Department of Education

Science 10

Optical Instruments
Elecricity and Magnetism

Second Quarter – Week 8

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EXPECTATIONS

This module is all about the Electricity and Magnetism. The learners should be able to demonstrate understanding on the operation of simple electric motor and generator.

This module is divided into two lessons, namely:

- Lesson 1- Optical Instruments
- Lesson 2- Simple Electric Motor and Generator

Most Essential Learning Competencies:

1. Identify ways in which the properties of mirrors and lenses determine their use in optical instruments (e.g., cameras and binoculars) (S10-FE-Iih-52) and
2. Explain the operation of a simple electric motor and generator (S10-FE-IIj-54)

Specifically, the learners should be able to:

1. Explain the use of mirrors and lenses in cameras and microscopes.
2. Explain the use of mirrors and lenses in telescopes and binoculars.
3. Differentiate electric motor from electric generator.
4. Explain the working principle of simple electric motor.
5. Explain how electromagnetic induction is applied to electric generator.
6. Differentiate electric motor from electric generator.

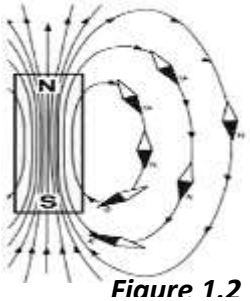


Figure 1.2

PRE-TEST

Directions: Encircle the letter of the correct answer.

1. What energy transformations take place in motor and generator?

	Motor	Generator
A.	thermal to electrical	electrical to thermal
B.	electrical to thermal	thermal to electrical
C.	electrical to mechanical	mechanical to electrical
D.	mechanical to electrical	electrical to mechanical

2. Refer to Figure 1.1, what is the direction of the magnetic field produced in the wire marked x if viewed on top when current flows into it?
   A. clockwise C. downward
   B. counterclockwise D. upward

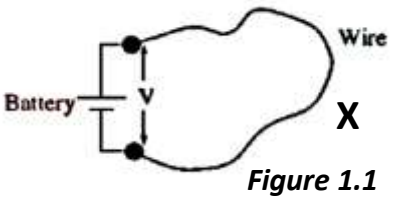


Figure 1.1

3. What can be inferred about the lines of induction from Figure 1.2?
   I. More lines of induction are found at the poles than at points
   farthest away.
   II. The direction of magnetic lines of induction is indicated by the N-pole of a compass needle.
   III. Lines of induction outside the magnet take the direction from S to N, while inside, from N to S.

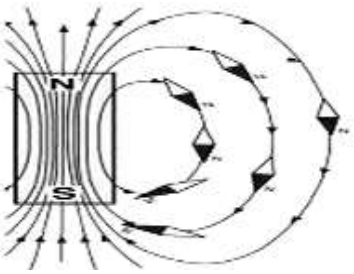


Figure 1.2

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

4. Suppose you made an electric motor using 4 dry cells and the armature turned fast. What should you do to make it slower?
   A. Use a bigger magnet.
   B. Remove one of the dry cells.
   C. Increase the number of turns in the coil of wire.
   D. Decrease the distance between the magnetic poles.
5. What energy transformations take place in motor and generator?
   A. motor - thermal to electrical
      generator - electrical to thermal
   B. motor - electrical to thermal
      generator - thermal to electrical
   C. motor - electrical to mechanical
      generator - mechanical to electrical
   D. motor - mechanical to electrical
      generator - electrical to mechanical
6. Refer to Figure 1.3, where should the conductor move when current flows in a direction away from the reader?
   A. upward C. to the left
   B. downward D. to the right

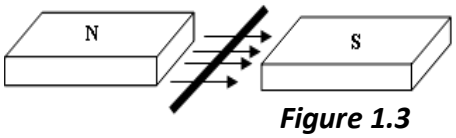
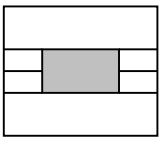
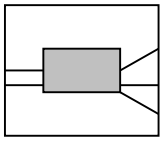
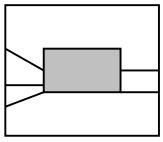
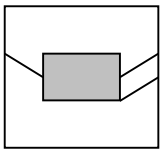


Figure 1.3

7. Which of the following diagrams correctly illustrates a step-down transformer?
   A 
   B. 
   C. 
   D. 
8. How many loops are needed in the secondary coil of a transformer to decrease the input voltage from 220 V to 110 V if there are 5,000 loops in the primary?
   A. 2,500 loops B. 7,500 loops C. 10,000 loops D. 12,500 loops
9. What basic principle enables ALL electric motors to operate?
   A. Iron is the only element that is magnetic.
   B. Opposite electric charges attract and like charges repel
   C. A moving conductor within a magnetic field will experience an electromotive force.
   D. A current-carrying conductor placed within a magnetic field will experience a magnetic force.
10. What transformation can take place in an improvised generator?
   A. Mechanical energy into electrical energy
   B. Electrical energy into mechanical energy
   C. Alternating current into direct current.
   D. Direct current into alternating current.
11. Which of the following is TRUE about electric motor?
   A. It operates in the same manner as generator
   B. Current is provided to the armature by an external source.
   C. The back EMF strengthens the applied voltge in the armature.
   D. It uses fuel to rotate the armature and produce electric current.
12. Which of the following may cause a motor of the electric fan to get burned out?
   A. Excessive heat produced
   B. Presence of dirt and dust
   C. some objects prevent the fan from turning
   D. all of the above are possible causes of motor burnout.
13. In what way is a DC generator different from an AC generator?
   A. The DC generator is operated by an applied voltage.

B. A DC generator follows Faraday's law while an AC generator works according to Lenz's law.
C. A DC generator creates on electric current that flows in one direction while the current produced in an AC generator flows in two directions alternately.
D. A DC generator creates an electric current that flows in a definite direction while the flow of current produced in an AC generator has no definite direction.

14. Why does generator produce alternate voltage?
A. unlike a battery, it produces alternating voltage
B. the changing magnetic field that produces it alternates
C. in effect, it is an AC motor in reverse
D. the current it produces alternates

15. Using Figure 1.4, if viewed in front, what is the rotation of the armature of the given motor?
A. clockwise
B. counterclockwise
C. half-left rotation
D. half-right rotation

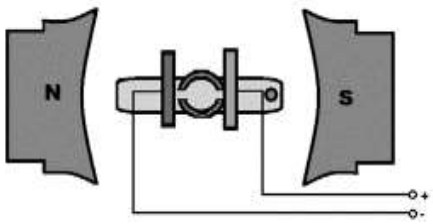


Figure 1.4

LOOKING BACK

Directions: Study the diagram. Arrange the steps in transmitting electricity by choosing the correct data from the information box.

Transformer on pole steps down voltage before entering homes	Transformer steps up voltage for transmission
Distribution line carries electricity to the house.	Power plant generates electricity
Neighborhood transformer steps down voltage	Transmission line carries electricity over long distances

1.	4.
2.	5.
3.	6.

BRIEF INTRODUCTION

Lesson 1: Optical Instruments

So far, you have learned two of the properties of light which are the reflection and refraction. You have gained concepts on the rules of reflection and refraction to describe and explain how the images are formed by mirrors and lenses. You also solved problems pertaining to the exact location and magnification of images formed by mirrors and lenses. In this activity, you will make use of these concepts you learned to improvise

an optical device. You will be asked to plan, brainstorm, design, and construct one of the following optical devices.

Making Improvised Optical Device

Option 1: The Camera

Task:

• Construct a pin hole camera and explain the factors that affect the image on the screen

Materials: • illustration board/cardboard • black cartolina, cutting mat • pin/sewing needle, glue/sticky tape • cutter, scissors, foot ruler, clear lamp

Procedure:

1. With your group mates and using the materials given, design and construct an improvised camera based on the information gathered from different resources.

2. Refer to the Problem Solving Sheet below.

Option 2: The Periscope

Task:

• Construct a periscope and trace the incident and reflected rays.

Materials: • 2 plane mirrors • illustration board/cardboard • cutting mat • glue/sticky tape • cutter, scissors, foot ruler, clear lamp

What to do: 1.

With your group mates and using the materials given, design and construct an improvised periscope based on the information gathered from different resources.

Problem Solving Sheet (Use separate paper for your answer)

Members:

Activity Title:

Problem:

Problem Type: (Construction, discovery, testing)

(Choose any of the suggested problem types.)

Procedure:

1. What we did to solve the problem?
2. Sketch/Diagram of the Device/Model Constructed.
3. What concepts our group considered in the construction of the device?
4. What our group found out?
5. What our group recommends to improve the design/model built?

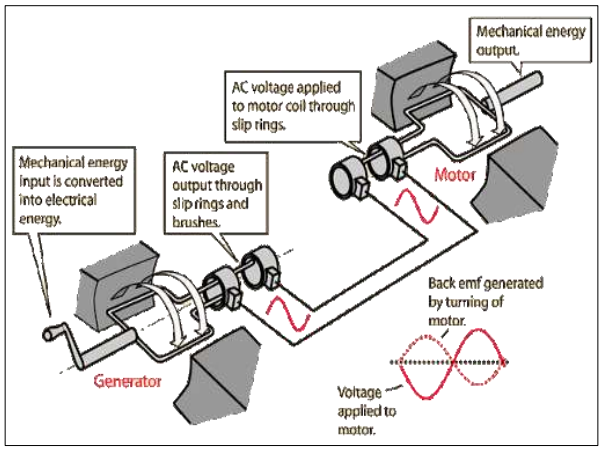
Lesson 2: Simple Motors and Generators

In your previous grade level, you have learned the different power plants located in the Philippines. These power plants generated electricity that are consumed by the consumers like us through its power transmission and distribution. Because of these power transmissions and distributions, we can use appliances like radio, television, oven, and other related gadgets at home. As you go through in this module, you will learn some common working principles in power plants that can be observed also in simple electric motor and generator. You can explain how the simple electric motor and generator works.

To begin with, an electric motor is a common type of machine that is largely present in the appliances that you have at home. Just like in the electric fans, electric motor converts electrical energy to mechanical energy. Therefore, the electric motor works oppositly what a generator does.

The generator produces or generates electricity too. Generators used movement to generate electricity while motors used electricity to create movements.

In an electric motor, current is provided to the armature by an external source. The current-carrying loop of wire in the armature produces magnetic forces causing it to rotate. As the armature rotates, an induced current is produced, which is the opposite of the voltage or EMF coming from an external source of power.



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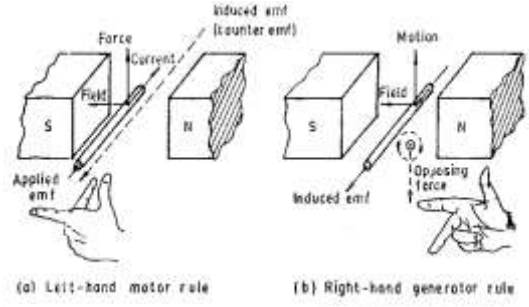
A generator is a device that converts mechanical energy to electrical energy. It produces an induced current through the rotation of a wound coil known as armature in a stationary magnetic field. There are two types of generator. An AC generator induces current in alternate directions when the armature turns and cuts magnetic lines of force in opposite directions. An AC generator may be converted into DC generator by using a split ring known as commutator connected to the armature terminals. In the DC generator, the current induced in the armature is still an alternating current but the split ring makes flow into the external circuit in one direction.

Faraday's law says that a changing magnetic flux can induce an emf, when the coil rotates in a magnetic field it is possible for the rotation to change the flux thereby inducing an emf. If the rotation of the coil is such that the flux doesn't change, i.e. the surface of the coil remains parallel to the magenetic field, then there will be no induced emf.

The Electric Motor and Generator are differentiated on various factors like the main principle of working or function of the motor and generator. Consumption or production of electricity, its driven element, the existence of the current in the winding. Fleming's rule followed by the motor and generator.



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Facts!

AC generators are also known as alternators. They are found in motor cars to charge the car battery.

The force on a current-carrying conductor due to a magnetic field is called Ampere's law.

ACTIVITIES

Activity 1

Activity 1

Spot the Difference

Directions: Fill in the gaps with the appropriate words/group of words from the item bank using differentiating property.

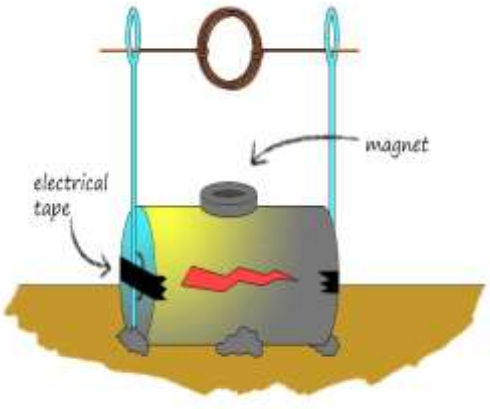
electrical energy	mechanical energy	left-hand, rule
electromagnetic induction.	magnetic force,	mechanical force
right-hand rule supplied	current-carrying conductor	produced

Differentiating Property	**Motor**	**Generator**
Definition	An electric motor is a machine that converts _____ to _____.	An electric generator is a machine that converts _____ to _____.
Rule	Electric motor follows Fleming's _____.	Electric generator follows Fleming's _____.
Principle	The working principle of a motor is based on the _____ that experiences a force when it is kept in the magnetic field	The working principle of generator is based on _____.
Driving force for shaft	The shaft of an electric motor is driven by a _____ which is developed between the armature and field.	The shaft of an electric generator is connected to the rotor which is driven by a _____..
Current Usage	In a motor, current is _____to the armature winding.	In a generator, current is _____ in the armature winding.
Example	Ceiling fans, cars, bicycle etc. are all examples of motor.	In power stations, generator is used to generate electricity.

Activity 2: Building the motor.

Materials:

- D battery
- Insulated 22G wire
- 2 large-eyed, long, metal sewing needles (the eyes must be large enough to fit the wire through)
- Modeling clay
- Electrical tape
- Hobby knife
- Small circular magnet
- Thin marker



Procedure:
1) Cut a 3 meter length of coated wire.
2) Wrap the wire into a circle 3 to 4 cm in diameter, leaving about 4 cm of wire protruding from each side of the circle.
3) Use sandpaper to carefully scrape the coating off of one side of one end of the protruding wire. Scrape all of the coating off of the other end of the wire.
4. Use electrical tape to secure the needles to the ends of the battery. Your coil should be hanging above the battery.
5. Tape the small magnet to the side of the battery so that it is centered underneath the coil and start the spinning with your finger.

Guide Questions: (You may use other sheet of paper for your answer.)

1. What keeps the wire coil spinning?
2. What provides a changing magnetic field in this motor?
3. Why must you scrape the coating off of the ends of the wire? Why do you scrape it from only one side of one of the ends?

REMEMBER

Directions: Complete the sentence frames on what you have learned about the concept of motors and generators.

1. I had learned that_____
_____
2. Electric motor is _____
_____.
3. Generators is _____
_____

CHECK YOUR UNDERSTANDING

A. Critical Thinking: Answer the following briefly.

1. How does the water stored in dams generate electricity?

_____

2. Explain the basic principle of an electric motor and generator?

_____

3. Use Faraday's Law to explain why a current is induced in a coil that is rotated in a magnetic field.

_____

B. Directions: Create a graphic organizer (Venn diagram) to show the difference between motors and generators. (You may use other sheet of paper for your answer.)

POST TEST

Directions: Encircle the letter of the best answer.

1. What is the transfer of electricity in a generator?
   A. Electrical to mechanical C. Mechanical to electrical
   B. Kinetic to Potential D. Physical to Mechanical
2. What can you use to make an electromagnet?
   A. Battery, nail, string C.iron nail, battery, wire
   B. Battery, pencil, wire D. wire, card board, electrical tape
3. Which device uses mechanical energy to produce electrical energy?
   A. Electric motor B. Generator C. solar cell D. Magnet
4. What two forces are required for generators and motors to work?
   A. Electrical and thermal force C. Magnetism and radiant
   B. Electricity and magnetism D. Electromotive and thermal
5. What is the fan that turns the magnet inside a generator called?
   A. Electromagnet B. Turbine C. Armature D. Pen-stock
6. In which case or cases is electric field present?
   I. A spark jumping between two nearby rods.
   II. A charge that is momentarily at rest.
   III. A rotating bar magnet.
   A. I only B. I and II only C. II and III only D. I, II and III
7. In which case can a magnetic field be produced?
   A. A charged comb. C. A falling glass rod.
   B. A welder's arc flash. D. A rolling plastic cylinder.
8. Which device can be used to determine the polarity of an unmarked magnet?
   A. a charged glass stirring rod C. a gold-leaf electroscope
   B. a sprinkle of iron filings D. an improvised compass
9. How will you describe the magnetic field around a straight current-carrying wire?
   A. The magnetic field is strongest near and around the wire.
   B. The magnetic field consists of straight lines parallel to the wire.
   C. The magnetic field does not vary with the distance from the wire.
   D. The magnetic field gets stronger with increasing distance from the wire.
10. Which statement about an electromagnet is TRUE?
   A. The electric field surrounding a battery-powered electromagnet alternates constantly.
   B. The current in the electromagnet coil temporarily magnetizes the iron core.
   C. The electric field strength is inversely proportional to the current.
   D. The magnetic field lines produced are all straight.
11. What transformation can take place in a ceiling fan's electric motor?
   A. electrical energy into mechanical energy
   B. mechanical energy into electrical energy
   C. alternating current into direct current
   D. direct current into alternating current

12. What basic principle enables ALL electric motors to operate?
    A. Iron is the only element that is magnetic.
    B. Opposite electric charges attract and like charges repel.
    C. A moving conductor within a magnetic field will experience an electromotive force.
    D. A current-carrying conductor placed within a magnetic field will experience a magnetic force.
13. Which rule does electric motor follows?
    A. Fleming's left-hand rule. C. Faraday's rule
    B. Fleming's right-hand rule D. Fleming's rule
14. What is known as alternators?
    A.DC generators C. simple motors
    B.AC motors D. all are correct
15. How are electric motors and electric generators similar?
    A. Both motors and generators use changing magnetic fields.
    B. Both motors and generators convert electrical energy into kinetic energy
    C.Both motors and generators convert kinetic energy into electrical energy.
    D.All of the above.

Answer key:

Pre-Test	Post Test
1. D	1. C
2. A	2. C
3. B	3. B
4. B	4. B
5. C	5. B
6. B	6. D
7. C	7. C
8. A	8. D
9. D	9. A
10. A	10. B
11. D	11. A
12. A	12. D
13. C	13. A
14. B	14. B
15. A	15. A

ACTIVITY 1

Differentiating Property	Motor	Generator
Definition	An electric motor is a machine that converts electrical energy to mechanical energy.	An electric generator is a machine that converts mechanical energy to electrical energy.`
Rule	Electric motor follows Fleming's left-hand rule.	Electric generator follows Fleming's right-hand rule.
Principle	The working principle of a motor is based on the current-carrying conductor that experiences a force when it is kept in the magnetic field.	The working principle of generator is based on electromagnetic induction.
Driving force for shaft	The shaft of an electric motor is driven by a magnetic force which is developed between the armature and field.	The shaft of an electric generator is connected to the rotor which is driven by a mechanical force.
Current Usage	In a motor, current is supplied to the armature winding.	In a generator, current is produced in the armature winding.
Example	Ceiling fans, cars, etc. are all examples of motor.	In power stations, generator is used to generate electricity.

References:

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