UNIT 1

Living Things and Their Environment

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

UNIT 1: Living Things and Their Environment

Introduction

At this point, students have already learned in Grade 8 how the body breaks down food into forms that can be absorbed through the digestive system and then transported to each cell, which was on the other hand discussed in Grade 7 to be the basic unit of life. The learners have also discovered that cells divide to produce new cells by mitosis and meiosis. They have understood that meiosis is an early step in sexual reproduction that leads to variation. Students have been introduced to genetics to be able to appreciate evolutionary differences among species. Learners have also found out that biodiversity is the collective variety of species living in an ecosystem, and by studying the ecosystem; they have come across the various cycling of materials and energy transformation.

All modules in **Grade 9 Unit 1-Living Things and Their Environment** present student-centered activities that will allow the learners to discover and develop concepts that they may consider useful to their everyday life. At the end of each lesson, key concepts are provided for the students to grasp ideas and information that they will remember even after they have left school. Instructional activities are designed to build up the students' knowledge, understanding, skills, and ability to transfer learning. The modules generally use authentic assessment for the students to perform real-world tasks demonstrating meaningful application of essential knowledge and skills.

There are four modules in this quarter, namely:

Module 1: Respiratory and Circulatory Systems Working Together with the other Organ Systems

Module 2: Heredity: Inheritance and Variation

Module 3: Biodiversity and Evolution

Module 4: Ecosystem: Life Energy

Use these modules to effectively facilitate learning. Guide the students in performing every task and discussing the answers to every question. K – 12 science teachers must initiate an inquiry-based learning phase rather than merely making the students passive recipients of information.

Suggested time allotment: 8 to 10 hours

Unit 1
MODULE

1

Respiratory and Circulatory Systems
Working with the other Organ Systems

Overview

This module will make the students appreciate that their bodies are wonderfully created to carry out incredible tasks and activities. They must bear in mind the importance of ensuring proper care and maintenance of their bodies to prevent health problems from developing. Students must associate their learning of the different organ systems in their daily activities such as eating, playing, dancing, singing, or sleeping.

In Grade 7, the students have been introduced to the different levels of organizations in the human body and the mechanisms involved in it. They 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 us alive. They have studied how the digestive system breaks down food to nourish the whole body.

In Module 1, students 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. They will also recognize the ways of prevention, detection, and treatment of diseases affecting the respiratory and circulatory systems.

Specifically, the activities in this module will enable the learners to:

- identify the key parts of the breathing system;
- describe the function of each part of the breathing system;
- explain how the lungs work;
- describe how the movement of the diaphragm helps the air go in and out of the lungs;
- 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;
- identify the components of the circulatory system;
- explain the different types of circulation;
- describe how the heart functions;
- explain how blood is pumped by the heart;
- measure and describe pulse (heart rate) after several different activities;
- explain how to use different time intervals to measure the heart rate;
- explain the negative effects of cigarette smoking on the circulatory and respiratory systems;
- identify ways of detecting and preventing diseases in the respiratory and circulatory systems;
- appreciate the importance of a healthy lifestyle in avoiding such diseases;
- infer how one's lifestyle can affect the functioning of the respiratory and circulatory systems.

At the end of Module 1, students 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?

Content Standards *The learners demonstrate understanding of…*	**Performance Standard** *The learners should be able to…*
• how the different structures of the respiratory and circulatory systems work together to transport oxygen-rich blood and nutrients to the different parts of the body • prevention, detection, and treatment of diseases affecting the circulatory and respiratory systems	• conduct an information dissemination activity on effective ways of taking care of the respiratory and circulatory systems based on the data gathered from the school or local health workers

Pre-assessment

Before starting off an activity, it is useful to get an idea of the students' background knowledge and interests. KWHL is one of the most effective examples of authentic assessment that you can use in your classroom as a diagnostic tool.

Ask the students to fill in the following chart, either individually or as a whole class.

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

This typically ignites an active discussion, as students enjoy displaying their knowledge. Not only does this activity present a picture of the students' background knowledge, but it also motivates curiosity and enthusiasm about the topic they are about to learn. This tool will also provide information on the skills that the students might use and develop throughout the learning process. If there are misconceptions, it is a good opportunity to address and correct them.

The Human Breathing System

Start off by asking the students to breathe in and out. Let them feel the air moving from the nose into the throat, through the air tubes, and into the lungs.

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.

Let the students perform Activity 1 for them to identify the key parts of the breathing system and describe the function of each part.

Activity 1

What a Bunch of Grapes!

Divide the class into groups of about 6 to 7 students, and let them perform the activity as a group. It will be a fun activity for the students, as they will enjoy eating the grapes after learning about the parts of the breathing system.

Advanced Preparation

Each group must be assigned to bring a small bunch of grapes for the activity ahead of time. If the students have difficulty in finding the main material, other fruits or vegetables that demonstrate bunching may be used. Suggested alternatives for grapes are *lanzones*, cauliflower, *niyug-niyogan, arosep* or *lato (*sea weeds*),* or even tree branches.

Teaching Tips

1. Guide the students in identifying the parts of the breathing system that are similar to the structure of the bunch of grapes. The analogy must be clear enough for the students to remember each part.
2. To avoid misconception, point out to the students that unlike the main stem of the grapes, the trachea is hollow so as to allow the air to go through. Also, there should only be two large branching stems to correctly illustrate the bronchi.

3. Remind the students not to eat the grapes until they finish the activity. They must get to the bronchioles by taking off some of the grapes from the stems, revealing more branching stems that ideally represent the bronchioles.
4. Let the students know that unlike the grapes, the alveoli are so numerous that they cannot be counted individually.
5. Take note of the singular and plural forms of the terms such as bronchus (singular) and bronchi (plural); alveolus (singular) and alveoli (plural).

Answers to the Activity

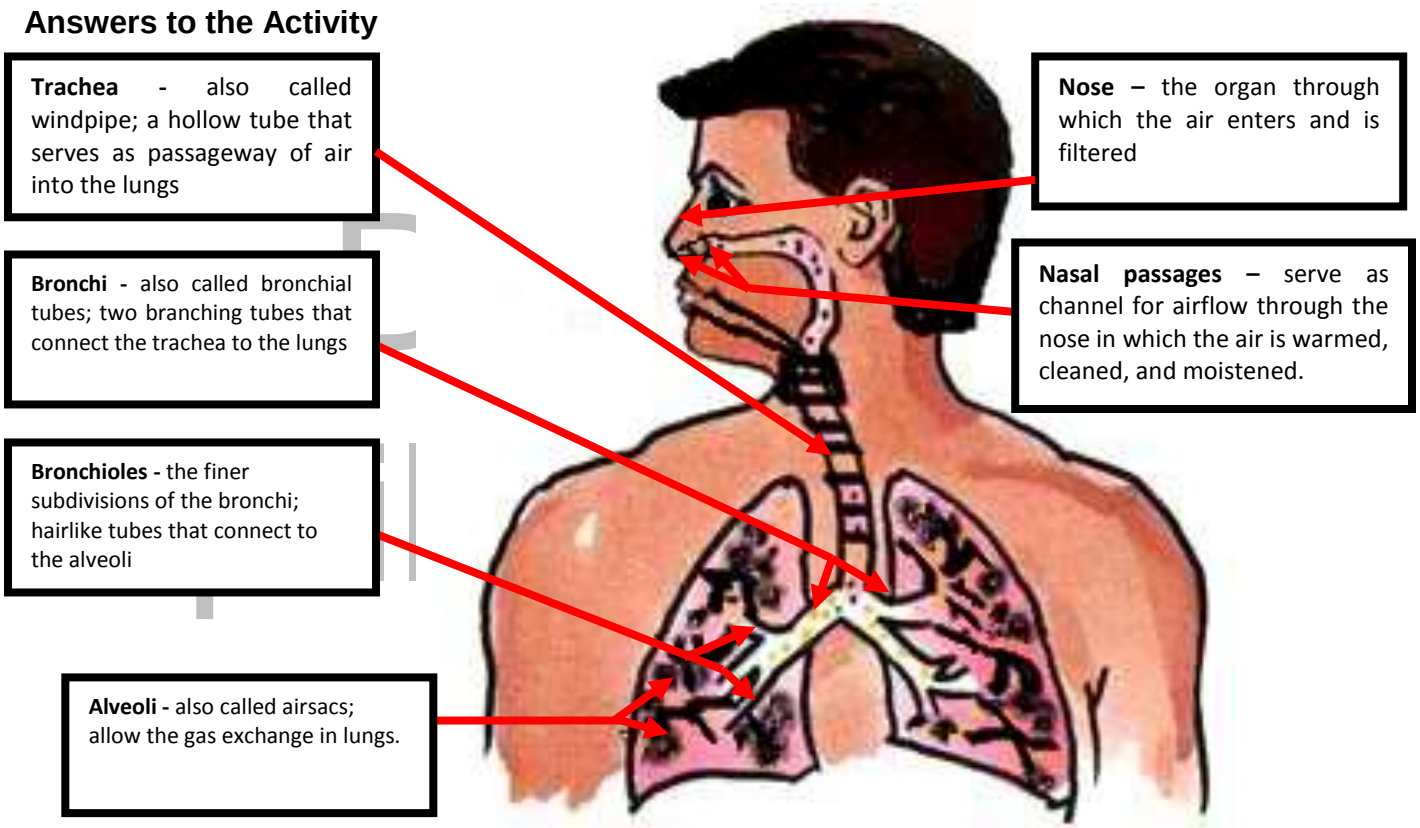


Figure 2. The human respiratory system

Answers to the Questions

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

main stem = **trachea**
two large branching stems = **bronchi**
little stems = **bronchioles**
individual grapes = **alveoli**

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

From the nose and mouth, oxygen travels to the trachea, bronchi, bronchioles, and then into the alveoli.

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

The other parts of the breathing system will not be able to carry out their corresponding functions as well, and the whole respiratory system will be affected.

KEY CONCEPTS TO EMPHASIZE:

The air we breathe goes through the nose, nasal passages, and then through **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.**

After students have discussed about the essential parts of the breathing system and their functions, now they are ready to learn the mechanism of the lungs and the diaphragm. In the next activity, students will be able to explain how lungs work, and describe how the movement of the diaphragm helps the air go in and out of the lungs.

Activity 2

Bottled Balloons

Answers to the Questions

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

2-liter plastic bottle = **chest cavity**
Two straws = **bronchi**
Two balloons = **lungs**
Larger balloon = **diaphragm**

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

Answer: The two balloons expand

Detailed Explanation: The air pressure inside the bottle is lowered by increasing the space inside the bottle. The outside air then enters through the tube, which makes the two balloons inside the bottle 'chest' expand.

Q6. What happens as you push up the balloon?

Answer: The two balloons loosen up and return to their original size.

Detailed Explanation: The air pressure inside the bottle is increased by decreasing the space inside the bottle. The inside air then exits through the tube, which makes the two balloons inside the bottle return to their original size.

Q7. How does the movement of the diaphragm cause the air to go in and out of the lungs?
The movement of the diaphragm affects the air pressure inside the chest cavity by either decreasing or increasing the space, thus allowing air to go in and out of the lungs.

Q8. What might happen if you prick the balloon?
If one of the balloons is pricked, it will not inflate anymore because the air will escape.

KEY CONCEPTS TO EMPHASIZE

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 to the outside where there is a lower air pressure.

In the following activity, the students will be able to describe blood flow and gas exchange within the circulatory and respiratory systems. The learners will see the mechanism of how the respiratory and circulatory systems work together.

Activity 3

Just Go with the Flow!

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

Teaching Tips:

1. The activity may be performed inside or outside the classroom. If you prefer to make it an outdoor activity, students must be guided to stay within the assigned premises only.
2. The activity will develop their kinesthetic ability, allowing them to simulate the gas exchange that takes place inside the body through circulation and respiration.
3. To save time, instead of writing down the words *oxygen* and *carbon dioxide* on the paper strips, colored papers such as blue and red art papers may also be used to represent each gas.

Answers to the Questions

Q9. How do the heart and the lungs work together?
The heart pumps the blood that transports the inhaled oxygen to every cell of the body. Carbon dioxide is given off in the process and is carried by the blood to the lungs and is released through exhalation.

Q10. What takes place when you inhale and exhale?
Gas exchange happens when we inhale and exhale. We take in the oxygen, and emit carbon dioxide.

Q11. What does blood deliver to every part of the body?
The blood delivers nutrients, oxygen, and other chemicals that are absorbed by the body

Q12. Why is oxygen important to your body?
Oxygen is important to our body because it processes the nutrients in the cell to make energy.

Q13. Describe the sequence of oxygen, carbon dioxide, and blood flow in your own words.
Oxygen enters the respiratory system through inhalation and then it enters the blood stream to be circulated throughout the body. Carbon dioxide from the tissues enter the blood, then to the lungs where it is exhaled.

KEY CONCEPTS TO EMPHASIZE:

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.

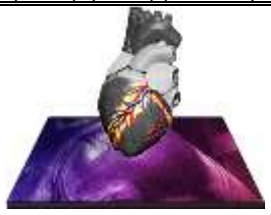
The **circulatory system** is the life support structure that nourishes your cells with food and oxygen. It also carries away the waste products. The circulatory system can be compared to a complex arrangement of highways, avenues and lanes connecting all the cells together into a neighborhood. Sequentially, the community of cells sustains the body to stay alive.

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

1. **Heart** – pumps the blood throughout the body

2. **Blood vessel** – carries the blood 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** – carries the materials 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

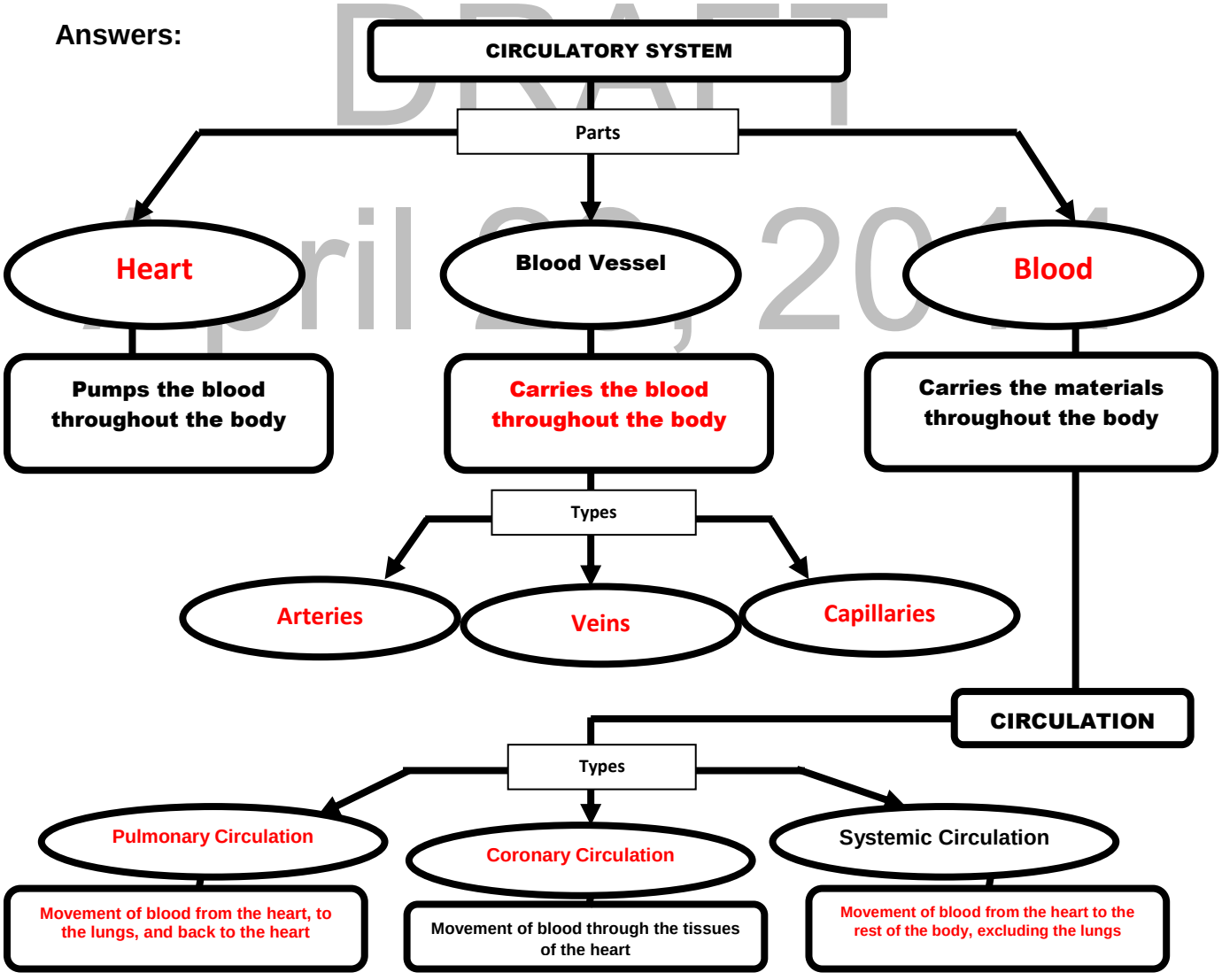
Let's Organize!

In this activity, students will be able to identify the components of the circulatory system and explain the different types of circulation.

Teaching Tips

1. You may choose to use the provided template for the graphic organizer or allow the students to map the concepts on their own.
2. Before the students perform the activity, you may show pictures of the different parts of the circulatory system for them to visualize each component.
3. It will also be useful to search for web resources of videos showing the animated flow of blood to different parts of the body.
4. Suggested links are:
   http://www.sumanasinc.com/webcontent/animations/content/humanheart.html
   http://www.dnatube.com/video/2864/Blood-circulation

Answers:



The Human Heart

Ask the students how big their heart is. Tell them to take a look at their fists. The heart is a hollow muscle, as seen in Figure 7, which is just as big as the 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**).

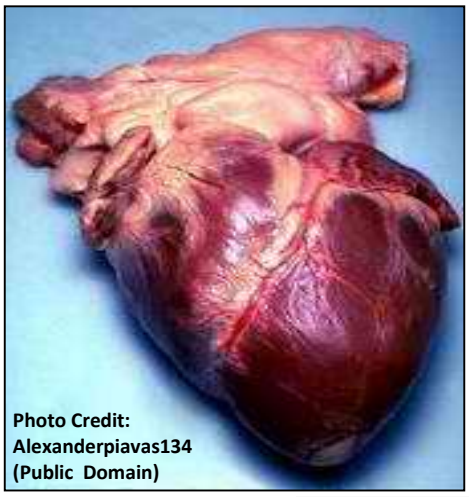


Figure 7. Photo of an actual human heart

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.

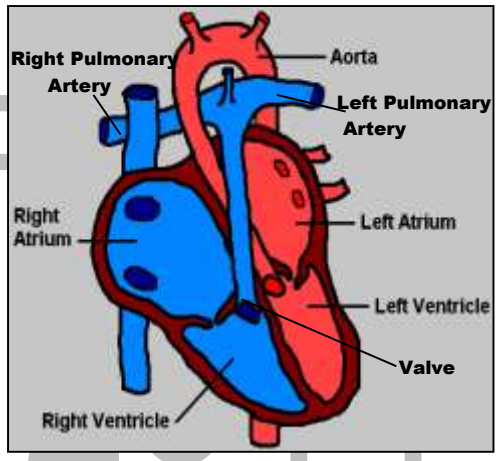
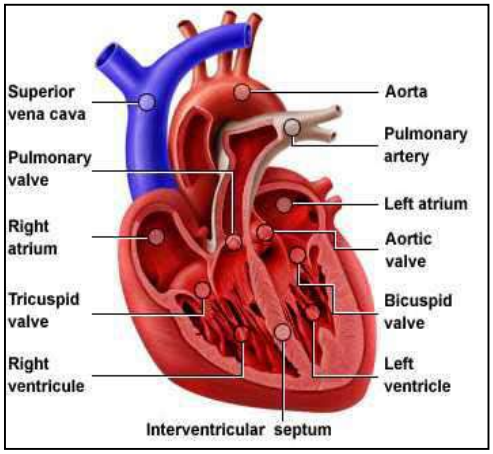


Figure 8. The major divisions of the heart

Q14. Explain how the heart works.
The heart propels the blood, which carries all the vital materials and removes the waste products that we do not need.

Q15. Evaluate how the heart can be compared to a mechanical pump.
The heart is a double pump that pumps on every side, the left and the right, to circulate the blood throughout the body.

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.



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

Figure 9. The detailed parts of the heart

Activity 5

Pump It!

This activity will enable the students to describe how the heart functions, and explain how blood is pumped by the heart.

Source:

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

Teaching Tips:

1. Assign the materials to be brought by the students beforehand so there is time for preparation. Let them identify what each part of the set-up represents.

2. In the fourth step of the procedure, it is important to carefully insert the straw through each hole in the balloon. The straws should fit as tightly as possible. If there are gaps between the straws and the balloon, students have to start over with a new balloon.

3. You may watch the video for the action using this link:
http://www.smm.org/heart/lessons/movs/heartPump.htm

4. Discuss with the students that the heart has valves that direct the current of blood in one direction. Blood is led through the flexible membranes which form the valves. As the blood passes through the membranes, the valves collapse into a barrier, preventing the backflow of the blood.

5. Students can find examples of pumps and valves in faucets, aerosol sprays, automobile fuel pumps, and many household items. Some beverage containers use a valve that resembles the valves in the heart.

6. Emphasize to the students that the heart is a muscle and not a mechanical pump. It can also be pointed out that comparison of this kind is known as reasoning by analogy and is an important part of scientific reasoning.

Answers to the Questions

Q16. What does the water inside the jar represent?
The water inside the jar represents the blood that is pumped by the heart.

Q17. How will you compare the heart pump model and the human heart?
The heart pump model moves water from the jar through the straws and into the pan. The heart pumps blood out into the body through the arteries in a similar way.

Q18. How does the heart function as a pump?
The heart is filled with blood which is squeezed out to circulate through the whole body.

Q19. Will the heart model be able to function properly if the straw is blocked? Explain your answer.
No. The blood will not be pumped out of the heart into the body because there is an obstruction.

KEY CONCEPTS TO EMPHASIZE:

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 one-way door, allowing blood to flow either forward into the next chamber, or out of the heart.

After the learners have already understood how the heart functions and how blood is pumped all over the body, they will then be ready to check their own heart rate.

Activity 6

The Rhythm of My Heart

At this time, students will be able to measure and describe their own pulse (heart rate) after several different activities, and explain how to use different time intervals in measuring heart rate.

Teaching Tips:

1. Ask the students to tell where the sound of their heart is coming from. Discuss to them that heartbeat is the sound produced by the heart as it pumps blood.

2. In doing the activity, remind the students to choose only the physical activities that they can tolerate so as to avoid injury or strain. Ensure that all of the students are in good health before starting the activity.
3. Emphasize that knowledge about our heart rates can help us monitor our fitness levels and it might even help us spot developing health problems.

Answers to the Questions

Q20. What was your resting pulse?
The answers of the students may vary due to measurement difference for every person.

Q21. What was your pulse after exercise?
The answers of the students may vary due to measurement difference for every person.

Q22. How will you compare your heart rates before and after exercise?
Heart rate after exercise is greater or faster than before exercise.

Q23. What is the advantage of timing for a full minute to find your pulse?
Timing to a full minute gives more accurate reading than shorter counting intervals in getting the pulse

Q24. What is the advantage of timing over a shorter period of time, especially when you have just finished exercising?
After exercise, the heart rate increases and eventually returns to resting pulse. Therefore, shorter interval is needed to take the heartrate just after the activity before it changes once again.

Q25. According to statistics, the maximum heart rate should be 220 minus a person's age. How will you compare your highest heart rate with that given number?
Answers may vary from person to person.

KEY CONCEPTS TO EMPHASIZE:

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). Different 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 the students are aware that strenuous activities may lead to an increased heart rate, they can now monitor their 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 cigarette.

Activity 7

Cigarette Smoking is Dangerous to Your Health

After performing this activity, students will be able to explain the negative effects of cigarette smoking on the circulatory and respiratory systems. The activity involves the use of meta plan technique. This strategy is simply a card technique for collecting ideas when a group of people are working together. Empty paper strips or blank cards may be used as materials for the activity.

Teaching Tips:

1. As the facilitator, you must learn moderation techniques in order to draw out the concepts from the students more effectively. All the ideas each group has presented must be collaborated to form the big idea.

2. Each participant must be given an opportunity to express his views and the assigned moderators facilitate the whole process of group work to make it organized and well-structured.

3. Students may share their own stories relevant to the topic to be able to inspire the class to take action upon knowing the negative effects of cigarette smoking on the respiratory and circulatory systems.

4. Enrichment activities such as gathering information about other diseases affecting the circulatory and respiratory systems may be given to further strengthen their learning.

KEY CONCEPTS TO EMPHASIZE:

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.

The leading causes of death around the world are diseases affecting the respiratory and circulatory systems can be prevented. 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. Let the students carry out the next task to further broaden their learning.

Activity 8

Prevention is Better than Cure

This activity will enable the learners to think of ways of detecting and preventing diseases in the respiratory and circulatory systems. Also, they will appreciate the importance of a healthy lifestyle in avoiding such diseases.

Teaching Tips:

1. Performing the activity will allow the students to develop their linguistic, kinesthetic, and interpersonal abilities. Therefore, it is important to lead the students into having full participation and collaboration with their group mates.

2. Let the students relate their personal experiences to the topic so as to have a more meaningful discussion.

3. The presentations and discussions must have an enduring impact on students' perception. They must be encouraged to practice what they have learned and to promote a healthy lifestyle.

4. Refer to the criteria below to assess the students' performance. This must communicate your expectations for their work. You may also customize your own rubric that will be used in evaluating their presentation.

STORY-MAKING AND ROLE PLAYING CRITERIA

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

KEY CONCEPTS TO EMPHASIZE:

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 diseases can easily be detected with regular health check-up and physical screening.

What's the Word?

The next activity is a variation of a famous application game, known as "Four Pics – One Word." Students will use their analytical thinking in answering each set of puzzles. At the end of the activity, they will be able to infer how one's lifestyle can affect the functioning of the respiratory and circulatory systems. Encourage the students to explain their answers to see if they understand how each picture relates to the given word.

Answers to the Activity

1.

What's the word?

ASTHMA

2.

What's the word?

HYPERTENSION

3.

What's the word?

ANEMIA

Answers to the Questions

Q26. What idea is common in each set of pictures?
Each set of pictures shows negative ways of living.

Q27. What are the negative lifestyles that are depicted in the pictures?
Cigarette smoking, polluting the environment, eating unhealthy foods, drinking liquor, sleep deprivation, etc.

Q28. How can lifestyle affect the functioning of the respiratory and circulatory systems?
One's lifestyle has a significant impact on the body as it can either strengthen or weaken the respiratory and circulatory systems.

Q29. How can these negative lifestyles be changed?
Negative lifestyles can be changed if a person decides to pay attention to his or her well-being by eating healthy foods, avoiding vices, exercising regularly, and having adequate rest.

Q30. What might happen if a person goes on with a negative lifestyle such as what was seen in the activity?
Various diseases affecting the respiratory and circulatory systems might begin to develop.

ENRICHMENT ACTIVITY

1. Ask the students to compose a short poem about how one's lifestyle can affect the functioning of the respiratory and circulatory systems, and let them recite their work in front of the class.

2. Ask the students to cut out different examples of unhealthy lifestyle from old magazines or newspapers, and let them create a collage out of the cut-outs on their notebooks or journals.

KEY CONCEPTS TO EMPHASIZE:

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: The objective of this performance task is for the students 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 they will be able to lead the people to take action rather than merely accepting the presented information. The students must consider obstacles to overcome such as the reluctance and pre-conceived notion of people upon changing lifestyle to promote health.

Role: Let the students assume that they work for an advertising company as a graphic artist and their job is to create public informational materials. They have to think of ways to disseminate information to the public regarding a lifestyle that ensures healthy condition of the respiratory and circulatory systems.

Audience: The target individuals to receive the information that the students will provide are the people in the school community including all students, teachers, and school officials. Parents and other persons who visit the school are also part of their audience.

Situation: Let the students gather information from the school or local health workers about how poor lifestyle affects the performance of the respiratory and circulatory systems. The challenge for the students involves dealing with this existing problem by creating a poster that will stir up the people's consciousness in having a healthy lifestyle.

Product: The students will design a wall poster or placard that that will make members of their audience aware of how they can effectively take care of their respiratory and circulatory systems. Any medium may be used for their artwork.

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

The students' outputs 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 of Concepts:

- 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 hair-like 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.

Answers to 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?
   The circulatory system distributes oxygen 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?
   Carbon Dioxide is released by the body as waste during respiration.

3. What happens to the diaphragm when a person breathes in or inhales?
   The diaphragm contracts allowing more air in the chest cavity.

4. Why is the human heart called a double pump?
   The heart pumps on every side, the left and the right, to circulate the blood throughout the body.

5. What will happen if oxygen is not transported by the blood to other parts of the body?
   The cells in our body will not be able to process the nutrients to provide energy for the body and they will die.

6. Since the valves act as the doors of the heart, what might happen if these doors do not close?
   If the valves of the heart do not close, the blood will flow backwards. Blood will escape back into the chambers rather than flowing forward through the heart or into an artery.

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?
   These gases will still pass from the lungs into the blood, and circulate throughout 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?
   The chemicals in cigarette harm the blood cells. They can also damage the function of the heart and the structure and function of blood vessels, thus increasing the risk of cardiovascular diseases.

9. How does singing from the diaphragm, instead of throat, help improve the voice quality of a singer?
   Singing from the diaphragm supports proper breathing and avoids voice straining

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?
    After running, the woman's heart rate increased to supply more oxygen through the blood to the muscles, since they need more oxygen when they are moving.

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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Electronic Sources:

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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

(Online Resources)

DnaTube.com - Scientific Video and Animation Site. 2013. *Blood circulation*. [online] Available at: http://www.dnatube.com/video/2864/Blood-circulation [Accessed: October 10].

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Suggested Time Allotment: 8 to 10 hrs

UNIT 1 Module 2

Heredity: Inheritance and Variation

Content Standard	Performance Standard
• Genetic information is organized in genes on chromosomes • Traits of organisms are inherited through different patterns.	

Overview

Non-Mendelian Patterns of Inheritance

In Grade 8, students learned that cells divide to produce new cells and meiosis is one of the processes producing genetic variations in Mendelian patterns of inheritance. The inheritance of characteristics is not always as simple as it is for the characteristics that Mendel studied in pea plants. In Mendel's experiments with pea plants, he found out that one allele was always dominant over the other. This resulted in just two possible phenotypes for each characteristic.

This module will focus on the modifications of the Mendelian principles. It is expected that the students will be able to explain the different patterns of non-Mendelian inheritance and see the difference between the Mendelian and non-Mendelian patterns of inheritance. The fundamental role of chromosomes and genes in heredity and variations and the role of DNA in the transmission of traits will be explained.

Key questions for this module:

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

Answers to Pre-Assessment :

1. RW
2. The right chain of the DNA molecule: G G C A T C C G G
3.

1. OO – No horn	2. AA – One center horn	3. BB – two horns	4. AB – three horns

In the Mendelian patterns of inheritance, the effects of the recessive gene are not observed when the dominant gene is present. In this lesson the teacher should stress that alleles always remain separate and distinct even in incomplete dominance. A very common error that students may believe is that alleles themselves blend in incomplete dominance.

Activity 1 Phenotypes and Genotypes in Incomplete Dominance

In this activity, the students should be able to explain incomplete dominance. They should illustrate by means of a Punnett square a cross involving incomplete dominance pattern of inheritance. Incomplete dominance is a pattern of inheritance in which neither gene is totally dominant over the other resulting in an intermediate form of the other two phenotypes.

Teaching Tips:

1. Divide the class into six (6) groups. Three (3) of the groups will solve Problem #1 and the other three (3) will solve Problem #2.
2. Ask for a volunteer group to present the solution to the problem and discuss the probabilities of the genotypes and phenotypes obtained from the cross.

Answers to Guide Questions:

- Ask students to answer the questions for each of the problems during the discussion.

Q1. Problem # 1: Two types of gametes for each parent, since their genotypes are RW & RW

Problem # 2: One parent will have one type of gamete and the other two types of gametes, since their genotypes are RR & RW.

Q2. Pink flowers

Q3. Problem # 1 Pink & Red flowers Problem # 2 Red, Pink & White flowers

Q4. Problem # 1 RR, RW, WW Problem # 2 RR, RW

- Emphasize the key concepts to the students.
- Include in the discussion possible applications to plant breeding.

Key Concepts TO EMPHASIZE:

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 the students are familiar with incomplete dominance, instruct the students to proceed with the next activity on codominance

Activity 2 Mystery Bull

In this activity, students are expected to solve problems demonstrating codominance of traits. A 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).

Teaching Tips:

- Before the activity, introduce the lesson by showing a red and white shirt hung up on the board.
- Ask students, "If the shirts represent traits for red and white, can you mix them to make pink?", "Why can't you make pink?"
- Ask about crossing a red cow with a white cow.
  "Can you have a pink cow?"

- Present a picture of a cow to the class, showing the phenotype of the cow with codominant trait. Ask students of other examples of codominant traits in plants.

Note: It would be better to reproduce a bigger copy of the picture below.

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

Source: www.biologycorner.com

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

- Assign additional reading from the given link:
  Link: http://www.wikidoc.org/index.php/Autosomal_recessive

Answers to Guide Questions:

Q5. Yes

Cow 1 will have red calves; Cow 2 will have roan calves; Cow 3 will have red and roan calves.

Q6. Yes

Q7. Student answers should be based on the Punnett square they have already prepared in their activity.

Q8. Students may give varied answers.

Q9. Students may give varied answers. Possible answer: Animal breeders can cross breed animals in order for them to get the desired traits that will improve livestock in terms of meat quality and milk production.

- Point out that solving problems involving non-Mendelian inheritance makes you realize that there are no absolutes in real life. Codominance is the result of two alleles sharing

their territory equally, so no color is dominant; they simply share traits, representing their color. In cows, red and white do not combine to make pink; instead, roan is produced. Remember, codominance is all about sharing space and being independent.

Key Concepts TO EMPHASIZE:

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 (more than two) alleles. An example is **ABO blood type** in humans.*

Activity 3  What's your blood type?

In this activity, the students will determine all possible combinations of genes for a blood type that a person might have and predict gene combinations expected in offspring based on the genes carried in male and female gametes.

Teaching tips:

Note: Assign students to know their blood types beforehand. If the blood type is unknown, ask them to just select any blood type they want.

- Start by dividing the class into four groups. Assign a student per group to make a record of the different blood types of the group members and prepare a tally using the given table.

	A	B	AB	O
Frequency				

- Ask the assigned students to consolidate the data.
- Ask the following questions:
  1. Which blood type frequently appeared among you?
  2. Do you know how blood types are inherited?

- Direct students to work on the activity and find out the answers to the questions.

Answers to the table:

Completed table. The first table will be answered by group.

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

Completed table. The second table will be done individually.

		Possible alleles from Father		
		A	**B**	**O**
Possible alleles from Mother	**A**	***I^A I^A ; Type A***	***I^A I^B ; Type AB***	***I^A I^A , ii; Type A& O***
	B	***I^A I^B ; Type AB***	***I^B I^B ; Type B***	***I^B I^B, ii; Type B & O***
	O	***I^A I^A, ii; Type A&O***	***I^B I^B, ii; Type B & O***	***ii; Type O***

Answers to Guide Questions:

Q10. AB, B, A, O

Q11. A, B, AB

Q12 . B, O

Key Concepts TO EMPHASIZE:

- 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.

Activity 4 Boy or Girl ?

In this activity, students will determine the probability of having male or female gender by illustrating the prediction using a Punnett square.

- Reproduce an enlarged version of Figure 3 & 4.
- Ask a student volunteer to explain what the figure is all about.

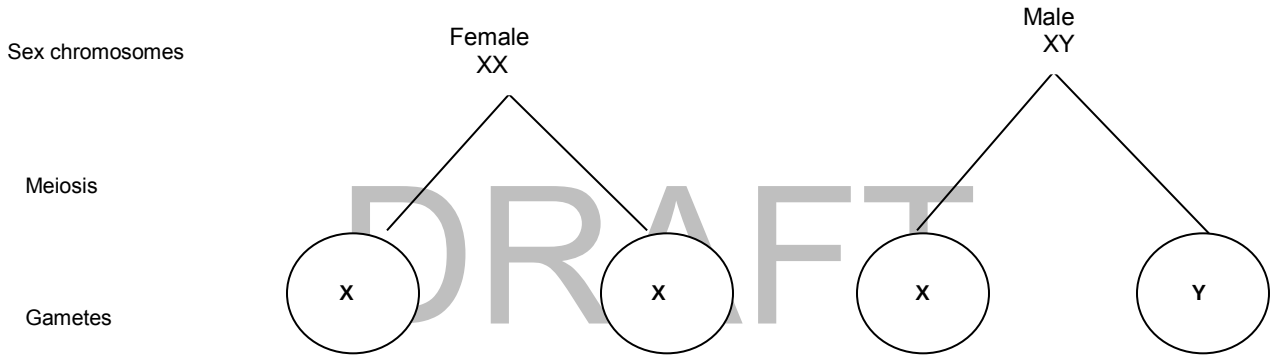

Figure 3. **Gamete formation involving only sex chromosome**

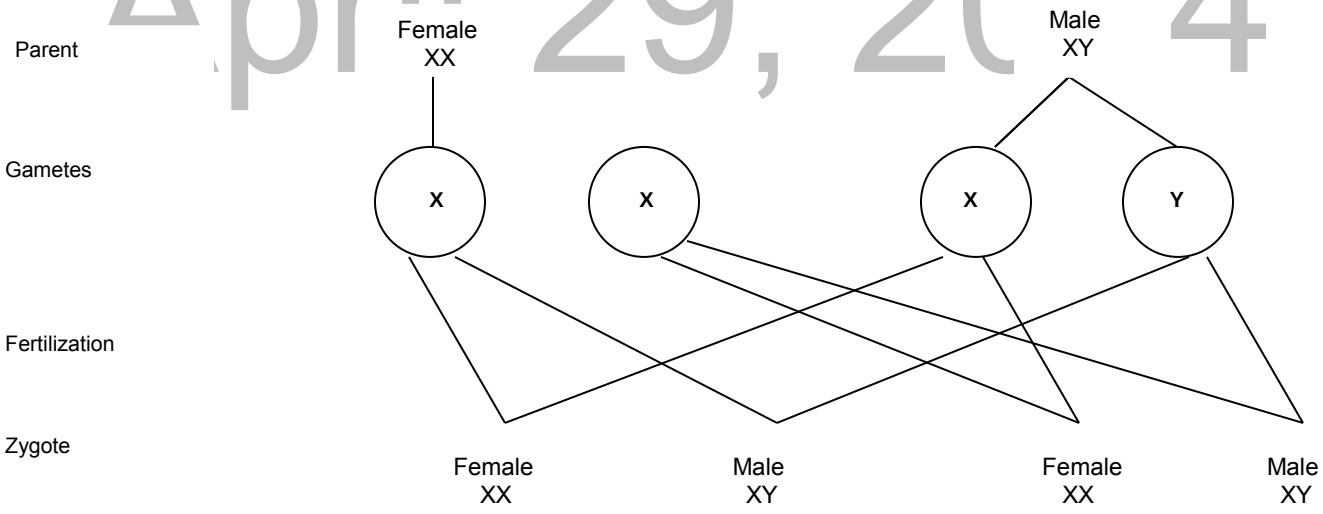

Figure 4. **Sex determination**

- Ask the students to work on the activity to help them understand the determination of sex.

Answers to Guide Questions:

Q 13. Male

Q 14. X bearing sperm

Q15. 50%

Q16. X chromosome

Q17. Y chromosome

Q18. Environmental factors, such as age of mother that may lead to nondisjunction (Trisomy 21), Aneuploidy where there is an excess or lack of X or Y chromosome and genital development during conception, and the social interactions after birth may contribute to a certain degree to 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 or 23 pairs of chromosomes. 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.

Activity 5 When Gender Matters

This activity diagrams a cross involving sex-linked genes. The teacher points out that when a gene controlling a trait is located in the sex chromosomes, the trait is said to be sex-linked. This is a term generally used with traits the genes of which are found in the X-chromosomes. Y-linked traits are often called holandric traits.

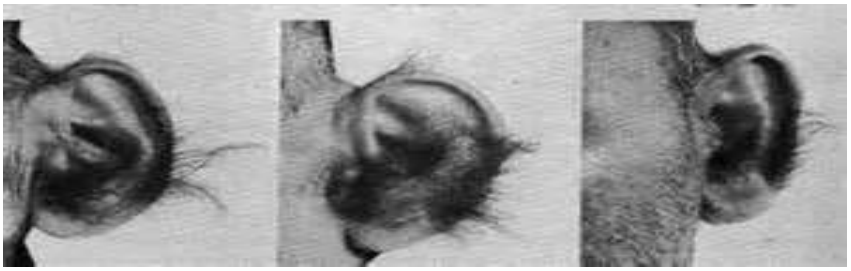

Figure 5. Sex-linked Genes Source: www.mun.ca

- Provide other examples of sex-linked traits by showing pictures.
- Use Table 3 to show inheritance of sex-linked traits.

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. $X^c X^c$	Color-blind female
4. $X\ Y$	Normal male
5. $X^c\ Y$	Color-blind male

- Instruct students to work on the activity to solve problems related to sex-linked traits and calculate expected genotypic and phenotypic ratios.

Answers to Guide Questions:

Q19 . **$X^c\ Y$**

Q20. **$X\ X^c$**

Q21. 50%

Q22. 50%

Q23. 50%

Key concepts TO EMPHASIZE:

- 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.

Ask students the following questions to introduce the next topic: 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.

- Use Table 4 to show the genotypes and phenotypes of the gene for lactation.
- Emphasize to the students that these genes are carried by both males and females, but it is only expressed in females.

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

Answers to Guide Questions:

Q24. Other examples of sex-limited traits: fanlike tail feather in peacocks that is never expressed in peahens and horns that are exclusively found in males of certain sheep species.

Sex-influenced Traits

Sex-influenced traits are also autosomal. 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 of 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.

Teaching Tips:

- Use Table 5 to explain sex-influenced traits.
- Assign students to prepare a family tree.
- Trace the inheritance of baldness in their family.
- Direct students to go over the readings in the Learners' module to help them understand better the inheritance of baldness
- Emphasize the difference between sex-limited and sex-influenced traits.

Table 5. Expression of Baldness Pattern in Humans

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

Source: Functional Biology Modular Approach, Second edition

Answers to Guide Questions:

Q25.

	Xb	Yb
XB	XXBb	XYBb
XB	XXBb	XYBb

Genotypic ratio: 1XXBb: 1XYBb

Phenotypic ratio: 1 female non bald: 1 male bald

Q26. Sex-limited and sex-influenced traits are similar in that their expression depends on whether the person is male or female.

Q27. Sex-limited traits are exclusively in one sex and never in the opposite sex. Sex-influenced traits are expressed in both males and females, only more frequently in one sex than in the other.

Key Concepts TO EMPHASIZE :

- **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)

Answers to the questions:

1. Key for the trait. Mother: $X^H = X^H X^H$ Father $X^h = X^h Y$

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

	X^H	X^H
X^h	$X^H Y^h$	$X^H Y$
Y	$X^H Y^h$	$X^H Y$

   Q28. Man : $X^h Y$, : . Female : $X^H X^H$

   Q29. Yes

   Q30.100% of the female will be carriers of the disease. All males will be haemophiliacs.

- If the genotype of the father is I^A **i** and mother is **ii**, it is possible for them to have children with blood type A and O. Refer to the Punnett square.

	I^A	i
i	I^A i	ii
i	I^A i	ii

   Q31. Blood type A and blood type O

   Q32. Out of every child conceived, there will be 50% chance that the child will have blood type A and 50% blood type O.

- Connect the lesson to the chromosome and the inherited trait that genes produce.

Instruct the students to perform an activity that will help them understand some important concepts in DNA structure.

Activity 6 DNA Modeling

In this activity, the students should be able to describe the composition and structure of DNA. The students should be able to manipulate the nucleotides (basic building blocks) of DNA and get a feel of how the molecule is produced.

Teaching Tips

- Assign students to read in advance about DNA structure.
- Ask each group to bring the materials necessary for the activity.
- Reproduce the template of the nitrogen bases a day before the activity.
- Prepare a diagram of the DNA structure.
- Create your own model of the DNA following the same procedure in the activity sheet of the students. The model will be shown to the students to give them concrete example of what they will do.
- Divide the students into 6 groups.
- Review the hereditary traits that were passed from the parents to their offspring and ask the students: "What do you think is responsible for the formation of such traits? "
- Summarize individual responses and relate the ideas of students of what the DNA is.

Answers to Guide Questions:

Q33. Sugar and phosphate

Q34. Base

Q35. Adenine, thymine, cytosine, guanine

Q36. Yes, adenine can only pair with thymine because of their chemical structures.

Q37. Yes, guanine can only pair with cytosine because of their chemical structures.

Q38. Sugar and phosphate; nitrogen bases

Key Concepts TO EMPHASIZE:

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 associated with phenomena such as codominance, incomplete dominance, multiple alleles, and sex-linked traits.
- **Codominance** occurs when both alleles are expressed equally in the phenotype of the heterozygote.
- **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.
- 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 based 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 base. 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)

Answers to questions

1.

	R	R
r	Rr	Rr
r	Rr	Rr

Genotypic ratio: Rr 100%

Phenotypic ratio: 100% pink

2. A third phenotype results when traits are inherited in incomplete dominance.

3.

F_2	r	r
r	rr	rr
r	rr	rr

Phenotypic ratio :100% white

4. Co- dominance

5.

	B	B
W	BW	BW
W	BW	BW

Phenotype: checkered

Answer key
Summative Assessment (for end of the unit)
Knowledge:

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? **G G C G A**

Understanding:

2. Predict the phenotypic ratios of offspring when a homozygous white cow is crossed with a roan bull. Illustrate using a Punnett square.

	W	W
R	RW	RW
W	WW	WW

Process skills

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**, where as females are **ZW**.
In chickens, barred feathers (Z^B) are dominant over nonbarred feathers (Z^b).
   a. Draw a Punnett square that shows the results of a cross between a barred female and a nonbarred male.

	Z^B	W
Z^b	$Z^B Z^b$	Z^b W
Z^b	$Z^B Z^b$	Z^b W

   b. What is the probability that the offspring will be:
      i. Barred females? none
      ii. Nonbarred females? 50%
      iii. Barred males? 50%
      iv. Nonbarred males? None

4. A. phosphate B. base C. sugar 5.

Blood type	Gene Pairs
A	AA,AO
B	BB,BO
AB	AB
O	OO

References:

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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

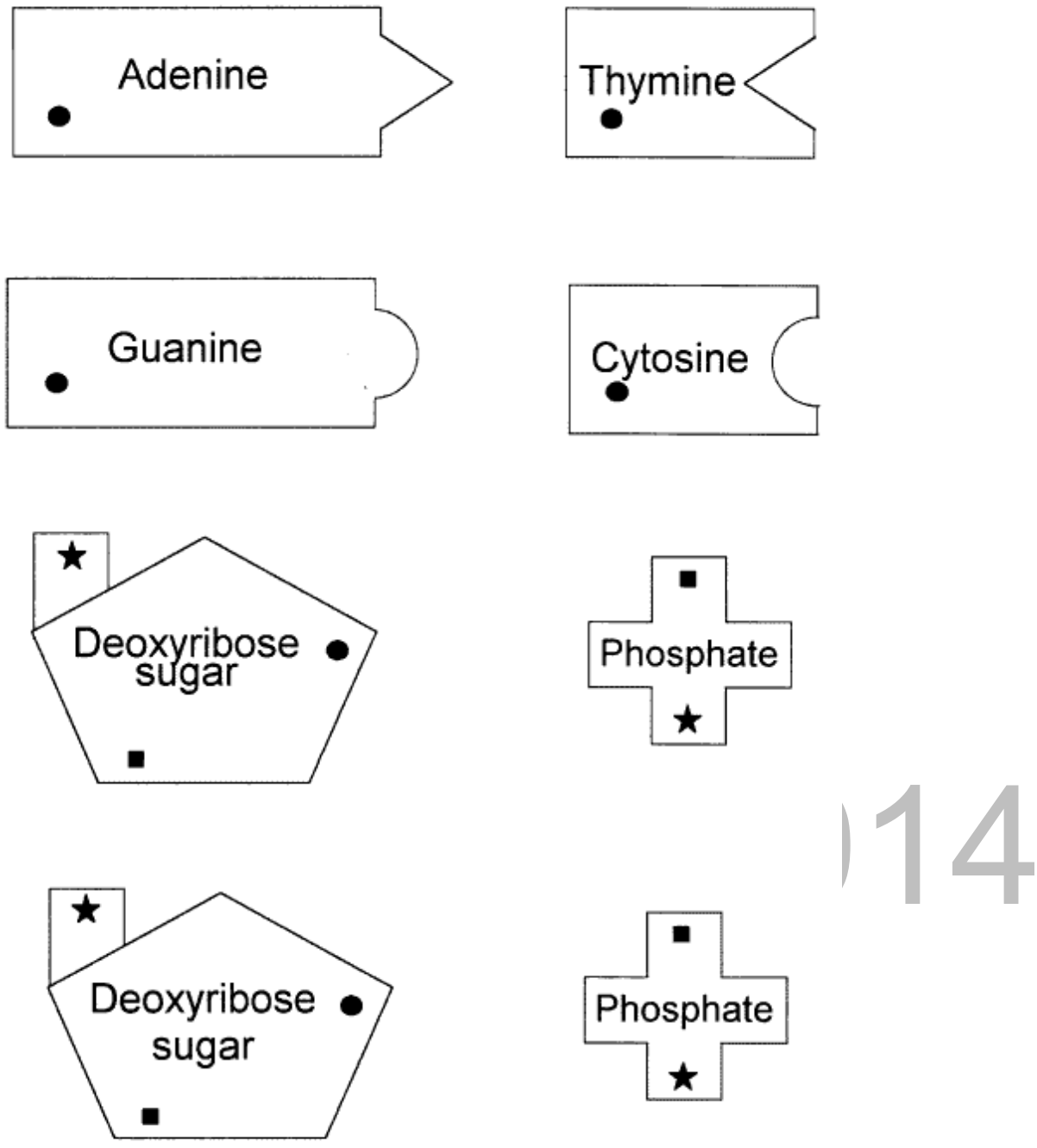

Figure 7 Basic Subunits of DNA

Reference:

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

UNIT 1
Module 3

Suggested Time Allotment: 4 to 5 hrs

Biodiversity and Evolution

Overview

Causes of Species Extinction

In Grade 8, the students learned about the concept of species and classification of organisms using the hierarchical taxonomic system and the advantage of high biodiversity in maintaining the stability of an ecosystem. In Grade 9, the students 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 things are interacting successfully, in an environment where even non-living things are adequately present in order to sustain life. 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 students find answers to these questions.

In this module, the students 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 species extinction?

Answers to Pre-assessment:

A.

1. Hunting and trapping
2. Taking animals for profit
3. Destruction of habitat
4. Pollution
5. Overharvesting

B.

1. water lily

2. Varied answers: Loss of habitat, lack of food, disease, environmental factors

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 the students will study the various threats that are considered causes of the loss of biodiversity.

Activity 1 Index of Diversity

In this activity, the students should be able to measure species distribution using mathematical way of expressing the amount of biodiversity and species distribution in a community.

Teaching Tips:

1. Introduce the lesson with a string or yarn exercise. Assign the students to bring a ball of string or yarn.

2. Select or ask for 15 volunteers. Instruct students to choose from the environment, anything they would like to be, e.g. grass, wind, flower, soil, earthworm, etc. Choices should be different from each other.

3. Ask students to write their choices in a 5 inch. x 8 inch. size of paper and clip or tape it in front of their chest. Let them form a circle.

4. Instruct one student to start off by holding on to one end of the string and passing the ball to another student in the circle with whom the student can be "related" and explain the significance of that part. For example, the "bird" student holds the end of the string. That student passes it to the "earthworm" student and says, " I am a bird that eats the earthworm."

5. Remind students to continue making connections and follow the same procedure until everyone has participated and the yarn is intertwined into a web.

6. Act as the agent of destruction, by cutting the connections inside the circle while describing the destruction of each link. Continue to cut connection until the web is destroyed.

7. Ask students the following questions:

    - What does the exercise illustrate?
    - What is the message?

8. Relate students' answers to the first activity.

9. Divide the students into 6 groups or add more groups depending on the number of students in your class.

10. Inspect the area where the students are expected to do the activity since this is to be done outside the classroom. If you think, the school grounds have

very limited species of plants, you can prepare a species map of a community in your area that may indicate species distribution.

11. Make sure that the students are properly oriented about the procedure of the activity.

Answers to Guide Questions:

Q 1. Vacant lots would have a low I.D. since there are fewer species distribution and the grass lawn would also have a low I.D. The tree I.D. might also have a low I.D. Communities with many different species have a high I.D.

Q 2. Communities with many different species have a high index of diversity, this will enable the communities to withstand environmental changes better than communities with only a few species or with low index of diversity.

Key Concepts TO EMPHASIZE:

- 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).

- *Use the given statements to introduce the next activity. Get student responses to the question.*

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?

Activity 2 Measuring Population Density

In this activity, the students will understand changes in population, factors affecting population growth and size and learn about the needs and characteristics of a population.

Teaching Tips:

1. Start the lesson with a picture analysis activity or show a video about Philippine biodiversity.
2. Show different pictures of populations of different species of animals or plants which are considered to be endangered. If you choose to show a video about Philippine biodiversity, you may download from YOU TUBE and show it to the students.
3. You may also present "TRIVIA ON PHILIPPINE BIODIVERSITY" (Get this information from Haribon Trivia on Philippine Biodiversity, 2005)
4. Relate this to the lesson by asking the following questions:
    - What brings about changes in the population?
    - Can environmental factors affect the population growth and size?
    - Predict what will happen to these populations of species if the environment is not favorable for their survival.
5. Divide the students into 6 groups or add more groups depending on the number of students in your class.
6. Remind the students to read the procedure of the activity.
7. Ask for some volunteer groups to present and discuss their output.

Answers to Guide Questions:

Q 3. The Bermuda grass population is the largest then the lily population. The clover population has the least number.

Q 4. The Bermuda grass population has the greatest density.

Q 5. Answers may include: availability of sunlight, nutrients, or water; presence of other organisms that feed on the plants; the space available to each individual plant.

Q 6. Answers may vary. Any change in the factors listed in question 5 could lead to change in population density.

Q 7. Population density is based on the relationship between the needs of individual species and a complex mix of limiting factors. Differences might point to potential problems such as pollutants or disease.

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. Limiting factors are often related to population density. The greater the population density, the greater the effect limiting factors have on a population. For example, plants may be a limiting factor to herbivores. If the population of herbivores is so dense, there may not be enough food for each of them.

Key Concepts TO EMPHASIZE:

- 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?

Activity 3 Endangered but not Extinct...yet

This activity is a simulation designed to show that habitat destruction can be a factor causing species extinction. This activity is best done outdoors but it can also be done as a classroom activity.

Teaching Tips:

1. Introduce the lesson with a Species Charade Game.
2. Prepare a list of endangered species, threatened species, extinct species. Write their names in small pieces of paper and place it in a small box.
3. Ask one student to pick a piece of paper without looking and pretend to be the animal written on it. The rest of the students guess what it is.
4. Continue the game until you have about six students doing the act.
5. Relate the activity to the lesson.
6. Remind the students to read the procedure of the activity.
7. A day before the activity, inspect the area where the students are supposed to work.
8. Divide the students into six groups or add more groups depending on the number of students in your class.
9. Ask for some volunteer groups to present and discuss their output.
10. Prepare a handout of the Extinction Simulation Data table. Make copies for your students.

EXTINCTION SIMULATION DATA TABLE				
Round	No. of grasshopper toothpick at the start of round	No. of grasshopper toothpick during the round	No. of grasshopper toothpick at the end of round	No. of grasshopper toothpick scattered
1	100			
2				
3				N/A

Answers to Guide Questions:

Q 9. Answers may vary: the number was reduced or the number became steady.

Q 10 Answers may vary: there were different kinds of grass in each circle, the backgrounds were different, the "hunters" were different.

Q11. Limiting factors in the environment; biotic and abiotic factors.

Q12 Answers may vary: Habitat destruction will lead to the reduction of grasshopper population and eventually they will die.

Q 13. Answers may vary: Conduct a research using the scientific research process. .

When a species' population becomes so low that only a few remain, that species is considered e**ndangered** and 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 biologist 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. **(Rabago, L. 2010)**

Extinction is the disappearance of a species when the last of its members dies. 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 TO EMPHASIZE:

- Extinction occurs when the last members 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 in endangered when its population has become so low

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

This activity will help students understand the effects of environmental issues on ecosystems.

Teaching Tips:

1. Direct students to work on the activity.
2. Remind the students to read the procedure of the activity.
3. Divide the students into six groups or add more groups depending on the number of students in your class.
4. Ask for some volunteer groups to present and discuss their output.
5. Proceed with the discussion about local and global environmental issues affecting biodiversity.

6. Provide video clips or pictures for each environmental issue as discuss in the Learner's material. Another option is to assign a group to discuss about the environmental issue.
7. Provide guide questions for the students.
8. Synthesize the lesson pointing out to the key concepts and mention also the Ecological Principles. (Source: Philippine Biodiversity Conservation; Haribon Foundation)

   Ecological Principles:

   - Nature knows best.
   - All life forms are important.
   - Everything is connected to everything else.
   - Everything changes.
   - Everything must go somewhere.
   - Ours is a finite earth.
   - Humans are the stewards of nature.

Answers to Guide Questions:

Q 14. Answers may vary.

Q 15. Answers may vary

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 the students' prediction in the activity, they 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.

The students probably need to know more about some of the local and global environmental issues/problems that are also affecting their 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

Figure 7 Monkey-eating Eagle

Figure 8 Tarsier

Figure 9 *Dugong*

- Water Pollution

A major problem in lakes, rivers and ponds is **eutrophication,** 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.

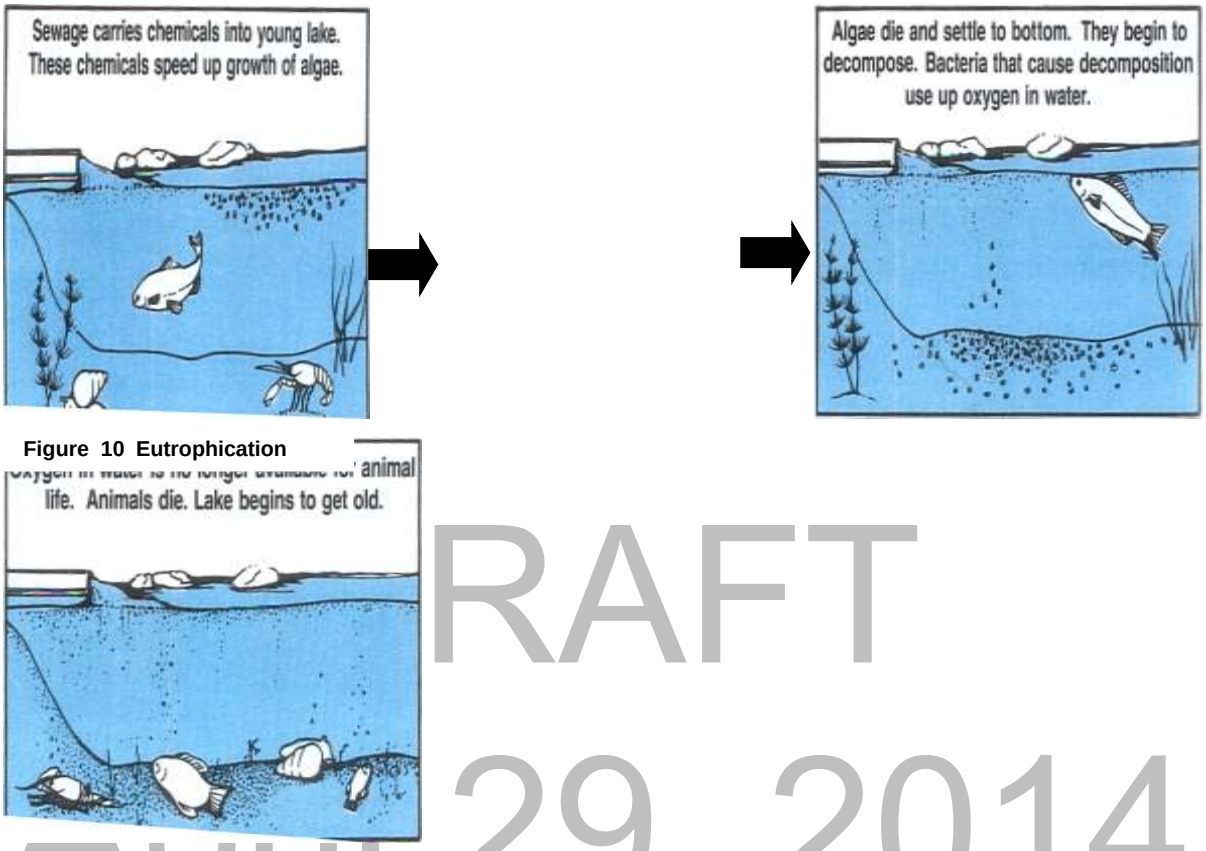

Figure 10 Eutrophication

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. Fishes 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 store them in their tissues. As the salmon feeds on the smaller fish, they took the PCB in their bodies. Like the smaller fish, the salmon was not killed by the PCB. They stored it in their tissues. The concentration of PCB in salmon rise to 5000 times the concentration of PCB in the water in which they feed.

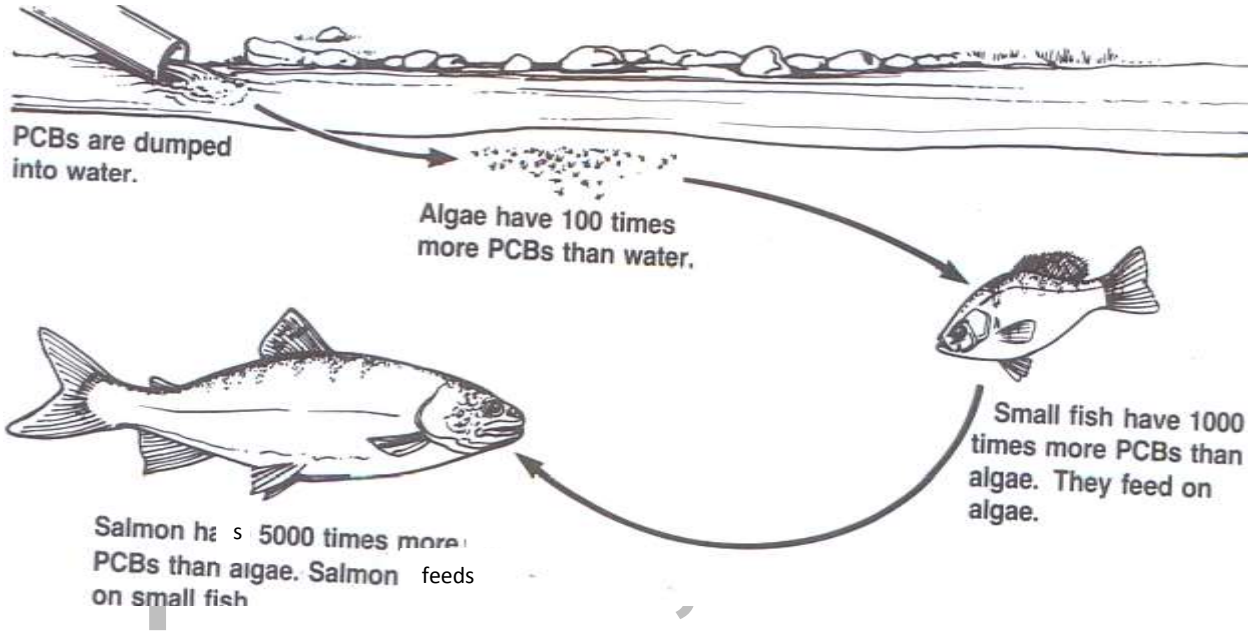

Figure 11 PCB dumped in lakes (please redraw)

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

- Air Pollution

Figure 12 shows the harmful pollutants present in air.

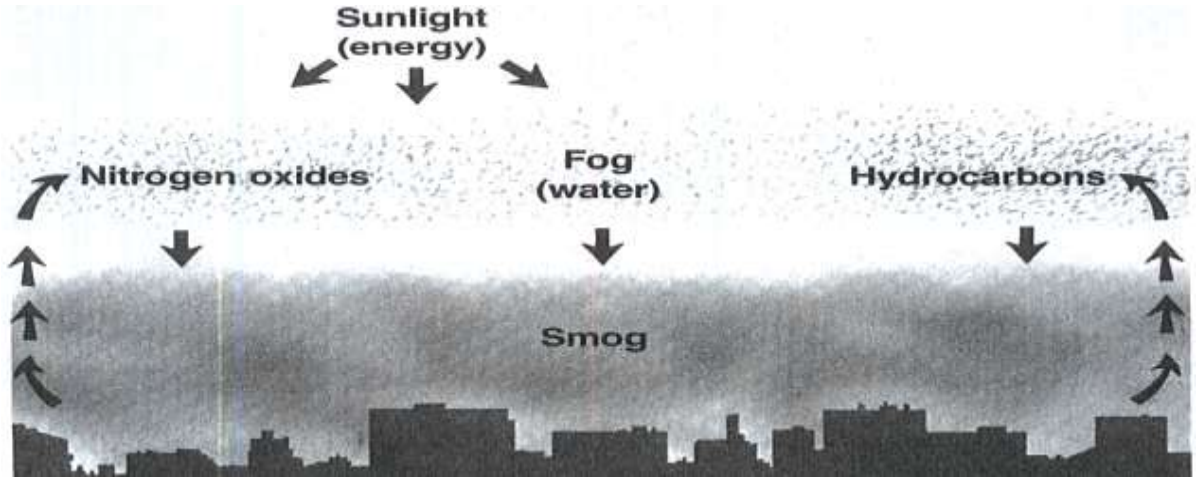

Figure 12 Air Pollution

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.

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.

Destruction of Coastal Resources

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.

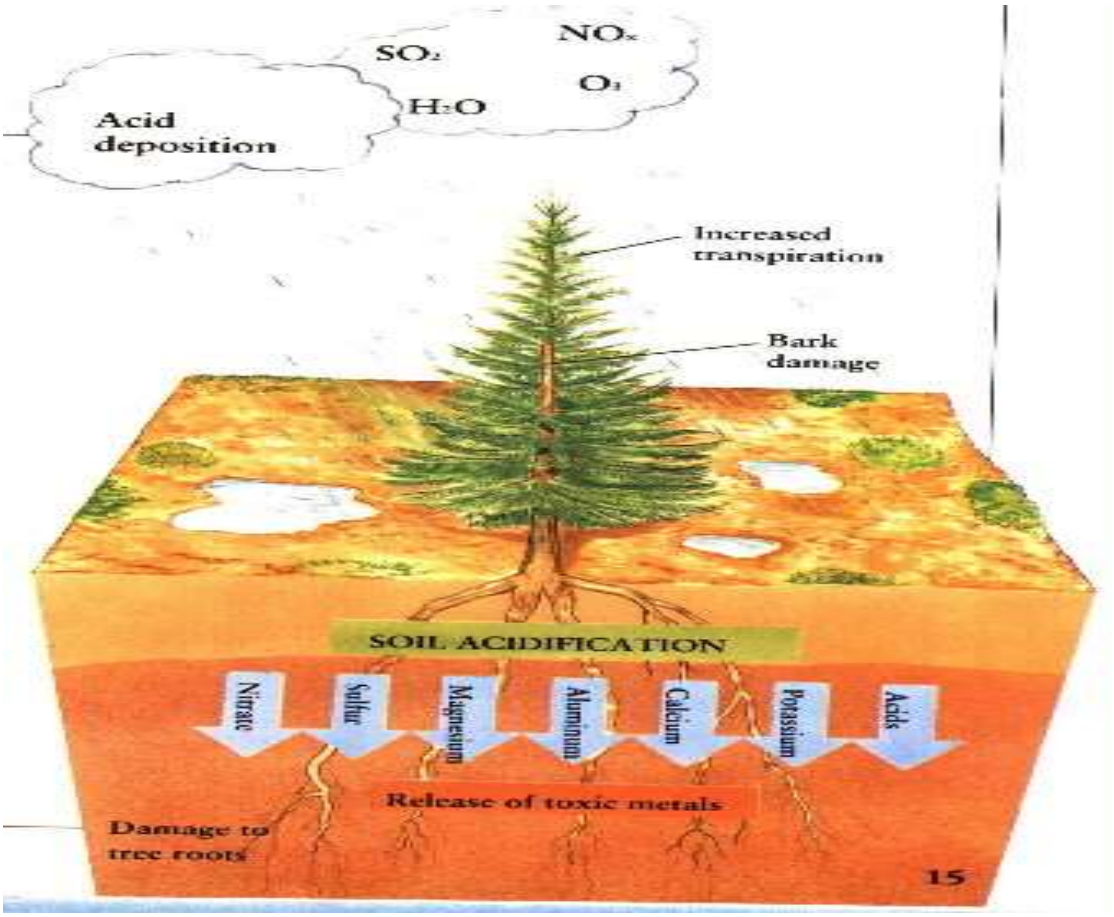

Figure 16 Acid precipitation

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 TO EMPHASIZE:

- 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 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

1. Give students tips on how to prepare the timeline.(Suggested methods are given)

   For the students:

   a. Decide what the timeline will include.
   b. Make a list of events to include
   c. Decide when it will begin and end. (8 to 15 events is a good number to include for most timelines)
   d. Aim to present a well-rounded history.
   e. Layout the timeline.
   f. Choose any available multimedia material.

2. Evaluate the timelines using the suggested attached

TIMELINE RUBRIC

NAME _____ **DATE** _____

CRITERIA			points		
	4	**3**	**2**	**1**	
Contents/facts	Facts were accurate for all events reported on the timeline	Facts were accurate for at least 80% of all events reported in the timeline	Facts were accurate for at least 60% of the events reported on the timeline.	Facts were often inaccurate for events reported in the timeline	____
Dates	All dates indicated on timeline are correct and are sequenced in the proper order	At least 1 of the dates or sequences is not in the proper order	At least 2 of the dates or sequences are not in the proper order	At least 3 of the dates or sequences are not in the proper order	____
Learning of content	The student can accurately describe 75% or more of the events on the timeline without referring to it and quickly determine which of two events came first	The student can accurately describe 50% of the events on the timeline without referring to it and can quickly determine which of the two events occurred first	The student can describe any event on the timeline if allowed to refer to it and can determine which of two events occurred first	The student cannot use the timeline effectively to describe events or to compare events.	____
Resources	The timeline contained at least 9 events related to the topic	The timeline contained at least 7 events related to the topic	The timeline contained at least 5 events related to the topic	The timeline contained less than 5 events related to the topic	____
				Total	____

Teacher's Comments:

TIMELINE RUBRIC

Category	4	3	2	1
Quality of Contents	Included events are important and interesting. No major details are excluded.	Most of the included events are important or interesting. One or two major events may be missing.	Some events included are trivial, and major events are missing.	Many major events are excluded, and too many trivial events are included.
Quantity of Facts	The timeline contains at least 8–10 events related to the topic being studied.	The timeline contains at least 6–7 events related to the topic being studied.	The timeline contains at least 5 events related to the topic being studied.	The timeline contains fewer than 5 events.
Accuracy of Content	Facts are accurate for all events reported on the timeline.	Facts are accurate for almost all events reported on the timeline.	Facts are accurate for most (75%) of the events reported on the timeline.	Facts are often inaccurate for events reported on the timeline.
Sequence of Content	Events are placed in proper order.	Almost all events are placed in proper order.	Most (75%) of the events are placed in proper order.	Most events are incorrectly placed on the timeline.
Dates	An accurate, complete date has been included for each event.	An accurate, complete date has been included for almost every event.	An accurate date has been included for almost every event.	Dates are inaccurate or missing for several events.
Sentence Fluency	Events are clearly described using accurate and vivid language.	Events are described well, but language is sometimes vague or inaccurate.	Events are not described well and language is often vague or inaccurate.	Events are described using vague language or inaccurate information.
Mechanics	Punctuation, spelling and capitalization were checked by another student and are correct throughout.	Punctuation, spelling and capitalization were checked by another student and are mostly correct.	Punctuation, spelling, and capitalization are mostly correct, but were not checked by another student.	There are many punctuation, spelling, and capitalization errors.

Answers to Summative Test:

I.

1. Competition for resources would increase as resources decline.
2. The greater the population density, the greater the effect of limiting factors. For example, when population density of plant seedlings is too great, there may not be enough water to support the growth and development of all the seedlings. Many will not survive, reducing the size of the population.
3. The soy beans might be killed by the fungus, which would most likely also die.
4. Plants and animals living in the forest will lose their habitats and will decrease in number. Soil erosion increases
5. Destruction of habitat is the main cause of extinction.

II.

1. 15 ants per sq. m. size, 60 ants divided by 4 sq.m. equals 15; if there are 100 ants in an 8 sq.m. plot, the population density is 12.5 ants per sq.m.
2. About 27 per sq.km.
3. 20 monkeys

III.

1. The ocean
2. The greenhouse effect
3. Alternative
4. Medicine
5. More

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 endangered when its population is so low that it is nearly extinct.
- Human actions have resulted in habitat loss and degradation that have 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 to 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 organism of the same species inhabiting a place at the same time.

Population density the number of individuals in an area

Limiting factors environmental conditions that keep a population from over increasing in size and 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 (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.

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PRINTED

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Strauss E. & Lisowski, M. (2000).Biology:The Web of Life. Pearson Education Asia

Biggs. A. Gregg, K., et.al. (2000).Biology: the Dynamics of Life.the McGraw Hill Companies. Inc.

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Philippine Biodiversity Conservation: A Trainer's Manual

Suggested Time Allotment: 15 hrs.

Unit 1
Module

4

ECOSYSTEM: Life Energy

Content Standard	Performance Standard
The learner demonstrates the understanding of: • Structure and function of plant parts and organelles involved in photosynthesis • Structure and function of the mitochondrion as the main organelle involved in respiration	Design and conduct an investigation to provide evidence that plants can manufacture their own food.

Overview

In grade 8, students learned how energy is transformed and how materials are cycled in the ecosystem. In grade 9, students will focus on how plants capture energy from the sun and use it for cellular activities. They will describe the processes involved in the flow of energy and matter in the ecosystem by differentiating the basic features and importance of photosynthesis and respiration. This module shows the structure and function of plant parts and organelles involved in photosynthesis and cellular respiration as well as the factors that affect the rate of food making and cellular respiration.

In this module, students will learn about the basic features and importance of photosynthesis and respiration to living organisms. Students should know the process of food making by plants and how this food benefits animals and man. Students will conduct investigations on the factors that affect the rate of photosynthesis, and its effect on the harvest of crops. Students will be able to:

- Identify the cell structure and functions of plants involved in the food making process.
- Identify the raw materials needed for photosynthesis.
- Explain the phases involved in photosynthesis and cellular respiration.
- Describe how the materials and energy flow in the ecosystem.
- Analyze the importance of photosynthesis on the quality and quantity of harvest.

- Identify strategies to improve farm practices.

The module has activities that will help students understand the process of food making, the conversion of food into chemical energy and how it flows throughout the ecosystem. The understanding of these concepts and development of skills will be strengthened through inquiry-based activities like: gathering information through observations, internet search, survey/interview; analyzing collected data and explaining how these materials are of benefit to the entire ecosystem.

Key questions for this module

How do plants manufacture 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?

In this module, students will perform activities and gather evidences that will provide them ideas on how plants capture energy for food making and how other materials affect the rate of photosynthesis. Then they will demonstrate understanding on how these materials and energy flow in the ecosystem. Finally, students will make a proposal on how these learned concepts can help farmers improve their harvest and promote urban gardening to community members.

Note: As you give an overview of what the students will go through, the time frame, standards set that are found in the rubric, and the final product that the students must develop at the end of the module.

Answers to pre-assessment:

1) a
2) d
3) c
4) d
5) d
6) b
7) d
8) c
9) c
10) a

Activity 1

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

In activity 1, students will do activities in different learning stations. For each station, the students will learn a specific concept on photosynthesis such as identifying the cell structures involved in photosynthesis, describing the process of food making done by plants, identifying the raw materials and products of photosynthesis. The Teacher will provide an activity sheet as a form of assessment tool to guide students in the attainment of the learning objective/task.

For ICT integrated: The teacher will prepare three learning stations in the computer laboratory room and post the activity sheet and procedure to each station. If the computer laboratory room is not available, you may set up three computer units or laptop in the science laboratory room for the three learning stations.

Note: If ICT infrastructure is not available, you may just use the textbook or charts for each learning station.

Links as of October 2013

a. Learning station 1: Plant structures for photosynthesis (Identifying plant structure for photosynthesis)
   http://dendro.cnre.vt.edu/forestbiology/photosynthesis.swf
b. Learning station 2: Photosynthesis (identifying raw materials and products of photosynthesis)
   http://www.youtube.com/watch?v=C1_uez5WX1o (as of October 2013)
   http://earthguide.ucsd.edu/earthguide/diagrams/photosynthesis/photosynthesis.html
c. Learning station 3: (Understanding the process of photosynthesis)
   http://www.sites.ext.vt.edu/virtualforest/modules/photo.html

Each group will make a summary of the different concepts they learned from each learning station which will be presented to the class.

Presentation Checklist:

	Observed	Not Observed
Content:		
• Include the following: ○ Important parts/structures of plants involve in photosynthesis ○ Raw materials and products for each stage/phase of photosynthesis ○ Brief description of the whole process		
Delivery		
• Clarity of voice – loud enough to be heard by the entire class		
• Confident – establishes eye contact with the audience		
• Uses a good visual material		

Sample rubric/Scoring guide for the students' presentation:

Criteria	10	7	4
Content	We included the following: • the important parts/structures of plants involved in photosynthesis • raw materials and products for each stage/phase of photosynthesis • a brief summary of the whole process during our discussion/presentation of output	We missed one of the following: • the important parts/structures of plants involved in photosynthesis • raw materials and products for each stage/phase of photosynthesis • a brief summary of the whole process during our discussion/presentation of output	We missed two of the following: • the important parts/structures of plants involved in photosynthesis • raw materials and products for each stage/phase of photosynthesis • a brief summary of the whole process during our discussion/presentation of output
Delivery	• We were able to present the result of our group activity confidently with a clear and loud voice so that everybody can hear us • We also used visual materials that make our presentation easy to understand.	• Our group used visual materials that made our presentation easy to understand • We presented with a loud voice but were not able to establish eye contact with our classmates and teacher.	• We were able to share the result of our group activity with visual aid but were not confident • Some of our classmates could not hear clearly what we were saying.

Teaching Tips:

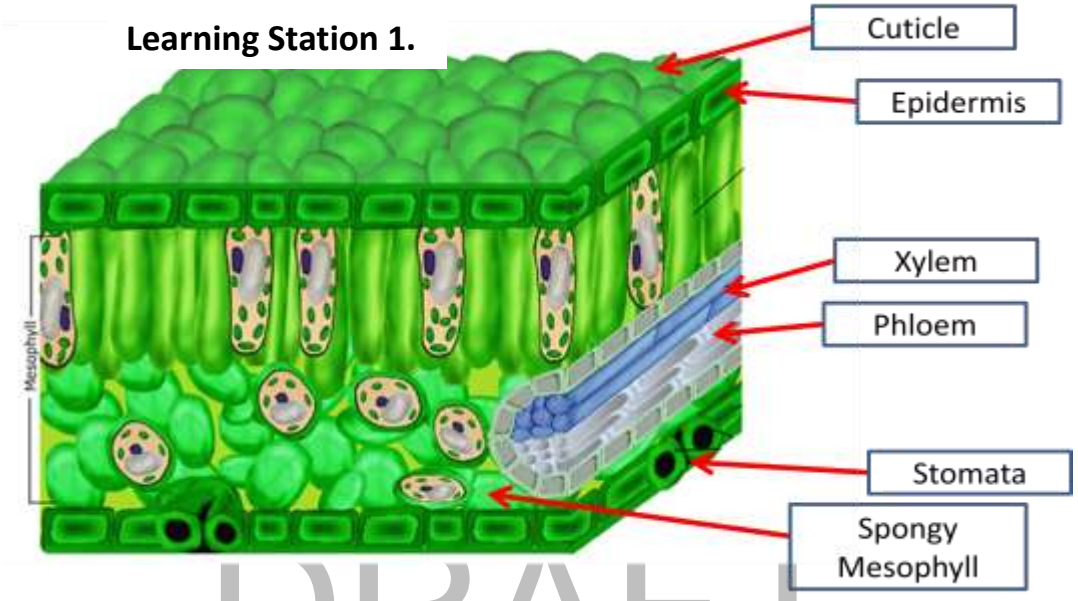
1. Things to do before the session:
    a. Secure a schedule on the use of the computer laboratory room from the computer laboratory in-charge.
    b. Divide the members of the class based on their abilities/skills. Consider the students' technology skills (use of computer and the internet).
    c. Create a rubric for the students' presentation of learned concepts (optional)
    d. Reproduce the activity sheets
    e. Visit the links for each learning station to check if the links are still working and to familiarize yourself with the concepts that can be found on each website.
2. Encourage collaboration and teamwork by giving specific roles/tasks to each member of the group.
3. Orient the students on the Do(s) and Don't(s) while inside the computer laboratory room.
4. Ensure that everybody is participating in the completion of the task.
5. Make sure that the computer laboratory technician or in-charge is with the class during the computer laboratory use to help you in case technical issues will be encountered by the students.
6. Presentation can be done in the classroom
7. Refer to the sample activity rubric in assessing the students' performance below. This can be modified.

ACTIVITY RUBRIC

Criteria	5	4	3	2	1
Content	Correctly answered all the questions in the activities	Incorrectly answered 1 of the questions in the activities	Incorrectly answered 2 of the questions in the activities	Incorrectly answered 3 of the questions in the activities	Incorrectly answered 4 or more of the questions in the activities
Completion of task	Perform all the procedures in the activities and completed on or before the given time.	Perform all the procedures in the activities and completed 1 minute after the given time	Perform all the procedures in the activities and completed 2-3 minutes after the given time	Perform and completed all the procedures in the activities 4-5 minutes after the given time	Was not able to complete the task in the activities
Neatness	Wrote the results of the activities on manila paper without erasures	Wrote the results of the activities but with one erasure	Wrote the results of the activities but with two erasures	Wrote the results of the activities but with three erasures	Wrote the activities but with four or more erasures

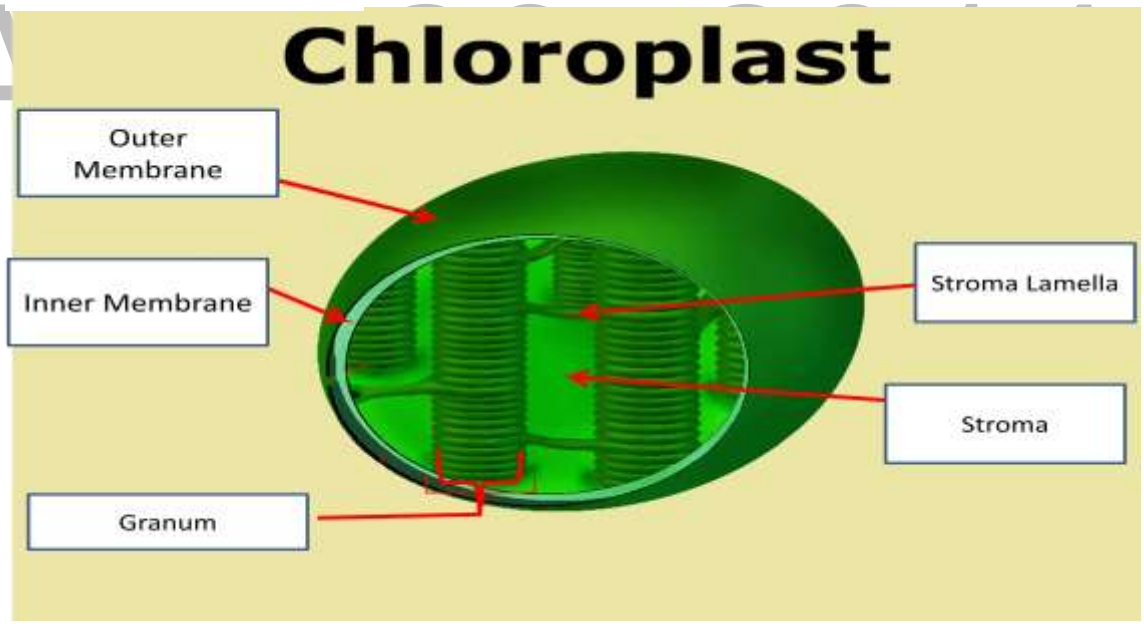
Answers to Activity sheets:

Learning Station 1.



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

Learning Station 1b.

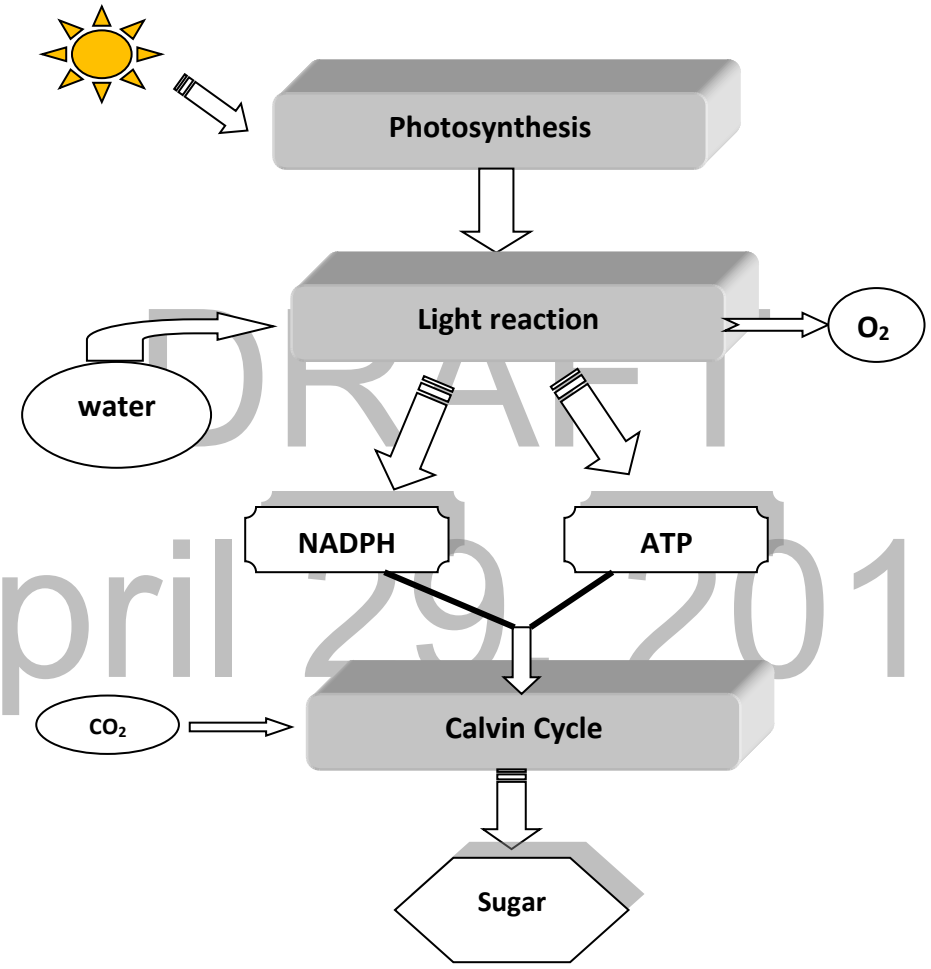


Source: http://dendro.cnre.vt.edu/forestbiology/photosynthesis.swf

Learning Station 2:

Raw Materials	Products
Sunlight Chlorophyll Carbon dioxide Water	Oxygen Sugar (food, glucose)

Learning station 3:



KEY CONCEPTS TO EMPHASIZE:

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**. Below is a summary equation for photosynthesis.

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

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 mainly 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 stomata. The upper and lower epidermis protects the leaves and has nothing to do with photosynthetic processes. The 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 are collected in the spongy layer and enter and exit 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 are absorbed, thus making these colors unavailable to our eyes while the green light is reflected which makes the chlorophyll looks green. However, it is the energy from red and blue light that is absorbed will be used in photosynthesis. The green light that we can see is not absorbed by the plant and thus, cannot be used to do photosynthesis.

There are two stages of photosynthesis: (a) light-dependent reaction and (b) Calvin Cycle (dark reaction). The 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. These products will be needed by the next stage to complete the photosynthetic process.

The 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 the light reaction, thus it occurs immediately after the light-dependent phase.

The chemical equation for photosynthesis may be summarized as follows:

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

Activity

2

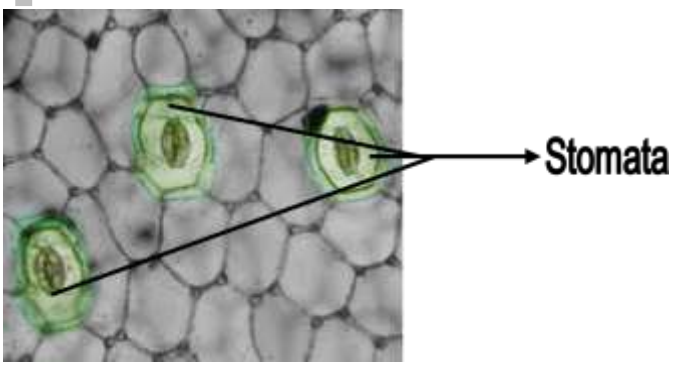
Investigating the Leaf Stomata

Note: The teacher must conduct a try-out of the activity before doing it in the class.

Teaching Tips:

1. Provide the students with clear nail polish and a sharp blade.
2. Give laboratory precautionary measures to the students before asking them to do the activities.
3. Explain the objective of the activity and the standards found in the rubric. Provide each group a copy of the rubric to guide the students in the completion of the task.
4. Make sure the students have painted a thick clear nail polish and had it dried completely before covering a clear tape on the painted area of the leaf. This will ensure a good stomata imprint for microscopic observation.
5. Prepare the laboratory room by arranging the microscope per table depending on the number of groups.
6. During the processing of students' output, the discussion must focus on the structure and function of the stomata.
7. The teacher may want other groups to use a sharp blade to peel off a very thin portion of the lower part of the leaf in making their specimen. (Strict supervision is needed to avoid accidents)

Answers to Questions:

Q1. 

KEY CONCEPTS TO EMPHASIZE:

Stomata are mostly found on the lower surface of the leaf of land plants. They consist of two specialized cells, called guard cells. Their main function is to allow gases such as carbon dioxide, water vapor, and oxygen to move rapidly into and out of the leaf.

Activity 3

Evidence of Photosynthesis

In this activity the students will conduct an investigation by performing several experiments. Depending on the students' readiness, the teacher may ask them to perform the activity once every session or simultaneously.

For simultaneous experimentation, the teacher may assign different experimental designs to show evidences that plants are capable of making food through photosynthetic process.

Divide the activities into three sets: (a) products of photosynthesis, (b) raw materials for photosynthesis, (c) factors affecting the rate of photosynthesis.

3A. To show that oxygen is produced in Photosynthesis:

Answers to Questions:

Q2. Bubbles were seen on the surface of the leaf.
Q3. Yes, there are bubbles seen in the setup.
Q4. These bubbles indicate that the leaf releases gas (O_2).

3B. To show that sugar is produced in photosynthesis

Answers to Questions:

Q5. Possible answers:

- The leaf can perform photosynthesis.
- The leaf contains starch.
- The leaf can produce sugar or starch.
- Green parts of the plant can produce sugar.

Part3C. To show the effect of light on the rate of photosynthesis

For Advanced Learners: Ask students to design an experiment that will show the effect of environmental factors on the rate of photosynthesis such as light intensity, temperature, and carbon dioxide concentration. Use the notes below as guide for the students in designing their experiments.

- When checking the effect of each of the above factors, it is important that the factors (such as light intensity, temperature, amount of carbon dioxide) are at a suitable

value and are kept constant at that value. To do this, the following must be considered:

- Temperature: It should be kept constant at 25ºC by using a heated water bath monitored with a thermometer.
  Light Intensity: Use a lamp close to the plant at a fixed distance and monitor it using a light meter.
- Carbon Dioxide Concentration: Prepare a saturated CO_2 solution by using sodium bicarbonate or baking soda in water. (It dissolves moderately in water, releasing carbon dioxide.)

Note: Remember to tell the students how the variables are changed.

1. Temperature: water baths at different temperatures
2. Light Intensity: lamps at different distances from the plant
3. Carbon Dioxide Concentration: different concentrations of baking soda in water

Possible experimental designs:
source:(http://www.skoool.ie/skoool/homeworkzone.asp?id=233)

1. To show the effect of varying the temperature on the rate of photosynthesis

A. Place a funnel over Elodea, pondweed, or Santan leaf or Hydrilla in a beaker of freshwater at 25°C.
   The funnel is raised off the bottom on pieces of blue-tack to allow unhampered diffusion of CO_2 to Elodea.
B. Invert a test tube full of water over the stem of the funnel to collect any gas from the Elodea.
C. Place the lamp (the only light source) at a fixed distance from the plant - check its constancy with a light meter.
D. Excess sodium bicarbonate is placed in the water to give a constant saturated solution of CO_2.
E. The temperature is 20°C - room temperature; thermostatically controlled room-heating system.
F. Allow the plant five minutes to adjust to the new conditions.
G. Count the number of oxygen bubbles given off by the plant in a five-minute period. Repeat procedure G for the next five-minute period. Count twice more and calculate the average of the three readings. (5 minutes, 10 minutes, 15 minutes)
   This is the rate of photosynthesis at that particular temperature.
   The gas should be checked to prove that it is indeed oxygen - relights a glowing splint.
H. Repeat at different temperatures: 0°C - surround the beaker with an ice jacket; greater than room temperature (25°C, 30°C, 35°C, 40°C, 45°C, etc.,) by using a hot plate.
I. Graph the results placing temperature on the x-axis.

2. To show the effect of varying the carbon dioxide on the rate of photosynthesis

A. Place a funnel over Elodea, pondweed, or Santan leaf or Hydrilla in a beaker of freshwater at 25°C.
   The funnel is raised off the bottom on pieces of blue-tack to allow unhampered diffusion of CO_2 to Elodea.
B. Invert a test tube full of water over the stem of the funnel to collect any gas from the Elodea.
C. Place the lamp (the only light source) at a fixed distance from the plant - check its constancy with a light meter.
D. The temperature is 20°C - room temperature; thermostatically controlled room-heating system.
E. Excess sodium bicarbonate is placed in the water to give a constant saturated solution of CO_2.
F. Allow the plant five minutes to adjust to the new conditions.
G. Count the number of oxygen bubbles given off by the plant in a five-minute period. Repeat the count twice more and calculate the average of the three readings. This is the rate of photosynthesis at that particular temperature.
   The gas should be checked to prove that it is indeed oxygen - relights a glowing splint.
H. Repeat at different lower carbon dioxide concentrations by using different dilutions of a saturated solution.
I. Graph the results placing carbon dioxide concentration on the x-axis.

For average and challenged class use the activities below:

Effect of Light on the production of bubbles

Make two setups similar to Figure 1. Take a 2-3 small santan leaves and place them in a glass funnel; invert the funnel in a beaker of water. Invert a test tube over the stem of the funnel. Leave one setup in sunlight for 3 minutes. While cover the other setup with a black garbage bag in a shaded area or room. Count the number of bubbles every 30 seconds and record it on the observation table.

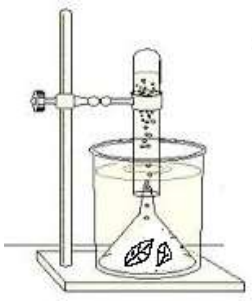


Figure 1: Sample setup

Optional: Remove the test tube carefully and insert a glowing splinter (glowing match stick) into it. The splinter burns brightly.

Note: The teacher must carefully supervise the students in using glowing splinter.

Observation table:

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

Answers to Questions:

Q6. The setup that is exposed to sunlight
Q7. The bubbles indicate that there is photosynthesis
Q8. The gas collected was Oxygen, because the glowing splinter burns brightly.
Q9. The number of bubbles also increases.
Q10. Production of bubbles indicates that photosynthesis takes place.
Q11. As the intensity of light increases, the rate of photosynthesis also increases.

3D. To show that carbon dioxide is needed in photosynthesis

Testing for the presence of carbon dioxide

- As a safety measure, it is advised that the teacher must prepare the lime water solution. To do this, follow the steps below:
  a. Weigh 10 grams of lime (apog) and place it in an empty bottle.
  b. Add 450 mL tap water, cover and shake thoroughly.
  c. Leave it for five minutes and wait for the lime to settle.
  d. Transfer the liquid to another empty bottle and discard the solid particles of lime to another bottle properly.
- Highlight specific instructions that will help the students to be successful in performing the experiment.
- If carbon dioxide is present, the water turns cloudy.

2. **Photosynthesis and carbon dioxide** *(adapted from DepEd NSTIC Science II, Exercise 9, pages 20-22)*
   - Observations may vary depending on the results of the experiments done by the students.

Relate the importance of photosynthesis to global warming by asking the students **How can photosynthesis help solve global warming?**

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

Teaching Tips:

Note: If mayana is not available in the school garden, ask each group to bring one pot of mayana plant**.** After the session, ask the students to arrange the pots of mayana plant in the school garden.

- Show a sample leaf to the students and remind them not to get sample leaves from just one mayana plant found in the garden so that the students will not harm the plant.
- Remind the students to read the procedures carefully. To ensure that they can follow the procedure correctly, ask a volunteer to demonstrate the steps.
- Give precautionary measures in handling equipments and chemicals (alcohol lamp, test tube, denatured alcohol, and iodine solution).

Answers to Questions:

Q19. The color of the alcohol becomes green.

Q20. The color of the leaf was extracted and mixed with the alcohol.

Q21. The color of the leaf was removed.

Q22. Most of the area of the leaf is green.

Q23. The green part of the leaf is shaded.

Q24. The shaded part produced more starch.

Q25. The presence of green pigment enables the leaf to produce starch. The greener the leaf, the greater is the rate of photosynthesis.

Cellular Respiration

Food is considered as the major source of energy for all organisms. In activities 1 to 3, the teacher developed students' understanding of food production in plants.

In respiration, the food is broken down to release the energy (ATP) in the presence of oxygen. It takes place in the cell, specifically in the mitochondria.

We can divide cellular respiration into three metabolic processes: glycolysis, Krebs Cycle, and oxidative phosphorylation. Each of these occurs in a specific region of the cell.

1. Glycolysis occurs in the cytosol or cytoplasm.
2. Krebs Cycle takes place in the matrix of the mitochondria.
3. Oxidative phosphorylation via the electron transport chain is carried out in the inner mitochondrial membrane.

In the absence of oxygen, respiration consists of two metabolic pathways: glycolysis and fermentation. Both of these occur in the cytoplasm.

Teaching tips:

- Teacher can make the students play a game such as word hunt, puzzle, or one man standing as motivational activity before starting the lesson. Below are some of the words that can be used in the word hunt activity. It would be more exciting if the teacher will make a big copy of the word hunt chart posted on the board or use ICT tools like a computer, multimedia projector and make the word hunt template/chart interactive.

Word List

ANAEROBIC RESPIRATION	FERMENTATION		AEROBIC RESPIRATION
CITRIC ACID CYCLE	LACTIC ACID	ATP	NADP
GLYCOLYSIS	ELECTRON TRANSPORT	CARBON DIOXIDE	WATER
OXYGEN	GLUCOSE	ETHYL ALCOHOL	

Presentation of the Lesson:

- The teacher, together with selected students, may want to demonstrate the cellular activity in yeast. The results must be shown to the class to be used as a springboard in the discussion of cellular respiration.

Cellular Respiration in Yeast

(*activity adapted from EASE Module 5, pages 11-13*)

Materials:

Distilled water	pH paper	2.5 grams table sugar
Test tube	Baker's yeast	Test tube rack
Balloon	Rubber band	

Procedure:

1. Warm water to 37°C.
2. Place lukewarm water in a test tube.

A. Add sugar to produce 5% sugar solution. Dip a pH paper into the mixture. Match the color of the wet pH paper with the accompanying color chart.

3. Drop 5-10 granules of yeast.
4. Mix with swirling motion.
5. Place the test tube in a test tube rack.
6. Attach a balloon to the mouth of the test tube.
7. Secure the balloon with a rubber band.
8. Wait for a few minutes.
9. Once the balloon is fully inflated, remove the balloon and tie it with a rubber band.
10. Dip another pH paper. Note the color change of the pH paper.

Questions:

- What does the yeast represent?

Ans. The yeast represents the cell doing cellular respiration.

- What is the purpose of sugar?

Ans. Sugar is the source of carbohydrates/glucose to be broken down by the cell.

- Why did we use lukewarm water?

Ans. Because metabolic process occurs at 37°C.

- What did you notice at the surface of the sugar solution after you dropped the yeast?

Ans. There were bubbles at the surface.

- What happened to the balloon after attaching it to the mouth of the test tube?

Ans. The balloon was inflated.

- What filled up the balloon? Explain your observation.

Ans. The balloon was filled by gas (carbon dioxide).

- What was the pH of the mixture after removing the balloon? Why?

Ans. The pH of the mixture was below neutral (acidic).

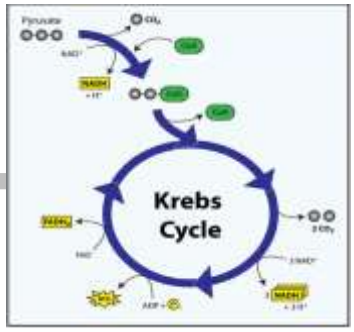
In the activity, you saw bubbles coming out from the mixture. This means that the yeast fed on the sugar. The evidence is bubbles formation, which is carbon dioxide. The mixture became acidic as shown by the color change of the pH paper.

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

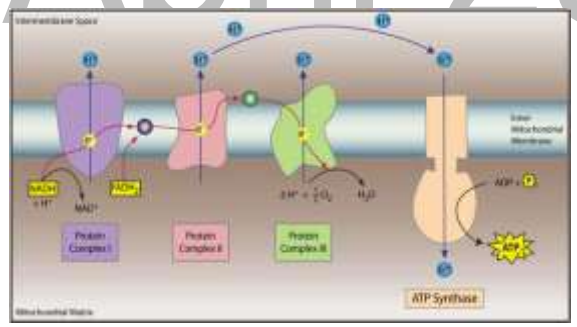
The Krebs Cycle occurs in the mitochondrial matrix and generates a pool of chemical energy (ATP,NADH, and $FADH_2$) from the oxidation of pyruvate, the end product of glycolysis.



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.

Generate students' enthusiasm by giving an overview of what they are about to work on for the next few days.

Activity 4

The Power House!

This activity involves reading comprehension. Students will read silently the information given in the module and will work on the task describing the parts and function of the mitochondrion based on what they have read.

Activity 5

Let Us ReCharge!

Answers to Questions:

A. **Understanding Glycolysis**

Q26. The term found in the diagram that denotes a process is GLYCOLYSIS.

Q27. Glycolysis takes place in the cytoplasm of the cell.

Q28. The raw material for Glycolysis is glucose or sugar.

Q29. The products are pyruvate and ATP
Possible answer: Glycolysis occurs in the cytoplasm of the cell. The material needed in this process is glucose or sugar that is broken down into 2 molecules of pyruvate and chemical energy or ATP.

B. Let us go round and round

Answers to Questions:

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

C. Pump it out!

For those who do not have ICT infrastructure, make a chart showing the flow of electrons during the electron transport chain. Then ask the students to answer the

questions in their module. Click on the link below to see a sample chart for electron transport chain.

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

http://www.wiley.com/college/boyer/0470003790/animations/electron_transport/electron_transport.htm

Answer to Questions

Q30. The electrons flow along the membrane and change to ATP.

Q31. NADH and $FADH_2$ are high energy carriers that provides electron for the synthesis of ATP.

Q32. The final acceptor of electron in the ETC is oxygen.

Q33. When electrons (hydrogen) combine with the last acceptor (oxygen) it forms water molecule.

Activity 6

Comparing Photosynthesis and Respiration

In this activity, the teacher must guide the students in understanding how photosynthesis and respiration help in the cycling of materials in the ecosystem and allow the continuous one-way flow of energy in the ecosystem.

Answer:

Basis of Comparison	Photosynthesis	Respiration
1. Cell structure involved	Chloroplast	Mitochondrion
2. Starting materials/raw materials	Carbon dioxide and water	Sugar and oxygen
3. End Product	Sugar and oxygen	Carbon dioxide and water
4. Energy Requirement	Sunlight/ light energy	ATP

Product/Project Making:

Finally, the class will make a product that will be helpful for the community members to put up a vegetable urban garden at home or in the community. The students will make a collection of strategies on how to improve the quantity and quality of harvest of crops in an urban garden. To do this, the students will collect data through interview, survey and internet search. Students will conduct interviews with the officer-in-charge, staff of the city agriculture office and farmers in the locality. A survey will be done in the community to determine the number of residents who know how to plant crops and are willing to put up an urban garden in their homes. An internet search will be done to gather more information about different styles or lay-out of urban gardens suited for different residential building designs, and lot areas. The product can be a multimedia presentation, a brochure, webpage, or a blog that will be presented during a culminating activity. You may invite farmers, community members or local government officials that will serve as audience for the students' presentation.

The creation of their project should be guided with a product/project rubric that can also be used as a scoring guide for grading the students' performance and learning output. Task, progress and group contribution checklists must be given to the students to help them monitor progress and promote self direction. Use planning template to guide students to think how they will go about completing the task.

Things to do before project making:

- Make a timetable for the activities and an assessment timeline that will guide you on the assessment tools to be used before, during, and after the project-making.
- Create a planning template to guide your students during the planning session
- Arrange appointments with the staff/officer-in-charge of the local agriculture office, farmer, or community members for the survey and interview.
- Request schedule for computer laboratory use for the sorting of data collected and creation of the product. For those who do not have a computer laboratory room, the teacher may ask the students to go to internet café or survey students who have computers at home where they can sort collected data and create their products.
- Secure a letter signed by the department head and school head for the parents' consent and involvement for the outdoor activities.
- Prepare a monitoring, progress and task checklist, product and collaboration rubric, that will help both students and teacher in the project making.

Sample Assessment Tools:

Source: Intel® Assessment Library https://educate.intel.com/assessing/PersonalLibraryPage.aspx

Collaboration Checklist

	Examples
Examples of what I offered to project planning:	
Examples of what I contributed to the project's completion:	
Examples of my ideas that helped make the project successful:	
Examples of what I did to help our group stay on task:	
Examples of strategies I used to resolve conflicts or problems:	
What I enjoyed most about this project:	
What I learned from this project:	
Examples of changes I would make the next time I work on a group project:	

Blog Checklist

	Present	Comments
My blog has a purpose and a topic.		
I get information from reliable sources.		
My blog is accurate.		

	Present	Comments
I draw original conclusions from my research.		
My blog is written for a specific audience.		
I encourage readers to respond.		
I update my blog regularly.		
I include extra features that add meaning to my blog.		
I cite my sources and follow copyright laws.		
My blog has no spelling or grammatical errors		
My blog has some surprising and original parts.		

Group Task Rubric/Self-Assessment

	4	3	2	1
Understanding of Task	I/we demonstrated an in-depth understanding of the content, processes, and demands of the task.	I/we demonstrated substantial understanding of the content and task, even though some supporting ideas or details may be overlooked or misunderstood.	I/we demonstrated gaps in our understanding of the content and task.	I/we demonstrated minimal understanding of the content.
Completion of Task	I/we fully achieved the purpose of the task, including thoughtful, insightful interpretations and	I/we accomplished the task.	I/we completed most of the assignment.	I/we attempted to accomplish the task, but with little or no success.

	4	3	2	1
	conjectures.			
Communication of Findings	I/we communicated our ideas and findings effectively, raised interesting and provocative questions, and went beyond what was expected.	I/we communicated our findings effectively.	I/we communicated our ideas and findings.	I/we did not finish the investigation and/or were not able to communicate our ideas very well.
Group Process	We used all of our time productively. Everyone was involved and contributed to the group process and product.	We worked well together most of the time. We usually listened to each other and used each other's ideas.	We worked together some of the time. Not everyone contributed equal efforts to the task.	We really did not pull together or work very productively as a group. Not everyone contributed to the group effort.
Problem Solving	Problems did not discourage us. We were positive and worked together to solve problems.	We worked together to overcome problems we encountered.	We might have worked more productively as a group.	Some people did more work than others. OR Nobody worked very well in the group.

Multimedia Presentation Rubric

4	3	2	1
Content: Purpose			
My presentation has a purpose or theme. All the parts of my presentation say something meaningful about the purpose or	My presentation has a topic. All the parts of my presentation say something important about the topic.	My presentation has a topic. Most parts of my presentation say something important about the topic.	My presentation's topic is unclear. Many parts of my presentation seem off topic.

4	3	2	1
theme.			
Content: Conclusions			
I use my background knowledge to interpret my research information and draw meaningful conclusions.	I draw reasonable conclusions from my research.	With help, I draw conclusions from my research.	I rarely draw conclusions from my research.
Content: Key Points			
My presentation combines my research and the conclusions I have drawn into a few concise, important points.	My presentation describes the main ideas of my research and the conclusions I have drawn in a few points.	I try to describe the main ideas of my research in a few points, but my presentation may be too wordy or missing information.	My presentation is too wordy or missing important information.
Content: Supporting Information			
I include appropriate, meaningful findings from credible research that support and explain my main points.	I include appropriate findings from research to support and explain my main points.	I try to include findings from research to support and explain my main points, but some information is incomplete or inaccurate.	I do not include enough information to support and explain my main points.
Multimedia Features			
I use graphics, video,	I use graphics, video,	I use graphics, video,	I do not use the

4	3	2	1
sound, and other multimedia features effectively to support my key points and make my presentation more meaningful. I follow all copyright laws when I use multimedia features.	sound, and other multimedia features to support my key points. I follow copyright laws when I use multimedia features.	sound, and other multimedia features, but sometimes they distract from the meaning. I usually follow copyright laws when I use multimedia features.	features of multimedia presentations, or the features that I use are distracting. I often do not follow copyright laws when I use multimedia features.
Creativity			
My presentation includes unusual and surprising features and components that excite my audience about my topic and add to the meaning.	My presentation includes some unusual and surprising features that interest my audience and relate to the meaning.	I try to include unusual and surprising features, but they do not add to the meaning of my presentation.	My presentation includes no unusual or surprising features, or the features I add detract from the meaning.
Organization			
My presentation begins with a slide that introduces the theme in an interesting way, builds information in a logical way, and ends with a slide that leaves the audience with an interesting idea about the theme to think about.	My presentation begins with a slide that introduces the theme, builds information, and ends with a concluding slide.	My presentation is missing a clear introduction or conclusion, and information may be presented in an illogical way.	My presentation is missing an introduction, a conclusion, and a sense of order.
Oral Presentation			

4	3	2	1
I am prepared and have rehearsed my presentation. I speak clearly and smoothly in an engaging way.	I am prepared and have rehearsed my presentation. I speak clearly.	I am somewhat prepared, but I should have spent more time rehearsing. I deliver a presentation but I sometimes forget what I am doing or lose the audience's attention.	I am not at all prepared. I have not rehearsed my presentation. I often forget what I am doing and lose the audience's attention.
Conventions			
My presentation contains no spelling, punctuation, capitalization, or language errors.	My presentation contains no spelling, punctuation, capitalization, or language errors that take away from the meaning.	My presentation contains a few spelling, punctuation, capitalization, or language errors that take away from the meaning.	My presentation contains so many spelling, punctuation, capitalization, and language errors that it is difficult to understand.

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:

$$\textbf{Carbon dioxide} + \textbf{water} \xrightarrow[\textbf{sunlight}]{\textbf{chlorophyll}} \textbf{glucose} + \textbf{oxygen}$$

- Photosynthesis occurs in the chloroplast found in the leaves of the plants.
- Essentially, the two major stages in photosynthesis are:
  - Light reaction phase
  - Calvin cycle
- Improved farming practices enhance photosynthesis that results 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 of respiration is as follow:

Glucose + oxygen ⟶ carbon dioxide + water + ATP

- The breakdown of glucose involves three major steps: glycolysis; Krebs cycle; electron transport chain

Answers to Summative Assessment:

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

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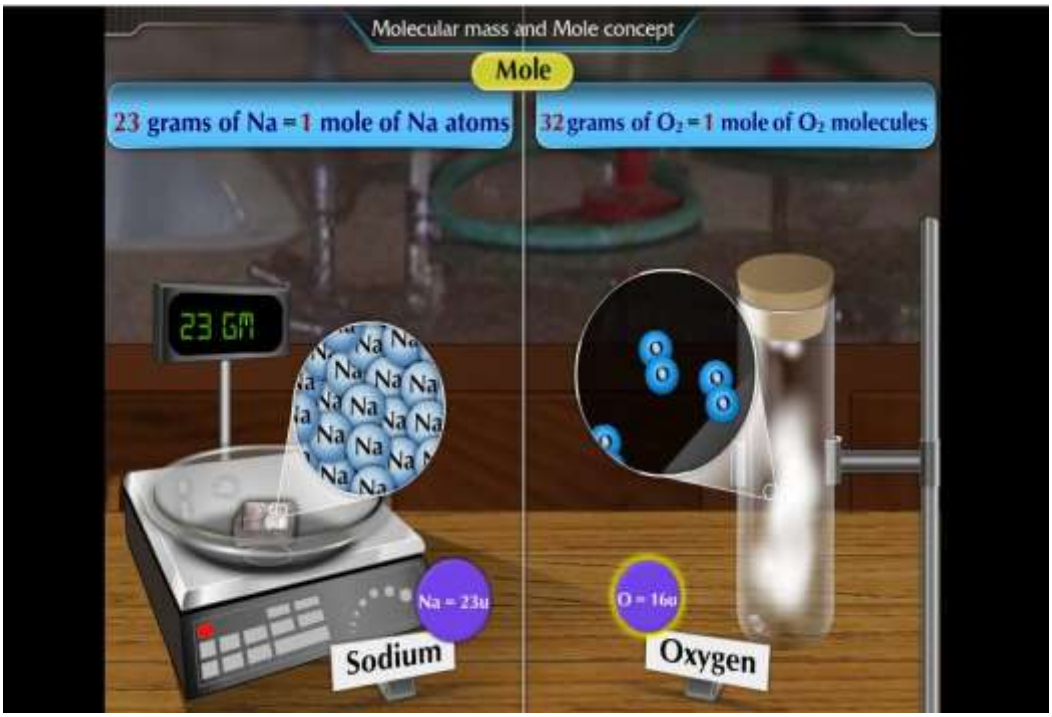
Unit 2: Countless and Active Particles of Matter



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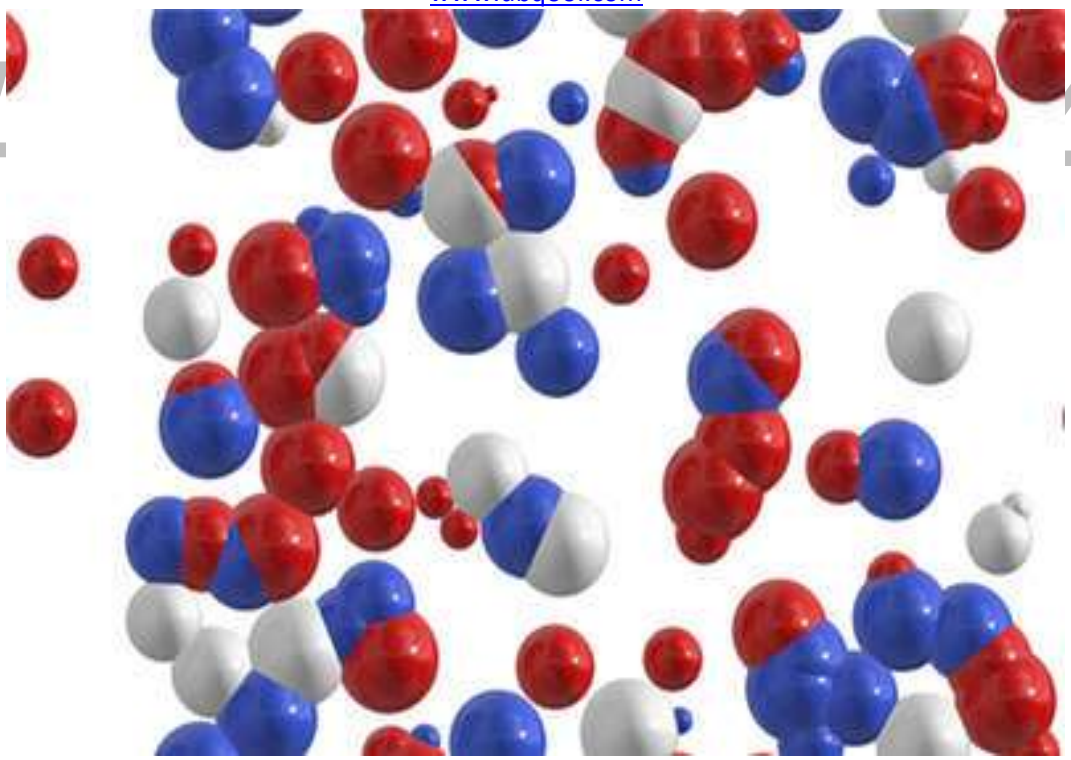

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Unit 2: Countless and Active Particles of Matter

Students learn best when they are given tasks that enable them to discover and/or experience the science concepts they need to understand. The four modules in this unit capitalize on this principle. Thus, the four modules in this unit are packed with different activities which will help you in the development of conceptual understanding among your students.

Each module in the learners' materials takes note of the previous lessons discussed during the grade 7 and 8 chemistry to facilitate the realization of the spiral progression way of presenting the chemistry concepts included in the K to 12 Curriculum. As a science teacher, your role is to make your students grasp that each and every topic discussed is interrelated and interconnected with one another for them to see the bigger picture and how it is like to acquire an interwoven knowledge where they can draw solutions to real life problems or answers to queries. This scenario will create satisfaction among students causing them to be more engaged with the lessons you are facilitating as you progress in the teaching-learning process.

To create appropriate teaching-learning scenario, make it sure to try all the activities before you ask your students to perform them.

The title of this unit gives a general idea of what they are going to learn about matter in grade 9. Countless because of the enormous number of particle present in one mole and active particles because of the chemical bonds that lead to the formation of different kinds of substances including carbon compounds.

The modules included in this unit are as follows:

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

The pre-assessment in each module will give you a feedback on the students prior knowledge of the topic to be discussed, thus, the teacher can gage how to start and where to start. Formative assessments are incorporated in each activity giving the teacher a clue on how well the learners go along with the lesson. Finally, the summative assessment will give a clear cut view of the learning outcome.

Suggested time allotment: 4 hours

Unit 2
Module
1

Electronic Structure of Matter

Content Standard	Learning Competencies
• Understand the development of atomic models that led to the description of the behavior of electrons within atoms.	• 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.

The module presents further development of the atom structure particularly the electron. The electron was believed to be a negatively charged particle in an atom. Scientists continue studying what is the real structure of an atom.

The nuclear atom of Rutherford comprised the proton and neutron and that their masses are concentrated in the nucleus. For Bohr, these are not the only particles in the atom because he found other particles. He also found out that electrons moved in definite orbits around the nucleus.

Further experiments were made, until they came up with the present model of the atom. Students are also motivated to do simple activities that will increase their interests in knowing scientific concepts to satisfy their curiosity.

Key questions:

How does Bohr's 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?

Answer Key:

Pre-Assessment:

1. c
2. c
3. d
4. a
5. d
6. c
7. c
8. d
9. d
10. C

Activity 1

The Flame Test

Earlier concepts of the atomic structure appeared when scientists began to study the emission and absorption of light from different elements. They theorized that emission of light of these elements have something to do with the structure of their atoms.

Students learned about characteristics and properties of light when they were in grade 8. Light exhibits properties that when it absorbs energy in the form of heat, it will display color that corresponds to a certain wavelength.

Perform Activity 1 and find out what happens when metal salts are subjected to heat.

Teaching Tips:

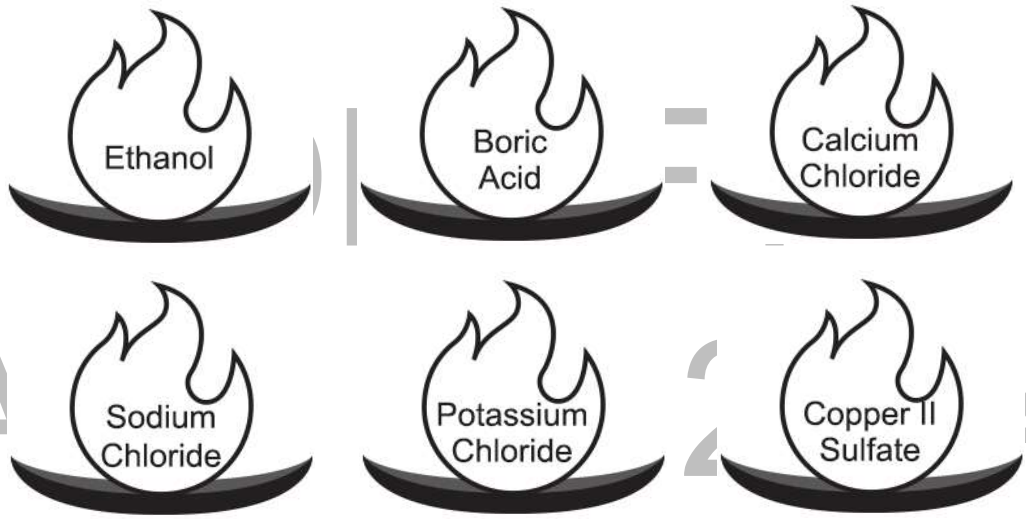
1. Since this is the first activity of the class, the teacher may conduct a pre-lab discussion on the earlier concepts of the atomic structure.
2. Let the students do the activity.
3. Make sure that all materials needed are ready.
4. The teacher will prepare the 3 M Hydrochloric acid solution ahead of time. (If not available, use a commercial muriatic acid).
5. Remind the students that boron is not a metal. It is a metalloid .
6. Write the safety and precautionary measures on the board.

7. For time management, it is ideal that each activity will be given one (1) hour for both the activity proper and concept processing provided that the teacher has complete resources.

Safety and Disposal:

- ✓ Wear goggles, gloves and a safety apron while performing the activity.
- ✓ Do this activity in a well-ventilated area.
- ✓ Hydrochloric acid is corrosive.
- ✓ Ethanol is flammable and should therefore be handled with care unless necessary, keep it away from fire
- ✓ Be careful to extinguish all matches after use.

The following are the expected results of the flame test.



Note:

In case of unavailability of chemicals you may use common substances in your locality as alternative, for example you may use *apog* or calcium oxide in place of calcium chloride, potassium permanganate instead of potassium chloride, and borax instead of boric acid. You may also use indigenous materials which contain the needed metals.

If you do not have concentrated hydrochloric acid (HCl), you may use the commercially available muriatic acid in place of the 3M HCl_{aq}

If watch glass is not available, you may use any ceramic container for this purpose.

Observation:

Metal salt tested	Element producing color	Color of the flame
Boric acid	boron	green
Calcium chloride	calcium	orange
Sodium chloride	sodium	Yellow orange
Potassium chloride	potassium	Light violet
Copper(II) sulfate	copper	Blue-green

Explain to the learners that flame test is a form of qualitative analysis that is used to visually determine the identity of an unknown metal or metalloid ion based on the color emission. A distinctive color is emitted because the heat of the flame excites the electrons of the metal ions, causing them to emit visible light. Remind the students of the limitations of flame test which are as follows:

- It cannot detect low concentrations of almost all ions.
- The intensity of the visible light differs from one sample to another. For example, the yellow emission from sodium is much brighter than the red emission from the same amount of lithium.
- Contaminants affect the test results. Sodium, in particular, is present in most compounds and will color the flame. Sometimes a blue glass is used to filter out the yellow of sodium.
- The test cannot differentiate between all elements. Several metals produce the same flame color. Some compounds do not change the color of the flame at all.

Answer to Questions

Q1. Metal salts emitted different colors because of the absorption of heat from the flame.

Q2. The outermost particles in the metallic element are responsible for the production of colored light.

Q3. The colors observed is an indication that definite energy transformations occurs inside the atom emitting light. It follows that electrons must occupy orbits of fixed energy.

At this point, the teacher will have a post activity discussion on the students' observation.

Q4. The electrons are moving around the nucleus in circular orbits. When an electron absorbed extra energy from an outside source (flame), the electron moves to a higher orbit. Colored light is emitted when the electron falls back to a lower orbit. This light is the difference between the energies of the two orbits involved.

Q5. B. The energy levels (orbits) 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 amounts of energy are not the same. The higher energy levels are closer together. The higher energy level occupied by an electron, the less energy it takes to move from that energy level to the next higher energy level.

You may further discuss the answer in Q5. You may include the different colors seen in a fireworks display.

Activity 2

Predicting the Probable Location of an Electron

In Bohr's atomic model, electrons move in orbits of certain amounts of energy. However, these findings showed that it is not possible to tell the exact position of the electron at any given instant and how it moves in the atom.

In this activity the student will use an analogy to understand the interpretation of Schrodinger's treatment of the atom.

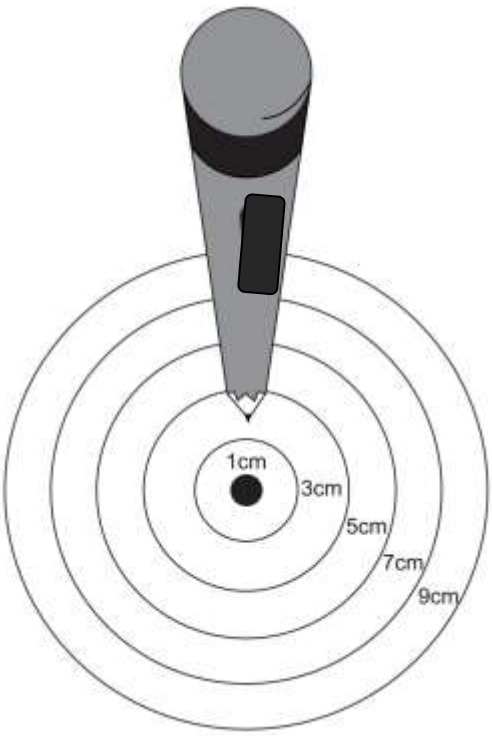
Teaching Tips:

1. You may start by asking the definition of probability and giving an example of similar circumstance.

2. Let students work in pairs if there are enough materials. Felt-tipped marker is preferable than pencil.

3. The teacher should demonstrate how the activity will be done. The center of the circle represents the atom's nucleus and it is the target when dropping the pencil or marker. The dots represent the electrons.

The set up



4. Record the number of dots on the table below.

Shown is a data table with hypothetical values for the last three columns.

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	44	0.8753	88.53
3	5.0	78.54	75.40	32	0.4244	42.44
4	7.0	153.94	100.53	19	0.1890	18.90
5	9.0	254.47	125.66	0	-	-

5. The formula for calculating the area of circle, column (C), is $A = \pi r^2$. For example, for a circle with a radius of 1cm, the area = 3.14 x $(1cm)^2$ = 3.14 cm^2

6. The calculated values in column (D) is the difference of the areas of the two consecutive circles like for Circle 1 & 2 = 28.17 – 3.14 = 25.13.

7. Determine the probability of finding a dot in each of the circles by dividing the number of dots per cm^2 (column F) by the total number of dots (100).

Example: Percent Probability of Finding Dots = 0.1920/ 100 = 19.20%

8. Values in columns E, F, and G may vary.

9. Make sure the students know how to plot a graph.

Answers to Questions

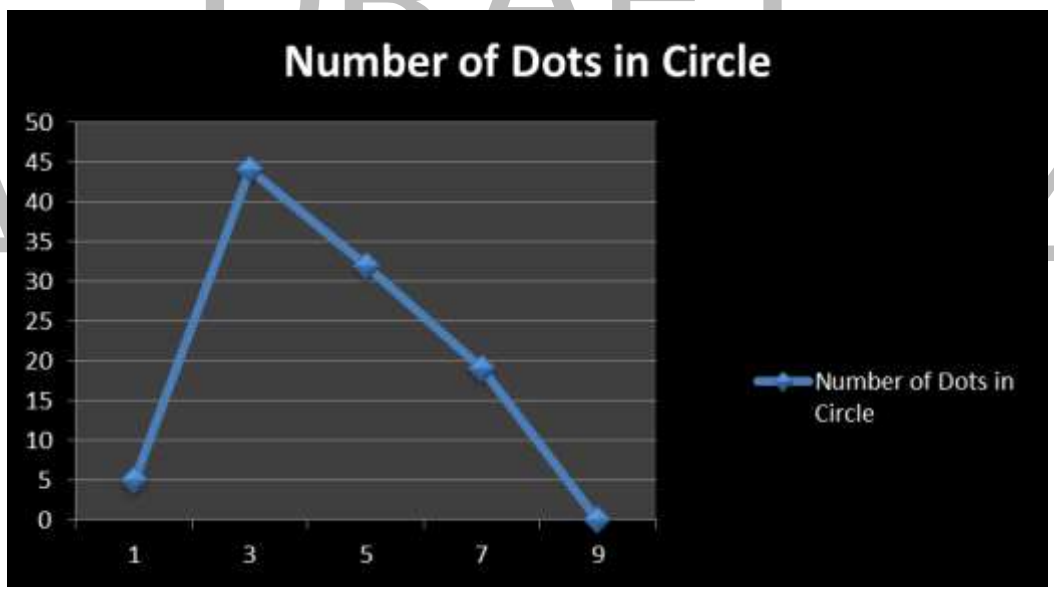
Q1. (Answers will vary)

Based on the data above, the number of dots increases abruptly and then decreases as the dots go farther from the center

Q2 (Answer will vary)
Shown in the table **Percent probability** = [No. of dots /cm^2] X 100

= [0.1920 X 100 = 19.20%

Q3 (Answer will vary) 3 cm



Q4. (Answer will vary) 44 dots

Q5. The results of the activity are similar to the structure of the atom because the probability of finding an electron (dot) increases abruptly then decreases as it goes farther from the nucleus (target).

Q6. There are three types of orbitals (s, p, and d) in the principal energy level three.

Q7. There are five atomic orbitals in the highest sublevel of the principal energy level three.

Activity 3

Electron Configurations

The properties of elements depend mainly on the arrangement of electrons outside the nucleus. Although there are other known particles in an atom, only the electron is located outside the nucleus.

The arrangement of electrons in the orbitals of an atom is called electron configuration. It is important for us to work out electron arrangement to be able to understand more and predict the properties of elements.

Teaching Tips:

1. You may describe an atom by its principal energy levels, sub-energy levels and atomic orbitals. Make illustrations other than the table below.
2. Guide the students while doing the activity.
3. The electron configurations of the elements in the third period of the periodic table is shown below.

Symbol		O	R	B	I	T	A	L		Electron Configuration
	1s	2s	$2p_x$	$2p_y$	$2p_z$	3s	$3p_x$	$2p_y$	$2p_z$	
$_{11}$Na	↑↓	↑↓	↑↓	↑↓	↑↓	↑				$1s^2 2s^2 2p_x^2 2p_y^2 2p_z^2 3s^1$
$_{12}$Mg	↑↓	↑↓	↑↓	↑↓	↑↓	↑↓				$1s^2 2s^2 2p_x^2 2p_y^2 2p_z^2 3s^2$
$_{13}$ Al	↑↓	↑↓	↑↓	↑↓	↑↓	↑↓	↑			$1s^2 2s^2 2p_x^2 2p_y^2 2p_z^2 3s^2 3\ p_x^1 3p_y\ 3p_z$
$_{14}$Si	↑↓	↑↓	↑↓	↑↓	↑↓	↑↓	↑	↑		$1s^2 2s^2 2p_x^2 2p_y^2 2p_z^2 3s^2\ 3p_x^1 3p_y^1 3p_z$
$_{15}$P	↑↓	↑↓	↑↓	↑↓	↑↓	↑↓	↑	↑	↑	$1s^2 2s^2 2p_x^2 2p_y^2 2p_z^2 3s^2\ 3p_x^1 3p_y^1 3p_z^1$
$_{16}$S	↑↓	↑↓	↑↓	↑↓	↑↓	↑↓	↑↓	↑	↑	$1s^2 2s^2 2p_x^2 2p_y^2 2p_z^2 3s^2\ 3p_x^2 3p_y^1 3p_z^1$
$_{17}$Cl	↑↓	↑↓	↑↓	↑↓	↑↓	↑↓	↑↓	↑↓	↑	$1s^2 2s^2 2p_x^2 2p_y^2 2p_z^2 3s^2\ 3p_x^2 3p_y^2 3p_z^1$
$_{18}$ Ar	↑↓	↑↓	↑↓	↑↓	↑↓	↑↓	↑↓	↑↓	↑↓	$1s^2 2s^2 2p_x^2 2p_y^2 2p_z^2 3s^2 3p_x^2 3p_y^2 3p_z^2$

Answers to Questions:

Q1. Yes

Q2. Some patterns are:

1. An orbital has a maximum of two opposite spins.
2. An orbital in the same sublevel is filled with one spin before pairing.
3. Filling the orbitals with electron starts from the lowest energy level to the highest energy level. (1s 2s 2p 3s 3p 4s 3d 4p 5s 4d 5p…)
4. The total number of electrons on the outermost energy level is the same as the group number in the periodic table of elements.

Q3. Some rules are:

1. An electron can be represented by a spin.
2. In filling the orbitals with electron, it should start with the lowest energy level.
3. An orbital in the same sublevel should be filled with one electron before pairing.
4. An orbital has a maximum number of two electrons.

Summative Assessment:

I.

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

II.

1. $2p_x^2$: $1s^2 2s^2 2p_x^1 2p_y^1$
2. $3d_1^1 3d_2^1$: $1s^2 2s^2 2p_x^2 2p_y^2 2p_z^2 3s^2 3p_x^2 3p_y^2 3p_z^2\ 4s^2$
3. $4s^1$: $1s^2 2s^2 2p_x^2 2p_y^2 2p_z^2 3s^2 3p_x^2 3p_y^2\ 3p_z^1$

4. $3p_x^2\ 3d_1^1$: $1s^2 2s^2 2p_x^2 2p_y^2 2p_z^2 3s^2 3p_x^1 3p_y^1 3p_z^1$

5. $3d_1^2\ 3d_2^2$: $1s^2 2s^2 2p_x^2 2p_y^2 2p_z^2 3s^2 3p_x^2 3p_y^2 3p_z^2\ 4s^2$

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Suggested Time allotment: 12-14 hours

Unit 2
MODULE

2

Chemical Bonding

Content Standard	Learning Competencies
• How atoms combine with other atoms by transferring or by sharing electrons • Forces that holds metals together	• 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.

Chemical bonding is a complex topic for Grade 9 students. Its complexity is aggravated by the fact that students cannot observe what is going on at a sub-microscopic level wherein atoms react to form a compound. As a Science teacher you need to present this topic in such a way that the students will understand. Asking the students to prepare a representation of the bonds existing between or among atoms will make you assess their mental models about the topic. You should be very careful with the analogy you are going to use because it might lead to misconceptions and/or alternative conceptions.

Overview:

The students already have knowledge about the particle nature of matter from Grade 8. It is helpful for the students to provide scenarios or activities that will enable them to connect these bits of information to cope up with the new lesson.

In this module, you will introduce the forces of attraction between atoms that lead to chemical bonding. This may result in the sharing or complete transfer of electrons causing the atoms to become isoelectronic with the noble or inert gases, indicating that they have attained stability.

In the course of the discussion, it would be better if you will focus and direct the discussion of this module towards the discovery of concepts that will answer the following focus questions:

How are ionic and covalent compounds formed?
Why is an ionic compound different from a covalent compound?
How is a metallic bond formed?

Answer Key:

Pre-Assessment:

1. b. electronegativity
2. b. molecule
3. d. A metallic element like sodium transfers an electron to a non-metallic element like fluorine.
4. d. nonpolar covalent bond
5. c. metallic bond
6. c.They are malleable.
7. a. it take place when atoms share electrons with one another.
8. c. 3
9. a. sodium chloride (salt)
10. d. having 8 valence electron

Activity 1 Mapping the Periodic Table

This activity highlights the location of the metals, non-metals, and noble gases in the periodic table of elements. This is important for the students to realize that with the use of the periodic table they can easily determine the kind of atom they are dealing with. This will also help you in teaching the students the concept that metals tend to donate electrons while non-metals tend to gain electrons.

Answers to Questions:

Q1. Where can you find metals, non-metals, and noble gases in the periodic table of elements?

Facing the periodic table, metals are located before the metalloids, on the left side of the periodic table of element (Groups I -13).
Facing the periodic table, non-metals are found after the metalloids, on the right side of the periodic table (Groups 14-17).
Noble gases are at the rightmost column of the periodic table (Group 18).

Q2. Which number tells you the number of valence electrons?

The representative elements or main group elements are found in the s-block and p-block of the periodic table. The group number of the s-block (Groups 1 and 2) elements tells us the number of valence electrons. For example, all elements belonging to Group 2 have two (2) valence electrons. An exception is helium in Group 18. For the p-block elements (Groups 13 to 18), the number of valence electrons is the group number minus 10. This pattern does not include the transition elements.

Q3. What do you notice in the number of valence electrons of metals, non-metals, and noble gases?

Metals have lesser valence electrons than non-metals. All noble gases have 8 valence electrons except for helium, which has 2 valence electrons.

Q4. What kind of element has:

a. less than 4 valence electrons?
   Metals have valence electrons less than 4.
b. more than 4 valence electrons?
   Non-metals have valence electrons of more than 4.
c. low electronegativity?
   Generally, metals have low electronegativity.
d. high electronegativity?
   Generally, non-metals have high electronegativity.
e. low ionization energy?
   Metals have low ionization energy.
f. high ionization energy?
   Non-metals have high ionization energy.

Process this activity in such a way that the students will realize the strength of non-metals in attracting the valence electrons and what will happen to the atom if it loses or gains electrons.

Reiterate to the students that the valence electrons are the outermost electrons directly involved in chemical bonding. Thus, they need to know how to represent the valence electrons through the Lewis symbol.

Activity

2

Lewis Symbol

Table 1. Lewis Symbols

Element	Family/Group	Lewis Symbol	Electronegativity Value	Ionization Energy (kJ/mol)
lithium	1	Li ·	0.98	520
fluorine	7	:F:	4.0	1681
sulfur	6	:S:	2.5	1000
calcium	2	Ca:	1.0	590
nitrogen	5	:N:	3.0	1402
aluminum	3	Al:	1.5	578

Answers to Questions:

Q1. Arrange the elements in increasing:

a. valence electrons

Li<Ca<Al<N<S<F

b. electronegativity values.

Li<Ca<Al<N<S<F

c. Ionization energy.

Li<Ca<Al<N<S<F

Q2. What do you notice with the number of valence electrons, electronegativity values, and ionization energies of the elements?

As the number of valence electron increases, electronegativity, and ionization energy also increase.

Q3. What kind of element has the greatest tendency to attract electrons? Why?

Non-metals have the greatest tendency to attract electrons because they have high electronegativity.

Q4. What kind of element requires high energy to remove its valence electrons? Why?

Non-metals have high energy requirement to pull its valence electrons.

Make it clear to the students that electrons move and atoms may gain or lose electrons. You may also discuss that there is an electrostatic force of attraction existing between and among atoms. For them to experience how electrostatic force of attraction works, you may use a magnet or rub plastic and place it above small pieces of paper.

Activity 3

Bonding by Transfer of Electrons

Bonding by transfer of electrons is ionic bonding. It is good to emphasize to the learners that this kind of chemical bond only exists between metals and non-metals. Knowledge acquired from the first two activities can be used to represent ionic bonding.

You may guide your students in choosing the metallic and the non-metallic elements for this activity. Remind them that they need to consider metals from Groups 1 and 2 and the non-metals from the halogen group (Group 7). Tell your students that the best way in choosing the combination that will form ionic bond is by computing the electronegativity difference between the two elements. A combination which has an electronegativity difference of above 1.9 will result to ionic bond.

Answers to Questions:

Q1. What kind of element forms cation after ionic bonding? Why?

Metals form cations because they completely transfer or give away electrons.

Q2. What kind of element forms anion after ionic bonding? Why?

Non-metals form anions because they attract electrons toward themselves.

Q3. Why do ions form after ionic bonding?

Ions form after ionic bonding because this type of bond involves complete transfer of electrons.

Q4. Did the atoms attain stability after ionic bonding? Explain you answer.

Yes, after ionic bonding the participating atoms attain the stable electronic configuration of the nearest noble gas.

Q5. How can you tell that ionic bonding will take place between metals and non-metals?

Ionic bonding will take place between metal and non-metal with

electronegativity difference of greater than 1.9.

Q6. Will all combinations of metals and non-metals form ionic bond? Why?

Not all metal-nonmetal combinations will result in an ionic bond. Only those with electronegativity difference of more than 1.9 will result to an ionic bond.

The best example of a metal-non-metal combination which did not result to ionic bond is $AlCl_3$ because the electronegativity difference is only 1.5. Thus, instead of ionic bond the chemical combination formed a polar covalent bond.

Activity 4

Bonding by Sharing of Electrons

Reiterate to the learners that there are compounds where the combining atoms do not transfer electrons or accept electrons. Instead, the combining atoms are held together by shared electrons. At this point you can now introduce the concept of bonding by sharing of electrons which is called a **covalent bond**.

Ask your student to recall Activity 2, the Lewis symbols or electron dot formulas do not include the inner electrons of the atom. Tell them that it only shows the valence electrons as dots. For example, fluorine has seven valence electrons. Thus, to form the fluorine molecule, the two fluorine atoms will share electrons. Each fluorine atom has eight electrons (an octet) in its valence shell, just like the electronic configuration of the nearest noble gas element, neon (Ne). It is important to emphasize to the learners that after chemical bonding atoms became isoelectronic with noble gases. Discuss also that there is a pair of bonding electrons between the two F atoms and three pairs (six electrons) of nonbonding electrons belonging to each atom as shown below:

The bonding electrons are counted as belonging to both atoms. The nonbonding electrons are those that are not shared with another atom.

You can detect the number of bonding and nonbonding electrons through a computation based on octet rule. Introduce to your students a mind-set of determining the total available valence electrons and detecting electrons needed to attain stability. It will help them identify the number of shared electrons (bonds) and unshared electrons through the following computations:

a. Get the total available valence electrons in a compound (**TAVE**).

For H_2S

hydrogen atom has 1 valence electron
sulfur atom has 6 valence electrons

Total Available Valence Electrons = (2 H atoms x 1) + (1 S atoms x 6)
= 2 + 6
= 8

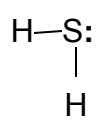
b. Compute for the Octet Rule requirement that each atom should have 8 valence electrons to become stable except for hydrogen, it only needs 2electrons to become stable.
Number of Electrons based on Octet Rule = (2 H atom x 2) + (1 S atom x 8)
= 4 + 8
= 12

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.

$$\text{Number of bonds} = \frac{(12 - 8)}{2}$$

$$= 2$$

Thus, there will be two pairs of shared electrons and two pairs of unshared electrons.



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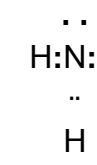
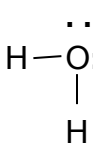
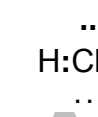
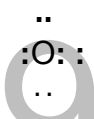
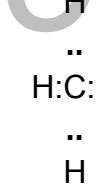
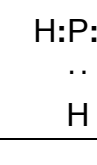
Completion of Table 2 will facilitate the acquisition of the above-mentioned skills.

Table 2. Types of Covalent Bonds

Compound	Chemical Formula	Lewis Structure	Type of Bond (polar covalent/nonpolar covalent)
ammonia	NH_3		**polar covalent**
water	H_2O		**polar covalent**
hydrogen chloride	HCl		**polar covalent**
Fluorine gas	F_2		**nonpolar covalent**
oxygen gas	O_2		**nonpolar covalent**
methane	CH_4		**nonpolar covalent**
hydrogen gas	H_2	H:H	**nonpolar covalent**
phosphine	PH_3		**polar covalent**
sulfur dioxide	SO_2		**polar covalent**

chlorine gas	Cl_2	.. .. :Cl:Cl:	**nonpolar covalent**

Note:

Emphasize to the students that there are molecules and ions which have more than eight (8) valence electrons around the central atom. These are elements which are non-metals from Period 3 or higher, which have ***d*** orbitals that are available for the two extra electrons to occupy. Thus, sulfur (S) in sulfur dioxide is surrounded by 10 electrons.

Answers to Questions:

Q1. How do covalent bonds form between atoms?

Covalent bonds form between atoms due to the sharing of electrons to attain stability.

Q2. What kind of element usually forms covalent bond? Is it possible for metals and non-metals to form nonpolar covalent bonds? Why? How about polar covalent bonds? Why?

Generally, non-metals form covalent bonds. However, there are cases that metals and non-metals also form polar covalent bond. It is impossible for a metal and a non-metal to form a nonpolar covalent bond.

Q3. Why is it that diatomic molecules always form nonpolar covalent bonds?

Diatomic molecules always form nonpolar covalent bonds because of the equal electronegativity values resulting to equal sharing of electrons.

Q4. Differentiate polar covalent bond from nonpolar covalent bond.

Polar covalent bond involves unequal sharing of electrons while nonpolar covalent bond involves equal sharing of electron.

Activity

5

Bonding Among Metals

Metals have low ionization energy so they easily lose their outermost electrons. A large number of metal atoms can share their valence electrons through a special type of bond called metallic bonding. This type of bonding is different from the covalent and the ionic bond. In metallic bonding, the electrons are not moving around one nucleus. The positive atomic nuclei of the metal are surrounded by electrons moving freely throughout the piece of metal. These moving electrons in metals are called a "sea of electrons." So, what holds the metal together are the strong forces of attraction between the positive nuclei and the freely moving electrons.

You may ask your students to draw how a metallic bond looks like. This is in order for you to find out their mental models about metallic bonding after you have explained what takes place in metallic bonding.

This is a simplified model of metallic bonding. It cannot account for the differences in properties of individual metals. The bond theory of metals will be able to explain the individual differences among metals. This bond theory will be explained in chemistry lessons at the university level.

Answers to Questions:

Q1. What do you think will make bonding among metals possible?

Metals tend to lose electrons to become stable. This property makes metallic bonding possible the positive atomic nuclei are surrounded by moving electrons. Since the latter are negatively charged, they are attracted to the positively charged nuclei.

Table 3. Metallic Properties

Metallic Property	Explanation
Luster	**Metals are lustrous because when light strikes the surface of the metal, the free valence electrons reflect the light giving the metal a shiny appearance.**
Malleability	**Metals can be flattened or can be formed into sheets when being hammered because of the ability of the metal atoms to slide over one another without breaking the metallic bond.**
Ductility	**Metals can be drawn into fine wire because of the free moving electrons which enable the metal atoms to slide over each other.**
Good Conductor of electricity	**Metals are good conductors of electricity because the electrons are free to move within the metal.**
Good thermal conductor	**Metals are good conductors of heat because the positive metal nuclei are close together and can easily transfer the heat. The motions of the moving electrons also transfer heat.**

Table 4: Uses of Metals

Metal	Uses
1. copper	Electrical wiring, metal sculpture and component of jewelry
2. aluminum	Cookware, housing and building materials
3. gold	Jewelry
4. iron	Manufacturing of machine and equipment; housing and building materials
5. nickle	Production of alloy
6. silver	Jewelry

Table 5: Types of Chemical Bonds

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

Activity 6

Differences between Ionic and Covalent Compounds

The Electrical Conductivity Apparatus is used to test whether a solution can conduct electricity. The improvised electrical conductivity apparatus can be made out of a piezo buzzer which can be obtained from a musical card. Electrical wire is attached to the piezo buzzer connection and the dry cell which serves as the positive and negative electrodes. When the electrodes are dipped in the aqueous solution, sound is produced which indicates that the solution is a good conductor of electricity.

If you cannot find a musical card in your place you can construct an open circuit just like in the piezo buzzer with the use of 1.5 volts LED. The long leg of the LED is connected to the negative terminal of a 1.5 volt-dry cell. Attach the wire to the positive end of the dry cell and strip its end exposing the copper wire. Connect wire to the short leg of the LED. This will serve as the end to be dipped in the sample solution. Once the positive, and the negative electrodes (jumper wire in both ends) are dipped in the solution, the LED will produce light. This means the solution can conduct electricity (See figure 8).

Refer to the following figures for your guidance in the construction of electrical conductivity apparatus.

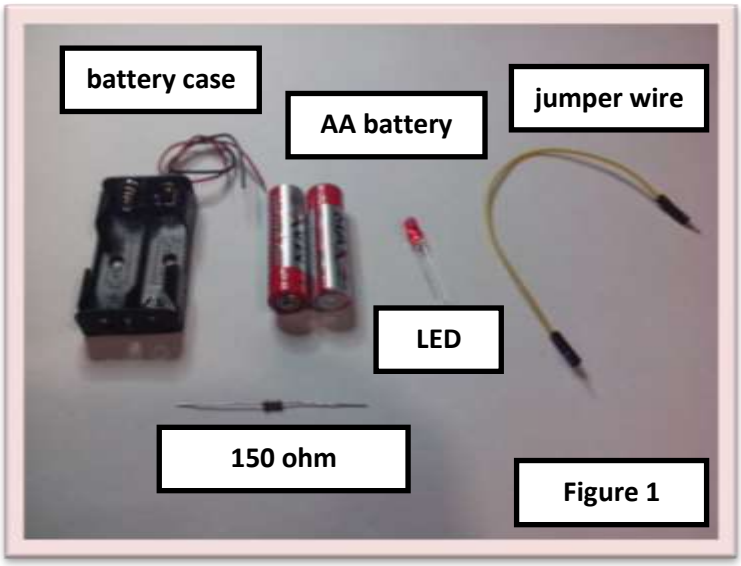


Figure 1

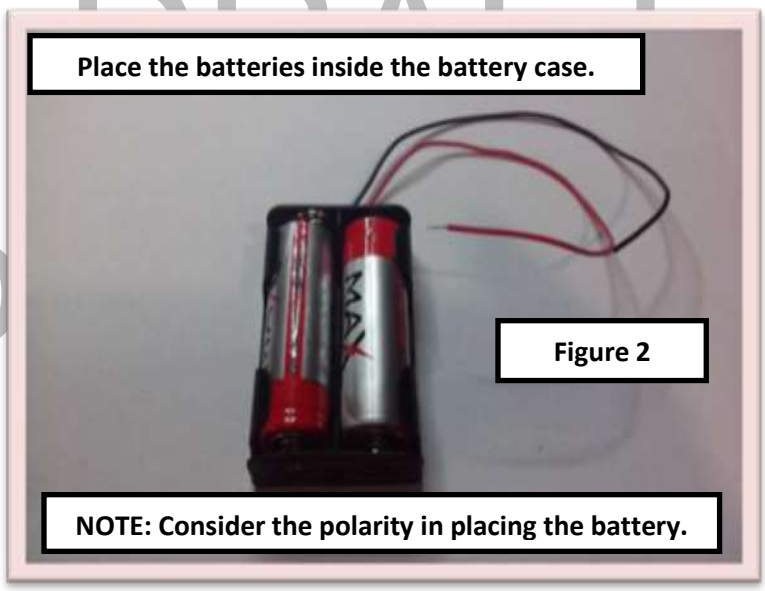
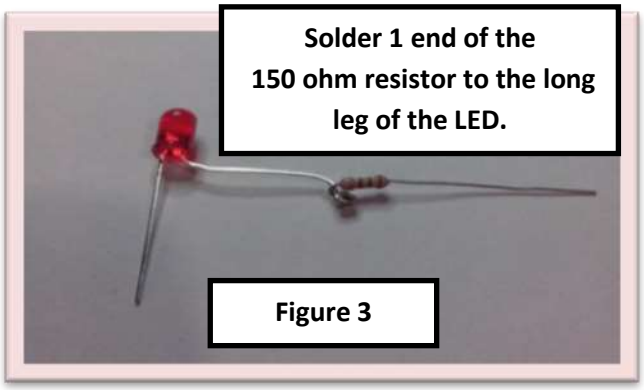
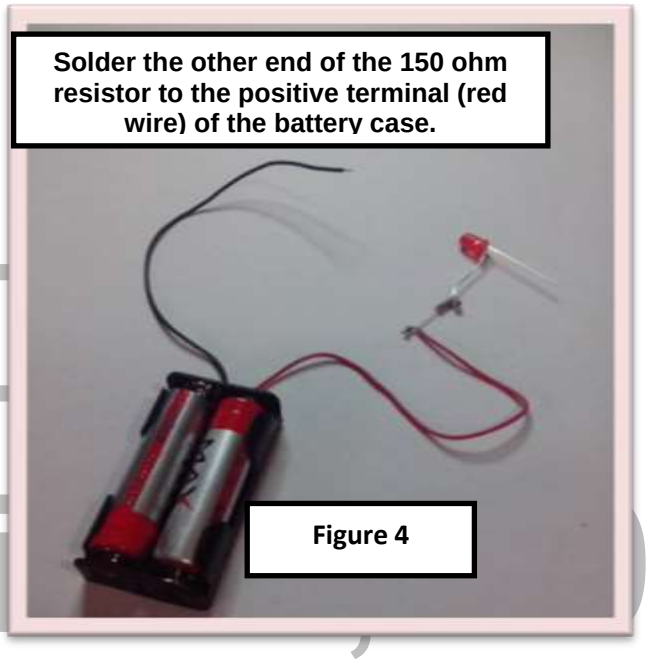
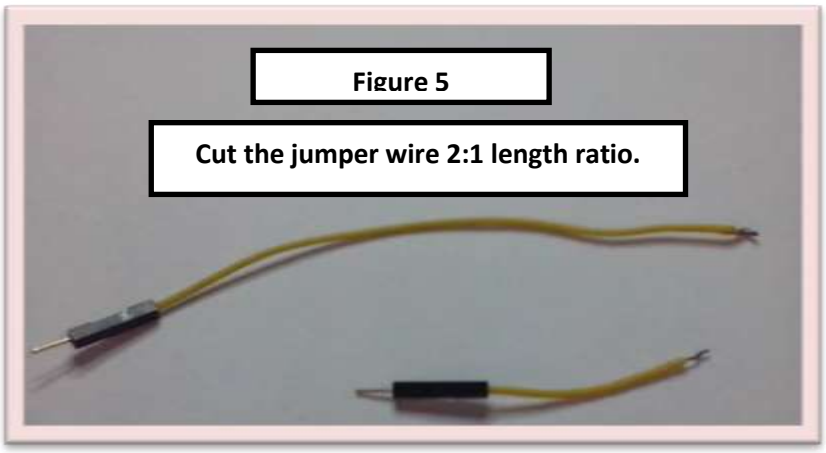
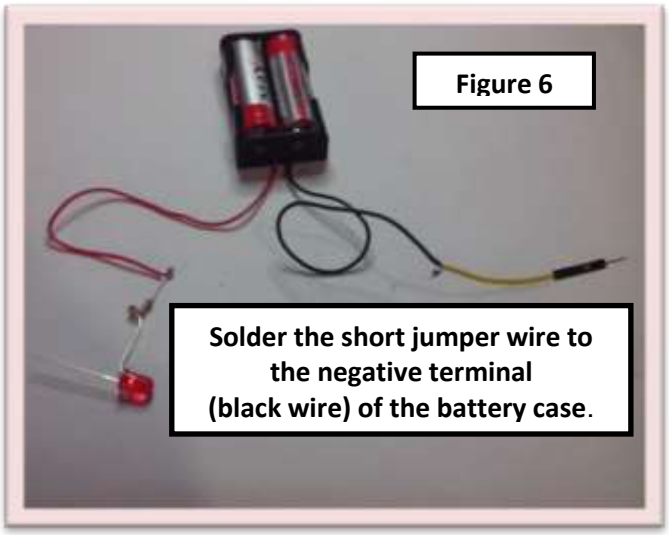


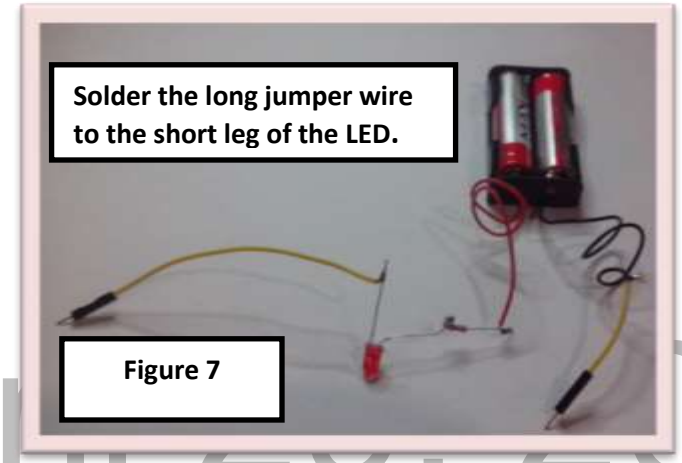
Figure 2

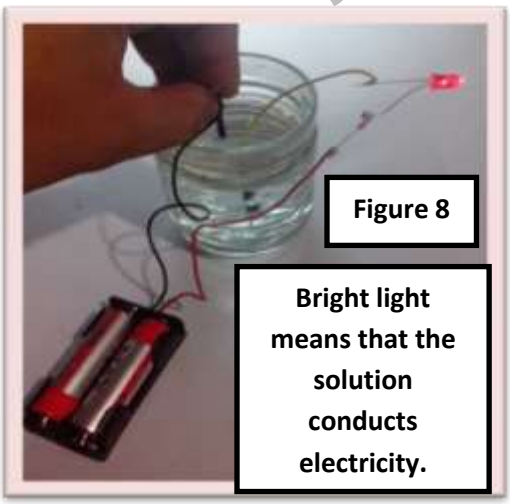












In performing this activity, remind your students to wash the electrodes after every use. While supervising your students, see to it that the two electrodes are not touching each other in doing the electrical conductivity test.

For further investigation, you may ask the learners to bring different samples of beverages and ask them to test its electrical conductivity. They will find out that the beverages with ions (usually energy drinks) can conduct electricity.

Table 6: Properties of Some Compounds

Compound	Reaction to Heat (melted easily/ did not melt easily) (1)	Electrical Conductivity (2)	Solubility in Water (soluble/ not soluble (3)	Type of Compound (ionic/polar covalent/ nonpolar covalent) (4)
salt	did not melt easily	conducts electricity when dissolved in water does not conduct electricity in solid form	soluble	ionic bond
vetsin	did not melt easily	conducts electricity when dissolved in water does not conduct electricity in solid form	soluble	ionic bond
wax	melted easily	does not conduct electricity in solid form	insoluble	nonpolar covalent bond
sugar	melted easily	does not conduct electricity both in aqueous and solid form	soluble	polar covalent bond

Answers to Questions:

Q1. What type of compound:

a. dissolves easily in water?
polar covalent and ionic compounds

b. conducts electricity in solution?
ionic compounds

c. melts easily?
covalent compounds have low melting temperature

Q2. Explain why salt and vetsin can conduct electricity in solution.

Ionic compounds, like salt and vetsin, give off positive (cations) and negative (anions) ions in solution that is why they can conduct electricity. Salt and vetsin release sodium cation (Na^+). Salt also releases chloride anion (Cl^-) in aqueous solution while vetsin releases glutamate anion.

Q3. Make a general statement about the properties of ionic and covalent compounds.

Ionic compounds are water soluble, they have a high melting point, and can conduct electricity in solution. Covalent compounds have a low melting point. Nonpolar covalent compounds are insoluble in water, and poor conductors of heat and electricity.

For further investigation, you may prepare different kinds of solutions like *apog* (CaO) in water, *salitre* ($NaNO_3$) in water, energy drinks in water, mothballs (naphthalene) in kerosene, and hotcake syrup in water in separate beakers or any glass containers. Then, let the students identify whether the solution contains ionic or covalent compound applying the electrical conductivity test. This is a simple test wherein students can apply the concept they learned in this activity.

Summative Assessment

1. c. low electronegativity
2. b. II & III
3. d. nonpolar covalent bond
4. d. Li and F
5. c. The bond in Br_2 is covalent while the bond in MgF_2 is ionic.
6. a. attain stability
7. b. electrostatic force
8. d. monosodium glutamate
9. c. metallic bond
10. a. bronze, paraffin wax, and salt

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Internet Links:

chemed.chem.purdue.edu
http://curriculum.nismed.upd.edu.ph
http://www.smallscalechemistry.colostate.edu/PowerfulPictures/ChemicalBonding.pdf
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

Unit 2
Module
3

The Carbon Compounds

Time Allotment: 12 hours

Content Standards	Performance Standards	Learning Competencies
The learners should be able to: • demonstrate understanding of the types of bonds that carbon atom forms resulting to the diversity of carbon compounds.	The learners should be able to: • perform guided experiments in determining the properties of common organic compounds • investigate the ability of ethyne (acetylene) to hasten the ripening of fruits such as bananas.	The learners should 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.

After learning about how non-metals form chemical bonds to form compounds in module 2, the students in this module will now study about common carbon compounds or organic compounds. They will also learn why carbon is so special compared to other elements. The module will provide adequate activities to the students that will make them learn about carbon compounds, their uses and the properties that are attributed to their uses.

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?

This module is designed for a maximum of 12 hours. You can make adjustments, however, to shorten the time of some activities. You can do this by pre-assigning some activities instead of letting the students conduct the experiments during the sessions. Every activity in this module is designed in such a way that the students will be guided or will be able to learn in stages because the activities are set in proper sequence. Each activity is connected to the next activity.

Make necessary safety precautions on all the activities, particularly on activities that will use chemicals to avoid accidents. Always review the materials safety data sheet. You can download a copy of the materials safety data sheet (MSDS) in the internet.

Activity 1

Organic Compounds: Are they Useful?

Many organic compounds are commonly used at home or in the community. These compounds have their specific uses. Some of these compounds are used to fuel vehicles, light lamps, cook food, disinfect wounds, flavor beverages, and lubricate machines. However, students are not really familiar with the kinds of these organic compounds and their specific purposes. In this activity, the students will be able to learn about the specific kinds of common organic compounds that they usually see or use. In addition, the activity will make them aware of the importance of these compounds in their everyday life.

Teaching Tips

1. As an assignment, let your students search for the uses of the following common compounds: gasoline, acetic acid, lubricating oil, liquefied petroleum gas (LPG), ethyl alcohol, diesel oil, acetone and kerosene. (*This is only optional. If you

think the class is already familiar with these compounds, you can just introduce these compounds in the beginning of the session.)

2. Before giving the lesson to the class, show them pictures of the following products: gasoline, isopropyl alcohol, ethyl alcohol, liquefied petroleum gas (LPG), acetone, acetic acid (vinegar). These products are all composed of organic compounds.

3. In the class, let your students work in groups. Tell them to brainstorm about the uses of the compounds listed in Table 1. Using the format of the table in the module let the students write their outputs on a piece of Manila paper.

4. After the given working time, select some groups of students to present their outputs in front of the class. Make sure to start a discussion by asking questions based on their outputs. This will allow the students to assess and see the value of their own work and at the same time reinforce learned concepts.

5. When all the selected groups are done with their presentations, show the class other examples of organic compounds and facilitate a brief discussion about them or let some students tell about the uses of these compounds. This will make them more familiar with many kinds of organic compounds.

6. After the presentation of the other examples of common organic compounds, discuss to the students the definition of the term “organic compounds”. Be clear with the definition and explain to them clearly why these compounds are referred to as organic compounds.

7. This lesson is good for two (2) meetings. Let the students do the activity first and have the discussions on the next meeting or session.

8. In case some of the materials needed in this activity are not locally available you may replace it with the similar kind of materials available in your community.

I. You may use the following information about the meaning of organic compounds.

A. Traditionally, the term “organic compound” is used for the compounds that are derived from plants and animals like ethyl alcohol, sugar and acetic acid.

B. However, these kinds of compounds are also produced artificially. For example: alcohol and acetic acid can be derived from petroleum.

C. Therefore, how are these compounds classified as organic compounds? Organic compounds are group of carbon-containing compounds. Organic compounds

contain carbon and hydrogen; other organic compounds are combined with other elements namely oxygen, nitrogen, phosphorous, sulfur, and halogens (fluorine, chlorine, bromine, and iodine). Ethyl alcohol, isopropyl alcohol (rubbing alcohol), acetic acid, acetone and diesel oil are just some of the many examples of useful organic compounds.

1. **Table 1: Organic compounds and their uses**

Organic Compounds							
		Gasoline	**Ethyl alcohol**	**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.

Compounds	**Uses**	**Compounds**	**Uses**
Gasoline	Fuel for vehicles	***Ethanol***	Disinfectant, and used as main ingredient in liquors
Kerosene	Fuel for lamps (*gasera*)and portable cooking stove (*kusinilya*).	***Acetone***	Used to remove nail polish
	Can be used to remove paints.	***Acetic acid***	Used as component of vinegar (4% by volume)
***LPG* (*liquefied petroleum gas*)**	Fuel for gas stove and cars.		Can be used to treat fungal infection

Q2. These common organic compounds are very important because they have many uses at home and in the industry.

Activity 2

Properties of Common Organic Compounds

In this activity, the students will be able to observe the properties of common organic compounds and relate these properties to their uses. This activity will make your students learn why some organic compounds have their own specific purposes.

Teaching Tips

1. Before letting the students do the experiments, discuss first the safety precautions that the students should take on the conduct of the experiments and make sure that each group of students has complete materials. This is to guarantee students' safety and task completion.

2. During the activity, constantly supervise the students to ensure that they are doing things according to the given procedure. This will save time and the students will be properly guided in their tasks.

3. After their experiments, choose one group to present its output. Once the group is done with their presentation, discuss the answers to the questions so that valid generalizations will be made clear to the students.

4. This lesson is good for three (3) sessions.

Use the following information in discussing the properties of the liquids used in the activity:

I. *Phase of matter* is the physical state of the material. This describes the physical property of matter whether it is solid, liquid, or gas.

II. *Viscosity* is a measure of a fluid's resistance to flow. If the viscosity is high, the flow of the liquid is slow or the liquid is thick. In this activity, the viscosities of the liquids will be measured based on the average time it takes the plastic bead to reach the bottom of the test tube. Although the flows of the liquids were not directly measured, the speed of the fall of the plastic bead from top to bottom of the container is relative to the thickness or viscosity of the liquids. Thus, if the time it takes the marble to reach the bottom of the graduated cylinder is slow, it means that the viscosity of the liquid is high.

III. *Volatility* is the measure of the tendency of substance to evaporate or to turn into its gaseous state. In this activity, volatilities of the liquids were measured based on the time it take the liquids to evaporate.

IV. *Flammability* is the measure of how easily a material burns. In this activity, flammability of the liquids will be measured based on the time it takes the wet cotton buds to finish burning.

Answers to Questions

Q1. Lubricating oil. Common uses of viscous materials or liquids are used to lubricate parts of machines, instruments, or appliances such as motor of electric fan; and protect metals from rusting.

Q2. Kerosene and ethyl alcohol. Flammable liquids such as kerosene is used as fuel for lamps (*gasera*) and portable stove (*kusinilya*). Although ethyl alcohol is also flammable, it is not used as fuel for stoves or lamps only. It is also used as a component of biofuels for vehicles, as an ingredient for liquors, and as a disinfectant.

Q3. Kerosene and ethyl alcohol.

Q4. It is important to have knowledge about the properties of these compounds so people will be aware of their behaviour, uses, and effects on people.

Activity 3

The Hydrocarbon

This activity will acquaint the students with the useful characteristics of carbon atoms and the relationship of the structures and properties of the special group of another type of organic compounds, the hydrocarbons.

Teaching Tips

1. As an assignment, instruct the students to search for the uses of the following compounds: methane, butane, octane, ethane, ethyne (acetylene), propene, and propyne.

2. In this activity, the students must have a good background about covalent bonding for them to be able to complete the tasks. To make sure that the students still remember their lesson from module 2 about the types of bonds formed in covalent bonding, ask them the following questions:

   a. How do atoms of non-metal elements form their compounds? *Answer: By bonding through sharing of electrons with other elements or with same elements.*

   b. What types of bonds do non-metals form in compounds?
   Answers: single bond, double bond, and triple bond

3. After checking the background knowledge of the students about covalent bonding, clearly discuss to them the meaning *of structural formula*, *condensed formula*, and *boiling point*. The meanings of these terms are very important because the students will be drawing the trends about these properties from the given tables of information in the learning module. The definitions of the terms are as follow:

   a. *Structural formula* is a formula for a molecular compound that indicates the atoms present and the bonding sequence of the atoms. The covalent bonds between atoms are conveyed as lines connecting the symbols of the bonded atoms. This formula gives a clear illustration about the structure of a compound.

b. *Condensed Formula* is a formula for a molecular compound that indicates the bonding sequence without showing all the bonds. It should be clear that the carbon atoms are bonded together in sequence, and each carbon is bonded to the hydrogen atoms next to the formula.

c. *Boiling point* is the temperature at which a liquid evaporates or becomes vapor.

4. Before letting the students start the activity, make sure to give them clear instructions about what they are going to do exactly in the activity. Explain to them the objectives of the task and make clarifications on some questions they are likely to get confused with, without leading them to the exact answers. They should figure out on their own the trends or the patterns of the compounds from the tables of data. The students may also be allowed to work in groups so they can have collaboration or exchange of ideas, or individually if they can. Give them enough time to get the ideas about the trends in the properties included in the tables of data, and answer all the questions in the activity. Thirty (30) minutes will be enough for the students to study the tables of data and answer the questions. If they don't finish in 30 minutes, they may be given a five (5) minutes extension.

5. After the students are done answering all the questions, select or ask a group to present its work in front of the class. Do not let all the groups or many students present their outputs because you don't have enough time to let them all share their answers. One group will be enough to start a discussion about the correct answers in the activity.

6. When the group is done with its presentation, make sure also to clarify or correct some answers regarding the trends of the properties of the compounds in the tables of data. Discuss with them the information about the common groups of hydrocarbons: alkanes, alkenes, and alkynes. Use the information below.

a. *Alkanes* are hydrocarbon compounds that only have single bonds in the compounds. Alkanes are also known as saturated hydrocarbons because additional hydrogen atoms can no longer bond in the compound. The first alkane is methane, CH_4, and the second member is ethane, CH_3CH_3, which are common alkane compounds. The name of the compounds in this group all end with -ane.

b. *Alkenes* are hydrocarbons that have one or more carbon-carbon double bonds in their structures. The name of alkene compounds end in –ene. The simplest alkenes are ethene, CH_2CH_2, and propene, CH_2CHCH_3.

c. *Alkynes* contain at least one carbon-carbon triple bond. The most common alkyne compound is ethyne or acetylene.

*This lesson is good for two (2) meetings.

Answers to Questions

Q1. Compounds in the alkanes group only have single bonds between carbon atoms. Alkenes have at least one double bond between carbon atoms in the compounds. Alkynes have at least one triple bond between carbon atoms in the compounds.

Q2. The *physical state* of the alkanes from methane to butane is gas, and from pentane to octane: liquid. The reason for this is related to the structure of the compounds. If the molecule of the compound is small it interacts less with each other. Just like methane, it is likely to be a gaseous compound. When the molecules become bigger in size or structure, they can closely interact with each other and they will become more likely to be liquid just like in the case of octane. Octane molecule has a very long chained structure that makes it too heavy to be a gaseous compound. The trend in the phase of the compounds is also the same with the alkenes and the alkynes. The phase of the alkenes and alkynes is a gas when the molecules is small and becomes liquid as the molecules become bigger.

The trend in the *structures* of the compounds in alkanes, alkenes, and alkynes is the same. The size of the structures of the compounds is increasing because the compounds become bigger or longer.

Q3. The trend in the ***boiling point*** of the compounds in alkanes, alkenes, and alkynes is also in an increasing pattern. This is because of their structures. As the structures of the compounds become bigger, they also interact more with each other. Bigger molecules that interact with each other more strongly require higher temperature to evaporate. That is why they have a higher boiling point.

Q4. The reason why there are hydrocarbons that are gases and liquids is because of the structure or the size of the molecules of the compounds. When the molecules are small, they tend to interact less among each other. Smaller molecules are usually gases. And when molecules have bigger structures, they interact more with each other. Thus, bigger molecules then tend to settle in liquid state.

Q5. The reason for so many hydrocarbon compounds is the carbon atom. Carbon atoms have four valence electrons. This atomic structure of the carbon makes it possible to form many types of bonds with other elements and with other carbon atoms. The formation of these bonds results in many different hydrocarbons.

Q6. What hydrocarbon compounds are gases and liquids? What are the uses of gaseous hydrocarbon compounds and liquid hydrocarbon compounds? Common examples of gaseous hydrocarbon compounds are methane, butane, propene, and ethyne (acetylene). ***Methane*** gas is the most common hydrocarbon. It is used as fuel for cigarette lighters and LPG. It is also mixed with other fuel for vehicles. ***Butane*** gas is used as fuel, blended with other hydrocarbons to produce liquefied petroleum gas (LPG), and is also used as fuel cigarette lighter. The color of the flame when butane is used in cigarette lighter is blue. ***Ethyne*** gas or commonly known as acetylene is used commonly in flame torch that is used in welding of iron, and it is also used for hastening the ripening of fruits.

Examples of common liquid hydrocarbons are octane and pentene. ***Octane*** and ***pentene*** are used as components of gasoline.

Activity 4

Which bananas will ripen faster?

In the previous activity, you have already discussed about the uses of common hydrocarbons particularly ethyne or acetylene. The students now know their uses. In this activity, you will let the students investigate the actual use of ethyne (acetylene), a hydrocarbon. The students will conduct an experiment to find out if acetylene gas can really ripen bananas in just a short period of time compared to the natural process of ripening.

Teaching Tips

1. The experiment will use a chemical compound called calcium carbide, CaC_2 (*kalburo*). Though this chemical is not that dangerous, it still needs to be handled properly so that possible harm to the students may be avoided. It is advised that you be the one to prepare this material in the experiment. Remember that when calcium carbide is mixed with water, acetylene gas will be produced. Acetylene is a flammable gas. So even if this experiment will not be used with water, extreme precaution for the safety of the students must be observed.

Safety Tips:

Make sure that calcium carbide does not come in contact with water!
Use safety goggles to protect your eyes.

2. Prior to this experiment, ask the students to bring 6 green, unripe bananas. 6 bananas are needed for this activity because these bananas will be divided into two groups, with 3 bananas per group, so that each group will have acceptable number of replicates. Tell the students that the bananas should be matured or are ready to ripen in several days, but are still green or are not yellowish in color. Let them also bring two (2) empty shoe boxes or empty fruit juice boxes and newspapers. If the students cannot afford to do this experiment individually, let the students to this in groups so that the materials will not be too costly for them or you can just demonstrate this experiment in the class.

3. In the class, before letting the students prepare their experiments, let them answer Q1, Q2, Q3 and Q4. Answering these questions will give the students an about what to do and expect to happen in the experiment and will also set their mood for the new learning activity.

4. Let the students prepare the materials. Emphasize to them the need to follow all the instructions and the safety precautions they are given. Enjoin them to act like real scientists. This will help them to understand that they really have to be careful in doing their experiments. Make sure that the students who handle the wrapped calcium carbide are using their hand gloves and face mask because the odor of the material is unpleasant.

5. When all the groups are done preparing the set-ups of their experiment, tell them that the result will take at least 2 to 3 days, depending on the maturity of unripe bananas. Instruct them to make their observations after 2 to 3 days.

6. Study the following information. It will help you guide the students in this kind of activity.
7. This lesson is good for two (2) meetings.

Answers to Questions

Q1. Acceptable answers: "The effect of acetylene gas on the rate of ripening of bananas" or "The effect of using calcium carbide (*kalburo*) on the rate of ripening of bananas

Q2. Acceptable answers: Acetylene or calcium carbide

Q3. Number of fruits that ripened

Q4. Acceptable answers: The bananas in the shoe boxes with calcium carbide will ripen faster than the bananas in the shoe boxes without calcium carbide or Group B bananas will ripen slower than Group A bananas.

Q5. Expected outcomes: 4-5 ripe bananas in group A, 0-2 ripe bananas in group B.

Q6. Expected answer: Group A has many ripened bananas than group B.

Q7. Using calcium carbide (*kalburo*) makes the ripening of bananas faster than without using calcium carbide. This is because when calcium carbide (*kalburo*) reacts with the moisture in the air, acetylene gas is produced. Acetylene gas is the compound that makes the ripening of the fruits becomes faster. Acetylene imitates the action of the natural ripening agent called ethene or ethylene (C_2H_4). Ethene or ethylene is a plant hormone that regulates activity of the genes that are responsible for the ripening of fruits.

(Students's answers may vary, but make sure that their answers have similar ideas to the given answers above).

Activity 5

Alcohols and their Uses

In this learning activity, you will let the students learn about the uses and structures of alcohols. You must also let the students understand the similarities that different alcohols have which also make them share some common properties.

Teaching Tips

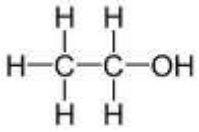
1. Provide each group of students with LABELS or PICTURES of the following products: one antiseptic or disinfectant that contains ethyl alcohol, one antiseptic that contain isopropyl alcohol, one beverage that contain ethyl alcohol, and one denatured alcohol.

2. Let the groups of students read the information written on the labels and tell them to fill out the table of data with information from the labels. After this, give them the instructions to answer all the questions in the activity.

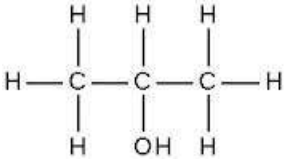
3. After the activity, select students from a group to present their answers in front of the class. This may be done to begin your discussions about the uses of the alcohols and the relationship between their structures and properties.

4. Use the following concepts to explain the relationship between the structures and the properties of the different alcohols.

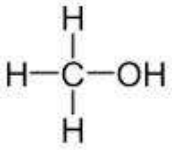
   a. *Functional group.* Functional group is a group of atoms that are bonded to the molecule. This group is responsible for the characteristics or property of that compound. Alcohols have hydroxyl group (-OH). If you are going to observe the structures of ethyl, isopropyl, and methyl alcohol, you will notice the hydroxyl group (-OH) in their structures.



Ethyl alcohol



Isopropyl alcohol



methyl alcohol

5. This lesson is good for two (2) meetings.

Answers to Questions

For Q1-Q2

Name of Products	**Name of Alcohol/s Present in the Product**	**Percentage (%) of alcohol in the Product**	**Uses**
Brand X alcohol	Ethyl alcohol	70%	Disinfectant/antiseptic
Rubbing alcohol	Isopropyl alcohol	70%	Disinfectant/antiseptic
Denatured alcohol	Ethyl alcohol and Methyl alcohol	95% ethyl and 5% methyl alcohol	Fuel for lamps and portable stoves

Q3. The structures of the alcohols in this activity only have single bonds.

Q4. Alcohols have the same hydroxyl group as their functional group that is why they have some similar properties or characteristics.

Activity 6

What is common between acetone, and formalin?

In this activity, the students will be made to recognize other different, important organic compounds: acetone, and formaldehyde. These compounds are commonly used at home and at school. However, students are not really fully aware about the identities and the basic nature of these compounds. Most often, they are just aware of the products' names of these materials.

Teaching Tips

1. Some students might not be familiar with these common compounds, because these compounds are often times just known for their products' brand names. So as an assignment, let the students search for the compounds that are present in the following products: common brand of acetone, and formalin. Let them also search for the uses of the products.

2. Before letting the students answer the activity, make sure to explain all the instructions from the learning module. Have the learners work in groups, so that they will be able to share their ideas and assignments with one another. Also discuss first that the carbonyl () group is the functional group of aldehydes and ketones just like hydroxyl group (-OH) of alcohols.

3. In the post-activity discussion, let at least two students from two different groups give their answers in class. After the students' presentation of their answers, start facilitating a discussion by showing the students the compounds, acetone, and formalin. For example, show a bottle of formaldehyde (formalin) with a

preserved animal or insect in it. For acetone, demonstrate how to remove nail polish using the compound. Acetone and formaldehyde both have different ending suggesting that they are different compounds, therefore, they are not known as carbonyl compounds, but rather carbonyl group containing compounds.

4. The following information may be used for further discussion of the activity.

a. Acetone is also one of the compounds that are commonly used. It is used in removing nail polish. It is also used as solvent in some industrial preparations, such as production of plastic materials.

b. Formaldehyde is a compound that is commonly known as formalin. Its common use is to preserve organic materials because of its ability to crosslink proteins including enzymes. This is also the reason why this kind of organic compound is used in the embalming process.

5. This lesson is good for two (2) meetings.

Answers to Questions

Q1. Acetone is commonly used as solvent and nail polish remover. Formaldehyde is used as a preserving agent and disinfectant.

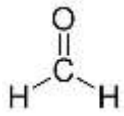
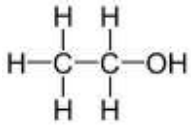
Q2. The structures of acetone, and formaldehyde all have single and double bonds.

Q3. The structures of acetone, and formaldehyde both have carbonyl functional group. These make them carbonyl containing compounds.

Answer Key:

Pre-Assessment:

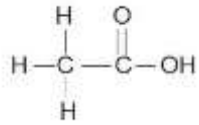
Encircle the letter of the correct answer

1. **C.** **Organic compounds are composed mainly of carbon and hydrogen**
2. **B.** **By forming many bonds with other carbon atoms and other elements**
3. **C.** **4**
4. **A.** **kerosene**
5. **D.** **liquefied petroleum gas, kerosene**
6. **D.** **lubricating oil**
7. **B.** **because gasoline is flammable**
8. **B.** **isopropyl alcohol**
9. **B.** **kerosene**
10. **D.** **ethyne**
11. **B.** **2**
12. **C.** **alkene**
13. **C.** **acetylene**
14. **C.** **butane**
15. **D.** **fuel**
16. **B.** **II and III only**
17. **C.** **kerosene**
18. **C.** 
19. **B.** **formaldehyde**
20. **B.** 

Summative Assessment

Have the students answer the following questions by encircling the letter of the correct answer.

1. **D. II, III and IV only**
2. **C. carbon atoms form many types of bonds with other carbon**
3. **B. 3**
4. **B. gasoline**
5. **D. liquefied petroleum gas (LPG)**
6. **D. lubricating oil**
7. **B. because gasoline is flammable**
8. **B. isopropyl alcohol**
9. **D. all of the above**
10. **C. propene**
11. **B. 2**
12. **B. alkyne**
13. **C. fuel**
14. **C. increases**
15. **C. fuel for welding torch**
16. **B. II and III only**
17. **C. acetone**
18. **A.**



19. **B. formaldehyde**
20. **D. hexene.**

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Unit 2
MODULE

4

Suggested Time allotment: 12-14 hours

What's in a Mole?

Content Standards	Performance Standards	Learning Competencies
the unit mole that quantitatively measures the number of very small particles of matter	*analyze the percentage composition of different brand of two food products and decide on products on appropriate percentage composition*	*-use the mole concept to express mass of substances* *-determine the percentage composition of a compound given its chemical formula and vice versa*

Before teaching, it is good to be reminded of the important features of inquiry-based learning because science instruction is anchored on this approach.

Through your effective motivation, students become interested with the topic and start forming a question that can be answered in a scientific way. You will most likely have to modify the students' questions into ones that can be answered by the students with the available resources, while being mindful of the content. In the quest to answer the questions, students must rely on evidences that can be derived from gaining access to an activity, observing teacher demonstration, reading books, investigating, and other valid sources of information. Then the students will form an explanation to answer the question based on the collected evidences. The next essential thing to see from the students is that they are able to evaluate the explanations they have made, communicate and justify the proposed explanations with the other students. In the course of having these interactions, you should see to it that all misconceptions and alternative conceptions are ironed out to facilitate meaningful conceptual understanding.

Most of the activities in this module are based on this learning approach. The teacher may customize some of the activities based on the needs and preparedness of his/her students.

Overview

In the previous science lessons, the students were introduced to the concept of mass. This can be a good starting point to introduce the mole concept.

The mole concept is the foundation of stoichiometric calculations which is the very reason why it is important for a student to fully understand this topic. This topic appears to be very complex for the students, and extra effort must be exerted in order to make sure that this concept is properly understood.

In this module, the mole concept is strategically introduced by banking on the prior knowledge of the students. Activities were designed in such a way that the starting activity makes use of the concepts they already know, and through a series of activities, they are led to the attainment of the desired competencies they need to develop. From counting and weighing, they will be able to apply mole concept in expressing the mass, number of moles, and particles of a given substance and compute for the percentage composition. Realistic problems involving mole concept in daily life scenarios were also provided for the learners to realize that this concept is not alien to them. Understanding this topic will make them wise consumers, good farmers, effective environmentalists, and well-informed individuals.

Key questions for this module:

How is the mole used to express the mass of a substance?

How is the percentage composition of a given compound determined?

Answer Key:

Pre-Assessment:

1. a. 75 g cream
2. d. The same number of materials of different kinds has different masses.
3. c. molecule
4. a. 80g
5. b. 6.02×10^{23} particles

6. d. Mole concept can be used in quantifying the amount of pollutant-particles released in the atmosphere.

7. d. all of the above

8. b. 11.21%

9. c. mole

10. c. showcase of 1mole of different elements having different masses

Reminders:

See to it that you have assigned the materials for the different activities ahead of time.

Try first all the activities before asking your student to perform it in the class.

Suggestion for Motivation

Have a bowl of marbles and ask the students to guess the number of marbles and its approximate weight in the bowl. The student who can give the nearest answer will be given a prize.

Relate this game with the first activity in this module. You may use coins, buttons, and candies instead of marbles or, if you have a better activity for motivation, you are free to have your students perform it.

Let's Find Out!

Photograph Marbles in a Glass Bowl by Nancy Andersen on 500px from www.flickr.com

Now that you have set the mood of your students you may introduce Activity 1: Counting by Weighing.

Activity 1

Counting by Getting the Mass of an Object

This activity is given to the students for them to have a feel of how chemists determine the number of particles based on the mass of the substance. The concept of having an enormous number of particles in the things that surround them is hard to comprehend by Junior High School (JHS) students that is why we need to give concrete activities which will give them ideas on how it is being done in the scientific world. In this activity, paper clip is used because the manufacturers set a standard mass for its production. You may use other materials based on its availability in your community for as long as there is a standard mass set for its reproduction. You may use nails, candies, or chocolates with the same sizes. In choosing the replacement for paper clips, you should consider the availability and cost of the materials and the students' safety.

There are things you need to consider in supervising your students in performing this activity. You need to remind them of the laboratory techniques in using the platform balance. The skill of the students in measuring the mass of the materials is of utmost concern because it will greatly affect the result of this activity.

The answer of the students in this table may vary depending on their skills in measuring the mass of the paper clips and its kind.

Answers to Questions

To compute for the average mass using this formula:

$$\text{Average Mass} = \frac{\text{Mass}}{25}$$

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?

Yes, the number of paper clips computed in step 2 is the same with the number of paper clips counted in step 3. In both steps, the number of paper clips

is the same because the average mass of the paper clips is used in the computation and all paper clips in the box has the same mass.

Q2. Having an experience in counting by getting the mass, give some ways in which you can apply this procedure in daily life situations.

Counting by weighing can be used in packaging volume of materials instead of going through the tedious process of counting one-by-one. Knowing the average mass of the products will make monitoring in the production unit in industries easier and with validity.

Counting by weighing also facilitates easy and accurate estimation of the needed materials.

In repacking goods to be sold in the "sari-sari" store, this technique can be useful.

Another interesting point of discussion is the origin of the mole concept. It would be interesting to the learners if you will discuss trivia pertaining to the origin of the mole concept. Knowing how this concept started will help the student understand how information is being updated as time passes by, with the presence of competent people in the field of science.

You may present the origin of mole concept as a storytelling activity or trivia if your students do not have internet access. In areas with internet access, you may give this topic as an assignment.

In a storytelling way, you may discuss the following:

In 1865, August Wilhelm Hofmann, a German chemist introduced the word "molar" (from the Latin word *moles* which means *a large mass*) to refer to any large macroscopic mass in contrast with the word derived from *moles with the Latin suffix –cula* which means small or tiny. Thus, he made use of the word molar for big quantities (macroscopic) and molecular for minute quantities (microscopic).

A German physical chemist, in the person on Wilhelm Ostwald, gave a more definite use of the term molar and its noun mole. More than a macroscopic sample, this term was used by Ostwald to denote the mass in grams which represents the mass of its fundamental molecules. This was mentioned in several of his textbooks written around the turn of the 20th century; though it was connected to atomic molecular theory and his attempt to establish a macroscopic alternative for the explanation of the laws of stoichiometry.

The clear inter-conversion of grams and moles as part of standard stoichiometry problems does not appear to have been common before the 1950s.

(*Source: Jensen, W. B. The Origin of Mole Concept. Journal of Chemical Education, 2004, 81 (10),p1409. Retrieved November 9, 2013, from http://www.che.uc.edu/Jensen/W.%20B.%20Jensen/Reprints/114.%20The%20Mole.pdf*)

Just in case inquisitive students will ask you about stoichiometry, you may explain to them that it is a chemical computation that involves the amount of reactants and products in a chemical reaction.

The following are just analogies for your students to visualize how much Avogadro's number is. When we deal about Avogadro's number we always deal with the number of atoms, ions, or molecules not to the whole objects.

Questions	Answer
How many mongo seeds are equal to 3.50 moles of mongo seeds?	***2.11 x 10 ^{24} mongo seeds***
How many bananas are equal to 7.50 moles of bananas?	***4.52 x 10 ^{24} bananas***
How many moles of rice grains are equal to 1.807 x 10 ^{24} grains of rice?	***3.002 moles of rice grains***
How many moles of tomatoes are in 3.01 x 10 ^{23} tomatoes?	***0.500 moles of tomatoes***

Sample computations:

$$3.50 \text{ moles of mongo seeds} \times \frac{6.02 \times 10^{23} \text{ mongo seeds}}{1 \text{ mole of mongo seeds}} = 2.11 \times 10^{24} \text{ mongo seeds}$$

$$1.807 \times 10^{24} \text{ rice grains} \times \frac{1 \text{ mole of rice grains}}{6.02 \times 10^{23} \text{ rice grains}} = 3.002 \text{ moles of rice grains}$$

Always remind your students of the Avogadro's number which is always equal to 6.02 x 10 ^{23} particles. Particles can be in the form of atoms, ions or molecules.

Emphasize to them that in order to convert number of particles to number of moles they have to divide the given number of particles by the Avogadro's Number and if they want to convert the number of moles to its equivalent number of particles, they have to multiply the number of mole s by the Avogadro's Number.

In processing this activity, it is important that the students grasp the idea that if the material has standard mass, they can count it by weighing especially in cases that involves voluminous quantities. You can also relate this experience with how scientists identify the number of moles through weighing (for the advance students).

Activity 2 Total Count Vs. Mass

The focus of this activity is to make the students fully understand that even though they have the same number of materials, different types of materials have different masses.

Answers to Questions

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	**8.5**	**1.7**	**25.5**	**14**
soft drink crown	**5.0**	**1.0**	**15.0**	**25**
10-centavo coin	**10.5**	**2.1**	**31.5**	**12**

Q1. Do the three different materials have the same masses? Explain your answer.

No, even though they have the same number of pieces, different materials have different masses.

Q2. Was your expected number of pieces per material the same as the number of pieces equal to 25.00g?

Yes, through the average mass, the same number of pieces was obtained as expected.

Q3. What can you infer from this result?

The same number of materials of different kinds has different masses.

In the course of the discussion, it is essential that the learners will understand the concept that can be related to molar mass. In this way the students will discover the relation of this activity to the next activity.

Activity 3

The Mass of One Mole of a Substance

It would be helpful in teaching this topic if you going to unlock difficulties through the definition of some terminologies such as atomic mass and molar mass. Atomic mass is the average of the masses of the naturally occurring isotopes. As an element is weighed according to its abundance, its unit is expressed in amu (atomic mass unit) which is exactly equal to 1/12 the mass of a carbon-12 atom. In short, what you see in the periodic table is the atomic mass of the elements in amu. Molar mass, on the other hand, is the mass of one mole of particles (atoms, molecules, formula units) of a substance expressed in terms of g/mol. It would be helpful to mention that the mass of one atom and the mass of one mole of the same atom are numerically the same. Only the atomic mass of an element is expressed in amu while the mass is expressed in g. This means that the atomic mass of calcium atom is 40.02 amu and the mass of one mole of calcium atom is 40.08g. Likewise, one atom of potassium weighs 39.10amu and its molar mass is 39.10g.

Answers to Questions

Table 4-A: Molar Mass of Some Common Elements

Element	Symbol	Mass (g)	Molar Mass (g/mol)
Sulfur *(Asupre*)	S	32.07	32.07
Lead (*Tingga*)	Pb	207.20	207.20
Copper (*Tanso*)	Cu	63.55	63.55

Table 4-B: Molar Mass of Some Common Compounds

Compound	Chemical Formula	Mass (g)	Molar Mass (g/mol)
Water	H_2O	18.02	18.02
Table Salt	NaCl	58.44	58.44
Table Sugar	$C_{12}H_{22}O_{11}$	342.34	342.34

Q1. Do you think that one mole of different substances have the same amount?

No, because based on the answers in tables 4-A and B, the mass of different substances differs from one another.

Q2. What do you observe about the mass of the substances in Tables 4-A and 4-B?

The mass of the substances in tables 4-A and B differs from one another.

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?

Yes, because one mole of any kind of substance has the same number of particles which is equal to 6.02 x 10 ^{23} (Avogadro's number)

Q4. What can you infer about this activity?

One mole of different kinds of substances has the same number of particles but different masses.

You may give Table 5 as an exercise or take home activity for the learners to have a practice in the computation of molar mass.

Table 5. Molar Mass

Chemical Name	Chemical Formula	Molar Mass (g/mol)
Iron (II) sulfate (ferrous sulfate)	$FeSO_4$	151.92
Ethyl alcohol	C_2H_5OH	46.08
Ammonia	NH_3	17.04
Citric acid	$C_6H_8O_6$	176.14
Aluminum hydroxide	$Al(OH)_3$	78.01

Sample calculation:

$Al(OH)_3$

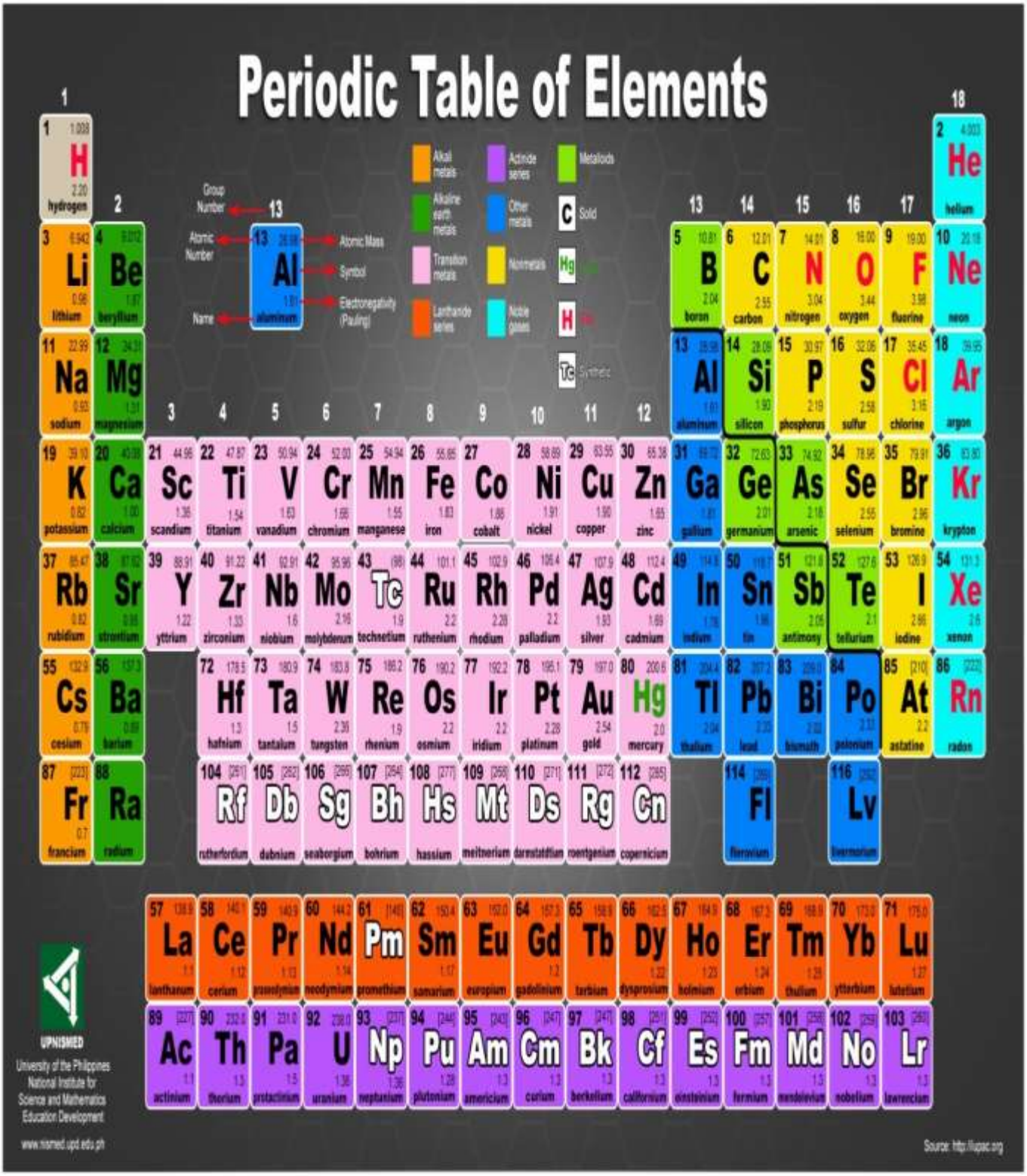
3 x 1.01 g/mol = 3.03 g/mol

3 x 16.00g/mol =48.00g/mol

1 x 26.98g/mol = 26.98g/mol

78.01g/mol

As you can see in the number of atoms per element in the compound is multiplied by the molar mass. The numerical value of the molar mass can be seen in the periodic table.



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

Just in case the students need additional activity on this topic, you may give this to them to facilitate better understanding of the topic or you can use the following activity to introduce molar mass to the learners.

Substance	Chem. Formula	No. of C Atom	Atomic Mass of C (amu)	Molar Mass of C in the Compound (g/mol)	No. of H Atom	Atomic Mass of H (amu)	Molar Mass of H in the Compound (g/mol)	Molar Mass (g/mol)
Methane	CH_4	1	12.01	12.01	4	1.01	4.04	16.05
Ethyne	C_2H_2	2	12.01	24.02	2	1.01	2.02	26.04
Butane	C_4H_{10}	4	12.01	48.04	10	1.01	10.10	58.14
Propene	C_3H_6	3	12.01	36.03	6	1.01	6.06	42.09
Ethane	C_2H_6	2	12.01	24.02	6	1.01	6.06	30.08
Octane	C_8H_{18}	8	12.01	96.08	18	1.01	18.18	114.26

Activity 4 The Relationships among Number of Moles, Mass, and Number of Particles

It is important that the students see the connections/relationships among the mass, number of moles, and number of particles for a good assimilation of the mole concept. In this activity, they will realize that in a quantitative experiment, the use of a tablespoon and other such measuring devices to determine the quality of different substances are not always advisable because it may yield inaccurate results.

Answers to Questions

Table 6. Data on Molar Relationship

Substance	Sulfur	*Aluminum foil	Sugar	Salt
Mass (g)	5.3	1.8	7.8	11.0
No. of Moles	0.17	0.10	0.023	0.19
No. of Particles	1.0×10^{23}	6.0×10^{22}	1.4×10^{22}	1.1×10^{23}

**Cut into tiny pieces*

Q1. List down the substances based on the following order:

a. Increasing mass (light to heaviest)

aluminum foil	sulfur	sugar	salt

b. Increasing number of particles (lowest to highest amount)

sugar	aluminum foil	sulfur	salt

c. Increasing number of moles (lowest to highest amount)

sugar	aluminum foil	sulfur	salt

Q2. Is the number of particles in the sample directly related to the number of moles? Why do you say so?

Yes, because as the number of moles increases the number of particles also increases. This can be reflected in the formula used to compute for the number of particles (number of particles = number of moles x Avogadro's number)

Q3. Is the mass of the sample related to the number of moles? Explain your answer.

Increase in mass of the different substances does not necessarily mean increase in the number of moles because the number of moles is computed by dividing the mass of the sample by its molar mass.

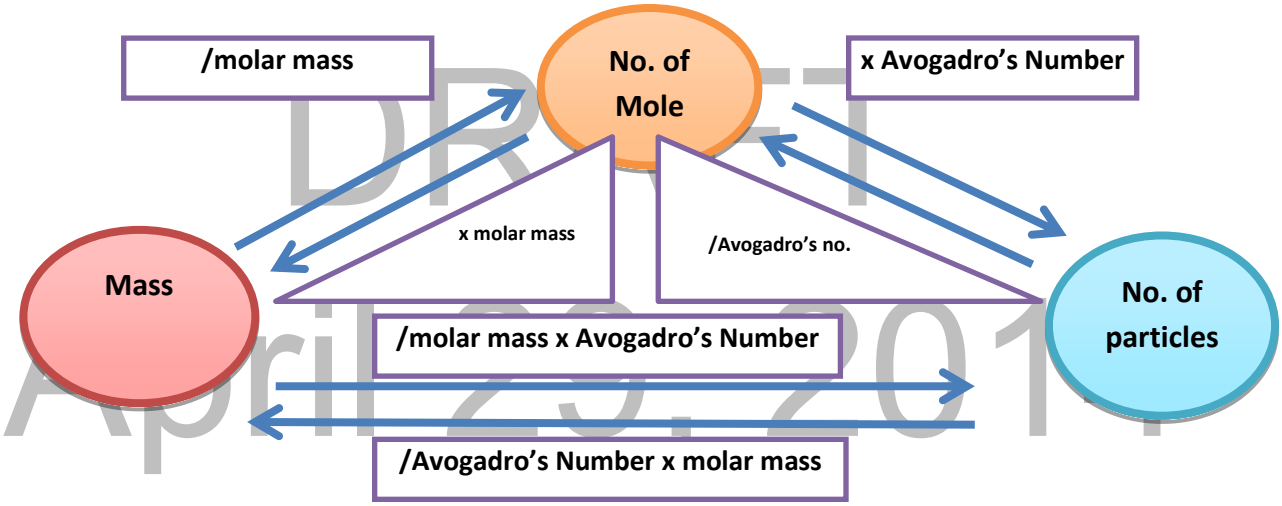
Q3. Explain why one tablespoon of different substances does not have the same mass in grams (g), the same number of moles and the number of particles.

One tablespoon of different substances has different masses, number of moles and particles because they have different molar masses.

Activity 5

The Chemist's Mole

You may use the following diagram in explaining the computations about the mole concept. This will further demonstrate the relationships among the mass, number of particles, and number of moles of the substances under study.



Answers to Questions

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**	**molecule**	**110.03**	**2.5**	**1.505×10^{24}**
Gold (Au)	**197.00**	**atom**	**197.00**	**1**	**6.02×10^{23}**
Glucose ($C_6H_{12}O_6$)	**180.18**	**molecule**	**360.36**	**2**	**1.205×10^{24}**
Calcium fluoride (CaF_2)	**78.08**	**formula unit**	**234.24**	**3**	**1.806×10^{24}**
Nitrogen gas (N_2)	**28.02**	**molecule**	**140.10**	**5**	**3.010×10^{24}**

Q1. When is a particle classified as an atom, a molecule, or a formula unit?

A particle is called an atom when it represents an element; molecule when it represents a molecular compound (CO_2, CH_4, H_2O and other compounds alike) and elements (N_2, O_2, H_2, and other diatomic molecules; and formula unit when it represents ionic compounds (NaCl, CaF_2, KCl)

Q2. Show how you will convert the mass of a given sample to number of moles and vice versa.

Mass divided by the molar mass is equal to the number of mole.

Q3. Show how you will compute for the number of particles given the following:

a. Mass of the sample

number of moles x molar mass = mass

$$\text{mole} \times \frac{g}{\text{mole}} = g$$

number of particles divided by Avogadro's number x molar mass equals mass

$$\text{number of particles} \times \frac{1\ \text{mole}}{6.02 \times 10^{23}\ \text{particles}} \times \frac{g}{1\ \text{mole}} = g$$

b. Number of moles of the sample

Mass divided by the molar mass = number of moles

$$\frac{g}{g/\text{mol}} = \text{mol}$$

number of particles divided by Avogadro's number =

number of moles

$$\frac{\text{number of particles}}{6.02 \times 10^{23}\ \text{particles/mole}} = \text{mole}$$

Presenting the formula in the above-cited manner will help the learners understand how the cancellation of units takes place and how it is converted to the other unit.

The following are the solutions to the problem exercises on mole concept:

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 everyday for one month? b) How many molecules of ascorbic acid does he need everyday to fight the cancer cells?

a. Compute for the molar mass of $C_6H_8O_6$

molar mass of $C_6H_8O_6$ = 180.18g/mole

Compute for the mass of ascorbic acid needed for 1 month

$$\frac{13.00\text{g}}{1\text{day}} \times \frac{30\text{ days}}{1\text{month}} = \frac{390.0\text{g}}{\text{month}}$$

Solve for the number of moles of $C_6H_8O_6$ using the molar mass

$$390.0\text{g } C_6H_{12}O_6 \times \frac{1\text{mole } C_6H_8O_6}{180.18\text{ g}} = 2.165\text{ moles}$$

****the patient needs 2.165 moles of $C_6H_8O_6$ in a month***

b. To compute for the number of $C_6H_8O_6$ molecules of needed by the patient daily to fight cancer, multiply the number of moles by the Avogadro's number divided by the number of days in a month.

$$\frac{2.165\text{ moles}}{\text{month}} \times \frac{6.02 \times 10^{23}\ C_6H_8O_6\text{molecules}}{1\text{mole } C_6H_{12}O_6} \times \frac{1\text{month}}{30\text{ days}} =$$

$$4.344 \times 10^{22}\ C_6H_8O_6\text{ molecules/day}$$

****43,440,000,000,000,000,000,000 molecules of ascorbic acid are fighting the cancer cells daily***

2. **Aspartame ($C_{14}H_{18}N_2O_5$)** is a synthetic table sugar substitute used in food and drinks. If a food product needs 0.25 g of $C_{14}H_{18}N_2O_5$ to sweeten the Queenie cupcake, and you ate this food product, how many molecules of aspartame have you eaten?

Compute for the molar mass. It will serve as the conversion factor to compute for the number of moles.

Molar mass of $C_{14}H_{18}N_2O_5$ = 294.34g/mol

$$0.25\ g\ C_{14}H_{18}N_2O_5 \times \frac{1\ mole\ C_{14}H_{18}N_2O_5}{294.34\ g\ C_{14}H_{18}N_2O_5} = 0.00085\ mole\ C_{14}H_{18}N_2O_5$$

Calculate for the number of molecules using Avogadro's number.

$$0.00085\ mole\ C_{14}H_{18}N_2O_5 \times \frac{6.02 \times 10^{23}\ molecules\ C_{14}H_{18}N_2O_5}{1\ mole\ C_{14}H_{18}N_2O_5} = 5.1 \times 10^{20}\ molecules\ C_{14}H_{18}N_2O_5$$

****510,000,000,000,000,000,000 molecules of aspartame entered the body***

3. During exercise, **lactic acid ($C_3H_6O_3$)** forms in the muscle causing muscle cramp. If 5.0 g of lactic acid ($C_3H_6O_3$) concentrate in your leg muscle, how many moles of lactic acid ($C_3H_6O_3$) are causing you pain?

Solve for the molar mass of $C_3H_6O_3$

Molar mass of $C_3H_6O_3$ = 90.09 g/mole

To solve for the number of moles of lactic acid causing the leg pain, divide the mass of lactic acid by the molar mass.

$$5.0\ g\ C_3H_6O_3 \times \frac{1\ mole\ C_3H_6O_3}{90.09\ g\ C_3H_6O_3} = 0.056\ mole\ C_3H_6O_3\ is\ causing\ leg\ pain$$

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?

To solve for the number of molecules of CO_2 a 20.0 g candle emitted after combustion, multiply the number of moles equal to 20.0g $C_{22}H_{46}$ by the Avogadro's number.

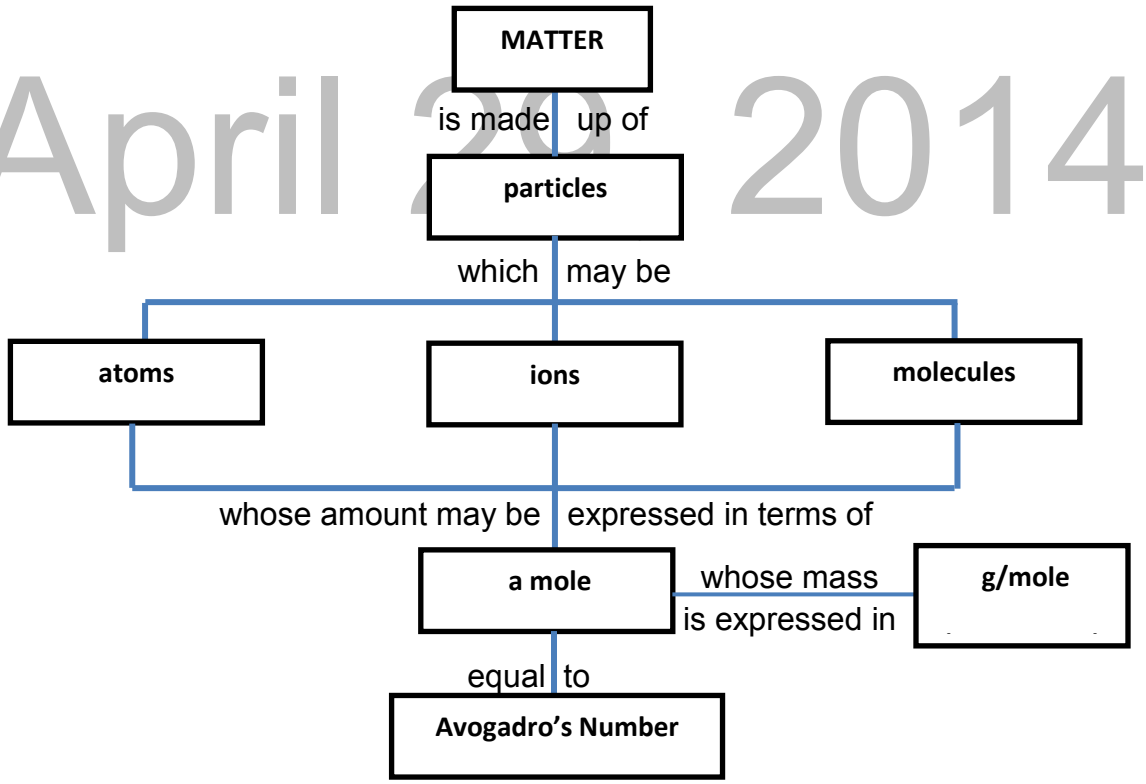
$$1.42 \text{ mole } CO_2 \times \frac{6.02 \times 10^{23} \text{ molecules}}{1 \text{ mole } CO_2} = 8.55 \times 10^{23} \text{ molecules } CO_2$$

****855,000,000,000,000,000,000, 000 molecules of CO_2 are released to the environment after consuming a 20.0g candle***

Activity 6

The Mole Map

This activity will give focus to the students' attention on what to remember about the mole concept on a conceptual level approach.



Give emphasis on how they are going to differentiate the particles of matter. In module 2, they have learned the kinds of bonding, thus they can efficiently differentiate an atom, a molecule and an ion from one another. You should also be mindful of the information the learners need to process so that it will be transferred to their long-term memory. The mole concept which tells us that one mole of a substance contains Avogadro's number of particles equal to 6.02 x 10^{23} particles and 1 mole of different substances have different masses must be processed efficiently with all the activities provided in this module.

Percentage Composition

In answering the problems involving percentage composition, you always start with the computation of molar mass if it is not given in the problem. The following problems were given for the students for them to realize the importance of understanding this topic.

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 sulphate - $(NH_4)_2SO_4$**

c. **ammonium nitrate - NH_4NO_3**

molar mass of ammonia, NH_3

= (1N atom x 14.01g/mole) + (3 H atoms x 1.01g/mole)

= 17.04 g/mole

$$\%N = \frac{14.01\ g/mole}{17.04\ g/mole} \times 100$$

= 82.22 %

molar mass of ammonium sulfate, $(NH_4)_2SO_4$

= (2N atoms x 14.01 g/mole) + (8H atoms x 1.01 g/mole) +

(1S atom x 32.07 g/mole) + (4) atoms x 16.00 g/mole)

= 112.17g/mole

$$\%N = \frac{28.02\ g/mole}{112.17\ g/mole} \times 100$$

= 24.98%

molar mass of ammonium nitrate, NH_4NO_3

= (2N atoms x 14.01g/mole) + (4H atoms x 1.01 g/mole) +

(3O atoms x 16.00 g/mole)

= 80.06 g/mole

$$\%N = \frac{28.02\ g/mole}{80.06\ g/mole} \times 100$$

= 35.00%

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?

molar mass of **glucose ($C_6H_{12}O_6$)**

= (6C atoms x 12.01g/mole) + (12H atoms x 1.01 g/mole) +

(6O atoms x 16.00 g/mole)

= 180.18 g/mole

$$\%C = \frac{72.06\ g/mole}{180.18\ g/mole} \times 100$$

$$= 39.99\%$$

3. The “fuel value” of the hydrogen-containing fuels depends on the mass percentage of hydrogen (H). Rank the following compounds based on 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)

molar mass of ethane (C_2H_6)

= (2C atoms x 12.01g/mole) + (6H atoms x 1.01 g/mole)

= 30.08g/mole

$$\%H = \frac{6.06\ g/mole}{30.08\ g/mole} \times 100$$

= 20.15%

molar mass of propane (C_3H_8)

= (3C atoms x 12.01g/mole) + (8H atoms x 1.01 g/mole)

= 44.11g/mole

$$\%H = \frac{8.08\ g/mole}{44.11\ g/mole} \times 100$$

= 18.32%

molar mass of ethanol (C_2H_5OH)

= (3C atoms x 12.01g/mole) + (6H atoms x 1.01 g/mole) +

(1O atom x 16.00g/mol)

= 46.08g/mole

$$\%H = \frac{6.06\ g/mole}{46.08\ g/mole} \times 100$$

= 13.15%

Ranking of the substances based on their "fuel value":

Rank	*Substance*	*%H*
1	*ethane (C_2H_6)*	*20.15%*
2	*propane (C_3H_8)*	*18.32%*
3	*ethanol (C_2H_5OH)*	*13.15%*

Through this problem, you can make the learners realize that the greater number of atoms of a certain element in a compound would not necessarily mean that it will have higher percentage composition. In the case of the substances cited above, propane has higher number of H atom than ethane but it has the higher percentage H, thus it has the higher "fuel value".

Activity 7

It's Grocery Time!

This is the final activity in this module. It is designed for the students' appreciation of the topics discussed in this module. Through this activity they will be able to realize that chemistry concepts can be of great help in the usual activities they are doing regularly specifically in choosing grocery products and monitoring the amount of substance intake.

Answers to Questions

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?

The answer of the leaners may vary depending on their food preferences. Generally speaking softdrinks, fruit juices in doy packs, cupcakes, and other foods which contain sugar that is reported as carbohydrates in the nutrition facts will give them a lot of carbon atoms. On the other hand, grocery items commonly known as"junk food," such as crackers, potato chips, and corn chips and canned goods contain salt that provide sodium ions to their body.

Q2. Are these good for your body? Why? Research on how much of these types of food are recommended for your age group.

Too much intake of those foods is not good for the body. The Food and Nutrition Research Institute has a recommended value intake to individuals of Junior High School (JHS) age.

Q3. In what other ways can you make use of the concept on percentage composition?

The concept on percentage composition can be used in the preparation of food (baking and cooking), preservation of food, production of paste, paint, and alloy to name a few. There is a wide variety of application for this topic.

Summative Assessment

1. a. 105 g cacao
2. d. formula unit
3. b. 6.02×10^{23}
4. c. 6.14×10^{22} molecules of $C_6H_4Cl_2$
5. a. Ann
6. b. K_2O
7. a. 1.20×10^{24}
8. d. 50.05%
9. b. $CH_4 < NH_3 < H_2O < N_2 < Cl_2$

10. d. All of the above

11. a. 35.00%

12. c. 0.029 mole

13. a. 52.11%

14. d. 116.18 g/mole

15. b. 0.0225 mole

References:

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DRAFT
April 29, 2014

Suggested time allotment: 10 hours

Unit 3

MODULE 1

VOLCANOES

Content Standard	Performance Standard
The Learner demonstrates understanding of volcanoes found in the Philippines.	The Learner participates in activities that reduce risks and lessen effects of natural phenomenon such as volcanic eruption.

I. Overview

The spiralling of concepts in geology starts from the Learner's awareness of his immediate surroundings to the processes within the Earth's interior. In the lower grades, we have taken up the following so far: landforms and bodies of water, importance of soil and water in the community, weathering and erosion, effects of earthquakes and volcanic eruptions, the Philippine environment and models of earthquakes. In this grade level, we are focusing on one of the most spectacular but Earth's surface-transforming event: volcanism.

Many people are aware that we are located along the Ring of Fire. But not everyone understands about the process of volcanism. We are impressed with the scenic beauty of the volcano but we are not so aware of what have caused the formation of volcanic cone and the fiery emission of volcanic materials.

There are five activities in this module: a) Volcano concept map; b) Volcanoes in the Philippines; c) Under pressure; d) Viscosity race; and e) In and out

After the activity, a performance task is provided. Actually, this task is very important for us to know how this natural phenomenon happens and how to reduce the risks and effects it may cause.

II. Learning Competencies/Objectives

In this module, the Learners 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

Answer: d

2. Which of the following characteristics of a volcano depends on its magma emission? a. age
b. size
c. shape
d. location

Answer: c

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

Answer: d

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 become heavy as they pile up.

Answer: d

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

Answer: b

B. Answer the following questions briefly.

6. Aside from Mayon Volcano, name another volcano that has erupted recently.*Answer: Answers may vary.*

7. What causes a shield volcano to be shaped like a broad dome?
Answer: A shield volcano is formed from lava emission. Since lava is a fluid, it flows easily and travels far resulting in a wide base with a shallow slope.

8. By what process can a volcanic eruption affect temperatures around the world?
Answer: When a volcano ejects so much sulfur dioxide and ash, they prevent the sunlight from reaching the Earth's surface. It results in a decrease in temperature, not only within the volcanic area, but also around the world as winds carry the volcanic materials as they circulate.

9. Give one positive effect and one negative effect of volcanic eruptions.
Answer: Positive effects – Makes soil fertile, volcanic materials provide clue about the Earth's internal structure, formation of minerals. (Answers may vary.)
Negative effects – Destruction of properties and lives; Death of organisms (Answers may vary.)

10. How is energy from volcanoes tapped as source of electricity?
Answer: The heat from inside the Earth is collected in a geothermal power plant by drilling a hole in the ground at great depth. The heat is used to boil water to produce a steam that turns the turbine. The mechanical energy from the turbine is transferred to the generator which in turn, transforms the mechanical energy to electrical energy.

IV. Reading Resources and Instructional Activities

What is a volcano?

Prior to activity 1, group the students according to their hometowns. If they came from the same region, divide them into three groups, namely: Luzon, Visayas, and Mindanao. Assign them to conduct a research on the volcanoes found in their respective or assigned region.

First, the student's prior knowledge of the volcano is very crucial to the understanding of the details of volcanism. This is a springboard for further learning of the concept. It is for this reason that we must be very careful in assessing the

concept maps given by the students. All the descriptions given by the students must be solely based from the pictures in Figure 1.

Activity 1. Volcano concept map

Answers to questions

Q1. Based on the picture, give five descriptions of a volcano. Present your answer in a concept map as shown below.

Answer: These are the possible answers:

- *A volcano is cone-shaped.*
- *It has an opening at the top (or in some case, on the sides)*
- *Hot thick cloud of gas, molten rocks, ash forming a cauliflower shaped-cloud comes out of its opening.*

Fig. 2. Concept map in volcano

In giving points to student responses, consider the following:

5 points: if the concept map is completely filled in with unique and correct ideas
4 points: if the concept map is completely filled in with correct but not unique ideas
3 points: if one part of the concept map is not filled in but the supplied ideas are correct
2 points: if two parts of the concept map is not completely filled in and some of the supplied ideas are incorrect
0 point: no effort exerted

Classification of volcanoes

The students may tell you that there are other classifications of volcano aside from active and inactive. While it is true there may be other ways, emphasize to the students that the classification of PHIVOLCS will be used for consistency and ease.

Before the start of Activity 2, check the understanding of the students on locating places using the latitude and longitude that they have learned in grade 7 and even reinforced in grade 8. If some students fail to plot the location, practice exercises must be given to the students.

Activity 2. Volcanoes in the Philippines

Answers to questions:

Plotting the volcanoes in their location is found on the next page.

Q1. Are all the volcanoes found in the same location?

Answer: No. They are found in different places in the Philippines.

Q2. Which of the volcanoes had the most number of eruptions? least number of eruptions? no record of eruption?
Answer: Mayon volcano has the most number of eruptions while Iraya volcano has the least number of eruptions. The following volcanoes have no record of eruption: Cabaluyan, Cocoro, Pulung, Tamburok and Urot.

Q3. How will you classify the volcanoes that have records of eruptions within 10,000 years?
Answer: Active volcanoes

Q4. How will you classify volcanoes with no record of eruption?
Answer: Inactive volcanoes

Q5. In your own words, differentiate an active volcano from an inactive one.
Answer: Active volcanoes are those that have records of eruption or have erupted recently while inactive volcanoes are those that show no record of eruption.

When the students have classified the given volcanoes correctly as active or inactive, we can ask them to make a research for classification of other volcanoes in the Philippines. They can share their research work in the class.

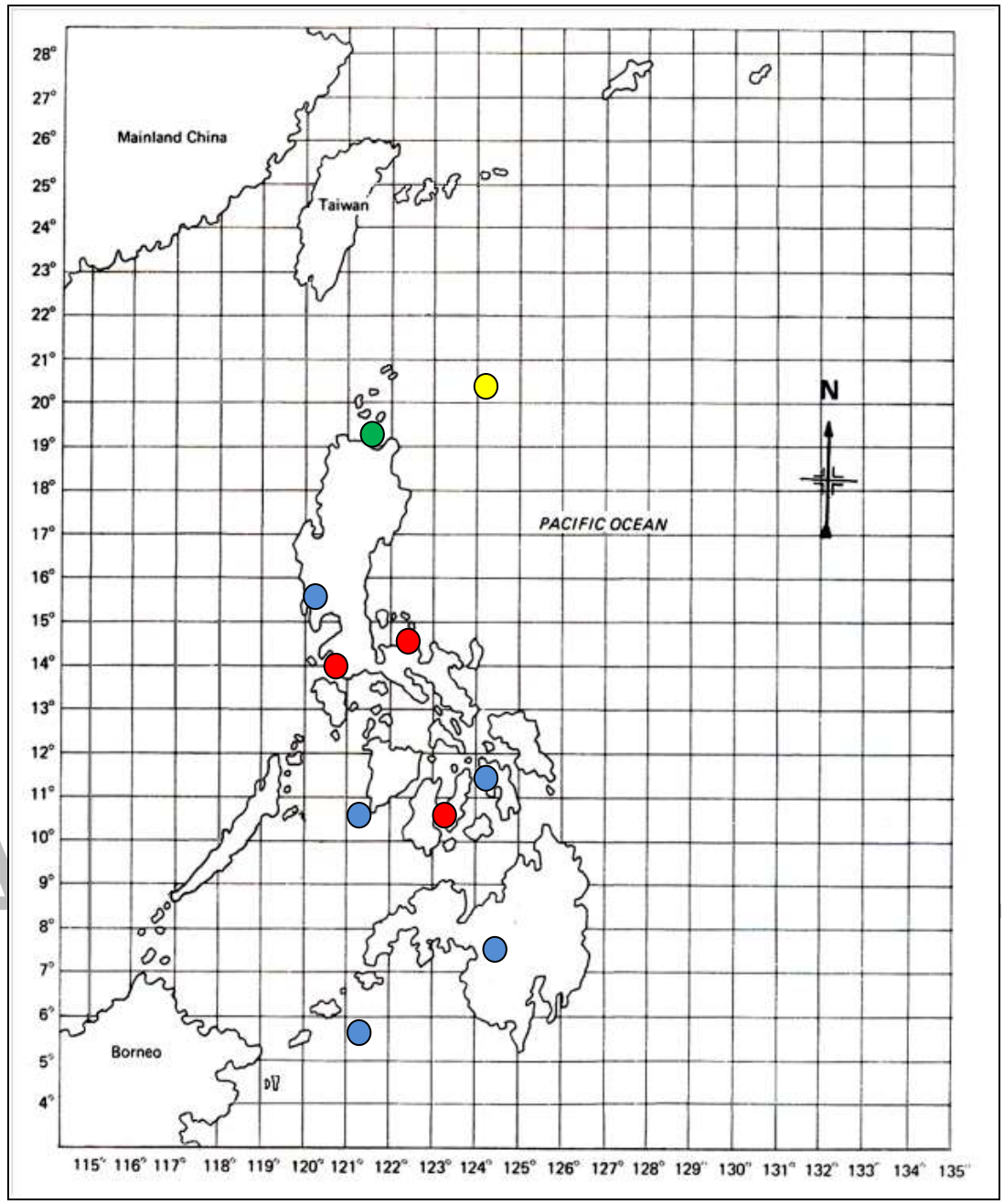


Fig. 3. Map of the Philippines (Source: Gr 8 LM, UPNISMED)

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

Activity 3. Under pressure

For the definition of viscosity, the student may be asked to compare their definitions and observations with their classmates.

Lavas differ in their rate of flow due to their viscosity. More viscous lava flows slower than the less viscous ones.

Bubbles move slowly in a more viscous liquid such as in syrup. Relating this observation with magma it can be said that magma with a large amount of gas is less viscous than that of magma with less amount of gas.

Activity 4. Viscosity race

This activity can be done through teacher's demonstration or by the students themselves. Remind the students to be observant.

Answers to questions

Q1. What did you observe in each bottle?
Answer: A fizzing sound was heard followed by the rushing out of bubbles from the bottle dipped in hot water. There was also a sound heard in the bottle placed in cold water but not as much as in bottle A.

Q2. Explain your observation.
Answer: There was accumulated gas inside the bottle.

Q3. What is the role of hot water in the setup?
Answer: The hot water increases the temperature of the soda drink inside the bottle. As the temperature increases, more gas is accumulated inside the bottle. This causes the fizzing sound.

Q4. Do you have the same observation as in the soda drinks?
Answer: The observation in the bottle of cooking oil is not the same as in the soda drinks.

Q5. Explain your answer.
Answer: There was not much gas released in the bottled cooking oil because of its composition. Soda drink is carbonated. The high temperature released the gas from the soda drinks.

In the activity, we have seen the effect of temperature on the amount of gas that can be produced in a liquid. What is the role of pressure in the setup?

The accumulated gas inside the bottle has increased the pressure causing the liquid to rush out of the bottle.

Volcanic landforms and eruptive styles

Introduce this topic by showing pictures of volcanoes with different shapes. We should show the students the different parts of the volcano namely: slope, crater, and summit. We must also point out the difference between a crater and a caldera.

We can also show some video clips showing the different types of volcanic eruptions. If there is no available video clip, the pictures shown in the learner's material can be used.

To show viscosity, use syrup or cooking oil and water. Let the students observe how each liquid flows. The concept that we would like to point out here is that, the more viscous the fluid is, the harder it flows.

We can discuss the different factors that affect the viscosity of magma using Figure 5. The primary factors that affect the viscosity of magma are: magma's temperature, its chemical composition, and the amount of dissolved gases it contains. To varying degrees these factors affect the magma's viscosity.

Activity 5. In and out

In doing this activity, we have to emphasize to the students that the pebbles to be used must be rounded or sub-rounded with a size of approximately 1-2 cm, as shown in Figure 4, for the pebbles to pile up.

Fig. 4. Pebble forvolcano model

Answers to questions

1. Make a data table like the one shown below.*(Data may vary)*

Table 2. Volcano model and slope

Cone	Drawing of cone	Slope (in degrees)
A		1-5
B		30-40 (with wide crater)
C		Any answer between angles of cones A and B

Q1. Compare the appearances of the cones.

Answer: Cone A was almost flat, cone Ctallest while cone B was in-between the two cones.

Q2. Which volcano has the greatest slope? Which has the least slope?
Answer: Cone B has the greatest slope while cone A has the least slope.

Q3. Explain how the type of material extruded from a volcano affects the shape of its cone.
Answer: Cone A was almost flat because it was formed from lava.Fluid flows freely, forming a very wide base.

Q4. In what way does the formation of a volcanic cone model differ from a real volcano?
Answer: In real life, the emissions come from within while,in the model, the cone is from the materials that are poured from outside.

How will you describe the slope of Pinatubo Volcano? Infer the type of materials from which it was formed.

Pinatubo volcano is a stratovolcano. In other words, it came from alternate solidification of lava and cinders.

In discussing the volcanic cones, always relate it to the type of material emissions. We have to provide pictures and examples as the one shown below. It would also help if the model of volcanoes will be shown to the students after processing the activity. We can use clay for the model, but it should be a cross section to show the layers of materials that led to the formation of the cone.

Energy from the volcano

In teaching this source of energy, we must introduce the topic by calling it as the energy flowing from inside the Earth. Use picture or video clip to explain the topic. If possible, show pictures of geothermal power plants in the Philippines.

Point out to the students that geothermal power plants are built in an area that has a lot of hot springs, geysers, or volcanic activity. Some students often have a misconception that a magma chamber can be drilled as source of electricity. At a geothermal power plant, wells are drilled deep into the Earth to pump steam or hot water to the surface. Hot water is pumped from deep underground through a well under high pressure.

Q1. Use a flowchart to describe how energy is transformed to generate electricity in a geothermal power plant.

Answer: thermal energy from inside the Earth → mechanical energy in a turbine → mechanical energy of a generator → electrical energy

Performance task

Prior to this topic, we should ask our students to research on disaster preparedness specifically on what to do before, during, and after volcanic eruptions.

Although the students can choose their own groupmates, we can also assign them their groups if there are some concerns that arise as they choose their own group.

Before the activity, the objective and the criteria for rating must be clear to the students. We may consider the rubrics below.

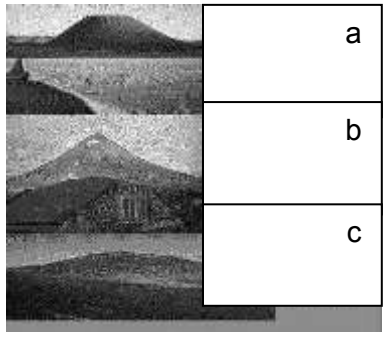
Criteria	Excellent 4	Proficient 3	Adequate 2	Limited 1
Details and Information	Has included at least 5 things to remember before, during, and after a volcanic eruption	Has included 4 things to remember before, during, and after a volcanic eruption	Has included 3 things to remember before, during, and 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 a 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 moderately suitable about what to do before, during, and after a 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 a 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 – hidden under the squares)

Which among the following volcanoes is formed from:



1. cinders and ash?
Answer: a

2. mostly lava?
Answer: c

3. alternate solidification of lava and cinders?
Answer: b

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
Answer: d

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
Answer: d

6. How does the eruption of a volcano lower the atmospheric temperature?
Answer: Sulfur dioxide and ash fall are carried by wind during volcanic eruption. As it circulates, it may block the sunlight causing a decrease in the Earth's temperature.

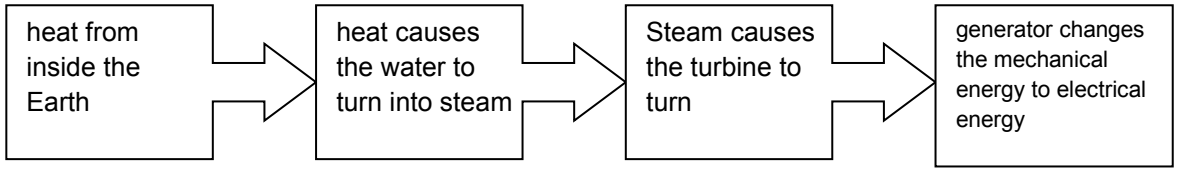
7. Give one positive effect and one negative effect of volcanic eruption.
Answer: May include the following – positive: makes the soil fertile;
negative: destruction of properties and loss of lives

8. Describe the shape of the volcanic cone formed from the following type of volcanic emission:

a. high temperature magma – *wide base and almost flat slope*
b. low amount of gas magma – *wide base and almost flat slope*
c. high silica content magma – stratovolcano

9. Give three things that a person should do during volcanic eruption in order to avoid getting hurt. *Answers may vary*

10. Complete the chart below to show how the heat from the Earth is tapped as 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 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
Climate

Suggested Time Allotment: 8 to 9 hours

Content Standard	Performance Standard
The learners demonstrate understanding of the factors that affect climate, the effects of changing climate, and how to adapt to climate change.	The learners should participate in activities that reduce risks and lessen the harmful effects of climate change.

In grade 8, students learned how typhoons develop, how typhoons are affected by landforms and bodies of water, and why typhoons follow certain paths as they move within the Philippine Area of Responsibility. In this module, students will explore how different factors affect the climate of a certain place. The learners will also learn to distinguish climate from weather. Students are also expected to understand the impacts of climate change to people, animals, and society. Furthermore, students are expected to make a strategic plan to mitigate and to adapt tothe impacts of climate change.

At the end of this module, students 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

Key questions for this module

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?

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 windwardside receives more heat than the leeward side.
    d. The leeward side receives more precipitation than the windwardside.

Answer: a

2. What happens to the temperature of air when altitude increases?
    a. remains the same
    b. increases
    c. decreases
    d. varies

Answer: c

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.

Answer: b

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

Answer:c

5. What will happen when the rates of evaporation and condensation are equal?
    a. Clouds form.
    b. The dew point is reached.
    c. The humidity increases.
    d. Precipitation occurs.

Answer: d

6. Which of the following can cause global warming?
    a. volcanic eruptions
    b. theincrease of the amount of rainfall
    c. the rising of warm air into the atmosphere
    d. increase of the amount of CO_2 in the atmosphere

Answer: d

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 the outer space.
d. Greenhouse gases in the lower atmosphere absorb heat from the earth's surface.

Answer: d

8. Which activity does not contribute to global warming?

a. reforestation
b. illegal fishing
c. mining activities
d. incineration of garbage

Answer: a

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

Answer: d

10. Which of following is an indication of global warming?

a. rising of sea level
b. decrease of global temperature
c. coastal erosion
d. land and water pollution

Answer: a

II. Answer the following questions.

1. What are the factors that affect climate?
Answer: The factors that affect climate are latitude, altitude, topography, and distance from the ocean.

2. How can you lessen the harmful effects of climate change?
Answer: By reforestation, construction of houses that can sustain strong winds, make clothes that can protect us against extreme temperature, construct improvised boat in preparation for flooding

3. Explain how greenhouse effect happens.
Answer: Greenhouse effect happens when greenhouse gases allow solar radiation to enter the Earth's atmosphere and prevent heat from escaping.

4. How is a rain shadow formed?
Answer: It is formed when the other side of the mountain does not experience precipitation.

5. What are some impacts of climate change to people and animals?
Answer: Some of the impacts are the following: strong typhoons, extinction of some animals, loss of lives, and destruction of agricultural crops.

Activity 1When the Sun's Rays Strike

In this activity, students should recall their knowledge about latitude and longitude.

1. Students will identify latitude and longitude using a globe or a map.They will also locate the Tropical Region, Temperate Region, and Polar Region.

2. Students will give examples of places that are found in Tropical regions, Temperate regions and Polar regions. Ask the students, why does earth have different climate zones?

3. Introduce Activity 1 "When the Sun's Rays Strike" a paper-and-pen activity using the diagram (see Figure 1 of the LM).

4. When the students finished the activity, let them emphasize the relationship of climate and latitude. They should explain that when an area is farther from the equator, the air temperature is lower resulting in a cold climate. When the place is closer to the equator, the air temperature is higher which results in a warm climate. As the latitude increases, the greater the angle the sun's rays strike.

Answers to Questions

Q1. 23.5^0

Q2. Equator

Q3. It is due to the tilting of the earth's axis and the shape of the earth.

Q4. They receive less amount of heat.

Q5. Due to the tilting of the earth's axis, places near the equator receive more heat making the air temperature higher.

Q6. When the area is farther from the equator, the air temperature is lower resulting in a cold climate. When the place is closer to the equator, the air temperature is higher which results in a warm climate.

Activity 2 The Higher, the Colder

This activity will show how altitude affects climate.

1. Start the lesson by posing the following questions:

a. Where dopeople usually go during summer vacations? Elicit answers from the students. B. Why do they go there? Elicit answers from the students.

c. Why is it cold there? Elicit the answers of the students.

2. Present the Activity 2, "The Higher, the Colder". Tellthe students that this activity could help answer the third question.

3. After the students have finished the activity, emphasize the relationship of altitude and climate. Students will explain how altitude affects climate based on the result of the activity.

4. Cite some examples to explain the relationship between altitude and climate. Let the students explain why the peak of Mt. Kilimanjaro is covered with snow although it is located near the equator (refer to Figure 2 of the LM). You may also raise these questions: Why do many people visit Baguio City (see Figure 2.2 of the LM))? Why do mountaineers wear thick clothes when they go up a mountain (refer Figure 2.3 of the LM)?

Key concepts:

- The air temperature decreases as the altitude increases. Places with higher elevations have cold climates.

- For every 1000 m, there is a drop of 6.5^0C. The decrease in air temperature is due to the decrease in air pressure.

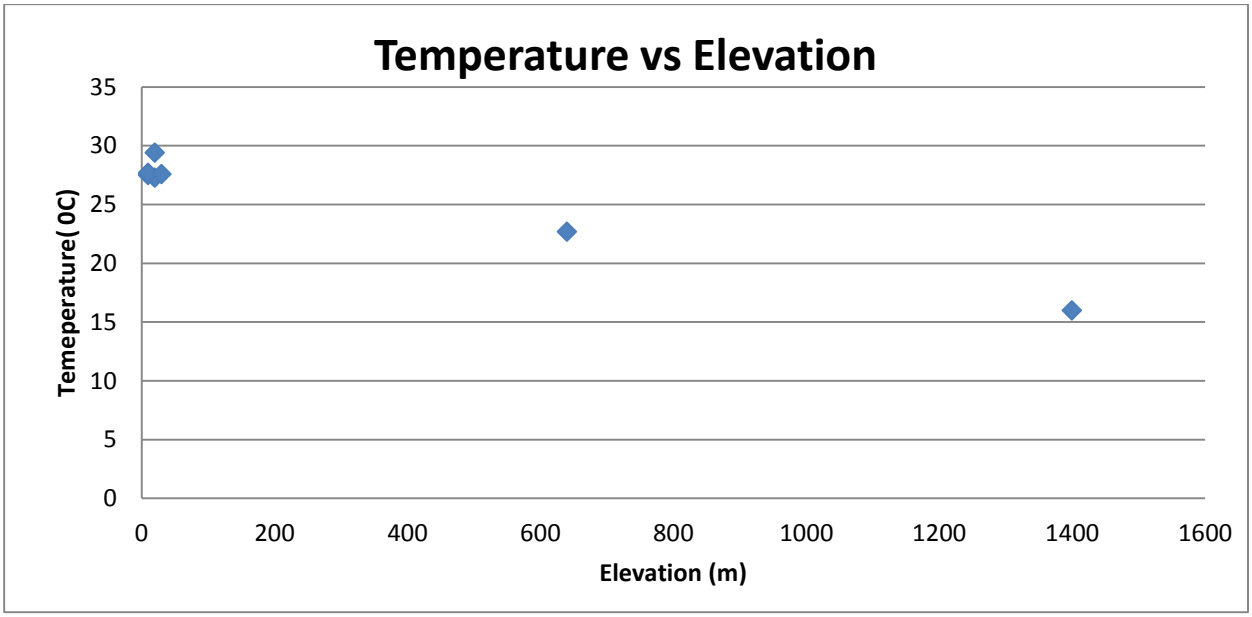
Answers to Questions

Q1. Baguio

Q2. Manila

Note: Emphasize that there are other factors that contribute why Metro Manila has the highest temperature. These factors include pollution, overpopulation, a lot of factories, and many vehicles.

Q3. Temperature (y) vs Elevation



As the altitude increases, the temperature decreases.

Activity 3 Which cools and heats faster?

This activity is similar to the activity performed by the students when they were in Grade 7. By doing this activity again, learners will show their scientific skills that they acquired when they performed this activity.

1. You should try this activity ahead of time for you to know the right amount of water and sand or soil to be used. The amount of soil/sand and water may affect the rate of absorption of heat. Since this activity requires sunlight, this should be performed on a sunny day. If the weather does not permit, use lamps. Lamps can simulate the radiation effect of sunlight. If electricity is not available, use alcohol lamps. But emphasize to the students that heat coming from alcohol lamps do not simulate the radiation effect of sunlight. It simulates only the absorption of heat by sand/soil and water from the alcohol lamps.

2. You must carry out first the Preactivity. Remind the learners of the Dos and Don'ts regarding the activity such as: they have to be careful in getting the data. They should follow the procedure carefully to get reliable data. Point out also that the bulb of the thermometer must not be allowed to touch the bottom of the container.

3. Post the questions on the board: "Which heats faster: water or soil? Which cools faster: water or soil? Tell the students that they will be performing an activity to answer these questions.

4. After the activity, the students must emphasize the effect of the distance of bodies of water. Use Figure 3.1 of the LM to help students understand the effect of bodies of water on a certain area. Students will revisit the effects of land breeze and sea breeze.

Key Concepts

- The soil absorbs heat faster than water. At the same time, the soil releases heat faster compared to water.

- During daytime, the air above the sea is colder than the air above the land. The warm air flows from land to sea. Thus, the rise of temperature on land would be moderated.

- During nighttime, warm air would flow from sea to land, making the temperature on land higher.

Answers to Questions

Q1. Answers may vary.

Q2. Answers may vary.

Q3. Over the same time interval, temperature of soil rise faster..

Q4. The temperature decreases or becomes lower.

Q5. Soil cools faster.

Q6. A body of water circulates the warm air and cold air. It absorbs more heat and can slowly release heat making the change in temperature of a country moderate.

Q7. Because there no bodies of water that will moderate the change in temperature in the location.

Activity 4Which should I choose, Windward or Leeward?

This activity will help learners explain how topography affects climate. By using the diagram, learners will help deepen their understanding of the effects of topographic features on climate.

1. The students will study Figure 4.1 of the LM before they answer the questions.

2. After they finished the activity, explain how topography affects the climate. Explain that rain shadow is seldom found here in the Philippines because our country is surrounded by bodies of water. Another reason is that the Philippines has two local wind systems such as Amihan and Habagat. These local winds bring precipitation in every part of the Philippines.

3. You may opt to use this video link (as of November 7, 2013):

http://www.youtube.com/watch?v=Tmv_8j_UnTs to deepen the understanding of the students.

Key Concepts

- Moist wind coming from the sea flow up the mountain. Because temperature falls with altitude, water vapor eventually condenses and there is precipitation. Since this is the side of the mountain facing the wind, it is called the ***windward side***.

- Formation of the clouds in the windward side of the mountain is caused by the condensation of water vapor.

- Since precipitation occured on the windward side, the wind often loses its moisture content by the time it reaches the peak. The wind flowing down the other side, called the ***leeward side***, is dry. Since it barely rains on this side, the mountain is said to form a rainshadow on the leeward side. Without rain to cool it down, this side of the mountain also has higher temperature.

Answers to Questions

Q1. It condenses to form clouds.

Q2. The windward side.

Q3. The leeward side.

Q4. It rises up the atmosphere.

Q5. Rain shadow

Q6. Moist wind coming from the sea flow up the mountain. Because temperature falls with altitude, water vapor eventually condenses and there is precipitation.

Activity 5 Temperatures of Different Cities around the World

This activity will serve as follow-up for the previous lessons. It focuses on the three factors that affect climate such as latitude, altitude, and distance from the ocean. The learners will be using map or globe in locating the latitude of different cities.

1. Post a big world map on the board. The students will locate some major cities in the world(e.g. Tokyo, Beijing, Moscow, and Warsaw). (Note: This activity is just a conditioning process in finding the location of major cities that are included in the activity.)

2. Group the students by minimum of three and maximum of five members in each group in performing Activity # 5. Each group must have a world map.

3. After the activity, the students should emphasize the effects of latitude, altitude, and distance from bodies of water. The learners should relate the result of the activity to their explanation.

4. You may use this video link http://www.youtube.com/watch?v=E7DLLxrrBV8 as an enrichment activity. (as of October 11, 2013)

Key Concepts

- When a place is closer to the equator,the temperature is likely to be higher. When a place is farther from the equator,the temperatureтends to be lower.

- Places that have high elevations have lower air temperature.

- The closer a region is to a body of water, the temperature range is smaller. Places far from bodies of water tend to have larger temperarture range.

Answers to Questions

Q1. Manila

Q2. It is the altitude and the closeness to the equator.

Q3. Vienna

Q4. The distanceto the equator affects its climate.The farther the place from the equator the lower the air temperature.

Q5. The distance from the body of water affects the moderate climate of Tokyo. The closer a region to the bodies of water, themoderate the climate is. The farther from bodies of water, the colder the climate or the warmer the climate.

Q6. Paris has a lower elevation. A place with low altitude tends to have higher air temperature.

Activity 6 Ocean Currents

This activity will help learners to explain how ocean currents affect climate. By using the map, learners will be able to identify the different ocean currents in the world.

1. Ask the students to look for a partner. One student will make a straight line on a bond paper/cardboard. As one student makes straight line, the other partner will slowly spin the paper.

2. Let the students observe the result of the activity. Raise these questions to the students: What shape was formed? Why is that so?

3. Ask the students to look at the picture of Figure 6.1. Let them study the map that shows the different ocean currents in the world. Have them identify the different ocean currents in the world.

4. Let the students perform Activity 6.

5. At the end of the activity, students must explain how ocean currents affect the climate of a certain region. Students should emphasize that ocean currents will either warm or cool the air above them. 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.

Answers to Questions

Q1. Kuroshio Current, Gulf Stream, Agulhas Current, North Equatorial Current

Q2. Labrador Current, Kamchatka Current, East Australian Current, Greenland Current

Q3. Cold air because it carries cold water from the pole towards the equator.

Q4. Kamchatka Current brings cold water to the northeastern part of Japan making the temperature lower. Kuroshio Current brings warm water towards southern part of Japan making the temperature higher.

Q5. Ocean currents either warm or cool the air above them. When ocean currents that bring cold water move towards a coastal region, the temperature of that area decreases. When the ocean currents that take along warm air go to a land mass, the temperature of that place rises.

Activity 7Getting Ready!

This activity is an introduction to climate change. This will help to assess learners' prior knowledge and misconceptions about climate change. Through this activity, the teacher could identify the weaknesses and strengths of the learners about climate change.

1. In doing this activity, you have to give out the instructions very well. Let two to three students repeat the instructions.

2. You should emphasize that whoever could finish the activity first with all correct answers will be declared winner. (If you have the capacity to provide the prize, please do so.)

3. Remind the students that they have to minimize their voices in performing this activity.

4. Stop the activity if somebody has submitted the Bingo Card with complete answers. Check the answers if they are all correct. Call out the name of the students who answered the questions in the Bingo Card one by one. Let them answer the questions or the statement they chose.

5. You must emphasize that this is an assessment of their prior knowledge. Give feedbacks to the outcome of the activity.

Answers to Questions

Student will say it.	Recycle	chlorofluorocarbons	Student will say it.	Bus or tricycle
Student will say it.	Methane	Thomas Edison	Ilocos Norte	Yes or no
Carbon dioxide	Yes		Hydroelectric energy	Yes or No
Yes	Reduce, Reuse, Recycle	Yes	Hydroelectric power plant	Anyone
Climate	Paper, plastic, cans	1. Turn off appliance when not in use. 2. Clean up fluorescent lamp or bulbs. 3. Use low wattage electric appliance.	Solar Energy	Paper bag

Activity 8It'sgettin' hot in here!

This activity simulates how greenhouse gases trap heat. It helps to explain how the atmosphere prevents heat from escaping the surface. This is a group activity.

1. Start the lesson by instructing the students to read the opening statement indicated above the activity. Tell the students that they will be helping Jen to explain her situation.

2. During the pre-activity, emphasize the proper positioning of the thermometer. The thermometer should be placed in a way that the students could easily read the markings. You should emphasize that the temperature they will get is that of the air that surrounds the thermometer. It is notthe sun's heat. The thermometer should not be hit directly by the sunlight to avoid getting the wrong data. You have to point out that being a researcher or a scientist, he/she must obtain the correct data to give correct information.

3. During the activity, you have to check if the students placed the thermometer properly inside the aquarium or glass or shoebox. You have to check also if the thermometers are not hit directly by the sunlight.

4. In the post-activity, explain that this is just a simulation of the role of greenhouse gases in the atmosphere. The walls of the aquarium or glass do not represent the role of greenhouse gases. You should emphasize this so that students will not be misinformed about this concept.

5. Use Figure 8.2 of the LM to help the students understand how greenhouse gases absorb heat instead of letting it flow out of the atmosphere. (Try this video link: http://www.youtube.com/watch?v=5zLuqSYF68E) (as of October 8, 2013)

Key Concepts

- Greenhouse gases absorb heat, preventing them from flowing out ofthe earth. Naturally, greenhouse gases play an important role in keeping the earth warm. The Earth would be very cold if there were no greenhouse gases that absorb heat.

- Global temperature increases when the amount of greenhouse gases in the atmosphere increases.

- Greenhouse gases include carbon dioxide, methane (CH_4), chloroflurocarbons (CFCs), and nitrous oxide (N_2O)

- Greenhouse effect happens when there there is too much carbon dioxide in the atmosphere.

Answers to Questions

Q1. Thethermometer inside the aquarium

Q2. The heat is trapped inside the aquarium.

Q3. The wall of the aquarium prevents heat from flowing out of the aquarium. In the same manner, the greenhouse gases absorbs heat and keep it from flowing out of the atmosphere.

Q4. The greenhouse gases.

Activity 9 CO_2 is the reason!

This activity will help students toexplain the relationship between carbon dioxide and global temperature.

Day 1

1. Use this activity as a spring board for the next lesson. It should take only for five to eight minutes.

2. Let the students emphasize the relationship of carbon dioxide and global temperature. As the carbon dioxide increases in the atmosphere, the more heat is absorbed resulting to the increase of global temperature. The increase of global temperature will lead to global warming.

3. After the discussion, introduce the next activity.

Answers to Questions

1. 1.3^0F

2. increased by 100 ppmv

3. They are directly proportional. As the amount of carbon dioxide increases, the global temperature increases too.

4. It was highest in 2007 and lowest in 1909

Acitivity 10. Am I a Climate Hero or a Climate Culprit?

This activity is a continuation of Activity 9. It helps students todetermine whether they are heroes or culprits of climate change.

1. Before carrying out this activity, the teacher should try first the carbon footprint calculator. To get this,download it from http://wwf.org.ph/wwf3/search.php?search=carbon+footprint+calculator. (as of October 9, 2013). But, if you opt to use the ecological footprint checklist, instruct the students very well on how to utilize the checklist (see Activity 10, Table 10.1 of the LM.)

2. Post this question on the board: “Am I a climate hero or a climate culprit?” Instruct the students to perform this activity to answer the question.

3. Tell the students to calculate their ecological footprint by adding the corresponding points to each statement. After the activity, each group must present their output in class.

4. Tell the students that the data they got will be used for the next day.

Day 2

4. Instruct the students that each member of the group should choose the top three sources of carbon emission. Then, they shouldmake a strategic plan to lessen their carbon emission (see the example below).

Example:

Name of the Member: John Tugade

My Top Three Sources of Carbon

1. Waste

2. Transportation

3. Electricity

Sample Strategic Plan.

Put a check if you had done this strategy every week, otherwise put an X.

Month: November

Strategy Plan	Week 1	Week 2	Week 3	Week 4
A. Waste 1. I still use the back of the used paper as a scratch paper. 2. I put left over foods, vegetables' peelings in a compost pit.				
B. Transportation				

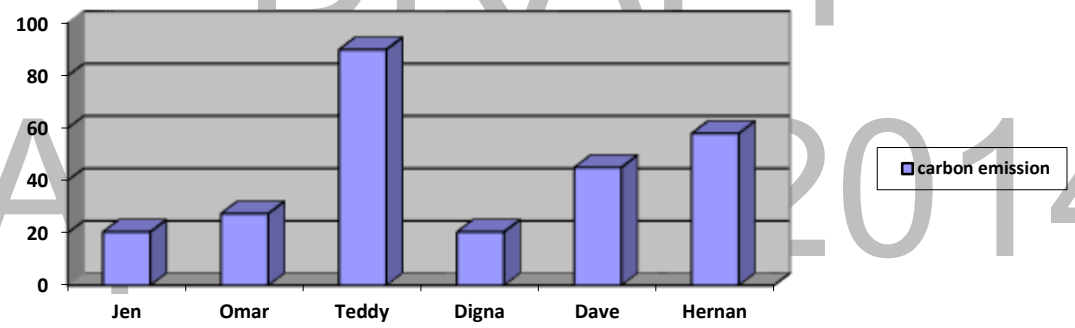
1. I will just walk if the place I will go to is near.				
C. Electricity 1. I will turn off electric appliances when not in use. 2. I will limit my time in watching **t.v** or listening to the radio				

My Carbon/Ecological Footprint:_____

5.Students will make a bar graph to represent the result of the Carbon/Ecological Footprint of all the members in the group.

Sample Result

The Carbon Emission of Group 1 Month: October



6. The members of the group will monitor their carbon emission within the third quarter. The group leader will gather the result and place it in a portfolio.

7. The students will report the result in the class. They will give recommendations/advice to their classmates on how to lessen their carbon emission.

Answers to Questions

Q1. The answer may vary.

Q2. The answer may vary.

Q3. The answer may vary.

Q4. The answer may vary.

Q5. The answer may vary.

Impacts of Climate Change

This a performance task of the students. This activity shows the impacts of climate change and how to mitigate and adapt them. This is a group activity.

1. You should give a situation that the school is observing like a Science Month Celebration with a theme: Disaster Risk Reduction and Climate Change Adaptation. They must come up with a presentation that can disseminate to and educate their fellow students about the impacts of climate change and on how to reduce the effects.You may refer from the different suggested tasks below.

Group 1 – A comic sketch
Group 2 – A jingle or song
Group 3 - Newscasting
Group 4 – Poster and slogan
Group 5 – Poem

2. Instruct students that they may use the reading materials provided in the module about the **Impact of Climate Change and El Niño and La Niña** as their references for the tasked assigned**.** Students may also try this video link as their reference: (http://www.youtube.com/watch?v=QjnV8-oo12A, if the internet is available. (As of October 11, 2013)

3. This performance task must be given at the start of the third grading period.

4. This should be presented at the end of the chapter.

5. Teacher must set a date when to present this performance task.

To measure the output of the students you may refer from 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.	

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.
Answer:b

2. What will happen if there is too much carbon dioxide in the atmosphere?
a. Greenhouse effect occurs.
b. Temperature increases.
c. Water vapor condenses.
d. Climate changes.
Answer:a

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.
Answer:b

4. Which condition happens during 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
Answer:d

5. It refers to the atmospheric condition of a place over a long period of time.
a. climate
b. monsoon
c. weather
d. topography
Answer:a

6. Which side of the mountain often receives the most precipitation?
a. leeward side
b. windward side
c. rain shadow
d. peak
Answer:b

7. Which is the best practice to reduce the effect of climate change?
a. livestock raising
b. burning fossil fuel
c. organic farming
d. car manufacturing
Answer:c

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
Answer:a

9. During summer, many people visit Baguio because of the cold weather. What do you think makes Baguio cold?
a. The latitude
b. The topography
c. The altitude
d. The distance from the ocean
Answer:c

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.
Answer:c

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Suggested time allotment: 6 hours

Unit 3
MODULE

3

CONSTELLATIONS

Content Standard	Performance Standard
The Learner understands the relationship between the visible constellations in the sky and Earth's position along its orbit.	The Learner discusses whether or not popular beliefs and practices with regard to constellations and astrology have scientific basis.

I. Overview

The spiralling of the astronomy concepts starts from the Learner's awareness of the natural objects that he/she sees in the sky. In grade 5, the students have learned about the star patterns seen in sky at different times of the year. In this module, the students will learn about the characteristics of stars and 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, the Learners 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
   Answer: D

2. Which star is very similar to our Sun?
   A. A
   B. B
   C. C
   D. D
   Answer: B

3. Which is the coolest star?
   A. A
   B. B
   C. C
   D. D
   Answer: A

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
   Answer: A

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.
   Answer: A

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.
   Answer: A

7. Which constellation is prominently seen in the sky during summer?
   A. Orion
   B. Pegasus
   C. Hercules
   D. Virgo
   Answer: D

8. Based on apparent magnitude, which of the following stars is the brightest?
   A. Alpha Centauri
   B. Betelgeuse
   C. Rigel
   D. Sirius
   Answer: D

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.
   Answer: C

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
   Answer: C

Activity 1 Characteristics of Stars

In this activity, students will be able to infer the relationship between the color of a star and its brightness.

NOTE: This activity is best done in a dark room.

Answers to the questions

Part A

Q1. What is the color of the filament as you dim the bulb?

A1. The color of the filament is red

Q2. What is the color of the filament as you turn the switch at full power?

A2. It becomes blue.

Q3. What happens to the temperature of the filament as the bulb becomes brighter and brighter?

A3. The temperature increases.

Part B

Q1. Why do the two flashlights have different brightness?

A1. The absolute brightness of the source and the distance from the source affect the brightness of the flashlight.

Activity 2 Patterns in the Sky

In this activity, students will be able to infer that stars are fixed and can be grouped together**.**

Answers to the question

1. Answers may vary

Activity 3 Apparent Movement of the Stars through the Night

In this activity, students will be able to describe the apparent motion of stars at night.

Answers to the Questions

Q1. Compare the position of the stars in the sky. What do you notice?

A1. The constellations move from right to left as the night deepens.

Q2. Are the stars visible at 7 pm still visible at 11 pm in their “original position”? Why is this so?

A2. No, because they move.

Q3. How do the stars move? Describe the movement of the stars in the night sky.

A3. Stars seem to move from East to West

Q4. How is the motion of stars similar to the motion of the Sun?

A5. Like the sun, stars move from east to west during the course of day (for the sun) and night (for the stars)

Activity 4 Different Star Patterns through the Year

In this activity, students will be able to explain why some constellations are not seen at certain months.

1. Present a multimedia presentation or pictures showing constellation for a given month.

Answers to Questions

Q1. Compare the photographs. What do you notice?

A1. Different patterns are formed in different months.

Q2. Why are some stars visible in March but not visible in September?

A2. This is due to earth's revolution

Q3. What constellations are prominent during winter? fall? summer? spring?

A3. Canis Major, Cetus, Eridanus, Gemini, Perseus, Taurus, and Orion are seen during winter or cold season. Aquila, Cygnus, Hercules, Lyra, Ophiuchus, Sagittarius, and Scorpius are prominent on summer. During spring, Bootes, Cancer, Crater, Hydra, Leo, and Virgo are seen. At autumn, Andromeda, Aquarius, Capricornus, Pegasus, and Pieces are prominent.

Suggested time allotment: 15 hours

Unit 4

MODULE 1

FORCES AND MOTION

Content Standard	*Performance Standard*
The learners demonstrate understanding of uniformly accelerated motion, motion in two-dimensions using projectile motion as example, impulse and momentum, and conservation of linear momentum.	Propose ways to enhance sports related to projectile motion.

Overview

After describing and quantifying non-uniform motion through basic mathematical approach, the students will now explore a comprehensive uniform motion. They will now scrutinize the horizontal and vertical dimensions of Uniformly Accelerated Motion (UAM) using basic algebra. They will also solve problems dealing with two-dimensional motion as in Projectile Motion. They will also relate Impulse and Momentum to real life situations.

Key questions for this module

At the end of module 1, the students 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 do you think are other factors that may affect the motion of objects?
5. What is the total momentum before and after collision?

Uniformly Accelerated Motion: Horizontal Dimension

Start the module by reviewing students' prior knowledge about speed, velocity and acceleration since they were able to learn these concepts in their previous years. The following questions may be asked:

- *What is speed? velocity?*
- *What is the difference between speed and velocity?*
- *What is acceleration?*

A drill may be conducted by completing the table showing velocity, displacement and time to elicit their prior knowledge in velocity since they learned the concept when they were in Grade 7.

To introduce Uniformly Accelerated Motion (UAM) in horizontal dimension let the students imagine the motion of an airplane starting to takeoff. The following questions may be asked:

- *What do you think should be the motion of an airplane preparing for takeoff?*
- *How will you describe the speed of the plane from rest until it takes off?*

Using a schematic diagram, let them plot on the board the possible position of the airplane for every second.

ACTIVITY

1

Roll, roll, and away!

In this activity, the students are tasked to determine the acceleration of a rolling object by recording the time to travel different distances on an inclined plane.

- The students should form a group of five members. Everybody should have a part in the activity.

- Student 1 holds the timing device and accurately starts and stops the timing device (stopwatch or cellphone with stopwatch application).
- Student 2 records the time in the table provided for the activity.
- Student 3, 4, and 5 releases the tin can in each marked position.

- Instruct the students to plot in the graph d vs.t and then d vs. t^2.

- Instruct each group to repeat the experiment on different angles of inclination.

- During the post-activity discussion, students can be asked to recall what they learned in the previous grade level about non-uniform motion. They may be asked to state and enumerate the formula they learned from velocity and acceleration.

Answers to Questions

Q1. The d vs. t graph is a curve line or the d vs .t graph is a curved line. The d vs. t^2 graph is a straight line inclined to the right.

Q2. The relationship is quadratic.

Q3. The slope will be solved using the formula $(d_2 - d_1)/(t_2^2 - t_1^2)$. The slope of d – t^2 graph represents the acceleration. (This can be seen in the unit which is m/s^2)

Q4. The d – t and d –t^2 graphs tell that the tin can is accelerating uniformly. It tells that velocity increases over time. It means that for a regular time interval, distance is increasing quadratically.

Derivation of Formula

For the students to fully understand the concept of UAM, they need to solve word problems related to real life situations. But before solving problems, they need to derive the basic formula needed to solve such problems. To start the derivation, ask them the formula they learned in Grades 7 and 8 about velocity, average velocity, and acceleration, and label the formula into:

Equation A	$v = \frac{d}{t}$
Equation B	$v_{ave} = \frac{v_f + v_i}{2}$
Equation C	$a = \frac{v_f - v_i}{t}$

Guide the STUDENTS to use the three equations to derive the following equations:

Equation D	$d = \left(\frac{v_f + v_i}{2}\right) t$
Equation E	$d = v_i t + \frac{at^2}{2}$
Equation F	$v_f^2 = v_i^2 + 2ad$

Try solving this…(Answer)

A train accelerates to a speed of 20 m/s over a distance of 150 m. Determine the acceleration (assume uniform) of the train.

Given:
v_i = 0 m/s (assume the train starts from rest)
v_f = 20 m/s
d = 150 m

Find:
a = ?

$v_f^2 = v_i^2 + 2ad$

$(20 m/s)^2 = (0 m/s)^2 + 2(a)(150 m)$

$400 m^2/s^2 = 0 m^2/s^2 + (300 m)a$

$400 m^2/s^2 = (300 m)a$

$(400 m^2/s^2)/ (300 m) = a$

a = 1.3 m/s

Uniformly Accelerated Motion: Vertical Dimension

Introduce the concept of Uniformly Accelerated Motion (UAM) in vertical dimension by eliciting the students' knowledge about free-fall. From their learning in Grade 8, ask them the following:

- *What is gravity?*
- *What is the acceleration due to gravity on earth?*
- *Is the rate of gravity (acceleration) the same for all objects on earth?*

Note that they already learned free–fall from the concept of the second law of motion, which is the Law of Acceleration, so they should be able to answer this correctly.

ACTIVITY

2

Drop me!

In this activity, the students will apply the derived formula of the Uniform Accelerated Motion by calculating the height of the building.

- If the school does not have a tall building, find one outside the school and ask permission from the owner. Observe proper precautionary measures.

- If available, use *sepak takraw* instead of other balls since it will not bounce as much. This is to avoid having the students chase the ball, to prevent accidents.

- As much as possible, instruct students to drop the ball by just releasing it without applying force. Thetimershould accurately record the time by coordinating with the student who will release the ball.Ask

them to come up with ways to synchronize release of objects and starting the watch.

- From the derived formula of the Uniformly Accelerated Motion (UAM), students determine the height of the building

Answers to Questions:

Q1. The velocity of the ball just before it hits the ground will be solved using $vf^2 = 2a_g h$ since $v_i = 0$ (The value of h depends on the data on the table)

Q2. The actual height should be almost the same with the result of our experiment.

Q3. (*Answers may vary*)

$$Percentage\ Error\ = \frac{/Actual\ Value - Experimental\ Value/}{Actual\ Value}\ \text{x}\ 100\%$$

ACTIVITY

3

You raise me up!

In this activity, the students will determine the initial velocity and the maximum height of reach by the ball thrown upward.

- If available, use *sepak takraw* ball instead of other balls since if it is thrown upward, there will be lesser bouncing effect. This is to avoid having the students chase the ball to prevent accidents.

- As much as possible, instruct the students to throw the ball vertically upward and the timer to record the time accurately.

Answers to Questions:

Q1. The ball stops momentarily at its maximum height.

Q2. The velocity increases as it falls farther below the point of release.

Explain the comparison of formulae between horizontal and vertical formulae from the table below. Show that the corresponding displacement (d) and acceleration (a) for vertical dimension is height (h) and acceleration due to gravity (a_g) respectively.

Try solving this… (Answer)

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.

Given:
$a = 1.62\ m/s^2$
$v_i = 0\ m/s$
$h = 1.50\ m$

Find:
$t = ?$

$$h = -d = -(v_i t + \tfrac{1}{2} a_g t^2)$$
$$1.50\ m = -(0\ m/s)(t) - \tfrac{1}{2}(-1.62\ m/s^2)(t)^2$$
$$1.50\ m = 0 + (0.81\ m/s^2)(t)^2$$
$$1.50\ m/0.81\ m/s^2 = t^2$$
$$1.85\ s^2 = t^2$$
$$t = 1.36\ s$$

Motion in Two Dimensions

This lesson discusses a type of motion in two-dimensions using **projectile motion** as an example. It focuses on the idea that two-dimension motions can be described and predicted using kinematics and dynamics. It also defines true ***projectiles*** that follow a parabolic path due to the downward pull of gravity only. The activities show that the ***uniform horizontal motion*** (non-accelerated) is independent from the non-uniform (uniformly accelerated) vertical motion.

When in projectile motion, objects follow a ***curved trajectory*** which is ***parabolic.*** The initial launch force gives a projectile the needed initial velocity at any angle. This initial force no longer acts on the projectile. Only the force of gravity remains acting on the projectile. Thus, as the projectile moves horizontally at a constant rate, it accelerates toward the earth's center at 9.8 m/s^2, thus the curved path.

During the first two quarters of Grade 9 MAPEH, the students officiated team sporting events such as volleyball, basketball, *sepak takraw* and badminton games. Currently they are learning trigonometry in Math classes. A solid understanding of the key concepts in projectile motion will greatly enhance their little sporting experiences and skills.

Related Preconceptions:

Some existing force and projectile preconceptions that are wrong
1. The launch force keeps on acting on the object after it was thrown.
2. The projectile maintains its motion due to the acquired launch force.
3. At the top of the projectile's flight there is no gravity that's why projectiles start to fall.

Prepare to show the 4-min video clip entitled "*PALARONG PAMBANSA 2013 – The Faces of Our Future Sports Heroes…*" or some video on youth sports events. Let the students observe the different kinds of motion demonstrated and give them a minute or two to write on the *I Notice! I Wonder!* record sheet what they ***notice*** and what they ***wonder*** about two-dimensional motions.

Pool quickly the most common wonderings of the students and resolve to address these when appropriate during the week. Point out that projectile motion will serve as example of motion in two-dimensions.

In the following activities, the students will investigate more on the motion of projectiles and not on the forces acting on it in real environment.

If available, you may also show a brief interactive simulation on projectile motion laboratory activities just to show that this type of motion can be analyzed quantitatively with the use of video trackers, games or cameras. One example is video game "Angry Birds".

ACTIVITY

4

Curve me on an incline

In this activity, students will capture a full trajectory of projectile motion on an inclined surface. They will also investigate the relationships between the projection angle, the height, the range, and the time of travel of a projectile.

Preparation

Prepare a sample of a modified retractable pen to serve as projectile launcher of the marble and plastic bottle cap. Use the HBW Matrix pen or some other retractable pen that work as well. Practice using the pen to launch marbles, jackstones or bottle caps horizontally from a table top and up inclined surfaces.

The cookie baking sheet alone works as well as the illustration board on it. It is sturdy and can hold marbles and pencil on its own. It can also be written for projection angles and trajectory pencil marks. Paper can also be attached to the bottom right of the cookie sheet for extended ranges.

Materials Needed:

projectiles : marble or jackstone, soda/water plastic bottle cap, powder
(e.g. face powder or flour on low container)

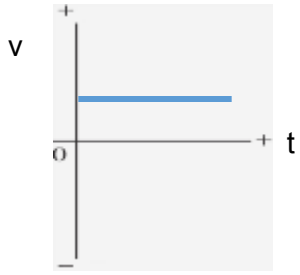
projectile launcher : retractable pen preferably HBW Matrix pen, sticky tape, pair of scissors, and 2 popsicle sticks

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

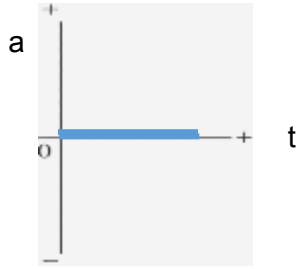
table top
protractor
pencil
tissue paper
ruler or tape measure

Answers to Questions

I. Linear horizontal motion



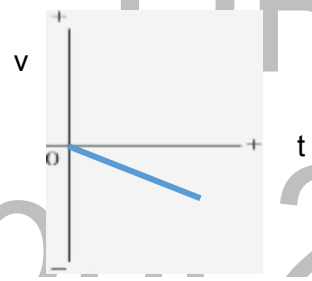
*Graph 1.*velocity – time graph for objects rolling horizontally



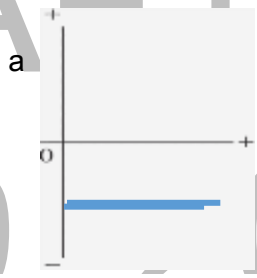
*Graph 2.*acceleration – time graph for objects rolling down an incline

Complete the sentence. A ball rolling horizontally has a velocity that is constant and an acceleration that is zero.

II. Linear motion down an incline



*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 increasing as the object moves downward, and an acceleration that is constant and downward.

III. Two-dimensional motion along an incline

Tips on the activity.

Tracing the Trajectory

1. Modifying the retractable pen as launcher. Tape the popsicle sticks together leaving a 3 cm extension. Hold the retractable pen with the push clip facing you. Press the top end and then tape the popsicle sticks to the side of the pen without covering the clip.

2. As the marble slides down the 20^0 incline it leaves a trail of white powder. Emphasize that this is the trajectory the students should trace with pencil.

3. Tilting the board greater than 20^0 present difficulty especially with launchings on incline at greater angles. The marble has greater tendency to slide off the launching pad even before the clip is pushed.

4. Sample photos of activity results.

Launching the Bottle Caps Horizontally

5. Make sure each group has enough space for the activity. Heights may be marked with chalk on corner walls facing enough length of unused hallways or floor space. Plastic bottle caps are safer to use than the metallic ones.

6. Have the students repeat launches that tend to veer sideways. Bottle cap should be centered on the launching pad. Student launchers should also hold pen horizontally in place before and during launching.

7. Landing spots are better noted and marked on tiled floors for range measurements. On plain floors, a strip of paper tape or long chalk mark along the landing stretch may also serve as guide.

8. Ensure that students follow the safety check for this activity as noted on the Learner's Materials.

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.*

9. Sample data tables.

Table 6. Range of the plastic bottle cap horizontally-launched 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	0.00	0.00	0.00	0.00	0.00	0.00
-0.50	0.64	0.63	0.65	0.64	0.64	0.64
-1.00	0.88	0.87	0.88	0.88	0.89	0.88
-1.50	1.03	1.05	1.08	1.08	1.05	1.06
-2.00	1.24	1.18	1.21	1.19	1.24	1.21

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	0.00	0.00	0.00
0.32	0.10	0.64	-0.50
0.45	0.20	0.88	-1.00
0.55	0.31	1.06	-1.50
0.64	0.41	1.21	-2.00

Answers to Questions

Q1. The trajectory is a half open-down parabola. Other students may answer curve down or concave down.

Q2. All the trajectories are full open-down parabolas. In addition, some students may also state something about different maximum heights, etc.

Q3. The trajectory peaks for each projection angle do not have the same location. The peaks are closest to the y-axis origin for shortest range or greatest angle of projection. Each peak is reached just before half the range was travelled. This indicates frictional forces between marble projectile and inclined surface resulting to a not so perfect open-down parabola.

Q4. The trajectories have different horizontal distances (range) reached, but some ranges are quite short, some extend beyond the board or cookie sheet.

Q5. The trajectory fired closest to or at 45^0 covered the greatest range.

Q6. The trajectory with the greatest launching angle recorded the highest peak.

Q7. Trajectories at $15^0$and 75^0 have almost similar ranges. Trajectories at 30^0 and 60^0 also have almost similar but longer ranges than those for 15^0 and 75^0. Some students may note close ranges for pairs of angles that are almost if not complementary angles.

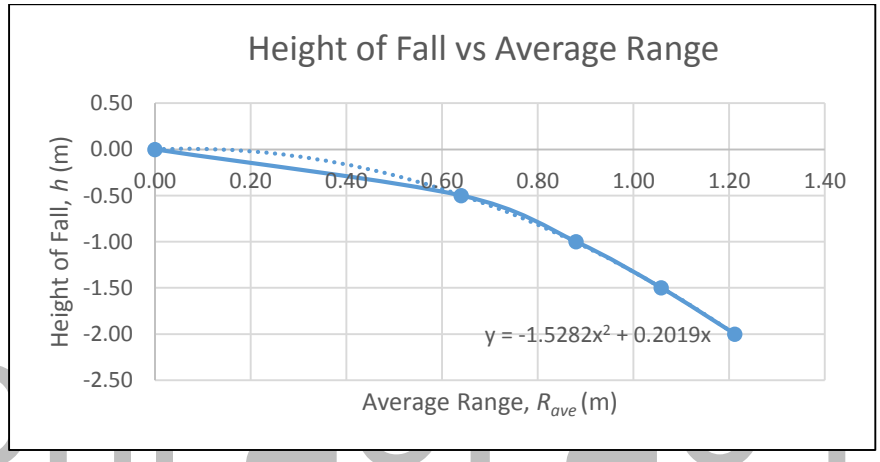
Q8. The average range is longest for the highest drop at 2 m and shortest at a 0.5 m height of fall.

Q9. The calculated time of fall is the longest for the highest drop at 2 m and shortest at a 0.5 m height of fall.

Extension Activity Notes:

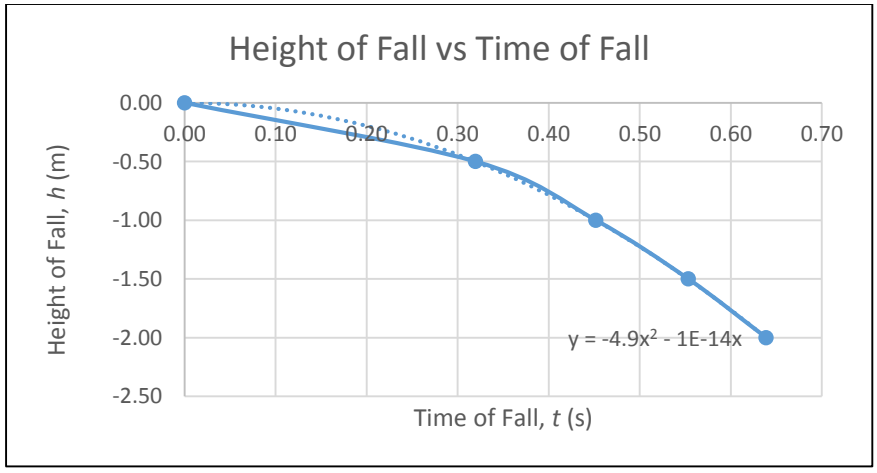
1. Graphs for horizontally-launched plastic bottle cap

(a) Height of Fall vs Average Range for a Horizontally-launched Bottle Cap



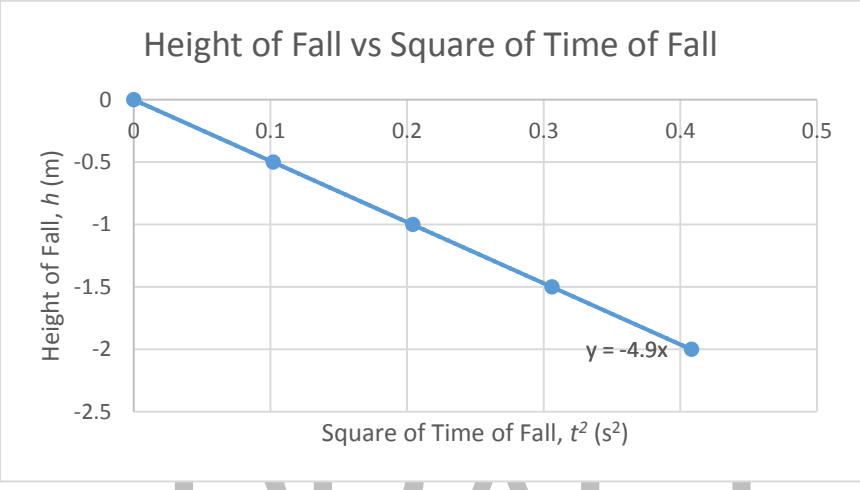
Graph (a) shows a parabolic curve for the plastic bottle cap's vertical and horizontal displacement during its entire projectile motion.

(b) Height of Fall vs Time of Fall for a Horizontally-launched Bottle Cap



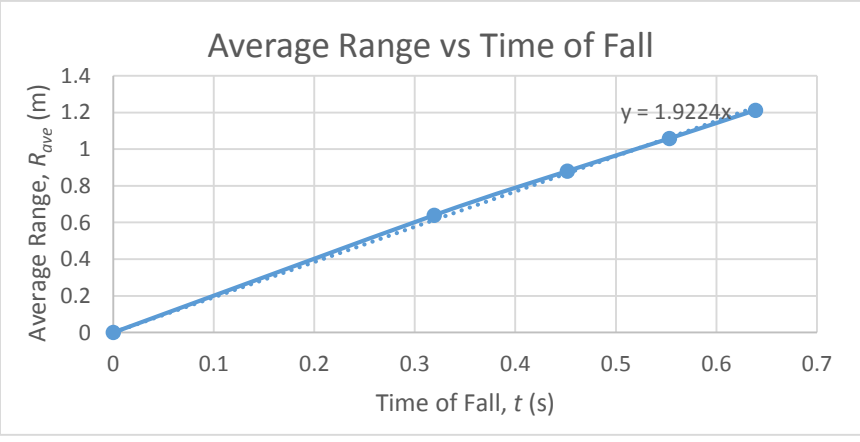
Graph (b) shows a parabolic curve for the plastic bottle cap's vertical displacement with respect to its time of fall. The slope represents an increasingly negative vertical velocity.

(c) Height of Fall vs Square of Time of Fall for a Horizontally-launched Bottle Cap



Graph (c) shows the linearized curve of graph (b) with a constant slope of -4.9 m/s^2. The graph's mathematical equation $y = -4.9x$ can be rewritten as the physics equation $h = -1/2gt^2$. This is the vertical displacement equation for horizontally-launched projectiles.

(d) Average Range vs Time of Fall for a Horizontally-launched Bottle Cap



Graph (d) shows a linear graph for the horizontal displacement of a horizontally-launched bottle cap with respect to its time of travel. The constant slope of +1.92 m/s represents the bottle cap projectile's constant horizontal velocity. The graph's mathematical equation $y = 1.92x$ can be rewritten as the physics equation $R = 1.92t$. This is the horizontal displacement or range equation for the horizontally-launched bottle cap.

Teacher's notes:

All projectiles, regardless of their 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 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 $\boldsymbol{gsin\theta}$.

3. The horizontal and vertical motions are completely independent of each other. Therefore, the velocity of a projectile can be separated into the horizontal and vertical components.

4. For a projectile (neglecting air resistance) that begins and ends at the same height, the time it takes to rise to its highest point equals the time it takes to fall from the highest point back to its original height of release.

The activities for motion in two dimensions using the marble on an inclined board were done to capture trajectories. So when interactive simulations on projectiles can be done in class, the students will recognize that what they captured is a trajectory for two-dimensional motion not necessarily of a true projectile where only the force of gravity influences the flight.

The trajectories are a result of a constant velocity across the board and an acceleration component down the incline equal to (9.8 m/s^2)(sin Θ), where Θ is the board's angle of inclination.

Because other forces (normal and frictional) aside from gravity are acting on the projectile marble, the marble's 'vertical' acceleration is smaller than the 9.8 m/s^2 rate that is entirely due to gravity.

ACTIVITY

5

Curve a Like

In this activity, students will match a ball's trajectory to pre-drawn parabolas, showing that projectile motion characteristics can be matched or anticipated.

With the manila paper posted vertically, instruct the students to give the ball an initial velocity resulting in a path parallel to the paper. Emphasize that the ball should not touch the paper anytime during the flight. With the proper start, students match the ball's path (trajectories A and B) to the pre-drawn parabolas.

Answers to Questions

Q1. The ball was thrown horizontally from the top

Q2. The ball's path is curved downwards similar to the drawn graph. At the start, it moved horizontally forward but as it moved forward, it also moved downward.

Q3. (*Depends on the thrower's skills*.)

Q4. (*Depends on the thrower's skills, but predictably lesser tries than before because of the visual goal.)*

Q5. Aiming at visual goals makes practice easier and results in better approximations of flight.

Q6. The ball was thrown upward from the bottom left at an angle from horizontal.

Q7. The ball moved up in a curved path until it reached a maximum height and then it moved downward still following the curved path.

Q8. It is best to have an imaginary target at the top of the curve rather than anywhere else along the parabola.

Q9. In both throws the balls always end up on a lower elevation. It is not possible that the ball will end at a higher elevation than its starting level.

Q10. The initial push from the throw.

Q11. The force of gravity acted at all times on the ball.

Q12. The spacing between horizontal lines is equal unlike the spacing between vertical lines which increases by the square of a span/unit.

Q13. The increasing distance between vertical lines indicate that the vertical motion is accelerated due to gravity.

Teacher's Notes:

Projectile motion can be understood by analyzing the horizontal and the vertical components of the displacement and velocity which add as vectors.

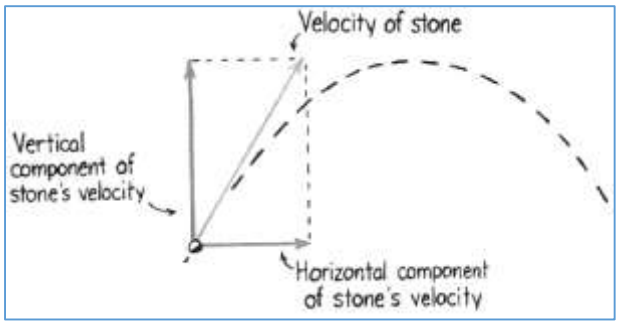


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Figure 8. Sketch of the velocity vector components

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 1. 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 $a_g = 9.8 m/s^2, downward$ the

Projectiles Launched Horizontally

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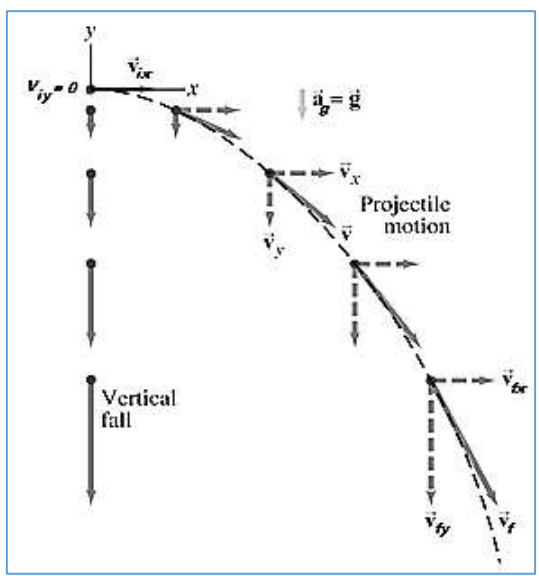
A projectile launched horizontally has no initial vertical velocity. Thus, its vertical motion is identical to that of a dropped object. The downward velocity increases uniformly due to gravity as shown by the vector arrows of increasing lengths. The horizontal velocity is uniform as shown by



the identical horizontal vector arrows.

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.)

Figure 9. Velocity component vector diagram for projectiles fired

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 $v_{iy} = 0$

$\Delta y = -\frac{1}{2} 9.8m/s^2 (0.47s)^2 = -1.08m$ 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 $v_{fy} = v_{iy} - a_g t = 0 - 9.8 m/s^2 (0.47) = -4.606 m/s = 4.61 m/s$ downward.

The magnitude of the resultant velocity is shown below.

$$v^2 = v^2{}_x + v^2{}_y = (1.50 m/s)^2 + (-4.61 m/s)^2$$
$$v = \sqrt{(1.50 m/s)^2 + (-4.61 m/s)^2}$$
$$v = \sqrt{2.25 + 21.25 m^2/s^2}$$
$$v = \sqrt{23.5 m^2/s^2}$$
$$v = 4.85 m/s$$

The direction of the velocity is determined using the tangent trigonometric function.

$$\tan\theta = \frac{v_y}{v_x}$$
$$\theta = \tan^{-1} \frac{-4.61 m/s}{1.50 m/s}$$
$$\theta = -71.976 \text{ deg}rees$$
$$\theta = 72.0 \text{ deg}rees$$ 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

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:

$$\theta = \tan^{-1} \frac{v_y}{v_x}$$

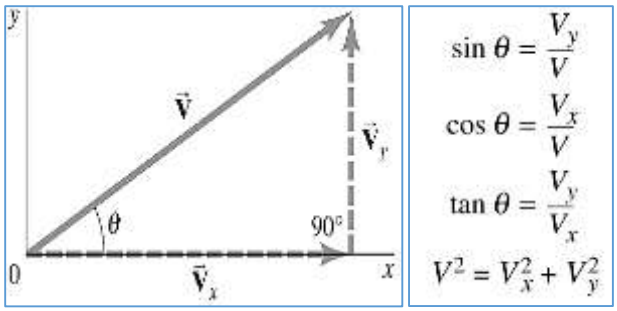


Figure 10. Finding the components of a vector using trigonometric functions.

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.

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

$$t = \frac{v_{fy} - v_{iy}}{g} = \frac{-14.1m/s - 14.1m/s}{-9.8m/s^2} = 2.9s$$

Concept Check: Tossed at an Angle

A ball tossed upward at θi has an initial vertical velocity component of 20 m/s, and a horizontal velocity component of 2 m/s. The location of the ball is shown at 1-second intervals. Consider air resistance to be negligible and g = 10 m/s^2 downward. Use the sign convention positive v_y for upward motion and negative v_y for downward motion.

Pre-concept check exercises for students:

Give the students some exercises on drawing components of vectors and a chance to use the techniques for solving projectile motion problems like the ones below:

1. Sketch a diagram and choose an origin and a coordinate system.
2. Decide on the time interval; this is the same in both directions, and includes only the time the object is moving with constant acceleration a_g.
3. Examine the *x* and *y* motions separately.
4. List known and unknown quantities. Remember that v_x never changes, and that v_y = 0 at the highest point.
5. Plan how you will proceed. Use the appropriate equations. You may have to combine some of them.

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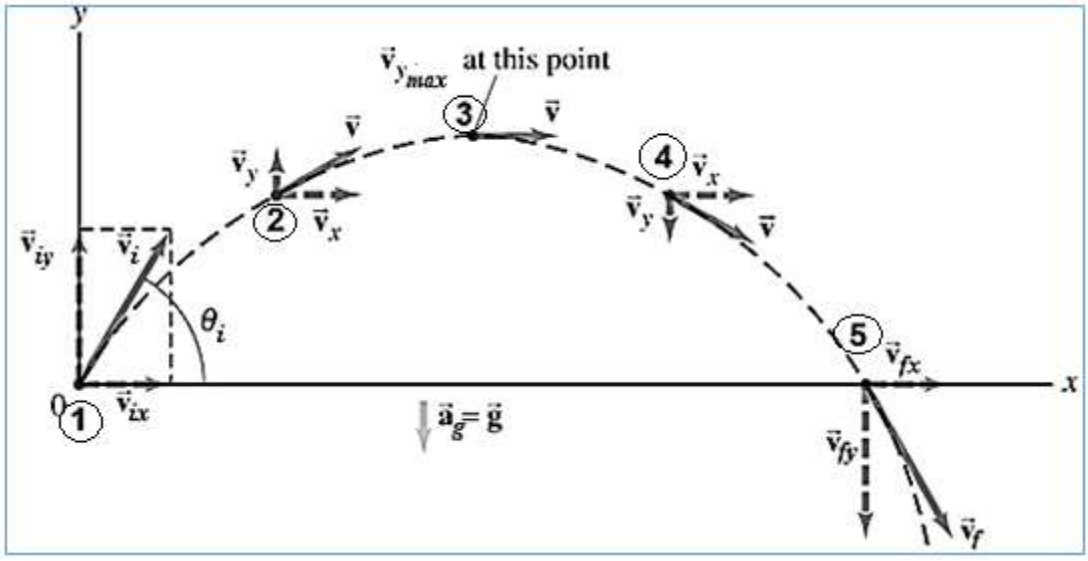


Figure 11. ***Tossed at an Angle***. Path of a projectile fired with initial velocity v_i at angle θ_i to the horizontal. The trajectory is shown in black dash, the velocity vectors are in solid arrows, and velocity components are dashed.

A. In the box, write the magnitude and sign for the velocity and acceleration of the ball in each position in the figure above:

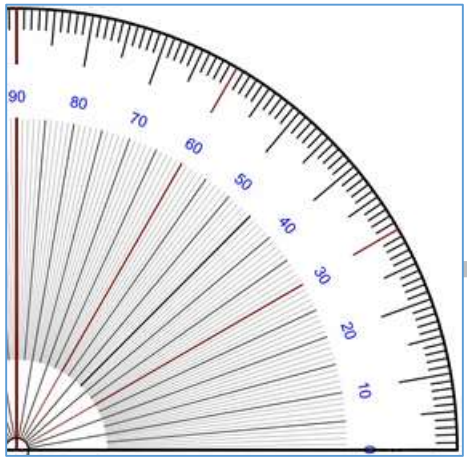
Position	v_x (m/s)	v_y (m/s)	v_{net} (m/s)	a_x (m/s^2)	a_y (m/s^2)	a_{net}, (m/s^2)
1	2	+20	20.1	0	-9.8	-9.8
2	2	+10	10.2	0	-9.8	-9.8
3	2	0	2.00	0	-9.8	-9.8
4	2	-10	-10.2	0	-9.8	-9.8
5	2	-20	-20.1	0	-9.8	-9.8

B. Complete each sentence.

1. The net acceleration of the ball is a constant at -9.8 m/s^2.
2. The horizontal acceleration of the ball is zero at all times.
3. The vertical acceleration of the ball during ascent is always directed downward.
4. The vertical acceleration of the ball during descent is always directed downward.
5. The net velocity of the ball is least at the peak or at maximum height.
6. The net velocity of the ball is zero nowhere.
7. The net velocity of the ball is the same as the horizontal velocity at the peak.
8. The horizontal velocity is constant in all locations.
9. The vertical velocity is zero in position 3.
10. The vertical speeds are identical in positions 1 and 5; and in 2 and 4.
11. At the same elevation, vertical velocities are equal but opposite in direction.
12. The time in going up the peak from an elevation is as long as the time in going down from the peak back to the same elevation.

Projectile motion problems launched at an angle from the ground can be made mathematically simpler when the release point (at t = 0) is taken to be the origin then $x_0 = y_0 = 0$.

The teacher can also simplify analysis by determining right away the magnitudes of the horizontal and vertical components of velocity ready for use in the Kinematic Equations for Projectile Motion listed in Table 1.



Sample protractor template that can be taped on the illustration board or cookie sheet for easy angle of projection marking. Photo credit: Paint modified image from http://upload.wikimedia.org/wikipedia/commons/7/70/Protractor_Rapporteur_Degrees_V3.jpg

Impulse and Momentum

Start the module by showing pictures of two vehicles moving at the same velocity but having different masses.

What affects motion?

Ask the question: If the two vehicles suddenly lose their breaks and crash against the brick wall, which do you think would be more damaging? Accept all answers of the students. This would be further explained later after the activity.

ACTIVITY

6

Investigating Momentum

In this activity, the students will investigate which factors would affect momentum. Based on their data, the students should be able to observe that the big toy truck displaces the block of wood farther. This implies that the heavier vehicle has more momentum than lighter vehicle.

Answers to Questions

Q1. The stopping distance for the heavy toy truck is longer than the stopping distance for the small toy car.
Q2. No. The heavier toy car dragged the block of wood along a longer stopping distance than the lighter car did.
Q3. The big toy truck had a greater stopping distance. The stopping distance increases as the point of release increases.
Q4. The big toy truck had a greater momentum.

Answers to Exercises:

Object	Mass (kg)	Velocity (m/s)	Momentum (kg-m/s)
Bird	0.03	18	0.54
Basketball player	100	5	500
Bullet	.004	600	2.40
Baseball	.14	30	4.20
Frog	.9	12	10.80

Answers to Check-up Questions:

1. A small toy cart that is moving
2. Twice
3. Greater

Answers to the problems

1. 10 kg – m/s
2. 2 kg
3. 20 m/s

What causes changes in momentum?

It is important to impress on the students that changes in momentum happen every time. Installing safety devices like air bags and seat belts are therefore necessary to ensure safety for both passengers and vehicles. Use this as an introductory discussion to impulse.

ACTIVITY

7

Playing Egg Volleyball

This activity needs to be performed outside of the classroom. It is suggested that the mechanics of the game be explained thoroughly to the students before going out to perform the activity. The activity is intended to introduce the concept of impulse to students.

Answers to Questions

Q1. Yes. The egg did not break when the handkerchief was used to toss and catch it.

Q2. Yes, the egg broke immediately.

Q3. The handkerchief increased the time of action therefore lessening the impact of force on the egg. This prevented the egg from breaking.

Conservation of Momentum

Teaching Tips

- You can use the Newton's Cradle (executive toy) to catch the attention of the students.

- Ask, “If you raise one ball and let it collide with the other four balls, what happens?” Let them predict what happens when 1 ball is made to collide with other four balls. Then follow up with 2 balls.
- In this short demonstration, it is the momentum of the first ball is transferred to last ball, through the other three balls. When the word “transfer” is heard, you may ask them, “How is momentum transferred?”

ACTIVITY

8

Balloon Rocket

In this activity, the students will be able to describe how a balloon rocket works and explain how momentum is conserved. 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. The balloon moves when we let the out air inside the balloon. 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 than the velocity of the balloon.

Concept Check:
Take note that we should consider Earth and the people on it to be part of system for the total momentum to be conserved. The Earth also moves in the opposite direction. The change in momentum of the Earth is equal to that of the people but opposite in direction. Because of Earth’s large inertial mass, however, there is no perceptible change in motion.

Can you identify which type of collision is shown in each situation?

(a) elastic
(b) elastic
(c) inelastic

Answers to Questions

Q1. The momenta are the same in magnitude

Q2. The velocity of the air is greater than that of the balloon.

ACTIVITY

9

Bouncy Balls

In this activity, students will classify and select a collision as perfectly elastic, slightly inelastic, moderately inelastic, highly inelastic, or perfectly inelastic.

Case			Bounce (m)	Elastic/ Inelastic?
1	Ball 1 _____			
2				
3				
4	Ball 2 _____			
5				
6				
7	Ball 3 _____			
8				
9				

Q. Answers may vary (e.g., the collision of basketball with the floor is moderately elastic)

Diagnostic Assessment (Answers)

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

5. D
6. B
7. D
8. A
9. B
10. C
11. C
12. A
13. B
14. A
15. C
16. B
17. A
18. A
19. C
20. A

Summative Assessment (Answers)

1. B
2. D
3. B
4. D
5. A
6. C
7. B
8. D
9. C
10. C
11. A
12. C
13. C
14. A
15. B
16. B
17. A
18. A
19. C
20. A

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Suggested time allotment: 6-7 hours

Unit 4
MODULE

2

WORK, POWER, AND ENERGY

Content Standard	Performance Standard
The Learners demonstrate an understanding of the conservation of mechanical energy	The Learners create a device that show conservation of mechanical energy

In the previous two years, the students learned that energy transfers may cause changes in the properties of the object. They related the energy changes of particles to the observable changes in the temperature, electric current, and the sound amplitude. They also demonstrated an understanding of mechanical work using constant force, and related work done to the general types of mechanical energy and power.

This year, the focus of study will be on the energy changes and its conservation with emphasis on mechanical energy. The students need to demonstrate their understanding of mechanical energy and its conservation by performing activities showing mechanical work. They also need to identify and analyze the accompanying energy transformations that will take place. Ultimately, they should be able to recognize that in every natural or human-powered process, the total mechanical energy remains constant.

If in Module 1 the students learned that moving objects possess momentum and mechanical energy. Now, in this module, they will learn through Activity 1 that the working mechanisms of objects involve energy transformations and conservation. This principle will be studied contextually using common events and man-made devices or structures with emphases on practical and safe applications.

This module is good for six to seven sessions. The activities were made simple or broken into parts so that students will be able to finish them and still have time to discuss the results, the process or the products made and collaborate with others on the conduct of the next part or the pursuit of enrichment activities.

Specifically, at the end of Module 2, the students should be able to answer the following key questions below and use the learning objectives as guide:

Key questions for this module

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 the 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 Forms and Transformations

Table 1 summarizes the various forms of energies categorized as either kinetic or potential mechanical energy, while Table 2 gives a quick review of the potential and kinetic energy equations needed for mechanical energy conservation computations.

Ask students to discuss why each form of energy is categorized as such. For example, some students might prefer to categorize electrical energy under kinetic energy due to their more common understanding of macroscopic electricity as movement of electrons in a conductor as compared to their understanding of microscopic electricity as a result of the electric potential energy used to move charges.

ACTIVITY

1 Little Shop of Toys

In this activity, students can work with each available toy or object in any order they want as long as they can identify the transfers and transformations of the different energy forms present in the use of the toys or objects.

Teaching Tips

1. Figures 1 to 4 serve as specific examples of tracing changes in energy forms. Help the students identify the energy storage system where energy is processed, before tracing where the energy source is coming from and where it is going into as used and unused energy outputs.

2. The energy forms and the processes involved in making each available toy work or move can be somewhat open-ended. A brief focused group discussion after the activity will help the students process and finalize their exploration on energy transformations.

   Review briefly the operational definition of mechanical work and remind the students that this is different from the common term *"work"* ("*umandar*" or "*gumana*" in Filipino) used when referring to the functional operation of things. Although most toys can do mechanical work, not all necessarily does mechanical work when in operation.

3. Showing tricks or using toys for other purposes may be fun for students and can be used as springboard for the activity. See to it that the students will have enough time analyzing these after exploring the available toys or selected objects. A 'minute-to-explore it' activity mode may be used to ensure completion of tasks on time.

4. Students may trace energy input from the chemical energies of their hands converted into mechanical energy as their hands work to operate toys and objects.

Answers to Questions

A. YOYO

Pls. redraw

Q1. What does the toy or object do?
A1. *The yoyo can unroll down and roll up. (Some yoyos may also light up or make sounds when in use. Some also use strings that tend to behave elastically.)*

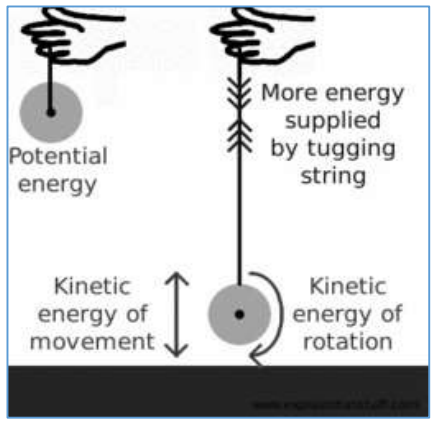

Figure 1. Energy in a Yoyo

Q2. What energy changes take place as this toy or object operates?
A2. The elevated yoyo initially stores gravitational potential energy. When flicked down, it unrolls changing its gravitational potential energy into linear and rotational kinetic energies until it fully unrolls and stops or sleeps (rotating uniformly at the looped end). When tugged back by the finger, it rolls up again changing its kinetic energy back into potential energy.

Q3. What form does the stored energy start out in?
A3. The yoyo started with stored gravitational potential energy.

Q4. What form does the stored energy turn into?
A4. The yoyo ended with kinetic energy at the bottom of the drop.

Q5. What form is the output energy in when it stops?
A5. When the yoyo stopped, all its potential and kinetic energies are converted into thermal energy.

B. FRICTION TOY CAR

A1. *The toy car can move forward.*

Pls. redraw with hand on top pulling back, indicate motion (hand & toy)

A2. As the car is pushed down and pulled backwards (action force), the forward frictional force between the wheels and the running surface (reaction force) stored elastic potential energy in the car, as a spring is tightly wound during this process. When the car was released, the spring extends, and the elastic potential energy is converted into kinetic energy of the moving car. All through these processes, friction is at work, and some of the potential and kinetic energies are converted to heat and sound energy.

Figure 2. Energy Forms in a Friction Toy Car

A3. The toy car started with elastic potential energy when pulled back before release.

A4. The toy car moved with kinetic and sound energy.

A5. Some of the stored energy went into moving the car (non-conservative work) and some of it turned into heat due to friction causing the car to eventually stop.

C. DEFLATED BALLOON

A1. *The balloon, when inflated and then released, can fly off on its own randomly. The balloon may also be inflated, tied, attached to an object, and then pricked to pop, causing the object unto which it is attached to move.*

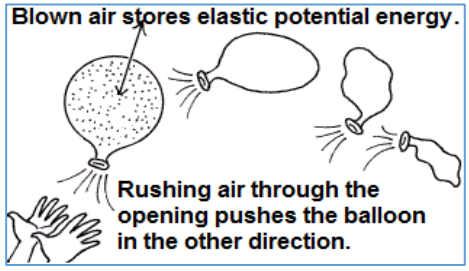

Figure 3. Inflated balloon when released

A2. *When pumped or blown with air the balloon stretches and expands storing elastic potential energy. The enclosed air particles also possess potential and kinetic energies. When released, the balloon deflates, air flows out the opening changing some of the stored energy into kinetic energy of the rushing air and some into mechanical work on the balloon that is moving in the other direction.*

A3. *The balloon started with elastic potential energy when inflated.*

A4. *The balloon deflated and moved randomly forward with kinetic and sound energy as air rushes backward through the opening at the back.*

A5. *Part of the stored energy went into moving the balloon and part of it turned into heat because of friction causing the balloon to eventually stop.*

Q6. In summary, what made each object begin moving and what made each object stop?

The energy that is received or given off by an object can change into different forms as it is transferred or used when work is done and accompanied mostly by heat dissipated into the air or other forms of energy such as light, sound. The input energy coming from the energy source, is stored in an object and when used can be transferred or transformed into a used (work) and unused (heat) energy output.

ACTIVITY

2

HEP HEP HOORAY!

In this activity, students work by group in constructing a) a simple turbine out of glued plastic materials to be used as a water wheel; and b) a water storage model. Each group will then use these devices to assemble a hydroelectric power (HEP) unit to demonstrate mechanical energy transformations in harnessing hydropower.

PREPARATION

A. Construction of the Turbine Model

1. Prepare in advance to show simple water wheels made up of plastic spoons or cut plastic bottle sides attached to a cork centered on a stick or straw. Prepare also the turbine model they will be making.
2. Remind students that glue may burn, bond skin, or release gas that may irritate the eye. Too much glue takes a longer time to set. Remind students to trim or smoothen the cut plastic bottle to avoid scratches and cuts.
3. The turbine model should be light but strong enough for use in the next activities. Melted hot glue may hold blades more securely than ordinary super glue. If students prefer to use cork for inserting the blades securely before fixing with glue, then suggest that they trim the cork to a cylindrical shape for a better blade assembly.

B. Construction of the Water Reservoir Model

1. Prepare in advance the sample water reservoir. Marked lines may be made using thin strips of masking tape then labeled. It is best to fill the bottle first with water up to the different levels so the marks will follow the water lines.
2. The holes made from the push pin are wide enough for water to be projected out the bottle's side. The water projections will also have enough force to rotate the blades at an adequate speed.

C. Mechanical Energy in Hydropower

1. In a real hydroelectric power plant, the tail water level is fixed at the bottom of a water channel or penstock with openings to control the volume and flow rate of water that leaves the dam and enters the power plant containing the turbine and generating units. The water that rotates the turbines returns to the body of water below the dam.
2. Some groups may opt to modify the activity by using only the hole on the 5-cm level for the different heads of flow due to different head water levels. This way the elevation of the exit openings relative to the turbine is constant

for different flow heads. This models reflects more closely realistic water storage levels that differ over a period of time.

Answers to Questions

Q1. Using the turbine model, what are some ways you can do to lift the hanging paper clips? Cite at least three methods.

A1. Rotating the straw by hand or by other means like blowing on blades, directing hot air, e.g. from a hair dryer or boiling water, dropping grain/sand on the blades, dripping water, etc.

Q2. For each method, what forms of energy will be involved in the process? Trace the transformations of energy.

A2. Rotating the straw by hand or blowing on blades means doing work powered by chemical energy from body. Moving air, heat, steam, grain, sand, water, and other objects push on the blades, rotate the straw and winds up the string bringing with it the paper clips. From chemical, mechanical, thermal or potential energy as input energy, the rotating turbine stores (i.e. when designed to lift a load), redirects and/or releases energy into kinetic and potential energies.

Q3. In lifting the paper clips, how will you quantify and relate the work that you will do to the energy transformations involved?

A3. The work input in lifting the paper clips can be quantified by equating it to the decrease of potential energy of the falling grains, sand or water using the equation $PE_{grav} = mgh$. This means that the total mass it took to completely lift, and the total height fallen by the objects causing the rotation can be measured.

Moreover, the work input should be comparably greater than the work output which is equated with the small increase in potential energy of the lifted paper clips plus the greater part of unused energy due to friction of moving parts plus the surplus kinetic energy of the water flowing past the turbine. The total mass of the paper clips lifted and the height of lift need also to be measured.

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 be?

A4. Problem : How does the projected water's range depend on the stored water's head of flow?

Q5. What quantities will serve as the (a) independent variable, (b) dependent variable, and (c) parameter?

A5. (a) independent variable – head of flow, (b) dependent variable – range of projection, and (c) parameter – head water level

Q6. What mechanical energy transformations took place when water got projected out of the holes?

A6. The gravitational potential energy of the stored water transformed into the kinetic energy of the water rushing out of the openings. As the falling water hits the turbine, some of the kinetic energy is transferred to the rotating turbine appearing as rotational kinetic energy. The runoff water keeps the remaining kinetic energy which again increases as the water continues to fall into the container, as gravitational potential energy further transforms to kinetic energy.

Q7. What was the effect of the stored water's head of flow to its range?

A7. The greater the stored water's head of flow, the longer the range of water projection.

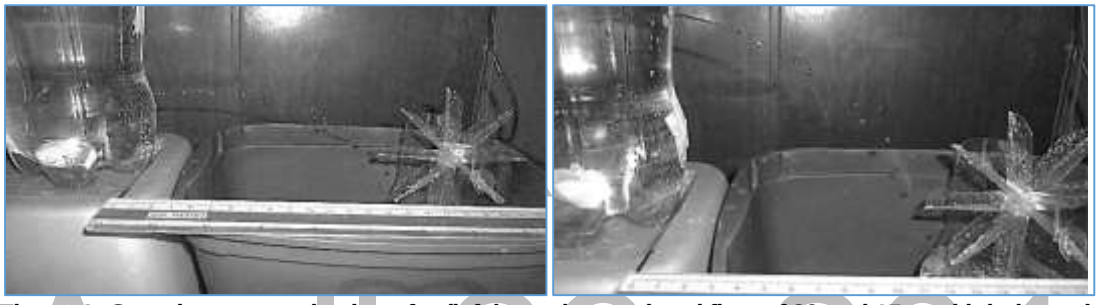

Figure 4. Sample water projections for (left image) water head flow of 20 and 15 cm (right image)

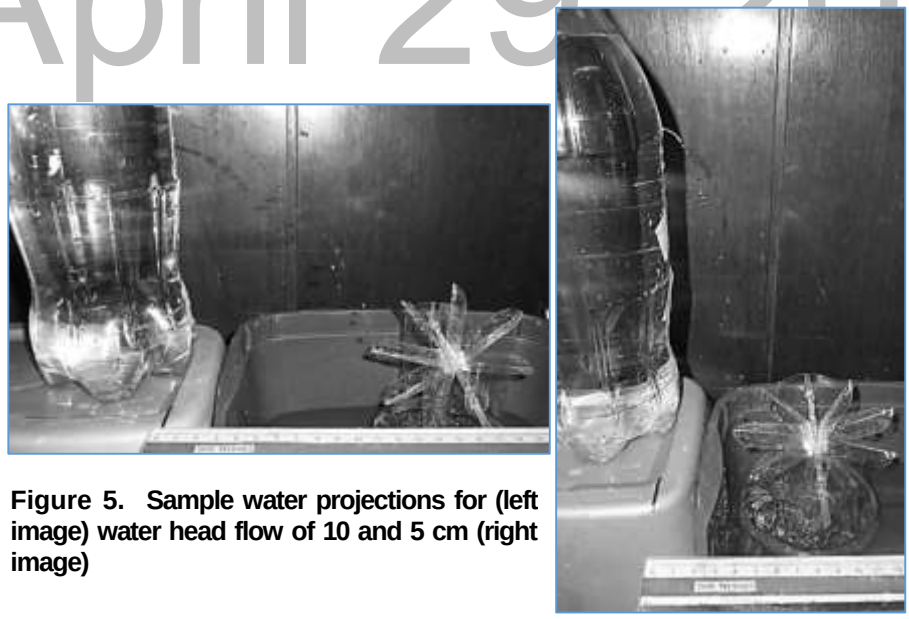

Figure 5. Sample water projections for (left image) water head flow of 10 and 5 cm (right image)

Q8. How would you explain this effect in terms of energy transformation?

A8. The greater the stored water's head of flow, the higher the drop. Higher drop leads to greater decrease in gravitational potential energy equivalent to the increase in kinetic energy of moving water. This results in and force, powering the water to travel a longer horizontal distance or range.

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?

A9. The projected water's range is directly proportional to the stored water's head of flow.

Q10. Was the hypothesis you made correct? Why or why not?

A10. Tabulated data shows that the water's range is longer for greater head of Flow. This suggests that the hypothesis is correct.

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?

A11. By observation, the biggest head of flow resulted in the longest water range that actually caused the turbine to move the fastest. This fastest rotation indicates that the force of the moving water is at its greatest power.

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?

A12. The turbine's rotation can be used to power something and convert its mechanical work into a useful energy output like connecting the turbine to an electric energy generator such as a dynamo working in reverse principle. Connecting the turbine's straw to the shaft of a dynamo enables the turbine to rotate the motor of the dynamo within the magnetic field of permanent magnets inside the dynamo. This relative movement between the motor's coil of wire and magnetic field induces magnetic forces that move charges and generate electrical energy.

Q13. In a typical actual Hydroelectric Power (HEP) Plant, the turbines are fixed and so the tail water level is constant. Only the head water level from the reservoir varies depending on the availability of water for storage. How would you modify this activity to model a real working HEP plant?

A13. Use only one opening like the hole at the 5-cm mark that gives the greatest head of flow. Then vary the head water level to still investigate its effect on the water's range. An electrical energy generating unit may also be

attached to the turbine, the electrical output of which can be measured and recorded in terms of voltage read from a voltmeter.

Problem with varying range is that you have to move the turbine to catch the water. Use a slide or tube instead. Range is only a proxy measure of water speed as it squirts out of the bottle. What really matters is the rotation speed. If you direct the water through a slide or tube, the turbine can stay in one place, and you can relate rotation rate with head of flow directly.

Sample Data on Activity 2 C.

Table 1. 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	17.5	18.0	18.5	18.0
25.0	10.0	15.0	11.5	12.0	12.0	11.8
25.0	15.0	10.0	9.0	9.5	8.5	9.0
25.0	20.0	5.0	4.5	3.5	3.0	3.7

For advanced students, graphing of the average range against the head of flow can be done for quantitative analysis of the hypothesis. The data can be used as extension or application activity in conservation of mechanical energy problems.

Typical hydropower plants have energy transformation efficiency about 90%. For this model, it is expected that greater energy will be wasted as water passes through small openings and the projected water spreads out, resulting in experimental errors in estimating the exact location to measure the range. For purposes of measuring range more accurately, students may remove the turbine and lay out the ruler right under the projected water's path.

Conservation of Mechanical Energy

The students already have prior knowledge in transformation of energy so start the module by reviewing them by asking the following questions:

- *What is potential energy? Kinetic energy?*
- *What are examples of energy transformation?*

To introduce conservation of mechanical energy, a demonstration may be done using a marble and a mini-roller coaster. Using the marble, students demonstrate the transformation of energy.

- *How will you describe the energy transformation in the demonstration?*

- *Can we measure the amount of energy being transformed in the marble from one kind into another?*

ACTIVITY

3

Can you hit me?

In this activity, the students will analyze the energy of a swinging ball.

Safety Precautions

The heavy bowling ball may injure the feet or cause damage to the floor when dropped. Use a durable mesh sack or net to hold the bowling ball. Make sure the mesh sack holding the bowling ball is tied securely to the ceiling and that the ceiling can support the weight of the swinging bowling ball. Remind the student to keep his or her head still once the bowling ball is released. **Do not push the ball when releasing.** Even a small push may injure the student's nose. Do not let other students stand near the swinging ball or touch, interrupt the swinging ball.

A shot put may be welded to a strong cable instead of the bowling ball. Moreover, the door jamb is also one sturdy place to hang the giant pendulum. Make sure the hallway is clear of students. Students already done with the activity may be tasked to advise and redirect passersby.

Preparation

- If your school does not have a bowling ball, a basketball is a good substitute
- Find a secure, rigid area in the ceiling where you can tie the rope.
- Make sure that the ceiling can support the weight of the ball (especially if a bowling ball is used)
- You might have to find some place outside the room where you can hang the ball if the ceiling cannot support the swinging ball.
- The ball should hang 1 – 2 feet above the floor.
- Practice the swing to make sure that the ball swings smoothly and the path is clear of obstacles.

- To make the demonstration more dramatic, use a high-swinging, fast-moving pendulum. Make the volunteer lean on the wall so that his head is placed against the wall. This will prevent him/her from moving his/her head forward or backward and give impression that she/he has nowhere to go.

- As a teacher, be prepared to demonstrate first the activity before throwing the challenge to the students. Students should not be put to risk and made to feel in danger.

Answers to Questions

A1. No. The ball will not reach the tip of the nose of the student and will not exceed its original height.

A2. The kinetic energy of the ball is highest at the lowest point in its swing.

A3. The gravitational energy of the ball is highest at the highest point in its swing.

ACTIVITY 4

Bouncy Balls, Revisited!

This activity is related to the activity in the previous section about Bouncing Balls. This activity will verify that the total kinetic energy is not conserved in an inelastic collision.

- If possible, form groups with three members. Have each member take the following roles:
  - Student 1 will observe, measure, and record the height of the bounce;
  - Student 2 will hold the meter stick in place and give signal;
  - Student 3 will drop the ball when signal is given;

- The activity may be done inside or outside the classroom provided there is enough space (if inside the room) and will not disturb other classes (if outside the room).

Answers to Questions:

A1. We may use the Kinematics Equation, $v_f{}^2 = v_i{}^2 + 2gy$ or the Conservation of Total Mechanical Energy equations with the assumption that air friction is negligible.

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	0.04	1.0	0.50	4.43	3.13	0.39	0.20	0.19
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

To get the velocity of the ball just before it hits the ground use

(1) $v_f{}^2 = v_i{}^2 + 2gy$ or (2) $PE_i + KE_i = PE_f + KE_f$

Remember the sign conventions for vector quantities (Ex: downward displacement is negative, g = -9.8m/s^2)

Example:

If the ball is dropped from a height of 1.0 m, Using equation (1),

$$v_f{}^2 = v_i{}^2 + 2gy$$

$$v_f{}^2 = 0 + 2(-9.8)(-1.0)$$

$$v_f = \sqrt{19.6} = 4.4\ m/s$$

Using equation (2),

$$PE_i + KE_i = PE_f + KE_f$$

$$mgh_i + 0 = 0 + \frac{1}{2}mv_f{}^2$$

$$2gh = v_f{}^2$$

$$\sqrt{2gh} = v_f = \sqrt{19.6} = 4.4\ m/s$$

To get the velocity of the ball just after it hits the ground use

(1) $v_f{}^2 = v_i{}^2 + 2gy$ or (2) $PE_i + KE_i = PE_f + KE_f$

where y is the observed bounce height (final height h_f).

For example, if $y = h_f$ is 0.5m,

using equation (1),

$$v_f{}^2 = v_i{}^2 + 2gy$$

$$0 = v_i{}^2 + 2gy$$

$$v_i = \sqrt{-2(-9.8)(0.5)} = 3.1\ m/s$$

using equation (2),

$$PE_i + KE_i = PE_f + KE_f$$

$$0 + \frac{1}{2}mv_i{}^2 = mgh_f + 0$$

$$2gh_f = v_i{}^2$$

$$\sqrt{2gh_f} = v_i = \sqrt{9.8} = 3.1\ m/s$$

A2. The ball loses kinetic energy after the collision with the floor. Kinetic energy is converted to other forms of energy (i.e., heat and sound) Recall that in an inelastic collision, kinetic energy is not conserved.

Key Learning Ideas

1. The Law of Conservation of Energy states that the energy can neither be created nor destroyed; it is merely converted from one form to another. In terms of mechanical energy, the sum of the potential and kinetic energies of an object remains constant.

$$ME_1 = ME_2 = ME_3 = \ldots$$

$$PE_1 + KE_1 = PE_2 + KE_2 = PE_3 + KE_3 = \ldots$$

2. For a freely falling body released from rest, the vertical distance traveled from the top is $h = 1/2a_gt^2$, since $v_1 = 0$.

3. The velocity at any point is given by: $v_f = a_gt$, since $v_1 = 0$, where t = time elapsed from release.

.

Summative Assessment

Directions. A. Choose the letter of the best answer.

1. What is the energy of a motorcycle driven 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 event 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 stone 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 wound up 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 with 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

Given *mass, m = 2 kg*
speed, v = 6 m/s

$KE = \frac{1}{2}mv^2 = \frac{1}{2}(2kg)(6m/s)^2 = \mathbf{36\ kg\frac{m}{s^2}\ or\ J}$

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

Given *mass, m = 3 kg*
height, *h = 2 m*

$PE = mgh = (3kg)\left(9.8\frac{m}{s^2}\right)(2m) = \mathbf{58.88\ J}$

To wrap up the module and encourage the students to do accounting of energy conservation, ask students to conduct and document an energy audit of a

real-life tasks that is of personal interest to them such as a skill or hobby, a favorite amusement park-ride experience, or a sporting event.

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

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.

After completing this module, you will be able to:

1. demonstrate that heat can be turned to work;
2. infer that doing work releases heat;
3. explain how heat transfer energy

Key questions for this module

At the end of module 3, the students will be able to answer the following questions:

How is heat converted to work?

How is work related to energy?

Heat and Work

Start the module by reviewing students' prior knowledge in about heat and temperature since they were able to learn these concepts in their previous years.

After learning the difference between heat and temperature, the teacher is ready to discuss how energy is converted into work. The following questions may be asked:

- How heat is converted into work?
- How work is related into heat?
- How heat flows from colder temperature to higher temperature?
- What is the function of heat pump and heat engines in reversing the flow of energy?
- What environmental implications brought about by heat pump and heat engine?

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

Let the students do the next activity activity

ACTIVITY 1

Heat and Internal Energy!

In this activity, the students are tasked to determine the temperature of water before boiling, while boiling and after boiling.

- The students should form a group of five members. Everybody should have a part in the activity.
    - Student 1 measure the temperature of water before boiling.
    - Student 2 measure the temperature of water while boiling.
    - Student 3 measure the temperature of water after boiling.
    - Student 4, and 5 record the temperature readings.

- Tell them to be extra cautious in handling hot substances, thermometer and hot stove.

- It is always better to perform this in the laboratory if materials are available like tripod, tripod, and beaker instead of stove and pot.

Answers to Questions

Q1. The temperature is lower than 100° C before it is boiled, 100° C when it was boiling and after it has boiled.
Q2. It means an increase in internal energy of the water.

Try this…(Answer)

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?

Answer:

Given: Q= 120J
W= 40J
Find: U
Solution: U= Q-W
= 120J-40J
= 80J

Note: The teacher may add some more word problems as needed by the learners.

ACTIVITY

2

Where do I Belong?

In this activity, students are asked to identify spontaneous and non-spontaneous processes. They are to distinguish these processes. Since, the activity is very simple and practical, it could be done individually. The teacher may add some more processes not listed on the module.

Though this activity is quite simple , the teacher should point out that whatever object involved in a given example has heat, this could be in lower or in higher temperature. Emphasize on the terms such as internal energy, thermal and heat.

During the post activity discussion, the given guide questions should be answered.

Possible Answers to Complete the Table:

Spontaneous Process	Non-spontaneous Process	Needs work to reverse the process
Drying of leaves	Breakage of egg	Drying of leaves
Spoilage of food	Ice Production	Spoilage of food
Water falls	Rice cooking	Water falls

Possible Answers to Questions:

Q1. Drying of leaves, spoilage of food and water falls are just some of the examples of spontaneous process.

Q2.

a. By using plant press
b. By putting them together using scotch tape
c. By using refrigerator.
d. By using stove
e. By using water pump or motor

Q3. An application of work or using motor or a heat pump.

Now that it is known that every non-spontaneous process needs work or mechanical energy in able to reverse the process, it is about time to find out how heat pump functions.

Heat Pump

To introduce the concept of heat pump, the teacher should differentiate spontaneous and non-spontaneous process.

1. **Ask students to enumerate some spontaneous and non-spontaneous processes present in their immediate environment or experienced by them.**
2. From this, the teacher will identify whether the given process can occur naturally. If not, an external force should be done, which will lead to the application of work or mechanical energy.
3. It is important to define and differentiate the following terms:
   Internal/ Thermal energy- is the sum of potential and kinetic energy of the bodies.
   Heat- is the thermal energy that flows from a substance of higher temperature to a substance of lower temperature.

ACTIVITY

3

The Reverse of It

In this activity, the students will discuss how heat pumps (refrigerator and air conditioner) work.

Answers to Questions:

Q1. Work has to be done by the compressor to “suck” the colder gas from inside the refrigerator out, effectively forcing energy to flow from a chamber of lower temperature to a warmer room outside.

Q2. A compressor is a motor which compresses a gas known as freon to a pressure of several atmospheres.

Note: Freon is a refrigerant with relatively low boiling point.

Q3. The hot gas produced by the compressor runs through a condenser.
Q4. The condenser turned the cooled gas to near room temperature which then condenses into liquid. This cool liquid which has high pressure flows through a narrow tube connected to the evaporator.

Q5. The liquid evaporates due to its low pressure. At the same time, it absorbs heat from the contents of the refrigerator.

Q6. The gas produced that has already absorbed heat goes back to the compressor and then the cycle repeats.
Q7. The refrigerator cooling cycle follows the following mechanisms:

a. The compressor compresses the freon into a pressure of several atmospheres.
b. The gas is cooled to near room temperature which then condenses into liquid of high pressure.
c. The liquid evaporates due to its low pressure and heat is absorbed from the contents of the refrigerator.
d. The gas produced that has already absorbed heat goes back to the compressor and then the cycle repeats.

Q8. An air conditioning unit is a heat pump used for home heating and cooling.

Q9. It cools the inside of the house and heats the outside.
Q10. It takes heat from the air outside to warm the inside.
Q11. Mechanical energy is needed to transfer heat from a cold object to a warmer one.

Heat Engines

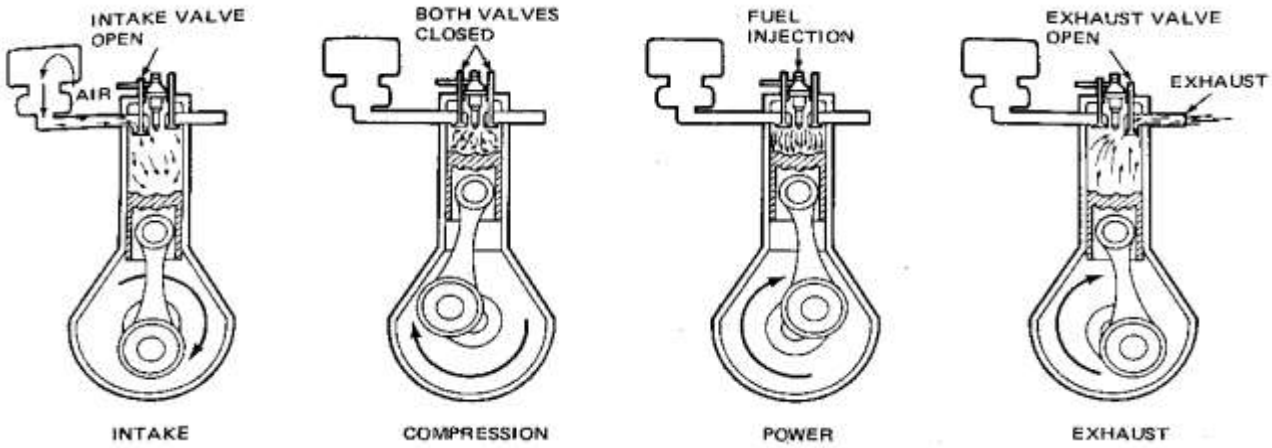
The teacher should assign the learners to research on heat engine and the four-cycle stroke of a gasoline engine prior to this activity. Or the teacher will provide the text materials for the students.

ACTIVITY

4

Start the Engine!

This activity discusses the four-cycle stroke of a gasoline engine. The following are the expected answer after studying the illustration.



The four cycle-stroke of gasoline engine (to the artist, please redraw)

Answers to Complete the Table:

Cycle stroke	Movement of the piston	What happened to mixture of gases?
Intake	Moves down	Filled in the cylinder
Compression	Moves upward	Compressed into fractional amount
Power	Moves down	Ignited by the spark plug
Exhaust	Moves up	Expelled out by the exhaust pipe

Answers to Questions

Q1. The gas expands.

Q2. The piston moves up. The mixture of gases is compressed into fractional amount.

Q3. The spark plug ignites the mixture. This will increase the temperature of the mixture

Q4. The piston moves down. No heat enters or leaves the system.

Q5. The piston moves down, the exhaust valve opens and the burned gas expelled out through the exhaust valve.

Q6. This gas will constitute to the air pollution. Eventually, it causes thermal pollution.

Q7. No, a heat engine could not be 100% efficient because some of the gases are exhausted into the environment.

Q8. I will inform the vehicles' operators to always clean their muffler. I will inform the general public the bad effects of this exhaust gases to one's health and to the environment. I will encourage them to use unleaded gasoline. I will advocate to plant trees so that carbon monoxide and halogens will be absorbed by them.

ACTIVITY

5

Fill me In

This activity will verify that machine is not 100% efficient.

Answers to Complete the Table:

Temperature/ energy in cold reservoir	Temperature/ energy in hot reservoir	Thermal efficiency
250K	500K	50%
230K	700K	33%
287.5K	575K	50%
650J	1054J	38%
259J	677J	62%
30°C	88°C	16%
56°C	92°C	10%
47°C	56°C	3%
77°C	93°C	4%
65°C	85°C	6%

Sample Computation to Complete the Table:

Given: T_C=250K
T_H=500K
Find: Thermal Efficiency
Solution:

$$\text{Eff: } = 1-\frac{T_C}{T_H} \times 100\%$$

$$= 1-\frac{250K}{500K} \times 100\%$$

= 50%

For other items, follow the sample above, since they will be substituted directly the given.

For problems given the temperature in °C, add them in 273 to make it absolute temperature before proceeding to the equation.

Given: T_C= 30°C+ 273= 303K
T_H= 88°C+273= 361K
Find: Efficiency
Solution:

$$\text{Eff.} = \frac{1-T_C}{T_H} \times 100\%$$

$$= \frac{1-303K}{361K} \times 100\%$$

= 16%

Answers to Question

Q1. The lesser the work input/ temperature in the cold reservoir, the greater the efficiency of the heat engine.

Diagnostic Assessment (Answers)

I. MULTIPLE CHOICE

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

II. MODIFIED TRUE OR FALSE

6. TRUE
7. OUTSIDE
8. ONLY SOME
9. TRUE
10. TRUE

Summative Assessment (Answers)

1. A
2. A
3. D
4. A
5. B
6. A
7. C
8. B
9. B
10. A
11. C
12. B
13. B
14. B
15. D

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UPNISMED Teacher's Guide

Suggested time allotment: 9 hours

Unit 4
MODULE

4

ELECTRICITY AND MAGNETISM

Overview

In Grade 8, the students learned about the three basic electrical quantities–current, voltage, and resistance–and how they are related by Ohm's Law. The activities focused on identifying simple electric circuit components, constructing series and parallel connections and explaining the functions of safety devices in a circuit.

In Grade 9, the focus will be on how electrical energy is generated, transmitted and distributed. The students shall be led to discover various energy sources – solar, wind, hydro, nuclear, sea waves, geothermal---in their community in the hope of promoting sustainable development. They shall be able to identify the similarities and differences in the methods of power generation among the different energy sources utilized in the Philippines. At the end of the lesson, they shall be able to understand that although the sources differ, the basic mechanism of electrical generation is practically the same.

The students will be further tasked to trace the path of electricity as it is generated from the power plants, transmitted to the substations, and distributed to the households. They shall be able to compare step-up from step-down transformers operationally. Finally, they will be taught how to compute for their electrical energy consumption and suggest ways on how to conserve electrical energy at home.

Specifically, at the end of module 4, the students should 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 to houses in order to supply power to appliances?
4. How is the cost of electrical energy consumption computed?
5. How does magnetism produce electricity?

Learning Competencies/Objectives

1. Describe energy transformation in electrical power plants.
2. Describe the energy transformation in electrical energy from a power station to the community.
3. Describe how electric power is measured.
4. Calculate the electrical energy usage.
5. Explain how electricity is produced from magnetism.

Diagnostic Assessment

Direction: Choose the letter of the best answer.

1. In which of the following units is electrical consumption measured by electric companies for our household consumption in our homes?
   kilowatt hour
2. In power stations generating electricity, power is measured in _____.
   megawatt
3. Why do power stations generate AC, and not DC?
   It is easier to generate, safer and more economical to transmit AC than DC.
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?

Step-up

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?

power plant → transmission substations → distribution substations → residences

6. Who among the following scientists discovered the relationship between electricity and magnetism?

Michael Faraday

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?

remove one of the dry cells
8. What energy transformation takes place in a generator?
mechanical to electrical

9. In which case will electric current be induced in a coil of wire?

when a magnet is rapidly inserted into and out of the coil
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?
16

Diagnostic Assessment Answers:

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

How is electricity produced?

Prior to the class meeting, you may want to assign students to research on the different sources of energy and how each one differs from another. You may want to start a teacher-led discussion on this and summarize the concepts using a graphic organizer. You may want to ask questions similar to these for concept formation:

- **Identify the form(s) of energy at each labeled point in the diagram.**
  - ***Answers may vary.***
- **Describe the energy transformations that take place in each of the major components of the power plant.**
  - ***Answers may vary.***
- **How is a hydropower plant different from a coal-fired plant?**

A hydropower plant runs by passing the falling water directly through the turbines which are connected to a generator to produce electricity. A coal-fired plant uses the coal as fuel to heat and boil water to produce steam. The steam is directed to the turbines which are connected to a generator to produce electricity.

Activity 1
It's more "Power" in the Philippines

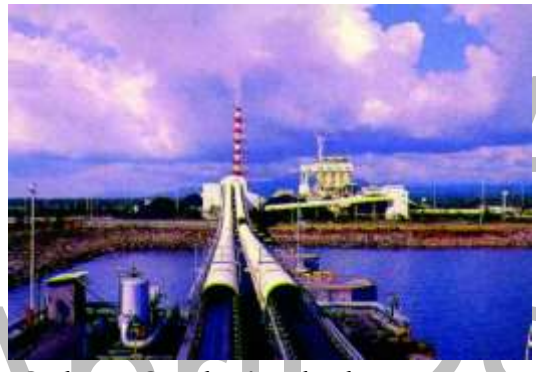
Start by asking the students if they could trace back the path of electricity when an electric appliance is switched on. Let the students identify the source of energy and differentiate it from other power plants. The students shall locate the Region in which the power plant is found. Encourage students to add to the list giving examples from their own communities. Let the student identify the location of the power plant in the map.

Answers to Activity 1:

Name	Type	Source	Location	Operational?	Region
Agus 1	**Hydro**	**Water**	**Maria Cristina Falls, Iligan City, Lanao Del Norte**	**Yes**	**X**
Calaca Thermal Plant	**Thermal**	**Coal**	**Calaca, Batangas**	**Yes**	**IV-A**
Tiwi Plant	**Geothermal**	**Earth's Interior**	**Tiwi, Albay**	**Yes**	**V**
Bohol Diesel Plant	**Diesel**	**Fossil Fuel**	**Dampas, Tagbilaran City, Bohol**	**Yes**	**VII**
Bataan Plant	**Nuclear**	**Nuclear Fuel**	**Bataan**	**No**	**III**

Note: The students are expected to provide additional information on the blank space.

Agus 1 Hydroelectric Plant



Calaca Coal-Fired Plant

Tiwi Geothermal Plant

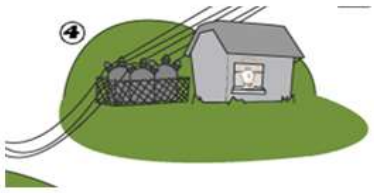
Bohol Diesel – Powered Plant

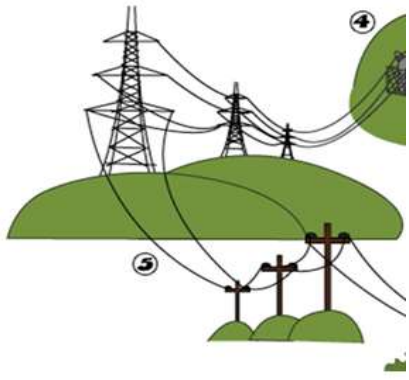
Bataan Nuclear Power Plant
Photo : http://www.napocor.gov.ph/

How is electricity transmitted and distributed?

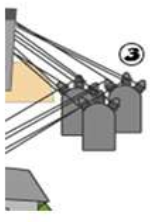
Let students perform the activity on Tracing Power, taking into consideration the different components of power transmission and distribution. Guide the students in making a perfect match among the pictures and descriptions. Reward the group that finishes ahead of the class. Let the students post their answers on the board and encourage them to explain their answers.

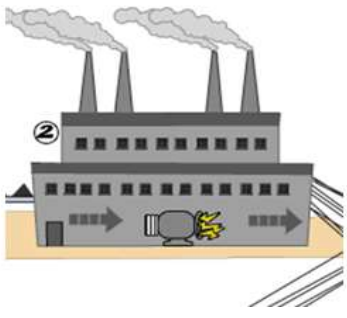
Activity 2
Tracing Power



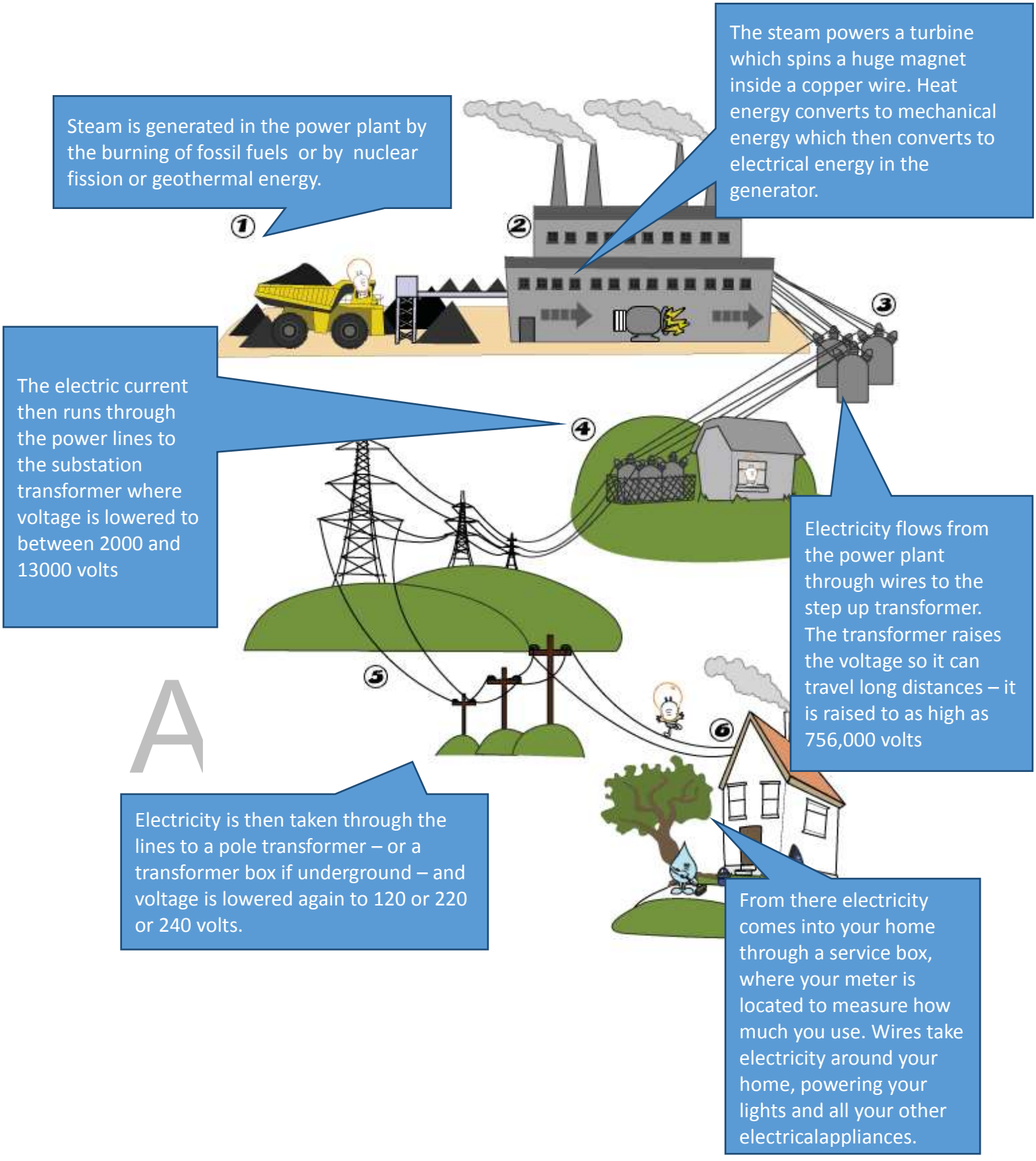


A| 4





Answers to the Activity:



Q1. What are the different stations in the transmission of energy?

Electricity is produced in the power plants, transmitted at high current and voltage in transmission substations, passed through the distribution substations, then finally distributed to business and residential areas.

Q2. What did you observe about the size of the transmission lines as electricity reaches the consumers?

Transmission lines have a greater cross-sectional area to allow a large amount of current to pass through. Having a large cross section also reduces the resistance, lessening transmission loss. The residential wirings have much smaller cross-sectional area.

Q3. Does the size of wires and cables used matter in energy transmission?

Yes, it ensures safety in the entire network system and reduces transmission losses.

Q4. What happens to the voltage that travels from the source to the consumers?

The voltage is stepped-up for transmission and stepped-down before being distributed to households.

Q5. What are step-up transformers? Step-down transformers?

Step-up transformers increase the voltage while step-down transformers decrease the voltage to be consumed at safe levels.

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 (http://www.thefreedictionary.com/diorama).

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. You may also use recycled materials. 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!

If you need additional information on how to create a diorama, you may want to refer to http://www.youtube.com/watch?v=_DJKyM3JIAI.

To the Artist: Please look for or draw a similar photo showing diorama with transmission lines, houses, generating stations, etc.

April 29, 2014

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?

After learning how electricity is generated, transmitted and distributed, the students will be taught how to compute for their electrical energy consumption. You may want to emphasize that generation charge is computed separately from the distribution charge. This further relates to the basic concepts of generation, transmission, and distribution. The learner's material is designed to teach students how to read their electric meter, analyze their electric bill and eventually come up with ways on how to conserve electricity. The concept of systems loss may also be introduced after analysing their electric bills. Ask them, "Why are we being billed for system loss?"

Take Home Task:

This task is suggested to be assigned to students as an enrichment activity – to further substantiate the understanding of the topic:

Can you think of some ways on how we can save on electrical energy consumption? List down at least three energy-saving tips for each appliance:

a. Washing machine
b. Refrigerator
c. Clothes Iron
d. Lights and lamps
e. Electric Fans
f. Television

Students' Possible Answers:

Lighting

- Use natural light whenever possible. It is the best source of light and will help you save kilowatt hours. Strategically arrange your household in such a way that you can use natural light. Place reading tables near windows and put skylights in other working areas.

- Use lamps that provide direct lighting over desks, beds, and other work areas. This method saves more energy compared to the higher wattage lighting needed to illuminate the whole room.
- Use low wattage light bulbs in areas that do not need strong lighting such as hallways, foyers, and doorways.

Washing Machine

- Do not over-wash clothes. Different types of clothes require different wash cycles. Delicate clothes do not take as long as dirty work clothes.
- Presoak soiled garments to avoid using additional wash cycles.
- When using your spinner, make sure that water is drained from the cylinder and clothes are squeezed to effectively spin-dry clothes.

Clothes Iron

- Iron large batches of clothing at one time to avoid wasting energy and reheating the iron several times.
- Dampen clothes moderately. Excessively moistened clothes take longer to iron.
- Do not overheat the iron. Set the temperature appropriately for the type of clothes to avoid scorching and wasting energy.

Electric Fan

- Turn off your electric fan when not in use.
- Perform regular maintenance to keep your electric fan running more efficiently, and save up to 30% of fan energy.
- Clean your electric fans regularly, to keep them running efficiently. Remove the dust accumulated at the fan blades, motor housings, and grills as it reduces the air current generated by the fan. Cobwebs, dust and other forms of impurities piling up at the motor's cover prevent air to naturally providing the cooling needed by the motor or heat produced by the motor to be released. This causes additional heating of the motor's windings, which leads to more consumption of energy.

Television

- Switch off your TV set when no one is watching. If you are using a transformer, unplug it because it consumes electricity.
- Don't use the standby mode because this uses 10% to as much as 60% of the electricity that would be used by your TV set if it were switched on.
- Too much television viewing and playing of video games of kids can be substituted by educational board games and teaching them light sports to lessen television electricity consumption.
- Replace old TV tube sets with solid-state TV sets because these types use significantly less energy.

How does magnetism produce electricity?

The material is designed to teach the concept of electric power generation and transmission through magnetism. By performing the simple activity, the students shall see that electricity can be generated even without the usual dry cell or a voltage

source. By allowing the compact disc with magnets to rotate on its axis, current is induced on the coils of copper wire enabling the LEDs to glow. The changing magnetic field induces current in the copper coils therefore producing electricity.

You need to encourage students to continue with or modify their experiment in case students are not successful in performing their activity at once. You may suggest using a stronger disc magnet or inverting the magnets to ensure that the polarity is the same. This creates a stronger magnetic field around the coil of wire.

You need to simplify the explanation to this concept by limiting the discussion to the direct effect of magnetism to the production of electricity. A more detailed discussion on this would be taken up in Grade 10.

Q1. Why did the LED light up when the magnet cd was made to turn around the axis?

Current was induced in the coils of copper wire due to the changing magnetic field.

Q2. Why was it possible to produce electricity without an energy source?

A changing magnetic field induces current in coils of wire. This is also known as electromagnetic induction.

Q3. In electric power plants, turbines are actually connected to generators which are composed of magnets and coils. How are turbines used to produce electricity?

Turbines are connected to generators consisting of large magnets and conductors. Turbines are rotated either mechanically or by means of steam from boiling water which is heated by the fuel source. Turbines produce a changing magnetic field inside the generator which in turn produces electricity.

Summative Assessment Answers:

1. B
2. B
3. D
4. B
5. B
6. B
7. B
8. D
9. D
10. A

References and Links

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