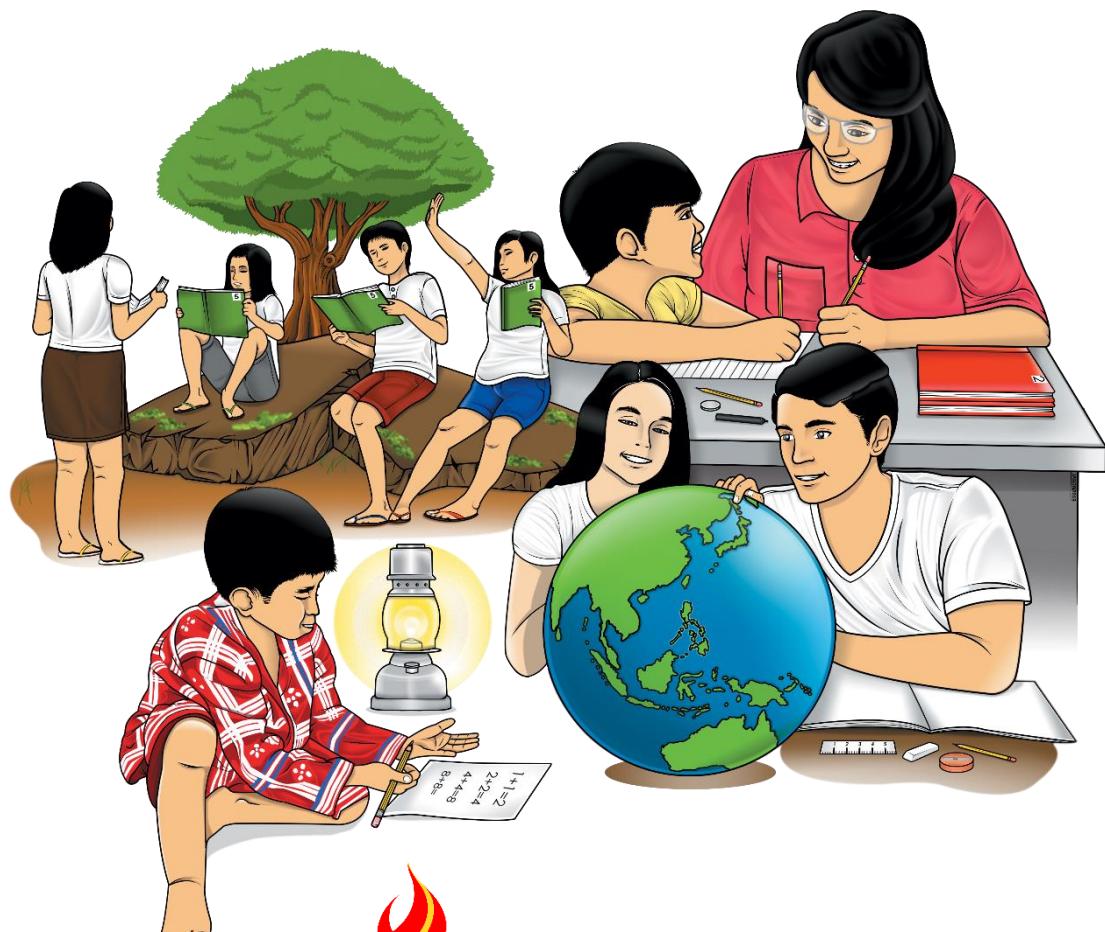


Science

Quarter 3 – Module 7.1: Be in Charge! Be Electrifying! (Charging by Friction & Induction)



Science – Grade 7

Alternative Delivery Mode

Quarter 3 – Module 7.1: Be in Charge! Be Electrifying! (Charging by Friction & Induction)
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Science

**Quarter 3 – Module 7.1:
Be in Charge! Be Electrifying!
(Charging by Friction & Induction)**



Introductory Message

This Self-Learning Module (SLM) is prepared so that you, our dear learners, can continue your studies and learn while at home. Activities, questions, directions, exercises, and discussions are carefully stated for you to understand each lesson.

Each SLM is composed of different parts. Each part shall guide you step-by-step as you discover and understand the lesson prepared for you.

Pre-tests are provided to measure your prior knowledge on lessons in each SLM. This will tell you if you need to proceed on completing this module or if you need to ask your facilitator or your teacher's assistance for better understanding of the lesson. At the end of each module, you need to answer the post-test to self-check your learning. Answer keys are provided for each activity and test. We trust that you will be honest in using these.

In addition to the material in the main text, Notes to the Teacher are also provided to our facilitators and parents for strategies and reminders on how they can best help you on your home-based learning.

Please use this module with care. Do not put unnecessary marks on any part of this SLM. Use a separate sheet of paper in answering the exercises and tests. And read the instructions carefully before performing each task.

If you have any questions in using this SLM or any difficulty in answering the tasks in this module, do not hesitate to consult your teacher or facilitator.

Thank you.



What I Need to Know

Hi! Have a great day! Welcome to the nature of Physics, wherein you will learn the nature of electricity around us. Do you know the energy needed to operate your appliances, gadgets and other machines? Yes, **electricity** is the main reason why those things are functional.

Electricity is a form of energy we encounter in everyday life. Lightning is an example of static electricity in nature. Light is often produced when an electric current passes through a gas. We see burst of light in the line sparks of static electricity or lightning. We are grateful and lucky enough that this kind of energy is present and available to humans for without it, most of the devices that we use today would be useless. In this module, you will learn the different types of charging processes. You will also study how objects can be charged. The field of science which deals with the characteristics and interactions of charges which are not moving is electrostatics. Knowing this lesson is very essential in your future use especially in understanding how electricity functions.

Most Essential Learning Competency:

1. Describe the different types of charging processes (**S7LT-IIIj-13**).

This module is divided into two lessons, specifically:

Lesson 1: Charging by Friction

Lesson 2: Charging by Induction

After going through this module, you are expected to:

1. describe Electricity using charges;
2. describe the different kinds of charging processes; and
3. differentiate the types of charging processes.



What I Know

Directions: Read each item carefully. Choose the letter of the best answer. Write the letter of your choice on a separate sheet of paper.

1. What will happen when two like sign of charges are brought together? They will _____.
 - A. repel each other
 - B. attract each other
 - C. neutralize each other
 - D. have no effect on each other

2. How can a material become positively charged?
 - A. By losing protons
 - B. By losing electrons
 - C. By gaining protons
 - D. By gaining electrons

3. Which of the following states that charges are neither created nor destroyed but only transferred from one material to another?
 - A. Friction law
 - B. Static discharge principle
 - C. Static Electricity definition
 - D. Conservation of charge principle

4. If you comb your hair and the comb acquires a positive charge, what will happen to your hair?
 - A. It will remain uncharged.
 - B. It will be repelled by the comb.
 - C. It will become positively charged.
 - D. It will become negatively charged.

5. Which of the following will be attracted to a positively charged object?
 - A. No other object
 - B. A negatively charged object
 - C. Another positively charged object
 - D. None of the above

6. Who among the following was the first to determine the electron's charge?
 - A. Coulomb
 - B. Faraday
 - C. Franklin
 - D. Millikan

7. What is the charge of a neutral atom after it gains an additional electron?

- A. Neutral
- B. Negative
- C. Positive
- D. Both positive & negative

8. Neutral atoms contain equal numbers of _____.

- A. protons and neutrons
- B. electrons and protons
- C. protons and electrons
- D. neutrons and electrons

9. What do you call the process of transferring charges between objects by rubbing?

- A. Proton transfer
- B. Static discharge
- C. Charging by friction
- D. Charging by induction

10. What is the symbol of an electron charge?

- A. $-e$
- B. $+e$
- C. e^x
- D. e^2

11. What is the SI unit of electric charges?

- A. Ampere (A)
- B. Coulomb (C)
- C. Meter (m)
- D. Voltage (V)

12. What do you call the attraction or repulsion between electric charges?

- A. Friction
- B. Conduction
- C. Electric field
- D. Electric force

13. Daniel rubs a piece of fur on a hard rubber rod, giving the rod a negative charge.

Which is most likely to happen?

- A. The fur is left neutral.
- B. Electrons are added to the rod.
- C. The fur is also charged negatively.
- D. Protons are removed from the rod.

14. Why does a plastic strip become positively charged after being rubbed with cotton?

- A. The plastic strip acquired extra protons from the cotton.
- B. The protons were created as the result of the charging process
- C. The plastic strip acquired extra protons during the charging process.
- D. The plastic strip lost electrons to the cotton during the charging process.

15. How does triboelectric charging works?

- A. By distributing the charges
- B. By touching the two uncharged objects
- C. By bringing it near to another charged object
- D. By transferring of electrons between two rubbed objects

Lesson 1

Charging by Friction



What's In

Hello kids! In the previous module, you learned that all matter is made up of atoms, and an atom has a center, called nucleus. The nucleus contains positively charged particles called protons and uncharged particles called neutrons. The nucleus of an atom is surrounded by a cloud of negatively charged particles called electrons.

Electric charges not only exist within an object; they can also move through an object. Just like how heat transfers to a material through conduction, convection and radiation. There are materials that can conduct heat and electric charges called conductors. There are also those that poorly conduct heat and electric charges called insulators and few materials that have characteristics in between conductors and insulators called semiconductors.

Try to classify the following materials as conductor, insulator or semiconductor by putting a check in it. Write your answer on a separate sheet of paper.

MATERIAL/S	CONDUCTOR	INSULATOR	SEMI-CONDUCTOR
Example: 1. Copper	✓		
2. Stainless spoon			
3. Frying pan			
4. Plastic spoon			
5. Paper plate			
6. Ceramic plate			
7. Wooden spoon			
8. Aluminum foil			

As we go along with our lesson, activities will be more exciting and fun. Are you ready? Let's get started.



What's New

We all know that the building blocks of matter is-the atom. The varying atomic properties of different materials gives them electrical properties. One of which is the ability of a material to lose and gain electrons when they are rubbed with a different material through friction.

Through this activity, you will learn how an object can be charged through the process of charging by friction. Are you set? Let's start!

Activity 1.1: Rub Me Hardly!

Materials: Inflated rubber balloon, Human hair, Microfiber cloth (cloth used to clean eyeglasses)

What to Do:

1. Inflate the balloon to just the right size.

2. Rub the rubber balloon with your hair or with the microfiber cloth

Question # 1: What did you observe after rubbing the balloon with your hair or with the microfiber cloth?

3. Pull the balloon away from your hair from the microfiber cloth.

Question #2: What did you notice about your hair?

4. This time, you need two balloons. Rub the two balloons with your hair or with the microfiber cloth.

5. Place the balloon near each other.

Question #3: What happened to the balloons when placed near each other?

Question #4: List down some question/s you thought of while doing the activity.

Here are your criteria to follow in answering this task for you to be guided and lead to an appropriate answer.

FEATURES	4	3	2	1
Ideas	Demonstrate in depth understanding of the topic. It uses scientific reasoning to address ideas.	Demonstrates understanding of the topic. Somewhat uses scientific reasoning to address ideas.	Demonstrates little understanding of the topic. Gives some new information but poorly organized	Lacks understanding of the topic. Gives no new information and poorly organized.
Grammar, Usage & Mechanics	No incorrect spelling, punctuation or grammatical errors.	Few spelling and punctuations, errors, minor grammatical errors.	A number of spelling, punctuation or grammatical errors.	So many spelling, punctuation and grammatical errors that it interferes with the meaning.
Effort	Took so much of time and worked hard on the activity	Slightly worked hard for the activity	Put a small effort into the activity	It was done in a rushed and did not work hard



What is It

Let us start discussing how charging by friction truly takes place. But before that, let us try to understand what electricity is.

Electricity may be described as a form of energy. Understanding electricity entails understanding charges – the basic unit of electricity. Charge is a quantity measured in Coulombs (C). Charges may be transferred to and from objects and may move in conductors as current measured in Amperes (I). The world we live in is highly dependent on the electric energy and power (measured in Watts) supplied by our power plants. The unit watt (W) is named to honor James Watt, the inventor of the steam engine during the industrial revolution.

Electric charge is an intrinsic property of protons and electrons. Charge is a quantity with a magnitude and a unit. The SI unit of charge is the Coulomb (C). A neutron has zero net electrical charge because it is neutral. A proton carries a positive charge ($+e$), while electron carries a negative charge ($-e$). These two types of charges (positive and negative) were named by Benjamin Franklin. JJ. Thomson discovered the electron and Robert Millikan discovered the charge of the electron. The charge of the electron is the negative of the elementary charge e which is equal to 1.6×10^{-19} Coulomb. The charge of the electron and the proton are the same only that the proton is positive ($+1.6 \times 10^{-19}$ Coulomb).

Like sign of charges repel and unlike sign of charges attract each other. Materials may contain several charges and when these are neutral they contain equal numbers of positive and negative charges. Materials or bodies may be left with a certain charge. This may be done through the process of charging. Charging means gaining or losing electrons. There are various types of charging processes namely, charging by friction, charging by conduction and charging by induction. Let us describe first the process of charging through friction.

There are many different types of atoms and these atoms can combine in a variety of ways to form the nature of objects we encounter every day. Depending on the type of atoms an object is made of, an object can be more or less attracted to an electron. This electrical property is known as electron affinity. If an object has a high electron affinity, then it is more attractive to electrons. Different materials have different affinities of electrons. This is important as we explore the most common methods of charging- triboelectric charging, also known as charging by friction or rubbing.

In Activity 1, when you rubbed one balloon with your hair, you are experiencing friction. During the process, atoms in the balloon are forced to be close to the atoms with your hair. The protons in the atoms of one object start to interact with the electrons on the other object. The rubber of the balloon has a higher electron affinity and will take electrons from the atoms of your hair. When you pull the balloon away

from your hair, the balloon will have more electrons or has gained electrons which made it negatively charged, while your hair has lost some electrons, and now has a positive charge. You might also notice that your hair is attracted to the balloon. This is the evidence that oppositely charged objects attract each other. If you rub two balloons on your hair and place the balloons near each other, you will notice that the two balloons repelled. This may be attributed to the similarity in the charge acquired by the balloons.

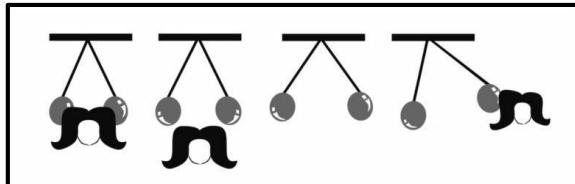
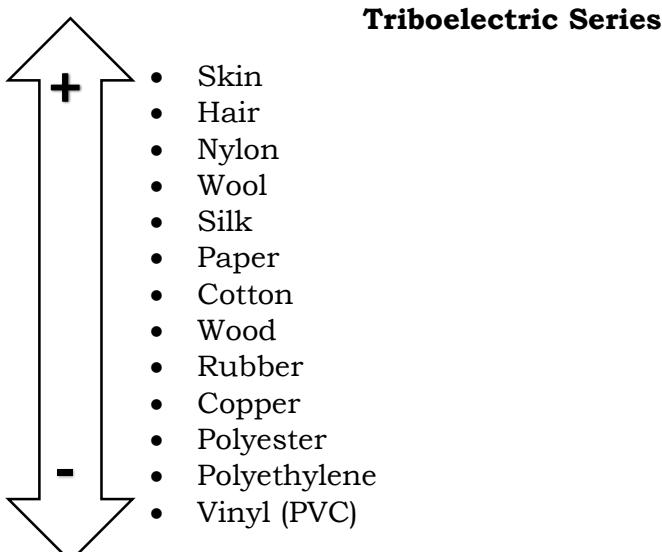


Figure 1: Two balloons rubbed on human hair will become negatively- charged and have an attractive contact with the hair. If the hair is removed, the balloons will repel each other.

Illustrator: Cherry Mae Candelario

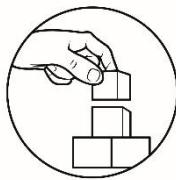
Charging by friction simply means rubbing of material to another. By rubbing a variety of materials against each other and testing their resulting interaction with objects of known charge, the tested materials can be ordered according to their affinity for electrons. Such an ordering of substances is known as Triboelectric Series. It is an arrangement of material/ substances giving their ability to gain or lose electrons. Materials that are placed at the upper end of the sequence (e.g. skin, glass, hair) will most likely to give up/ lose electrons and become positively charged. However, materials found at the bottom end of the sequence (e.g. polyester, polyethylene, PVC) gain electrons and become negatively charge. The farther the materials are from each other in the series, the stronger the electrical force of attraction.



It is important to remember that during the charging process, ideally, the amount of charge lost by the object is equal to the amount of charge gained by another object. This is generally true in any charging process. The idea is known as:

The Law of Conservation of Charge

Charges cannot be created nor destroyed but can be transferred from one material to another. The total charge in a system must remain constant.



What's More

Directions: Study the list of materials rubbed together. Base your answer on Triboelectric Series mentioned above; the first item is already done for you as your guide. Write your answer on a separate sheet of paper.

Materials Rubbed Together	Material which would lose electrons	Charge of the material after losing electrons	Material which would gain electrons	Charge of the material after gaining electrons
1. glass and copper	glass	positive	copper	Negative
2. hair and paper				
3. wool and silk				
4. vinyl and wool				
5. rubber and skin				



What I Have Learned

Activity 1.2: Perfect Combing-nation!

Material/s: plastic comb, towel

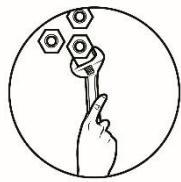
Procedures:

1. Towel dry your hair. Comb your hair using the plastic comb in 60 seconds.
2. Observe what happens.
3. Answer the following questions and write on a separate sheet of paper.

1. Which among the comb and your hair has greater affinity to electrons?
2. Assume your hair and comb were all neutral before combing. What is the charge of the comb afterwards?
3. What is the charge of your hair after combing?

Here are your criteria to follow in answering this task for you to be guided and lead to an appropriate answer.

FEATURES	4	3	2	1
Ideas	Demonstrate in depth understanding of the topic. It uses scientific reasoning to address ideas.	Demonstrates understanding of the topic. Somewhat uses scientific reasoning to address ideas.	Demonstrates little understanding of the topic. Gives some new information but poorly organized	Lacks understanding of the topic. Gives no new information and poorly organized.
Effort	Took so much of time and worked hard on the activity	Slightly worked hard for the activity	Put a small effort into the activity	It was done in a rushed and did not work hard



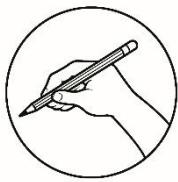
What I Can Do

Directions: Explain the underlying concepts by applying the friction charging process. Write your answer on a separate sheet of paper.

Saran Wrap has a larger electron affinity than Nylon. If Nylon is rubbed against Saran Wrap, which would end up with excess negative charge? Why?

Here are your criteria to follow in answering this task for you to be guided and lead to an appropriate answer.

FEATURES	4	3	2	1
Ideas	Demonstrate in depth understanding of the topic. It uses scientific reasoning to address ideas.	Demonstrates understanding of the topic. Somewhat uses scientific reasoning to address ideas.	Demonstrates little understanding of the topic. Gives some new information but poorly organized	Lacks understanding of the topic. Gives no new information and poorly organized.
Grammar, Usage & Mechanics	No incorrect spelling, punctuation or grammatical errors.	Few spelling and punctuations, errors, minor grammatical errors.	A number of spelling, punctuation or grammatical errors.	So many spelling, punctuation and grammatical errors that it interferes with the meaning.
Effort	Took so much of time and worked hard on the activity	Slightly worked hard for the activity	Put a small effort into the activity	It was done in a rushed and did not work hard



Assessment

Directions: Read each item carefully. Choose the letter of the correct answer. Write the letter of your choice on a separate sheet of paper.

For items 1 and 2, study the table below.

Materials	Number of Protons	Number of Electrons
W	32	30
X	22	28
Y	18	18

1. Which material could be attracted to a positively charged Z?
 - A. W only
 - B. X only
 - C. X and Y
 - D. W, X, Y

2. Which material could attract an uncharged Material Q?
 - A. W & X only
 - B. X & Y only
 - C. W & Y only
 - D. Y only

For items 3 and 4: Material A attracts Material B. On the other hand, Material C repels Material A. However, Material D can attract any of the other materials.

3. If Material A is positively charged, which of the following is true?

- I. Material C is positively charged.
 - II. Material B is negatively charged.
 - III. Material D is uncharged.

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

4. If Material B is positively charged, which of the following is true?

- I. Material A is negatively charged.
- II. Material C is negatively charged.
- III. Material D is uncharged.

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

For items 5 and 6: Study the given Triboelectric Series where moving up means positive and moving down means negative.

Melqi
Xatzki
Lofku
Khamri
Welcru
Zysmu



5. Which of the following pair has strongest electrical force of attraction?
- A. Welcru & Lofku
 - B. Zysmu & Melqi
 - C. Xatzki & Melqi
 - D. Khamri & Xatzki
6. Which of the following would have a negative net charge when rubbed with Khamri?
- A. Melqi
 - B. Lofku
 - C. Welcru
 - D. Zysmu
7. Which of the following refers to the attraction or repulsion between electric charges?
- A. Friction
 - B. Conduction
 - C. Electric field
 - D. Electric force
8. In a neutral atom the _____.
- A. number of protons = number of electrons
 - B. number of protons = number of neutrons
 - C. number of electrons = number of protons
 - D. number of neutrons = number of protons = number of electrons
9. What do you call the process of transferring charge between objects by touching or rubbing?
- A. Proton
 - B. Static discharge
 - C. Charging by contact
 - D. Charging by induction

10. Your classmate was electrocuted accidentally. Which of the following should you do to be able to save her?

- I. By pulling her hair.
 - II. By holding onto her metal bangles.
 - III. By grasping her cotton jackets.
 - IV. By pulling her in her rubber shoes.
-
- A. I only
 - B. I and II only
 - C. II only
 - D. III and IV only

11. Ms. Jojo rubbed two balloons with a piece of wool separately. What will happen when the balloons are brought near each other?

- A. The balloons will pop.
- B. The balloons will repel each other.
- C. The balloons will attract each other.
- D. The balloons will become positively charged.

12. Which of the following statements explain why the rod becomes negatively charged when rubbed with fur?

- I. The rubber that rod is made of is a better insulator than fur.
- II. The fur is better insulator than the rubber.
- III. Molecules in the rubber rod have a stronger attraction for electron than the molecules in the fur.
- IV. Molecules in the fur have stronger attraction for electron than the molecules in the rubber rod.

- A. I, II, & III only
- B. II, III & IV only
- C. I, II, & IV only
- D. I, III, & IV only

13. When a glass rod is rubbed with silk, which of the following statement BEST describes what happens?

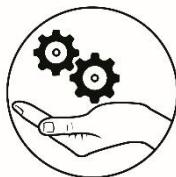
- A. the silk is charged positively
- B. protons are removed from the rod
- C. protons are removed from the silk
- D. electrons are removed from the rod

14. Why does a rubber rod becomes negatively charged when rubbed with fur?

- A. The fur is a better insulator than the rubber.
- B. The rubber that the rod is made of is better than the fur.
- C. Molecules in the rubber rod have a stronger attraction for electrons than the molecules in the fur.
- D. Molecules in the fur have a stronger attraction for electrons than the molecules in the rubber rod.

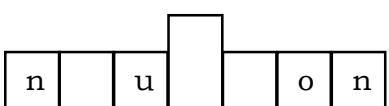
15. How can a charged object attract an uncharged object made of non-conducting material?

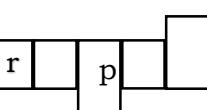
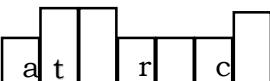
- A. Attraction of an insulator is not possible.
- B. The uncharged object must somehow gain a like charge.
- C. The charges in the uncharged object can become polarized.
- D. Attraction of an insulator is possible only by another insulator.

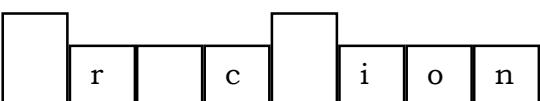


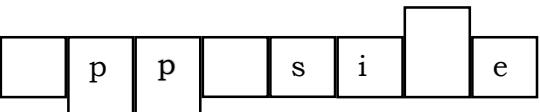
Additional Activities

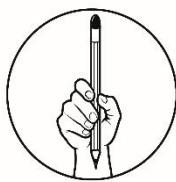
Directions: Identify the following terms described in each statement by filling in the missing letter. Write your answer on a separate sheet of paper.

1. A  has no net charge.

2. Like sign of charges  each other; unlike sign of charges  each other.

3. Walking across a carpet is an example of charge being transferred by 

4. The girl's hair and the comb are attracting one another. The hair and the comb have  charges.



What I Know

Directions: Read each item carefully. Choose the letter of the best answer. Write the letter of your choice on a separate sheet of paper.

1. Which of the following is **NOT** an insulator?
 - A. Copper wire
 - B. Hair
 - C. Rubber band
 - D. Wooden spoon
2. An uncharged conductor is supported by an insulating stand. I pass a positively charged rod near the left end of the conductor, but do not touch it. The right end of the conductor will be _____.
 - A. neutral
 - B. positive
 - C. repelled
 - D. negative
3. What do you call the process of charging a conductor by bringing it near another charged object?
 - A. Conduction
 - B. Induction
 - C. Neutralization
 - D. Polarization
4. What do you call to the materials in which electrons do not move freely?
 - A. conductor
 - B. insulator
 - C. metals
 - D. neutrons
5. Which of these is the best definition of polarization?
 - A. Two objects attract each other because they are both charged.
 - B. The objects gain a positive or negative charge from another object.
 - C. The charges in a neutral object separate due to a nearby charged object.
 - D. Charges on a neutral object jump off onto a charged object due to attraction of opposite charges.
6. An atom loses an electron. What type of charge does it have now?
 - A. Neutral
 - B. Negative
 - C. Positive
 - D. Both positive and negative

7. Which of the following is **NOT** a good conductor of electricity?
- Aluminum
 - Copper
 - Glass
 - Silver
8. Atoms may have neutrons which have _____.
- no charge
 - positive charge
 - negative charge
 - opposite charge
9. What device is used for detecting charges?
- Barometer
 - Electroscope
 - Microscope
 - Telescope
10. An uncharged conductor is supported by an insulating stand. I pass a positively charged rod near the end of the conductor, but do not touch it. The right end of the conductor will be _____.
- neutral
 - positive
 - repelled
 - negative
11. There are two cans A and B, a negatively charged balloon is brought near can A. Which is most likely to happen?
-
- The diagram shows a grey balloon with a black tail being held by a blue arrow pointing towards two metal cans. The top can is labeled "Can A" and the bottom can is labeled "Can B".
- Illustrator: Leah S. Aliperio*
- The positive charges in Can B move towards the balloon.
 - The negative charges in Can B move towards the balloon.
 - The positive charges in Can A move away from the balloon.
 - The negative charges in Can A move away from the balloon.
12. If balloon B is negatively charged, then balloon C must be _____.
- neutral
 - negatively charged
 - positively charged
 - both negatively & positively charged
-
- The diagram shows three balloons labeled A, B, and C hanging from a single point. Balloon B is shaded grey, indicating it is negatively charged. Balloons A and C are white, indicating they are neutral or positively charged.
- Illustrator: Cherry Mae Candelario*
13. A positively charged rod is brought close to one end of a neutral metallic plate. What type of charge is induced on the closest side of the plate?
- Neutral
 - Negative
 - Positive
 - Both negative & positive charged

14. How does an atom becomes charged?
- A. By losing protons.
 - B. By gaining neutrons.
 - C. By distributing the charges.
 - D. By gaining and losing of electrons

15. How can we know if an object is electrically polarized?
- A. Has no net charge.
 - B. It is electrically charged.
 - C. It is only partially conducting.
 - D. Its charges have been rearranged.

**Lesson
2**

Charging by Induction



What's In

In the previous lesson, you learned about Charging by friction which simply means rubbing of material to another. By rubbing a variety of materials against each other and testing their resulting interaction with objects of known charge, the tested materials can be ordered according to their affinity for electrons.

Also in previous Activity, you learned that when you rubbed one balloon with your hair, you are experiencing friction. During the process, atoms in the balloon are forced to be close to the atoms with your hair. The protons in the atoms of one object start to interact with the electrons on the other object. The rubber of the balloon has a higher electron affinity and will take electrons from the atoms of your hair. When you pull the balloon away from your hair, the balloon will have more electrons or has gained electrons which made it negatively charged, while your hair has lost some electrons, and now has a positive charge. You might also notice that your hair is attracted to the balloon. This is the evidence that oppositely charged objects attract each other. If you rub two balloons on your hair and place the balloons near each other, you will notice that the two balloons repelled.

In Lesson 2 you will learn more about Charging by Induction.

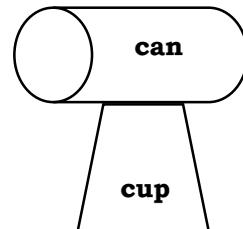


What's New

Activity 2.1: Touch Me Not!

Materials:

1. Inflated rubber balloon
2. Empty soft drink can
3. Styrofoam cup



What to Do:

1. Inflate the balloon.
2. Mount the soft drink can on the Styrofoam cup as seen in Figure 2.
3. Charge the balloon by rubbing it off your hair for 1 minute.

Figure 2

Illustrator: Cherry Mae Candelario

4. Place the charged balloon as near as the possible to the soft drink can without the two objects touching. See Figure 3 below.

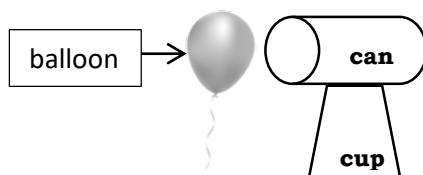


Figure 3

Illustrator: Cherry Mae Candelario

5. Touch the can with your finger at the end opposite of the balloon.

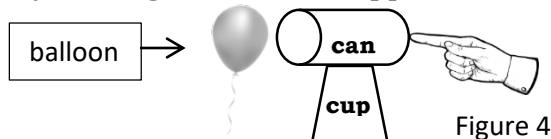


Figure 4

Illustrator: Cherry Mae Candelario

6. Remove your hand and observe how the balloon and the can will interact.
7. Answer the following questions on a separate sheet of paper.

1. What do you think is the charge acquired by the balloon after rubbing it against your hair?
2. Based on your answer in question #1, what do you think is the charge of the soft drink can?
3. What is the purpose of touching the can in step 5?
4. Were you able to charge the soft drink can? Explain.

Here are your criteria to follow in answering this task for you to be guided and lead to an appropriate answer.

FEATURES	4	3	2	1
Ideas	Demonstrate in depth understanding of the topic. It uses scientific reasoning to address ideas.	Demonstrates understanding of the topic. Somewhat uses scientific reasoning to address ideas.	Demonstrates little understanding of the topic. Gives some new information but poorly organized	Lacks understanding of the topic. Gives no new information and poorly organized.
Grammar, Usage & Mechanics	No incorrect spelling, punctuation or grammatical errors.	Few spelling and punctuations, errors, minor grammatical errors.	A number of spelling, punctuation or grammatical errors.	So many spelling, punctuation and grammatical errors that it interferes with the meaning.
Effort	Took so much of time and worked hard on the activity	Slightly worked hard for the activity	Put a small effort into the activity	It was done in a rushed and did not work hard



What is It

In the previous lesson, it was explained that an object can be charged through rubbing or friction. Charging by friction is a very common method of charging an object. Furthermore, it was explained that like charges repel and unlike charges attract. In this section, the second method of charging- charging by induction will be described and explained.

The behavior of a charged material depends on its ability to allow charges to flow through it. A material that permits charges to flow freely within it is a good electrical conductor. Metals are usually good conductors of electricity.

In contrast to conductors, insulators are materials that hinder the free flow of charges within it. If the charge is transferred to an insulator, the excess charge will remain at the original location charging. Some examples of insulators are glass, porcelain, plastic and rubber.

An object becomes polarized when electrons rearrange such that one side of an object is more negative than the other.

The observations you had made in Activity 2 depended on the fact that the balloon and Styrofoam are good insulators while the soft drink can and you are good conductors. You have observed that the soft drink can has become charged after you touched one of its ends. The charging process used in this activity is called induction charging, where an object can be charged without actual contact to any other charged object.

Another example of charging by induction can be seen in Figure 2 below.

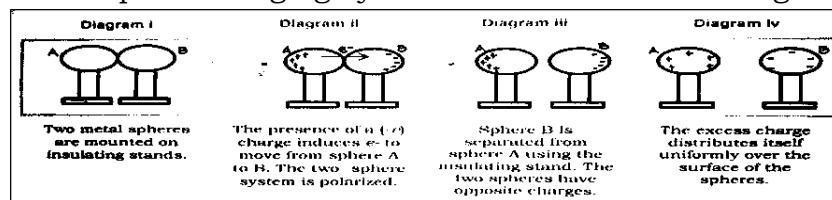


Figure 2: Charging by induction

Source: K to 12 Science Grade & Learners Material

We have two conductive metal spheres supported by an insulating stand. This ensures that no electrons will leave the metal sphere through the stand. When conducting spheres are placed next to each other, the electrons are free to move about the two spheres. Let's say we bring a negatively charged balloon (you just rubbed it on your hair) towards one of the spheres. Since like charges repel, the electrons on the sphere will be repelled by the negative charge of the balloon. Note that the protons do not move toward the negative balloon, but that the side of the metal sphere closest to the balloon has a positive charge due to a lack of electrons. So there is a stronger negative charge in the furthest from the negative balloon. When the spheres are separated, we have two charged objects: one positive and one negative. Again, the net charge in the system is zero- charge is conserved.

The **Law of Conservation of Charge** is easily observed in the induction charging process. Prior to the charging process, the overall charge of the process is zero. There were equal number of protons and electrons within the two spheres. If sphere A has 100 units of positive charge, then sphere B has 100 units of negative charge. Determining the overall charge of the system is easy arithmetic; it is simply the sum of the charges of the individual spheres.

$$\text{Overall Charge of the Two Spheres} = +100 \text{ units} + (-100 \text{ units}) = 0 \text{ units}$$

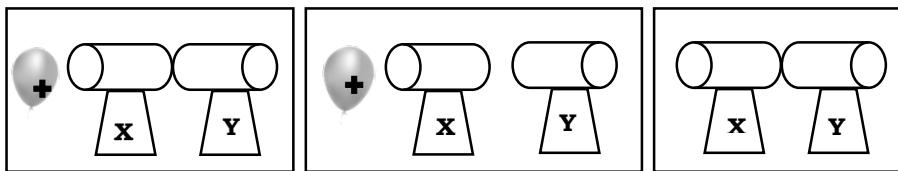
Charge is neither created nor destroyed during this charging process; it is simply transferred from one object to the other object in the form of electrons.



What's More

I'm so happy that you did a great job in every challenge in this module. Now, let us test how far you've gone with our lesson. Be ready to answer this task. Good luck!

Use your understanding of charging by induction to answer this question base on the diagram given below. Choose the correct answer inside the box. Write it on a separate sheet of paper.



Illustrator: Cherry Mae Candelario

Two neutral conducting pop cans are touching each other. A positively charged balloon is brought near one of the cans as shown above. The cans are separated while the balloon is nearby, as shown. After the balloon is removed the cans brought back together. When touching again, can X is _____.

- A. neutral
- B. negatively charged.
- C. positively charged
- D. Both B & C



What I Have Learned

Directions: Illustrate and explain the underlying concepts of the induction type of charging process given the materials below. Write your answer on a separate sheet of paper.

A neutral metal sphere and a negatively charged rubber rod that will result in a positive charge on the sphere's surface.

Here are your criteria to follow in answering this task for you to be guided and lead to an appropriate answer.

FEATURES	4	3	2	1
Ideas	Demonstrate in depth understanding of the topic. It	Demonstrates understanding of the topic. Somewhat uses	Demonstrates little understanding of the topic.	Lacks understanding of the topic. Gives no new

	uses scientific reasoning to address ideas.	scientific reasoning to address ideas.	Gives some new information but poorly organized	information and poorly organized.
Grammar, Usage & Mechanics	No incorrect spelling, punctuation or grammatical errors.	Few spelling and punctuations, errors, minor grammatical errors.	A number of spelling, punctuation or grammatical errors.	So many spelling, punctuation and grammatical errors that it interferes with the meaning.
Effort	Took so much of time and worked hard on the activity	Slightly worked hard for the activity	Put a small effort into the activity	It was done in a rushed and did not work hard



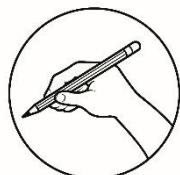
What I Can Do

Directions: Describe the process of charging by induction through an illustration. Draw this on a separate sheet of paper.

CHARGING BY INDUCTION

Here are your criteria to follow in answering this task for you to be guided and lead to an appropriate answer.

FEATURES	4	3	2	1
Following Directions	All directions were followed	Most directions were followed	Some directions were followed	None of the directions were followed
Creativity	Uses own ideas and imagination	Uses own ideas most of the time	Uses some imagination	Did not use own ideas or imagination
Craftsmanship	The illustration is neat and carefully made	The illustration has few of erasures	The illustration has numerous of erasures	The illustration has very numerous of erasures
Effort	Took so much of time and worked hard on the activity	Slightly work hard for the activity	Put a small effort into the activity	It was done in a rushed and did not work hard



Assessment

Directions: Read each item carefully. Choose the letter of the correct answer. Write the letter of your choice on a separate sheet of paper.

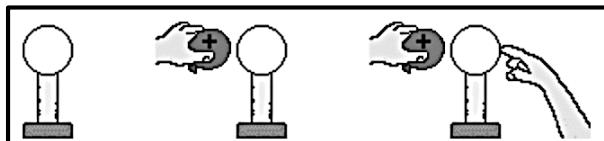
1. Which of the following object is an example of insulator?
 - A. Aluminum
 - B. Copper
 - C. Gold
 - D. Plastic

2. Two charged bodies are brought near each other and are observed to attract each other. What can you infer about their charge?
 - A. Both positive
 - B. Both negative
 - C. Neutral charges
 - D. Negative and positive

3. Pith balls are little Styrofoam balls coated in conductive paint. An uncharged pith ball is suspended by a nylon fiber. What will happen to a pith ball when a negatively charged rubber rod is brought near it without touching?
 - A. Becomes attracted
 - B. Becomes polarized
 - C. Is repelled by the rod
 - D. Becomes charged by induction

4. What do you call the process of charging a conductor by bringing it near another charged object?
- A. Conduction
 - B. Induction
 - C. Neutralization
 - D. Polarization
5. Which of the following best characterizes electrical insulators?
- A. Their electric charges move freely.
 - B. Charges on the surface don't move.
 - C. Insulators are good heat conductors.
 - D. Insulators have high tensile strength.
6. What do you call to the materials that hinder the free flow of charges within it?
- A. Conductors
 - B. Insulators
 - C. Golds
 - D. Neutrons
7. Which of the following pairs of objects are insulators?
- A. Rubber & gold
 - B. Plastic & glass
 - C. Copper & aluminum
 - D. Copper & aluminum
8. To say that an object is electrically polarized is to say that _____.
- A. it is electrically charged.
 - B. the charges are distributed.
 - C. it is only partially conducting.
 - D. its charges have been rearranged.
9. A neutral atom gains an electron. What type of charge does it have now?
- A. Neutral
 - B. Negative
 - C. Positive
 - D. Both positive & negative
10. You wish to use a positively charged rod to charge a ball by induction. Which statement is correct?
- A. The ball must be a conductor.
 - B. The charge on the ball will be positive.
 - C. The ball is charged as the area of contact between the two increases.
 - D. The ball must be an insulator that is connected temporarily to the ground.
11. A positively charged piece of Styrofoam is placed on the table. A neutral aluminum pie plate is brought near. While held above the Styrofoam, the aluminum plate is touched. At this point there is a movement of electrons. Electrons move _____.
- A. into the aluminum plate from the hand.
 - B. out of the aluminum plate into the hand.
 - C. from the Styrofoam through the aluminum plate.
 - D. from the ground through the aluminum plate to the Styrofoam.

12. A positively charged balloon is brought near a neutral conducting sphere as shown below. While the balloon is near, the sphere is touched (grounded). At this point, there is a movement of electrons. Electrons move _____.



Source: K to 12 Science Grade & Learners Material

- A. into the sphere from the balloon.
 - B. out of the sphere into the balloon.
 - C. into the sphere from the ground (hand).
 - D. out of the sphere into the ground (hand).
13. A positively charged sphere A is brought close without touching to a neutral sphere B. Sphere B is touched with a grounded wire. What is the charge on Sphere B after the wire is removed?
- A. Positive
 - B. Negative
 - C. It stays neutral
 - D. Both positive & negative
14. How is charging by induction carried out?
- A. If a neutral object cancels out both charges
 - B. If there is a transfer of electrons between the 2 objects when rubbed together
 - C. If a negatively charged object is in contact with a neutral object both objects were takes a negative charge
 - D. If a negatively charged object is used to charge a neutral object and the neutral object will acquire a positive charge.
15. How does an atom becomes charged?
- A. By losing protons
 - B. By gaining neutrons
 - C. By distributing the charges
 - D. By gaining and losing of electrons



Additional Activities

Directions: Fill in the crossword puzzle. Be guided by the *Across* and *Down* clues below. Write your answer on a separate sheet of paper.

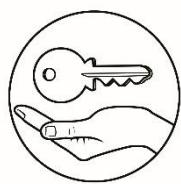
A crossword grid consisting of a 10x10 grid of squares. There are several numbered entries: '1' is a 10-letter word across the top; '2' is a 2-letter word down the first column; '3' is a 10-letter word across the middle row; '4' is a 10-letter word across the middle column; and '5' is a 5-letter word down the middle column. The grid has thick black borders between the rows and columns.

Across

- 1- the realignment of charge on the surface of an insulator
 - 3- it is a device that can be used for detecting charges
 - 6- the process of charging that requires no contact with the object inducing the charge

Down

- 2- these are materials which permits the flow of electric charges
 - 5- materials that do not allow charges to move freely
 - 4- a carrier of positive charge



Answer Key

Assessment	Lesson 1	Lesson 2	What I Know	Assessment
1. A	1. C	1. A	1. D	1. A
2. B	2. A	2. B	2. C	2. B
3. D	3. D	3. B	3. B	3. D
4. D	4. D	4. B	4. B	4. D
5. B	5. C	5. B	5. B	5. B
6. D	6. C	6. D	6. B	6. D
7. B	7. A	7. C	7. B	7. A
8. C	8. B	8. A	8. D	8. C
9. C	9. B	9. A	9. D	9. B
10. A	10. B	10. A	10. A	10. B
11. B	11. D	11. B	11. A	11. C
12. D	12. C	12. B	12. C	12. D
13. B	13. D	13. B	13. B	13. D
14. D	14. C	14. D	14. D	14. C
15. C	15. D	15. C	15. D	15. D

References

Books

Alvie J. Asuncion et.al. 2017. *K to 12 Science Grade & Learners Material*. Pasig City: Bureau of Learning Resources (DepEd- BLR).

Jomar Aries T. Laurente et.al. 2015. *Science for the 21st Century Learner 7*. Makati City: DIWA LEARNING SYSTEMS INC.

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