving and Protecting Natural Resources

There are two types of natural resources on Earth - renewable and nonrenewable. Students should know the difference between these two kinds of resources. Both kinds of resources have to be used wisely.

This lesson has two activities: one allows students to brainstorm on how people destroy natural resources and the next gives them an opportunity to plan and implement a school activity to conserve these resources.

Activity 6

How do people destroy natural resources?

1. Start the lesson by differentiating renewable and nonrenewable resources. Give examples of natural resources and let students label them as either renewable or nonrenewable.

2. Introduce Activity 6 "How people destroy natural resources," a paper- and-pencil activity-completing a table. Some information can be recalled from previous lessons.

3. Call on students to give their answer for each row. Sample answers in italics are provided in the table below.

Activities (1)	Effects on Natural Resources (2)
• When roads are built, mountains are blown off using dynamite.	• Natural habitats damaged. • Plants and animals are killed
• Rice fields are turned into residential or commercial centers.	• *Food resources are reduced.* • *Areas are excavated sometimes also destroying waterways.*
• People cut too many trees for lumber or paper or building houses.	• *Many plants and animals grow on trees; biodiversity is reduced.* • *Soils in the area become easily eroded.* • *Reduced food source.* • *Plants and animals used as medicine are reduced*
• More factories are being built to keep up with the demands of a fast growing population and industrialization.	• *Natural habitats are damaged* • *Plants and animals move away or die* • *Bodies of water and landscape are destroyed*
• Uncontrolled mining and quarrying for the purpose of getting precious metals and stones and gravel.	• *Mountain areas are destroyed* • *Natural habitats are damaged* • *Plants, animals and even miners are killed* • *Cause siltation of rivers* • *Cave- ins may occur*
• Some farmers use too much chemical fertilizers to replenish soil fertility.	• Destroys the quality of the soil • Both human and animals are harmed
• Plastics and other wastes are thrown into canals and other waterways indiscriminately	• *Materials made of plastics take long year to decay* • *Plastic bags clog waterways and makes waterways shallow* • *Plastics serve as breeding places of disease-carrying organisms*
• Plastics are burned along with other wastes	• *Petroleum is the raw material for plastic materials* • *Air and water pollution*
• Cars, trucks, and tricycles that emit dark smoke (smoke belchers) are allowed to travel.	• *Air and water pollution* • *Government spend more money for reducing pollution* • *People get sick*
• Other activities	Students can add.

4. Add a third column in the table. Let students present ideas on what they can do to prevent or reduce the effects of the activities listed in column 1.

Activity

7

Are you ready for "Make-a-Difference" day?

This activity will engage students 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.

Guide students on what to do. The instructions in the module are simple. Let them choose any activity that will make a difference. Then later, help students write a letter to the Principal to make this activity a 'whole school' mission. (Ask their English teacher to help.)

Summarizing Statements

Before giving the posttest let students answer the key question for this module:

- Is there a connection between the location of our country and its natural resources (abundant water, fertile soil, diverse plants and animals, precious metal deposits, and geothermal power, to name a few)? What is the evidence?
- Most resources are finite. 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?

PRE/POST TEST

1. In which body of water is 15°S, 75°E located?

2. In which body of water is 30°N, 45°W located?

3. Is it possible for a city to be located at 120°S, 30°W? Explain.

4. Is it possible for a city to be located at 30°N, 150°W? Explain.

5. What are natural resources?

   These are materials or elements from the environment that people
   a. did not create
   b. invented for themselves
   c. use to meet their needs
   d. observe using a scientific equipment

6. What do you call a resource that people can use again and again but its supply can be replaced?

    a. renewable
    b. recyclable
    c. reliable
    d. unlimited

7. What two factors have the greatest influence on soil formation?

    a. temperature and rainfall
    b. slope of the land and rainfall
    c. kind of soil particles and temperature
    d. reforestation and use of compost as fertilizer

8. Which pair of resources is renewable?

    a. cotton and leather
    b. aluminum and iron
    c. coal and solar energy
    d. soil and minerals

9. Why are coal, petroleum, and natural gas considered nonrenewable resources if they were produced from plant and animal remains?

    a. It takes a very long time to produce them.
    b. Using them results in environmental problems.
    c. They are difficult to locate and explore from Earth.
    d. The Philippines is dependent on supply from other countries.

10. Give three energy resources in the Philippines that are considered feasible as alternatives to fossil fuels? Give a reason for each choice.

    a. _____
    b. _____
    c. _____

11. A table is provided below. Fill in the table based on the tasks listed.

    a. Give three examples for each major resource.
    b. Label the examples you gave as renewable (R) or nonrenewable (NR)?
    c. Give one way to preserve the land and water resources that you listed?
    d. Resources on Land: _____
    e. Resources in Water: _____

Resources	Example 1	R or NR	Example 2	R or NR	Example 3	R or NR
Land resources						
Water resources						

12. You see pieces of cardboard, empty softdrink cans, and a broken wooden chair dumped in a vacant lot.

    a. What resources were used in producing these materials?
    _____

    b. What materials are being wasted in the dumpsites?
    _____

13. What objects do you use that are made from materials produced from

    Mines:
    _____
    Forest:
    _____
    Farm:
    _____

14. Is there a relationship between the presence of minerals in the Philippines with any geologic structure? Give one reason for your answer.
    _____

15. Is there a relationship between our latitude position and the high diversity of life forms in the country? Give one reason for your answer.
    _____

16. Make a concept map using the following words in the box:

natural resources, minerals, rocks, soil, water, watershed, plants, animals, biodiversity, energy, people, conservation

Answer Key

1. Indian Ocean
2. Atlantic Ocean
3. No. The maximum value for latitude is 90°N or 90°S. There is no latitude 120°S.
4. No. There is no landmass at location 30°N, 150°W.
5. c (use to meet their needs)
6. a (renewable)
7. a (temperature and rainfall)
8. a (cotton and leather)
9. a (It takes a very long time to produce them)
10. Any three of the following: **geothermal energy** (we have large deposits because of the presence of many volcanoes); **hydrothermal energy** (we have abundant rain that can be stored in dams and rivers and other bodies of water); **wind energy** (many places have strong winds with a speed of more than 20 km per hour); solar energy (we have lots of sunshine all year round); **biogas** (organic waste can be converted to fuel)
11.

Resources	Example 1	R or NR	Example 2	R or NR	Example 3	R or NR
Land resources	Metals	NR	Trees, crops	R	Soil, sand	NR
Water resources	Fish and other food products	R	Water	R	Corals, seashells	R

c. (Answers may vary. Sample answers are given below.)

Resources on land:
1. Metals: Recycle discarded products made of metals.
2. Trees: Avoid cutting trees all over the place (indiscriminately).
3. Soil: Plant trees (reforestation) to reduce soil erosion.

Resources in water:
1. Fish: Reduce or avoid too much use of fertilizers that may be washed into lakes and streams.
2. Water: Do not throw waste of any kind into bodies of water.
3. Corals: Reduce soil erosion that may lead to siltation. (Too much siltation damages or destroys corals.)

12. a. Resources used in producing….
Cardboard: Trees and other plant fiber, starch, plant pigments
Empty softdrink can: metals
Broken wooden chair: trees

b. Materials being wasted in the dumpsites when the following are thrown away

Cardboard: paper
Sofdrink can: metals
Broken chair: wood

13. Objects used that are made of materials produced from

Mines: jewelry, cans, knives, spoons and forks, toys with metal parts, kitchen utensils
Forest: paper, pencil, chairs, tables, house components, leather shoes or bags, medicine from plants, food products
Farm: food products, medicine from plants, pillows made of cotton fiber, animal feathers for varied purposes

14. Relationship between the presence of minerals in the Philippines with any geologic structure:

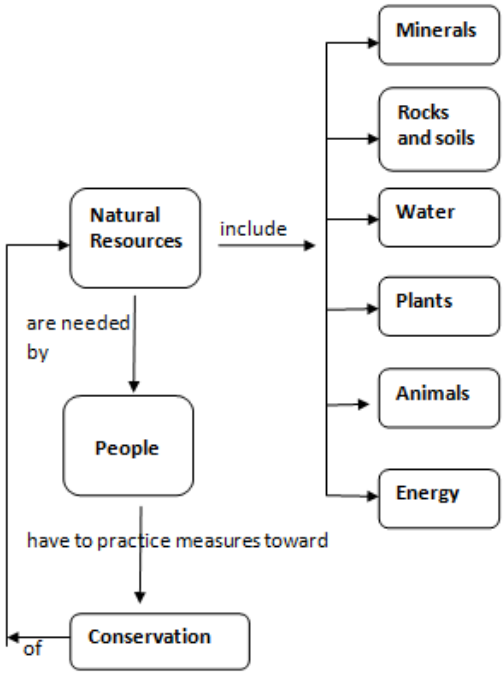
Yes, metallic mineral deposits are found near volcanic areas or in trenches; metals concentrate there when magma circulates under the Earth

15. Relationship between our latitude position and the high diversity of life forms in the country:

Yes, the Philippines is near the equator where there is sunshine all year round and rainfall is abundant. Water is needed by all living things; sunlight is needed by plants to manufacture food and provides the right temperature for humans, plants and animals to grow and reproduce.

16. Accept different kinds of concept maps as long as there are connecting words between concepts. You can start with any concept from the list. The arrows will help determine what concepts are connected

For example:



Links and Other Reading Materials

Natural Resources https://www.cia.gov/library/publications/the-world-factbook/fields/2111.html
http://en.wikipedia.org/wiki/Wikipedia:Blank_maps
http://www.geographyalltheway.com/ks3_geography/maps_atlases/longitude_latitude.m
http://en.wikipedia.org/wiki/Ilocos_Norte
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)
gdis.denr.gov.ph (Geohazard Map)
What Is the Ring of Fire? eHow.com http://www.ehow.com/info_8114548_ring-re.html#ixzz1yaL75Ezz
Where Do Volcanoes Form in Relation to Rings Fire? eHow.com http://www.ehow.com/info_8311896_do-form-relation-rings-fire.html#ixzz1yaOeblks

Unit 4
MODULE

2

SOLAR ENERGY AND THE ATMOSPHERE

Overview

Our planet receives an abundant supply of life-giving energy from the Sun. The heat of the Sun or solar energy also propels atmospheric phenomena. This module will focus on two concepts that will help students understand why the wind blows, why monsoons occur, and what is the so-called intertropical convergence zone.

Since weather events happen in the atmosphere - the envelope of air that surrounds the Earth- it is important that students be familiar with the structure and composition of the atmosphere. They can then give reasons for the weather events as well as global atmospheric phenomena that result from changes in the composition of the gases in the atmosphere.

Key question for this module

How is Earth's atmosphere affected by solar energy?

How does the location of the Philippine influence its climate and weather?

Layers of the atmosphere

The atmosphere is divided into layers. The division is based on a single factor. Students will be able to come up with the answers to the activity question by analyzing and interpreting a graph. These are higher- order thinking skills.

Activity 1

What is the basis for dividing Earth's atmosphere into Layers?

By studying Figure 1, students will be able to describe the features of each of the five layers; compare the features of the five layers; and explain the basis for the division of the layers of the atmosphere. This activity integrates some mathematics skills, e.g., estimating height and using a measuring instrument like a ruler. Scaling (e.g., how many cm in a ruler is one km) may also be introduced as well as imagining how long a km distance put vertically (as in altitude) looks like.

Teaching Tips

1. Some references give only four layers of the atmosphere. Others mention sublayers. For this activity, focus on the layers shown in the graph.

2. Let students first identify what is in the vertical and horizontal axes in the graph. When graphing, the independent variable or variable that is manipulated is usually placed in the X (horizontal) axis while dependent variable (variable that responds to the change) is placed in the Y (vertical) axis. In Fig 1, the temperature, which is the dependent variable, is in the Y axis and the altitude or height of the atmosphere in the X axis. To make sense of height (or depth), it is practical to place height in the vertical axis rather than in the horizontal axis. Altitude means height from the ground.

3. Let students follow the procedure step-by-step and to answer guide questions.

4. Note that the graph does not contain information about the gases that make up each layer in the atmosphere. Students can get these information from the description of the layers in the text. To put the information together, let students organize the data from the graph and the text that describes the features of each layer. They will then be able to compare the layers of the atmosphere and tell the basis for dividing the layers. Making a table to organize data about an event or phenomenon from varied sources is also a higher- order thinking skill.

Answers to Questions in Activity 1

Q1. Based on the graph, the five layers of the atmosphere starting from the ground or Earth's surface are: troposphere (about 10 km), stratosphere (about 40 km), mesosphere (about 30 km), thermosphere (about 415 km), and exosphere (cannot be determined from the graph).

Q2. In the **troposphere**, the temperature decreases as the altitude (height of the atmosphere) increases.

In the **stratosphere**, at heights around 10-20 km above the ground, the temperature is almost the same. From about 20 to 50 km above, the temperature increases.

In the **mesosphere**, the temperature decreases as height increases.

In the **thermosphere**, from heights about 87 to 100 km, the temperature change is small; it increases gradually from about 100 to 110 km. From 110 km to the end of the layer the temperature steadily increases with height.

The gradual increase in temperature with altitude continues to the **exosphere.**

(Note: Though it is not necessary to explain to students at this point the reason for the variation in temperature, it is good for you to know that these variations are due to changes in the chemical and physical characteristics of the atmosphere with altitude.)

Q3. In the lower part of the stratosphere, the temperature increases with height. The same is observed starting from the thermosphere up to the exosphere.

Q4. In the troposphere, the temperature decreases as height increases (from about 15 degrees Celsius to minus 45 degrees). A mountain climber will feel the temperature difference as he or she moves from the ground, up. The temperature also decreases in the mesosphere (from minus 5 to about minus 90 degrees Celsius).

Take note that the temperatures are global averages. The atmospheric temperature of countries above the poles is different from the temperature above the equator.

Q5. (Let students repeat the trends described above.)

Q6. The layers of Earth's atmosphere is divided based on temperature differences

Q7. Overall, the graph shows that the closer the atmospheric layer is to the Sun, e.g. thermosphere and exosphere), the hotter the temperature. However, if one studies the temperature in the lower layer, the reverse trend is observed. For example, in the troposphere, the temperature close to Earth is higher than the temperature above the ground. Ask students to guess what the reason is.

(FYI: The main reason why temperature decreases with altitude in the troposphere is that it is heated from below. The atmosphere is predominantly transparent to sunlight, so the Sun heats the ground directly. The ground warms the bottom layers of the atmosphere by radiation and by convection. This will be discussed in the next section. The situation is like water heated in a pan on the stove--the water is hottest at the bottom and coolest at the top.)

In general, the variations are also due to changes in the chemical and physical characteristics of the atmosphere with altitude. However, students may not yet be ready to discuss this.

Q8. What other information about Earth's atmosphere can you derive from the graph?

Let students notice the zigzag portion on the vertical axis (thermosphere layer). Let them explain why this is not a straight line.

A sample table of data about the Earths' atmosphere may look like this:

Layer	Estimated distance from the ground	Estimated temperature	Relationship between temperature and altitude	Events happening in that layer	Other information
Troposphere					
Stratosphere					
Mesosphere					
Thermosphere					
Exosphere					

The students are now ready to study some global atmospheric phenomena.

What is the Greenhouse Effect?

The most abundant gases in the Earth's atmosphere are nitrogen (78%) and oxygen (21%). The remaining 1% is a mixture of carbon dioxide, water vapor, 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.

Activity 2

Does a greenhouse retain or release heat?

In the Philippines, greenhouses are used by commercial plant growers or plant lovers. If there is a greenhouse in your locality, use it as a springboard for the lesson. Introduce the concept of greenhouses by asking students what they know about it.

Teaching Tips

1. A week before the lesson, ask students to gather 1.5 L or 2.0 L softdrink plastic containers. Use these to construct your own model greenhouse while students do their own. Then try out the activity before you ask students to do it.

2. Each group needs two thermometers. If thermometers are not enough for, say, six groups (12 thermometers are needed), have at least two pairs of setups to allow comparison of data. Check the thermometers first if they are working before distributing to students.

3. The activity procedure is easy to follow. Put the setups in different locations. The temperature readings reported in different locations might not be the same. What is important is that the temperature in the bottle with windows is lower (cooler) than the temperature in the bottle without. They should be able to derive this information from the activity. Use the result of the activity to introduce the greenhouse effect clearly stating what bottles A and B represent.

Answers to Questions in Activity 2

Q1. Accept any prediction. They can say that one bottle will have a higher temperature than the other. Let them mention which bottle.

Q2. (Let students write their prediction in their notebooks and the reason for the prediction. They can accept or reject this prediction after the activity.)

Q3 & Q4. The graph should have the following:
X axis: Time (variable that is manipulated or changed)
Y axis: Temperature (variable that responds to the change)

Q5. (Check graph)

Q6. (Check graph)

Q7. In both bottles, the temperature increased with time.

Q8. The temperature reading in Bottle A is higher than the temperature reading in Bottle B. Bottle A is the model greenhouse (close setup)

Q9. A greenhouse retains heat. The evidence is the higher temperature reading in Bottle A than in Bottle B.

After the activity, discuss the topic on 'greenhouse effect', highlighting the small percentage of carbon dioxide in the atmosphere (0.03%) in olden times. This small percentage keeps the temperature of Earth's atmosphere suitable for life forms.

Introduce the new data about carbon dioxide and other gases. This discussion will lead to global warming. Take note that global warming is a different process from ozone depletion. Though ozone is a greenhouse gas, global warming is the increase in global atmospheric temperature due to the increase in greenhouse gases while ozone depletion means the reduction of ozone molecules in the stratosphere. In the stratosphere, the ozone molecules absorb the high energy

radiation from the Sun (thus the increase in temperature). This is good for living things. If the high energy radiation reaches Earth's surface, they will be harmful to all life forms, including humans.

Make an analogy to make the concept of greenhouse effect clearer. A car parked in an open air has a higher temperature than outside. The car is like the closed bottle in the activity (the model greenhouse). Inside the car (like a greenhouse), infrared radiated by sun-warmed objects do not pass readily though the glass. The trapped energy warms the interior of the car. The trapping of hot air so that it cannot rise and lose energy by convection also plays a major role.

Common Atmospheric Phenomena

Now, we are going to look at some of the natural processes that occur in the troposphere, the lowest part of the atmosphere. As mentioned earlier, the troposphere is where different weather events happen. In this part of the module, the students will learn that the Philippines experiences certain weather phenomena because of the country's location. In particular, the students will learn that we experience the monsoons because the Philippines is located near certain landmasses and bodies of water. They will also learn that the occurrence of thunderstorms during certain months of the year is due to the country's location near the equator. These events in the troposphere cannot happen without the heat provided by the Sun. So we start by investigating what happens when air is heated.

Activity 3

What happens when air is heated?

Activity 3 answers the question, "What happens when air is heated?" The short answer is, when air is heated, it rises. The teacher should not provide this answer to the students; they should discover this by themselves by doing the activity and using their own observations. But the teacher can lead the students toward the right answer by asking guiding questions.

Answers to Questions in Activity 3

Q1. When the lighted candle was placed under one bag, the bag moved up.

Q2. At the start, the two bags contain about the same amount of air. What happens when the candle is placed below one bag? The air inside heats up. The air expands and spills out of the bag. There will be less air in that bag than before. So the bag rises.

The students may find it hard to think of such an explanation. If so, the teacher may ask a series of questions whose answers will lead to the desired explanation. For example, the teacher may ask the following questions:

Teacher:	What does the candle flame do to the air in the bag?
Student:	The flame heats the air inside the bag.
Teacher:	What happens when air is heated?
Student:	Air expands when it is heated. (If they do not know this, do the following activity: Take a glass bottle and attach a balloon to its mouth. If the bottle is placed in hot water, the air inside will expand. One cannot see the expanding air but one can see its effect: the balloon will become inflated.)
Teacher:	If the air expands [meaning, the volume increases], where will the expanding air go?
Student:	Out of the bag.
Teacher:	That means that there will be less air in the bag than before. Will it become lighter or heavier?
Student:	It will become lighter.
Teacher:	So, will the bag sink or will it rise?
Student:	It will rise.
Teacher:	Okay. Will you please summarize what we just talked about?

This kind of question-and-answer interaction will help the students think and come up with the explanation themselves.

Teaching Tips

1. For safety purposes and because of time constraints, the teacher may opt to perform this activity as a demonstration.

2. The teacher should try out this activity before doing it in class. The stick should not be too heavy; the rising bag may not be able to move it. The stick must be balanced in a way so that it can move like a see-saw. If the stick is placed on a flat surface, it will not budge at all.

3. Make sure that the air in the classroom is still. Turn off the electric fan and close the windows if there is a strong breeze blowing into the room.

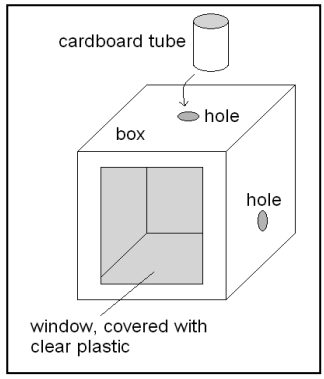
Now that the students know that warm air rises, the next question they should investigate is, what is the effect of rising warm air on the air in the surroundings?

Activity 4

What happens to the air in the surroundings as warm air rises?

In Activity 4, the students should come to the conclusion that the air in the surroundings will move toward the place where warm air is rising.

In this activity, the class will need boxes like the one shown on the right. Any box will do: a shoebox or the box used in packaging juice drinks. To save time, the boxes may be prepared during the students' free time or at home. For easy access into the box, the clear plastic should be attached to the window so that it opens like a door. It is better if the plastic is a bit stiff so that one can push on it during the activity to make the box airtight. Each group should have one box.



In step No. 3, the students are asked to place the smoke source near the hole. Some students will overlook this and insert the smoke source into the hole. Make sure that the smoke source is not placed inside the box. It should be out of the box, but near the hole. The teacher should go around and check on it.

Answers to Questions in Activity 4

Q1. Answers will vary.

Q2. The smoke went through the hole into the box toward the lighted candle.

Q3. The candle flame warms up the air above it. The warm air rises out of the box. The air in the surroundings goes into the box and moves toward the place where warm air is rising.

If the students are not convinced, let them do the activity without the lighted candle. (Make sure that the box and the air inside have already cooled down.) Without the candle flame, there will be no rising warm air. Without rising warm air, the surrounding air will not move into the box. How will the students know? The smoke will not go into the box.

After Activities 3 and 4, the teacher should ask the students to state the two concepts that they have learned: a) warm air rises and b) air moves toward the place where warm air is rising. With these two concepts, the teacher can now explain many processes, including why the wind blows.

What Makes the Air Move?

The Sun heats up the surface of the Earth. Because the Earth's surface is made of different things, some places heat up faster than others. The air above the warmer places will also warm up and will rise as a result. The air in the surroundings will then move toward the place where warm air is rising. We call this moving air, wind. The wind may have special names, depending on certain conditions. For example, in one situation the wind may be called a land breeze or sea breeze. In another situation, the wind may be called the monsoon. Winds may also be called westerlies or easterlies, depending on where the winds come from. The following activity will be used to explain the occurrence of sea and land breezes.

Activity 5

Which warms up faster?

In this activity, the students are supposed to discover that sand heats up faster than water, and that sand cools down faster than water.

Answers to Questions in the Activity 5

Q1. The sand has a higher temperature.

Q2. Answers vary. But there is a greater increase in the temperature of the sand.

Q3. The sand became hot faster.

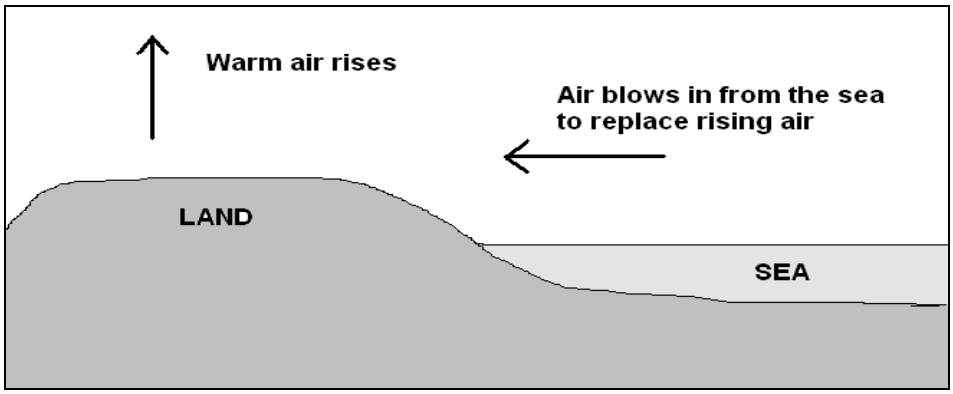
Q4. The temperature of the water and sand decreased.

Q5. Answers vary. But there is a greater decrease in the temperature of the sand.

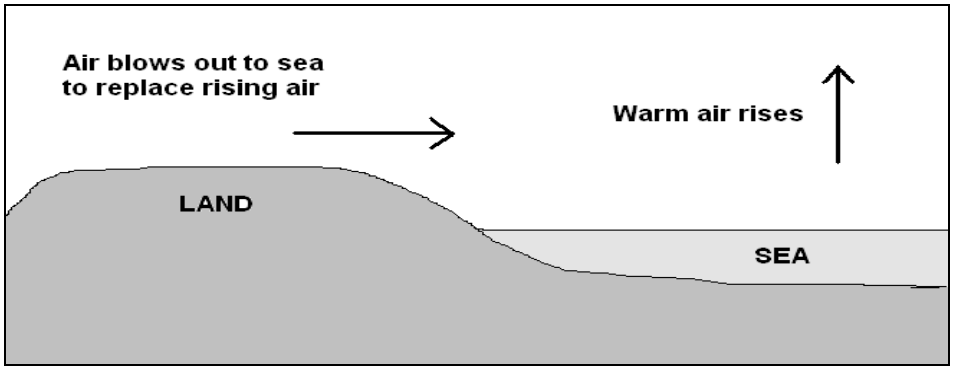
Q6. The sand cooled down faster.

Sea Breeze and Land Breeze

The results of this activity can be used to explain the movement of air from land to sea, and from sea to land. The sand in the activity represents land while the water represents the sea. During the day, both land and sea are heated by the Sun. But the land heats up faster than the sea (similar to what happened in the activity). So the air above land becomes warm and rises. The air in the nearby sea then moves in toward the place where warm air is rising. The moving air or wind from the sea is called a sea breeze.



Conversely, during nighttime, the land and sea both cool down. As in the activity, the land cools down faster than the sea. Later on, the land is already cool but the sea is still warm. The air above the sea will then be warmer than the air above land. The air above the sea will rise, and the air over land will move toward the place where warm air is rising. The moving air or wind from land is called a land breeze.



Monsoons

The monsoons are commonly mistaken for rains. But monsoons are winds. Like the sea breeze and land breeze, monsoons can also be explained using the two concepts that were learned earlier: warm air rises and the surrounding air moves in toward the place where warm air is rising. But while sea and land breezes alternate on a day-night cycle, the monsoons occur from season to season. And while sea and land breezes occur locally, along coastal areas, the monsoons affect a much wider area, including large bodies of water and land.

Activity 6

In what direction do winds blow-from high to low pressure area or vice versa?

Students will learn from Activity 6 why the monsoons (locally known as *habagat* and *amihan*) occur and why they change in direction during certain months of the year. Before conducting the activity, the concept of air pressure must be introduced to the students. Air pressure is the weight of the air above a certain place. We do not feel the weight of the air above us because we are used to it. The air pressure is not the same everywhere. In places where warm air is rising, the air pressure is low. A low-pressure area therefore is a place where warm air is rising (where the air is 'light' or where the air is less dense). In contrast, a high-pressure area is a place where cool air is sinking. In the activity, the maps that will be used are marked with "L" and "H." These letters refer to "low-pressure areas"' and "high pressure areas," respectively.

Answers to Questions in Activity 6

Q1. From the arrows on the map, one can see that the winds move toward low-pressure areas.

Q2. Winds move away from high-pressure areas.

Q3. Winds blow from high-pressure areas to low-pressure areas.

Q4. North is toward the top portion of the map. South is toward the bottom. West is toward the left while east is toward the right.

Q5. (Let the students encircle the Philippines.)

Q6. Near the Philippines, the wind blows from the northeast in January.

Q7. Near the Philippines, the wind blows from the southwest in July.

From this activity, the students will learn several things.

1. The wind moves from a high-pressure area toward a low-pressure area.

2. There are two types of monsoons. From October to March, the northeast monsoon (*amihan*) comes from the northeast and moves toward the south. Why does the wind move from north to south? Because there is a low-pressure area in the south (near Australia) at that time.

3. From July to September, the southwest monsoon or *habagat* comes from southwest and moves toward the north. That means that the low-

pressure area is no longer in the south. This time it is located to the north of the Philippines (in the Asian continent).

4. The northeast monsoon or *amihan* is cold because it comes from cold areas, such as Siberia and Mongolia, in the Asian continent.

Both the *amihan* and *habagat* bring rain to the Philippines. This is because the winds pass over bodies of water which supply a lot of moisture. The *amihan* passes over the Pacific Ocean before it reaches the Philippines, bringing rain to the eastern part of the Philippines. The *habagat* passes over the Indian Ocean and South China Sea (West Philippine Sea) before it arrives in our country, bringing rain to the western portion of the country.

The maps may also be used to show that the air pressure all over the world is not the same. There are high-pressure areas and there are low-pressure areas. And at certain months of the year, their locations change. Why? That is because the Earth is tilted and it goes around the Sun. This will be explained in more detail in the following module.

The monsoons, *habagat* and *amihan*, affect people in different ways. Farmers welcome the monsoons because they supply rain for their crops. Fisherfolk are not so happy because it is not safe to go fishing when it is raining and the wind is also blowing hard. Fishpen owners worry about monsoon rains because when the pens overflow, they lose all the fish within. But rains from the monsoons fill up the dams that store water for a variety of purposes, such as domestic use (drinking, washing), irrigation, and electricity generation. Ask the students how the monsoons affect their daily lives.

We have already tackled two common weather phenomena, breezes and monsoons. In the next section, we will discuss a natural process that occurs in the tropical region but not in temperate or polar areas.

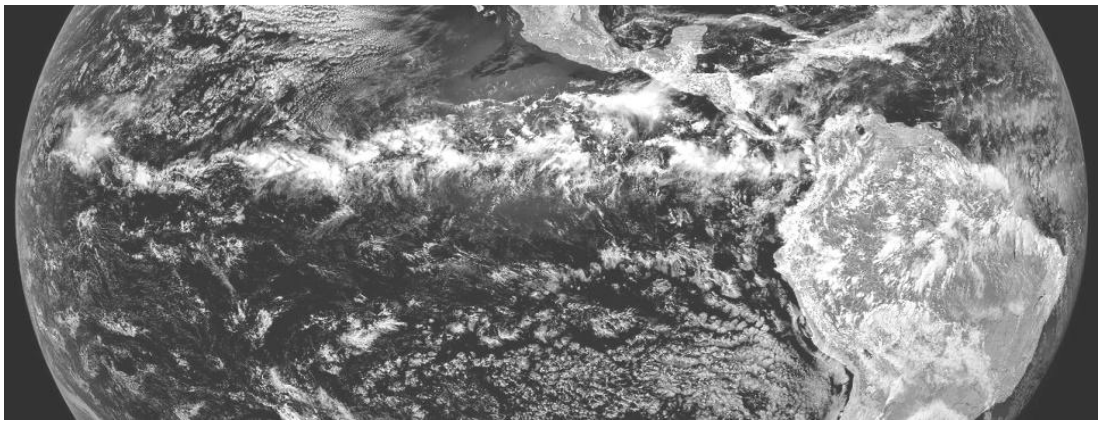
The Intertropical Convergence Zone

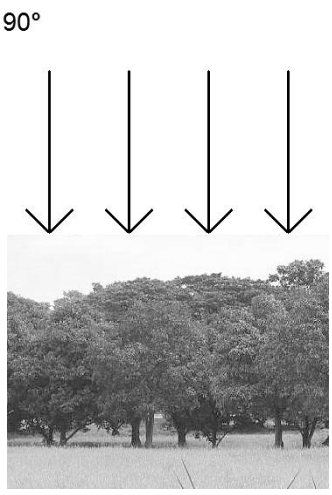
This long technical phrase is often mentioned in many weather news as the ITCZ. But usually, no explanations are provided to describe what it is. The process is easy to understand as long as one knows that warm air rises and that air in the surroundings will move toward the place where warm air is rising.

We all know that the equatorial region is a warm place. The reason is because the equator and nearby areas are places that receive direct rays from the Sun. What does the word “direct” mean? It means that the Sun is directly overhead and the Sun’s rays hit the ground vertically (see picture below). We can also say that the rays strike the ground perpendicularly, at right angles, or at 90 degrees. One way of demonstrating “vertical rays” to students is by showing them vertical posts at noon and noting that they have no shadows. That means the Sun is directly overhead.

Because the equatorial area receives direct rays from the Sun, it is much warmer than any other place on Earth. The warm equatorial area heats up the air

above it. The warm air then rises. Moisture in the rising air will lead to the formation of clouds, which result in torrential downpours. Thus, the ITCZ is the reason why we get a lot of thunderstorms during certain months of the year. Which months? During the months when the Sun's rays are most direct, during the warm months.





Arrows illustrate what is meant by "direct" rays of the Sun. The rays hit the ground vertically (left photo). Clouds in this satellite photo show the location of the ITCZ (right photo).

As warm air over equatorial areas rises, the air in the surroundings will move in. Air from north of the equator and south of the equator will then meet or converge at the place where warm air is rising. Areas north and south of the equator are called the tropics. Thus, we now know why it is called the intertropical convergence zone. It is the place where winds in the tropics meet, rise and form clouds, resulting in thunderstorms during certain times of the year.

At the end of this module, it should become clear that certain weather phenomena can be explained by using the same scientific concepts. There is a common explanation behind why the wind blows, why monsoon winds change direction, and what the ITCZ is. It is suggested that these phenomena be explained together because the underlying concepts that are needed to understand them are practically the same. If these processes are explained separately, it may lead students into thinking that there are three different explanations. The varied natural processes that occur around us are all governed by the same scientific laws.

PRE/POST TEST

1. What is the most abundant element in the Earth's atmosphere?
   a. Argon
   b. Carbon dioxide
   c. Nitrogen
   d. Oxygen

2. What is the correct order of Earth's atmospheric layers from bottom to top?
   a. Stratosphere, Mesosphere, Troposphere, Thermosphere, Exosphere
   b. Stratosphere, Troposphere, Thermosphere, Mesosphere, Exosphere
   c. Troposphere, Mesosphere, Stratosphere, Thermosphere, Exosphere
   d. Troposphere, Stratosphere, Mesosphere, Thermosphere, Exosphere

3. Which layer of the atmosphere contains the ozone layer?
   a. Mesosphere
   b. Stratosphere
   c. Thermosphere
   d. Troposphere

4. In which layer do virtually all weather phenomena take place?
   a. Exosphere
   b. Mesosphere
   c. Stratosphere
   d. Troposphere

5. In which atmospheric layer is most water vapor found?
   a. Troposphere
   b. Stratosphere
   c. Mesosphere
   d. Thermosphere

6. What is meant by 'trace' gases?
   a. They are not harmful.
   b. They are emitted by trees.
   c. They are naturally occurring on Earth.
   d. They are present in very small amounts.

A Grade 7 Science teacher gave her students data about Earth and an imaginary planet XYZ. The data are shown below. Give at least TWO REASONS why human beings could not survive on XYZ. Explain your answer (adapted from TIMSS, 2003).

	Earth	**Planet XYZ**
Distance from the Sun (in km)	148, 640, 000	902, 546, 000
Atmospheric conditions • Gas components • Ozone layer • Cloud cover	 21% oxygen, 0.03% carbon dioxide, 78% nitrogen YES YES	 7% oxygen, 5% carbon dioxide, 88% nitrogen NO NO
Presence of Minerals	YES	YES
Presence of Volcanoes	YES	YES

7. What is the basis for the division of the layers of the atmosphere surrounding Earth?
   a. Changing temperature
   b. Changing amount of oxygen
   c. Changing weather patterns
   d. Changing composition of gases

8. Why is the presence of ozone above the troposphere important for the survival of living thing on Earth?
   a. It warms Earth's surface.
   b. It helps in cloud formation.
   c. It makes jet flying more comfortable.
   d. It offers protection from the Sun's harmful UV rays.

9. The greenhouse effect is a natural phenomenon. Without a natural greenhouse effect, the temperature of the Earth would be about -18°C instead of its present 14°C. Why are scientists concerned about the greenhouse effect?
   a. There is no technology that will keep the temperature of Earth constant.
   b. Planting trees in wider areas is not possible; Earth has many desert areas.
   c. Human activities like burning of fossil fuels and deforestation enhance the greenhouse effect.
   d. The human population is increasing rapidly; more carbon dioxide will be released to the atmosphere.

10. Why do hikers put on thicker clothes when climbing a high mountain?
   a. For protection against insect bites
   b. The air temperature decreases with altitude
   c. So they can easily be located when they get lost
   d. To add more weight so they will not be pushed by the wind

11. Water vapor and carbon dioxide are both greenhouse gases. Why are we so worried about increasing carbon dioxide and NOT water vapor?

12. Cutting of trees in large areas contributes to global warming. Give one reason to support this statement.

13. Give two ways by which you can help prevent global warming from getting worse. Give a reason for each.

14. What happens when air is heated?
   a. It rises.
   b. It stays in place.
   c. It spreads in all directions.
   d. It moves toward a lower elevation.

15. Which warms up faster, land or water?
    a. Land
    b. Water
    c. Both warm up at the same rate.
    d. Rate of warming varies; depends on weather conditions.

16. Make a drawing showing the direction of wind during a sea breeze.

17. What happens to the surrounding air as warm air rises?
    a. Moves in all directions
    b. Moves to a higher altitude
    c. Moves away from the rising air
    d. Moves toward the place where warm air rises

18. In what direction do winds blow?
    a. From the northeast to the southwest
    b. From the southwest to the northeast
    c. From low pressure areas to high pressure areas
    d. From high-pressure areas to low-pressure areas

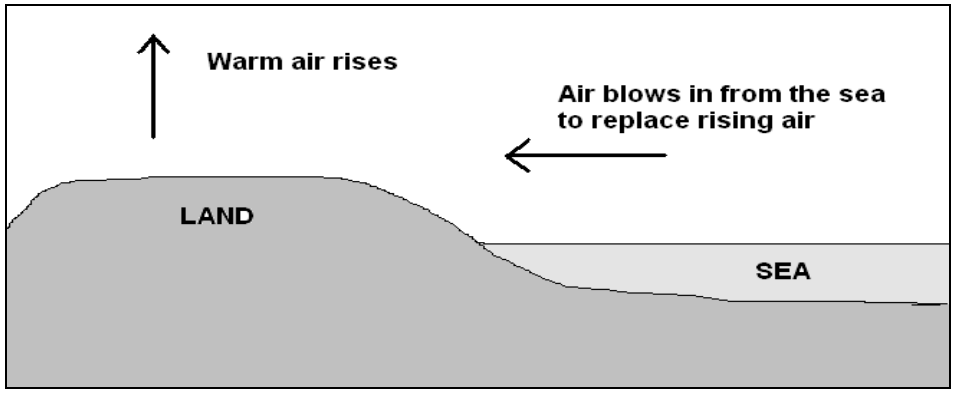
19. Which of the following does NOT describe the *amihan*?
    a. Brings lots of rain
    b. Brings cold weather
    c. Comes around July to September
    d. Comes from the northeast and moves southward

20. What is FALSE about ITCZ?
    a. It results in thunderstorms.
    b. It occurs in countries near the equator.
    c. It occurs in the Philippines all year round.
    d. It is a place where winds in the tropics meet, rise, and form clouds.

Answer key

1. c. nitrogen
2. d. Troposphere, Stratosphere, Mesosphere, Thermosphere, Exosphere
3. b. Stratosphere.
4. d. Troposphere
5. a. Troposphere
6. c. They are present in very small amounts.
7. Any two of the following: Too cold (far from the Sun); absence of ozone; absence of cloud cover (no water); low percentage of oxygen; high percentage of carbon dioxide
8. a. Changing temperature
9. d. It offers protection from the Sun's harmful UV rays.
10. d. The human population is increasing rapidly; more carbon dioxide will be released to the atmosphere.
11. b. The air temperature decreases with altitude

12. Water vapor collects in the atmosphere but falls as rain when they are heavy enough.
13. Plants use carbon dioxide to make food. When trees are cut, CO2 in the atmosphere will not be used up.
14. Mention any two of the following: Planting trees; Reducing use of gasoline and gasoline-related products (burning of these in car engines release CO2); Walking or riding a bicycle if travelling short distances.
15. a. It rises.
16. a. Land



17. d. Moves toward the place where warm air rises.
18. d. From high-pressure areas to low-pressure areas
19. c. Comes around July to September (The correct answer is around October to March.)
20. d. It occurs in the Philippines all year round. (The correct answer is: It only occurs during the warm months when our location received the direct rays of the Sun.)

References

Denecke. Edward Jr. J. (2009). Let's Review: Earth Science The Physical Setting. 3rd ed. New York: Barron's Educational Series, Inc.

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Tarbuck, Edward J.; Lutgens, Frederick K. (2004). Earth Science. 10th ed. Singapore: Pearson Education South Asia Pte Ltd.

Links

The Earth's Atmosphere
(http://csep10.phys.utk.edu/astr161/lect/earth/atmosphere.html)
The Greenhouse Effect
http://hyperphysics.phy-astr.gsu.edu/hbase/thermo/grnhse.html
Images of the Greenhouse Effect
http://www.ucar.edu/learn/1_3_1.htm
World Global Warming and Climate Change Solutions
http://worldglobalwarmingprevention.blogspot.com/

Unit 4
MODULE

3

SEASONS AND ECLIPSES

After talking about atmospheric phenomena in Module 2, it is only logical to move on to a discussion about the seasons. However, you may be wondering why eclipses are discussed with the seasons in this final module of the quarter. The reason is because the seasons and eclipses are caused by the movement of the Earth around the Sun, and the Moon around the Earth, respectively. We do not directly see the motions of the Earth and Moon but we can certainly observe the effects of their motion in the form of the seasons and eclipses.

Key question for this module

What is the relationship of the seasons with the position of the Sun in the sky?

Why do eclipses occur?

Seasons

According to the Philippine Atmospheric, Geophysical, and Astronomical Services Administration (PAGASA), the Philippines has two seasons using temperature and rainfall as bases: the rainy season from June to November, and the dry season from December to May. But the rainy season does not come at the same time in different places in the Philippines. For example, the rainy season along the western part of the country occurs when the *habagat* blows, while the rainy season on the eastern part of the country occurs upon the arrival of the *amihan*. In certain places of the Philippines, the dry season is further subdivided into the cool dry season from December to February, and hot dry season from March to May.

Why do the seasons occur in a regular manner? Why do the seasons change at practically the same time every year? What this means is that the cause of the changes in the seasons must be something that is repeated every year. That is what the students will find out in the following activity.

Activity 1

Why do the seasons change?

In this activity, the students will discover that the seasons change because the Earth is tilted and the Earth revolves around the Sun. Before doing this activity, the teacher should refresh the students' minds regarding the tilt of the Earth and its motion around the Sun (revolution). During the activity, the students will learn that sometimes the direct rays of the Sun will hit the Northern Hemisphere, and at other times the direct rays will strike the Southern Hemisphere. Whichever hemisphere receives the direct rays of the Sun, that hemisphere will experience summer. In the meantime, the other hemisphere will receive oblique rays and it will be winter there.

When the direct rays of the Sun hit the Northern Hemisphere, it will be summer there. At exactly the same time, it is winter in the other hemisphere, the Southern Hemisphere. But since the Earth moves around the Sun, the Earth will soon reach the other side of its orbit. There, it will be the Southern Hemisphere which will receive the direct rays from the Sun. This time it will be the Southern Hemisphere which will experience summer, and the Northern Hemisphere will experience winter.

Answers to Questions in Activity 1

Q1. The North Pole is tilted toward the Sun in June.
(That means that the Northern Hemisphere is also tilted toward the Sun in June.)

Q2. The North Pole is tilted away from the Sun in December.
(That means that the Northern Hemisphere is also tilted away from the Sun in December.)

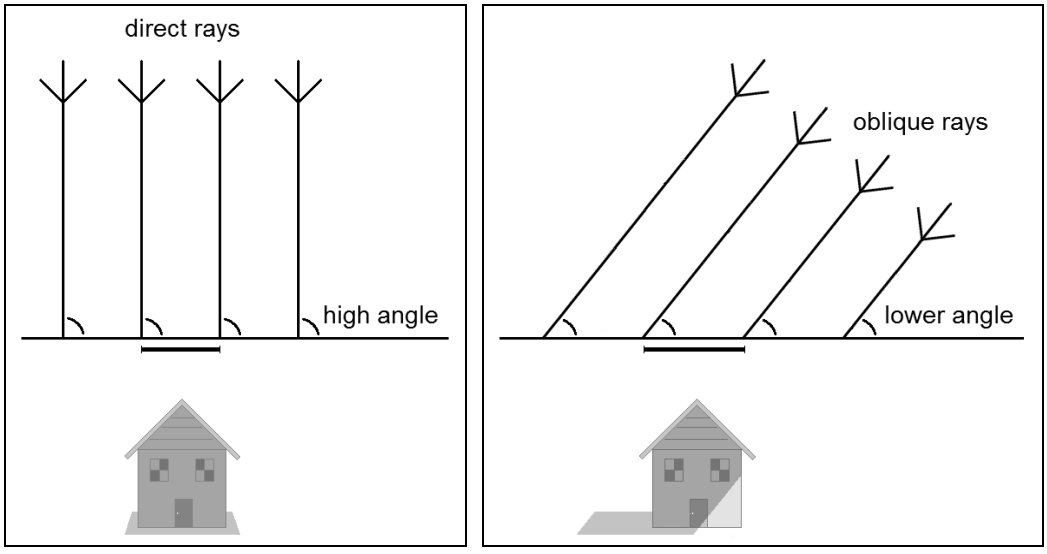
Q3. In June, the Northern Hemisphere receives direct rays from the Sun.
(This is the reason why it is warm during this time in the Northern Hemisphere. Actually, from April to August, different countries just north of the equator will receive direct rays and experience summer.)

Q4. In December, the Southern Hemisphere receives direct rays from the Sun. (Therefore it will be summer in the Southern Hemisphere in December. That is strange to hear for people like us who live in the Northern Hemisphere. Since the Northern Hemisphere will not receive direct rays, it will become cold and winter will fall.)

To summarize, the warm season is brought on by the direct rays of the Sun. But since the Earth is tilted, only one hemisphere receives direct rays at any one time and that hemisphere will experience summer at that time. Since the Earth goes around the Sun, there will come a time when the other hemisphere will receive the Sun's direct rays and that hemisphere will experience summer at that time. When

one hemisphere of the Earth is experiencing summer, the other hemisphere experiences winter. We do not experience winter in the Philippines because we are too near the equator. But we are happy nonetheless to experience a cold December, January and February.

A bit of explanation may be in order. What do “direct rays” mean? Direct rays mean that the rays of the Sun hit the ground at 90 degrees. 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. Study the drawings below.



You can also use the table below to illustrate why it is hotter during certain months of the year. As can be seen, the closer the height of the Sun is to 90 degrees, the “warmer” the month. We feel the oppressive heat in April, when the altitude of the Sun is 87.4 degrees. (Note: this is not the temperature of the surroundings. This is the angle between the horizon and the Sun.) It is cooler in December, when the Sun is much lower in the sky at 52 degrees.

Day	Height of the Sun (Altitude)	Day	Height of the Sun (Altitude)
Jan 22, 2011	55.6°	Jul 22, 2011	84.3°
Feb 22, 2011	65.1°	Aug 22, 2011	87.3°
Mar 22, 2011	75.9°	Sep 22, 2011	75.9°
Apr 22, 2011	87.4°	Oct 22, 2011	64.5°
May 22, 2011	84.3°	Nov 22, 2011	55.4°
Jun 22, 2011	81.2°	Dec 22, 2011	52.0°

Aside from the effect of the direct rays of the Sun, there are other reasons why it becomes hot during summertime (and cold during wintertime). The following activity will show another reason.

Activity 2

How does the length of daytime and nighttime affect the season?

In this activity, the students will analyze the data in a table that contains the times of sunrise and sunset in Manila. (You can get data for any locality through the internet. Just search for the times of sunrise and sunset and submit the proper latitude and longitude.) The students will learn that during certain months, the days become short while the nights grow longer. But during other months, the opposite occurs.

Answers to the Questions in Activity 2

Q1. From January to December, the time of sunrise changes from being late (6:25 am), then becoming earlier (5:27 am), then becoming late again (6:16 am). (The teacher must see to it that the students will realize that the Sun does not rise at the same time the whole year round.)

Q2. From January to December, the time of sunset changes from being early (5:50 pm), then becoming late (6:28 pm), then becoming early again (5:32 pm).

Q3. The Sun rose earlier on June 22, 2011.

Q4. The Sun set later on December 22, 2011.

Q5. Daytime was longest on June 22, 2011.

Q6. Daytime was shortest on December 22, 2011.

What is the effect of a long day, followed by a short night? Longer hours of daylight mean that the Sun is in the sky for a longer time. Thus, there is a longer time to heat up the surface of the Earth. And a short night means the time to cool down is less. So the heat adds up day after day. The result is summer. In contrast, a short day means a shorter time that the Sun is in the sky and there is less time for the surface of the Earth to warm up. And a long night means there is more time to cool down. This leads to the cold months that we are familiar with.

Before proceeding to the last section of this module, you must make sure that the students have realized that indeed there is a connection between the location of a country, such as the Philippines, and what makes up its environment. And in preparation for the next topic, let us be clear that eclipses do not occur preferentially

over a country because of its location. Eclipses are discussed here because they are a product of the motions and positions of objects in space—just like the seasons.

Shadows and Eclipses

The second part of this module will help students develop a scientific understanding on the occurrence of eclipses. The activities and discussions in the Module were sequenced in way that scientific bases are discussed first before explaining the beliefs attributed to eclipses. However, you can reverse the sequence of presentation, meaning do Activity 4 first before Activity 3.

Start the lesson with a shadow play to help students recall how shadows are formed and how shadows affect the surroundings. In the activity afterward, the students will be able to use what they just learned about shadows in understanding eclipses. The post-activity discussion will later show that there is a scientific explanation for the occurrence of eclipses. The students should be able to develop a scientific understanding of eclipses to promote scientific literacy in their community.

Pre-Activity

Teacher demonstration on formation of shadows

Materials

shoebox (or other cardboard box)
wax paper or white paper
tape
flashlight
small objects (such as plastic animals, pencil, coin)

What to do

1. Make two openings on the shoebox, one on top and another on the bottom (see figure below).

2. Cover one opening with wax paper (or white paper) and secure it with tape.
3. Hold a flashlight inside the box and shine the light on wax the paper.
4. Place the mystery object close to the flashlight. (The shadow will appear very big.)

5. Ask students to identify the shadows viewed on the wax paper. (At this distance, students cannot guess the shadows accurately).
6. Slowly move the objects away from the flashlight to make the shadow of the object clearer. (This time, students can now accurately guess the shadow.)
7. Do steps 4-6 to another mystery object.

Ask the following questions:

a. What is projected on the paper?
b. How are shadows formed?
c. What is the effect of shadows?
d. What are some things you noticed about shadows while the object changes its distance from the flashlight?

Teaching Tips

1. Draw out from the students the idea that shadows are formed when an object blocks light.
2. Let the students explain the effect of distance of objects on its shadow.

Activity 3

Are there shadows in space?

This activity will make use of the students' concept about shadows in space. It is a prerequisite concept in understanding the occurrence of eclipses. Remind students that in their group, they must agree with a common answer to each in each question in the activity. To do this, all of them must observe what is happening to the shadows. They should take turns in handling the materials so that everyone can see it.

1. Follow the steps in the procedure. The objects must always be in a straight line. The shadow of the small ball must be seen on the big ball. The shadow of the big ball must be seen on the white paper.

2. The distances of the objects must be followed strictly. The umbra is darker while the penumbra is paler when the materials are one foot step away from each other.

Teaching Tips

1. As suggested earlier, you can reverse the sequence of the activities by starting with students' beliefs about eclipses (Activity 4) before doing Activity 3.

2. If plastic balls are not available, students may use any smooth rounded object. You will not get the same result if you use something that has a rough surface.

3. The umbra and penumbra are dependent on the type of flashlight and the distance of the objects from each other. Make sure that the light of the flashlight does not 'spread out' too much.

4. Before the activity, find the distance where students can clearly see the difference between umbra and penumbra.

Discussion on the Activity

During the post-activity discussion, first review the formation of a shadow and its effect on the surroundings. Refer to Activity 3. Then introduce the idea that when the shadow is not seen, it does not mean that it has disappeared. When the object moves, the shadow moves with it.

Discuss the occurrence of eclipses by referring to the objects that were used in the activity, the figures in the modules, and the explanation about how eclipses occur. To check understanding, ask students to illustrate and explain in their own words how eclipses occur using the models used in the activity.

During the discussion on lunar eclipses, explain why the Moon will not become totally dark. The appearance of the Moon will depend on the color of the light that reaches it. When light from the Sun passes through the Earth's atmosphere, light with shorter wavelengths are scattered, leaving light of longer wavelengths to reach the Moon. So the color of the Moon during lunar eclipses may range from yellow through orange to red.

Answers to the Questions in Activity 3

Q1. None.

Q2. The shadow of the small ball is formed on the surface of the big ball.

Q3. The shadow of the big ball is formed on the paper.

Q4. As the small ball moves, its shadow moves too.

Q5. The shadow of the big ball darkened the small ball.

Activity 4

Does a *Bakunawa* cause eclipses?

The scientific bases on how eclipses occur have been discussed. In this activity you will collect and evaluate students beliefs related to eclipses.

Teaching tips

1. As suggested earlier, this activity can serve as springboard for the lesson on eclipses.

2. Ask students to interview elderly people in their family or in the community about beliefs and practice related to eclipses and to share these in class.

3. After doing the activity on "Are there shadows in space?" students must realize that some beliefs attributed to eclipses have no scientific bases. Emphasize also their roles in educating others about eclipses.

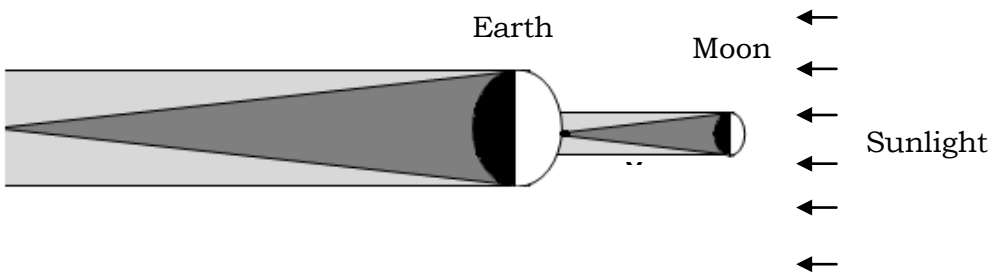
Answers to the Questions in Activity 4

Q1. Answers may vary

Q2. Answers may vary

PRE/POST TEST

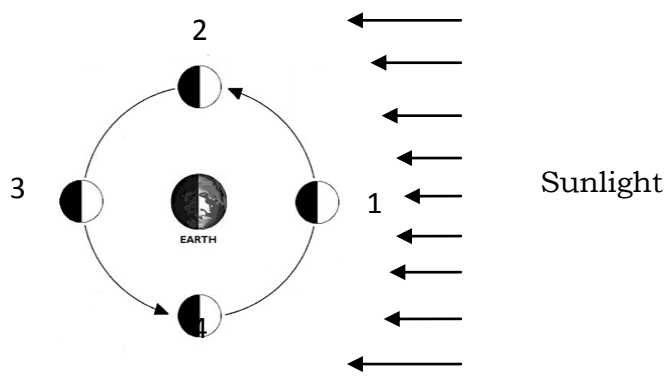
1. The diagram below shows the relative positions of the Sun, the Moon and Earth when an eclipse was observed on Earth. Positions X and Y are locations on Earth's surface.



Which statement correctly describes the type of eclipse that was occurring and the position on Earth where this eclipse was observed?

a. A total solar eclipse was observed in position X
b. A total solar eclipse was observed from position Y
c. A total lunar eclipse was observed from position X
d. A total lunar eclipse was observed from position Y

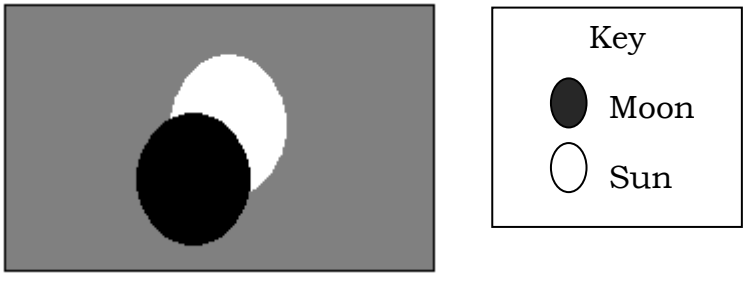
2. The diagram below shows the Moon at four positions in its orbit around Earth.



An observer on Earth could see a lunar eclipse when the Moon is at position

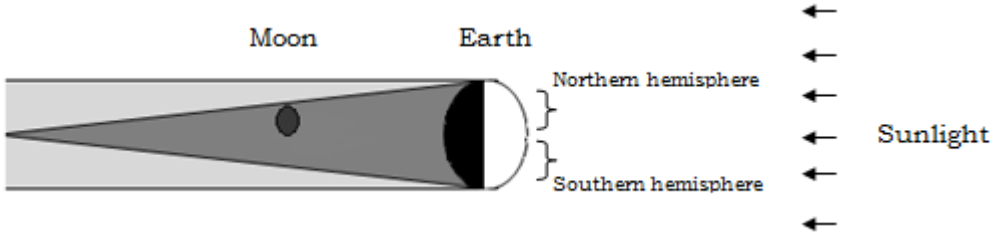
a. 1
b. 2
c. 2
d. 4

3. Below is an image of a partial solar eclipse as seen by an observer on Earth. Which part of the shadow do you think is the observer watching?



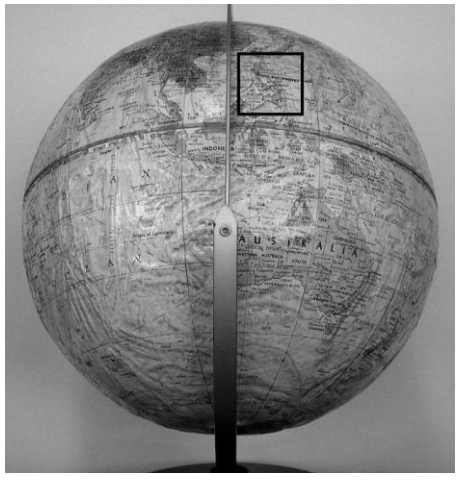
a. Penumbra of the Moon
b. Penumbra of the Earth
c. Between the umbra and penumbra of the Moon
d. Between the umbra and penumbra of the Earth

4. Where on Earth can a lunar eclipse be observed?



a. Daytime of northern hemisphere
b. Nighttime of northern hemisphere
c. Daytime of northern and southern hemisphere
d. Nighttime of northern and southern hemisphere

5. Study the globes below. They represent the Earth as seen from the direction of the Sun. In the left photo, the Northern Hemisphere is tilted toward the Sun. In the right photo, the Northern Hemisphere is tilted away from the Sun. The 'Philippines' is inside the black square. Which photo shows the Philippines during summer?



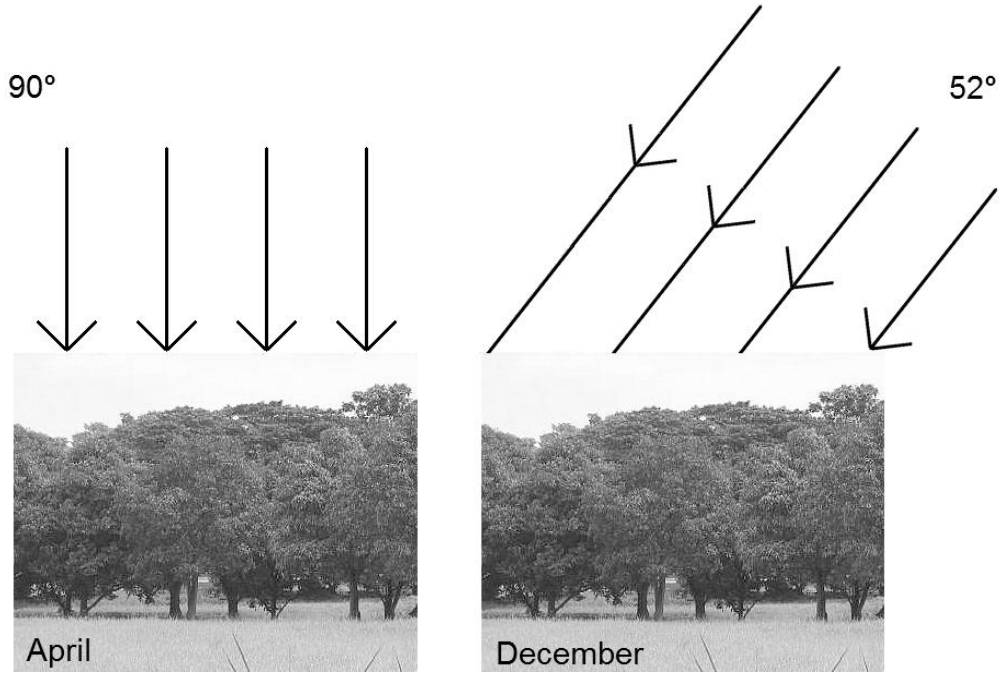
6. Study the data in the table below.

a. Fill in the last column.

b. Explain why it is likely to be hotter in April than in December.

Day	Sunrise	Sunset	Length of day
Apr 26, 2011	5:36 AM	6:12 PM	
Apr 27, 2011	5:36 AM	6:12 PM	
Apr 28, 2011	5:35 AM	6:12 PM	
Apr 29, 2011	5:35 AM	6:12 PM	
Apr 30, 2011	5:34 AM	6:13 PM	

Day	Sunrise	Sunset	Length of day
Dec 26, 2011	6:18 AM	5:34 PM	
Dec 27, 2011	6:19 AM	5:35 PM	
Dec 28, 2011	6:19 AM	5:35 PM	
Dec 29, 2011	6:20 AM	5:36 PM	
Dec 30, 2011	6:20 AM	5:36 PM	



7. Study the photos above. The arrows represent the rays of the Sun. Explain why it is warmer in April than in December?

Answer Key

1. a
2. c
3. b
4. d
5. The left photo shows the Philippines during summer.
6. a.

Day	Sunrise	Sunset	Length of day
Apr 26, 2011	5:36 AM	6:12 PM	12h 36m
Apr 27, 2011	5:36 AM	6:12 PM	12h 36m
Apr 28, 2011	5:35 AM	6:12 PM	12h 37m
Apr 29, 2011	5:35 AM	6:12 PM	12h 37m
Apr 30, 2011	5:34 AM	6:13 PM	12h 39m

Day	Sunrise	Sunset	Length of day
Dec 26, 2011	6:18 AM	5:34 PM	11h 16m
Dec 27, 2011	6:19 AM	5:35 PM	11h 16m
Dec 28, 2011	6:19 AM	5:35 PM	11h 16m
Dec 29, 2011	6:20 AM	5:36 PM	11h 16m
Dec 30, 2011	6:20 AM	5:36 PM	11h 16m

b. It is hotter in April because the days are longer during that month than in December.

7. It is warmer in April because of the direct rays of the Sun. Direct rays mean each square meter of the ground receives more solar energy than when the rays are inclined.

   Conversely, it is cooler in December because the Sun's rays hit the ground obliquely. Oblique rays spread solar energy over a wider area.

References

Denecke. Edward Jr. J. (2009). Let's Review: Earth Science The Physical Setting. 3rd ed. New York: Barron's Educational Series, Inc.

Institute for Science and Mathematics Education Development (1983). Earth Science: The Philippines in Focus. Diliman, Quezon City, Philippines.

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Links

http://www.pagasa.dost.gov.ph/
http://www.timeanddate.com/worldclock/astronomy.html