8

Science

Teacher's Guide

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

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UNIT 1
Force, Motion, and Energy

UNIT 1: Force, Motion, and Energy

In Grade 7, students learned about the various forms of energy, namely motion energy, light, sound, heat, and electrical energy. They learned about the different energy forms in terms of their sources, their nature or characteristics, and the ways by which they can be transferred from one object or place to another. In Grade 8, students deepen their understanding of energy by describing how energy transfer affects, and is affected by, matter. They explore some changes when there is energy transfer such as changes in temperature, changes in the current in a circuit, or changes in the speed of sound travelling through a medium. They relate these changes to the energy of the particles that make up matter.

This unit has six modules. The first two modules deal with the transfer of energy by applying force to large objects; Modules 3 and 4 discuss changes in energy of the particles of matter which accompany energy transfer; and Modules 5 and 6 describe the interaction between waves and matter. Most of the lessons found in each module take off from the lessons covered in Grade 7.

The table below shows the general and specific topics covered in Grade 8:

Module Title	Specific Topics	Focus Questions
Forces and Motion	Balanced and Unbalanced Forces Laws of Motion	*How do forces affect the motion of an object?*
Work and Energy	Work Kinetic and potential energy	*How are work and energy related?*
Heat	Effects of heat on matter Factors affecting the amount of heat transferred	*How does heat affect matter?*
Electricity	Voltage-current- resistance relationship Series and parallel circuits	*What are the factors that affect the current in a circuit?*
Sound	Speed of sound Reflection and refraction of sound	*What are the factors that affect the speed of sound?*
Light	Color, wavelength, frequency, and energy of light	*What properties of light explain the separation of colors in white light?*

Most of the topics in this module are dealt with qualitatively in order for students to have a basic understanding of the concepts. Some tasks include measurements and computations to illustrate the relationship among quantities. The activities included in each module aim to make students interested in these topics and motivate them to learn more in the succeeding grade levels.

Unit 1
MODULE
1

FORCES AND MOTION

In Grade 7, students learned the different ways of describing the motion of an object in one dimension. This time, they will learn to explain the motion of an object using Newton's laws of motion. They will describe the relationship between the forces acting on an object and its motion due to these forces.

Key questions for this module

Do forces always result in motion?

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

How is force related to acceleration?

Related Misconceptions

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

Balanced and Unbalanced Forces

To introduce the concept of FORCE, place an object on top of a table and ask:

Is this object at rest or in motion? What evidence can you give to support your answer?

Then continue the discussion by asking the following questions:

Will this object move by itself? When will it move? Or how can we make it move?
(While the object is moving) How can we make it move faster? Move slower? Change its direction? Stop?

Some students can be asked to demonstrate some ways to make the object move or change its state of motion. Then ask:

What 'common thing' did you do on the object to make it move, stop, or change its speed?"

This will lead them to realize that the object can be made to move, stop, or change its speed or direction by *pushing* or *pulling*. The motion of the object can be changed if FORCE is applied on it. Then place again the object on top of the table and ask:

Since this object is now at rest, can we then say that there is/are no force/s acting on it?

Then let them do Activity 1.

Activity 1

Forces on objects at rest

In this activity, students are asked to identify the forces acting on objects at rest.

Teaching Tips

1. Students may be asked to work on the activity in pairs or in smaller groups to ensure that they will all be actively involved while doing the activity.

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

   - Gravitational force is the attraction between any two objects or bodies with mass. If the mass of either object increases, the gravitational force between them also increases.
   - As the Earth attracts objects around it, these objects also attract the Earth. But the Earth is much more massive than them that is why their attraction is not as great as the gravitational pull of the Earth.
   - All things on Earth fall (or are attracted) towards the center of the Earth.

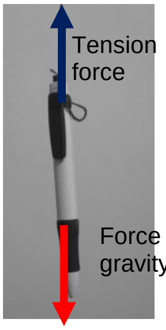
3. During the discussion, emphasize that when objects are at rest, it does not mean that there are no forces acting on them (Misconception #1). Then ask the students this question:

   Then what makes them stay at rest (even if there are forces acting on them)?

   Then let them perform Activity 2.

Answers to Questions

Situation 1: Hanging pen



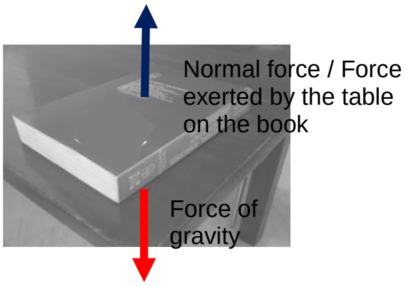
Hanging pen

Q1. The pen is at rest.

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

Q3. When we cut the string, the pen fell to the ground because gravity pulled on it downward.

Situation 2: Book on a table



Book on a table

Q4. The book is at rest.

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

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

Activity 2 Balance of forces

The aim of this activity is to help the students understand and explain how the forces acting on the objects in Activity 1 help in keeping them at rest.

Teaching Tips

1. Each group can work first on the activity using a pair of spring balances. Then they can join another group to complete the 4 spring balances needed for the challenge part (Step 7).

2. During the post activity discussion, emphasis must be given on the following ideas:

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

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

- If the forces acting on an object are unbalanced, the state of motion of the object will change. (This concept was discussed in the module using the rolling ball as an example). Emphasize that the ball slowed down and eventually stopped not because *its force is already used up* (misconception). The ball slowed down and stopped because an unbalanced force (friction) caused it to change its motion.

Answers to Questions

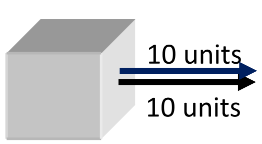
Q7. The forces are equal in magnitude but opposite in direction.

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

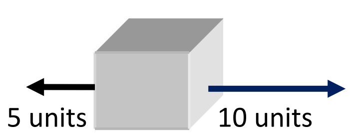
Note: At this point, the term "concurrent forces" may be introduced. When the lines of action of the forces acting on an object meet at a single point, they are considered as concurrent forces. When the forces acting on an object are concurrent, the object does not move nor rotate.

Concept check:

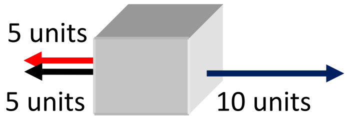
1. A boy and a girl pull a heavy crate at the same time with 10 units of force each as shown in the diagram. What is the net force acting on the object?



2. What if the boy and the girl pull the heavy crate at the same time in opposite directions with 10 units and 5 units of force respectively, what will be the net force acting on the object? Will the object move? To what direction will it move?



3. Suppose another girl pulls the heavy crate with 5 units of force in the same direction as the girl, what will be the net force acting on the object? Will the object move?



Answers:

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

Newton's Three Laws of Motion

1. Start the session by introducing first Isaac Newton to the students. Provide some pictures if possible. Discuss some of his significant contributions especially in the field of physics, e.g., *Newton combined his ideas and the ideas of the other scientists like Galileo to give us a more unified picture of how our universe works. He formulated the laws of motion and gravitation. Through his three laws of motion, we can describe and predict the movement of everything around us.*

<u>Newton's First Law of Motion: Law of Inertia</u>

Activity 3 Investigating inertia

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

Teaching Tips

1. After discussing the result of the activity, relate the Law of Inertia to the previous discussion on balanced and unbalanced forces. Emphasize that if an object is acted upon by balanced forces, its motion or its velocity will not change. Since acceleration is defined as the change in velocity over time, then we can say that the object will not accelerate. It will only accelerate if the forces acting on it are unbalanced. This is what the Law of Inertia is all about. It states that, "*An object will stay at rest or move at constant velocity unless an unbalanced external force acts on it.*"

2. If time permits, discuss also the effect of mass on inertia.

3. For the application part, relate the concept of inertia to the students' experience while riding a vehicle. Then discuss the importance of using a seatbelt.

Answers to Questions

Coin Drop

Q9. When we slowly pulled the cardboard, the coin on top moved with the cardboard.
The frictional force between the coin and the cardboard had caused the coin to stay on top of the cardboard and move with it.

Q10. When we flicked the cardboard with our finger, the cardboard moved forward but this time, the coin did not move with it. So when the cardboard was removed from underneath the coin, the coin dropped into the glass.

The coin did not move forward with the coin because of its inertia.

Stack of Coins

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

Newton's Second Law of Motion: Law of Acceleration

- To introduce the second law of motion, refer the students back to the discussion on the effects of unbalanced forces on the motion of objects by saying:

  If the forces acting on an object are unbalanced (F_{net}>0), the object ***accelerates****. But how is the acceleration of the object related to the amount of the net force acting on it?*

Activity 4 Force and acceleration

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

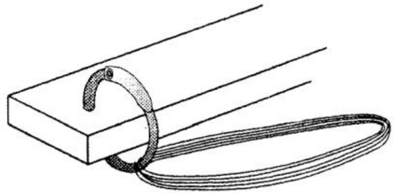
Note that the students will not actually perform the activity using the ticker tape timer. It will be assumed that some other students have done it already. What they will just do is to analyze the tape charts that are supposedly obtained by the students who performed the activity.

Teaching Tips

1. Reproduce the tape charts found in the teacher's guide (Figure 3) to be distributed among the students.

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

Figure 1



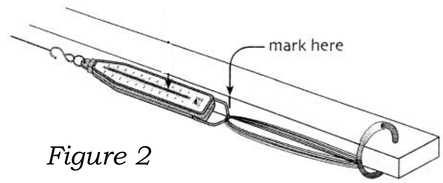


Figure 2

3. In the absence of a ticker tape timer, students can be allowed to watch a video showing what a ticker tape timer is and how it works to produce tapes with dots.

4. Note that the ticker timer in the activity produces 60 dots on the tape per second. This is why the time interval (equivalent to 6 dots) = 0.10 seconds. *(Just like 30 dots = 0.5 seconds; 15 dots = 0.25 seconds, and so on.)*

5. Students may work on the activity as a group. But if there are enough copies for everyone, they can be asked to work on Part A first individually. Then, assign each group with a specific tape chart to work on.

6. Note that their measurements may differ even if they are provided with the same copies of the tape charts. Make sure to discuss the reasons for the differences in their measurements.

7. Ask the students to compute for the acceleration three times using different values of Δv (from Step 6). Then ask them to get the average value.

8. Ask the students to obtain the other values of acceleration (average only) from the other students who worked on the other tape charts to complete the data for F = 1 unit to F = 4 units. Then ask them to use the data to come up with a *relationship between the net force acting on the body and its acceleration.*

9. Use the result of the activity to discuss about Newton's second law of motion, or Law of Acceleration. If there is still enough time, students can also be asked to plot the graph of force against acceleration (Figure 4 below). This is also another way of showing the relationship between the two variables.

10. Since the law of acceleration quantifies the relationship among mass, force, and acceleration, it is better if the relationship between the mass of the object and its acceleration will also be discussed.

As the mass of the object increases, with the same amount of force applied, its acceleration also increases. To state in another way, if the same force acts on two bodies of different masses, the acceleration of the body with lesser mass is greater than the acceleration of the body with greater mass.

Answers to Questions

Tape chart analysis

Q12. (Similarities) The lengths of the strips are increasing.

(Differences) The change in length differs among the tape charts.

Q13. The change (increase) in the length of the strips means that the average velocity of the cart increases at equal time interval.

The cart is accelerating.

This is also true to all other tape charts.

Q14. The increase in length of the strips in F = 1 unit is almost the same or constant.

This indicates that the velocity of the cart increases uniformly at equal intervals of time when the force acting on it is constant.

Q15. The amount of change in the length of the strips varies among the tape charts. It is greatest in F = 4 units and least in F = 1 unit.

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

Quantitative analysis

Q17. The computed values of v_{ave} are increasing. This indicates that the cart is accelerating.

Q18. The computed values of Δv are equal (or almost equal). This means that the cart is accelerating uniformly or its acceleration is constant.

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

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

<u>Newton's Third Law of Motion: Law of Action - Reaction</u>

Activity 5 Action-reaction

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

Answers to Questions

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

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

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

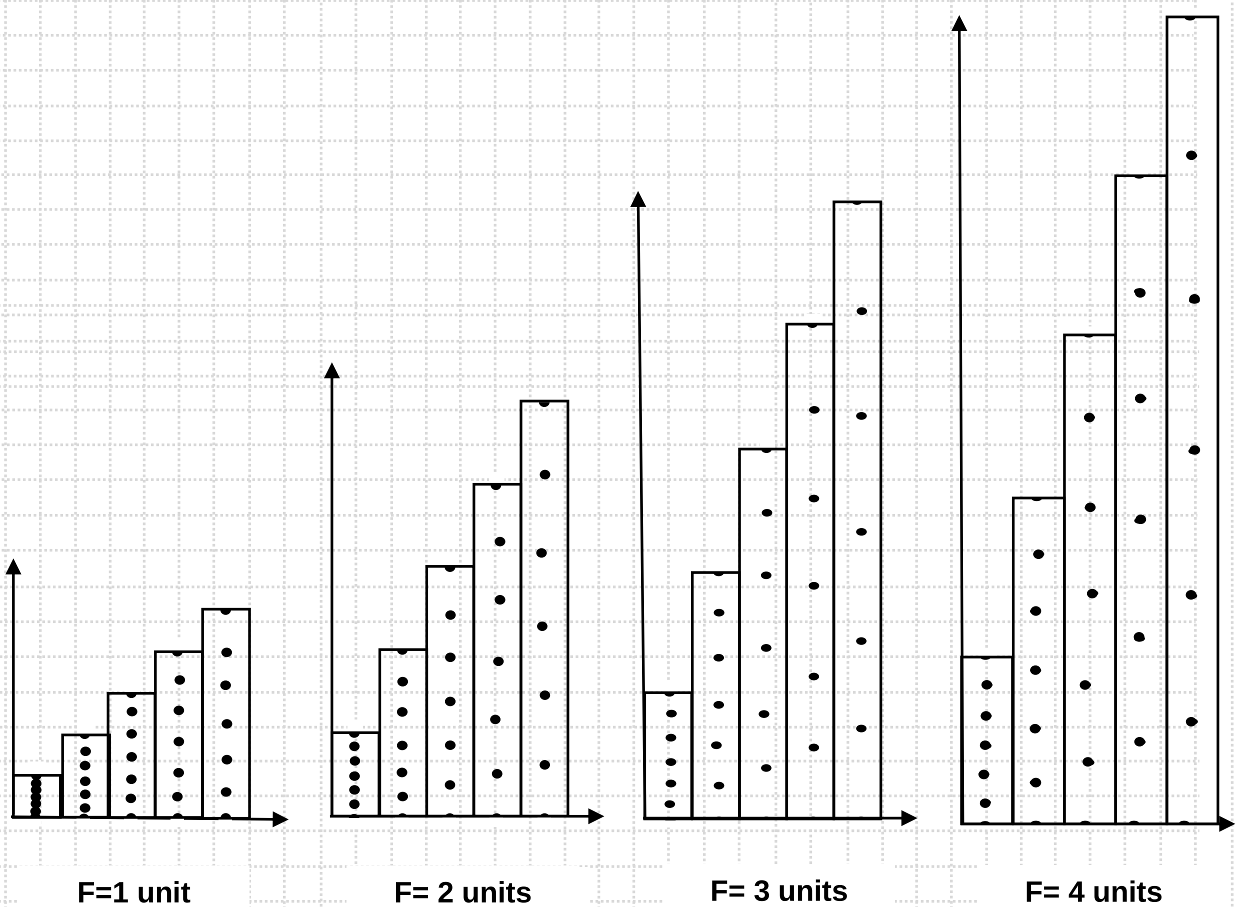
Q23. (*The readings this time should be greater than the previous ones*)

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

Q25. (*readings may vary*)

Q26. The forces are of opposite directions.

Figure 3: Tape charts



Sample computation for F= 2 units

Strip Number	Length of strip (cm)	Average velocity, v_{ave} (cm/s)	Change in velocity, Δv	Acceleration (cm/s^2)
1	1.1	11	11	110
2	2.2	22	10	100
3	3.2	32	11	110
4	4.3	43	12	120
5	5.5	55		

a_{ave} = 110 cm/s^2

Sample data for Table 1

Force	# of rubber bands	Acceleration
F = 1 unit	1	55 cm/s^2
F = 2 units	2	110 cm/s^2
F = 3 units	3	165 cm/s^2
F = 4 units	4	221 cm/s^2

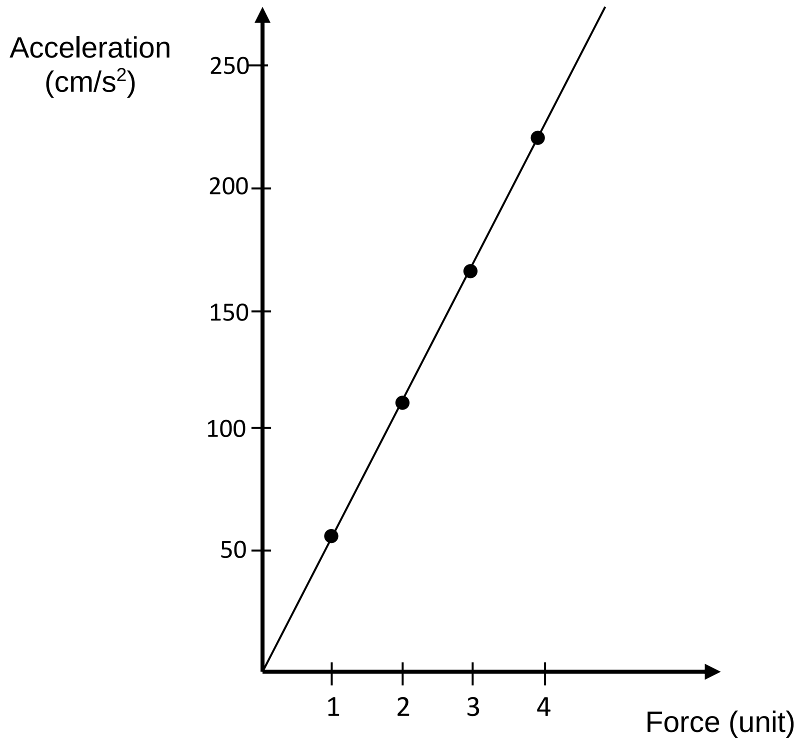


Figure 4: Graph of force vs acceleration

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Unit 1
MODULE

2

WORK AND ENERGY

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

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

Key questions for this module

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

What is *Work*?

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

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

Activity 1

Is there work done?

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

Teaching Tips

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

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

3. Recall the lesson about force in Module 1.

Answers to Questions

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

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

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

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

Calculating work

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

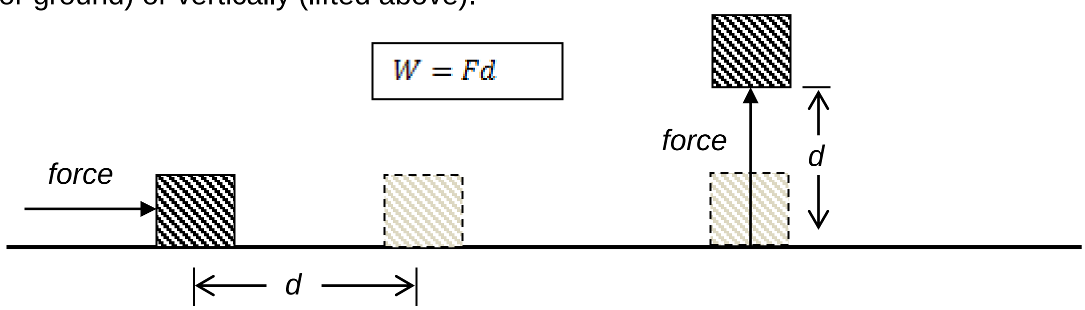

Figure 1. Equation for solving work

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

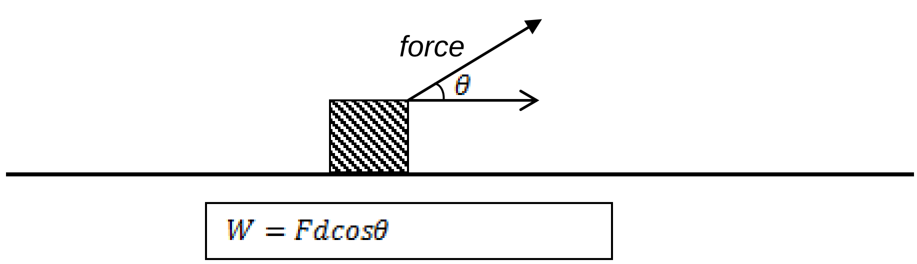

Figure 2. Equation for solving work if the force is at an angle

Answer to the problem

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

$$W = Fd$$

$$W = mgh$$

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

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

Work is a Method of Transferring Energy

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

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

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

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

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

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

Kinetic Energy

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

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

Answer to the problem:

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

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

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

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

Potential Energy

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

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

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

Teaching Tips

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

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

Answer to the problem:

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

$$PE = mgh$$

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

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

Activity 2 Rolling toy

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

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

Answers to Questions

Q1. It rolls.

Q2. Potential energy

Q3. Kinetic energy

Q4. Potential to kinetic energy

Work, Energy and Power

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

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

Activity 3 How POWER-ful am I?

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

Sample data for Table 1

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

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

Q5. Troy

Q6. $P = \frac{Energy}{time} = \frac{2450\,J}{8\,s} = 306\frac{J}{s}$

Q7. Mae

Q8. $P = \frac{Energy}{time} = \frac{1960\,J}{10\,s} = 196\frac{J}{s}$

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

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

Summary

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

- Work is done on an object when the force applied to it covers a distance in the direction of the applied force.
- Work is a way of transferring energy.
- When work is done by an object it loses energy and when work is done on an object it gains energy.
- The energy of an object enables it to do work.

- A moving object has energy called energy of motion or kinetic energy.
- An object above a specified level has energy due to its position called potential energy.
- An elastic object that is stretched or compressed or twisted has energy called potential energy.
- Power is the rate of doing work or the rate of using energy.

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Unit 1
MODULE
3

HEAT AND TEMPERATURE

In Grade 7, students learned about the conditions necessary for heat transfer to occur and the ways by which *heat* transfers from one place to another. This time, they will explore what happens to an object when *heat* is transferred to or from it. They will also explore the factors that affect the amount of *heat* that an object can transfer.

Key questions for this module

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

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

Are *heat* and temperature one and the same?

Related Misconceptions

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

Notes:

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

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

- Since the students will be using laboratory thermometers in most of the experiments that they will do, it is recommended that the guides on how to handle properly the thermometer and use it to measure temperature are discussed clearly at the beginning of the chapter.

Activity 1 Explaining hotness or coldness

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

Teaching Tips

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

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

2. When students are asked to determine the hotness of the water through sensation, make sure that they use a different finger for each water sample. The explanation can be found in Grade 7 (Module 5: Heat Transfer).

3. Note that heat transfer may continuously take place between the cold water and the surrounding (as long as there is a temperature difference). So there will be a possibility that the values of the initial temperature of the water inside the three containers will vary even if the cold water was taken from the same source. (Refer to the table below.) Make sure to discuss about this during the post activity discussion.

Sample Data

Container	**Temperature**		**Change in Temperature**
	Initial	**Final**	
Container 1	12°C	56°C	44C°
Container 2	11°C	20°C	8C°
Container 3	12°C	11°C	1C°

Answers to Questions

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

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

Q3. (Answers may vary)

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

Q5. Because of the different temperatures of the water added to the containers.

Q6. Heat transfer took place in containers 1 and 2. There were changes in the temperature of water inside these containers.

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

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

Activity

2 Dye in water

The aim of this activity is to explain why the temperature of water in Activity 1 increases when *heat* was added to it. Also, by observing the behavior of the dye through the water, students will be able to describe the changes that occur due to heat transfer at the particle level.

Teaching Tips

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

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

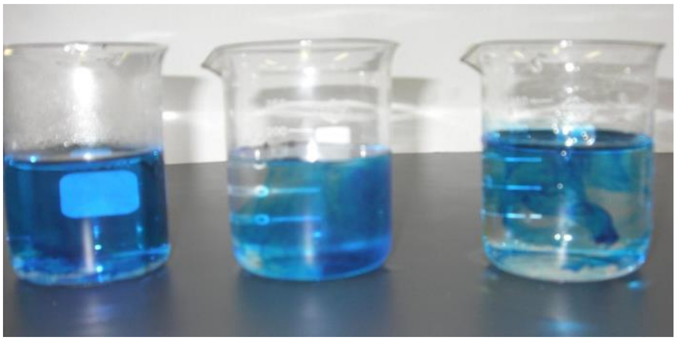
3. At the end of the discussion, students should be able to recognize that "hotness or coldness" indicates how fast the particles move. "Hot" may be considered as faster movement of the particles or higher kinetic energy of the particles.

4. During the post activity discussion, emphasis must be given on this idea

   - *The change in the kinetic energy of the particles of a substance varies with the amount of heat transferred to it. The greater the amount of heat transferred, the greater the increase in the kinetic energy of the particles. In the case of the dye, the particles of the dye added to the container with hot water move faster due to the greater amount of energy transferred to them from the hot water. This makes the dye scatter faster throughout the medium (water).*

Sample data for Table 2

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



Hot water Water at room temp Cold water

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

Answers to Questions

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

Q10. Hot water. Cold water.

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

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

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

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

Thermal Expansion

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

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

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

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

Phase Change

Activity 3.1 What happens when ice melts?

Teaching Tips

1. If the materials are available, some students may be allowed to use a heating device like a burner, instead of hot water, to 'heat' the beaker of ice. Then they can infer the difference in the amount of *heat* transferred to the ice based on the melting time.

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

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

4. Try out the activity first to determine the amount of ice that will allow the students to finish their activity within the day. Discussion of results may follow during the next session.

5. During the post activity discussion, give emphasis on the idea that it is not always true that the energy transferred to an object or substance will cause a change in the kinetic energy of particles.

Answers to Questions

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

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

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

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

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

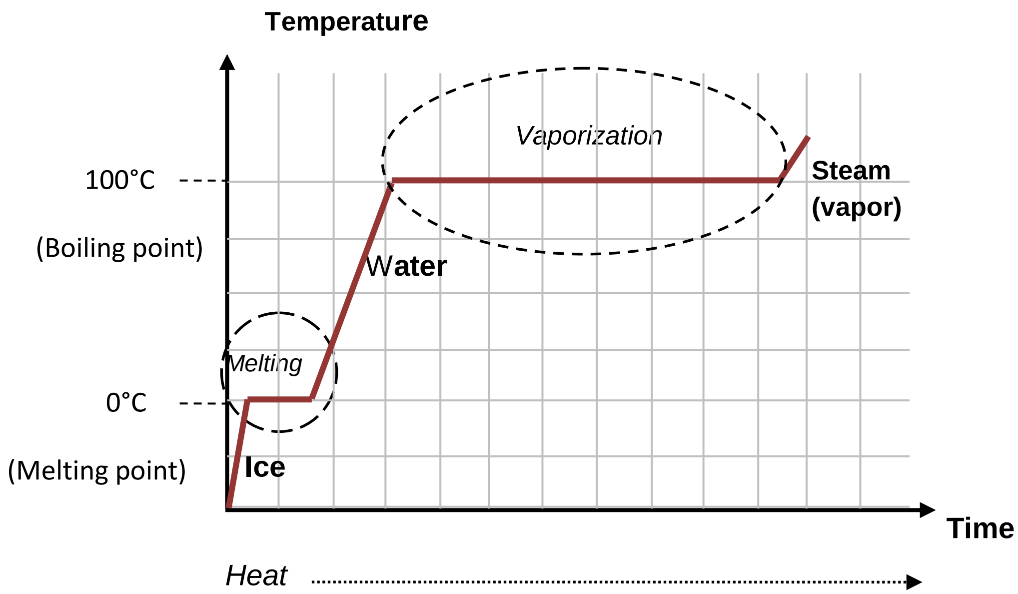


Figure 2

Activity
3.2

What happens to the temperature of water as it boils?

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

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

Activity
4

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

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

Example:

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

Activity 5

Comparing heat capacities

Teaching Tips

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

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

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

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

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

Answers to Questions

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

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

Q24. The water has greater heat capacity.

Links

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Unit 1
MODULE
4

ELECTRICITY

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

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

Key questions for this module

How do voltage and resistance affect electric current?

What are the safety precautions needed in using electricity?

Current and Voltage

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

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

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

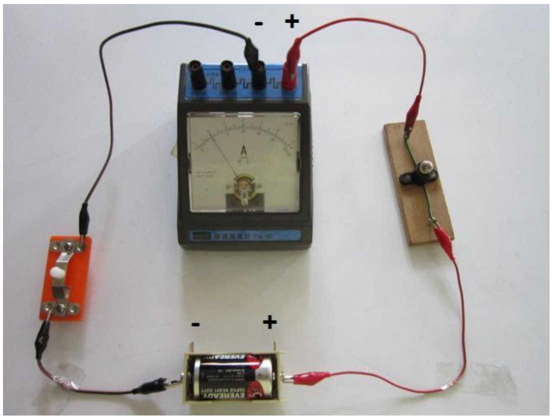


Figure 1. Ammeter connected in a circuit

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

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

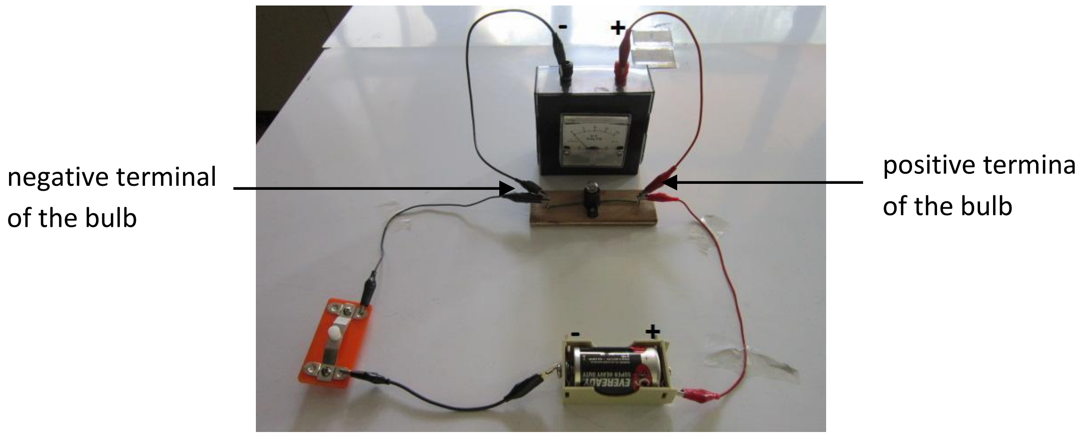


Figure 2. Voltmeter connected across the load

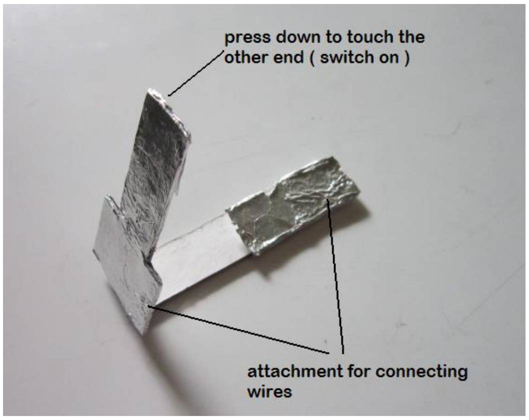
Activity 1 Current and voltage

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

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

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

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



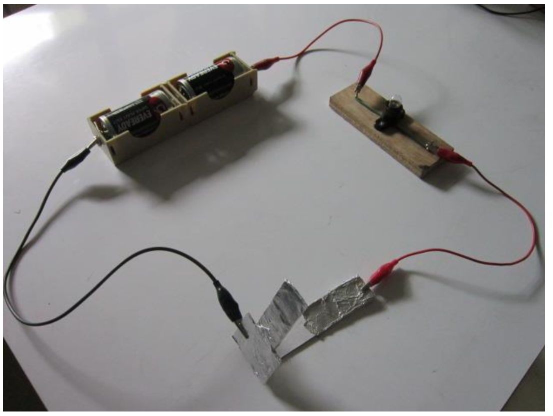


Figure 3. An improvised switch

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

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

Answers to Questions:

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

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

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

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

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

Q6. The bulb glows brighter.

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

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

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

Sample Data

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

<u>Activity 1 Discussion</u>

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

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

Current and Resistance

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

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

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

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

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

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

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

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

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

Activity 2

Current and resistance

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

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

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

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

Answers to Questions

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

Sample data:

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

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

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

Electrical Connections

Series Connection

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

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

Parallel connection

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

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

Activity 3 What's the connection?

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

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

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

- Most textbooks show parallel connections shown in Figure 6:

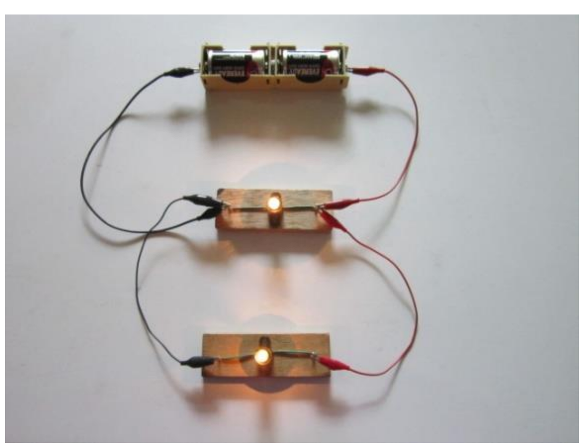


Figure 4 A parallel circuit

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

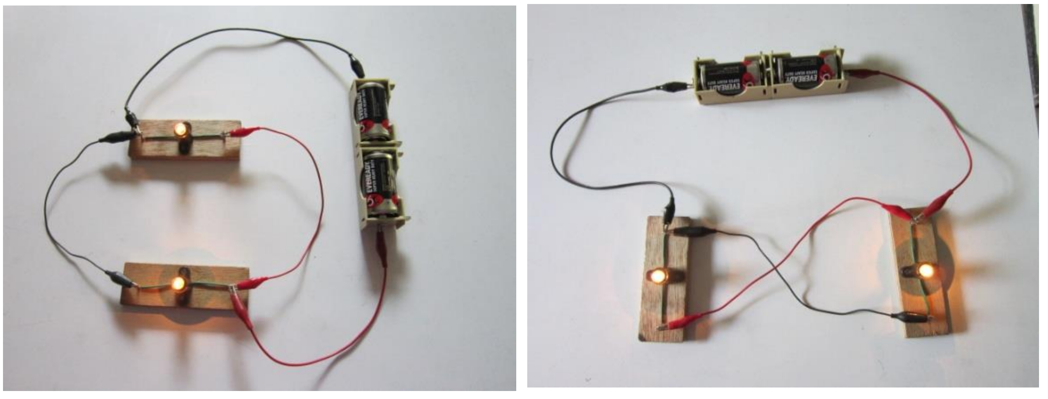


Figure 5 Parallel circuits

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

Table 3

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

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

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

Answers to Questions

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

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

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

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

Q17. Circuit B has brighter bulbs.

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

Safety in Using Electricity

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

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

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

Activity

4

Stay safe!

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

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

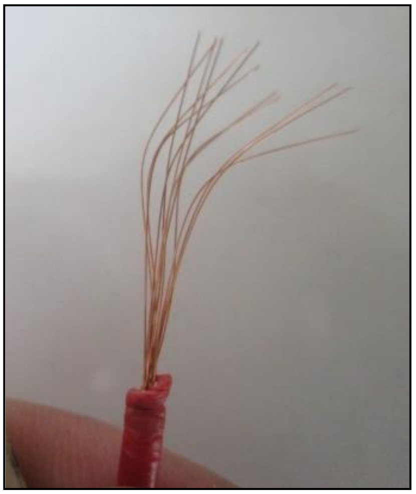


Figure 6 Strands of copper wires

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

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

Answers to Questions

Q19. The candle touching the wire melts.

Q20. The current in the circuit increases.

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

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

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

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

Q25. The current in the short circuit increases.

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

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

Q28. The total current increases.

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

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Unit 1
MODULE
5

SOUNDS

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

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

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

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

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

Related Misconceptions

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

Key questions for this module

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

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

How are reflection and refraction manifested in sound?

WORKSHEET 1: Solids, Liquids, and Gases

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

Comparing Solids, Liquids, and Gases

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

Teaching Tips

Motivation

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

Facilitating Learning

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Activity 1 The dancing salt and the moving beads!

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

Answers to Questions:

Q1. The salt bounced up and down.

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

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

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

Q5. Sound waves are vibrations of air particles.

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

Q7. The amplitude of the wave.

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

Q9. Yes

Q10. Yes

Q11. Sound wave is classified as a longitudinal wave.

Activity 2 Characteristics of waves: Comparing longitudinal and transverse waves

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

Answers to Questions

Q12. frequency

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

Activity 3 Sound race... Where does sound travel fastest?

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

Answers to Questions

Q14. Yes / Yes/ Yes

Q15. Yes / Yes / Yes

Q16. Wood/Water/Metal/Metal

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

Q18. Yes

Q19. Yes

Activity 4

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

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

Answers to Questions

Q20. Chime 2

Q21. Chime 2/Chime 2

Q22. Chime 3

Q23. Chime 3 / Chime 3

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

Q25. Chime 3

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

Activity
5
Faster sound… In hotter or cooler?

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

Answers to Questions

Q27. HOT cylinder

Q28. HOT cylinder

Q29. HOT cylinder

Q30. HOT cylinder

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

Activity
6
Reflecting and refracting sound

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

Answers to Questions

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

Q33. No they are not found on the same positions

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

Q35. The frequency of the wave increases

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

Q37. Amplitude increases

Q38. Louder sound is observed

Q39. Faster waves

Links

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Unit 1
MODULE
6

COLORS OF LIGHT

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

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

1. demonstrates the existence of the color components of visible light using a prism or diffraction grating;

2. infers that color is a manifestation of visible light's frequency or wavelength;

3. explains that red is bent the least and violet is bent the most according to their wavelengths or frequency; and

4. explains the hierarchy of colors in relation to energy.

Key questions for this module

How are refraction and dispersion demonstrated in light?

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

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

Description of Activities

- ***Activity 1: The colors of the rainbow...The colors of light***
  (The students will be able to infer that white light is made up of many different colors of light and each of these colors of light bends differently.)

- ***Activity 2: Red versus violet…***
  (Students will be able to infer that violet light bends more than red light when dispersed; and bending depends on the refractive index, frequency and energy of the color of light.)

- ***Activity 3: Which color has the MOST energy?***
  (Students able to infer that the energy of the colors of light increases as one goes towards the right side of the color spectrum and red light has the least energy and blue light has the most energy.)

- ***Activity 4: The color spectrum wheel revisited***
  (Students will be able to infer that light is composed of colors of light of different frequencies and wavelengths; the frequencies of the colors are inversely proportional the wavelength; the product of frequency and wavelength of the colors of light is a constant; and the arrangement of colors of light shows the hierarchy of the color's corresponding energy.)

- ***Activity 5: Scientific explanations behind certain beliefs***
  (Students should be able to come up with a presentation of the scientific explanations of certain superstitious beliefs related to observable phenomena in the sky.)

Teaching Tips

Motivation

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

Facilitating Learning

1. As a brief review, introduce the concept of apparent depth and the concept of refraction of light.

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

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

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

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

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

7. Then ask the students on which other characteristics does energy of colors depend on to introduce Activity 4. This activity was already done in Grade 7. The focus of the activity in Grade 7 was to identify the corresponding frequency and wavelength of each color of light and the computation of the speed of each of the colors of light. This time the focus is on how energy relates to the frequency of the colors of light. From the

given materials, students will be able to determine the relationship between frequency and the energy of the colors of light.

In preparation for Activity 4, reproduce several copies (preferably colored) of the patterns of the spectrum wheel found in pages 107-108 of the Learner's Module. Then paste the patterns on pieces of cardboard to make them stronger and more durable. Distribute the spectrum wheel patterns to the students only during the activity proper then collect them afterwards so that the next group of students will be able to use them as well.

8. Then ask them some inferences on how rainbows are formed. Ask them also some superstitious beliefs that the students are familiar with in relation to the existence of rainbows.

9. Let them identify all the major concepts they were able to grasp from all the activities to build a concept on how rainbows are formed. Then let them do Activity 5.

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

Answers to Questions

Activity 1

The colors of the rainbow… The colors of light

Q1. Red, Orange, Yellow, Green, Blue, Violet

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

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

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

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

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

Activity 2 Red versus violet

Q7. Yes

Q8. Red, Orange, Yellow, Green, Blue, Violet

Q9. Blue

Q10. The greater the angle of refraction, the greater is the refractive index and more bending is also observed.

Activity 3 Which color has the MOST energy?

Q11. Red

Q12. Violet

Q13. Violet

Q14. Red

Q15. Red/ Violet

Activity 4

The color spectrum wheel revisited

Q16. Violet, Violet

Q17. Red, Red

Q18. The wavelengths and frequencies of the colors of light vary. The wavelength decreases from red to violet while the frequency increases from red to violet.

Q19. The products of frequencies and wavelengths of the colors of light are equal or the same.

Q20. Yes

Q21. As the frequency of the color of light increase, the energy also increases. Red has the least frequency with the least energy and Violet has the highest frequency and the highest energy.

Q22. The higher the frequency of the color of light, the greater is its energy.

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