UNIT 1
Force, Motion, and Energy

UNIT 1: Force, Motion, and Energy

Overview

In Grade 7, students learned that energy exists in different forms and it can be transformed from one form to another. They also learned that energy can be transferred from one object or place to another in different ways. In Grade 8, students deepen their understanding of the different forms of energy by describing how the energy transferred affects, or is affected by, objects.

This unit has six modules. The first two modules discuss the effects of energy at the macroscopic level while the next four modules tackle these effects at the particle level. Module 1 focuses on the idea that if a net or unbalanced force acts on an object, the motion of the object will change. Module 2 picks up this idea and explains how the application of force can do work on an object with a corresponding transfer of energy. Module 3 describes the effects of heat on objects involved in energy transfer and explains these effects at the particle level. Module 4 deals with how energy affects the movement of charges in electrical circuits. Module 5 discusses how energy propagates through solids, liquids, and gases. It also describes how the speed of the energy transferred varies with some factors, such as temperature. Module 6 describes how the different colors of light differ in terms of their frequency and energy.

Most of the topics in this module are dealt with qualitatively in order for students to have a basic understanding of the concepts. Some tasks include measurements and computations in order to illustrate the relationship among quantities. Through the activities included in each module, it is also aimed to make students gain interest in these topics and motivate them to learn more in the succeeding grade levels.

The following ideas are expected to be developed among the students:

- Energy is transmitted in the form of **heat** from one place to another due to temperature differences or in the form of **mechanical work** (potential and kinetic energy).
- Energy affects objects. The effects are manifested in the changes that objects undergo. For example, energy can cause changes in the motion of objects, particles, or charges. It can also cause changes in some properties of matter such as temperature. The amount of change depends on the amount of energy transferred.
- The energy transferred can also be affected by the nature or kind of materials involved.

Unit 1
MODULE

1

FORCES AND MOTION

After learning about the ways by which the motion of an object can be described and represented in grade 7, students will now study the motion of objects using the concept of force. They will describe the effects of forces on an object and determine the relationship between the net force acting on an object and its acceleration due to this force.

Key questions for this module

Do forces always result in motion?

What are the conditions for an object to stay at rest, to keep moving at constant velocity, or to move with increasing velocity?

How is force related to acceleration?

This module aims to address the following misconceptions related to force and motion:

1. If an object stays at rest, there is no force acting upon it.
2. An object continues to move at constant velocity because a constant force acts on it.
3. If the speed of an object increases, its acceleration also increases.
4. Objects move because they have a force; they stop when their force is already used up. (Force is thought to be a property of a material)

Start the module by eliciting students' prior knowledge of force and motion. Questions such as the following may be asked:

- *What makes objects move the way they do?*
- *Why do objects move in different ways? Why are some objects faster than the others?*
- *What makes objects stay in place?*

Note that there are no correct or wrong answers yet at this point. Just take note of their answers and go back to some of them after they finish the module.

Balanced and Unbalanced Forces

1. To introduce the concept of FORCE, place a ball or any object on top of a table and ask:

    a) Will this object move by itself?
    b) How can we make this object move?
    c) While it is moving, how can we make the object speed up or slow down?
    d) How can make it stop?
    e) How can we make it change its direction?

    Ask students to describe or demonstrate how they can achieve the given conditions above. This will lead them to realize that to make the object move, speed up, slow down, stop, or change its direction, it has to be pushed or pulled. The motion of an object can be changed if we apply FORCE on it

2. Pose another question: *Consider again this ball here on top of the table. Since this ball stays at rest (meaning it does not change its motion) can we say that there is/are no force/s acting on it?*

Activity 1

Forces on objects at rest

- In this activity, students are asked to identify the forces acting on objects at rest. This is a very simple activity and the materials are readily available, so students can work on it individually or in pairs. This is to ensure that everybody is participating during the activity proper.

- At this point, students need not to explain why the objects stay in place. They may explain this after they finish doing Activity 2.

- During the post activity discussion, students can be asked to recall what they learned in the previous grades about the *force of gravity*. They may be asked to show or cite examples that demonstrate the presence of the force of gravity on Earth. If there is enough time, discuss more about gravitational force. Emphasis should be given on the following ideas:

    - Gravitational force is the attraction between any two bodies with mass.

    - Gravitational force increases with mass. If the mass of either object increases, the gravitational force between them also increases.

    - As the Earth attracts objects around it, these objects also attract the Earth. But the Earth is much more massive than them that is why their attraction is not as great as the gravitational pull of the Earth.

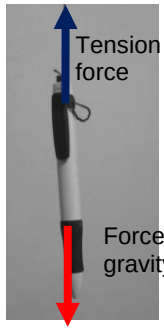
    - All things on Earth fall (or are attracted) towards the center of the Earth.

Answers to Questions

Situation 1: Hanging pen

Q1. The pen is at rest.

Q2. Yes. The forces acting on the pen are the tension force (the force exerted by the string on the pen) and the force of gravity.



Hanging pen

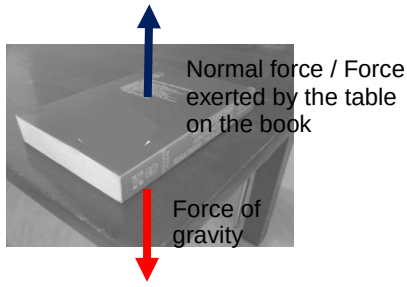
Q3. When the string was cut, the pen falls to the ground. The force of gravity makes the object fall down.

Situation 2: Book on a table

Q4. The book is at rest.

Q5. Yes. The forces acting on the book are the force exerted by the table on the book and the force of gravity.

Q6. No, the book stays at rest. The book may be moved by pushing it on one side only.



Book on a table

Activity 2

Balance of forces

The aim of this activity is to help the students understand how the forces acting on the objects in Activity 1 prevent them from moving.

- In case the number of spring balance is not enough, each group can work on the first part of the activity first using two spring balances. Then they can be asked to

join with another group to complete the 4 spring balances needed for the four holes around the board.

- During the post activity discussion, the students must realize that there are still forces acting upon objects at rest. But these forces balance each other thereby causing the objects to stay in place. Emphasize the following ideas:

  - If two forces acting on an object are equal in magnitude but opposite in direction, they are considered as balanced forces. These forces must lie along the same line.

  - If the forces acting on an object are balanced, the object either stays at rest or continues to move at constant velocity.

  - If the forces acting on an object are unbalanced, the motion of the object will change. This concept was discussed in the module using the rolling ball as an example. Emphasize that the ball slowed down and eventually stopped not because *its force was already used up* nor *the force acting on it was continuously decreasing* (misconceptions). The ball slowed down and stopped because an unbalanced force caused it to change its motion. That unbalanced force is friction. This can be reiterated when Newton's First Law of Motion is discussed.

Answers to Questions

Q7. The forces are equal in magnitude but opposite in direction.

Q8. If the lines of action of the forces are extended, they meet at a single point.

Note: At this point, the term "concurrent forces" may be introduced. When the lines of action of the forces acting on an object meet at a single point, they are considered as concurrent forces. When the forces acting on an object are concurrent, the object does not move nor rotate.

Concept check:

1. F_{net} = 20 units
2. F_{net} = 5 units. The object will move in the direction of the 10-unit force (larger force).
3. F_{net} = 0. The object will not move.

Newton's Three Laws of Motion

- If needed, introduce first Isaac Newton to the class. Discuss briefly some of his significant contributions especially in the field of physics. *e.g. Newton combined his idea and the ideas of the other scientists like Galileo to give us a more unified picture of how our universe works. He formulated the laws of motion and gravitation. Through his three laws of motion, we can describe and predict the movement of everything around us.*

Activity 3

Investigating inertia

This activity demonstrates how the inertia of an object affects its motion. Inertia is the tendency of the body to resist changes in its state of motion. This is described through Newton's First Law of Motion, also referred to as Law of Inertia.

Teaching Tips

- After discussing the result of the activity, relate the Law of Inertia to the previous discussion on balanced and unbalanced forces. Emphasize that if an object is acted upon by balanced forces, its motion or its velocity will not change. Since acceleration is defined as the change in velocity over time, then we can say that the object will not accelerate. It will only accelerate if the forces acting on it are unbalanced. This is what the Law of Inertia is all about. It states that, "*An object will stay at rest or move at constant velocity unless an unbalanced external force acts on it."*
- If time permits, discuss also the effect of mass on inertia: the greater the body's mass, the greater will be its inertia.
- For the application part, relate the concept of inertia to students' experiences while riding a vehicle. Then discuss the importance of using a seatbelt.

Answers to Questions

Coin Drop

Q9. When we slowly pulled the cardboard, the coin on top moved with the cardboard.

The frictional force acting between the coin and the cardboard caused the coin to stay on top of the cardboard and move with it.

Q10. When the coin was flipped quickly, the cardboard moved forward but the coin did not move with it. When the cardboard was removed from underneath it, the coin dropped into the glass.
The coin did not move forward with the coin because of the tendency of the coin to stay at rest (inertia).

Stack of Coins

Q11. When we hit the bottom coin with the edge of the ruler, it moved out from the pile of coins but the other coins stayed in place. The inertia of the coins has caused them not to move out with the coin that was hit by the ruler.

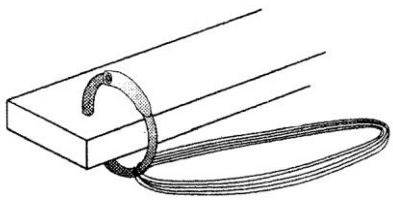
Activity 4

Force and acceleration

In this activity, students will describe the relationship between the unbalanced external force acting on an object and its acceleration by analyzing tape charts.

- If the materials are available, try to demonstrate how the data or tape charts were obtained. Hang four identical rubber bands from one end of a wooden bar as shown in Fig. 1. Then mark on the wooden bar the position where the rubber bands should be stretched (Fig. 2). When the rubber band is stretched, it pulls with it the cart. Make sure that the person holding the wooden board with rubber bands is free to move and ready to run, if needed to maintain the length by which the rubber band is stretched while pulling the cart. This is to ensure that the force acting on the cart is constant. The number of rubber bands used to pull the cart is related to the amount of force acting on the cart. If the number of rubber bands is changed, say doubled, the force acting on the cart is considered also to be doubled.

Figure 1



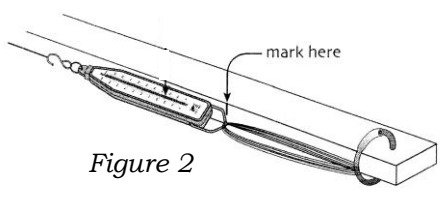


Figure 2

- Since they do not need to perform the activity, students can be asked to work on the tape charts (Figure 3) individually or in pairs. Note that their measurements may differ even if they are provided with the same copies of the tape charts. This is why they are asked to compute for the acceleration of the cart at least three times using different values of average velocity. Then they will just get the average.

- Relate Newton's Second Law of Motion, also called Law of Acceleration, to the previously discussed topics, particularly on the effects of unbalanced forces on the motion of objects.

- Since the law of acceleration quantifies the relationship among mass, force, and acceleration, it is but necessary to discuss also the effect of mass of the object on its acceleration. As the mass of the object increases, with the same amount of force applied, its acceleration also increases. To state in another way, if the same force acts on two bodies of different masses, the acceleration of the body with lesser mass is greater than the acceleration of the body with greater mass.

Answers to Questions

Tape chart analysis

Q12. We noticed that the lengths of the strips in all the tape charts are in increasing order.

In terms of the difference, we noticed that the amount of change in length of the strips differs among the tape charts. It is greatest in F=4 units.

Q13. The increase in lengths of the strips suggests that the average velocity of the cart at equal time interval increases.

The cart is accelerating.

This is also true to all other tape charts.

Q14. The increase in length of each strip from one strip to another is of equal size.

This indicates equal changes in the velocity of the cart at equal periods of time when the force acting on it is constant.

Yes, this is also true with the other tape charts.

Q15. The increase in length of the strips varies among the four tape charts. The amount of change increases as the units of force increases.

The increase in length is greatest in F = 4 units and least in F = 1 unit.

Q16. When the dots on top of the strips are connected, a straight line was formed. Yes, the same pattern exists for the other tape charts.

Quantitative analysis

Q17. The computed values of v_{ave} are increasing. The cart is accelerating.

Q18. The computed values of Δv are equal (or almost equal or very close).

This means that the cart is accelerating uniformly or its acceleration is constant.

Q19. The computed values of acceleration are equal (or almost equal).

Q20. The acceleration of the cart increases with the net or unbalanced force applied on it. Or as the amount of force applied on the cart increases, the acceleration of the cart also increases.

Activity 5

Action-reaction

The Newton's third law of motion, or sometimes called as Law of Action-Reaction, describes the relationship between the forces that two bodies exert on each other. In this activity, students should realize that these forces are equal in magnitude but opposite in direction.

- Make clear the difference between this pair of forces and the previously discussed balanced forces. Emphasize that this pair of forces are acting on different bodies, so they do not cancel each other out.

Answers to Questions

Q21. (answer may differ, but the values should be equal)

These values represent the amount of pulling force that we exerted on each other.

Q22. The forces that we exerted are in opposite directions.

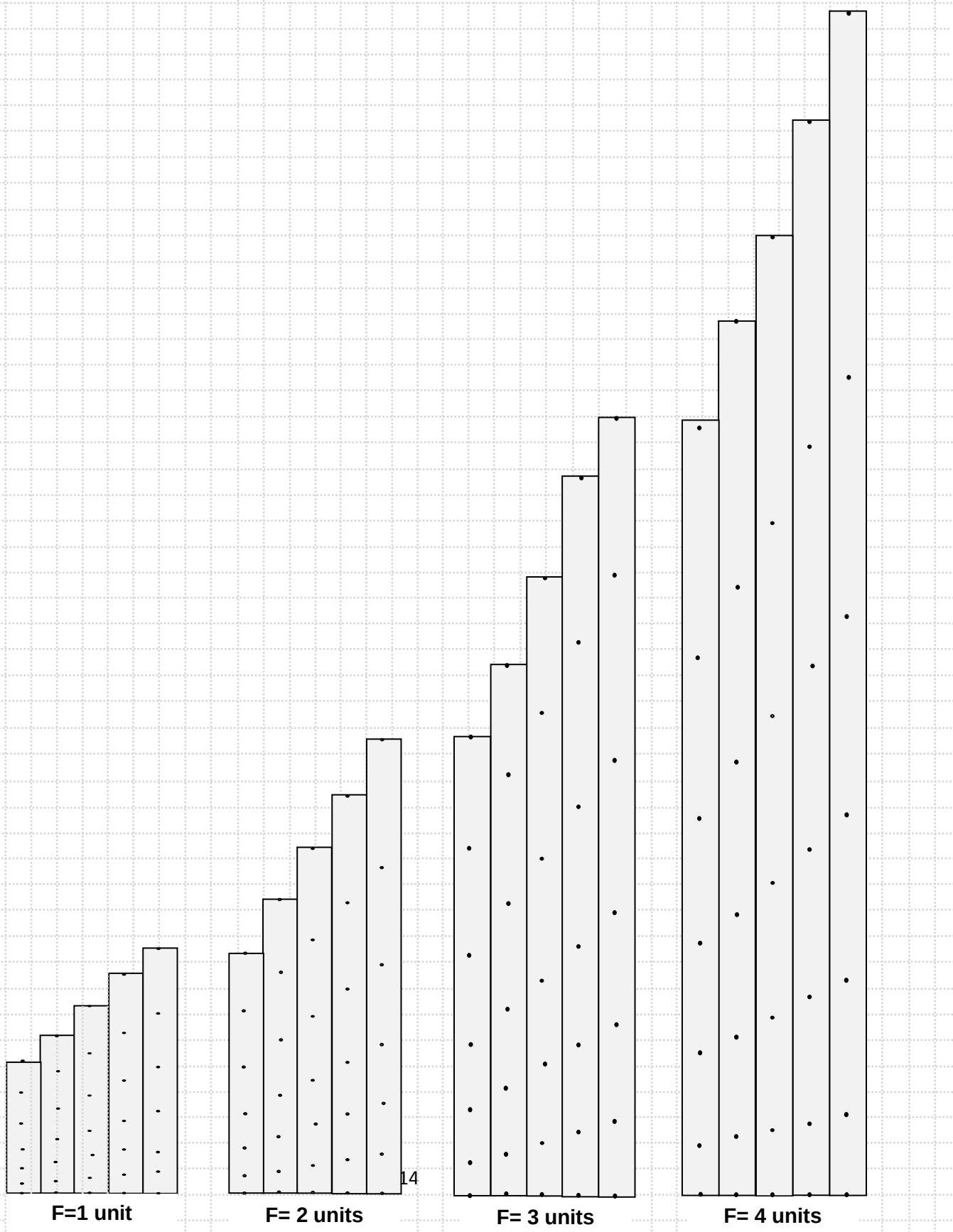
Q23. (*The readings this time should be greater than the previous ones*)

Q24. We increased the force that we exerted on each other.

Q25. (*readings may vary*)

Q26. The forces are of opposite directions.

Figure 3: Tape charts



Solutions:

For F = 1 unit V_1 = 2.5cm/0.10s = 25 cm/s V_2 = 3.0cm/0.10s = 30cm/s V_3 = 3.5cm/0.10s = 35cm/s V_4 = 4.0cm/0.10s = 40cm/s V_5= 4.5cm/0.10s = 45cm/s Solving for ***a*** $a_1 = \frac{v_2 - v_1}{t} = \frac{30cm/s - 25cm/s}{0.10s} = 50cm/s^2$ $a_2 = \frac{v_3 - v_2}{t} = \frac{35cm/s - 30cm/s}{0.10s} = 50cm/s^2$ $a_{ave} = 50cm/s^2$	**For F = 2 units** V_1 = 4.5cm/0.10s = 45 cm/s V_2 = 5.5cm/0.10s = 55cm/s V_3 = 6.5cm/0.10s = 65cm/s V_4 = 7.5cm/0.10s = 75cm/s V_5= 8.5cm/0.10s = 85cm/s Solving for ***a*** $a_1 = \frac{v_2 - v_1}{t} = \frac{55cm/s - 45cm/s}{0.10s} = 100cm/s^2$ $a_2 = \frac{v_3 - v_2}{t} = \frac{65cm/s - 55cm/s}{0.10s} = 100cm/s^2$ $a_{ave} = 100cm/s^2$
For F = 3 units V_1 = 8.5cm/0.10s = 85 cm/s V_2 = 10cm/0.10s = 100cm/s V_3 = 11.5cm/0.10s = 115cm/s V_4 = 13cm/0.10s = 130cm/s V_5= 14.5cm/0.10s = 145cm/s Solving for ***a*** $a_1 = \frac{v_2 - v_1}{t} = \frac{100cm/s - 85cm/s}{0.10s} = 150cm$ $a_2 = \frac{v_3 - v_2}{t} = \frac{115cm/s - 100cm/s}{0.10s} = 150cm/s$ $a_{ave} = 150cm/s^2$	**For F = 4 units** V_1 = 14.5cm/0.10s = 145 cm/s V_2 = 16.5cm/0.10s = 165cm/s V_3 = 18.5cm/0.10s = 185cm/s V_4 = 20.5cm/0.10s = 205cm/s V_5= 22.5cm/0.10s = 225cm/s Solving for ***a*** $a_1 = \frac{v_2 - v_1}{t} = \frac{165cm/s - 145cm/s}{0.10s} = 200cm/$ $a_2 = \frac{v_3 - v_2}{t} = \frac{185cm/s - 165cm/s}{0.10s} = 200cm$ $a_{ave} = 200cm/s^2$

Data for Table 1

Force	# of rubber bands	Acceleration
F = 1 unit	1	50 m/s^2
F = 2 units	2	100 m/s^2
F = 3 units	3	150 m/s^2
F = 4 units	4	200 m/s^2

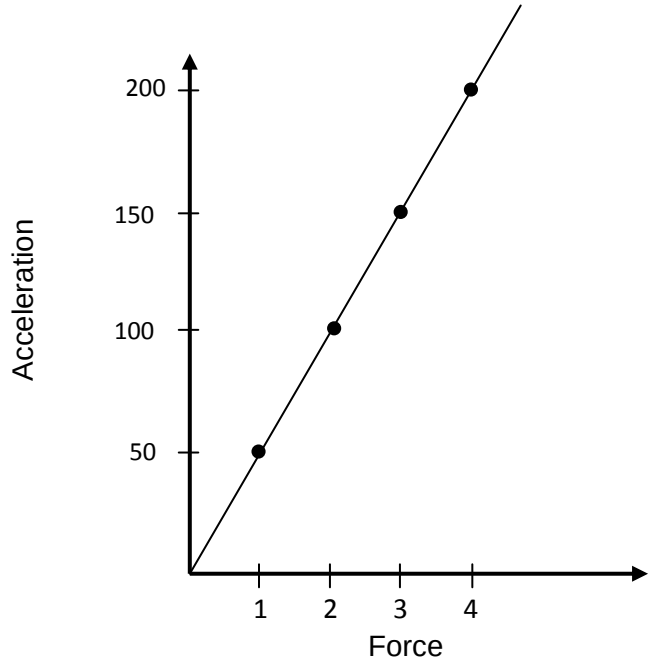


Figure 4: Graph of force vs acceleration

References

UP NISMED. (2002). Practical Work on High School Physics: Sourcebook for Teachers. UP NISMED. Quezon City

Unit 1
MODULE

2

WORK AND ENERGY

In this module, students will learn about motion from the perspective of work and energy. The concept of energy is one of the most important concepts in physics. The students have been studying about it since Grade 3 up to Grade 7. They have learned that energy takes many forms; there are different sources and uses of energy; and energy can be transferred.

The module starts with a discussion about *work*. In the first activity, they will explain whether a situation represents an example of work. It is followed by a discussion about work and energy, and then about kinetic and potential energy. In the second activity, students will construct a toy that demonstrates how a rubber band 'stores' energy. The last activity puts together the concepts of work, energy and power.

Key questions for this module

What is work?
What is energy?
How are work, energy and power related?

What is work?

Figures 1 to 3 in the student's module shows different situations. Ask the students to identify the one doing the work and on which object the work is done.

The students should be able to arrive at the concept that work is done on an object when the force applied to it covers a distance in the direction of the applied force.

Activity 1

Is there work done?

In this activity, students will analyze the situations shown in the illustrations. For them to explain if the situations represent examples of work they should be able to identify the one doing the work and on which object the work is done. They should also look into the direction of force exerted relative to the direction of the movement of the object or the distance covered by the applied force.

Teaching Tips

1. Ask the students what's the first thing that comes to their mind when they hear the word *work*.

2. Let them look for the meaning of *work* in a dictionary.

3. Recall the lesson about force in Module 1.

Answers to Questions

- A girl is pulling her toy car.
  Yes, the situation is an example of work. The work is done by the girl on the cart. The force exerted by the girl in pulling the toy car is in the same direction as the distance covered when the force is applied.

- A man is lifting a box to be placed on a table.
  Yes, the situation is an example of work. The work is done by the man on the box. The force exerted by the man is upward and the box is displaced upward.

- A girl carrying a bag walks down the street.
  No, the situation is not an example of work. There is force (the shoulder pushes up the bag) and there is displacement (the bag is moved horizontally). However, the line of action of the force and the displacement are not parallel but perpendicular. The distance covered is not along the direction of the applied force.

- A mango fruit falling from the branch
  Yes, the situation is an example of work. The work is done by the force of gravity on the mango. In this case, the mango loses energy as you will find out in the discussion of potential energy.

Calculating work

The students are given the equation of work in their module. However, the equation can only be used if the force is applied horizontally (pushed across the floor or ground) or vertically (lifted above).

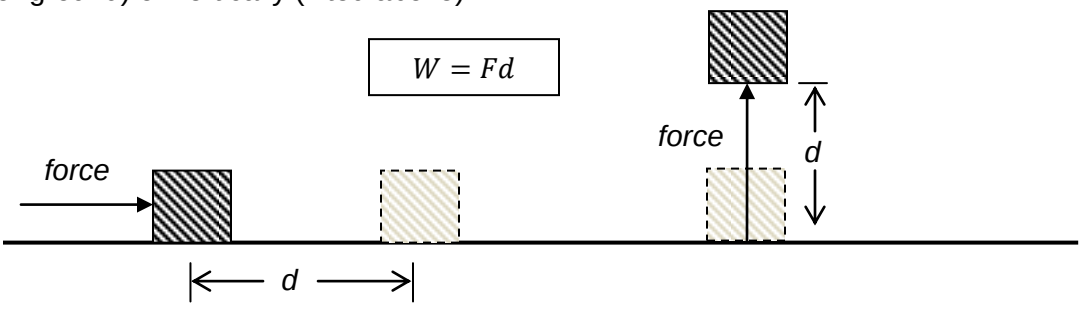


Figure 1. Equation for solving work

The equation of work for forces at an angle is not introduced to the students because they have not yet taken up *trigonometric functions* in their mathematics class. However, if the students ask how to solve for work if the force is at an angle, you may also show the equation.

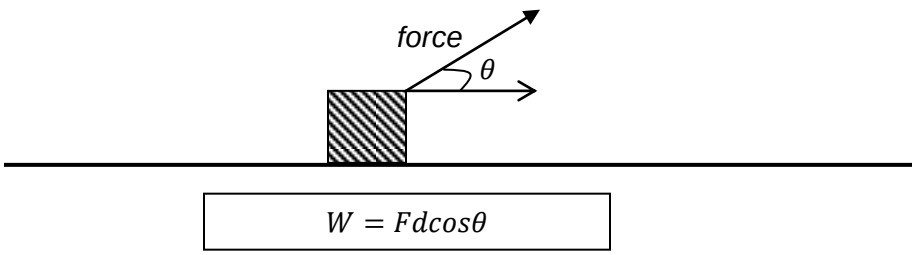


Figure 2. Equation for solving work if the force is at an angle

Answer to the problem:

A book which has a mass of 1 kg is on the floor. If the book is lifted from the floor to the top shelf which is 2 meters from the floor, how much work is done?

$$W = Fd$$

$$W = mgh$$

$$W = 1\ kg\ (9.8\ \frac{m}{s^2})(2\ m)$$

$$W = 19.6\ Nm\ or\ J$$

Work is a Method of Transferring Energy

- In Grade 7, students learned that there are different ways by which energy can be transferred from one place to another. This time, they will learn that work is a means of transferring energy from one object to another.

- Is there work done on the ball? In the bowling game described in the student's material, the work is done by the person on the ball to just start it moving. Because of the work done to the ball, it gained 'something' that enables it to move. That 'something' that was transferred to the ball is called energy. The energy became energy of motion of the ball.

- What can a moving ball do? A moving ball has energy. When it strikes the empty plastic bottle, it can push it through a distance. Thus, work is done by the ball on the empty plastic bottle. Since work is done on the bottle, energy is transferred to it.

- If energy can be transferred, what happens to the energy of the one doing the work and to the object on which work is done? The one doing the work loses energy and the object on which work is done gains energy. When work is done by an object, the object loses energy; when work is done on an object, the object gains energy. In the bowling game the students played, the one rolling the ball loses energy while the ball gains energy. When the moving ball strikes the empty plastic bottle it loses energy while the plastic bottle gains energy.

- Clarify to the students that it is energy and not force that is transferred when work is done.

- You may also show or demonstrate a billiard game wherein one ball hits another ball.

Kinetic Energy

- The energy of a moving object is called energy of motion or kinetic energy (KE). How the equation of KE is derived is shown in the student's module.

- The KE of an object depends on its mass and velocity. What will happen to the KE of an object if its mass is doubled but the velocity remains the same? The KE will be doubled. How about if the velocity is doubled but the mass remains the same? The KE is proportional to the square of the speed, thus if the speed is doubled, the KE will be quadrupled.

Answer to the problem:

A 1000 kg car has a velocity of 17 m/s. What is the car's kinetic energy?

$$KE = \frac{1}{2}mv^2$$

$$KE = \frac{1}{2}1000kg\ \left(17\ \frac{m}{s}\right)^2$$

$$KE = \ 144{,}500\ J$$

Potential Energy

Work is done in lifting an object. When work is done on an object, energy is transferred to it. Thus, an object lifted from the ground gains energy. Since the work is done against the force of gravity, it is called gravitational potential energy or simply potential energy (PE).

The force of gravity also acts on objects falling to the ground. As an object falls, the potential energy decreases because it is transformed to become the kinetic energy of the object.

The gravitational potential energy is the energy due to its position. This energy depends on the mass and height of the object. The height can be measured relative to an assigned level. But usually, the common reference level is the ground.

Teaching Tips

1. Point out that the higher the object is from the ground, the greater is its potential energy. The more massive an object is, the greater is its potential energy. These concepts were demonstrated in the problems.

2. Compare the potential energy of an object/s for different reference level.

Answer to the problem:

If the same 1.0 kg book is lifted 0.5 m above the table, but the table top is 1.0 m above the floor, what would be the potential energy of the book if the reference level were the floor?

$$PE = mgh$$

$$PE = 1\ kg\ x\ 9.8\ \frac{m}{s^2}\ x\ 1.5\ m$$

$$PE = 14.7\ N \cdot m\ \ or\ J$$

Activity 2

Rolling toy

- Prepare a sample toy made of a can instead of the transparent plastic container. This way the students cannot see the mechanism inside the can. Rotate the barbecue stick beforehand before asking them what they think will happen to the can when placed on the floor.

- After the activity, ask the students to demonstrate the game they played using a rubber band. Ask them how the rubber bands 'store' energy and what this energy can do once transformed to kinetic energy.

Answers to the questions:

Q1. It rolls.

Q2. Potential energy

Q3. Kinetic energy

Q4. Potential to kinetic energy

Work, Energy and Power

People possess energy. They get their energy from the food they eat. As shown and demonstrated in the previous lesson, this energy can be transferred to objects.

When people do things such as walking or running, they expend energy. The rate at which they expend energy is called power. Power is the rate of doing work or the rate of using energy.

Activity 3

How POWER-ful am I?

In this activity, the students will relate the concepts of work and energy to power. The energy expended in climbing a flight of stairs is equal to the gravitational potential energy, PE = mgh or weight x height.

Sample data for Table 1

Name	Weight (N)	Height of stairs (m)	Time taken to climb the stairs (s)	Energy expended (J)	Power (J/s)
Bella	441	5	10	2205	220
Troy	490	5	8	2450	306
Mae	392	5	10	1960	196
Elijah	441	5	9	2205	245

Answers to the questions (based on the sample data for Table 1):

Q5. Troy

Q6.

$$P = \frac{Energy}{time} = \frac{2450\,J}{8\,s} = 306\frac{J}{s}$$

Q7. Mae

Q8.

$$P = \frac{Energy}{time} = \frac{1960\,J}{10\,s} = 196\frac{J}{s}$$

Q9. Each member performed different amounts of work except for Bella and Elijah who performed the same amount of work because they weigh the same.

Q10. Power output is determined by the amount of work done or energy expended and the time taken to do the work.

Summary

Below is a list of concepts or ideas developed in this module.

- Work is done on an object when the force applied to it covers a distance in the direction of the applied force.
- Work is a way of transferring energy.
- When work is done by an object it loses energy and when work is done on an object it gains energy.
- The energy of an object enables it to do work.
- A moving object has energy called energy of motion or kinetic energy.
- An object above a specified level has energy due to its position called potential energy.
- An elastic object that is stretched or compressed or twisted has energy called potential energy.
- Power is the rate of doing work or the rate of using energy.

References

Henderson, Tom. (21 January 2013). Retrieved from http://www.physicsclassroom.com/class/energy/

Hewitt, P.G. (2002). *Conceptual physics*. USA: Prentice-Hall, Inc. Saddle River, New Jersey.

Kirkpatrick, L.D. and Wheeler, G.F. (1998). *Physics a world view*. USA: Saunders College Publishing

Ostdiek, V.J. and Bord, D.J. (1987). *Inquiry into Physics*. USA: West Publishing Company

DepEd. Science and Technology IV. SEDP Series. (1992). Philippines: Book Media Press, Inc.

Unit 1
MODULE

3

HEAT AND TEMPERATURE

In Grade 7, students learned about the conditions necessary for heat transfer to occur and the ways by which *heat* transfers from one place to another. This time, they will explore what happens to the object when *heat* is transferred to or from it. They will also learn about the factors that affect the amount of *heat* that an object can transfer. Students are also expected to understand the difference between heat and temperature. Furthermore, this module hopes to address the following misconceptions on *heat* and temperature:

1. *Heat* is a substance.
2. *Heat* is not energy.
3. *Heat* and temperature are one and the same.
4. The temperature of an object depends on its size or volume.
5. The amount of *heat* transferred is determined always by the change in temperature.

Key questions for this module

What happens to solids, liquids, or gases when they absorb or release *heat*?

Does *heat* affect all kinds of materials in the same way?

Are *heat* and temperature one and the same?

Notes:

- This module is good for 6 days. The experiments were made simple so that students will be able to finish them early and the discussion of the results can be done also on the same day.

- The word *heat* in the module is written in italic form to emphasize that it represents the quantity of thermal energy that is transferred to or from an object.

- Since the students will be using a laboratory thermometer in all the experiments, it is advised that the guides on how to use the device properly are discussed at the beginning of the chapter.

Activity 1

Explaining hotness or coldness

- In this activity, students will describe the hotness or coldness of water in terms of its temperature. They will also compare the amount of *heat* transferred to the water in terms of the changes in its temperature and describe the relationship between these two variables.

- The first part of the activity requires the students to recall their previous lesson on heat transfer. Since this is just a review of their previous lessons, students may be allowed to discuss their answers within their group. Make sure that the following concepts are made clear among the students:

    - ✓ *Heat* is a transfer of (thermal) energy between objects or places due to temperature difference.
    - ✓ *Heat* transfers from an object of higher temperature to an object of lower temperature.

- When determining the hotness or coldness of the water, make sure that students use different fingers for each water sample.

Sample Data

Container	Temperature		Change in temperature
	Initial	Final	
Container 1	12°C	56°C	44C°
Container 2	12°C	20°C	8C°
Container 3	12°C	12°C	0C°

Answers to Questions

Q1. *Heat* was transferred from my finger (higher temperature) to the cold water (lower temperature).

Q2. The water was cold. The energy was released from my hand to the water.

Q3. (Answers may vary, depending on how close the students' answers are to the measured value)

Q4. Container 1 or the container that was added with hot water
Container 3 or the container that was added with cold water

Q5. The water added to the containers are of different temperatures.

Q6. Heat transfer was taking place in containers 1 and 2. There was a change in the temperature of water in these containers.

Q7. Greater amount of *heat* was transferred in container 1. There was greater change in the temperature of water.

Q8. The amount of heat transferred is proportional to the change in temperature. The greater the amount of heat transferred to an object, the greater the increase in its temperature.

Activity 2

Dye in water

The aim of this activity is to explain why the temperature of water in Activity 1 increases when *heat* was added to it. Also, by observing the behavior of the dye through the water, students will describe the effect of *heat* transferred to the particles of water.

The greater the amount of heat transferred to an object, the greater the increase in the kinetic energy of the particles and the greater the increase in the temperature of the object.

Teaching Tips

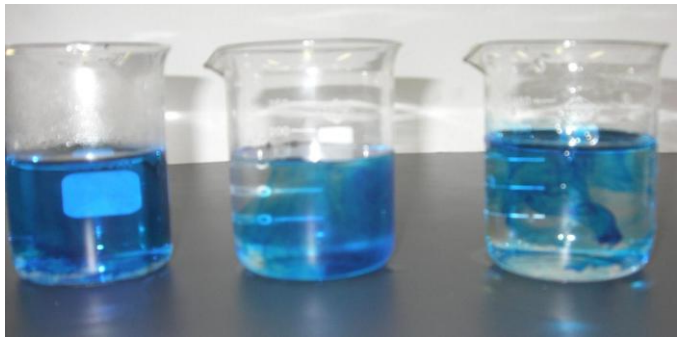
1. At this point, students should be made to realize that everything is made up of *moving particles*.

2. In Table 2, last column, students' observations must focus on the scattering of the dye through the water. Ask them to make comparisons, like *the dye scatters faster (or slower) or the dye scatters the most (or the least)*. They will later relate these observations to the speed of the moving particles.

3. At the end of the discussion, students should be able to recognize that "hotness or coldness" indicates how fast the particles move. "Hot" may be considered as faster movement of the particles or higher kinetic energy of the particles.

Sample data for Table 2:

Container	Temperature (^{0}C)	Observations
Container 1 (cold)	12 ^{0}C	Dye scattered the slowest
Container 2 (tap)	26 ^{0}C	Dye scattered slower than in hot water or faster than in cold water
Container 3 (hot)	76 ^{0}C	The dye scattered the fastest in this container



Hot water Water at room temp Cold water

Figure 1. Scattering of the dye among the three water samples

Answers to Questions

Q9. After putting drops of dye into the water, the dye scattered throughout the water. The rate of scattering of the dye differs in each container.

Q10. Hot water. Cold water.

Q11. The higher the temperature of the water, the faster the scattering of the dye.

Q12. The particles are moving fastest in the container with hot water. The particles are moving slowest in the container with cold water.

Q13. The higher the temperature of the water, the greater the speed of the moving particles.

Q14. The higher the temperature, the greater the kinetic energy of the particles.

Thermal Expansion

- Explain how liquid thermometers work using the concept of thermal expansion.

- Demonstrate the activity described or suggested in the module to explain thermal expansion of solid.

- Emphasize that objects or materials expand when heated and contract when cooled. But emphasize also that different materials expand or contract to different extents when heated or cooled.

- If time permits, ask the students to research more on the applications of thermal expansion to real life.

Phase Change

Activity 3.1

What happens when ice melts?

Teaching Tips

1. If the materials are available, some groups or students may be allowed to use a burner to heat the beaker of ice. Then let them compare their results and explain the difference in terms of the effect of the amount of heat absorbed by the ice to the time the ice takes to melt completely.

2. Students can be allowed to use an iron stand with clamp to hold the thermometer to ensure that it will not touch the bottom of the container.

3. At this point, some guides in constructing graphs might be needed. Note that the independent variable (heating time) is plotted along the horizontal axis while the dependent variable (temperature) is plotted along the Y-axis.

4. Try out the activity first to determine the amount of ice that will allow the students to finish their activity on time.

Answers to Questions

Q15. The ice melts because the *heat* from the surrounding (higher temperature) was absorbed by the ice (lower temperature).

Q16. The dependent variable is the 'temperature' while the independent variable is the 'time'.

Q17. *Descriptions may vary depending on how the graphs of the students look like. The accepted one should have a straight horizontal line like in the graph shown in Figure 2 below (melting*).

Q18. The temperature of the water while the ice was melting remains the same.

Q19. After the ice has melted the temperature of the water increases with time.

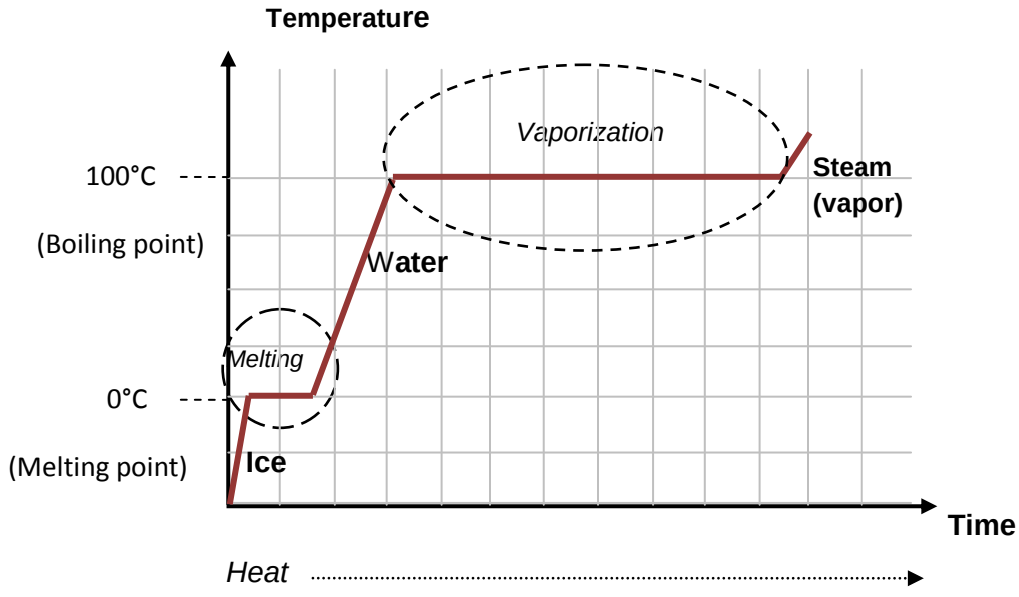


Figure 2

Activity
3.2

What happens to the temperature of water as it boils?

Q20. *Descriptions may vary depending on how the graphs of the students look like. The accepted one must have a straight horizontal line like in Fig. 2 (vaporization*).

Q21. *Both* graphs have a straight horizontal line but the temperature level corresponding to these lines differ.

Activity
4

What is the relationship between the mass of a material and the amount of *heat* it can transfer?

After students learned about the relationship between the temperature of the object and the amount of heat it can transfer, this time they will try to investigate on their own the relationship between the mass of the object and the amount heat it can transfer. In this activity, students are asked to plan and design their own investigation, including the steps on how they will gather and analyze data to come up with an answer to this question: *How does the mass of an object affect the amount of heat it can transfer?*

Example:

Students may fill identical containers with different amounts of water of the same temperature, say hot water. Then they pour both contents into two containers with water of the same amount and temperature. Then they measure the increase in temperature of water in both containers. The amount of increase in the temperature of water can be related to the amount of heat transferred to the object.

Activity

5

Comparing heat capacities

Teaching Tips

1. Make sure that the liquid samples are stored in the same room before the experiment to ensure that they will be of the same room temperature when they are used in the activity.

2. Aside from water and cooking oil, other samples of liquids can also be used.

3. If there are enough thermometers available, it is better to use a separate thermometer for each liquid sample.

4. During the post activity discussion, provide the class with the table containing the specific heat capacities of some materials. This will confirm their findings that different materials have different heat capacities.

5. During the post lab discussion, include some real life applications of specific heat capacity.

Answers to Questions

Q22. The water requires more time to increase in temperature.

Q23. The water requires more heat to increase in temperature.

Q24. The water has greater heat capacity.

Link

http://www.biol.wwu.edu/donovan/SciEd491/HeatTempUnit.pdf

Unit 1
MODULE

4

ELECTRICITY

In the previous modules, students learn about charges and how their charges determine the forces that exist between them. In this module, they will study charges as moving through conducting materials. Students will be dealing mostly on terms like voltage, current and resistance in studying electricity. In the first activity, they will determine how changing the voltage affects the current in an electric circuit. The second activity deals with how resistance affects the current in a circuit. The next activity talks about the two types of connection (series and parallel connections) and how the charges flow in these connections. The last activity of this module deals with the effects of too much current in the circuit on conducting materials, and how its effect can be useful in practicing safety practices in using electrical appliances in order to prevent accidents like fires or electric shock.

The topics covered in this module are relevant because of the applicability of the lesson in preventing accidents like fires caused by unsafe use of electricity.

Key questions for this module

How do voltage and resistance affect electric current?

What are the safety precautions needed in using electricity?

Current and Voltage

Electric charges can be made to move through a conducting material. The electric charges are the electrons of the conducting materials. Materials such as copper, steel, and aluminum have a lot of loosely held electrons which made them good conductors of electricity. Current is a measure of the number of charges passing through a cross-section of a conductor in a given time.

What is the direction of current? A battery has terminal marks "**+**"and "**-**". The plus (+) sign indicates surplus or excess of charge and the negative (-) sign means deficiency. The movement of charges from the positive side of the battery to the negative side is called ***conventional current*** or simply ***current***. However, this is not the actual motion of electrons in a circuit. The direction of the flow of electrons is from the negative terminal to the positive terminal. This is called ***electron current***. The direction of current does not affect what the current does.

An ammeter measures electric current. Because the device measures how much charges flow in a certain cross section at a given time, it has to be connected in series. Take note how the positive and negative signs of the ammeter and the terminals of the battery are oriented as shown in Figure 1.

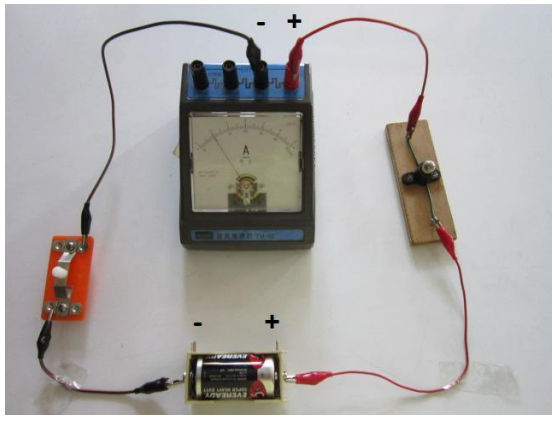


Figure 1. Ammeter connected in a circuit

Energy is needed to make the charges move. In Module 2, the students learned that when work is done on an object, energy is transferred. The voltage of a battery does the work on charges to make them move. Batteries are energy sources. The chemical energy in the battery is transformed to electrical energy. This electrical energy moves the charges in a circuit. The work done on the charges as it passes through a load is measured as the voltage across the load.

A voltmeter measures voltage. The voltmeter must be connected parallel or across the load as shown in Figure 2. The positive terminal of a voltmeter is connected to the positive terminal of the bulb while the negative terminal is connected to the negative terminal of the bulb as shown in Figure 2.

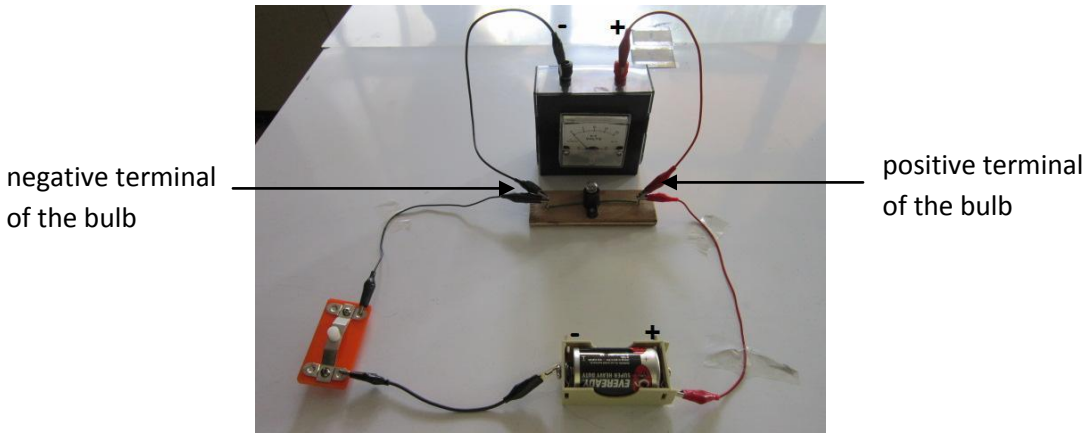


Figure 2. Voltmeter connected across the load

Activity 1

Current and voltage

- In this activity, students will determine how voltage and current are related.

- Students will use voltmeters and ammeters to measure the current and voltage in a circuit. Make sure that they follow the correct way of connecting the ammeter and voltmeter. If the school cannot provide voltmeters and ammeters, they can modify the activity by just relating the number of dry cellsor increase in voltage with the brightness of the bulb. The brighter the bulb, the bigger the current.

- The dry cells must be connected in series which means the positive terminal of one cell is connected to the negative terminal of the other.

- Ideally a switch must be included in the circuit so that they can turn off the circuit to avoid wasting energy. The teacher can make an improvised switch using illustration board and aluminum foil as shown in Figure 3.

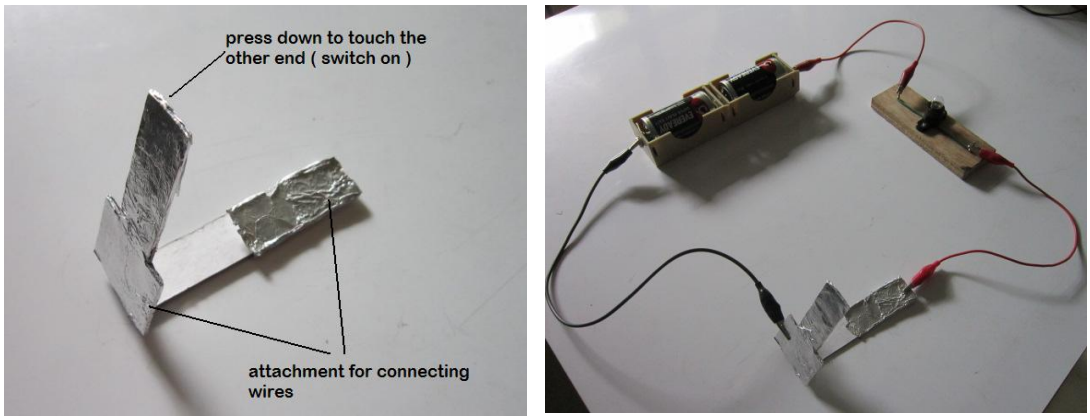


Figure 3. An improvised switch

- Be sure also to use new batteries for this activity especially when the brightness of the bulb is being asked. For the bulb, use a flashlight with a voltage rating of 2.5 V.

- In case no battery holders, use a cardboard to wrap two batteries tightly like a cylindrical holder. Tape the cartolina to secure the tightness of the connection of the batteries.

Answers to Questions:

Q1. (This will depend on the reading they get from the ammeter.)

Q2. The bulb glows brighter when two batteries are used.

Q3. (This will depend on the reading obtained in the ammeter.)

Q4. The current is higher for two dry cells as compared to one dry cell.

Q5. (This will depend on the readings obtained on the voltmeter.)

Q6. The bulb glows brighter.

Q7. This will depend on the readings obtained on the voltmeter.)

Q8. The voltage is bigger for two dry cells as compared to one dry cell.

Q9. For a constant load (one bulb), when the voltage increases the current also increases.

Sample Data

No. of batteries	Voltage (V)	Current (A)
1	1.5	0.2 A
2	2.5	0.3 A

Activity 1 Discussion

The dry cell provides the energy that moves the charges in a circuit. The dry cell must be connected by conducting wires to a load to form a complete circuit. Adding dry cells in series increases the voltage in a circuit.

In the activity, adding dry cells increases the current in a circuit as shown by the ammeter readings. The brightness of the bulb also indicates the amount of current passing through it. The bigger the current through the bulb, the brighter it glows. Both the meter readings and the brightness of the bulb show that voltage and current are related. The activity shows that as the voltage increases, the current also increases.

Current and Resistance

Another variable that can affect current is the resistance. As the term implies, the resistance of the material opposes the flow of charges. Resistance can also be measured and they are expressed in units called Ohms. A lower resistance would mean that there is less opposition in the flow of charges and therefore bigger current.

Different materials have different amounts of resistance. Conductors definitely have very little resistance and therefore allow more charges to pass through. Insulators are materials that have very high resistance and therefore flow of charges would be difficult.

The length and thickness of the conducting wire are factors that affect resistance encountered by current. The longer the wire the greater will be its resistance and the greater the cross sectional area (a measure of the thickness of the wire), the lower will be its resistance.

The resistance of an object also changes when the object becomes wet. Dry human skin for instance has a resistance of 100,000 ohms but when it gets wet its resistance is reduced to 1,000 ohms. That is why it is important to dry the hands when plugging an electrical appliance to reduce any chance of getting a lot of current if an accident occurs.

Understanding the relationship between current and resistance is important in protecting oneself from electric shock. The table below shows the physiological effects that happen when a certain amount of current passes through the human body.

Effects of Electrical Current in the Human Body[3,4]

Current	Reaction
Below 1 milliampere	Generally not perceptible.
1 milliampere	Faint tingle.
5 milliamperes	Slight shock felt; not painful but disturbing. Average individual can let go. Strong involuntary reactions can lead to other injuries.
6–25 milliamperes (women) **9–30 milliamperes** (men)	Painful shock, loss of muscular control. The freezing current or "let-go" range. Individual cannot let go, but can be thrown away from the circuit if extensor muscles are stimulated.*
50–150 milliamperes	Extreme pain, respiratory arrest (breathing stops), severe muscular contractions. Death is possible.
1,000–4,300 milliamperes	Rhythmic pumping action of the heart ceases. Muscular contraction and nerve damage occur; death likely.
10,000 milliamperes	Cardiac arrest and severe burns occur. Death is probable.
15,000 milliamperes	Lowest overcurrent at which a typical fuse or circuit breaker opens a circuit!

*If the extensor muscles are excited by the shock, the person may be thrown away from the power source. The lowest overcurrent at which a typical fuse or circuit breaker will open is 15,000 milliamps (15 amps).

Source: Department of Health and Human Services, Center for Disease Control and National Institute for Occupational Safety and Health

Activity 2

Current and resistance

In this activity, the students must be able to determine how resistance affects the current through the circuit.

- The purpose of the activity is to find if a relationship exists between current and resistance.

- If there is no ammeter available, the students can just compare the brightness of the bulb since the brightness is also associated with the current passing through them.

- In the last part of the activity, the students were asked to connect the ammeter at different points in the circuit. This is to show to them that current is the same anywhere in the circuit.

Answers to Question

Q10. The current decreases as the resistance increases or when the resistance increases the current decreases.

Sample data:

No. of bulbs	Current (A)
1	0.3 A
2	0.25 A
3	0.2 A

Q11. The current reading at different points of the circuit is constant.

Q12. The readings indicate that current is the same anywhere in the circuit.

Electrical Connections

Series Connection

Circuit A in Activity 3 is a series circuit. In a series circuit, loads form a single pathway for charges to flow. A gap or a break anywhere in the path stops the flow of charges. When one bulb is removed from the socket, a gap is created. The other bulb turns off as there is no longer current in the circuit.

The total resistance in a series circuit is equal to the sum of the individual resistances of the load (bulb). Current is the same in every part of the circuit. The current is equal to the voltage divided by the total resistance. As more load (bulb) is added in a series circuit, the smaller the current as reflected by the brightness of the bulb. The voltage across each load depends on the load's resistance. The sum of the voltage across each load is equal to the total voltage.

Parallel connection

Circuit B in Activity 3 is a parallel circuit. In a parallel circuit, loads form branches; each provides a separate path for charges to flow. A gap or a break in any branch will not affect the other branches. Thus, when one bulb is removed from the socket, a gap is created only for that branch. The other bulbs still glow as their path is still complete.

In a parallel connection the voltage is the same across each load. The total current is equal to the sum of the currents in the branches. The amount of current is inversely proportional to the resistance of the load.

Activity 3

What's the connection?

- In this activity students will find out how series and parallel connections are constructed. Giving them a situation to figure out how to do it stimulates problem solving skills of students.

- Be sure that when you let them do circuit A there should only be three wires for each group. For circuit B only four wires should be given. If the number of wires is not limited, they will not be able to execute the simplest way to demonstrate connections of bulbs in series and parallel.

- Tell the class to show them what they have constructed and check if it fits to the condition (one bulb unscrewed, then other one turns off for Circuit A; one bulb is unscrewed and the other bulb remains lighted for Circuit B). Usually the series connection is easier for the students. For parallel connections, students will experience some challenge in doing it.

- Most textbooks show parallel connections shown in Figure 6:

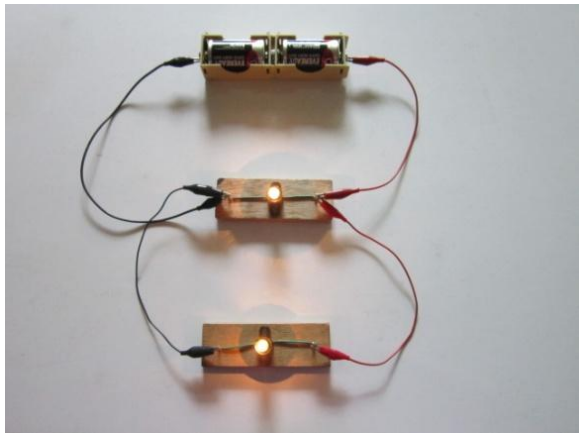


Figure 4 A parallel circuit

However, students might have another way of connecting the bulbs and these possible outputs shown below are also in parallel.

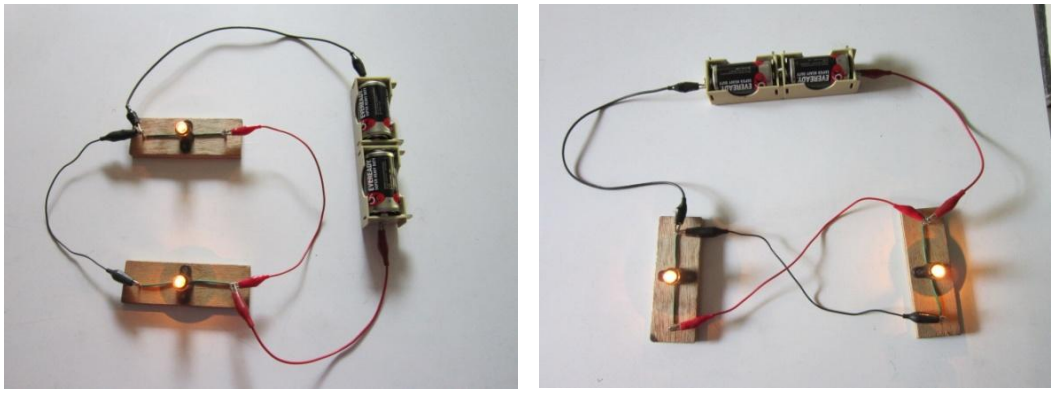


Figure 5 Parallel circuits

- In the last part of the activity, the students were asked to measure the voltage across the two bulbs and the voltage drop across each bulb in circuits A and B. Sample data is shown below:

Table 3

Circuit	Voltage drop (V)		Voltage across the two bulbs (V)
	Bulb 1	Bulb 2	
A	1.5	1.0	3
B	2.5	2.5	3

Circuit A shows that the voltage of the dry cell is divided between the two bulbs. The voltage depends on the resistance offered by the bulbs. If the bulbs are identical, the measurement should be the same.

Circuit B shows that the voltage across each bulb is almost equal to the voltage of the dry cells. This shows that in this type of connection, voltage is the same across any two points in the circuit.

Answers to Questions:

Q13. There is only one path for current in Circuit A.

Q14. Because there is only one pathway for the current, when one bulb is removed from the holder, it made a gap or a break in the path. A gap or a break anywhere in the path stops the flow of charges. All bulbs connected will go out.

Q15. There are two paths for current in Circuit B.

Q16. Since only the path of the unscrewed bulb has the gap, the other bulb shines because its path is complete. The current can still pass in the path of the bulb with a complete pathway.

Q17. Circuit B has brighter bulbs.

Q18. The current in Circuit A becomes smaller as more bulbs are added because the bulbs glow dimmer. The brightness of the bulbs in Circuit B remains the same as bulbs are added in the circuit. The current in Circuit B is bigger than in Circuit A.

Safety in Using Electricity

Fires can happen when the wires start heating up causing combustible parts of the house to be set on fire. The wires heat up when the current passing is more than what the wires can carry. In this case there is an **overloading of the circuit**. An example of how the circuit gets overloaded is by plugging a lot of appliances in a common outlet like an extension cord.

Another instance of overloading of the circuit is the presence of short circuits. Short circuits happen when wires with defective rubber insulation touch each other so the current does not pass to the supposed path it should take. It is a circuit where the current encounters very little resistance and therefore the amount of current will increase rapidly. Such increase in the amount of current leads to the overloading of the circuit and can lead to fires.

But why do wires heat up when there is too much current? In the wires the electrons that flow in a closed circuit collide with the atoms of the conducting wire. As the collisions take place the kinetic energy of the metal atoms increases. The increased kinetic energy of the atoms is dissipated as heat. You learn in the module on heat that temperature is related to the kinetic energy of the moving particles. The higher the kinetic energy of the particles, the higher will be its temperature. The higher the current passing through the wire, the more collisions between the electrons and the atoms of the wire take place. In the end the wire will become hot. So just imagine how much heat will be generated from an overloaded circuit.

Activity 4 Stay safe!

- There are two tasks in Activity 4. The first part shows how increasing the current can cause the wires to heat up. The second task shows how a short circuit happens.

- The fine copper wire to be used can be obtained from stranded electric wires. Remove the rubber insulation and get these fine copper wires for this activity

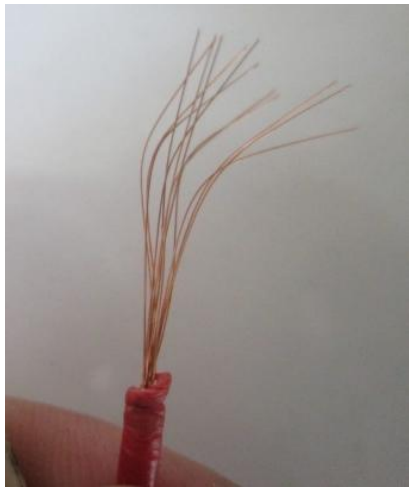


Figure 6 Strands of copper wires

- The first task shows the wire heats up melting the candle. The hotter the wire the deeper will be the cut made on the candle.

- The second task is a simulation of a short circuit. Supervise the students making sure that they don't let touching of the exposed parts of the wire take too long as the wires get hotter afterwards.

Answers to Questions:

Q19. The candle touching the wire melts.

Q20. The current in the circuit increases.

Q21. Heat is produced along the wire. The bigger the current in the circuit, the wire becomes hotter, and the more the candle will melt.

Q22. The light goes off when the wires touch each other.

Q23. The current took the path of the exposed part of the wire touching each other.

Q24. The resistance encountered in the short circuit where the charges flowed is lower.

Q25. The current in the short circuit increases.

Q26. Short circuits cause fire when the nearby materials near the wires becomes so hot and starts to burn.

Q27. Resistance decreases as more appliances are connected to one outlet.

Q28. The total current increases.

Q29. Overloading the circuit can make the wires hot setting combustible materials on fire.

References and Links

Henderson, Tom. (21 January 2013). Retrieved from http://www.physicsclassroom.com/class/energy/

Hewitt, P.G. (2002). *Conceptual physics*. USA: Prentice-Hall, Inc. Saddle River, New Jersey.

Kirkpatrick, L.D. and Wheeler, G.F. (1998).*Physics a world view*. USA: Saunders College Publishing

Ostdiek, V.J.and Bord, D.J. (1987).*Inquiry into Physics*. USA: West Publishing Company

DepEd.Science and Technology IV.SEDP Series. (1992). Philippines: Book Media Press, Inc.

http://www.allaboutcircuits.com/vol_1/chpt_3/4.html

Unit 1
MODULE

5

SOUNDS

This unit deals with the propagation of sound through solid, liquid, and gas. In the course of discussion, wave characteristics and properties particularly reflection and refraction will be taken into account. From the activities, students will be able to identify also the factors that affect the speed of sound.

At the end of the unit, students should be able to:

1. compare the speed of sound through solids, liquids and gases;

2. infer how the molecular structure of a material affect speed of sound moving through it; and

3. investigate the effect of temperature on speed of sound through fair testing

Related Misconceptions

1. Sounds can be produced without using any material objects.
2. Hitting an object harder changes the pitch of the sound produced.
3. Sounds can travel through empty space (a vacuum).
4. Sounds cannot travel through liquids and solids.
5. Sound travels slower in less dense medium.
6. The greater the density of the medium the faster the sound is transmitted.

Key questions for this module

On which medium does sound travel fastest? Solid, Liquid, or Gas?

How does the temperature of the medium affect the speed of sound?

How are reflection and refraction manifested in sound?

WORKSHEET 1: Solids, Liquids, and Gases

Direction: Using several resources and references, compare the different characteristics of solids, liquids and gases by completing the table below:

Comparing Solids, Liquids, and Gases

Characteristics	Solid	Liquid	Gas
Intermolecular spacing	very close	Slightly farther	Far from one another
Volume	Has definite shape	Takes the shape of the container	Takes the shape of the container
Ability to flow	Cannot flow	Able to flow	Able to flow
Compressibility	Not compressible	Not compressible	Highly compressible
Density	densest	dense	Low density

Facilitating Learning

Motivation

- The facilitator may start with the popular songs of popular artists like maroon 5, Justin Bieber, and Taylor Swift. Students may be asked to sing some of the popular tunes and ask them who are fun of watching concerts? Also ask them why concerts are usually done during night time and not during day time. Probe further until the concept of sound as a wave is deduced.

Facilitating Learning

- Introduce Activity No. 1 to arrive at the objectives: (1) to infer that sound waves are vibrations that travel through the air and (2) to infer that sound is transmitted in air through vibrations of air particles.

- Since Activity No. 1 includes two parts, emphasize the focus of each part so as to guide the students while on task.

- Data processing may be done by group presentation and class discussion of the guide questions to probe the concept that sound waves are vibrations that travel through the air and that sound is transmitted in air through vibrations of air particles.

- Discussion should also be extended to cover the differences and similarities of longitudinal and transverse waves and introduction to the characteristics of longitudinal waves.

- Then introduce Activity No. 2: Characteristics of Waves: Comparing Longitudinal Waves and Transverse Waves. In this activity the students will use a metal slinky to (1) distinguish the different characteristics of waves; (2) determine the frequency and wavelength; and (3) compute the wave speed based on the frequency and wavelength.

- Data processing may be done by group presentation. Class discussion of the data in tabular form and guide questions to the characteristics waves.

- Extend the discussion to emphasize that sound waves are also called pressure waves. From here, introductory discussion on factors affecting sound may be included.

- Then introduce Activity No. 3: Sound Race…Where Does Sound Travel Fastest?. In this activity the students should be able to distinguish which material transmits sound the best.

- Data processing may be done by group presentation and class discussion of the data and results in tabular form and guide questions to speed of sound in different media.

- Extend the discussion to include characteristics of other media like solids and liquids then let them do worksheet 1 and Activity No. 4: Chimes...Chimes...Chimes... In this activity, they will have to design their own chime and use this chime to determine how density of the material or medium affects the speed of sound.

- Ask where does sound travel faster? In hotter medium or cooler medium? Introduce Activity No. 5: Faster Sound...In Hotter or Cooler? In this activity the students will be able to determine how temperature affects the speed of sound.

- Extend the discussion to include calculation of the speed of sound with respect to the temperature of the medium. Let them do Worksheet No. 2.

- Summarize Lesson 1 by going back to the key questions particularly questions 1 and 2.

- Use the question posted in the motivation to introduce the concept of properties of sound. Then introduce Activity No. 6: Reflecting and Refracting Sound...

- Data processing may be done by group presentation and class discussion of the data and results in tabular form and guide questions to refraction and reflection of sound waves.

- Extend the discussion to include practical application of sound reflection and refraction.

- Summary of the whole module may be probed by asking the 3rd key question and by asking for insights and experiences they had during the preparation, presentation and post-presentation discussion of their outputs.

Activity 1

The dancing salt and the moving beads!

In this activity, students will be able to infer that sound is KE of vibrations that travel through the air; and sound is transmitted in air through vibrations of air particles.

Answers to Questions:

Q1. The salt bounced up and down.

Q2. When the small can is tapped loudly or forcefully.

Q3. Sound was produced when the small can is tapped. Yes the salt bounced up and down the plastic top while tapping the small can.

Q4. The sound produced in the small can made the plastic top of the large can vibrate making the salt bounce up and down.

Q5. Sound waves are vibrations of air particles.

Q6. The rock salt bounced higher the loudness of the sound is increased.

Q7. The amplitude of the wave.

Q8. The other colored beads collided with the blue bead.

Q9. Yes

Q10. Yes

Q11. Sound wave is classified as a longitudinal wave.

Activity 2

Characteristics of waves: Comparing longitudinal and transverse waves

In this activity, students will be able to distinguish the different characteristics of waves; determine the frequency and wavelength; and compute the wave speed based on the frequency and wavelength)

Answers to Questions:

Q12. frequency

Q13. Wavelength is decreased provided the frequency of shaking or disturbing the medium is the same or constant.

Activity 3

Sound race... Where does sound travel fastest?

In this activity, students will be able to distinguish which material transmits sound the best.

Answers to Questions:

Q14. Yes / Yes/ Yes

Q15. Yes / Yes / Yes

Q16. Wood/Water/Metal/Metal

Q17. The sound seems louder in the string as compared to air.

Q18. Yes

Q19. Yes

Activity 4

Chimes...Chimes...Chimes...

In this activity, students will be able to infer using improvised chimes that closely spaced particles of the medium are best transmitters of sound.

Answers to Questions:

Q20. Chime 2

Q21. Chime 2

Q22. Chime 3

Q23. Chime 3 / Chime 3

Q24. The chime with packed string objects produces sound that reached the farthest distance.

Q25. Chime 3

Q26. The more closely distanced the stringed objects in the chime, the better the sound is transmitted.

Activity 5

Faster sound...In hotter or cooler?

In this activity, students will be able to be able to determine how temperature affects the speed of sound.

Answers to Questions:

Q27. HOT cylinder

Q28. HOT cylinder

Q29. HOT cylinder

Q30. HOT cylinder

Q31. The higher the temperature, the faster the sound travels.

Activity 6

Reflecting and refracting sound

In this activity, students will be able to be able to observe how longitudinal waves reflect and refract.

Answers to Questions:

Q32. The compressions or rarefactions bounce off after hitting the wall

Q33. No they are not found on the same positions

Q34. Sound will also bounce off when it strikes a fixed end or the wall

Q35. The frequency of the wave increases

Q36. Increase in frequency of the sound is manifested as change in pitch

Q37. Amplitude increases

Q38. Louder sound is observed

Q39. Faster waves

References

http://www.hk-phy.org/iq/sound_night/sound_night_e.html

http://www.schoolphysics.co.uk/age11-14/Sound/text/Refraction_of_sound/index.html

Unit 1
MODULE

6

COLORS OF LIGHT

This unit is concerned with the demonstration of understanding of the some properties and characteristics of light. Among the characteristics and properties of light, we focus on refraction and specifically dispersion of light. We will try to find out through simple activities on how light disperse to form the colors of light. We will also try to find the hierarchy of colors of light in terms of frequency, wavelength, and energy. The different activities provided in this module will make us realize the beauty of everything with light.

At the end of the unit, students should be able to:

1. demonstrates the existence of the color components of visible light using a prism or diffraction grating;
2. infers that color is a manifestation of visible light's frequency or wavelength;
3. explains that red is bent the least and violet is bent the most according to their wavelengths or frequency; and
4. explains the hierarchy of colors in relation to energy.

Key questions for this module

How are refraction and dispersion demonstrated in light?

In the different colors of light, which is bent the most and the least?

Why do we see spectacular events in the sky like rainbows, red sunset and blue sky?

Facilitating Learning

Description of Activities

- ***Activity 1: The Colors of the Rainbow...The Colors of Light..***

  (The students will be able to infer that white light is made up of many different colors of light and each of these colors of light bends differently.)

- ***Activity 2: Red vs. Blue***

  (Students will be able to infer that *Violet light bends more than red light when dispersed; and Bending depends on the refractive index, frequency and energy of the color of light.)*

- ***Activity 3: Which Color has the MOST energy?***

  (Students able to infer that the energy of the colors of light increases as one goes towards the right side of the color spectrum and red light has the least energy and blue light has the most energy.)

- ***Activity 4: The Spectrum Wheel....Revisited...***

  (Students will be able to infer that light is composed of colors of light of different frequencies and wavelength; the frequencies of the colors of light are inversely proportional the wavelength; the product of frequency and wavelength of the color lights is a constant; and the arrangement of colors of light shows the hierarchy of the color of light's corresponding energy.)

- ***Activity 5: Scientific Explanations behind my Beliefs...***

  (Students should be able to come up with a presentation of the scientific explanations of certain superstitious beliefs related to observable phenomena in the sky.)

Motivation

- The facilitator may introduce a character named Roy G. Biv. Ask students whether they are familiar with the character. Ask them also if there is a connection between the character and the lessons. Ask the students if they could guess some information or concept from the name of the character. If the students recognize the colors of light then ask key question no. 3. Follow it up by the 1st 2 key questions.

- As a brief review, introduce the concept of apparent depth and the concept of refraction of light. Have a recall of the equation for index of refraction.

- Introduce the concept of dispersion as a special kind of refraction. Let them perform Activity 1 which will give students more information about how visible light refracts in different optical densities resulting to different colors of light. This activity is composed of two parts. One makes use of locally available materials while the other makes use of the standard materials like prism and artificial source of light. A comparison of the two may be highlighted during the discussion of results.

- The facilitator may let the students present their outputs per group and processing be done after all the groups have presented by culling ideas and concepts from the presented data and probing students to arrive at the concept of colors of light.

- From the students' outputs in Activity 1, the facilitator may ask why a certain hierarchy of colors of light is observed. Then introduce Activity 2 and let the students perform the activity to determine which is really more bent: the red light or the violet light. This will be explicitly described by the students during the processing when they present their outputs which would include the relation of the bending and the index of refraction of the color of light.

- The facilitator may let the students present their outputs per group and processing be done after all the groups have presented by culling ideas and concepts from the presented data and probing students to arrive at the concept that blue is bent more or violet is bent more than red light.

- Then ask the students which color of light gives the most energy. Let them predict – red or violet light. Let them perform Activity 3. The facilitator may let the students present their outputs per group and processing be done after all the groups have presented by culling ideas and concepts from the presented data and probing students to arrive at the concept that blue or violet has the highest energy and red has the least.

- Ask the students on which other characteristics of color of light does energy of colors depend on to introduce Activity 4. This activity was already done in Grade 7. The focus of the activity in Grade 7 was to identify the corresponding frequency and wavelength of the each color of light and the computation of the speed of each of the colors of light. This time the focus is on how energy relates to the frequency of the colors of light. From the given materials, students will be able to determine the relationship between frequency and the energy of the colors of light. Then the facilitator may ask which is really more bent the red light or the violet light?

- Then ask them some inferences on how rainbows are formed. Ask them also some superstitious beliefs that the students are familiar of related to the existence of rainbows.

- Let them identify all the major concepts they were able to grasp from activity nos. 1, 2, 3, and 4 to build a concept on how rainbows are formed. Then let them do Activity 5.

- Let the students present their outputs per group. Then go back to the key questions to be able to summarize the concepts on visible light.

Answers to Questions:

Activity 1

The colors of the rainbow… The colors of light

Q1. RED, ORANGE, YELLOW, GREEN, BLUE, VIOLET

Q2. From Top to Bottom: Red, Orange, yellow, Green, Blue, Violet

Q3. The refractive index of prism varies with the wavelength or color of the light used. This causes the different colors of light to be refracted differently. Then leave the prism at different angles, creating an effect similar to a rainbow

Q4. Some colors visible in the prism were not observed in the water

Q5. Small value for refractive index is observed in red and large refractive index for red

Q6. The refractive indices of the different color of light indicate that light of different colors travels at different speeds in the prism which accounts for the different amounts of bending. Thus, blue light with greater refractive index refracts more and appears at the bottom of the red light

Activity 2

Red vs Violet…

Q7. Yes

Q8. RED, ORANGE, YELLOW, GREEN, BLUE, VIOLET

Q9. BLUE LIGHT

Q10. The greater the refractive index of the color of light, a greater bending is also observed.

Activity 3

Which color has the most energy?

Q11. RED

Q12. Violet

Q13. Violet

Q14. RED

Q15. RED

Q16. Violet

Activity 4

The color spectrum wheel revisited

Q17. VIOLET, VIOLET

Q18. RED, RED

Q19. The wavelengths and frequencies of the colors of light vary. The wavelength decreases from red to violet while the frequency increases from red to violet.

Q20. White light separates into color light because it refracts with different refractive indices while passing through a medium like a prism.

Q21. YES

Q22. As the frequency of the color of light increase, the energy also increases. Red has the least frequency with the least energy and Violet has the highest frequency and the highest energy.

Q23. The higher the frequency of the color of light, the greater is its energy.

References

Hewitt, Paul. (1989). Conceptual physics (6th Ed.) London: Scoot, Foresman and Company

http://users.hal-pc.org/~clement/Simulations/Mixing%20Colors/rgbColor.html

http://www.cs.brown.edu/exploratories/freeSoftware/repository/edu/brown/cs/exploratories/applets/combinedColorMixing/combined_color_mixing_java_plugin.html

http://www.shs.d211.org/science/faculty/MJP/s369/light/docs/RayDiagrams.htm

UNIT 2
Earth and Space

UNIT 2: Earth and Space

Overview

What will students learn about Earth and Space in Grade 8? As in the previous grade, there will be three modules in this quarter: Module 1 is about *Earthquakes and Faults*. Module 2 is on *Understanding Typhoons*, and Module 3 will be about the *Other Members of the Solar System*.

In Module 1, we continue to emphasize the idea that our location on the globe is intertwined with what we experience in our daily lives. For instance, the Philippines is located along the Ring of Fire. This means that earthquakes and volcanic eruptions are normal occurrences in our country.

We share the same fate with other countries that surround the Pacific Ocean, including Indonesia to the south and Japan to the north. They too have faults in their land where energy is locked for some time before it is unleashed in devastating earthquakes.

Similar to our two neighboring countries, we are surrounded by the sea. And whenever the seafloor is suddenly jolted by a strong earthquake, a tsunami is generated and our coastal areas are swamped with deadly waves. Mindanao and Mindoro have been victims in the not-so-distant past.

In Module 2, we find out why we are prone to typhoons, too. In fact, The Philippines is hit by about 20 tropical cyclones each year. This number is an average, so sometimes we get more than that. What conditions in the vicinity of our country favor the formation of tropical cyclones?

Our country is located near the equator, surrounded by bodies of water. This combination means there is heat to warm up the waters of the ocean and produce a lot of water vapor. The rising warm air will soon turn into a low-pressure area that may intensify into a tropical cyclone.

If only the Philippines were at a higher latitude, it would suffer less tropical cyclones because the surrounding waters would be colder. Or if the Philippines were at the equator, it would likely be free of tropical cyclones because there is no Coriolis force to make the air spin.

Or if only there was a landmass in the way that would dull the edge of a tropical cyclone that came in from the Pacific. Alas, there is no such luck. The Philippines is located right where tropical cyclones form and there is nothing to do but learn how to survive their annual onslaught.

In Module 3, we will take up comets, asteroids, and meteors. Luckily, the Philippines is not a favored target. But even without a direct hit, everyone will be affected if a really large chunk of rock came crashing from outer space. The last time that happened, it ended the reign of the dinosaurs. So studying these foreign objects may pay off in the long run.

Unit 2
MODULE

1

EARTHQUAKES AND FAULTS

In Grade 7, the students learned that the Philippines is one of the countries located along the Ring of Fire. The Ring of Fire refers to the region around the Pacific Ocean that are commonly hit by earthquakes and volcanic eruptions. Earthquakes will be covered in this grade level while volcanic eruptions will be tackled in the next.

Every now and then, a strong earthquake hits the Philippines, leading to numerous deaths and widespread destruction. We cannot stop this natural event from occurring. And up to now, scientists have not found a way to predict when an earthquake will occur. Thus, students must learn about earthquakes in order to survive.

Key questions for this module

Why do earthquakes occur?

What is the relationship between earthquakes and faults?

What is a Fault?

Earthquakes occur when rocks along a fault suddenly move. The first thing to do then is to learn what a fault is. A fault is a break in the Earth's crust along which significant movement has taken place. Let us go through the definition in more detail.

The word "break" refers to a crack in the ground. The word "crust" refers to the outermost layer of the Earth. We live on the surface of the crust. "Significant movement" means that the rocks have been displaced or shifted considerably.

Activity
1

A fault-y setup

Activity 1 is short and easy to do. All that is needed are sand and two pieces of cardboard and the students are ready to go. Tell the students to work on top of the newspaper to avoid sand spilling everywhere. The activity is supposed to simulate what the ground looks like as rocks move along a fault.

Teaching Tips

1. Figure 1A is the starting point. Lay the two sheets side to side. Make the sand top flat so everything can be seen clearly. The two parallel lines are there so that the displacement will be obvious to the observer. Figure 1B, C, and D shows how a crack forms in the sand.

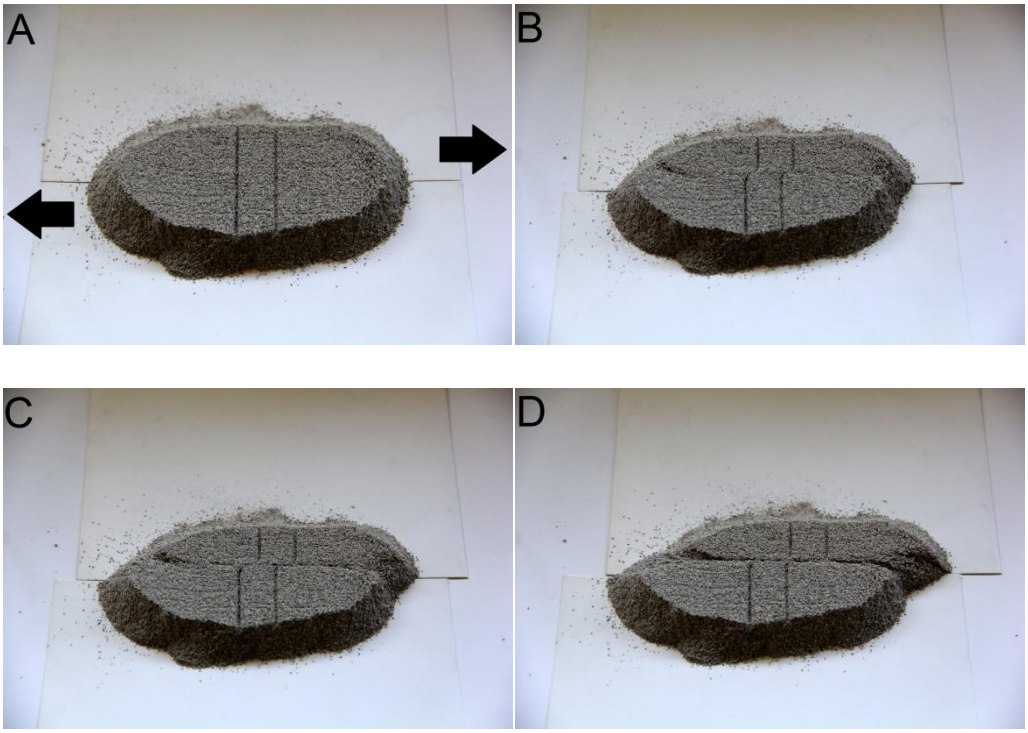


Figure 1A-D. Sheets are moved in the direction shown by the arrows. A crack forms in the sand and the lines are displaced.

2. Before doing this activity, experiment with sand of different sizes. If the sand size is too big, the expected crack in the sand may not form or may be hard to see. Look at Figure 1B, C and D. See the crack that goes from left to right? The students are supposed to see that.

3. After the activity, direct the students to Figure 4 in the student module. (This is Figure 2 in this guide.) Ask the students to compare what they saw in the activity to what is shown in the picture. The students are supposed to see that the crack in the sand is similar to the break across the road in the picture. You can then tell them that that is how a fault may look out in the field.

Figure 2. An example of a fault (Image courtesy of the GEER Association and National Science Foundation)

Answers to questions

Q1. As you move the sheets, what is formed in the sand?
Answer: A crack, 'line' or break is formed in the sand.

Q2. What happens to the lines?
Answer: The lines are shifted or displaced.

For advanced classes

In Activity 1, the movement along the “fault” is in the horizontal direction. That is, the “ground” moves sideways. You can also demonstrate movement in the vertical direction. The ground will be observed to move up or down. All that is needed is sand and a narrow box cover.

Figure 3. Sand and a narrow box cover cut into two pieces

1. Get the box cover and cut it so that the length of one piece is twice the other (Figure 3). If you cannot find a box cover, make one using cardboard.

2. Place the shorter box cover within the longer one (Figure 4, left photo). Put sand in the nested box covers. Shake the box side to side so the surface of the sand will become level (Figure 4, right photo).

Figure 4. (Left) The short box cover is put within the long box cover. (Right) Sand is poured into the nested covers.

3. Now, slowly pull the sides of the box covers as shown in Figure 5. Ask the students to observe carefully.

Figure 5. The box covers are pulled outward.

As you can see in Figure 6, two parallel cracks form in the sand. If you continue to pull, the sand in the middle of the cracks will subside (move down), forming a depression. This simulates what happens when the ground is pulled apart by forces within the Earth. Faults form, a portion of the land sinks, and a valley is formed.

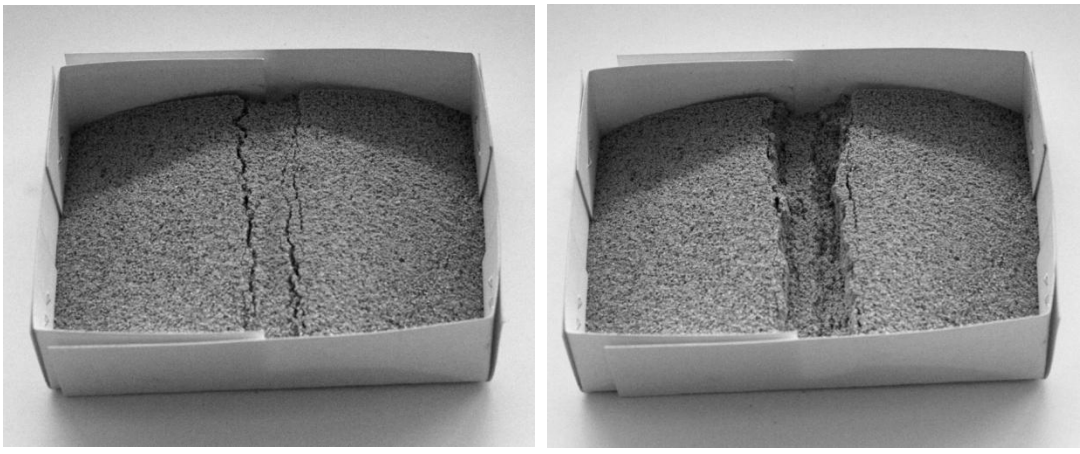


Figure 6. (Left) As the box covers are pulled outward, cracks form in the sand. (Right) With more outward pulling, the sand subsides.

5. Now, re-assemble the box covers as before. Do not forget to make the surface of the sand flat. This time, push the sides of the box covers toward each other (Figure 7). Let the students observe what happens.

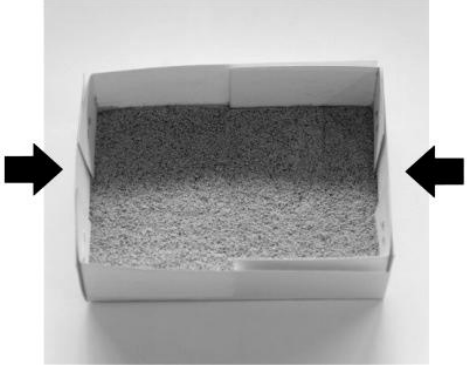


Figure 7. The box covers are pushed toward each

As can be seen from Figure 8, the opposite happens. Instead of the sand sinking, the sand forms a tiny ridge. Unfortunately, this model does not show a crack in the sand that would represent a fault. In the real world, a fault is formed when the ground is squeezed by forces from inside the Earth. A portion of the land is pushed up, and mountains are formed.

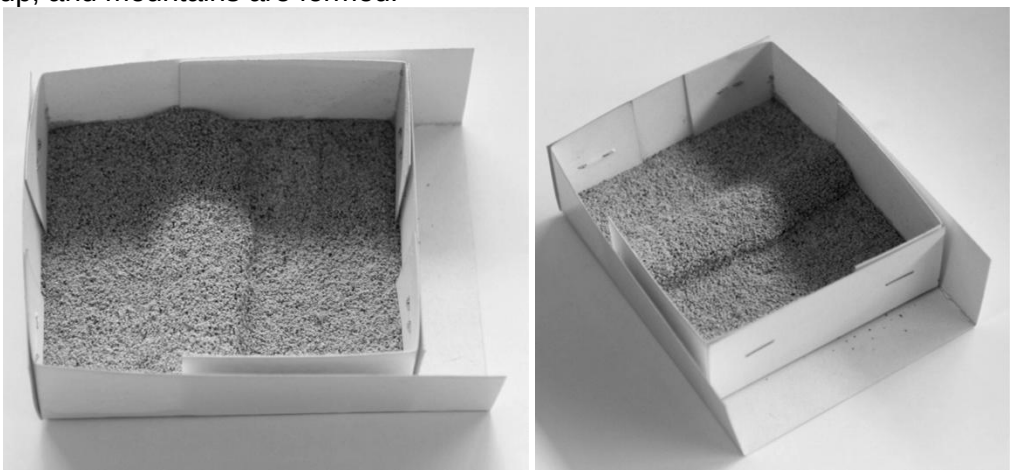


Figure 8. (Left) A tiny hump is formed in the sand. (Right) The hump as seen from another angle.

Note: Use fine sand when performing this demonstration. Coarse sand does not work as well. Experiment using different materials.

How do faults produce quakes?

Now that students have an idea of how faults look, let us show them how earthquakes occur along faults. To answer this question, the students will perform two short activities.

Activity 2

Stick 'n' slip

In this activity, two small boxes are needed. The cartons that fruit juice drinks are packaged in are perfect. Setting it up is simple (Figure 9, left photo). The activity can be performed in groups, or as a class demo if you are pressed for time. The activity is supposed to show the sudden jerk that occurs when rocks move along a fault in an earthquake.

Teaching Tips

1. The students may find it tricky to attach the rubber band to the box. Just punch two holes in the box, close enough so you can loop a paper clip (or a thin wire) through them. Then attach the rubber band to the clip.

2. Look at the photos in Figure 9 so you know how it should be done. The student is supposed to pull on the rubber band attached to one box while holding the other box in place. The rubber band should be pulled forward and horizontally, not sidewise, upward or downward.

3. Expected result: The box will not move at first because it is taped to the other box which is being held. The rubber band will stretch. The tape will suddenly come off. The box attached to the rubber band will jerk forward and the house will topple over (Figure 9, right photo). This simulates the sudden movement that occurs along a fault.

4. The success of this activity depends on the tape, which represents friction in real life. If it is too sticky, the tape will never come off, no matter how much the rubber band is pulled. Tape it on just enough for the rubber to stretch a bit before the box jerks free from the tape.

Figure 9. (Left) Setup before simulated earthquake (Right) After simulated earthquake.

5. In real world terms, this is what happens. Energy from inside the Earth exert a force on the rocks along faults. But the rocks do not move right away because of friction. The roughness of the rocks keeps them from slipping past each other. But when the limit is reached, the rocks suddenly slip—earthquake!

Answers to Questions

Q3. What happens to the rubber band?
Answer: The rubber band stretches.

Q4. What happens to the box attached to the rubber band?
Answer: The box jerks forward.

Q5. What happens to the "house"?
The "house" falls over.

Q6. Which is the "fault" in this setup?
The "fault" is the boundary between the two boxes.

While Activity 2 simulates the sudden movement along a fault, it does not show the shaking that accompanies the sudden movement. Activity 3 will demonstrate this.

Activity 3

Stick 'n' shake

This activity needs the simplest of materials: just two plastic rulers and some clay. The activity is supposed to demonstrate the shaking that occurs when the rocks along a fault suddenly jerk free from being locked in place.

Teaching Tips

1. Even if this activity is simple, it should be tried out first before doing it in class. What is expected to happen? The rulers are held together at the ends by a bit of clay (Figure 10). The rulers are then bent into an S-shape. When the bending goes beyond a certain limit, the rulers separate, vibrating in the process.

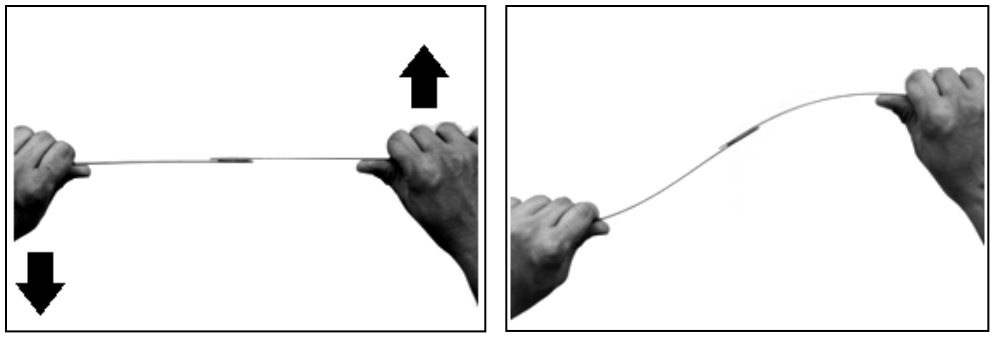


Figure 10. The right ruler is pushed away while the left one is pulled back until the rulers are bent into an S.

2. Choose rulers that vibrate nicely. If the plastic rulers are stiff, they will not vibrate. If the rulers are too soft, they will bend without separating. It is best if the rulers are of the same kind and length. The rulers must be held tightly. If they are held loosely, the rulers will not vibrate.

3. Experiment to find out the right amount of clay and how much the rulers should be pressed together. If you use too much clay, it will take a long time before the rulers separate. But if you use too little, they will separate before there is any bending, and vibration will be less.

4. It is challenging for students to transfer what they learned in an activity to real life. You could use the following drawings (Figure 11) to make this activity more concrete. Let the students imagine the rulers to be rocks making up the ground.

Drawing A shows the land before fault movement. In B, the rocks have undergone some bending. In C, friction has been overcome and the rocks have snapped straight from their bent position. This “snap and shake” motion is not possible to show in a drawing or picture. It is this motion that is demonstrated by the vibrating rulers.

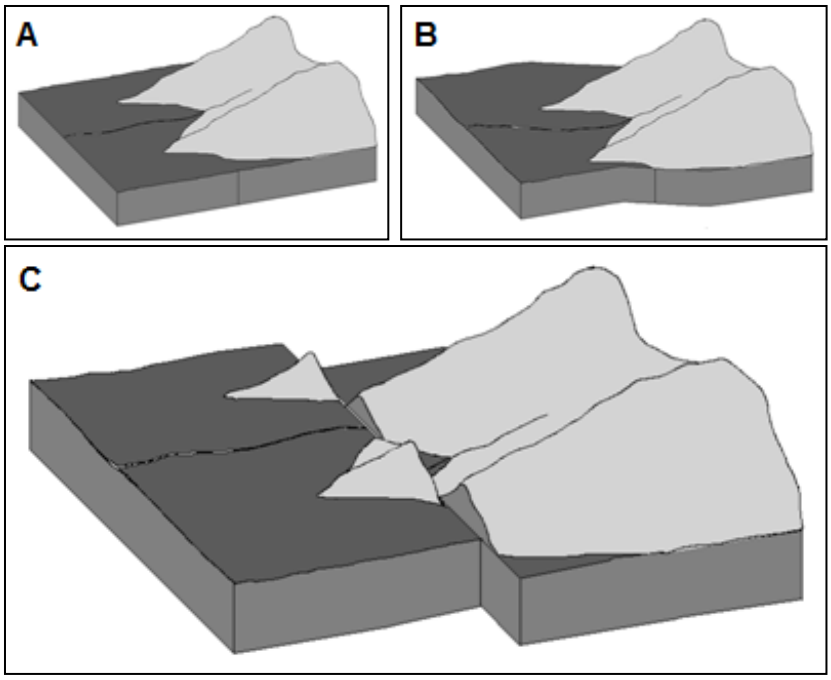


Figure 11. A, before fault movement. B, rocks bend, storing energy. C, friction is overcome, rocks snap straight, releasing energy in the form of earthquakes.

Answers to Questions

Q8. What happens when bending becomes too much?
Answer: The rulers separate and vibrate (Figure 11).

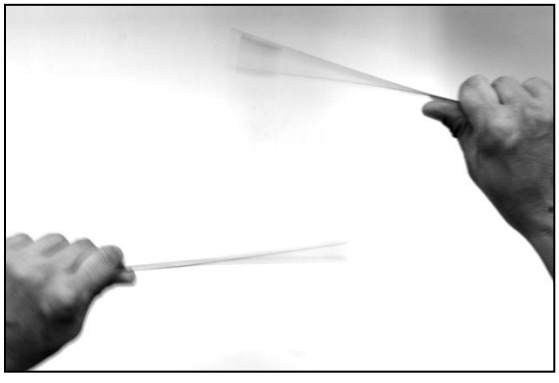


Figure 11. When bending is too much, the rulers snap straight and vibrate.

Focus and Epicenter

The students now know what a fault looks like. They also know that forces from inside the Earth make the rocks along a fault move. But friction prevents the rocks from moving right away. The rocks are stuck together. When a certain limit is reached, the rocks suddenly slip and shake, and an earthquake is born. But where exactly does the earthquake begin?

Activity 4

Where does an earthquake start?

In this activity, the students will make a paper model of a fault. They will learn the meaning of focus and epicenter. The latter term is always mentioned in news reports about earthquakes. But do students know what it means? They will also manipulate this model to explore the different ways that fault movement can occur.

Teaching Tips

1. For easier handling, the Fault Model may be pasted on a folder or cardboard before cutting it out. The model is made of two pieces that fit each other. Each piece has a top and sides but no bottom. When the model is assembled it will look like Figure 12 (left photo).

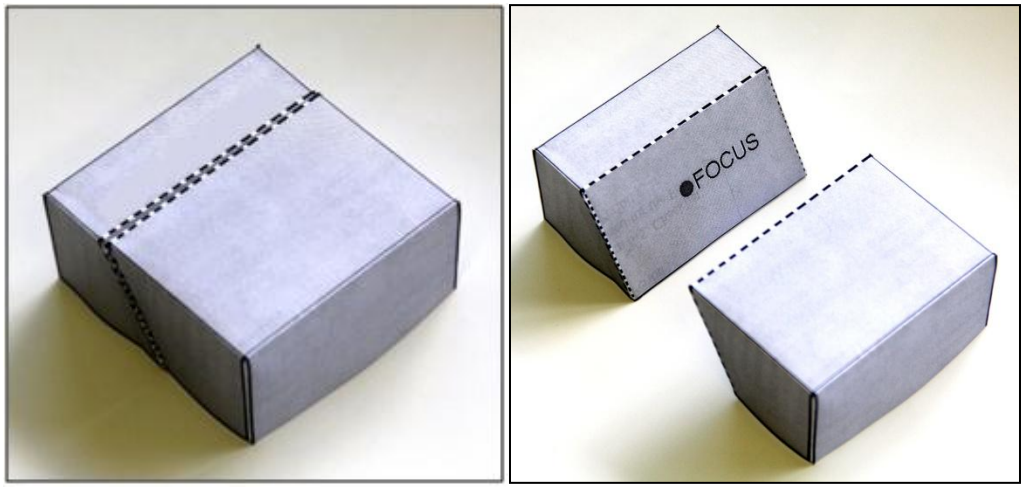


Figure 12. (Left) The Fault Model consists of two pieces that fit together. (Right) The planar surface where the focus is located is the fault plane.

2. Just go through activity with the students, providing clues and guide questions along the way. It should be clear to the students that the model represents a portion of the ground. The upper surface of the model represents the surface of the Earth. To emphasize this, you may cut a small human figure and paste it on top of the model.

3. Let the students read the definition of a fault line (it is in the activity) and ask them to point it out in the model. The "break" between the two pieces of the model is the "fault." But we can only see the part of the fault that is exposed at the Earth's surface. That is the broken line at the top of the model. That represents the fault line (Figure 13).

4. Next, ask the students to identify the fault plane. The definition provided in the activity will serve as a clue. If you separate the two pieces, the "fault plane" can be seen. This is the flat surface where the focus is (Figure 12, right photo). Fault movement occurs along the fault plane.

5. Next, ask the students to point out the focus and explain what it is. The focus is the place where the first break happens, where the fault starts to slip, where first movement takes place. It is the starting point of the earthquake.

6. Next, ask the students to locate the epicenter. The epicenter is on the surface of the Earth directly above the focus. Figure 13 shows the location of the epicenter (marked with a star) in the model. If a person stood on the epicenter, the focus would be directly below him at the fault plane. Use Figure 15 to show how the focus and epicenter are related in space.

Figure 13. The epicenter *(marked with a star) is the spot on the surface of the Earth directly above the focus.*

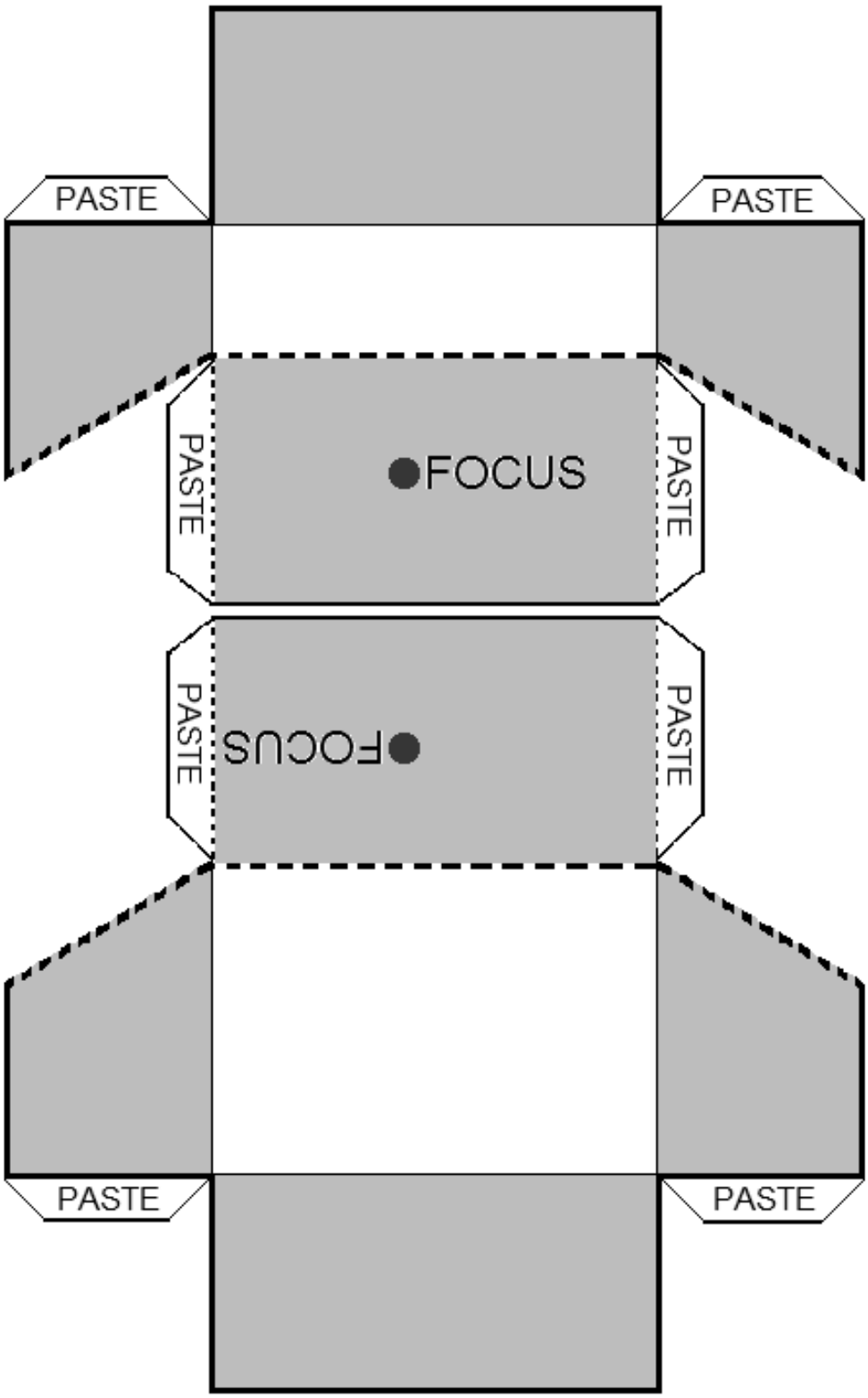


Figure 14. Fault Model

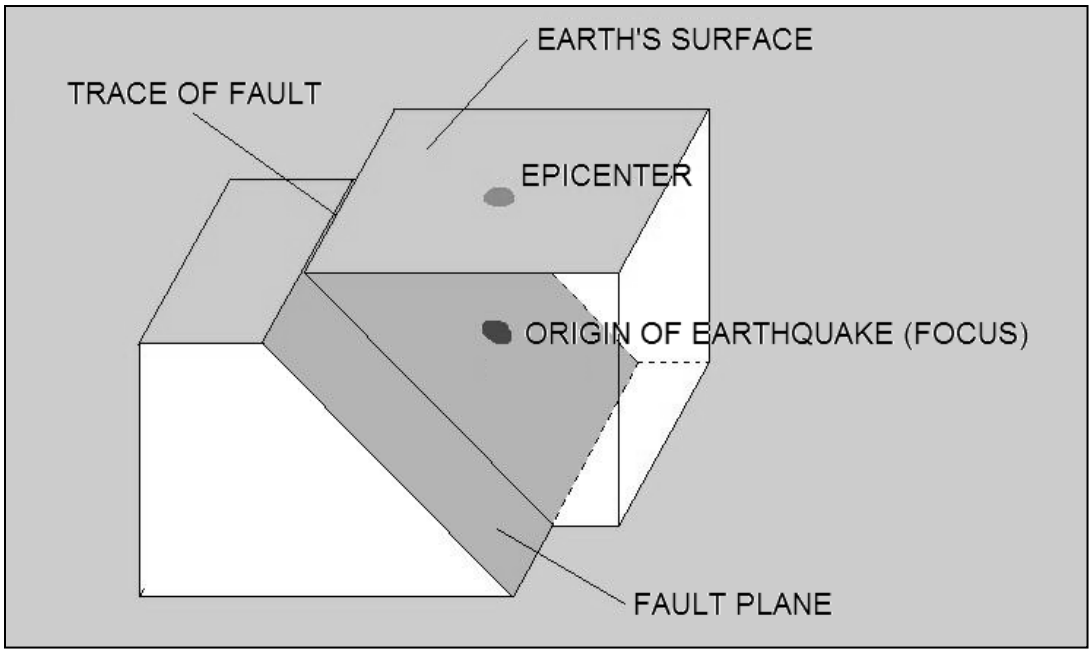


Figure 15. The place where the earthquake starts is called the focus. The focus is underground, along the fault plane. The spot on the surface of the Earth that is directly above the focus is called the epicenter. The trace of the fault is also known as fault line.

Answers to questions

Q9. Use your model to show different types of movement along a fault. How would the surroundings be affected?
Answer: See Figure 16. Models A and B show horizontal movement. Suppose a road is built across the fault, sooner or later, it would be displaced sideways.

Models C and D show vertical movement. In Model C, a portion of the "ground" dropped down, forming a low area. In Model D, part of the "ground" was raised, forming a high region.

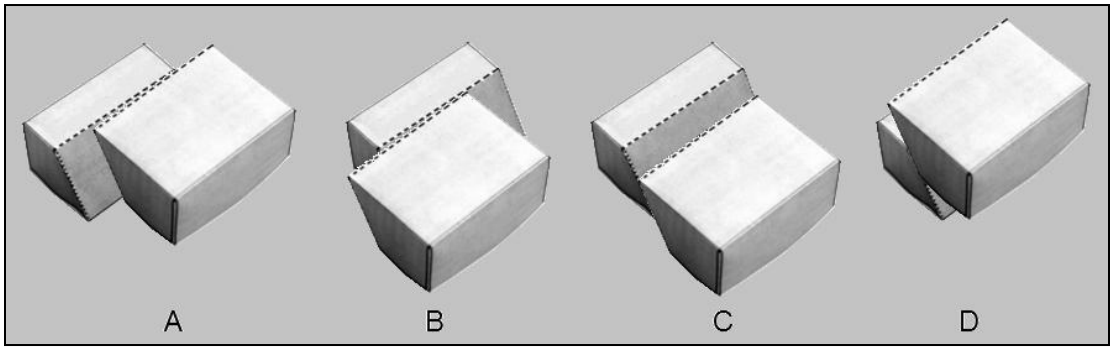


Figure 16. Using the model to show different fault movements.

How Strong is the Earthquake?

Scientists use two different ways to describe how powerful an earthquake is. One way is by noting the effects of the earthquake on people, structures, and the surroundings. This is called the *intensity* of the earthquake. The Philippine Institute of Volcanology and Seismology (PHIVOLCS) uses the following scale to describe the intensity of earthquakes in the Philippines.

Table 1. PHIVOLCS Earthquake Intensity Scale (PEIS)

Intensity Scale	Description
I	**Scarcely Perceptible** - Perceptible to people under favorable circumstances. Delicately balanced objects are disturbed slightly. Still water in containers oscillates slowly.
II	**Slightly Felt** - Felt by few individuals at rest indoors. Hanging objects swing slightly. Still water in containers oscillates noticeably.
III	**Weak** - Felt by many people indoors especially in upper floors of buildings. Vibration is felt like one passing of a light truck. Dizziness and nausea are experienced by some people. Hanging objects swing moderately. Still water in containers oscillates moderately.
IV	**Moderately Strong** - Felt generally by people indoors and by some people outdoors. Light sleepers are awakened. Vibration is felt like a passing of heavy truck. Hanging objects swing considerably. Dinner, plates, glasses, windows, and doors rattle. Floors and walls of wood framed buildings creak. Standing motor cars may rock slightly. Liquids in containers are slightly disturbed. Water in containers oscillate strongly. Rumbling sound may sometimes be heard.
V	**Strong** - Generally felt by most people indoors and outdoors. Many sleeping people are awakened. Some are frightened, some run outdoors. Strong shaking and rocking felt throughout building. Hanging objects swing violently. Dining utensils clatter and clink; some are broken. Small, light and unstable objects may fall or overturn. Liquids spill from filled open containers. Standing vehicles rock noticeably. Shaking of leaves and twigs of trees are noticeable.

VI	**Very Strong** - Many people are frightened; many run outdoors. Some people lose their balance. Motorists feel like driving in flat tires. Heavy objects or furniture move or may be shifted. Small church bells may ring. Wall plaster may crack. Very old or poorly built houses and man-made structures are slightly damaged though well-built structures are not affected. Limited rockfalls and rolling boulders occur in hilly to mountainous areas and escarpments. Trees are noticeably shaken.
VII	**Destructive** - Most people are frightened and run outdoors. People find it difficult to stand in upper floors. Heavy objects and furniture overturn or topple. Big church bells may ring. Old or poorly-built structures suffer considerably damage. Some well-built structures are slightly damaged. Some cracks may appear on dikes, fish ponds, road surface, or concrete hollow block walls. Limited liquefaction, lateral spreading and landslides are observed. Trees are shaken strongly. (Liquefaction is a process by which loose saturated sand lose strength during an earthquake and behave like liquid).
VIII	**Very Destructive** - People are panicky. People find it difficult to stand even outdoors. Many well-built buildings are considerably damaged. Concrete dikes and foundation of bridges are destroyed by ground settling or toppling. Railway tracks are bent or broken. Tombstones may be displaced, twisted or overturned. Utility posts, towers and monuments may tilt or topple. Water and sewer pipes may be bent, twisted or broken. Liquefaction and lateral spreading cause man-made structure to sink, tilt or topple. Numerous landslides and rockfalls occur in mountainous and hilly areas. Boulders are thrown out from their positions particularly near the epicenter. Fissures and faults rupture may be observed. Trees are violently shaken. Water splash or slop over dikes or banks of rivers.
IX	**Devastating** - People are forcibly thrown to ground. Many cry and shake with fear. Most buildings are totally damaged. Bridges and elevated concrete structures are toppled or destroyed. Numerous utility posts, towers and monument are tilted, toppled or broken. Water sewer pipes are bent, twisted or broken. Landslides and liquefaction with lateral spreadings and sandboils are widespread. the ground is distorted into undulations. Trees are shaken very violently with some toppled or broken. Boulders are commonly thrown out. River water splashes violently or slops over dikes and banks.

X	**Completely Devastating** - Practically all man-made structures are destroyed. Massive landslides and liquefaction, large scale subsidence and uplift of land forms and many ground fissures are observed. Changes in river courses and destructive seiches in large lakes occur. Many trees are toppled, broken and uprooted.

When an earthquake occurs, different places will have different intensities. That is because different areas will experience different degrees of shaking. Near the epicenter, shaking is great, so the intensity there will be high. Away from the epicenter, the intensity is less.

The intensity also depends on the type of material that makes up the ground. If the ground is made of solid rock, it will shake less. In comparison, loose materials such as sand and silt will undergo greater shaking and will result in more damage.

Scientists have another way of describing how strong an earthquake is. They measure the energy that is released in an earthquake. This is called the *magnitude* of the earthquake. Magnitude scales use Hindu-Arabic numerals while intensity scales use Roman numerals.

Magnitude 2 earthquakes are weak. Only instruments are sensitive enough to "feel" them. Magnitude 4 quakes are strong enough to be felt by most people. Magnitude 6 earthquakes can cause a lot of damage in populated areas. Magnitude 9 quakes are so powerful they can destroy whole communities at the epicenter.

Do You Live Near an Active Fault?

In this part of the module, the students are taught how to use a map to find out if there is an active fault near their community. Active faults are those that have moved and caused earthquakes in the past and are expected to do so again in the future. In relation to this exercise, the students must participate in an earthquake drill to be arranged by the school.

Teaching Tips

1. Now that students know that earthquakes originate from faults, the obvious question is, where are these quake-producing faults? Where are they located? These faults have been mapped by PHIVOLCS and the map is available to the public (Figure 17).

2. The first thing to do is to familiarize the students with the map of the Philippines. The students should be able to point out the different provinces in their own region.

3. Next, the students must know what the lines on the map mean. *Solid lines* tell us exactly where the active faults are. *Heavy dashed lines* tell us the approximate location of active faults. The meanings of the other symbols are found in the legend but they will be discussed in detail in Grade 10.

4. The task of students is to use the map to locate the nearest active faults that may affect their town. Those who live close to active faults must be extra prepared for earthquakes. PHIVOLCS recommends doing the following:

Before the earthquake
Prepare homes or schoolrooms by strapping heavy furniture to the walls. Check the stability of hanging objects. Breakable items, harmful chemicals and flammable materials should be stored properly. Know exit routes.

Know where fire extinguishers and first aid kits are located. Prepare an emergency supply kit that includes water, canned food, can opener, clothing, blanket, battery-operated radio, flashlight, and extra batteries. Participate in regular earthquake drills.

(Note: Earthquake drills should be led by school authorities.)

During the earthquake

Stay calm. If you are at home or inside a building, stay there. Duck under a sturdy desk or table and hold on to it. Stay away from glass windows, cabinets, and heavy objects. Beware of falling objects.

If you are outside, move to an open area. Stay away from trees, powerlines, and concrete structures. Move away from steep slopes which could be affected by landslides. If you are near the shore, move quickly to higher grounds. Tsunamis may follow.

After the earthquake
Do not use elevators or enter damaged buildings. Check yourself and others for injuries. Check for spills of chemical, toxic, and flammable materials. If you need to evacuate, leave a message and bring your emergency kit. Listen to the radio for updates.

What to do before, during, and after an earthquake is part of the Earthquake Preparedness Guide which can be downloaded from the PHIVOLCS website. *How to conduct an earthquake drill* is too long to reproduce here and can be downloaded from the same site. If this is not possible, please request assistance from the local PHIVOLCS station and other government agencies.

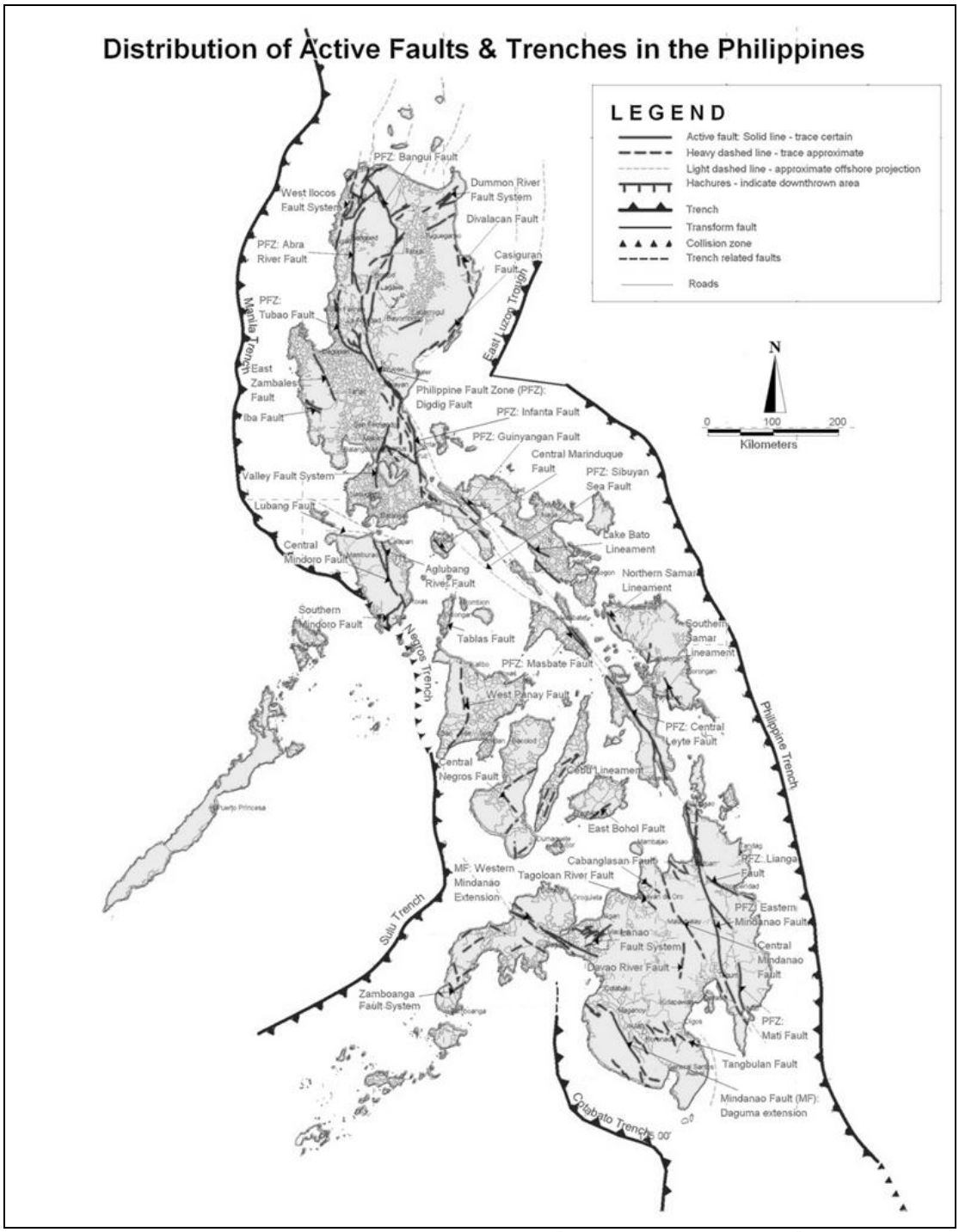


Figure 17. Active Faults and Trenches

Department of Science and Technology
PHILIPPINE INSTITUTE OF VOLCANOLOGY AND SEISMOLOGY
Geology & Geophysics R&D Division
Active Faults Mapping Group
February 2000

Earthquakes and Tsunamis

Faults are found on land as well as at the bottom of the sea. When an underwater fault suddenly moves, a tsunami may be formed. But not all fault movements generate tsunamis. If the fault moves sideways, the water above it will not be disturbed. The movement has to be in the vertical sense, a sudden upward or downward motion.

Activity 5

Tsunami!

In this activity, the students will simulate the sudden upward movement of rocks along a fault at the seafloor. The sudden push upward will disturb the water, forming a wave.

Teaching Tips

1. The materials needed for this activity are simple. A laundry tub or *batya* can be a substitute for the plastic tray shown in the photos. A piece of plywood can be used instead of the plastic panel.

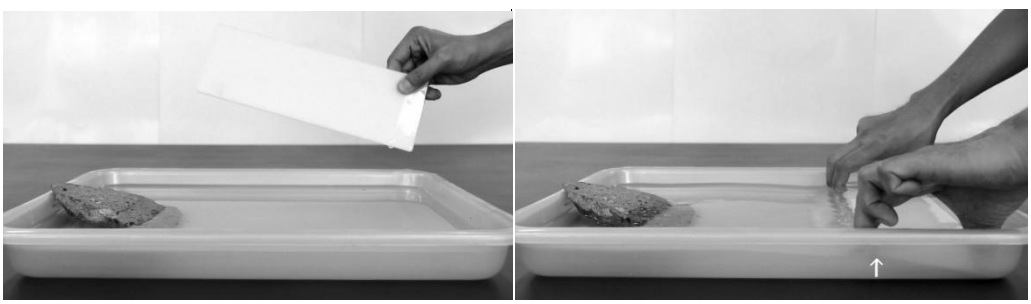


Figure 18. (Left) Setup for the tsunami activity. (Right) The plastic panel is jerked upward.

2. Make sure the students will observe the following: a) When the plastic panel is jerked upward, a wave is formed; b) the wave travels toward the rock; c) the wave runs up the side of the rock.

Figure 19. (Left) Before the wave reaches the rock, the water level by the rock goes down. (Right) When the wave reaches the rock, the water level rises.

3. Find the best way to jerk the plastic panel up so that a nice wave is formed. Between jerks, wait until the surface of the water is calm.

4. People often use the term tidal waves when they talk about tsunamis. This is not right. Tsunamis are due to the sudden upward (or downward) movement of rocks along a fault at the seafloor. Tsunamis are not related to tides, which are caused by the action of gravity.

5. The reason a tsunami is so powerful is because the wave involves the whole depth of the ocean, not just the water on the surface. And why does a tsunami rise to such great heights when it reaches the shore?

   The wave is long, about 100 km or so. When the "front" end reaches the shore, it slows down. But the "tail" end keeps on coming at great speed. So the water piles up and grows to dangerous heights, destroying everything in its path.

6. The Philippines is no stranger to tsunami. Mindanao had been affected by a devastating tsunami in 1976; Mindoro was struck in 1994. For more information about tsunamis, visit the PHIVOLCS website.

Answers to questions

Q10. What was formed in the water by the sudden push of the plastic panel?
Answer: A wave was formed by the sudden push.

Q11. How was the water level by the rock affected by the wave?
The water level went up.

Q12. What does the water represent? How about the rock?
The water represents the sea. The rock represents land.

Q13. What does the plastic panel represent?
The plastic panel represents the rocks that suddenly move along an underwater fault.

What's Inside the Earth?

Earthquakes are always linked with death and destruction. Is there anything good at all about earthquakes? Well, scientists have used earthquake waves to figure out the internal structure of the Earth.

When an earthquake occurs, vibrations or seismic waves start off from the focus and travel in all directions. The seismic waves travel through the Earth and carry information from the interior to the surface.

For instance, when seismic waves encounter a layer within the Earth, they are reflected. Like an echo, seismic waves are bounced back. They are also refracted or bent. This is how we know that the Earth has a crust, mantle, and core.

We know that the rocks get more dense with depth because the seismic waves speed up as they pass through these rocks. We know too that there are partially molten regions in the mantle because seismic waves slow down in those areas.

Scientists have found out that one type of seismic wave, s-waves, cannot travel through liquids. Since s-waves disappear when they reach the core, that means the outer core must be molten (liquid).

Thus, scientists know about the Earth's interior because of the occurrence of earthquakes. But a more detailed description of the Earth's internal structure will be made when plate tectonics is taken up in Grade 10.

References

Brady, J.E., & Senese, F. (2004). *Chemistry: Matter and its changes* (4th ed.). River Street Hoboken, NJ: John Wiley & Sons, Inc.

Links

http://www.youtube.com/watch?v=2uJN3Z1ryck&feature=player_embedded
(Tsunami in Japan 3.11 first person full raw footage)

Unit 2
MODULE

2

UNDERSTANDING TYPHOONS

In the lower grades, we have taken up the following so far: types of weather; how to measure weather components; characteristics of some weather disturbances; patterns in the weather; and why we have seasons. In this grade level, we are focusing on one of the weather disturbances that takes place in the Philippines every year: tropical cyclones.

A lot of people are not familiar with the term *tropical cyclone*. This is the reason why we are using the common word *typhoon* at the start to serve as a jump-off point. Hopefully, the students will see the distinction right away, that a typhoon is just one category of tropical cyclones.

There are three activities in this module: a) Plotting the Philippine Area of Responsibility; b) Tracking a Tropical Cyclone; and c) Dissecting a Tropical Cyclone. The module ends with the signals that the Philippine Atmospheric, Geophysical, and Astronomical Services Administration (PAGASA) uses in warning the people during severe weather.

Key questions for this module

Why is the Philippines prone to typhoons?

What conditions favor the formation of typhoons?

What is a Typhoon?

First, we have to clear up the meaning of some terms. Begin by asking the students what they commonly experience during typhoons. Floods and landslides may come up. But we will focus on two answers: excessive rain and strong winds.

Then show the students a picture of a typhoon taken from a satellite high above the Earth. (Figure 1 shows a supertyphoon but a typhoon looks the same.) The students are expected to see that the clouds are going around the center of the typhoon in a spiral. Explain that the clouds are being blown by strong winds.

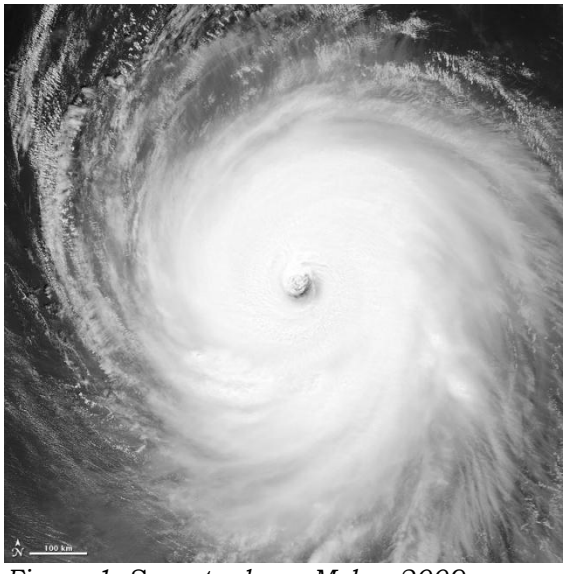


Figure 1. Supertyphoon Melor, 2009
Image by NASA Earth Observatory

Thus, apart from rain clouds, typhoons are characterized by winds that go around a center. To support the point, show the students some newspaper clippings or let them listen to recordings of radio or tv advisories about typhoons. The weatherperson always states the speed of the wind.

At this point, introduce Table 1. Explain that we call *bagyo* is called tropical cyclone by scientists. A tropical cyclone is just a system of thunderstorms that move around a center.

The public uses the word *bagyo* for all types of tropical cyclones. But scientists have subdivided tropical cyclones into four categories depending on the speed of the wind.

Thus, when a tropical cyclone has a low wind speed, no more than 64 kilometers per hour (kph), it is called a tropical depression. If the wind speed is from 65 to 118 kph, then it is a tropical storm.

If the tropical cyclone has a wind speed from 119 to 200 kph, it is called a typhoon. And if the wind speed is more than 200 kph, it is categorized as a supertyphoon (Table 1).

Table 1. Tropical cyclone categories

Category	Maximum Wind Speed kilometers per hour (kph)
Tropical Depression	64
Tropical Storm	118
Typhoon	200
Supertyphoon	greater than 200

Demonstration

At this point, show a video or animation of a tropical cyclone where the clouds are moving around the center, so the students will get a more concrete idea of how this happens.

Alternatively, you can give a demonstration that will simulate the movement of winds around a center in a tropical cyclone. You will need two plastic bottles with caps, masking tape, and a drill.

Figure 2. Bottles, caps, and masking tape

Place the two caps back to back. Wrap them with masking tape (Figure 2). Wrap the tape around several times to make the connection strong and leak-proof. Drill a hole through both of them. If you do not have a drill, use a heated nail to make a hole.

Fill one bottle with water. Then screw one of the caps onto the bottle. Then screw the other bottle onto the other cap. You should get the setup in Figure 3, left photo.

Figure 3. (Left) One bottle filled with water. (Right) Water swirls around as it spills into the other bottle.

Now, turn the whole setup so the filled bottled is on top. Shake the filled bottle with a circular motion (counter-clockwise) until a whirlpool is formed in the water (Figure 3, right photo).

In this simulation, the water represents the wind going around the center of a tropical cyclone. In the northern hemisphere, the winds blow in a counter-clockwise direction. In the southern hemisphere, the winds spin around in the opposite direction, clockwise.

The "funnel" in the center of the spinning water represents the "eye" of a tropical cyclone. When scientists talk about the location of a tropical cyclone, they are referring to the location of the eye.

Philippine Area of Responsibility

PAGASA starts monitoring tropical cyclones even before they enter the Philippine Area of Responsibility (PAR). But everything shifts into high gear when the weather disturbance is already inside the PAR. The PAR includes a big area east of the Philippines because this is where most tropical cyclones come from.

Activity 1

Plotting the PAR

In the following activity, the students are required to plot the PAR on a map. They already learned how to plot latitude and longitude in Grade 7. If the students are a bit rusty, perform some drills.

Teaching Tips

1. Activity 1 can be done in groups or as a class activity. Have the map enlarged and post it on the board. Call on students to come to the front and plot the points. There are six points to plot, meaning there are six pairs of latitude and longitude. So each point may be plotted by two students, one will find the latitude and the other the longitude.

2. Note that the eastern boundary of the PAR is much farther from the country than the western boundary. That is because most tropical cyclones that hit the Philippines come from the Pacific Ocean. The wide area gives us more time to prepare before the tropical cyclone hits land.

Answers to Questions

In the map below, the bold line marks the boundary of the Philippine Area of Responsibility. The latitude and longitude of each corner is also shown.

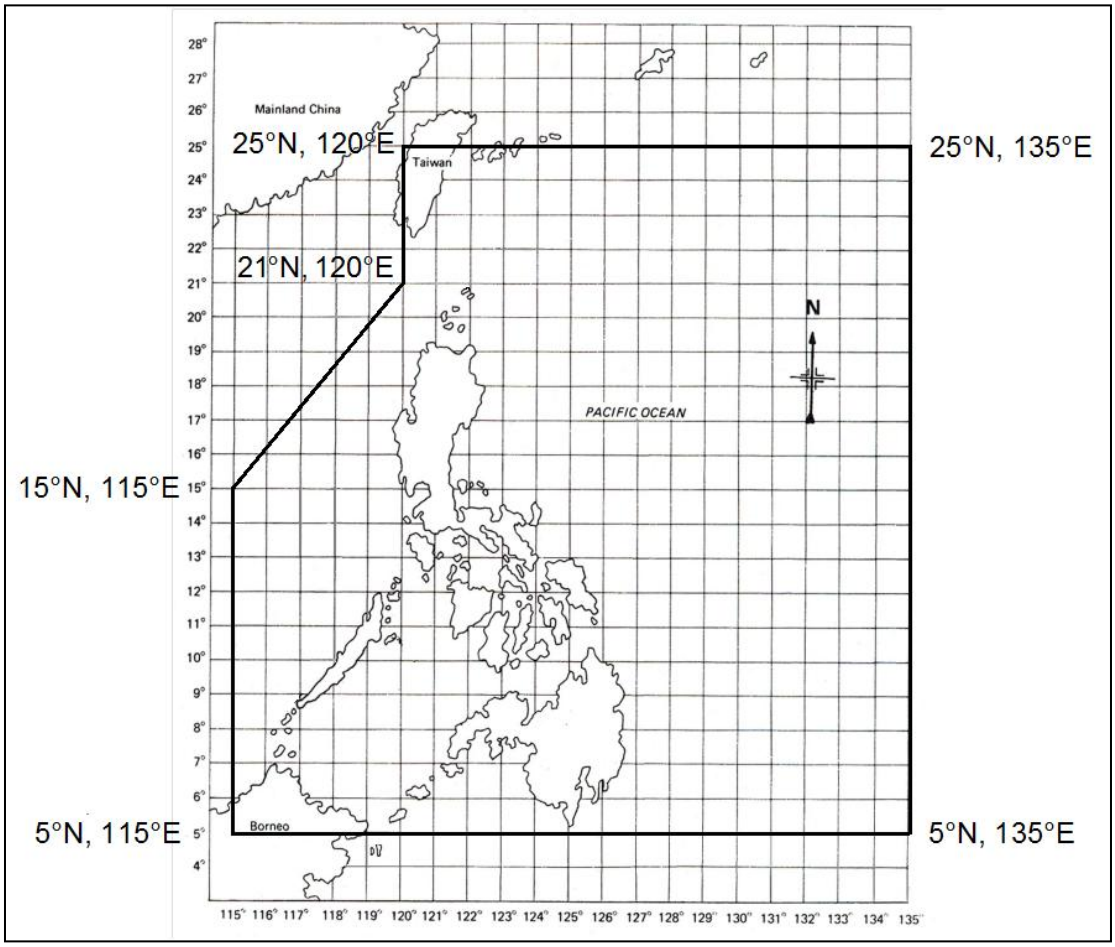


Figure 4. Philippine Area of Responsibility (PAR)

Q1. If a typhoon is located at 15°N, 138°E, is it within the PAR?
Answer: No, the typhoon is outside the PAR.

Q2. How about if the typhoon is at 19°N, 117°E, is it inside the PAR?
Answer: No, the typhoon is outside the PAR.

Under What Conditions do Tropical Cyclones Form?

Now that the students know where PAR is, it is time for them to learn why tropical cyclones keep on developing near our country. What conditions are present in the vicinity of the Philippines that allow the development of tropical cyclones?

Show the following maps to the students. The maps are from the PAGASA website. They show the tracks or paths of four tropical cyclones that entered the PAR in the early to mid-2000s. Guide the students in answering the following questions:

Where did the tropical cyclones form? On land or in the ocean?

Before asking the question, make sure that the students still remember the landmasses and bodies of water in the vicinity of the Philippines. If the students have already forgotten, a short review may be in order.

It is clear from the maps that all four tropical cyclones started out in the Pacific Ocean. Tropical cyclones usually form where there is warm water. The temperature should be 26.5°C or more.

The warm ocean water heats up the air above it. The warm air then rises. The rising warm air results in a low-pressure area. Air in the surroundings will then move toward the area. This was taken up in Grade 7.

Now, there is water vapor in the rising warm air. The water vapor soon condenses and heat is given off. The heat makes the air rise even more, and air in the surroundings will keep coming in. The air starts to spin, and a tropical cyclone is born.

What can you say about the temperature of the bodies of water in the vicinity of the Philippines? Is the water warm or cold?

Our country is located near the equator. Thus, it is warm in the vicinity of the Philippines, both on land and in the surrounding bodies of water. The warm water supplies the water vapor that a tropical cyclone needs to keep it going.

In what direction did the tropical cyclones move?

From the map, the students can see that the tropical cyclones move in a northwest direction. Not all tropical cyclones move this way. But this is the general rule for those that start from the Pacific Ocean.

But look at the track of Yoyong. At the end of its path, it curves to the northeast. Many tropical cyclones in the PAR do that. Instead of going straight toward Mainland China, they veer to the northeast and go toward Taiwan and Japan.

There are different reasons why this happens. One, there could be a low-pressure area in that region. So the wind in the surroundings move toward that region and the tropical cyclone is carried along. Remember, winds blow toward low-pressure areas.

Another reason is there could be a high pressure area in the path of the tropical cyclone. So the tropical cyclone cannot proceed and is diverted along a different way.

Which part of the Philippines was hit by the four tropical cyclones?

All the four tropical cyclones hit northern Philippines or the island of Luzon. Note where the tropical cyclones start: at the latitude of the Visayas and Mindanao. So when a tropical cyclone moves to the northwest, it ends up in Luzon.

This is the reason why Mindanao is not commonly hit by tropical cyclones. Unless the following happens: a) the tropical cyclone starts at a latitude closer to the equator, or b) the tropical cyclone moves directly to the west, instead of moving to the northwest. This is what happened in Mindanao in recent years.

In the case of Agaton, Yoyong, and Huaning, where did they die out? Near land or in the middle of the ocean?

Tropical cyclones weaken when they hit land. They die out over land because they need warm water to sustain them. They need water vapor to keep them going. Even when the tropical cyclone is still in a body of water, it may weaken and die out if the water is cold.

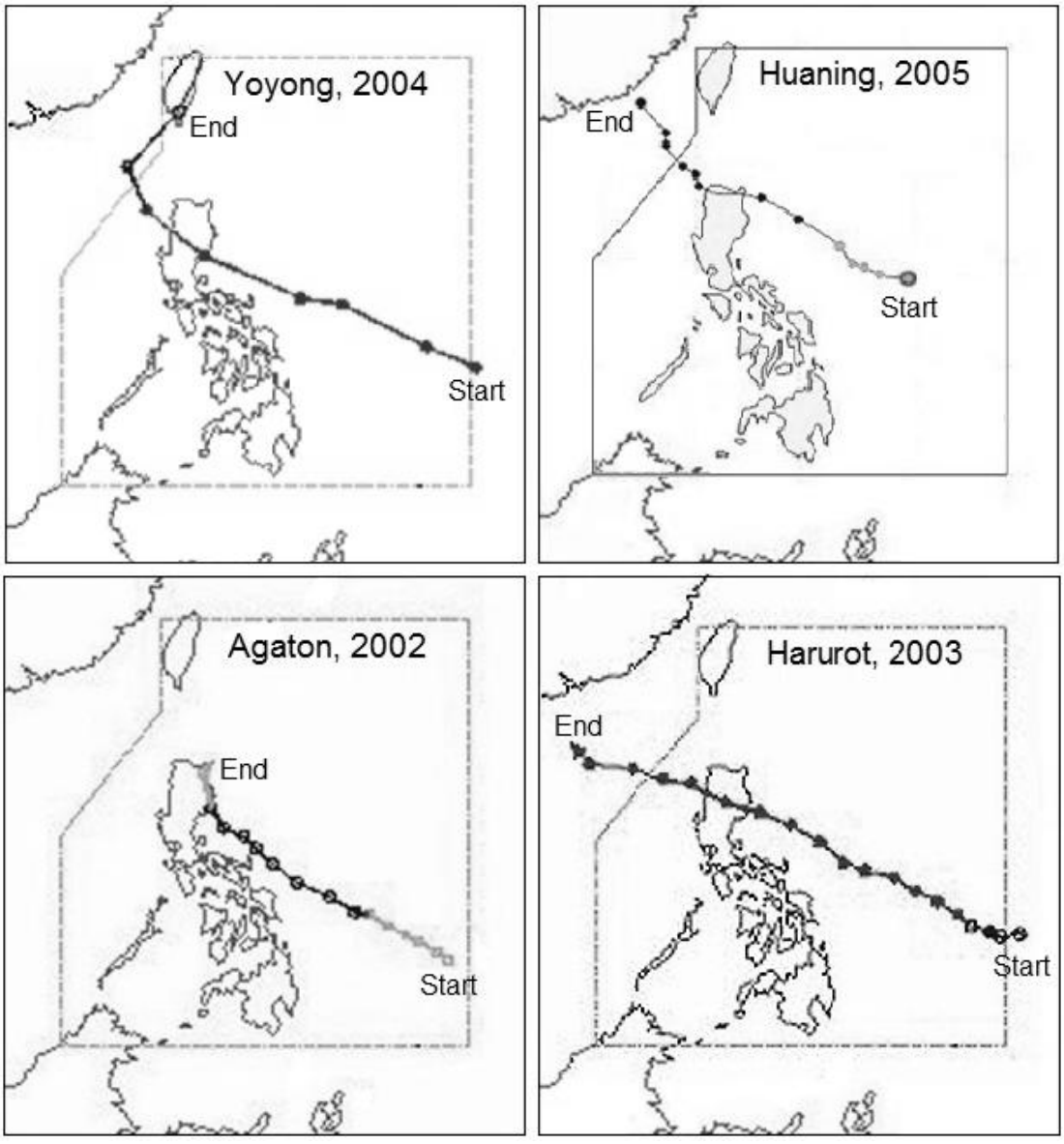


Figure 5. Tracks (paths) of selected tropical cyclones

In the following activity, the students will work again with latitude and longitude. But this time, they will apply their skill in plotting the track of a tropical cyclone as it passes through the PAR.

Activity 2

Tracking a tropical cyclone

Unlike Luzon, Mindanao is not hit by tropical cyclones every year. This is why people in Mindanao were caught by surprise when Sendong and Pablo came one after the other in recent years.

In this activity, the students will plot the track of Tropical Storm Sendong (International name: Washi). The students will use the map where they plotted the PAR in Activity 1.

Teaching Tips

1. Ask the students to indicate which points are not within the PAR. The points that are located at longitudes less than 115°E and more than 135°E will lie outside the map. But even when a storm is still outside the PAR, PAGASA is already monitoring it. And even when it has already left the PAR, there is still a chance that it will return.

2. Like all tropical cyclones, Sendong formed in the Pacific Ocean from a low-pressure area (LPA). It did not yet have a name at that point. Names are not given to LPAs. Then the winds became stronger and the LPA became a tropical depression. In other parts of the world, tropical depressions are not given names; they may be given a designation such as *27W*, for instance. On the other hand, PAGASA gives names to tropical depressions.

   Before Sendong crossed into the PAR, it had already become a tropical storm. That means its winds have speeded up. Since it was already within the PAR, PAGASA used its prepared list of names and called the tropical storm Sendong.

3. Ask the students what was the effect on Sendong when it hit Mindanao. Expected answer: Sendong weakened because it was cut off from the sea. Ask the students further what was the effect on Sendong when it reached the Sulu Sea. Expected answer: Sendong intensified again.

   Sendong then headed for Palawan. But when it encountered cold air beyond Palawan, Sendong finally died out.

Answers to Questions

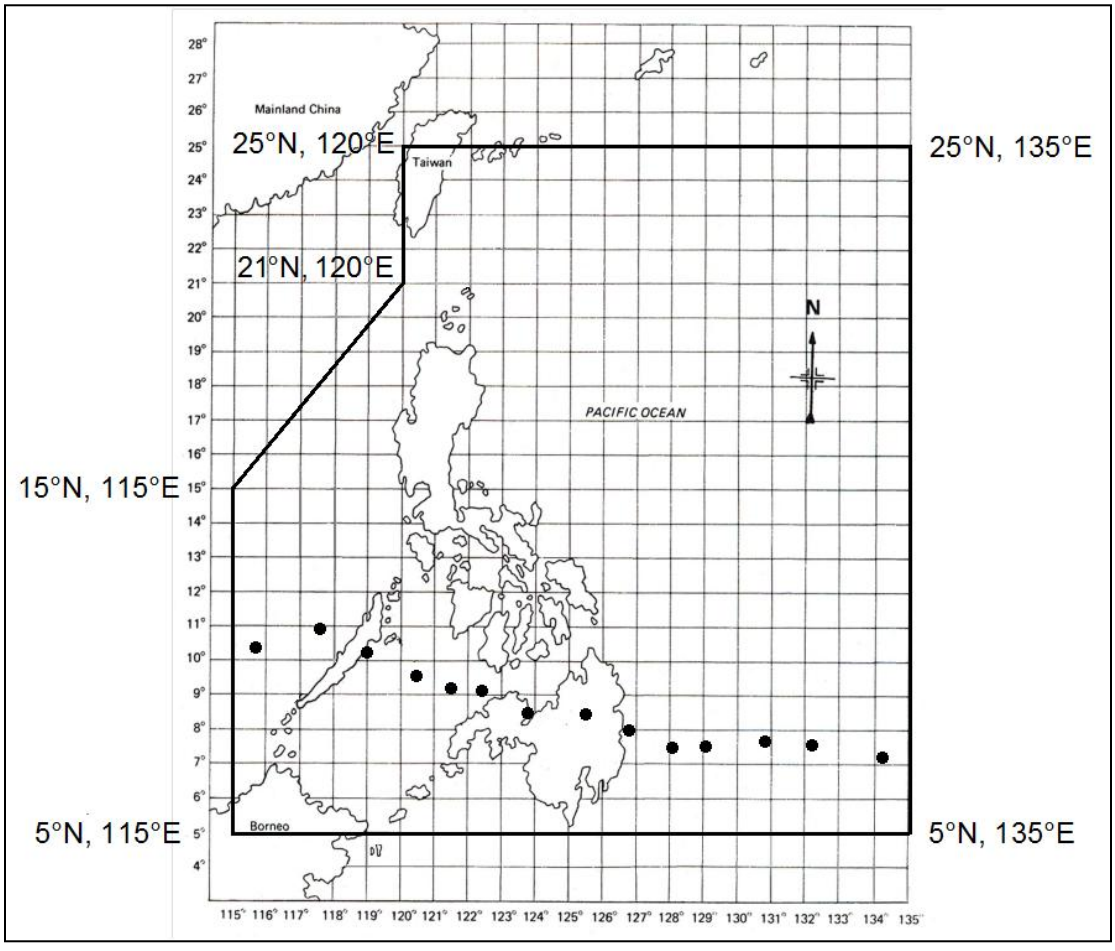


Figure 6. Track of Tropical Storm Sendong, 2011

Q3. Is it possible to plot all the points in the table on the map from Activity 1?
Answer: No, it is not possible. The points west of 115°E and east of 135°E are beyond the coverage of the map from Activity 1.

Q4. Where did Sendong form?
Answer: Sendong formed in the Pacific Ocean.

Q5. When did Sendong enter the PAR?
Answer: Sendong entered the PAR on December 15, 2011.

Q6. When did Sendong leave the PAR?
Answer: Sendong left the PAR on December 18, 2013.

Q7. In what direction did Sendong move?
Answer: Sendong moved in a westward direction.

If you have the means, visit the following webpage and download the tracking data of other powerful tropical cyclones such as Typhoon Pablo (International name: Bopha): http://weather.unisys.com/hurricane/w_pacific/2011H/index.php. Tracking data include the latitude and longitude needed for plotting.

The plotted tracks can be used as basis for discussing all sorts of questions such as, Where do tropical cyclones commonly form? Or conversely, where do they seldom develop? What paths do they take? Which provinces are usually hit? Where do tropical cyclones intensify? Where do they weaken and die out?

Inside Tropical Cyclones

The strong winds brought by a tropical cyclone are very dangerous. Many people have been hurt or killed by flying objects blown by powerful winds. And unlike earthquakes, tropical cyclones cause a lot of agricultural damage, destroying plants, trees, and crops that cost up to hundreds of millions of pesos.

In the following activity the students will look inside a tropical cyclone and find out where the winds are strongest and therefore most unsafe.

Activity 3

Dissecting a tropical cyclone

In this activity, the students will compare the air pressure and wind speed at different places within a tropical cyclone. They will see that within the eye, the winds are slight. But at the eyewall, the winds blow at deadly speeds.

Teaching Tips

1. Many students are challenged when they have to imagine objects in three dimensions. Before the students proceed to answer the questions, make sure that they understand the drawing in Figure 7.

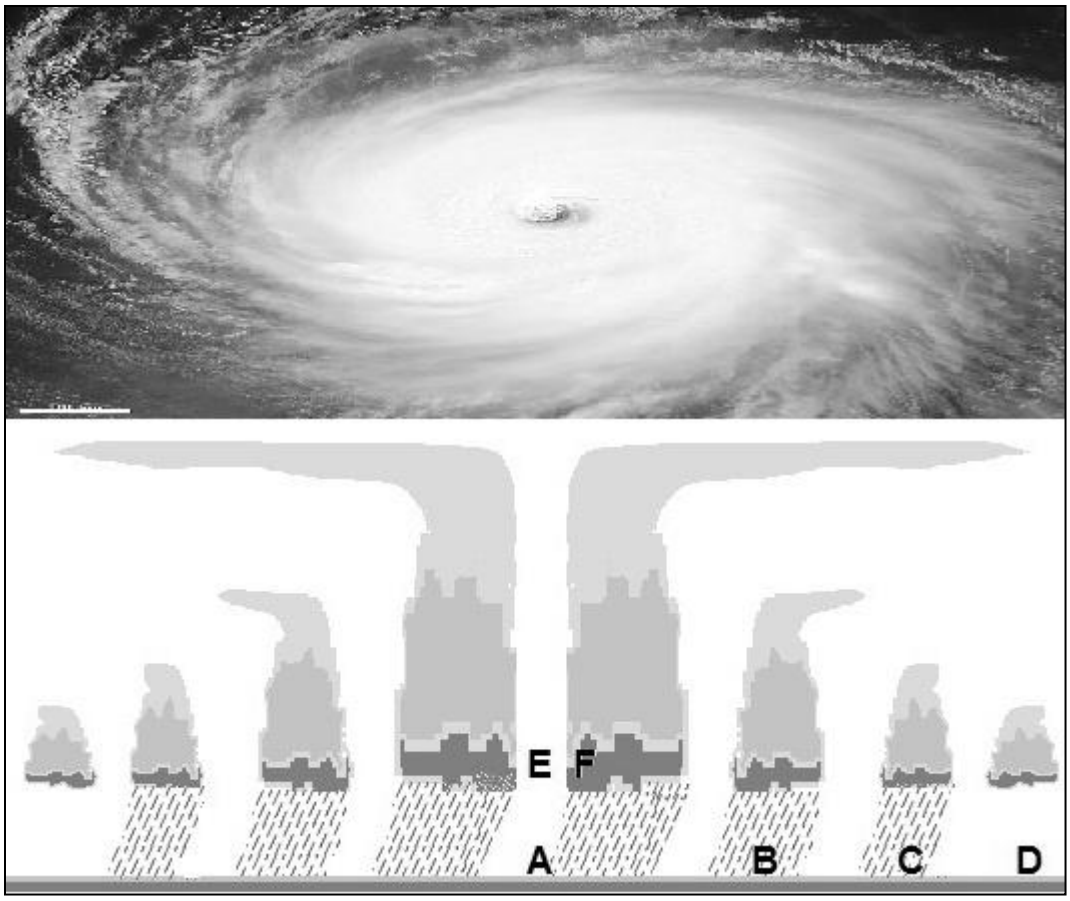


Figure 7. (Top) View of a tropical cyclone at an angle. (Bottom) Drawing of a tropical cyclone in cross-section. (Top image by NASA Earth Observatory)

The top image is a tropical cyclone as seen from above but at an angle. The drawing below it is a cross-section of a tropical cyclone. It is like cutting a cake in half and looking at it from the side. But in this case we are looking at a tropical cyclone and the clouds that make it up.

2. If the students need guidance in finding out the relationship between the table of air pressures and the drawing, let them write the numbers in the table on the drawing itself. For example, let them write 930 mb near letter A in the drawing; 960 mb near letter B; and so on. Then ask them if the air pressure is increasing or decreasing toward the eye.

3. If the students need guidance with the table of wind speeds, let them do the same as in the previous number. Help the students imagine "wind speed." The wind is invisible so it is hard to imagine how fast it is. Compare it to something they know, such as the speed of a car on the highway—about 100 km/h.

4. If it is possible, bring an anemometer to class and let the students see how it spins faster when wind speed increases.

Answers to Questions

Q8. Compare the air pressures at A, B, C and D. What do you notice?
Answer: The air pressure at A (within the eye of the typhoon) is less than the air pressures at locations away from the eye.

Q9. Compare the wind speed within the eye and at the eyewall. What can you say?
Answer: The wind speed at the eyewall is much greater than the wind speed at the eye.

The activity is supposed to show that the air pressure is lowest at the eye of a tropical cyclone. This is the reason why the surrounding air blows toward the eye. A barometer will show decreasing air pressure as a tropical cyclone approaches.

In contrast, as a tropical cyclone comes nearer, the wind speed increases. The wind speed is greatest at the eyewall, at the dense clouds surrounding the eye. When PAGASA quotes a wind speed, it is referring to winds at the eyewall.

But at the eye itself, the wind is light. So when the eye is over an area, people there think the weather has turned for the better. They may relax and lower their guard. But the tropical cyclone is far from over.

As the tropical cyclone leaves, the other side of the eyewall can still do much damage. That is because structures have already been battered earlier. It is just a matter of time before something worse will happen.

Are You Prepared?

Tropical cyclones by themselves are already dangerous. But they also cause other hazards. Those who live near hill and mountain slopes are susceptible to landslides during stormy weather.

Those who live near the coast are vulnerable to storm surges. And those who live in low-lying areas are helpless against flash floods. Remind students to always listen to advisories and obey the authorities.

We end the module by familiarizing the students with the early warning signals that PAGASA uses in their bulletins and advisories. There are four levels of Public Storm Warning Signals. (Visit the PAGASA website for the complete texts.) The phrase is rather long, so PAGASA shortens it to PSWS # 1, PSWS # 2, etc.

Each signal refers to a certain wind speed that will affect the locality. To acquaint the students with the storm signals, collect some newspaper clippings and let the students read these in class. Then ask them what corresponding wind speed is expected given a certain signal. (If it is possible, record some radio broadcasts and play them in class.)

When a signal is raised for the first time, that means that the effect of the tropical cyclone is still in the future. When PSWS # 1 is announced over a certain area, the effect is expected within 36 hours. That is still one and a half days in the future. People have time to prepare.

With PSWS # 2, the lead time (the time people have to prepare) is 24 hours; PSWS # 3, 18 hours; and PSWS # 4, 12 hours. But the lead time is applicable only when the signal is announced the very first time. If at a later time, the same signal is broadcast, the lead time is now less because the tropical cyclone has already moved closer.

To round up the lesson, ask the students to put together an emergency kit for use at home. Water is the most important thing that should be included in the kit. That is because during tropical cyclones, floods are likely to happen. And floods will contaminate our usual water sources, especially in rural areas. Thus, clean drinking water will be very hard to find during such times.

References and Links

Tarbuck, E.J., & Lutgens, F.K. (2004). *Earth Science* (10th ed.). First Lok Yang Road, Singapore: Pearson Education (Asia) Pte Ltd.

http://www.pagasa.dost.gov.ph/

http://www.ready.gov/hurricanes

http://www.noaawatch.gov/themes/tropical.php

http://weather.unisys.com/hurricane/w_pacific/2011H/index.php

http://en.wikipedia.org/wiki/Tropical_Storm_Washi

http://people.cas.sc.edu/carbone/modules/mods4car/tropcycl/index.html

http://earthobservatory.nasa.gov/NaturalHazards/view.php?id=40584

Unit 2
MODULE

3

COMETS, ASTEROIDS, AND METEORS

Recent advances in space technology have allowed scientists coming from different background like physics, chemistry, biology, and geology to collaborate on studying Near-Earth Objects (NEO) like comets and asteroids. With more powerful telescopes and space probes, the study of comets and asteroids provides more clues about the origins of our solar system. Over the past three years, amateur and professional astronomers have discovered several NEO's that came close to Earth, the most recent asteroid being Asteroid 2012 DA14. It made a very close approach to Earth as it orbited the Sun on February 16, 2012. On the morning of February 16, 2012, a meteoroid exploded in Earth's atmosphere over Lake Chebarkul in Russia hurting about 1,000 people in the process. These two events triggered superstitions, fears, and doomsday prophecies held by different cultures. But do these things have scientific basis?

Key questions for this module

Has Earth ever been hit by a comet or an asteroid? If yes, how have such impacts affected Earth? How often does a comet or an asteroid hit Earth?

Introduction

The pre-assessment activity will take 30-35 minutes of one class period. After the pre-assessment activity, give an introduction about comets and asteroids for the last 25-30 minutes of the period. In the introduction, focus on the comparison of key characteristics of a comet and an asteroid. Use the Student Learning Material as a guide for preparing your introduction.

Pre-assessment Activity (Eliciting Prior Knowledge)

1. Give a pre-assessment of what students know about comets, asteroids, and meteors. The following activities can be done. Choose the activity/ies which you think would best match the ability and interest of your class.

   a. Guessing game
      Variation 1:
      - Show three pictures (a comet, asteroid, and a meteor) to the class and ask them if they recognize what these objects are. If the students cannot recognize any of these three objects, tell them that one of the pictures is a comet, an asteroid, and a meteor. Make them guess which object corresponds to each picture.
      - After the students give their guesses, tell them that in the course of the unit, they will learn if their guesses are correct. Also, at the end of the lesson, the group will be awarded points as part of their recitation grade for every celestial object that they correctly identified.

      Variation 2:
      - Divide the class into smaller groups. Distribute to them three blank strips of paper and a crayon (for writing).
      - Tell the class that you will post a picture of a celestial object. The groups' goal is to identify what this object is. They have 15 seconds to discuss as a group to come up with their guess, and then they will write their answer on the strip of paper.
      - After 15 seconds, ask for a representative from each group to post their paper strip on the board, just beneath the photo of the celestial object.
      - Do this for the other two celestial objects (asteroid and meteor shower).
      - After the students give their guesses, tell them that in the course of the unit, they will learn if their guesses are correct. Also, at the end of the lesson, the group will be awarded points as part of their recitation grade for every celestial object that they correctly identified.

   b. Brainstorming
      - Divide the class into smaller groups. Give each group ½ Manila paper/whole cartolina/old, big calendar and a crayon (for writing).
      - Tell the groups to prepare a table with three columns (as shown below) and write the following words on each column: comet, asteroid, and meteor.
        Group _____

What we know about…		
Comets	Asteroids	Meteors

- Tell the groups to list down everything they know about these terms in the appropriate column. Give the class five (5) minutes to finish this.
- After five (5) minutes, call a representative from each group to post their output on the board.
- Tell the class to examine the output of the other groups. Ask them if they see similarities in the things they have listed about each term, and to point out these things.
- Tell the class that in the course of the unit, they will learn if the things they have listed under each term are correct. From time to time, you will ask them to revise the things they have listed about each term as they learn more about them.

c. Filling up a Venn Diagram
- Give the Venn Diagram activity found in the Pre/Post test part at the end of this TG.
- Call representatives from each group to present their answers and explain as necessary.

d. Story telling
- Call three to four volunteers to share about what they know or a past experience about comets, asteroids, or meteors based on recent events.

Activity 1

What happens when a comet or an asteroid hits Earth?

This activity is a simulation of a comet or asteroid hitting Earth. Explain to the class, while briefly going over the materials for the activity, what is being represented by the materials. The coloured flour or starch represents Earth's crust. The pebble represents a comet, asteroid, or fragments coming from either a comet or an asteroid. Remind the class that the activity is a group work. The group must arrive at a common answer so they must all observe and take turns in making "pebble craters". Students may throw the pebble into the coloured flour at any angle and position they want as long as the pebble hits the flour.

Teaching Tips

4. If you have internet access, there are many photos and video clips available which you can download and save to show to the class. Some of them are shown below.

- Module on Comets, Asteroids, and Meteors from the Canadian Space Agency: http://www.asc-csa.gc.ca/eng/educators/resources/astronomy/module5/content.asp#5
- A Naked-eye Comet in March 2013: http://www.youtube.com/watch?v=OZlenAvqLCI
- Asteroid 4179 Toutatis: http://echo.jpl.nasa.gov/asteroids/4179_Toutatis/toutatis.html
- What Exploded over Russia? http://science.nasa.gov/science-news/science-at-nasa/2013/26feb_russianmeteor/

5. Try out the student activity before performing it in class.
6. Prior to performing the activity, prepare materials for each group. Prepare colored flour by mixing ordinary flour or starch with powdered food coloring, plant extract, or dye (*e.g.*, *jobos*). Adding color to the flour is done to make observations of "pebble craters" easier to see. The rectangular container should have the dimensions of at least 22.86 cm (9 inches) wide, 30.48 cm (12 inches) long, and 7.62 cm (3 inches) high. If a rectangular container is unavailable, a round one can be used, about 30.48 cm (12 inches) in diameter and 7.62 cm (3 inches) high.
7. Encourage the groups to repeat the activity several times to allow every member the chance to perform the activity.
8. Make sure that the students make observations and discuss their answer to the questions based on their observations.
9. Before asking the groups to share their observations and results, ask them reflect on the activity they performed if they think they were able to do enough trials, make good observations, had a genuine exchange of ideas to come up with answers; and if their answers can be supported by evidence.
10. During the presentation of observations of all groups, encourage the students to compare their observations and constructively scrutinize the observations made by other groups.
11. Give feedback on the quality of their group work, focusing on delegation, discussion, and team work at the end of the activity (oral or written).
12. Remind the students that they do not need to memorize names of comets and asteroids.

Answers to Questions

Drawings a & b will depend on the students' actual observations. They should be assessed for the accuracy of the drawing. More or less, the pebble crater should have a rounded shape but a slight oblong shape is also correct.

Q1: The answer will depend on the students' actual observations. More or less, they should see that the shape of the crater is similar to the ones shown in the photos.

Q2: The plants and animals living in that area are most likely to have died on impact.

Q3: An asteroid because it has a shorter orbital period and its origin is most likely from the Asteroid Belt which is nearer than the Kuiper Belt and Oort Cloud.

Discussion on the Activity

During the discussion of the activity, highlight the similarities and differences of the two guided by Table 1 found in the Student LM. In addition, mention that comets and asteroids rotate in their own axes. In addition, mention that while asteroids usually come from the Asteroid Belt, some may originate from other parts of the solar system. Tell the class that while a comet or asteroid orbits the Sun, some parts may break off from the comet or asteroid. These fragments are called meteoroids. Comets, asteroids, or their fragments come from very distant places within and beyond the Solar System.

Stress that when a comet or asteroid enters and passes through Earth's atmosphere, it will be changed physically and chemically. Usually, the fragments from space are completely burnt and only cosmic dust reach Earth. But when these fragments do survive passing through Earth's atmosphere, the fragments can be as small as a sand grain or as big as a boulder. The impact releases great amounts of energy that can damage hundreds of miles from the point of impact. In fact, the discovery of an impact crater at the Yucatan peninsula in Mexico is being touted by scientists as the strongest evidence to support the Impact Theory which explains the extinction of dinosaurs and other species of animals in plants 65 million years ago. Include in the discussion that an asteroid impact 65 million years ago is being considered by scientists as the most probable cause of extinction of dinosaurs and other plants and animals that ended the Cretaceous Period. This was based on an initial study of sediments in marine layers by Luis and Walter Alvarez (father-and-son team of geologist).

Emphasize to the class that the scientific community does not just accept new findings easily. Rather, further studies by different groups of scientists proposing supportive or competing theories about mass extinction, findings compared, and then discussed and decided on by an international community of experts just like how the Alvarez Hypothesis was finally endorsed in March 2010 as the most probable cause of the mass extinction that killed the dinosaurs and other plants and animals 65 million year ago (refer to the Student LM). Similarly, students should also exhibit the same scientific attitude of critical thinking and scepticism in face of new or differing observations, and to openly discuss and validate findings with that of other groups before arriving at conclusions in class.

Suggested Investigation (for advance sections):

1. Guide the class in identifying possible factors that can affect the shape and size of an impact crater. Take up each characteristic one at a time.
2. After the class has enumerated several factors that can affect the shape of the crater, tell each group to choose one factor to investigate (i.e., size of the meteoroid, angle of contact with Earth's surface, speed of the approaching meteoroid).

3. Guide each groups in formulating an investigable question based on the factor they have chosen.
4. Then, instruct the groups to come up with an illustration of their experimental setups using the materials listed in the activity sheet. Ask each group what variable or factor they will make the same, and what they will make different.
5. Remind them to make their own data table and label appropriately.
6. Remind the group's to have at least three setups and conduct three trials for each.

Activity 2

Meteor, meteoroid, and meteorite: How are they related?

This activity will allow the students to know the difference among meteor, meteoroid, and meteorite and how these three are related. By this time, the students should know the difference between a comet and an asteroid. Review of these concepts by making the students compare and contrast the characteristics of a comet and an asteroid.

Teaching Tips

1. Look for three different objects (found in the classroom or anywhere in the school grounds) that have the approximate size of a meteoroid and a meteorite. You will use this in helping the students visualizing the size of a meteoroid and a meteorite.
2. Depending on your assessment of your class' reading skills, choose to give Activity 2 as an individual, paired, or group activity.
3. Remind the students that they do not need to memorize the names of the meteorites and the comet or asteroid source of the meteor showers.

Answers to Questions

Q1: A meteor is a light phenomenon or a streak of light as observed from Earth when a meteoroid passes through Earth's atmosphere.

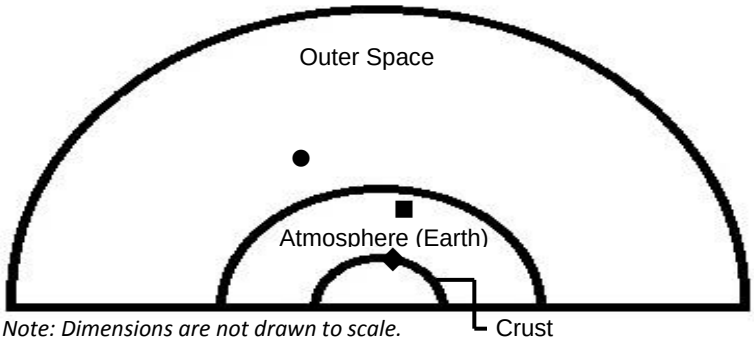
Q2: A meteoroid is a fragment from a comet, an asteroid, Moon, or even Mars that orbits around the Sun, following the orbit of its parent or source.

Q3: Meteoroids can come from comets, asteroids, the Moon, and Mars.

Q4: A meteor is observed when a meteoroid passes through Earth's atmosphere and burns up in the process.

Q5: When viewed from Earth, a meteor moves fast while a comet moves slow. Also, a comet is very difficult to see with an unaided eye due to its distance from Earth. A meteor is more readily seen on a cloudless night.

Q6: Use the following symbols for each: ■ meteor; ● meteoroid; and ◆ meteorite.



Note: Dimensions are not drawn to scale.

The placement of the legends need not be exact but the meteoroid should be just a little above the atmosphere (white space), the meteor in Earth's atmosphere (white space), but the meteorite should be on the crust (line).

Q7: A meteoroid is the space rock fragment before it enters Earth's atmosphere. When it enters the said atmosphere and burns up, a light phenomenon is observed and is called a meteor. When a meteoroid or part of a meteoroid survives passing through Earth's atmosphere, the space rock fragment that lands on Earth's crust is now called a meteorite.

Q8: A meteor shower is an annual light phenomena characterized by many meteors appearing in the sky in a short period of time.

Q9: A meteor shower happens when Earth passes through the orbit of a comet (or an asteroid) where fragments and dust remain in orbit and orbits the Sun as well while Earth goes around the Sun. Since there are more dust and fragments, there are more meteoroids that may burn up in Earth's atmosphere as Earth passes the orbit of the parent comet or asteroid.

Q10: The meteors in a meteor shower seem to come from one point in the sky because they are travelling in parallel paths with the same velocity.

Discussion on the Activity

Emphasize to the class that a comet or an asteroid may break apart while orbiting the Sun. When this happens, the fragments from comets or asteroids still orbit the same path as their mother comet or asteroid. These smaller fragments are called meteoroids. Use real-life objects to approximate and visualize the size of meteoroids (some can be as big as an asteroid or as small as a grain of sand).

Stress the concept of a meteor and a meteor shower as light shows or light phenomena in the sky. Refer to the report on a meteoroid explosion in Russia in

February 2013 which was reported as a meteor crashing on Earth; with the class, correct the terms used in the said report.

Highlight how the scientific community made use of meteorites collected in Earth, as well as newer studies made on orbiting comets and asteroids in learning more of Earth's past, including how past impacts with Earth changed the climate the planet leading to mass extinctions of plants and animals including the dinosaurs; and contributed to the variety and abundance of certain rare metals in impact crater's area, and the implications of such to astro mining in the near future.

Activity 3

Do superstitions about comets, asteroids, and meteors have scientifc basis?

This activity aims to address existing superstitions that the students have or superstitions that they will discover through library research. Stress to the class that since the activity is a group work, they must plan a way to make their library research, online research, and interview with elders effective and efficient. Suggest that they distribute members to do each of the research tasks. After giving general instructions, accompany the students to the library. Observe how they work in groups so that you can give feedback to the group on the following day. They will utilize the rest of the period to do the research needed. Those who will be doing interviews will be doing it as homework. The results of their research will be consolidated, discussed, and finalized on the next day.

Teaching Tips

1. Teach the students how to properly cite references found from different books, magazines, or journals in the library, as well as how to cite online resources.
2. Teach the students on how to search in the library for books using the card catalogue (you can ask the school librarian to do the orientation) or how to use key words in searching for references online (if computers with internet access are available). For example, key words would include "superstitions + Philippines + comets", "comets + superstitions", etc.
3. Facilitate the presentation of group outputs in such a way that there is a free exchange of ideas happening in the class. Ask the class why they think these superstitions are hard to change and why people believe in them despite scientific evidence that says otherwise.

Answers to Questions

All the answers to the activity will depend on the students' research. The rubric below is a guide for assessing their output. You may change the percentages, add more criterions, or revise the description of the related criterion.

Table 4

Sample Rubrics

Weight/ Percentage	Criterion	Description
25%	Quality of research	**All possible sources of information were exhausted (library, internet, people interviews)**
25%	Evidence-based stand	**Evidence gathered to support the group's stand is well supported by accurate scientific facts and information (latest or up-to-date information whenever possible).**
25%	Impact of proposed actions	**Proposed actions are doable, suited to the target audience, and effectively lessened the superstitious beliefs of the target audience.**
25%	**Group work**	**Tasks are well delegated among members; everyone participated in doing research or interviewing people; everyone participated and carried out their task well in implementing the proposed actions.**

Discussion on the Activity

Point out to the class that the need for evidence-based stands and arguments are important in the scientific community to highlight that information we now know changes as more information come into light after sufficient data gathering, sharing of data, and discussion of results and inferences. This highlights the nature of science as being tentative and evidence-based. More so, remind the class that in the course of addressing the superstitions of other people, they must also exercise sensitivity towards the religious and cultural background of the people they are trying to reach.

References

Bely, P. Y., Christian, C., & Roy, J. R. (2010). *A question and answer guide to astronomy.* United Kingdom: Cambridge University Press.

Jones, T. & Stofan, E. (2008). *Planetology: Unlocking the secrets of the solar system.* U. S. A.: National Geographic Society.

Plait, P. (2002). Meteors, meteoroids, and meteorites: Oh my! The impact of meteors and asteroids. *Bad Astronomy.* U. S. A.: John Wiley & Sons, Inc.

Links

American Meteor Society. (2013). Meteor FAQs. Retrieved from http://www.amsmeteors.org/meteor-showers/meteor-faq/#1

Burns, P. R. (2009, May 12). Meteors, meteoroids, and meteorites. Retrieved from http://www.pibburns.com/catastro/meteors.htm

Canadian Space Agency. (2004). Module 5: Comets, meteors, and asteroids. Retrieved from http://www.asc-Csa.gc.ca/eng/educators/resources/astronomy/module5/content.asp#5

Lawrence Hall of Science. (2013). Hands-on universe program: Cosmic cataclysms. Retrieved from http://www.globalsystemsscience.org/studentbooks/acc/ch1

Lunar and Planetary Institute. (2012). About comets. Retrieved from http://www.lpi.usra.edu/education/explore/comets/background/

Mihos, C. (1997-2006). Asteroids. Retrieved from http://burro.astr.cwru.edu/stu/asteroid.html

National Aeronautics and Space Administration. (2004). Asteroid 4179 Toutatis. Retrieved from http://echo.jpl.nasa.gov/asteroids/4179_Toutatis/toutatis.html

National Aeronautics and Space Administration. (2004). What exploded over Russia. Retrieved from http://science.nasa.gov/science-news/science-at-nasa/2013/26feb_russianmeteor/

Notkin, G. (2005-2013). Types of meteorites and classification. Retrieved from http://geology.com/meteorites/meteorite-types-and-classification.shtml

Phillips, T. (2012). Big asteroid tumbles harmlessly pass earth. Retrieved from http://science.nasa.gov/science-news/science-at-nasa/2012/12dec_toutatis/

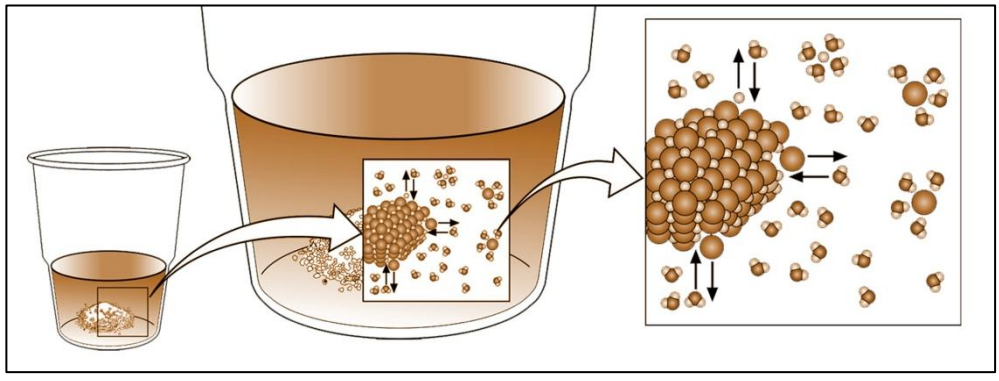
The Meteoritical Society. (2002-2012). Meteorites from the Philippines. Retrieved from Meteoritical Bulletin Database http://www.lpi.usra.edu/meteor/metbull.php

University of California Regents. (2000). The comet's tale: Characteristics. Retrieved from http://cse.ssl.berkeley.edu/segwayed/lessons/cometstale/frame_characteristics.html

University of California Regents. (2000). The comet's tale: Orbits. Retrieved from http://cse.ssl.berkeley.edu/segwayed/lessons/cometstale/frame_orbits.html

University of California Regents. (2000). Asteroid. Retrieved from http://cse.ssl.berkeley.edu/segwayed/lessons/cometstale/glossary/glossary_6th_new/asteroid.html

UNIT 3
Matter



UNIT 3: Matter

Overview

In Grade 7, the development of ideas about matter began with learning about common properties of solutions and becoming aware of materials in terms of the components they are made of—substances, elements, and compounds. These concepts were encountered by the students in the contexts and life situations that they were most familiar with. The focus was more on the 'macro' view (the tangible and visible). Such approach is how science concepts should be taught initially. As students move to Grade 8, they will now delve into what matter is made of and will go beyond what their eyes can see. In this unit, students will begin to explain some everyday situations at the sub-microscopic level (atomic level).

There are three modules in this unit: Module 1 is about the Particle Nature of Matter, Module 2 is about Atoms: Inside Out, and Module 3 is on The Periodic Table (PT) of the Elements. A variety of visual, multimedia, physical, and conceptual models to develop students' understanding will be used to teach about atoms, molecules, and elements.Many properties of matter as well as its changes in state can be explained in terms of the arrangement and motion of atoms and molecules. In the long term, students must grasp the particle model of matter to have a meaningful understanding of topics in the physical, life, and earth sciences.

While one view of learning science involves the mastery of content knowledge and science inquiry skills, another view sees students as taking an active role in building their own knowledge by modifying their existing conceptions of science ideas through the process of conceptual change. Students need to be engaged in a process of restructuring their conceptual understanding. The first important step in doing so is to determine their initial or prior ideas. Research has shown that students must undergo a conceptual change for them to move to a sub-microscopic view of matter.

The approach taken in the first module of this unit is for students to observe more closely different everyday phenomena that will help them gradually understand the particle model of matter. The activities in Module 1 provide opportunities for students to think, draw, represent, talk about, and explain ordinary changes of state such as evaporation, boiling, condensation, melting, and freezing using the particle model of matter. This strategy enables the teacher to take note of students of students' misconceptions and give them the opportunity to deal with them as teaching goes on.

It is hoped that after the first module, students are ready to examine the structure of the atom and explain how ions are formed In Module 2. They will have a number of opportunities to appreciate the atom's structure through the use of multimedia and other strategies. In Module 3, students will gain a better understanding of how the periodic table was developed and appreciate the value of the periodic table as an organizing tool in terms of knowing the properties of the elements.

Most of the activities in this unit are by themselves formative assessment. As you collect students' answers to questions, the results will indicate how far they have learned and what misconceptions they still hold. At certain portions of the module, you may use their outputs as part of your summative assessment for one module.

Unit 3
MODULE

1 THE PARTICLE NATURE OF MATTER

This module on the Particle Nature of Matter shifts students' thinking from the macroscopic view of materials, which was emphasized from Grades 3 to 7 to the sub-microscopic view of matter.

Key question for this module

What is matter made of?
How does the particle model of matter explain some observed properties and changes in matter?

Students' understanding of the particle nature of matter is crucial to how they will understand much of what is taught in the life, physical, and earth sciences. In addition, understanding the particle nature of matter helps students explain concepts such as chemical bonding, chemical reactions, the effects of pressure, temperature, and volume on gases, changes in state of matter, properties such as density and compressibility, and topics in life science such as osmosis and diffusion.

What Research Says about Teaching and Learning the Particle Nature of Matter

Research gives evidence that one of the most difficult concepts for students to understand is that of the particle nature of matter. One reason why students find this difficult is that books and instructional materials simply present the idea to students without helping them develop these concepts. Often, the particle nature of matter is introduced either as a short paragraph or as a chapter on the atom and the history of the atom (Harrison & Treagust, 2002). After a brief explanation of the particle nature of matter, students are not given the opportunity to apply and reapply these ideas to explain everyday situations. A number of research studies (Nakhleh,1992; Novick, S.& Nussbaum, J., 1978&1981; Lee, O., Eichinger, D.C., Anderson, C.W., Berkheimer, G.D., and Blakeslee, T.D., 1993) have shown that

students at the elementary and high school levels fail to fully understand the important aspects of the particle model of matter. These aspects of the model include the following: (1) matter is composed of tiny particles, (2) these particles have spaces between them, (3) the particles are moving all the time, and (4) the particles of matter attract each other. Students find these aspects of the model difficult since these they are more familiar with the observable properties of matter based on their "sensory perception."

Students find it difficult to learn the particle nature of matter is because it is represented at a level which is not observable to them. According to Johnstone (1991), concepts in chemistry should be learned at different levels of representation. These are the (1) macroscopic level, which refer to students' observable everyday experiences; (2) sub-microscopic or particulate level, which can be used to describe the structure of atoms and molecules, as well as the movement of particles and electrons; and (3) symbolic level, which includes the various pictorial representations, algebraic and computational forms.

However, at the elementary and junior high school levels, students still do not have a sub-microscopic or particulate view of matter. They think of particles as smaller parts or pieces of a bigger object (Skamp, 2009). In particular, students cannot imagine the empty space in matter, including that of gases.Thus, it is very important for teachers to properly guide students so they can build their ideas about the sub-microscopic particles, like atoms and molecules.

Building Ideas Through the Use of Models

To help students better understand the particle nature of matter, a number of researchers (Harrison & Treagust, 1996; Harrison & Treagust 1998; Harrison & Treagust 2002) have recommended the use of scientific models. Scientific models (1) are used to think about, explain, and predict scientific phenomena, (2) represent objects, systems, events or ideas, (3) describe or predict the behavior of objects, systems, or events, and (4) may be physical, mathematical, or conceptual, such as the particle nature of matter and the nuclear model of an atom. Therefore, the use of models help students make sense of their observations and visualize their ideas.

These studies have shown that students still hold misconceptions about the nature of sub-microscopic particles, like atoms and molecules even if they can reproduce the diagrams that teachers have taught them. Students fail to realize that different models represent different aspects of the same situation. Teachers should keep in mind that students do not see things the way adults do. Thus, students should be assisted in visualizing ideas by letting them build pictures or models step by step.

In particular, the particle nature of matter is an abstract concept, which can be understood through the use of models. The teacher can monitor students' way of sub-microscopic thinking as the students talk about, draw or illustrate their ideas. With this approach, it is possible for the teacher to notice misconceptions and deal with them immediately as the teaching proceeds (Kabapınar, 2009). Teachers need to develop and build the particle model of matter gradually among students since understanding the model does not happen in a single step (Department for Children, Schools & Families, 2008).

It is in this context that this module is developed. Since students have already been exposed to macroscopic, clearly observable, and concrete situations and events, as well as hands-on experiences from Grade 3 to Grade 7, it is important that teachers guide Grade 8 students to a higher level of explaining ideas and concepts.

Activity 1 Which is matter? Which is not?

In this module, the development of the activities is geared towards building the correct sub-microscopic view about matter. It starts with probing students' ideas about matter. This step is important to find out the nature of the students' initial ideas and determine what they have understood so far from previous grade levels (Smith, 2001). According to Stavy (1988), there is no point in teaching the particle nature of matter when students do not know what we mean by matter. In Activity 1, students are asked to distinguish which is matter from those which are not. They will identify the common characteristics of matter.

Teaching Tips

1. Let the students do the activity first before initiating a class discussion about what is and what is not matter.

2. Your objective in Activity 1 is to uncover students' ideas and reasons for classifying what is matter and what is not matter. Make sure that they give their reason for their classification.

3. Research has shown that most students agree that solids and liquids are matter. But, many students think that gases, heat, and light are not matter.

4. You have to spot areas of agreement and disagreements while students express their ideas.

5. Encourage students to share their ideas before coming to a consensus that matter has mass and occupies space.

Answers to Questions

Table 1. Identifying which is matter

Sample	Is the sample matter?			Reason for your answer
	Yes	No	Not sure	
sugar granules	✓			
water	✓			
stone	✓			
air inside ball	✓			
leaves	✓			
smoke	✓			
heat		✓		
light		✓		

Answers to Questions

Q1. The mass of the first 6 samples (sugar granules, water, stone, air inside ball, leaves, smoke) can be measured.

Q2. The mass of heat and light cannot be measured.

Q3. Not all of the samples occupy space.

Q4. If collected in a container and covered afterwards, it will be observed that smoke occupies space and its mass can be obtained.

Q5. No, heat and light do not have mass. They do not occupy space because these are not matter. Heat is energy in transit and light is a form of energy.

Activity 2

What is matter made of?

In Activity 2, students will infer from given situations or observable events what matter is made of and then explain how these observed situations or events give evidence that matter is made up of tiny particles.

Based on the study of Novick and Nussbaum (1978), three aspects of the particle model are least understood by students because these "contradict their sensory perception of matter." These aspects include: empty space (or the vacuum concept), continuous motion of particles, and interaction between particles. Research has demonstrated that many students cannot visualize space which is "empty." When students draw or represent "empty space", they fill the space with more particles, dust, or air. In their 1981 study, Novick and Nussbaum showed that most students even at the initial years of university education" do not retain a uniform distribution picture of the particles in a gas." Their study also revealed that senior high school and university students have difficulty imagining a vacuum or "empty space" between particles of matter.

Teaching Tips

1. To maximize time, go around each group and interact with the students by asking questions and clarifications regarding their observations, explanations and/or drawings.

2. Make sure that their drawings have explanations written beside the illustration.

3. You do not need to ask <u>all</u> the groups to share their explanations or drawings to the whole class. What is important is for you to collect the drawings of one or two representatives of each group.

Answers to Questions

Q1. The resulting mixture tastes sweet.

Q2. The mixture is sweet because sugar is still present but we cannot see it anymore. The sugar particles mixed well with the water particles.

Q3. (Expect students to give a volume less than 70 mL.)

Q4. The volume of the resulting mixture is less than the sum of the volumes of the unmixed sugar and water.

Q5. The combined volume is less than the sum of 20 mL sugar plus 50 mL water. This shows that water is made up of tiny particles with spaces between them. The sugar particles are able to fit into these spaces because the sugar particles that dissolved in water are very small. These could not even be observed with the unaided eye.

Q6. The food coloring flowed along the side of the bottle and spread slowly towards the bottom of the container and began to spread through out the water.

Q7. After one day, the food coloring has totally spread through out the water since the resulting mixture has a color almost the same as that of the food coloring.

Q8. Since both the food coloring and water are made up of particles, the particles of food coloring are able to fit into the spaces of the water molecules.

Activity 3

Are the particles of matter moving? What is between them?

From Activity 2 until Activity 3, you are developing students' understanding of the particle model of matter. As previously mentioned, research has shown that students cannot imagine the empty space in matter, including those in gases. Hence, they have difficulty understanding compression and expansion of gases.

According to Lee, Eichinger, Anderson, Berkheimer, and Blakeslee (1993), "students believed that air flows like water from one place to another and, thus, is unevenly distributed." When students compressed air in a syringe, some middle

school students thought that “air was pushed forward and moved to the opening of the syringe.”

Poor understanding of the four basic aspects of the particle nature of matter will affect how students think about changes of state. In this module, you are building the students’ present understanding of the particle model so that they will form more connected ideas over time. Your goal is to let the students understand the importance of using the particle model of matter to explain and predict change of state when they do Activities 4 to 6. Eventually, they will be able to use the particle model to explain situations or events they encounter in daily life, specifically various phase changes.

Teaching Tips

1. Please refer to Teaching Tips numbers 1 to 3 of Activity 2. The same tips hold true for Activity 3.

2. Emphasize that a gas can be expanded and compressed; it can be added to or removed from a container with a fixed volume.

3. Make sure that their explanations and/or drawings include the following aspects of the particle nature of matter:

    a. Solids, liquids, and gases are made up of tiny particles which are too small to observe with the unaided eye.
    b. There is nothing between the particles.
    c. The particles move and collide with each other and with the walls of the container.
    d. There are forces that act between the particles.

4. At this stage, point out the general differences between a liquid from a gas.

    a. Gases are easily compressed as they have observed Activity 3.
    b. Gases can expand to fill up its container.
    c. Liquids take the shape of their container but do not expand to fill them up.
    d. Liquids are not as easy to compress as gases because the spaces between the particles in a liquid are much smaller than in gases.

Answers to Questions

Q1. No, the plunger cannot be pushed all the way through the syringe. (The plunger can be pushed until the 15-mL level of the syringe and then it goes back near the 26-27 mL level).

Q2. The plunger of the syringe could be slightly pushed. The springiness of the air inside the syringe can be felt. This gives a hint about the distance between the particles of air.

Q3. We cannot push the plunger in the syringe with water inside.

Q4. We were able to push the plunger of the syringe with air in it but the plunger of the syringe with water in it could not be pushed. We felt the resistance of the water to being compressed.

Q5. Air, being a gas, can be compressed because there are large spaces between the particles so the particles can be made to come closer to each other. The plunger could not be pushed in the syringe with water because water is not as compressible as air. The particles of liquid water are closer to each other and it is difficult to push them even closer to each other.

Q6. Yes, water flowed freely as it is poured into another container. Water maintained its volume and took the shape of the container.

Q7. Water poured on the flat surface of a dinner plate spread out to fill all the space available.

Q8. When the bottle cap inside the bottle was transferred to the dinner plate by tilting the bottle, the bottle cap simply slid along the side of the bottle. The bottle cap retained its shape and volume.

Q9. The salt sample may or may not take the shape of the container depending on the diameter of the container and the amount of salt used. (But if the container has a narrow diameter, and there are more salt used, then salt takes the shape of the container.) The little pieces of salt or sand maintained their shape.

As students construct and revise their models while they discuss with you and their classmates, they realize that solids, liquids, and gases are made up of tiny particles too small to see and they have spaces between them. After doing Activities 2 and 3, they will be able to infer that the particles move based on their observation that the drop of food coloring slowly mixed with water even without being stirred.

According to Novick and Nussbaum (1978), the particle model becomes significant to the students if “several of the aspects are taken together and understood.”

Activity 4

What changes take place when water is left in an open container? In a closed container?

Activity 4 allows the students to use the particle model of matter to explain evaporation, the change that takes place when particles of a liquid are changed to a gas. They will observe evaporation in two different situations: in an open container and in another container which is covered.

Teaching Tips

1. Please refer to Teaching Tips numbers 1 and 3 of Activity 2. The same tips hold true for Activity 4.

2. Point out that during evaporation, the water molecules evaporate only from the surface of the liquid.

3. Students should realize the difference between the open and the closed containers in terms of how evaporation is taking place. Explain that in the open container, the molecules of water that evaporate from the surface mix with the surrounding air and the chance that they will return to the liquid is very small. All the water molecules will eventually evaporate.

4. In the closed container, the water in the gaseous state (or what we call vapor) accumulate above the liquid. They cannot escape. Some of these molecules return to the liquid state. Over time, the amount of vapor increases until the number of molecules that evaporate is equal to the number of molecules that go back to the liquid state.

Answers to Questions

Q1. The cover of container No. 1 had droplets of water on it.

Q2. There is no more water left on container No. 2. (In some cases, there may be a very small amount of water left, depending on the area of the room where it was placed overnight.)

Q3. In container No. 2, the water from the watch glass turned from liquid to gas and escaped to the air. (Some student may already know about evaporation. So, they would write, "water evaporated to the air above the liquid water."

Q4. Yes, it will be different if container No. 2 was heated. In a very short time, most of the water on the surface of the liquid will turn from liquid to gas because the higher temperature will cause the particles of water to move much faster and have more energy to escape from the surface of the liquid.

Activity 5

What changes take place when water is heated or cooled?

The study by Vanessa Kind (2004) revealed that many students up to 18 years of age still find it difficult to explain what happens when a gas is heated or cooled. She found out that students do not realize that particles are constantly moving. In the study of Novick and Nussbaum (1981), 40% of the 16-year olds thought that "particles are forced apart" when a gas is heated. Further, Kind (2004) showed that the idea that the motion of particles decreases when cooled seems to be harder to understand than the fact that particle motion increases when heated.

Activity 5 will give you the opportunity to observe the extent to which your students have grasped the different aspects of the particle model of matter. While the activity is commonplace, the students should be able to explain the phenomena of boiling and condensation beyond what they could observe with their eyes.

Teaching Tips

1. Please refer to Teaching Tips numbers 1 to 3 of Activity 2. The same tips hold true for Activity 5.

2. Point out that some differences between evaporation and boiling.

    a. During evaporation, the water molecules evaporate only from the surface of the liquid but during boiling, water molecules evaporate both from the surface and within the liquid.

    b. Evaporation can occur even at low or high temperatures, but boiling takes place at specific temperatures and pressures, depending on the liquid that is used.

3. A common misconception that might arise in the discussion within the groups or in class is that the temperature of a liquid increases as it boils. If this misconception arises, recall what they did in Quarter 1 of Grade 7 or do a short class demonstration to show that the temperature of a liquid remains constant when it has reached its boiling point.

Answers to Questions

Q1. There are bubbles formed at the bottom of the beaker and bubbles in the boiling water. There is also steam observed above the liquid.

Q2. The bubbles are water in the gaseous state. (It is very common for students to say that the bubbles formed are air. At the start of the heating process, however, the tiny bubbles that form are due to the air dissolved in the water. This is not boiling.)

Q3. The volume of water in the beaker will decrease if water will be kept boiling for more than 10 minutes because there will be rapid evaporation of water.

Q4. As the water is heated and the temperature of the water rises, the molecules gain more kinetic energy and they move faster. More molecules have the energy to overcome the forces of attraction of the neighboring molecules. These molecules escape to the gaseous phase.

Q5. Students' drawings will vary. What is important to note is how students represent and explain the escape of fast-moving molecules of water from the surface of the liquid to the air. Also, their representation or drawing of water in the gaseous state should show that the molecules of water are very far apart.

Q6. As the water began to cool, droplets formed under the watch glass that covered the beaker containing hot water. There are also drops of water formed on the inside wall of the beaker. Some of these drops of water were observed falling to the water inside the beaker.

Q7. The water droplets at the bottom of the watch glass are the molecules of water that escape from the liquid and go into the gaseous phase. These water vapor rise and some molecules touch the glass.

Q8. Students' drawings will vary. Their illustrations should show that the particles or molecules representing water in the gaseous state should be very far apart and as the water begins to cool, the particles should be drawn closer to each other.

Q9. When a gas is cooled, the motion of the particles slows down. If the particles lose enough energy, their attraction for each other can overcome their motion and cause them to come closer with one another to become a liquid.

Activity 6

What changes take place when ice turns into liquid water?

Activity 6 completes the common examples of changes of state observed in daily life which can be explained by the particle model of matter. After performing Activities 4 to 6, students should be able to understand that the solids, liquids, and gases differ because of the arrangement and motion of the particles in each state as well as the attraction between them. It should also be clear to the students that the same particles of matter are involved when these changes happen. No new substances are formed.

Teaching Tips

1. Please refer to Teaching Tips numbers 1 to 2 of Activity 5. The same tips hold true for Activity 6.

2. Since this is the last activity for the module, be on your guard that students do not simply say or define the aspects of the particle model of matter without supporting their statements with drawings or cartoons. As Liu and Lesniak (2006) pointed out in their study, teachers must be aware of students' ideas about matter.

At this stage, you should have bridged the students closer to the more scientific model of matter. Liu and Lesniak (2006) said that "developing understanding of matter needs to help students attend to all aspects of the matter concept and develop meaningful relations among the aspects."

Answers to Questions

Q1. After one to five minutes (depending on the room temperature), the ice begins to turn into a liquid. (Some students may write that "the ice melted.") When ice, which is a solid, turns into a liquid, the particles or molecules of solid water vibrate faster due to the higher temperature in the room compared to the freezer. Eventually, the particles or molecules break away from their fixed positions and so they turn to a liquid.

Q2. The liquid will turn into solid when transferred to the freezer.

References

Brady, J.E.,& Senese, F. (2004). *Chemistry: Matter and its changes* (4th ed.). River Street Hoboken, NJ: John Wiley & Sons, Inc.

Frank, D. V., Jones, T.G., Little, J.G., Miaoulis, B., Miller, S., & Pasachoff, J.M. (2008) *California focus on physical science*. Boston, Massachusetts: Pearson Prentice Hall.

Harrison, A.G. &Treagust, D.F. (2002).The particulate nature of matter: Challenges in understanding the submicroscopic world. In J.K. Gilbert, O.D. Jong, D. F. Treagust, & J.H. van Driel (Eds.), *Chemical Education: Toward research-based practice* (pp 189-212). Dordrecht, The Netherlands:Kluwer.

Harrison, A.G. & Treagust, D.F. (1996).Secondary students' mental models of atoms and molecules: Implications for teaching chemistry. *Science Education*, 80 (5), 509-534.

Johnstone, A. H. (1993). The development of chemistry teaching: A changing response to changing demand. *Journal of Chemical Education*, 70(9), 701-705.

Kind, V. (2004). Beyond appearances: students' misconceptions about basic chemical ideas (2nd ed.). Retrieved fromhttp://www.rsc.org/images/Misconceptions_update_tcm18-188603.pdf

Krajcik, J. S. (2012). The importance, cautions and future of learning progression research. In A.C. Alonzo & A.W.Gotwals (Eds.), *Learning progressions in science: Current challenges and future directions* (27-36)Rotterdam, Netherlands: Sense Publishers.
Retrieved from https://www.sensepublishers.com/media/593-learning-progressions-in-science.pdf.

Lee, O., Eichinger, D.C., Anderson, C. W., Berkheimer, G. D., & Bladeslee, T. D. (1993). Changing middle school students' conceptions of matter and molecules. *Journal of Research in Science Teaching*, 30 (3), 249-270.

Merritt, J.D., Krajcik, J. & Shwartz, Y. (2008).Development of a learning progression for the particle model of matter.ICLS'08 *Proceedings of the 8th International Conference for the learning sciences, International Society of the Learning Sciences 2, 75-81.*RetrievedfromhttP://dl.acm.org/citation.cfm?id=1599881

Nakhleh,M. (1992). Why some students don't learn chemistry, *Journal of Chemical Education*, 69(3), 191-196.

Nakhleh, M., Samarapungavan, A., & Saglam, Y. (2005). Middle school students' beliefs about matter. *Journal of Research in Science Teaching*, 42 (5), 581-612.

Novick, S. & Nussbaum, J. (1978). Junior high school pupils' understanding of the particulate nature of matter: An interview study. Science Education, 62 (3), 273-281.

Novick, S. & Nussbaum, J. (1981). Pupils' understanding of the particulate nature of matter: A cross-age study. *Science Education*, 65(2), 187-196.

Skamp, K. (2009). Atoms and molecules in primary science: What are teachers to do? Aust. J. Ed. Chem., 69, 5-10. Retrieved from http://www.raci.org.au/sitebuilder/divisions/knowledge/asset/files/38/ausjecissue69(pdffile)[1].pdf

United Kingdom. Department for Children, Schools & Families (2008).*Using models, science study guide.* Retrieved from http://www.iteach.ac.uk/LinkClick.aspx?fileticket=wc0DUlOOxMQ%3D&tabid=1006&mid=7745

Wilbraham, A.C., Staley, D. D., Matta, M.S., & Waterman, E.L. (2007).*Chemistry: Teacher's edition for California.* Boston, Massachusetts: Pearson Prentice Hall.

Unit 3
MODULE

2

ATOMS: INSIDE OUT

In the earlier module, students learned about the particulate nature of matter. They have learned that elements, the simplest form of matter, are made up of basic units called **atoms.** In this module, the students will delve deeper into the atom and look at its structure. It is imperative that the students recognize that the atomic structure they are studying is a *scientific model*. It is not the real thing as no one has ever seen what the atom really looks like, as pointed out in the Teacher's Guide for Unit 3 Module 1. However, several scientists design experiments that may manifest the composition and structure of the atom which may lead them to propose a model for the atom. Proposed models are tested further, sometimes by other scientists, to determine their validity. If new evidence would disprove a model, another model is proposed. In this module, students will realize that scientific models may evolve and the one that is currently accepted may still develop as modern scientists continue to investigate about the atoms.

With the discoveries about the atom that are yet to come, the students can be enjoined to partake in this exciting possibility. They can start by equipping themselves with knowledge as they explore the atoms inside out.

Key questions for this module

What makes up an atom?

How do these components differ from each other?

How are these components arranged inside the atom?

How are atoms different from ions?

Science Ideas

- **Atom is regarded as the smallest, basic unit of matter. Even if it is the basic unit of matter, it is still composed of parts.**
- **The parts are the electrons (-), protons (+), and neutrons (0).**
- **An atom has equal number of protons and electrons. This makes the atom neutral.**
- **Protons and neutrons are relatively heavier than electrons. They compose the nucleus and collectively called as nucleons. The mass of an atom is mainly determined by the mass of the nucleus.**
- **Several models have tried to show how the subatomic particles are arranged in an atom. Thus far, the accepted model places the protons and neutrons in the center of the atom; or the so-called, nucleus. Moving rapidly around the nucleus are the electrons.**
- **Atomic number, or the number of protons of an atom distinguishes an element from the others. This number is the same for all atoms of a particular element.**
- **While the number of protons is fixed for an atom of an element, the number of neutrons may vary. Atoms having the same number of protons but different number of neutrons are referred as isotopes. The isotopes are identified through their mass number which is the sum of the number of protons and the number of neutrons in an atom.**
- **Information on the subatomic composition of an element may be represented through shorthand notations.**

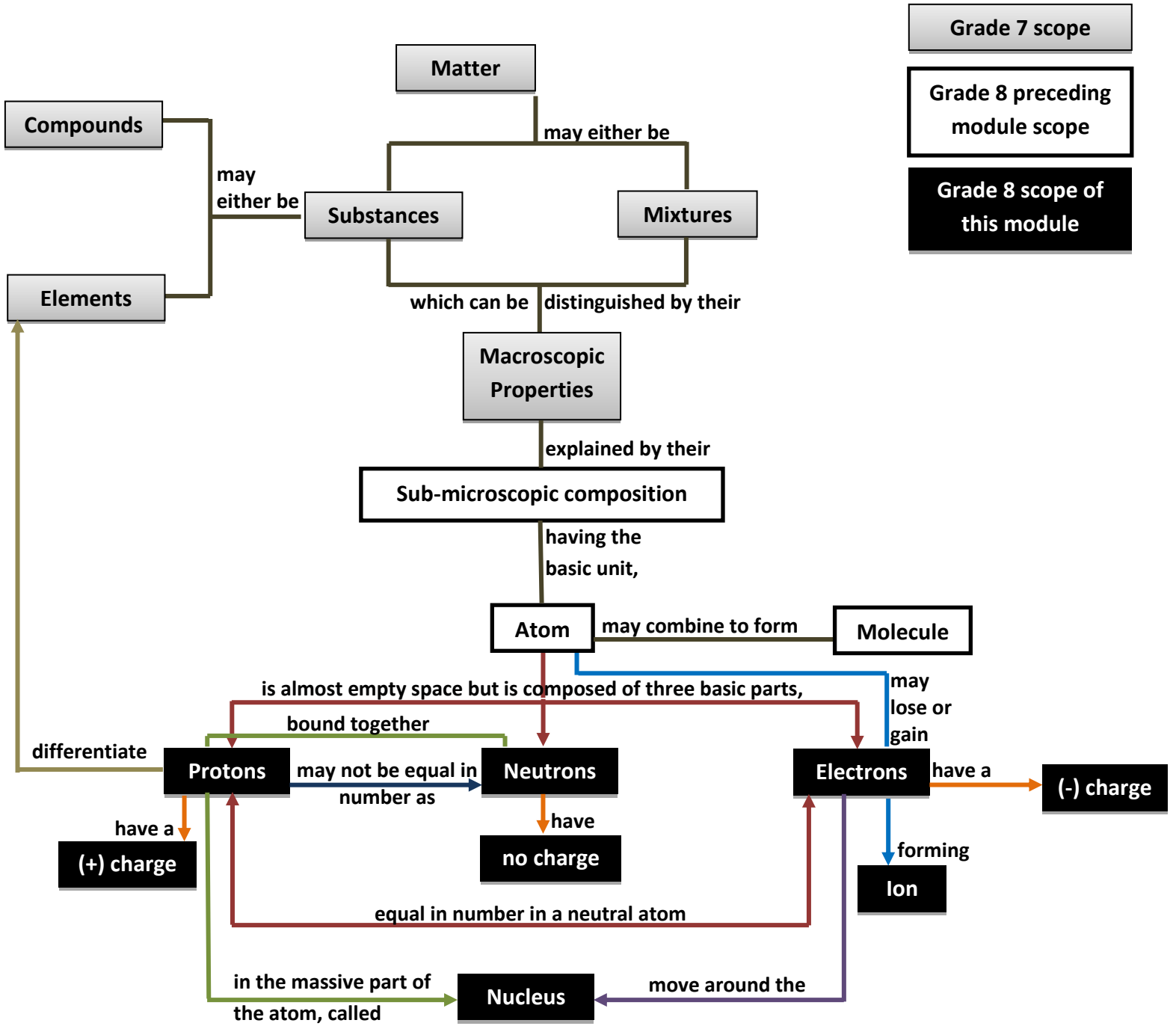


Figure 1. Concept map for atom

Activity 1

"Charge" it to experience!

The students might find it surprising that all objects contain charged particles; not everything they touch gives them an electric shock. This activity provides students an "experience" to deduce that even those objects that appear to be neutral contain charges. In these objects the positive charge equals the negative charge. To bring in this idea, the students are given this "experience" to remember that neutral objects may be "charged".

Teaching Tips

1. Let the students do the activity first before initiating a class discussion.

2. Your objective in Activity 1 is to let students realize that objects contain charges. This will be the jump-off point of the charged particles that compose the atoms. Perhaps, after the activity, you can pose a rhetorical question such as *"where do all these charges come from?".* Expectedly, there will be no way for students to see with their very own eyes these charged particles. However, the experience they will have in this activity will show that objects contain charges.

3. You may access http://phet.colorado.edu/en/simulation/balloons* for a simulation of how charges are transferred between objects. This simulation also used balloons. You may ask the students the net charge of the balloon after it was rubbed against their hair. Moreover, ask them about the charges of their hair and the frame glass.

   **Note: Some rights reserved. Please read about the organization's terms and conditions on the use of their software. You may access this in http://phet.colorado.edu/en/about/licensing*

4. Please take care of handling the picture frame glass in Procedure 3. In case it is not possible to monitor each student while performing the activity, it is advisable to make this part as a class activity. You may prepare one setup for the whole class. Ask a representative to perform this part of this activity for the whole class to observe.

5. This might be the students' first time to encounter the word, *relative*. It might be advisable to find an opportunity in giving them an idea on what relative means. They will encounter this word several times in the module such as relative masses, relative charges, size relative to-.

You may include the discussion below when Table 2 is presented to them.

Discussion: You may notice the word, *relative*, as part of the headings in Table 2. What do you mean by relative? It simply means that you have considered the relation-ship of something into a standard. Let us take for example the three persons on the image on the right. Among these three, the height of the person in the middle was chosen to be the standard or the basis for reference in comparing the heights. Relative to that standard height, the person on the extreme left (facing you) is shorter while the person on the extreme right is taller. What if the height of the person in the extreme left is the standard or the basis for comparison? Are the heights of the other two people relatively shorter or relatively taller? Right, they are relatively taller than the person on the extreme left.

Take a look at the *relative charges* in Table 2. Charges are measurements themselves. You use an instrument to know a measurement value. For example, you use a ruler to measure the length of an object and report the measured length in units such as meter. Similarly, an instrument is used to measure charges and the measured units may be expressed in *coulombs*. For the electrons, the actual charge is -1.602×10^{-19} coulombs; while for the protons it is $+1.602 \times 10^{-19}$ coulombs. Now, try to compare those values. What do you notice? How are the numerical values related? The numerical values are just the same, isn't it? The numerical value is 1.602×10^{-19}. With this, can you think why the relative charge of electron is -1, for proton is +1, and the neutron is 0?

Answers to Questions

Q1. The balloons pushed away each other. They moved toward opposite directions.

Q2. The balloons acquired the same charge since they repelled one another; like charges repel.

Q3. The balloons moved toward the glass.

Q4. The glass and balloon have different charges since they got attracted with each other; unlike charges attract.

Activity 2

The big difference

In this activity, students will be able to visualize through different ways of representation (bar graph, pie chart, seesaw), the big difference in mass of the protons and neutrons compared to the electrons. The numbers, alone, especially expressed in negative exponents might not give them enough idea on the said difference. This activity will then give them a visual feel of the relative masses of the subatomic particles. Transforming these values in different ways, including converting it to number of particles (Q5), may give them a picture of this difference. Moreover, the process skill of plotting and interpreting graphs are enhanced.

Ultimately, the students will deduce that the electrons do not contribute significantly to the mass of the entire atom. Having this in mind, they will later on connect this with the concept of mass number.

Teaching Tips

1. Student mathematical and graphing skills such as working with exponents and plotting the values may be challenged in this activity. They might need some help as they go about the activity.

Answers to Questions

Q1. Electrons

Q2. Neutrons

Q3. Neutrons and Protons

Q4. The masses of the protons and neutrons are almost the same. (Drawing: seesaw is just a little lower in the neutron side)

Q5. 1836 electrons

Computation:

no. of electrons (mass of 1 electron) = mass of 1 proton
no. of electrons (9.109×10^{-28} grams) = 1.672×10^{-24} grams
no. of electrons = 1.672×10^{-24} grams / 9.109×10^{-28} grams
no. of electrons = 1836

Q6. Neutrons and protons

Activity 3

Small but terrible

In the previous part of the module, students learned about the subatomic particles that compose the nucleus. They will learn in this activity that the model of the atom we currently hold true is a product of discoveries of different scientists. However, the group given the greatest recognition is the team of Rutherford with their discovery of the nucleus through their alpha scattering experiment. They bombarded a very thin sheet of gold foil with heavy positively-charged alpha particles. The observations were surprising! They never thought that there will be a certain region in the atom that would be "small but terrible". This very small region of the atom is where most of the mass and all the positively-charged (+) particles of the atom are situated. The effect of hitting it with another (+)-charged particle was quite unexpected! In Rutherford's words. "*It was as if you fired a 15-inch shell at a sheet of tissue paper and it came back to hit you.*"

Teaching Tips

1. *Advance preparation for Part A*. Cut out different shapes (e.g., triangle, star, U-shape) as the "mystery objects".

2. As pointed out in Module 1, models are used to represent things that are unobservable by the eyes. In this module, the model that the students will learn about is on the structure of the atom. They will learn some features of the current model of the atom such as:

a) at the center of the atom is the nucleus which is composed of protons and neutrons; the nucleus is massive and very small relative to the entire atom

b) moving rapidly around the nucleus are the electrons; and

c) most of the atom's volume is just empty space.

3. You may access http://phet.colorado.edu/en/simulation/rutherford-scattering* for a simulation of Thomson's plum pudding (raisin bread) model and Rutherford's alpha scattering experiment. You may use the plum pudding (raisin bread) simulation to reinforce your discussion after the students have finished Part B. Let them finish part C and use this simulation again to add to your discussion.

   **Note: Some rights reserved. Please read about the organization's terms and conditions on the use of their software. You may access this in http://phet.colorado.edu/en/about/licensing*

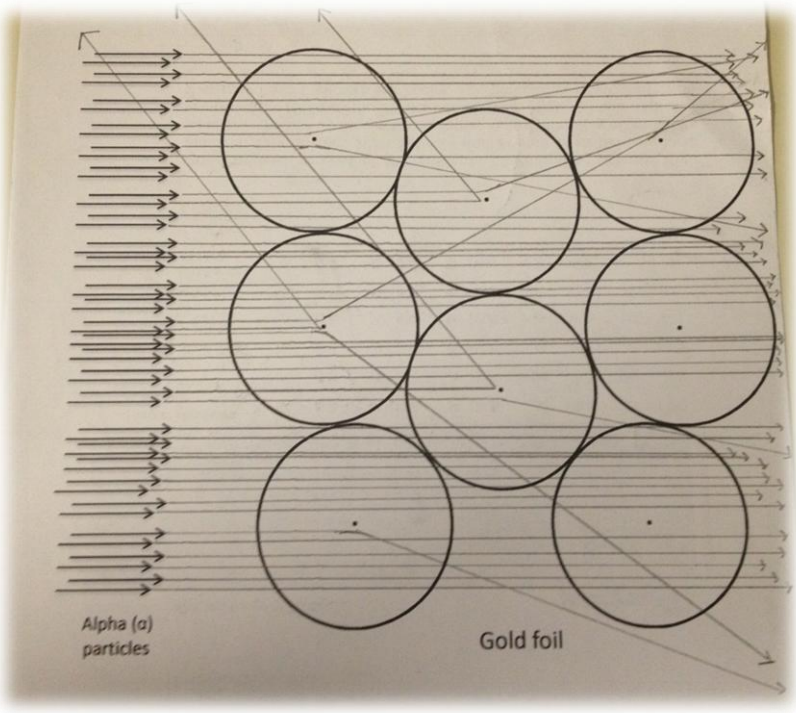
4. Students should realize that models may change over time. Emphasize that models may evolve as new observations are made, much like how Thomson's raisin bread model was replaced by Rutherford's nuclear model.

5. Below is a sample drawing for the schematic representation of the alpha scattering experiment. The drawing of the student may not be exactly the same. Important things to note are:

   a) Most of the alpha particles were undeflected.

   b) Some alpha particles were deflected in an angle.

   c) Few alpha particles deflected almost towards back to the source.



Answers to Questions

Part A

Q1. Depends on the sample

Q2. Depends on the sample

Q3. Depends on the sample

Q4. Inside the box, the marble was rolled over and around. There are times that the marble bumps the object inside the box. This gave helpful clues to infer the size, shape and location of the “mystery object”.

Part B

Q1. The coins came passing through the pieces of paper.

Part C

Q1. It will be repelled causing the positively-charged alpha particle to move at an angle away from the positively-charged nucleus.

Q2. It will be repelled but the repulsion will be stronger compared to the repulsion when the positively-charged alpha particle only came close to the positively-charged nucleus. The alpha particle will be more strongly deflected since it hits a particle with a bigger mass, the nucleus of the gold atom.

Q3. The nucleus is much tinier than the ones drawn in the diagram; therefore, there will be more alpha particles that will pass through.

Q4. There is a very small chance of hitting the target (the nucleus) since it is very tiny.

Activity 4

What's in a number?

In this activity, the students will deal with **atomic number** and **mass number.** They will learn that both these numbers tell information about the subatomic composition of an element. The atomic number, or the number of protons, distinguishes one element from others. The mass number, or the total number of protons and neutrons, distinguishes an **isotope** of a particular element to its other isotopes. The average mass number of the element's naturally occurring isotopes multiplied with their abundance gives the **atomic mass** of the element. On the other hand, they will also learn that the number of electrons of an atom may change resulting in the formation of **ions**. Depending on the number of electrons, an atom can be a positive ion (fewer electrons than protons) or a negative ion (more electrons than protons). Moreover, they will learn to write all of these information in shorthand notations.

Teaching Tips

1. You may access http://phet.colorado.edu/en/simulation/build-an-atom* to reinforce the concepts of *atomic number, mass number,* and *ions*. This may provide visual appeal on the inventory of subatomic particles they have done in Activity 4. Moreover, the visual addition may give the students insights such as:

a) only a change in the number protons changes the identity of the element

b) atoms of an element may have different number of neutrons; and the net charge remains zero

c) ions are formed by the addition or removal of electron/s

d) a positive ion is formed when electrons are removed from an atom and the number of electrons becomes less than the number of protons while a negative ion is formed when electrons are added to an atom and the number of electrons becomes more than the number of protons.

e) electrons do not have anything to do with mass number since their contribution to the mass of the atom is negligible

f) adding electrons may increase the size of the atom

Also, the students can assess their learning by clicking on the *Game* tab.

**Note: Some rights reserved. Please read about the organization's terms and conditions on the use of their software. You may access this in http://phet.colorado.edu/en/about/licensing*

2. You may access http://phet.colorado.edu/en/simulation/isotopes-and-atomic-mass* to reinforce the differences in atomic mass of the element's isotopes. Direct the students to notice that the atomic mass of an element is closest in value to the mass number of its most abundant isotope.

   **Note: Some rights reserved. Please read about the organization's terms and conditions on the use of their software. You may access this in http://phet.colorado.edu/en/about/licensing*

3. Post-activity Discussion.

   a) Q5 and Q6. You may emphasize the difference in the number of neutrons of the isotopes of an element.

   b) Q7. For simplicity and for this grade level only, you may not include mole in expressing the atomic mass. The mole concept will be dealt in Grade 9. Also, reinforce the students' learning from Activity 2, i.e., electron's mass is negligible with respect to the entire atom, by asking them the reason

why it is only the protons and neutrons that are considered to contribute to the atomic mass.

c) Procedure 5. Let the students analyze the completed table. Direct them to realize that:

- the number of neutrons may be different from the number of protons and electrons

- there is a net charge when there is unequal number of electrons and protons; in a positive ion (cation) there are less electrons than protons while in a negative ion (anion) there are more electrons than protons

d) Procedure 6, Shorthand notations. Note that the subscripts which indicate the atomic number are the same for all the isotopes of iron. They are isotopes of the same element, iron.

Answers to Questions

Q1. Phosphorus

Q2. 15 protons

Q3. 13 protons

Q4. Hydrogen

Q5. 6 protons; 6 neutrons

Q6. 6 protons; 7 neutrons

Q7. Mg: 24.30 grams; K: 39.10 grams

Q8. 3 protons

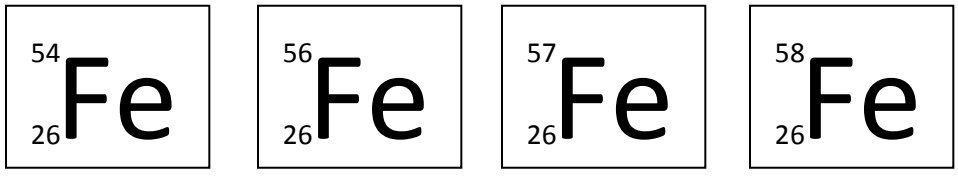
Q9. 4 neutrons

Q10. 2 electrons

Table in Activity 4

Isotope	Element Name	# of p^+	# of e^-	# of n^0	Charge
B-6	Boron	5	5	1	0
N-14	Nitrogen	7	7	7	0
F-19	Fluorine	9	10	10	-1
Ne-20	Neon	10	10	10	0
Mg-24	Magnesium	12	10	12	+2
Al-27	Aluminum	13	10	14	+3
Si-28	Silicon	14	14	14	0
S-32	Sulfur	16	16	16	0
K-35	Potassium	19	18	16	+1

Shorthand notation for the naturally occurring isotopes of iron, showing mass number and atomic number



References

Brady, J.E.,& Senese, F. (2004). *Chemistry: Matter and its changes* (4th ed.). River Street Hoboken, NJ: John Wiley & Sons, Inc.

Bucat, R.B. (Ed.). (1984). *Elements of chemistry: Earth, air, fire and water*, *Vol. 2*. Canberra City, A.C.T., Australia.

Elvins, C., Jones, D., Lukins, N., Miskin, J., Ross, B., & Sanders, R. (1990). *Chemistry one: Materials, chemistry in everyday life.* Port Melbourne, Australia: Heinemann Educational Australia.

Hill, J.W. & Kolb, D.K. (1998). *Chemistry for changing times* (8th ed.).Upper Saddle River, NJ: Prentice Hall.

Philippines. Department of Education. (2004).*Chemistry: Science and technology textbook for 3rd year*. (Revised ed.). Quezon City: Author.

Silberberg, M.S. (2007). *Principles of General Chemistry*. McGraw-Hill: New York

Links

Interactive Simulations: http://phet.colorado.edu/

Some rights reserved. Please read about the organization's terms and conditions on the use of their software. You may access this in http://phet.colorado.edu/en/about/licensing

NISMED's AgIMat website: http://curriculum.nismed.upd.edu.ph

Unit 3
MODULE

3

PERIODIC TABLE OF ELEMENTS

The development of the Periodic Table could be traced back in 1817 with the work of Johann Dobereiner, a German chemist who formed the triads of elements with similar properties like the triad of calcium, barium and strontium. In 1863, John Newlands, an English chemist proposed the Law of Octaves. He based his classification of elements on the fact that similar properties could be noted for every eight element in order of increasing atomic masses. Around 1869 two scientists determined a way to put the elements in order. Lothar Meyer and Dmitri Mendeleev both came up with periodic tables that showed how elements should be grouped. Both scientists were teachers living and working in different places. Meyer lived and worked in Germany while Mendeleev in Russia. Both arranged the elements in order of increasing atomic mass. Their arrangement made sense since such arrangement had the properties of elements repeat periodically. Later, in 1914, Henry Moseley, an English physicist observed that x-ray frequencies emitted by elements could be correlated better with their atomic numbers. This observation led to the development of the modern **periodic law** which states that the *properties of elements are periodic functions of their atomic numbers*.

In this module, the first activity is designed with a historical perspective and will provide students an experience similar to those of the early scientists who developed the periodic table. They would be able to come up with ideas on how and why things could be periodically arranged. The information which they would refer to on the element cards is the kind that Mendeleev and Meyer would have had at their disposal and will assist them on how the elements would be arranged. The second activity will make use of the periodic table to predict the reactivity of the metals.

Key question for this module

How did the Periodic Table develop?

What information about elements can be obtained from this organizing tool?

Science Ideas

- The periodic table is a chart containing information about the atoms that make up all matter.
- Early scientists developed the periodic table by arranging elements in order of increasing atomic mass.
- The modern periodic table shows elements arranged in order of increasing atomic numbers.
- A periodic property repeats itself at regular intervals when elements are arranged according to a common criterion.
- The properties of undiscovered elements can be predicted based on their position in Mendeleev's table.
- The modern periodic law states that the properties of elements are a periodic function of their atomic numbers.
- Elements may be classified into groups. Members of the same group exhibit similar properties.
- The modern periodic table is divided into groups or families- vertical columns and periods or series – horizontal rows.
- There are two sets of families: the *representative elements* and the *transition elements*.
- The uses of the different elements are based on their properties.

Activity 1

Tracking the path and constructing the Periodic Table

The periodic table was developed as a result of years of painstaking work by different scientists. Its present form was a result of meticulous and thorough study by scientists. The first activity provides you an experience similar to those of the early scientists who developed the periodic table.

Teaching Tips

1. *Advance preparation.* Print out the element cards found in the appendix.

2. Let students answer the following questions before doing the activity.
   a. What is an element? How many different kinds of atom an element is made of?
   b. Define atomic mass of an element.
   c. What is the atomic number of an element?

3. Arrange the element cards on the board in one horizontal line and in the order of increasing atomic mass. Instruct the class to perform Part A for at least 20 minutes. Make sure that students identify what is recurring property did they use as basis for moving the elements into groups. They should also know the operational meaning of *periodic* to understand the concept of periodicity. Anticipate that the students may find difficulty in placing the last two element cards, *tellurium* (Te) and iodine (I). Let it be. Allow the students to think this over. You may discuss their experience on this as Q4 is answered.

4. The table in page 5 shows the expected arrangement of the element cards in Part A. Assuming that the element cards have been arranged by the class this way, discuss the table as the whole class answers Q1 to Q4. Expected answers are found in the succeeding pages.

   Discuss with the class their experience in constructing their table of elements. Perhaps, it was similar to what the early scientists have experienced, in terms of grouping together elements with similar characteristics in rows and columns. Tell them also that they were not given the entire element cards, rather just some of the elements that had been discovered at the time Mendeleev and Meyer were working on their periodic tables. When answering Q3, allow them to remember their experience with the cards for Te & I. Guide them that similar properties have to take precedence over atomic mass. Discuss that maybe Mendeleev made the same switch or adjustment. Explain, too, that at present it is known that the atomic numbers, rather than atomic masses of the elements form a better basis for ordering them in the

periodic table Mendeleev had no way of knowing this since protons had not yet been discovered during his time. He thought that the masses of iodine and tellurium may have been measured incorrectly and that eventually better measurements would show iodine to be heavier than tellurium. In answering Q4, they may be able to guess that these gaps represent elements not yet discovered in 1870. Discuss that Mendeleev predicted that elements would be discovered in the future to fill these gaps. The prediction was realized with the discovery of gallium by the French chemist Paul-Emile Lecoq de Boisbaudran in 1875 and of germanium by Clemens Winkler, a German chemist, in 1886.

5. After telling students these facts, introduce part B. Ask the groups to try to fit the cards of gallium and germanium in their respective tables. Do the same with the cards for noble gases.

Answers to Questions

Part A

Q1. There are 7 families in the table. The noble gases constitute the 8th group but will be realized after doing Part B.

Q2. The properties of the element and the compounds formed

Q3. Iodine and tellurium broke the trend in terms of properties. The properties are quite dissimilar with the other elements belonging to the same column or group.

Q4. There are gaps in the family of boron and aluminum and in the family of carbon and silicon. These gaps might indicate that there were elements not yet discovered during Meyer's and Mendeleev's time.

Part B

Q1. Gaps were filled. Gallium was placed in the family of boron and aluminum while germanium was placed in the family of carbon and silicon. The noble gases, on the other hand, were arranged into a new family.

Q2. Our table of elements did not include the transition elements like the modern periodic table. The table stops at xenon and it is organized by atomic mass rather than atomic number.

Q3. While tellurium has a higher atomic mass than iodine, iodine has the higher atomic number. It is the atomic number and not the atomic mass that is the organizing principle of the periodic table.

Expected Arrangement for Table of Elements in Part A

H **Hydrogen** Atomic Mass: 1.008 Description: odourless gas, very flammable Compounds: H_2O, HCl						
Li **Lithium** Atomic Mass: 6.941 Description: soft gray metal, reacts with water Compounds: Li_2O, LiCl	Be **Beryllium** Atomic Mass: 9.012 Description: gray metal Compounds: BeO, $BeCl_2$	B **Boron** Atomic Mass: 10.81 Description: gray metalloid, semiconductor Compounds: B_2O_3, BCl_3	C **Carbon** Atomic Mass: 12.01 Description: black solid (graphite) or transparent crystal (diamond) Compounds: CO_2, CCl_4	N **Nitrogen** Atomic Mass: 14.01 Description: odorless gas, rather unreactive Compounds: NH_3, NCl_3	O **Oxygen** Atomic Mass: 16.00 Description: odorless gas, very reactive Compounds: H_2O	F **Fluorine** Atomic Mass: 19.00 Description: yellowish gas, extremely reactive Compounds: HF, NaF, CaF_2
Na **Sodium** Atomic Mass: 22.99 Description: soft gray metal, reacts vigorously with water Compounds: Na_2O, NaCl	Mg **Magnesium** Atomic Mass: 24.31 Description: gray metal, flammable Compounds: $MgCl_2$, MgO	Al **Aluminum** Atomic Mass: 26.98 Description: silvery metal Compounds: $AlCl_3$, Al_2O_3	Si **Silicon** Atomic Mass: 28.09 Description: gray metalloid, semiconductor Compounds: $SiCl_4$, SiO_2	P **Phosphorus** Atomic Mass: 30.97 Description: white, red, or black, spontaneously flammable Compounds: PH_3, PCl_3, PCl_5	S **Sulfur** Atomic Mass: 32.07 Description: yellow solid powder Compounds: H_2S, SCl_2	Cl **Chlorine** Atomic Mass: 35.45 Description: greenish gas, extremely reactive Compounds: HCl, NaCl, $CaCl_2$

K **Potassium** Atomic Mass: 39.10 Description: softgray metal, reacts violently with water Compounds: K_2O, KCl	Ca **Calcium** Atomic Mass: 40.08 Description: hard silvery metal, flammable Compounds: $CaCl_2$, CaO			As **Arsenic** Atomic Mass: 74.92 Description: gray metalloid Compounds: AsH_3, $AsCl_3$, $AsCl_5$	Se **Selenium** Atomic Mass: 78.96 Description: gray or red solid Compounds: H_2Se, $SeCl_2$	Br **Bromine** Atomic Mass: 79.90 Description: red-orange liquid, very reactive Compounds: HBr, NaBr, $CaBr_2$
Rb **Rubidium** Atomic Mass: 85.47 Description: soft gray metal, reacts violently with water Compounds: Rb_2O, RbCl	Sr **Srontium** Atomic Mass: 87.62 Description: soft silvery metal Compounds: $SrCl_2$, SrO	In **Indium** Atomic Mass: 114.8 Description: soft silvery metal Compounds: $InCl_3$, In_2O_3	Sn **Tin** Atomic Mass: 118.7 Description: silvery- white metal Compounds: SnO_2, $SnCl_4$	Sb **Antimony** Atomic Mass: 121.8 Description: bluish-white metalloid, semiconductor Compounds: SbH_3, $SbCl_3$, $SbCl_5$	I **Iodine** Atomic Mass: 126.9 Description: dark-purple solid, reactive Compounds: HI, NaI, CaI_2	Te **Tellurium** Atomic Mass: 127.6 Description: silvery-white metalloid, semiconductor Compounds: H_2Te, $TeCl_2$

Q4. The existence of aluminum and silicon gave Mendeleev an idea that gallium and germanium should also exist. Since Mendeleev did not know about any member of the noble gas family, he didn't have an inkling that others might also exist.

Q5. Element 120 would be placed below radium and element 121 would be placed below actinium.

Q6. The new element would belong to the group or family of carbon, silicon, and germanium.

Activity 2

Metal . . . Metal: How reactive are you?

This activity allows students to revisit metals. They will look at their chemical property by comparing the reactivity of some common metals. Reactivity is the ease and speed with which a metal reacts with other substances. Moreover, they will be discussing ways to prevent corrosion of metals.

Teaching Tips

1. Do the following before the activity.

    a. Using the Periodic Table, identify the portions corresponding to metals, nonmetals, and inert gases.

    b. Tell the students that they will be using aluminum as one of the metals in this activity. They will examine familiar objects made of aluminum such as a softdrink can, a disposable plate, heavy-duty aluminum foil, and aluminum foil. Compare the shape, thickness, and general appearance of the objects. Let them observe what happens if they bend and unbend each object.
    Based on the properties they have observed, let the students infer and explain why this metal was used to make each object.

    c. Proceed with the discussion of the reactivity or non-reactivity with other substances.

    d. Bring them back to their experience in Grade 7 Acids & Bases. Ask the students what would happen if some metals like iron will continue to be reactive with some substances in the environment? Can we stop reactivity of metals? How?

2. Students will perform the activity in groups and discuss answers to questions.

3. Remind students to be cautious when handling muriatic acid. Ask students to wash their hands in running water and rub the affected part with baking soda.

4. Guide the students to infer from the Activity Series of Metals that the more active metal can react with other substances by displacing or replacing a less reactive element from its compound. The activity series can be used as a reference to determine a metals' reactivity.

5. Important Ideas

    a) The metals in a group or family in the periodic table have similar properties and these properties change gradually across the table. The reactivity of metals tends to decrease from left to right across the periodic table and increases from top to bottom in a family.
    b) The Group 1 metals, from lithium to francium are called the alkali metals. These metals are so reactive that they are never found as uncombined elements in nature.
    c) Group 2, the alkaline earth metals are not as reactive as the Group 1 metals, but are more reactive than most other metals. Like the metals in Group 1, they are also never found uncombined in nature.
    d) Elements in Group 3 through Group 12 are called the transition metals. They are less reactive than the metals in Groups 1 and 2.
    e) Only some of the elements in Groups 13 and 15 of the periodic table are metals. These metals are never found uncombined in nature.
    f) The 2 rows of elements placed below the main part of the periodic table are the lanthanide series at the top row and the actinide series, at the bottom row. Different lanthanides are usually found together in nature and are always combined with other elements.

6. If there is a shortage of glass graduated cylinder, an empty glass bottle or vial can be calibrated to 10 mL and will be used as a measuring device.

Answers to Questions

Q1. Iron, aluminium and zinc reacted with muriatic acid while copper did not.

Q2. Iron, aluminium and zinc, the metals that reacted with muriatic acid (HCl), are higher than hydrogen in position in the activity series, hence they are reactive. Copper on the other hand is below hydrogen in the activity series, hence less reactive. This means that it cannot displace hydrogen.

Q3. The reactivity increases as it goes from top to bottom of the periodic table.

Q4. Yes, Group 2 metals followed the same trend for Group 1 metals in terms of reactivity.

Q5. The reactivity decreases as it goes from left to right of the periodic table.

Q6. a. Na is more reactive than Mg with HCl
b. Al is more reactive than Ag
c. Zn is more reactive than Fe

Q7. When metals react with other substances, the gradual wearing away or corrosion of a metal results. This may lead to the deterioration of metals.

Q7. Give ways of preventing corrosion of metals.

Q8. There are several ways of preventing corrosion of a metal:

1. Keep air and moisture away from the metal by covering the metal. This is done by painting, plastic coating, greasing, chromium plating, zinc plating or galvanizing and tin plating.

2. Fix small pieces of a more reactive metal to its surface.

Table 1.Data for Activity 2

Metal	**Observable Reactions with Muriatic Acid (Check and describe the metal observed)**		
	Violent	*Slow*	*No Reaction*
iron		Reacts slowly to form rust; accompanied by formation of bubbles due to formation of hydrogen gas	
copper			No reaction.
aluminum	Reacts vigorously. The metal tarnishes; accompanied by formation of bubbles due to formation of hydrogen gas		
zinc	Reacts vigorously. The metal tarnishes; accompanied by formation of bubbles due to formation of hydrogen gas.		

References

Elvins, C., Jones, D., Lukins, N., Miskin, J., Ross, B., & Sanders, R. (1991). Chemistry one: Materials, chemistry in everyday life. Port Melbourne, Australia: Heinemann Educational Australia.

Frank, D., T. Griffith Jones, J. G. Little, B. Miaoulis, S. Miller, & J. M. Pasachoff (2008). *California focus on physical science*. Upper Saddle River, New Jersey: Pearson Prentice Hall.

Hill, G., J. Holman, J. Lazonby, J. Raffan, & D. Waddington (1990).*Chemistry, the salters' approach.*Oxford: Heinemann Educational Books Ltd.

Magno, M. et al. (1995).*Science and technology for a better life series (Chemistry)* (2nded). *Teachers Manual*.Diwa Scholastic Press Inc. Makati, Philippines.

Magno. M. et al. (1990). Science and technology*III*.*Teachers Manual*. Raquel Commercial Press. Philippines.

Magno. M. et al. (1991). *Science and technology III*. Book Media Press. Philippines.

McDougal Littell (2007). *Science focus on physical science.* Sacramento,CA: Houghton Mifflin Company.

Mendoza, E.E. &Religioso, T.F. (1997).Chemistry. Phoenix Publishing House, Inc. Quezon City.

PASMEP et al. (1991).*Teaching resource package-chemistry*.

Philippines. UPNISMED (1991).*Science and technology textbook III*. Quezon City, Philippines: Instructional Materials Corporation.

Pedregosa, E. F. (1982). *Secondary science for learning and living 3 - Chemistry*. Quezon City, Philippines: Phoenix Press, Inc.

The American Chemical Society (1988).*Chemistry in the community*. Dubuque, Iowa: Kendall/Hunt Publishing Company.

The Collins Paperback English Dictionary (1986). William Collins Sons & Co. Ltd. Great Britain.

Links

http://www.slideshare.net/AmrHassaan/patterns-of-reactivity
http://amrita.olabs.co.in/?sub=73&brch=3&sim=59&cnt=1
2008 Chemical Heritage
Foundation.hhttp://www.gofoster.com/downloads/twe/chap06.pdf.
http://www.google.com.ph/search?q=Mark+Buchanan+Periodic+Table

Appendix: Element Cards for Activity 1 (you can make this bigger)

Part A

H **Hydrogen** Atomic Mass: 1.008 Description: odourless gas, very flammable Compounds: H_2O, HCl	**Li** **Lithium** Atomic Mass: 6.941 Description: soft gray metal, reacts with water Compounds: Li_2O, LiCl
Be **Beryllium** Atomic Mass: 9.012 Description: gray metal Compounds: BeO, $BeCl_2$	**B** **Boron** Atomic Mass: 10.81 Description: gray metalloid, semiconductor Compounds: B_2O_3, BCl_3

C **Carbon** Atomic Mass: 12.01 Description: black solid (graphite) or transparent crystal (diamond) Compounds: CO_2, CCl_4	**N** **Nitrogen** Atomic Mass: 14.01 Description: odorless gas, rather unreactive Compounds: NH_3, NCl_3
O **Oxygen** Atomic Mass: 16.00 Description: odorless gas, very reactive Compounds: H_2O	**F** **Fluorine** Atomic Mass: 19.00 Description: yellowish gas, extremely reactive Compounds: HF, NaF, CaF_2

Na **Sodium** Atomic Mass: 22.99 Description: soft gray metal, reacts vigorously with water Compounds: Na_2O, NaCl	**Mg** **Magnesium** Atomic Mass: 24.31 Description: gray metal, flammable Compounds: $MgCl_2$, MgO
Al **Aluminum** Atomic Mass: 26.98 Description: silvery metal Compounds: $AlCl_3$, Al_2O_3	**Si** **Silicon** Atomic Mass: 28.09 Description: gray metalloid, semiconductor Compounds: $SiCl_4$, SiO_2

P **Phosphorus** Atomic Mass: 30.97 Description: white, red, or black, spontaneously flammable Compounds: PH_3, PCl_3, PCl_5	**S** **Sulfur** Atomic Mass: 32.07 Description: yellow solid powder Compounds: H_2S, SCl_2
Cl **Chlorine** Atomic Mass: 35.45 Description: greenish gas, extremely reactive Compounds: HCl, NaCl, $CaCl_2$	**K** **Potassium** Atomic Mass: 39.10 Description: softgray metal, reacts violently with water Compounds: K_2O, KCl

Ca **Calcium** Atomic Mass: 40.08 Description: hard silvery metal, flammable Compounds: $CaCl_2$, CaO	**As** **Arsenic** Atomic Mass: 74.92 Description: gray metalloid Compounds: AsH_3, $AsCl_3$, $AsCl_5$
Se **Selenium** Atomic Mass: 78.96 Description: gray or red solid Compounds: H_2Se, $SeCl_2$	**Br** **Bromine** Atomic Mass: 79.90 Description: red-orange liquid, very reactive Compounds: HBr, NaBr, $CaBr_2$

Rb **Rubidium** Atomic Mass: 85.47 Description: soft gray metal, reacts violently with water Compounds: Rb_2O, RbCl	**Sr** **Srontium** Atomic Mass: 87.62 Description: soft silvery metal Compounds: $SrCl_2$, SrO
In **Indium** Atomic Mass: 114.8 Description: soft silvery metal Compounds: $InCl_3$, In_2O_3	**Sn** **Tin** Atomic Mass: 118.7 Description: silvery- white metal Compounds: SnO_2, $SnCl_4$

Sb **Antimony** Atomic Mass: 121.8 Description: bluish- white metalloid, semiconductor Compounds: SbH_3, $SbCl_3$, $SbCl_5$	**Te** **Tellurium** Atomic Mass: 127.6 Description: silvery-white metalloid, Semiconductor Compounds: H_2Te, $TeCl_2$
I **Iodine** Atomic Mass: 126.9 Description: dark-purple solid, reactive Compounds: HI, NaI, CaI_2	

Element Cards for Part B

Ge **Germanium** Atomic Mass: 72.59 Description: gray metalloid, semiconductor Compounds: GeO_2, $GeCl_4$	**Ga** **Gallium** Atomic Mass: 69.72 Description: silvery metal, melts at just above room temperature Compounds: $GaCl_3$, Ga_2O_3
He **Helium** Atomic Mass: 4.003 Description: odorless gas, very unreactive Compounds: none known	**Ne** **Neon** Atomic Mass: 20.18 Description: odorless gas, very unreactive Compounds: none known

Ar **Argon** Atomic Mass: 39.95 Description: odorless gas, very unreactive Compounds: none known	**Kr** **Krypton** Atomic Mass: 83.80 Description: odorless gas, very unreactive Compounds: KrF_2
Xe **Xenon** Atomic Mass: 131.3 Description: odorless gas, very unreactive Compounds: XeF_6, XeF_4	

UNIT 4
Living Things and Their Environment

UNIT 4: 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 8 starts with questions that 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 in this quarter:

Module 1: Biodiversity
Module 2: Interactions
Module 3: The Digestive System
Module 4: Nutrition and Wellness
Module 5: Cellular Reproduction and Genetics

.

Module 1 starts with the big picture - the diversity of organisms in various ecosystems. Module 2 follows which zeros in energy-matter interconversion. Organisms then need to break down the complex molecules during digestion (Module 3) to yield energy that leads to health and wellness (Module 4). The nutrients takes in by organisms will provide the energy for metabolic processes such as cellular reproduction (Module 5).

Activities in the Learning Materials are designed to help students connect the concepts and help them construct the big ideas. Some of the activities may be performed as groupwork while others may be performed individually. 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.

In the course of using these materials, it is important to engage in effective classroom discussions. These discussions provide students the necessary scaffolds to make connections and deepen their understanding of the concepts. These discussions also provide formative assessment opportunities. Feedback gained from these formative assessment opportunities will provide the essential data to determine the succeeding strategies that may be employed to reach the desired learning goals.

Maintaining students' curiosity about the world requires making them confident that they can use the methods of inquiry to find answers to their questions. The K to 12 curriculum spirals and increases in difficulty at each grade level so as to provide challenges appropriate to the students' age. As they acquire the tools and habits of inquiry, they would develop into effective and productive citizens of the 21st century.

Unit 4
MODULE

1

BIODIVERSITY

The module will enhance what students already know about organisms found in almost all places in the world. It will initially bring to mind in students what have been previously learned in the lower grades, and connect these to what they are going to study in Grade 8.

This module will introduce students to the system by which scientists have classified and named organisms for an organized and orderly keeping of information about them. It will let students explore the similarities and differences of the various groups of organisms and their representative examples. Through the module, students will know more of the uses and harm these organisms may bring to humans, other organisms and the environment.

Activity 1 will make students see that people from different places may call a particular organism with different names. Thus, it will help them recognize the need to classify and name them to avoid confusion.

Activity 2 will give students the opportunity to see and identify bacteria used in making food. At the same time it will make them adept in using the microscope.

Activity 3 will familiarize students with the life cycle of an insect that spread dengue. It will further help them develop practices that minimize the occurrence of this deadly disease.

After students survey the different groups of organisms, students will analyze situations which will enable them to realize the advantages of high over low biodiversity in Activity 4. Activity 5 will engage students in an activity towards the protection and conservation of their community's biodiversity.

The discussions, thought and developmental questions, and activities, will help students answer the key questions in the module. In addition, this should encourage them to take seriously what they have learned and will still learn about biodiversity. Hopefully, learning about the topic will culminate in students' realization of the importance of biodiversity in their lives and participate actively in protecting and conserving it.

Key questions for this module

Why is biodiversity important?

What human activities destroy or endanger the existence of rate and economically important species?

Have students read page 1 of the module. Then, ask them to recall what they have learned in Grade 7 about fungi and algae. You may need to pose questions like: *Are fungi or seaweeds/algae also plants? Are birds animals?* Why do you say so? Accept their answers and tell them they will be able to answer these and other questions as they discover more about organisms on Earth through the module.

Activity 1

What's in a name?

Activity 1 can be done by groups (8 groups per class) for convenience in procuring pictures of different organisms. Animal pictures can be pasted on colored paper as this will be more attractive to students.

Advanced Preparation

Gather pictures of any four of the following organisms. Paste each picture on a piece of paper. Prepare pictures according to the number of groups in your class.

Shark	Hibiscus (gumamela)
Dove	Coleus (mayana)
Periwinkle (tsitsirika)	Turmeric (Luyang Dilaw)
Eucheuma (gozo)	Lagundi
Green algae: (lato or ar-arusep)	Sambong

Teaching Tips

1. Two days before Activity 1 you may suggest to students to communicate with relatives and friends in other places (e.g., in other islands within the country) through text or email on how birds, shark, or green algae (lato/ar-arusep) are called in their area.

2. During the activity, tell students to start with the name used for an organism in their own locality. Accept all other names given by different students to a particular organism. Inform them that there's no need yet to come to a consensus how these organisms are to be called.

3. To save on time, you may request only particular groups to present their outputs. After the activity, discuss with the students how these organisms are named in different places in case they will not be able to get information from other areas in the country:

   BIRD (as a group): Ibon (Tag.), Pispis (P. Bis.), Langgam (C. Bis.), Mammanu (Ibanag)

   SHARK
   Common/Local Names: Pating (Tag), Bagis (Bis., P. Bis), Iho (Surigao), ihotiqui (Bohol)

   DOVE
   Common/local Names: Kalapati (Tag), Pating (P. Bis.)

   HIBISCUS
   Common/Local Names: Gumamela (Tag), Kayanga (Ilokano, Bik.), Tapulanga (Negros**)**

   COLEUS:
   Common/Local Names: Mayana/Malaina (Tag.) Lampunaya/Lapunaya/Daponaya (Bis.), Saimayu (Sulu)

   PERIWINKLE
   Common/Local Names: Tsitsirika /Atay-bia/Amnias (Tag.), Lubitos (Ivan.), Sirsirika (Bik.), Pinggan-pinggan(P. Bis.)

   GREEN ALGAE: Caulerpa lentillifera or C. racemosa
   Common/Local Names: Ar-arusep (Ilokano), Gulaman/Lato (Bis.)

   TURMERIC: Curcuma longa Linn.
   Common/Local Names: Luyang Dilaw/Dilaw(Tag.), Kulyaw(Ilk.), Kalawag(Mbo., Bis.), Salampawyan(Bag.)

   BLUMEA CAMPHOR
   Common/Local Names: Sambong(Tag .), Subsob/Subosob(Ilk), Alimon

Alibum/Alibhon (P. Bis.), Kaliban/Kalibura (Tagb.), Dalapot (C. Bis.)

FIVE-LEAVED CHASTE TREE
Common/Local Names: Lagundi (Tag., Ibn., Bik., P. Bis.), Dangla/Limo-Limo (Ilk.), Dagtan (If.)

EUCHEUMA
Common/Local Names: Gozo (Tag.)

4. Let students proceed with the topics contained in the module clarifying points which they may not understand or have questions. Discuss the inclusion of the three-domain classification system. You may need to assist them in analyzing Table 1 or in answering Questions 4 to 7. Students may wonder why scientific names are in the Latin language. Explain that Latin is an unchanging language. Mention that the genus-species name tells something about what the species is, where it is from and who discovered it. Mention that scientific names are sometimes written with an incomplete genus name like *E. coli*.

KINGDOM ARCHAEBACTERIA

Electron micrographs (Figures 1 and 2) are pictures of things and organisms observed using the electron microscope.

The cell walls of halophiles contain the pigment carotenoids which are yellow and orange in color. This accounts for such colors of salt ponds where they are present in large numbers. This can be observed in certain areas in Bulacan, Pangasinan, Mindoro Occidental, Davao, and Misamis Oriental where salt is produced. Encourage students to use the internet or library books to be able to answer Q9.

KINGDOM EUBACTERIA

Spirilla may occur in three forms, namely spirillum, vibrio and spirochete. Spirillum is thick, rigid and spiral shown in Figure 3 in the module. Vibrio is curved or comma-shaped while a spirochete is thin, flexible, and spiral.

In areas where White cheese (kesong puti) is produced, local people use the term ”starter”. It is **rennet** or **coagulant** which contains the lactic acid bacterium. Rennet is added to fresh unpasteurized milk of cow, carabao or goat to produce kesong puti.

Several strains of Lactobacillus are added to milk during the production of yogurt. These include *Lactobacillus acidophilus, Lactobacillus caseii and Lactobacillus reutri*. Bifidum bacteria, such as *Bifidobacterium animalis* and *Bifidobacterium lactis*, are also used in making yogurt.

Activity 2

How do bacteria in yogurt look like?

Advanced Preparation

Two or three days before the activity, procure plain yogurt without flavour from grocery stores or supermarkets and store in the refrigerator. Request methylene blue from your laboratory technician or get from a scientific supply store ahead of the class. To dilute yogurt, add two teaspoons of water to one-fourth (1/4) teaspoon of yogurt. Prepare this just immediately before students do the activity.

Teaching Tips

1. Ask students if they have any idea what fermented foods or drinks are. According to their response, you may mention that these are made using bacteria. Ask for examples that they might know and the availability of these in their area. In places like Sta. Cruz and Los Baños, Laguna, Bulacan, Isabela, Nueva Ecija and Cagayan Valley, "kesong puti" is made. You may mention other products like yogurt, *Yakult*, cheese and most recently *Probiotic* drinks.

2. Activitiy 2 is a good activity for students to do for schools with microscopes. You can review students on the proper way of using the microscope, if needed, especially if they have not done it in Grade 7. Thoroughly washed droppers from infant medicines can be used if no laboratory droppers are available.

3. If you still have time or if you have advanced students in the class, you can also let them do the alternate activity below using fermented milk like *Yakult* or any Probiotic drinks available in your locality. For Probiotic drinks use the unflavored one.

    3a. For areas where yogurt is not available, any fermented milk (as mentioned above) can be used. You must be aware that this is popular with kids. Introduce the use of bacteria in making yogurt and fermented milk. Tell them that they will do an activity to observe bacteria in fermented milk using the microscope. Give the following procedure for students to do.

Activity

How do bacteria in fermented milk look like?

Materials Needed:

dropper	cover slip
glass slide	fermented milk
methylene blue	microscope

Procedure:

1. Place a drop of fermented milk on a slide.

2. Add a drop of methylene blue and cover with a cover slip.

Q1. What is the purpose of adding methylene blue to the specimen?

3. Observe under the LPO and HPO of the microscope.

Q2. Describe what you see under the HPO.

Q3. What is the name of the bacteria involved in making this fermented milk drink?

Teaching Tips

1. Questions may arise regarding probiotic drinks. Probiotics refer to microorganisms that naturally live in the intestinal tract. They are "friendly bacteria" and believed to strengthen the immune system. It is helps in the overall maintenance of good health. Explain that fermented milk/probiotic drinks are also made by adding beneficial bacteria to skimmed milk. The process involved is the same as that in making yogurt. It occurs because bacteria break down substances into desirable products like food or drink. Tell students that they will understand more of the fermentation process in Grade 9.

2. For students to answer Q3, show them the container of the fermented/probiotic drink you used. Sometimes the bacteria used is in the list of ingredients found in the plastic package for 6 bottles of the fermented milk. You can ask from the saleslady this plastic cover to show to your students. Fermented drinks in the market may use *Lactobacillus casei* Shirota strain or *Lactobacillus paracasei*. A bacterial **strain** is a subgroup of a species having particular characteristics developed by breeders.

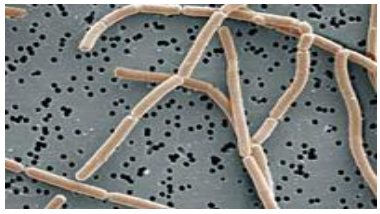
Answers to Questions in the Alternate Activity:

Q1. For clearer observation of the specimen.

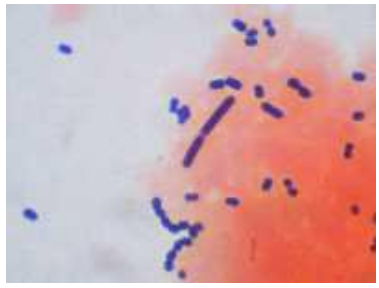
Q2. Possible answers: Rodlike/cylindrical/long structures can be seen

Q3. It depends on the fermented milk used: *Lactobacillus paracasei* (in probiotics); *Lactobacillus casei* Shirota strain (in Yakult)

In case your school does not have microscopes, show the following pictures of *Lactobacillus bulgaricus* and *Streptococcus thermophilus* as seen under the compound microscope.



Lactobacillus bulgaricus



Streptococcus thermophilus x 1000

Bacillus thuringiensis protein crystals have been developed as an effective biopesticide in tablet and powder form. It can be sprayed to crops to control corn borers and diamond backmoth. It is also used to regulate increase in population of mosquitoes carrying disease-causing organisms.

Some bacterial cells are rich in protein and are utilized as alternative sources of food. They are cultured in the laboratory as Single Cell Proteins(SCP). SCP can be mixed with a food base to add protein for cattle diet.

Whether in urban or rural areas those who waded in floodwaters or mud or stagnant waterlike farmers, veterinarians, pet shop owners and sewage workers are at risk of contacting leptospirosis. This also includes people who are into camping, hiking, rafting, canoeing. These people can swallow contaminated food or water and through contact with broken skin or with mucosal surfaces of the eyes or nose.

Warn students of the danger of wading or playing in floodwaters especially if they have cuts in the skin. If it cannot be avoided, remind them to thoroughly wash hands or shower with soap. *Leptospira* bacteria are killed by soap, disinfectants, and drying. They should use footwear especially when walking in mud or moist soil. It is also safe to wear gloves while gardening. Feeding raw offal to dogs must be avoided. Most importantly, homes and surroundings must be clean. No food sources must be lying around uncovered so rats can be controlled.

Anthrax is endemic in the Philippines. It can be treated when detected early. Students should help people understand about the danger of eating “double dead meat.” They should be on the look-out for reports in the news on anthrax cases as they provide excellent real-world connection and resources for learning more about the disease-causing bacteria. Encourage them to consult the barangay health officers on this matter.

Protists

Some books also refer to the group as Kingdom Protoctista. Chlorophyll in algae can be masked, thus, other than green algae, there are golden, brown and red ones. *Caulerpa lentillifera* is eaten as salad with tomatoes and onion. Clarify that **seaweed** as a term applied to *Caulerpa* and other green algae can mislead people and mistake it for a plant. Remind students to correct this misconception.

Alginate, the brown powder form of alginic acid, is naturally present in other brown algae. It is used as stabilizing, thickening or gel-forming agents in ice cream, candy, toothpaste, and cream cosmetics. Iodine can also be found in brown algae.

Carageenan, a complex carbohydrate from red algae, is used as a suspending agent in foods, medicines, and cosmetics. It is also a filtering agent in beverages. Microbiologists use agar as a solidifying agent in the growth medium for microorganisms and plant tissue culture.

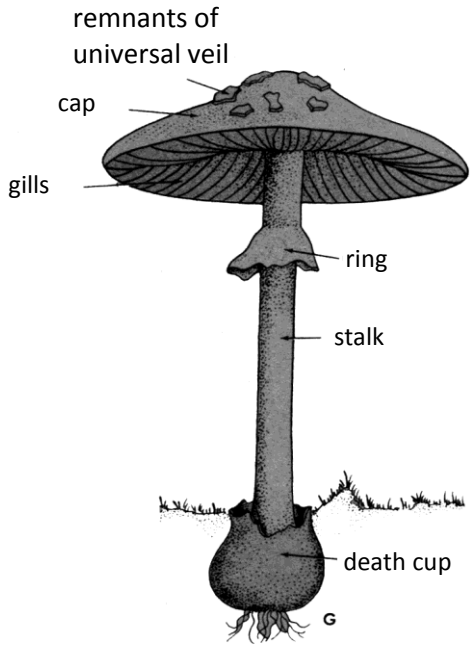
If a prepared slide of euglena is available in your school, have students view it under the microscope. You can get your specimen from an aquarium or pond water.

Humans develop malaria when infected with any of the protozoan parasites from the genus *Plasmodium.* The four species include: *Plasmodium falciparum*, *Plasmodium vivax, Plasmodium ovale*, and *Plasmodium malaria*.

Fungi

Certain fungi cause wilting of tomato, papaya, corn and banana. Fungi can also live together with a single-cell alga forming a **lichen**.

The figure below shows the structure of a poisonous mushroom. Students must be reminded of not just eating any kind of mushroom they find in the woods. A poisonous mushroom has a death cup, white spores, and a ring on the stalk. It contains **amatoxin, a** deadly substance which when ingested damages the kidney and the liver.



(Adapted from: Philippines. Department of Education. (2009). *Science and Technology II. Textbook* (Rev. ed.). Pasig City: Instructional Materials Development Corporation. p. 266.)

Yeasts are also utilized as SCP.

THE PLANT KINGDOM

As students start to study the plant group, discover if there are still students who think that all plants are colored green and that green algae are plants. Clarify that pigments can mask the green color of chlorophyll.

Clarify the term “lumot.” In the Philippines it is applied to algae, cyanobacteria and mosses. Students should be able at least to differentiate one from the other by Grade 8.

Vascular Plants Tracheophytes

Photo by: Alvin J. Encarnacion

Asplenium nidus bird's nest

Photo Courtesy of Michael Anthony B. Mantala

Azolla sp.

Start with how ferns are called in your locality. Show pictures of other fern examples. Or you can show them some species planted in flower pots that may be found in your school.

The giant fern of the genus *Angiopteris* (Figure 15a) in the student module has grown to about 206 centimeters from the base to the highest point of a leaf. In answering Q31, they should be able to see the height of *Angiopteris* almost as high as the first floor of the building.

Azolla can be cultured so that it will be readily available for use in science classes. The places you can ask about how and where you can get the plants are the Department of Agriculture offices in your locality, commercial plant gardens, pet shops, aquarium stores and the UP NISMED website. Here are the materials you need and the procedure in raising and maintaining an azolla culture:

In an artificial pond, medium sized-basin or pail, put about 2 inches of loam soil. Add water from an existing aquarium or pond, creek, river, artesian well or faucet. Add a handful or a few azolla plants and if a pail or basin is used, place in a shady area. You may stir the soil from time to time for the nutrients to be easily absorbed by the plants. These can be left to grow and may reproduce fast and can soon fill up your whole container or pond. During hot days, their leaves may turn brown or red but can recover during the rainy or cooler season. You can mention that azolla is also used as food for tilapia.

Other members of the spore-reproducing plants include the whisk ferns, club mosses and horsetails.

Athyrium esculentum (Retz.) Copel or *Diplazum esculentum* Retz. called "*pako*" is an edible fern. Some eat them raw as salad or steamed with tomatoes. Dried *nito* stems are good sources of fiber and are made into handicraft items.

Gymnosperms

If you or your school has internet connection, look for images of **Welwitschia** at darkroastedblend.com., Dark Roasted Blend: The Strangest Plant on Earth.

Gymnospersms are excellent sources of timber. The bark of pine trees yield tannin used in tanning animal skins in producing leather. Tannin is also used to make ink.

Angiosperms

Angiosperms are plants that belong to Phylum Anthophyta. Water plants like *Quiapo*, water lily, duckweed, water hyacinth *Hydrilla* and *Vallisneria* which grow in freshwater habitats may need to be introduced to students. Water hyacinth, is often mistaken as water lily. Water hyacinths have green heart-shaped leaves, bladders and smaller violet flowers. It also serves as a depollutant, being able to absorb pollutants in water. In salt waters, seagrasses like the eel grass are found in coastal areas. Students will see in the next module that aquatic plants play an important role in food chains.

Have students recall from the earlier grades about aerial plants they know. Add that the endemic orchid *Waling-waling* is an endangered species. There is also a move in congress to make it the second national flower.

An activity or project about medicinal plants can be done by students in this topic. It will make students aware of the plants in their locality that may be used in preventing or curing particular diseases.

Harmful Plants

People sometimes forget the importance of weeding. Remind students of the bad effects of competition for nutrients between weeds and economically important crops.

Some plants harm animals. Young sorghum leaves contain a toxic substance that can cause cyanide poisoning. Others like *Kantutai/coronitas*/*baho-baho,* and *Hantalakaw*/*malasili* contain chemicals that can be fatal to animals. Morning glory is also host to the snout beetle (sweet potato weevil) that greatly lessen sweet potato harvest.

Dieffenbachia maculata (dumbcane), an ornamental house and garden plant, can be dangerous to children. The leaves and stem with its bitter and poisonous juice burns the mouth. This causes swelling of the tongue that can affect speech and block the air passage that may lead to death.

Many cases of tuba-tuba poisoning which led to death of some have been reported in several areas in the country. Give warning to students about eating any part of unfamiliar plants.

THE ANIMAL KINGDOM

To start the discussion on animals have students recall what they learned about them in the lower grades. The first invertebrate that students will study are members of Phylum Porifera, the sponges, also called pore-bearing animals (from *porus* meaning “pore,” and *fere* meaning “to bear”).

Cnidarians

Most members of Phylum Cnidaria live in salt waters. Adult corals, sea anemone and the freshwater hydra live attached to solid materials. Jellyfishes differ from them as the young are attached but become free-swimming adults. Hydra may be observed under the microscope using water from bottom portion of ponds or aquarium.

Encourage students to open internet links for more information about corals. Mention that coral reefs once damaged take a long time to restore. Bring up incidents of oil spills in Guimaras, General Santos/Sarangani areas and other places and the latest damage to the Tubbataha reefs. Discuss the destruction of coral reefs in relation to fish stock decline resulting to less fish catch, increase in fish prices, less food supply and economic effects to fishermen.

Several cases of box jelly fish attacks and even deaths in the Philippines have been reported in the news and feature shows on TV. The sting cause itchiness and leave severe marks in the body. Warn students to be cautious while swimming in beaches. If stung by jelly fish, wet cotton with vinegar and place in the affected area. Ask for suggestions of ways to protect coral reefs.

Flatworms

Flatworms belong to Phylum Platyhelminthes (in Greek *platys* means flat, *helmins* means worm). Encourage students to find out if their towns have slaughterhouses where beef and pork meats are strictly checked for the presence of tapeworm cyts. Livestock slaughtered by local people in their homes must be checked too.

Roundworms

Roundworms such as pinworms and *Ascaris* are notorious parasites in children. Hygienic practices are important to avoid being parasitized by these worms. Young *ipi-ipil* seeds are usually eaten to expel these worms.

Segmented Worms

Emphasize the role of earthworms in agriculture and of leeches in medicine. Care, however, must be taken by farmers or researchers in muddy fields so as not to be victims of the blood-sucking leeches.

Mollusks

Point out the thin and flexible skeleton of squids and the white “cuttlefish bone” usually fed to birds to add calcium to their diet.

A lot of mollusks are used as food by humans and also by other animals. Many shells are collected for ornaments while others produce pearls.

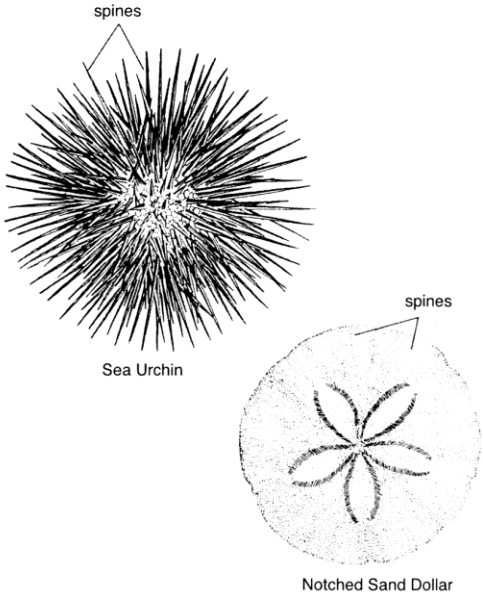
The marine seashell *Turris dollyae (synonymous to Turris crispa),* present in the Philippines and Queensland, Australia was found to have medicinal value. Dr. Baldomero M. Olivera, its discoverer, has named it after Dr. Dolores (Dolly) Hernandez, in honor of her outstanding contributions to Philippine Science Education. Dr. Olivera is a Professor of Biology at the University of Utah.

Photo: Courtesy of Dr. Baldomero M. Olivera

Overcollection of mollusks for food as well as pollution caused by pesticides used in farming that have reached bodies of water have killed some mollusks have caused their populations to decline.

Echinoderms

The sea star is what was previously referred to as the “starfish.” Point out that spines of the sea urchin are long while those of the sand dollar are short as shown below.



(Source: Philippines. Department of Education. (2009). *Science and Technology II. Textbook* (Rev. ed.). Pasig City: Instructional Materials Development Corporation. p. 293).

Arthropods

Students usually mistake spiders as insects. Point out the differences between insects and arachnids, specifically, the number of body sections and legs. They should also be able to distinguish a centipede from a millipede as they may be bitten by a centipede which is painful and with venom.

Aedes aegypti is the principal carrier (vector) of the virus causing dengue. The disease is endemic to the Philippines being a sub-tropical country. The activity will help students understand the life cycle of this insect so occurrence of dengue can be controlled. Point out that research has found out that young people are at greater risk of getting sick with the disease because of their lifestyle, that is, wearing of shorts and sleeveless shirts or blouses and staying in cool dark places.

Activity 3

What can you do to prevent dengue?

Teaching Tips

1. In studying the life cycle *of A. aegypti,* students should take note of what happens in each stage for them to be able to answer the questions.

2. In answering Q52, they should take note of the white spots, number of body sections, wings, antenna and legs. For Q54, they must think of any place where nonflowing and clean water exists.

3. Ask students what larva of mosquitoes are called in the locality. In other places, they are called ”*waya-waya*.”

4. Other questions that may be asked of students include: How many stages does *Aedes aegypti* go through in its life cycle; how would you describe a pupa; in which stage does a young mosquito stop eating and which stage/s is/are easy to destroy or eliminate?

Emphasize that at present there is still no cure nor vaccines for dengue. A person may also get sick of the disease four times in his/her lifetime. The reason is there are four strains of the virus that cause dengue. Remember, the next attack by another strain is more critical. When a person is sick with dengue they are just given medicines to relieve the symptoms and prevent complications brought by the disease. Early detection is important in the recovery of dengue patients. When there is sudden onset of fever that lasts for two days, extreme body and joint pains and chills or rashes are observed, the patient should immediately be examined by the doctor.

Methods to prevent spread of the disease are: 1) control of the vector, that is, preventing reproduction of the mosquito by removing breeding places, 2) avoiding mosquito bites by using mosquito nets or installing screens in windows and door, 3) using safe repellants, trapping and killing larvae and 4) employing biocontrol by introducing predators of mosquitoes such as dragonflies. Have students recall the use of *Bacillus thuringiensis* as microbial pesticide. Mention that it is also applied to breeding places of mosquitoes that spread diseases.

The Department of Science and Technology- Industrial Technology Development Institute (DOST-ITDI) has developed an *Aedes* Mosquito Ovi/Larvicidal Trap System which is a safe and cheap way of controlling mosquito populations. For details please visit the following websites: www.science .ph; www.dengueoltrappcti.com; youtube.com- type "Oltrap". It is also available in all Mercury Drug outlets. Or contact the licensee of the technology, Heritage Veterinary Corporation. They can be reached at Tel. No. 921-8978 and 579-9379.

Another mosquito-born (*A. aegypti*) disease to watch out for is Chikungunya. It affects anybody and exhibit the same symptoms but not as deadly as dengue. It is distinguished from dengue by the presence of anti-CHK antibodies in blood samples of patients. Cases of chikugunya have been reported in Metro Manila, Laguna, Pangasinan, and some parts of Mindanao.

The DOH has launched the 4-S Campaign against dengue, namely:

1. **S**earch and destroy breeding places of dengue virus-carrying mosquitoes. This is done by removing all possible breeding places of mosquitoes. Examples are: changing water in flower vases once or twice a week, regular cleaning of roof gutters which can retain water, draining water from unused old tires, flower pots, tin cans, bottles, and plastic cups and keeping them in areas where they cannot collect water, and covering water containers like drums or pails and draining water from tree holes, base of leaves like those of the bromeliads, coconut shells and bamboo posts.

2. **S**elf-protection measures that include wearing of long sleeves and pants, using mosquito nets and applying mosquito repellants.

3. **S**eek early consultation when symptoms appear, meaning when one has fever for two days and begin to have rashes, he/she must immediately consult the doctor at the nearest health center or hospital.
4. **S**ay no to indiscriminate fogging unless there is an outbreak.

Chordates

Not all members of Phylum Chordata have backbones. Acorn worm is another chordate without a backbone.

Vertebrates

Vertebrates have an internal skeleton that gives them more flexibility in moving. Fishes, amphibians, reptiles, birds and mammals are members of the vertebrate group.

Fishes

Students should know that not all sharks attack humans. Except for the great white, tiger and bull sharks, whale sharks (*Butanding*) are friendly species. Studies have discovered that sharks, attack people mistaking them for prey or food especially those wearing silvery wetsuits. Seals, food to sharks have silvery covering. Some shark species are attractions in zoos and ecotourism spots. Care, however, should be taken that these fishes are not abused.

Fish supply has also decreased because of another fishing practice like use of big boats and fine nets. You can then ask students how this method cause decrease in fish population. Emphasize the need for people of all ages to be aware of conserving fish species by following rules set by the government for marine sanctuaries and laws against dynamite and cyanide fishing. For students living in fishing villages, they should help the *Bantay-dagat* in their efforts to implement these laws. Those living in urban or mountain areas may check the internet, listen to news or watch TV features and inquire from local government officials on what these organizations are doing to protect and conserve fish species.

Amphibians

Point out differences of frogs and toads which are the more familiar amphibians. Mention that there was a time when toads were introduced to the Philippines to control mosquito population. Mention too that in other places frog legs are eaten with some restaurants serving them as exotic food. They should however be aware that these vertebrates also suffer from population decline due to loss of wet or moist areas where they live.

Reptiles

The large saltwater crocodile *Crocodylus porosus* are not a threatened species. They are found in rivers, large lakes, coastal waters, mangroves and especially in estuarine or brackish water. It can swim long distances. In the Philippines, they have become extinct in certain areas where they abound before. "***Lolong,***" the largest caught saltwater crocodile of Agusan Marsh in Mindanao, which died recently should be teaching people a lesson on biodiversity. Check out the internet for an article (http://www.rappler.com/move-ph/23498-lolong-angel-alcala) written by a Filipino expert on crocodiles. Because of this incident, a non-government organization encourages government to ban capture of animals from the wild.

The smaller threatened Philippine crocodile can be found only in Philippine rivers, freshwater lakes and creeks. This crocodile species should be given priority in study and conservation activities.

Birds

Some members of the bird group have also become a major source of food to humans like chickens and ducks (including their eggs).

If you are in areas other than those mentioned where Philippine Eagles live, ask students what they have read or heard about causes of the destruction of the birds' habitat.

In 2010, the International Union for the Conservation of Nature (IUCN) has declared the Philippine Eagle as critically endangered species. Aside from the causes of its decline in number presented in the student module, add to these illegal hunting and collection, lessening availability of food, pollution brought by mining and use of pesticides in nearby farmlands close to where they live. Students should know that pollution affect the eagles' breeding. It causes the thinning of their eggshell resulting to nonhatching of the eggs. Encourage students to read more about activities of the IUCN.

Mammals

The spiny anteater lives on land. It has spines in between the hairs all over its body. Platypus on the other hand have thick water proof fur and lives both in water and land.

Mention that whales are mammals that lack hair. *Dugong* is also called sea cow. Ask students to give their observations regarding differences of humans and other primates.

Ask students if they are aware of television shows that teach about biodiversity. Convince them that current technologies must be used for learning and not just as entertainment.

LOW AND HIGH BIODIVERSITY

Tropical rainforests are found mostly in Latin America. Others are in West Africa, the Pacific Islands and South East Asia including the Philippines. Add that rainforests serve to trap rainwater that flows into rivers and streams. Plants that abound in forests minimize soil erosion, landslides and floods. They are also sources of crops that may resist pests and diseases or produce more harvest and chemicals that can be made into medicines.

Discuss monocroping. Let them describe and classify it as to having low or high diversity. This would help them in doing Activity 4.

Activity

4

What is the importance of biodiversity to ecosystems?

Teaching Tips

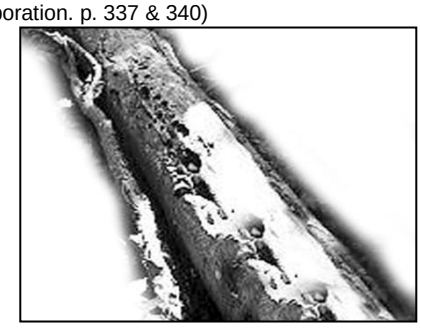
1. This is a group work. Make copies of the following photos depending on the number of groups. If not, just provide names of ecosystems and have members discuss each for them to be able to answer the questions in the activity.

A tropical rainforest

Rice Farm
(Source: Philippines. Department of Education. (2009). *Science and Technology II. Textbook*

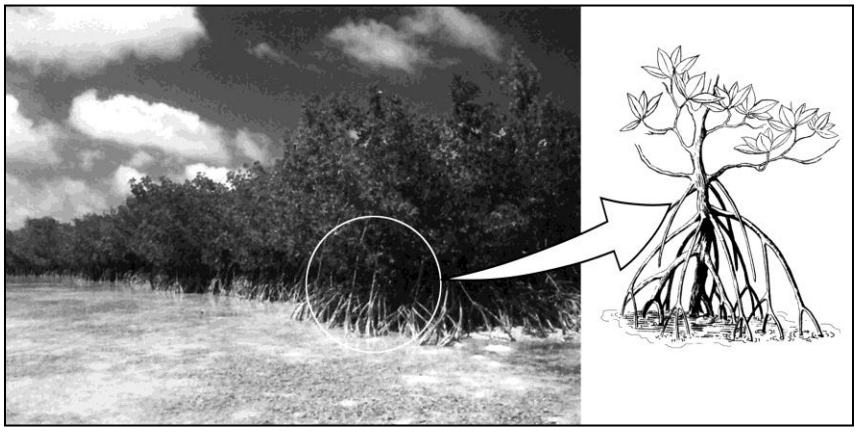
(Rev. ed.). Pasig City: Instructional Materials Development Corporation. p. 337 & 340)

Lake



Rotting Log

(Adapted from: Philippines. Department of Education. (2009). *Science and Technology II. Textbook* (Rev. ed.). Pasig City: Instructional Materials Development Corporation. p. 335)



Mangrove

(Source: Philippines. Department of Education. (2009). *Science and Technology II. Textbook* (Rev. ed.). Pasig City: Instructional Materials Development Corporation. p. 338)

2. Answers to Q69 will depend on the ecosystems you presented.

3. Students should be able to recognize that a banana plantation is an example of monocroping.

4. In answering Q75, have them recall the discussion about the sea star, crown of thorns.

5. In answering Q78, encourage students to think of familiar places that have low biodiversity.

Protecting and Conserving Biodiversity

Pose the questions: What are your responsibilities towards biodiversity for a sustained supply of food and other resources for all organisms? What actions must you take to protect and conserve biodiversity? If some of the abundant species present thirty or fifty years ago in your community are lesser now or have disappeared, what would the future look like for these organisms?

Activity

4

I create the future

Teaching Tips

1. Have ready copies of the "Priority Pyramid" and the "Making it Happen" handout. There should be one for each student and for each small group.

2. *Part I: My Future World.* Brainstorm students' ideas about the conditions that they want to see present in the world they will live in the future. Direct students to answer the questions, "What do you want the future world to be? "What things or conditions do you want to see 50 years from now?" Give them time to individually list down about five of such conditions. Then, get them to share their ideas to the class. Write on the board students' ideas.

3. Once students have shared their ideas, give them a copy of the "Priority Pyramid" worksheet. Explain to them that they are going to fill up the blocks in the pyramid with what they consider as important conditions of the future that they want. Direct them to the ideas written on the board. Tell students to rank the conditions from most important to the least. They are supposed to write on the topmost block the most important condition, the second most important conditions on the second level, and so on. Students may write down up to ten conditions. Assist students so that they are able to arrive at a pyramid with at least three levels (about six conditions).

4. Assign students to groups of four or five. If students have previously been grouped, you can split their original group into two. Have the students share their pyramids with their groupmates. They should show their pyramid and explain how they arrive at the ranking. Then, have students work together to arrive at a group pyramid. Be ready to help groups who may have difficulty arriving at a consensus.

5. Then, call the small groups to a whole-class sharing of their pyramids. Ask each team's representative to share their top three priorities. The representative can also briefly talk about how they were able to reconcile their differences to come up with a group pyramid.

   As each group presents their priorities, discuss with them what their priorities entail. For example, if they prioritized "food for all people", then they should see that vast spaces with the appropriate environment and resources are needed so that a great variety of plants and animals that serve as food can survive and grow.

As students discuss each condition, they should realize that everything they want to see in their future world can be traced, at least in part, to a healthy environment.

6. *Part II: Making it Happen*. Lead students to discuss strategies that will help make their dream future to happen. Distribute copies of the "Making it Happen" handout. The handout contains various projects, initiatives, legislations that are on-going and in effect that may in one way or another already contribute to the realization of the conditions that students wish to happen in the future.

   In preparing the Project/Legislation descriptions, you can include projects that are initiated by government agencies (local and national), non-government organizations (national, regional and global), private sector, and even individuals. You can farther help students to appreciate what other people are already doing and the value of taking action by describing projects and legislations that affect their community or locality. When choosing a law or policy on protected areas for example, you can describe those that pertain to their locality or community. A great site for information and resources on biodiversity conservation projects is the Protected Areas and Wildlife Bureau (PAWB) of the Department of Environment and Natural Resources (http://www.pawb.gov.ph).

7. *Part III: Future Log.* Require students to keep a future log for a week. Explain to them that they should use the log as a diary, where they write all their activities, behaviors, conversations and thoughts each day of the week. To make their log easier, instruct them to write these in bullet form, instead of complete sentences and paragraphs the way they would on a diary. Encourage students to realize that their actions, words and thoughts can actually affect their future. At the end of each day, require them to think and write about how each item in their bulleted list may affect the world around them, either positively or negatively, and what the consequences could be for the future.

   As students progress from day to day, encourage them to add more ways, that is, engage in more actions, thoughts and words that will help them contribute to the conservation of biodiversity in their locality.

"Ocean Treasures", is a video lesson developed by UPNISMED that can be used as an alternate activity. It identifies both plant and animal resources found in our oceans. It also shows how these resources can be used wisely by protecting and maintaining balance in the different shallow ecosystems in the ocean. The package consist of a DVD and a Teacher's Guide with emphasis on concepts, what questions to ask, a short activity and some formative assessment items which teachers can give as students view it. You can check out the UPNISMED website for details on how to procure it.

Remind students that with understanding of what biodiversity can do for humans and the whole world, there is no choice but to care for and conserve them. Encourage them to help in promoting awareness of the importance of biodiversity, help minimize threats to biodiversity and actively participate in programs and projects for the protection and conservation of biodiversity.

As a culminating activity, you may have students have a field trip to just a nearby forest park, zoo or even your school's medicinal or botanical garden. They then, can make a report of the biodiversity in such areas.

To summarize the lesson, ask some students what they have learned from it. Take note if they have **alternative conceptions** in any of the topics taken up. Check if they are able to answer the key questions found at the beginning of the module.

Answers to Questions

Q1. Answers may vary. It is possible that in their community organisms may have a local name and thus, organism/s may be called with the same name. Or due to parents' background, may differ. Examples should be given for those with same names.

Q2. Answers may vary. Examples should be given for those which are differently named.

Q3. Students may say that they are confused which is really to be used or they may wonder why organisms are called in different ways.

Q4. Domesticated cat, dog, wolf and lion.

Q5. Dog and wolf. They belong to the same category up to the genus level.

Q6. No, they cannot produce a fertile offspring because they belong to different species. Only organisms that belong to the same species can breed and produce fertile offspring.

Q7. The species row consist of two words/names.

Q8. The first name refers to the genus, the second one to the species.

Q9. Water in both is up to ten (10) times more salty than sea water or both are very salty environments.

Q10. Possible answers: dirty, small, disease, harmful, present in some food, used in making medicine, vaccine.

Q11. Cocci are round/spherical/circular. Bacilli are rod-like/narrow and cylindrical/long. Spirilla are spiral/coiled/twisted.

Q12. Avoid wading, swimming or playing in flood waters which may be contaminated with animal urine, wear gloves in gardening, cover cuts on the skin while working in farms, wear footwear in walking in mud, keep homes and surroundings clean, thoroughly wash hands with soap, wash vegetables well before cooking.

Q13. Farmers, veterinarians, people involved in raising carabaos, people who have the practice of eating meat from animals which are suspected to die from the disease (carabaos).

Q14. For clearer observation of the specimen.

Q15. Possible answers: Rodlike/cylindrical and round structures/bacteria.

Q16. The rod-shaped are *Lactobacillus*, while the round ones are *Streptococcus* bacteria.

Q17. Bacillus bacteria are rod-like and cocci bacteria can form chains and called streptococcus.

Q18. Crops will be supplied with usable form of nitrogen for their growth and development.

Q19. Through the bladders brown algae would be able to capture light energy by chlorophyll present in their cells.

Q20. Light is important to algae because they need it to produce food (for photosynthesis).

Q21. These clams may have fed on the dinoflagellate with poison causing paralysis of the diaphragm

Q22. Foraminiferans have threadlike extensions, radiolarians have sharp needlelike extensions while amoeba have blunt extensions.

Q23. They produce food for organisms, green algae serve as food, some brown algae are source of alginic acid, some red algae are source of food and agar and carageenan.

Q24. Ascus, ascopores.

Q25**.** Basidiospores, basidium.

Q26. Many fungi would grow**.**

Q27. In moist/damp, humid, dark places.

Q28. Liverworts are flat and ribbonlike. Mosses have many small leaflike structures. Hornworts grow flat leaves on top of each other.

Q29. They have no true roots, stems and leaves that can transport food and materials to different parts.

Q30. It has big leaves and it is tall almost reaching 1st floor of the building

Q31. They will provide usable nitrogen to plants or serve as natural/organic fertilizer.

Q32. Some serve as food, or used in making handicraft items.

Q33. In cool, elevated areas.

Q34. Less oxygen will be available. There will be erosion, less timber, no home for birds and other animals.

Q35. Alternate cashew, radial garlic, opposite coffee.

Q36. Dicot.

Q37. Monocot.

Q38. Food (meat and juice), cleaning implements, oil, etc., (accept right answers of students)

Q39. Home for birds, provide seeds for food, nectar for butterflies, leaves food to worms, etc. (accept other correct answers)

Q40. Production of oxygen, food for other organisms.

Q41. Weeds, which often grow along with food crops, compete for nutrients needed by the latter. Such competition results in decreased harvest.

Q42. Animals react quite rapidly to stimuli. (act fast, move fast)

Q43. Sea fan, sea pen (enumerate those in sand). Jelly fish, etc.,(enumerate those floating in water).

Q44. They feed on digested food.

Q45. Two.

Q46. They have a single shell. Bivalves have two shells.

Q47. Bivalve, univalve, bivalve.

Q48. Arthropods have exoskeleton, echinoderms have endoskeleton.

Q49. For protection.

Q50. Arachnids.

Q51. Arachnids have four pairs of legs, insects have three pairs.

Q52. The adult *A. aegypti* has white spots/bands on its body and legs. It has three body parts: head, thorax and abdomen. It has a pair of wings, three pairs of legs and pair of antenna.

Q53. It breeds in clean, non-flowing or standing water.

Q54. Possible places in the home where *Aedes* mosquito can breed include: containers with water placed under the table's legs, flower vases, old tires left outside which can collect rainwater, roof gutters which can retain rainwater, containers placed under flower pots that collect excess water, tin cans, bottles, and plastic cups left outside which can collect rainwater, uncovered water containers like drums and pails, tree holes, bamboo posts of fences around the house. Breeding places in the school can be flower vases, containers placed under flower pots, plastic cups or bottles left in the grounds which collect rainwater, and also tree holes and bamboo posts.

In the surroundings, it can be animal food containers, clean stagnant waters in canals, potholes, and any container or items that can collect and retain water.

Q55. It will die.

Q56. Water is important to *Aedes* mosquito because it is where they reproduce. If there is no clean, nonflowing water available, no egg will develop into adult mosquitoes.

Q57. Reproduction of *Aedes* mosquito can be stopped by removing all possible breeding places of mosquitoes. The following are some ways to do this:

- changing water in flower vases once or twice a week,
- regular cleaning of roof gutters which can retain water,
- draining water from unused old tires, flower pots, tin cans, bottles, and plastic cups and keeping them in areas where they cannot collect water,
- draining water from containers placed under flower pots or table legs from time to time,
- covering water containers like drums or pails, and
- draining water from tree holes or bamboo posts

Q58. Insects because it has three body parts: head, thorax and abdomen. It has a pair of wings, three pairs of legs and a pair of antenna.

Q59. Skeleton of the shark is made of cartilage, that of *tilapia* is made of bone.

Q60. Toad and tree frog.

Q61. Caecilian.

Q62. Sharp hooked beaks bite, cut or tear prey into pieces,

Q63. Only the legs of birds have scales.

Q64. Possible answers: hunting for food or income, *kaingin*

Q65. Whales, dolphins, dugong and manatee live in salty waters.

Q66. Some answers are: humans have the ability to walk erect, they have well developed arms and hands, nails in fingers and toes, lemurs, monkeys and apes live in trees, humans have communities.

Q67. Mammals differ from other animals in that they have mammary glands that produce milk to nourish their young and most have hair or fur.

Q68. It has a single or few number of species.

Q69. The answers will depend on the pictures shown.

Q70. Low diversity.

Q71. Many of the banana plants will be affected/damaged or die.

Q72. Banana plants will be toppled down, some may be washed to other areas, or whole plantation will be wiped out. Small animals living in the plants will also die.

Q73. Farm helpers will have no income (cannot be paid by owner) and owner will lose his harvest and consequently his profit.

Q74. There are corals, fishes, sponges, algae, molluscs, seastars, sea anemone etc. (Students may give other answers as long as they should be organisms associated with a coral reef)

Q75. Fishes come to the coral reef to breed, molluscs eat the algae present, sponges will feed on the floating algae near the reef, clownfish feed on leftover food of sea anemone, etc.

Q76. Crown of thorns may eat all the algae in the reef that provide oxygen to the other animals, leading to death of these organisms.

Q77. With high biodiversity, the risk of damage from pest infestation is minimized leading to better income or profit, low input of pesticides because different pests feed on different plants, various soil nutrients will be available to different plants because of presence of other organisms or nutrients are recycled, it can support more organisms

Q78. Competition among organisms is less as there are more choices for food, more shelter and water available to organisms, balance of consumers and decomposers, less possibility of species extinction, support more organisms. Biodiversity is important to ecosystems because of interdependence of organisms to one another.

Q79. Mango plantation, ranch containing grass and a few trees and cows only, coffee plantation.

Q80. Actual students' answers. May include: cure for illnesses, food for all people, etc.

Q81 to Q84. Actual student answers.

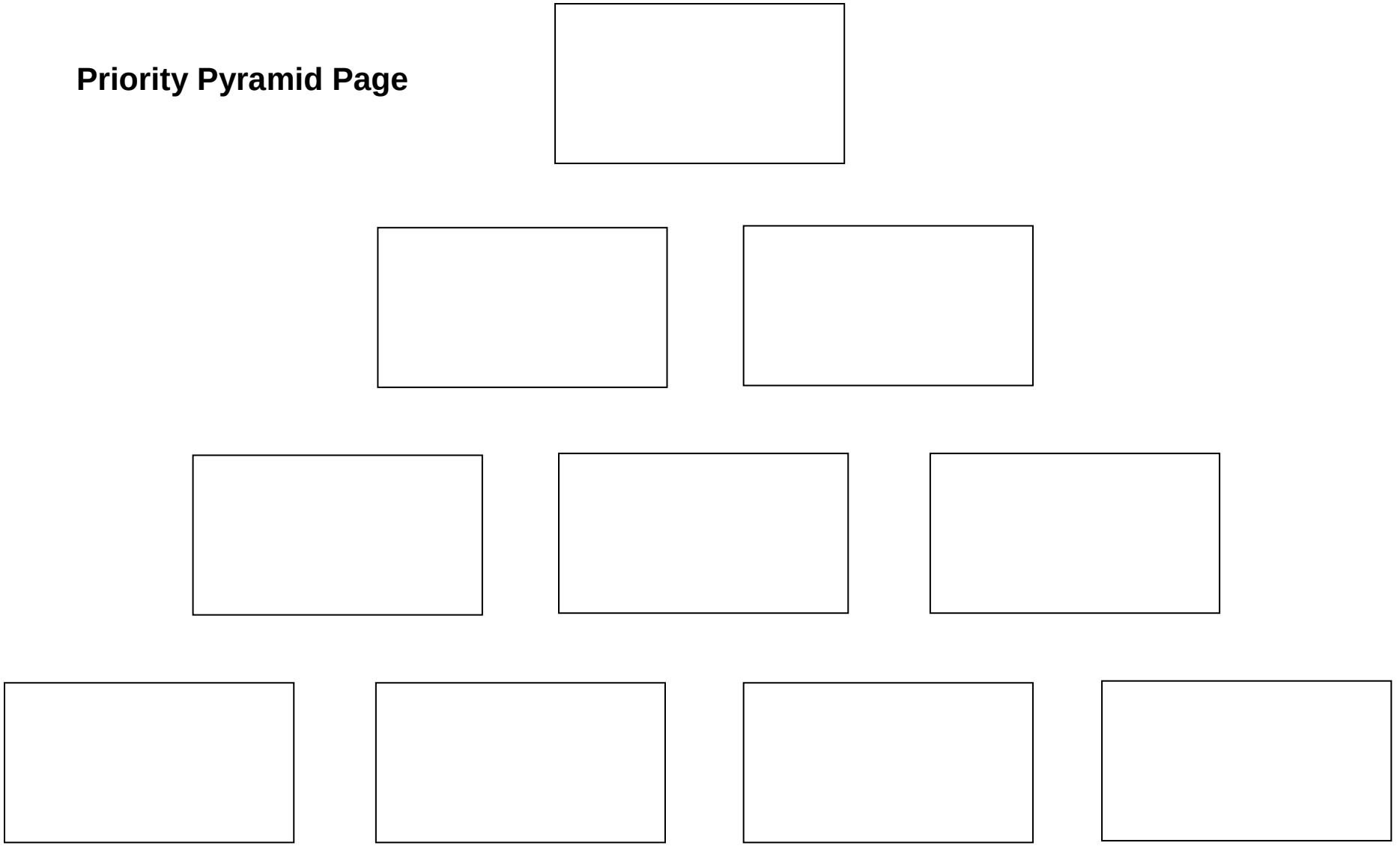
Q85. Examples of acceptable answers: Bantay Dagat, Clean Air Act RA 8550(Philippine Fisheries Code of 1998), local resolutions on conservation of important species and protection of the environment by the town, city or provincial governments

Q86. DENR, Local government units, PAWB, BFAR

Q87. Actual student answers.

Q88. Actual student answers.

Priority Pyramid Page



Making It Happen

(Note: These are some examples. Each project to be included should be described in detail to enable students to match the project to their priority conditions for the future.)

1. Programs and projects of the Protected Areas and Wildlife Bureau (PAWB) of the Department of Environment and Natural Resources
    a. Invasive Alien Species Project
    b. New Conservation Areas in the Philippines Project
    c. The Coral Triangle Initiative
    d. Peatland Project
    e. Integrated Coastal Resource Management Project
    f. Samar Island Biodiversity Project

2. Laws and Policies related to protection and conservation of biodiversity in the Philippines
    a. Republic Acts (e.g., Philippine Clean Air Act of 1999: Republic Act 8749)
    b. Executive Orders (e.g., Guidelines for Ecotourism Development: Executive Order No. 111)
    c. Presidential Proclamations (declaring certain places as protected areas and buffer zones)
    d. DENR Administrative Order (declaring certain places for specific biodiversity conservation activity; e.g., DENR AO 2011-10 declaring Cabusao Wetland Area in Camarines Sur as critical habitat)
    e. DENR Memorandum Circular/Order (e.g., DMO No. 2011-04: Strict regulation of activities, projects and land uses in all areas proposed for inclusion in the National Integrated Protected Areas System)
3. The Ramsar Convention and Ramsar Sites in the Philippines
4. Palawan Council for Sustainable Development
5. Organic farming
6. "No fishing" : species, zone and timeframe (e.g., Zamboanga waters: sardines)
7. Herbal medicine
8. Planting of mini-forests in cities and municipalities
9. National Ecotourism Strategy (database of ecotourism sites and protected areas in each region)
10. Biodiversity Hotspots of the World
11. "No plastic" drive in some cities and municipalities
12. IRRI Rice Seed Bank
13. Species Conservation Programs (e.g., Philippine Eagle Center, crocodile, tamaraw, tarsier, etc.)
14. SM (Shoemart's) M.O.B. Day Campaign

References

Crisci, J. V., Mclnerney, J. D., & McWethy, P. J. (1993). *Order and diversity in the living world: Teaching taxonomy and systematic in schools.* Reston, VA: The Commission for Biological Education of the International Union of Biological Sciences in Cooperation with UNESCO.

Hernandez, R.S. (1993, March). *Microorganisms in biotechnology* [Module]. Quezon City: UP Institute for Science and Mathematics Education Development.

Khan, M. M. (1988). *Azolla agronomy*. Laguna: IBS-UPLB and SEARCA.

Strauss, E., & Lisowski, M. (1998). *Biology: The web of life* (Teacher's ed.). Reading, MA: Scott Foresman-Addison Wesley.

Reece, J. B., Taylor, M. R., E. J., & Dickey, J. L. (2012). *Campbell biology: Concepts and connections* (7th ed.). Singapore: Pearson Education

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

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

University of the Philippines Institute for Science and Mathematics Education Development. (1996). *Plants of the Philippines* (2nded.). Manila: Pundasyon sa Pagpapaunlad ng Kaalaman sa Pagtuturo ng Agham.

Links

Extreme Science. (2013). *Deep sea hythermal vents*. Retrieved from http://extremescience.com/deep-sea-vents.htm

Globio. Glossopedia. (n.d.). *Species*. Retrieved from http://www.globio.org/glossopedia/article.aspx?art_id=34

Karser, G. E. (2006). *The prokaryotic cell: Bacteria*. Retrieved from http://faculty.ccbcmd.edu/courses/bio141/lecguide/unit1/shape/shape.html

http://www.stuartxchange.com/Dilaw.html

www.aquaticcommunity.com/**crocodiles**/**philippine**.php

www.mabuwaya.org/index.cfm?p=1EB9CC43-F1ED-2AA3...
en.wikipedia.org/wiki/**Tunicate**
marinelife.about.com › Education › Marine Life › Sharks

What causes malaria? (n.d). Retrieved from
http://www.davidson.edu/academic/psychology/ramirezsite/neuroscience/psy324/rebergner/what_causes_malar...2/20/2013

www.**iucn**.org/about/
http://www.philippineeagle.org/index?pageval=the thephileagle

Unit 4
MODULE

2

INTERACTIONS

In this module, students will learn about the concept of “Interactions” in which organisms in the ecosystems acquire energy for their survival. Students should know that all organisms they observe in the environment interact in order to survive. This module introduces the idea of flow of energy in an ecosystem through interactions of organisms in the ecosystems. These interactions can be observed in many ways. Some interactions are beneficial; others are harmful. There are also interactions in which populations of organisms are neither benefitted nor harmed.

Teachers should also emphasize the idea that organisms interact with each other and their environment to meet their basic needs and survive. Interactions between organisms and their environment are also a familiar scene: *carabaos* helping farmers till the soil, earthworms burrowing in the ground may contribute in the fertility of soil which is beneficial to plants, and birds gathering twigs to build their nests.

Human intervention has had a range of effects on natural biodiversity. Agriculture has expanded into environmentally sensitive regions. In its natural state, an area of land that has shrubs and grasses on it has an inherent tolerance against flooding, drought and insect infestation. Because of expanding lands for agriculture and diversification of crops such as growing corn, some ecosystems have become more vulnerable.

In this module, students will identify the roles of organisms in food chains and food webs. Students conduct a simulation to investigate how energy is transferred from one source to another. Students will be able to:

- sequence a food chain to show the transfer of energy from one trophic level to another trophic level
- identify the organisms comprising a food chain and the function of each
- identify the organisms comprising a food web and the function of each
- describe a food pyramid in terms of the amount of biomass or energy at each level
- analyze the relationship between energy and matter
- analyse the harmful effects of some farming practices to increase crop yield
- identify alternative agricultural practices which can minimize or possibly eliminate the problem that go with some farming practices

The module has activities that will help students construct their science ideas and develop science thinking skills through embedded questions. The understanding of these concepts and skills will be strengthened through inquiry-based activities

such as making observation, analyzing information 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 transfer of energy in higher grade levels particularly in the topic of photosynthesis and cellular respiration.

Key question for this module

How does energy become transferred from one organism to another?

In this module, students gather evidence to understand that organisms in an ecosystem are tied together by their need for energy. Students execute the activities that provide them the idea that the Sun's energy is captured by producers and passed along to other consumers in the food chain. They then demonstrate their understanding of the flow of energy in an ecosystem by feeding on other organisms. They will learn these in the succeeding activities. There are embedded questions both in the discussion portion of the text and within the activities.

Answers to the Questions:

Q1. What raw materials from the environment are needed in the process of photosynthesis?
Answer: Water and carbon dioxide

Activity 1

How do you identify the components of a food chain in an ecosystem?

In Activity 1, students will read a short article about "Monfort Bat Cave." Remind the students to read the procedure. Student should answer the questions within the activity.

Q2. What are the organisms found in the surrounding area of Monfort Bat Cave? List them down in the table below.

Table 1. Organisms found in Monfort Bat Cave

Plants	Animals
durian trees	bats
other trees	crows
	rats
	pythons
	monitor lizards
	dogs (untamed)
	cats (untamed)
	humans

Q3. What groups of organisms are considered producers?
Answer: In this situation, the durian trees and other trees are the producers, providing food to the bats.

Q4. What part of the durian trees and other trees served as food for the bats?
Answer: nectar, fruits

Q5. The population of cave-dwelling bats is declining because they are being eaten by other organisms. What are these organisms that feed on bats?
Answer: crows, rats, pythons, monitor lizards, cats (untamed), dogs (untamed), humans

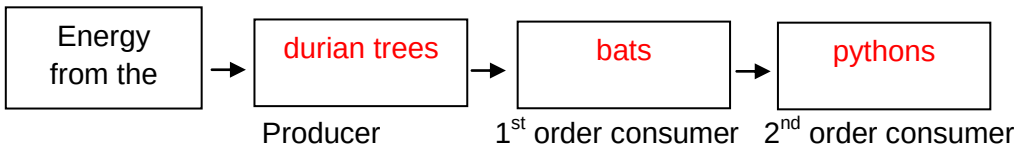
Q6. Among the organisms that feed on bats, are there organisms that possibly feed on the predators of bats? ✓ Yes _ No

3. Divide the organisms into the following categories as shown in the table below:

Table 2. Categories of organisms living in the Monfort Bat Cave

Producers	1st Order Consumer	2nd Order Consumer
durian trees	bats	crows
other trees		rats
		pythons
		monitor lizards
		cats (untamed)
		dogs (untamed)
		humans

4. Based on Table 2, construct a food chain with at least 3 organisms representing the producer, 1st order consumer and 2nd order consumer.



Q7. You have just analyzed by categorizing the organisms according to their trophic level. In your own words, describe a food chain.
Answer: A food chain is a transfer of energy from the Sun in sequence, for example, from green plants (convert energy from the Sun into chemical energy), to animals that eat plants, to animals that eat other animals. The feeding of one organism upon another in a series of energy transfers is known as a food chain.

Q8. Without decomposers will producers stay alive? Why?
Answer: No. Decomposers act on dead organisms and change these to simple nutrients which plants can use again. Without decomposers, nutrients needed by producers will not be available. Producers cannot stay alive.

Q9. Without producers, will consumers stay alive? Why?
Answer: Without producers, there will be no food for consumers.

Activity 2

Making food webs

Think of the food your family ate for supper last night. Make a food web based on your meal. Remember, your food web must have producers, consumers, and decomposers.

Q10. To which group of organisms do you belong?
Answer: Consumer

Q11. Which trophic level do you occupy?
Answer: Answer will depend on the food web constructed by students. Definitely, humans occupy the top trophic level in the students' food webs.

Q12. Which group of organisms has the greatest biomass? Which has the greatest energy?
Answer: The producers, example grass, cabbage, and shrub – greatest biomass and greatest energy

Q13. Which group of organisms has the least biomass? Which has the least energy?
Answer: The top consumer: hawk

Q14. What happens to the amount of biomass from the bottom to the top of the pyramid?
Answer: The amount of biomass decreases at each succeeding level from the bottom to the top of the pyramid.

Activity

3

Meat eaters vs. plant eaters

Q15. How much biomass of humans can the chickens support?
Answer: 50 kg

Q16. How much biomass of humans can 5 000 kg of corn support?
Answer: 500 kg

Q17. How much biomass of chicken can 5 000 kg of corn support?
Answer: 500 kg

Q18. Which is more efficient in converting biomass of producers to biomass of consumers – a meat eater or a plant eater? Give your explanation.
Answer: Plant eater; the same biomass of producers (corn) can support a greater biomass of consumers (humans) than if one were an animal eater. (Note: The teacher can explain that in the illustrated pyramids, if each person has a mass of 50 kg. 5 000 kg of corn can support 10 plant eaters with a total mass of 500 Kg and only 1 meal eats with mass of 50 kg.)

Q19. What gas do plants produce that animals use?
Answer: oxygen

Q20. What gas do animals produce that plants use?
Answer: carbon dioxide

Q21. Describe one way by which the following practices may disrupt a food chain or food web:

- monoculture
- use of insecticides
- use of fertilizers

Note: There are several ways that are suggested in the module. Students can pick up from the text in the module.

Summary

- Energy flow in the ecosystem is a one-way process. Energy flows from the sun, to the producers, and to the consumers. An ecosystem consists of all the organisms in an area interacting with one another and the nonliving environment.

- Producers such as plants, algae, and certain bacteria capture the energy of sunlight to produce food molecules. Consumers such as animals eat or consume producers and other organisms to obtain energy.

- The flow of energy between organisms can be shown by a food chain or a food web.

- A food chain is a sequence of organisms used as food and the organisms that feed on them. It starts with a producer followed by a series of consumers.

- A food web shows the complex feeding interrelationships between organisms in an area. It consists of interconnected food chains.

- Energy flows through different feeding levels called trophic levels in food chains and in food webs. Producers occupy the first trophic level. Consumers are at succeeding trophic levels ending with the top or highest-level consumers.

- A food chain or a food web can be arranged in the form of a pyramid. A pyramid of biomass shows the decreasing amount of matter or tissue while an energy pyramid depicts the decreasing amount of energy. The greatest amount of biomass or energy is at the base of the pyramid. The amount of biomass or energy decreases towards the top.

- While matter is recycled in ecosystems, energy flows only in one direction 1st order from producer to consumer to 2nd order consumer, etc.

- People are the top consumers in many food webs. To increase food production, they use methods which may disrupt food chains or food webs. They have to learn how to make decisions to correct these mistakes.

References

Campbell, N. A., Reece, J.B., Taylor, M.R., Simon, E.J., Dickey, J.L. 2012. Campbell Biology: Concepts and Connections. Seventh Edition. Pearson Education, Inc. publishing as Pearson Benjamin Cummings, USA.

Lantaw - Philippines Outdoor and Travel Photos 2009: Retrieved March 13 2013 http://www.lantaw.com/2009/10/samal-monfort-bat-cave.html

Department of Education, Culture and Sports. Instructional Materials Corporation. (1990). Science and technology II: Textbook. Quezon City: Author.

Unit 4
MODULE

3

THE DIGESTIVE SYSTEM

This module revisits the lessons on organ systems taken up in Grades 6 and 7. In Grade 6, the students learned how the different organ systems work together. In Grade 7, they were introduced to the levels of organization in an organism of which, organ systems are but a part.

In this module, the students will learn not just the structures of certain organ systems that work together but also the processes they undertake to keep the state of balance in organisms. Emphasis will be given on the digestive system.

Four of the major functions of the digestive system are covered here: ingestion of food, digestion of food, absorption of nutrients, and elimination of waste materials. This module covers also the complementary role played by the respiratory and circulatory systems in the digestion of food.

Key question for this module

How does the digestive system break down food to nourish the body?

Start the lesson with a review of the different structures of the digestive system and their functions. These are lessons the students have learned in Grades 5, 6, and 7. Draw out in your review with the students the concept of interaction among these structures and the importance of such interaction in the survival of species. Activity 1A may serve as a motivational activity.

Activity

1A A gutsy game

Activity 1 is a board game that is played with tokens and a die (refer to the board game on the next page. This game aims to help students identify the organs that make up the digestive system and describe the function of each organ. Moreover, the game should also be able to help students describe the interaction taking place in the digestive system as these organs carry out the digestion of food.

Guide the students through the procedure. The game may be played in pairs or in groups of 5, at the most. There should be as many tokens as there are members of the group. The first member to make it all the way through the digestive system wins the game. As the students play the game, guide them through the questions that follow. After they have finished the game discuss with the class their answers to the questions.

Teaching Tips

13. The game is an analogy of some processes involved in the digestive system and not a simulation. As such, it has its limitations. The game aims to help students to identify the organs that make up the digestive system and to describe the function of each organ.

14. Discuss with the students what they understood about the concept of digestion and the processes involved in the digestive system after playing the game. After which, ask them what other things they would like to learn about the digestive system.

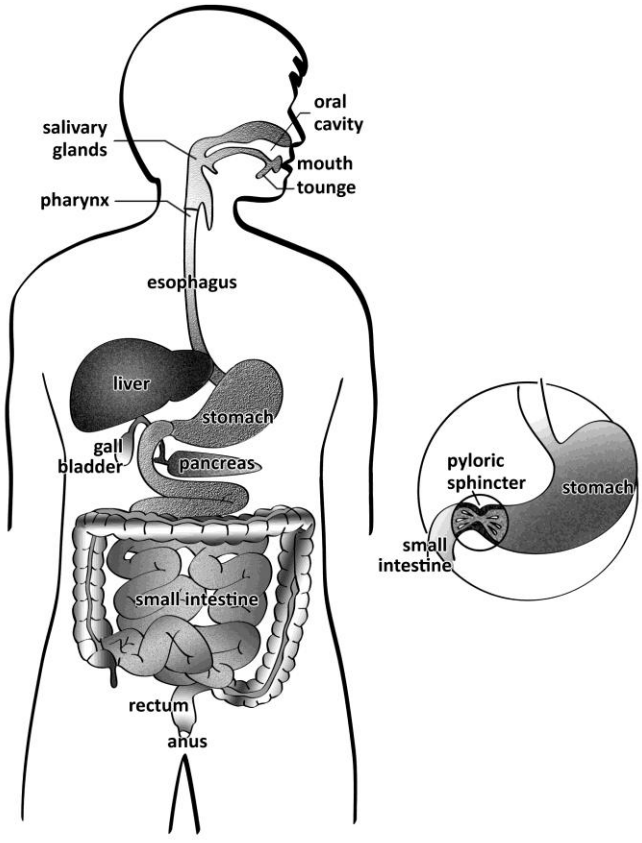
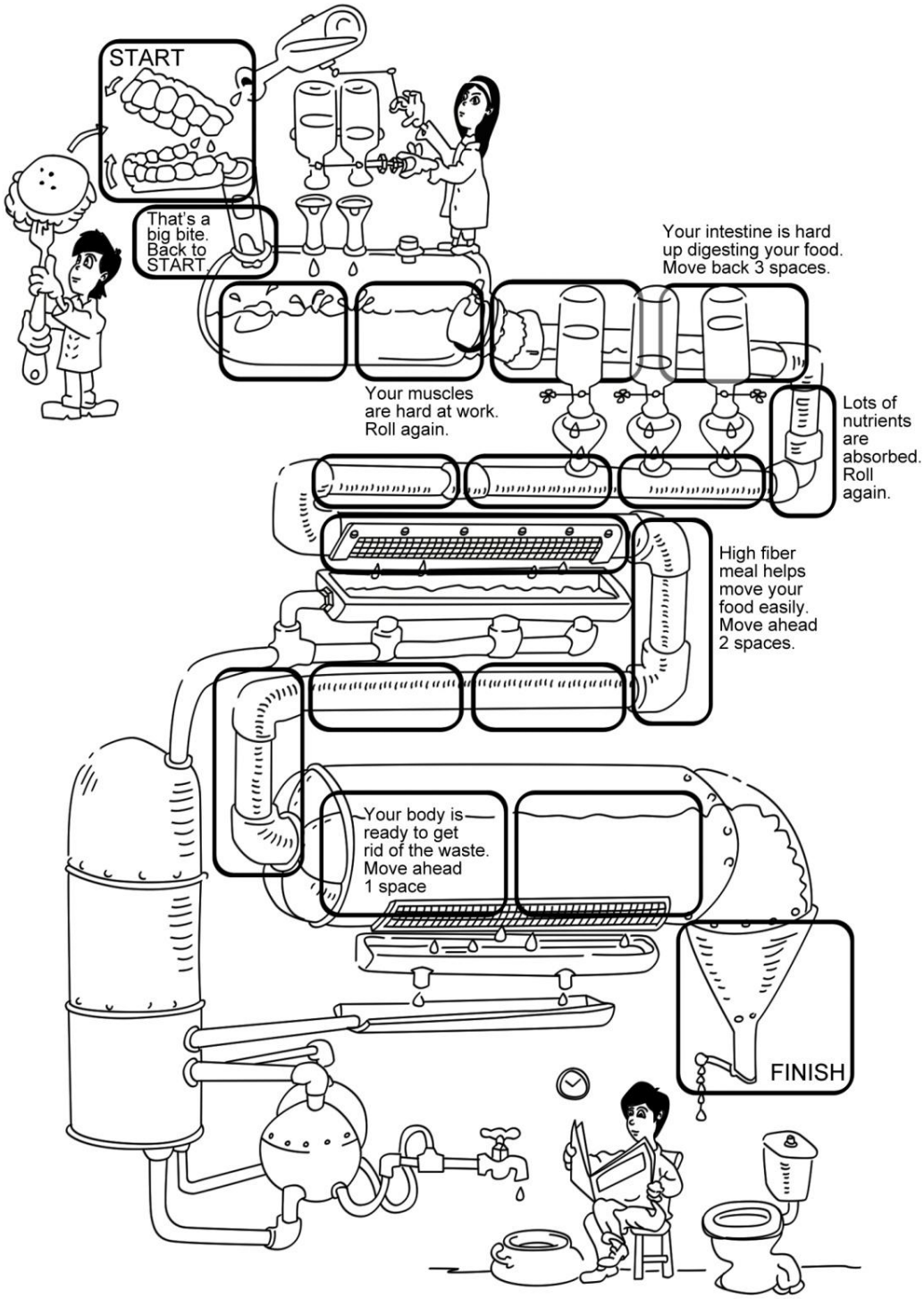


Figure 1. The human digestive system.


START
That's a big bite. Back to START
Your intestine is hard up digesting your food. Move back 3 spaces.
Your muscles are hard at work. Roll again.
Lots of nutrients are absorbed. Roll again.
High fiber meal helps move your food easily. Move ahead 2 spaces.
Your body is ready to get rid of the waste. Move ahead 1 space
FINISH

15. During the game, it helps if you post on the board an illustration of the digestive system or display a model of the human torso -- if available. If not, the students can refer to Figure 1.

The playing pieces or tokens used in the game represent the food we eat. The spaces on the game board are a representation of the different parts of the digestive system through which food passes. Have the students describe the illustrations in the board game and how these illustrations relate to the digestive system and the process of digestion. Notice that there are spaces or boxes on the game board that asks the players to move back several spaces. Ask the students if they can think of an instance when the food that was just eaten moved back.

Answers to Questions

Q1. The tokens represent the food that was eaten.

Q2. The spaces on the board game represent the different organs or structures of the digestive system.

Q3. The directions on some of the spaces describe the different physical and chemical conditions that affect proper functioning of the digestive system.

Q4. The digestive systems of different representative species of animals are similar to each other in that they are all made up of a continuous tube with two openings: the mouth and the anus. But as shown in Figure 2, certain differences are also noted particularly on the structures that compartmentalizes the different digestive tracts.

Digestion in Animals

Digestion in animals is carried out physically and chemically. Physical digestion refers to the physical breaking down of food to smaller pieces; chemical digestion changes the large molecules in food into their building blocks. In the lower grades, the students have learned how these processes are carried out in the human digestive system.

At this point, call the students' attention to Figure 2. Have them compare the different structures of the digestive systems of different representative organisms. How are they alike and how are they different? What structures do some species have in their digestive system that other species do not have? What purpose do these structures have in the digestive system of these species?

At the end of the activity, have them visit the library or certain trusted websites to read more about the parts or structures that are unique to each of these organisms. Ask the students how these structures and their functions are the same or different from those of humans.

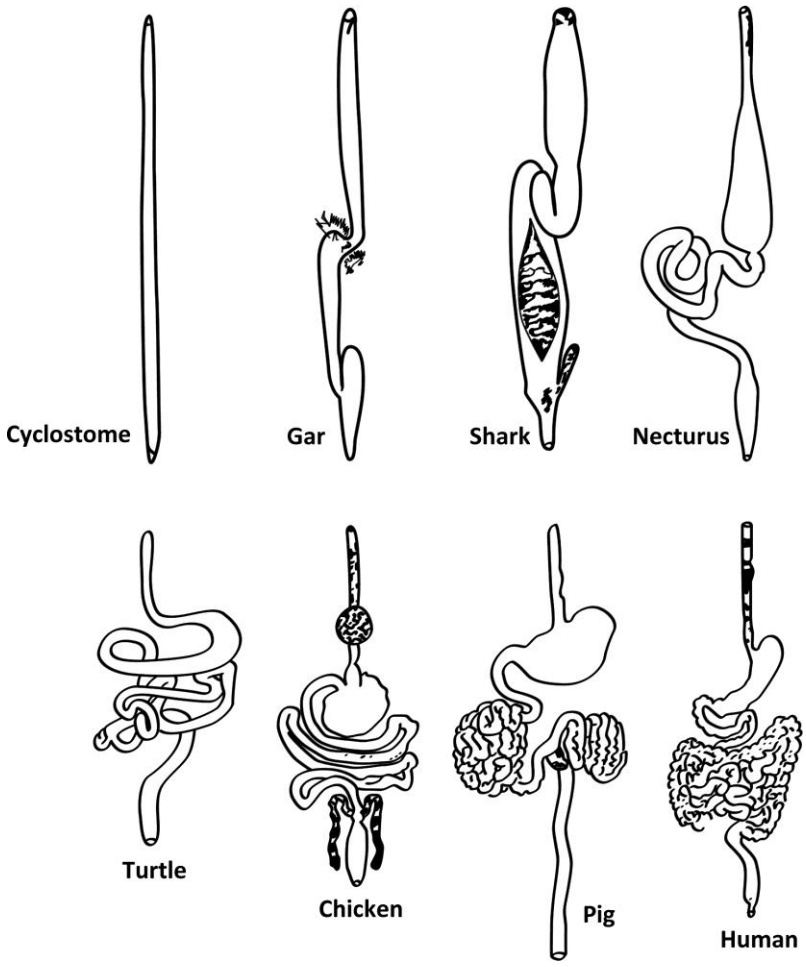


Figure 2. Digestive systems of different representative species of animals.

The process of digestion is not unique to humans. Even the simplest animals -- the invertebrates -- have structures they use to digest food. Refer the students to Figure 3 and have them describe the process of digestion in *Hydra.* The students should be able to note that the *Hydra* has a 'digestive system' that has only one opening -- the mouth! This is called an **Incomplete Digestive System.**

Have the students read more about digestion among invertebrates and have them name other organisms that have incomplete digestive systems. In your discussion have them compare the digestive system of invertebrates with those of the vertebrates.

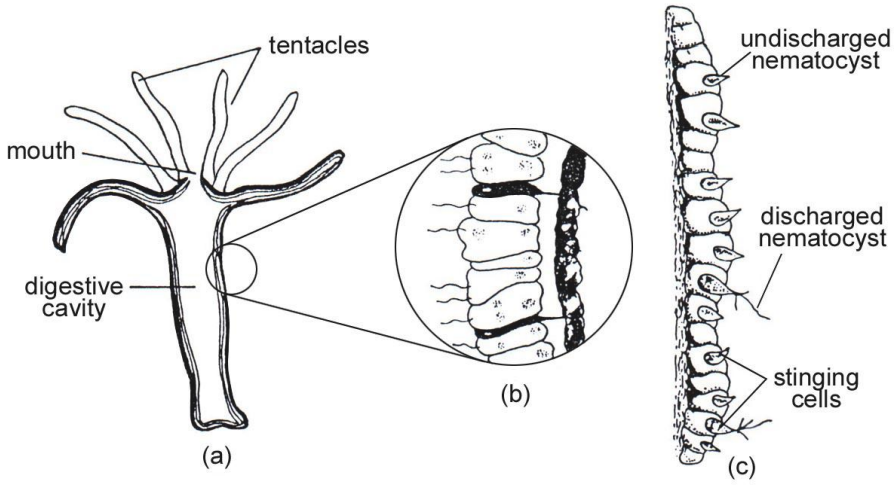


Figure 3. (a) Hollow body of Hydra. The animal takes in food, digests food in its digestive cavity, and removes wastes through its mouth, (b) is an enlarged part of the body wall, and (c) the outer part of the wall shows the nematocysts.

Revisit these lessons with the students to help them better understand the importance of the whole process of digestion. Activity 2 gives emphasis on the chemical digestion of food. They will discover what enzymes are, which ones are involved in digestion, and the role these enzymes play in making the nutrients in food available to organisms.

Activity 1B

A sweet break!

Chewing breaks down food into smaller pieces. To help students draw out the idea of smaller pieces of food being more easily chemically digested, have them think of what happens when they chew a piece of candy rather than waiting for the whole candy to dissolve.

Breaking down food to smaller pieces increases the surface area of the food on which enzymes like the amylase found in saliva act. Amylase breaks down large carbohydrate molecules like starch into simple sugars. This is why you might notice that a boiled sweet potato tastes a little sweeter after chewing it for a while. Note however that the sugar in sweet potatoes is starch; it is the simple sugars released from the breaking down of starch that tastes sweet.

This activity should enable students to describe what happens to food as it gets digested mechanically and to infer the importance of breaking down food to speed up its digestion.

Teaching Tips

1. Explain to students that simple sugars dissolve readily in water. They require little digestion and are quickly absorbed into the bloodstream. Starches are also relatively simple and are converted to sugars in the mouth.
2. While sugars and starches quickly can be prepared to go into the bloodstream, most foods are more complex. Ask students to respond to this question: if they placed a piece of food (lettuce, meat, bread) into their mouths without chewing, would it completely dissolve in their mouth so that the body could absorb the nutrients in it?
3. Explain that the digestive system produce many different chemicals called enzymes that help digest nutrients. Introduce students to the concept of enzymes and enzyme actions. The following activities will help them better understand the role that enzymes play in the digestion of food.

Answers to Questions

Q5. Breaking the candy to smaller pieces increases the surface area of the food on which solvents like water and digestive juices act. For which reason, the rate of the food's dissolution and chemical digestion also increases.

Q6. Crushing the candy represents the chewing of food -- a form of mechanical or physical digestion of food.

The stomach is made up of muscles that perform both in the mechanical and chemical digestion of food. These muscles contract and help the stomach churn its contents; this turns the food into even smaller particles as it gets mixed with the gastric juices. The stomach also produces hydrochloric acid -- a strong acid -- and pepsin -- a digestive enzyme. Together, they start breaking down protein. After digestion of food in the stomach, it gets moved on to the small intestine as a chyme.

Activities 2 and 3 will try to simulate the chemical environment of the stomach and the processes it carries out to help in the digestion of food.

Activity 2

How do enzymes affect digestion?

The importance of enzymes in the proper functioning of the body cannot be overstated. The different biological processes such as reproduction, growth, and development are all influenced by enzymes.

In this activity, the students will be introduced to the nature of enzymes and their role in the digestive system and the digestion of food. As an introduction, the discussion on enzyme and its function does not include the chemical reactions in

which they are involved. Note that the topic on chemical reaction will be taken up in Grade 9 Chemistry.

After performing this activity, the students should be able to infer the role that enzymes play in digestion.

Teaching Tips

1. Activity 2 simulates a part of chemical digestion that takes place in the stomach and the small intestine. In your discussion, the students should also be able to realize that what they observed is not the whole of chemical digestion. There are other enzymes involved in the process and each of these enzymes has a specific reaction that it can catalyze or speed up.
2. This activity is best carried out in groups. A week before you perform this activity, assign each group to bring the materials that will be used for this activity.
3. It helps also if you have prepared in advance, setups to show the class. These setups can serve as their guide.
4. Walk the students through the procedure. There may be steps in the procedure where close supervision is needed such as in the preparation of gelatin and bromeliad leaf juice. Remind the students of the precautionary measures they need to observe in handling heating equipment, hot materials, and hazardous chemicals such as acids and bases.

Answers to Questions

Q7. Bromelain prevented the solidification of gelatin.

Q8. Observations made on test tubes 2 and 3 showed this effect.

Q9. Enzymes speed up the digestion of food.

Digestive Enzymes

In Activity 2, the students have explored an important part of the nature of enzymes; they speed up the chemical reactions that help in the digestion of food. There are different enzymes involved in the digestive system. In fact, there is a specific enzyme involved in the chemical breakdown of each of the different food groups.

Carbohydrases -- which include amylase among others -- facilitate the digestion of carbohydrates – breaking them down into simple sugars, Proteases such as Bromelain help in the digestion of proteins into amino acids. Lipases on the other hand, aids in the digestion of fats and lipids into fatty acids and glycerol.

Bromelain, which is a protease, was used in Activity 2. It breaks down collagen -- the protein present in gelatin. This change should have been observed in

test tubes 2 and 3. Bromelain is an enzyme that is naturally present in the leaves, stems, and fruits of bromeliad plants such as pineapple, kiwi, and papaya.

Enzyme activity of bromelain and the other enzymes is influenced by different factors such as pH, temperature, and enzyme concentration. There are certain conditions to these factors that allow the enzymes to work optimally. In the next activity, only pH will be considered. Here, the students will investigate the effect of pH on enzyme activity.

Activity 3

How does pH affect enzyme activity?

The stomach is naturally acidic. This acidic environment of the stomach helps kill microorganisms to keep the food safe to the body as it gets moved along the digestive tract. It also enables enzymes to do their job like in the case of proteases that work best under acidic conditions. Proteases help in the digestion of proteins.

Activity 3 simulates the acidic chemical environment of the stomach and its effect on one particular group of enzymes -- the proteases. Some enzymes like a number of proteases need a certain degree of acidity to optimize their enzyme activity. That is to say that at a given pH range, some proteases are better able to help in the digestion of proteins.

Activity 3 should enable students to infer the function of the acidic chemical environment of the stomach and the intestine in providing an optimal condition for certain enzymes to speed up the digestion of proteins. They should also be able to infer the relationship of pH to enzyme activity in general.

Teaching Tips

1. Activity 2 simulates the effect of pH on the chemical digestion of proteins. This activity is best carried out in groups.
2. Assign each group in advance to bring the materials that will be used in the activity. Most of the materials they will need in this activity have already been made available in Activity 2. Replenish only those that have already been consumed or those that needed replacement.
3. It helps also if you have prepared setups to show the class. This serves as their guide.
4. Walk the students through the procedure. There may be steps in the procedure where close supervision is needed such as in the preparation of gelatin and bromeliad leaf juice. Remind the students of the precautionary measures they need to observe in handling heating equipment, hot materials, and hazardous chemicals such as acids and bases.

Answers to Questions

Q10. Digestive enzymes speed up the digestion of food.

Q11. The greatest degree of protein digestion is shown in Test Tube A.

Q12. The least amount of protein digestion is shown in Test Tube B.

Q13. Results show that Bromelain -- a kind of protease -- is better able to speed up the digestion of proteins under acidic environments.

Q14. Yes, the data support our hypothesis that the greatest degree of protein digestion will take place under acidic conditions. Or,
No, the data do not support our hypothesis that the greatest degree of protein digestion will take place under acidic conditions.
(Either way the students answer the question, they should be able to account for their answers using the data they have gathered.)

Q15. Protein is chemically digested in the stomach and the small intestine.

Start the lesson by revisiting Activities 1A, 1B, 2, and 3 of Module 3. At this point, they should have learned already that food goes through physical and chemical digestion. In Activity 4, which is an optional activity for this module, you will present a video clip to the class. This video clip shows the changes that food undergoes as it gets digested and what happens to it next once digested. Activity 4 provides an audiovisual summary of Module 3.

Activity 4

A journey into the digestive system

Activity 4 is an **optional activity**. A video clip that tracks the changes that food undergoes as it gets moved to the different parts of the digestive tract will be shown to the class. Have the students take down notes as they watch the video clip. After watching the video clip, guide the students through the questions embedded in the activity. You can also use these questions to start a discussion on the topic.

In your discussion, the students should be able to describe how the different organs of digestion – including those of the circulatory, respiratory, and excretory systems – and the different enzymes and gastric juices released, work together to break down food, nourish the body, and maintain overall wellness.

More specifically, the students should be able to explain how the nutrients are broken down into small particles that can be used by the body. They should also be able to explain how these particles are absorbed into the bloodstream. In the human body, most of the process of absorption takes place in the intestine. Inside the

digestive tract, the surface area is increased by folds and protrusions (villi and microvilli) to allow more contact with the materials that pass through it.

Teaching Tips

1. Activity 4 features a video clip that tracks the fate of food as it is moved all the way through the digestive tract. You can access the video clip through this link: http://www.youtube.com/watch?v=e3O1AdlC8bI. Note however, that you are not limited to using just this video clip. You can use other similar multimedia resources.
2. It will help if you watch the video clip in advance. This way, you can help the students to understand the narration better.
3. Have the students take down notes as they watch the video clip. Alternatively, you can start discussion
4. After watching the video clip, have the students narrate what they understood about the video clip. You can also use the questions in the Learning Material to guide the class through the discussion.

Answers to Questions

Q16. The video clip shows the changes that food goes through as it gets digested and moved through the different parts of the digestive tract.

Q17. What was shown in the movie is the digestion of a mashed food for infants. The food disintegrates as it mixes with the liquid content of the stomach. Other changes were also shown as the food is moved from one part of the digestive tract to the other.

Summary

The digestive system carries out the following processes: ingestion of food, digestion of food, absorption of nutrients, and elimination of wastes (refer to Figure 5).

Have the students describe each of these processes. They should also be able to infer that all these processes are part of a continuous biological event called digestion and therefore, are related to each other. These processes work together to enable organisms to obtain energy from the food they eat.

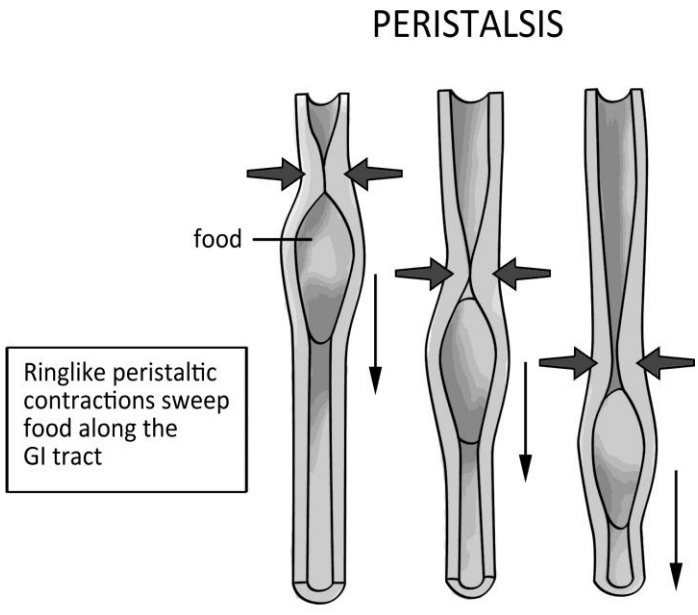


Figure 4. Peristalsis in the esophagus.

In your discussion, draw out from the students the concept of interaction among the different organ systems. In this particular case, describe how the circulatory system helps the digestive system in transporting the soluble particles to the different parts of the body.

In Grade 9, this topic will be revisited to kick start the topic on respiration – cellular respiration, in particular – and the respiratory system. Interaction of the respiratory system with the digestive and circulatory systems will also be covered as well as the system's role in the derivation of energy from food.

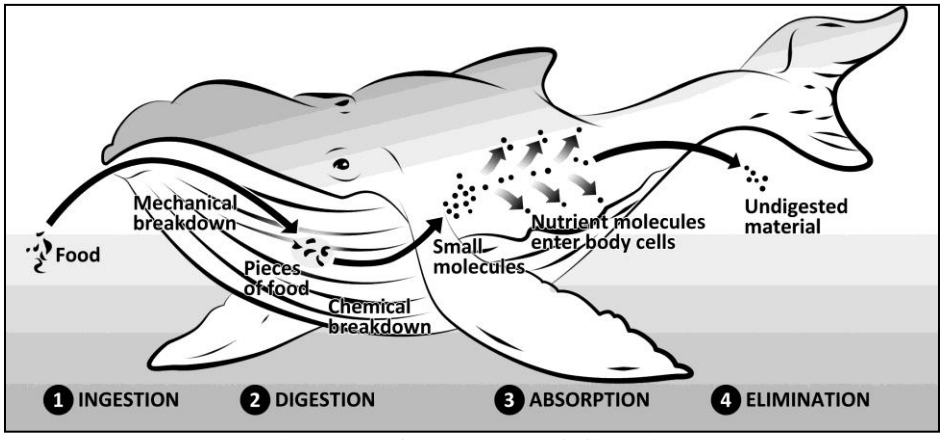


Figure 5. The process of digestion.

References

Beckett, B. & Gallagher, R. (2001). Modular science: Biology. Oxford: Oxford University Press

Goldsmith, I. (1969). Human anatomy for children. New York: Dover Publications

Guyton, A. (1964). Function of the human body. Philadelphia: W. B. Saunders

Ravielli, A. (1963). Wonders of the human body. New York: The Viking Press.

VanCleave, J. (1995). Jan VanCleave's the human body for every kid: Easy activities that make learning science fun. New York: John Wiley

Link

Journey of the digestive system
Link: http://www.youtube.com/watch?v=e3O1AdlC8bI

Unit 4
MODULE

4

NUTRITION AND WELLNESS

This module explores the connection between nutrition and wellness, the effects of nutrients in maintaining a healthy body, and how students can apply the concepts of nutrition to their daily lives.

There are three activities in this module. Activity 1 familiarizes the students with the food pyramid and the food plate and enables them to track down their food intake. Activity 2 will lead them into understanding that the human body has nutrient requirements for proper maintenance, growth, and development, and the severe consequences of nutritional deficiencies. Finally, in Activity 3, the students plan a 3-day menu where they can now apply the concepts they have learned in Activities 1 and 2.

Key questions for this module

What are the nutritional needs of our body?

What happens when the body's nutritional needs are not met adequately?

Activity 1

Am I eating right?

In Part A of this activity, the students will make a record of their daily meals for 3 days. Give this as an assignment before the start of this module. Show the *Sample Daily Meal Journal* (Table 1) to the class. The Daily Meal Journal will provide the students with a record of what their food intake is. **The journal is not meant to be shared to the class**.

Invite a resource person (a school nutritionist, school nurse, or barangay health worker) to impart information on what nutrients are important for a healthy diet. Request the resource person to share the recommended dietary allowance of nutrients for teenagers.

Divide the class into groups of 4-5 students. Ask the students to gather data on what local produce are available in their province and two nearby provinces.

Use the Food Pyramid (Figure 1) to classify the local produce they have identified into the food groups indicated in the food pyramid.

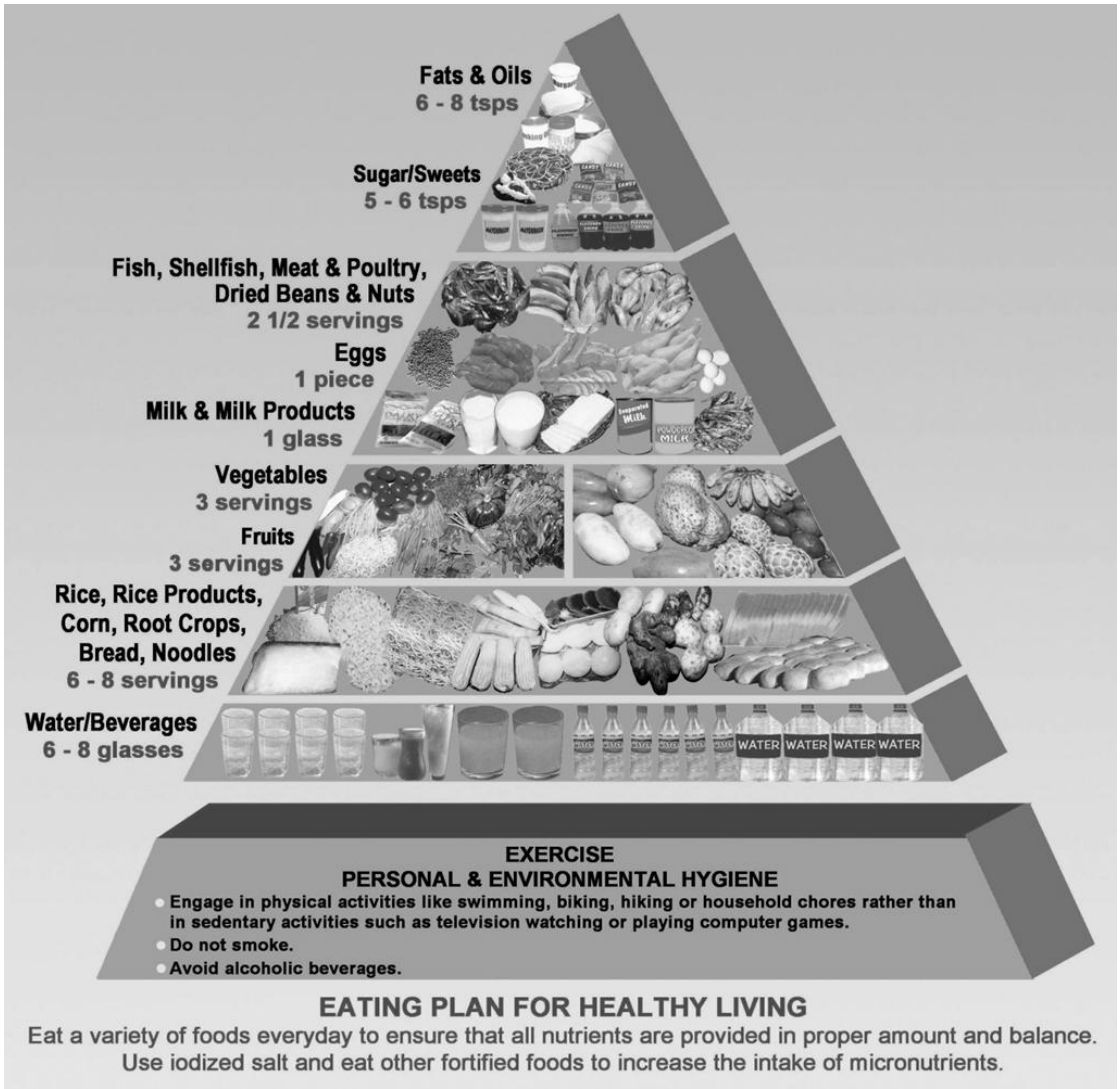


Figure 1. The Food Pyramid for teenagers recommends eating a variety of foods to ensure that all nutrients are provided in proper amount and balance. Source: Food and Nutrition Research Institute, Department of Science and Technology

To wrap up Activity 1, have the students compare their food intake with the recommended variety and number of servings. Inform them that the recommended number of servings vary across age, activity level, gender, if pregnant or breastfeeding, or body size.

Activity 2

What happens when nutritional needs are not adequately met?

In this activity, the students will be divided into groups of five. Each group researches on specific nutrients including food sources, functions, and symptoms of deficiency of the nutrient. If possible, examples of food sources should include local produce. All of the groups present their findings to the class.

One of the main objectives of Activity 2 is for students to realize that food directly affects and makes up the structures of the body. A complete diet is necessary to supply the nutrients that organisms need for growth, development, and maintenance. Dietary deficiencies in these important nutrients can result in complications and diseases.

Activity 3

Using essential concepts in nutrition in planning a menu

In this activity, students will now apply the concepts that they have learned in Activities 1 and 2. They will develop a 3-day menu that meets the daily nutritional requirements as identified in the food pyramid for teenagers. Menus should include breakfast, lunch, dinner, and two snacks. Emphasize that their menu should include food products that are locally available. You may ask representative students to present their outputs.

Criteria	4 Outstanding	3 Proficient	2 Satisfactory	1 Needs more instruction
Required information in menu -variety and amount of food groups -inclusion of local food produce -inclusion of required meals	All meals are balanced in terms of the variety and amount of food groups. Menu includes local food produce. Menu includes breakfast, lunch, snacks, and dinner.	Most of the meals are balanced in terms of the variety and amount of food groups. Menu includes local food produce. Menu includes breakfast, lunch, snacks, and dinner.	Some (80% and below) of the meals are balanced in terms of the variety and amount of food groups. Menu includes local food produce. Menu includes breakfast, lunch, snacks, and dinner.	Most of the meals are not balanced in terms of the variety and amount of food groups. Menu does not include local food produce. Some meals (breakfast, lunch, snacks, and dinner) are missing or incomplete.

Decide on the appropriate intervention to help the students improve when the output reflects that the students need more instruction.

You may wrap up the Unit with this statement: Your body needs nutrients for growth, development, and maintenance. Eating healthy and balanced meals provides you nutrients that your body needs.

Answers to Questions

Q1. Rice, rice products, corn, root crops, bread, noodles

Q2. Rice

Q3. Fruits, vegetables

Q4. Fruits – 3 servings; Vegetables – 3 servings

Q5. Include servings of fruits and vegetables in his diet

Sample Output for the Take Home Activity

Province	**Fruits / Vegetables / Root crops / Seaweeds**	**Poultry / Livestock / Fisheries**
Albay	Malunggay	Chicken
	Rice	Duck
	Coconut	Beef
	Kamansi (*ogob*)	Galunggong
	Sigarilyas (*puro-pagulong*)	Kuhol
	Jackfruit	Shellfish
	Sweet potato (*kamote*)	
	Seaweeds (*lato*)	
	Papaya	
	Kangkong	
	Mongo	
Sorsogon	Rice	Crabs
	Corn	Shrimps
	Coconut	Native chicken
	Banana	Beef
	Root crops	Kuhol
	Seaweeds (*lato*)	Dilis
	Guyabano	Grouper (*bataway*)
	Peanut	Shellfish
	Ampalaya	
	Santol	

References

Daily Nutritional Guide Pyramid for Filipino Children (13-19 years old). Retrieved from:http://www.fnri.dost.gov.ph/index.php?option=content&task=view&id=1676

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

Philippines. Science Education Center. (1971). *Plants of the Philippines* (2nd ed.). Quezon City, Philippines: Pundasyon sa Pagpapaunlad ng Kaalaman sa Pagtuturo ng Agham, Ink.

Unit 4
MODULE

5

CELLULAR REPRODUCTION AND GENETICS

This module will focus on the relationships of the chromosome and heredity. Emphasis is given on the behaviour of the chromosomes during meiosis to understand the basis of the Mendelian laws of modern genetics.

Key questions for this module

What are the different types of cell division?

How are traits passed on to the next generation?

Activity 1

Observing mitosis

In this activity, the students should be able to identify in the white fish blastula and onion root tip slides the mitotic cells based on the descriptions given. The students should also be able to distinguish these cells from the interphase or non-dividing cells. Note that during interphase, the chromosomes are not readily seen because they are thin and uncoiled. For the onion root tip, the interphase cells have distinct nucleoli, which are readily seen as one or two darkly stained bodies inside the well-defined nucleus.

Answers to questions:

Q1. Centrioles are found in animal cells.

Q2. Cleavage furrows form in animal cells but not in plant cells. Plant cells have cell walls, which do not permit the formation of the cleavage furrows.

Activity 2

Comparing mitosis and meiosis

In this activity, the students should distinguish between mitosis and meiosis. At the end of the activity, they should also know the role of meiosis in the production of gametes. Meiosis produces daughter cells that become gametes with only half the chromosome number in order to prevent the doubling of the chromosome number every time the gametes fuse during fertilization.

Completed table:

	Mitosis	Meiosis
Number of daughter cells produced	Two	Four
Number of chromosomes is halved. (Yes/No)	No	Yes
Pairing of homologous chromosomes take place. (Yes/No)	No	Yes
The daughter cells produced are always identical in terms of genetic material. (Yes/No)	No	Yes

The teacher should emphasize to the students that during the S phase of the cell cycle, each chromosome will undergo replication; from one sister chromatid, each chromosome will now have two identical sister chromatids. During crossing over in Pachytene stage, however, segments of sister chromatids from homologous chromosomes are exchanged. This will result in non-identical sister chromatids for each chromosome, which is seen in Figure 3 (see below). Thus, the daughter cells produced during meiosis will not be identical in terms of the genetic material they contain as a consequence of crossing over.

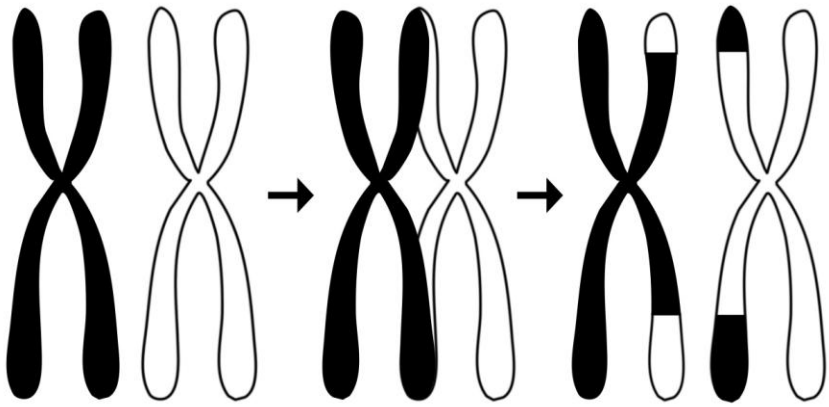


Figure 3. Crossing over of homologous chromosomes during meiosis I.

Activity 3

Tossing coins and probability

Answers to Questions

This activity would introduce the principle of probability to students using a simple exercise involving tossing coins. This principle could also be applied to predict the outcomes of genetic crosses.

In the first part of the activity involving a single coin toss, the students should discover that because a coin has two sides (Head and Tail), each side would have an equal probability of coming up. Therefore, a single coin tossed 50 times should have a ratio of approximately 25 H: 25 T or 1:1. A small deviation might be expected if the result is not exactly 25:25 due to chance.

If we assume the coin to represent the genotype of a parent, and each face is an allele, with the head as the dominant allele (H) and the tail as the recessive allele (h), then this would make the parent a heterozygote.

Answers to Questions

Q2: As with the coin toss exercise, this parent would be able to produce two types of gametes, one with H and the other with h, each with equal probability of occurring.

Q2: Assume that by tossing two coins, you are crossing two heterozygote parents, and each time the two coins face up, the combination represents the genotype of the offspring. Therefore, the expected ratio should be ¼ *HH*, ½ *HT* and ¼ *TT*.

Q4: The ratio should remain the same even if the number of tosses increases. In fact, as the number of tosses increases, the closer the results should be in approximating the expected ratio.

Q5: The results should approximate the expected ratio of Mendel's experiments involving a single hybrid cross.

Activity 4

Comparing genotypic and phenotypic ratios for a typical Mendelian trait

This activity would allow the students to recognize the different Mendelian ratios based on the different types of crosses involving parents of various genotypes. The students are strongly encouraged to remember these phenotypic and genotypic ratios as it would help them solve for genetic problems involving crosses.

Completed table.

Cross	Genotypic Ratio	Phenotypic Ratio
1. *DD x DD*	100% *DD*	100% dominant
2. *DD x Dd*	(½) *DD*: (½) *Dd*	(1 or 100%) dominant
3. *DD x dd*	(1 or 100%) *Dd*	(1 or 100%) dominant
4. *Dd x Dd*	(¼) *DD*: (½) *Dd*: (¼) *dd*	(¾) dominant: (¼) recessive
5. *Dd x dd*	(½) *Dd*: (½) *dd*	(½) dominant: (½) recessive
6. *dd x dd*	(1 or 100%) *dd*	(1 or 100%) recessive

Activity

5

Filling up the Punnett square for a dihybrid cross

This activity would teach the students how to solve for genetic problems involving two loci. In this example, the two loci are both heterozygous (hybrid), although the technique can also be performed using other genotypes. One thing the students should bear in mind is that, if the pairs of alleles are found in separate chromosome pairs, then they should segregate independently of each other. Therefore, different possible combinations will arise, as shown in Figure 10.

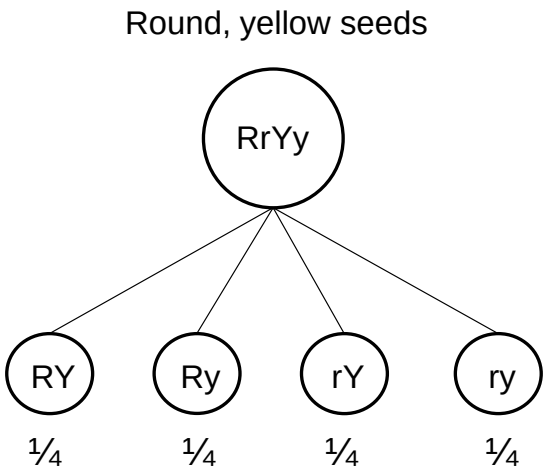


Figure 10. Gametes produced by a dihybrid genotype.

Once the different types of gametes and their expected frequencies are determined, then the expected frequencies of the different genotypes can be computed.

Completed table:

♀ \ ♂	¼ **RY**	¼ **Ry**	¼ **rY**	¼ **ry**
¼ **RY**	1/16 G:*RRYY* P:*RY*	1/16 G:*RRYy* P:*RY*	1/16 G:*RrYY* P:*RY*	1/16 G:*RrYy* P:*RY*
¼ **Ry**	1/16 G:*RRYy* P:*RY*	1/16 G:*RRyy* P:*Ry*	1/16 G:*RrYy* P:*RY*	1/16 G:*Rryy* P:*Ry*
¼ **rY**	1/16 G:*RrYY* P:*RY*	1/16 G:*RrYy* P:*RY*	1/16 G:*rrYY* P:*rY*	1/16 G:*rrYy* P:*rY*
¼ **ry**	1/16 G:*RrYy* P:*RY*	1/16 G:*Rryy* P:*Ry*	1/16 G:*rrYy* P:*rY*	1/16 G:*rryy* P:*ry*

NOTE: G = Genotype; P = Phenotype

Answers to Questions

Q1. Since both parents have the same genotype (*RrYy*), they would have the same types and frequencies of gametes: ¼ RY, ¼ Ry, ¼ rY, and ¼ ry.

Q2. For *RY*: 1/16 *RRYY* + 2/16 *RrYY* + 2/16 *RRYy* + 4/16 *RrYy* = 9/16
For *Ry*: 1/16 *RRyy* + 2/16 *Rryy* = 3/16
For *rY*: 1/16 *rrYY* + 2/16 *rrYy* = 3/16
For *ry*: 1/16 *rryy* = 1/16

Q3. There are 9 genotypes in all (see answer in Q2).

Q4. For *RRyy* = 1/16
For *RrYy* = 1/4
For *Rryy* = 1/8
For *RRYY* = 1/16

Activity 6

Phenotypes and genotypes in incomplete dominance

For this activity, the students should remember that in incompletely dominant traits, the heterozygote condition is expressed as a distinct phenotype. Therefore, the genotypic ratio of a particular cross would also become the phenotypic ratio.

Answers to Questions

Q1. Since the parents produce pink flowers, this makes them heterozygotes (R_1R_2). They would produce two types of gametes: R_1 and R_2, each with ½ probability.
Q2. The genotypes of the offspring are as follows: (¼) red, (½) pink and (¼) white.
Q3. The genotypic and phenotypic ratios are the same: (½) red or R_1R_1: (½) pink or R_1R_2.

Activity 7

Inferring genotypes of ABO blood types based on the parental blood types

This activity should develop in students the ability to infer the most probable genotype(s), and therefore the phenotype(s), of an unknown individual if the phenotypes of his/her family members are known.

Completed table:

Mother's Blood Type	Father's Blood Type	Child's Blood Type
A	A or O	A
B	A or AB	AB
AB	A or B or AB or O	B
O	O	O

References and Links

Brooker, R.J. (2008). *Genetics: analysis and principles* (3rd ed). Irwin/McGraw-Hill.

Cold Spring Harbor Laboratory DNA Learning Center. (2 February 2013). How insulin is made using bacteria. Retrieved from http://www.dnalc.org/view/15928-How-insulin-is-made-using-bacteria.html.

Klug, W. S., M. R. Cummings, and C. A. Spencer. (2007). *Essentials of genetics* (6th ed). New Jersey, USA: Pearson Education, Inc.

Lewis, R. (1999). *Human genetics*: *concepts and applications* (3rd ed). WCB/McGraw-Hill.

Philippines. Department of Education. (2004). *Biology: Science and technology textbook for 2nd year*. (Revised ed.). Quezon City: Author.

Ramirez, D.A., Mendioro, M.S. and Laude, R.P. (2010). *Lecture notes in genetics* (9th ed). San Pablo, Philippines: 7 Lakes Printing Press.