GP2 Module 5B WEEK 5 - Physics Material

Computer Science (University of Batangas)

SHS

AIRs - LM in
GENERAL PHYSICS 2
Quarter 3 - Module 5B: Electricity

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General Physics 2

Grade 11/12 Quarter 3 - Module 5B: Electricity
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Target

What would your life be like without electricity? Can you imagine a modern home without electric lights and appliances? How do you feel when, for one reason or another, you suddenly lose your electricity during a brownout? How does your mother react about all the frozen food when there is a long power interruption?

Electricity is useful because it is easily transformed into other form of energy. It can give us light and heat. It makes motors run and produce mechanical energy. It can have changed to sound energy in radios and stereos.

Electricity has become so important in our daily lives that ways and means to produce it in great quantities have been devised. Huge dams and other power supply projects including geothermal power plants have been undertaken by the government and some private enterprises to keep us supplied with electricity.

Electricity supplies the energy needed to operate your household appliances, calculator and radio. You know that electrons at rest produce static electricity. However, electrons are called Electric Current.

After studying this Self-Learning Module in General Physics 2, you are expected to:

a. Distinguish between conventional current and electron flow (**STEM_GP12EMIIId-32**);
b. Apply the relationship charge = current x time to new situations or to solve related problems (**STEM_GP12EMIIId-33**);
c. Describe the effect of temperature increase on the resistance of a metallic conductor (**STEM_GP12EMIIId-35**);
d. Describe the ability of a material to conduct current in terms of resistivity and conductivity (**STEM_GP12EMIIId-36**);
e. Apply the relationship of the proportionality between resistance and the length and crosssectional area of a wire to solve problems (**STEM_GP12EMIIId-37**);
f. Differentiate ohmic and non-ohmic materials in terms of their I-V curves (**STEM_GP12EMIIId-38**); and
g. Differentiate emf of a source and potential difference (PD) across a circuit (**STEM_GP12EMIIId-40**)

Before going on, check how much you know about this topic. Answer the pretest on the next page in a separate sheet of paper.

LESSON 1

Current, Conventional Current and Electron Flow

Jumpstart

For you to understand the lesson well, do the following activities.
Have fun and good luck!

Activity 1: UNSCRAMBLE ME!

Directions: Unscramble the following letters to identify the concept being described. Use a separate sheet of paper for your answers.

SCRAMBLED LETTERS	DESCRIPTION	ANSWER
T U C R R E N	It is the flow of charge (electrons)	
S I S T A N C E R E	It is anything that keeps the current from flowing	
M P E R E A	The unit of current	
I T C C U I R	the complete path of electrical energy	
N D U R S C O C T O	Substances that allow the passage of charges	
O E N L N A C O N V T I **T U C R R E N** **O W F L**	Assumes that current flows out of the positive terminal	
L R O N E C T E **L O W F**	It is what actually happens and electrons flow out of the negative terminal	

Discover

Electric current is the flow of electrons through a complete circuit of conductors. It is used to power everything from our lights to our trains. Everything we see is made up of tiny little particle called atoms. The atoms are made of even smaller parts which are called protons, electrons and neutrons or the sub-atomic particles. An atom usually has the same number of protons (which have a positive charge) and electrons (which have a negative charge). Sometimes electrons can be moved away from their atoms.

Electric current is the movement of electrons through a wire. Electric current is measured in **amperes** (amps) and refers to the number of charges that move through the wire per second.

When current flows, electrical work is done and energy transferred. The amount of charge passing a point in the circuit can be calculated using the equation:

charge = current × time

$$Q = I\ x\ t$$

This is when:

charge (Q) is measured in coulombs (C)
current (I) is measured in amperes (A)
time (t) is measured in seconds (s)

Electrons are negatively charged particles and they transfer energy through wires as electricity.

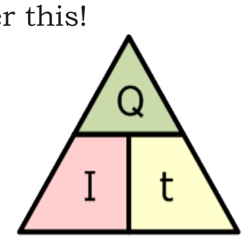
Charge is a property of a body which experiences a force in an electric field. Charge is measured in coulombs (C).

Since electrons are so small and one electron will not have much of an effect anywhere, it is more useful to refer to large groups of electrons. One coulomb of charge is equivalent to 6,250,000,000,000,000,000 electrons.

Example 1:

A current of 1.5 amps (A) flows through a simple electrical circuit. How many coulombs of charge flow through a point in 60 seconds?

Remember this!



Given:

I = 1.5 A
t = 60 s

Unknown:

Q =?

Solution:

Q = I x t

= 1.5 A x 60 s

Answer:

Q = 90 C (Coulombs)

In order for a current to flow, the circuit must be closed; in other words, there must be an uninterrupted path from the power source, through the circuit, then back to the power source.

Remember that a **circuit** is the complete path of electrical energy. In the circuit we have created here with the light bulb, wire and battery, the battery provides the voltage and the light bulb gives us resistance, by slowing down the flow of charge and changing it into light. The current flows through the battery, the light bulb and the wires.

What might happen if we disconnect the battery? The light goes off because the current has nowhere to flow. This creates what we call an **open circuit**. It is like an open circle because there is a break in the line of flow. A **closed circuit** is like a closed circle or a completed circle. Current can only travel through a closed circuit.

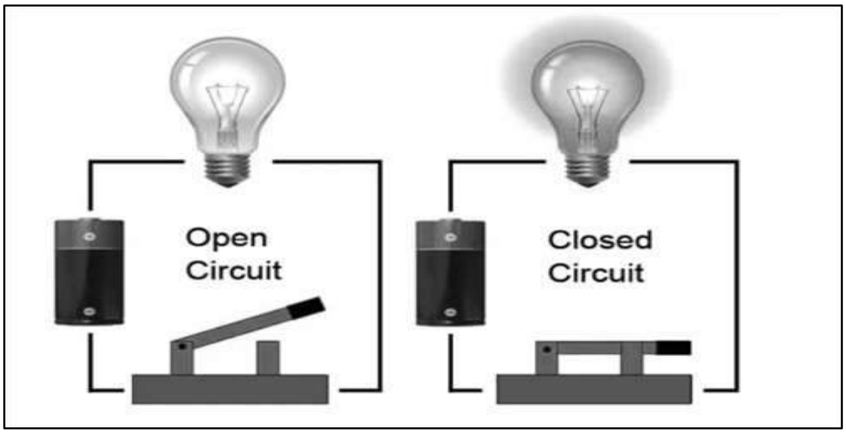


Figure 1: Image taken from https://www.georgetownisd.org/Page/21329

All circuits need to have three basic elements. These elements are a voltage source, conductive path and a load. The voltage source, such as a battery, is needed in order to cause the current to flow through the circuit. In addition, there needs to be a conductive path that provides a route for the electricity to flow. Finally, a proper circuit needs a load that consumes the power. The load in the above circuit is the light bulb.

Conventional Current VS Electron Current Flow

In 1752, prior to electricity being identified with the electron, Benjamin Franklin chose a convention regarding the direction of current flow. Franklin assumed that positive charge carriers flowed from positive to negative terminals. We now know this is incorrect. In metals, the charge carrier is the electron whose charge is negative by definition (note negative sign): (-1.6×10^{-19} C).

The flow of electrons is termed electron current. Electrons flow from the negative terminal to the positive. **Conventional current** or simply **current**, behaves as if positive charge carriers cause current flow. **Conventional current flows** from the positive terminal to the negative.

Perhaps the clearest way to think about this is to pretend as if movement of positive charge carriers constituted current flow.

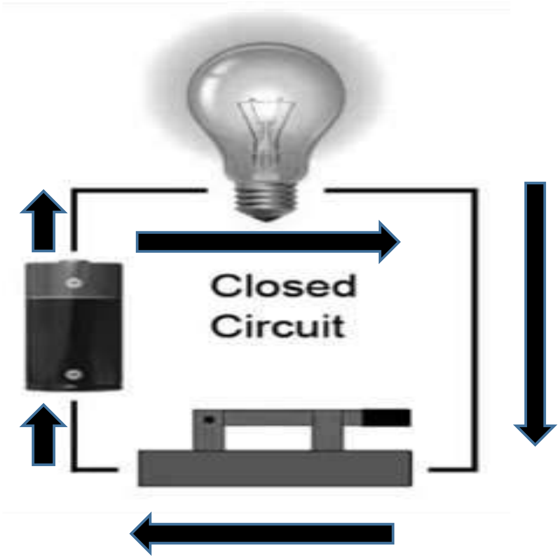


Figure 2: Conventional Current Flow

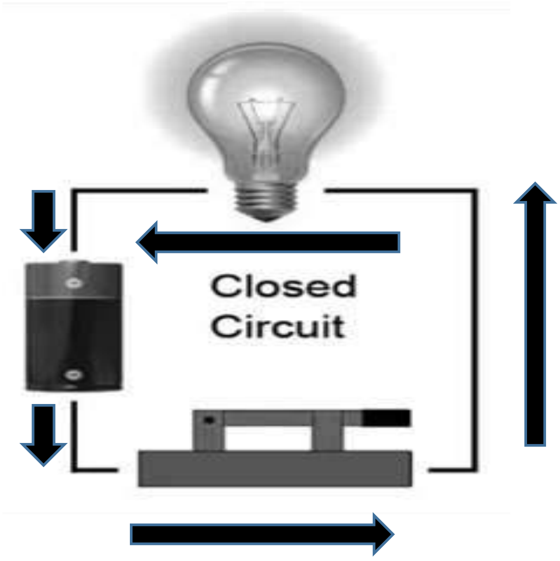
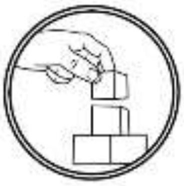


Figure 3: Electron Current Flow

It is important to realize that the difference between conventional current flow and electron flow in no way effects any real-world behavior or computational results. In general, analyzing an electrical circuit yields results that are independent of the assumed direction of current flow.

Conventional current flow is the standard that most all of the world follows.



Explore

Here are some enrichment activities for you to work on to master and strengthen the basic concepts you have learned from this lesson.

Activity 1: FILL IN THE BLANKS

Directions: Read each statement or question below carefully and fill in the blank(s) with the correct answer. Choose your answers that are found inside the box. Use a separate sheet of paper for your answers.

ELECTRIC CURRENT	OPEN	ELECTRIC
ELECTRIC CHARGES	CLOSED	ELECTRICITY

1. ____________________ is the movement of electrons from one place to another.
2. An incomplete or broken path for electric current is a/an ________ circuit.
3. A/An __________________ circuit is a path for electric current to flow.
4. ______________________ are the particles of matter that are positively or negatively charged.
5. A complete, or unbroken path for electric current is a _____________ circuit.
6. A form of energy produced by the movement of electrons is _________________.

Activity 2: DRAW A DIAGRAM OF AN OPEN AND CLOSED CIRCUIT

Directions: Draw a correct diagram of an open and closed circuit. Use a separate sheet of paper for your answers.

Closed Circuit **Open Circuit**

Activity 3: DRAWING THE PATH OF ELECTRONS

Directions: Draw a picture of the circuit. Label the light bulb, switch and battery. Use arrows to show the true direction the electrons flowed. Use a separate sheet of paper for your answers.

Activity 4: SOLVE ME!

Direction: Read and analyze the following problems below. Write your answers correctly. Use a separate sheet of paper for your answers.

1. A current of one ampere is a flow of charge at the rate of _______ coulomb per second.
2. When a charge of 8 C flows past any point along a circuit in 2 seconds, the current is ________ A.
3. If 5 C of charge flows past in 10 seconds, then the current is _________ A.
4. If the current is 2.0 A, then _______ C of charge flow past in 10 seconds.
5. If 12 C of charge flows past point A in 3 seconds, then 8 C of charge will flow past in ________ seconds.

Great job! You have understood the lesson.
Are you now ready to summarize?

Deepen

At this point you are now ready for your last activity. Remember the things that you learned in this lesson. Good luck!!!

What you need: Pen and Paper

What to do: Answer the last wave of activities on this part of module. This activity shall be the basis of how you have learned in this module. Use a separate sheet of paper for your answers. Good luck!

Enrichment Activity 1

- ✓ Two people are debating electron flow versus conventional flow. One of them says that you will get different results predicting polarity of voltage drops in a resistive circuit depending on which convention you use. The other person says that the convention for labeling current does not matter at all, and the correct polarities will be predicted either way. Which of these two people is correct? Explain why, and give an example to prove your point.

ANSWER:

Gauge

DIRECTIONS: Choose the letter of the correct answer. Write your answer on a separate sheet of paper.

1. What is the formula for electric current?
   A. I = Q.t   C. I = t/Q
   B. I = Q/t   D. I= W.t

2. A current is passed through a conducting wire for 1 min. How much charge will flow through the wire?
   A. 2 C   C. 60 C
   B. 30 C   D. 120 C

3. The SI unit of electric charge is ______.
   A. Ampere   C. Watt
   B. Volt   D. Coulomb

4. In schematic diagrams, currents are indicated using arrows. What do the arrows indicate?
   A. The direction of motion of the electrons
   B. The direction of the current vector
   C. The direction of motion of the charge carriers
   D. The direction that positive charge carriers would move

5. Current is a measure of ________.
   A. Force that moves a charge past a point
   B. Resistance to the movement of a charge past a point
   C. Energy used to move a charge past a point
   D. Smount of charge that moves past a point per unit time

6. What is the formula to calculate charge?
   A. Q=I*t   C. Q = V*E
   B. Q=I/t   D. Q = V/E

7. Which of the following describes current?

A. Current is a flow of electrical charge: electrons.
B. Current is the capacity of a physical system to do work.
C. The current across an electrical component is the electrical energy supplied to it per coulomb of charge flowing through it
D. A unit of matter that expresses the extent to which it has more or fewer electrons than protons.

8. How much charge must pass by a point in 10 s for the current to be 0.50 A?
   A. 0.05C
   B. 5.0C
   C. 20C
   D. 2.0C

9. Materials that cut down or resist the flow of charges are called _________.
   A. Conductor
   B. Insulator
   C. Resistor
   D. Circuit

10. Flow of charges in the direction of electrons is called __________.
    A. Conventional Flow
    B. Electron Flow
    C. Current Flow
    D. Photonic Flow

11. What is current measured in?
    A. Ω (Ohms)
    B. V (Volts)
    C. A (Amps)
    D. W (Watts)

12-15: Draw and label the parts found in a closed Circuit.

LESSON 3

Resistance, Resistivity, and Voltage

Jumpstart

For you to understand the lesson well, do the following activities. Have fun and good luck!

Pretest:

DIRECTIONS: Choose the letter of the correct answer. Write your answer on a separate sheet of paper.

1. What is the unit of electrical resistance?
   A. Ampere C. Volts
   B. Ohm D. Joule

2. This factor that affects electron flow depends on the thickness, length, resistivity or kind of a material used.
   A. Current C. Resistance
   B. Voltage D. Power

3. Which one is a poor conductor of electricity?
   A. Human body C. Sea water
   B. Dry Wood D. Earth

4. This device is used to measure the resistance of a circuit?
   A. Ammeter C. Ohmmeter
   B. Voltmeter D. Power meter

5. The amount of charge flowing through a cross-sectional area of a wire per unit of time is called:
   A. Voltage C. Resistance
   B. Power D. Work

6. A wire of length L and cross-sectional area A has a resistivity ρ. Which of the following formulas can be used to calculate the resistance of the wire?
   A. A. R = $\rho L/A$ C. C. R = $L/\rho A$
   B. R = $\rho A/L$ D. R = $A\ /\rho L$

TRUE or FALSE:

7. The resistance of a conductor is directly proportional to its length

8. The cross-sectional area of a conductor is one factor that determines the conductor's resistance to current.

9. A longer wire has more resistance than a shorter wire. Current must travel farther through a longer wire, so there are more chances for it to collide with particles of matter.

10. A cooler wire has less resistance than a warmer wire. Cooler particles have less kinetic energy, so they move more slowly.

11. The extremely thin wire has more resistance than a wider wire would. This helps the wire resist electric current and change it to light.

12. All materials have resistance. How much resistance a material has depends on the type of material, its width, its length, and its temperature.

13. Resistance is a hindrance when a material is being used to transmit electric current. Resistance is helpful when a material is being used to produce heat or light.

14. Materials such as plastics have high resistance to electric current. They are called electric insulators.

15. Electricity flowing through a wire is like water flowing through a hose. More water can flow through a wide hose than a narrow hose. In a similar way, more current can flow through a wide wire than a narrow wire.

Activity 1: FACTORS AFFECTING ELECTRICAL RESISTANCE

Objectives

1. Determine how length of a wire affects resistance
2. Determine how the diameter of a wire affects resistance

Materials/Equipment

2 1.5 V dry cells
3 W flashlight bulb
Connecting wires with alligator clip
3 nichrome wires of different length (20 cm, 60 cm, 80 cm)
2 nichrome wires of the same length but different diameter (thin and Thick)

Procedure

1. Make a circuit with one flashlight bulb, two dry cells and connecting wire.
2. Connect the alligator clip to the nichrome wire

3. Use the 20 cm, 60 cm and 80 cm long wires. Observe and indicate the brightness of the bulb as bright, brighter, and brightest for each wire
4. Remove and replace the wire again, this time using thin and thick nichrome wires of the same length
5. Fill out the table provided

Wire	**Brightness of the Bulb**
A. Length 20 cm 60 cm 80 cm B. Diameter Thin Thick	

Guide Questions:

1. What happened to the brightness of the bulb as the length of the wire was increased? What did this indicate about resistance of the circuit?

____
____
____
____

2. What happened to the brightness of the bulb as the diameter or thickness of the wire was increased? What did this indicate about the resistance of the circuit?

____
____
____
____

Conclusion

____
____
____
____

Application

Why is it important to know the wire gauge in house wiring?

____
____
____
____

Discover

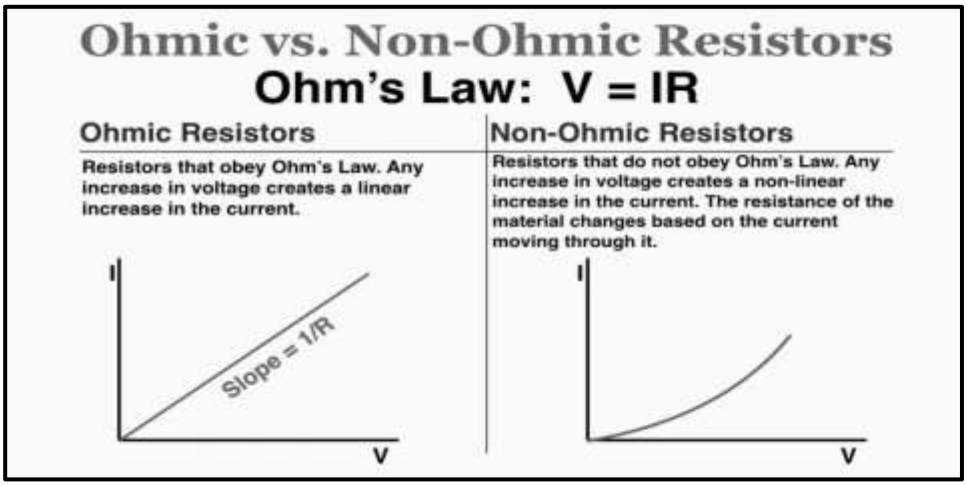
Resistance

Resistance is the opposition a material offers to current. The symbol for resistance is **R**. All materials offer some resistance to current but amount of resistance differs from each other. There are high-resistance and low-resistance materials. More energy is required to move electrons through high-resistance materials.

Ohmic and non-Ohmic Material

A resistor is an electrical device that resists current, and the difference between ohmic and non-ohmic resistors relates to how the resistor reacts to different types of current that pass through it. In an ohmic resistor, the resistance provided is the same regardless of the type of current that passes through the device. In a non-ohmic resistor, the resistance changes depending on the type of current passing through it.

The designation of ohmic versus non-ohmic involves an electrical law known as Ohm's Law, which was developed by Georg Ohm. Ohm's law basically says that the current in a circuit is proportional to the amount of voltage in the circuit. Because of this proportionality, when voltage and current are plotted on a graph, their relationship is linear. An ohmic resistor also has this linear relationship if its current and voltage are graphed, according to the physics Web page for Nayland College. Non-ohmic resistors, on the other hand, have an irregular graph that is not linear.



It is important to note that the distinction between ohmic and non-ohmic resistors can be made only when the conditions of the resistor are constant. If conditions are not constant, then the distinction cannot be made between ohmic and non-ohmic resistors.

The unit used to specify the amount of resistance is the **ohm**. It is represented by the symbol **Ω**. The ohm is defined as the amount of resistance that allows 1 A of current to flow when the voltage is 1 V. It can also be defined as the amount of resistance of a column of mercury 106.3cm in length, with cross-sectional area of 1 mm^2, and at a temperature of 0 ^oC.

Resistance of an object depends on the following factors discussed below.

LAWS of RESISTANCE

A greater electrical pressure or emf will increase the current flowing through a conductor. This is true only if the conductor is made of the same material, of the same length, of the same diameter, and if the temperature remains constant. These four factors affect the amount of current that flows through the conducting wire. With the same potential difference (voltage), current may increase or decrease depending on which of the factors varies.

1. **Law of lengths**. The current flowing through a wire will be reduced if the wire were made longer, using the same power source. This has been proven through experiments. The results of such experiments enable us to state that resistance of a uniform conductor is directly proportional to its length, $R \propto l$ or

   $$\frac{R_1}{R_2}=\frac{l_1}{l_2}$$

   where R is the resistance in ohms and l is the length of the conductor in centimeters. Remember! Never equate resistance with resistivity. Resistance is the opposition offered by any object to the passage of an electric current through it.
2. **Law of Diameters**. The resistance of a conductor is inversely proportional to the square of its diameter or its cross-sectional area; that is $R \propto 1/d^2$, or $R \propto 1/A$, where d is the diameter and A is the area of the wire. Therefore,

   $$\frac{R_1}{R_2}=\frac{d_2^2}{d_1^2}$$

Sample Problem

An iron wire with a diameter of 0.80 mm will have a resistance of 0.4 Ω. What resistance will the iron wire of 0.40 mm diameter have if it has the same length as the iron wire?

Given:

R1 = 0.4 Ω
d1 = 0.80 mm
d2 = 0.40 mm

Unknown:

R2 =?

Solution:

$$\frac{R_1}{R_2} = \frac{d_2{}^2}{d_1{}^2}$$

$$\frac{0.4\ \Omega}{R_2} = \frac{(0.40\ mm)^2}{(0.80\ mm)^2}$$

$$R_2 = \frac{0.4\Omega \times 0.64\ \ mm^2}{0.16\ mm^2}$$

Answer:

R_2 = ***1.60 Ω***

3. **Law of Nature of the Material**. Wires of different materials offer different amounts of resistance. At the same temperature, copper wire offers only 1/6 the resistance of an iron wire of the same length and diameter. A single wire of the same size offers even much less resistance. The resistance therefore of a given conductor depends on the kind of material the conductor was made. Table 1 below show the list of materials that are considered as good conductor.

Conductors	Poor Conductors	Insulators
Earth Moist materials Seawater Human body Metals	Dry wood Paper Oil Distilled Water	Glass Plastics Dry silk Sealing wax Porcelain Paraffin Mica Dry air Rubber Wool

Table 1. List of Materials as good conductor

This is known as resistivity ρ (rho) of the wire dependent on the material out of which the wire is made and its temperature. In symbol,

$$R = \frac{\rho l}{A}$$

Where:

ρ = reistivity in ohm-meters (Ω.m)
l = length of the wire in meters
A = Area of the wire in square meters

Sample problem

What is the resistance of a silver wire 15 m long at 20°C and whose diameter is 0.00085m? The resistivity ρ of silver at 20°C is $1.60 x 10^{-8}$ Ω.m?

Given:

l = 15m
d=0.00085 m
ρ=$1.60 x 10^{-8}$ Ω.m

Unknown:

Resistance R

Solution:

$$\boldsymbol{R = \frac{\rho l}{A}}$$

$$\mathbf{A=\pi r^2}$$

$$radius = \frac{diameter}{2}$$

$$radius = \frac{0.00085m}{2}$$

$$r = 0.000425\ m$$

$$\boldsymbol{A=3.14\ (4.25x10^{-4}m)^2}$$
$$\boldsymbol{=56.72\ x\ 10^{-8}\ m^2}$$

$$R = \frac{(1.60x10^{-8}\ \Omega.m)(15m)}{56.72\ x\ 10^{-8}\ m^2}$$

Answer:

R = 0.42 Ω

4. **Law of temperatures**. All substances whether metal or non metal, register a change in electrical resistance as the temperature changes. In pure metals and in alloys, the resistance increases significantly as the temperature rises. Carbon, a semiconductor like silicon, and few electrolytic solutions however have lower electrical resistance at higher temperature. Special alloys like constantan and manganin hardly show any increase in resistance even at high temperatures. The resistance of these special alloys may be considered as independent of temperature. Over limited temperature range, the resistance of a metal increases lineary with temperature***. That is,***

$$\boldsymbol{R = Ro\ (l + \alpha T)}$$

Where:

Ro = resistance of the metal at 0 °C
α = temperature coefficient of resistance

T=temperature in °C

TABLE 2 Resistivity and Temperature Coefficients (at 20°C)		
Material	**Resistivity, ρ ($\Omega \cdot m$)**	**Temperature Coefficient, α $(C°)^{-1}$**
Conductors		
Silver	1.59×10^{-8}	0.0061
Copper	1.68×10^{-8}	0.0068
Gold	2.44×10^{-8}	0.0034
Aluminum	2.65×10^{-8}	0.00429
Tungsten	5.6×10^{-8}	0.0045
Iron	9.71×10^{-8}	0.00651
Platinum	10.6×10^{-8}	0.003927
Mercury	98×10^{-8}	0.0009
Nichrome (Ni, Fe, Cr alloy)	100×10^{-8}	0.0004
Semiconductors‡		
Carbon (graphite)	$(3–60) \times 10^{-5}$	−0.0005
Germanium	$(1–500) \times 10^{-3}$	−0.05
Silicon	0.1 – 60	−0.07
Insulators		
Glass	$10^{9}–10^{12}$	
Hard rubber	$10^{13}–10^{15}$	

‡ Values depend strongly on the presence of even slight amounts of impurities.

Table 2 gives the values for resistivity and temperature coefficient at 0 °C

(Image taken from https://www.chegg.com/homework-help/questions-and-answers/table-18-1-resistivity-temperature-coefficients-20-c-resistivity-temperature-coefficient-c-q33610988)

Voltage

Voltage, which is also known as electromotive force (emf) or potential difference (PD) is the electric pressure that causes current to flow. Potential difference is potential energy divided by charge. The potential energy here is the work needed to move a charged body against the electric force toward or away from another charged body. If the two bodies have the same charge (e.g. both are positive), work is needed to move them closer. If the two charge bodies are opposite charge, work is needed to move them apart. Also, the term “electromotive force” could be misleading; it is not a force.

The symbol used to represent Voltage is V. The unit of voltage is joule per coulomb, which is called volts (V).

The relationship between charge, energy and voltage is

$$voltage = \frac{energy}{charge} \quad or \quad V = \frac{W}{q} \quad ; \quad the\ unit\ is\ \ Volt = \frac{joule}{coulomb}\ or\ V = \frac{J}{C}$$

The concept of grounding appliances, such as washing machines, transformers, and refrigerators, is applied by connecting them to the ground since the earth is considered to have zero potential.

Sample problem

In a 1.5 V dry cell, how many joules of work is done by every coulomb of charge?

Given:

V = 1.5 V
Q = 1C

Unknown:

W =?

Solution:

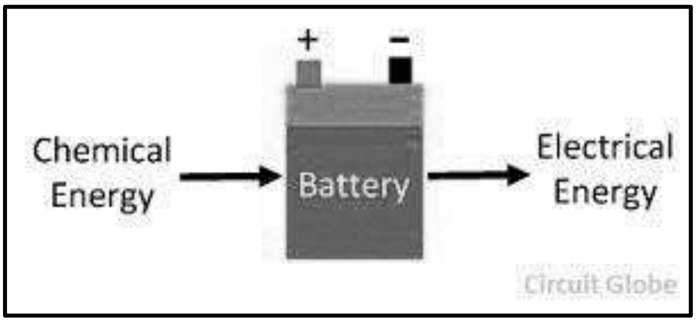
W = Vq
= (1.5V)(1C)

Answer:

W = 1.5 J

Potential Difference vs. Electromotive Force

The **potential difference** is defined as the amount of energy used by one coulomb of charge in moving from one point to the other. It is measured in volts and represented by the symbol V. The potential difference is measured by the Voltmeter.



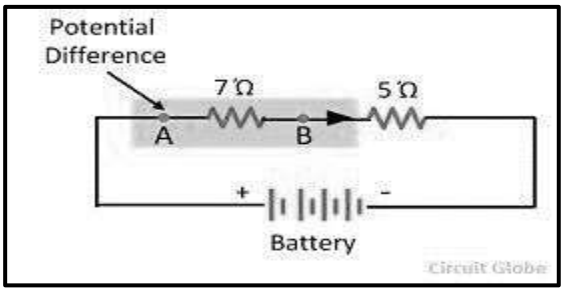
The potential difference between the two point charges is expressed by the formula shown below.

$$Potential\ Difference = \frac{Energy\ or\ Work}{Charge}$$

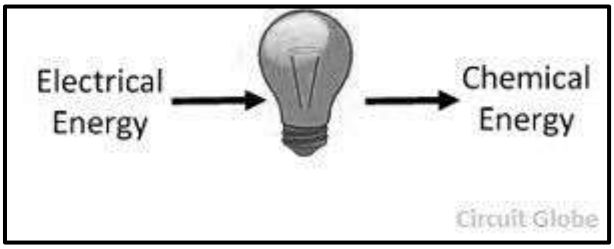
$$V = \frac{W\ or\ E}{Q}\ Volts$$

Example – Consider a circuit shown in the figure below.

A 12 volt supply applies across the resistance of the circuit. The potential difference between any two points, says A and B, is the energy used by one coulomb of charge in moving from one point (A) to the other (B). Thus, the potential difference between point A and B is 7 volts.



The **electromotive force** is the total voltage induces by the source. In other words, it is the amount of energy supplied by the source to each coulomb of charge. It is measured in volts and represented by the symbol ε (epsilon).



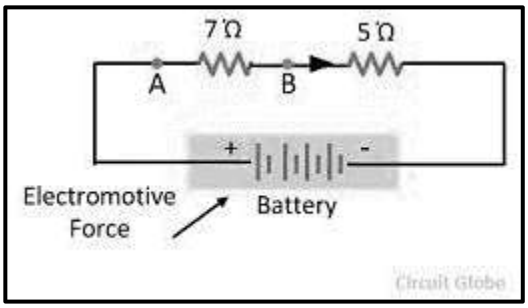
The emf is the maximum voltage that can be attained by the circuit. Naturally, it is generated when the fluctuation occurs in the magnetic field. The emf is expressed by the formula shown below

$$EMF = \frac{Work}{Charge}$$

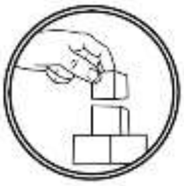
$$\varepsilon = \frac{w}{q} \; volts$$

The electromotive force is the type of energy which forces a unit positive charge to move from the positive to the negative terminal of the source. It separates the two charges from each other.

Example – Consider a circuit shown in the figure below.



A battery has an EMF of 12 V; it means that the battery supplies 12 joules of energy to each coulomb of charge. The charge is travel from the positive terminal to negative terminal through an external circuit; it gives a whole of the energy



Explore

Here are some enrichment activities for you to work on to master and strengthen the basic concepts you have learned from this lesson.

Activity 1: WHICH IS WHICH?

Direction: Given that all other factors are equal, the current will be greatest in a circuit that has ….

a. … a high resistance …………………………………………… a low resistance
b. … wires that are long ……………………………………… wires that are short
c. … wires that are wide ………………………………………wires that are thin
d. … 12-gauge wires (1/12th inch diameter) or 14-gauge wires (1/14th inch diameter)
e. … copper wiring ………………………………………………. silver wiring

Activity 2: PROBLEM SOLVING!

Direction: Solve each problem. Show complete solution in a separate sheet of paper.

1. What is the resistance of a 30 m silver wire with a 2 mm diameter?

2. A carbon wire with a 3 mm diameter has a resistance of 100 ohms. How long is the wire?

3. A 200 m long aluminum wire has the same resistance and cross-sectional area as a carbon wire. What is the length of the carbon wire?

4. A wire made of an unknown substance has a resistance of 125 mΩ. The wire has a length of 1.8 m and a cross-sectional area of 2.35×10^{-5} m^2. What is the resistivity of the substance from which the wire is made? Give your answer in scientific notation to one decimal place

5. Differentiate Ohmic from no-Ohmic materials.

6. Differentiate emf of a source and potential difference (PD) across a circuit

Great job! You have understood the lesson.
Are you now ready to summarize?

Deepen

At this point you are now ready for your last activity. Remember the things that you learned in this lesson. Good luck!

What you need: Pen and Paper

What to do: Answer the last wave of activities on this part of module. This activity shall be the basis of how you have learned in this lesson. Good luck!

Enrichment Activity 1

Directions: Solve the following problems below. Show your complete solution. Use the Rubric as your guide in answering. The rubric shall be used by the teacher in checking your answer. Use a separate sheet of paper for your answer

1. Compute the resistance of a hardened copper rod 2 meters long and 8 mm in diameter if the resistivity of the material is 1.756 x 10-8 ohm-meters.

2. A 0.500-meter length of wire with a cross-sectional area of 3.14 x 10-6 meters squared is found to have a resistance of 2.53 x 10-3 ohms. According to the resistivity chart, from what material is the wire made?

3. The resistance of a uniform copper wire 50.0 meters long and 1.15 mm in diameter is 0.830 ohms at 20° C. What is the resistivity of the copper at this temperature?

4. A 200 m long aluminum wire has the same resistance and cross-sectional area as a carbon wire. What is the length of the carbon wire?

Rubric for Problem Solving

Criteria & Rating	5	4	3	2	1
Strategic Approach (S)	Approach chosen is clearly shown, clearly written & all elements are valid.	Valid approach with minor errors that don't disrupt understanding.	Valid approach with multiple errors that impede understanding.	Invalid approach that demonstrates little understanding of the problem.	Little or no understanding of how to approach the problem.
Physics Concepts (P)	Appropriate concepts that are fully understood (symmetries, conserved quantities, etc.), clearly stated & employed correctly.	Appropriate concepts that are mostly understood but employed with errors.	Appropriate concepts identified, but not employed or understood.	At least one concept identified but unable to demonstrate understanding.	Little or no understanding of physics concepts.
Mathematical Concepts (M)	Correct starting equations; All mathematical steps are clearly shown and they flow easily toward the correct answer.	Correct starting equations. All mathematical steps are clearly shown but minor errors yield wrong answer. OR Correct starting equations with correct final result but the mathematical steps are hard to follow.	Correct starting equations. The mathematical steps are hard to follow and errors begin to impede application.	Can identify at least one equation, but unable to apply them.	Incorrect equations; demonstrates little or no understanding of mathematical concepts involved.
Answer (A)	100% correct answer – analytically (IA) numerically (If any) & conceptually (IA).	Correct answer analytically (IA), but not numerically (IA).	Incorrect answer, but on the right path.	Unable to reach a correct answer on this path.	No answer.

Enrichment Activity 2

Directions: Complete the table below. Use another sheet of paper for your answer.

Laws of Resistance	What will happen to the resistance?
1. Law of Length	
2. Law of Diameter	
3. Law of Nature of the material	
4. Law of Temperature	

Gauge

TRUE OR FALSE

Directions: Write *TRUE* if the statement is correct and *FALSE* if it gives incorrect information. Write your answer on a separate sheet of paper.

1. At constant temperature, the resistance of a conductor changes according to the applied voltage.

2. The electrical resistance of a wire would be expected to be greater for a longer wire, less for a wire of larger cross sectional area, and would be expected to depend upon the material out of which the wire is made.

3. Resistance and resistivity are the same.

4. The resistivity does not depend on the temperature of most metal wires.

5. While maintaining a constant voltage (V), the current (I) increase when the resistivity ρ of a wire increases.

6. While maintaining a constant voltage (V), the current (I) decrease when the length (L) of a wire increases.

7. If the voltage across a circuit of constant resistance is doubled, I will decrese.

8. The electromotive force is the total voltage induces by the source. In other words, it is the amount of energy supplied by the source to each coulomb of charge.

9. A shorter wire has more resistance than a shorter wire. Current must travel farther through a longer wire, so there are more chances for it to collide with particles of matter.

10. A cooler wire has less resistance than a warmer wire. Cooler particles have less kinetic energy, so they move more slowly.

11. The extremely thick wire has more resistance than a wider wire would. This helps the wire resist electric current and change it to light.

12. All materials have resistance. How much resistance a material has depends on the type of material, its width, its length, and its temperature.

13. Resistance is a hindrance when a material is being used to transmit electric current. Resistance is helpful when a material is being used to produce heat or light.

14. If the two charge bodies are opposite charge, work is needed to move them apart.

15. Electricity flowing through a wire is like water flowing through a hose. More water can flow through a wide hose than a narrow hose. In a similar way, more current can flow through a wide wire than a narrow wire.

Key to Answers

Lesson 1

Jumpstart

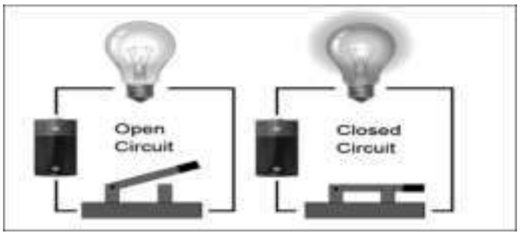
1. Current
2. Resistance
3. Ampere
4. Circuit
5. Conductors
6. Conventional Current Flow
7. Electron Flow

Explore

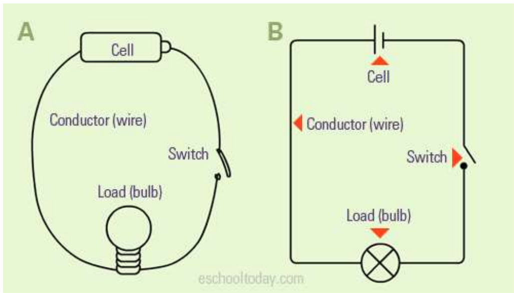
Activity 1

1. Electric Current
2. Open
3. Circuit
4. Electric charges
5. Close
6. Electricity

Activity 2



Activity 3



Activity 4

1. 1C
2. 4A
3. 0.5A
4. 20C
5. 2s

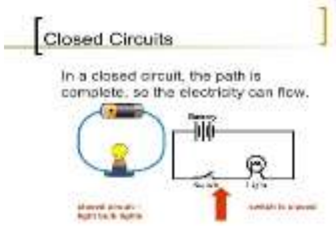
Deepen

*Answer may Vary

Gauge

1. B	8. B
2. D	9. C
3. D	10. B
4. A	11. C
5. D	
6. A	

12-15



Lesson 2

Jumpstart

1. B
2. C
3. B
4. C
5. C
6. A
7. T
8. T
9. T
10. T
11. T
12. T
13. T
14. T
15. T

Activity 1

*Answer may vary

Explore

Activity 1

1. A low resistance
2. Wire that are short
3. Wires that are wide
4. Silver wire

Activity 2

1. 0.477 ohms
2. 20.2 m
3. 0.16 m
4. 1.6 x 10^{-6} ohm-meter

5 and 6 – answers may vary

Deepen

1. 6.19 x 10^{-4} ohm-meter
2. 1.6 x 10^{-8} ohm-meter-Silver
3. 1.726 x 10^{-8} ohm-meter
4. 3.195 ohms

Gauge

1. T	14. T
2. T	15. T
3. T	
4. T	
5. T	
6. T	
7. F	
8. T	
9. F	
10. T	
11. F	
12. T	
13. T	

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