UNIT 1

Living Things and Their Environment

Photo Credit: http://www.flyingfourchette.com/2013/05/25/around-ubud/

Suggested time allotment: 8 to 10 hours

Unit 1
MODULE
1

Respiratory and Circulatory Systems Working with Other Organ Systems

Overview

Your body is a fascinating creation that can carry out incredible tasks and activities. It is like a machine that is able to function with proper organization of parts and systems. However, our bodies also require proper care and maintenance. It is just fitting to keep going with a healthy lifestyle to ensure that each part is maintained appropriately while getting the most out of it.

In the past, you were introduced to the different levels of organizations in the human body and the mechanisms involved in it. You have learned that the human body is composed of different systems, which are collections of cells, tissues, and organs, each of which has a special job that keeps you alive. Whether you eat, play, dance, sing, or sleep; each part of your organ systems performs particular functions. You also discovered how the digestive system breaks down food to nourish your whole body.

Now, you will learn how the different structures of the circulatory and respiratory systems work together to transport oxygen-rich blood and nutrients to the different parts of the body. You will, also understand the prevention, detection, and treatment of diseases affecting the respiratory and circulatory systems.

At the end of this module, you are expected to:

1. explain the mechanism on how the respiratory and circulatory systems work together to transport nutrients, gases, and molecules to and from the different parts of the body;
2. infer how one's lifestyle can affect the functioning of respiratory and circulatory systems.

Respiratory system is made up of the organs in the body that help us to breathe. Just remember that the word **respiration** is linked to breathing. **Circulatory system** is responsible for distributing materials throughout the body. Take note that **circulation** means transportation or movement in circles. Both systems are essentially meant for each other. The common purpose could not be attained without the other system.

In Module 1, you will be able to answer the following key questions:

- How do the respiratory and circulatory systems work with each other?
- How do the diseases in the circulatory and respiratory systems begin to develop?
- How can a person's lifestyle affect the performance of the respiratory and circulatory systems?

Pre-assessment

Direction: Fill in the K-W-H-L Chart below to assess your prior knowledge and understanding of the topic, **Respiratory and Circulatory Systems, Working with the other Organ Systems.**

K	W	H	L
What do I know?	**What do I want to find out?**	**How can I find out what I want to learn?**	**What did I learn?**
Skills I expect to use:			

The Human Breathing System

Breathe in and out. Notice your chest and belly moving and feel the soft air passing from the nose. Listen to the quiet sounds of breathing in and out. Imagine the air moving from the nose into the throat, through the air tubes, and into the airsacs. The parts of the respiratory system that are in charge of supplying oxygen are the nose, nasal passageways, windpipe, lungs, and diaphragm. In the nose and nasal passages, the entering air is made warm, damp, and clean of unknown particles. Next, the air moves down through the trachea, bronchi, bronchioles, and alveoli. **Trachea** is the empty tube that serves as passageway of air into the lungs. **Bronchi** are the two branching tubes that connect the trachea to the lungs. **Bronchioles** are the hairlike tubes that connect to the alveoli. **Alveoli** are the airsacs that allow gas exchange in the lungs.

Perform the following simple activity to widen your understanding of the human breathing system.

Activity 1

PART A

What a Bunch of Grapes!

Objective:

- Identify the key parts of the breathing system

Materials:

Bunch of grapes
(or any other bunch of fruits or vegetables such as *arosep* or *lato* (seaweed), *lanzones*, cauliflower, etc.)

Procedure:

1. Hold up the bunch of grapes. Let the bunch of grapes represent the breathing system.
2. Within your group, locate the parts of the breathing system: the main stem as the **trachea**, the large branching stems as the **bronchi**, and all the little stems as the **bronchioles**. The individual grapes are the airsacs or **alveoli**.
3. One by one, gently take out some of the grapes to expose more of the branching stems (bronchioles). Observe its structure.
4. Trace the pathway of oxygen using the "Bunch of Grapes" model. Note that air moves from the nose (nasal cavity) and mouth (oral cavity) to the trachea, bronchi, bronchioles, and then into the alveoli (air sacs). The air we breathe carries the gas *oxygen*. When we breathe, the oxygen goes to the lungs.

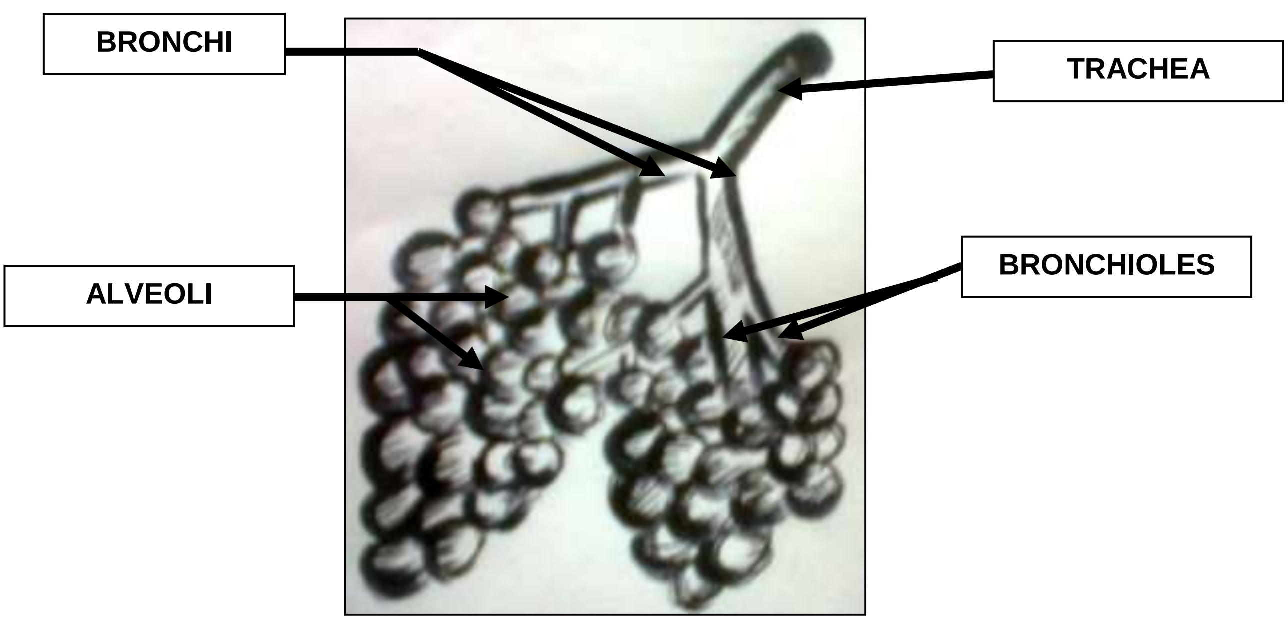


Figure 1. The bunch of grapes model of the breathing system

PART B

Objective:

- Describe the function of each part of the breathing system

Procedure:

1. Refer to the diagram, and check your understanding of the breathing system by labeling each part and giving its functions in the box corresponding to the part.

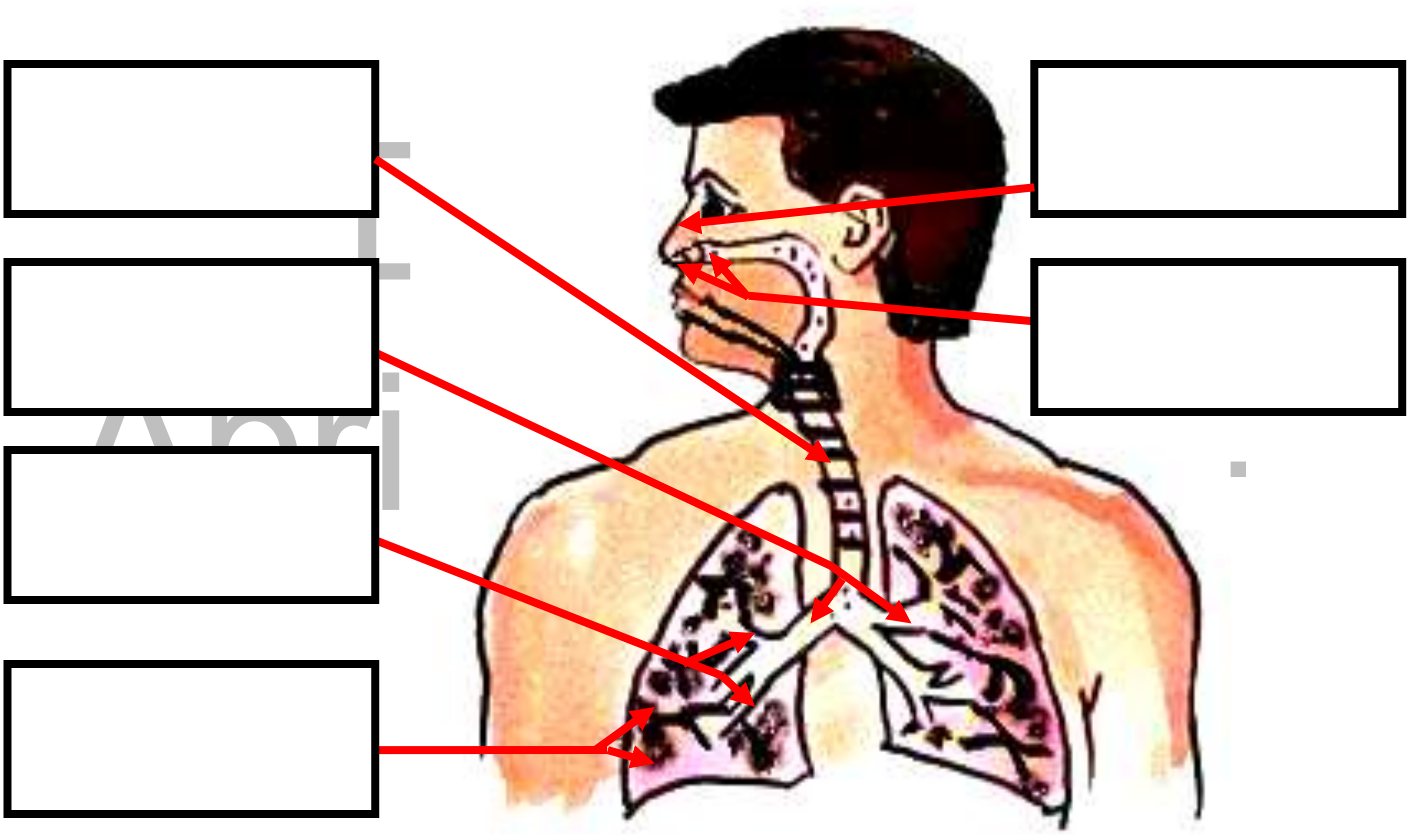


Figure 2. The human respiratory system

Guide Questions:

Q1. What does each part of the "Bunch of Grapes" model represent, in relation to the breathing system?

Q2. How will you describe the pathway of oxygen in the breathing system?

Q3. What will happen if one part of the system fails to carry out its function properly?

KEY CONCEPTS

The air we breathe goes through the nose, nasal passages, and then through the **trachea** or windpipe, which separates into two branches, called bronchial tubes or **bronchi**, one entering each lung. The bronchi subdivide many times inside the lungs, analogous to the branching pattern of grapes, finally becoming hairlike tubes called **bronchioles**. In the last part of the terminal bronchioles are tiny bubble-like bunch of structures called **alveoli or airsacs.**

Previously, you have already learned about the essential parts of the breathing system and their functions. Now, you will understand the mechanism and activities of the lungs and the diaphragm.

Have you experienced being in a jam-packed train? You almost certainly could not wait to get out where there are fewer people so you could freely move. This is analogous to the process that makes air move in and out of your lungs. The air molecules are either crowded outside and tend to get into the lungs where there are fewer air molecules (inhalation), or they tend to get outside because they are too crowded inside the lungs (exhalation). When you breathe in, your diaphragm muscle contracts downward and rib muscles pull upward causing air to fill up the lungs. Can you explain why? Well, when your diaphragm goes lower and ribs shift up, they provide more breathing space in your chest. This also reduces the force on your lungs so the air will move in from the outside. Breathing out is a reverse process. Your diaphragm loosens up and the ribs and lungs thrust in, causing the gas to be exhaled.

Activity 2

Bottled Balloons

Objectives:

- Explain how the lungs work
- Describe how the movement of the diaphragm helps the air go in and out of the lungs

Materials:

1 two-liter empty plastic bottle
1 sturdy straw
1 pair of scissors
3 balloons (1 big, 2 small)
5 rubber bands

Procedure:

1. Using a pair of scissors, cut the bottom out of the 2-liter plastic bottle.
2. Create two holes that are apart from each other in the cap of the plastic bottle. Make sure that each hole is just big enough for a straw to fit through.
3. Stick the two straws through the two holes of the bottle cap.
4. Place one balloon on the end of each straw, and secure them with rubber bands, as shown in the figure below.

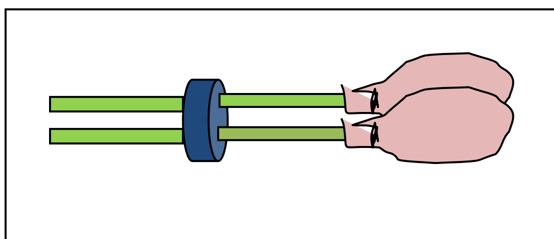


Figure 3. The two straws with the balloons are inserted into the plastic bottle cap.

5. Stick the balloon ends of the straws through the bottle opening and screw the lid on tightly.
6. Stretch out the larger balloon and place it over the open bottom of the bottle. Secure it with the rubber band as tightly as possible. Refer to the diagram of the finished lung model below.

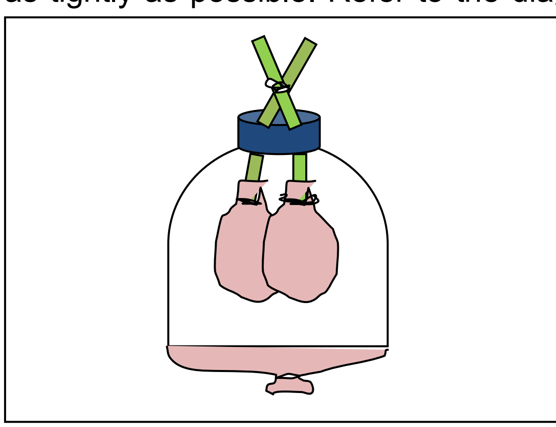


Figure 4. A constructed model of the human chest cavity

5. Pull the larger balloon down; that is, away from the bottle, in order to blow up the two small balloons.
6. Push the larger balloon towards the bottle in order to let the air out of the two small balloons.
7. Write down your observations.

Guide Questions:

Q4. What does each part of the constructed lung model represent?

Q5. What happens as you pull down the balloon at the bottom of the model?

Q6. What happens as you push up the balloon?

Q7. How does the movement of the diaphragm cause the air to go in and out of the lungs?

Q8. What might happen if you prick the balloon?

KEY CONCEPTS

When you breathe in, or **inhale**, the diaphragm muscle contracts. Inhaling moves the diaphragm down and expands the chest cavity. Simultaneously, the ribs move up and increase the size of the chest cavity. There is now more space and less air pressure inside the lungs. Air pushes in from the outside where there is a higher air pressure. It pushes into the lungs where there is a lower air pressure. When you breathe out, or **exhale**, the diaphragm muscle relaxes. The diaphragm and ribs return to their original place. The chest cavity returns to its original size. There is now less space and greater air pressure inside the lungs. It pushes the air outside where there is lower air pressure.

Why do we believe that life is possible only on planets where oxygen is present? Oxygen is necessary for life to exist. Without it, the cells in the body would not be able to release the energy in food for power, and they would die within minutes. When you inhale air, your respiratory system gets oxygen. When you exhale, carbon dioxide is released. How do the respiratory and circulatory systems work together to carry out their common purpose?

Perform the next activity to learn more about the gas exchange that takes place in the respiratory and circulatory systems.

Activity 3

Just Go with the Flow!

Objectives:

- Describe blood flow and gas exchange within the heart, circulatory system, and lungs
- Explain the mechanism of how the respiratory and circulatory systems work together

Materials:

Paper strips
Marking pen
Rope or ribbon
Chalk

Source:

Glencoe/McGraw-Hill - http://www.glencoe.com/sites/common_assets/health_fitness/gln_health_fitness_zone/pdf/heart_rate_monitor_activities/the_heart/the_heart_activity_2.pdf

Procedure:

1. Perform the activity with your group mates (7-8 persons).

2. Assign and label different areas in the outdoor setting as: **lungs**, **left atrium, left ventricle, arteries, capillary, veins, right ventricle, and right atrium**.

3. Using the marking pen, write down the word *oxygen* on as many paper strips as you can and place them in the lung area. The capillary area should have papers with *carbon dioxide* written on them.

4. Use the chalk to mark and define the different areas such as what is given in the diagram below. Assign some members of your group to stand still on the different marked areas.

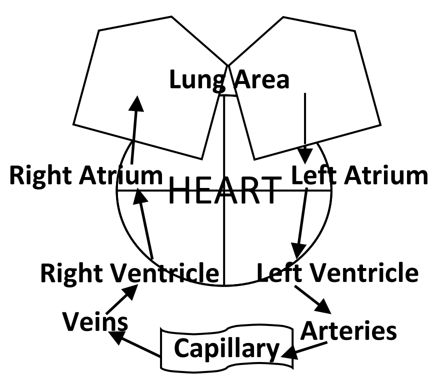


Figure 5. Illustration of the gas exchange activity

5. Choose two members from the group to take the trip around the different posts. Let the partners start the tour in the lung area and together pick up a paper labeled as oxygen from another member standing at his post. They should carry the strip of paper to the heart, passing through the left atrium, and then to the left ventricle. As the partners go to every station, they must leave a trail of rope or ribbon held by another member in a designated area, until the path of the journey is completely traced.

6. Partners must run along the chalk marks representing the arteries into the capillary area.

7. Tell the partners to exchange the strip of paper representing oxygen for a piece of paper representing carbon dioxide with a member in his designated area.

8. Make the partners run along the chalk marks representing the veins into the heart area, first to the right ventricle, then to the right atrium.

9. The partners must then run back into the lung area where the process begins again. When there are no more strips of paper, the activity is over. The leader may want to keep placing new papers into designated areas to keep the game going on longer.

10. After the activity, record your observations and answer the guide questions.

Guide Questions:

Q9. How do the heart and the lungs work together?

____

Q10. What takes place when you inhale and exhale?

____

Q11. What does blood deliver to every part of the body?

____

Q12. Why is oxygen important to your body?

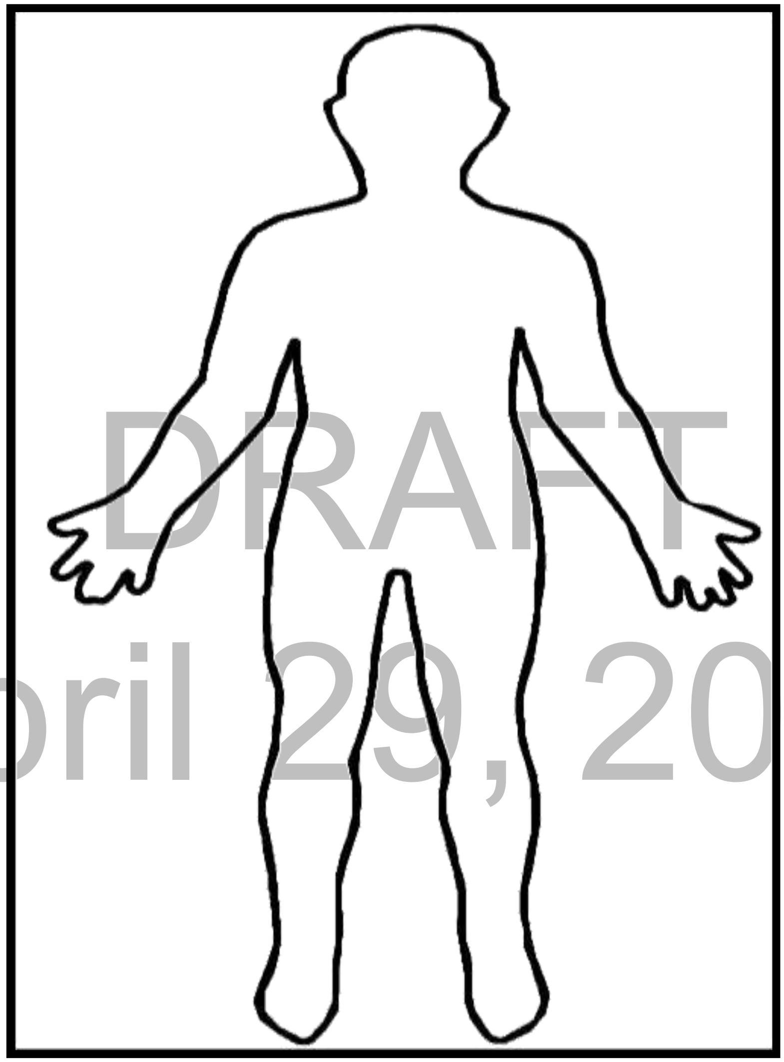
____

Q13. How will you describe the sequence of oxygen, carbon dioxide, and blood flow in your own words?

____

ENRICHMENT ACTIVITY

In the given framework of the human body below, illustrate the blood flow and gas exchange in the respiratory and circulatory systems using diagrams and arrows. Color your work to show the distinction of oxygen and carbon dioxide carried in the blood.



KEY CONCEPTS

Air first enters your lungs and then into the left part of your heart. It is then driven by your heart into the bloodstream, all the way through your body. The heart pumps blood, which transports essential nutrients, oxygen, and other chemicals to every cell in your body. Once it reaches the cells, oxygen processes the nutrients to release energy. Carbon dioxide is given off during this process. The blood delivers carbon dioxide into the right portion of your heart, from which it is pumped to the lungs. Carbon dioxide leaves your body through the lungs when you exhale.

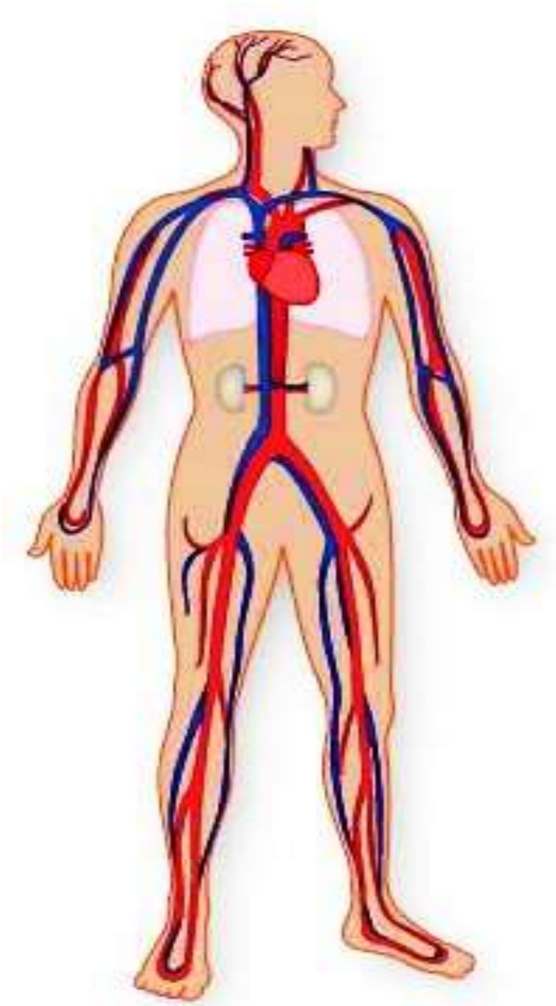


Figure 6. The human circulatory system

The **circulatory system** is the life support structure that nourishes your cells with nutrients from the food you eat and oxygen from the air you breathe. It can be compared to a complex arrangement of highways, avenues and lanes connecting all the cells together into a neighborhood. Sequentially, the community of cells sustains the body to stay alive. Another name for the circulatory system is the cardiovascular system.

The circulatory system functions with other body systems to deliver different materials in the body. It circulates vital elements such as oxygen and nutrients. At the same time, it also transports wastes away from the body.

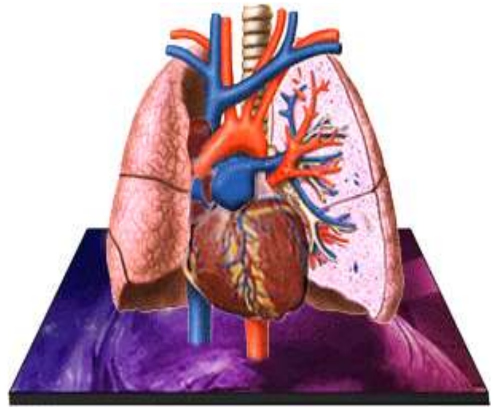
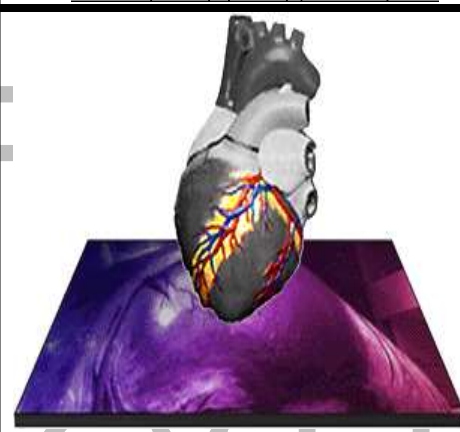
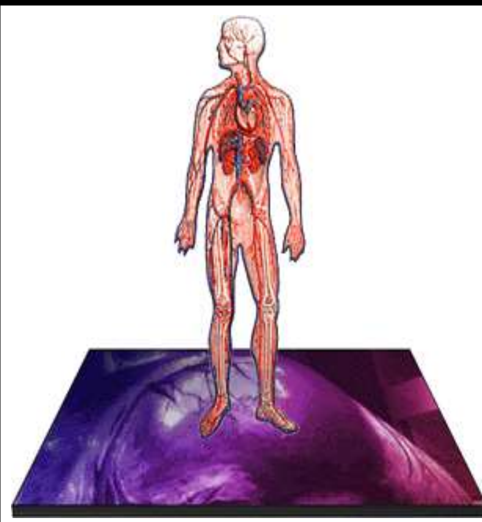
The following are the three major **parts of the circulatory system**, with their roles:

1. **Heart** – <u>pumps the blood</u> throughout the body

2. **Blood vessel** – <u>carries the blood</u> throughout the body
   - Arteries - carry oxygenated blood away from the heart to the cells, tissues and organs of the body
   - Veins - carry deoxygenated blood to the heart
   - Capillaries - the smallest blood vessels in the body, connecting the smallest arteries to the smallest veins
     - the actual site where gases and nutrients are exchanged

3. **Blood** – <u>carries the materials</u> throughout the body

CIRCULATION

TYPE OF CIRCULATION	DESCRIPTION	DIAGRAM
1. Pulmonary Circulation	Movement of blood from the heart, to the lungs, and back to the heart	 sln.fi.edu/biosci/systems/ pulmonary.html
2. Coronary Circulation	Movement of blood through the tissues of the heart	 sln.fi.edu/biosci/systems/ pulmonary.html
3. Systemic Circulation	Movement of blood from the heart to the rest of the body, excluding the lungs	 sln.fi.edu/biosci/systems/ pulmonary.html

Activity 4

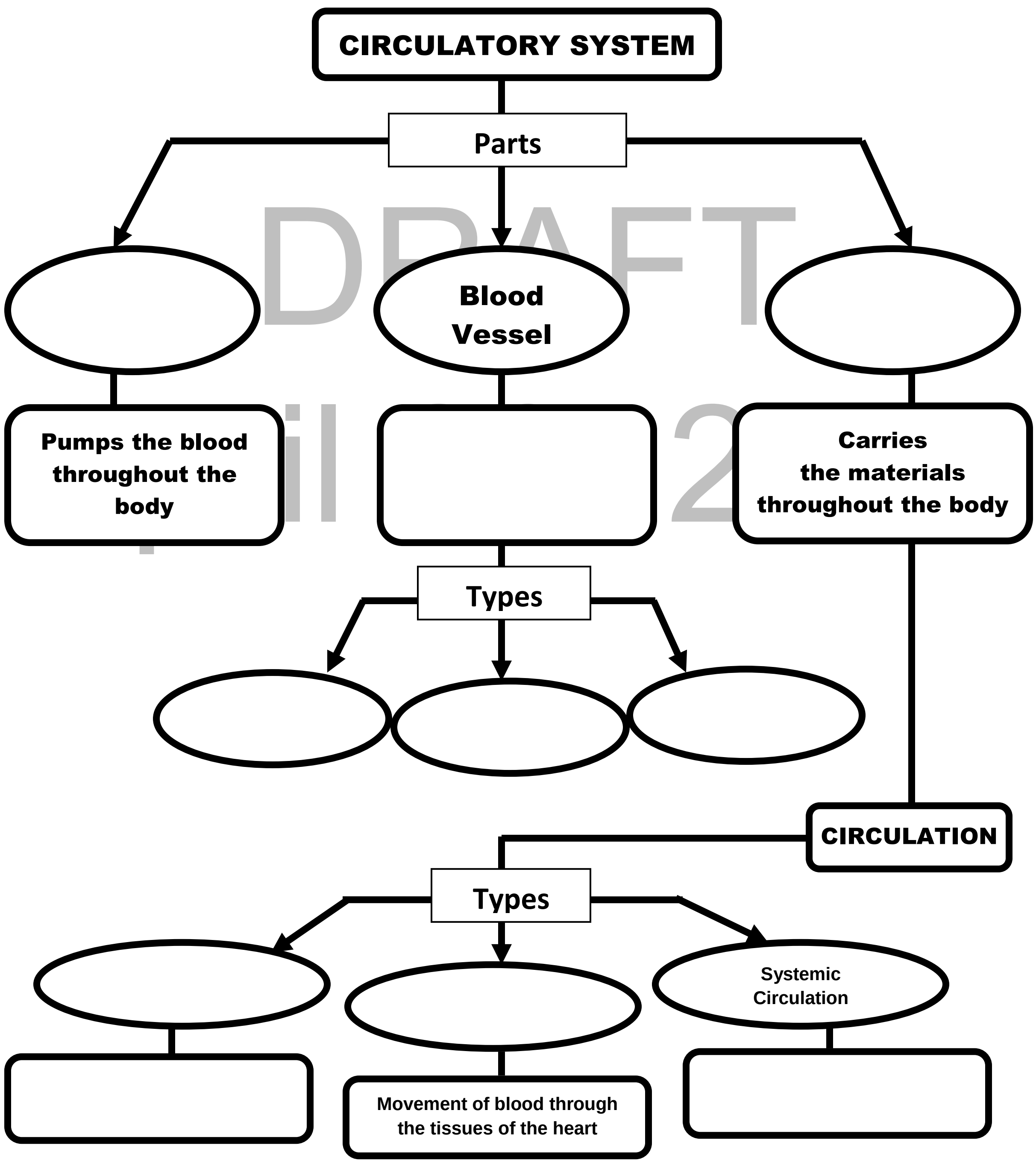
Let's Organize!

Objectives:

- Identify the components of the circulatory system
- Explain the different types of circulation

Procedure:

Using the given graphic organizer, fill in the missing parts, description, and functions to complete the entire concept.



The Human Heart

Do you know how big your heart is? Take a look at your fist. The heart is a hollow muscle, as seen in Figure 7, which is just as big as your fist. It has **four chambers** with specific tasks to do: two ventricles and two atria. The atria are the receiving chambers of the heart, accepting blood from the body (**right atrium**) and from the lungs (**left atrium**). The ventricles are the pumping chambers, moving blood to the lungs (**right ventricle**) and into the body (**left ventricle**).

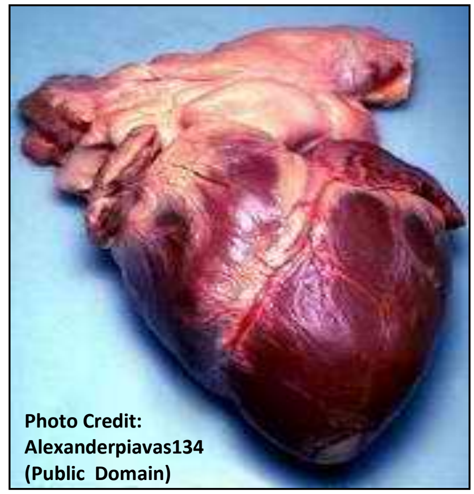


Figure 7. Photo of an actual human heart

The heart has two pumps. Each pump has two chambers, the upper and lower chambers. The upper chamber is the atrium that receives blood coming in from the veins. The lower chamber is the ventricle that forces the blood out into the arteries. There is a **valve** between each atrium and ventricle to prevent the blood from flowing backwards. The valves are like one-way doors that keep the blood moving in only one direction. Valves control movement of blood into the heart chambers and out to the aorta and the pulmonary artery. Refer to Figure 8.

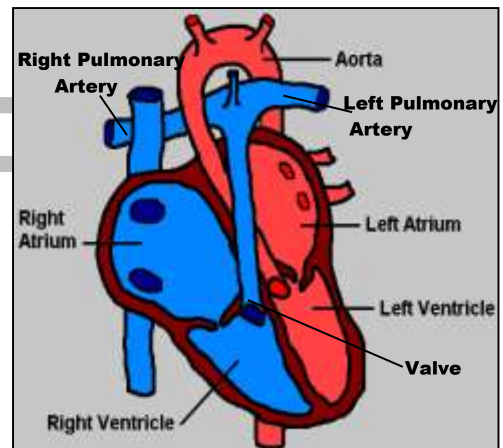


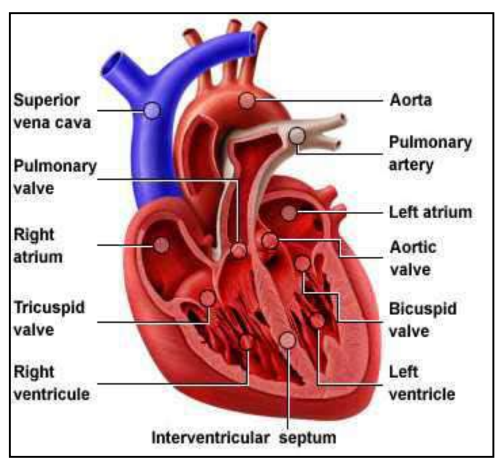
Figure 8. The major divisions of the heart

Q14. Explain how the heart works.

Q15. Evaluate how the heart can be compared to a mechanical pump.

All of the muscle tissues of the heart do not contract at the same time. Different parts of the heart contract at different times. When the top portion contracts, the bottom part relaxes. When the bottom contracts, the top relaxes. When a chamber contracts, it becomes smaller and the blood inside gets squeezed or pumped out.

To have a better understanding of how your heart works, do the next simple activity.



Source: sln.fi.edu/biosci/systems/ pulmonary.html

Figure 9. The detailed parts of the heart

Activity 5

Pump It!

Objectives:

- Describe how the heart functions
- Explain how blood is pumped by the heart

Materials:

1 beaker or wide mouthed jar
1 balloon
2 flexible drinking straws
1 pair of scissors
1 large pan or sink
adhesive tape
water

Source:

Home Science Tools -
http://www.hometrainingtools.com/make-a-heart-pump-science-project/a/1852/

Procedure:

1. Fill the jar half full of water.
2. Cut the neck of the balloon off at the part where it starts to widen into a balloon. Set the neck part aside to be used later on.
3. Stretch the balloon over the opening of the jar, pulling it down as tightly as you can. The flatter you can get the surface of the balloon, the better.
4. Carefully poke two holes in the surface of the balloon. Make them about an inch apart from each other and near opposite edges of the jar.
5. Stick the long part of a straw into each hole. The straws should fit securely in the holes so no air can get through around the straws.
6. Slide the uncut end of the balloon neck onto one of the straws and tape it around the straw.
7. Set your pump in a large pan or the sink to catch the pumped water. Bend the straws downward. Gently press in the center of the stretched balloon and watch what happens to the water in the jar.
8. Refer to the photo below to know what your setup must look like.

Source: http://www.hometrainingtools.com/make-a-heart-pump-science-project/a/1852/

Figure 10. The heart pump model

Guide Questions:

Q16. What does the water inside the jar represent?

Q17. How will you compare the heart pump model and the human heart?

Q18. How does the heart function as a pump?

Q19. Will the heart model be able to function properly if the straw is blocked? Explain your answer.

KEY CONCEPTS

The **heart** is a hollow muscular organ, about the size of your fist, which is located in the center of your chest between the lungs. It is a double pump that pumps on the left and right sides. Every side is divided into two chambers, the **atrium** and the **ventricle**, each of which has left and right portion, totaling to four chambers altogether. The top chamber is the atrium (plural: atria). The bottom chamber is called the ventricle. The **valve** acts as a one-way door, allowing blood to flow either forward into the next chamber, or out of the heart.

Since you have already understood how the heart functions and how blood is pumped all over the body, you are now ready to check your own heart rate. Your heart beat is the sound that your heart makes as it pumps blood. Let us further investigate about it in the next activity.

Activity 6

The Rhythm of My Heart

Objectives:

- Measure and describe your pulse (heart rate) after several different activities
- Explain how to use different time intervals to measure your heart rate

Materials:

Stopwatch / timer
Data Logbook

Procedure:

1. Sit quietly for a few minutes before beginning the activity.
2. When you are ready, place your first two fingers either on your neck or on the inside of your wrist and locate your pulse.
3. Once you find your pulse, start the watch, and for 60 seconds, count the number of beats you feel. That is your pulse.
4. Try the experiment again, but this time count for only 30 seconds. When you are done, multiply your count by two. Compare your pulses.
5. Repeat by counting for 15 seconds and multiplying your count by four, then counting for 10 seconds and multiplying by six, and so on.
6. Once you have determined your resting pulse, go to a place where you can exercise vigorously for at least one minute. Exercise of this sort might include a fast jog, running stairs, skipping rope, or doing pushups. When you are done, you should be breathing hard.

TAKE CARE! **If you know that you have a serious medical condition, do not perform this activity.**

7. Choose the length of the test you wish to perform and find your pulse again.
8. Compare your resting pulse with your pulse after exercise.
9. After the activity, record your observations and answer the guide questions.

Guide Questions:

Q20. What was your calculated resting pulse?

____

Q21. What was your pulse after exercising?

____

Q22. How would you differentiate your heart rates before and after exercising?

____

Q23. What is the advantage of timing for a full minute to find your pulse?

____

Q24. What is the advantage of timing over a shorter period of time, especially when you have just finished exercising?

___

Q25. According to statistics, the maximum heart rate should be 220 minus a person's age. How would you interpret your highest heart rate in relation to that given number?

___

KEY CONCEPTS

Each time your heart beats, it delivers oxygen-rich blood to your body, which allows it to function properly. Your **heart rate** or pulse is the number of times your heart beats in a minute (BPM or beats per minute). Shorter time intervals may be used in taking the pulse as long as it comes to 60 seconds upon multiplying with a factor. When you are resting, your heart rate slows down, as your body does not need as much blood as it does when you exercise.

Now that you are aware that strenuous activities may lead to an increased heart rate, you can now monitor your activities to avoid the dangers of cardio-respiratory diseases. Another risk factor that drastically increases heart rate and decreases the amount of oxygen in the blood is smoking cigarettes. Perform the next simple activity to learn more about the negative effects of cigarettes on a person's circulatory and respiratory systems.

Activity 7

Cigarette Smoking Is Dangerous to Your Health

Objective:

- Explain the negative effects of cigarette smoking on the circulatory and respiratory systems

Materials:

meta cards
marking pen
adhesive tape

Procedure:

1. Look at the picture of the smoker's body below, and take note of the illnesses that might develop due to cigarette smoking.

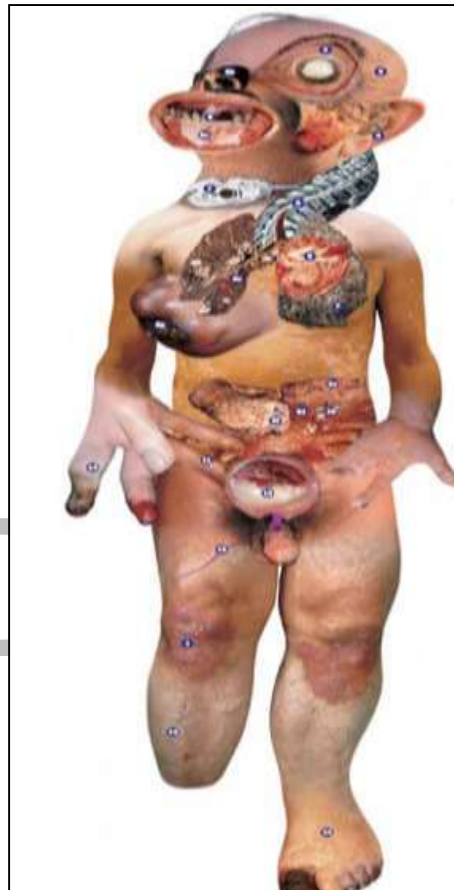


Photo Credit: http://www.clarkisit.com/smoking-kills/

Figure 11. The smoker's body

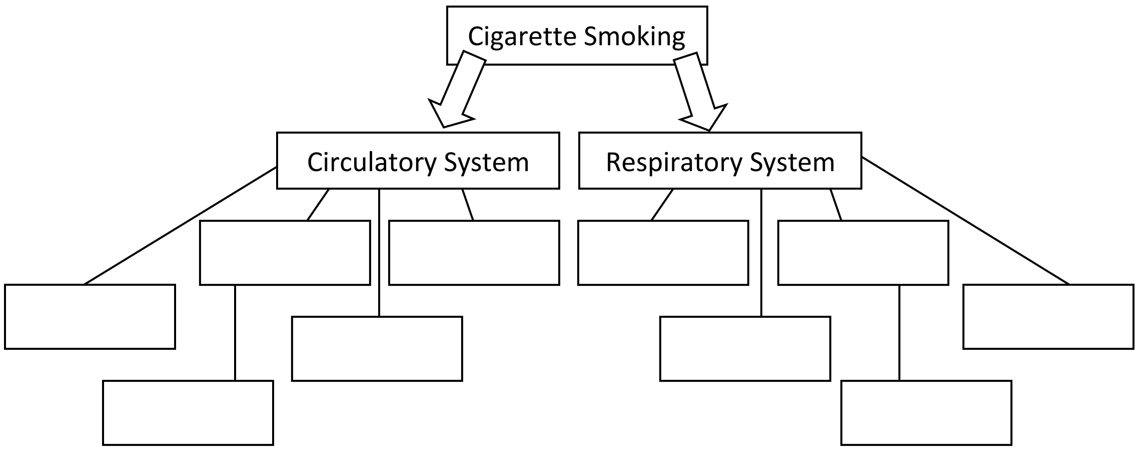
2. Within your group, brainstorm ideas about the effects of cigarette smoking on a person's respiratory and circulatory systems using the meta plan strategy.

3. Choose a group member who will act as moderator to solicit all the ideas of the members about the negative effects of cigarette smoking on the circulatory and respiratory systems.

4. Each participant must give at least three negative effects of cigarette smoking on both circulatory and respiratory systems. Answers must be written on the blank cards.

5. The moderator collects the meta cards and reads each one of them while showing the cards to the whole group so that everyone can read them.

6. After discussing the ideas within the group, stick and organize all the responses on the blackboard to categorize which answer falls under the respiratory and circulatory systems. Refer to the example given below.



7. Group the cards with identical or similar statements together into clusters, allowing multiple statements to emerge clearly.

8. Choose a representative to explain the work of the group.

KEY CONCEPTS

Cigarette smoking harms nearly every organ in the body, causing many illnesses and affecting health in general. The negative effects of smoking on circulatory system include increased heart rate and blood pressure, coronary heart disease, arteriosclerosis, and vascular diseases. The respiratory diseases caused by smoking are chronic bronchitis, emphysema, asthma, cough, colds, tuberculosis, lung cancer, and other respiratory infections.

Enrichment Activity

Gather and write down information about the different diseases affecting the respiratory and circulatory systems, and their common causes.

The leading causes of death around the world are diseases affecting the respiratory and circulatory systems. However, they can be prevented simply by having a lifestyle that promotes wellness. Circulatory and respiratory diseases begin to develop with unhealthy living. Symptoms of these illnesses must not be neglected and appropriate cure must be given immediately. Carry out the next task to further broaden your learning.

Activity 8

Prevention Is Better Than Cure

Objective:

- Identify ways of detecting and preventing diseases in the respiratory and circulatory systems
- Appreciate the importance of a healthy lifestyle in avoiding such diseases

Procedure:

1. With your groupmates, create a story that illustrates various ways of preventing diseases that affect the respiratory and circulatory systems. You must also show the importance of keeping our bodies healthy and free from illnesses.

2. Present the story that you made in front of the class by means of role-playing.

3. Consider the following criteria to serve as your guide in completing the given task.

STORY-MAKING AND ROLE PLAYING CRITERIA

CRITERIA	Percentage
Preparation	15%
Achievement of Objective	35%
Imagination and Creativity	30%
Presentation	20%
TOTAL	**100%**

KEY CONCEPTS

The best way to prevent diseases in the respiratory and circulatory systems is to have a healthy lifestyle, which includes balanced diet, regular exercise, adequate rest, proper hygiene, and avoiding vices such as cigarette smoking and alcohol drinking. Circulatory and respiratory disease can easily be detected with regular health check-up and physical screening.

The following activity that you will perform is a variation of a famous application game, known as “Four Pics – One Word.” Use your analytical thinking in answering each set of puzzles.

Activity 9

What’s the Word?

Objective:

- Infer how one’s lifestyle can affect the functioning of the respiratory and circulatory systems

Procedure:

All four pictures in each given set depict negative ways of living. They are connected by one common word that indicates the effect of one’s lifestyle on the functioning of the respiratory and circulatory systems. The expected answers are illnesses that are brought about by the negative lifestyles. Write your answers in the box provided for each number.

1.

What’s the word?

A _ _ _ _ A

2.

What's the word?

H_ _ _ _ _ _ _ _ _ _ _ N

3.

What's the word?

A_ _ _ _ A

Guide Questions:

Q26. What idea is common in each set of pictures?

Q27. What are the negative lifestyles that are depicted in the pictures?

Q28. How can lifestyle affect the functioning of the respiratory and circulatory systems?

Q29. How can these negative lifestyles be changed?

Q30. What might happen if a person goes on with a negative lifestyle such as what was seen in the activity?

ENRICHMENT ACTIVITY

1. Compose a short poem about how one's lifestyle can affect the functioning of the respiratory and circulatory systems, and recite it in front of the class.

2. Cut out different examples of unhealthy lifestyles from old magazines or newspapers, and create a collage out of the cut-outs on your notebook or journal.

KEY CONCEPTS

Several lifestyle choices can affect a person's risk for developing respiratory and circulatory diseases. Negative lifestyle weakens your system while healthy lifestyle leads to complete wellness. Vices, stressful environments, and unhealthy eating habits can cause various diseases, specifically of the respiratory and circulatory systems.

Performance Task: Information Dissemination Activity

Goal: Your objective is to present helpful information to the public about effective ways of taking care of the respiratory and circulatory systems based on gathered data. The challenge is how you will be able to lead the people to take action rather than merely accepting the presented information. There are obstacles to overcome such as the reluctance and preconceived notion of people against changing their lifestyle to promote health.

Role: Suppose you work for an advertising company as a graphic artist and your job is to create public informational materials. You are asked to disseminate information to the public regarding a lifestyle that ensures healthy condition of the respiratory and circulatory systems.

Audience: Your target individuals to receive the information that you will provide are the people in your school community including all students, teachers, and school officials. Parents and other persons who visit your school might also see your work. Therefore, it is important that you convince them to consider the ways of taking care of their bodies, specifically the circulatory and respiratory systems.

Situation: Upon gathering information from the school or local health workers, you have found out that poor lifestyle affects the performance of the respiratory and circulatory systems. Many people are unaware of this, so they simply continue with their busy lifestyles, neglecting their health, and exploiting their bodies. The challenge involves dealing with this by creating a poster that will stir up the people’s consciousness in having a healthy lifestyle.

Product: Design a wall poster or placard that will make members of your audience aware of how they can effectively take care of their respiratory and circulatory systems. You may use any medium for your artwork.

Standards: You will be given three (3) days to conceptualize and execute your ideas through poster-making. Once the product is finished, post it in a conspicuous place such as the canteen where everyone can see it.

Your output will be assessed in accordance with the following rubric.

Poster Making: Information Dissemination on How to Take Care of the Respiratory and Circulatory Systems

RUBRIC

CATEGORY	4	3	2	1
Presentation	The poster clearly communicates the main idea and strongly promotes awareness	The poster communicates some of the important ideas and slightly promotes awareness	The poster indirectly communicates the idea and hardly promotes awareness	The poster does not sufficiently communicate any idea that can promote awareness
Creativity and Originality	All of the graphics used on the poster reflect an exceptional degree of student ingenuity in their creation.	Most of the graphics used on the poster reflect student ingenuity in their creation.	The graphics were made by the student but were copied from the designs or ideas of others.	The graphics were not made by the student.
Accuracy and Relevance of the Content	All graphics in the poster are accurate and related to the topic.	Most graphics in the poster are accurate and related to the topic.	Some graphics in the poster are accurate and related to the topic.	The graphics in the poster are neither accurate nor related to the topic.
Required Elements	The poster includes all required elements as well as additional information.	All required elements are included.	Few required elements are included.	Required elements are missing.

Summary

- Air enters the body through the nose, nasal passages, and then through windpipe or **trachea**, which divides into two branches, called bronchial tubes or **bronchi**. The bronchi subdivide many times inside the lungs, forming hairlike tubes called **bronchioles**. At the end of the bronchioles are tiny bubble-like structures called **alveoli.**

- When you breathe in or **inhale**, the **diaphragm muscle contracts**. When you breathe out, or **exhale**, the **diaphragm muscle relaxes**. The diaphragm helps the air go in and out of the lungs.

- Air first enters your lungs and then into the left part of your heart. It is then pumped by your heart into the bloodstream, all the way through your body. Once it reaches the cells, **oxygen** processes the nutrients to release energy. **Carbon dioxide** is the waste material given off during this process. The blood delivers carbon dioxide into the right portion of your heart, from which it is pumped to the lungs. Carbon dioxide leaves your body through the lungs when you exhale.

- The **heart** is a hollow muscular organ, about the size of your fist, which is located in the center of your chest between the lungs. It is a double pump that pumps on the left and right sides. Each side is divided across into two chambers. The top chamber is called the **atrium**. The bottom chamber is called the **ventricle**. The **valve** acts as one-way door, allowing blood to flow either forward into the next chamber, or out of the heart.

- **Heart rate** or pulse is the number of times your heart beats in a minute (BPM or beats per minute). When you are resting, your heart rate slows down, as your body does not need as much oxygen as it does when you exercise.

- Cigarette smoking harms nearly every organ in the body, causing many illnesses and affecting health in general. The negative effects of smoking on the circulatory system include increased heart rate and blood pressure, coronary heart disease, arteriosclerosis, and vascular diseases. The respiratory diseases caused by smoking are chronic bronchitis, emphysema, asthma, cough, colds, tuberculosis, lung cancer, and other respiratory infections.

- The best way to prevent diseases in the respiratory and circulatory systems is to have a healthy lifestyle, which includes balanced diet, regular exercise, adequate rest, proper hygiene, and avoiding vices such as cigarette smoking and alcohol drinking. Circulatory and respiratory disease can easily be detected with regular health check-up and physical screening.

Summative Assessment

Answer the following questions briefly.

1. The nutrients obtained from the food during digestion are supplied by the circulatory system to the body. What does the circulatory system distribute to the body as it works with the respiratory system?
   ____

2. If solid and liquid wastes are removed from the body through defecation and urination, what is released by the body as waste during respiration?
   ____

3. What happens to the diaphragm when a person breathes in or inhales?
   ____

4. Why is the human heart called a double pump?
   ____

5. What will happen if oxygen is not transported by the blood to the different parts of the body?
   ____

6. Since the valves act as the doors of the heart, what might happen if these doors do not close?
   ____

7. When we breathe in, we inhale many gases present in the air, including oxygen. What do you think happens to the gases that are not needed by the body?
   ____

8. You always hear and see the statement, “Government Warning: Cigarette smoking is dangerous to your health.” How does cigarette smoking increase the risk of developing cardiovascular diseases?
   ____

9. How does singing from the diaphragm, instead of the throat, help improve the voice quality of a singer?
   ____

10. An old woman joined a kilometer-dash sprint and felt very exhausted afterwards. How did the old woman’s activity affect her heart rate?
    ____

Glossary of Terms

- **Arteriosclerosis** – a condition in which there is thickening and hardening of the arteries

- **Atrium** – the upper chamber of the heart that receives blood coming in from the veins

- **Chamber** – the empty space of the heart where blood is contained

- **Chest Cavity** – a hollow space in the body enclosed by the ribs between the diaphragm and the neck and containing the lungs and heart

- **Chronic Disease** – any illness that is prolonged in duration, does not often resolve suddenly, and is rarely treated completely

- **Coronary** – relating to, or affecting the heart

- **Diaphragm** – a large flat muscle that separates the lungs from the stomach area and that is used in breathing

- **Emphysema** – a type of pulmonary disease involving damage to the airsacs

- **Pulmonary** – relating to, or affecting the lungs

- **Pulse** – the number of times the heart beats per minute

- **Vascular** – relating to the blood vessels, which includes the arteries, capillaries, and veins

- **Ventricle** – the lower chamber of the heart that squeezes blood out into the arteries

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BEAM: Biology – Organ System – Circulatory System

EASE Biology M11 Energy Producing & Distributing Systems, Lessons 2 & 3

APEX Biology – Unit IV, The Organ Systems, Lessons 11 & 12

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UNIT 1 Module 2

Suggested Time Allotment: 8 to 10 hrs

Heredity: Inheritance and Variation

Overview

Non-Mendelian Patterns of Inheritance

In Grade 8, you learned that cells divide to produce new cells and meiosis is one of the processes producing genetic variations in Mendelian patterns of inheritance. In Grade 9, you will focus on describing the location of genes in chromosomes, explain the different patterns of non-Mendelian inheritance and describe the molecular structure of the DNA.

Gregor Mendel's principles form the base for the understanding of heredity and variation. Although Mendel's work failed to discuss thoroughly the 'factors' or genes he mentioned in his laws of inheritance, his findings prompted other scientists to probe further into the mystery of heredity. Several researches were conducted after the rediscovery of Mendel's work.

Walter Sutton and Theodore Boveri became popular because they found the best evidence that an inherited trait is determined by chromosomes. Chromosome Theory of Inheritance explained that genes are in the chromosomes.

Mendelian laws of inheritance have important exceptions to them. For example, not all genes show simple patterns of dominant and recessive alleles.

In this module, you are expected to:

1. Explain the different patterns of non-Mendelian inheritance
   a. Identify characters whose inheritance does not conform with predicted outcomes based on Mendel's laws of inheritance;
   b. Solve genetic problems related to incomplete dominance, codominance multiple alleles and sex-linked traits.
   c. Identify the law that was not strictly followed in the non-Mendelian inheritance
2. Describe the location of genes in chromosomes.
   a. Explain the chromosomal basis of inheritance.
   b. Identify the components of a DNA molecule

As you work on different activities in this module, you should be able to answer the following key questions:

- How is non-Mendelian inheritance different from Mendel's observations?
- What is the role of DNA in the transmission of traits?

Before you start with the module, be sure to answer the pre-assessment questions.

Pre-Assessment :

Answer briefly the following questions:

1. Pink four o'clock flowers are obtained from a cross between pure bred red flower plant and white flower plant. What is the genotype of the pink flowers?

   ____

2. The structure of the DNA is actually in a double helix arrangement. The nitrogen bases in each of the chain can only pair with specific bases, like adenine pairs only with thymine and cytosine pairs only with guanine. If the left chain of a DNA molecule has the nucleotide sequence CCGTAGGCC, what is the sequence of the right chain of the DNA molecule?____

3. Read the given problem.

In some aliens, one center horn (A) is codominant with two horns (B). If an alien inherits both alleles (AB), then the alien has three horns. A recessive allele (O) results in an alien which has no horns. Can you match the genotype to each of the pictures below? Write the genotype and phenotype of the four aliens in the box provided.

1.	2.	3.	4.

Source: (image) www.biologycorner.com

In the Mendelian patterns of inheritance, ***the effects of the recessive gene are not observed when the dominant gene is present.*** *In this lesson, you will find out that certain traits do not always follow the Mendelian principles of heredity.*

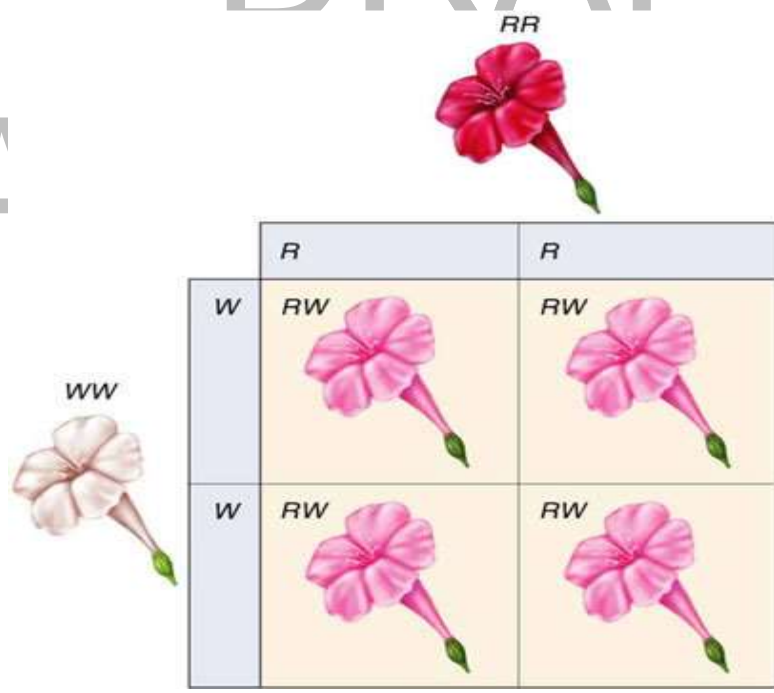
1. **Incomplete Dominance**

In **incomplete dominance,** a heterozygote shows a phenotype that is intermediate between the two homozygous phenotypes. Neither allele is dominant over the other.

An example of incomplete dominance is flower color in four o'clock plant, like those shown in Figure 1. When a pure red-flowered four o'clock plant is crossed with a pure white-flowered four o'clock plant, the offspring will produce neither red nor white flowers. Instead, all flowers will be pink.

- Do you think the alleles blended to make pink?

In incomplete dominance, it is only the phenotype that is intermediate. The red and white alleles remain separate and distinct. Half the gametes of the pink four o'clock carry the allele for red and half carry the allele for white. Therefore, the genotypic ratio also becomes the phenotypic ratio.



Source: buffonescience9.wikispaces

Figure 1. Punnett square showing a cross between red and white four o'clock flowers

Now, work on this activity to help you understand better incomplete dominance.

Activity 1 Phenotypes and Genotypes in Incomplete Dominance

Objectives:

- Explain incomplete dominance pattern of inheritance
- Illustrate by means of Punnett square a cross involving incomplete dominance pattern of inheritance.

Materials:

Activity sheets

Manila paper

Marking pen

Procedure:

1. Read the given problem:

> In four o'clock plants, R is the allele for red color and W is allele for white color. Two pink flowered four o'clock plants were crossed.

Show the possible outcome of the cross between two pink flowered four o'clock plants by using the Punnett square.

2. Now, another cross was made involving a red flowered four o'clock plant and a pink flowered four o'clock plant.
3. Using the Punnett square again, show the possible outcome.
4. Show your Punnett square for problems 1 and 2 using a Manila paper.
5. Present and discuss your answers.

Guide Questions:

Q1. How many types of gametes will each parent produce in problem no. 1?_________

In problem no. 2? ___________

Q2. What is the phenotype of a heterozygous four o'clock flower?__________

Q3. What are the possible phenotypes of the offspring from the cross of the parental plants in problem no. 1?_________________

In problem no. 2?_____________

Q4. What are the possible genotypes of the offspring from the cross of the parental plants in problem no. 1?_________________

In problem no. 2?_____________

Key Concepts

Incomplete dominance is a form of intermediate inheritance in which one **allele** for a specific trait is not completely dominant over the other allele. This results in a third **phenotype** in which the expressed physical trait is a combination of the dominant and recessive phenotypes.

Now, that you are familiar with incomplete dominance, let us find out what happens when one allele is not dominant over the other.

2. Codominance (adapted from Grade 8 Learner's module –since non-Mendelian is not included in the learning competency)

Another pattern of inheritance is codominance. This results when one allele is not dominant over the other. The resulting heterozygotes exhibit the traits of both parents. One example of codominance is the MN blood typing in humans. On the surface of our red blood cells are proteins bound to sugar molecules, forming complexes called antigens. One group of antigens are controlled by a pair of alleles, LM and LN. The pairing of these alleles will determine the blood type of an individual, and there are three: M, MN and N. Table 1 summarizes the genotypes and phenotypes of the MN blood typing in humans.

Table 1 Human MN blood types and their genotypes.

Blood Types	Genotype
M	$L^M L^M$
MN	$L^M L^N$
N	$L^N L^N$

Note that in the heterozygote condition, both LM and LN alleles are expressed in that the red blood cells will have the M and N antigens. Just like in incomplete dominance, the genotypic ratio in codominance also becomes the phenotypic ratio.

Another good example of codominance is roan fur in cattle as shown in Figure 2. Cattle can be red (RR = all red hairs), white (WW = all white hairs), or roan (RW = red & white hairs together).

Source: www.biologycorner.com

Figure 2 Codominance in cattle (Please include the colored picture of a roan cow to show the appearance of red and white hair together)

You will work on the activity that demonstrates codominance of traits.

Activity 2 Mystery Bull

Objectives:

- List the genotypes of the bull and cow in the given problem
- Diagram and complete a Punnett square
- Give phenotypic percentages of the offspring

Materials: (by group)

Marking pen
Manila paper

Procedure:

1. Read the given problem:

> *Mang Marcelino owns purebred red cows. In his farm he noticed that after a typhoon several months ago, all of the fences that separate his cattle from his neighbor's cattle were destroyed. During the time that the fences were down, three bulls, one from each neighbor, mingled with his cows. For awhile, he thought that none of the bulls found his cows, but over the months, he noticed that all of his cows are pregnant. He suspected that one of the bulls is the father. Which bull is it? Help Mang Marcelino look for the father by solving the given problem.*

Determine the possible traits of the calves if :

- *a red (RR) bull is mated with a red (RR) cow 1*
- *a red(RR) bull is mated with a white (WW) cow 2*
- *a roan(RW) is mated with a red(RR)cow 3*

2. Illustrate your answers using a Punnett square.
3. Write your answers on the Manila paper.
4. Present and discuss your answers.

Q5. Will you be able to trace the father of the calves?______________
What are the possible phenotypes of the calves for each cow?____

Q6. Do you think you will make Mang Marcelino happy about the result of your investigation? _________________________________

Q7. How are you going to explain it to him? ________________________

Q8. How would you apply what you have learned to improve the breeds of livestock in your area?
____

Q9. What possible suggestions can you give to animal breeders in your area?

Key Concepts

In **codominance,** both alleles are expressed equally in the phenotype of the heterozygote. For example, red cows crossed with white cows will have offspring that are roan cows. Roan refers to cows with red hair and white blotches.

*Many genes have multiple alleles. An example is **ABO blood type** in humans.*

1. Multiple Alleles (adapted from Grade 8 Learner's module –since non-Mendelian is not included in the learning competency)

Sometimes, even if only two alleles control a trait, there may actually be more than two types of alleles available. This will also lead to more than two phenotypes expressed. Another blood group system in humans, the ABO system, is an example of a character governed by multiple alleles. Three alleles are responsible for this blood system: I^A, I^B, and *i*. The ABO blood type is determined by the presence or absence of two antigens, A and B. Allele *i* does not code for an antigen. There are four possible blood types as shown in Table 2.

Table 2. Human ABO blood types and their phenotypes.

Blood Types	Genotypes
A	$I^A I^A$, $I^A i$
B	$I^B I^B$, $I^B i$
AB	$I^A I^B$
O	*ii*

The I^A and I^B alleles are dominant over the i allele, which is always recessive. However, when the I^A and I^B alleles are inherited together, both alleles are expressed equally. This also makes I^A and I^B codominants of each other.

- What is your blood type? Do you know your blood type? What are your parents' blood types?

Activity 3  What's your blood type?

Objective:

- Infer the unknown phenotypes of individuals on the basis of the known phenotypes of their family members

Materials:

- Paper
- Pencil

Procedure:

A. Given the blood types of the mother and the child, identify the possible blood type of the father.

Mother's Blood Type	Father's Blood Type	Child's Blood Type
A		A
B		AB
AB		B
O		O

B. Show the possible alleles that can be found in each offspring and write the blood type for each offspring.

		Possible alleles from Father		
		A	**B**	**O**
Possible alleles from Mother	**A**			
	B			
	O			

Use the table to answer the following questions, and list all possible blood types.

Q10. What blood type (or types) can be found in an offspring if a mother has type A blood and the father has type B blood?__________________________________

Q11. What blood type (or types) can be found in an offspring if a mother has type AB blood and the father has type B blood?__________________________________

Q12. What blood type (or types) can be found in an offspring if a mother has type O blood and the father has type B blood?________________________________

Key Concepts:

- In humans, there are four blood types (phenotypes): A, B, AB, O.
- Blood type is controlled by three alleles: A, B, O.
- O is recessive, two O alleles must be present for a person to have type O blood.
- A and B are codominant. If a person receives an A allele and a B allele, their blood type is type AB.

The inheritance of some characters does not strictly follow Mendel's Law of Independent Assortment. There are many traits that are inherited together more frequently. For example, the expression of certain traits depends on whether one is male or female. Apparently, the expression of the traits is determined by or related to one's sex.

Sex Chromosomes and Sex Determination

Humans have 46 chromosomes in each cell. Observation of the human body cells shows 23 pairs of chromosomes for both males and females. Twenty- two pairs are somatic chromosomes. The 23rd pair consists of sex chromosomes. Human males and some other male organisms, such as other mammals and fruit flies, have non-identical sex chromosomes (XY). Females have identical (XX) sex chromosomes.

- How is sex determined and inherited?

Let us study gamete formation based on the sex chromosomes. You will observe in Figure 3 that all egg cells receive an X chromosome; while half of the sperm cells receive X chromosomes and the other half receive Y chromosomes.

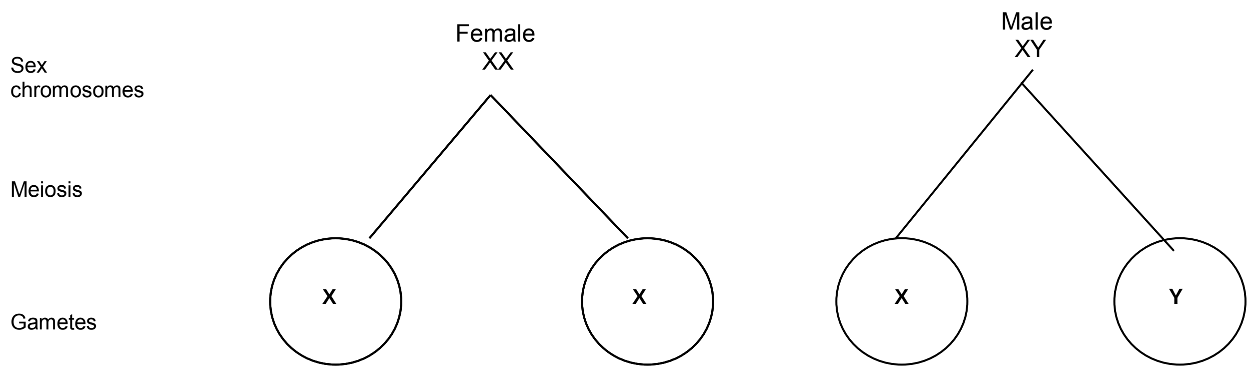


Figure 3. **Gamete formation involving only sex chromosomes**

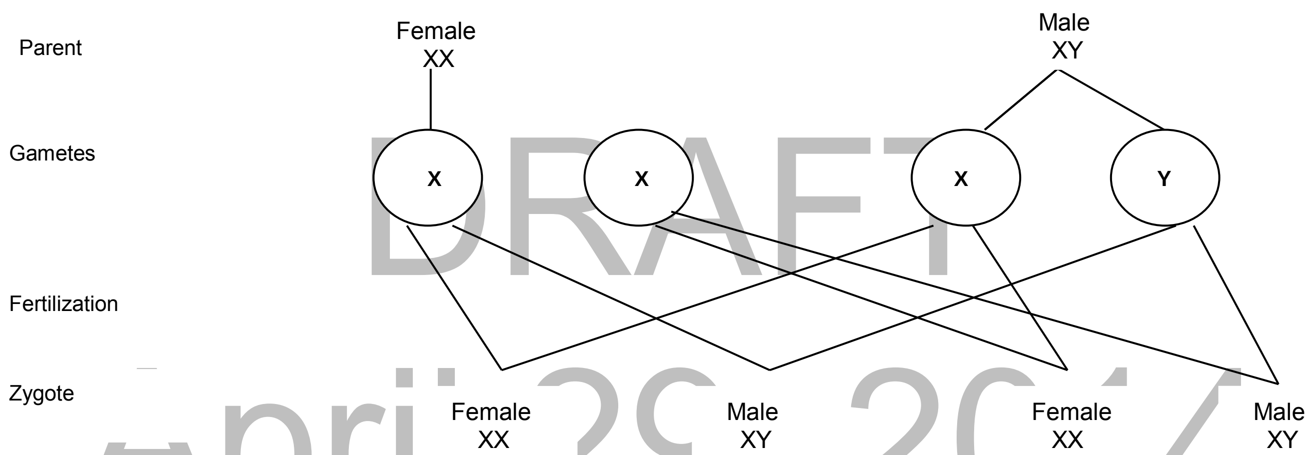


Figure 4. **Sex determination**

If an egg is fertilized by a sperm with a Y chromosome, as shown in Figure 4, the offspring is male. When an egg is fertilized by a sperm carrying an X chromosome, the offspring is female. Note that there is a 50 percent chance of having a male or female offspring. The greater the number of offspring, the greater is the chance of getting the expected 1:1 ratio of male and female.

Activity 4 Boy or Girl ?

Objective:

- Discuss how sex in humans is determined

Materials:

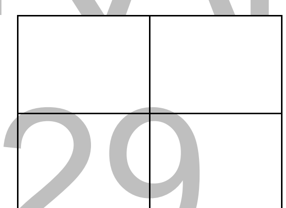
Activity sheets

Pen

paper

Procedure:

1. Draw a Punnett square which shows the inheritance of the sex chromosomes. Represent the female sex chromosomes with XX and the male sex chromosomes with XY.



Guide Questions:

Q 13. What will be the sex of a child produced when an egg is fertilized by a sperm that has a Y chromosome?

____

Q 14. What type of sperm must fertilize an egg to result in a female child?____

Q 15. Based on this Punnett Square, what percent of children would you expect to be male?____

Q 16. Which sex chromosome is present in both male and female?____

Q 17. Infer which sex chromosomes determines a person's sex.

____

18. What are the other factors that may influence the expression of human sexuality?.____

____

Key Concepts

- Males have 44 body chromosomes and two sex chromosomes X and Y. The males determine the sex of their children. Females have 44 body chromosomes and two sex chromosomes, both X. The total number in each cell of an individual is 46. These chromosomes contain the genes, which are the factors of heredity.

This section discusses three kinds of sex-related inheritance, namely, sex-limited, sex-influenced and sex-linked.

Sex-Linked Genes

Genes located on the X chromosomes are called X-linked genes. Genes on the Y chromosomes are called Y-linked genes. An example of an X-linked trait in humans is hemophilia. A person suffering from hemophilia could die from loss of blood even from a small wound because the blood either clots very slowly or does not clot at all. Another example of an X-linked trait is color blindness. To illustrate the inheritance of an X-linked trait, we will use color blindness in our discussion. Let us study Table 3. The X chromosome with the gene for color blindness is represented as X^C, while the one without is represented as X.

Table 3 **Genotypes and phenotypes of color blindness in humans**

Genotype	Phenotype
1. X X	Normal female
2. X X^c	Normal female, carrier of the gene
3. X^cX^c	Color- blind female
4. XY	Normal male
5. X^cY	Color-blind male

Can you identify the genotype of the female who is color-blind? Notice that for a female to become color-blind, she must be homozygous ($X^C X^C$) for the color-blind genes. The trait is, therefore, recessive in females. If a female has only one X chromosome with the allele for color blindness, she becomes normal but can pass on the trait to her offspring. She is therefore a carrier of the trait. Since males have only one X chromosome, the gene for color blindness when present in the male, will always be expressed because it does not have an allele to hide or prevent its expression. Thus, the male will be color- blind. This is the reason why color blindness is more common in males than in females.

Figure 5 is an example of a Y-linked trait, **hypertrichosis pinnae auris**, a genetic disorder in humans that causes hairy ears. Since the trait is found in the Y chromosome, then only males can have the trait. A father who has the condition will pass it on to all his sons, and they, in turn, will pass it on to their own sons.

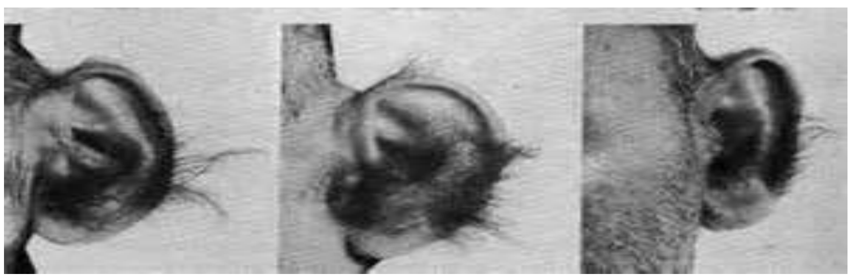


Figure 5. Sex-linked Genes Source: www.mun.ca

Activity 5 When Gender Matters

Objective:

- Solve problems related to sex-linked traits.

Materials:

Activity sheets

Procedure:

1. Read the given problem:

   A. Color-blindness is a recessive, sex-linked disorder in humans. A color-blind man has a child with a woman who is a carrier of the disorder.

   KEY: X = normal vision X^c = color-blindness

2. Illustrate using a Punnett square the probability of having children who will have normal vision and children who will be color-blind.

Guide Questions:

Q19. What is the genotype of the male?___________________________________

Q20. What is the genotype of the female?_________________________________

Q21. What is the chance that the child will be color-blind?_____________________

Q22. What is the chance that a daughter will be color-blind? ___________________

Q23. What is the chance that a son will be color-blind?________________________

Key Concepts

- Sex-linked traits are inherited through the X chromosomes.
- Males have only one X chromosome. Thus, if they inherit the affected X, they will have the disorder.
- Females have two X chromosomes. Therefore, they can inherit/carry the trait without being affected if it acts in a recessive manner.

Have you seen a bald man? What about a bald woman? It appears that gender matters for the other kinds of traits as well.

Sex-Limited Traits

Sex-limited traits are generally ***autosomal***, which means that they are not found on the X or Y chromosomes. The genes for these traits behave exactly the same way that any autosomal gene behaves. The difference here comes in the expression of the genes in the phenotype of the individual. Sex-limited traits are expressed in only one gender. In cattle, for instance, lactation is expressed in females but never in males. Both male and female cattle however possess a gene pair for lactation. The gene for lactation (L) is dominant over the non-lactating gene(l). Table 4 shows the genotypes and phenotypes of the gene for lactation. These genes are carried by both males and females, but it is only expressed in females. Have you noticed that in female cattle, if at least one gene pair is for lactation (L), the female produces milk? In male cattle, it does not matter if they possess one or two genes for lactation. They never produce milk.

Table 4. **Expression of Lactation in Cattle**

Female Genotypes	**Female Phenotypes**
XXLL	**Female lactating**
XXLl	**Female lactating**
XXll	**Female not lactating**
Male Genotypes	**Male Phenotypes**
XYLL	**Male not lactating**
XYLl	**Male not lactating**
XYll	**Male not lactating**

Source: Functional Biology Modular Approach, Second edition

Guide Questions:

Q24. Can you give other examples of sex-limited traits in animals?

____

Sex-Influenced Traits

Sex-influenced traits are also autosomal, meaning that their genes are not carried on the sex chromosomes. Again, what makes these traits unusual is the way they are expressed phenotypically. In this case, the difference is in the ways the two genders express the genes.

One classic example of a sex-influenced trait is **pattern baldness** in humans, though the condition is not restricted to males. This gene has two alleles, “bald” and “non-bald”. The behaviors of the products of these genes are highly influenced by the hormones in the individual, particularly by the hormone testosterone. All humans have testosterone, but males have much higher levels of this hormone than females do. The result is that, in males, the baldness allele behaves like a dominant allele, while in females it behaves like a recessive allele. Study Table 5 which shows the pattern of expression for baldness.

.

Table 5. Expression of Pattern Baldness in Humans

Male Genotypes	Male Phenotypes
XYBB	**Male bald**
XYBb	**Male bald**
XYbb	**Male nonbald**
Female Genotypes	**Female Phenotypes**
XXBB	**Female bald**
XXBb	**Female nonbald**
XXbb	**Female nonbald**

Source: Functional Biology Modular Approach, Second edition

Guide questions:

Q25. Predict the genotypic and phenotypic ratios in the offspring if the mother is bald and the father is not bald. Perform a cross using a Punnett square.

Q26. In what way are sex-limited and sex-influenced characters similar?

Q27. What is the main difference between sex-limited and sex-influenced traits?

If you look at the heterozygous gene pair for baldness (Bb), males express baldness, while females do not. Baldness may be expressed in females but it occurs more frequently in males. Such trait is sex-influenced because of a substance that is not produced equally in males and females.

Key Concepts

- **Sex-limited traits** are those that are expressed exclusively in one sex.
- **Sex-influenced traits** are expressed in both sexes but more frequently in one than in the other sex.

Try this (optional)

Solve the following problems:

1. Hemophilia is a disease caused by a gene found on the X chromosome. Therefore, it is referred to as a sex-linked disease. The recessive allele causes the disease. A man with hemophilia marries a woman that is homozygous dominant for the trait.

   Make a key for the trait. X^H=____________ X^h = _____________

   A. Illustrate using a Punnett square the probability that their children will have the disease.

Q28. Identify the genotype of the male?_________ female?_____________

Q29. Will any of their children have the disease?______________________

Q30. Predict the probabilities of their children having the disease._________________

2. Blood type is determined by the presence or absence of two antigens – antigen A and antigen B. The body's ability to produce antigens is a trait that is inherited. Using the information about inheritance of blood type, answer the given problem:

   - A father of four children has blood type A. The mother has blood type O.

Q31. Predict the possible blood types of their children.________________________

Q32. Explain why two of their children have blood type A while the other two have blood type O.____

DNA is a macromolecule that forms a double helix structure in the cells (mostly in the nuclei and mitochondria) of living organism. The DNA molecule is considered the genetic material of all living cells. It is present in bacteria, protists, fungi, plants and animals. DNA is responsible for determining the specific characteristics of an organism.

DNA: The Genetic Material

We've talked a lot so far about chromosomes and the inherited trait that genes produce. But what are genes? How do they work? After the discovery of the Chromosome Theory of Inheritance, many questions remained unanswered.

- Of what material are genes made?
- How does the genetic material produce the characteristics of an organism?
- How is the genetic code passed from parents to offspring?

Scientists now know that the genetic material is DNA (Deoxyribonucleic acid). Modern research techniques helped scientists to answer many questions about DNA and heredity. The work of earlier scientists gave Watson and Crick a lot of information about DNA. By the end of the 1940's, scientists had found that DNA consists of long strands of nucleotides. Each nucleotide contains a pentose sugar called **deoxyribose**, a phosphate group, and one of the four compounds called **nitrogenous bases**. Look at Figure 5. What are the components of the nucleotide?

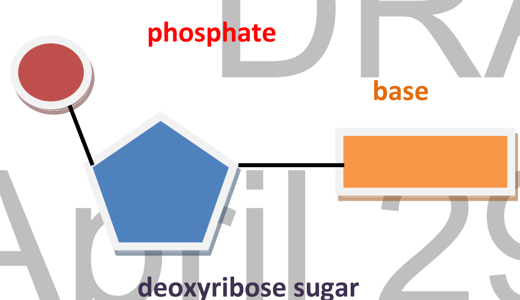


Figure 6. Structure of a nucleotide

This activity will introduce you to DNA. DNA is a complex molecule that is found in almost all living organisms. You will be able to manipulate the nucleotides (basic building blocks) of DNA and get a feel of how the molecule is produced.

You will perform an activity that will help you understand some important concepts in DNA structure.

Activity 6 DNA Modeling

Objectives:

- Identify the components of a DNA molecule
- Construct a model of a molecule of DNA

Materials:

Cutouts of basic subunits of DNA

Crayons

Scissors

Tape or glue

Procedure:

1. Cut out all of the units needed to make the nucleotides from the handout provided at the end of the module.
2. Color code the nitrogenous bases, phosphorus, and sugars according to the teacher's directions. Adenine = yellow, Guanine = green, Thymine = blue, Cytosine = red, Phosphate = brown, and Deoxyribose = . black
3. Using the small squares and stars as guides, line up the bases, phosphates and sugars.
4. Now glue the appropriate parts together forming nucleotides.

   Construct DNA model using the following sequence to form a row from top to bottom:

   Thymine
   Adenine
   Cytosine
   Guanine
   Adenine
   Cytosine
5. Let this arrangement represent the left half of your DNA molecule.
6. Complete the right side of the ladder by adding the complementary bases. You will have to turn them upside down in order to make them fit.

7. Your finished model should look like a ladder.

Guide Questions:

Q33. What are the common parts of a nucleotide?________________________

Q34. What is the one part of the nucleotide that differs among the other different nucleotides?____

Q35. List the different kinds of nitrogen bases___________________________

Q36. Is there always going to be an equal number of adenine and thymine nucleotides in molecule? Why?____

Q37. Is there always going to be an equal number of guanine and cytosine nucleotides in a molecule? Why?______________________________________

The structure of the DNA is actually in a double helix arrangement as shown in Figure 6..

Figure 7. Double helix structure of DNA Source: www.nsdsoftl.com

Q38. The sides of the ladder are made up of alternating ___________and_______________ molecules. The steps (or rungs) of the ladder are made up of ____________ held together by hydrogen bonds.

Key Concepts

DNA is composed of chains of **nucleotides** built on a sugar and phosphate backbone and wrapped around each other in the form of a double **helix**. The backbone supports four bases: **guanine, cytosine, adenine,** and **thymine**. Guanine and cytosine are complementary, always appearing opposite each other on the helix, as are adenine and thymine. This is critical in the reproduction of the genetic material, as it allows a strand to divide and copy itself, since it only needs half of the material in the helix to duplicate successfully.

Summary

- Many characteristics have more complex inheritance patterns than those studied by Mendel. They are complicated by factors such as codominance, incomplete dominance, multiple alleles, and sex-linked traits.
- **Incomplete dominance** occurs when the phenotype of the offspring is somewhere in between the phenotypes of both parents; a completely dominant allele does not occur.
- **Codominance** occurs when both alleles are expressed equally in the phenotype of the heterozygote.
- Many genes have multiple (more than two) alleles. An example is **ABO blood type** in humans. There are three common alleles for the gene that controls this characteristic. The alleles $\mathbf{I^A}$ and $\mathbf{I^B}$ are dominant over **i**.
- In humans, **XX** chromosomes determine femaleness and **XY** determine maleness.
- A **sex-linked trait** is on the X chromosome. Females have two X chromosomes; they can inherit or carry the trait without being affected if it acts in a recessive manner.
- **Sex-limited traits** are those that are expressed exclusively in one sex.
- **Sex-influenced traits** are expressed in both sexes but more frequently in one than in the other sex.
- Genes are located in the chromosomes.
- **DNA** contains the information needed to form and control the physical make-up and chemical processes of an organism.
- DNA is a **double-stranded helix** made up of repeating units of nucleotides.
- A **nucleotide** is composed of the following: sugar and phosphate molecules, and nitrogeneous bases. The base can either be adenine, guanine, thymine, and cytosine.

Glossary

- **Allele** – a different form of a gene that controls a certain trait.
- **Codominance** – two dominant alleles of a contrasting pair fully expressed at the same time in the heterozygous individual.
- **Incomplete dominance -** occurs when the phenotype of the offspring is somewhere in between the phenotypes of both parents; a completely dominant allele does not occur.
- **Multiple Alleles** – when more than two alleles control the inheritance of a character.
- **Sex-influenced traits** – are expressed in both sexes but more frequently in one sex than in the other.
- **Sex-limited traits** that are expressed exclusively in one sex of the species.
- **Sex-linked traits** – traits that are controlled by genes located on the same sex chromosome.
- **DNA** - deoxyribonucleic acid
- **Punnett square** – the method by which one can determine the possible genotypes and phenotypes when two parents are crossed
- **Antigen -** A substance that when introduced into the body stimulates the production of an antibody
- **Gamete -** are reproductive cells that unite during sexual reproduction to form a new cell called a zygote.

Summative Assessment (for end of module assessment)

Answer the following questions.

1. Complete the Punnet square for a cross between a homozygous red-flowered snapdragon (RR) and a homozygous white-flowered snapdragon (rr). Give the ratio for the phenotype and the genotype.

Key

RR – red

rr – white

Rr – pink

F$_1$

Genotypic Ratio: ________________

Phenotypic Ratio ________________

2. What happens to the phenotype of the heterozygotes when traits are inherited in an incomplete dominance pattern?

3. Complete the Punnet Square for a cross between two F$_1$ plants (rr). Give the phenotypic ratio for the F$_2$ generation.

F$_2$

Phenotypic ratio ___________________

4. What is the name of the inheritance pattern in which both alleles are expressed equally?

5. Complete the Punnet square for a cross between a black chicken (BB) and a white chicken (WW). Give the phenotype of the offspring in the F$_1$ generation.

Key

BB – black

WW – white

BW – checkered

F$_1$

Phenotype ____

Summative test (for end of the unit)

1. One chain of a DNA molecule has a nucleotide sequence C, C, G, C, T. What is the sequence of the nucleotides on its partner chain?______________________________
2. Predict the phenotypic ratios of offspring when a homozygous white cow is crossed with a roan bull. Illustrate using a Punnett square.

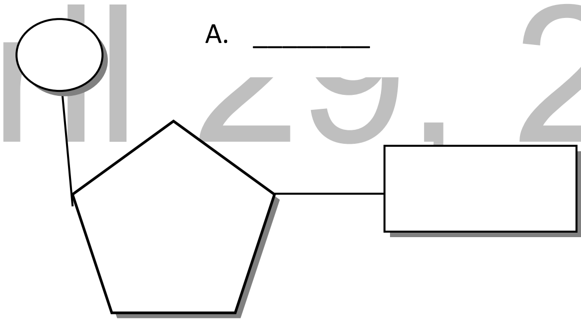
3. In fruit flies, humans and other mammals, sex is determined by an **X-Y system**. However, many organisms do not have the X-Y system of sex determination. For example, birds have a **Z-W system**. Male birds are **ZZ**, whereas females are **ZW**.
   In chickens, barred feathers (Z) are dominant over nonbarred feathers (Zb).

a. Draw a Punnett square that shows the results of a cross between a barred female and a nonbarred male.

b. What is the probability that the offspring will be:

   i. Barred females? __________
   ii. Nonbarred females? __________
   iii. Barred males? __________
   iv. Nonbarred males? __________

4. Identify the components of the DNA nucleotide.



A. _________

B. _________

C. _________

5. Using the following information mentioned, complete the following table.

Blood type	Possible Gene Pairs
A	
B	
AB	
O	

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University of the Philippines National Institute for Science & Mathematics Education Development 2000. Sourcebook on Practical Work for Teachers: High school biology (Vol. 2). Q.C.

DepEd. (2009). Biology Science and Technology Textbook for second year, Book Media Press, Inc.

Electronic Sources

http://www.karenmayes.com/pages/dna.pdf

http://www.wikidoc.org/index.php/Autosomal_recessive

LRMDS

Project EASE Module

APEX

DNA Model Template

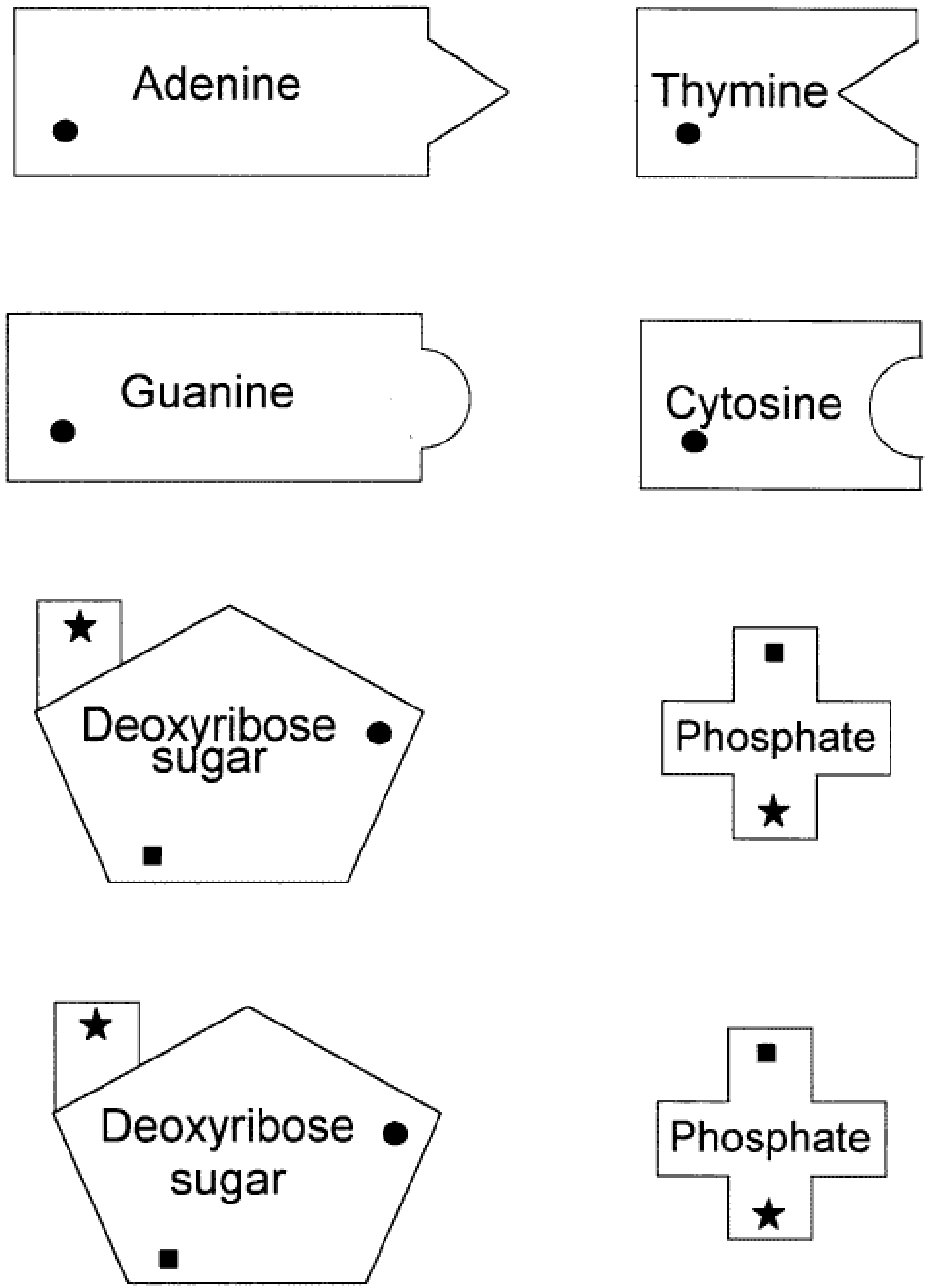


Figure 7 Basic Subunits of DNA

Reference:

DNA Paper Model Activity
http://www.karenmayes.com/pages/dna.pdf

DRAFT
April 29, 2014

UNIT 1
Module
3

Suggested Time Allotment: 4 to 5 hrs

Biodiversity and Evolution

Overview

Causes of Species Extinction

In Grade 8, you learned about the concept of species, classification of organisms using the hierarchical taxonomic system and the advantage of high biodiversity in maintaining the stability of an ecosystem. In Grade 9, you will explain the importance of biodiversity, find out how changes in the environment may affect species extinction and relate species extinction to the failure of populations of organisms to adapt to abrupt changes in the environment.

In any ecosystem, organisms need a balanced environment. A balanced ecosystem is one in which all living and nonliving things are interacting successfully. If any part of the ecosystem is disturbed, other parts will also be disturbed.

What happens to a community when its species diversity is reduced? Does loss of biodiversity affect an ecosystem's ability to sustain the species that remain or to perform certain functions that may contribute to the needs of that ecosystem? This module will help you find answers to these questions.

In this module, you are expected to:

1. Relate species extinction to the failure of populations of organisms to adapt to abrupt changes in the environment,
   - Explain the importance of biological diversity.
   - Find out how changes in the environment can affect species extinction.
   - Distinguish environmental changes that may result in the loss of the species.
2. Make a multimedia presentation of a timeline of extinction of representative microorganisms, plants, and animals

Key Questions:

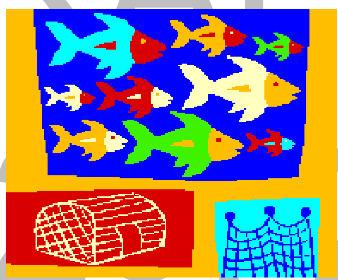
- What causes species extinction?
- How can changes in the environment affect the continued survival of the species?

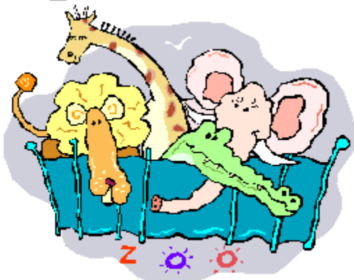
Now read carefully the questions and give your best answer. These will help your teacher determine the knowledge you have for this topic.

Pre-Assessment:

Taking Animals for Profit	***Introduced species***
Hunting and Trapping	***Destruction of habitat***
Overharvesting	***Pollution***

A. Photo Quiz: The words in the box are some of the causes of species extinction. Look at the pictures below and identify which cause of extinction matches each group of pictures.

1.  

2.  

3.  

4.  

5.  

B. The map below shows the population distribution of fish, water bugs, frogs and water lily plants in a pond.

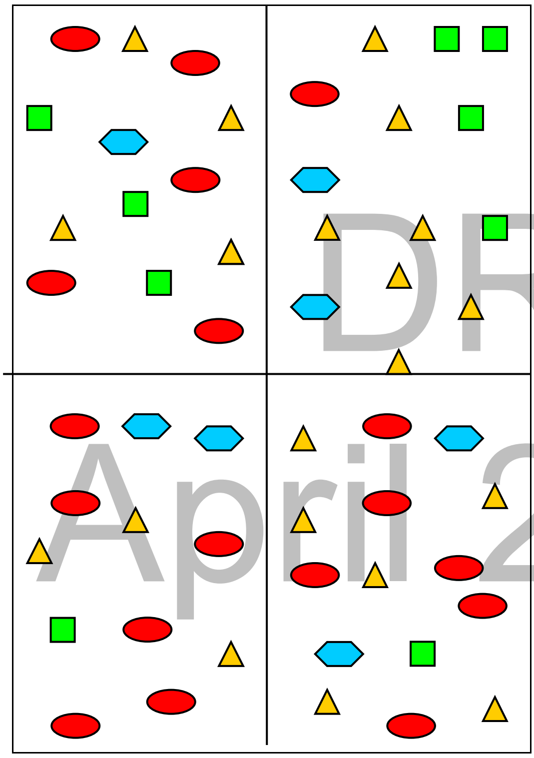
Key:

= fish

= frogs

= water bug

= water lily



1. Which species has the largest population in the community?

____

____

2. What factors might influence a change in the population?____________________

Different parts of the ecosystem interact with one another. Changes to one part affect other parts. When all the members of a species die, that species' place in the ecosystem is gone forever. In this module you will study the various threats that are considered causes of the loss of biodiversity.

Figure 1 Tubbataha Reef

Figure 2 Coconut Plantation

Study Figures 1 and 2. Picture yourself swimming and diving in Tubbataha Reef Marine Park, where very high densities of marine species are found. What organisms are in Figure 1? How many different kinds of organisms do you think you will see? Now, imagine yourself standing in a coconut plantation. Which species do you think dominates this area? The Tubbataha Reef Marine Park has many populations. You can see hundreds of different species of organisms, whereas in a coconut plantation, only one species dominates. A **population** is a group of living things within a certain area that are all of the same species.

Several different populations may be found in a community. A population of one kind may affect a population of another kind within the community. A jungle has a greater amount of biological diversity, or biodiversity, than a cornfield. **Biodiversity** refers to the variety of life in the area. In a jungle community, some populations, such as ants, fungi, and ferns, can be very large in number. Other populations such as tigers and snakes have fewer members. Why do you think population sizes vary among organisms?

Now work on the activity to find out the amount of biodiversity and species distribution in a community.

Activity 1 Index of Diversity

Objective:

- Measure species distribution using mathematical way of expressing the amount of biodiversity and species distribution in a community.

Materials:

Pen
Paper

Procedure:

1. This is an outdoor activity. Go to the area designated by your teacher.
2. Record the number of different species of trees present in the area. (It is not necessary to know their names, just make sure that they differ by species.) Record this number in your data table.

DATA TABLE	
Number of species	
Number of runs	
Number of trees	

3. Go to the designated area again. This time, make a list of the trees by assigning each a number as you walk by it.
4. Place an X under Tree 1 on your list. If tree 2 is the same species as Tree 1, mark another X under Tree 1. Continue to mark an X under the trees as long as the species is the same as the previous one.

5. When a different species is observed, mark an O under that tree on your list. Continue to mark an O if the next tree is the same species as the previous. If the next tree is different, mark an X.
6. Record in your data table:
   a. The number of "runs". Runs are represented by a group of similar symbols in a row. Example – XXXXOOXO would be 4 runs (XXXX – 1 run, OO – 1 run, X – 1 run, O – 1 run).
   b. The total number of trees counted.
7. Calculate the Index of Diversity (I.D.) using the given formula:

   $$\text{Index of diversity} = \frac{\text{Number of species} \times \text{number of runs}}{\text{Number of trees}}$$

Guide Questions:

Q 1. Compare how your tree I.D. would be different in a vacant lot than that in a grass lawn. Explain your answer. ____________________

____

Q 2. If humans were concerned about biological diversity, would it be best to have a low or high I.D. for a particular environment? Explain your answer.

____

Key Concepts

- Population pertains to the number of organisms of the same species living in a certain place.
- Biodiversity refers to the variety of life in an area.
- Communities with many different species (a high index of diversity) will be able to withstand environmental changes better than communities with only a few species (a low index of diversity).

In a balanced ecosystem, organisms need a balanced environment. A change in population sizes may be due to factors affecting the environment. Why is it that populations do not increase without end?

Figure 3 Park reserve in Calauit, Palawan

Look at Figure 3. This is an area in Calauit, Palawan, that is set aside as a park preserve, and no hunting is allowed in the park. A number of animals like giraffe and zebra are placed in the area. There are plenty of plants to serve as food for the giraffe and zebra population. The herd of giraffe and zebra are assumed to be healthy and begin to multiply faster than expected. Predict what will happen if the giraffe and zebra population continues to increase in the park area.

You will work on the next activity to help you understand changes in population, factors affecting population growth and size, and learn about the needs and characteristics of a population.

Activity 2 Measuring Population Density

Objective:

- Determine the pattern of population distribution using mathematical formula
- Compare the distribution patterns of the different populations.

Materials:

Ruler

Pencil & Paper

Procedure:

1. Study the three patterns of population distribution in Figure 4.
2. Using the given formula for computing population density, calculate the density of each population.

$$\text{Density} = \frac{\text{number of individuals}}{\text{Size of area}}$$

3. Count the total number for each population. Record the number in the table.

Figure 4.

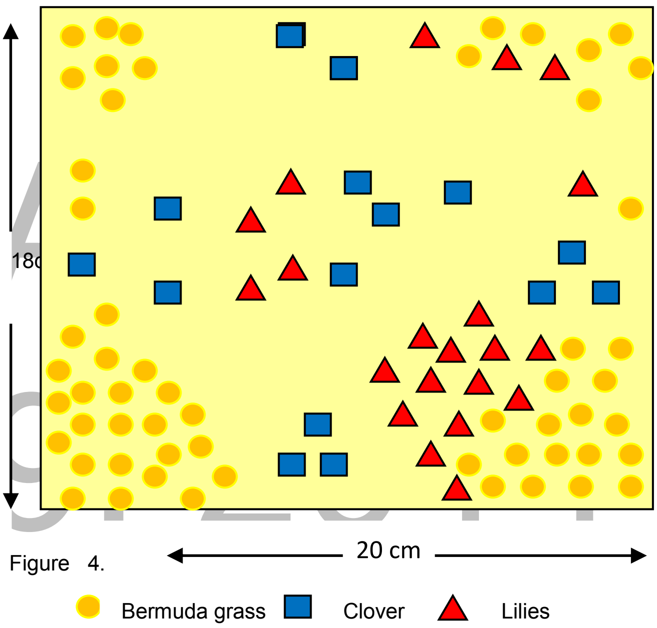


Figure 4.

4. On a sheet of paper, prepare a table to record the data for population density.

Table 1 Population Density

Population name	Number of organisms	Density

5. Calculate the density of each population. Record it in the table.

Guide Questions:

Q 3. Compare the distribution patterns of the three populations.

____

Q 4. Which population has the greatest density?______________________

Q 5. Infer from recorded data from the possible causes for the differences in the population density.

Q 6. What conditions could change the density of any of the population.

____

Q 7. Describe how a population's density can be used to learn about the needs and characteristics of that population.

____

Populations can be of the same size, but they may have different densities. When we consider the number of individuals per unit area, we are referring to the density of the population. Differences in population density in any community may be attributed to many factors. Population sizes change when new members move into the ecosystem. They decrease when members move out of an ecosystem. The birth rate and death rates can also affect a population's size. Anything that limits the size of a population like certain environmental conditions are called **limiting factors**. Limiting factors keep a population from increasing in size and help balance an ecosystem. Examples of limiting factors are the availability of food, water, and living conditions. Light, temperature and soil nutrients are also limiting factors because they help determine the types of organisms that can live in an ecosystem. The maximum population size an environment can support is called its **carrying capacity**. If the population size rises above the carrying capacity, organisms die because they cannot meet all their needs.

Q 8. How are limiting factors related to population density?

____

Key Concepts:

- Population sizes vary among organisms. They change with the number of births and when they move into an ecosystem. They also change when members die or move out of an ecosystem.
- Limiting factors are environmental conditions that keep a population from increasing in size and help balance ecosystems.
- The carrying capacity is affected by changes in the environment.

Life depends on life. Animals can not exist without green plants. Living things create niches for other living things. But what happens if the living conditions of these organisms are not ideal for their survival? What do you think are the major causes of species extinction?

Work on the next activity which demonstrates the probable causes of species extinction.

Activity 3 Endangered but not Extinct…yet

Objective:

- Demonstrate, using a simulation activity, that habitat destruction can contribute to species extinction.

Materials:

Box of toothpicks
Stopwatch/wristwatch
Pencil & paper
Flour for marking areas in the lawn

Procedure:

1. Create teams of seven members.
2. Designate two students as the "Hunters", two students as the "Timers", two students as the "Counters " and one student as the Leader.
3. Get your copy of the Extinction Simulation Data Table handout from your teacher.
4. Go to the area in the school grounds designated by your teacher. Using the flour draw out a circle measuring about 20 feet wide.
5. In the circle, scatter 100 toothpicks as randomly as possible. These are the "toothpick grasshoppers".
6. The Leader gives instructions to the students assigned as the following:

- **Hunters:** "Catch" by picking up as many toothpick grasshoppers as they can
- **Timers:** Set the time for two minutes for the Hunters to collect the toothpick grasshoppers.

- **Counters:** Determine how many toothpick grasshoppers have been caught and calculate the number of toothpick grasshoppers remaining in the circle. Record this information in the Extinction Simulation Data Table handout.

7. Begin the activity. The Leader sees to it that the students perform their assigned task for the activity.
8. After the first round, put an additional toothpick grasshopper into the circle for every pair of toothpick grasshoppers remaining. This simulates reproduction.
9. Rotate roles and repeat the activity a second time and record the data in the handout.
10. After the second round, rotate roles once again and repeat the activity for a third time and record the data in the handout.
11. Draw a line or bar graph of the number of toothpick grasshoppers in the grass at the end of the round.

Guide Questions:

Q 9. What happened to the toothpick grasshoppers over time?

____

Q 10 What factors might account for differences in the graphs and /or total number of toothpick grasshoppers in each group?

____

Q 11. In nature, what environmental factors might account for differences in the total number of grasshoppers?

____

Q 12. What effects do you think will habitat reduction have on the toothpick grasshoppers' population?_______________________________

____

Q 13. Suggest a method for testing your hypothesis in Q 12.

____

____

When a species, population becomes so low that only a few remain, the species is considered **endangered** will possibly become extinct. In the Philippines, some terrestrial species like the *tamaraw* in Mindoro, mouse deer in Palawan, Philippine deer, Monkey-eating eagle, and aquatic species like the *dugong* found in Negros, Batangas, and Leyte are in danger of extinction.

Sometimes, there is a particular species that declines so fast that it becomes endangered and is said to be **threatened.** In a study conducted by field biologists on population size and distribution of Philippine fauna, they reported that as of 1991, 89 species of birds, 44 species of mammals, and eight species of reptiles are internationally recognized as threatened. These include also the Philippine Eagle or Monkey-eating Eagle in the list of Philippine Endangered Species. (Source: cf. Rabago, L. et.al. Functional Biology:Modular Approch. 2nd ed)

Extinction is the disappearance of a species when the last of its members die. Changes to habitats can threaten organisms with extinction. As populations of people increase, the impact of their growth and development is altering the face of the Earth and pushing many other species to the brink of extinction.

Key Concepts:

- Extinction occurs when the last member of that species dies.
- When the population of a species begins declining rapidly, the species is said to be a threatened species.
- A species is endangered when its population has become so low that it is possible of becoming extinct.
- Human actions have resulted in habitat loss and degradation that have accelerated the rate of extinction.

Many changes take place in the communities. You may have noticed that the natural vegetation in the area has been cleared. Concrete structures and increasing populations of people and other organisms gradually take over the area. Perhaps some areas were destroyed by natural disasters or by human activities. Just as vegetation changes, animal populations also change. These may have major effects on the ecosystem causing replacement of communities or development of a new environment.

The next part of the module is basically a discussion of local and global environmental issues that contributed to species extinction.

Activity 5 Making Predictions

Objective:

- Determine differences between two hypothetical islands

Materials:

Paper & pencil

Procedure:

1. Imagine that you and your friends are being sent to explore two islands. The islands are very similar in size, age, and location. But one has human population and the other does not have.
2. Predict what you will see in each island.
3. Tabulate your predictions as shown below.

Island A	Island B
1. 2. ↓	1. 2. ↓

Guide Questions:

Q 14. What did you predict you will see in each island?________________________

____

Q 15. How would you explain the differences that you will see in each island?

____

Have you eaten? Did you turn on an electric light, ride a tricycle or jeepney, or use a computer today? When you do any of these activities, you use one or more natural resources. Natural resources are materials in the environment that people use to carry on with their lives. But are you using these natural resources wisely? Will the time come when these materials will no longer be available to you? You would probably have the same question in mind.

Many of the changes that man has done to the environment were made by accident. If you examine your predictions in the activity, you probably listed them in the column meant for the island inhabited by human population. Land would be cleared for housing and farming. These might decrease plant and animal populations, and some pollution and other environmental problems would result.

You probably need to know more about some of the local and global environmental issues/problems that are also affecting your community.

- **Deforestation**

One of the country's environmental problems is the rapid rate at which trees are cut down. Did you encounter the same problem in your community? In the Philippines, the major causes of deforestation are:

- *Kaingin* farming
- Illegal logging
- Conversion of agricultural lands to housing projects
- Forest fires
- Typhoons

Figure 5 Kaingin farming

Figure **6 Forest hit by typhoon**

As a consequence of cutting down trees, the following effects could take place:

- Soil erosion
- Floods
- Decrease in wildlife resources that will eventually lead to extinction

- **Wildlife Depletion**

As human population gets bigger, huge space is needed for shelter, for growing crops, and for industries. Deforestation is one of the major causes of the disappearance of wildlife species. What happens to animal populations that are driven away from their natural habitat? If they cannot find enough space, many will die or become **extinct.** Some species may become **endangered, or** in the verge of becoming extinct. In other cases, some animals may be **threatened,** referring to

Figure 7 Monkey-eating Eagle

Figure 8 Tarsier

Figure 9 *Dugong*

- **Water Pollution**

A major problem in lakes, rivers and ponds is **eutrophication.** It happens when the concentration of organic nutrients that comes from domestic garbage and thrown in bodies of water, increases rapidly. one of the effects of water pollution. It is supposed to be a slow process, but man's activities hasten it up. **Figure 10** shows the causes and stages of eutrophication in a lake.

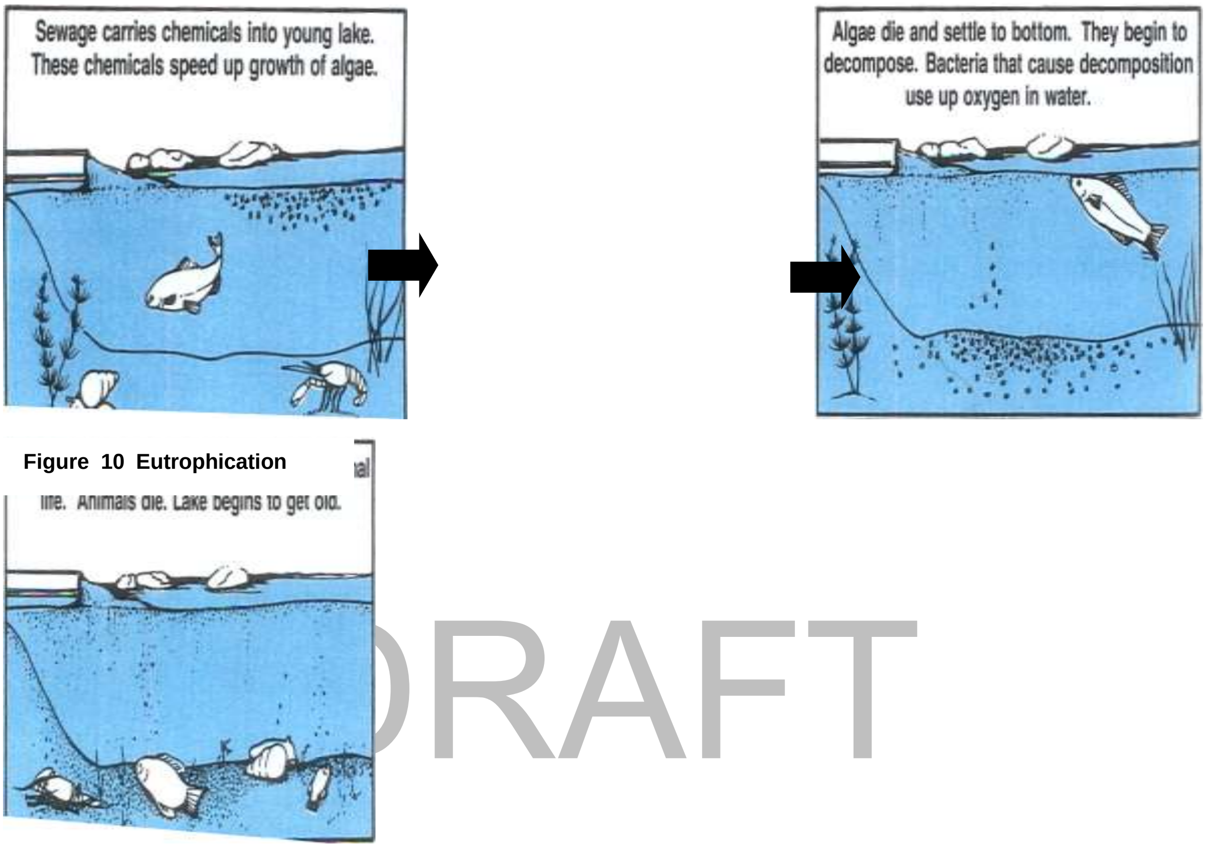


Figure 10 Eutrophication

Another effect of water pollution is mass death of fish, or 'fish kill'. Have you read articles from the newspapers about 'fish kill' in Manila Bay or some other places? Have you seen such an event in your area?

A 'fish kill' usually happens when there is an increase in concentration of organic nutrients in bodies of water. This condition causes algal bloom and growth of aquatic plants. When the algae die, they sink to the bottom and the process of decomposition proceeds. This process uses up oxygen and as a result, aquatic animals die due to lack of oxygen.

Bodies of water are also polluted with toxic wastes, untreated sewage, and fertilizer run-offs from farm lands. One class of dangerous chemicals present in water is PCB (polychlorinated biphenyl). PCBs are toxic wastes produced in the making of paints, inks and electrical insulators. **Figure** 11 shows what happens in the food chain when PCB is present.

At each level of the food chain, the amount of PCB in each organism increases. They are unable to excrete PCB from their bodies.

Through the process of biological magnification, the PCB becomes concentrated in the body tissues of water organisms. **Biological magnification** is the buildup of pollutants in organisms at higher trophic levels in a food chain. Fish living in contaminated ecosystems contain builtup high concentration of PCB as shown in **Figure 11.** The fish were not killed by the chemicals, but they stored them in their tissues. As the salmon feeds on the smaller fish, it took in the PCB in their bodies. Like the smaller fish, the salmon was not killed by the PCB. It stored the PCB in its tissues. The concentration of PCB in the salmon has rise to 5,000 times the concentration of PCB in the water in which it fed.

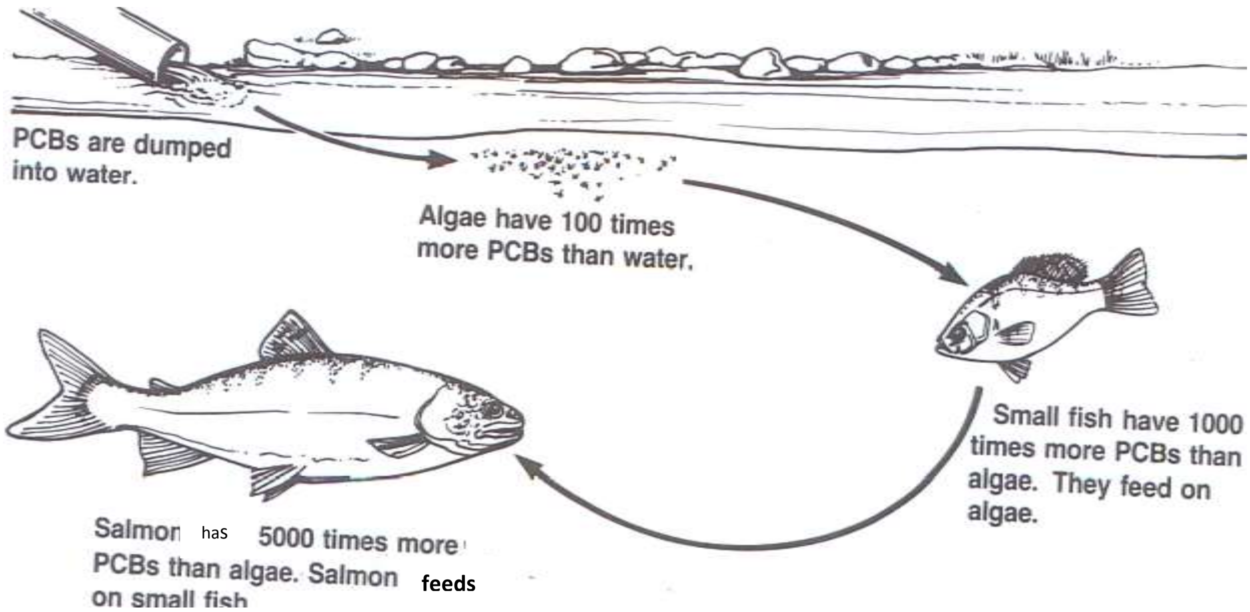


Figure 11 PCB dumped in lakes (Please redraw)

Other pollutants found in water are heavy metals such as lead, mercury, and cadium. These metals come from factories that dump their wastes into rivers or lakes.

- Air Pollution

Do you know that cars are one of the major contributors to air pollution? Pollutants can enter the air as gases, liquids, or solids. Cars burn fuel and produce harmful gases–carbon dioxide, nitrogen oxides, and hydrocarbons. **Figure 12** shows the harmful pollutants present in the air.

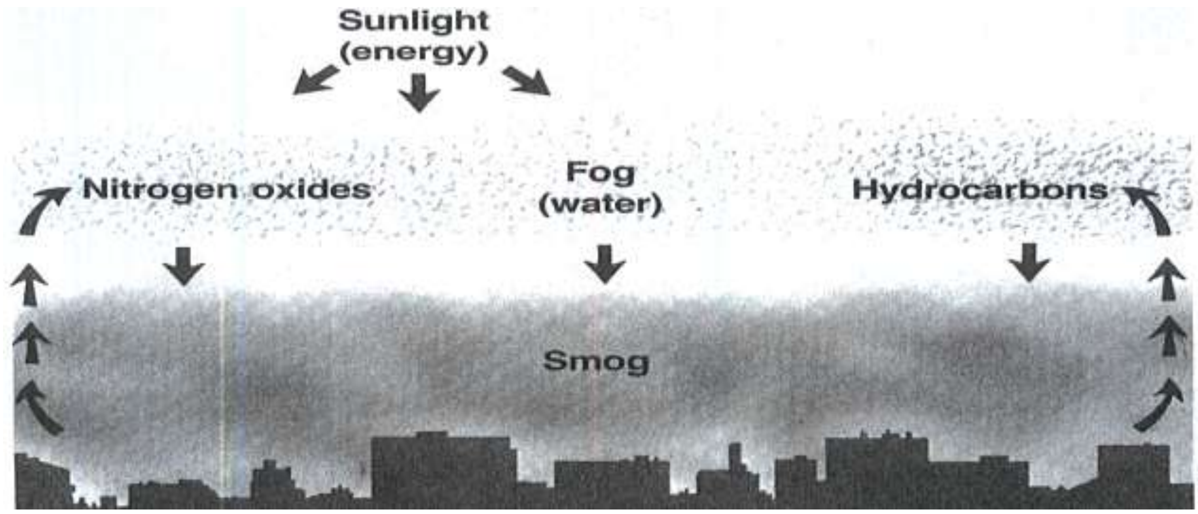


Figure 12 Air Pollution

In Metro Manila where a great volume of cars travel each day, smog blankets the area, nitrogen oxides and hydrocarbons from car exhausts react with water vapour or dust particles and produce new irritating chemicals.

Carbon dioxide acts like a blanket over the Earth, holding in the heat that would otherwise radiate back into space. The trapping of heat by gases in the earth’s atmosphere is called **greenhouse effect.**

The greenhouse effect is a natural process. But as carbon dioxide in the atmosphere increases, greenhouse effect also intensifies–this will lead to global warming. **Global warming** is an increase in the earth’s temperature from the rapid buildup of carbon dioxide and other gases. This, in turn, could change the world climate patterns.

Are there factories in your area? Factories and power plants that burn coal are also major contributors to air pollution. Coal contains sulfur. When coal burns, sulfur combines with oxygen in the air to form sulfur dioxide, with choking odor. Power plants also burn coal to give off particulates into the air. Particulates are tiny particles of soot, dust, and smoke. These particulates block sunlight and get into your lungs when you breathe. Do you see smog and smell such foul odor and often wonder where it comes from? Well, your place might be a victim of air pollution from the factories nearby.

- **Destruction of Coastal Resources**

Do you live near coastal areas? Do you remember the times when you and your friends went to the seashore to gather seashells or played with some corals or, perhaps, played hide and seek among mangrove trees?

Coral reefs and coastal mangrove forests in the Philippines serve as breeding grounds and nurseries of marine fishes. But due to man's activities, coastal areas are getting destroyed through the years. Some of these activities include the following:

- Deforestation, agricultural activities, and mining activities
- Dynamite fishing and *muro-ami*
- Coastal areas' conversion to beach resorts, residential areas
- Overharvesting

Figure 13 Destruction of coral reefs

Figure 14 Damaged mangrove areas

Figure 15 Dynamite Fishing

- **Acid Precipitation**

Acid precipitation is commonly known as acid rain. Rainwater is normally acidic, because carbon dioxide is normally present. Other pollutants, mostly sulfur and nitrogen oxides, make rainwater even more acidic, with a pH of 5.6 or lower. Emissions from factories and from exhaust of motor vehicles are some examples of pollutants.

Acid rain can be harmful to living things. It causes yellowing of leaves of trees and cause leaves to fall. Examine **Figure 16.** It summarizes the effect of acid rain.

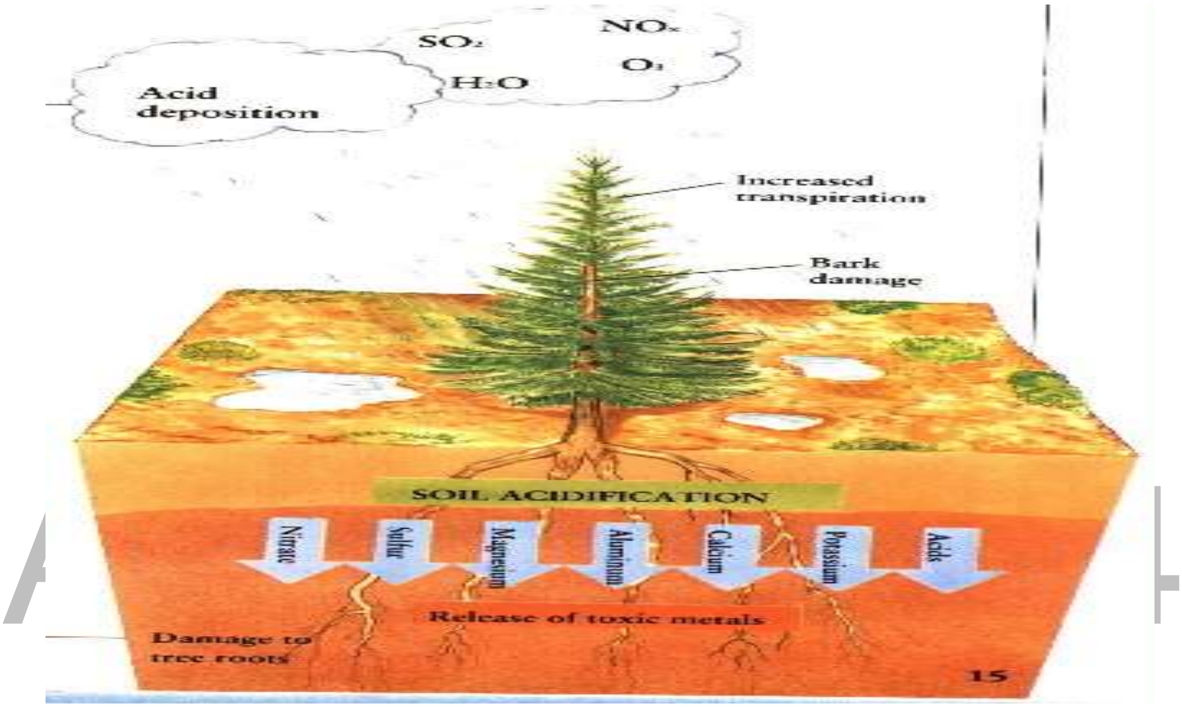


Figure 16 Acid precipitation

Along with nutrients being lost through direct leaching from leaves and no movement of nutrients in forest litter (leaves, stems, and fruits), nutrients can be lost from the soil. Acid water flowing through the soil can exchange acidic hydrogen ions for essential plant nutrient ions such as calcium, magnesium, and potassium. If these nutrients migrate beneath the rooting zone, they become unavailable to tree roots.

Human activities and overpopulation have caused most of the environmental problems nowadays. People are beginning to realize that the way they interact with the environment must change to ensure the survival of all living things. This is one big challenge to maintain the resources needed for survival while ensuring that they will still be available in the future. This is a practice called **sustainable development.** This means that a sustainable society should live under the carrying capacity of the environment. This means that the rate at which society uses renewable resources does not exceed the rate at which the resources are generated.

Key Concepts :

- The principal causes of deforestation are illegal logging, *kaingin* farming, forest fires, and conversion of agricultural lands to housing projects and typhoons.
- The effects of deforestation include soil erosion, floods and depletion of wildlife resources.
- The major cause of wildlife extinction is the loss of habitat.
- Coral reef destruction is caused by dynamite fishing and muro-ami, while mangrove destruction is caused by overharvesting and conversion of the area into other uses.
- In eutrophication, nutrients are washed away from the land to enrich bodies of water. It causes excessive growth of aquatic plants and algae and results in algal bloom, which eventually die and decompose. The process depletes the oxygen dissolved in water, causing fish and other aquatic organisms to die.
- Acid rain is a result of air pollution mostly from factories and motor vehicles.
- Sustainable development means that a society should live under the carrying capacity of the environment.

Performance Task

Now that you have understood the causes of species extinction, you will try to make a multimedia presentation of a timeline of extinction of representative microorganisms, plants, and animals.

Your teacher will give you detailed instructions on this task.

Summary

- Population is a group of organisms of the same species living in a certain place.
- Biodiversity refers to the variety of life in an area.
- Communities with many different species (a high index of diversity) will be able to withstand environmental changes better than communities with only a few species (a low index of diversity).
- Population sizes vary among organisms. They change with the number of births and when they move into an ecosystem. They also change when members die or move out of an ecosystem.
- Limiting factors are environmental conditions that keep a population from increasing in size and help balance ecosystems.
- The carrying capacity is affected by changes in the environment.
- Extinction occurs when the last member of a species dies.
- When the population of a species begins declining rapidly, the species is said to be a threatened species.
- A species is in endangered whenits population is so low that it is nearly extinct.
- Human actions have resulted in habitat loss and degradation that has accelerated the rate of extinction.

- The principal causes of deforestation are illegal logging, *kaingin* farming, forest fires, and conversion of agricultural lands to housing projects, and typhoon.
- The effects of deforestation include soil erosion, floods, and depletion of wildlife resources.
- The major cause of wildlife depletion is the loss of habitat.
- Coral reef destruction is caused by dynamite fishing and *muro-ami*, while mangrove destruction is caused by overharvesting and conversion of the area into other uses.
- In eutrophication, nutrients are washed away from the land to enrich bodies of water. It causes excessive growth of aquatic plants and algae and results in algal bloom, which eventually die and decompose. The process depletes the oxygen dissolved in water, causing fish and other aquatic organisms to die.
- Acid rain is a result of air pollution mostly from factories and motor vehicles.
- Sustainable development means that a society should live under the carrying capacity of the environment.

GLOSSARY

Species	A group of organisms that have certain characteristics in common and are able to interbreed.
Biodiversity	refers to the variety of life in an area.
Population	the total number of organisms of the same species inhabiting a place at the same time.
Population density	the number of individuals in an area
Limiting factor	environmental conditions that keep a population from over increasing in size and thus help balance ecosystems
Carrying capacity	number of organisms of one species that an environment can support.
Endangered species	a species in which the number of individuals falls so low that extinction is possible

Threatened species	species that have rapidly decreasing numbers of individuals
Deforestation	removing or clearing of a forest to include the cutting of all trees, mostly for agricultural or urban use
Eutrophication	the process by which a body of water becomes enriched in dissolved nutrients (such as phosphates) that stimulate the growth of aquatic plant, life usually resulting in the depletion of dissolved oxygen
PCB	**(**polychlorinated biphenyl) toxic wastes produced in the making of paints, inks and electrical insulators
Acid rain	broad term referring to a mixture of wet and dry deposition (deposited material) from the atmosphere containing higher than normal amounts of nitric and sulfuric acids.

Summative Test

I. Answer briefly the following questions in your answer sheet:

1. If the population species of a given area is doubled, what effect would this have on the resources of the community?
2. In a population, limiting factors and population density are often related. Suppose that the population density of plant seedlings in an area is very high, explain how limiting factors may affect population density.
3. In a farm, soy beans were the only crop that that was planted on several hectares of land. A farmer noticed that a fungus was growing all over the soy bean fields. Predict what might eventually happen to the soybeans and the fungus.
4. How is forest ecosystem affected when trees are cut down?
5. What is the main cause of extinction in plant and animal species?

II. Work on the following problems:

1. Suppose 60 ants live in a 4 sq m plot of grass. What would be the population density of the ants? What would the population density be if 100 ants live in an 8 sq m plot of grass?
2. If 40 carabaos live in a 1 ½ sq m area, what is their population density per sq. km. ?

3. How many monkeys would have to live in a ¾ sq. km. area to have the same population density as the carabao?

III. Choose the best answer that completes each sentence.

1. Pollutants dumped into the rivers and streams eventually find their way to (a. the ocean b. the atmosphere c. groundwater supplies)
2. The average temperature of the earth's atmosphere may rise as a result of (a. the greenhouse effect b. water pollution c. garbage dumping)
3. Many (a. non-renewable b. alternative c. expensive) energy sources are being developed to replace fossil fuels.
4. Some endangered species of plants in tropical rain forests may be sources of (a. fossil fuel b. medicine c. hazardous waste)
5. Humans are using (a. fewer b. better c. more) natural resources than they did 100 years ago.

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Philippine Biodiversity Conservation: A Trainer's Manual

Suggested Time Allotment: 15 hrs.

Unit 1
Module
4

ECOSYSTEM: Life Energy

Overview

In module 3, you have learned how changes in the environment may affect species extinction. It helps you understand how to prevent extinction of organisms in an ecosystem.

In this module, you will learn that all organisms need energy to sustain life. Your study will focus on how organisms obtain energy from food and how organisms produce energy.

In order to sustain life, all organisms require energy, but not all of them can use light energy directly for life activities. To provide the energy needed by all organisms, plants and other chlorophyll-bearing organisms capture the energy of sunlight and convert it into chemical energy stored in the food. When people and other heterotrophic organisms eat food from producers and consumers, chemical energy stored from food is transferred to their bodies. **Do you know how these processes are being done by our body and by other living organisms?**

What are expected of you to learn?

1. Differentiate basic features and importance of photosynthesis and respiration.
   a) Describe the parts of organelles involved in photosynthesis and cellular respiration.
   b) Describe the process of food making by plants.
   c) Describe how stored energy from food is changed to chemical energy for cell use.
   d) Identify the factors that affect the rate of photosynthesis and cellular respiration.
2. Design and conduct an investigation to provide evidence that plants can manufacture their own food.

Key questions for this module

How do plants manufacture their own food?
What are the factors that affect the rate of photosynthesis?
How do cells convert stored energy in food into chemical energy?
How do materials and energy flow in the ecosystem?

Now you have to read and answer the questions that follow in the best way you can. Your answers will give the teacher the necessary information on what you already know and those topics that need to be given more emphasis.

Pre Assessment:

1. Plants make food by absorbing water and carbon dioxide. Which of the following substances is the origin of oxygen released as gas by green plants during photosynthesis?
   a. water c. carbon dioxide
   b. sugar d. ribulose-1,5-biphosphate
2. Oxygen and carbon dioxide are gases that cycle out in the ecosystem. Which of the following gases is important to photosynthesis?
   a. ozone gas b. water vapor c. oxygen d. carbon dioxide
3. Plants are considered as food makers. In which of the following cell organelles does photosynthesis occur?
   a. ribosome b. chlorophyll c. chloroplast d. mitochondrion
4. The light-dependent reaction of photosynthesis must come first before the light independent reaction because its products are important to the fixation of carbon dioxide. Which of the following is/are the product/s of the light–dependent reaction?
   a. ADP only b. NADPH only c. ATP only d. NADPH and ATP
5. Plants are very unique among other organisms due to their capability to trap sunlight and make their own food. Which of the following enables plants to trap energy from the sun?
   a. epidermis b. chloroplast c. cuticle d. chlorophyll
6. All organisms get energy from food to perform different life processes. This is done in the cells by breaking down sugar molecules into chemical energy. Which of the following cell organelles is associated with the production of chemical energy?
   a. chloroplast b. mitochondrion c. endoplasmic reticulum d. nucleus

7. Pyruvate is the product of glycolysis. If there is no oxygen available to cells of the human body, what becomes of pyruvate?
   a. alcohol b. lactic acid c. CO_2 d. a and c
8. If you did not eat for three days, where did your cell get the glucose for ATP production?
   a. blood sugar
   b. glycogen in the liver
   c. glycogen present in the muscle
   d. protein in the blood
9. How many molecule/s of carbon dioxide is/are released from one pyruvic acid molecule being oxidized?
   a. 1 b. 3 c. 2 d. 4
10. During the synthesis of ATP, what is the direction of hydrogen flow?
    a. from matrix to intermembrane space
    b. from intermembrane space to matrix
    c. from matrix of mitochondrion to cytoplasm
    d. from cytoplasm to matrix of mitochondrion

Photosynthesis

Plants are great food providers. **Why do you think they are called great food providers?** As you go through the activities in this module, you will understand how plants provide food and help to make the flow of energy in the ecosystem possible.

You will understand how each plant structure helps in the process of food making, as well as the factors that may affect the rate of food production done by plants.

Photosynthesis is a process of food making done by plants and other autotrophic organisms. The presence of chlorophyll enables these organisms to make their own food. Autotrophic organisms require light energy, carbon dioxide (CO_2), and water (H_2O) to make food (sugar).

In plants, photosynthesis primarily takes place in the leaves and little or none in stems depending on the presence of chlorophyll. The typical parts of the leaves include the upper and lower epidermis, mesophyll spongy layer, vascular bundles, and stomates. The upper and lower epidermis protects the leaves and has nothing to do with photosynthetic processes. Mesophyll has the most number of chloroplasts that contain chlorophyll. They are important in trapping light energy from the sun. Vascular bundles - phloem and xylem serve as transporting vessels of manufactured food and water. Carbon dioxide and oxygen were collected in the spongy layer and enters and exits the leaf through the stomata.

The parts of a chloroplast include the outer and inner membranes, intermembrane space, stroma and thylakoids stacked in grana. The chlorophyll is built into the membranes of the thylakoids. Chlorophyll absorbs white light but it looks green because white light consists of three primary colors: red, blue, and green. Only red and blue light is absorbed thus making these colors unavailable to be seen by our eyes while the green light is reflected which makes the chlorophyll looks green. However, it is the energy from red light and blue light that are absorbed and will be used in photosynthesis. The green light that we can see is not absorbed by the plant and thus, cannot be used in photosynthesis.

There are two stages of photosynthesis: (a) Light-dependent Reaction and (b) Calvin Cycle (dark reaction). Light-dependent reaction happens in the presence of light. It occurs in the thylakoid membrane and converts light energy to chemical energy. Water-one of the raw materials of photosynthesis-is utilized during this stage and facilitates the formation of free electrons and oxygen. The energy harvested during this stage is stored in the form of ATP (Adenosine Triphosphate) and NADPH(Nicotinamide Adenine Dinucleotide Phosphate Hydrogen). These products will be needed in the next stage to complete photosynthetic process.

Calvin Cycle (dark reaction) is a light-independent phase that takes place in the stroma and converts Carbon dioxide (CO_2) into sugar. This stage does not directly need light but needs the products of light reaction. This is why it occurs immediately after the light-dependent phase.

The chemical reaction for photosynthesis is:

$$\underset{(CO_2)}{\text{Carbon Dioxide}} + \underset{(H_2O)}{\text{Water}} \xrightarrow[\text{Sunlight}]{\text{Chlorophyll}} \underset{(C_6H_{12}O_6)}{\text{Glucose}} + \underset{(O_2)}{\text{Oxygen}}$$

What do you think are the plant structures that enable a plant to make food? Try the activities below to find out.

Listen to your teacher for further instructions on how you can complete the task in the activities that follow.

Activity 1

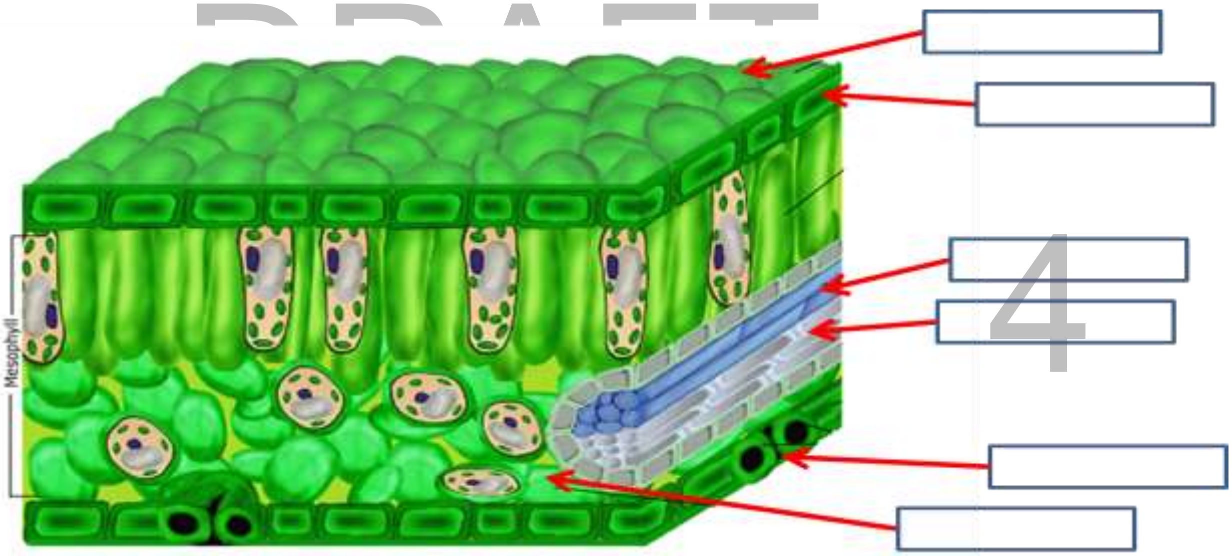
What are the structures involved in the food making process in plants?

You will go to different learning stations by group and will visit some websites found on the activity sheets provided by your teacher. These websites contain information about the plant structures and processes involved in photosynthesis. As you visit the websites in different learning stations you must answer the questions.

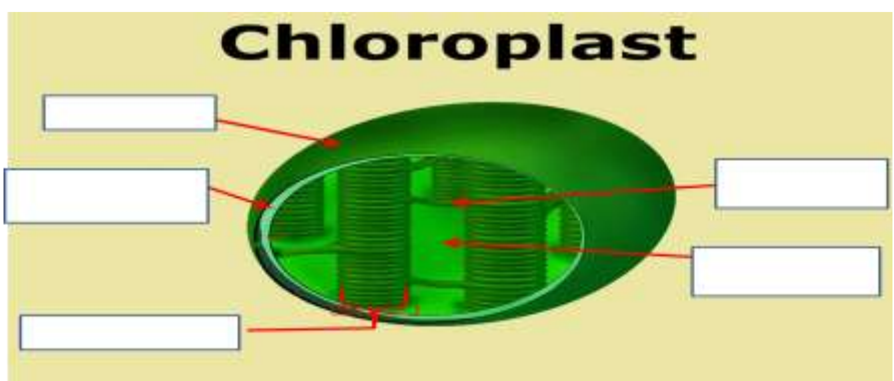
Learning station 1: Plant Structure for Photosynthesis

Label the parts of a chloroplast and the internal structure of a leaf. Write your answer in the box.

A. **Internal structure of a leaf**



B. **Chloroplast**



Source: http://dendro.cnre.vt.edu/forestbiology/photosynthesis.swf

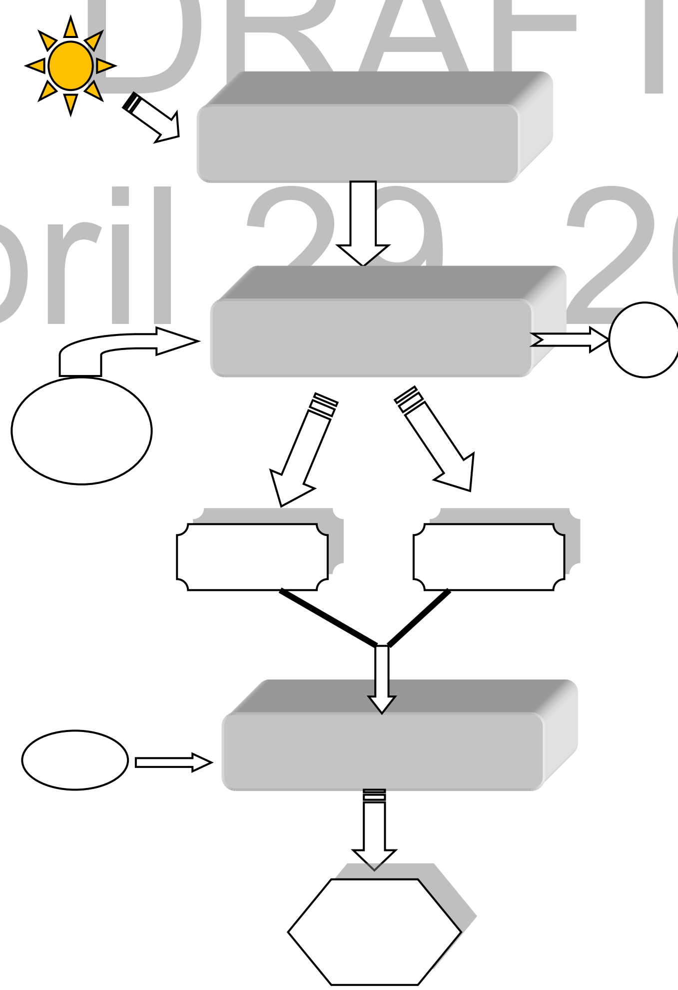
Learning Station 2: Identify the raw materials and end products of photosynthesis.

Complete the table below: Write the raw materials and products of photosynthesis.

Raw Materials	Products

Learning Station 3: Understanding the Process of Food making

After watching the video clip on photosynthesis, make a concept map of the entire process by filling up the figures with the processes involved, raw materials used, and end products of the entire process of food making.



KEY CONCEPTS:

Plants have green pigments called **chlorophyll** stored in the **chloroplast.** This pigment aids in capturing light energy from the sun that enables plants to change it into chemical energy stored in the food. This process is called **photosynthesis**.

$$\underset{(CO_2)}{\text{Carbon Dioxide}} + \underset{(H_2O)}{\text{Water}} \xrightarrow[\textbf{Chlorophyll}]{\textbf{Sunlight}} \underset{(C_6H_{12}O_6)}{\text{Glucose}} + \underset{(O_2)}{\text{Oxygen}}$$

Now that you understand photosynthesis, try to look and examine the structure that enables the entrance and exit of gases in the leaf.

Activity 2 Investigating the Leaf Stomata

Objectives:

- **Identify the stomata**
- **Describe the function of the stomata**

Materials:

Leaf of *Rheo discolor* (boat lily)
Glass slide
Microscope
Clear nail polish
Clear tape

Procedure:

1. Paint a thick patch of clear nail polish on the lower surface of the leaf.
2. Allow the nail polish to dry completely.
3. Put a clear tape to the dried nail polished patch.
4. Gently peel the nail polished patch by pulling the corner of the clear tape. This will serve as your leaf impression for microscopic observation.
5. Tape your leaf impression on a clean glass slide.
6. Observe the leaf impression under low power objective of the microscope. Have you seen similar structures as shown in Figure1?

   Q1. Draw and label the stomata as seen under the microscope. Which do you think are the stomata?

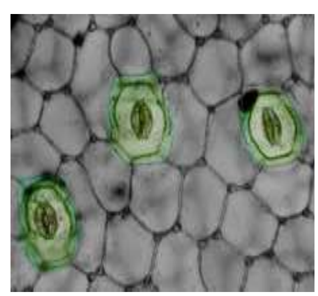


Figure 1: Stomata

Source: http://www.flickr.com/photos/ajc1/8642458098/

KEY CONCEPTS:

Stomata are found on the lower surface of the leaf that allows the entrance of carbon dioxide needed for photosynthesis. They also serve as exit point for the oxygen produced during photosynthesis.

Are you excited to know more about photosynthesis? This time you will conduct investigations that will show evidences that plants are really capable of making food.

Activity 3 Evidence of Photosynthesis

3A. To show that oxygen is produced by photosynthesis (Santan leaf can be used if Elodea or Hydrilla is not available)

Materials:

Test tube   water   available plant sample

Procedure:

1. Place a fresh Santan leaf or Elodea or Hydrilla inside a test tube. Add water to the test tube to cover the leaf or plant.
2. Leave the setup for about 10 to 15 minutes at room temperature (29°C).
3. Observe the set-up.

Figure 2: Sample set-up

Q2. What did you see on the leaf/plant?

____.

Q3. Did you see any bubbles in the set-up?

____

Q4. What do these bubbles indicate?

____

3B. To show that sugar is produced by photosynthesis

Materials:

Tincture of iodine	Medicine dropper	Wire gauge
Denatured alcohol	Beaker	Box of matches
Water bath	Petri dish	Fresh leaf of mayana
Alcohol lamp	Tripod	

Procedure:

1. Get a coleus leaf (mayana).
2. Remove the leaf color by boiling it in alcohol. To do this, follow the steps below:
   A. Fill the beaker (3/4 of its capacity) with water. Let it boil. See Figure 3 for the sample set-up.
   B. While waiting for the water to boil. Get a leaf sample and place it on a test tube. Pour denatured alcohol into the test tube, until the leaf has been submerged. See Figure 3 for the sample setup.

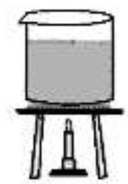


Figure 3

   C. When the water in the beaker boils, place the test tube with leaf and alcohol in it. Let the water boil for another three minutes or until all the color of the leaf has been extracted. See Figure 4 for the sample setup.

Figure 4

3. Remove the test tube from the beaker. Then, get the leaf out of the test tube.
4. Rinse the leaf with water, and then place it on a petri dish.
5. Put drops of iodine, until the leaf has been soaked.
6. Observe the leaf. **If the color of the leaf turns to bluish black, it indicates the presence of starch. No change in color indicates absence of starch.**

   Q5. What can you infer from your observation?

3C. To show the effect of light on the rate of photosynthesis

Materials:

2 Beakers	2 test tubes
2 Funnels	2 Santan leaf or twigs of Hydrilla or Elodea
Glowing splinter	

Procedure:

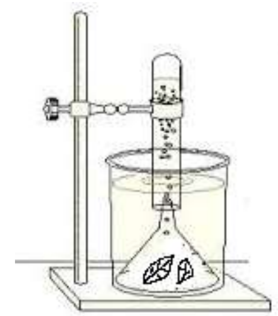


Figure 5: Sample set-up

1. Make two setups similar to Figure 5.
2. Take 2-3 pcs. of small Santan leaves and place them in a glass funnel
3. Invert the funnel in a beaker of water.
4. Invert a test tube over the stem of the funnel.
5. Leave one of the setups in sunlight for three minutes. At the same time, cover the other setup with a black garbage bag in a shaded area or room.
6. Count the number of bubbles every 30 seconds and record it in the observation table.
7. Plot the data on a graphing paper.

Caution **Do not insert the glowing splinter without the teacher's supervision**

Optional: Remove the test tube carefully and insert a glowing splinter deep into it. The splinter burns brightly. It indicates that oxygen is the gas collected in the test tube.

Observation Table:

Time (seconds)	No. of Bubbles Produced	
	Exposed leaf	Covered leaf
30		
60		
90		
120		
150		
180		
210		

Q6. Which setup produced more bubbles?

____

Q7. What do the bubbles indicate?

____

Q8. What gas is collected by the downward displacement of water in the test tube?

____

Q9. What happens to the number of bubbles as time passed?

____

Q10. How did you know that photosynthesis has taken place?

Q11. How does the amount of light affect the rate of photosynthesis?

3D. To show that carbon dioxide is needed in photosynthesis
(*adapted from DepEd NSTIC Science II, Exercise 9, pages 20-22*)

1. **Testing for the presence of carbon dioxide**

Materials:

4 Test tubes
4 Rubber stoppers
2 500 mL empty mineral water bottles with cap
1 Graduated cylinder
Drinking straw
lime water

Procedure:

a) Label the test tubes A and B.
b) Measure 5 mL of lime water using a graduated cylinder and pour into test tube A and test tube B.
c) Use a straw to blow air into **test tube A, a**s shown in Figure 6.
d) Cover it immediately with a rubber stopper. (Note that exhaled air contains 3-4% carbon dioxide.)
e) Cover test tube B with rubber stopper
f) Shake both test tubes very well.

Photo credit: taken from DepEd-NSTIC Manual

Figure 6. Student blowing air into the test tube

Q12. What happened to the contents of the two test tubes?

Write your observations in the table below.

Table1.

Setup	Observation	Possible Explanation
Test tube A (exhaled with air)		
Test tube B		

2. Photosynthesis and carbon dioxide

Materials:

Small fresh leaves	drinking straw
Water	2 Test tubes
Limewater	2 Rubber stoppers
Test tube rack	

Procedures:

a) Prepare two test tubes; label them test tube C and test tube D.

Photo Credit: Maricel Peña-SJDMNHS

Figure 7a. Test tubes C and D

b) With the use of a drinking straw, blow air into test tube C.

c) Insert two to three small leaves into the test tubes gently. Don't compress the leaves because they won't be able to absorb adequate carbon dioxide.

d) Cover both test tubes with a rubber stopper. See Figure 7b.

e) Place the two test tubes on a test tube rack. And put them under sunlight for 20 minutes.

f) After 20 minutes, get back the two test tubes and bring them back to your working area.

g) Add 5 mL of lime water to each test tube and cover with rubber stopper.

Figure 7b. Sample Set-up

Photo Credit: Maricel Peña-SJDMNHS

h) Shake well. Observe what happens to the contents of the two test tubes.

Write your observation on Table 2.

Table 2.

SetUp	Observation	Possible Explanation
Setup C		
Setup D		

Carbon dioxide is one of the important materials to enable plants to produce food.

After investigating the evidences that plants are photosynthetic organisms, the next thing that you will do is to conduct another experiment that will show the factors affecting the rate of photosynthesis. This will tell you how you can speed up the process of food making and how it can affect the quantity and quality of harvests.

3E. To show the effect of the varying amount of chlorophyll in the rate of photosynthesis.

Materials:

1 fresh coleus leaf (mayana)	Alcohol lamp
Denatured alcohol	Beaker
Petri dish	Wire gauze
Tripod	Test tube
Medicine dropper	Tincture of iodine

Procedure:

Figure 8. Mayana Leaf

a) Get a variegated fresh coleus leaf (mayana) as shown in Figure 8.
b) Draw the leaf. Shade the green parts. Label it Leaf A.
c) Remove the chlorophyll from the leaf by boiling it in alcohol. To do this, follow the steps below.
   1. Fill the beaker with (3/4 of its capacity) with water. Let it boil.
   2. While waiting for the water to boil, get the leaf sample, then place it in a test tube.
   3. Pour alcohol in the test tube until the leaf has been completely soaked as shown in Figure 9.
   4. When the water in the beaker boils, place the test tube in it. Let the water boil for another three minutes or until all the colors of the leaf have been extracted as shown in Figure 10.

Figure 9

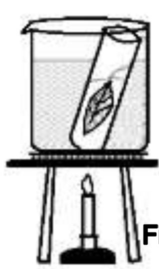


Figure 10

Caution — **Keep the alcohol away from the fire!**

Q19. What changes did you observe?

____

Q20. What do you think caused the changes?

____

d) Using a test tube holder, remove the test tube from the beaker using. Then get the leaf out of the test tube.
e) Rinse the leaf with water and place it on a petri dish.
Q21. What happened to the leaf after boiling?
____
Q22. What can you infer from your observation?______________________
____
f) To test for the presence of starch, put drops of iodine until the leaf has been soaked.
g) Observe the leaf. Draw the leaf and shade the bluish black area. Label it Leaf B.
h) Compare your drawings of leaf A and leaf B.
Q23. Which part of the leaf is shaded?___________________
Q24. Which part of the leaf produced more starch?____________
Q25. How does the presence of green pigment affect the production of starch? ____

KEY CONCEPTS:

> The factors that affect the rate of photosynthesis are temperature, carbon dioxide, water, and light. Providing the plant with the right amount of these materials will ensure good quality and quantity of the harvest.

Cellular Respiration

All heterotrophic organisms including man, depend directly or indirectly on plants and other photosynthetic organisms for food. Why do we need food? Organisms need food as the main source of energy. All organisms need energy to perform essential life processes.

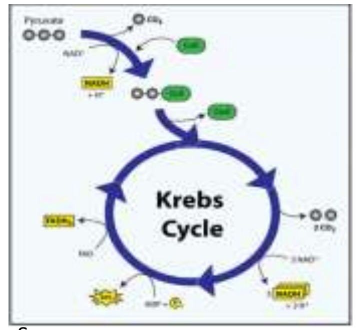
The food must be digested to simple forms such as glucose, amino acids, and triglycerides. These are then transported to the cells. The immediate energy source of the cells is glucose. Glucose inside the cell is broken down to release the stored energy. This stored energy is harvested in the form of adenosine triphosphate (ATP). ATP is a high-energy molecule needed by working cells.

Glycolysis

In glycolysis, the 6-carbon sugar, glucose, is broken down into two molecules of a 3-carbon molecule called pyruvate. This change is accompanied by a net gain of 2 ATP molecules and 2 NADH molecules.

Krebs Cycle

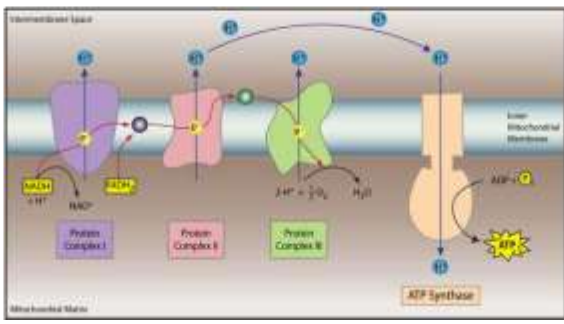
The Krebs Cycle occurs in the mitochondrial matrix and generates a pool of chemical energy (ATP, NADH, and $FADH_2$) from the oxidation of pyruvate, the end product of glycolysis.



Source: http://www.hartnell.edu/tutorials/biology/cellularrespiration.html

Pyruvate is transported into the mitochondria and loses carbon dioxide to form acetyl-CoA, a 2-carbon molecule. When acetyl-CoA is oxidized to carbon dioxide in the Krebs cycle, chemical energy is released and captured in the form of NADH, $FADH_2$, and ATP.

Electron Transport Chain



Source: http://www.hartnell.edu/tutorials/biology/cellularrespiration.html

The electron transport chain allows the release of the large amount of chemical energy stored in reduced NAD^+ (NADH) and reduced FAD ($FADH_2$). The energy released is captured in the form of ATP (3 ATP per NADH and 2 ATP per $FADH_2$).

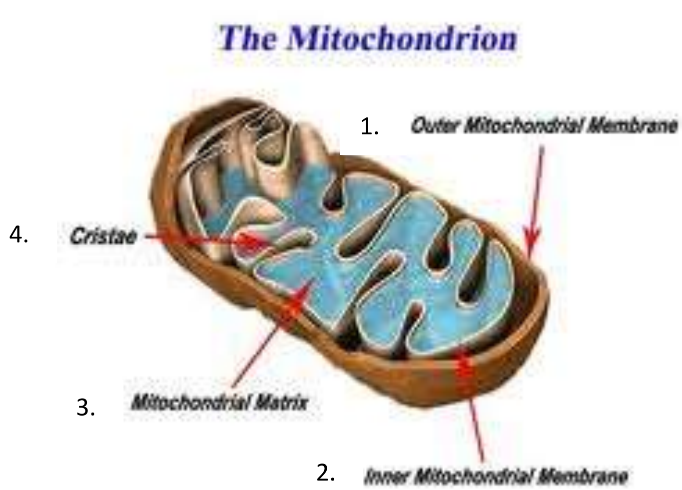
The electron transport chain (ETC) consists of a series of molecules, mostly proteins, embedded in the inner mitochondrial membrane. This phase of cellular respiration produces the greatest number of chemical energy in the form of ATP.

In the following activities, you will learn how the chemical energy of "food" molecules is released and partially captured in the form of ATP (Adenosine Triphosphate). You should learn first the part of the cell where ATP is produced.

Activity
4
The Power House!

Mitochondria are membrane-enclosed organelles distributed through the cytoplasm of most eukaryotic cells. Their main function is the conversion of the potential energy of food molecules into ATP. This organelle has important parts. An outer membrane encloses the entire structure that contains many complexes of integral membrane proteins that form openings. A variety of molecules and ions move in and out of the mitochondrion through the openings. An inner membrane encloses a fluid-filled matrix. This membrane contains five complexes of integral proteins such as:

- NADH dehydrogenase
- succinate dehydrogenase
- cytochrome c reductase (the cytochrome b-c1complex)
- cytochrome c oxidase
- ATP synthase



Task: Describe each part of the mitochondrion.

Eg. Cristae are the inner folded membrane of the mitochondrion.

KEY CONCEPTS:

Mitochondrion is considered as the power house of the cell. It plays an important role in the breakdown of food molecules to release the stored energy in the form of ATP (Adenosine Triphosphate).

Activity 5

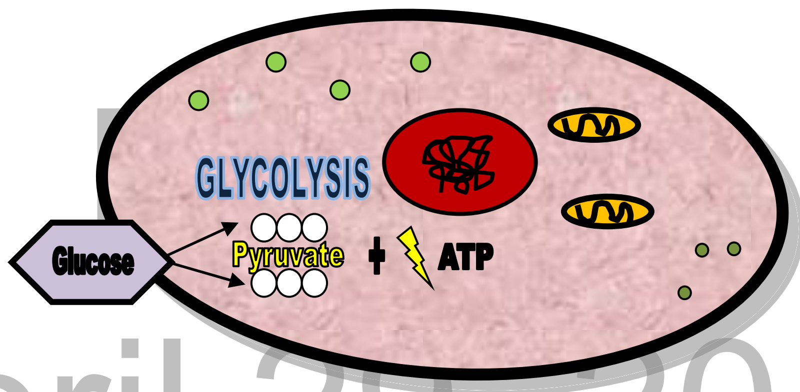
Let Us ReCharge!

In this activity, you will learn the basic concept of how your cells release the energy from the food you eat. Thus, you will understand how your eating habits and daily activities affect the production and storage of energy of your body cells.

B. Understanding Glycolysis

Wait for further instructions to be given by your teacher.

Look at the diagram below and answer the questions that follow.



Guide Questions:

Q26. Which of the terms found in the diagram is considered a process?

____

Q27. In which part of the cell does the process take place?

____

Q28. What is the raw material?

____

Q29. What are the products?

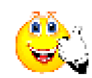
____

Based on the diagram shown above, briefly describe the first step of cellular respiration, emphasizing the location, raw materials needed and the end products.

____
____
____
____.

Use the task checklist below as your guide in describing the first metabolic process of cellular respiration.

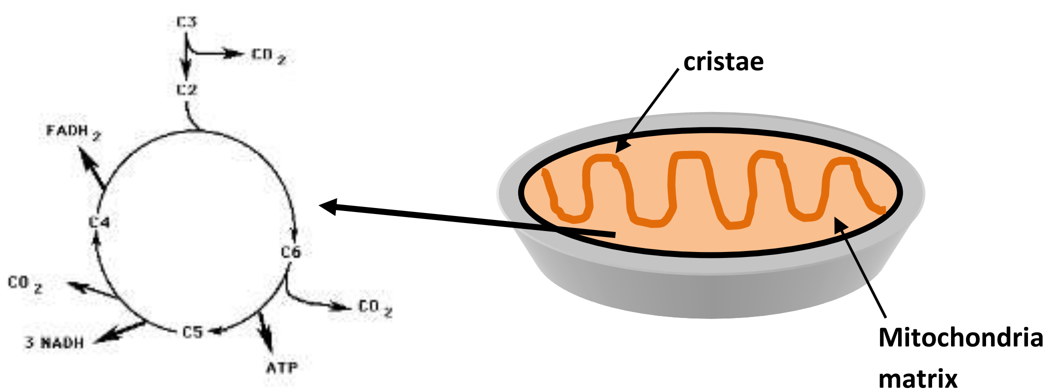
Task Checklist

Category		
Content: • States the raw materials and products of glycolysis • Tells specifically the location in the cell where it takes place.		
Organization of data: The ideas are presented in the right order, beginning with where the process takes place, the raw materials used, up to the processes involved in the formation of end products.		
Spelling: All words are spelled correctly **.**		

C. Let us go round and round..

You have understood and identified the raw material and end products of Glycolysis. This time you will see the importance of the end products of Glycolysis in the next stage, the KREBS CYCLE.

Your task is to arrange the following events in the Krebs Cycle in proper sequence. Base your answer on the diagram. Assign numbers 1-7 in the space provided to indicate the correct sequence of events; then rewrite them in a paragraph form.



_____ A. In a series of steps, the hydrogen and high energy electrons are removed from the 2-carbon molecule.

_____ B. The 2-carbon molecule enters the cycle and joins a 4-carbon molecule.

_____ C. One ATP is formed.

_____ D. Two carbon dioxide are released.

_____ E. Three NAD^+ are converted to 3 NADH and 3 H^+.

_____ F. At the end of the cycle, nothing remains of the original glucose molecule.

_____ G. One FAD is converted into 1 $FADH_2$.

____
____
____
____
____

D. Pump it out!

You will watch a short video clip about oxidative phosphorylation or electron transport chain, the final stage of cellular respiration. After viewing the clip, answer the following questions. The animation of electron transport chain can be viewed on the link below.

http://www.hartnell.edu/tutorials/biology/cellularrespiration.html

Q30. How will you describe the flow of electrons? ____

Q31. What do you think is the importance of NADH and $FADH_2$ in the process?____

Q32. What is the final acceptor of the electron in the process? ____

Q33. What compound is formed when the electron combines with the last acceptor? ____

The electrons in NADH and $FADH_2$ flow through a series of electron transport acceptors. The flow of electrons and H^+ results in ATP formation. The last electron (hydrogen ions) combine with the last acceptor (oxygen) to form water.

$$\underset{(C_6H_{12}O_6)}{\text{Glucose}} + \underset{(O_2)}{\text{Oxygen}} \longrightarrow \underset{(CO_2)}{\text{Carbon dioxide}} + \underset{(H_2O)}{\text{Water}} + \text{ATP}$$

Activity 6

Comparing Photosynthesis and Respiration

There is recycling of materials through the chloroplast and mitochondrion. Study the diagram below.

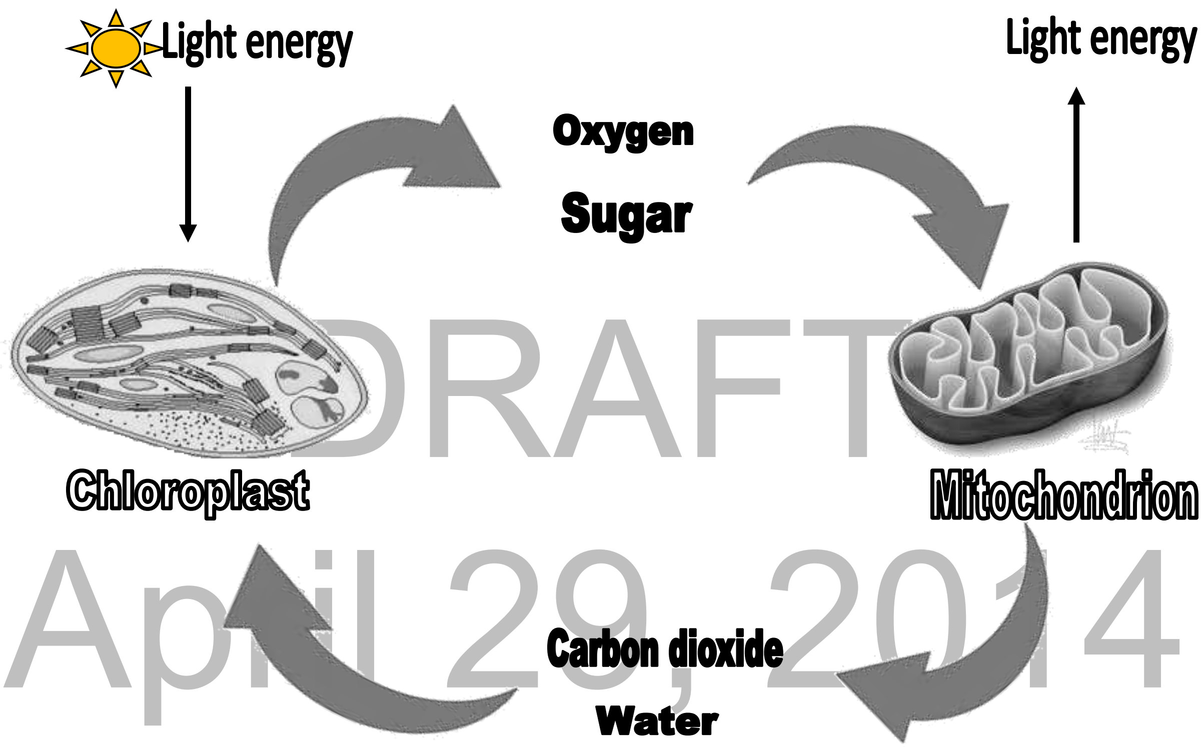


Table 2. Comparing Photosynthesis and Respiration

Basis of Comparison	Photosynthesis	Respiration
1. Cell structure involved		
2. Starting materials/raw materials		
3. End product		
4. Energy requirement		

Materials are recycled through the processes of photosynthesis in the chloroplast and respiration in the mitochondrion. However, the flow of energy is one-way.

Performance Task:

Now you have understood how energy from the sun is captured and converted to life energy. This time, you will try to provide possible solutions to a community problem or issue on food production. Most communities in urban areas depend mostly on the supply of the crops from rural areas. What you need to do is to provide urban communities with insights on how they can build small urban gardens in their homes. You will apply what you have learned in photosynthesis.

Each group may develop a material such as brochure, multimedia presentation, a facebook page, or a web page that contains tips and information on how to put up an urban garden for crops suited for homes with limited space for planting.

Your teacher will give you detailed instructions on this task. Use the rubric as your guide in planning, doing, and completing the task which will be provided to you by your teacher. Your teacher will also give you a progress checklist form to help you keep track of and monitor your progress.

Summary

- Through the process of photosynthesis, plants and other chlorophyll-bearing organisms produce food for themselves.
- In photosynthesis, plants capture light energy and convert it into chemical energy stored in food.
- The summary equation for photosynthesis is as follows:

  $$\textbf{Carbon dioxide} + \textbf{water} \xrightarrow[\textbf{chlorophyll}]{\textbf{sunlight}} \textbf{glucose} + \textbf{oxygen}$$
- Photosynthesis occurs in the chloroplast found in the leaves of plants.
- Essentially, the two major stages in photosynthesis are:
  - Light reaction phase
  - Calvin Cycle
- Improved farming practices enhance photosynthesis that result in good harvest.
- Cellular respiration occurs in the mitochondria of the cells.
- Organisms release stored energy in food through the process of respiration.
- Respiration breaks down glucose into carbon dioxide, water and energy (ATP) in the presence of oxygen.
- The summary equation of respiration is as follows:

  $$\text{Glucose} + \text{oxygen} \longrightarrow \text{carbon dioxide} + \text{water} + \text{ATP}$$
- The breakdown of glucose involves three major steps: glycolysis, Krebs cycle; electron transport chain

SUMMATIVE TEST:

Choose the letter of the best answer. Write your answer on your answer sheet.

1. A farmer is experiencing a problem in growing his crops. Most of the leaves of the crops are turning yellow. Which of the following will likely result from the yellowing of the leaves of the crops?
   a. It will increase the production of food.
   b. It will decrease the production of food.
   c. The production of food will remain the same.
   d. None of the above.

2. Abby wants to know if leaves are capable of making food during nighttime. Which of the following experimental design should Abby do to get an accurate answer to her question?
   a. Put one potted plant in a very dark place over night and test for the presence of starch.
   b. Cover the plant with paper bag overnight and test for the presence of starch.
   c. Put one potted plant under the sun and the other in a shaded area for two hours and test for the presence of starch.
   d. Cover one leaf of a potted plant with carbon paper for two hours and test for the presence of starch.

3. Which of the following materials are cycled out by the chloroplast and mitochondrion?
   a. Carbon dioxide, water, oxygen, and ATP
   b. Carbon dioxide, water, sugar and oxygen
   c. Sugar, water, oxygen, and ATP
   d. Sugar, water, sunlight, and oxygen

4. When cells breakdown a sugar molecule completely to produce chemical energy (ATP), the cells need the following materials_________
   a. Sugar and oxygen
   b. Sugar and water
   c. Sugar only
   d. Sugar and carbon dioxide

5. A vegetable farmer wants to increase his harvest. Which of the following conditions should the farmer consider?
   a. The kind of soil only
   b. The amount of water only
   c. The location of the plots only
   d. All of the above

6. Oxygen is essential in cellular respiration. What is the role of oxygen in the electron transport chain?
   a. It provides a high energy proton.
   b. It releases an electron.
   c. It serves as the final acceptor.
   d. It forms water.

7. What will happen if ATP and NADPH are already used up at night?
   a. Less oxygen will be produced.
   b. Less carbon dioxide will be used.
   c. Glucose production will stop.
   d. Water molecule will split to form electrons.
8. Which of the following best explains why planting trees and putting up urban gardens can help prevent global warming?
   a. Plants produce oxygen during day time and perform transpiration.
   b. Plants absorb carbon dioxide that contributes to the rising of earth's temperature.
   c. Plants perform photosynthesis.
   d. Plants use up carbon dioxide during photosynthesis, release oxygen to the environment, and perform transpiration.
9. Sugarcane juice is used in making table sugar which is extracted from the stem of the plant. Trace the path of sugar molecules found in the stem from where they are produced.
   a. Root ---- stem
   b. Leaf ----- stem
   c. flowers ---- leaf ----stem
   d. roots --- leaf ---- stem
10. When cells break down food into chemical energy it undergoes three major processes, glycolysis, Krebs cycle and electron transport. Which of these processes provides the most number of ATP molecules?
   a. Glycolysis b. Krebs cycle c. electron transport chain d. no idea

GLOSSARY

Adenosine Triphospate (ATP): compound that stores energy in the cell

Autotrophs: organisms that can make their own food.

Calvin Cycle: name given to the cycle of dark reaction in photosynthesis

Cellular Respiration: catabolic process pathways of aerobic and anaerobic respiration, which break down organic molecules for the production of ATP.

Chlorophyll: green pigment in the chloroplast of photosynthetic organisms that captures light energy

Chloroplast: organelle found in photosynthetic organisms that absorb sunlight and use it to synthesize carbon dioxide and water

Cristae: inner folded membrane of the mitochondrion

Guard Cell: specialized epidermal cell that controls the opening and closing of the stomata by responding to the changes in water pressure

Heterotrophs: organisms that cannot make food

Krebs Cycle: cyclical series of reaction in cellular respiration that produces carbon dioxide, NADH, and $FADH_2$

Light Reaction: stage/phase of photosynthesis that require light

Mitochondrial Matrix: the compartment of the mitochondrion enclosed by the inner membrane, containing enzymes and substrates for the citric acid cycle.

Mitochondrion: organelle that serves as site for cellular respiration

Photosynthesis: process done by autotrophs of converting light energy into chemical energy that is stored in food (sugar).

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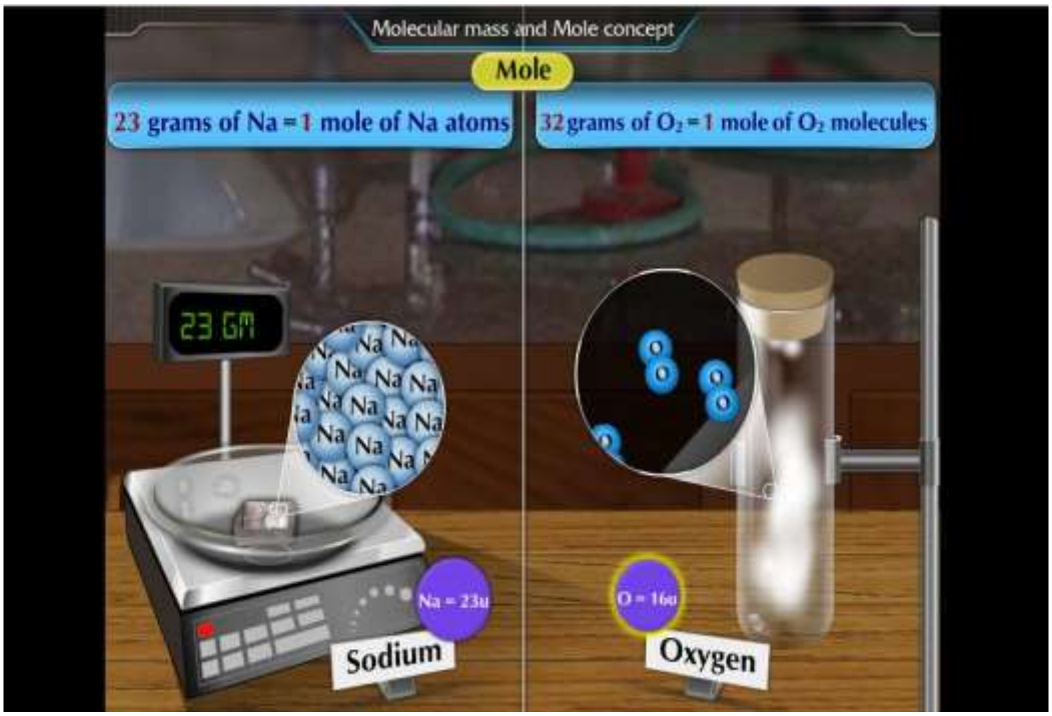
Unit 2: Countless and Active Particles of Matter



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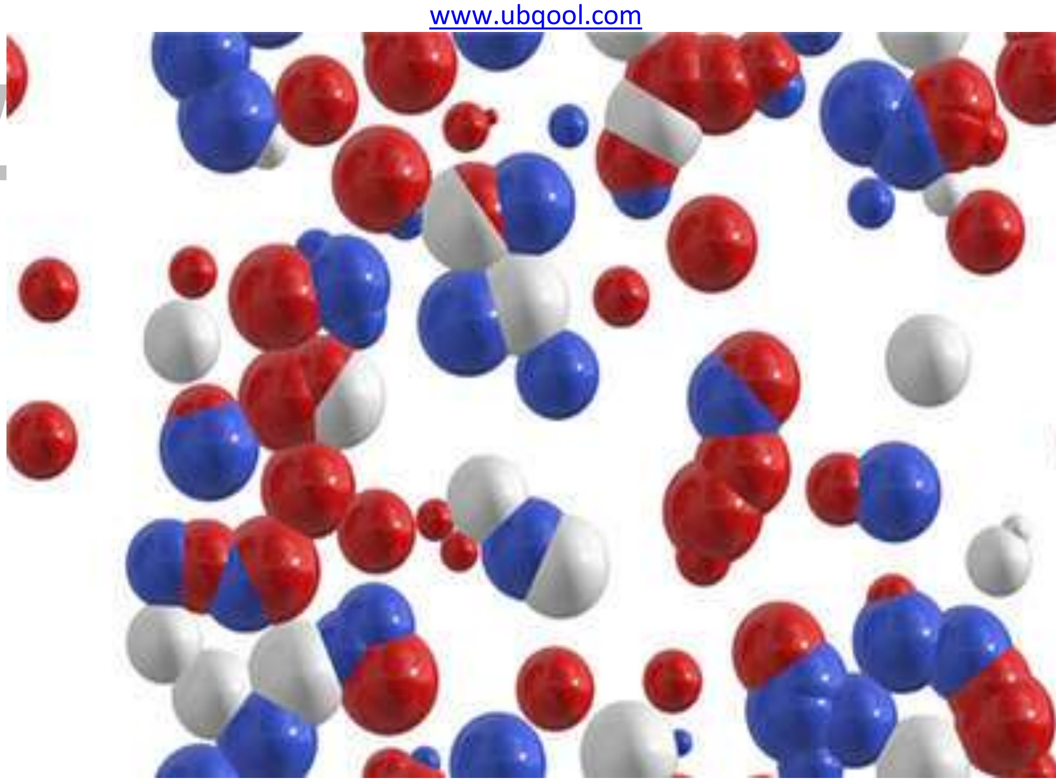

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Unit 2: Countless and Active Particles of Matter

Overview:

In Grade 8 Chemistry, you have learned about the particles of matter. How it can be used in explaining properties, physical changes, structure of substances and mixtures. You also learned that particles of matter like atoms are composed of electrons, protons, and neutrons. An atom has its own structure distinct from the other kind of atoms. Atoms are present in the elements and these elements are arranged in the periodic table which can be used as a tool in determining the properties of elements.

This school year your knowledge about matter will increase as you study this unit. This unit will provide an opportunity to learn additional atomic models which you can use in understanding how atoms chemically combine with one another to form bonds producing compounds. Through this unit, you will also discover that this phenomenon is responsible for the numerous organic compounds available for us. Lastly, you will get to know the mole concept which will give you an idea on how much particles are equal to one mole and how heavy it is.

Unit 2 is composed of the following modules:

Module 1: Electronic Structure of Matter
Module 2: Chemical Bonding
Module 3: The Carbon Compounds
Module 4: What's in a Mole?

Each module is packed with interesting activities which will make you enjoy chemistry class even more.

Are you ready for the continuation of chemistry learning? You may now start with Module 1.

Unit 2
MODULE
1

Suggested Time allotment: 4 hours

Electronic Structure of Matter

Overview

In Grade 8, you have learned the Rutherford's atomic model which pictures the atom as mostly empty space and its mass is concentrated in the nucleus, where you find the protons and the neutrons. This model has worked well during his time, but it was only able to explain a few simple properties of atoms. However, It could not explain why metals or compounds of metals give off characteristic colors when heated in a flame, or why objects–when heated to much higher temperatures first glow to dull red, then to yellow, and then to white. A model different from Rutherford's atomic model is necessary to describe the behavior of atoms

Niels Bohr refined Rutherford's model of an atom. Based on his experiments, Bohr described the electron to be moving in definite orbits around the nucleus. Much later, scientists discovered that it is impossible to determine the exact location of electrons in an atom. In Activity 1, you will learn about the evidence that Bohr used to explain his model of the atom. In Activity 2, you will do a task that will help you understand that there is a certain portion of space around the nucleus where the electron is most likely to be found.

In addition, you will know more about the present model of the atom, which is called the quantum mechanical model of the atom. It is important for you to understand that the chemical properties of atoms, ions and molecules are related to how the electrons are arranged in these particles of matter. You will find out the answers to the following questions as you perform the activities in this module.

How does the Bohr atomic model differ from Rutherford's model? What is the basis for the quantum mechanical model of the atom? How are electrons arranged in the atom?

The questions above were anchored on the following learning competencies:

- Describe how the Bohr Model of the atom improved Rutherford's Atomic Model.
- Explain how the Quantum Mechanical Model of the atom describes the energies and positions of the electrons.

Excited to discover the answers to the above sited questions? Before you start studying this module, answer the following pre-assessment.

Pre-Assessment:

1. On the basis of Rutherford's model of an atom, which subatomic particle is present in the nucleus of an atom?

a. proton and electron
b. neutron and electron
c. proton and neutron
d. proton only

2. If the first and second energy levels of an atom are full, then what would be the total number of electrons in the atom?

a. 6 b. 8 c. 10 d.18

3. Which atomic model is proposed by Schrodinger?

a. nuclear model
b. planetary model
c. raisin bread model
d. quantum mechanical model

4. Which electron transition results in the emission of energy?

a. 3p to 3s
b. 3p to 4p
c. 2s to 2p
d. 1s to 2s

5. The symbol "n" in the Bohr theory of atomic structure refers to

a. the energy of electron
b. the total energy of the atom
c. the number of electron in an energy level
d. the orbit in which an electron is found.

6. Which of the following sublevels is correctly designated?

a. $1p^5$ b. $3f^9$ c. $2p^6$ d. $3d^{11}$

7. How many orbitals are in the third principal energy level?

a. 3 b. 6 c. 9 d. 12

8. Which configuration is possible in an excited state of electron?

a. ${}_2He$: $1s^2$
b. ${}_1H$: $1d^1$
c. ${}_{11}Na$: $1s^2\ 2s^2\ 2p^6\ 3d^1$
d. ${}_{10}Ne$: $1s^2\ 2s^2\ 2p^5\ 3s^1$

9. What are the orbitals present in the fifth principal energy level?

a. s orbital b. s, p orbitals c. s, p, d orbitals d. s, p, d, and f orbitals

10. For a neutral atom with the electron configuration of $1s^2\ 2s^2\ 2p^5\ 3s^1$, which statement is *false*?

a. The atomic number is ten.
b. The 1s and 2s orbitals are filled
c. The atom is in the ground state.
d. The atom is in the excited state

As early as the 17th century, knowledge about the structure of the atom grew when scientists began to study the emission and absorption of light from different elements. In Grades 7 and 8, you have learned about the characteristics and properties of light. As you perform Activity 1, you will find out what happens when metal salts are subjected to heat. `The colors you observe could be related to the structure of the atom.

Activity 1: The Flame Test

Objectives:

- determine the characteristic colors that metal salts emit; and
- relate the colors emitted by metal salts to the structure of the atom.

Materials:

0.50 grams of each of the following metal salts:

- Calcium chloride
- Sodium chloride
- Copper(II) sulfate
- Potassium chloride
- Boric acid

- 6 pcs watch glass
- 1 pc 10-ml graduated cylinder
- 1 pc dropper
- safety matches
- 100 mL 95% Ethanol (or ethyl alcohol)
- 100 mL 3 M hydrochloric acid

Precautions:

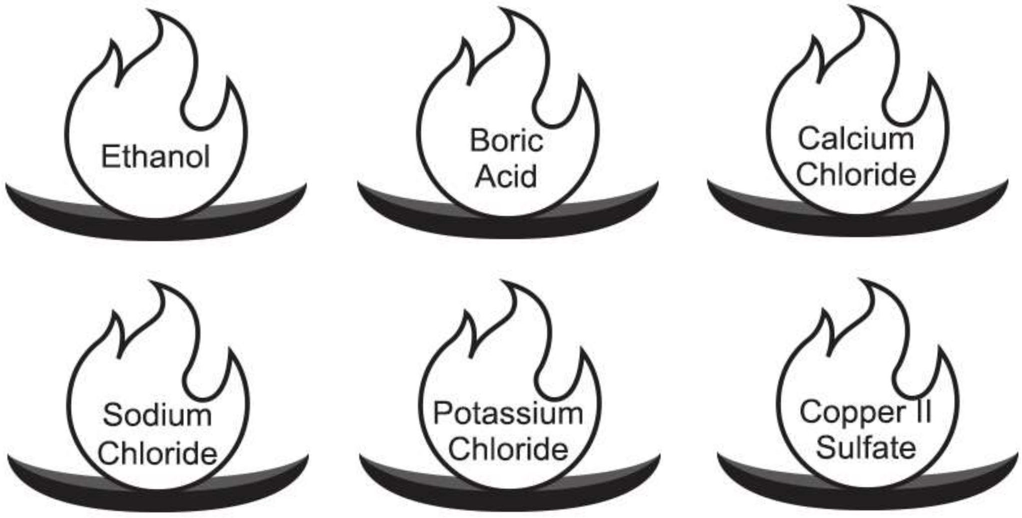
1. **Wear goggles, gloves and a safety apron while performing the activity.**
2. **Do this activity in a well-ventilated area.**
3. **Handle hydrochloric acid with care because it is corrosive.**
4. **Ethyl alcohol is flammable.**
5. **Be careful to extinguish all matches after use.**

Procedure:

1. Place each metal salt on a watch glass and add 2 to 3 drops of 3 M hydrochloric acid.

2. Pour about 3 - 5 mL or enough ethyl alcohol to cover the size of a 1 peso-coin in the first watch glass. Light with a match and observe the color of the flame. (This will serve as reference for comparison of the flame color). Wait for the flame to be extinguished or put out on its own.

3. Repeat procedure No. 2 for each salt. Observe the color of the flame.



4. Write your observation in a table similar to the one below.

Table 1. Color of flame of metal salts

Metal salt tested	Element producing color	Color of the flame
Boric acid	boron	
Calcium chloride	calcium	
Sodium chloride	sodium	
Potassium chloride	potassium	
Copper(II) sulfate	copper	

Q1. Why do you think are there different colors emitted?

Q2. What particles in the heated compounds are responsible for the production of the colored light?

Q3. How did the scientists explain the relationship between the colors observed and the structure of the atom?

You have observed that each of the substances you tested showed a specific color of the flame. Why do certain elements give off light of specific color when heat is applied? These colors given off by the vapors of elements can be analyzed with an instrument called spectroscope. See Figure1.

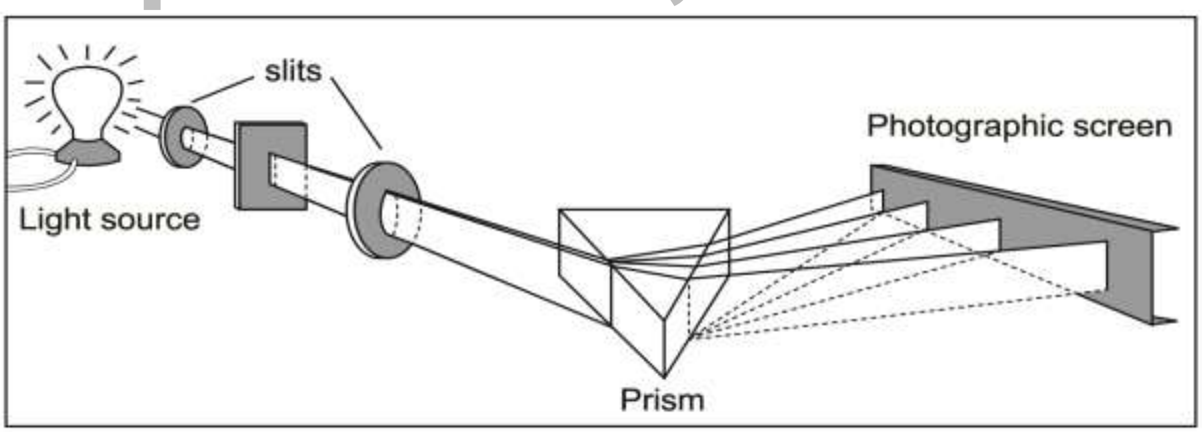


Figure 1. An atomic spectroscope

A glass prism separates the light given off into its component wavelength. The spectrum produced appears as a series of sharp bright lines with characteristic colors and wavelength on a dark background instead of being continuous like the rainbow. We call this series of lines the atomic spectrum of the element. The color, number and position of lines produced is called the "fingerprint" of an element. These are all constant for a given element. See Fig. 2.

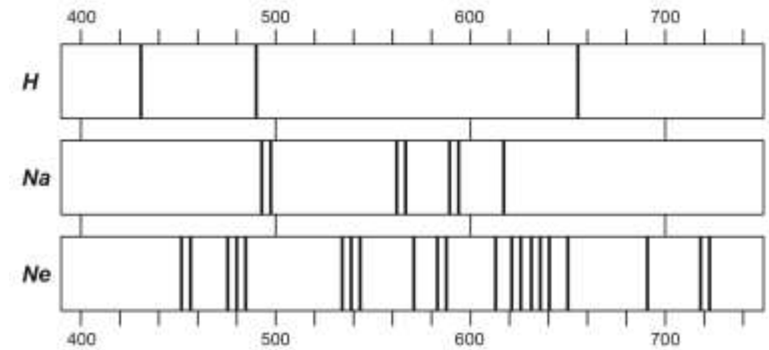


Figure 2. Atomic spectra of H, Na, and Ne

How did Bohr explain what you observed in Activity 1 and the findings about the elements in a spectroscope? Individual lines in the atomic spectra of elements indicate definite energy transformations within the atom. Bohr considered the electrons as particles moving around the nucleus in fixed circular orbits. These orbits are found at definite distances from the nucleus. The orbits are known as the energy levels, n where n is a whole number 1, 2, 3…and so forth.

Electrons in each orbit have a definite energy, which increases as the distance of the orbit from the nucleus increases. As long as the electron stays in its orbit, there is no absorption or emission of energy. As shown in Figure 3, when an electron of an element absorbed extra energy (from a flame or electric arc), this electron moves to a higher energy level. At this point the electron is at its excited state. Once excited, the atom is unstable. The same electron can return to any of the lower energy levels releasing energy in the form of light with a particular color and a definite energy or wavelength. Bohr's model explained the appearance of the bright line spectrum of the hydrogen atom but could not explain for atoms that has more than one electron.

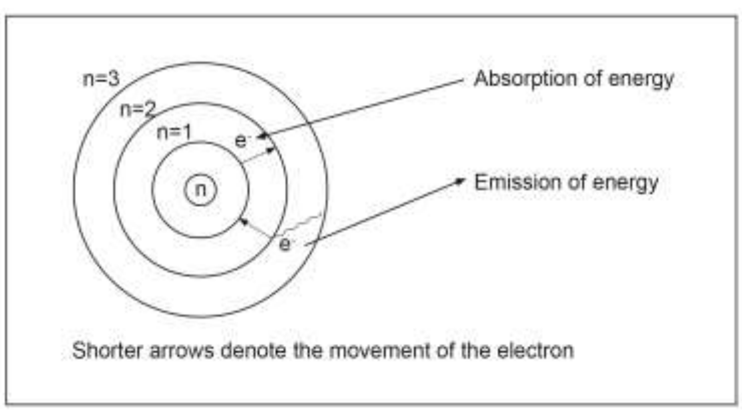
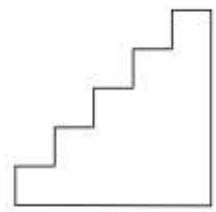


Figure 3. Excited state of an electron

Q4. Explain how your observation in Activity 1 relates to Bohr's model of the atom. You can explain using an illustration.

Q5. Which illustration below represents the energy of the electron as described by Bohr? Explain your answer.

a. 

b 

The energy levels of electrons are like the steps of a ladder. The lowest step of the ladder corresponds to the lowest energy level. A person can climb up and down by going from step to step. Similarly, the electrons can move from one energy level to another by absorbing or releasing energy. Energy levels in an atom are not equally spaced which means that the amount of energy are not the same. The higher energy levels are closer together. If an electron occupies a higher energy level, it will take less energy for it to move to the next higher energy level. As a result of the Bohr model, electrons are described as occupying fixed energy levels at a certain distance from the nucleus of an atom.

However, Bohr's model of the atom was not sufficient to describe atoms with more than one electron.

The way around the problem with the Bohr's model is to know the arrangement of electrons in atoms in terms of the probability of finding an electron in certain locations within the atom. In the next activity, you will use an analogy to understand the probability of finding an electron in an atom.

Activity 2: Predicting the Probable Location of an Electron

Objective:

- Describe how it is likely to find the electron in an atom by probability.

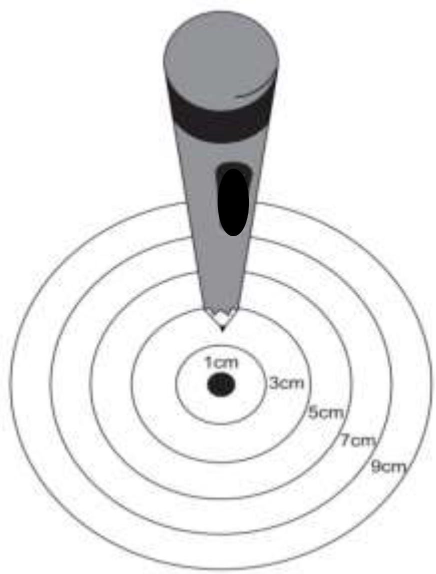
Materials:

One sheet of short bond paper or half of a short folder
pencil or colored marker with small tip
compass
graphing paper
one-foot ruler

Procedure:

1. Working with your group mates, draw a dot on the center of the sheet of paper or folder.

2. Draw 5 concentric circles around the dot so that the radius of each circle is 1.0 cm, 3 cm, 5 cm, 7 cm and 9 cm from the dot



3. Tape the paper on the floor so that it will not move.

4. Stand on the opposite side of the target from your partner.(Target is the center which represent the nucleus of an atom). Hold a pencil or marker at chest level above the center of the circles you have drawn.

5. Take turns dropping the pencil or marker so that it will leave 100 dots on the circles drawn on paper or folder.

6. Count the number of dots in each circle and record that number on the data table.

7. Calculate the number of dots per square centimeter (cm^2).

8. Using a graphing paper, plot the average distance from the center on the x-axis and number of dots per sq.cm on the y-axis.

Data Table:

Circle Number (A)	Average Distance from Center cm (B)	Area of Circle, cm^2 (C)	Difference of Areas of the Two Consecutive Circles, cm^2 (D)	Number of Dots in Circle (E)	Number of Dots per cm^2 (E)/(D) (F)	Percent Probability of Finding dots, % (G)
1	1.0	3.14	25.13	5	0.1920	19.20
2	3.0	28.27	50.27			
3	5.0	78.54	75.40			
4	7.0	153.94	100.53			
5	9.0	254.47	125.66			

Q1. What happens to the number of dots per unit area as the distance of the dots go farther from the center?

Q2. Determine the percent probability of finding a dot in each of the circle drawn on the target by multiplying No. of dots /cm^2 (column D) by the total number of dots (100). For example: In circle 1(A)

Percent probability = No. of dots /cm^2 X 100
= [0.1920 / 100] X 100 = 19.20%

Q3. Based on your graph, what is the distance with the highest probability of finding a dot? Show this in your graph.

Q4. How many dots are found in the area where there is highest probability of finding dots?

Q5.How are your results similar to the distribution of electrons in an atom?

This activity demonstrates what scientists found out that it is not possible to know the exact position of the electron. So, Bohr's idea that electrons are found in definite orbits around the nucleus was rejected. Three physicists led the development of a better model of the atom. These were Louie de Broglie, Erwin Schrodinger, and Werner Karl Heisenberg. De Broglie proposed that the electron (which is thought of as a particle) could also be thought of as a wave. Schrodinger used this idea to develop a mathematical equation to describe the hydrogen atom. Heisenberg discovered that for a very small particle like the electron, its location cannot be exactly known and how it is moving. This is called the *uncertainty principle.*

Instead, these scientists believed that there is only a probability that the electron can be found in a certain volume in space around the nucleus. This volume or region of space around the nucleus where the electron is most likely to be found is called an **atomic orbital**. Thus, we could only guess the most probable location of the electron at a certain time to be within a certain volume of space surrounding the nucleus.

The quantum mechanical model of the atom comes from the mathematical solution to the Schrodinger equation.

The quantum mechanical model views an electron as a cloud of negative charge having a certain geometrical shape. This model shows how likely an electron could be found in various locations around the nucleus. However, the model does not give any information about how the electron moves from one position to another.

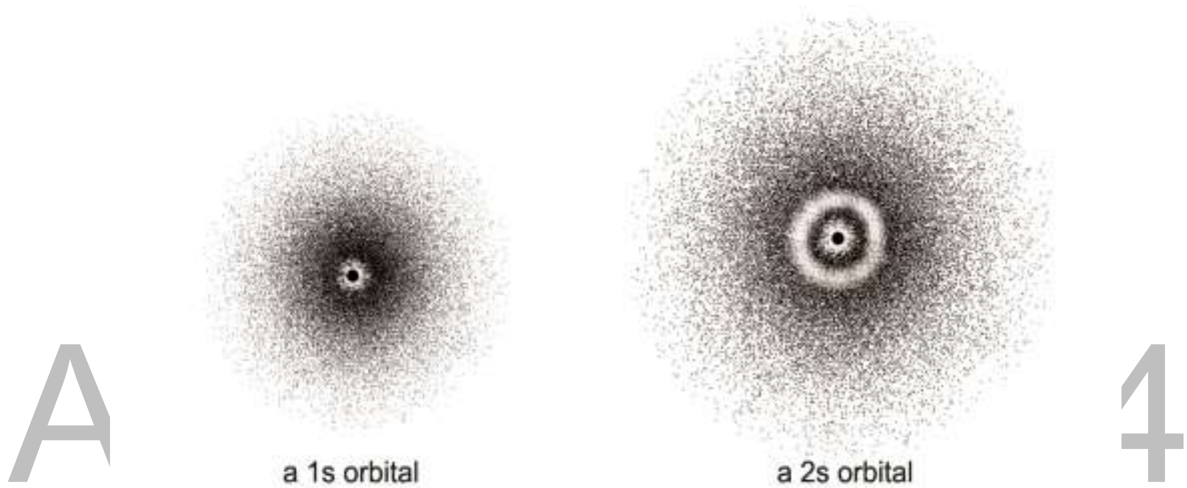


Figure 4. Average distance of electrons having high and low energies

Figure 4 shows that the darker an area, the greater is the probability of finding the electron in that area. The quantum mechanical model also gives information about the energy of the electron. The model also describes the region of space around the nucleus as consisting of *shells.* These shells are also called *principal* or *main energy levels*. The principal energy levels or shells may have one or more sublevels. These sublevels are assigned with letters: *s, p, d, f, and g* as shown in Table 2.

Table 2. Principal Energy Levels and Sublevels of Electrons

Principal energy level, n	Number of Sublevels	Type of Sublevel and number of orbitals	Maximum number of electrons
1	1	1s (1 orbital)	2
2	2	2s (1 orbital), 2p (3 orbitals)	8
3	3	3s (1 orbital), 3p (3 orbitals) 3d (5 orbitals)	18
4	4	4s (1 orbital), 4p (3 orbitals) 4d (5 orbitals), 4f (7 orbitals)	32
5	5	5s (1 orbital), 5p (3 orbitals) 5d (5 orbitals), 5f (7 orbitals) 5g (9 orbitals)	50

As shown in Table 2, the principal quantum number always equals the number of sublevels within that principal energy level. The maximum number of electrons that can occupy a principal energy level is given by the formula $2n^2$, where **n** is the principal quantum number.

Q6. Based on Table 2, how many types of orbitals are in principal energy level three (3)?

Q7. How many atomic orbitals are in the highest sublevel of principal energy level three (3)?

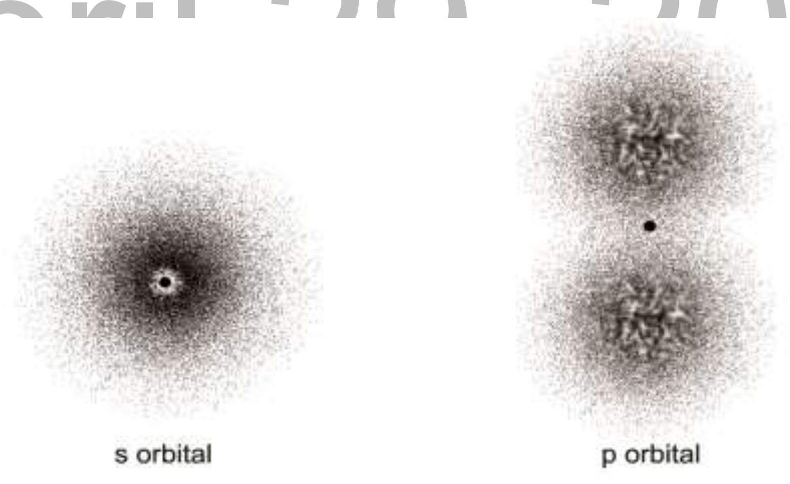


Figure 5. Shapes of s Orbital and p Orbital

Orbitals have specific energy values. They have particular shapes and direction in space. The **s** orbitals are spherical, and **p** orbitals are dumbbell-shaped, as shown in Figure 5. Because of the spherical shape of an s orbital, the probability of finding an electron at a given distance from the nucleus in an s orbital does not depend on direction, unlike the three kinds of p orbitals which are oriented along the x, y, and z axes. So they different orientations in space, p_x, p_y, and p_z.

The shapes of other orbitals (d and f orbitals) were derived from complex calculation and will not be discussed in this module.

In an atom, electrons and the nucleus interact to make the most stable arrangement possible. The way in which electrons are distributed in the different orbitals around the nucleus of an atom is called the *electron configuration*.

Table 3. Arrangement of electrons in the atoms of the first 10 elements

	O	R	B I	T	A L	
Chemical Symbol	1s	2s	$2p_x$	$2p_y$	$2p_z$	Electron Configuration
$_1$H	↑					$1s^1$
$_2$He	↑↓					$1s^2$
$_3$Li	↑↓	↑				$1s^22s^1$
$_4$Be	↑↓	↑↓				$1s^22s^2$
$_5$B	↑↓	↑↓	↑			$1s^22s^22p_x^1$
$_6$C	↑↓	↑↓	↑	↑		$1s^22s^22p_x^12p_y^1$
$_7$N	↑↓	↑↓	↑	↑	↑	$1s^22s^22p_x^12p_y^12p_z^1$
$_8$O	↑↓	↑↓	↑↓	↑	↑	$1s^22s^22p_x^22p_y^12p_z^1$
$_9$F	↑↓	↑↓	↑↓	↑↓	↑	$1s^22s^22p_x^22p_y^22p_z^1$
$_{10}$Ne	↑↓	↑↓	↑↓	↑↓	↑↓	$1s^22s^22p_x^22p_y^22p_z^2$

$_1$H = element hydrogen with an atomic number of 1.
Atomic number is the number of proton = the number of electron for an atom

Use this table as guide for the next activity.

Activity 3: Electron Configurations

Objectives:

- Write the electron configuration of the elements in the third period;
- Determine the pattern of filling the orbitals based on the given distribution for the first 10 elements; and
- Devise rules in filling up the orbitals.

Materials:

Pen and paper
Periodic table

Procedure:

1. Work with your group mates to write the electron configurations for the elements in the third period of the periodic table.

2. Compare the electron configurations of the second period (see Table 3) and the third period elements.

   Q1. Do you see patterns in the distribution of their electrons?

   Q2. What are these patterns you have observed?

   Q3. What do you think are some rules that apply in filling up the orbitals for the elements from atomic number 1 to 18?

Based on Activity 3, you were able to write the electron configuration of an element using the periodic table as a guide. Recall from Grade 8 that the elements are arranged in the periodic table in the order of increasing atomic number. This also means that the elements are arranged according to the number of electrons.

If you noticed from Table 3, both hydrogen and lithium have one electron in the highest energy level. Beryllium has two, and boron has three. So, the number of electrons in the highest energy level of the elements is the basis of their location on the periodic table. Since the experimental basis of the periodic table is chemical properties of the elements, knowing the arrangement of electrons in an element will help us understand and predict their chemical properties.

Summary:

- Rutherford's nuclear atomic model describes the atom as mostly empty space. Its mass is concentrated in the nucleus that consist of protons and neutrons. However it could not explain the chemical properties of elements.

- Bohr's atomic model describes the atom like a solar system, where the electron is found only in specific circular paths, or orbits, around the nucleus.

- In the Bohr model, each electron carries a fixed amount of energy and does not lose energy as long as it stays in its given orbit. The fixed energies that the electrons have are called **energy levels**. An electron that has received enough energy can jump to a higher energy level. When the electron returns to a lower energy level, energy is emitted in the form of light.

- The Bohr model was later replaced by a model of the atom that showed that electrons are not limited to fixed orbits around the nucleus.

- Through mathematical calculations, scientists explained that there is only a probability that the electron can be found in a certain volume in space around the nucleus. This volume or region of space around the nucleus where the electron is most likely to be found is called an **atomic orbital**

- Schrodinger formulated a mathematical equation that describes the behavior of the electron. The solution to the equation is used to calculate the probability of finding the electron at a particular region in space around the nucleus.

- The quantum mechanical model of the atom describes the atom as having a nucleus at the center around which the electrons move. This model describes a region in space where the electron is most likely to be found.

- An electron is imagined to be a cloud of negative charge having a certain geometrical shape. The electrons are arranged in principal or main energy levels that consist of one or more sublevels.

- The way in which electrons are distributed in the different orbitals around the nucleus of an atom is called the *electron configuration*. Filling of electrons start from lower energy level to highest energy level

Glossary:

Atomic orbital – the region of space in which there is a high probability of finding the electron in an atom

Electron cloud – an imaginary representation of an electron's rapidly changing position around the nucleus over time

Electron configuration – the distribution of electrons within the orbitals of the atoms of an element

Excited state – any electron configuration of an atom or molecule other than the lowest energy(ground) state

Exclusion Principle – a principle developed by Wolfgang Pauli stating that no two electrons in an atom can have the same set of four quantum numbers

Ground state – the electron configuration of an atom or ion that is lowest in energy

Quantum number- a number that specifies a property of an orbital or an electron

Summative Assessment:

I. Multiple Choice: Select the best/correct answer.

1. Who proposed the probability that electrons will be found in certain locations around the nucleus of an atom?

   A. Neils Bohr C. Ernest Rutherford
   B. Erwin Schrodinger D. J.J. Thomson

2. Which of the following statements is NOT true of the atomic model of Bohr?

   A. The hydrogen is made up of a positively charged nucleus
   B. The electron revolves around the nucleus in a circular orbit.
   C. The energy of the electron in a given orbit is not fixed.
   D. An electron can absorb or emit a quantity of radiation.

3. Which orbital designation has the highest energy?

   A. 2s B. 2p C. 3d D. 4s

4. Which statement is *incorrect?*

A. Orbital is a region in an atom where an electron can be found.

B. An electron can absorb energy when it jumps to a higher energy level.
C. An electron can emit energy when it jumps to a higher energy level.
D. Filling of electrons in an atom starts from a low energy level to the highest energy level.

5. What occurs when an electron moves from high energy level to a low one?

A. another electron goes from a low energy level to a high one
B. the atom moves faster
C. colored light is given off
D. this process is not possible

6. Which combination describes the flame color of the compound when heated?

A. sodium chloride – orange
B. copper(II) sulfate – violet
C. potassium chloride – blue
D. boric acid – red

II. Shown here are orbital configurations for the elements named. Each configuration is incorrect in some way. Identify the error in each and write the correct configuration.

1. carbon : $1s^2\,2s^2\,2p_x^2$

2. calcium: $1s^22s^22p_x^22p_y^22p_z^23s^23p_x^23p_y^23p_z^23d_1^13d_2^1$

3. chlorine: $1s^22s^22p_x^22p_y^22p_z^23s^23p_x^23p_y^24s^1$

4. aluminum: $1s^22s^22p_x^22p_y^22p_z^23s^23d_1^1$

5. titanium: $1s^22s^22p_x^22p_y^22p_z^23s^23p_x^23p_y^23p_z^2\ 3d_1^2\ 3d_2^2$

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Suggested Time allotment: 14-16 hours

Unit 2
MODULE
2

Chemical Bonding

Overview

It is interesting to look back at the lessons you have learned about matter when you were in Grades 7 and 8. Do you still remember them? Yes! In g
Grade 7, you were able to describe the properties of metals and non-metals and to recognize elements and compounds. In Grade 8, you observed different common changes such as evaporation, condensation, boiling, and melting that helped you learn about the particles that matter is made of. You have also learned that the elements are systematically arranged and grouped in the Periodic Table of Elements. Your knowledge about matter is continuously growing. In fact, in the previous unit you were introduced to how electrons in different atoms are distributed. You have learned a lot so far!

Studying this module will certainly increase your understanding about matter.

Get your periodic table. What do you notice about the electronic configuration of the noble gases? You're right! Except for helium, all of them have eight electrons at the outermost energy level. The sharing or the complete transfer of electrons causes an atom to have the same electronic configuration as that of the nearest noble or inert gas. The sharing or the complete transfer indicates that the atom has attained stability. Either the sharing or the complete transfer of electrons leads to the formation of compounds.

Going through this module will make you understand what is happening in the atoms during the formation of compounds. Look at the periodic table. Did you notice the vertical arrangement of the elements? This is called family or group. Notice the number in each group? Do you know what information it gives you? It tells about the number of valence electrons. Do you still remember the meaning of valence electrons? *Valence electrons* give you the number of electrons at the outermost energy level of the atom. This is the information you need to know in order for you to determine whether atoms transfer, accept, or share electrons to become stable. Why do we need to talk about the transfer or the sharing of electrons? You will discover the answer to this question as you study this module.

Further, you will find out the answer to the following questions:

How are ionic and covalent compounds formed?

Why is an ionic compound different from a covalent compound?

How is a metallic bond formed?

The following objectives will help you focus as you go about studying this module.

Learning Competencies/Objectives

- Explain the formation of ionic and covalent bonds.
- Recognize different types of compounds (ionic or covalent) based on their properties such as melting point, hardness, polarity and electrical and thermal conductivity.
- Explain properties of metals in terms of their structure.
- Explain how ions are formed.

Before you study this module, please answer the pre-assessment below.

Pre-Assessment:

Direction: Encircle the letter of the best answer for each question.

1. Which of the properties of atoms is the most suitable reference for the kind of bond that will take place between/among them?
   a. atomic size   b. electronegativity
   c. ionization energy   d. electron affinity

2. What kind of particle is produced after covalent bonding?
   a. atom   b. molecule
   c. ion   d. electron

3. How does ionic bonding take place?
   a. Two non-metallic elements of different kinds form strong forces of attraction.
   b. Two non-metallic element of the same kind form strong forces of attraction.
   c. A non-metallic element like fluorine is attracted to a metallic element like sodium.
   d. A metallic element like sodium transfers an electron to a non-metallic element like fluorine.

4. What kind of chemical bond will form between two oxygen atoms?
   a. ionic bond   b. metallic bond
   c. polar covalent bond   d. nonpolar covalent bond

5. Which of the following type of bonds will have the highest electrical and thermal conductivity?
   a. ionic bond
   b. metallic bond
   c. polar covalent bond
   d. nonpolar covalent bond

6. Why can metals be hammered without breaking?
   a. They are ductile.
   b. They are not brittle.
   c. They are malleable.
   d. Its particles are strong.

7. When does covalent bonding take place?
   a. It takes place when atoms share electrons with one another.
   b. It takes place when the attraction between atoms is strong.
   c. It takes place when atoms collide with one another.
   d. It takes place when atoms attain stability.

8. Nitrogen (N) belongs to family 5A and it is diatomic. How many nonpolar covalent bonds will there be in N_2 molecule?

   a. 1 b. 2 c. 3 d. 4

9. Which of the following will have the highest melting temperature?
   a. sodium chloride (salt)
   b. paraffin wax (candle wax)
   c. sucrose (table sugar)
   d. lead wire

10. Which among the following shows that an atom is stable?
   a. having 2 valence electrons
   b. having 4 valence electrons
   c. having 6 valence electrons
   d. having 8 valence electrons

After doing this pre-assessment, you are now ready to do the succeeding activities of this module.

There are concepts you need to know in order to fully understand why atoms form compounds. Let us start with the basic information, the number of valence electrons, octet rule, and electronegativity.

Activity 1: Mapping the Periodic Table

Objectives:

- Identify the number of valence electrons of atoms.
- Compare the electronegativity and ionization energy values of metals and non-metals.

Materials:
Periodic Table
Crayons

Procedure:

1. Locate the metals, non-metals, and noble gases in figure 1. Color the area with metallic elements blue; the non-metallic elements yellow; and the noble gases green.

   Q1. Where can you find metals, non-metals, and noble gases in the periodic table of elements?
   Q2. Which number will give you an idea on the number of valence electrons?
   Q3. What do you notice in the number of valence electrons of metals, non-metals, and noble gases?

1							18
H	2	13	14	15	16	17	He
Li	Be	B	C	N	O	F	Ne
Na	Mg	Al	Si	P	S	Cl	Ar
K	Ca	Ga	Ge	As	Se	Br	Kr
Rb	Sr	In	Sn	Sb	Te	I	Xe
Cs	Ba	Tl	Pb	Bi	Po	At	Rn

Figure 1. Periodic Table of the Representative Family/Group

2. Observe the number that corresponds to the valence electrons, electronegativity and ionization energy of metals and non-metals using a periodic table.
   Q4. What kind of element has:
   a. less than 4 valence electrons?
   b. more than 4 valence electrons?
   c. low electronegativity?
   d. high electronegativity?
   e. low ionization energy?
   f. high ionization energy?

The *valence electrons* are the electrons directly involved in forming bonds to form compounds. It is important that you know the number of valence electrons so that can illustrate how bonds are formed. It is good that you have found out that metals have low electronegativity and non-metals have high electronegativity because this property plays an important role in forming compounds. Do you know what electronegativity means? **Electronegativity** is a measure of the tendency of an atom to attract electrons, the higher its value, the higher its tendency to attract electrons. How about ionization energy? Did you know that **ionization energy** is the energy needed to pull or remove one or more electron/s from a neutral atom? The lower the ionization energy the easier it is to remove its valence electrons.

You can also show the number of valence electrons through the Lewis Symbol. This symbol is composed of the chemical symbol of the element and dots that represent the number of valence electrons.

The next activity will make you familiar with the Lewis Symbol.

Activity 2: Lewis Symbol

Objectives:
- Write the Lewis Symbol of the common metals and non-metals.
- Show the relationship among the number of valence electrons, electronegativity, and ionization energy.

Materials:
Periodic Table of Elements

Procedure:
Use the given periodic table of elements to determine the number of valence electrons. You may refer to the group number where it belongs in filling up the table below.

Table 1. Lewis Symbols of Some Elements

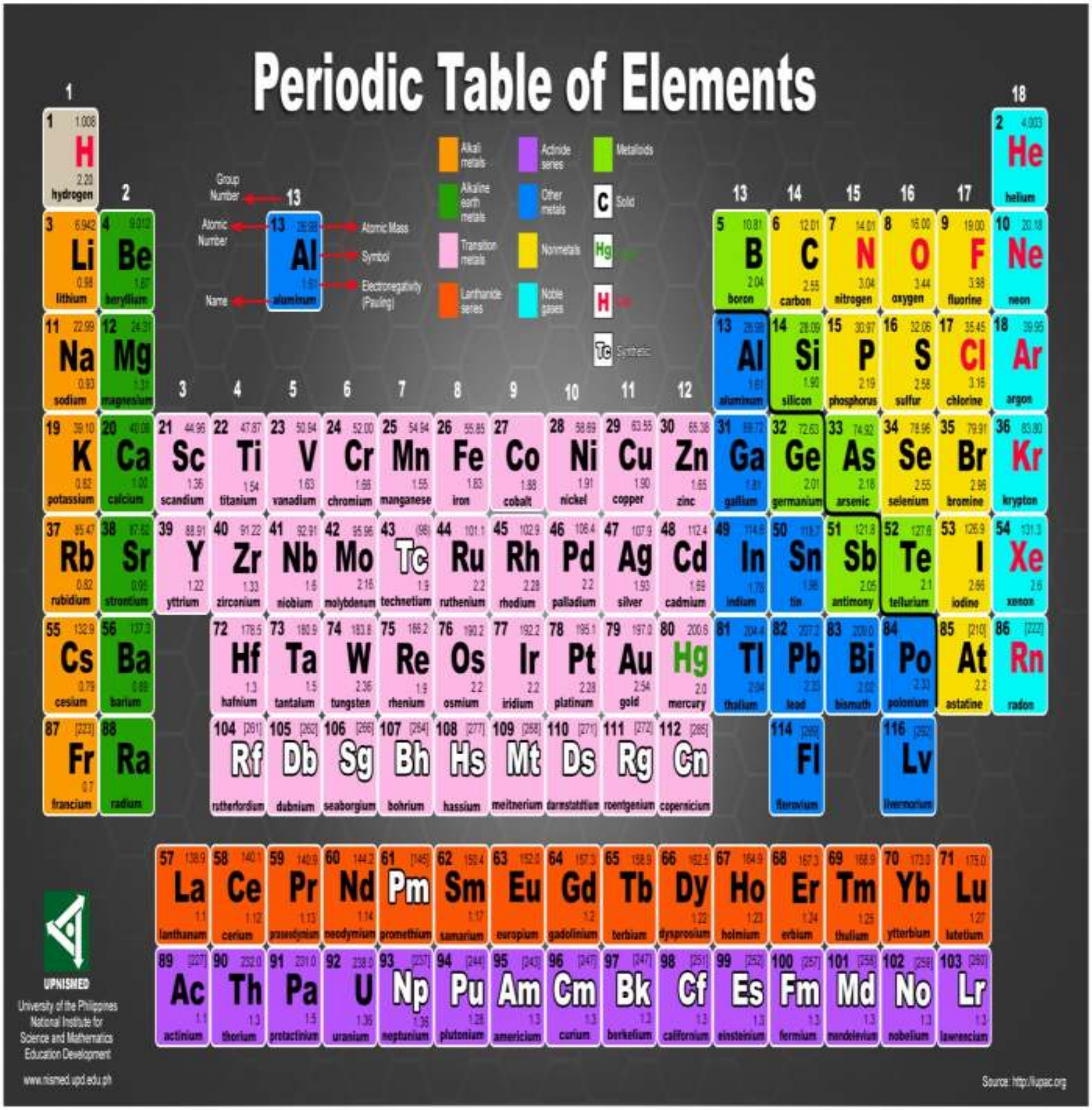
Element	Family or Group	Lewis Symbol	Electronegativity Value	Ionization Energy (kJ/mol)
lithium	1	Li ·	0.98	520
fluorine				
sulfur				
calcium				
nitrogen				
aluminum				

Q1. Arrange these elements in increasing:
   a. valence electrons
   b. electronegativity values.
   c. Ionization energy.

Q2. What do you notice with the number of valence electrons, electronegativity values

and ionization energies of the elements?
Q3. What kind of element has the greatest tendency to attract electrons? Why?
Q4. What kind of element requires high energy to remove its valence electrons? Why?

Examine the periodic table below. Does it verify your answers in Q1 and Q2?



Source: http://curriculum.nismed.upd.edu.ph

Ionization Energy of the Main-Group Elements in kJ/mol

1	2	13	14	15	16	17	18
H 1311							He 2372
Li 520	Be 1312	B 800	C 1085	N 1402	O 1314	F 1681	Ne 2080
Na 496	Mg 738	Al 578	Si 786	P 1012	S 1000	Cl 1251	Ar 1520
K 419	Ca 1312	Ga 579	Ge 761	As 947	Se 941	Br 1140	Kr 1351
Rb 403	Sr 1312	In 558	Sn 709	Sb 834	Te 869	I 1008	Xe 1170
Cs 376	Ba 1312	Tl 589	Pb 716	Bi 703	Po 813	At 926	Rn 1037

You have just learned the relationship among the number of valence electrons, electronegativity and ionization energy. You also realized that it is easy to write the Lewis Symbol of the representative element. The information that you found out from the previous activity will be helpful in understanding chemical bonding.

Do you know why atoms form compounds? Have you heard about the *Octet Rule*? Atoms always strive to attain the most stable arrangement of electrons. Atoms are stable if their electrons have the same kind of arrangement as that of noble gases, where the ***s*** and ***p*** orbitals are filled with electrons except for helium, where only the ***s*** orbitals are filled up. All the noble gases except for helium have 8 valence electrons. The Octet Rule tells you that elements gain or lose or share electrons to achieve the electronic configuration of the nearest noble gas. Thus after chemical bonding, elements become isoelectronic with the nearest noble gas in the periodic table.

Metals have low electronegativity and ionization energy, thus they tend to transfer or loose electrons. Non-metals have high electronegativity and ionization energy. They have a greater tendency to attract electrons towards themselves. Thus non-metals tend to gain electrons.

You will gain information about chemical bonding that involves gaining and losing electrons as you do the next activity.

Activity 3: Bonding by Transfer of Electrons

Objectives:
- Illustrate how an ionic bond is formed.
- Show how ions are formed.

Materials:

Periodic Table of Elements

Procedure:

1. Select a metallic and a non-metallic element. Write the Lewis Symbol of the selected elements. Take note of the electronegativity value of both elements. Subtract the electronegativity value of the metallic element from the non-metallic element.

   ..
   Na · EN = 0.90 :Cl: EN = 3.0
   ·

   Thus:

   2.0 – 0.90 = 2.1

   If the difference is greater than 1.9, complete transfer of electron/s is possible.

2. With the use of an arrow, show the complete transfer of electrons.

   ..
   Na · → :Cl:
   ·

3. Indicate the formation of cation and anion.

   $Na^{+}Cl^{-}$

After ionic bonding, sodium (Na) became isoelectronic with neon (Ne) while chlorine became isoelectronic with argon (Ar), thus both sodium and chlorine attained stability. Isoelectronic means sodium (Na) attain the same electronic configuration with neon (Ne) and in the case of chlorine it acquired the same configuration with that of argon (Ar). Thus, both of them become stable.

4. Make 5 combinations that will result to ionic bonding by following steps 1-3.

   Q1. What kind of element forms cation after ionic bonding?
   Q2. What kind of element forms anion after ionic bonding?
   Q3. Why do ions form after ionic bonding?
   Q4. Did the atoms attain stability after ionic bonding? Explain you answer.
   Q5. How can you tell that ionic bonding will take place between metals and non-metals?
   Q6. Will all combinations of metals and non-metals form ionic bond? Why?

Try aluminum and chlorine. Will they form an ionic bond?

Al: EN = 1.5 :Cl: EN = 3.0

Based on the difference in the EN values of Al and Cl, the difference is only 1.5, these two elements cannot form an ionic bond. In this case, there is not enough energy to facilitate the complete transfer of electrons. Instead, another bond is formed, the covalent bond, in which sharing of electrons takes place. This sharing helps the Al and Cl atoms attain stability.

There are two types of covalent bond: the **polar covalent bond** and the **nonpolar covalent bond**. If the electronegativity difference is equal to **0.4 or less,** it results to a nonpolar covalent bond. If the electronegativity difference is **less than 1.9 and more than 0.4,** polar covalent bond is formed.

Try to do the next activity to find out if covalent bonding takes place. Take note of the Octet Rule in considering the number of bonds that will be formed between atoms. These steps will help you figure out if sharing of electrons will take place.

a. Get the total available valence electrons in a compound.

For CO_2

carbon atom has 4 valence electrons
oxygen atom has 6 valence electrons

Total Available Valence Electrons (**TAVE**) = (1 C atom x 4) + (2 O atoms x 6)
= 4 + 12
= 16

b. Compute for the Octet Rule requirement that each atom should have 8 valence electrons to become stable.
Number of Electrons based on Octet Rule = (1 C atom x 8) + (2 O atoms x 8)
= 8 + 16
= 24

c. Subtract a from b, then divide the difference by 2 because a pair of shared electron is equal to 1 bond. The quotient will give you the number of bonds around the central atom.

$$\text{Number of bonds} = \frac{(24 - 16)}{2}$$
$$= 4$$

Thus, there will be 4 bonds surrounding a carbon atom as shown in the Lewis structure:

```
 ..    ..        ..    ..
:O::C::O:  or   :O=C=O:
```

Can you do the same for the next activity? Let's see!

Activity 4: Bonding by Sharing of Electrons

Objectives:

- Explain how covalent bonding takes place.
- Illustrate the sharing of electrons.

Materials:

Periodic Table of Elements

Procedure:

1. Show how the sharing of electrons form covalent bond in the following compounds:
   a. ammonia (NH_3)
   b. water (H_2O)
   c. hydrogen chloride (HCl)
   d. nitrogen gas (N_2)
   e. oxygen gas (O_2)
   f. methane (CH_4)
   g. hydrogen gas (H_2)
   h. phosphine (PH_3)
   i. sulfur dioxide (SO_2)
   j. chlorine gas (Cl_2)

Supply Table 2 with the data obtained in number 1.

Table 2. Types of Covalent Bonds

Compound	Chemical Formula	Lewis Structure	Type of Bond (polar covalent/nonpolar covalent)
ammonia			
water			
hydrogen chloride			
nitrogen gas			
oxygen gas			
methane			
hydrogen gas			
phosphine			
sulfur dioxide			
chlorine gas			

Q1. How do covalent bonds form between atoms?
Q2. What kind of element usually forms covalent bond? Is it possible for metals and non-metals to form nonpolar covalent bond? Why? How about polar covalent bond? Why?
Q3. Why is it that diatomic molecules always form nonpolar covalent bonds?
Q4. Differentiate polar covalent bond from nonpolar covalent bond.

What have you learned about covalent bonds? Is it now clear to you that covalent bonds result from the sharing of electrons? Unlike ionic bonds, there is no complete transfer of electrons in covalent bonds, just sharing of electrons.

In covalent bonding, a pair of shared electrons is equal to one (1) bond. Notice that after the sharing of electrons, each of the atoms in the compound attains a stable configuration and a covalent compound is formed. Such compound could exist as independent units called **molecules**. As a whole, the molecule does not carry a charge.

Recall that an ionic bond is formed when a metal bonds with a non-metal while a covalent bond exists between or among non-metals. However, there are cases when polar covalent bond involves a metal and a non-metal, like in the case of aluminium chloride ($AlCl_3$).

Is it possible that metals form bonds with one another? Can you visualize how it will be? The next activity will ask you to make a representation of how you think metallic bonding takes place.

Activity 5: Bonding Among Metals

Objectives:
- Make a model of a metallic bond.
- Relate the properties of metals to the kind of bond they are made of.

Materials:
drawing pen

Procedure:
1. Recall from Activity 3 how metals behave to attain stability.
2. Visualize what will happen to a group of metallic atoms.
3. Prepare a model that will represent a metallic bond. You may draw it.
   Q1. What do you think will make bonding among metals possible?

Your teacher will explain to you how metallic bonding takes place. After she explains, try to describe some metallic properties. Try to explain those properties in terms of the way metallic atoms are bonded together.

In Table 3, list down the metallic properties that you know and try to explain why metals possess those properties.

Table 3. Metallic Properties

Metallic Property	Explanation
Luster	Metals are lustrous because when light strikes the surface of the metal the loosely-bound electrons near the surface move and reflect the light giving the metal a shiny appearance.

Based on the properties you have listed above, make a list of the uses of metals.

Table 4: Uses of Metals

Metal	Uses
1. copper	Electrical wiring, metal sculpture, and component of jewelry
2.	
3.	
4.	
5.	
6.	

Deeper understanding of the properties of metals can be explained through the way its atoms are bonded together. It is amazing to realize that as your knowledge in matter is continuously growing you acquire better understanding of the things around you and the phenomena happening to them.

So far, you have learned about the three types of chemical bonding. Perform the next activity to find out if you have fully understood the three types of chemical bonding.

Complete the table below.

Table 5: Types of Chemical Bonds

Material	Type of Chemical Bonds
BH_3 (borane)	
CaF_2 (calcium fluoride)	
KCl (potassium chloride)	
Al (aluminium foil)	
Cu (copper wire)	
I_2(iodine gas)	
CO (carbon monoxide)	

It's good that you were able to recall the different types of chemical bonding. Knowledge about the type of bond helps you relate the basic properties of the compound. Like what you have done with metallic bonding, ionic and covalent compounds also have properties which show the type of chemical bond the compound has. Do you want to find out these properties on your own? Go and perform the next activity!

Activity 6: Differences between Ionic and Covalent Compounds

Objectives:

- Recognize ionic and covalent compound based on their physical properties.

Materials:

improvised electrical conductivity apparatus
distilled water
alcohol burner
metal spoon
sugar (sucrose)
grated paraffin wax (candle wax)
salt (sodium chloride)
vetsin (monosodium glutamate)
vials or very small bottles
medicine dropper

Procedure:

1. Get a pinch of salt, place it in a spoon, and heat it with the use of an alcohol burner in 1 minute. Do the same with vetsin, sugar, and grated candle wax. Record what you observe in column 1 of Table 6.
2. Place a pinch of salt, vetsin, sugar, and grated candle wax on a clean dry sheet of paper. Label each sample. Let the electrodes of the electrical conductivity apparatus touch each of the solid sample. Be sure you clean the electrodes before transferring to the sample. Record your observations in column 2a of Table 6.
3. Transfer each sample to individual vial. Add approximately 3 mL of distilled water in each vial and label. Observe the solubility of each sample in the distilled water. Record your observations in column 3 of Table 6. Test the conductivity of the compound with distilled water. Record your observations in column 2b of Table 6. Fill out the table below.

Table 6: Properties of Some Compounds

Compound	Reaction to Heat (melted easily/ did not melt easily) (1)	Electrical Conductivity (x-did not conduct electricity ✓ -conduct electricity) (2) (a)	(b)	Solubility in Water (soluble/ insoluble) (3)	Type of Compound (ionic/polar covalent/ nonpolar covalent) (4)
		Sample without water	Sample with water		
salt					
vetsin					
wax					
sugar					

Q1. What type of compound:

a. dissolves easily in water?
b. conducts electricity in solution?
c. melts easily?

Q2. Explain why salt and vetsin can conduct electricity in solution?
Q3. Make a general statement about the properties of ionic and covalent compounds.
Q4.What common properties did you observe in this activity?

You have noticed that ionic compounds conduct electricity when in solution but not in solid phase and they are generally soluble in water. Covalent compounds are non-conductors of electricity in solid phase and in solution. Unlike ionic compounds, they melt easily, so they have low melting temperature.

Summary:

Let us have a synthesis of the concepts you have learned in this module:

- The valence electrons are the outermost electrons which are directly involved in chemical bonding.
- Lewis symbol is composed of the symbol of the element and dots which represent the number of valence electrons of an atom that can easily be determined through the family/group number in the Periodic Table of Elements.
- Atoms form bonds with one another to become stable and attain the electronic configuration of the noble gas nearest it.
- An ionic bond involves complete transfer of electrons, thus ions are formed. It involves metals with low electronegativity and non-metals with high electronegativity.
- Ionic compounds conduct electricity when in solution but not in solid phase.

- Ionic compounds are generally soluble in water and in polar solvents.
- A covalent bond involves the sharing of electrons that results in the formation of covalent compound whose representative particle is a molecule. As a whole, a molecule does not carry a charge.
- Covalent bonds may be polar or nonpolar.
- Two identical non-metallic atoms always form nonpolar covalent compound such as N_2, O_2, H_2, F_2 and other diatomic molecules.
- Non-identical atoms with electronegativity difference higher than 0.4 and lower than 1.9 produce polar covalent bond.
- Covalent compounds are non-conductors of electricity in the solid phase and in solution. They have a lower melting temperature than compounds formed by ionic bonds.
- Metallic bonding exists in metals through the attraction between the freely-moving valence electrons and the positively charged metal atom. The valence electrons of these metal atoms are usually called "sea of electrons."
- Thermal and electrical conductivity in metals are due to the free flow of electrons in the solid phase. Aside from these properties, metals are lustrous, malleable, and ductile. These properties are related to the kind of bonding metals have.

Glossary:

anion a negatively charged particle

cation a positively charged particle

chemical bond the force or energy that holds atoms or ions together

covalent bond a bond formed when atoms share electrons to attain stability

electronegativity is a measure of the tendency of an atom to attract electron

ionic bond a bond which involves complete transfer of electrons

ionization energy is the energy required to remove an electron from the outermost energy level of an atom

ions charged particles

luster the property of metals to reflect light

malleable the property of metals to be hammered into thin sheet

metallic bond a bond formed by the attraction of cations and the electrons around them

valence electrons the electrons at the outermost energy level

Summative Assessment

Write the letter of the best answer.

1. Element X belongs to Group 1. Which of the following best describes element X?

    a. high electronegativity
    b. high ionization energy
    c. low electronegativity
    d. a non-metallic element

2. What will most likely happen to a non-metallic atom after ionic bonding?
    I. It forms a cation
    II. It forms an anion
    III. It becomes stable
    IV. It becomes unstable

    a. I & II　　b. II & III　　c. III & IV　　d. I & IV

3. What kind of bond will result when two identical non-metallic atoms combine?
    a. ionic bond　　c. polar covalent bond
    b. metallic bond　　d. nonpolar covalent bond

4. Choose 2 elements that would likely form an ionic bond among the following elements: Li, Si, F, Ne
    a. Li and Si　　b. Si and F　　c. Ne and Si　　d. Li and F

5. How is the bond in Br_2 different from the bond in MgF_2?
    a. The bond in Br_2 is metallic while the bond in MgF_2 is covalent.
    b. The bond in Br_2 is ionic while the bond in MgF_2 is covalent.
    c. The bond in Br_2 is covalent while the bond in MgF_2 is ionic.
    d. There is no bond difference between the two.

6. Why do atoms react with one another to form chemical bonds?
    a. to attain stability　　b. to form compounds
    c. to form molecules　　d. to produce ions

7. What kind of force is present in ionic bond?
    a. repulsive force　　b. electrostatic force
    c. neutral force　　d. retentive force

8. Which of the following substances when dissolve in water will conduct electricity?
    a. glucose　　b. oil
    c. gasoline　　d. muriatic acid

9. What bond holds the atoms of the elements in Groups 1and 2 of the Periodic Table?
   a. nonpolar covalent bond
   b. polar covalent bond
   c. metallic bond
   d. ionic bond

10. Which of the following sets of samples has metallic bond, covalent bond and ionic bonding in this order?
   a. bronze, paraffin wax, and salt
   b. alloy, vetsin, and water
   c. gold ring, baking soda, and starch
   d. coins, salt, and carbon dioxide

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http://www.chemguide.co.uk/atoms/bonding/electroneg.html
http://chemistry.about.com/od/electronicstructure/a/Octet-Rule.htm
http://www.edu-resource.com/chemistry/what-are-ionic-compounds.php
http://misterguch.brinkster.net/ionic.html

Suggested Time allotment: 4 hours

Module 3 The Carbon Compounds

Overview

In the previous module, you have learned about how non-metals make chemical bonds by sharing electrons from their outer shells to attain stable electronic configurations. This is also the process by which every carbon compound or organic compound is formed. In this module, the lessons will be about the uses and properties of common organic compounds like hydrocarbons, aldehydes and ketones, carboxylic acids and alcohols.

In this module, you will be able to answer the following key questions:

What are organic compounds?

What are the important uses of organic compounds?

How are the carbon atoms able to form many organic compounds?

In what ways are the properties of organic compounds related to their uses?

In your quest to answer the above thought provoking questions you will be able to:

- explain how the structure of carbon atom affects the types of bonds it forms
- recognize the general classes and uses of organic compounds.

Before anything else, please answer the pre-assessment prepared for you.

Pre-Assessment:

Write the letter of the correct answer.

1. Which of the following statements best describe organic compounds?

   A. Organic compounds are compounds that contain carbon and oxygen only
   B. Organic compounds are compounds that are produced by living things
   C. Organic compounds are composed mainly of carbon and hydrogen
   D. Organic compounds are compounds that contain carbon atoms only

2. How do carbon atoms form many organic compounds?

   A. By attracting other elements toward themselves to form the bonds
   B. By forming many bonds with other carbon atoms and other elements
   C. By sharing their electrons with other metal and non-metal elements
   D. By transferring their electrons to the atoms of surrounding elements

3. What is the maximum number of bonds can a carbon atom form?

   A. 2 C. 4
   B. 3 D. 5

4. Emmanuel Juan, a fisher man, went home with some of his catch and told his son to cook the fish. But his son said, “father the stove ran out of fuel already”. Then his father told him to buy some so that they could start cooking the fish. Which organic compound do you think the boy will buy?

   A. kerosene C. lubricating oil
   B. gasoline D. isopropyl alcohol

5. Which of the following pairs of organic compounds is highly flammable?

   A. gasoline, acetone
   B. water, ethyl alcohol
   C. lubricating oil, isopropyl alcohol
   D. liquefied petroleum gas, kerosene

6. Honey is applying something to the ball bearings of the wheels of her bicycle so that friction will be minimized. Which of the following material do you think she is using?

   A. vinegar
   B. isopropyl alcohol
   C. kerosene
   D. lubricating oil

7. A gasoline boy was being scolded by his store manager for smoking in the vicinity of the gasoline station. Why do you think the manager scolded his employee?

   A. because gasoline is volatile
   B. because gasoline is flammable
   C. because gasoline is viscous
   D. all of the above

8. Joimee scratched herself when her arm bumped into the concrete post. What do you think should she apply to make her bruises free from harmful germs?

   A. formalin
   B. isopropyl alcohol
   C. water
   D. acetone

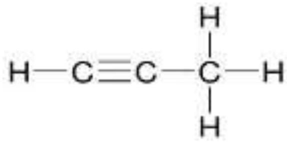
9. Which organic compound is used as a cleaning agent?

   A. gasoline
   B. kerosene
   C. liquefied petroleum gas (LPG)
   D. ethyl alcohol

10. Which hydrocarbon compound has a triple bond in the molecule?

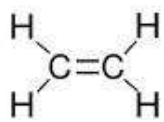
   A. octane
   B. methane
   C. ethene
   D. ethyne

11. How many types of bonds are there in the following hydrocarbon compound?



A. 1 C. 3

B. 2 D. 4

12. To which group of hydrocarbon does the molecule with the structure  belong?

A. alkane C. alkene

B. alkyne D. none of the above

13. Ethene is a natural gas produced in plants, which acts as a natural ripening agent of fruits. Which of the following organic compounds has the same ability to ripen fruits?

A. butane C. acetylene

B. propene D. pentyne

14. Which alkane will most likely have a very low boiling point?

A. propane C. butane

B. pentane d. hexane

15. What is the common use of methane?

A. disinfectant C. artificial ripening agent

B. fertilizer D. fuel

16. Which are TRUE about the use of isopropyl alcohol?

I. cleaner III. disinfectant
II. fuel IV. fertilizer

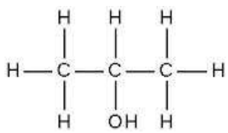
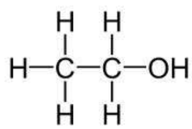
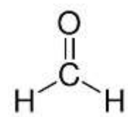
A. I and II only C. III and IV only

B. II and III only D. I and IV only

17. Salvador has to remove the red paint in the paintbrush so that he could still use it again next time. What organic compound should he use to remove the paint in the paintbrush?

    A. acetic acid
    B. lubricating oil
    C. kerosene
    D. formaldehyde

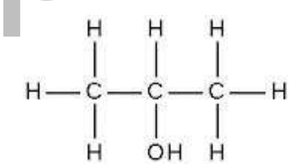
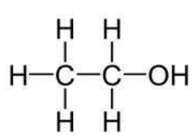
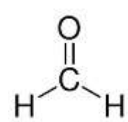
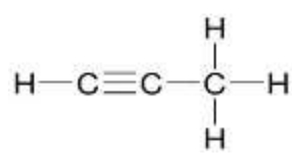
18. Which of the following compounds is a carbonyl compound?

    A. 
    B. 
    C. 
    D. all of the above

19. What organic compound is used by embalmers in treating human cadavers?

    A. acetic acid
    B. formaldehyde
    C. methyl alcohol
    D. acetone

20. Which compound is an alcohol?

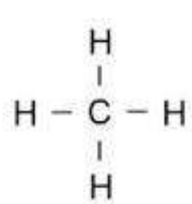
    A. 
    B. 
    C. 
    D. 

You may now start exploring this module.

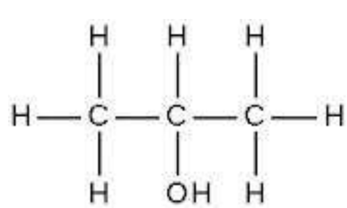
Activity 1: Organic Compounds: Are they Useful?

Organic compounds are group of compounds that contain the element carbon. Organic compounds contain carbon and hydrogen combined with other elements namely oxygen, nitrogen, phosphorous, sulfur, and halogens (fluorine, chlorine, bromine, and iodine) Ethyl alcohol, acetone, gasoline, napthalene, acetic acid, vanillin, acetylene, and esters are just a few examples of many useful organic compounds. These kinds of compounds are produced by plants and animals. However, these carbon-containing compounds can also be produced artificially. There are also organic compounds that are produced from petroleum: liquefied petroleum gas (LPG), gasoline, lubricating oil and kerosene. These compounds have different uses in the community.

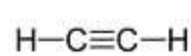
Many organic compounds are formed because of the special characteristics of the element carbon. A carbon atom has four (4) valence electrons. This kind of atomic structure makes the carbon atom able to form four covalent bonds with atoms of other elements and other carbon atoms. Carbon atoms can also make many types of arrangements: single bond, double bond, and triple bond. With these abilities of the carbon atoms, chemical bonds between carbon atoms and other elements can form different kinds of compounds with short and long straight and branched chained structures such as the following compounds.



Methane



Isopropyl Alcohol



Acetylene

Objective:

In this activity, you will be able to recognize the uses of common organic compounds.

Materials:

paper and pen pentel pen manila paper

Labels or Pictures of the following products:

gasoline acetone kerosene acetic acid LPG ethanol

Procedure:

1) With your groupmates, use the labels/pictures of the materials to answer the following questions:

Complete the table about the uses of the compounds. Using a check mark, indicate the uses of the compounds. You may have more than one check mark per sample depending on its use/s.

Table 1: Organic compounds and their uses

		Organic Compounds					
		Gasoline	**Ethanol**	**Acetone**	**LPG**	**kerosene**	**Acetic acid**
Uses	Beverage						
	Food						
	Antiseptic						
	Fuel						
	Cleaner						

(* *This activity is adapted, with minor modification, from Glencoe Physical Science Texas Edition .(1997). Glencoe/McGraw-Hill Companies Inc., page 369)*

Q1. What do you think are the characteristics of the materials which give their uses?

Q2. Why do you think these kinds of organic compounds are very important?

You just learned the important uses of common organic compounds that are commonly used. In the next activity, you will learn about the properties of these common compounds that will help you to appreciate their specific uses.

Activity No. 2: Properties of Common Organic Compounds

Every kind of organic compound has specific properties or characteristics. Although these compounds may show similarities in some properties, these compounds do not have exactly the same properties.

Gasoline, kerosene, diesel oil, lubricating oil, vanillin, acetic acid, and ethyl alcohol are organic compounds with different properties. Gasoline, for example, has a strong odor, is volatile, and highly flammable. In this activity, you will find out about the properties-namely, odor, viscosity, volatility, and flammability-of some other common organic compounds.

Odor is the smell of the compound. Every compound has its own specific odor. Viscosity is a measure of a liquid's resistance to flow. Volatility is the measure of the tendency of a compound to evaporate or turn into gaseous state. Flammability is the measure of how easily material burns.

Objectives:

- Observe the properties of common organic compounds; and
- Relate these properties to their uses.

Materials

kerosene	stop watch	4 pieces of half inch-plastic beads
lubricating oil	paper and pen	4 pieces of ¼ sheet of long bond papers
ethyl alcohol	calculator	25 mL graduated cylinder
diesel oil	matches	4 identical test tubes (about 5 inches)
4 medicine droppers		4 bottle crowns (*tansan*)

Warning:

Follow the procedure carefully, you are about to use flammable substances.

Prepare sand or wet rags to be used in case of fire.

Procedure

1) a. With your group, use the table below to record your data from this activity.

Table 1. Properties of Common Organic Compounds

Materials	Odor	Phase	Viscosity (average time it takes the marble to reach the bottom)	Volatility (the time it takes the liquid to evaporate)	Flammability (average time it takes the material to burn completely)
Kerosene					
Lubricating oil					
Diesel oil					
Ethyl alcohol					

b. Place 15 ml of each liquid in the four (4) identical test tubes and label each test tube according to the liquid it contains.

c. Observe the materials and write the phase and odor of the materials on the table.

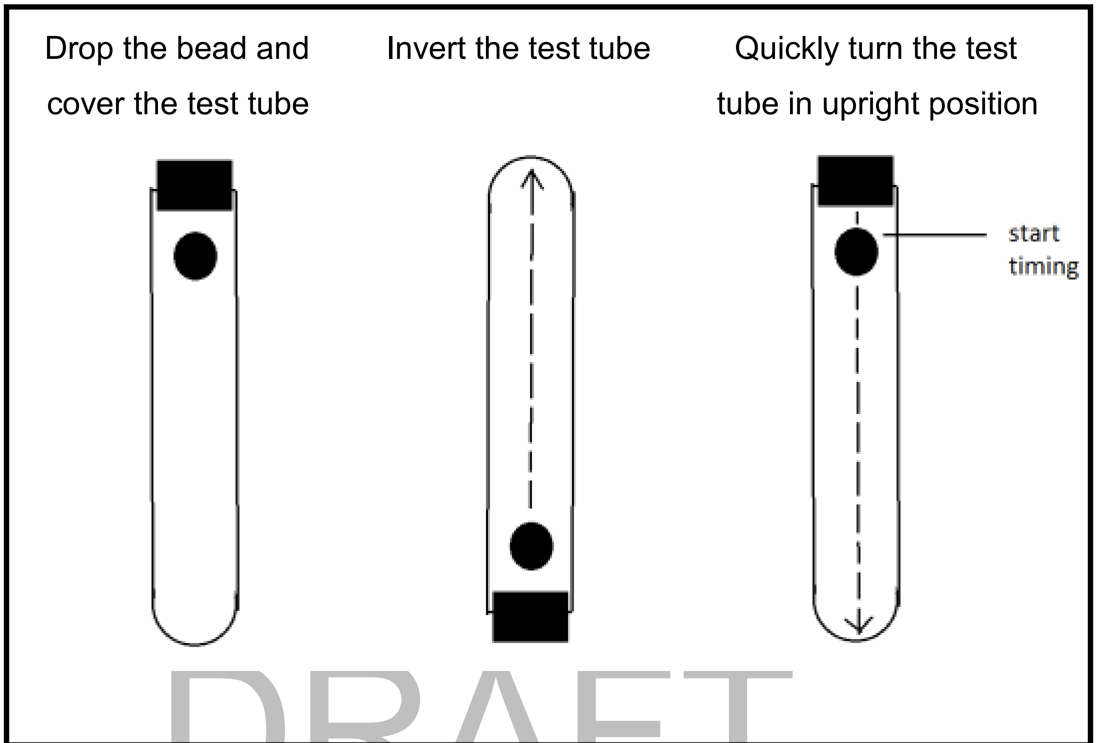
2) Testing the *viscosity* of the materials

a. Fill a test tube with the first liquid, drop one plastic bead, and then cover it tightly with a cork or rubber stopper.

b. Invert the test tube so that the bead falls and touches the cork as shown in the illustration.

c. Quickly turn the test tube in an upright position. Determine the time it takes the bead to fall or reach the bottom of the test tube.

d. Procedures a, b, and c should look like the illustration below.



3) Testing the *Volatility* of the Materials

a. Using a medicine dropper, put two drops of each liquid material on the separate pieces of bond papers. You and your group mates should do this at the same time and place it on the armrest.

b. Record the time it takes the papers to get dry. This is equivalent to the time it takes the liquid to completely evaporate.

3) Testing for *Flammability* of the Materials

Warning:

Wear mask before performing the following procedure. Have the sand or wet rags near you while doing the test for flammability.

a. Prepare four bottle crowns (*tansan*) and then place a cotton bud in each crown.

b. Wet the cotton buds with10 drops of the liquid materials.

c. Ignite each wet cotton bud using a lighted match stick.

d. Record the time it takes each cotton bud to burn completely.

e. Repeat steps a, b, c and d four (4) more times so that you will have five (5) trials per liquid material.

e. Compute for the average time it takes each cotton bud to burn completely.

**This activity is adapted, with minor modification, from the Teaching Resource Package S & T III-Chemistry. (1992) of The Philippine-Australian Science and Mathematics Education Project (PASMEP), University of the Philippines Institute of Science and Mathematics Education Development, and The Department of Education Culture and Sports (DECS)*

Q1. Which material is most viscous? What are the common uses of viscous materials?

Q2. Which materials are flammable? In what ways are these materials used?

Q3. Which liquid materials have strong odor and weak odor?

Q4. Why is it important to know the properties of these kinds of organic compounds?

In this activity, you have learned about the properties of some common organic compounds and the relationship of these properties to their uses. You were able to observe in the experiments that kerosene, ethyl alcohol, and diesel oil are flammable compounds. Ethyl alcohol is a volatile compound and lubricating oil is a thick or viscous liquid.

In the next activity, you will learn about a specific group of organic compounds, the hydrocarbons.

Activity 3: The Hydrocarbons

Hydrocarbons are organic compounds that contain carbon and hydrogen atoms only. Hydrocarbons such as methane, ethane and butane are components of natural gas. Hydrocarbons are grouped into families namely, *alkanes*, *alkenes* and *alkynes*.

The compounds in each group have certain structures that make their properties different from the other.

Objectives:

- Recognize common kinds of alkanes, alkenes, and alkynes and their uses.
- Identify the types of bonds formed in alkanes, alkenes, and alkynes.
- Relate the structures of alkanes, alkenes, and alkynes to their properties.

Materials

bond paper pen

Procedure

1) With your groupmates, use the data in Tables 1 to 3 to answer the questions in this activity.

Table 1. Alkanes

Name	Phase	Condensed Structural Formula	Boiling Point (ºC)
Methane	Gas	CH_4	-162
Ethane	Gas	CH_3CH_3	- 89
Propane	Gas	$CH_3CH_2CH_3$	- 42
Butane	Gas	$CH_3CH_2CH_2CH_3$	-0.5
Pentane	Liquid	$CH_3CH_2CH_2CH_2CH_3$	36
Hexane	Liquid	$CH_3CH_2CH_2CH_2CH_2CH_3$	69
Heptane	Liquid	$CH_3CH_2CH_2CH_2CH_2CH_2CH_3$	98
Octane	Liquid	$CH_3CH_2CH_2CH_2CH_2CH_2CH_2CH_3$	126

Table 2. Alkenes

Name	Phase	Condensed Structural Formula	Boiling Point (ºC)
Ethene	Gas	$CH_2{=}CH_2$	-104
Propene	Gas	$CH_2{=}CHCH_3$	-47
1-Butene	Gas	$CH_2{=}CHCH_2CH_3$	-6
1-Pentene	Liquid	$CH_2{=}CHCH_2CH_2CH_3$	30
1-Hexene	Liquid	$CH_2{=}CHCH_2CH_2CH_3$	63

Table 3. Alkynes

Name	Phase	Condensed Structural Formula	Boiling Point (ºC)
Ethyne	Gas	C_2H_2	-84
Propyne	Gas	$CH \equiv C - CH_3$	-47
2-Butyne	Gas	$CH_3C \equiv CCH_3$	8.08
Pentyne	Liquid	$HC \equiv CCH_2CH_2CH_3$	40.2

Q1. What are the types of bonds present in the following: alkanes, alkenes, and alkynes?

Q2. Using Tables 1 to 3, what pattern do you observe in terms of the phase, number of carbon atoms, structure and boiling point of the alkanes, alkenes, and alkynes? Explain the patterns you observe.

Q3. What do you think will be the boiling point of the next alkane, alkene, and alkyne? Will the boiling point of each hydrocarbon be higher or lower? Explain your answer.

Q4. Why do you think some hydrocarbons are gases and others are liquids?

Q5. Why do you think there are many hydrocarbon compounds?

Q6. What hydrocarbon compounds are gases and liquids? What are the uses of gaseous hydrocarbon compounds and liquid hydrocarbon compounds?

You have just learned how the structures of hydrocarbons affect their properties, such as physical state and boiling point. Your teacher will discuss the uses of these groups of hydrocarbons. In the next activity, you will learn a common application of acetylene, an alkyne.

Activity 4: Which bananas will ripen faster?

Calcium carbide (CaC_2) is a compound that is commonly known as *kalburo.* Fruit vendors use this substance to speed up ripening of fruits like mangoes and bananas in just a couple of days. When calcium carbide reacts with water such as moisture in the air, ethyne gas is produced. Ethyne or commonly known as acetylene is a kind of alkyne.

Objective:

- Investigate how a common organic compound namely ethyne can ripen fruits faster than the natural way.

Materials:

Calcium carbide (*kalburo*)	hand gloves
Newspapers	face masks
12 unripe, green bananas of same variety	small plastic cups
2 empty shoe or fruit juice boxes	packaging tape

Warning:

Wear mask before performing the following procedure.
Calcium carbide has a strong and irritating odor.
Make sure that calcium carbide does not come in contact with water!

Procedure:

1) Using a sheet of newspaper, wrap ¼ kilo (250g) of crushed calcium carbide (*kalburo*). Make sure that the wrapped calcium carbide will just be enough to fit the area of the bottom of one shoe box.
2) Put the wrapped calcium carbide at the bottom of the shoe box and cover it with another piece of newspaper.
3) Place 3 unripe (nearing maturity) bananas of the same kind inside the first box with calcium carbide. This will be Group A.
4) Do not put wrapped calcium carbide in the other shoe box.
5) Place another set of 3 green, unripe bananas of the same kind in the second box. This will be Group B.
6) After putting all the bananas in each box A and box B, cover both boxes.
7) Leave the shoe boxes for 48 hours.

   Q1. What are you going to find out or investigate in the experiment?

   Q2. What is the independent variable?

   Q3. What is the dependent variable in the experiment?

   Q4. Write your hypothesis or prediction about what might happen in the experiment.
8) After 2 or 3 days, put on your face masks and observe what happened to the bananas. Write your observation in the data table below.

Group	Observations
	Number of Ripe Bananas and their Appearance
A (with calcium carbide)	
B (without calcium carbide)	

Q5. How many bananas ripened in Group A and in Group B?

Q6. Which group has fully ripened bananas?

Q7. What conclusion can you make from the results of your experiment?

Q8. Look for the properties of ethyne and explain how it can introduce ripening of fruits?

In this activity, you were able to observe how ethyne or acetylene, which is an alkyne, can make banana ripen faster. This is just one of the many applications of acetylene.

In the next activity, you will learn about the other common organic compounds, alcohols and carbonyl group containing compounds such as aldehydes and ketones.

Activity 5: Alcohols and Their Uses

Alcohols are another group of organic compounds. These organic compounds also have very important uses. Some alcohols are used as antiseptic or disinfectant, some are used as cleaning agents, others are used as components of liquors and a few alcohols are used as fuel for portable stoves or other types of burners.

Objectives:

- recognize the uses of common alcohols;
- identify similarities in the structures of different kinds of alcohols; and
- relate these similarities to the common properties they have.

Materials:

Labels or pictures of commonly used alcohol products brought by your teacher.

pentel pen paper and pen manila paper

Procedure:

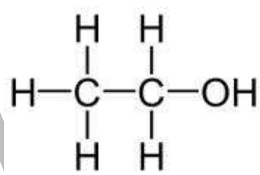
1) With your group, read the labels of the products that contain alcohols.
2) Write in the table below, the names of the products and the alcohol compounds that are found in the labels of the product and their uses.

Name of Products	Name of Alcohol/s Present in the Product	Percent (%) or amount of alcohol in the Product	Uses

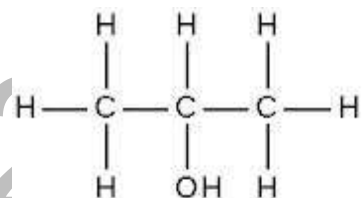
Q1. What are the common products that contain alcohol?

Q2. Why are these alcohols important?

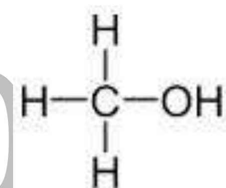
3) With your group, use the following illustrations of the structures of common alcohols to answer the following questions.



Ethyl alcohol



Isopropyl alcohol



Methyl alcohol

Q3. What types of bonds are present in ethyl alcohol, methyl alcohol, and in isopropyl alcohol?

Q4. What accounts for the similar physical properties of alcohols?

You have learned the uses of common alcohols and the relationship between the structures of alcohols and their physical properties.

In the next activity, you will learn about simple carbonyl compounds, their properties and uses.

Activity 6: What is common between acetone and formalin?

Acetone and formalin are examples of simple carbonyl containing compounds which have common uses. Carbonyl containing compounds are organic compounds that contain carbonyl functional group, which is composed of a carbon atom double-bonded to an oxygen atom: C=O.

Objectives

- Give the common uses of acetone, and formalin.
- Relate the structures of acetone, and formalin to the carbonyl compounds where they belong.

Materials:

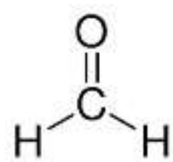
acetone
formalin
manila paper
paper and pen
pentel pen

Procedure:

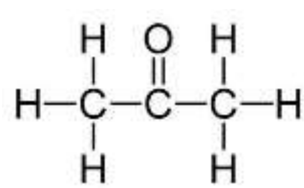
1. With your group, talk about the uses of the simple compounds shown to you by your teacher.

Q1. What are the common uses of acetone and formalin?

2. With your group, use the illustrations of the structures of acetone, and formaldehyde (formalin) below to answer the questions.



formaldehyde



acetone

Q2. What types of bonds do the common compounds have in their structures?

Q3. Formalin and acetone are common carbonyl containing compounds. Why do you think they both belong in the group of carbonyl containing compounds?

Summary:

- Carbon atoms have special abilities: carbon atoms can form chemical bonds with other carbon atoms and other nonmetal atoms in many ways. They can form single, double, and triple bonds. These abilities of carbon atoms are the reasons why there are som many kinds of organic compounds.

- Organic compounds are compounds that are primarily composed of carbon atoms, which are chemically bonded with hydrogen and other elements such as oxygen, sulfur, and nitrogen. Organic compounds are naturally produced by living organisms, but can also be produced artificially.

- Organic compounds such as gasolene, kerosene, ethyl alcohol, isopropyl alcohol, formaldehyde, acetic acid, acetone, and lubricating oil have important uses. These uses are based on their specific chemical properties.

- Hydrocarbons are a specific group of organic compounds which contain carbon and hydrogen only. Alkanes, Alkenes, and Alkynes are the three (3) basic groups of hydrocarbon compounds. Alkanes are hydrocarbons that have single bonds between carbon atoms. Alkenes are hydrocarbons that have double bonds between carbon atoms and Alkynes have triple bonds between carbon atoms.

- Ethyne or commonly known as acetylene is an alkyne hydrocarbon with a chemical formula C_2H_2. This organic compound is commonly used as fuel in an oxy-acetylene welding torch. Ethyne (acetylene) is also produced when Calcium carbide, CaC_2, reacts with water in the air. It has the ability to hasten the ripening of fruits. That is why fruit vendors use calcium carbide in ripening their fruits in just a few days.

- Ethene is a gaseous organic compound with a chemical formula CH_2CH_2. It is a plant's compound that is responsible for the ripening of fruits.

- Alcohols are a group of organic compounds that contain a hydroxyl group, -OH, that is chemically bonded to a carbon atom in the compound. They have special uses such as a disinfectant, fuel, and as a main component (ethyl alcohol) of liquor and other alcoholic drinks.

- Carbonyl compounds like acetone, and formaldehyde have a carbonyl functional group, C=O, which is chemically bonded to a carbon atom in the compound. These common carbonyl compounds also have important uses: acetone is used as a cleaning agent like a nail polish remover, and formaldehyde is used in preserving organic materials like an animal specimen. This is also the compound used in embalming human cadavers.

Glossary

***Alkanes*.** Alkanes are hydrocarbon compounds where atoms only form single bonds with other carbon atoms.

Alkenes. Alkenes are hydrocarbon compounds which have double bonds between carbon atoms.

Alkynes. Alkynes are hydrocarbon compounds which have triple bonds between carbon atoms.

Boiling point. It is the temperature in which a substance goes from the liquid phase to the gas phase.

Carbonyl containing compounds. Carbonyl compounds are organic compounds where a carbon atom is bonded to a carbonyl group (C=O). To illustrate: C—C=O

***Flammability*.** Flammability is the property of a substance that describes how easily it burns.

Hydrocarbons. Hydrocarbons are organic compounds consisting primarily of carbon and hydrogen atoms.

***Organic compound*.** Organic compound is any chemical compound that mainly contain carbon that is chemically bonded with hydrogen and other nonmetal elements like oxygen, sulfur, and nitrogen.

***Viscosity*.** Viscosity is the property of a fluid that describes a substance’s resistance to flow or deformation.

Volatility. Volatility is the property that describes how a substance easily evaporates

Summative Assessment:

Write the letter of the correct answer:

1. Which are TRUE about organic compounds?

    I. organic compounds contain calcium
    II. organic compounds contain carbon
    III. organic compounds can be produced by living organisms
    IV. organic compounds can be produced artificially

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

2. Why are carbon atoms able to form many organic compounds?

    A. carbon atoms have strong attraction to other elements
    B. carbon atoms attract electrons from other atoms
    C. carbon atoms can form many types of bonds with other carbon
    D. none of the above

3. How many types of bonds can a carbon atom form?

    A. 1   C. 2
    B. 3   D. 4

4. Marcy's car stopped at the middle of the road. She found out that her car has ran out of fuel. Which compound must she buy?

    A. kerosene   C. lubricating oil
    B. gasoline   D. water

5. Juan Victor's grandmother was cooking their supper when she suddenly stopped and said, "Oh, the tank is already empty!" Then her grandmother asked him to buy another tank. What did Victor's grandmother ask him to buy?

   A. gasoline
   B. water
   C. lubricating oil
   D. liquefied petroleum gas (LPG)

6. Juan Miguel wants to protect his bicycle's parts from rusting fast. Which of the following material do you think will Miguel use?

   A. vinegar
   B. isopropyl alcohol
   C. kerosene
   D. lubricating oil

7. Marcela told her grandson, Miguel, never to play with gasoline. Why do you think she does not allow him to do it?

   A. because gasoline is volatile
   B. because gasoline is flammable
   C. because gasoline is viscous
   D. all of the above

8. Emmanuel Juan cut his finger accidentally when he was cutting his nails. He has to apply something on his wound so that it will not get infected. Which compounds should he use?

   A formalin
   B. isopropyl alcohol
   C. kerosene
   D. acetone

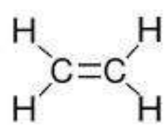
9. Why is it important to know the properties of common liquid materials?

   A. To know the uses of the liquids
   B. To know possible danger from these kind of material
   C. To know how these liquids affect people
   D. all of the above

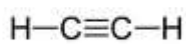
10. Which hydrocarbon compound has a double bond in the molecule?

A. ethane C. propene
B. methane D. propyne

11. How many types of bonds are there in the following hydrocarbon compound?



A. 1 C. 3
B. 2 D. 4

12. To which group of hydrocarbon does the molecule with the structure  belong?

A. alkane C. alkene
B. alkyne D. none of the above

13. Methane is a component of natural gas. What is the common use of methane?

A. disinfectant C. fuel
B. medicine D. cleaning agent

14. What happens to the boiling point of hydrocarbon compounds when the number of carbon atoms increases?

A. remains the same C. increases
B. decreases D. increases then decreases

15. What is the common use of ethyne?

A. disinfectant C. artificial ripening agent
B. fertilizer D. antibiotic

16. Which are TRUE about the use of ethyl alcohol?

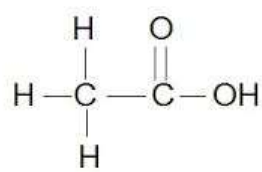
I.	medicine	III.	disinfectant
II.	fuel	IV.	Fertilizer

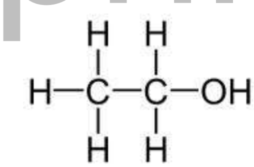
A. I and II only
B. II and III only
C. III and IV only
D. I and IV only

17. Veronica wants to change her nail polish because it does not look good with her new dress. What must she use to remove her fingers' old nail polish?

A. acetic acid
B. lubricating oil
C. acetone
D. formaldehyde

18. Which of the following compounds is a carbonyl compound?

A. 

B. 

C. 

D. all of the above

19. Maria Paula wants to preserve a fish for her project in Biology class. What kind of compound should she use to preserve the animal?

A. acetic acid
B. formaldehyde
C. methyl alcohol
D. acetone

20. Which alkene will most likely have the highest boiling point?

A. ethene C. pentene
B. propene D. hexene.

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Unit 2
MODULE
4

Suggested Time allotment: 14-16 hours

What's in a Mole?

Overview

In real life situations, pieces of matter are quantified by finding the mass or by counting. Market vendors for example, would rather sell mongo seeds by getting the mass and salted eggs by counting. The choice of quantifying goods is determined by convenience. It is easier to get the mass of rice grains rather than count the grains. It is more convenient to count the number of eggs rather than get their mass. To measure these quantities, mass units such as kilogram or gram, or counting units such as dozen or case are being used.

In the laboratory, chemists measure out a chemical substance and react it with another substance to form the desired quantity of a new product. In this case, chemists want to know the number of atoms, ions, or molecules because these are the ones that react with each other. However, these things are too small and too many to count individually so chemists use a unit called **mole** to count them by weighing. Like a dozen, a ream, or a case, a mole also represents a certain number of particles. Can you guess how many particles are equal to one mole?

As you go through this module you will be able to answer the following key questions:

How is the mole used to express the mass of a substance?

How is the percentage composition of a given compound determined?

Learning Competencies/Objectives

- use the mole concept to express mass of substances; and
- determine the percentage composition of a compound given its chemical formula and vice-versa.

Before you work on this module, answer first the pre-assessment prepared for you.

Pre-Assessment:

Direction: Choose the letter of the correct answer.

1. Suppose you were asked to prepare a 250-g chocolate mousse which is 35% chocolate, 30% cream, 20% milk, 10% sugar, and 5% butter, how much cream are you going to use?

a. 75 g cream b. 60 g cream
c. 73 g cream d. 62 g cream

2. Cheska measured the mass of 10 pieces of each of the following materials: marble, pebble, and ballpen cap. What will be her findings based on the data she obtained?

Table 1. Data on Mass

Materials (10 pieces)	Mass (g)
marble	50
pebble	35
ballpen cap	20

a. Different materials have different masses.
b. Materials of different kinds differ in amount, color, and texture.
c. The same number of materials has different colors and appearance.
d. The same number of materials of different kinds has different masses.

3. The following are representative particles of matter: which among them represents a covalent compound?

a. atom b. ion
c. molecule d. particle unit

4. A bag of NPK fertilizer marked 16-4-8 contains 16% nitrogen, 4% phosphorous and 8% potassium, the other 72% is usually inert filler material, such as clay pellets or granular limestone. What is the mass of nitrogen present in 500g pack of NPK fertilizer?

a. 80g b. 40g
c. 20g d. 10g

5. How many particles are equal to 1 mole?

a. 6.02×10^{22} particles b. 6.02×10^{23} particles
c. 6.02×10^{24} particles d. 6.02×10^{25} particles

6. How can the knowledge about mole be useful for environmentalists?
    a. Mole concept can be used in environmental monitoring.
    b. It gives information on the most dangerous pollutant in the atmosphere.
    c. It gives a feedback on the kinds of pollutants present in the atmosphere.
    d. Mole concept can be used in quantifying the amount of pollutant-particles released in the atmosphere.

7. How can you apply knowledge on percentage composition?
    a. In maintaining the quality of food product.
    b. In checking the amount of sugar present in the softdrink.
    c. In identifying the correct amount of substance present in a sample.
    d. all of the above

8. How many percent of hydrogen (H) is present in water (H_2O)?
    a. 12% b. 11%
    c. 13% d. 10%

9. Which of the following units is used in expressing the amount of substance in terms of the number of particles?
    a. liter b. gram
    c. mole d. Celcius

10. What do you expect to observe in a "Mole Exhibit of Different Substances?
    a. different kind of elements
    b. different colors of substances
    c. showcase of 1mole of different elements having different masses
    d. showcase of 1mole of different substances having the same masses

Now that you are done with the pre-assessment, let us perform the activities in this module to understand the mole concept.

Activity 1: Counting by Getting the Mass of an Object

Objectives:

- Measure the mass of an object.
- Record the mass with the correct number of significant figures.
- Relate the mass of the object to the number of pieces per item.

Materials Needed:

25 pieces paper clips of the same size and kind
Platform balance (preferably with 0.01 precision)

Procedure:

1. Measure and record the mass of 25 pieces paper clip using the platform balance. Divide the mass obtained by 25 to find the average mass of one paper clip. Perform three trials.

Table 1: Data on the Average Mass of Paper Clips

Trial	Mass (25pieces in g)	Average Mass (g) of one paper clip
1		
2		
3		

2. Get a handful of paper clips and measure their mass. Compute for the number of paper clips using your data from step #1. Be sure to do it through computation and not by counting.
3. This time, count the number of paper clips in the handful of paper clips in step #2.
4. Repeat steps 2 and 3 by getting a different handful of paper clips. Record your answer on Table 2.

Table 2: Data on the Number of Paper Clips

Trial	Mass of a handful of paper clips	Number of Paper Clips based on Computation	Number of Paper Clip Based on the Actual Count
1			
2			
3			

Q1. Is the number of paper clips in step 2 the same as the number of paper clips in step 3? Why do you think so?
Q2. Having an experience in counting by getting the mass, give some ways in which you can apply this procedure in daily life situations.

You have just experienced how chemists determine the number of particles by getting the mass. It is impossible to count the number of atoms present in a gold bar or the number of molecules present in a glass of water but by knowing their masses, computations can be done which will eventually give the number of particles with the use of a number called Avogadro's number.

Avogadro's number is the number of particles in one mole of a substance. It is a very large number equal to **6.02×10^{23} particles.** So, a **mole** (mol) of a substance is 6.02×10^{23} representative particles of that substance. The representative particles can be atoms, molecules, or formula units. So, one mole of carbon-12 contains 6.02×10^{23} atoms, one mole of water contains 6.02×10^{23} water molecules and one mole of sodium chloride (table salt) contains 6.02×10^{23} formula units of sodium chloride. For you to figure out how large Avogadro's number is, try to imagine this, ***"if you put together 6.02×10^{23} basketballs, it will be as big as the Earth or if you have 6.02×10^{23} rice grains, it would cover the land masses of the Earth to a depth of 75 meters."*** Now that you have realized how big Avogadro's number is. Let us try to visualize the number of particles in a given sample.
(**Source:* Wilbraham, A.C., Staley, D.D., Matta, M.S. & Waterman, E.L. (2007). Chemistry, Teacher's Ed. Boston, Massachusetts: Pearson, Prentice Hall, Inc.*)*

Example:

How many molecules are there in 4.0 moles of CO_2?

To answer this question you have to consider this:

1 mole = 6.02×10^{23} particles

Thus, using dimensional analysis approach, you will be able to convert number of moles to its equivalent amount in the number of particles.

$$4.0\ \cancel{\text{moles } CO_2} \times \frac{6.02 \times 10^{23} \text{ molecules } CO_2}{\cancel{1 \text{ mole } CO_2}} = 2.41 \times 10^{24} \text{ molecules } CO_2$$

For you to have a feel on how it is being done, you may answer the following questions.

a. How many mongo seeds are equal to 3.50 moles of mongo seeds?
b. How many bananas are equal to 7.50 moles of bananas?
c. How many moles of rice grains are equal to 1.807×10^{24} grains of rice?
d. How many moles of tomatoes are in 3.01×10^{23} tomatoes?

Were you able to get the correct answer? Now that you already know how to use 1 mole = 6.02×10^{23} particles as conversion factor, let us move on to the next activity.

Do substances with the same mass have the same number of particles?
Let's now have an activity about measuring the mass of an object with the same number of particles. Do different substances having the same number of particles have the same masses? You will discover the answers to these questions as you perform Activity 2.

Activity 2: Total Count Vs. Mass

Objectives:

- Measure the mass of a given number of objects.
- Record the mass showing the precision of the measuring device.
- Convert the number of items to its equivalent mass in grams or vice versa using the equivalents taken from the result of the activity.

Materials Needed:

5 plastic bottle caps (must be of the same brand)
5 soft drink crowns of the same brand
5 10-centavo coins
platform balance

Procedure:

1. Measure and record the mass in grams of the above caps, crowns, and coins in Table 2:
2. From the data you got from step #1, compute for the mass of 1piece and 15 pieces for each kind of material.
3. Measure approximately 25.00g of each material

Table 2. Mass of the Materials

Materials	Mass (g) 5 pieces	Mass (g) 1 piece	Mass (g) 15 pieces	Number of pieces in 25.00 g
plastic bottle cap				
soft drink crown				
10-centavo coin				

Q1. Do the three different materials have the same masses? Explain your answer.

Q2. Was your expected number of pieces per material the same as the number of pieces equal to 25.00g?

Q3. What can you infer from this result?

You have observed from this activity that although you have the same number of items, different objects will have different masses. In the same way, one mole of different substances always contains 6.02×10^{23} particles but each of these substances has a different mass. Examine the sample substances in Table 3. You will observe that each of the substances contains 6.02 x 10 ^{23} particles.

Table 3. Mass of One Mole of Different Substances

Substance	Chemical Formula	Molar Mass (g/mol)	Number of Particle
oxygen gas	O_2	32.00	6.02 x 10 ^{23}
Sucrose (table sugar)	$C_{12}H_{22}O_{11}$	342.34	6.02 x 10 ^{23}
Hydrogen peroxide	H_2O_2	34.02	6.02 x 10 ^{23}
Elemental Calcium	Ca	40.08	6.02 x 10 ^{23}

Are you now convinced that one mole of different substances have different masses? Remember that one mole of a substance contains 6.02x10 ^{23} particles.

This time, consult the periodic table of elements. Look for the atomic mass of hydrogen, oxygen, carbon, sulfur, potassium, and phosphorus. What do you observe about their atomic masses? Each element has its own mass different from the others in the same way that different compounds have different masses.

Let us perform Activity 3 to visualize how one mole of different substances differs in mass.

Activity 3: The Mass of One Mole of a Substance

Objective:

- Compute for the molar mass of common substances.

Materials:

6 pcs 100 mL beaker or small jars of the same size
platform balance
Periodic Table of Elements

Procedure:

1. For table 4-A, consult the periodic table of elements for the atomic mass, which has the same numerical value with its molar mass. For table 4-B, compute the molar mass of the compound using this formula:

(Number of atom A x atomic mass of A) + (Number of atom B x atomic mass of B)…
Example: $MgCl_2$ (1 x 24.21g) + (2x 35.45g) = 95.11g

Table 4-A: Molar Mass of Some Common Elements

Element	Symbol	Mass (g)	Molar Mass (g/mol)
Sulfur (*Asupre*)			
Lead (*Tingga*)			
Copper (*Tanso*)			

Table 4-B: Molar Mass of Some Common Compounds

Compound	Chemical Formula	Mass (g)	Molar Mass (g/mol)
Water	H_2O		
Table Salt	NaCl		
Table Sugar	$C_{12}H_{22}O_{11}$		

2. Get the mass of an amount equal to one mole of the substances in tables 4-A and 4-B. Put the sample substances in containers of the same size. Observe closely the amount equal to one mole.

Q1. Do you think that one mole of the different substances have the same amount?

Q2. What do you observe about the mass of the substances in Tables 4-A and 4-B?

Q3. Would 1.50 moles of H_2O have the same number of particles as 1.50 moles of any of the substances you weighed?

Q4. What can you infer about this activity?

Let us have more exercises on the molar mass of the different compounds common to us.

Table 5. Molar Mass

Chemical Name	Chemical Formula	Molar Mass (g/mol)
Iron (II) sulphate (ferrous sulfate)	$FeSO_4$	
Ethyl alcohol	C_2H_5OH	
Ammonia	NH_3	
Citric acid	$C_6H_8O_6$	
Aluminum hydroxide	$Al(OH)_3$	

Knowing the number of particles present in one mole of a substance and how to compute for the molar mass, you are ready for the next activity.

Activity 4: The Relationships among Number of Moles, Mass, and Number of Particles

Objective:

- Describe the relationships among the number of moles, mass, and number of particles.

Materials:

sulfur
sugar
salt
aluminum foil
platform balance
watch glass
measuring spoon

Safety Tips

Avoid skin contact with sulfur.

Procedure:

1. Measure the mass of one tablespoon of each of the following substances: sulfur; aluminum foil ; sugar; and salt

2. Using the molar mass of each of the substances, in Table 6, compute how many moles are present in each sample. Record your answer.
3. Compute for the number of particles of each substance.

Table 6. Data on Molar Relationship

Substance	Sulfur	*Aluminum foil	Sugar	Salt
Mass (g)				
No. of Moles				
No. of Particles				

Cut into tiny pieces

Q1. List down the substances based on the following order:

a. Increasing mass (light to heaviest)

b. Increasing number of particles (lowest to highest amount)

c. Increasing number of moles (lowest to highest amount)

Q2. Is the number of particles in the sample directly related to the number of moles? Why do you say so?
Q3. Is the mass of the sample related to the number of moles? Explain your answer.
Q4. Explain why one tablespoon of different substances does not have the same mass in grams (g), the same number of moles, and the number of particles.

Now that you have learned the connections and relationships among the mass, number of moles, and the molar mass of some substances, you can easily figure out its amount in terms of its mass, the number of moles and the number of particles. Can you state the relationship between the following properties?

a. Mass and number of moles
b. Number of moles and number of particles

The next activity will help you understand these relationships better.

Activity 5: The Chemist's Mole

Objective:

- Apply the mole concept in completing a given set of data.

Material:

Periodic Table of Elements

Procedure

Complete the table with the needed information.

Table 7. Molar Relationships

Substance	Molar Mass (g/mol)	Representative Particle	Mass (g)	Number of Moles	Number of Particles
Carbon Dioxide (CO_2)	44.01			2.5	
Gold (Au)		atom		1	
Glucose ($C_6H_{12}O_6$)			360.36		1.205×10^{24}
Calcium fluoride (CaF_2)		formula unit		3	
Nitrogen gas (N_2)	28.02		140.10		

Q1. When is a particle classified as an atom, a molecule, or a formula unit?
Q2. Show how you will convert the mass of a given sample to number of moles and vice versa.
Q3. Show how you will compute for the number of particles given the following:

a. Mass of the sample
b. Number of moles of the sample

Test your understanding about the mole concept by answering the following problems at home.

1. A cancer patient needs to increase his **ascorbic acid ($C_6H_8O_6$)** intake to fight cancer cells. a) How many moles of ascorbic acid does he need to complete the doctor's prescription of 13.00g of intravenous ascorbic acid every day for one month? b) How many molecules of ascorbic acid does he need everyday to fight the cancer cells?

2. **Aspartame ($C_{14}H_{18}N_2O_5$)** is synthetic table sugar substitute in food and drinks. If a food product needs 0.25 g of $C_{14}H_{18}N_2O_5$ to sweeten the ***Chemitria cupcake***, and you ate this food product, how many molecules of aspartame have you eaten?

3. During exercise, **lactic acid ($C_3H_6O_3$)** forms in the muscles causing muscle cramps. If 5.0 g of lactic acid ($C_3H_6O_3$) concentrate in your leg muscles, how many moles of lactic acid ($C_3H_6O_3$) are causing you pain?
4. **Paraffin ($C_{22}H_{46}$)** is a wax used in candle-making. During combustion, a 20.0 g candle produces 1.42 moles of CO_2. How many molecules of CO_2 are released in the atmosphere after using the candle?

Applying the mole concept can be a useful quantitative tool in daily life. Understanding this concept gives you an idea of how many molecules of vitamins and or medicines are introduced into our body. Given the mass, you also have a clearer idea of how many molecules of pollutants are produced and released in the environment due to human activities even though your unaided eyes cannot see them.

In the next activity, you are going to summarize what you have learned from the previous activities. Recall all the key ideas and make a concept map about them.

Activity 6: Mole Map

Objective:

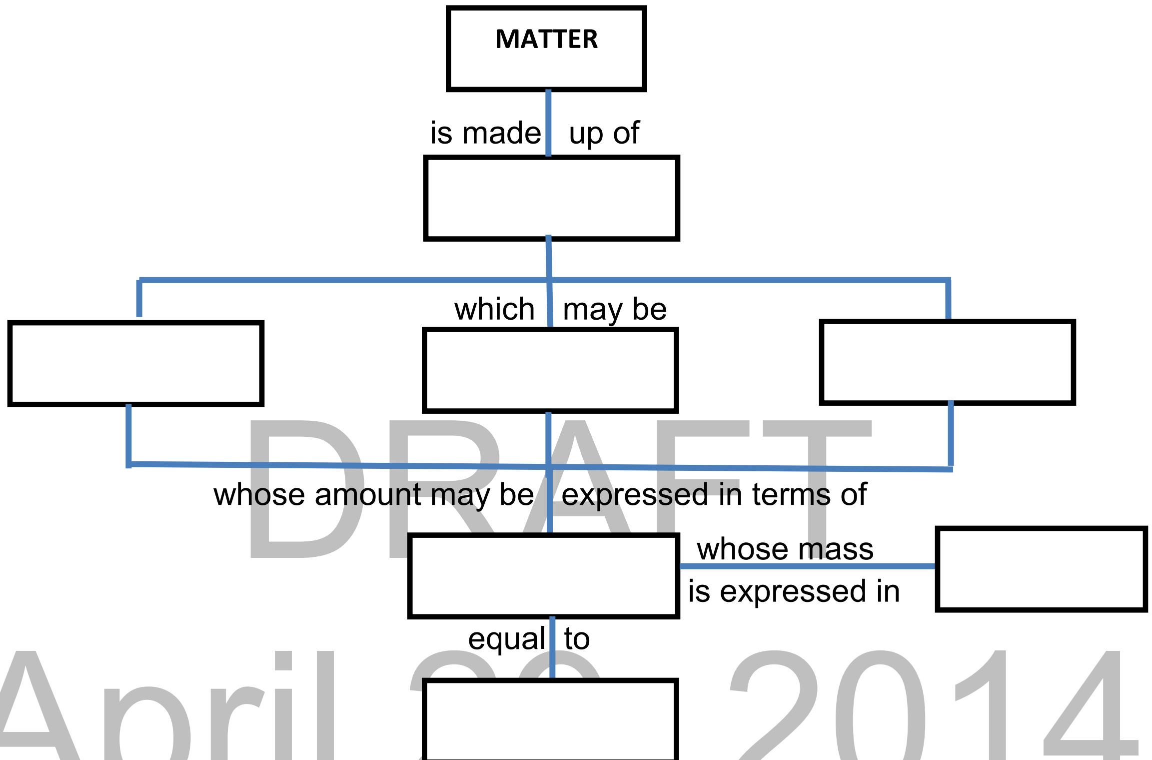
- Prepare a concept map on the mole concept.

Material:

Activity sheet

Procedure:

Complete the following concept map with the appropriate terms using the following words: ions, Avogadro's number, mole, atoms, molecules, particles, mass, compound, g/mole(molar mass), elements.



Accomplishing the concept map means that you have understood the lessons you have studied. Let's proceed to the next topic.

Percentage Composition of a Compound

Are you interested to know how much of an element is present in a compound? You can answer this question by determining percentage composition.
The mass of each element in a compound compared to the entire mass of the compound multiplied by 100 percent is called the percentage composition of the compound. So, the percentage composition of a compound tells you the percentage of the mass made up by each element in a compound. Let us compare it in a classroom situation. You are 50 in your section with 21 boys and 29 girls. If you will be asked what percent of the class are boys and what percent are girls, how are you going to compute for the answer? If your answer is 42% boys and 58% girls, you got it correctly! Let us have an example for the compound which is so important to all of us,

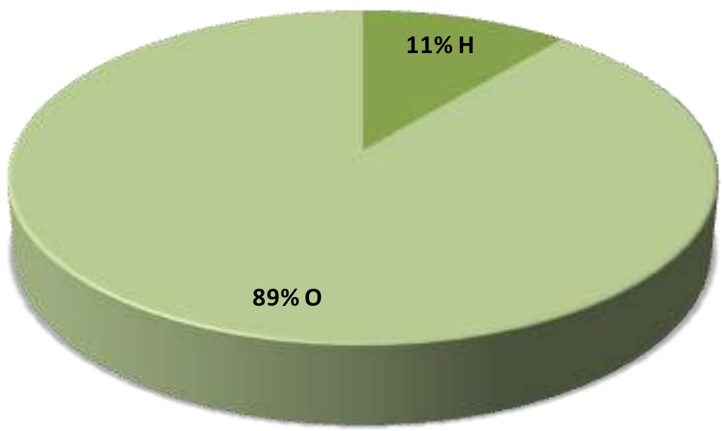
water (H_2O). The computation below shows the molar mass of water. If you will be asked to compute for the percentage of oxygen and hydrogen in water, how are you going to do it?

H_2O

1 O atom (16.00 g) = 16.00 g
2 H atoms (1.01g) = 2.02 g

18.02 g

Did you answer 89% oxygen and 11% hydrogen? Your answer is correct! To get the percent oxygen, mass of oxygen is divided by the mass of water multiplied by 100%. The same is true with hydrogen.



% Composition of Water

Can you present a general formula for the computation of percentage composition?

We can have the formula as:

$$\textbf{\% mass of element} = \frac{\textbf{mass of element in the compound}}{\textbf{mass of the compound}} \textbf{ x 100\%}$$

Let us apply this formula to problem solving.

1. Soil that is already depleted of its nutrients needs fertilizer. One of the nutrients needed to replenish the soil is nitrogen. If you are an agricultural technician helping a

farmer, which among these fertilizers are you going to use? Show your computations to convince the farmer about your choice.

a. ammonia - NH_3
b. ammonium sulfate - $(NH_4)_2SO_4$
c. ammonium nitrate - NH_4NO_3

2. Glucose ($C_6H_{12}O_6$) is a six-carbon sugar (hexose) which is also known as the blood sugar. It is an energy source that fuels our body. How many percent of carbon is present in glucose?

3. The "fuel value" of the hydrogen-containing fuels depends on the mass percentage of hydrogen (H). Rank the following compounds in terms of their "fuel value" with 1 as the highest fuel value and 3 as the one with the lowest value:

a. ethane (C_2H_6)
b. propane (C_3H_8)
c. ethanol (C_2H_5OH)

In what other ways can we use percentage composition in our daily lives? Can you give suggestions for its practical use?

Activity 7: It's Grocery Time!

Objectives:

- apply the concept of percentage composition in choosing grocery items.
- realize that the amount of substance intake can be monitored with the use of percentage composition.

Materials:

Grocery item containers or packages (food wrappers, can, bottles etc)

Procedure:

1. Get 3 samples of containers or packages of grocery items such as canned goods, snacks, and beverages.
2. List the substances written as contents/ingredients on the label. Choose two (2) substances from each type of grocery item.
3. Research from a chemistry book or from the internet the chemical formula of the

substances on your list.
4. Compute for the percentage composition of the substances you have listed.
Q1. Based on this activity, what food do you regularly consume which gives your body a lot of carbon (C) atoms and sodium (Na) ions?
Q2. Are these good for your body? Why? Research on how much of these types of food are recommended for your age group.
Q3. In what other ways can you make use of the concept on percentage composition?

Knowledge about percentage composition is useful in choosing the best fertilizer that gives higher amount of nitrogen and potassium in the soil. Aside from this, it will help us to be a wise consumer because it is a good basis of choosing the food product we need to eat based on its content. Whenever you buy t-shirt, it is good to check whether it is 100% cotton or just 75% cotton. In terms of product development, percentage composition will indicate the correct amount of substances needed in order to produce the expected product. For example, if a manufacturing company wants to produce resin, it will not be able to do if it does not know the correct percentage of every component needed to form resin..

Summary:

It is important that you remember the following ideas from this module:

- Different kinds of materials with the same number of particles have different masses.
- One mole contains Avogadro's number of particles equal to 6.02×10^{23}.
- Different substances with the same number of moles have the same number of particles but they have different masses.
- Molar mass is the mass of one mole of a substance expressed in grams.
- The molar mass of a monatomic element like Na, Li, Mg is numerically equal to its atomic mass expressed in grams.
- The mass of the substance divided by its molar mass gives the number of moles of the substance.
- The number of moles multiplied by Avogadro's number gives the number of particles.

- Percentage composition of a compound tells you the percentage of the mass made up by each element in a compound

Glossary:

Avogadro's Number the number equal to 6.02×10^{23} which refers to the number of atoms or ions or molecules equal to 1 mole

chemical formula a combination of the symbol of elements and subscript numbers representing a compound

molar mass the mass of one mole of a substance

mole SI unit to express the amount of a substance

molecule the smallest unit of a substance that retains its physical and chemical properties, it may be composed of one kind of atom or two or more kinds of atoms bonded together.

percentage composition the percentage by mass of each element in a compound

Summative Assessment

Direction: Choose the letter of the correct answer.

1. The label of the dark chocolate indicates that its mass is 150g and it is 70% cacao, if you consume the whole chocolate bar, how much cacao did you eat?

   a. 105 g cacao   b. 45 g cacao
   c. 100 g cacao   d. 50 g cacao

2. What is the representative particle of ionic compounds?

   a. atom   b. ion
   c. molecule   d. formula unit

3. How many particles are there in one mole of any kind of substance?

   a. 3.01×10^{23} b. 6.02×10^{23}
   c. 3.01×10^{24} d. 6.02×10^{24}

4. Moth balls (paradichlorobenzene-$C_6H_4Cl_2$) are used as cockroach repellent. It is often placed inside the cabinet. If 1 piece of moth ball weighs 5.0g and your mother put 3 pieces in your cabinet, how many molecules of paradichlorobenzene-$C_6H_4Cl_2$ (Molar Mass = 147.00 g/mol) will be circulating inside your cabinet considering all the moth balls have sublimed?

a. 6.02×10^{22} molecules of $C_6H_4Cl_2$
b. 6.02×10^{23} molecules of $C_6H_4Cl_2$
c. 6.14×10^{22} molecules of $C_6H_4Cl_2$
d. 6.14×10^{23} molecules of $C_6H_4Cl_2$

5. Who among the following students describes the result of the activity on counting by weighing correctly?

Ann – Different sets of materials having the same mass have different number of pieces.
Dan – Different sets of materials have the same number of pieces and the same mass.
Tom - The same sets of materials, have the same number of pieces but different masses.

a. Ann b. Dan
c. Tom d. none of them

6. The roots of the plants absorb the nutrients from the soil. For the farmers, it is important to strengthen the root system of their plants to ensure its growth. Potassium is the mineral responsible for a healthy root system. If you were a farmer, which of the following fertilizers are you going to use?

a. K_2SO_4 b. K_2O
c. KCl d. K_2CO_3

7. Methane (CH_4*Molar Mass* = 16.04 g/mol) is one of the greenhouse gases. If 32.08 g of CH_4 is released in the atmosphere, how many molecules of CH_4 are added in the atmosphere?

a. 1.20×10^{24} b. 1.20×10^{23}
c. 6.02×10^{24} d. 6.02×10^{23}

8. The presence of SO2 in the atmosphere causes acid rain. How many percent of sulfur is present in SO_2 (Molar Mass = 64.07g/mole)?

a. 40.00% b. 49.95%
c. 60.00% d. 50.05%

9. Arrange the following substances from the lightest to the heaviest:

Cl_2; CH_4; H_2O; NH_3; N_2

a. $H_2O < NH_3 < N_2 < CH_4 < Cl_2$
b. $CH_4 < NH_3 < H_2O < N_2 < Cl_2$
c. $N_2 < Cl_2 < H_2O < CH_4 < NH_3$
d. $NH_3 < CH_4 < Cl_2 < H_2O < N_2$

10. Why is mole concept important?
a. It is useful when converting between grams and atoms or molecules.
b. It gives us a convenient way to express large numbers
c. It can be applied to any type of particle representative
d. All of the above

11. Ammonium nitrate (NH_4NO_3 Molar Mass = 80.06g/mole) is a substance used to produce dinitrogen monoxide (N_2O), a dental anesthetic. Determine the mass percent of N in ammonium nitrate?
a. 35.00%
b. 40.65%
c. 39.50%
d. 43.68%

12. People usually use hydrogen peroxide (H_2O_2 Molar Mass = 34.02 g/mole) to clean their wounds. If Cheska used 1.0 g of H_2O_2 to clean her wound, how many mole of H_2O_2 did she use?
a. 0.035 mole
b. 0.030 mole
c. 0.029 mole
d. 0.025 mole

13. In cold areas, many fish and insects, including the common housefly produce large amounts of glycerol ($C_3H_8O_3$ Molar Mass = 92.11 g/mole) to lower the freezing point of their blood. How many percent of oxygen is present in glycerol?
a. 52.11%
b. 50.11%
c. 51.11%
d. 53.11%

14. Ethyl butanoate ($C_3H_7COOC_2H_5$) is the substance responsible for the aroma of pineapple. What is the molar mass of ethyl butanoate?
a. 118.00 g/mole
b. 117.12 g/mole
c. 120.12 g/mole
d. 116.18 g/mole

15. Calcium carbonate ($CaCO_3$ Molar Mass = 100.09 g/mole) is an antacid used to neutralize extra acid in the stomach. Lorie is prescribed by the doctor to take 250mg-tablet of $CaCO_3$ three times a day. How many moles of $CaCO_3$ will Lorie consume for 3 days?
a. 0.0252 moles
b. 0.0225 moles
c. 0.0242 moles
d. 0.0235 moles

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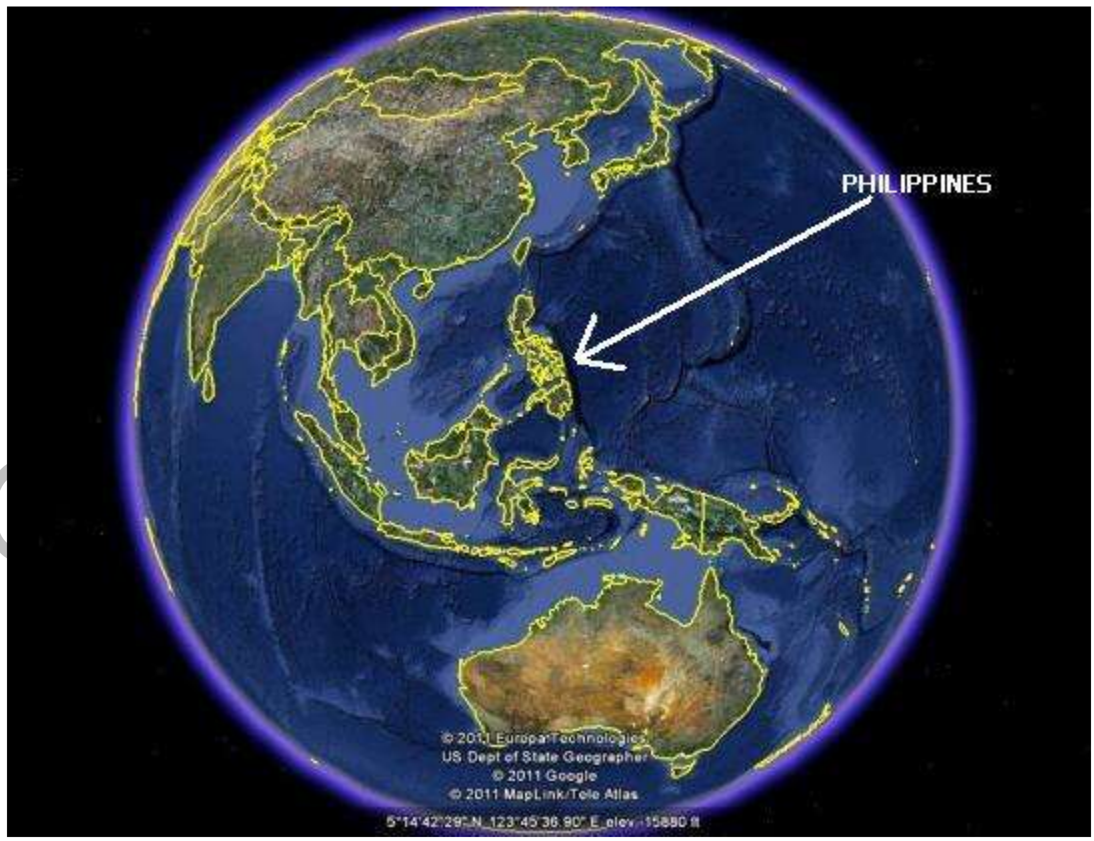
UNIT 3

Earth and Space



(Photo credit: missebinboracay.blogspot.com)

NOTE: Please re-draw the picture in such a way that, the globe shows the Philippines (without the arrow pointing on it) and the Earth is covered with clouds as shown below.)

(Photo credit: Billy Frymire)

Unit 3: Earth and Space

Overview

What will students learn about Earth and Space in Grade 9? As in the previous grade, there will be three modules in this quarter. Module 1 is about *Volcanoes, Module* 2 is about *Climate,* and Module 3 is about *Constellations*.

In Module 1, we continue to make use of our observations in the environment. We emphasize our location along the Ring of Fire. As learned in Grade 8, the Philippines is prone to earthquakes. At grade 9, we will still give emphasis on the location of the Philippines but as a home to volcanoes.

Just like any country along the Ring of Fire, we, too, have active and inactive volcanoes that continuously shape the Earth's surface. These volcanoes can be described in different ways. Active volcanoes have different features based on their activities and emissions.

Likewise, volcanoes have energy that can be tapped for human use. After all, volcanism is not all bad. As part of the disaster risk reduction, we must also point out how the negative effects of volcanic eruption can be minimized through disaster awareness.

In Module 2, we find out the difference between weather and climate. We look into the different factors affecting the climate of an area such as altitude, latitude, distance from the ocean, and presence of landmass.

Since the Philippines is located just north of the equator, we have a tropical climate. Unlike other countries with a wide range of temperature during the course of the year, we experience a minimal difference. What are other variations that we experience?

We also look into certain climatic phenomena that occur on a global level. We talk further the about greenhouse effect discussed in Grade 7. In Grade 9, we will relate it with global warming or climate change. We have to make our students aware of risks of climate change and how its effects can be lessened.

In Module 3, we will take up constellations. In grade 5, the students were introduced to star patterns. In Grade 9, the word constellation will be used. The relationship between the constellations in the sky and Earth's position along its orbit will be given emphasis. Likewise, we have to assist our students make inferences about the characteristics of the stars based on the characteristics of the Sun.

Suggested time allotment: 10 hours

Unit 3

MODULE 1

VOLCANOES

I. Introduction

The Philippines is located along the Ring of Fire. As a result, it is a home to many volcanoes. The most famous among our volcanoes is the Mayon Volcano that has erupted last May 7, 2013 while a group of hikers were exploring its beauty.

Who could forget the terrible eruption of Pinatubo Volcano in 1992 after 600 years of inactivity? Based on statistics, in the first five years following the eruption, lahars destroyed the homes of more than 100,000 people. Lahars also covered about 120,000 hectares with sediment to an average depth of about one meter, and floods spread rock debris over a larger area.The eruption also affected other countries as its emissions in the atmosphere lowered the air temperature.

According to the Philippine Institute of Volcanology and Seismology (PHIVOLCS), our country is an ideal site for any volcanic activity. It is therefore, important for us to know how this natural phenomenon happens to reduce the risks and effects it may cause.

II. Learning Competencies/Objectives

In this module, the Learner should be able to:

1. differentiate active and inactive volcanoes;
2. describe the different types of volcanoes;
3. explain what happens when volcanoes erupt; and
4. illustrate how energy from volcanoes may be tapped for human use.

III. Pre-/Diagnostic Assessment

A. Choose the letter of the best answer.

1. Which characteristic of magma mainly determines its explosiveness?
   a. color
   b. amount
   c. temperature
   d. silica content

2. Which of the following characteristics of a volcano depends on its magma emission?
   a. age
   b. size
   c. shape
   d. location

3. Which of the following factors associated with huge volcanic eruptions may cause the decrease in the Earth's average temperature for a few years?
   a. heat
   b. light
   c. acid rain
   d. volcanic ash

4. A thick layer of volcanic ash can be heavy enough to collapse the roofs of buildings because ash ________.
   a. is solid.
   b. cannot be blown by winds.
   c. becomes heavier as it cools.
   d. consists of tiny fragments of rocks that becomes heavy as they pile up.

5. Which of the following is an active volcano in the Philippines?
   a. Apo in Davao
   b.Bud Datu in Sulu
   c.Isarog in Camarines Sur
   d.Kanlaon in Negros Oriental

B. Answer the following questions briefly.

6. Aside from Mayon Volcano, name another Philippine volcano that has erupted recently.
7. What causes a shield volcano to be shaped like a broad dome?
8. By what process can a volcanic eruption affect temperatures around the world?
9. Give one positive effect and one negative effect of volcanic eruptions.
10. How is energy from volcanoes tapped as source of electricity?

IV. Reading Resources and Instructional Activities

In Grade 8, you have learned about the relationship between the occurrence of earthquakes and the location of the Philippines along the Ring of Fire. Due to its location, the Philippines is a home to many volcanoes. This module will guide you through the study of volcanism in the Philippines.

What is a volcano?

Since you were in elementary, you have heard about volcanoes. But do you know what a volcano is? To find out, let's do the following activity.

Activity 1. Volcano concept map

Objective

- characterize a volcano

Fig. 1. Mayon Volcano(pls re-draw)

Materials:
pictures of a volcano
paper and pen

Procedure:

Q1. Based on the picture, give five descriptions of a volcano. Present your answer in a concept map as shown below.

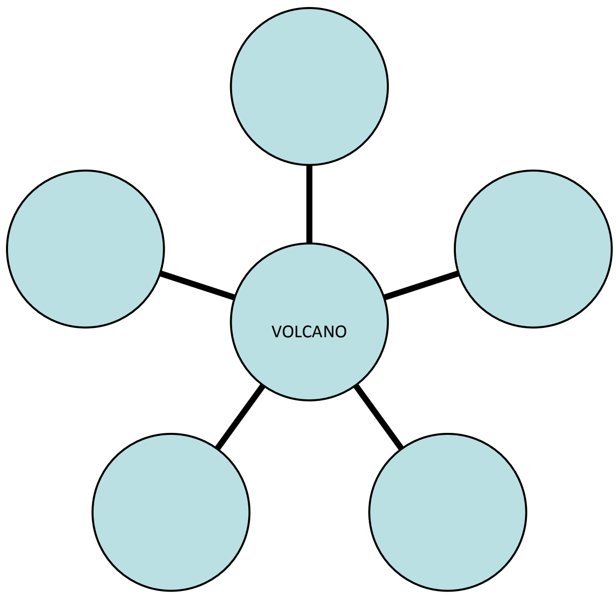


Fig. 2. Concept map in volcano

In activity 1, you have described what a volcano is. The next thing to do is to classify them. Do you have an idea how they are classified? Let's find out in the next activity.

Classification of volcanoes

There are several ways by which volcanoes can be classified. PHIVOLCS have adapted a systemwherethe Philippine volcanoes as active or inactive. Active volcanoes are those that have a record of eruption within the last 600 years or those that erupted 10, 000 years ago based on analyses of their materials.

Inactive volcanoes, on the other hand, are those that have not erupted for the last 10, 000 years and their physical form is being changed by agents of weathering and erosion through formation of deep and long gullies.

According to PHIVOLCS,our country has more than a hundredvolcanoes as of 2013. Twenty-three are active while the rest are inactive. Some of these volcanoes will be mentioned in the next activity.

Perform the next activity to classify the volcanoes according to their record of eruption.

Activity 2. Volcanoes in the Philippines

Objective

- classify volcanoes as active or inactive

Materials:
Philippine map
colored pens
triangle ruler

Procedure:
1. Using the Philippine map (fig. 3), plot the location of thefollowing volcanoes. Assign colors for the volcanoes. Indicate this in the legend.

Table 1. List of some volcanoes in the Philippines

Volcano	Latitude	Longitude	Number of historical eruptions	Latest eruption or activity
Cabaluyan	15° 42′	120° 19′	0	-
Cocoro	10° 53′	121° 12′	0	-
Iraya	20° 29′	124° 01′	1	1454
Kanlaon	10° 24′	123° 7′	26	2006 June
Mayon	13° 15′	123° 41′	49	2013 May
Pulung	7° 55′	124° 38′	0	-
Smith	19° 32′	121° 55′	6	1924
Taal	14°	120° 59′	33	1977
Tamburok	11° 33′	124° 26′	0	-
Urot	5° 59′	121° 15′	0	-

(Source: Philippine Institute of Volcanology and Seismology, accessed Sept. 30, 2013)

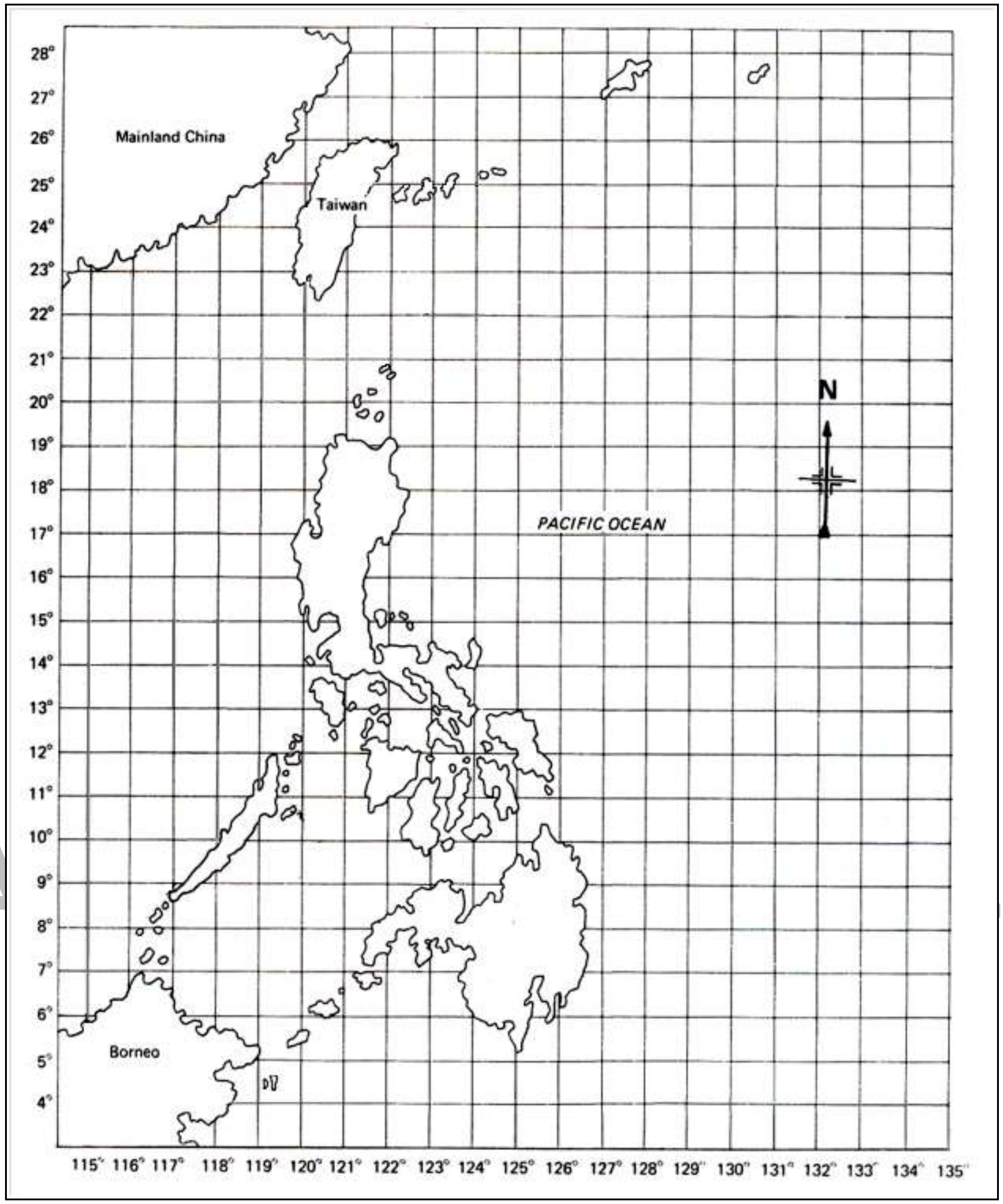


Fig. 3. Map of the Philippines (Source: Gr 8 LM, UPNISMED)

Legend:

- = volcano that has no record of eruption
- = volcano that has erupted 1 to 5 times
- = volcano that has erupted 6 to 10 times
- = volcano that has erupted more than 10 times

Q1. Are all the volcanoes found in the same location?

Q2. Which of the volcanoes had the most number of eruptions? least number of eruptions? no record of eruption?

Q3. How will you classify the volcanoes that have records of eruptions?

Q4. How will you classify volcanoes with no record of eruption?

Q5. In your own words, differentiate an active volcano from an inactive one.

Now that you have differentiated an active volcano from an inactive one, the next question could be: what causes volcanoes to erupt? Let's find out in the next activity.

Activity 3. Under pressure

Objective

- describe the effect of high temperature to the formation of gas

Materials

two 300 ml bottled softdrinks(must be sealed before using)
two 300 ml bottled cooking oil
two identical small basins
hot water

Procedure

1. Hall-fill basin A with hot water and basin B with cold water.

2. Put one bottled soda in basin A and another one in basin B. Wait for three minutes.

3. Slowly unscrew the caps from the bottlein each basin and observe.

Q1. What did you observe in each bottle?

Q2. Explain your observation.

Q3. What is the role of hot water in the setup?

What if we use another liquid such as oil instead of softdrinks? Will we have the same observation? Let's find out in the next procedure.

4. Replace the hot water in basin A.

5. Put one of the bottled cooking oil in hot water and the other one in cold water. Wait for three minutes.

6. Slowly unscrew the caps and observe.

Q4. Do you have the same observation as in the soda drinks?

Q5. Explain your answer.

In the activity, you have seen the effect of temperature on the amount of gas that can be produced in a liquid. How does this affect the pressure inside the bottle? What is the role of pressure in the setup?

Let us relate this concept to what is happening inside the volcano. Magma inside the volcano has high temperature. As the magma is continuously heated, it goes up. As it rises, gas bubbles are developed. The gas bubbles are trapped and expand causing the molten material to swell also, resulting in a gradual increase in pressure within the volcano. When the pressure exceeds the strength of the overlying rock, fracturing occurs. The resulting breaks lead to a further drop in confining pressure, which in turn causes even more gas bubbles to form.

Lava may appear to be the primary material ejected from a volcano, but this is not always the case. Aside from lava, broken rocks, lava bombs, fine ash and dust are also ejected. Does this have any effect on the volcanic shape? Let's find out how.

Volcanic landforms and eruptive styles

Volcanoes come in different shapes and sizes, and each structure has a unique history of eruption. However, volcanologists have been able to classify them according to their landforms and eruptive patterns. We have considered the three general volcanic types according to the shape of their cones: namely: shield volcanoes, cinder cones, and composite cones.

Before we go further, let us discuss the external parts of a volcano.

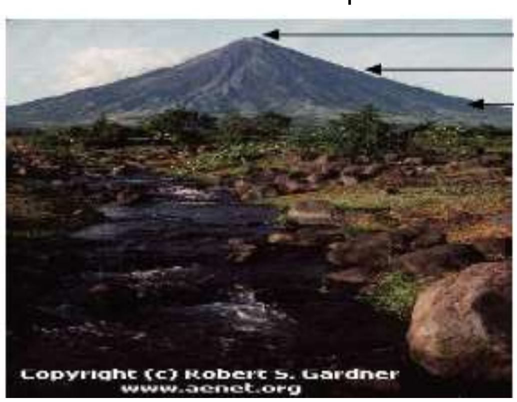


Fig. 4. Parts of a volcano(Source: Project EASE Module 12)

A volcano usually has a summit, slope, and base. At the summit, there is an opening which may either be a crater or a caldera. A crater is a funnel-shaped opening at the top of a volcano while a caldera is formed when a part of the wall collapses following an explosive eruption as shown in Figure 5. A volcano can have one crater, like Mayon Volcano, or more than one, like Taal Volcano that has 47 craters.

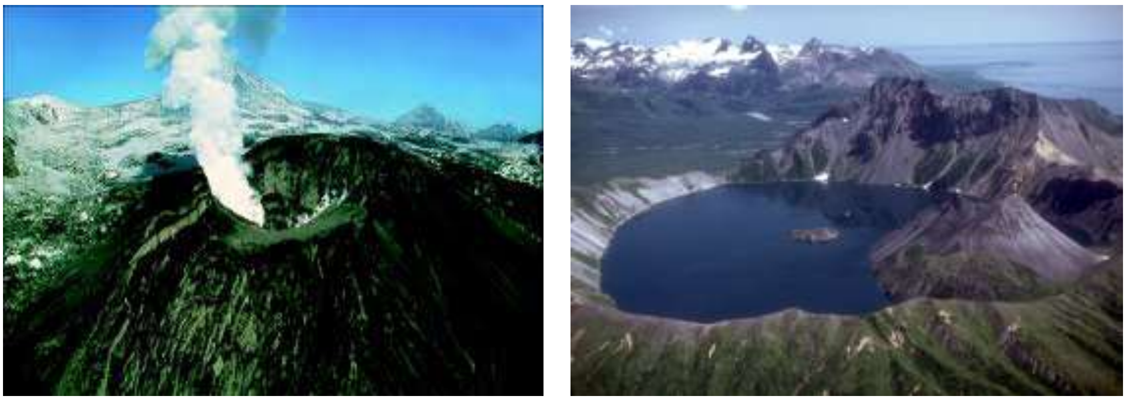


Fig. 5. A crater and a caldera(pls. re-draw)

Volcanic activity can be very fascinating. After an explosive eruption, a scenic cone-shaped structure may be produced or changes on its slope can be observed. The emissions of a volcano provide us with clues on what materials are found inside the Earth. Some eruptions are very explosive, while many others are not.

What determines the nature of eruption? There are primary factors affecting the volcanoes' eruptive style, namely: the magma's temperature, its chemical composition, and the amount of dissolved gases it contains. These factors can affect the magma's viscosity in different ways. **Viscosity** is the property of the material's resistance to flow. It is also described as the liquid's thickness and stickiness. The more viscous and thicker the material is, the greater is its resistance to flow. For instance, syrup is more viscous than water.

Let us discuss how each factor affects the viscosity of magma. First, let's look into how temperature of magma affects its viscosity. The viscosity of magma decreases with temperature. The higher the temperature of magma is, the lower is its viscosity. Aslava flows, it cools and begins to harden, its ability to flow decreases and eventually it stops.

Next, let's look at how the composition of magma affects its viscosity. Magmas with high silica content are more viscous than those with low silica content as shown in Figure 6.The magma that contains less silica is relatively fluid and travels far before solidifying.

Lastly, the amount of gases contained in the magma affects its viscosity. Other factors being equal, gas (mainly water vapor) dissolved in magma tends to increase its ability to flow. Therefore, in near-surface environments, the loss of gases makes magma more viscous, forming a dome or a columnar as shown in Figure 6.

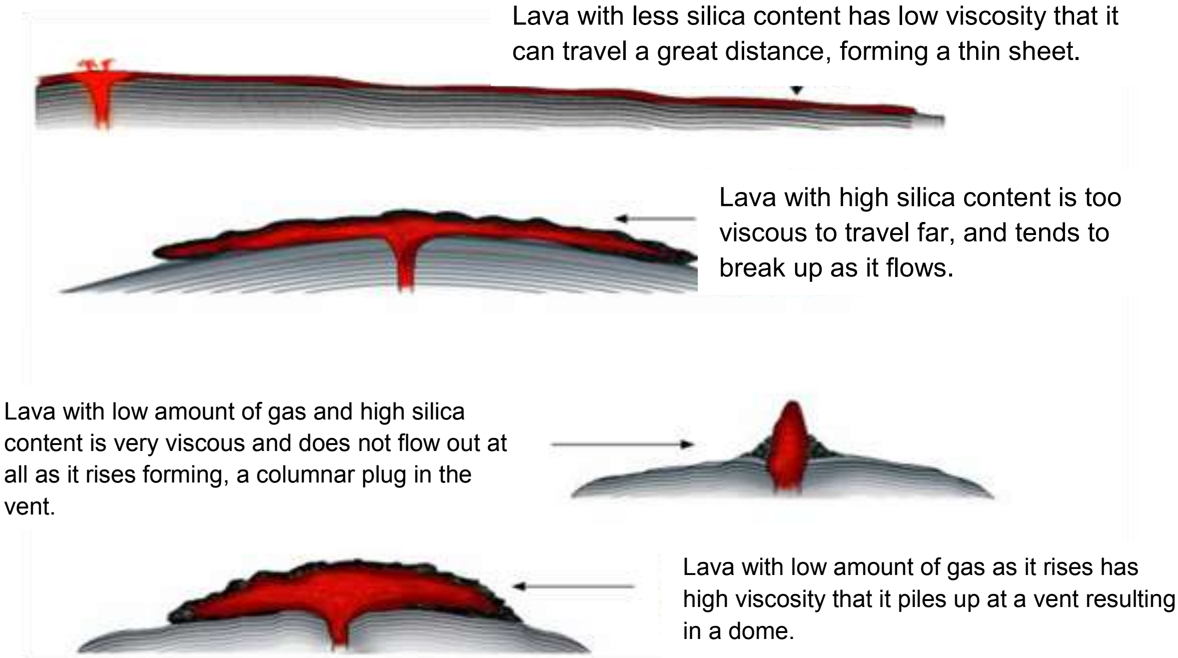


Fig. 6. Viscosity of magma in different conditions(Source: Project EASE Module 12)

To understand more about viscosity, do the following activity.

Activity 4. Viscosityrace

Objectives:

- determine the viscosity of some liquids; and
- describe the flow of gas in different liquids

Materials:
four pieces of cone out of a cardboard
clear drinking glass
beaker
drinking straw
tray
timer
water
syrup
honey
cookingoil

Procedure:

1. Before doing the activity, predict which liquid (water, syrup, honey, and cooking oil) takes the least amount of time to reach the tray. Which liquid will take the most amount of time?
2. Place the cone marked A, B, C, and D on the tray.
3. Pour water on the top of cone A. Record the time it takes for the water to reach the tray.
4. Do it three times for each material.

NOTE: Use the same amount of material each time.

Table 2. Travel time of some liquids

Liquid	Travel time (seconds)			
	1st	2nd	3rd	Average
water				
cooking oil				
syrup				
honey				

Q1. Is your prediction correct?

Q2. Which liquid is the most viscous? How do you know?

Q3. Which liquid is the least viscous?

Q4. Explain viscosity in your own words.

Q5. Compare how these liquids flow with how you think lava flows. Why do some types of lava travel faster than others?

6. Put 100 mL syrup in a clear glass.

7. Using a drinking straw, blow some air from the bottom of the liquid. Observe.

8. Repeat procedure 7 by blowing harder on the liquid. Observe.

Q6. Compare the movement of the liquid as the bubbles move on the surface.

In activity 3, you have observed that different liquids have different viscosities. If the liquid represents the magma, then its rate of flow depends on several factors. In the same way, you have seen in this activity that the amount of gas affects the viscosity of the liquid.

What type of magma do you think the Mayon Volcano ejects? Why do you say so?

Types of volcanic eruptions

Volcanoes erupt differently.They are generally classified as wet or dry depending on the magma's water content. Volcanoes are described according to the style of eruption as follows:

a. Phreatic or hydrothermal – is a stream-driven eruption as the hot rocks come in contact with water. It is short-lived, characterized by ash columns but may be an onset of a larger eruption. Shown on the right is our Taal Volcano in Batangas.

b. Phreatomagmatic – is a violent eruption due to the contact between water and magma. As a result, a large column of very fine ash and high-speed and sideway emission of pyroclastics called base surges are observed.

Fig. 7. Taal Volcano (Photo credits: USGS)

c. Strombolian - a periodic weak to violent eruption characterized by fountain lava, just like the Irazu Volcano in Costa Rica.

Fig. 8. Irazu Volcano (Photo credit: USGS)

d. Vulcanian – characterized by tall eruption columns that reach up to 20 km high with pyroclastic flow and ashfall tephra like that of Paricutin Volcano in Mexico.

Fig. 9. Paricutin Volcano (Photo credits: USGS)

e. Plinian – excessively explosive type of eruption of gas and pyroclastics, just like our Pinatubo Volcano in Zambales.

Fig. 10. Pinatubo Volcano (Photo credits: USGS)

Now that you have learned about the factors that affect the viscosity of magma, it's time to find out how the type of material emissions affects the volcano's slope.

Activity 5. In and out

Objective:

- relate the volcano's slope to its material emissions

Materials:

two ¾ cups of cornstarch
two ¼ cups of water
1 cup gravel
3 cardboard pieces
three 250 ml paper cups
stirrer (any wooden stick)
ruler
protractor

Procedure:

1. Make a data table like the one shown below:

Table 3. Volcano model and slope

Cone	Drawing of cone	Slope (in degrees)
A - cornstarch		
B - gravel		
C - mixed		

2. Mix about 3/4 cup of cornstarch with 1/4 cup of water in a paper cup. Stir the mixture well until it thickens.

3. Pour the mixture on a piece of cardboard from a height of 2-3 cm. Write “cone A” on the cardboard and set it aside.

4. Fill another cup with gravel. Pour the gravel slowly on the second piece of cardboard from a height of about 10 cm. Label this model “cone B” and set it aside.

5. In a cup, mix the rest of the cornstarchwith the rest of the water. Fill the other paper cup with gravel. Pour a small amount of the cornstarch mixture on the third piece of cardboard, then pour some gravel on top. Repeat until all the cornstarch mixture and gravel have been used. Label this model “cone C” and set it aside until the mixtures in both cone A and cone C have hardened (about 20 min).

6. Draw the cone of volcanoes A, B and C.

7. Use the protractor to measure the approximate slope of each cone. You can measure the slope from the base as shown below. Enter the data in Table 2.

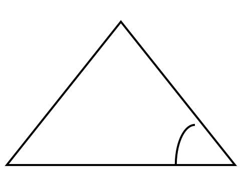


Fig. 11. Measuring the slope of the cone

Q1. Compare the appearances of the cones.

Q2. Which volcano has the greatest slope? Which has the least slope?

Q3. Explain how the type of material extruded from a volcano affects the shape of its cone.

Q4. In what way does the formation of a volcanic cone model differ from a real volcano?

How will you describe the slope of Pinatubo Volcano? Infer the type of materials from which it was formed.

Fig. 12. Pinatubo Volcano
(Source: https://www.google.com.ph/url/mt-pinatubo-things-that-matter)

Although volcanologists have different basis for classifying volcanoes, one way to classify volcanoes is by their cones.Now that you have learned about the relationship between volcanic emission and the shape of its slope, let's discuss the three volcanic cones, namely: shield, cinder, and composite cones.

Shield volcanoes are formed by the accumulation of lava that oozes out from the volcano. Since non-viscous lava can flow freely, a broad, slightly domed structure that resembles a warrior's shield is formed as shown in Figure 13. An example of this type is the Mauna Loa in Hawaii.

Cinder cones, on the other hand, are built from ejected lava fragments. They have a steep slope, wide crater and are the most abundant of the three major volcano types. One example of this type is the Paricutin in Mexico.

Composite cones or stratovolcanoes are large, nearly perfect sloped structure formed from alternate solidification of both lava and pyroclastic deposits. One perfect example of this type of cone is ourMayon Volcano.

Fig. 13. Types of volcanic cones(pls re-draw)

Energy from the volcano

Since our country is a home to more than a hundred volcanoes, energy has been tapped from them. Actually, the Philippines ranks second in the world's production of geothermal energy. According to the Department of Energy, 14.4% of the country's total power generation is produced from geothermal energy. The production of electricity from geothermal energy is cheaper than the electricity production using natural gas, coal, and hydropower.

What is geothermal energy?

The Earth is believed to be extremely hot from within. This heat from the Earth's interior is a source of energy called geothermal energy. The heat of the Earth warms up water which is trapped in rock formations beneath its surface.

How is geothermal energy generated?

Geothermal energy is generated in two ways: geothermal power plants and geothermal heat pumps.They differ in the depth of heat source to produce energy.

In geothermal power plants, the heat from deep inside the Earth is used to produce steam to generate electricity compared with geothermal heat pumps that use the heat coming from close to the Earth's surface to heat water orprovide heat for buildings.

In the Philippines, geothermal power plants are used to generate electricity in Tiwi (Albay), Kidapawan (North Cotabato), Calaca (Laguna), Tongonan (Leyte), Bago City (Negros Occidental), Valencia (Negros Oriental), and Bacon (Sorsogon). The figure 14 below shows the Mak-Ban Geothermal Power Plant in Laguna.

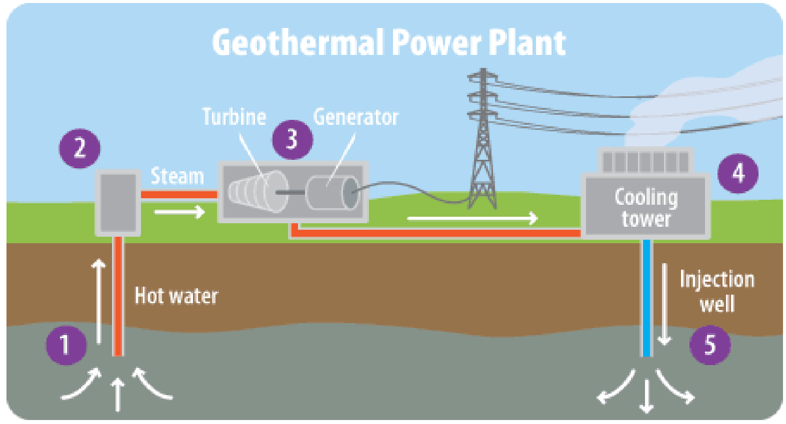


Fig. 14. Generating electricity from geothermal energy(pls. re-draw)

Power plants are built in an area where it is particularly hot just below the surface such as near a group of geysers,hot springs, or volcanic activity.

The following steps are followed to generate electricity in a geothermal power plant:

1. Wells are drilled deep into the Earth to pump steam or hot water to the surface.
2. When the water reaches the surface, the drop in pressure causes the water to turn into steam.
3. The steam spins a turbine, which is connected to a generator that produces electricity.
4. Cooling tower cools the steam which it condenses back to water.
5. The cooled water is pumped back into the Earth to begin the process again.

Q1. Use a flowchart to describe how energy is transformed to generate electricity in a geothermal power plant.

How do volcanic eruptions affect society?

Volcanic eruption is often associated with negative effects. It can cause loss of lives and properties. As the lava flows or pyroclastic materials are ejected in the air, they can destroy anything in their way. Actually, it has a good and a bad side. For example, the eruption of Pinatubo in 1991, one ofthe longest volcanic eruptions, has caused the decrease in the Earth's surface temperature foralmost two years. The strong winds during its eruption spread the aerosol particles from the plume around the globe. The result was a measurable cooling of the Earth's surface for a period of almost two years.

Volcanoes also affect people positively. For example, the eruption of Pinatubo Volcano has created spectacular scenery in its wake. Likewise, the eruption of Musuan Volcano in Bukidnon has produced very rich soils for farmingyears after its eruption in 1867. People became creative also by making earthenware out of the ashfall from the Pinatubo Volcano eruption.

Fig. 15. The Pinatubo caldera

Despite the advantages that people get from volcanic eruption, the major concern now is how to reduce the negative effects of disasters to reduce loss and save lives.

Fig. 16. The aftermath of Pinatubo Volcano eruption (Photo credits: USGS)

Are you prepared?

Signs of an impending volcanic eruption

According to the Philippine Institute of Volcanology and Seismology (PHIVOLCS), the government agency tasked with monitoring earthquakes and volcanoes in the country, the following are commonly observed signs that a volcano is about to erupt. These may vary from one volcano to another.

1. Increase in the frequency of volcanic quakes with rumbling sounds; occurrence of volcanic tremors;

2. Increased steaming activity; change in color of steam emission from white to gray due to entrained ash;

3. Crater glow due to presence of magma at or near the crater;

4. Ground swells (or inflation), ground tilt and ground fissuring due to magma intrusion;

5. Localized landslides, rockfalls and landslides from the summit area which not attributable to heavy rains;

6. Noticeable increase in the extent of drying up of vegetation around the volcano's upper slopes;

7. Increase in the temperature of hot springs, wells (e.g., Bulusan and Canlaon) and crater lake (e.g., Taal) near the volcano;

8. Noticeable variation in the chemical content of springs, crater lakes within the vicinity of the volcano;

9. Drying up of springs/wells around the volcano; and,

10. Development of new thermal areas and/or reactivation of old ones; appearance of solfataras.

Performance Task

You are a volcanologist from Bicol. On your way back to your hometown, you saw the destruction brought about by the eruption of Mayon Volcano. You decided to invite your colleaguesto come with you on your next visit with a mission, that is, to create awarenessamong your townmates aboutvolcanic hazards – before, during, and after a volcanic eruption. Decide on how you will accomplish your mission.

Your presentation will be rated based on the following criteria:

- Details and information
- Method of presentation

- Techniques/creativity
- Accuracy

Criteria	Excellent 4	Proficient 3	Adequate 2	Limited 1
Details and Information	Has included at least 5 things to remember before, during, and after a volcanic eruption	Has included 4 things to remember before, during, and after a volcanic eruption	Has included 3 things to remember before, during, and after a volcanic eruption	Has included only 2 things to remember before, during, and after a volcanic eruption
Method of presentation	Presentation is easy to understand, unique, and exemplary.	Presentation is uniquebut not organized	Presentation is not unique but organized	Presentation is not unique and not organized
Techniques / Creativity	Well-prepared with a variety of props or materials used to create a powerful image about what to do before, during, and after volcanic eruption	Well-prepared but limitedprops or materials used to create an interesting image about what to do before, during, and after a volcanic eruption	Variety ofprops or materials used to create an adequate image that is moderately suitable about what to do before, during and after volcanic eruption	Limited props or materials used to create an image which minimally appeals to or is not suitable about what to do before, during and after volcanic eruption
Accuracy	Information contains essentially no errors which interfere with clarity of communication	Information contains minor errors, none of which interfere with clarity of communication	Information contains errors which somewhat interferes with clarity of communication	Information contains many errors which limit the clarity of communication

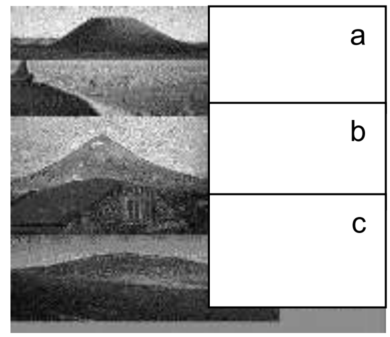
V. Summative Assessment

Answer the following questions:

For numbers 1 to 3, choose from the illustration below. (pls re-draw without the labels)

Which among the following volcanoes is formed from:

1. cinders and ash?
2. mostly lava?
3. alternate solidification of lava and cinders?



4. Which of the following are active volcanoes?

I. Mayon in Albay
II.Taal in Batangas
III. Vulcan in Camiguin
IV. Kanlaon in Negros Oriental

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

5. Which of the following characteristics of magma mainly affect the explosiveness of a volcanic eruption?

a. color
b. amount
c. temperature
d. silica content

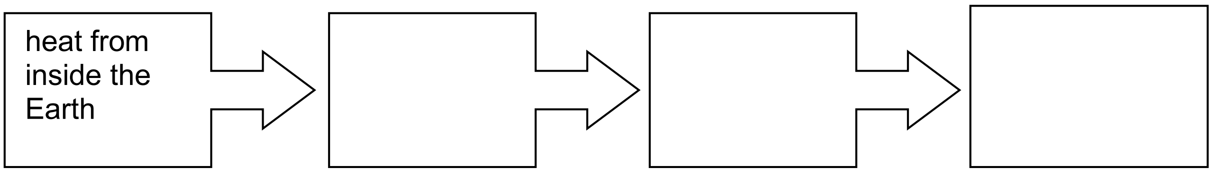
6. How does the eruption of a volcano lower the atmospheric temperature?

7. Give one positive effect and one negative effect of volcanic eruption.

8. Describe the shape of the volcanic cone formed from the following types of volcanic emission:
a. high temperature magma
b. low amount of gas magma
c. high silica content magma

9. Give three things that a person should to do during volcanic eruptions in order to avoid getting hurt.

10. Complete the chart below to show how the heat from the Earth is tapped as a source of electricity in a power plant.



VI. Summary/Synthesis/Feedback

- A volcano is a natural opening in the surface of the Earth where molten rocks, hot gases, smoke, and ash are ejected.

- Volcanoes are classified according to
  a. record of eruption – as active or inactive
  b. shape of volcanic cone – as shield, cinder, or composite

- The shape of a volcanic cone depends on three factors, namely:
  a. composition of magma
  b. temperature of magma
  c. amount of gas

- The heat flowing from inside the Earth is tapped as source of electricity in the geothermal power plant.

Glossary of terms

active volcano– a volcano that has erupted within the last 600 years and are documented by man or those that erupted 10,000 years ago based on analyses of datable materials.

ash – fragments of rocks; fine-grained lava

caldera – a volcanic crater that formed when a part of the wall of the crater collapses following an explosive eruption

cinder – loose fragments of solidified lava

cinder cone – characterized by narrow base and steep slope

crater- a funnel-shaped depression at the top of a volcano formed as a result of explosive eruptions

composite cone – formed from alternate solidification of lava and cinders characterized by large and symmetrical slope.

geothermal – heat coming from inside the Earth

inactive volcano– a volcano that has no record of eruption

lava – magma that has been ejected out of a volcano

magma – molten rock inside the Earth

shield cone - formed by accumulation of lava resulting in a broad, slightly domed structure that resembles a warrior's shield

silica – a compound of silicon (SiO_2)

slope – degree of slant; inclination

summit – peak or highest point

viscosity – the resistance to flow

volcano – an opening in the Earth's surface where molten rocks, smoke, gases, and ashes are erupted.

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Unit 3
Module 2

Suggested Time Allotment: 8 to 9 hours

CLIMATE

Overview

What are the things you usually consider whenever you plan to have a picnic? Most probably, you will consider the time, place, and most of all, the weather. Weather affects your day-to-day activities. In your previous year level, you had encountered different factors that affect weather. These factors help to determine the weather for today each day.

Some of you may mistake climate with weather. But in fact, they are not the same. Climate is the general pattern of weather in a certain area over a long period of time. On the other hand, weather is the condition of the atmosphere at a specific place and time.

In this module, you will learn to distinguish climate from weather. You will find out the factors that affect climate. You will understand why the climate of one country differs from that of others. This module will also help you understand the causes of global warming and other phenomena such as El Niño and La Niña.

At the end of this module, you are expected to answer the following questions:

What are the factors that affect climate? How does each factor affect climate? What is climate change? What are the negative effects of climate change? How can we lessen the bad effects of global warming?

II. Learning Competencies/Objectives

At the end of this module, you should be able to:

1. explain how different factors affect the climate of an area

2. describe certain climatic phenomena that occur on a global level

3. make a strategic plan to help mitigate and adapt to the effects of climate change

Pre-/Diagnostic Assessment

1. How does the windward side differ from the leeward side of a high land?
   a. The windward receives more precipitation than the leeward.
   b. The leeward side has more vegetation than the windward side.
   c. The windward side receives more heat than the leeward side.
   d. The leeward side receives more precipitation than the windward side.

2. What happens to the temperature of air when altitude increases?
   a. remains the same c. decreases
   b. increases d. varies

3. Which of the following BEST describes climate?
   a. The weather that occurs in the atmosphere within a day.
   b. The pattern of weather that occurs in a region over a long period of time.
   c. The pattern of weather that occurs in a region over a short period of time.
   d. The disturbance in the atmosphere that happens in a long period of time.

4. Why are the coldest places on earth found at the poles?
   a. great amount of gaseous particles trap heat from the surface
   b. great amount of thermal radiation is received by these areas
   c. less amount of thermal radiation is received by these areas
   d. less amount of gaseous particles trap heat from the surface

5. What will happen when the rates of evaporation and condensation are equal?
   a. Clouds form. c. The humidity increases.
   b. The dew point is reached. d. Precipitation occurs.

6. Which of the following can cause global warming?

   a. volcanic eruptions
   b. the amount of rainfall
   c. the rising of warm air into the atmosphere
   d. increase of the amount of CO_2 in the atmosphere

7. When does greenhouse effect happen?
  a. Greenhouse gases on the surface absorb heat from the atmosphere.
  b. Greenhouse gases on the surface absorb heat from the earth's interior.
  c. Greenhouse gases in the upper atmosphere absorb heat from outer space.
  d. Greenhouse gases in the lower atmosphere absorb heat from the earth's surface.

8. Which activity does not contribute to global warming?
  a. reforestation
  b. illegal fishing
  c. mining activities
  d. incineration of garbage

9. City A is surrounded by bodies of water and has a moderate climate. It is located near the equator. What will most likely affect the climate of the city?
  a. latitude
  b. altitude
  c. topography
  d. all of these

10. Which of following is an indication of global warming?
  a. rising of sea level
  b. decrease of global temperature
  c. coastal erosion
  d. strong waves in the ocean

II. Answer the following questions.

1. What are the factors that affect climate?

2. How can you lessen the harmful effects of climate change?

3. Explain how greenhouse effect happens.

4. How is a rain shadow formed?

5. What are some impacts of climate change to people and animals?

In Grade 7, you have learned that the earth's axis is not perpendicular to the plane of its orbit. The shape of the earth resulted in the uneven heating of the earth's surface. The equator receives much of the radiant energy released by the sun, so places near the equator have warm climate. The areas closer to the poles receive less amount of heat because the angle of sunlight becomes smaller.

In activity 1, you will find out the role of latitude in varying the climate of different places.

Activity 1. When the Sun's Rays Strike

Objective

- explain how latitude affects climate.

Study the illustration below.

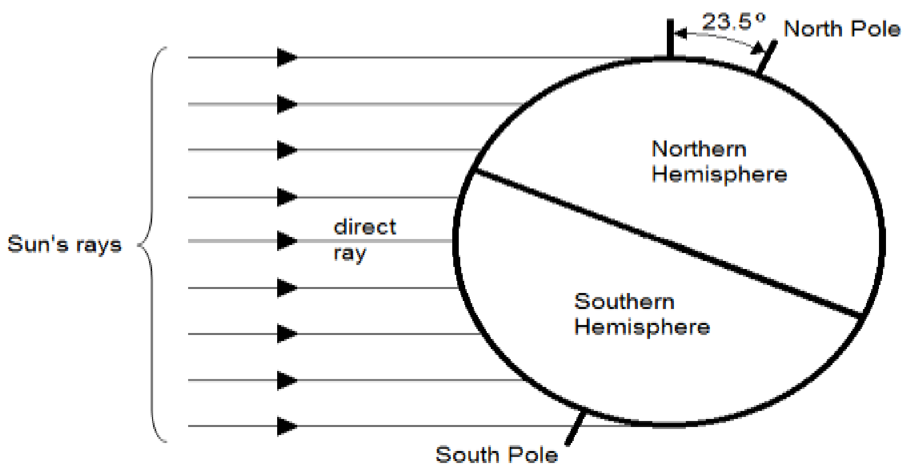

Figure 1 The Sun's rays and the Earth
Source: Grade 7 Science Module

Q1. How much is the tilt of the earth's axis?

Q2. Which part of the earth receives most of the sun's rays?

Q3. Why does the amount of heat receive by places far from the equator become less?

Q4. Why are the coldest places on earth found near the poles?

Q5. Why are places with high temperature found at the equator?

Q6. How does latitude affect climate?

You have noticed that most of the sun's rays strike vertically in places near the equator. This makes the temperature higher in these areas, resulting in warm climate. Places that are not always vertically hit by the sun's rays experience cold climate. As the latitude increases, the smaller the angle of the sun's rays strike the surface. Therefore, when the area is farther from the equator, the air temperature is lower. When the place is closer to the equator, the air temperature is higher.

Do you think the altitude of the place might affect the climate? How does altitude affect climate? The next activity will guide you in answering these questions.

Activity 2. The Higher, the Colder

Objective

- explain how altitude affects climate

Materials Needed

Pencil or ballpen

Ruler

Procedure

1. Study Table 2.1 below.

Table 2.1 Different Cities in the Philippines and Their Annual Average Temperature

Name of Place	Elevation above Sea level (m)	Annual average temperature (^{0} C)
Bacolod	10	27.5
Baguio	1400	16.0
Laoag	20	27.3
Manila	10	27.7
Tacloban	20	29.4
Tagaytay	640	22.7
Zamboanga	30	27.6

Source: http://mapcarta.com (as of September 30)

Q1. Which place is the coldest?

Q2. Which place is the hottest?

2. Construct a scatter graph based on the data above.

Q3. Based on the data, what is the relationship between altitude and temperature of a place?

The altitude of a place will affect the air temperature. Look at Figure 2. Mt. Kilimanjaro is located in Africa and found near the equator. It stands 5895m above sea level. The peak of this mountain is covered by ice. How is this possible? That's because the air temperature decreases as the altitude increases.

Figure 2.1 Mt.Kilimanjaro
Source:http://www.eightup.co.uk/

Refer to Figure 2.2. Why is it that during summer many people visit Baguio City? Obviously, the reason is the cold climate there. It has an annual average temperature of 16^{o}C. It has an elevation of 1435m above sea level.

Figure 2.2 Baguio City
Source: http://jauntsandjoints.blogspot.com/2012/04/love-affair-with-city-of-pines.html
Photo credit: Chelo's Treat

See Figure 2.3. Why do mountain climbers wear jackets and thick clothes when they go up the mountain? The air temperature decreases as the altitude increases. For every 1000 m, there is a drop of 6.5^{0}C. At higher elevations, there is less air. The air molecules are farther apart, thus making the air less dense. Lighter air cannot absorb much heat, making air temperature lower. Ultimately, the decrease in air temperature is due to the decrease in air pressure.

Figure 2.3. Mt. Apo Adventures
Photo credits: Gabo'

In the next activity, you will be able to find out the role of surrounding bodies of water to the climate of a certain region.

Activity 3 Which cools and heats faster?

Objectives

- explain how distance from the ocean affects climate
- compare the effect of heat on water and land

Materials Needed

Water	soil/sand	iron stand and iron clamp
2 laboratory thermometers	2 beakers	thick cloth or pot holder
Sunlight or 2 lamps or alcohol lamps	timer	

Procedure

1. Fill one can with soil/sand. Put label on it.

2. Fill another can with water. Label the container.

3. Prepare the setup like in Fig 3.1.

4. Take the initial temperatures of the water and soil.

(Write your data in the table)

Fig. 3.1 Heat absorption
Photo credits: NSTIC

5. Place the setup under the sun. Take the temperature every two minutes, for a total of ten minutes.

6. Record your data in Table 3.1

(Caution: Do not allow the tip of the thermometer to touch the bottom of the container.)

Table 3.1 Temperature readings in heating the soil and water

Time (min.)	Temperature of soil (°C)	Temperature of water (°C)
0		
2		
4		
6		
8		
10		

Q1. What are the initial temperatures of water and soil?

Q2.What is the difference between the temperature of soil and water after 6 minutes?

Q3. Which heats up faster, water or soil?

7. After ten minutes of heating, remove the containers from each tripod.

8. After removing the containers from the tripods, take the temperatures of soil and water.

Record your data in Table 3.2

9. Take the temperature of each container every two minutes. (You will do this for 10 minutes.)

(Caution: Do not allow the tip of the thermometer to touch the bottom of the container.)

Table 3.2 Temperature readings in cooling the soil and water.

Time (min.)	Temperature of soil (°C)	Temperature of water (°C)
0		
2		
4		
6		
8		
10		

Q4. What happens to the temperatures of water and soil after you remove the containers from each tripod?

Q5. Which cools faster, water or soil?

10. On a graphing paper, make a line graph to show your data presented in Tables 3.1 and 3.2. Then, interpret your graph.

The climate of the place is influenced by the surrounding bodies of water. Soil absorbs heat faster than water. At the same time, soil releases heat faster compared to water. These slow absorption and release of heat by the body of water greatly affect the climate. Places that are near the oceans have moderate climate as the body of water regulates the temperature. Even as both soil and water absorb the same amount of heat, the temperature of water rises more slowly than that of soil. Because soil heats up faster than water, air temperature above the sea is lower than above ground during day time. Warm air thus moves out from land to sea, slowing down the rise of air temperature above land. Thus, places without a body of water nearby tend to have higher air temperature during day time.

At night, soil cools down faster than water, so the air temperature above ground is lower than that above the sea. Warm air then flows from sea to land, so the drop in air temperature above ground is moderated. Places that are far from the bodies of water have extreme climates, as there are no immediate bodies of water that will help to circulate the movement of cold and warm air. The reason why temperature of water rises or falls more slowly than soil is that water has higher heat capacity. Because of this, water also absorbs more heat in warm days and slowly releases it in cold days. That is why during summer, areas that are near a body of water will have moderate temperature because water absorbs more heat. Similarly during winter, surrounding water slowly releases heat causing the cooling effect to become lesser than normal in the nearby landmass.

Figure 3.2 Map of British Isles and Moscow, Russia (Redraw)
Source: http://www.youtube.com/watch?v=E7DLLxrrBV8 (as of November 7, 2013)

Figure 3.2 shows the tip of British Isles and the part of Russia near Moscow. Being in the temperate region, both places have four seasons. Even though both places are on the same latitude, the northern tip of the British Isles has a more moderate climate due to the neighboring bodies of water (refer to the picture above). The British Isles experiences average maximum temperature of 17 ^{o}C and an average minimum temperature of 0^{o}C.

Moscow on the other hand, has an average maximum temperature of 21 ^{o}C and very cold winter with an average of -8 ^{o}C.

Q6. How does a body of water regulate the temperature of a certain region/country?

Q7. Why do some areas that are far from bodies of water have extreme climates?

Now, you have learned another factor that affects climate. It is time for you to explore more factors that influence climate.

Activity 4 Which should I choose, Windward or Leeward?

Objectives

- differentiate windward and leeward sides of a high land
- explain how topography affects climate

Materials Needed

Pencil or ballpen

An illustration of the windward and leeward sides of a mountain

Procedure

1. Study the illustration below.

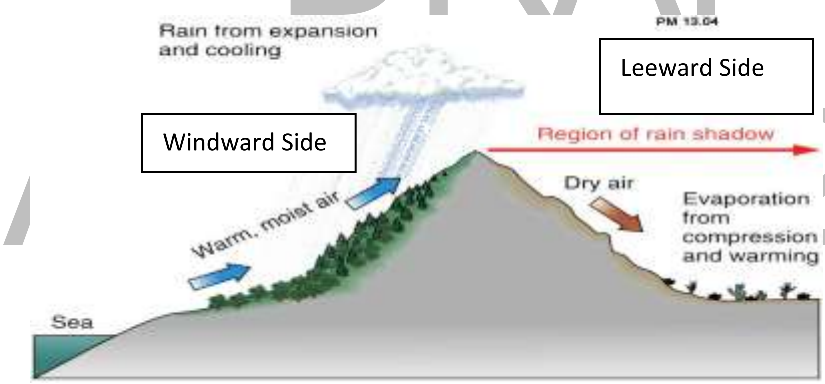

Figure 4.1 The surface features
Source: http://www.proprofs.com/flashcards/cardshow.php?title=chapter-3-climate-vegetation&quesnum=1
Photo Credit: Proprofs.com (As of November 5, 2013)

Mountain is an example of topographical features of the land. As you noticed, the picture shows the two sides of the mountain. One side is facing the wind and has low temperature. Clouds are forming here due to the condensation of water vapor. This formation of clouds develops to become rain. On the other side of the mountain, there is no cloud formation. The temperature is high and precipitation does not happen. This results in the formation of a dry and warm region.

Q1. What happens to water vapor as it rises over the mountain?

Q2. Which side of the mountain experiences low temperature?

Q3. Which side of the mountain experiences high temperature?

Q4.What happens when air becomes warmer and drier as it moves down the leeward side?

Q5. What dry region forms at the back of the mountain?

Q6. How does topography affect climate?

Topography is another factor that affects the climate of a certain place. One of the topographic features of an area is mountain. Mountainous areas greatly affect the amount of precipitation in a certain region. The area in which the wind blows is called the windward side. Here, the wind is blocked by the mountain, forcing it to move upward. As it moves up, the water vapor condenses and forms clouds. This will result in precipitation on the windward side. The air moves down towards the opposite region called leeward side. The cold air mass starts to absorb heat and becomes warm and dry. As a result, the area near the leeward side becomes dry and has less precipitation. The dry region on the leeward side is called rain shadow. Vegetation in this region includes desert plants and grassland.

You have now identified some factors that affect climate. The next activity will help you deepen your understanding about climate.

In Grade 7, you learned how to locate the Philippines using the latitude and the longitude coordinates. The next activity will let you use the skills in finding the location of some major cities in the world. It will also help you understand what affects the climate of a certain city.

Activity 5 Temperatures of Different Cities around the World

Objective

- explain how latitude, altitude, and distance from the ocean affect climate.

Materials Needed

World Map Table with data

Table 5.1 World City Temperatures

City	Altitude (m)	Temperature (ºC) (October 4, 2013)	
		High	Low
Paris	30 .0	23	18
Beijing	43. 7	24	11
Cairo	74.1	31	22
Berlin	36.0	15	2
Denver	1609.3	7	-3
Manila	13.1	30	26
Tokyo	20.1	21	18
Vienna	19 .1	-1	-6
Warsaw	110.0	11	-1

Source: http://www.hko.gov.hk/wxinfo/worldwx/majorcities.htm

Here are the low and high temperatures of some cities in the world dated October 4, 2013. On a world map, locate the two warmest and coldest cities in the table. Determine what affects the regional temperature for each city. Record your findings. Then answer the following questions.

Q1. Which city had the highest temperature?

Q2. What factor do you think is the cause of high temperature in that city?

Q3. Which city had the lowest temperature?

Q4. What factor do you think is the cause of low temperature in that city?

Q5. What factor do you think greatly affects the climate of Tokyo? Support your answer.

Q6. How does the elevation of Paris affect its climate?

In this activity you learned about the effects of latitude, altitude, and distance from the ocean on the climate of a specific area. It is clear that the amount of heat received by the places near the equator is greater compared to those that are far from the equator. Hence, countries that are found near the equator have tropical climate. In contrast, countries that are somewhat farther from the equator have temperate climate. Regions with high altitude have colder temperatures than those in low-lying areas. Areas near bodies of water may have more moderate climate. Places that are far from bodies of water usually experience extremely cold or extremely warm climate.

Note: Try this video link: (http://www.youtube.com/watch?v=E7DLLxrrBV8 to learn more about factors that affect climate. (as of October 11)

You have learned about how latitude, altitude, distance from the ocean, and topography affect climate. For the next activity, another factor that affects climate will be discussed.

Activity 6 Ocean Currents

Objective

- explain how ocean currents affect climate.

Materials

Pen or pencil

Map that illustrates ocean currents

Ruler

Short bond paper

Procedure

1. Study the map below.

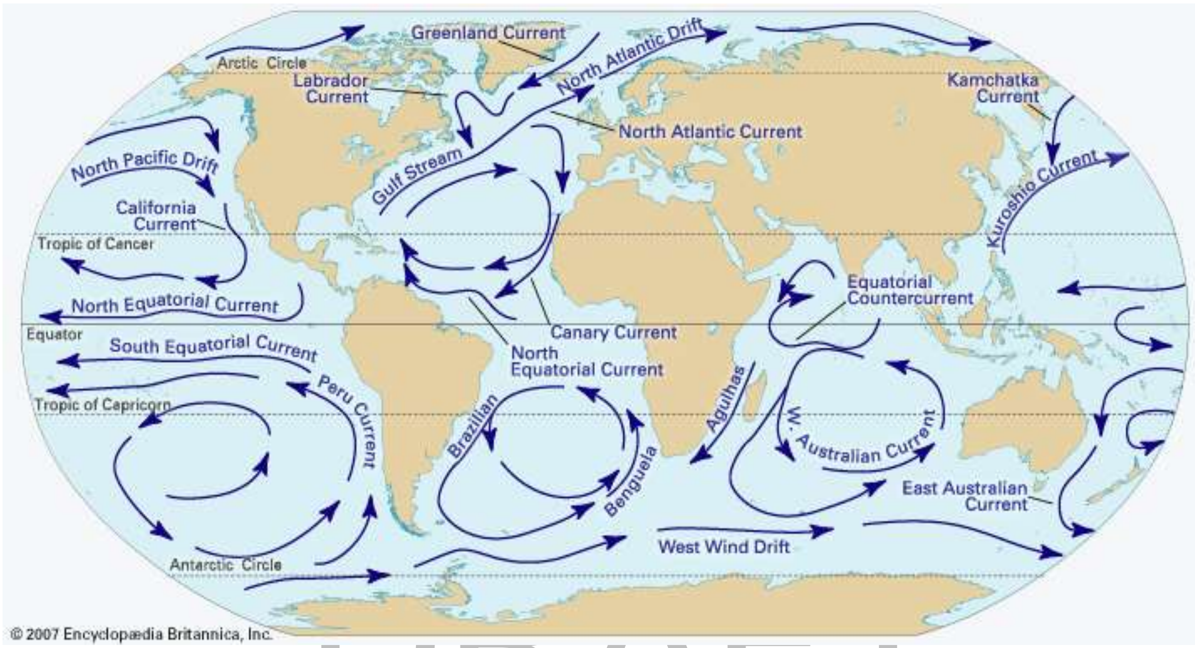

Figure 6.1 The Ocean currents

Source: http://www.plumanities.org.uk/geography-2/higher/atmosphere/atmospheric-circulation

Figure 6.1 shows different **loops or gyres** of surface currents around the world. In the northern hemisphere, the current flows in a clockwise direction. On the other hand, in the southern hemisphere, the current flows in counterclockwise direction. These clockwise and counterclockwise of ocean currents are caused by the Coriolis Effect. Ocean currents that flow away from the equator carries warm water. The air above the warm water has higher temperature. When ocean currents that bring cold water move towards a coastal region, the temperature of that area decreases as warmer air from the land flows to the sea resulting in a cold climate. When warm ocean currents that take along warm water go to a land mass, the temperature of that place increases as warmer air above the water flows inland, resulting in a warm climate.

Q1. What are the different ocean currents that carry warm water? Give at least three examples.
Q2. What are the different ocean currents that carry cold water? Give at least three examples.

Q3. What kind of air does Greenland Current take along? Explain.

Q4. How do the Kamchatka Current and Kuroshio Current affect the northeastern part and southern part of Japan?

Q5. How do ocean currents affect climate?

In this activity, you learned that ocean currents have also an important role in changing the climate of a certain area. They affect the temperature of the nearby land mass. Warm currents that move from the equator towards the poles carry warm water. On the other hand, cold currents that travel from the poles towards the equator carry cold water.

When ocean current carries cold water, the air above it becomes colder. When this ocean current moves toward the coastal region, the temperature of that area becomes lower. For example, (see Figure 6.1) the southwestern parts of Singapore and Indonesia have lower temperature because of the cold air brought by West Australian Current. On the other hand, the ocean current that carries warm water makes the air warmer. When this current goes toward a land mass, the temperature of that place becomes higher. For example, (see Figure 6.1) the warm Kuroshio Current that comes from the northeastern part of the Philippines brings warm water. This raises the temperature of places in the southeastern part of Japan. Therefore, ocean currents that bring along cold water inland make the climate cold. On the other hand, ocean currents that take along warm water to coastal areas make the climate warm.

Climate Change

Is climate change real? Is climate change man-made or is it just a natural occurrence? These are just few questions that can be asked once we talk about climate change. Climate change is one of the most current worldwide issues. Some experts say that it is true that the Earth does go through a period of cooling and a period of warming. The increase of temperature that we are experiencing right now is caused by factors other than human activity. Another point of view is that the increase of Earth's temperature is brought about by human intervention.

Whether the cause is man-made or not, climate change is a change in the environment. Global warming can bring about a rising of the sea level due to the melting of ice caps and glaciers. We may experience severe weather disturbances such as much stronger typhoons and heavier rainfalls. Some parts of the world may experience the so-called El Niño or La Niña phenomena. And most of all, it can cause extinction of some fauna and flora.

To learn more about climate change, do the following activities.

Activity 7 Getting Ready!

Objective

- assess your prior knowledge and experiences about climate change.

Materials Needed

Bingo Card with questions

Ball pen or pencil

Procedure

1. Fill out the Bingo Card below (Table7.1) by seeking help from your classmates. Your classmates will take turns in choosing which question they can answer. Then, they will write their respective names below the chosen question/statement. All the questions/statements must be filled up. (Wait for the signal of your teacher when to start.)

Table 7.1 Bingo Card

Can say the word "carbon dioxide "in a scary way	What is this sign? 	CFCs stand for?	Say the word "renewable" 10 times	Which do you ride to go to school, bus or a tricycle?
Can say "Climate Change" 7 times while covering the nose	What type of gas is released in landfills? (methane or CO2)	Who invented the standard incandescent bulb?	Where can you find the 1st wind farm in Southeast Asia	Do you eat vegetables?
What type of greenhouse gas is released when coal is burned?	Yes or No: Writing on both sides of paper is called reusing.		A renewable energy that uses water to produce energy	Do you use a glass when drinking water?
Yes or No: weather is the atmospheric condition that can quickly change in a day.	What does 3Rs stand for?	Is Energy efficiency being "sulit"?	What renewable energy facility is found in Lanao del Norte?	A person who is wearing something white
The general condition of the atmosphere within a year is known as?(climate or weather)	Name 3 things that can be reused.	Give 2 examples on how to conserve electricity.	A type of renewable technology that uses energy of the sun	Which do you prefer to use; paper bag or plastic bag?

(Adapted from http://www.wwf.org.ph/)

This activity is an indication of how much you know about this worldwide issue- the climate change. For those who have answered many questions, you are very much aware of the events that are happening in the environment. But for those of you who answered very few questions, this is the beginning for you to learn more about climate change.

Each one of us interacts with our environment that is why we are affected by changes in our environment. You should not disregard the things that are happening in your surroundings.

So, do you want to be a hero of humanity? Let's join together in this journey in learning more about climate change. But first, you have to learn about one of the major causes of climate change the so-called greenhouse effect.

On a warm and dry day, Jen was left by her dad in the car. She noticed that the air conditioner of the car was not working well. Then, she started to sweat a lot.

Let us help Jen understand her situation by performing the next activity.

Activity 8 It's gettin' hot in here

Objectives

- demonstrate how closed spaces trap heat
- explain how greenhouse gases trap heat

Materials Needed

A small glass tank or an aquarium with thin walls or shoe box

2 laboratory thermometers with cover setup

Sunlight (if not available, you may use study lamp)

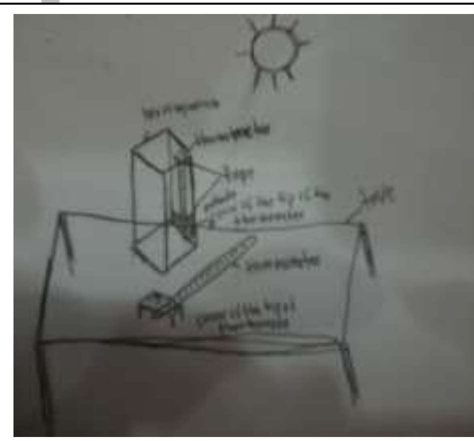

Figure 8.1Greenhouse effect (Redraw)

Procedure

1. Place the tank or aquarium on the surface with thermometer inside. Position the thermometer so that you can read the markings. Refer to Fig. 8.1.

2. Place another thermometer just outside the tank or aquarium.

3. Expose the setup to sunlight.

4. Take the temperature every two minutes over a period of 20 minutes. Record your data in Table 8.1.

Table 8.1 Temperature Readings

Time (minutes)	Thermometer Inside (^0C)	Thermometer Outside (^0C)
2		
4		
6		
8		
10		
12		
14		
16		
18		
20		

5. Construct a line graph to present your data.

Q1. Which thermometer shows a faster rise in temperature?

Q2. What happened to the temperature inside the aquarium?

Q3. How does the wall of the aquarium relate to greenhouse gases?

Q4. What traps heat in the atmosphere?

The thermometer reading inside the tank went up faster than the thermometer reading outside the tank. This was due to the temperature that was rising in the container. The rising of the temperature resulted from keeping the heat from flowing. Thermal radiation coming from the sun was absorbed by the air inside the tank. The wall of the tank kept the warm air from flowing out, causing its temperature to rise as it continued to absorb heat from sunlight. Outside the tank, air warmed by sunlight can interact with the surrounding cooler air. This allowed heat to flow from warm air to cooler air through convection, and kept the temperature from rising as fast as that of the air inside the tank.

Solar radiation warms the Earth as its energy is absorbed by the atmosphere. In the atmosphere, there are greenhouse gases present. These include water vapor, carbon dioxide, methane, and nitrous oxide. Greenhouse gases prevent heat from escaping the earth thus making earth's temperature higher.

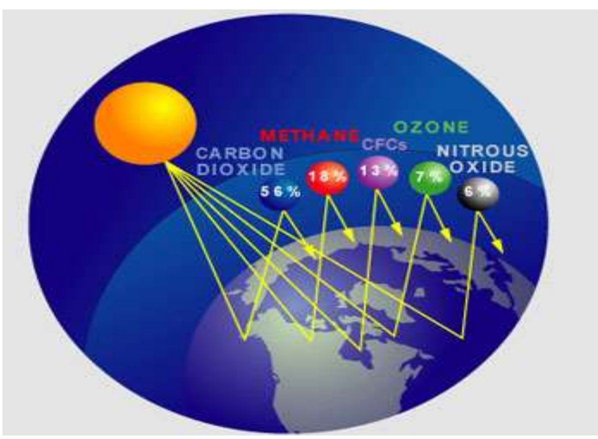

Figure 8.2 The greenhouse effect

Source: http://www.learner.org/courses

Figure 8.2 shows that greenhouse gases such as carbon dioxide, methane (CH_4), chlorofluorocarbons (CFCs), and nitrous oxide (N_2O) trap heat preventing it from escaping the Earth. All gases absorb heat, although some just absorb more than others. Thus, assuming solar radiation is constant, the average atmospheric temperature depends on the mix of gases. More greenhouse gases in the atmosphere mean that the equilibrium temperature will be higher as these gases absorb more heat. This will result in the increase of global temperature. Less greenhouse gases will mean lower temperature. Mankind evolved under conditions of a specific mix of gases (of course, with a certain degree of variation) in the atmosphere and thrived under these conditions. If the mix of gases in the atmosphere were altered considerably, the Earth's temperature would change significantly, and we will be faced with new conditions that we are not used to, which we will have to somehow adapt to, or face extinction. Areas that are found in temperate regions may have shorter winters. Countries that are found in tropical regions may have longer and drier summers. Glaciers that cover land will melt which will result in the rise of sea levels.

Note: Try this video link: http://www.youtube.com/watch?v=5zLuqSYF68E(as of October 11, 2013)

In the next activity, you will find out what main component of air that causes the rising of the global temperature.

Activity 9. CO_2 is the reason!

Objective

- interpret the relationship of carbon dioxide and temperature.

Materials Needed

Graph of CO_2 and global temperature

Ball pen or pencil

Procedure

1. Study the graph below (Fig. 9.1). Answer the guide questions.

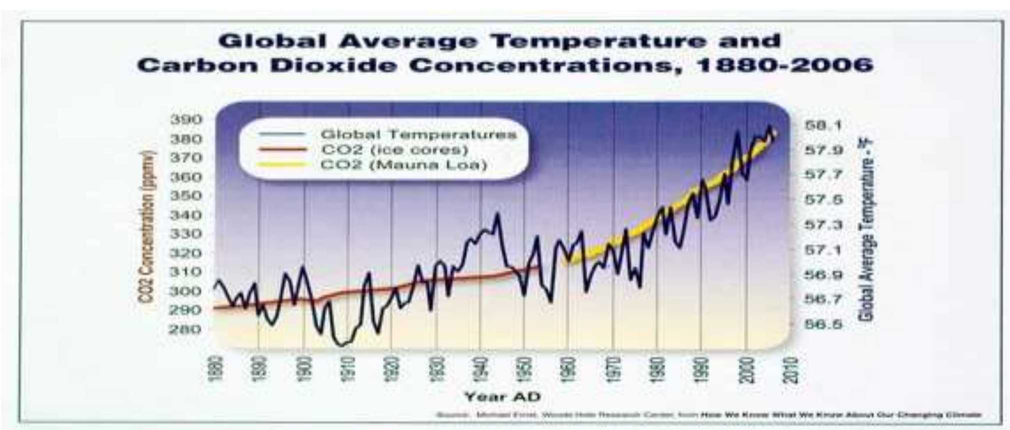

*Figure 9.*1 Global temperature and carbon dioxide. (Redraw)
Source: http://www.worldviewofglobalwarming.org/pages/paleoclimate.php

Q1. How much is the increase in temperature from 1880 to 2010?

Q2. What happened to the amount of carbon dioxide from 1880 to 2010?

Q3. What is the relationship between the amount of carbon dioxide and global temperature?

Q4. When was temperature at its highest and at its lowest?

Figure 9.2 Industrial Revolution
Source: http://www.dadychery.org

When the Industrial Revolution began, more emissions of carbon dioxide and other greenhouse gases threatened all living things. Developed countries and developing countries became more dependent on fossil fuels. Burning of fossil fuels is one of the main sources of carbon dioxide emission. What would be the outcome if there is too much carbon dioxide in the atmosphere? There would be an increase of global temperature. So, when will you take action to help stop global warming? Remember that your time is ticking. Act now before it's too late.

Figure 9.3 Act now
Source: http://theglobalcause.blogspot.com
Photo credits: Russel Miller

Many experts say that human activity is the reason why climate change happens. Why is this so? What crime did humanity commit? Are you part of this crime? Whom are we going to blame for the outcome? So, let us now find out if you are part of this big conspiracy by doing the next activity.

Activity 10. Am I a climate hero or a climate culprit?

Objectives

- calculate your personal carbon emission
- take an action to lessen the effects of climate change

Materials Needed

Carbon Footprint Calculator /Checklist

Manila paper

Short bond paper

Laptop/Computer with internet

Procedure

1. Each member of the group will compute his/her carbon footprint by using WWF-Philippines' Carbon Footprint Checklist (see table 10.1). Note: For schools that have access to the internet use Carbon Footprint Calculator from this link: http://wwf.org.ph/wwf3/search.php?search=carbon+footprint+calculator (as of October 9, 2013)

Table 10.1 What's your carbon footprint? Evaluate your carbon emission.

Different Activities	Always (1 Pt)	Sometimes (3pts)	Never (5pts)
I use water wisely.			
I eat a mixture of meat and vegetarian meals.			
We use kerosene lamp or low energy light bulbs at home.			

I use basin in washing our dishes.			
I eat locally grown food.			
I turn off electric appliances or battery-operated gadgets instead of leaving them on standby.			
I use a glass of water when brushing my teeth.			
I eat organic foods.			
I use reusable bags when buying things from the market.			
I avoid eating ready meals. (e.g. noodles, sardines etc)			
I use recycled notebooks and papers.			
I throw my biodegradable wastes into a compost pit.			
I replace my toy or gadget when it stops working rather than just to get the most up-to-date model.			
I always know where my food or products are made.			
I give the clothes I have outgrown to charity or to my younger siblings and friends.			
I throw my trash into the garbage bin or bag.			
I just walk if the place I want to go to is near.			
I do recycling at home.			
I do recycling in school.			
I share a ride or walk or cycle on the way to school.			
Total Score			

Source: http://www.wwf.org.uk/oneplanetchallenge/downloads/energy_session_all.pdf

How did your score?

20-50 - You're a Green Queen/King and a globally aware consumer! Keep up the good work.

50-80 - You've made a start but there are more you can do to reduce your ecological footprint.

80-110 – You are a long way to go; it is best to start now.

2. Each group should present the data using a bar graph on Manila paper.

Q1. Which member has the highest carbon footprint?

Q2. Which member has the lowest carbon footprint?

Q3. What is the average carbon footprint of the group?

Q4. What is your highest source of carbon emission?

Q5. What is your lowest source of carbon emission?

3. Each member of the group should choose the top three highest sources of carbon emission. From that, each of them will make a strategic plan to reduce his/her contribution to climate change.

4. After performing the activity, each group will make a portfolio to check the improvement made by each member. All members will recalculate their carbon footprint. They will do this every month. Each group will report the outcome at the end of the third quarter. They have to show the data (carbon/ecological footprint) using a bar graph.

From this activity, you found out how much you contribute to carbon emission. This activity helps you realize that you are either a climate hero or climate culprit. Anyone can be a contributor in changing our climate. It is up to you if you want to make this world remain hospitable to human beings.

The climate is always changing. It has shown how much it could affect our lives. You have seen how strong the winds of Yolanda were, and how heavy the rainfall from Ondoy was. We still have to change our course. The future of humanity lies in our collective hands.

(Note: You may try this video link as of October 11, 2013: http://www.youtube.com/watch?v=W7a-Hs9UxYo)

Performance Task

Your school is celebrating Science Month with the theme: "Disaster Risk Reduction and Climate Change Adaptation". You are tasked to have an information drive to increase awareness and educate your fellow students about the impacts and how to reduce the effects of climate change.

To measure the output of the students you may refer to this prepared rubric.

	4	3	2	1	Score
Purpose	The presentation had a clear topic, purpose, and theme. All the parts of the presentation contributed to the clear and interesting presentation of topic, purpose, and theme.	The presentation had a topic, but its purpose and theme were only somewhat clear. All the parts of the presentation said something rather important about the topic and appropriate to the topic, purpose, and theme.	The presentation had a topic, but its purpose and theme were not clearly conveyed. Most of the parts of the presentation said something vaguely important about the topic, purpose, and theme.	The presentation's topic was not clear and its theme and and purpose were not at all presented. Many parts of the presentation needed improvement because they did not contribute to the making of a clear presentation	
Creativity	The presentation was made up of unique, imaginative, and surprising features and components which elicited a high degree of interest and excitement from the audience, and loaded the presentation with a lot of information.	The presentation included some unique, imaginative, and surprising features which elicited a moderate degree of interest and excitement from the audience, and loaded the presentation with just enough information about the topic.	The presentation included a few unique, imaginative, and surprising features which elicited a degree of interest and excitement from the audience. However, these features gave very little information about the toipc.	There was nothing unique, imaginative, or surprising about the presentation and did not impart any clear information about the topic.	
Organization	The presentation introduced the topic in an interesting way, built up the theme in a logical manner, and ended with a slide presentation that left the audience with a clear purpose to think about and act on it.	The presentation introduced the topic in an interesting way, but built up the theme in a somewhat confusing manner, and ended with a slide presentation that left the audience with a rather unclear purpose to think and talk about.	The presentation simply introduced the topic, did not build up a clear theme, and ended with a slide presentation that did not state the purpose of the presentation for the audience to think about.	The presentation inadequately introduced the topic and was so disorganized that the audience did not understand what was its theme and purpose.	

Oral Presentation	The reporter spoke clearly, with the right modulation, and in an engaging manner.	The reporter spoke clearly, with the right modulation, but in a not so engaging manner.	The reporter sometimes did not speak clearly and, at times, too softly. He was oftentimes looking up at the ceiling or over the audience's head and did not at all elicit the audience's interest.	The reporter did not speak clearly and too softly for the greater part of the presentation. Nothing of what he/she said caught the audience's interest in the least bit.	

Impacts of Climate Change

You were reading the first page of your favorite magazine when your eyes were caught by the passage: "Climate Change Is Here!" And it says," climate change is really happening. Its effects are felt by animals, plants, and people." You got very interested in the topic because it is a worldwide issue. As you continued reading, you found out that there were some species of birds that laid eggs earlier than usual. There were some species of plants that bloomed earlier than expected. There were some animals that supposedly should still be hibernating, but were already awake. There was an earlier migration of birds and some were arriving to their nesting ground and others appeared to be later. Sometimes, some animals and birds tended to stay in their local territory because the climate is already suitable for them.

You were surprised with the things you discovered about climate change. As you kept on reading, you were disturbed that even the sea level was rising. The melting of glaciers that covered the land caused the sea level to rise. If sea level increased by 50 cm, sea turtles may lose their nesting areas. People and animals that live near shorelines may be forced to move out. Animals moving out of their natural habitat face challenges that could lead to the extinction of their species.

At the back of your mind, you were thinking that, hopefully, the effects of climate change will not be felt by people here in the Philippines. But to your dismay, we felt them already.

Heavy rainfalls were brought by typhoon Ondoy and Hanging Habagat which resulted in submerging most parts of Metro Manila and some provinces. Typhoon Yolanda brought the strongest wind ever encountered by people in the Visayas, leaving great destruction and much loss of lives. Hanging Amihan brought very cold wind affecting the climate of the country and destroying some crops of farmers in the northern part of Luzon.

Aside from these impacts of the climate change that we are experiencing, we still have two cyclical events that we encounter- El Niño and La Niña

El Niño and La Niña

El Niño is an abnormal and lengthy warming in the eastern part of the Pacific Ocean. This natural phenomenon occurs at irregular intervals of two to seven years and lasts for nine months or two years at most. Usually, it starts at the end of the year or during the Christmas season that is why it is termed as El Niño which refers to the "Christ child".

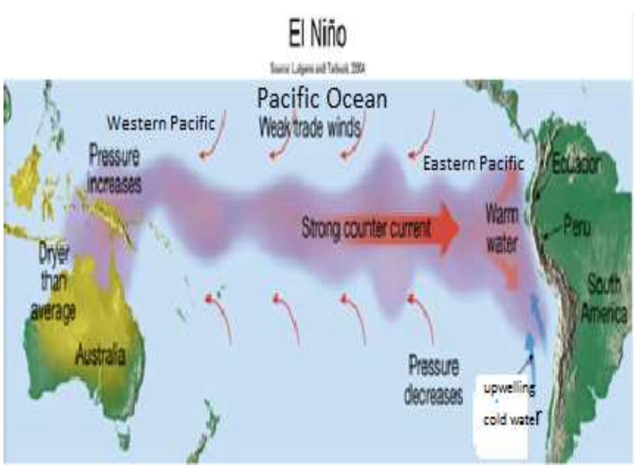

Figure 10.1 El Niño (please redraw)

Refer to Fig. 10.1 Normally, as trade winds move from east to west, they collects warm air. But when trade winds are weakened, they causes the piling up of warm surface water and making the part of the Pacific Ocean warmer leading to the El Niño phenomenon. This happens when the upwelling of colder water is blocked by the large quantities of warm surface water. (The cause of the weakening of the trade winds is still unknown and it is still being investigated)

Since the Pacific Ocean is to the east of the Philippines, El Niño phenomenon will affect the country. When there is an increase of the temperature in the eastern part of the Pacific Ocean, it is expected that some areas in the Philippines will experience this climatic phenomenon. Some areas in the country will experience near to above average rainfall and some areas may experience drier than normal rainfall.

El Niño will most likely bring severe drought. It is believed that it causes stronger thunderstorm disturbance and massive storms. It also causes the decrease in the population of some species.

See Figure 10.2. La Niña is the opposite climatic disturbance to El Niño. This natural phenomenon may, but does not always, follow El Niño events. It may last for nine to twelve months but in some cases, it lasts for two years. This event is triggered by the cooling of the eastern part of the Pacific Ocean that is why it is sometimes called "cold Pacific."

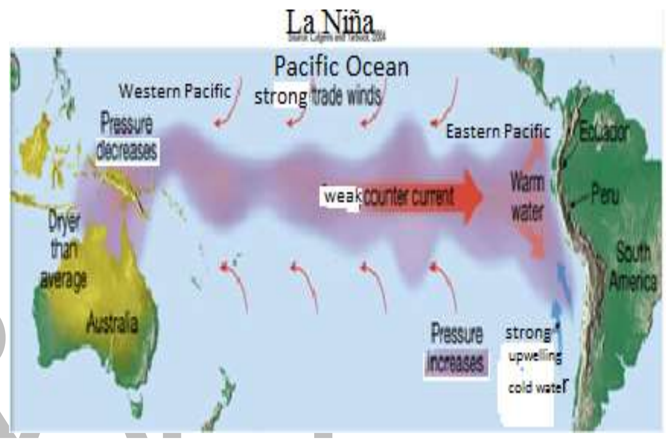

Figure 10.2 La Niña (please redraw)

Trade winds that move from east to west are strengthened. Upwelling of colder water intensifies. Moving air brings along too much water vapor. When it reaches the land mass such as the Philippines, precipitation is experienced. There would be an increase of rainfall in some areas in the Philippines. For instance, areas that experienced severe drought caused by El Niño may encounter above normal rainfall. But in some cases, areas that experience dry season will have drier than normal conditions. La Niña's effects are the opposite of El Niño.

Post-test/ Summative Test

Encircle the letter that corresponds to the correct answer.

1. Why do mountain climbers bring thick jackets when they go up the mountain?
a. The temperature increases as the altitude increases.
b. The temperature decreases as the altitude increases.
c. The altitude increases as the temperature increases.
d. The altitude decreases as the temperature increases.

2. What will happen if there is too much carbon dioxide in the atmosphere?
a. Greenhouse effect occurs. c. Water vapor condenses.
b. Temperature increases. d. Climate changes.
3. Why does cloud formation disappear as the air moves slowly towards the leeward side of a mountain?
a. The air condenses as it moves to the leeward side.
b. The amount of water vapor is not enough.
c. The temperature becomes lower.
d. There is too much water vapor.

4. Which condition happens during the La Niña phenomenon?
a. Air pressure in the western Pacific increases
b. Air pressure in the eastern Pacific decreases
c. Upwelling of cold water is blocked
d. Trade wind becomes stronger

5. It refers to the atmospheric condition of a place over a long period of time.
a. climate c. weather
b. monsoon d. topography

6. Which side of the mountain often receives the most precipitation?
a. leeward side c. rain shadow
b. windward side d. peak

7. Which is the best practice to reduce the effect of climate change?
a. livestock raising c. organic farming
b. burning fossil fuel d. car manufacturing

8. Which of the following shows the effect of climate change?
a. rising of sea level
b. deforestation of the forest
c. coastal erosion in some places
d. siltation of bodies of water

9. During summer, many people visit Baguio because of the cold weather. What do you think makes Baguio cold?
a. The latitude c. The altitude
b. The topography d. The distance from the ocean

10. Why do places at the same latitude but different altitudes have different climate?
a. Amount of heat received varies.
b. Amount of precipitation differs.
c. Higher altitudes have lower temperature.

d. Higher altitudes have higher temperature.

Summary

- Climate is the overall atmospheric condition of a place for a period of 30 years or more.
- Climate is influenced by latitude, altitude, distance from bodies of water, ocean currents, and topography.
- The closer the place is to the equator, the warmer the climate; the farther the place is from the equator the colder the climate.
- Air temperature decreases when altitude increases.
- Bodies of water help regulate the climate of a certain area.
- Mountain ranges affect the formation of precipitation.
- Ocean currents will either cool or warm the air above them.
- Cold currents bring cold water while warm currents take along warm water.
- Coriolis Effect deflects the ocean currents.
- Climate change brings drastic effects to some people and animals.
- Human activities may speed up the rising of the global temperature.
- El Niño happens when the temperature in eastern Pacific rises above normal.
- La Niña occurs when the temperature in eastern Pacific decreases below normal

Glossary

altitude - the height above sea level.

climate - the overall condition of an area over a long period of time.

climate change - a long term shifting of global weather pattern

El Niño - brought about by the current of the ocean bringing warm air to a landmass in the Pacific region.

fauna – all the living animals in a given area.

flora - all the plants in a given area.

greenhouse effect - the increase of global temperature due to some atmospheric gases.

gyre - the circular patterns formed by surface currents.

latitude - an imaginary line that is parallel to the equator.

leeward - the side of the mountain that receives less amount of precipitation.

longitude - an imaginary line that extends from north pole to south pole.

mitigation – a manner of modifying something to become useful.

precipitation - forms when water vapor condenses and falls to the ground as rain, snow, hail or sleet.
topography - the surface features of an area.

temperature - refers to the hotness or coldness of an object.

windward - the side of the mountain that receives most of the precipitation.

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Suggested time allotment: 6 hours

Unit 3
MODULE
3

CONSTELLATIONS

I. Introduction

In this module, you will learn about the characteristics of stars. You will also learn about the patterns that form from groups of stars. These patterns in the night sky appear to move in the course of the night because of Earth's rotation. Different star patterns are seen at different times of the year because of the Earth's movement around the Sun.

II. Learning Competencies/Objectives

In this module, you should be able to:

1. Infer some characteristics of stars based on the characteristics of the Sun
2. infer that the arrangement of stars in a group (constellation) does not change for a very long period of time;
3. observe how the position of a constellation changes in the course of a night; and,
4. use charts that show which constellations may be observed at different times of the year

III. Pre/-Diagnostic Assessment

A. Choose the letter of the best answer.

For numbers 1 to 3, use the table below that presents information about stars A, B, C, and D.

Star	Color
A	Red
B	Yellow
C	White
D	Blue

1. Which star is the hottest?
   A. A
   B. B
   C. C
   D. D

2. Which star is very similar to our Sun?
   A. A
   B. B
   C. C
   D. D

3. Which is the coolest star?
   A. A
   B. B
   C. C
   D. D

4. How do stars appear to move in the night sky?
   A. From East to West
   B. From North to South
   C. From West to East
   D. From South to North

5. Stars appear to move in the sky because
   A. The Earth is rotating on its axis.
   B. The Universe is expanding.
   C. The night sky is rotating.
   D. New galaxies are formed.

6. If you are located at the North Pole, where will you see the Polaris?
   A. Overhead
   B. Just above the horizon
   C. Around 45° from the horizon
   D. Polaris will not be seen in the North Pole.

7. Which constellation is prominently seen in the sky during summer?
   A. Orion
   B. Pegasus
   C. Hercules
   D. Virgo

8. Based on apparent magnitude, which of the following stars is the brightest?
   A. Alpha Centauri
   B. Betelgeuse
   C. Rigel
   D. Sirius

9. Why do stars have colors?
   A. It is because of the presence of oxygen.
   B. It is because of the presence of carbon dioxide.
   C. It is because of varied temperatures.
   D. It is because of the different locations.

10. Stars can be found in large groups throughout the universe. What are these groups called?
   A. solar system
   B. comets
   C. constellations
   D. asteroids

IV. Reading Resources and Instructional Activities

Characteristics of Stars

Figure 1.The Night Sky. Are the stars same in size? Are the stars same in color? Are the stars equally bright?

When we look at the night sky, we see thousands of stars. In reality, there are approximately 400 billion stars in our galaxy, and there are about 170 billion galaxies. A person can see only about 3,000 stars on the average.

These stars differ in many ways. We see stars of different sizes, brightness, and color.

Using Figure 1, which star is bigger-Sirius or Rigel? Can you really tell the size of the star by just looking at it?

Figure 2 shows the size of the Sun, the closest star to Earth, as compared to some other stars that we see at night. As we can see, the Sun is so small compared to other nearby stars. Also, Sirius, which appear bigger than Rigel, is actually very small compared to Rigel. It appears larger only because it is closer to us.

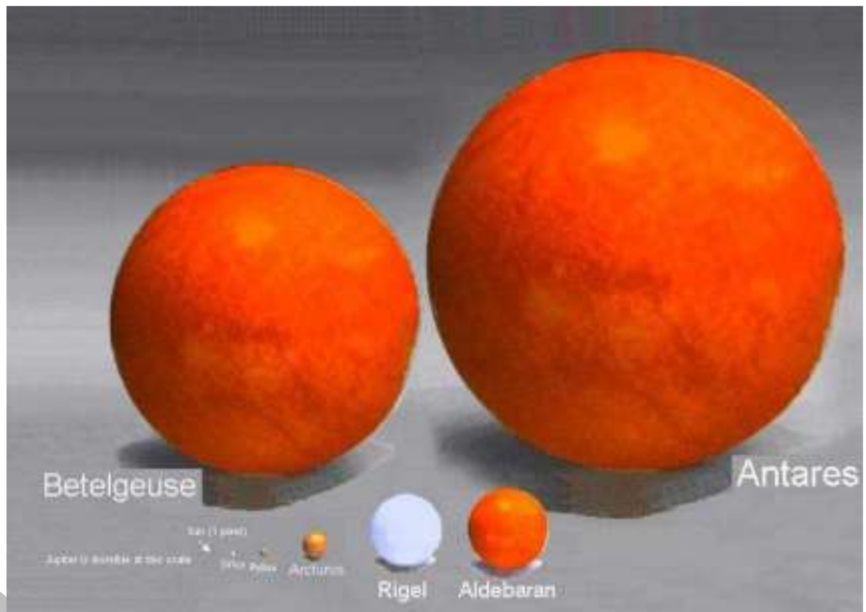


Photo Credit: Quantrek, Inc.
http://www.quantrek.org/size_comparison/size_comparison.htm

Figure 2. The size of the Sun compared to other stars.

What does the color of a star mean? Why do stars differ in brightness? Do the following activities to find out.

Activity 1

Characteristics of Stars

Objectives:

Materials:

2 flashlights (small and big), incandescent light, light dimmer,

Procedure:

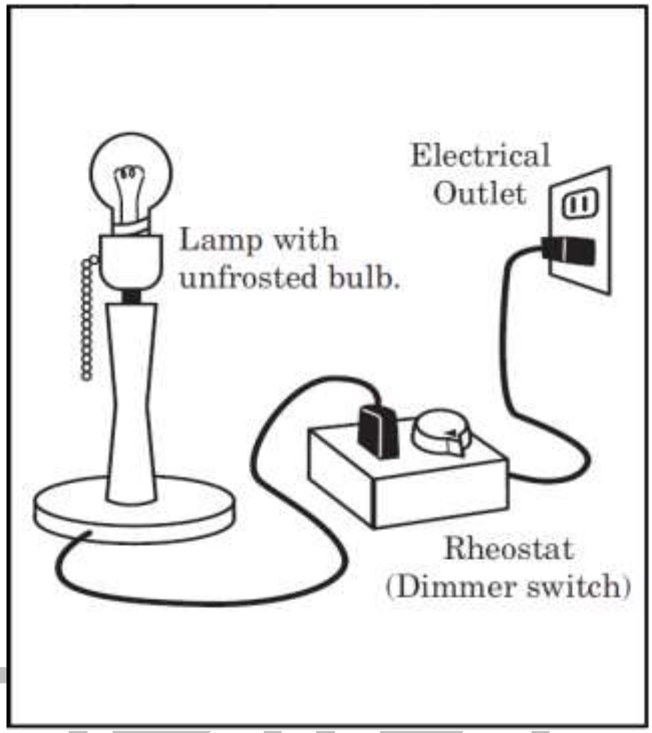
Part A. Color

1. Plug the incandescent lamp to a light dimmer switch.
2. Darken the room and turn on the lamp.
3. Adjust the dimmer switch slowly until the bulb becomes dim.
4. Observe and note the color of the glowing filament.
5. Adjust the dimmer switch slowly until the bulb becomes brighter and brighter.
6. Observe and note the color of the glowing filament.

   Q1. What is the color of the filament as you dim the bulb?

   Q2. What is the color of the filament as you turn the switch at full power?

   Q3. What happens to the temperature of the filament as the bulb becomes brighter and brighter?



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Star color ranges from red to blue. The color of the star indicates its surface temperature. The table below shows the surface temperature and color of different nearby stars, including the Sun.

Table 1. Color and Temperature of Selected Stars

Star	Color	Surface Temperature in Celsius
Sun	Yellow	5,700
Proxima Centuari	Red	2,300
Epsilon Iridani	Orange	4,600
Vega	White	9,900
Sirius	White	10,000

Alnilam	Blue	27,000

Part B. Brightness

1. Place the two identical small flashlights on a table or chair near the front of the room.
2. Darken the room and turn on the two flashlights. Compare the brightness of the two flashlights.
3. Place one flashlight on a table or chair at the back of the room. Darken the room and turn on the two flashlights.
4. Observe the two flashlights from the front of the room. Compare the brightness of the two flashlights. *Which flashlight appears to be brighter?*

(please redraw)

5. Replace the small flashlight at the back of the room with a bigger flashlight. Compare the apparent brightness of the two flashlights. *Which flashlight appears to be brighter?*
6.
7.
8.

(please redraw)

9. Adjust the positions of the two flashlights until they appear to have the same brightness.

   Q1. Why do the two flashlights have different brightness?

The brightness of a star as seen from the Earth depends on two factors-distance and the actual brightness (or absolute brightness) of the star. The star's brightness as seen from Earth is its **apparent brightness**. Based on the activity, apparent brightness depends on how far away a star is from the Earth.

Let's take Sirius and Rigel (refer to Figure 1) to illustrate the effect of distance to apparent brightness. Compared to the Sun, Sirius is about 27 times as powerful as the Sun, but Rigel has the power of many thousands of Suns. In terms of distance from the Earth, Rigel is almost 100 times farther away than Sirius. In terms of apparent brightness, Sirius is about twice as bright as Rigel. Sirius looks very bright when viewed from Earth because it is closer to Earth.

Astronomers consider the star's **absolute brightness** when comparing stars. A star's absolute brightness is the brightness the star would have if all stars were the same standard distance from Earth.

What is a Constellation?

When you look at the sky, what do you see? Do you see images of animals or objects?

Observers in ancient times also imagined group of stars that form pictures of animals, objects and people. These imaginary groups of stars are called **constellations**.

Activity 2

Patterns in the Sky

Objective:

After performing this activity, you should be able to:

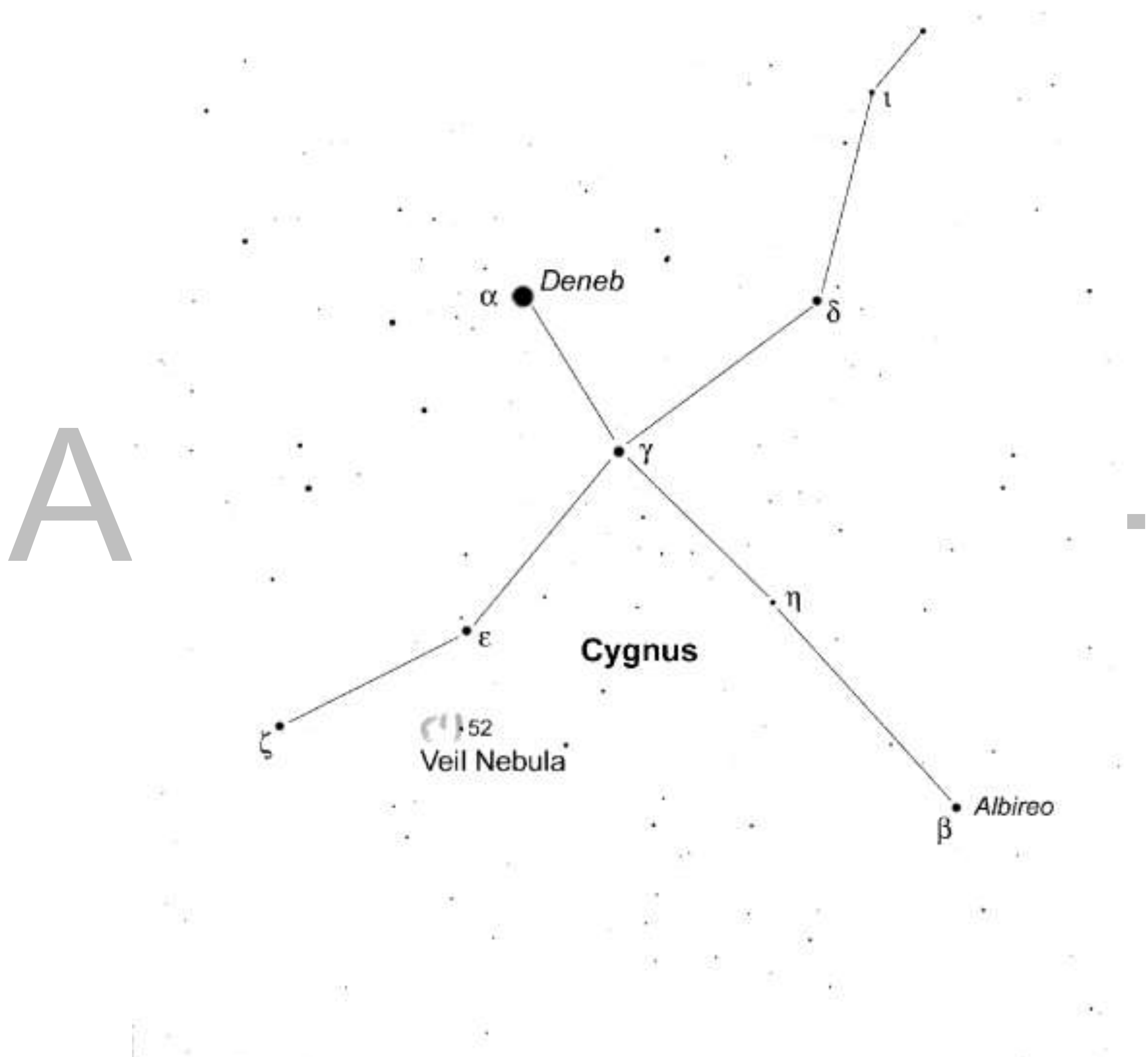
- Group stars together in a recognizable pattern

Materials Needed:

markers

Procedure

Given a plain map of stars, draw any pattern, name it, and tell a story about your figure. Write your bases for coming up with your figure.



Please redraw without the lines, labels and other markings.

Many of these constellations have names that can be traced back to early Babylonians and Greek civilizations, but nearly all cultures have different names for the constellations. For example, the Greeks called the large constellation Orion, which means hunter and is prominent in the night sky all over the world during winter. Early Filipinos visualized the same group of stars as Balatik, a trap used in hunting wild pigs. Christian Filipinos named the three stars (Orion's belt) Tatlong Maria or Tres Marias.

Activity 3

Apparent Movement of the Stars through the Night

Objectives:

After performing this activity, you should be able to:

- Describe the apparent motion of stars at night.

Procedure:

1. On a clear night sky, look at the stars from 7 pm to 11 pm.
2. Focus on one or two constellations like the Auriga and Orion which are best seen in the month of December.
3. Look at the stars clearly every hour of the night, from 7 pm to 11 pm.

Q1. Compare the position of the stars in the sky. What do you notice?

Q2. Are the stars visible at 7 pm still visible at 11 pm in their "original position"? Why is this so?

Q3. How do the stars move? Describe the movement of the stars in the night sky.

Q4. How is the motion of stars similar to the motion of the Sun?

By observing Sun's movement and position in the sky, we can tell what time of the day it is. When it seems to rise in the east, it is morning. When it is above us, it is noon. When it seems to move towards the west, it is afternoon. At night, stars are used to tell the time. Just like the Sun, stars also seem to move from East to West.

The Polaris

Polaris, commonly known as North Star**,** is the brightest star in the constellation Ursa Minor (Little Dipper). It is very close to the north celestial pole, making it the current northern pole star. Because it lies nearly in a direct line with the axis of the Earth's rotation "above" the North Pole, Polaris stands almost motionless in the sky, and all the stars of the Northern sky appear to rotate around it. In Figure 3, Polaris and the star trail are seen. Star trail is a type of photograph that utilizes long-exposure times to capture the apparent motion of stars in the night sky due to the rotation of the Earth.

Photo Credit: Norman P. Aquino

http://www.flickr.com/photos/landscapist

Figure 3. Polaris and the Star Trail over Mt. Pulag

In Metro Manila, when you face North, Polaris, which is 11.3^{o} from the horizon, is seen at around 15° due to atmospheric refraction. In some parts of the country (i.e. Southern Philippines), it would be very difficult to locate Polaris since starlights near the horizon are washed out by lights lit by men, and /or obstructed by man-made or topographical structures and/or trees.

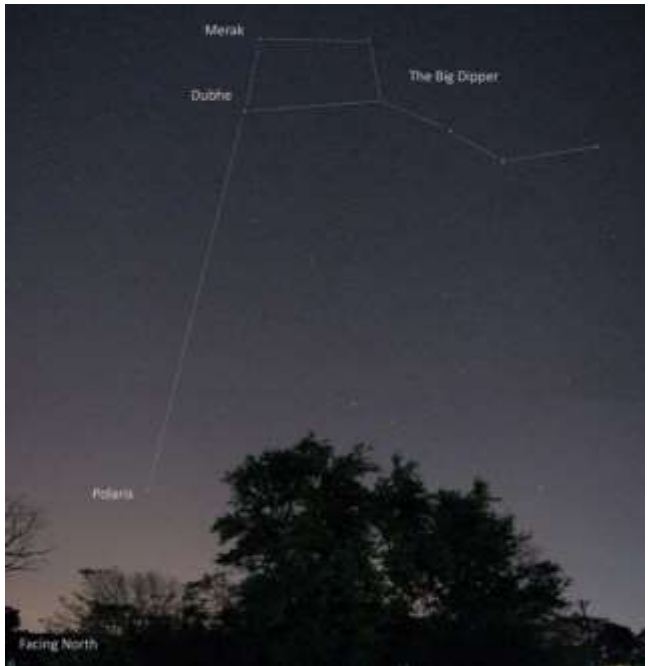


Photo Credit: Anthony Urbano
http://nightskyinfocus.com/2012/02/03/how-to-find-polaris-the-north-star/

Figure 4. Polaris as viewed from the Philippines (Quezon City). To locate the Polaris, face North and locate the Big Dipper. Two stars (Merak and Dubhe) in the Big Dipper are called pointer stars because they seem to point to Polaris.

Why are some constellations only visible at particular months? Do the next activity to answer this question.

Activity 4
Different Star Patterns through the Year

Objectives:

After performing this activity, you should be able to:

- Explain why some constellations are not seen at certain months

Materials Needed:

Photographs of the night sky at different months (Manila), Print-out (or drawings) of Constellations, globe, small toy figure , lamp

Procedure:

1. Look at the series of photographs below. This is how you see the night sky in Manila (while facing North) at different months.

Q1. Compare the photographs. What do you notice?

Q2. Why are some stars visible in March but not visible in September?

Figure 5a. March Night Sky (9 p.m.)

Figure 5b. June Night Sky (9 p.m.)

Figure 5c. September Night Sky (9 p.m.)

Figure 5d. December Night Sky (9 p.m.)

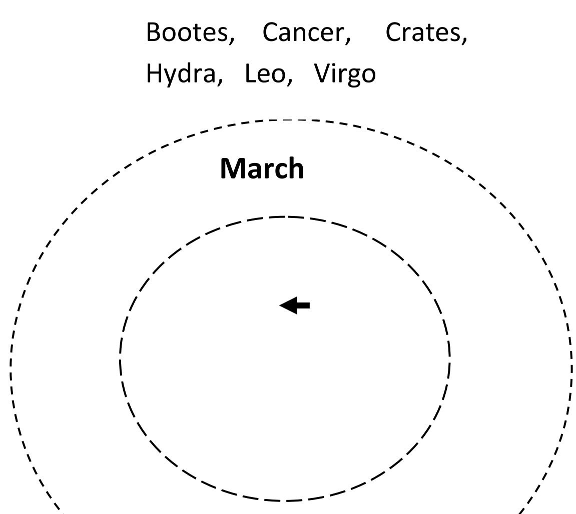
While the rotation of the Earth on its axis causes the apparent nightly movement of the stars across the sky, the revolution is responsible for the fact that we can see different parts of the sky at different parts of the year.

2. Position the printed constellations as shown in Figure 6.
3. Look for the Philippines in the globe and use an adhesive tape to put a small figure (e.g., toy soldier) within its vicinity. The small figure will represent an observer on Earth (in the Philippines).

4. Turn on the lamp. Always focus the lamp on the globe. *What do the (a) lighted and (a) unlighted parts of the globe represent?*

5. Move the globe around the lamp (counterclockwise, from A to D). Make sure the globe maintains its tilt or orientation as you move it around (Figure 7).

Q3. What constellations are prominent during winter? fall? summer? spring?



Saggitarius, Aquila, Cygnus, Hercules, Lyra Ophiuchus, Scorpius

June

Lamp (sun)

globe

December

Orion, Cetus, Eridanus, Gemini, Perseus, Taurus, Canis Major

September

Pegasus, Andromeda, Aquarus, Capricornus, Pisces

Figure 6. Top View of the Set up

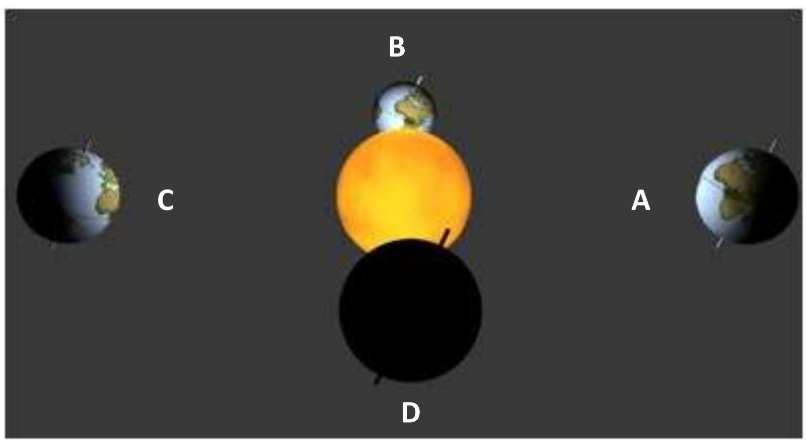


Figure 7. Orientation of the globe as it moves around the lamp (Sun). The globe moves counterclockwise (from A-D) around the lamp.

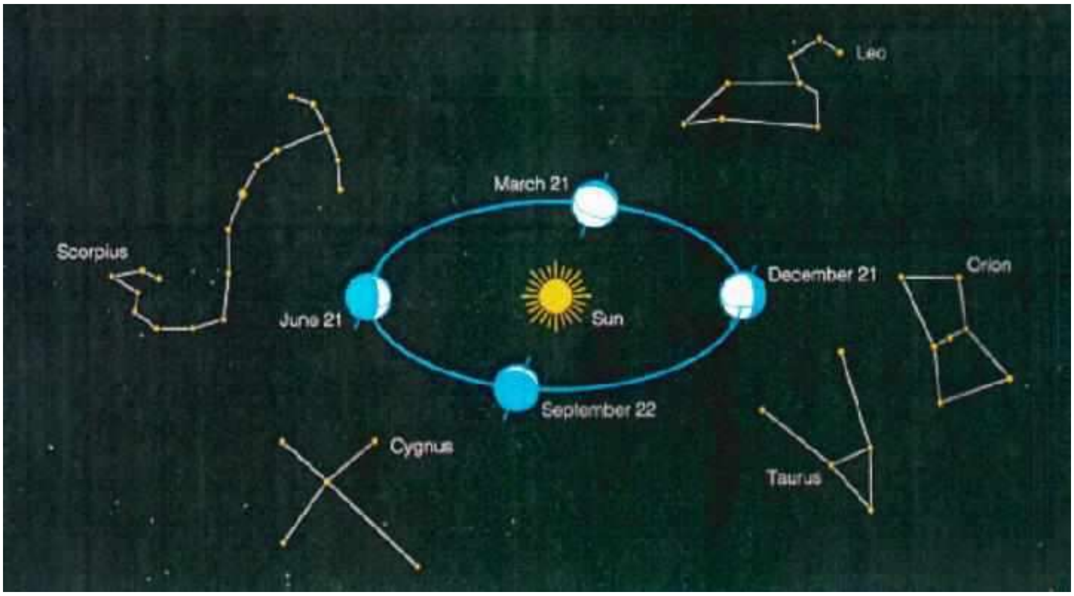


Figure 8. Constellation Seen on Different Months of the Year

An observer from Earth will be able to see the stars that are on the night side. The stars on the same side as the sun cannot be seen because sunlight overpowers all the starlights.

During summer in the Philippines, the constellations of Orion and Taurus are not visible at night. They will be visible again as the cold season begins. During this time, Scorpius will not be seen in the night sky.

As the Earth revolves around its orbit, the stars that were concealed by the bright light of the Sun in the previous months will appear in the night sky.

How Early People Used the Constellations

While constellations were associated with religion, they also have practical uses. Before the calendars, people had no way of determining when to sow or harvest except by looking at these patterns in the sky. Ancient people developed a way to remember the patterns by giving these patterns names and stories. For example, in the northern hemisphere, the constellation Orion indicates the coming of cold season.The constellations made it easier for them to recognize and interpret patterns in the sky. For example, Gemini is seen in the Philippines during the months of April and May. Farmers interpreted the appearance of Gemini as the end of planting season and it signified rich harvest. The table below shows how the Matigsalug Manobo of Bukidnon used the stars and constellations in relation to their agriculture.

Table 2: Stars and Constellations Used by Matigsalug Manobo of Bukidnon

Local Name	Month of Appearance	Related Agricultural Activity	Western Equivalent
Baha	December to February	Clearing of forest	Taurus
Pandarawa	January	Start of planning what kind of crops to be planted and how wide is the area to be planted	Pleiades
Balatik	February	Start of planting and setting of traps to protect the crops from animals	Orions's Belt
Malihe	March	Planting of rice, corn, or vegetables	
Gibbang	April and May	End of planting season; signifies rich harvest	Gemini
Malara	May	Stop planting	Canis Minor
Lepu	Late May	time to clean or clear the fields while waiting for harvest time	Aquila
Buwaya	June	start of the rainy season	

Other Uses

Another use of constellations was in navigation. The Polaris is widely used in navigation because it does not change its position at any time of the night or year. Also, one can figure out his/her latitude just by looking at how high Polaris appears in the night sky. This allowed sailors to find their way as they sail across the seas.

V. Summative Assessment

Answer the following questions.

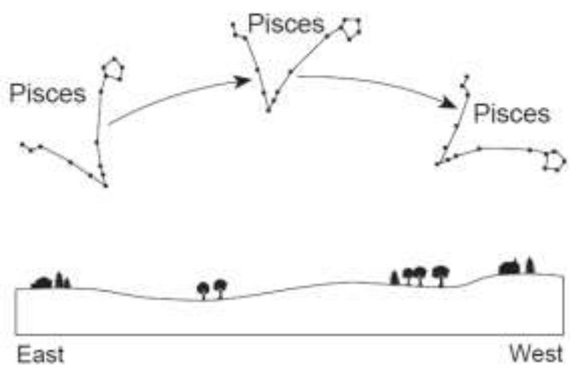
1. The star *Algol* is estimated to be as bright as the star *Aldebaran* and have approximately the same temperature as the star *Rigel*. Which of the following statement is correct?
   A. Algol and Rigel have same color.
   B. Algol and Rigel have the same brightness.
   C. Algol and Aldebaran have the same in size.
   D. Algol and Rigel have the same brightness and color.

2. The constellation below represents the constellation Cygnus.

   Which statement best explains why Cygnus is visible to an observer in Manila in September but not visible in March?

   A. Earth spins on its axis.
   B. Earth orbits the Sun.
   C. Cygnus spins on its axis.
   D. Cygnus orbits the Earth.

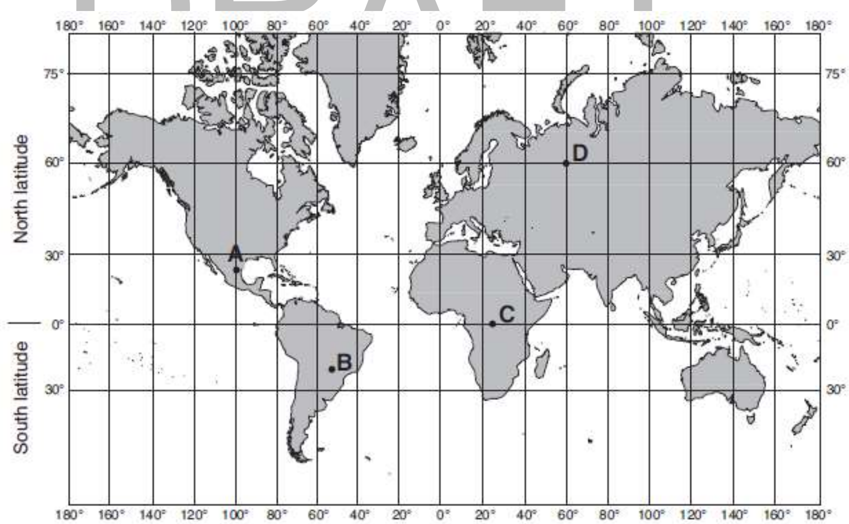
3. The constellation Pisces changes position during a night, as shown in the diagram below.



Which motion is mainly responsible for this change in position?

A. Revolution of Earth around the Sun
B. Rotation of Earth on its axis
C. Revolution of Pisces around the Sun
D. Rotation of Pisces on its axis

4. At which location can an observer not see Polaris in the night sky at any time during the year?



A. A and D
B. B and C
C. C and D
D. D and B

References and links

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UNIT 4
Force, Motion & Energy

UNIT 4: FORCE, MOTION AND ENERGY

Overview

At this level, you are already equipped with some basic ideas in Physics from your previous lessons in Grades 7 and 8. You were able to describe motion and the forces that affect it and explained why objects move the way they do. Heat and temperature are exciting topics that you also explored. As a student, you acquired basic concept on how heat is transferred. You also gained greater appreciation of the natural phenomena of light and sound through the concept of waves and understanding of the laws of optics. From these ideas that you have learned, you were able to understand your environment and the different changes happening to it.

Now, you are going to do physics in a more mathematical way. This will allow you to unlock ideas about your physical environment. At the same time, this will improve the mathematical skills you gained in your previous grade levels, by finding new ways of applying math. Four modules will be presented to you for deeper understanding on forces, motion, and energy.

In module 1, you will learn how to describe uniform motion mathematically. With forces and motion, you will be able to apply Newton's Laws of motion to practical problems in free-fall and projectile motion, and understand the concepts of impulse, and momentum. With these, you will find out how ideas in physics can help you play better in your favorite sports.

In module 2, you will tackle work, power, and energy and explain how they are related to one another. You will learn how the law of conservation of energy can be used to describe the motion of man-made objects like roller coasters, and natural features like waterfalls. All these objects will involve the use, transfer, and transformation of different mechanical energies.

In module 3, you will encounter topics in heat and work and how these two relate with each other. The basic concepts on heat and work, energy transfer and transformation, as well as the law of conservation of energy will prepare you to understand the science behind motor vehicles or appliances you see or use at home or in school.

In module 4, you will learn how the concepts learned in the previous modules assist your understanding of electrical energy generation and transmission. You will further develop your understanding of the transmission of electricity from power stations to your homes. This will also make you differentiate the law of conservation of energy from conserving energy (such as electrical, heat, light). Your appreciation will show in the way you use energy in your day to day activities.

Suggested time allotment: 15 hours

Unit 4

MODULE 1

FORCES AND MOTION

Overview

You learned in Grade 8 the effects of forces on motion and applied the concepts in real-life situations. You did various experiments and activities on Newton's Three Laws of Motion and gained insights on the relationship of mass, force, and acceleration. From the Law of Inertia, you were able to gain an understanding of the behavior of bodies at rest and bodies in motion. The Law of Acceleration was thoroughly discussed where you related force and acceleration. You also appreciated the Law of Interaction through simple activities in daily life.

From your previous grade levels, you were able to quantify non-uniform motion. You will mathematically describe the horizontal and vertical dimensions of Uniformly Accelerated Motion (UAM). You will use basic trigonometric functions in solving problems dealing with two-dimensional motion as in Projectile Motion and adapt techniques in playing your favorite sports.You will also discuss Impulse and Momentum and understand how these concepts can be applied in real life situations.

At the end of module 1, you will be able to answer the following questions:

1. How will you describe Uniformly Accelerated Motion (UAM) qualitatively and quantitatively?
2. How will you describe the horizontal and vertical motions of a projectile?
3. What are the factors that determine the projectile's flight?
4. What are other factors that may affect the motion of objects?
5. What is the total momentum before and after collision?
6. How will you relate the effects of collisions in real-life situations?

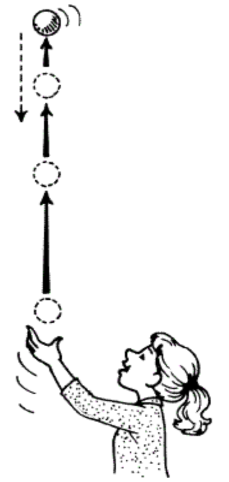
Learning Competencies/ Objectives

1. Describe the Uniformly Accelerated Motion (UAM) qualitatively and quantitatively.
2. Describe the horizontal and vertical motions of a projectile.
3. Investigate the relationship between the projection angle and the height and range of the projectile.
4. Describe momentum and impulse and relate it to collisions.
5. Observe that the total momentum before and after collision is equal.
6. Relate the effects of collisions in real-life situations.

Diagnostic Assessment

Directions. Choose the letter of the best answer.

For questions 1-5, consider the given situation.
Maria throws a ball straight up with an initial velocity of 10 m/s.



1. What is its velocity at the highest point?
2. What is its velocity when it returned to the elevation from where it was thrown?
3. What is its acceleration at the highest point?
4. What is its acceleration just before it hits the ground?
5. After 1 second what is the acceleration of the ball?

A. 0 m/s
B. 0 m/s^2
C. 9.8 m/s^2
D. - 9.8 m/s^2
E. 10 m/s^2
F. -10 m/s
G. cannot be determined

(pls.redraw the figure above)

6. The initial velocity of Manuel playing "*luksong tinik*" has horizontal and vertical components that are equal in magnitude. What angle does his velocity make with the horizontal?
   A. 30°
   B. 45°
   C. 60°
   D. 90°
7. A sepak takraw that is kicked from a height of two meters follows a path that is____________.
   A. circular
   B. linear
   C. hyperbolic
   D. parabolic
8. A goalie made three soccer punts at 70^0, 50^0, and 30^0 with varying speeds – all reaching the same maximum heights. Which statement is correct?
   A. All punts have the same hang time
   B. The punt at 70^0 has the longest hang time
   C. The punt at 50^0 has the longest hang time
   D. The punt at 30^0 has the longest hang time
9. A volleyball is served at a speed of 8.0 m/s at an angle 35° above the horizontal. What is the speed of the ball when received by the opponent at the same height?
   A. 4.0 m/s
   B. 8.0 m/s
   C. 9.8 m/s
   D. 16.0 m/s
10. A Batang Pinoy athlete from your school throws a javelin, always at the same speed, at four different angles(30°, 40°, 60°, and 80°) above the horizontal. Which two throws cause the javelin to land the same distance away?
   A. 30° and 80°
   B. 40° and 80°
   C. 30° and 60°
   D. 40° and 60°

For questions 11 and 12, refer to the table below:

vehicle	mass (kg)	velocity (m/s)
jeepney	2000	10
motorcycle	300	20

11. In the table above, what is the momentum of the jeepney?
   A. 6,000 kg•m/s   c. 20,000kg•m/s
   B. 40,000 kg•m/s   d. 3,000 kg•m/s
12. Which has greater momentum, the jeepney or the motorcycle?
   A. jeepney   c. both have the same momentum

B. motorcycle d. cannot be determined

13. Two identical cars are travelling along EDSA. Which of the two cars would have a greater momentum?
    A. the slower car
    B. the faster car
    C. both have the same momentum
    D. cannot be easily determined
14. A bus and a car are travelling along EDSA having the same velocity. Which of the two vehicles would have a greater momentum?
    A. the bus
    B. the car
    C. both have the same momentum
    D. cannot be easily determined
15. A 25-kg girl is riding a 5-kg with a velocity of 5 m/s the East. What is the total momentum of a girl and a bike together?
    A. 100 kg m/s
    B. 125 kg m/s
    C. 150 kg m/s
    D. 200 m/s

16. Which of the following is a necessary condition for the total momentum of a system to be conserved?
    A. Kinetic energy must not change.
    B. No net external force acts on the system.
    C. The system must be at rest.
    D. Only the force of gravity acts on the system.

For numbers 17 and 18 the given data are: Two 0.5 kg balls approach each other with the same speed of 1.0 m/s.

17. What is the total momentum of the system before collision?
    A. 0
    B. 0.50 kg m/s
    C. 1.0 kg m/s
    D. -1.0 kg m/s
18. If there is no external force acting on the system, what the total momentum of the system after collision?
    A. 0
    B. 0.50 kg m/s
    C. 1.0 kg m/s
    D. -1.0 kg m/s

19. Two billiard balls approach each other with the same speed. If they collide in a perfectly elastic collision, what would be their velocities after collision?
    A. Zero
    B. Same in magnitude and direction
    C. Same in magnitude but opposite in direction

D. Different in magnitude and opposite in direction

20. A 50 kg astronaut ejects 100 g of gas from his propulsion pistol at a velocity of 50 m/s. What is his resulting velocity?
    A. -0.10 m/s
    B. -0.50 m/s
    C. 0 m/s
    D. -100 m/s

Uniformly Accelerated Motion: Horizontal Dimension

If a body maintains a constant change in its velocity in a given time interval along a straight line, then the body is said to have a uniform acceleration.

Consider an airplane on a runway preparing for takeoff. Positions taken at equal time intervals are indicated in the figure below.

(pls.redrawthefigure of an airplane preparing for takeoff

(pls.draw figure of a runway)

Figure 1: An airplane preparing for take off.

The change in an airplane's position for each time interval is increasing as shown in Figure 1, thus, it is moving faster and faster. This means that the plane is accelerating. Try the next activity to further understand acceleration.

Activity 1
Roll, roll, and away!

Objectives:

- Record the time for the tin can to travel a given distance;
- Calculate the acceleration of the can rolling down an inclined plane, given a distance vs. time and distance vs. time^2 graph of its motion; and
- Describe the motion of an object given a distance vs. time or a distance vs. time^2 graph.

Materials Needed:

Board/plank (at least 200 cm long)
Timing device (stopwatch)
Tin can
Stack of books
Protractor

Procedure:

1. Set up an inclined plane by putting one end of the plane on top of a stack of books. Mark the plane for every 40 cm and label these as 40 cm, 80 cm, 120 cm, and so on, starting from the lowest end.
2. Measure the base and the height and calculate the angle of inclination. Use the formula, $\Theta = \tan^{-1}$(height / base)
3. Roll the tin can from each labeled point starting with the 40 cm mark. Start the timer as the tin can is released, and stop the timer when the tin can reaches the bottom of the inclined plane.
4. Ask your partner to record the time (t) taken by the tin can to travel each distance (d) down the plane. Perform three trials from each mark. Use the table below for your data.
5. Graph d vs. t and then d vs. t^2.

TABLE 1. Data on the Motion of a Rolling Tin Can

Distance, d (cm)	Time, t (s)				Time^2, t^2 (s^2)
	Trial 1	Trial 2	Trial 3	Ave	
40					
80					
120					
160					
200					

Angle of inclination:___________

Q1. How will you describe the graphs of:
a. distance vs. time?
b. distance vs. time^2?

Q2. What is the relationship between distance and time of travel of the rolling can?

Q3. What is the slope of d – t^2 graph? What quantity does the slope of d – t^2 graph represent? (Refer to the unit of the slope)

Q4. What do the graphs of distance vs. time and distance vs. time^{2}suggest?

From the activity, you related distance and time. In computing the slope, you divided distance by time which is actually the speed of the can. You will now relate these quantities in the derivation of formula to solve problems relating to uniformly accelerated motion.

You have learned about displacements, velocities and acceleration when you were in Grades 7 and 8. Now you will use those basic equations to derive formulae used in Uniformly Accelerated Motion(UAM). Using the following equations on velocity, average velocity, and acceleration, you can derive other equations.

Equation A $$v = \frac{d}{t}$$

Equation B $$v_{ave} = \frac{v_f + v_i}{2}$$

Equation C $$a = \frac{v_f - v_i}{t}$$

where: v = velocity
v_f = final velocity
v_i = initial velocity
v_{ave} = average velocity
d = displacement
t = time
a = acceleration

To find out how displacement changes with time when an object is uniformly accelerated, rearrange equation A to arrive at $d = vt$. Since the velocity of the object changes when it is uniformly accelerating, we use the average velocity to determine displacement, so substituting v by v_{ave} in equation B, you will get:

$$d = vt$$

Equation D
$$d = \left(\frac{v_f + v_i}{2}\right) t$$

Rearrange equation C to arrive at $v_f = v_i + at$ and substituting the v_f in equation D, you will get

$$d = \left(\frac{v_f + v_i}{2}\right) t$$

$$d = \left[\frac{(v_i + at) + v_i}{2}\right] t$$

Combining v_i, you will arrive at

$$d = \left(\frac{2v_i + at}{2}\right) t$$

Distributing t will give you

$$d = \frac{2v_i t + at^2}{2}$$

Simplifying further will provide you

Equation E
$$d = v_i t + \frac{at^2}{2}$$

This shows that the displacement of the body is directly proportional to the square of time. This confirms that for equal interval of time, displacement increases quadratically.

To find out how final velocity depends on the displacement, substitute v and t from equations B and C to $d = vt$ and you will find that

$$d = vt$$

$$d = \left(\frac{v_f + v_i}{2}\right)\left(\frac{v_f - v_i}{a}\right)$$

Recall from your algebra class that (a+b) (a-b) = $a^2 - b^2$.

$$d = \left(\frac{v_f{}^2 - v_i{}^2}{2a}\right)$$

Simplifying, you will get

$$2ad = v_f{}^2 - v_i{}^2$$

Rearranging, you will get

Equation F

$$v_f^2 = v_i^2 + 2ad$$

To apply these derived equations, study the following problems.

Sample Problem 1:

An airplane accelerates from rest on a runway at 5.50 m/s^2 for 20.25 s until it finally takes off the ground. What is the distance covered before takeoff?

Given:

a = 5.50 m/s
t = 20.25 s
v_i = 0 m/s

Find:
d = ?

$$d = v_i t + \tfrac{1}{2} at^2$$

$$d = (0 \text{ m/s})(20.25 \text{ s}) + \tfrac{1}{2}(5.50 \text{ m/s}^2)(20.25 \text{ s})^2$$

$$d = 1130 \text{ m}$$

(Pls. retype all the solutions and equations for consistency with the mathematical format)

Sample Problem 2:

From rest, a jeepney accelerates uniformly over a time of 3.25 seconds and covers a distance of 15 m. Determine the acceleration of the jeepney.

Given:
v_i = 0 m/s
d = 15 m
t = 3.25 s

Find:
a= ?

$$d = v_i t + \frac{1}{2} a t^2$$

$$15 \text{ m} = (0 \text{ m/s})(3.25 \text{ s}) + \frac{1}{2} a (3.25 \text{ s})^2$$

$$15 \text{ m} = (5.28 \text{s}^2) a$$

$$a = (15 \text{ m})/(5.28 \text{ s}^2)$$

$$a = 2.8 \text{ m/ s}^2$$

Try solving this…

A train accelerates to a speed of 20 m/s over a distance of 150 m. Determine the acceleration (assume uniform) of the train.

Uniformly Accelerated Motion: Vertical Dimension

You learned in Grade 8 that the pull of gravity acts on all objects. So on Earth, when you throw something up, it will go down. Things thrown upward always fall at a constant acceleration which has a magnitude of 9.8 m/s^2. This means that the velocity of an object in free fall changes by 9.8 m/s every second of fall.

Consider a stone dropped from a cliff as shown in the Figure 2. For equal time interval, the distance travelled increases quadratically.

(Pls. redraw the figure) Show the letters in each stone)

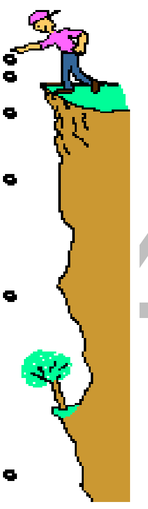


Figure 2.
Motion of the stone dropped from a hill

Another example of free-fall is a body thrown upward. Consider Figure 3 on the right where a ball is thrown upward. As the ball goes up, it decelerates with a magnitude of 9.8 m/s^2 until it stops momentarily and changes direction. That means, it reaches its maximum height before it starts to fall. Using equation F, you will also find that when the ball falls back to the point where it was thrown, its speed will be equal to the speed at which it was thrown. Note that the magnitudes of the two velocities are equal, but they have opposite directions – velocity is upward when it was thrown, but downward when it returns.

Do the next activities to further see the behavior of falling objects.

(Pls. insert a figure of a girl throwing a stone upward)
Show the letters in each path of the stone)

Figure 3. Motion of the stone thrown vertically upward

Activity 2
Drop me!

Objectives:

- Record the time for the ball to reach the ground; and
- Calculate the height of a building;

Materials Needed:

Stopwatch
Ball (e.g. tennis ball, sepak takraw, etc.)
Long string

Procedure:

1. Look for a tall building in your school. Drop the tennis ballfrom the tall building.
2. Using the stopwatch, ask your classmate to record the time it takes the ball to reach the ground. Record your data.
3. Calculate the height covered by the ball using the formula $h = ½\, a_g t^2$(since $v_i = 0$)

TABLE 2. Data on the Time and Height of the Building

Trial	Time, t (s)	Height, h (m)
1		
2		

3		
Average		

4. Using the data from the table, calculate the final velocity of the ball using the formula $vf = at$ since $v_i = 0$. Try also calculating final velocity using the formula $v_f = \sqrt{2a_g h}$ and compare your answers.

Q1. What is the velocity of the ball just before it hits the ground?

5. Using a very long string, get the actual height of the building.

Q2. How will you compare the actual heightof the building from the result of the experiment?

Q3. What is the percentage error?

Activity 3
You raise me up!

Objectives:

- Determine the initial velocity of a ball thrown upward;
- Record the time for the ball to reach the ground;
- Record the time for ball to reach its maximum height; and
- Calculate the maximum height reached by the ball thrown vertically upward.

Materials Needed:

Stopwatch
Ball (e.g. tennis ball, sepak takraw, etc.)

Procedure:

1. Throw the ball vertically upward in the air as hard as you can in an open space.
2. Using your stopwatch, ask your classmate to record the total time the ball remains in the air. Get the time from point of release of the ball until it reaches its maximum height by the dividing the total time into two. Record your data.

TABLE 3. Data on the Total Time and Time of the Ball in the Air

Trial	Total Time, (s)	Time, t (s)
1		
2		
3		
Average		

Q1. What do you think happens to the speed of the ball as it reaches its maximum height?

3. Calculate the initial velocity of the ball using the formula $v_i = v_f - a_g t$. Use -9.8m/s^2 for a_g.
4. Solve for the maximum height reached by the ball using $h = v_i t + ½ a_g t^2$. Use -9.8m/s^2 for a_g.

TABLE 4. Data on the Velocity of the Ball and Height of the Building

Trial	Velocity, v(s)	Height, h (m)
1		
2		
3		
Average		

Q2. What will happen to the ball's velocity as it falls farther below the point of release?

Study the following sample problems.

Sample Problem 1:

Zed is playing with a ball on top of a building but the ball fell and hit the ground after 2.6 seconds, what is the final velocity of the ball just before it hits the ground and how high is the building?

Given:
a_g = -9.8 m/s^2
assume v_i = 0 m/s
t = 2.6 s

Find:
vf = ?
h= ?

$$v_f = v_i + a_g t$$

$$v_f = 0 + (-9.8\ m/s^2)(2.6\ s)$$

$$v_f = -26\ m/s$$

$$d = v_i t + ½ a_g t^2$$
$$h = -d = -[\ (0\ m/s)(2.6\ s) + ½\ (-9.8\ m/s^2)(2.6\ s)^2]$$

$$h = 33\ m$$

Sample Problem 2:

The Philippine tarsier is capable of jumping to a height of 1.5 m in hunting for food. Determine the takeoff speed of the tarsier.

Given:
a = -9.8 m/s2
h = 1.5 m

Find:
v_i = ?

At the highest point, velocity of the tarsier is zero.

$$v_f^2 = v_i^2 + 2ah$$
$$(0\ \text{m/s})^2 = v_i^2 + 2(-9.8\ \text{m/s}^2)(1.5\text{m})$$

$$0\ \text{m}^2/\text{s}^2 = v_i^2 - 29.4\ \text{m}^2/\text{s}^2$$

$$29.4\ \text{m}^2/\text{s}^2 = v_i^2$$

$$v_i = 5.4\ \text{m/s}$$

Try solving this…

The acceleration of gravity on the moon is 1.62 m/s^2. If a ball is dropped on the moon from a height of 1.50 m. Determine the time for the ball to fall to the surface of the moon.

In solving problems on UAM refer to Table 5.

TABLE 5. Summary Of Uniformly Accelerated Motion (UAM) Formulae

Uniformly Accelerated Motion Formulae
$v_f = at + v_i$
$d = v_i t + \frac{at^2}{2}$
$d = \left(\frac{v_f + v_i}{2}\right) t$
$v_f^2 = v_i^2 + 2ad$

Free-fall is an example of uniformly accelerated motion, with its acceleration being -9.8 m/s^2, negative because it is downward.

Motion in Two Dimensions

"Oh the places you'll go! There is fun to be done! There are points to be scored. There are games to be won. And the magical things you can do with that ball will make you the winning-est winner of all." - Dr. Seuss

Many neighborhood games you play and sporting events you join and/or officiate in MAPEH classes involve flying objects or balls.

Have you noticed the ***curved paths*** they make in mid-air? This curve is what naturally happens when an object, called a ***projectile,*** moves in ***two dimensions*** **–**having both horizontal and vertical motion components, acted by gravity only. In physics this is called **projectile motion**.

Not only balls fly when in projectile motion. Have you noticed that in many sports and games, players come "flying" too? Understanding motion in two-dimensions will help you apply the physics of sports and enhance game events experiences.

Activity 4
Curve me on an incline

Objective:

- Capture a full trajectory of projectile motion on an inclined surface.
- Investigate the relationships between the projection angle, the height, the range, and the time of travel of a projectile.

Materials Needed:

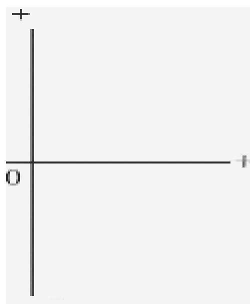
Projectiles : marble or jackstone, soda/water plastic bottle cap, powder (e.g. face powder or flour on low container)
Projectile launcher : retractable pen preferably HBW Matrix pen, sticky tape, pair of scissors, and 2 popsicle sticks
Inclined surface : 1/8 illustration board (10" x 15") on cookie baking sheet or cookie baking sheet (13" x 17") alone, 4 books (~1" thick) for 20^0 incline and weight support
Table top
Protractor
Pencil
Tissue paper
Ruler or tape measure

Procedure:

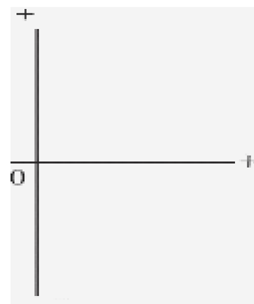
Day One Activity

I. Linear horizontal motion

Use the pen to move the marble horizontally along the table top. (*See that the depressed end of the pen will hit the object about the center*.) Observe the motion. Sketch and label the velocity-time and the acceleration-time graphs on the axes below.



Graph 1. Velocity – time graph for objects rolling horizontally

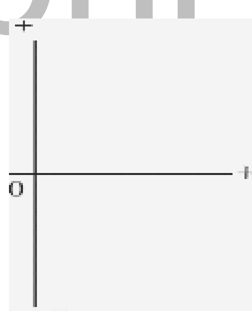


Graph 2. Acceleration – time graph for objects rolling down an incline

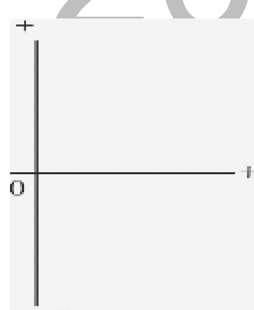
Complete the sentence.
A ball rolling horizontally has a velocity that is __________, and an acceleration that is ___________.

II. Linear motion down an incline

Release a ball on an inclined board. Sketch and label the velocity-time and the acceleration-time graphs on the axes below.



Graph 3. velocity – time graph for objects rolling straight down an incline



Graph 4. acceleration – time graph for objects rolling straight down an incline

Complete the sentence.
A ball rolling straight down an incline has a velocity that is __________, and an acceleration that is ___________.

III. Two dimensional motion along an incline

Tracing the Trajectory

1. Tape the popsicle sticks together. Using tape, attach these firmly to one side of the retractable pen to serve as the launching pad. Push the top end and position the object to launch (marble or bottle cap). Refer to Figure 4 below.
2.

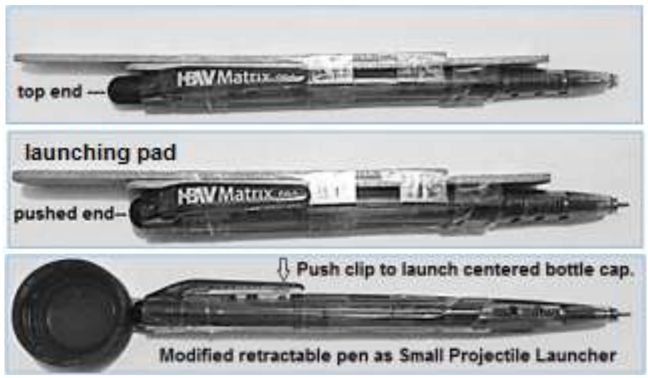


Figure 4. Retractable pen attached with popsicle launching pad

3. Using a protractor and pencil, mark the bottom left of the illustration board or cookie baking sheet with selected angles at 15 or 20 degree-intervals. Tape the illustration board at the top right of the cookie sheet.

   On the board select and draw fix origins at points A and B. The left and bottom ends of the board or cookie baking sheet may serve as the *y-axis* and *x-axis* respectively.

Figure 5a. The modified retractable pen mounted with a powder-coated marble at Point A ready for horizontal projection along the labeled inclined illustration board.

To complete the set-up, elevate one end of the board or cookie sheet using books with an angle of inclination of about 20^0. Use another book to hold the inclined surface in place as shown in Fig. 5b.

4. Push the top end of the modified retractable pen and firmly hold it horizontally at point A. Then carefully place the powder-coated marble on its launching pad. Launch the marble by pushing the clip of the modified retractable pen.

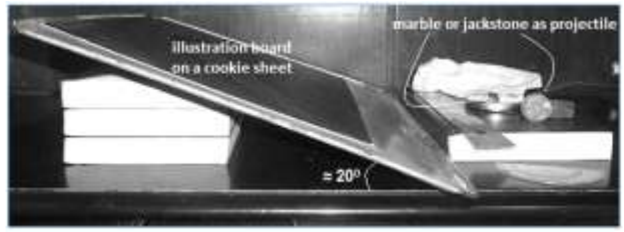


Figure 5b. Inclined illustration board-cookie baking sheet propped between books for the marble projectile.

5. Trace the powder-marked trajectory with a pencil. Dust off the powder. Label this path as 'horizontally-launched' for later analysis.

6. At point B, repeat steps 3 and 4 but this time carefully launching the marble at selected angles (e.g. 15^0, 30^0, 45^0, 60^0, and 75^0) and marking the pencil-traced trajectories as 'launched at __ angle.'

Figure 5c. Marble projectile at point B ready for launching at an angle up the inclined board.

Figure 5d. Tracing with pencil the powder-marked trajectory of the marble launched at an angle.

Note: The actual projections may not exactly follow the initial angles that your group selected. At least try to have projection angles close to the angle intervals selected.

Q1. Describe the trajectory for horizontally fired projectiles along an incline. Sketch the trajectory.

Q2. Describe the shape of the trajectory for projectiles fired at angles along an incline. Sketch the trajectory.

Q3. Compare the locations of the trajectory peaks in terms of maximum height, h_{max} reached.

Q4. Compare the horizontal distances, x (range) reached when they return to the elevation from which they were projected.

Q5. Among the trajectories of projectiles fired at different angles, for the same launching velocity, which covered the greatest range (horizontal distance in the *x-axis*)?

Q6. Among the trajectories of projectiles fired at different angles, for the same launching speed, which recorded the highest peak?

Q7. Which pairs of trajectories have ranges that are almost equal?

____

What will happen to the horizontal distances of the trajectory if the board is inclined at 90^0 that is now totally vertical? On to the next activity…

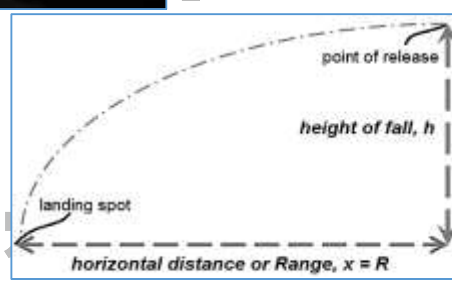
Day Two Activity

IV. Two dimensional motion on air

Launching Bottle Caps Horizontally

7. Use the modified retractable pen to launch a bottle cap horizontally five to ten times from *heights, h* of 0.5 m, 1.0 m, 1.5 m, and 2.0 m.

Figure 5f. Displacement of horizontally launched plastic bottle cap from a height.



Note the place on the floor where the plastic bottle cap lands. Measure and record the projectile's horizontal distance from this spot up to the point on the floor that is exactly below the release location of the bottle cap. Record as range.

8. Repeat step 6 and complete Tables 6a and 6b below.

Safety check: *Ensure that the trajectories are free from obstructions and the person assigned to launch the plastic cap is tall enough for the 2.0 m release height. If standing on a table or a chair, assign another member to hold the table/chair in place.*

Table 6a. Range of horizontally launched bottle cap from different heights

***Height of Fall, h* (m)**	***Range, R* (m)**					***Average Range, R* (m)**
	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	
0.00						

-0.50						
-1.00						
-1.50						
-2.00						

Q8. At which height of fall is the average range the longest? Shortest?

A projectile like the bottle cap moves freely through the air with a constant horizontal velocity v_x and accelerates vertically the same as that of a freely falling object.
The horizontal and vertical positions of the horizontally projected bottle cap can be

described by the equations $x = v_x t$ and $h = \frac{1}{2} a_g t^2$ respectively, where h is taken to be negative, being a displacement below the point of release and a_g is - 9.8 m/s^2. The times for the horizontal motion and the vertical motion are equal.

Table 6b. Calculated time of fall of horizontally-launched plastic bottle cap

***Calculated Time of Fall, t_{calc}* (s)** $t_{calc} = \sqrt{\frac{2h}{g}}$	***Square of Calculated Time of Fall,* t_{calc}^2 (s^2)**	***Average Range, R (m)***	***Height of Fall, h* (m)**
			0.00
			-0.50
			-1.00
			-1.50
			-2.00

Q9. At which height of fall is the calculated time of fall the longest? Shortest?

Extension Activity:

9. Using Excel, generate the scatter graph with smooth lines and markers for the following graphs:
   (a) Height of Fall vs Average Range
   (b) Height of Fall vs Time of Fall,
   (c) Height of Fall vs Square of Time of Fall
   (d) Average Range vs Time of Fall

10. Right click on the linear or parabolic graph and add trend line options such as the *set intercept,* and the display *equation on chart*.

11. Rewrite the linear mathematical equations into physics equations by replacing the y and x variables with the symbols of the physics quantities plotted along the y and x axes.

Q10. What concepts or principles regarding the plastic bottle cap's projectile motion were indicated in the graphs and equations?

Reminder: Excel automatically plots the leftmost highlighted column along the x-axis. Rearrange the columns of data so as to generate correctly the graph asked for.

In Activity 4, the concept check on horizontal uniform velocity motion and vertical uniform acceleration motion in one dimension should serve as reminder that all projectiles regardless of its path will always follow these principles:

1. Projectiles always maintain a constant horizontal velocity (neglecting air resistance).
2. Projectiles always experience a constant acceleration along the axis where the constant net force is directed. There is a constant vertical acceleration of 9.8 m/s^2, downward (neglecting air resistance) for projectiles on air. For projectiles on inclined surfaces, the constant "vertical" acceleration will be smaller than 9.8 m/s^2 down the tilt which is equal to $\boldsymbol{g sin\theta}$.
3. The horizontal and "vertical" motions are completely independent of each other. Therefore, horizontal and vertical motion can be treated separately.

For the third principle, what can be done to show the independence of the two components of projectile motion? Considering horizontal and vertical components separately is important when solving projectile exercises and investigating real life applications.

Meanwhile, the activity on capturing the motion of the marble launched on an inclined board can model real projectile motion trajectories. Instead of launching the projectile in a vertical plane, it was launched up an incline where the powder-coated marble leaves a trail of white mark as it slides down the inclined illustration board.

Aside from gravity, other forces such as normal and frictional forces act on the marble, thus its acceleration is smaller than the 9.8 m/s^2 rate due to gravity. In spite of this, the trajectories are still a result of a constant horizontal velocity and a "vertical motion" of constant acceleration.

And yes, there are other examples of motion in two dimensions. Projectile motion is only one example. Do the next activity to explore the idea that projectile trajectories can be matched.

Activity 5
Curve a like

(Adapted from http://www.nuffieldfoundation.org/practical-physics/testing-projectile-motion-drawn-parabola)

Objective:

- Set a ball in projectile motion to match pre-drawn parabolic trajectories.

Materials Needed:

chalk or marker
2 whole sheets of manila paper
small ball or round object safe to throw (e.g. tennis ball, sepak takraw, etc.)

Procedure:

1. **Match-a-curve**.

a. Draw a rough parabola by sketching vertical and horizontal lines on a manila paper and throw the ball similar to Figure 6 below.

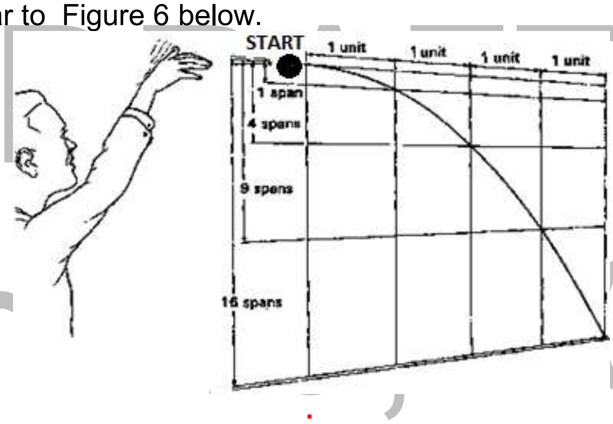


Figure 6. Matching trajectory A to a half parabola

To the artist: Please redraw figure with the student in short sleeves

Q1. In what direction or orientation did you throw the ball?

Q2. How would you describe the ball's path and motion?

Q3. How many tries did you make to match the curved paths?

b. Draw a box at the bottom end of the parabola. Throw again the ball with the box as the target.

Q4. How many tries did you make before you matched the curves this time?

Q5. What does this tell you regarding visuals or imaginary targets in sports?

2. **What a curve-a-throw!**

a. On another manila paper, draw a complete parabola and throw the ball similar to the Figure 7 below.

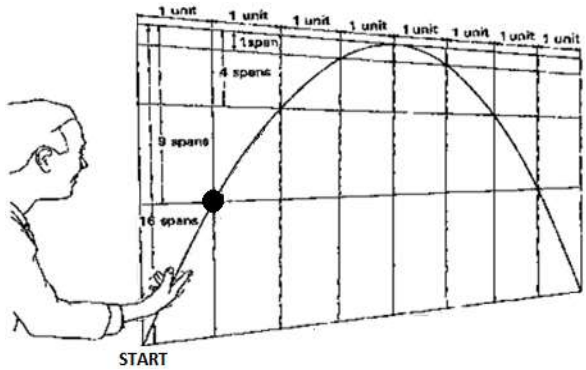


Figure 7. Matching trajectory B to a complete parabola

To the artist: Please redraw figure with the student in short sleeves.

Q6. In what direction or orientation did you throw the ball?

Q7. How would you describe the ball's path and motion?

Q8. Aside from doing more trials or "practices", for this parabola where will you place the imaginary target to aim at for better matching results?

Q9. Based on the activity, is it possible that the ball will end at a higher elevation than its starting level?

Q10. What force got the ball projected?

Q11. What force continues to act on the ball when it is in mid-air?

3. Of curves . . .

a. The drawn curved graphs on the paper are parabolic curves. Similarly, trajectories A and B are also parabolic curves.

Q12. How will you compare or contrast the horizontal and vertical spacing?

Q13. What does the spacing in the set of vertical lines indicate about the vertical displacement and vertical velocity of the projectile motion?

4. **. . . and arrows**.

The displacement **đ**, and velocity **ṽ**, are vector quantities. Projectile motion can be understood by analyzing the horizontal and the vertical components of the displacement and velocity which add as vectors.

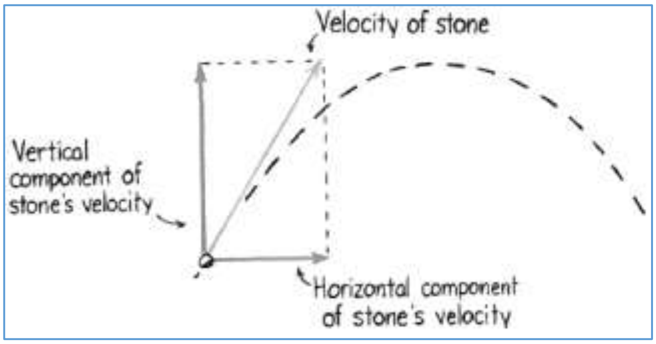


Figure 8. Sketch of the velocity vector components

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Recall that **vectors are quantities with magnitude and direction**. And any vector can be represented by a **vector arrow**, the length of which corresponds to the magnitude, while the arrow point in the direction of the vector quantity.

For a horizontally projected object, the displacement and velocity vector has both magnitude and direction that you can separate into

horizontal components Eq. 1 $d_H = x = v_x t$, Eq. 2 $v_H = v_x = \frac{x}{t}$

and vertical components Eq. 3 $d_V = h = \frac{1}{2} a_g t^2$, Eq. 4 $v_V = v_y = a_g t$

Table 7. Kinematic Equations for Projectile Motion

Horizontal Motion	Vertical Motion
$a_x = 0$, $v_x =$ constant	$a_y = -a_g =$ constant
$v_{fx} = v_{ix}$	$v_{fy} = v_{iy} - a_g t$
$x_f = x_i + v_{ix} t$	$y_f = y_i + v_{iy} t - \frac{1}{2} a_g t^2$
	$v_{fy}{}^2 = v_{iy}{}^2 - 2a_g (y_f - y_i)$

Vertical displacements and velocities are taken positive upward and negative downward from the point of release. While the $a_g = 9.8 m/s^2, downward$

Projectiles Launched Horizontally

PLEASE Redraw

A projectile launched horizontally has no initial vertical velocity. Thus, its vertical motion is identical to that of a dropped object. The downward velocity increases uniformly due to gravity as shown by the vector arrows of increasing lengths. The horizontal velocity is uniform as shown by the identical horizontal vector arrows.

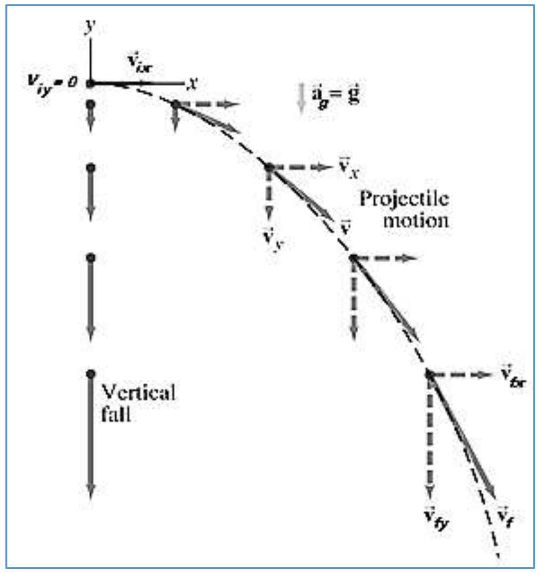

Figure 9. Velocity component vector diagram for projectiles fired

The dashed black line represents the path of the object. The velocity vector v at each point is in the direction of motion and thus is tangent to the path. The velocity vectors are solid arrows, and velocity components are dashed. (A vertically falling object starting at the same point is shown at the left for comparison; **v_y is the same for the falling object and the projectile**.)

For a projectile beginning and ending at the same height, the time it takes a projectile to rise to its highest point equals the time it takes to fall from the highest point back to its original position.

Sample Problem 1

A marble is thrown horizontally from a table top with a velocity of 1.50 m/s. The marble falls 0.70 m away from the table's edge.

A) How high is the lab table?
B) What is the marble's velocity just before it hits the floor?

Before you can find the height of the lab table, you must determine first how long the marble is in mid-air. For the horizontal distance travelled, this equation $x_f = x_i + v_{ix}t$ will be used.

Given: $\Delta x = 0.70m$

$v_{ix} = 1.50m/s$

$v_{iy} = 0$

Find: $\Delta t = ?$; a) $\Delta y = ?$; b) $v_{fy} = ?$

a) Solve $\Delta t = \Delta x / v = 0.70m / 1.50m/s = 0.47s$ total time of marble in air

Now that you know the time it took the marble to fall to the ground, you can find the vertical distance it travelled in the same time.

Use $\Delta y = -\frac{1}{2} a_g t^2$ from the equation $y_f = y_i + v_{iy} t - \frac{1}{2} a_g t^2$ where $v_{iy} = 0$

$\Delta y = -\frac{1}{2} 9.8 m/s^2 (0.47s)^2 = -1.08m$ or 1.8 m below the table top; table is 1.08 m high.

b) To determine the magnitude of the resultant velocity, find first the two velocity components and then solve for the resultant using the Pythagorean Theorem equation $v^2 = v^2{}_x + v^2{}_y$. If the horizontal velocity is uniform at 1.50 m/s while the vertical velocity is uniformly accelerated at $v_{fy} = v_{iy} - a_g t$ where $v_{iy} = 0$.

Then solve $v_{fy} = v_{iy} - a_g t = 0 - 9.8m/s^2(0.47) = -4.606\,m/s = 4.61m/s$ downward.

The magnitude of the resultant velocity is shown below.

$$
\begin{aligned}
v^2 &= v^2{}_x + v^2{}_y = (1.50m/s)^2 + (-4.61m/s)^2 \\
v &= \sqrt{(1.50m/s)^2 + (-4.61m/s)^2} \\
v &= \sqrt{2.25 + 21.25 m^2/s^2} \\
v &= \sqrt{23.5 m^2/s^2} \\
v &= 4.85 m/s
\end{aligned}
$$

The direction of the velocity is determined using the tangent trigonometric function.

$$
\begin{aligned}
\tan\theta &= \frac{v_y}{v_x} \\
\theta &= \tan^{-1}\frac{-4.61m/s}{1.50m/s} \\
\theta &= -71.976 \deg rees \\
\theta &= 72.0 \deg rees
\end{aligned}
$$

clockwise from the floor

In some projectile problems, there is also a need to find the magnitudes of the motion components using trigonometry as shown below

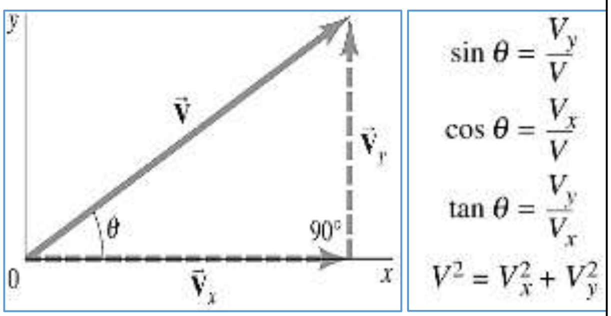

Figure 10. Finding the components of a vector using trigonometric functions.

Equations for:

horizontal velocity component:

$$v_x = v\cos\theta$$

vertical velocity component:

$$v_y = v\cos\theta$$

magnitude of resultant vector:

$$|v| = \sqrt{v^2{}_x + v^2{}_y}$$

direction of resultant vector:

$$\theta = \tan^{-1}\frac{v_y}{v_x}$$

Projectiles Launched At an Angle

When a projectile is launched upward at an angle, its velocity has two components:

1. a constant horizontal velocity that moves in the same direction as the launch, the acceleration of which is zero; and

2. an upward positive vertical velocity component that is decreasing in magnitude until it becomes zero at the top of the trajectory (therefore it no longer goes up any further). But because gravity makes it accelerates downward at a rate of 9.8 m/s per second or 9.8 m/s^2, (therefore it stays at rest only for an instant) it will start to descend with an increasing negative vertical velocity until it is stopped by something.

So as the projectile moves forward horizontally with uniform velocity, its vertical velocity is also accelerated creating a trajectory that is a parabola.

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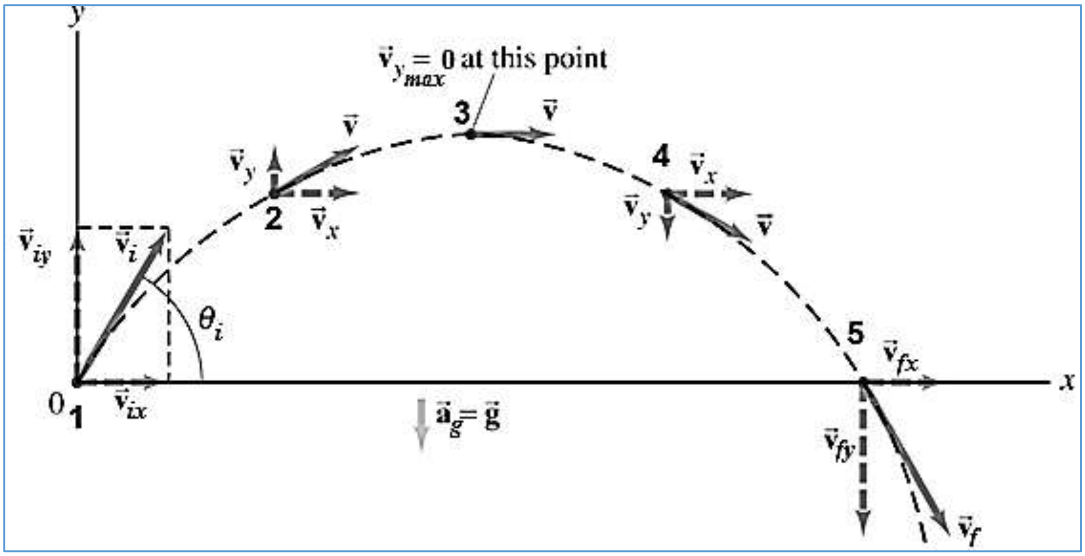


Figure 11. Path of a projectile fired with initial velocity $\mathbf{v}_i$ at angle θ_i to the horizontal. The trajectory is shown in black dash, the velocity vectors are in solid arrows, and velocity components are dashed.

Sample Problem 2

A soccer ball is kicked at ground level with a speed of 20 m/s at an angle of 45^0 to the horizontal. How much later does it hit the ground?

Choose the kicking point as the origin. When the soccer ball reaches the ground again, the change in vertical displacement Δy is 0. To break the problem into workable parts, determine first the initial horizontal component v_{ix} = (20.0 cos 45^0) m/s = 14.1 m/s; and the initial vertical component v_{iy} = (20.0 sin 45^0) m/s = -14.1 m/s.

And because the final vertical position y_f is at the same elevation as the initial y_i, the final vertical component v_{fy} is -14.1 m/s but will be at 45^0 below the x-axis which is perpendicular to the initial direction.

Using the concept of acceleration, you can solve for total time using the equation

$$t = \frac{v_{fy} - v_{iy}}{g} = \frac{-14.1 m/s - 14.1 m/s}{-9.8 m/s^2} = 2.9 s$$

How many other ways can you solve this same problem?

Impulse and Momentum

What makes things move? Why do some objects move continuously while some moving objects stop suddenly? These might be some of the questions you had in mind but were not really answered in last year's science class.

In grade 8, you learned that unbalanced forces cause stationary objects to move. In fact, according to Newton's Second Law of Motion, the greater the force applied, the larger the acceleration of an object. It also stated that with the same force, heavier objects have smaller acceleration, thus, Force = mass x acceleration or F=ma.

What affects motion?

Consider a cargo truck with a mass of 10,000 kilograms traveling at a velocity of 40 kilometers per hour and a small car with a mass of 2000 kilograms traveling at the same velocity as shown below. If the two vehicles suddenly lose their breaks and crash against the brick wall, which do you think would be more damaging? On what factor would the impact of collision depend if their velocities are the same?

(To Artist : Please draw the graphics instead.)

Figure 12. A truck and a car hitting a wall

If you suggested that it would be the mass of the truck, then you are correct. Although the two vehicles have the same velocities but different masses, the impact of the truck's collision with the brick wall is far damaging compared with the impact of the car's collision with the brick wall.

Let us investigate this further.

Activity 6
Investigating Momentum

Objective:

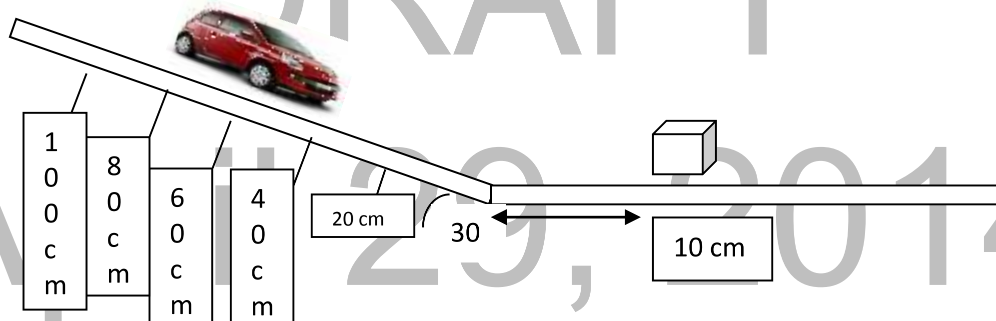
- Identify the factors that affect momentum.

Materials Needed:

Board or plank (at least 1.0 m long)
Books
Block of wood
Masking tape
Protractor
Ruler / meterstick
toy cars/trucks, one at least twice as heavy as the other

Procedure:

1. Place several books on top of a table and position the plane board at an angle of about 30^o from the horizontal.
2. Using masking tape and marker, label distances of every 10 cm starting from the lower portion of the inclined plane up to the other edge of the inclined plane.
3. Place the block of wood about 10 cm from the foot of the inclined plane. Label this as the block's initial position.
4. Position the small toy car at the 20-cm mark and record the time it takes for the toy car to move down the inclined plane and hit the block of wood.



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Note: The measurement should be written on the inclined plane and not placed in the text box.

Figure 13. A toy car on an inclined plane

5. Measure how far the block moved. Record this as the stopping distance.

Table 8. Stopping Distance and Time of the Toy Cars

Initial Distance (cm)	Stopping Distance (cm) of Small toy car	Stopping Distance (cm) of Big toy car
20		
40		
60		

80		
100		

6. Repeat steps 4 and 5 while varying only the initial position / distance for 40 cm, 60 cm, 80 cm, 100 cm.
7. Do steps 4 to 6, this time using the bigger toy vehicle. Record your data in the table.

Q1. How will you compare their stopping distances?

Q2. Did the two toy vehicles immediately stop as they hit the block of wood? Describe the stopping distances of the two toy cars.

Q3. Which has a greater stopping distance, the small toy car or the big toy truck? How do the stopping distances of each one change according to the point of release?

Q4. If momentum is a measure of how difficult it is to stop a moving object, which of the two vehicles had a greater momentum?

What affects momentum?

Which of the two toy vehicles was more difficult to stop – the lighter one or the heavier one? The heavier one is more difficult to stop. This is because it possesses a greater inertia in motion which depends on an object's mass and velocity. Do you still remember Newton's First Law of Motion? It is also known as the Law of Inertia. An object's momentum is also known as inertia in motion. For objects moving at the same velocity, a more massive object has a greater inertia in motion therefore a greater momentum. Momentum depends on two factors, mass and velocity. Two cars of the same mass but different velocities will also have different momenta.

r A

Pls. redraw the figure

Figure 14. Two identical cars of different velocities

Consider the two identical cars on the left. Car A is traveling at 80 km/h while Car B is traveling at 30 km/h. Which of the two cars would be more difficult to stop? Which of the two cars has more momentum? Car A, being faster, is more difficult to stop. It has more momentum.

On what two factors does momentum depend on? It depends on mass and velocity. Operationally, momentum is defined as the product of mass and the velocity of an object. In equation,

$$p = mv$$

where p = is the momentum
m = is the mass
v = is the velocity

Moving objects have velocities which can be measured directly or indirectly. For stationary objects where the velocity is zero, the momentum is also zero.

Let us practice computing for momentum.

Exercises:

Given the following data, solve for momentum using the formula p = mv.

Object	Mass (kg)	Velocity (m/s)	Momentum (kg-m/s)
Bird	0.03	18	
Basketball player	100	5	
Bullet	.004	600	
Baseball	.14	30	
Frog	.9	12	

Remember this:

Equation to use	if you are looking for…	If you know…
$p = mv$	momentum	mass and speed
$m = \frac{p}{v}$	Mass	momentum and velocity
$v = \frac{p}{m}$	velocity	momentum and mass

From the concepts that you have learned, answer the check up questions:

1. Which has more momentum, a huge truck that is not moving or a small toy cart that is moving?
2. A moving car has momentum. If it moves twice as fast, its momentum would be __________ as much.
3. Two cars, one twice as heavy as the other, moves down a hill at the same time. The heavier car would have a _________ momentum.

Applying the equation learned, answer the following problems:

1. A bowling ball whose mass is 4.0 kg is rolling at a rate of 2.5 m/s. What is its momentum?

2. A skateboard is rolling at a velocity of 3.0 m/s with a momentum of 6.0 kg-m/s. What is its mass?

3. A pitcher throws a baseball with a mass of 0.5 kg and a momentum of 10 kg-m/s. What is its velocity?

What causes changes in momentum?

Changes in momentum happen every time. A fast-moving car when suddenly stopped might have damaging effects not only to the vehicle itself but also to the person riding it. Various devices have been installed in vehicles in order to ensure the safety of the passengers. The use of seatbelts is even prescribed by law in order to lessen injuries from car crashes. Inflatable airbags are also installed in most cars aimed to increase the time of impact between the driver or passenger and the crashing vehicle in the event of an accident. Can you think of some other safety devices installed on vehicles?

(Redraw pictures with seatbelts and airbags.)

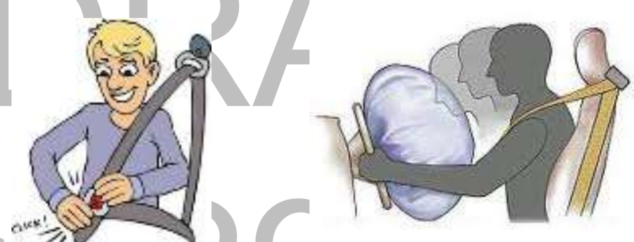


Figure15. Seatbelts and airbags

What factors may contribute to the changes in momentum? Let us find it out in the next activity.

Activity 7
Playing Egg Volleyball

Objective:

- Identify the factors that affect the time of impact of moving objects.

Materials Needed:

1 raw egg
Clear plastic bag where an egg can be inserted

Piece of cloth / large handkerchief

To Editor: Please look for a similar photo of Filipino students depicting two teams throwing and catching eggs using a piece of cloth.

Figure 16. Students playing egg volleyball

Procedure:

1. Look for an open space in your school where you can perform this activity.
2. Place the raw egg inside the clear plastic bag and tie the plastic bag securely. This is needed to prevent the egg contents from splattering in case the egg breaks.
3. Depending on the number of students, form two teams comprising of pairs of students. Each pair should have one large handkerchief or"*bandana*".
4. The two opposing teams must be at least 3 meters away from each other. The objective of the game is to have the eggs travel back and forth from each team to the other without breaking the egg. The players are only allowed to throw the egg in a curved path.
5. The players are not allowed to use their hands in throwing and catching the egg. Instead, they will use a cloth or handkerchief.
6. The players toss coin to determine who goes first.
7. The pair who fails to catch the egg, and/or breaks it, is considered out of the game.
8. The teacher may want to increase the distance by 1 meter between the two teams in order to make the game more interesting and challenging.
9. The pair who is able to catch and throw the most number of eggs without breaking would be declared as the winner.

Q1. Was the handkerchief able to protect the egg from breaking?

Q2. Did the egg break immediately when it hit the ground?

Q3. How was the impact force lessened by the use of the handkerchief?

How was the handkerchief able to protect the egg from breaking? If a different material was used to catch the egg, say, a piece of wood, will the egg break or will it not?

The egg is a naturally-fragile material. However the choice of material may prevent the egg from breaking by increasing the time of impact, therefore lessening the impact force. If one throws an egg directly to a wall it will definitely break. This is because when the egg's motion is abruptly stopped, its momentum suddenly changes. However, if it is thrown on a piece of cloth, the time of impact will be increased due to the cushioning effect of the piece of cloth, therefore, it will lessen the impact force.

(Draw an egg hitting a brick wall and splattered on all directions.)

Figure 17a. Egg hitting a brick wall

(Draw an egg hitting a curtain / cloth and pushes the cloth backward.)

Figure 17b. Egg hitting a curtain

In physics, an external force acting on an object over a specific time leads to a change in momentum of the object. A special name is given to the product of the force applied and the time interval during which it acts: impulse.

Impulse = force x time

Do you still remember Newton's Second Law of Motion? It states that the net force is directly proportional to the mass of a body and its acceleration. In equation form,

$$F = ma$$

Since $a = \frac{v_f - v_i}{t}$, then

$$F = m(v_f - v_i) / t$$

Rearranging the equation will give you

$$Ft = mv_f - mv_i$$

Since $p = mv$, then

$$Ft = p_f - p_i$$

or

$$Ft = \Delta p$$

It turns out that the same impulse invariably leads to the same change in momentum. The above equation implies that for a fixed value of the change in momentum, the impact force is smaller when the impact time is bigger while the impact force is bigger when the impact time is smaller. A quick jab by a boxer makes a hard hit. A net, a cushion and corrugated containers all decrease the impact force.

From the equation, we can see that the product of force and time, which is impulse, equals the change in momentum. Can you think of some other applications of impulse in our everyday lives?

Sports like karate, taekwondo, baseball, golf and tennis utilize the concept of follow-through as an important strategy to obtain a greater momentum. When a tennis player hits the ball, a follow-through keeps the tennis racket in contact with the ball for a longer time, and so the ball experiences a greater change in momentum for the same force applied.

Let's try this:

Tiger Woods hits a 0.02 kg golf ball, giving it a speed of 25 m/s. What impulse does he impart to the ball?

Given: $m = 0.02$ kg
$\Delta v = 25$ m/s – 0 = 25 m/s

Find: I

Solution:
Since the golf ball is initially at rest, the initial velocity is equal to zero.
Thus, $I = \Delta p = m\Delta v$

$= (0.02 \text{ kg})(25 \text{ m/s})$
$= 0.50$ kg-m/s or 0.50 Ns

Conservation of Momentum

In Grade 8, you have learned that an external force is required to make an object accelerate. Similarly, if we want to change the momentum of an object, an external force is required. There will be no change in momentum if there is no external force.

Let's take this situation as an example. Two children on skateboards are initially at rest. They push each other so that eventually the boy moves to the right while the girl moves

Figure 18. A system is a group of objects that interact and affect each other. Examples are (a) Bowling ball and pin and (b) two football players.

in the opposite direction away from each other. Newton's Third Law tells us that the force that the girl exerts on the boy and the force that makes the girl move in the other direction are of equal magnitude but opposite direction. The boy and the girl make up a system – a collection of objects that affect one another (Figure 18). No net/unbalanced external force acts on the boy-girl system, thus, the total momentum of the system does not change (Figure 19). Remember that momentum, like velocity and force, is a vector quantity. The momentum gained by the girl is of equal magnitude but opposite direction to the momentum gained by the boy. In this system, no momentum is gained or lost. We say that momentum is **conserved**.

Explain how momentum is conserved in the following activity.

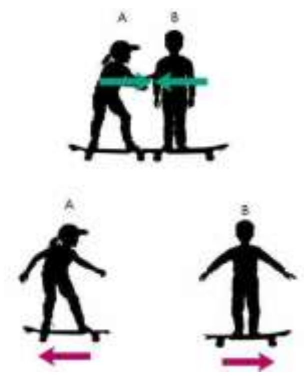


Figure 19. In this example, the totalmomentum of the boy-girl system before pushing is zero. After pushing, the total momentum of the boy-girl system is still zero because the momentum of the girl is of equal magnitudebut opposite direction to the momentum of the boy.Note that the momentum of the boy alone is not the same before and after pushing; and the momentum of the girl alone is not the same before and after pushing. (redraw figure as pushoff/provide own photograph)

Activity 8
Balloon Rocket

Objectives:

- Describe how a balloon rocket works and how conservation of momentum explains rocket motion.

Materials Needed:

balloon (long shape)
string (nylon, if available)
tape

Procedure:

1. Stretch the string over two posts. You can use chairs or iron stands as posts. Make sure that the string is taut.
2. Inflate the balloon. Twist the open end and temporarily secure it with a paper clip.

3. Tape the straw to the balloon such that it is aligned with the balloon's opening (see Figure 20).

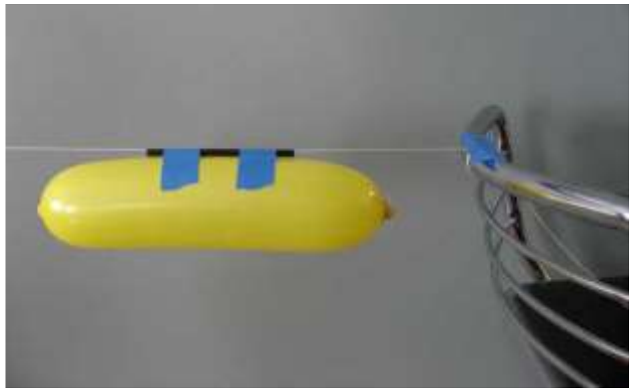


Figure 20. Balloon rocket set up.

4. Draw a diagram showing the momentum vectors of your balloon rocket and the air.

Q1. How do these momenta compare?

Q2. How does the velocity of the air that is pushed out of the rocket compare to the velocity of the balloon rocket?

At the start, our system, which consists of the balloon and the air inside it are stationary so the total momentum of the system is zero. When we let the air inside the balloon out, we notice that the balloon moves. The force that causes the balloon to move comes from the air that is pushed out of it. There is no external force involved. Thus, the total momentum of the system is conserved and must remain zero. If the balloon has momentum in one direction, the air must have an equal and opposite momentum for the total momentum to remain zero.

$$\begin{aligned} \textit{Change in momentum} &= 0 \\ \textit{Total Initial Momentum} &= \textit{Total Final Momentum} \\ 0 &= p_{balloon} + p_{air} \\ -p_{balloon} &= p_{air} \\ -(mv)_{balloon} &= -(mv)_{air} \end{aligned}$$

Since the mass of the balloon is greater than the mass of air, the velocity of the air must be greater in magnitude than the velocity of the balloon, and must be opposite in direction.

Concept Check:

Suppose the entire world population gathers in one spot and at the sounding of a prearranged signal, everyone jumps up. While all the people are in the air, does Earth gain momentum in the opposite direction?

Example 1a

Two iceskaters stand together. They “push off” and travel directly away from each other, the boy with a velocity of 1.50 m/s. If the boy weighs 735 N and the girl, 490 N, what is the girl’s velocity after they push off? (Consider the ice to be frictionless.)

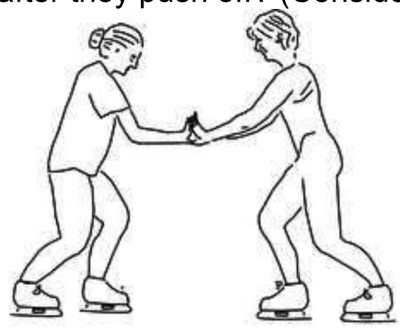


Figure 21. Pushoff

Solution:

Remember that W = mg, thus, m = W/g.

	mass	velocity
Boy	75 kg	1.50 m/s
Girl	50 kg	?

The ice where they stand on is considered to be frictionless, thus, no external force is present. The momentum of the boy-girl system is conserved. There is no change in the momentum of the system before and after the push off.

$$\begin{aligned} \textit{Total Initial Momentum} &= \textit{Total Final Momentum} \\ 0 &= p_{boy} + p_{girl} \\ -p_{boy} &= p_{girl} \\ -(mv)_{boy} &= (mv)_{girl} \\ -37.5\ kg\ m/s &= 50\ kg\ (v_{girl}) \\ -0.75\ m/s &= v_{girl} \end{aligned}$$

The girl moves with a velocity of 0.75 m/s opposite to the direction of the boy.

Remember!

Momentum is a vector quantity. It must have both magnitude (numerical value) and direction. The direction of the momentum vector is always in the same direction as the velocity vector. Like all vector quantities, momentum vectors can be added. For situations in which the two vectors are in opposite directions, one vector is considered negative and the other positive.

Example 1b

Two iceskaters stand together. They “push off” and travel directly away from each other, the boy with a speed of 0.50 m/s and the girl with a speed of 0.65 m/s. If the mass of the boy is 60 kg, what is the girl’s mass? (Consider the ice to be frictionless.)

Solution

The momentum of the boy-girl system is conserved. There is no change in the momentum of the system before and after the push off.

$$\begin{aligned} \textit{Total Initial Momentum} &= \textit{Total Final Momentum} \\ 0 &= p_{boy} + p_{girl} \\ -p_{boy} &= p_{girl} \\ -(mv)_{boy} &= (mv)_{girl} \\ 30.0\ kg\ m/s &= (m_{girl})\ 0.65\ m/s \\ 46kg &= m_{girl} \end{aligned}$$

Elastic and Inelastic Collisions

A **collision** is an encounter between two objects resulting in exchange of impulse and momentum. Because the time of impact is usually small, the impulse provided by external forces like friction during this time is negligible. If we take the colliding bodies as one system, the momentum of the system is therefore approximately conserved.

The total momentum of the system before the collision is equal to the total momentum of the system after the collision.

total momentum before collision = total momentum after collision

Collisions are categorized according to whether the total kinetic energy of the system changes. Kinetic energy may be lost during collisions when (1) it is converted to heat or other forms like binding energy, sound, light (if there is spark), etc. and (2) it is spent in producing deformation or damage, such as when two cars collide. The two types of collision are:

1. **Elastic collision** – one in which the total kinetic energy of the system does not change and colliding objects bounce off after collision.
2. **Inelastic collision** – one in which the total kinetic energy of the system changes (i.e., converted to some other form of energy). Objects that stick together after collision is said to be **perfectly inelastic**.

Can you identify which type of collision is shown in each situation?

(a)

(b)

Figure 22. Examples of collisions. (a) colliding pendulum (b)colliding cars

In Figure 22a, a moving steel ball pendulum collides head-on with another steel ball.The collision is elastic, that is, the total kinetic energy of the system (2 steel balls) is the same before and after the collision. The total momentum of the system before the collision is equal to the product of the first ball's mass and velocity. The total momentum of the system after the collision must be equal to the total momentum before the collision. The first ball comes to rest while the second ball moves away with a velocity equal to the velocity of the first ball. This is the case when the two balls have equal masses. The momentum of the first ball is transferred to the second ball. The first ball loses its momentum while the second ball gains momentum equal to that of the first ball's momentum (Figure 23a).

What do you think would happen if you pull two balls away and release them at the same time? Why is it so?

Example 3

A 300 g cart moves on an air track at 1.2 m/s. It collides with and sticks to another cart of mass 500 kg,which was stationary before collision. What is the velocity of the combined cartafter collision?

Solution

	mass	Velocity (before collision)
Cart 1	0.30 kg	1.2 m/s
Cart 2	0.50 kg	0

The total momentum of the system is conserved before and after the collision.

$$
\begin{aligned}
\textit{Total Momentum (before collision)} &= \textit{Total Momentum(after collision)}\\
(cart_1 + cart_2)_{before} &= (cart_1 + cart_2)_{after}\\
(mv)_{1,\ before} + 0 &= (m_1 + m_2)\, v_{after}\\
0.36\ kg\ m/s &= 0.80\ v_{after}\\
0.45 m/s &= v_{after}
\end{aligned}
$$

Since the two carts stuck together after collision, they have the same velocity after collision. The combined carts move at 0.45 m/s after the collision.

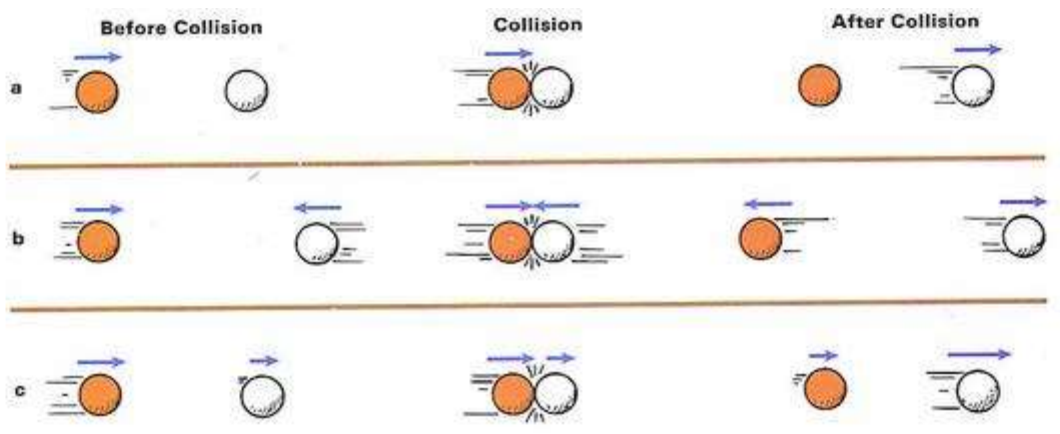


Figure 23. Elastic Collisions. (a) moving object collides with a stationary object (b) two moving objects collide head-on (c) two objects moving in the same direction collide

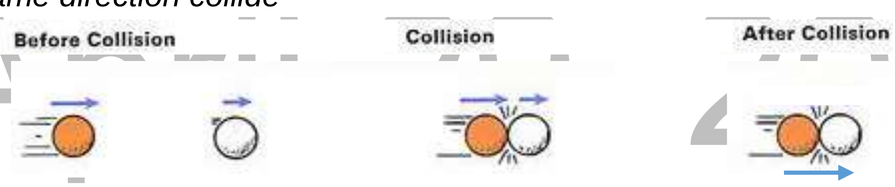


Figure 24. Inelastic Collision. Two objects collide, stick together and move as one.

In everyday life, however, perfectly elastic collisions are rare, and most collisions are inelastic to some extent. In the next activity, we shall use different types of balls to demonstrate different degrees of inelasticity.

Activity 9. Bouncy Balls

Objective:

- Classify a collision as perfectly elastic, slightly inelastic, moderately inelastic, highly inelastic, or perfectly inelastic

Materials Needed:

4-5 types of balls(e.g. clay ball, marble, etc), 3 different surfaces (e.g., tiled, wood, concrete, grass)

Procedure:

1. Drop each ball from a distance of 1 meter onto the surface and record how high it bounces in meters (example: 0.46 meters).
2. Note whether the ball and surface showed perfectly elastic, or perfectly inelastic collision. Classify the collision as follows:

- If the ball bounces up by 1 meter, then the collision is perfectly elastic
- If the ball does not bounce up, the collision is perfectly inelastic.

4. Repeat steps 1, 2 and 3 for the twoother surfaces.

Data:

Table 9. Data on the Height of the Bounced Ball

Surface		Mass	Bounce (m)	Degree of Elasticity
A	Ball 1 ________________			
B				
C				
A	Ball 2 ________________			
B				
C				
A	Ball 3 ________________			
B				
C				
A	Ball 4 ________________			
B				
C				
A	Ball 5 ________________			
B				
C				

Q. Which ball is generally more elastic? Which surface is generally more elastic? Was there an elastic collision? Was there a perfectly inelastic collision?

Development and Demonstration of a Volleyball Team Drill

A Performance Task

Objective:

- Develop and demonstrate a fun 5-minute team drill that will apply projectile motion concepts and principles to the learning and development of three motor skills in volleyball.

Materials Needed:

Volleyball (required)
stop watch (required)
meter stick / tape meter
other materials selected by proposing team
written proposal

Procedure:

1. Conduct the group meeting and plan out the role of each member in thedevelopment of the volleyball drill proposal.

2. Select from the following volleyball skills (bump, set, underarm serve, blockingand spike) three motor skills which will be enhanced in the proposed team drill.

3. Develop together the mechanics of a five-minute drill in terms of:

   a) target motor skill,
   b) materials to be used,
   c) team or pair details,
   d) sequence and duration of drill movements,
   e) evaluation of skills test,
   f) safety precautions; and
   g) analysis and application of projectile motion concepts and principles,
   (Show playing area diagrams and computations for ranges, heights and time)

4. Get a space and try out your team's proposed drill sequence and movements.Make adjustments according to equipment/materials and ability. Make themodifications and

practice the final drill for presentation of proposal and demonstration of team drill the next session.

5. Write your group proposal.

Performance Task: Development and Demonstration of a Volleyball Team Drill

Goal:

Develop and demonstrate a 5-minute team drill that will apply projectile motion concepts and principles to the learning and development of three motor skills in volleyball.

Role:

You are a team of physical education teacher-coaches who conduct volleyball clinics under a youth sports program of the school. The program targets to entice students who are interested or are still learning volleyball to join the sports clinics while the trained volleyball student players may assist or officiate drill and lead up games geared towards the development of basic volleyball skills.

Situation:

The school's sports program suffered a mass promotion of ball game athletes who recently graduated. To speed up the promotion of renewed interest in ball game trainings and beef up the remaining number of ball players, the MAPEH teachers came up with the idea to conduct fun sports clinics using modified volleyball games, drills and lead up game plans. Starting next Friday, the drills will be used in the weekly sports clinics. This try outs will give coaches, varsity players and interested students an avenue to scout, mingle and develop volleyball skills with the others.

Product, Performance and Purpose:

You will develop, present and demonstrate a five-minute volleyball drill proposal that will apply projectile motion concepts and principles to the learning and development of three motor skill in volleyball.

Standards

The group proposes ways to enhance sports related to projectile motion.

Criteria for Success

The sports clinic participants will rate the proposed volleyball drill game based on the following criteria:

- Communication of Proposal
- Physics of Sports Justification
- Movement Composition
- Performance

Task Rubric for Development and Demonstration of a Volleyball Team Drill

Criterion	7-8	5-6	3-4	1-2
***Communication of Proposal**	The group communicated the ideas and explained concept applications clearly and effectively, and raised interesting questions on the developed drills.	The group communicated the clearly the ideas and explained effectively selected concept applications only.	The group communicated the ideas and concept applications clearly.	The group was able to present their ideas but not the concept applications.
*** Use of Physics Knowledge**	Uses techniques for 3 skills based on physics concepts and principles. Uses terms appropriately throughout the presentation.	Uses techniques for 2 skills based on physics concepts and principles. Uses terms appropriately in some parts of the presentation.	Uses techniques for 1 skill based on physics concepts and principles. Uses a term or two inconsistently during the presentation.	Unclear use of technique for skills based on physics concepts and principles. Uses terms inappropriately most of the presentation time.
Movement Composition	Creates a wide range of athletic moves that are appropriate to the demonstration of all three skills. The drill sequence shows a sophisticated use of space, time, level, force and flow.	Creates athletic moves that are appropriate to the demonstration of all two skills. The drill sequence shows a competent use of space, time, level, force and flow.	Selects some athletic moves appropriate to the demonstration of 1 or two skills. The drill sequence shows a simple use of space, time, level, force and flow.	Has some difficulty in creating moves appropriate to the demonstration of skills. The drill sequence is a simple use of space, time, level, force and flow.
Performance	The group performs with a high degree of precision, style, and energy. The group applies movement concepts and tactics, in a critical and effective manner.	The group performs with appropriate degree of precision, style, and energy. The group applies movement concepts and tactics appropriately.	The group performs with some energy and precision. The group applies some movement concepts and tactics appropriately.	The group performs with little energy and precision. The group shows awareness of movement concepts and tactics, but has difficulty applying.

***** These criteria must be assessed against a written proposal

Summative Assessment

1. If a freely falling ball is somehow equipped with a speedometer, by how much would its speed reading increase for every second?
   A. 0 m/s
   B. 9.8 m/s
   C. 10 m/s
   D. 20 m/s

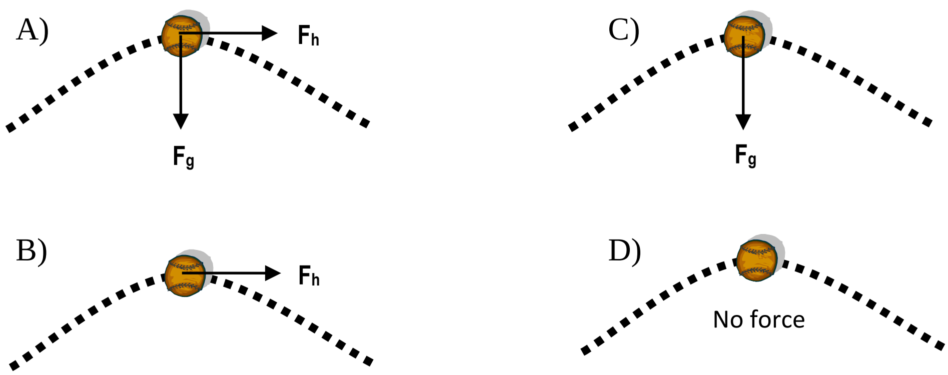
2. A sepaktakraw ball is hit vertically upward by a player. What is its acceleration after 1 second?
   a. 0
   b. 1 m/s^2
   c. 9.8 m/s^2
   d. -9.8m/s^2

3. A volleyball is tossed vertically upward, with an initial velocity of 5 m/s and caught back at the same level as when it was thrown. What is the velocity of the ball at that point?
   a. 0 m/s
   b. -5 m/s
   c. -9.8 m/s
   d. -9.8 m/s^2

4. The motion of an object with constant acceleration is also known as ________.
   a. Motion
   b. Uniform Motion
   c. Constant Motion
   d. Uniformly Accelerated Motion

5. A ball is thrown vertically upward. What is its instantaneous speed at its maximum height?
   a. 0
   b. 5 m/s
   c. 9.8 m/s
   d. 9.8 m/s^2

6. A fielder throws a softball to a baseman. Which diagram below shows the force(s) acting on the ball while it is on air if F_g represents the force of gravity, and F_h refers to the throwing force?



To the artist: Please redraw.

7. A ball is hit at an angle of 30°. At what point in its trajectory does this projectile have the least speed?
    a. Just after it was launched
    b. At the highest point in its flight
    c. Just before it hits the ground
    d. halfway between the ground and the highest point
8. Suppose a ping pong ball is tossed. When the ball reaches the highest point, which statement about the ball's velocity and acceleration is true?
    a. Both its velocity and its acceleration are zero
    b. Its velocity is zero and its acceleration is not zero
    c. Its velocity is not zero and its acceleration is zero.
    d. Neither its velocity nor its acceleration is zero.
9. At what angle should a water hose be aimed in order for the water to land with the greatest horizontal range?
    a. 0°
    b. 30°
    c. 45°
    d. 60°
10. A ball is hit at an angle of 30° and it reaches a distance of 50 m. Given the same initial velocity, at what other angle should a ball be hit to reach the same distance.
    a. 15°
    b. 45°
    c. 60°
    d. 75°.
11. Which has more momentum, a heavy truck moving at 30 km/h or a light truck moving at 30 km/h?
    a. heavy truck
    b. light truck
    c. Both have the same momentum
    d. Cannot be determined.

12. A moderate force will break an egg. However, an egg dropped on the road usually breaks, while one dropped on the grass usually doesn't break. This is because for the egg dropped on the grass:
    a. The change in momentum is greater.
    b. The change in momentum is less.
    c. The time interval for stopping is greater.
    d. The time interval for stopping is less.
13. The impulse experienced by a body is equal to the change in its:
    A. Velocity
    B. Kinetic energy
    C. Momentum
    D. Potential energy
14. In certain martial arts, people practice breaking a piece of wood with the side of their bare hand. Use your understanding of impulse to explain how this can be done without injury to the hand.
    a. Given the same change in momentum, when the time interval is smaller the impact force is bigger.
    b. Given the same change in momentum, when the time interval is bigger the impact force is bigger.
    c. Given the same change in momentum, when the time interval is smaller the impact force is smaller.
    d. Given the same change in momentum, when the time interval is bigger the impact force is smaller.
15. A lady tennis player hits an approaching ball with a force of 750 N If she hits the ball in 0.002 s, how much impulse is imparted to the tennis ball?
    a. 0 N s
    b. 1.5 N s
    c. 3.0 N s
    d. 6.0 Ns
16. Which is a necessary condition for the total momentum of a system to be conserved?
    A. Kinetic energy must not change.
    B. No external force is present.
    C. An object must be at rest.
    D. Only the force of gravity acts on the system.

For numbers 17 and 18: Two 0.5 kg balls approach each other with the same speed of 1.0 m/s.

17. What is the total momentum of the system before collision?
    A. 0
    B. 0.50 kg m/s
    C. 1.0 kg m/s
    D. -1.0 kg m/s

18. If there is no external force acting on the system, what the total momentum of the system after collision?
    A. 0
    B. 0.50 kg m/s
    C. 1.0 kg m/s
    D. -1.0 kg m/s
19. Two billiard balls approach each other at equal speed. If they collide in a perfectly elastic collision, what would be their velocities after collision?
    A. Zero
    B. Same in magnitude and direction
    C. Same in magnitude but opposite in direction
    D. Different in magnitude and opposite in direction

20. A 50-kg astronaut ejects 100 g of gas from his propulsion pistol at a velocity of 50 m/s. What is his resulting velocity?
    a. -0.10 m/s
    b. -0.50 m/s
    c. 0 m/s
    d. -100 m/s

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Suggested time allotment: 6-7 hours

Unit 4
MODULE
2

WORK, POWER, AND ENERGY

Overview

In Module 1, you studied about objects moving in two-dimensions. These moving objects possess momentum and experience impulses during interactions with other objects. Not only that, these objects also possess mechanical energy. On their own or during interactions, there are energy transfers and/or transformations.

In this module, the transformations of mechanical energy and its conservation will be studied conceptually and mathematically as applied in many natural events as well as in the working principles of man-made structures such as rides and electric power plants.

At the end of this module, you are expected to answer the following key questions below and use the learning competences as study guide:

What are the changes in the forms of mechanical energy?

How is mechanical energy conserved during transfers and transformations?

Learning Competencies / Objectives

1. Trace and explain the energy transformations in various activities.
2. Perform activities to demonstrate conservation of mechanical energy.
3. Ascertain that the total mechanical energy remains the same during any process.

Pre – Assessment / Diagnostic Assessment

Directions. Choose the letter of the best answer.

1. What is the energy of a motorcycle moving slowly at the top of a hill?
   A. entirely kinetic
   B. entirely potential
   C. entirely gravitational
   D. both kinetic and potential

2. Which event is explained in the sequence of energy changes shown in the diagram below?

Chemical Energy → Heat → Mechanical Energy (with wasted heat)

   A. a headlight is on
   B. a turbine spins
   C. electric current powers a flat iron
   D. gasoline burns to run a jeepney

3. In the Agus VI Hydroelectric Power (HEP) Plant, which energy transformation takes place?
   A. electrical energy → mechanical energy → electrical energy.
   B. gravitational potential energy → kinetic energy → electrical energy
   C. heat → mechanical energy → electrical energy.
   D. nuclear energy → heat → electrical energy

4. Which event does NOT describe potential energy being changed into kinetic energy?
   A. A box sliding down a ramp.
   B. A mango falling from a crate.
   C. A pen spring being compressed.
   D. A stretched rubber band got loosened.

5. Which event illustrates the direct transformation of potential to kinetic energy?
   A. A basketball player catches a flying ball.
   B. A Kalesa moves from rest.
   C. Kathy's arrow is released from its bow.
   D. The spring mechanism of a toy is rotated until it locked.

6. Which sequence of energy transformation best describes what happens when you switch on your battery-run radio?
   A. Mechanical Energy → Electrical Energy → Sound Energy
   B. Mechanical Energy → Chemical Energy → Sound Energy
   C. Chemical Energy → Electrical Energy → Sound Energy
   D. Chemical Energy → Mechanical Energy → Sound Energy

7. Which among the forms of energy is considered a potential energy?
   A. chemical energy
   B. radiant energy
   C. sound energy
   D. thermal energy

8. Which of the following happens to a coconut that falls freely?
   A. Loses potential energy and gains kinetic energy.
   B. Loses both potential energy and kinetic energy.
   C. Gains potential energy and loses kinetic energy.
   D. Gains both potential energy and kinetic energy.

9. A torchlight fell from a watch tower. The potential energy of the torchlight at the highest point compared to its kinetic energy at the lowest point is _______
   A. lesser.
   B. equal.
   C. greater.
   D. not related.

10. The potential energy of a 1-kg object on top of a hill is 18 J. What is its velocity in m/s just before it hits the bottom of the hill?
   A. 36
   B. 18
   C. 6
   D. 3

11. The total mechanical energy of a swinging bungee jumper
   A. is equally divided between kinetic energy and potential energy.
   B. at any one instant, is either all kinetic energy or all potential energy.
   C. can never be negative.
   D. is constant, if only conservative forces act.

12. A bag drops some distance and gains 90 J of kinetic energy. Considering air resistance, how much gravitational potential energy did the bag lose?
   A. more than 90 J
   B. exactly 90 J
   C. less than 90 J
   D. cannot be determined from the information given

13. The wind-up toy that is fully wound and at rest possesses
   A. kinetic but no potential energy
   B. potential but no kinetic energy
   C. both potential and kinetic energy in equal amounts
   D. neither potential nor kinetic energy

14. In which case is there a decrease in gravitational potential energy?
   A. Amada stretches horizontally a rubber band.
   B. A car ascends a steep parking ramp.
   C. Pamela's puppy jumps down the chair.
   D. Water is forced upward through a pipe.

15. A picture frame falls off the wall. Considering the presence of air, how does the kinetic energy (K) just before striking the floor compare to the potential energy (P) at its hanging point?
   A. K is equal to P.
   B. K is greater than P.
   C. K is less than P.
   D. It is impossible to tell.

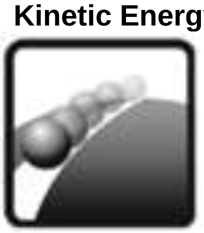
Mechanical Energy Rules! (*Of forms and transformations...*)

Pls. redesign

Energy is the name of the game. Everything exists or cease to exist because of its presence or absence. It is stored in different forms and can transfer and/or transform. It can be transferred without being transformed. It can also be transformed without being transferred. It can also be transformed during transfers.

In general, the energy acquired by objects upon which work is done is known as mechanical energy. You have learned in Grade 8 Science that mechanical energy fall under two categories:

Table 1. Different Forms of Mechanical Energy

Pls. redraw **A. Potential Energy** 	- Energy in matter due to arrangements of its parts, its composition, location and structure. It is commonly considered as a stored energy having the potential to do mechanical work. - The various forms of potential energy:  gravitational chemical elastic electrical nuclear
B. Kinetic Energy 	- Energy in moving matter and wave. - Some forms of kinetic energy:  motion radiant sound thermal wave

*Chemical, electrical and nuclear energies in general exhibit characteristics that are electromagnetic in nature...though they also have potential energy. (*Excerpt from the Encyclopedia Britannica)*

Recall in Grade 8 Science that mechanical work done when equated to changes in the mechanical energies resulted to operational definitions of kinetic and potential energy in the following equations:

Table 2. Mechanical Potential and Kinetic Energy Equations

Pls. redraw **A. Potential Energy** 	$PE_{grav} = mgh$ $PE_{elas} = \frac{1}{2}kx^2$	where PE_{grav} = gravitational potential energy m = mass of object g = acceleration due to gravity h = height or elevation difference where PE_{elas} = elastic potential energy k = spring constant x = compression or extension length
B. Kinetic Energy 	$KE = \frac{1}{2}mv^2$	where KE = kinetic energy m = mass of object v = velocity of object

Pls. redesign

ENERGY Transformations

The evidence and varied uses of the different energy forms is everywhere. Its flow causes change through heat and work.

Be it energy moving through the food chain or an electric power plant, energy can never be created from nothing nor can it be destroyed into nothing. Energy is simply transformed from one form to another or transferred from one system to another. It flows from a source (serving as input system) into an output system during transfers and/or transformations.

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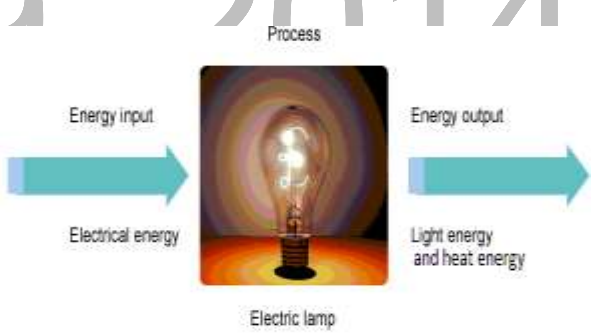

Figure 1. Energy transformation in a lit electric lamp.

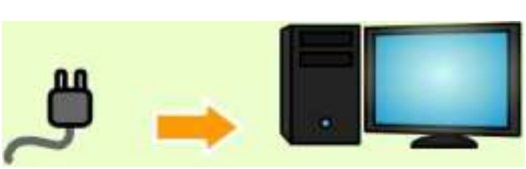

Figure 2. In a plugged television, electrical energy is converted into radiant, heat and sound energies.

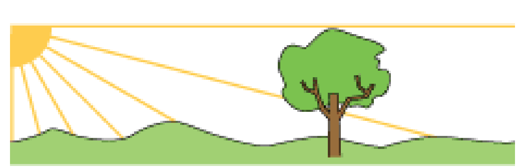

Figure 3. During photosynthesis, the sun's radiant energy is converted into chemical energy.

Study the examples of energy transformations that are shown in Figures 1-3. Use your understanding of the labeled illustrations as guide for doing Activity 1.

Activity 1
LITTLE SHOP OF TOYS

Objectives:

At the end of the activity, you should be able to:

- identify the energy forms present in the operation of simple toys, and
- describe the energy transformations in the toys.

Materials Needed:

yoyo
friction toy car
deflated balloon
2 mystery objects
Activity Sheet / science notebook

Procedure:

1. Operate each toy to move and observe closely what causes it to start and stop moving.
2. For each toy, identify all forms of energy involved in the process.
3. Trace the energy transformations by sketching and labeling the toy while in motion.
4. From inside the room, choose two objects/toys of interest to you. Do steps 1 to 3.
5. For each toy or object, answer the following questions:

Q1. What does the toy or object do?
Q2. What energy changes take place as this toy or object operates?
Q3. What form does the stored energy start out in?
Q4. What form does the stored energy turn into?
Q5. What form is the energy output in when it stops?
Q6. What made each object to move a certain displacement and what made each object to come to a stop?

Example: "Sipa" **(Pls. redraw)**

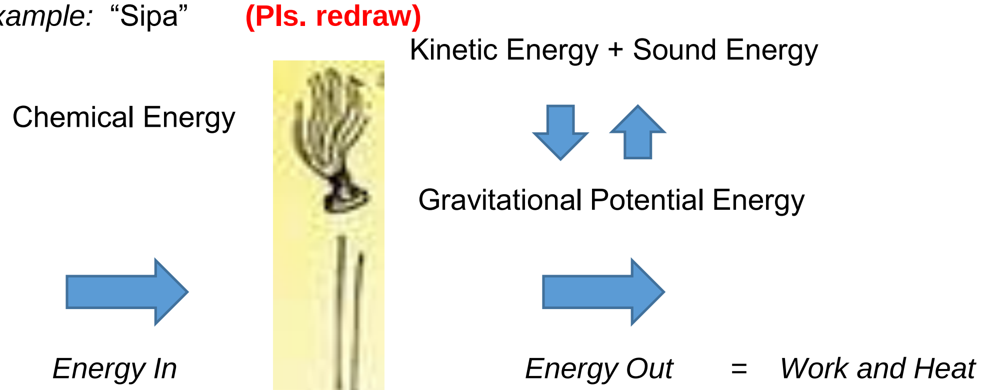

Figure 4. Energy transformations in the Filipino traditional game "sipa".

You just identified the different energy forms and its changes in simple toys. Toys can be simple, but the physics behind it can be quite complicated. Indeed when these energy got transferred or transformed, work and heat plus other energy forms like sound and light were produced. Some of these energy can also be stored in other forms. In general, when you made each toy or object to operate in the activity and set it to move then the physics behind the toys caused transformations of mechanical energies from potential to kinetic or from kinetic to potential.

Now ponder these questions. . . What are the similarities in the mechanical energy forms present in a stretched bowstring and in an elevated volume of water? What mechanical work can possibly be done by the transformations of these mechanical energies?

Think about your answers as you do the next activity.

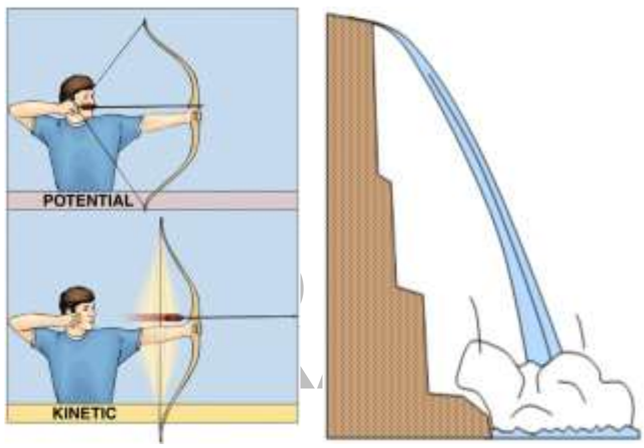

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Figure 5. Comparison of mechanical energy in a stretched bow and a waterfalls.

Activity 2
HEP HEP HOORAY!

(Adapted from the Energy of Moving Water Student Guide from www.NEED.org)

Objectives:

At the end of the activity, you should be able to:

- construct a simple turbine unit
- demonstrate mechanical energy transformations, and
- demonstrate Hydroelectric Power (HEP) using a water reservoir system.

Materials Needed:

plastic folder or acetate
permanent marker pen
ruler or tape measure
pair of scissors
cutter
juice drink straw
hot melt glue or super glue (cyanoacrylate adhesive)
masking tape

thread
5-10 pcs paper clips
2 1.5-Liter plastic bottle
1 push pin
3-inch nail
2 3-Liter ice cream container
2-Liter bottled tap water supply
hand towel or rag
funnel
activity sheet / science notebook

Safety Precautions:

- Danger of injury from the pair of scissors and cutter.
- Danger of eye or skin injury from glue
- Use of water container for collecting water.
- Use of towel or rag to dry off wet surfaces.
- Follow all safety lab rules.

Procedure:

A. Construction of the Turbine Model

1. Prepare 8 blades for the turbine. Cut 2 inch by 1 inch strips of plastic folder or acetate. Shape it any way you want.

Figure 6. a) shaped strips for turbine blades

2. Glue the blades to the middle of the straw similar to the sample in Fig. 6 b). The straw will serve as the shaft of the turbine.

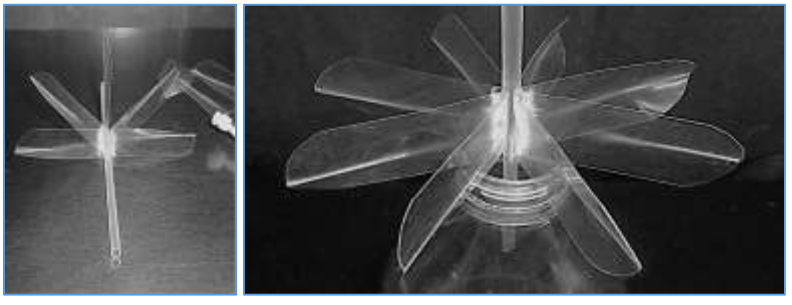


Figure 6. b) the turbine model blade assembly

3. Make a turbine holder using one of the plastic bottles. Use a push pin then a 3-in nail to make holes at a 10-cm height to hold the straw. Ensure that the turbine can rotate freely. If needed, make some plastic stopper to hold the turbine in place.

Figure 6. c) the turbine model on its mount

4. Tie a meter-long thread around the turbine shaft (straw). Secure the knot to the shaft with a tape. Loop the hanging end of the string and hook the paper clips on it.

5. Position the turbine model on a table with the hanging paper clips free to move.

Q1. Using the turbine model, what are some ways you can do to lift the hanging paper clips? Cite at least three methods.

Q2. For each method, what forms of energy will be involved in the process? Trace the transformations of energy.

Q3. In lifting the paper clips, how will you quantify and relate the work that you will do to the energy transformations involved?

6. Without needing other additional materials, try the methods you can right away do. This will also help you test the functionality and durability of your turbine model.

7. Reinforce the turbine holder or strengthen the blades with melted hot glue if needed. Adding the watery super glue may just loosen the already set bond between the blades and the straw.

8. Remove the string and the paper clips from the straw to have the turbine model ready for the Hydropower activity.

Figure 6. d) Testing the turbine model

B. Water Reservoir Model Construction

1. From the bottom of the bottle, measure and mark with dots the 5-cm, 10-cm, 15-cm, and 20-cm spots. These dots should lie along the same vertical line and would be the exit points. Acrosss these, make horizontal lines as tail water levels, h_t.
2. Use the push pin to make a hole on each dot. Then put masking tape over each hole. Fold the top as flap for pulling.
3. Make another horizontal line 5 centimeters above the 20-cm hole and mark as the head water level, h_w of the stored water.
4. Determine the stored water's Head of Flow, H by taking the difference between the head water level and the tail water level as indicated in the equation $H = h_w - h_t$. Record these values in Table 3.

   Q4. If you are to investigate the relationship between the stored water's *head of flow* (the height of the stored water above the exit point) and the projected water's *range* (the horizontal distance), what would your problem and hypothesis be?

Figure 7 a) Water Reservoir Model

   Suggested format of problem in question form:
      How does the *dependent variable* depend on the independent variable?

   Q5. What quantities will serve as the
      a) independent variable - manipulated to affect the dependent variable;
      b) dependent variable - will be affected thus measured; and
      c) parameter variable - controlled and kept constant?

5. Write your problem and hypothesis on your activity sheet.
6. Fill the bottle with water up to the 25-cm mark. Elevate this bottle on an inverted ice-cream container with its holed-side facing the other water container where the turbine model is.


Figure 7 b) water reservoir and turbine assembly, and Figure 7 c) range measurement

7. Line with masking tape the back of a ruler for easier readings. Use the ruler to measure the falling water's maximum range (horizontal distance between the bases of the hole and the point the projected water hits the blade).
8. Examine the water reservoir with the turbine model assembly and be familiar with its operation. Reposition the turbine when needed.

C. Mechanical Energy in Hydropower

1. Remove the masking tape from the 5-cm hole to release the water. Be ready to reposition the water turbine model such that the nearest blade hit by the projecting water is in the horizontal position. Cover the hole with your finger or with a tape when needed.
2. Measure the maximum range of the water and record this result in Table 3.
3. Uncover again the 5-cm hole and observe the projecting water as well as the movement of the turbine blades.
4. Cover again the 5-cm hole. Use the funnel and the bottled water supply to refill the water reservoir up to the 25-cm mark.
5. Repeat steps 1 to 4 for a total of three trials. Compute and record the average range.
6. Dry the wet surfaces and check the tape hole covers.
7. Follow steps 1 to 6 for the 10-cm, 15-cm, and 20-cm holes.
8. *Water conservation tip.* Reuse the water collected on the pan. Use the funnel to transfer water from the collecting container back into the water reservoir model or the water supply bottle.

Table 3. Effect of the Water's Head of Flow on the Water Range

head water level, h_w (cm)	**tail water level, h_t (cm)**	**Stored Water's Height or Head of Flow, H (cm)** *Equation: $H = h_w - h_t$*	**Range, R (cm)**			**Average Range, R_{ave} (cm)**
			Trial 1	Trial 2	Trial 3	
25.0	5.0	20.0				
25.0	10.0					
25.0	15.0					
25.0	20.0					

Q6. What mechanical energy transformations took place when water got projected out of the holes?

Q7. What was the effect of the stored water's head of flow to its range?

Q8. How would you explain this effect in terms of energy transformation?

Q9. In Question 4, you formulated your hypothesis regarding the effect of the stored water's height to the water's range. What was your hypothesis?

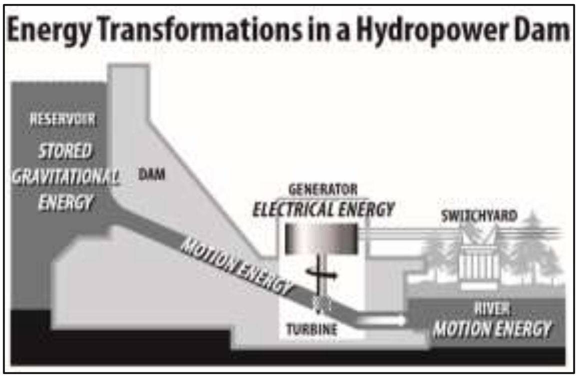
Q10. Was the hypothesis you made correct? Why or why not?

Q11. The data collected showed the effect of the head of flow on the flow range and not on the water's force that powers the blades to rotate. How would you relate the range to the water's force?

Q12. In the activity, the hydropower was to do mechanical work by rotating the blades. What can be done to make good use of the water's power?

Q13. In a typical actual Hydroelectric Power (HEP) Plant, the turbines are fixed and so the tail water level is constant (Refer to Figure 8). Only the head water level from the reservoir varies depending on the stored water. How would you modify this activity to model a real working HEP plant?

A typical Hydroelectric Power Plant has three main parts as shown below:



1) the water reservoir
2) the dam
3) the power plant
   (turbines and generators)

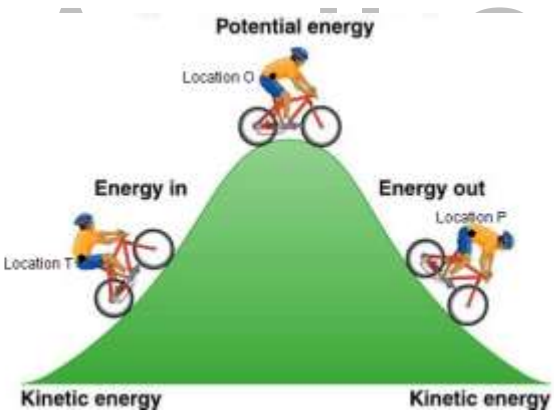
Just like the stretched bowstring and the elevated waterfalls, the stored water in the reservoir has potential energy. When water is made to flow down the penstock, the potential energy changes into kinetic energy.

Figure 8. Illustration on the main parts of a HEP Plant courtesy of www.NEED.org

The power of the rushing water spins the turbine, which in turn spins the coils of wire inside a ring of magnets, thus generating electricity. You will look into these in detail when you tackle electric power generation in Module 4.

But before that, your concern at this point is to master tracking mechanical energy transfers or transformations. Take note that a greater head means a higher drop. A higher drop leads to a faster flow. Why is this so?

On the other hand, a faster flow carries greater power, exerting a greater force in rotating the turbine. Does this mean that a greater mechanical work was done?



Move on to Lesson 2 to complete your understanding about work, power and energy. Hop on and prepare to have fun with amusement events and rides…

Refer to Fig. 9, Ponder this question: “How would you compare the total energy of the biker in locations T, O, and P?”

Figure 9. Biker’s mechanical energy **Pls. redraw**

Conservation of Mechanical Energy Reigns!

You learned in Module 1 that a body falling freely constantly increases its velocity. Its height therefore decreases quadratically from the point of release since it is falling faster and faster. You also learned in the previous discussion that mechanical energy depends on an object’s changing position and motion or the conversion between the object’s potential energy and kinetic energy.

Let us now examine what happens to the mechanical energy of a roller coaster from Figure 10 below. If the cart moves from positions H to O, the potential energy decreases since its height decreases. On the other hand, its speed increases as it moves down, thus its kinetic energy increases. From point O to P, it gains back its potential energy since it is moving up at higher elevation. In contrast, its kinetic energy decreases as it moves up because it slows down. This exchange of potential and kinetic energy is known as mechanical energy.

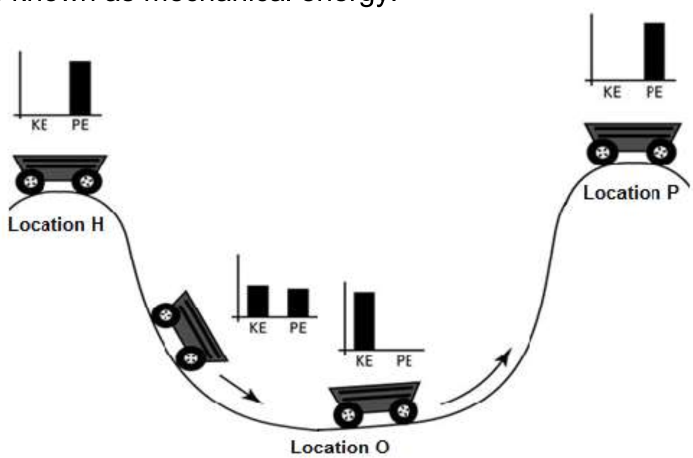


Figure 10. Conservation of Mechanical Energy in a Roller Coaster

Pls. redraw the figure

Well, at the top of the hill, the car is stationary, so as the car begins to move down the hill, the potential energy begins to be converted to kinetic energy. The car gathers speed until it reaches back on top of the other side of the hill and converts the gained kinetic energy back to potential energy.

Ignoring frictional force, the total mechanical energy, which is the sum of its kinetic and potential energies, remains constant at all points of the track. In equation form,

$$ME_1 = ME_2 = ME_3 = \ldots$$
$$PE_1 + KE_1 = PE_2 + KE_2 = PE_3 + KE_3 = \ldots$$

To confirm further the transformation between potential energy and kinetic energy, try the next activity.

Activity 1
Bashing Ball!

Objectives:

At the end of the activity, you should be able to:

- identify the positions where kinetic energy or potential energy is at maximum or minimum; and
- explain the result of the demonstration using conservation of energy.

Materials Needed:

bowling ball or basketball
rope
ceiling

Procedure:

1. Ask a custodian or a maintainance personnel to hang a bowling ball or a basketball using a mesh or a net from the ceiling. Make sure that the ceiling is stable and sturdy.
2. After the teacher demonstrates the activity, ask for a willing and brave volunteer from the class.
3. Have the student grab the ball and walk backwards carefully until the ball is level with his/her nose.
4. Ask the student to remain still as possible while holding the ball against the tip of his/her nose. Make sure the string is taut so the ball will swing smoothly and evenly when it is released.
5. Warn the student to keep his body still, especially the head. S/he should not move his/her head backward or forward.
6. Ask the student to release the ball without any additional push.

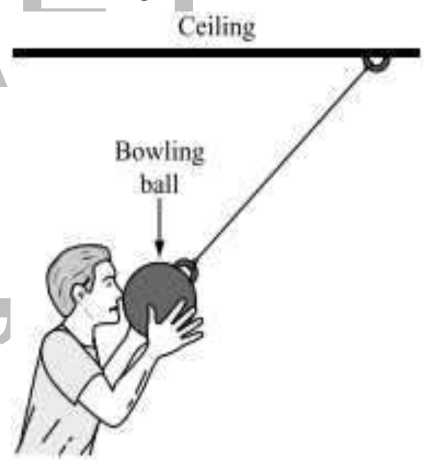


Figure 10. Giant Pendulum
Pls. redraw

7. Ask the other students to predict what will happen when the bowling ball is released and returns.

Q1. Did the bowling ball reach the tip of the nose of the student volunteer? Did it rise higher or lower than its original height?

Q2. At what location(s) along the path of the bowling ball is the ball's kinetic energy highest?

Q3. At what location(s) along the path of the bowling ball is the ball's gravitational potential energy highest?

From the activity, you identified the point where potential energy and kinetic energy is at its highest and lowest point. You are now ready to quantify or measure the potential and kinetic energy from these points.

Consider a 1-kg stone dropped on top of a hill and reached the ground after 3s. From your concept on free fall, the height of the hill can be computed using the formula

$$h = \frac{1}{2} a_g t^2 \text{ and } v_f = a_g t \text{ since } v_i = 0.$$

Now let us determine what happens to the free falling object's kinetic energy and potential energy.

At t = 0 s, the object is 44.1 m from the ground. Using the equations for Potential Energy, we have

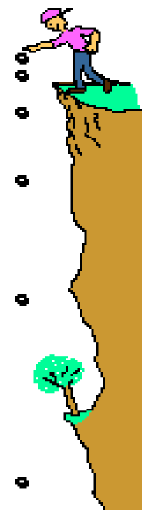


Figure 11. A dropped stone

$$\begin{aligned} PE &= mgh \\ &= (1\text{ kg})(9.8\text{ m/s}^2)(44.1\text{ m}) \\ &= 432.18\text{ J} \end{aligned}$$

The Kinetic Energy at t = 0 s is,

$$\begin{aligned} KE &= \tfrac{1}{2} mv^2 \\ &= \tfrac{1}{2}(1\text{kg})(0)^2 \\ &= 0 \end{aligned}$$

The Total Mechanical Energy of the free falling object at t = 0s is

$$\begin{aligned} TME &= PE + KE \\ &= 432.18 + 0 \\ &= 432.18\text{ J} \end{aligned}$$

At t = 1 s, the Potential Energy is,

$$PE = mgh$$
$$PE = (1\text{ kg})(9.8\text{ m/s}^2)(44.1\text{m} - 4.9\text{ m})$$
$$PE = (9.8\text{kg m/s}^2)(39.2\text{ m})$$
$$PE = 384.16\text{ J}$$

The Kinetic Energy at t = 1 s is,

$$KE = \tfrac{1}{2} mv^2$$
$$KE = \tfrac{1}{2}(1\text{ kg})(9.8\text{ m/s})^2$$
$$KE = 48.02\text{ J}$$

The Total Mechanical Energy is,

$$TME = PE + KE$$
$$TME = 384.16\ J + 48.02\ J$$
$$TME = 432.18\ J$$

Summarizing the answers in the table, you can see clearly the equivalence of the Total Mechanical Energy in every second.

Following the steps in getting the Kinetic Energy and Potential Energy for t = 0 s and t = 1 s, complete the table.

Table 4. Summary of the Mechanical Energy of a Free Falling Body

Time (s)	Height (m)	Velocity (m/s)	PE (J)	KE (J)	TME (PE + KE) J
0	44.1	0	432.18	0	432.18
1	39.2	9.8	384.16	48.02	432.18
2					
3					

You have observed that an object freely falling gains kinetic energy since its velocity increases constantly. On the other hand, its potential energy decreases since its height decreases. The increase in its kinetic energy comes from the lost in its potential energy. In the example of a 1- kg stone dropped from a hill, at t = 0, its stored energy which is the potential energy is not yet converted into kinetic energy. As the stone falls as in t = 1 s, the decrease in potential energy, 48.02, is equal to the increase in its kinetic energy. After 2 s, the amount of energy lost and gained by potential energy and kinetic energy respectively is still the same. At all points in its path, the change in its potential energy is equal to the change in its kinetic energy.

Activity 2
Bouncy Balls, Revisited

Objectives:

At the end of the activity, you should be able to:

- infer that the kinetic energy of a bouncing ball is not conserved

Materials:

three balls of different masses,
ruler or meter stick

Procedure:

1. Drop each ball from a height of your choice. Measure the height of the bounce of each ball. Perform three trials for each ball. Note how each ball bounces upon impact.
2. Record the heights in the table below.
3. Calculate the velocity of the ball just before it hits the ground and after it hits the ground.

   Q1. Which equation(s) can you use to calculate these velocities?

4. Calculate the kinetic energies of the ball just before it hits the ground and after it hits the ground.
5. Get the difference in the kinetic energies of the ball.

Table 5. Summary of the Mechanical Energy of a Free Falling Body

Ball	Mass of Ball, m (kg)	Initial Height, h_i (m)	Final Height, h_f (m)	Initial Velocity, v_i (m/s)	Rebound Velocity, v_f (m/s)	Initial Kinetic Energy, KE_i (J)	Rebound Kinetic Energy, KE_f (J)	Change in Kinetic Energy, ΔKE_f (J)
1								
2								
3								

Where v_i = velocity of the ball just before it hits the ground

V_f = Rebound velocity of the ball right after it hits the ground

KE_i = Kinetic Energy of the ball just after it hits the ground

KE_f = Kinetic Energy of the ball right after it hits the ground

Q2. What happens to the kinetic energy of the ball after its collision with the ground? What does this mean?

Summative Assessment

Directions. A. Choose the letter of the best answer.

1. What is the energy of a motorcycle going fast midway down a hill?
   A. entirely kinetic
   B. entirely potential
   C. entirely gravitational
   D. both kinetic and potential

2. Which event is explained in the sequence of energy changes shown in the diagram below?

Chemical Energy → Heat → Mechanical Energy (with wasted heat)

   A. a blue spotlight is on
   B. a runner doing stretches
   C. an electric fan rotates
   D. the battery-powered toy car runs forward

3. In the Agus VI Hydroelectric Power (HEP) Plant, which energy transformation takes place?
   A. electrical energy → mechanical energy → electrical energy.
   B. gravitational potential energy → kinetic energy → electrical energy
   C. heat → mechanical energy → electrical energy.
   D. nuclear energy → heat → electrical energy

4. Which events does NOT describe potential energy being changed into kinetic energy?
   A. A cart rolling down a hill.
   B. A rubber foam being compressed.
   C. A student lets go a stretched slinky.
   D. A twig falling from a branch.

5. Which event illustrates the direct transformation of potential to kinetic energy?
   A. A volleyball player blocks an incoming ball.
   B. A sleeping cow stirs awake.
   C. The wide-open spring door closes slowly.
   D. The spring of a broken toy shoots up.

6. Which sequence of energy transformation best describes what happens when you prepare scrambled egg using an egg beater?
   A. Mechanical Energy → Electrical Energy → Sound Energy
   B. Mechanical Energy → Chemical Energy + Sound Energy
   C. Chemical Energy → Mechanical Energy → Sound Energy
   D. Chemical Energy → Mechanical Energy + Sound Energy

7. Which among the objects is considered as having potential energy?
   A. ambulance siren
   B. candle flame
   C. hot plate
   D. milk

8. Which of the following happens to raindrops?
   A. Loses potential energy and gains kinetic energy.
   B. Loses both potential energy and kinetic energy.
   C. Gains potential energy and loses kinetic energy.
   D. Gains both potential energy and kinetic energy.

9. A runner jumps over a hurdle. Neglecting friction, the potential energy of the runner at the highest point compared to his kinetic energy at the lowest point is _____
   A. lesser.
   B. equal.
   C. greater.
   D. not related.

10. The potential energy of a 4-kg object on top of a hill is 72 J. What is its velocity in m/s just before it hits the ground?
   A. 36
   B. 18
   C. 6
   D. 3

11. The total mechanical energy of a yoyo
   A. is equally divided between kinetic energy and potential energy.
   B. at any one instant, is either all kinetic energy or all potential energy.
   C. can never be negative.
   D. is constant, if only conservative forces act.

12. A stone rolls down some distance and gains 45 J of kinetic energy. Considering air resistance, how much gravitational potential energy did the bag lose?
   A. more than 45 J
   B. exactly 45 J
   C. less than 45 J
   D. cannot be determined from the information given

13. A fully spring-wound toy fan that is about to rotate possesses
   A. kinetic but no potential energy
   B. potential but no kinetic energy
   C. both potential and kinetic energy in equal amounts
   D. neither potential nor kinetic energy

14. In which case is there an increase in gravitational potential energy?
 A. Alex stretches horizontally a rubber band.
 B. A car ascends a car wash ramp.
 C. The monkey-eating eagle swoops down from a tree.
 D. Water flows out a horizontal pipe.

15. A decorative stone fell off the fence. Considering the presence of air, how does the kinetic energy (K) of the stone just before striking the ground compare to its potential energy (U) on the fence?
 A. K is equal to U.
 B. K is greater than U.
 C. K is less than U.
 D. It is impossible to tell.

B. Solve the following problems.

1. A 2-kg toy car moves along a frictionless surface with a uniform speed of 6 m/s. What is its kinetic energy?

 A. 3.6 J
 B. 36 J
 C. 366 J
 D. 3660 J

2. Budoy, a junior high school student, lifts a 3-kg book from the floor into a cabinet 2.0 m high. With reference to the floor, how much potential energy does the book acquire?
 A. 5.88 J
 B. 58.88 J
 C. 588.88 J
 D. 5888.88 J

Synthesis

The activities in this module show you that the working principles of natural objects such as waterfalls and man-made devices from simple toys, to hydro-powered electric plants and amusement park rides all involve the use, transfer and transformation of different mechanical energies.

The concepts you learned from Module 1 on two-dimension motions and of momentum changes and its conservation are integrated here as you demonstrated the Law of Energy Conservation through the activities.

The constructed turbine device and water reservoir model your group constructed can also be used in the remaining modules 3 and 4 for this quarter. It would be best to keep these or modify for use later this quarter. With little modification, these can be used to show how heat energy can be converted to work. Moreover, it can also be used to show how mechanical energy from the turbine can be converted into electrical energy using a dynamo working in reverse. All of these are in store for you in the next two modules.

Glossary

Dam	-	barrier of a water storage structure that is used to control the stored water level and the release of the stored water
Head of water flow	-	difference of the head water level and the tail water level
Head water level	-	surface height of the stored water in the reservoir
Hydroelectric Power (HEP) Plant	-	A power plant that generates electrical energy using the energy from flowing water
Mechanical energy	-	energy acquired by objects upon which work is done
Penstock	-	close pipe or channel where the water flows from the water reservoir up to the water turbine's location
Tail water level	-	exit height of the water in the dam's penstock or the height where the turbines are located
Turbine	-	a rotating device with appropriately shaped blades used to convert the kinetic energy of moving fluids into mechanical power for energy generators

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Suggested time allotment: 5 hours

Unit 4

MODULE 3

HEAT, WORK and ENERGY

Overview:

Have you tried to heat a pot of tap water on a hot burner of a stove? It is observed that the water temperature increases. In this situation, heat flows from hot burner to the cold water. When two objects at different temperatures are put in contact, heat spontaneously flows from an object of high temperature to the object of low temperature. The natural flow of heat is always in the direction tending to equalize the temperature. If the two objects are kept in contact long enough for their temperatures to become equal, the two bodies are said to be in thermal equilibrium, and there is no further heat flow between them. Let us take for example, when you have a fever. You will use fever thermometer in your armpit in able to monitor your temperature. Heat is flowing from your armpit to the thermometer; when the temperature reading stops increasing, the thermometer is then in equilibrium with your armpit, and they are at the same temperature.

These are frequent questions when studying heat and work:

How is heat converted to work?

How is work related to energy?

Learning Competencies/ Objectives

1. demonstrate that heat can be turned to work;
2. infer that doing work can release heat;
3. explain how heat transfer energy

Diagnostic Assessment:

Multiple Choice: Choose the letter of the best answer.

1. Francis stretched a rubber band five times. After that, he observed that the rubber band felt warmth. Did the rubber band gain heat?

A. No, it is not evident.
B. Yes, the rubber band felt warmth means it gained heat
C. Yes, the rubber band felt warmth means it loss heat.
D. No, temperature is not related to a gain or loss of heat.

For nos.2-4

(to the artist, please provide 4 beakers with water, the 1st two with half-filled water; the 2nd two full with water)

Label them as:

- Beaker I, half-filled with water on hot plate for 2.5 minutes
- Beaker II, half-filled with water on hot plate for10minutes
- Beaker III, full of water on hot plate for 5 minutes
- Beaker IV, full of wateron hot plate for2.5 minutes

Four identical beakers, I,II,III,IV are placed on a large electrical hotplate. I and II are half-full and III and IV are full of tap water at the same initial temperature. I and IV are placed on the hot plate for 2.5minutes, III is left on for 5minutes, and II is left on 10minutes. The water does not boil in any of the beakers.

2.Which one of the bakers of water will receive the most heat? B.

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

3.Which one of the beakers of water will have the lowest temperature right after being heated? D

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

4.Which two beakers of water will have almost the same final temperature after being heated? B

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

5.What is commonly used as refrigerant for most of the refrigerators?

A. Liquid that is easy to solidify.
B. Liquid that is hard to solidify.
C. Gas that is easy to liquefy.
D. Gas that is hard to liquefy.

Part B.

Modified True or False. Study each statement. Write True if it is correct and if not, change the underline word/s to make it true.

6.Heat engine is any device that <u>converts</u> thermal energy into mechanical work.

7.In every heat engine, <u>all</u> of the heat can be converted into work.

8.Mechanical work takes place in the <u>piston</u> of a gasoline engine.

9.There is no ideal heat engine, making some heat <u>exhaust</u> in the environment.

10.<u>Thermal pollution</u> is brought about by the accumulated exhaustion of heat from diesel, gasoline and industrial engines.

Heat and Work

This module focuses on heat and work. It aims to explain how heat can be turned into work and how doing work releases heat. It discusses on the spontaneous processes where heat flows from an object of higher temperature to an object of lower temperature. Furthermore, how heat engines functions, specifically, car's engine is given emphasis. It tackles also how heat pump operates. Efficiency of heat engines is discussed through some worded problems and its effects to the environment. Thermal pollution is explained as a result of rise in temperature of bodies of water that is detrimental to aquatic animals and is caused by the disposal of heated industrial waste water. Being aware of the disadvantages of less efficient heat engines, we could design ways and means to lessen its effects.

In your grade 7, it is learned that heat is related to temperature. Heat transfer may change one's temperature or one's phase. This change in temperature, either a decrease or an increase means that there is an energy transfer in the form of heat. On the other hand, phase change means that there is a change in body's internal energy

We will be focusing only on the adiabatic or no heat enters or leaves the system.

Reading Resources: (Heat has been discussed in grade 7 and in grade 8)

The concept of the conservation of energy states that: *Energy cannot be created or destroyed.* The first law of thermodynamics is actually based on this concept. It states that: *The change in internal energy of a system equals the difference between the heat taken in by the system and the work done by the system.* **Internal energy** of a substance is the sum of molecular kinetic energy (due to the random motion of the molecules), the molecular potential energy (due to forces that act between the atoms of a molecule and between the molecules), and other kinds of molecular energy.

When heat flows in instances where the work done is negligible, the internal energy of the hot substance decreases and the internal energy of the cold substance increases. While heat may originate in the internal energy supply of a substance, *it is not correct to say that a substance contains heat.* The substance has internal energy, not heat. The word "heat" is used only when referring to the energy actually in transit from hot to cold.

The law is expressed as

$$\Delta U = Q - W$$

where Q = the amount of heat flowing into a system during a given process
W = the net work done by the system
ΔU = the change in the system's internal energy

This is derived from the conservation of energy given as how heat is related to work? Or how heat is related to work?

$$Q = W + \Delta U$$

We will use *Joule (J)* as our SI unit for energy. The first law tells us that a system's internal energy can be changed by transferring energy by either work, heat or a combination of the two.

Let us find out how heat is converted into work or work is converted into heat.

Activity 1
Heat and Internal Energy

Objective:

The learners will demonstrate how heat causes the internal energy of the water increase.

Materials:

Pot
Thermometer
500ml of water
stove

Procedure:

1. Put 500ml of water into a pot.
2. Place a pot of water into a stove. Measure the temperature of water.
3. Let it boil. Measure its temperature while boiling and after boiling.

TAK
E

Be extra cautious in handling very hot substances.

Temperature before boiling (°C)	Temperature while boiling (°C)	Temperature after boiling (°C)

Guide Questions

Q1.Compare the temperature of water before it is boiled, while it is boiling, and after it has boiled.

.

Q2.What does the increase in temperature indicate?

Now that you have seen that heat can cause the internal energy of the water increase, let us study a sample problem below:

Sample problem:

If 150J of energy is added to a system when no external work was done, by how much will the thermal energy of the system raised?

Given: Q= 150J
W= 0

Find: U

Solution:

U= Q- W
= 150J- 0
= **150 J**

Try this:

A 120J of energy is added to a system that does 40J of external work, by how much thermal energy of the system is raised?

Summary:

1. The increase in the internal energy of a system is equal to the amount of heat added to a system minus the work done by the system.
2. **Adiabatic process** is a process without gain or loss of heat.
3. **Internal/ thermal energy** is the sum of all kinetic and potential energies of the atoms/ molecules in the system.

Heat Pump

An object with a high temperature is said to be hot, and the word “hot” brings to mind the word “heat.” Heat flows from a hotter object to a cooler object when the two objects are placed in contact. It is for this reason that a pot of chocolate drink feels hot to the touch, while the scoop of an ice cream feels cold. The temperature of hot chocolate is higher than the normal body temperature of 37°C, while the temperature of an ice cream is lower than 37°C. When you touch a cup of hot chocolate drink, heat flows the hotter cup into a cooler hand. When you touch a cone of ice cream, heat again flows from hot to cold, in this case from the warmer hand into a colder cone. The response of the nerves in the hand to the arrival or departure of heat prompts the brain to identify the cup of chocolate drink as being hot and the cone of an ice cream as being cold.

How can we do the reverse? A ***heat pump*** is used to reverse the process. It is a device that allows heat to transfer from a cold reservoir to a warmer one, which cannot happen spontaneously, or on its own. Work is required for the heat to flow from a lower to a higher temperature. This work is provided by the motor of a heat pump. Let us find out how this process takes place. You have learned from activity 1 that non-spontaneous process needs a heat pump in order to reverse the process. Mechanical work should be applied so that heat could be transformed.

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Reading Resources and Instructional Activities

Heat flows normally from higher temperature to lower temperature. It is a natural or ***spontaneous process****.* It does not require any external energy to occur. When heat flows from lower temperature to higher temperature, it needs mechanical energy to happen. It is called ***non-spontaneous process***. In so doing, work should be done. Mechanical energy is required for this to happen. The *Second Law of Thermodynamics* is applied here. It states that **Heat will never of itself flow from a cold temperature to a hot temperature object.** The work is provided by the motor of the *heat pump*.

Let us perform the following activity to find out how.

Activity 2
Where do I belong?

Objective:

The learners should be able to distinguish the process as spontaneous or non-spontaneous process.

Materials Needed:

Illustrations/ pictures of

a. Drying of leaves
b. Breakage of an egg
c. Spoilage of food
d. Cooling of water
e. Waterfall
f. Rice cooking

Figure 1(to the artist, pls. provide pictures/ illustrations of the six examples above)

Procedure:

1. Study the illustrations given.
2. From the illustrations above, fill in the table like this

Spontaneous Process	Non-spontaneous Process	Needs work to reverse the process

Guide Questions:

Q1.Which of them are spontaneous processes?

Q2.How can we reverse the process for each of the following:

a. Drying of leaves to making them fresh again
b. Fixing an eggshell to make it whole

c. Keeping the food fresh from spoilage
d. Heating of water
e. Flowing the water back to the top

Q3.What is needed to reverse the process?

Now that we have known that every non-spontaneous process needs work or mechanical energy in able to make it happen, it is about time for us to find out how heat pump functions.

Activity 3
The Reverse of It

Objectives:

The learners should be able to discuss how heat pumps (refrigerator and air conditioner) work.

Materials Needed:

Illustrations of refrigeration and air conditioning cycle

Refrigeration cooling cycle

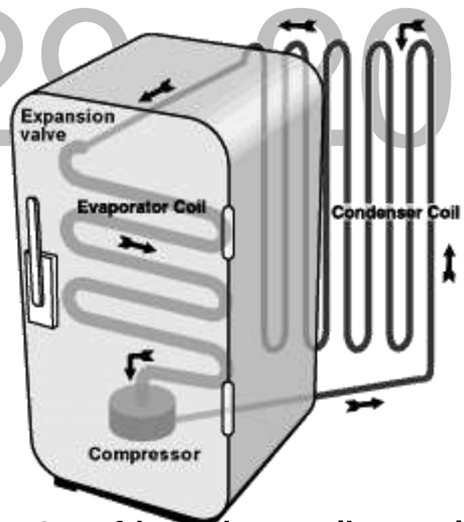

Figure 2. Refrigeration cooling cycle

Illustration of a refrigeration cooling cycle (to the artist, please redraw the ff. figure)

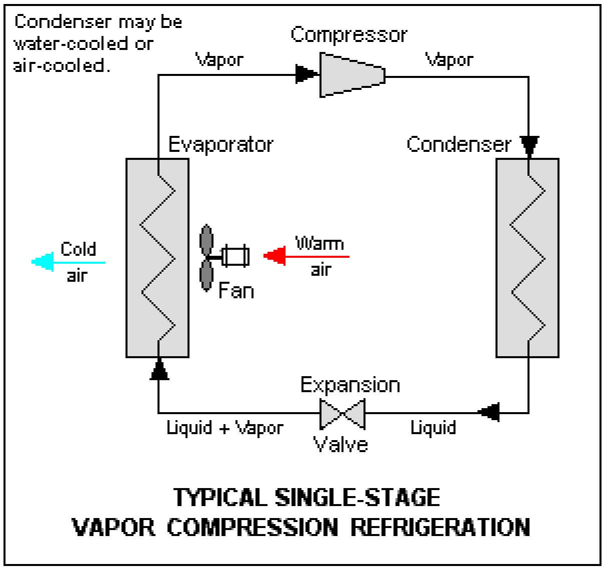

Figure 3. Refrigeration Cycle

Procedure:

Study the illustrations and their parts.

Guide Questions:

Q1. How refrigerator works?

Q2.Describe a compressor. How does it work? What gas is inside the compressor which has low boiling point?

Q3.What happened to the hot gas produced by compression?

Q4.How condenser functions?

Q5.What happens to the pressure and heat in the evaporator?

Q6.When does the cycle repeat?

Q7.Discuss the complete cycle of how refrigerator works.

A. How the air conditioner works?

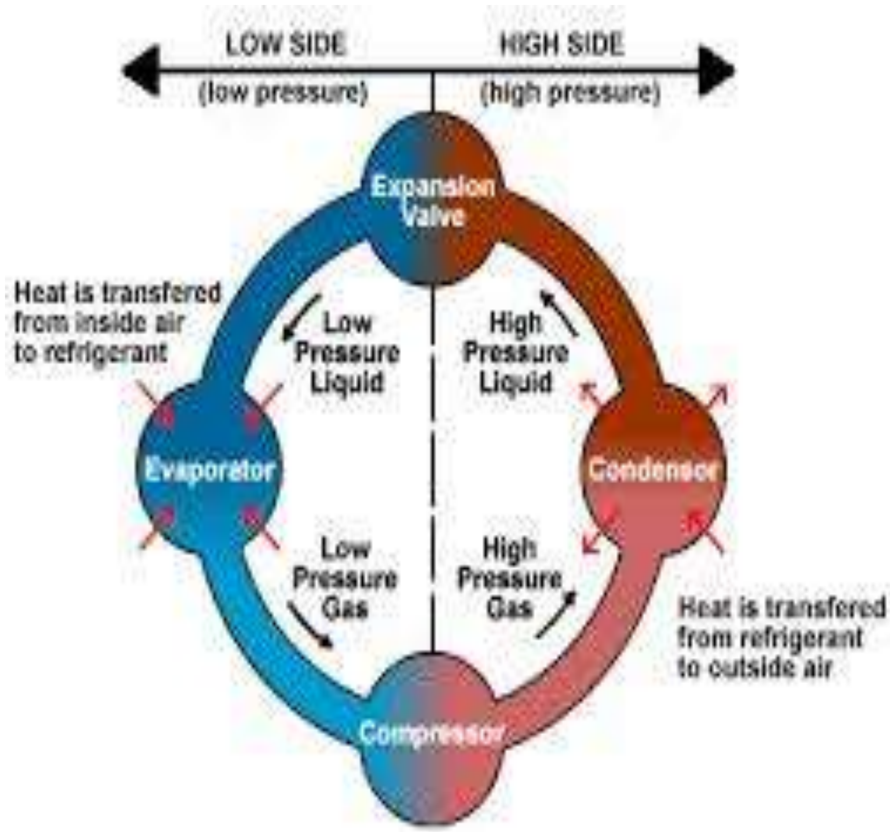

Figure 4. An air conditioning cooling cycle

Q8.What is the function of an air conditioning unit?

Q9.How air conditioning unit works during summer?

Q10.What is the function of the air conditioner during cold days?

Q11.What is needed to transfer heat in this device?

Summary:

1. Heat flows normally from higher temperature to lower temperature which is ***spontaneous process***. It does not require any external energy to occur.
2. ***Non-spontaneous process*** happens when heat flows from lower temperature to higher temperature. It needs mechanical energy to occur.
3. The *Second Law of Thermodynamics* states that **Heat will never of itself flow from a cold temperature to a hot temperature object**. Hence, heat pump is used.
4. A *heat pump* is a device that reverses the direction of the heat flow: from a cold reservoir to a warmer one. Refrigerator and air conditioning unit are examples of heat pump.

Heat Engines

Work can be easily transformed into heat. It is very evident when doing work. All the work we do in overcoming friction is completely changed to heat. Example, eating (which is a method of work due to tearing and chewing food particles) can be completely converted into heat (which is the product of mechanical and chemical combustion and absorption of nutrients occurred in the digestive system). Reversing the process is impossible such as changing heat completely into work. To make it possible, we have to convert some heat to mechanical work. This would happen only using *heat engines*. *Heat engine* is a device that changes thermal energy into mechanical work. How does it happen? What implication this will bring to the environment?

Reading Resources and Instructional Activities

A device that changes thermal energy into mechanical work is a *heat engine.* A heat engine consists of a gas confined by a piston in a chamber. If the gas is heated, it expands, making the piston moves. A practical engine is operated through cycles; the piston has to move back and forth. When the gas has heated, the piston moves up. When it is cooled, the piston moves downward. A cycle of heating and cooling will move the piston up and down.

A very important component of heat engines, then, is that two temperatures are involved. At one cycle, the system is heated, at another, it is cooled.

Three things happen in a full cycle of a heat engine:

1. Heat is added. It is an input heat (Q_H) which is relatively high temperature.
2. Some of the energy from that input heat is used to do work (W).
3. The rest of the heat is removed at a relatively cold temperature (Q_C).

Let us find out the four cycle- stroke of a gasoline engine in the activity below.

Activity 4
Start the Engine!

Objective:

After the activity, the learners should be able to discuss the four-cycle stroke of a gasoline engine.

Materials Needed:

Illustration of four-cycle stroke

Procedure:

1. Study the illustration.

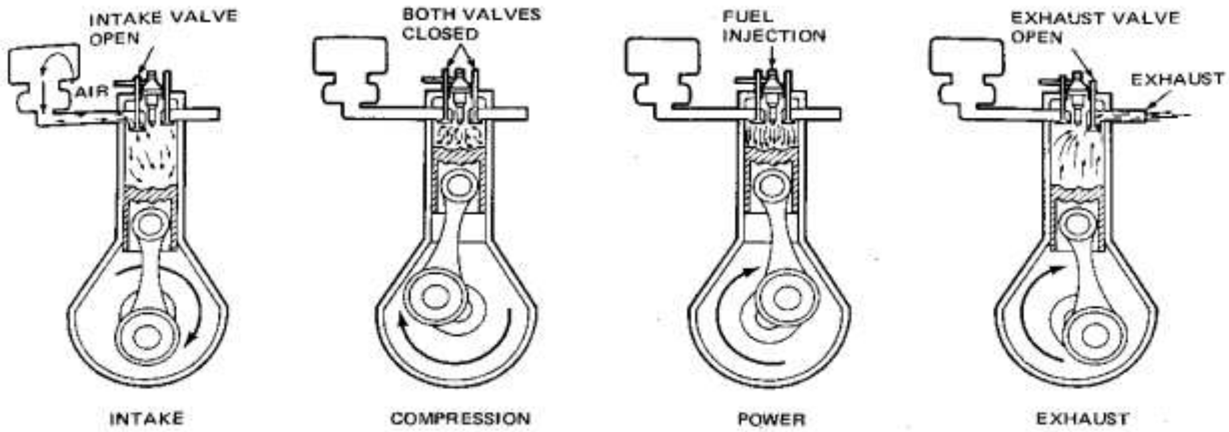

Figure 5. The four cycle-stroke of gasoline engine (to the artist, please redraw)

2. Fill in the table

.

Cycle stroke	**Movement of the piston**	**What happened to mixture of gases?**
Intake		
Compression		
Power		
Exhaust		

Guide Questions:

Q1.What happens to the gas if it is heated inside the engine's cylinder?

.

Q2.What happens to the piston and the gases during compression stroke?

Q3.What is the function of the spark plug? What is its effect to the mixture's temperature?

.

Q4.Describe the piston and the gases during power stroke.

Q5.In exhaust stroke, what happens to the piston and the mixture of gases?

Q6.What do you think is the effect of this exhaust gas into the environment?

Q7.Can we consider heat engine 100% efficient? Why?

Q8.As a student, how can you help to minimize the effects of thermal pollution?

In our activity, it is shown that there are four cycle-stroke in a gasoline engine. In the *intake stroke*, the inlet valve opens, the piston moves down as the fuel-air mixture fills in the cylinder. In *compression stroke*, the piston moves up and compresses the mixture---adiabatically, since no heat transfer happens. The spark plug ignites the mixture making its temperature high. Adiabatic process tends to push the piston down, thus it is called *power stroke*. In *exhaust stroke*, the burned gases are pushed out of the exhaust valve. The intake valve once again opens and the cycle repeats.

Thermal Efficiency

`It was thought before the full understanding of the second law of thermodynamics that at very low friction heat engine could convert nearly all the input energy into useful work. It was then that Sadi Carnot carefully studied the compression and expansion cycles.

How well a machine operates is the ratio of the useful work done to the heat provided is the *thermal efficiency*. Applying Conservation of Energy, $Q_H = W + Q_C$

An important measure of a heat engine is its efficiency: how much of the input energy ends up doing useful work? The efficiency is calculated as a fraction (although it is stated as a percentage).

$$\text{Efficiency} = \frac{Work\ done}{Input\ heat} = \frac{W}{Q\mathrm{H}}$$

Work is just the input heat minus the exhaust heat, so

$$\text{Efficiency} = \frac{QH - QC}{QH} = 1 - \frac{QC}{QH}$$

where:

Q_C = energy removed byheat/energy in cold reservoir

Q_H = energy added by heat/energy in hot reservoir

T_C = absolute temperature in cold reservoir

T_H = absolute temperature in hot reservoir

Note: The temperatures are the absolute temperatures on the Kelvin scale.

Studying our equation, we can only have a 100% efficiency if there is no energy transferred away from the engine by heat. But in reality, there is no 100% efficient engine. There will be other losses (to friction, for example) that will reduce the efficiency.

Sample Problem 1

What is the efficiency of a gasoline engines that receives 192.75J of energy from combustion and lose 125.25 J by heat to exhaust during one cycle?
Given: Q_C= 125.25 J
Q_H = 192.75 J
Find: Efficiency
Solution:

$$\text{Efficiency} = 1 - \frac{Q_C}{Q_H} \times 100\%$$

$$= 1 - \frac{125.25\ \text{J}}{195.75\ \text{J}} \times 100\%$$

Efficiency = 0.36 or 36%

Sample problem 2

Suppose a steam engine receives steam at 600K. The engine uses part of this thermal energy for work. It exhausts the rest to a condenser at a temperature of 350K. What is the maximum efficiency of this steam engine?
Given: T_C = 350K
T_H = 600K
Find: Efficiency
Solution: $\text{Efficiency} = 1 - \frac{T_C}{T_H} \times 100\%$

$$= 1 - \frac{350\text{K}}{600\text{K}} \times 100\%$$

Efficiency= 41.67%

Activity 5
Fill me In

Objective:

The learners should be able to verify that machines are not 100% efficient.

Materials Needed:
calculator

Procedure:
1. Study the table below.
2. Using the equation learned and with the aid of the calculator, solve for the unknown quantity.
3. Supply the table with the final answer obtained from the computation to show the relationship existing among thermal efficiency, temperature/energy in hot reservoir and temperature/ energy in cold reservoir.

Temperature/ energy in cold reservoir	Temperature/ energy in hot reservoir	Thermal efficiency
250K	500K	
230K	700K	
287.5K	575K	
650J	1054J	
259J	677J	
30°C	88°C	
56°C	92°C	
47°C	56°C	
77°C	93°C	
65°C	85°C	

Guide Question:

Q1. What are the factors to thermal efficiency? How each factor affects thermal efficiency?

Summary:
1. The **total kinetic and potential energy** of all its particles **is the internal energy** of a body**.**
2. The internal energy of a body increases when a) its temperature increases and b) it changes from solid to liquid or from liquid to gas.
3. **Heat** is the energy transferred from one body to another as a result of a temperature difference.

4. **Heating** is the process in which heat is transferred from one body to another as a result of a temperature difference.
5. By doing **work** or by **heating**, internal energy can be increased.
6. **Joule (J)** is the unit to express internal energy.
7. ***Heat engine*** is a device that changes thermal energy into mechanical work.
8. **Internal combustion engines** are engines that combustion takes place inside the engine chamber. Examples are gasoline, diesel engine and our human body. **External combustion engines** are engines where the fuel combustion takes place outside the engine. Steam, piston engine and the atmosphere are examples of external combustion engine.
9. **Thermal Pollution**of the air can affect the weather; thermal pollution of water can be harmful to aquatic animals.

In the next module, heat engines will be used to run a power plant like in geothermal power plant.

Summative Assessment:

Multiple Choice: Write the letter of the correct answer.

1. The internal energy of a system is initially 35J. The system does 34J of work. What is the system's final internal energy when a total of 46J of energy is added to the system by heat?
A. 47J B.26J C.37J D.36J

2.While a gas does 400J of work on its surroundings, 900J of heat is added to the gas. What is the change in the internal energy of the gas?
A. 500J B.400J C. 900J D.300J

3.If 500calories of heat are added to a gas, and the gas expands doing 500J of work on its surroundings, what is the change in the internal energy of the gas?
A. 1555J B. 5915J C. 5159J D.1595J

For numbers 4-5, consider this situation:
A beaker containing 400g of water has 1200J of work done on it by stirring and 200cal of heat added to it from a hot plate.

4.What is the change in the internal energy of the water in joules?
A.2038J B.3028J C.2308J D.3820J

5.Determine the change in the internal energy of the water in calories?

A. 684calories B.486calories C.648calories D.846calories

6.An ideal gas is compressed without allowing any heat to flow into or out of the gas.What will happen to the temperature of the gas in this process?

A.The temperature increases since no heat flows during the process.
B. The temperature decreases since heat flows during the process.
C. The temperature remains the same since heat flows in and out on the process.
D. The temperature could not be determined since heat is absorbed during the process.

7. Is it possible to change the temperature of a glass of water by stirring the water, even though the glass is insulated from its surroundings?

A.No, stirring will not affect the temperature of the water.
B.No, insulation prevents the change of temperature of the water.
C. Yes, stirring the water increases its internal energy causing the increase of its temperature.
D. Yes, stirring the water decreases its internal energy causing the decrease of its temperature.

8..MangFermin, a carpenter, is planing a piece of wood with his planar. After how many minutes, he observed that it is hot. What is the evidence that there is heat transfer?

A. It is not evident.
B. Hotness means there is an increase in thetemperature.
C. Yes, hotness means there is a decrease in the temperature
D. No, hotness is not related to a change in temperature

9.How doescan water from the deep well move upward?

A. It occurs naturally.
B.It uses waterheat pump.
C. It is a spontaneous process.
D.It flows from higher temperature to cooler temperature.

10.Given the following mechanisms, which best describes correct sequence of the refrigeration cycle?

1. compression 3.expansion
2. condensation 4. Evaporation

A. 1,2,3,4 B. 2,3,4,1 C. 3,4,1,2 D.4, 3,1,2

11. How canair conditioning unit functions as heater during cold days and cooler during hot days?

1. It cools the inside of the house and heats the outside.
2. It takes heat from the air outside to warm the inside.

A. 1 only B. 2 only C. 1 and 2 only D. None of them

12.What is the function of a heat engine?

A. It converts chemical energy to mechanical energy.
B. It converts thermal energy to mechanical energy.
C. It converts mechanical energy to chemical energy.
D. It converts thermal energy into chemical energy.

13.What is the correct sequence of four cycle-stroke of gasoline engine?

1. Intake
2. Power
3. Exhaust
4. Compression

A. 1,2,3,4
B. 1,4,2,3
C. 2,3,4,1
D. 1, 3,4,2

14.Why is heat engine not 100% efficient?

A. Because all mixture of gases is converted into work.
B.Because engine needs to be cooled down.
C.All of the gases are used up by the engine.
D. Some of the gases is taken up in the piston.

.

15..What causes thermal pollution?

A. Exhaust of different vehicles.
B. Exhaust from different industrial engines.
C.Degradation of water.
D. All of them

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UPNISMED Teacher's Guide

Suggested time allotment: 9 hours

Unit 4
MODULE
4

ELECTRICITY AND MAGNETISM

Overview

In Grade 8, you learned about the relationship among the three basic electrical quantities – electric current, voltage and resistance. You were tasked to construct simple electric circuits that led to your understanding of Ohm's Law and you were able to apply it to everyday situations. Your teacher also led the class in discussing safety precautions in order to avoid electrical hazards such as short circuits through proper electrical connections and proper grounding.

In this module, you will discover sources of energy and how electricity is generated from power plants. You will be able to trace the path of electrical energy transmission and distribution from the source, to your homes, and calculate the cost of your energy consumption. This relevant information would help you in understanding your own electrical energy usage and lead you to think of ways on how to conserve electrical energy at home and in school.

At the end of module 4, you will be able to answer the following questions:

1. How is electricity generated in power plants?
2. How is electricity transmitted in cables / wires?
3. How is electricity distributed in houses in order to supply power to appliances?
4. How is the cost of electrical energy consumption computed?

Learning Competencies/ Objectives

1. Describe energy transformation in electrical power plants.

2. Describe the energy transmission and distribution from a power station to the community.
3. Describe how electric power is measured.
4. Calculate the electrical energy usage.

Pre-Assessment

Direction: Choose the letter of the best answer.

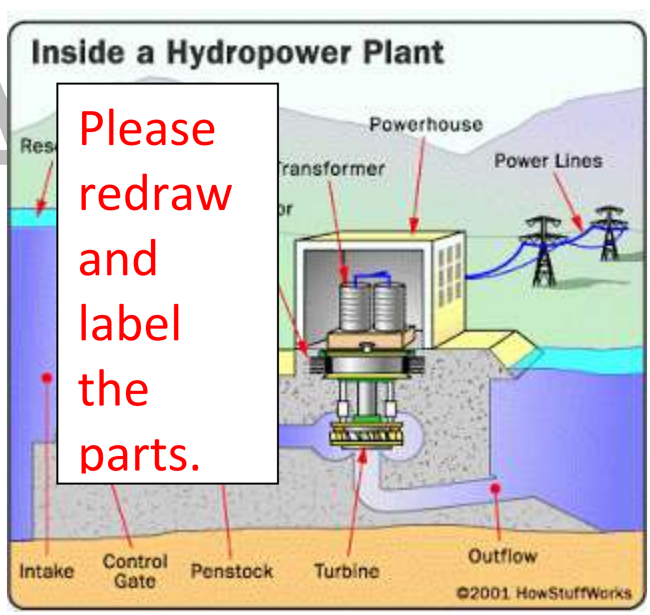
1. In which of the following units is electrical consumption measured by electric companies four our household consumption in our homes?
    a. kilowatt
    b. volt
    c. megawatt
    d. kilowatt hour
2. In power stations generating electricity, power is measured in _________.
    a. joule
    b. kilojoule
    c. kilowatt
    d. megawatt
3. Why do power stations generate AC, and not DC?
    a. It is easier to generate, safer and more economical to transmit AC than DC.
    b. Transformers work with AC.
    c. AC is used in mobile devices and gadgets.
    d. AC is more efficient and economical.
4. Transformers are used to raise the voltage along substations and lower it for residential consumption. What kind of transformers is used to raise the voltage?
    a. Step-up
    b. Step-down
    c. Neither of the two.
    d. Both.
5. Shayne turned on a lamp switch in her room. Which of the following is the correct path of electrical power that can be traced back to the source?
    a. power plant → transmission substations → distribution substations → residences
    b. transmission substations → power plants → residences → distribution substations
    c. residences → distribution substations → power plants → transmission substations
    d. distribution substations → transmission substations → power plants → residences

6. Who among the following scientists discovered the relationship between electricity and magnetism?
    a. Andrei Marie Ampere
    b. Michael Faraday
    c. Hans Christian Oersted
    d. Alessandro Volta

7. You made an electric motor in school. When you tested it in using 4 dry cells, the armature turned very fast. What should you do to make it turn slower?
    a. use a bigger magnet
    b. remove one of the dry cells
    c. increase the number of turns in the coil of wire
    d. decrease the distance between the magnetic poles
8. What energy transformation takes place in a generator?
    a. electrical to mechanical   c. mechanical to electrical
    b. heat to mechanical   d. chemical to mechanical
9. In which case will electric current be induced in a coil of wire?
    a. when it is connected to a galvanometer
    b. when a magnet is held stationary inside the coil
    c. when a magnet is rapidly inserted into and out of the coil
    d. when a magnetic compass is held beside it
10. If a 100 W light bulb is lit for 8 hours each day for 20 days in a month. How many kilowatt-hours will the bulb consume?
    a. 16   b. 160   c. 1600   d.16000

How is electricity produced?

Electricity powers all our gadgets and appliances at home. Have you ever wondered how electricity reaches us from the electric power plant? What processes does electricity have to go through in order to reach us at home?



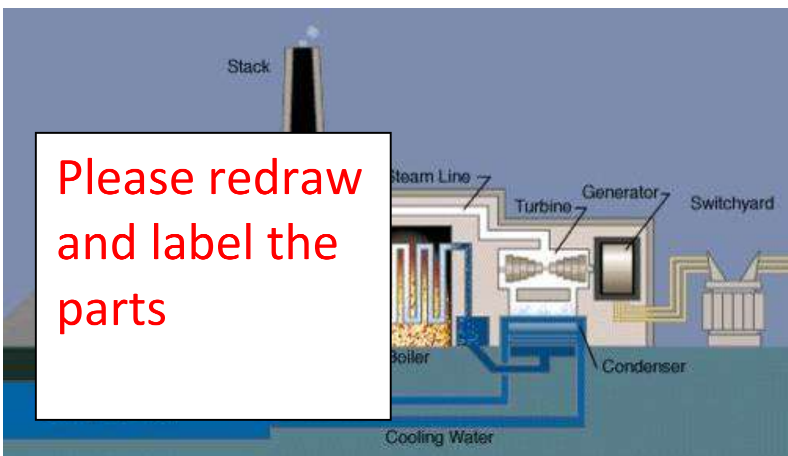
ropower Plant

Various sources of energy are utilized to provide electricity to power our households. For example, the tremendous energy produced by falling water is used by water turbines to rotate large generators at a hydroelectric power plant.

As the water falls from the reservoir, its kinetic energy increases and it flows very fast. The falling stream of water turns a fan-like device called a turbine, which is connected to the generator's shaft.

The rotation of the shaft turns powerful electromagnets that are surrounded by the coil of copper wires. The coil is connected to a step-up transformer that sends high-voltage current to power lines.

Other sources of energy at power plants include steam from burning fossil fuels, nuclear reactions, wind and ocean tides. Each source provides the energy of motion to turbines then to the generators, producing electrical energy. Power plants, in general, use generators to convert kinetic energy into electrical energy. One specific source, however, uses solar panels made of photovoltaic cells to convert sunlight into electrical energy instead of turbines. Can you explain how other power plants work?



Activity 1 It's more "Power" in the Philippines

Objectives:

After performing this activity, you should be able to:

- identify the location of some power plants in the Philippine map;
- determine the Region in which the power plant belongs;

Materials Needed:

Pictures of power plants in the Philippines
Philippine map
Magnets or pins

Procedure:

1. Using the Philippine map, identify the location of power plants based on the tabulation below.
2. Write the region of the power plant's location on the space provided in the table.
3. Pin the pictures of the power plants on the map.
4. Fill in additional sources and types of power plants available in your communities and supply the needed information. Also, cut-out pictures of these power plants and pin them on the Philippine map.

Name	Type	Source	Location	Operational?	Region
Agus 1	**Hydroelectric**	**Water**	**Maria Cristina Falls, Iligan City**	**Yes**	
Calaca Thermal Plant	**Thermal**	**Coal**	**Calaca, Batangas**	**Yes**	
Tiwi Plant	**Geothermal**	**Earth's Interior**	**Tiwi, Albay**	**Yes**	
Bohol Diesel Plant	**Diesel-Power**	**Fossil Fuel**	**Dampas, Tagbilaran City**	**Yes**	
Bataan Plant	**Nuclear**	**Nuclear Fuel**	**Bataan**	**No**	

Photos: http://www.napocor.gov.ph/

Agus 1 Hydroelectric Plant

Calaca Coal-Fired Plant

Tiwi Geothermal Plant

Bohol Diesel – Powered Plant

Bataan Nuclear Power Plant

Figure 3. Different Power Plants

Please redraw

Guide Questions:

Q1. Where is your place of residence?

Q2. What source of energy is nearest your place?

Q3. What electric power plants are present in your area?

Q4. Identify the location of these plants on the Philippine map.

How is electricity transmitted and distributed?

From the power plants, electricity is then made to travel along cables and wires called transmission lines. Transmission lines are commonly put up between transmission substations which are regulated by the National Power Corporation. Transmission lines may either be constructed overhead on towers or they may be underground. They are operated at high voltages, send out large amounts of electrical power and extend over considerable distances.

From the generating station, the transmission substations step up the voltage to a range of 138,000 – 765,000 volts. Within the operating area, transmission substations reduce (step down) the transmitted voltage to 34,500 – 138,000 volts. This power is then carried through lines to the distribution systems located in the local service area.

The distribution system connects the transmission system to the customer's household. MERALCO is in charge of electrical energy distribution in Metro Manila. The distribution substations further step down the voltage to 2,400 – 19, 920 volts. A step-down transformer further reduces the voltage to 220 V – the standard AC voltage in the Philippines. This voltage powers most of the electrical appliances we have at home.

Can you identify the different stages of power generation, transmission and distribution?

Let's try this simple activity:

.

Activity 2
Tracing Power

Objectives:

After performing this activity, you should be able to:

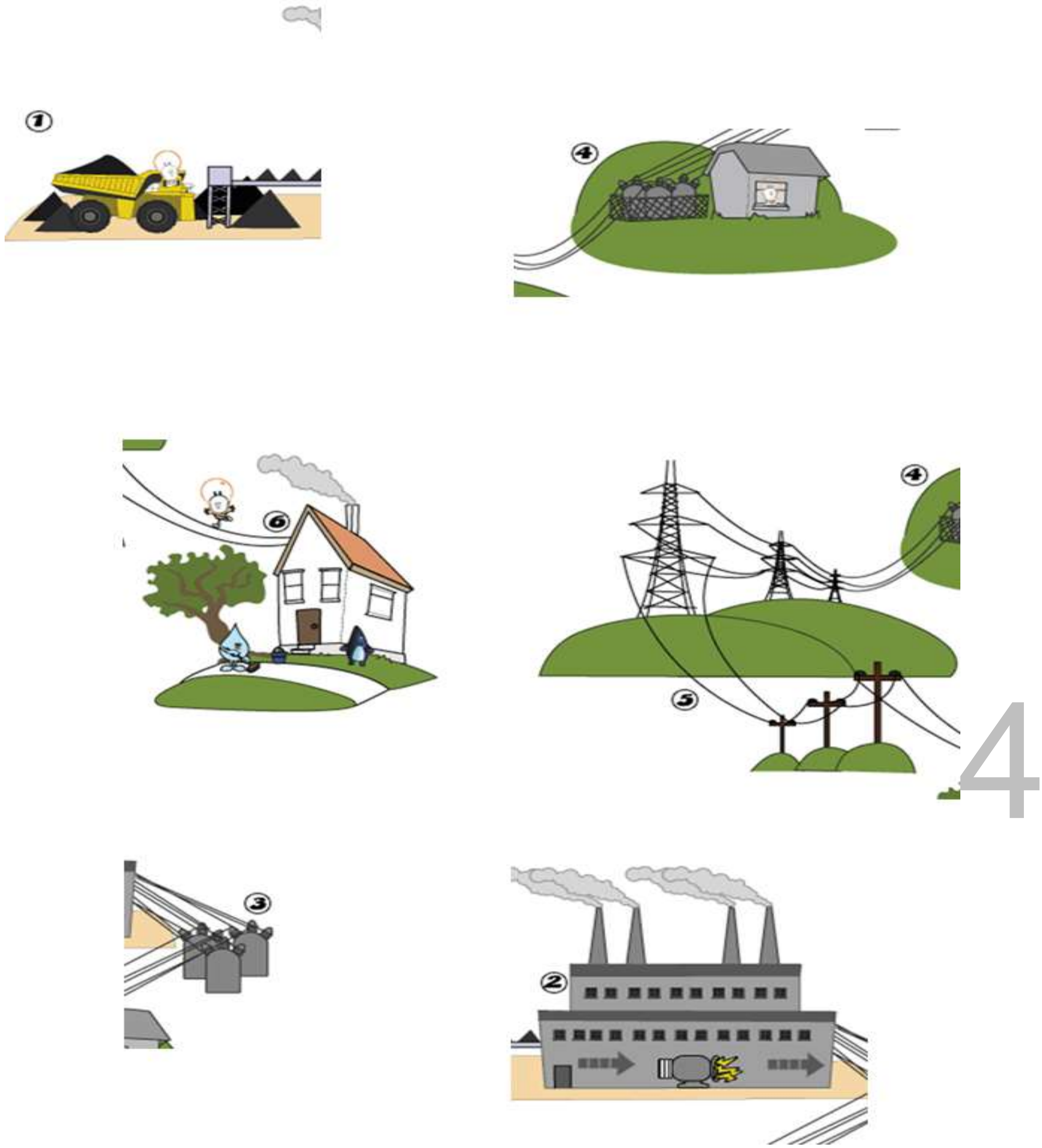
- Trace the path of electricity from the generating station, transmission station and residential areas.
- Differentiate between a step-up transformer and a step-down transformer.
- Identify specific areas where step-up transformers and step-down transformers are utilized.

Materials Needed:

Enlarged pictures of power transmission components
Concept strips

Procedure:

1. Obtain from your science teacher an enlarged copy of the pictures in this Learner's Manual found on page _____.
2. Carefully analyze the pictures and assign one picture to each member of the group.
3. Match the descriptions to the pictures by laying them on top of the table. The first group to finish wins.



To the artist: Please draw similar graphics.

Figure 5. Power Transmission Stations

Match the descriptions to the correct illustrations:

A The electric current then runs through the power lines to the substation transformer where voltage is lowered to between 2000 and 13000 volts.

D Electricity flows from the power plant through wires to the step up transformer. The transformer raises the voltage so it can travel long distances – its raised as high as 756,000 volts.

B The steam powers a turbine which spins a huge magnet inside a copper wire. Heat energy converts to mechanical energy which then converts to electrical energy in the generator.

E Electricity is then taken through the lines to a pole transformer – or a transformer box if underground – and voltage is lowered again to between 120 and 240 volts.

C Steam is generated at the electricity plant by the burning of fossil fuels – or at a nuclear or hydroelectric plant.

F From here electricity comes into your home through a service box, where your meter is located to measure how much you use. Wires take electricity around your home powering your lights and all your other appliances

Guide Questions:

abQ1. What are the different stations in the transmission of energy?

Q2. What do you notice about the size of the transmission lines as it reaches the consumers?

Q3. Does the size of wires and cables used matter in energy transmission?.

Q4. What happens to the voltage that travels from the source to the consumers?

Q5. What are step-up transformers? Step-down transformers?

Performance Task: Diorama Making

A diorama is a three-dimensional miniature or life-size scene in which figures, stuffed wildlife, or other objects are arranged in a naturalistic setting against a painted background

As a group, design and build a diorama that would show the path of electric power from generation, transmission and distribution. Apply what you have learned in the previous activity and stay as factual as possible. Use materials that can be easily obtained from your home and in your communtity. Recycled materials are always welcome. Pay attention to details and make your representations drawn to scale. Your teacher will give you the exact dimensions you will need for your project. Happy project making!

To the Artist : Please look for a similar photo showing diorama with transmission lines, houses, generating stations, etc.

Criteria for rating Diorama Diorama Rubric

Category	4	3	2	1
Appearance of the Project (15%)	The project's appearance is professional and polished without distractive elements.	The project's appearance is quite professional and polished few distractive elements.	The project's appearance is somewhat poor. Some distractive elements.	The project's appearance is quite poor. Many distractive elements.
Content Facts (20%)	The project content is exemplary and suggests the student has discovered the important ideas of his / her topic.	The project content is good and suggests the student has discovered most of the important facts of his/her topic.	The project content is fair/poor and suggests the student has not discovered most of the important facts.	The project content is poor and suggests the student has not done sufficient research.
Images & Models (15%)	All images or models are effective.	All images or models are effective, but there appear to be too few or too many.	Some images or models are effective.	Too few images or models are used to be an effective presentation.

Style & Organization (10%)	Display is interesting and attractive. Materials are complete and organized to present the ideas well.	Display is interesting and attractive. Materials are complete and well organized. Presentation has sequence and plan evident.	Some parts of the display are interesting, not tidy. Some materials are complete and organized. Presentation has some sequence and plan evident.	Display is uninteresting, not tidy. Materials are incomplete and not organized. Presentation has no sequence or plan evident.
Creativity & Appearance (10%)	Project is excellently presented reflecting creativity and a lot of thought.	Good creative effort. Project is neat and shows evidence of time spent on it.	Some attempt made to add color and originality. Project is neat.	Little attempt to add color or originality. Project has sloppy appearance.
Knowledge (30%)	The diorama demonstrates a thorough knowledge of the subject investigated.	The diorama demonstrates good knowledge of the subject investigated.	The diorama demonstrates some knowledge of the subject investigated.	The diorama demonstrates very little knowledge of the subject investigated.

Adapted from:
http://www.lausd.k12.ca.us/Allesandro_EL/docs%20and%20temps/Diorama%20rubric.pdf

How is the cost of electrical energy consumption computed?

Calculating Energy Use

Do you know that you can calculate your electric bill? But before that, let us know the basis for calculating your electric bill. One of the factors to be consider is the power rating of your appliance. By the way, what is power?

You learned in Grade 8 the three electrical basic quantities which are current, voltage, and resistance. Multiplying the voltage and current is equal to power. For instance, the power rating of an appliance depends on both the voltage and current. The formula in finding power (in watts) is written below.

$$P = VI$$

where: P = Power (Watts)
V = Voltage (Volts)
I = Current (Amperes)

For example, an electric fan draws 5-A current from a 220-V outlet, its power input is 1,100 W. For one appliance, the power rating is large in number, so the unit used for combined power rating in a household is in kilowatt (kW) which is equal to

1000 watts. All of the appliances in a household may have a combined power rating, that is why, energy is usually computed based on the time of usage of the appliances.

To get the total energy used by an appliance in an hour, multiply the power consumption by the one hour as in the formula below:

$$E = Pt$$

where: E = Energy used (kWh)
P = Power, (W)
T = Time (s)

Figure 6: An analog electric meter
Photo credit: Ms. Maria Amparo R. Ventura

The unit of measurement for energy usage is kilowatt-hour (kWh) which is one kilowatt of power for a period of one hour. For example, the reading in the analog meter in Figure 1 shows that the customer has used almost 8000kWh, 7796 kWh to be exact, while the reading in the digital meter of another customer is exactly 40.608 kWh. To find how much energy you used in one month, your last month's reading is subtracted from the total.

Try to solve the following sample problems in calculating energy cost.

Figure 7: A digital electric meter
Photo credit: Dave Angeles

Sample Problem:

1. All of the computers in the ICT room are in use for 5 hours every day and together use 8.3 kW. How much energy is used in a day?

   Given: $P = 8.3\ kW$
   $T = 5\ h$
   Find: Energy used

   $$E = Pt$$
   $$= (8.3\ kW)(5h)$$
   $$E = 41.5\ kWh$$

2. How much does it cost to operate a 400 W television for 8 hours if electrical energy costs 6.88 pesos per kWh (includes both generation and distribution charges - Meralco rate as of January, 2014) ?

   Find: cost to operate

   $$E = Pt$$
   $$= (0.400\ kW)(8\ h)$$
   $$E = 3.2\ kWh$$

   $$Cost = (3.2\ kWh)\ (6.88\ pesos/kWh)$$
   $$= 22.02\ pesos$$

Try to examine the sample billing statement in Figure 8, the total energy consumed for a month is 419 kWh. This means that the company charges 4.36 pesos/kWh as seen in the Generation charge which is 1,827.01. But why did the company charged a total of 4321.31 to the consumer. As seen in the billing summary, the company enumerates other fees to be paid.

Billing Info

Bill Date	: 29Oct 2010
Billing Period	: 29Sep 2010 to 29Oct 2010
Due Date	: 07 NOV 2010
Total kWh	: 419
Total Current Amount	: P 4,321.35
Other Unpaid Bill/s	: P 5,233.90
TOTAL Amount Due	: P 9,555.25

Billing Summary

BILL SUBGROUP	SUBTOTAL	PERCENTAGE
Generation	1,827.01	42.3%
Transmission	408.53	9.5%
System Loss	227.73	5.3%
Distribution (Meralco)	1,367.00	31.6%
Subsidies	60.42	1.4%
Government Taxes	410.59	9.5%
Universal Charges	20.07	0.5%
Other Charges	0.00	0.0%
Total	4,321.35	100.0%

Source: http://www.meralco.com.ph

Figure 8: Sample electric billing information and summary

Take Home Task:

Can you think of some ways on how we can save on electrical energy consumption? List down at least 3 energy-saving tips for each appliance:

a. Washing machine
b. Refrigerator
c. Clothes Iron
d. Lights and lamps
e. Electric Fans
f. Television

How does magnetism produce electricity?

Electricity from magnetism

How do electrical power plants produce electricity? In the previous discussions, we learned that most energy sources such as coal, oil, diesel, heat from the earth's interior are used to make turbines work, which are then connected to a device called a generator which converts mechanical energy to electrical energy.

In the next activity, we will learn how generators in these power plants are able to produce electricity.

Activity 3
Light me up!

Objectives:

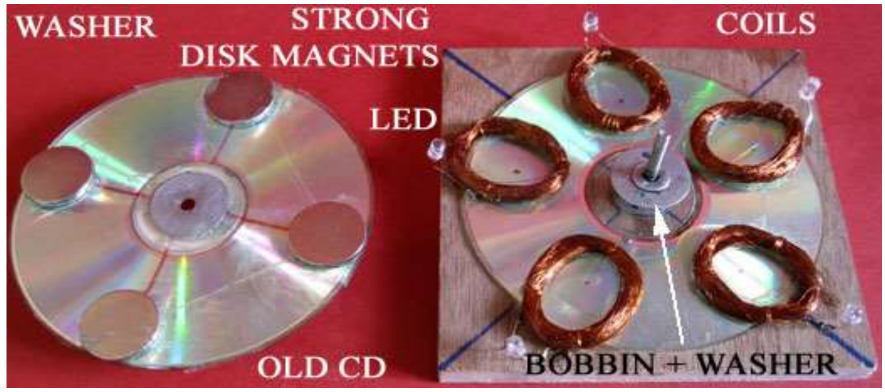
- Build a model of a simple electric generator
- Discuss how electricity is generated from the interaction between coils and magnets
- Relate the motion of a simple electric generator to the motion of an actual generator being used in a real-life electric power plant

Materials Needed:

2 old discarded compact discs
Round disc magnets
Copper wire
LEDs
Glue
Toothpaste cap
Wooden stand
2-3 inch wood Screw

Procedure:

1. Fasten a 2-3 inches wood screw in the middle of a wooden board. Using glue, attach the disc magnets to the cd and arrange them as seen in the figure.



2. Make 500 turns of copper wire by winding it around a small circular barrel. Scrape the ends of the insulation and connect a light emitting diode (LED). Attach the copper coils to the base cd. Attach disc magnets on the other cd as shown below.

3. Place a sewing machine bobbin / washer in the center of the cd.

4. Attach a toothpaste cap on top of the magnet cd and secure it on top of the copper coil cd as shown. Let the cd turn around on its axis to produce light in the LED.

Figure 9. Activity Set-up

Guide Questions:

Q1. Why did the LED light up when the magnet cd was made to turn around the axis?

Q2. Why was it possible to produce electricity without an energy source?

Q3. In electric power plants, turbines are actually connected to generators which are composed of magnets and coils. How do turbines produce electricity?

Electric generators are devices which convert mechanical energy to electrical energy. This is possible due to the interaction between a changing magnetic field and a conductor inside the generator assembly. A steady magnet and a conductor at rest cannot produce electric current. Either the magnet or the conductor should be in motion in order to induce current. Michael Faraday is known for his work on electricity and magnetism in 1821 using an iron ring – coil apparatus. His work paved the way for more advanced discoveries on electromagnetism. For now, we will limit our discussion on the relationship between magnetism and electricity. This concept will be further explained in Grade 10

Summative Assessment:

Direction: Choose the letter of the best answer.

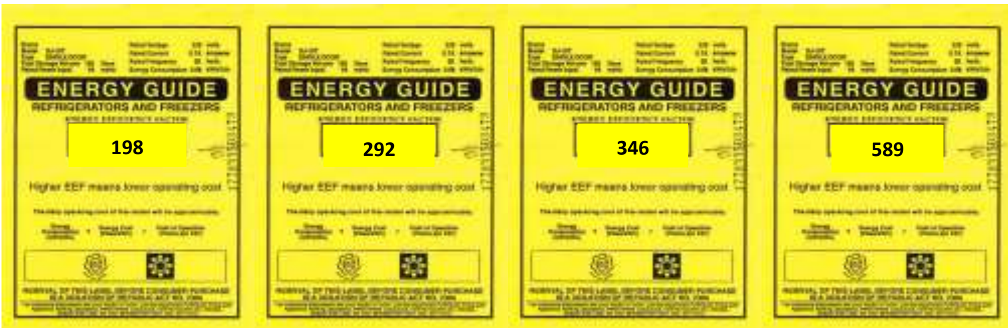
1. Last month, Ms. Alcantara's electric meter reads 8765 kWh. How much will she pay for power generation if the charge of electric company per kWh is 6.88 pesos and her electric meter reads 9975 this month?

A. ₱ 8765.00
B. ₱ 8324.80
C. ₱ 1210.00
D. ₱ 3457.42

2. Jaypeth paid ₱1250.00 for electric bill. How much energy (in kWh) is consumed if the electric company charges ₱6.88/kWh?

A. 186.81
B. 181.69
C. 188.61
D. 181.86

3. In buying an appliance, which of the following efficiency guide would you consider? Why



A B C D

4. How is the energy efficiency ratio (EEF) related to the operating cost?
   a. the higher the EEF, the higher the operating cost
   b. the higher the EEF, the lower the operating cost
   c. the lower the EEF, the higher the operating cost
   d. the lower the EEF, the lower the operating cost

5. Gemma wanted to improve the lighting condition of her room by buying a lamp. What suggestions can you give her and why?
   a. Buy an incandescent bulb because it gives off more light.
   b. Buy a compact fluorescent lamp (CFL) or LED lamp because it is more energy efficient.
   c. Buy a fluorescent lamp because it is brighter than an incandescent bulb.
   d. Buy an incandescent bulb because it is cheaper.

6. A 60 watt bulb is connected to 120V plug. What is the current in the lighted bulb?
   a. 0.25 A b. 0.5 A c. 2 A d. 4 A

7. To reduce your electric bill
   a. make use of limited appliances
   b. put off appliances when not in use
   c. put off main switch during the day
   d. connect appliances in series

8. What is produced if the magnet and the conductor move relative to each other?
   a. voltage b. magnetic field c. resistance d. current

9. When there is a change in the magnetic field in a closed loop of wire,
   a. a voltage is induced in the wire.
   b. current is made to flow in the loop of wire.
   c. electromagnetic induction occurs.
   d. all of these

10. All of the following power plants use steam to drive the turbines to produce electricity except
a. hydropower b. geothermal c. coal-fired d. nuclear

Take Home Task:

Can you think of some ways on how we can save on electrical energy consumption? List down at least 3 energy-saving tips for each appliance:

g. Washing machine
h. Refrigerator
i. Clothes Iron
j. Lights and lamps
k. Electric Fans
l. Television

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