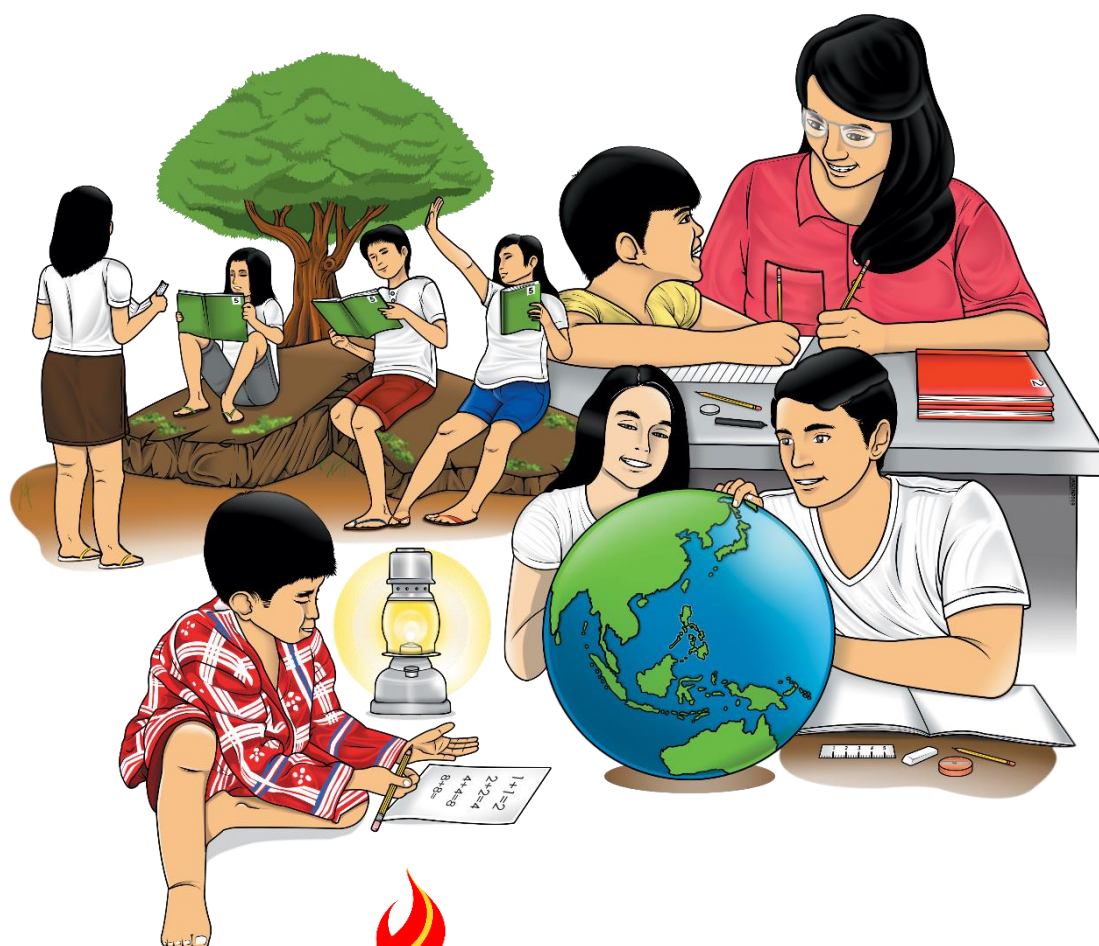


Science

Quarter 1 - Module 8: Electrical Circuit



Science – Grade 8
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Science

Quarter 1 - Module 8:

Electrical Circuit

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 them.

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.

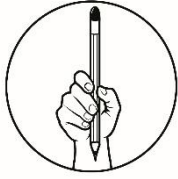


What I Need to Know

This module was designed and written with you in mind. It is here to help you understand the properties, advantages and disadvantages of electric circuit. The scope of this module permits it to be used in many different learning situations. The language used recognizes the diverse vocabulary level of students. The lessons are arranged to follow the standard sequence of the course. But the order in which you read them can be changed to correspond with the textbook you are now using.

After going through this module, you are expected to:

1. Explain the advantages and disadvantages of series and parallel connections at homes. (*MELC Week 7 S8FE-li-31*)



What I Know

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

1. It is a closed-loop through which current flows.
 - A. Circuit
 - B. Current
 - C. Resistance
 - D. Voltage

For question nos. 2 to 6, the choices are as follows:

- A. series circuit
 - B. parallel circuit
 - C. either A or B
 - D. neither A nor B
2. What type of circuit is appropriate in connecting appliances and light bulbs at home?
3. What type of circuit connection is used in Christmas lights?
4. What type of circuit connection should a light bulb be connected to maintain maximum brightness?
5. What type of circuit connection should a light bulb be connected to maintain the amount of current in the conducting wire?
6. Circuits at home are usually connected in _____.
7. The following are advantages of bulbs connected in series EXCEPT:
 - A. It does not overheat.
 - B. It is easy to install and maintain.
 - C. Low current is needed to light all the bulbs.
 - D. Large amount of current is needed to light all the bulbs.
8. The following are disadvantages of connecting too many bulbs in parallel EXCEPT:
 - A. Bulb will easily overheat.
 - B. It is difficult to maintain and install.
 - C. There will be current overloading in the conducting wire.
 - D. There will be equal amount of voltage for every load in a circuit.

9. If one bulb of Christmas lights, connected in series is burned out, what will happen to the other light bulbs?
- A. All other bulbs will no longer work.
 - B. All other bulbs will continue to light.
 - C. The brightness of the bulbs will increase.
 - D. The brightness of the bulbs will decrease.
10. Three light bulbs with resistances $2000\ \Omega$, $1600\ \Omega$, and $800\ \Omega$ are connected in series respectively. Which one has the highest brightness when the circuit is plugged to a 220 V voltage source?
- A. $800\ \Omega$
 - B. $1600\ \Omega$
 - C. $2000\ \Omega$
 - D. none of the above
11. Which of the following is usually connected in a series circuit?
- A. Christmas lights
 - B. appliances at home
 - C. light bulbs at home
 - D. headlight of motorcycle
12. Which of the following best describes a parallel circuit?
- A. Current flows along one pathway.
 - B. Current flows along more than one pathways.
 - C. The flow of current comes from several sources.
 - D. The flow of current comes from more than one load.
13. Which of the following best describes a series circuit?
- A. Current flows along one pathway.
 - B. Current flows along many pathways.
 - C. The flow of current comes from the switch.
 - D. The flow of current comes from the light bulb.
14. What will happen if one light bulb is removed from a series circuit?
- A. The other bulbs will not work.
 - B. The other bulbs will get dimmer.
 - C. The other bulbs will get brighter.
 - D. The battery will become stronger.
15. What will happen if one light bulb is removed from a parallel circuit?
- A. The other bulbs will not work.
 - B. The other bulbs will get dimmer.
 - C. The other bulbs will continue to light.
 - D. Some bulbs will get dimmer and some will get brighter.

Lesson 1

Advantages and Disadvantages of Series and Parallel Circuits

In our previous lesson, we learned how to apply Ohm's Law for every current that passes through a load. Ohm's law is applicable within a circuit at home. Meaning, the amount of voltage, current and resistance, could be determined when electrical devices are working or functioning at home. Also, these devices need a closed loop from the voltage source for the electrical charges to flow in a conducting wire. In this lesson, we shall explain more about circuit, types of circuit and their distinctive properties including their advantages and disadvantages when used at home.



What's In

Basics of Electric Circuit

A closed loop through which current can flow is called an **electric circuit**. For a continuous flow of electrons, there must be a complete circuit with no gaps. A gap is usually provided by an electric switch that can be opened or closed to either cut off or allow energy to flow.

The flow of electron starts from the negative terminal of a battery where there are abundant negative charges, to the load, to the electrical switch, and back to the positive terminal where there are deficient negative charges.

Here in the Philippines, most electric circuits at home have a voltage of 220 volts. The amount of current a circuit carries depends on the number and power of electrical devices connected to the circuit. Home circuits have maximum service drop current of 60 A. But for safety purposes what is supplied for every voltage source is from 15 to 30 A.

Components of Electric Circuit

All electric circuits have at least three components: a voltage source, conducting wires, and loads. They may have other parts as well, such as switches.

Voltage source is a device that maintains a constant amount of voltage. Common voltage sources used at home are battery, generator, wall socket, and electric outlet.

Conducting wires are special kind of conductors where current can pass through easily. There is a corresponding safe amount of current that can pass through for every size, thickness, or cross-sectional area of conducting wire. So, it is important to consider the dimension of wire to be used when connecting a load or number of loads in a circuit.

Electrical switch is a device that can control the entrance of current. When it is on, the circuit is closed, then current can pass through. When it is off, the circuit is open, and current cannot pass through.

Electrical load is an electrical device that converts electrical energy to heat like in the case of electric iron, and to light and heat like in the case of a light bulb.

Activity 1. Familiarizing Electric Circuit

Directions: Draw and label the parts of a basic electrical circuit. Write your answers on a separate sheet of paper.

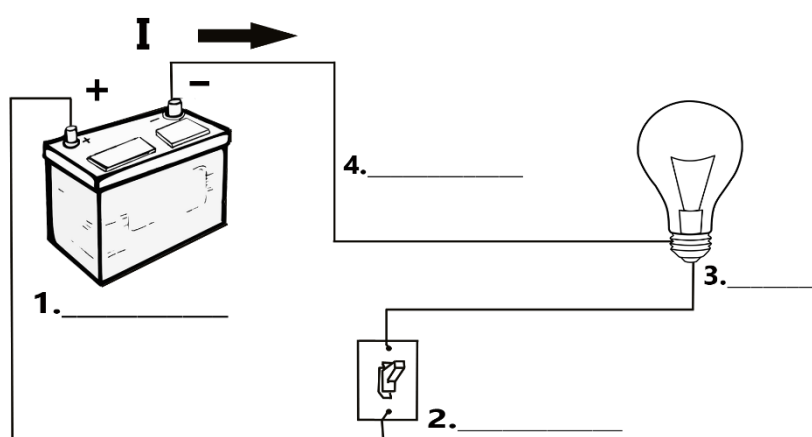


Fig. 1 Components of Electric Circuit

Illustrated by: Rosa Mia L. Pontillo

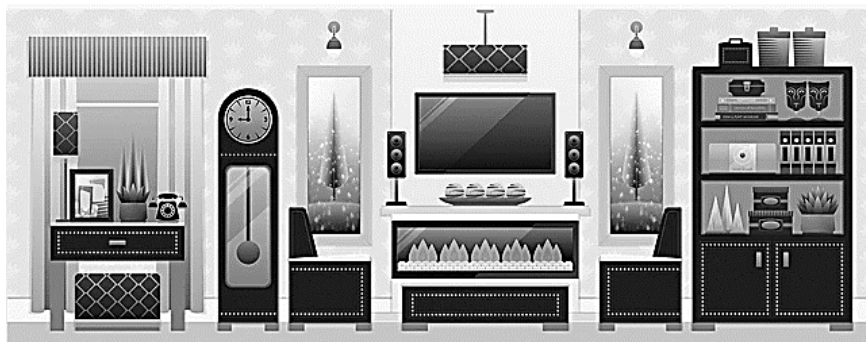


What's New

Activity 2. Identifying Circuit Connection at Home

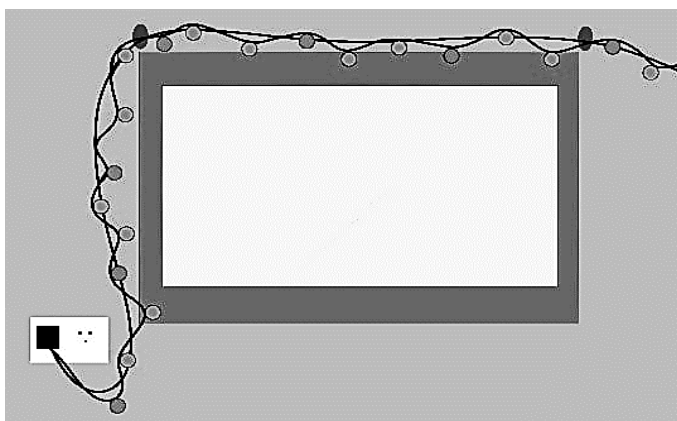
Directions: The pictures below show common circuit connection at home. Describe how these appliances and light bulbs are connected at home. Write your answers on a separate sheet of paper.

1.



Illustrated by: Rosa Mia L. Pontillo

2.



Illustrated by: Rosa Mia L. Pontillo

Rubrics for Scoring	
2 points	Descriptions about circuit connections at home are complete.
1 point	Descriptions about circuit connections at home are incomplete.
0	No description.



What is It

We shall now explore the two types of circuit connections. At this point, it is again important to recall that circuit provides a path for electrons to flow. This path can be in a single direction or can be a branched path. If you were an electron and were given a single path, you do not have another option but to proceed and take that path. If you were given more paths to take, then you can choose from among these paths. If there were many of you, you may divide yourselves among the paths. Do electrons behave in the same manner? Yes, you are right! They move through the conducting wires in the circuit.

Series Circuit

A circuit that consists of one loop is called a **series circuit**. You can see a simple series circuit diagram in Figure 2. If a series circuit is interrupted at any point in its single loop, no current can flow through the circuit and no loads in the circuit will work. In series circuit, if one light bulb burns out, the other light bulb will not work because it will not receive any current. Series circuits are commonly used in Christmas lights. The electrical switch is also connected in series with the light bulbs.

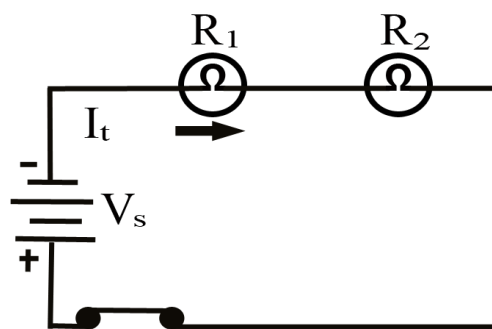


Fig. 2 Series connection with two light bulbs

Illustrated by Rey R. Angel

where: V_s = voltage source

I_t = total current

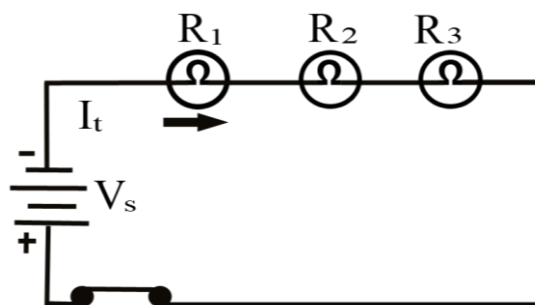
R_1 and R_2 are loads connected in series

Properties of a Series Circuit

1. The total resistance of a series circuit is the sum of all resistances in the circuit. Total resistance is always greater than the individual resistances in a series circuit.
2. The voltage source is equal to the sum of all voltages in each load in a circuit.
3. The current is constant across each load.

Figure 3 shows an example of an electric circuit diagram in series connection. There are three loads in the circuit with corresponding resistances: R_1 , R_2 and R_3 respectively. Using the properties of series connection, the total resistance (R_t) is equal to the sum of R_1 , R_2 and R_3 or $R_t = R_1 + R_2 + R_3$. The total resistance is greater than R_1 , R_2 and R_3 or $R_t > R_1$, $R_t > R_2$, $R_t > R_3$. Each load has different voltage V_1 for R_1 , V_2 for R_2 and V_3 for R_3 . But the voltage source (V_s) is equal to the sum of V_1 , V_2 and V_3 or $V_s = V_1 + V_2 + V_3$. Since current is equal across each load, therefore,

$$I_t = I_1 = I_2 = I_3.$$



*Fig. 3 Series connection with three light bulbs
Illustrated by Rey R. Angel*

Using Ohm's Law, voltage can be expressed as follows:

$V_s = I_t R_t$	Voltage source using the values of R_t and I_t
$V_1 = I_t R_1$	Voltage at R_1 using the constant value of I_t
$V_2 = I_t R_2$	Voltage at R_2 using the constant value of I_t
$V_3 = I_t R_3$	Voltage at R_3 using the constant value of I_t

Since, $V_s = V_1 + V_2 + V_3$
Then, $I_t R_t = I_t R_1 + I_t R_2 + I_t R_3$
 $= I_t (R_1 + R_2 + R_3)$

Resulting to $R_t = R_1 + R_2 + R_3$, total resistance of a series circuit for three resistances.

So generally, for a series circuit the total resistance

$$R_t = R_1 + R_2 + R_3 + \dots$$

Since $I_t = \frac{V_s}{R_t}$, in a series circuit, the more load is added, the total resistance increases at constant current. The load with higher resistance has greater amount of voltage across it, causing the load to convert more electrical energy to light and heat.

Advantages of Using Series Connection

The following are some of the advantages of series connection:

1. A series connection does not overheat easily. For a given circuit of two loads, the amount of current passing through each load is constant. If you add more loads, the amount of current passing through in all the loads is still constant. However, the amount of current in a circuit with two loads is higher than the amount of current in a circuit with more than two loads. Meaning, the more loads connected in series circuit the amount of current reduces.

2. In a series circuit, there is the only one path for the current to flow from the voltage source to the different loads. It would be easy to connect and disconnect new load.

3. Since series circuit is less likely to overheat, there is no need to use expensive, thick wires.

Disadvantages of Using Series Connection

The following are some of the disadvantages of series connection:

1. If one of the light bulbs is damaged or removed in a series connection, all other light bulbs in the circuit will not light too. This is because the point where the bulb is damaged or removed causes the circuit to open, resulting to discontinue the flow of current in the circuit.

2. The addition of more light bulbs in series circuit causes a decrease in the brightness of the bulbs. Given a fixed amount of voltage supplied by the voltage source, the more bulbs are added would mean more bulbs will share the available electrical energy to be converted to light energy.

3. The loads in a series circuit are difficult to control individually. When the switch is off, all loads in the circuit will not function anymore.

4. It is difficult to identify the damaged bulb in the circuit.

Parallel Circuit

A circuit that has two or more loops is called a **parallel circuit**. A simple parallel circuit diagram of two loops is shown in Figure 4. If one loop is interrupted, the current can still flow through the other loop. In the parallel circuit, if one light bulb burns out, the other light bulb will still work because current can still flow through it. A common example of parallel circuit is the connection of electrical wirings at home.

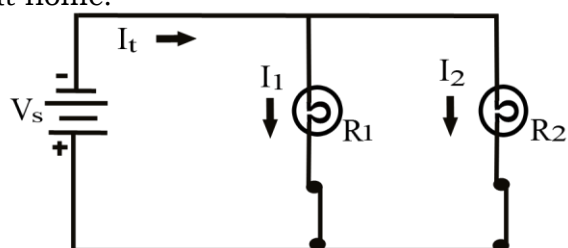


Fig. 4 Parallel connection with two light bulbs

Illustrated by Rey R. Angel

Where: V_s = voltage source
 I_1 = current at R_1
 I_2 = current at R_2
 I_t = total current
 R_1 and R_2 are loads connected in parallel

Properties of a Parallel Circuit

1. The reciprocal of the total resistance in a parallel circuit is the sum of the reciprocal of all resistances in the circuit. Total resistance is always less than the smallest resistance in the circuit.
2. There is only one voltage which is equal to a voltage source.
3. The total current is equal to the sum of all currents in each load in a parallel circuit.

Figure 4 shows an example of an electric circuit diagram in parallel connection. There are two loads in the circuit with corresponding resistances, R_1 and R_2 respectively. Using the properties of parallel connection, the total resistance

(R_t) is always less than the smallest resistance in the circuit. Each load has different current I_1 for R_1 and I_2 for R_2 . But the total current (I_t) is equal to the sum of I_1 and I_2 or $I_t = I_1 + I_2$. Since voltage is equal across each load, therefore, $V_s = V_1 = V_2$.

Applying Ohm's Law in Figure 4, current can be expressed as follows:

$$\begin{aligned} I_t &= \frac{V_s}{R_t} && \text{Total current using the values of } V_s \text{ and } R_t \\ I_1 &= \frac{V_s}{R_1} && \text{Current at } R_1 \text{ using the constant value of } V_s \\ I_2 &= \frac{V_s}{R_2} && \text{Current at } R_2 \text{ using the constant value of } V_s \end{aligned}$$

Since, $I_t = I_1 + I_2$ equation 1

Then, $\frac{V_s}{R_t} = \frac{V_s}{R_1} + \frac{V_s}{R_2}$ equation 2

Multiplying equation 2 with $\frac{1}{V_s}$ would result to:

$$\frac{1}{R_t} = \frac{1}{R_1} + \frac{1}{R_2}, \quad \text{Total resistance of a parallel circuit}$$

So generally, the total resistance for more than two loads connected in parallel is given by:

$$\frac{1}{R_t} = \frac{1}{R_1} + \frac{1}{R_2} + \dots$$

Since $I_t = \frac{V_s}{R_t}$, the more load is added in parallel connection, the total resistance decreases and current also increases.

Advantages of Using Parallel Connection

The following are some of the advantages of parallel connection:

1. All loads in parallel connection are directly connected to the voltage source. Even the resistances vary, all light bulbs can still have their maximum brightness.
2. In a parallel circuit, even if one of the light bulbs is damaged, all other light bulbs will still function since the flow of current is not entirely interrupted.
3. Individual load in a parallel circuit is easy to control. Each load has a connecting wire for the current to flow, and each may have its own switch. Even if you switch off one bulb, other bulbs are not affected.
4. All light bulbs and appliances at home are connected in parallel. Switching off some appliances does not affect other appliances.

Disadvantages of Using Parallel Connection

The following are some of the disadvantages of parallel connection:

1. Overloading may happen if appliances are simultaneously used at home. With more loads, total resistance decreases resulting to excessive, large amount of current that would pass through the conducting wires. Consequently, overheating of wires takes place which may lead to fire.
2. A parallel connection is difficult to install, maintain, and repair since large volume of conducting wires is needed. When problem in the connection occurs, it is difficult to identify which loop among the many loops does not work.
3. It requires the use of several conducting wires of varying sizes.



What's More

Activity 3. Checking Your Understanding on Series and Parallel Circuit

Directions: Write **True** if the statement is true and if the statement is false, change the underlined word to make the statement true. Write your answers on a separate sheet of paper.

- _____ 1. In a series circuit, if one light bulb does not function all other light bulbs will still function.
- _____ 2. In a parallel circuit, not all light bulbs do not have the same brightness in the circuit.
- _____ 3. In a parallel circuit, loads are easy to control individually.
- _____ 4. A parallel circuit is easy to install.
- _____ 5. Series circuits do not overheat easily.
- _____ 6. Adding more loads in parallel circuit may overload the circuit.
- _____ 7. Every load in a parallel circuit has the same voltage.
- _____ 8. The parallel circuit is difficult to install and repair due to the volume of conducting wires required in the connection.
- _____ 9. In a series circuit, loads are difficult to control individually.



What I Have Learned

Directions: Fill in the blanks to complete the statements. Write your answers on a separate sheet of paper.

1. Circuit connections can either be series or parallel. In a _____ connection, there is only one path of electrons, and loads connected have the same current passing through them. However, in a _____ connection, there are several pathways for the current to flow through.
2. The total resistance in a _____ circuit is the sum of all resistances connected in the circuit.
3. The voltage source in _____ circuit is the sum of all voltages of the loads connected in the circuit.
4. The total resistance in a _____ circuit is greater than the largest resistance across the circuit.
5. Loads connected in parallel circuit have the _____ voltage.
6. The reciprocal of the total resistance in a _____ circuit is the sum of the reciprocal resistances across the circuit.
7. The total resistance in a parallel circuit is _____ than the smallest resistance across the circuit.
8. Switches are connected in _____ connection with the load.
9. In _____ circuit, all loads are directly connected to the voltage source. However, if too many loads are simultaneously connected at home, overloading may happen.
10. In _____ circuit, overheating does not easily happen. But, the addition of more light bulbs in this circuit causes a decrease in the brightness of the bulbs.



What I Can Do

Activity 4. Electrical Connection at Home

Directions: Study the situation below, then answer the questions that follow. Write your answers on a separate sheet of paper.

In a household, a family of seven members shares the spaces of two bedrooms, one comfort room, a kitchen, a living room and a balcony. The bedrooms have light bulbs and ceiling fan. The comfort room that has one light bulb is situated near the living room that also has light bulb, refrigerator, ceiling fan, and TV in place. In the kitchen space, light bulb, washing machine, heater and electric stove can be found. The household has also a balcony installed with a light bulb.

1. How are the light bulbs connected in the household?

2. How are the appliances in the living room connected?

3. How are the appliances in the kitchen connected?

4. Based on your answers in questions 1 to 3, what are the advantages and disadvantages when electrical devices at home are connected in that manner?

Rubric for Scoring	
2 points	Discussions are complete based on the advantages and disadvantages of circuit connections.
1 point	Discussions are incomplete based on the advantages and disadvantages of circuit connections.
0	No discussion.



Assessment

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

1. Which of the following electrical quantities in parallel circuit is constant?
 - A. Voltage
 - B. Current
 - C. Resistance
 - D. Total resistance

2. What happens to the brightness of the bulbs connected in series when more and more bulbs are added to the circuit?
 - A. increases
 - B. decreases
 - C. remains the same
 - D. cannot be predicted

3. The following are advantages of a series circuit EXCEPT:
 - A. Series circuits do not overheat easily.
 - B. Easy to install and easy to repair and maintain.
 - C. All loads in a series circuit have the same current.
 - D. If one load fails, all loads in the circuit will not function.

4. The following are disadvantages of a series circuit EXCEPT:
 - A. It is difficult to control the load individually.
 - B. It is easy to install, repair and maintain the circuit.
 - C. It is difficult to identify the damaged light bulb in the circuit.
 - D. Since voltage is not equal for every load, not all loads will have the same brightness.

5. The following are advantages of a parallel circuit EXCEPT:
 - A. Loads are easy to control.
 - B. If one load fails, other loads can still function.
 - C. Large volume of conducting wires will be needed.
 - D. Every load connected in parallel circuit gets an equal amount of voltage.

6. The following are true about parallel circuit EXCEPT:
- A. Voltage is constant across the circuit.
 - B. Total resistance is less than the smallest resistance in the circuit.
 - C. Total resistance is greater than the largest resistance in the circuit.
 - D. Total current is the sum of current passing through all the loads in the circuit.
7. Which of the following is correct, when the resistances of $1.0\ \Omega$, $2.0\ \Omega$ and $3.0\ \Omega$ are connected in series circuit?
- A. The total resistance is less than $1.0\ \Omega$.
 - B. The total resistance is less than $2.0\ \Omega$.
 - C. The total resistance is less than $3.0\ \Omega$.
 - D. The total resistance is greater than $3.0\ \Omega$.
8. Which of the following is correct, when the resistances of $1.0\ \Omega$, $2.0\ \Omega$ and $3.0\ \Omega$ are connected in parallel circuit?
- A. The total resistance is less than $1.0\ \Omega$.
 - B. The total resistance is greater than $1.0\ \Omega$.
 - C. The total resistance is greater than $2.0\ \Omega$.
 - D. The total resistance is greater than $3.0\ \Omega$.
9. Which of the following is connected in series with the load at home?
- A. TV
 - B. Switch
 - C. Light bulbs
 - D. Refrigerator
10. The following are connected in parallel circuit at home EXCEPT:
- A. TV
 - B. Light bulbs
 - C. Refrigerator
 - D. Christmas lights

For question nos. 11 to 15, the choices are as follows:

- A. advantage of series circuit
 - B. advantage of parallel circuit
 - C. disadvantage of series circuit
 - D. disadvantage of parallel circuit
11. The circuit does not overheat easily.
12. It is easy to control the load individually.
13. Adding more loads may cause overloading in the circuit.
14. If one bulb is damaged in the circuit, other bulbs will still function.
15. If one bulb is damaged in the circuit, all other bulbs will not function too.



Additional Activities

Activity 5. The Use of Extension Wires at Home

Directions: State the advantages and disadvantages when the manner of using extension wires at home is the same with what is shown in figure 5. Write your answers on a separate sheet of paper.

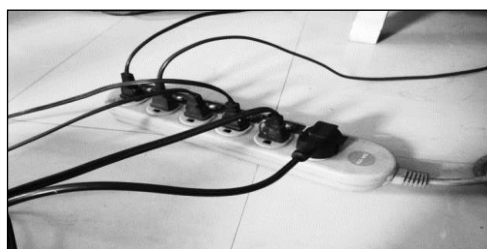


Fig. 5 Actual use of extension wire at home

Illustrated by: Rosa Mia L. Pontillo

Advantages:

Disadvantages:

Rubric for Scoring	
2 points	Discussions are conceptually complete.
1 point	Discussions are conceptually incomplete.
0	No discussion



Answer Key

<p>What I Know</p> <ol style="list-style-type: none"> A B A B A B D D A C A B A A C 	<p>What I In</p> <p>Activity 1</p> <ol style="list-style-type: none"> battery electrical switch light bulb/load conducting wire 	<p>What's More</p> <p>Activity 3</p> <ol style="list-style-type: none"> Parallel circuit Series circuit True difficult True True True True True
<p>What's New</p> <p>Activity 2</p> <ol style="list-style-type: none"> Appliances and light bulbs are connected in two different conducting wires. One wire connects from the source to the appliances and light bulbs, and another wire is connecting them back to the voltage source. Christmas lights are connected in single conducting wire from the voltage source. 	<p>What I Have Learned</p> <ol style="list-style-type: none"> series, parallel series series series same/constant parallel less/less series parallel series 	<p>What I Can Do</p> <p>Activity 4</p> <ol style="list-style-type: none"> Light bulbs are connected in parallel. Appliances in the living room are connected in parallel. Appliances in the kitchen are connected in parallel. In parallel circuit, appliances and light bulbs can be controlled individually. However, operating

Additional Activities

Activity 5

1. Possible answers to the advantages of extension wire:
 - a. Easy supply of voltage to appliances far from the voltage source.
 - b. Easy to plug in or plug out gadgets connected in the extension wire; and
 - c. Portable temporary voltage source.
2. Possible answers to the disadvantages of extension wire:
 - a. Using all available sockets may cause overloading
 - b. Not safe when devices or loads are connected permanently; and
 - c. Not safe even if a single fracture in the conducting wire is observed.

Assessment

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

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