NATIONAL UNIVERSITY - MANILA

CCPHYS2L: College Physics 2 Lab

ACTIVITY NO. 2

SCORE:

SIMPLE CIRCUIT, CONDUCTORS, AND INSULATORS

(TITLE OF EXPERIMENT)

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CCPHYS2L - COM231

(SUBJECT CODE AND SECTION)

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(DATE OF PERFORMANCE)

3

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COLLEGE PHYSICS 2 LABORATORY	ACTIVITY 2

ACTIVITY 2: Simple Circuit, Conductors, and Insulators

2.1 Program Outcomes (POs) Addressed by the Activity

a. Apply knowledge of computing fundamentals, knowledge of a computing specialization, and mathematics, science and domain knowledge appropriate for the computing models from defined problems and requirements.
b. Identify, analyze, formulate, research literature, and solve computing problems and requirements reaching substantiated conclusions using fundamental principles of mathematics, computing sciences, and relevant domain disciplines.

2.2 Activity's Intended Learning Outcomes (AILOs)

At the end of this activity, the student shall be able to:

a. Determine whether a sample material is a conductor or insulator.
b. Interpret and implement basic circuit schematic diagram.

2.3 Objectives of the Activity

The objectives of the activity are:

a. Build simple circuits.
b. Draw the corresponding circuit diagrams.
c. Test different materials and electrical components (resistances) for conductivity.

2.4 Principle of the Activity

A circuit is a closed loop where charges can freely flow from the power source through the conductor to the load without interruption and back again to the power source or sometimes to the ground. This flow of charges is called electric current or current.

A simple circuit is a circuit that consists of a battery (power source), a bulb (load), and conducting wires that connects the positive and negative terminal of a battery to the bulb. However, there is a mechanical device that can alter an electric signal, which results in turning on and off an electric circuit. This mechanical device is called a switch.

Conductors are material that allows an electron to flow from one particle to another particle. A material will permit the charge to be transferred across its entire surface if it is made up of a conducting material. Metals are good conductors and the most economical and most common conductor that is available in the market and widely used is copper. However, copper is not the best conductor when it comes to conductivity, the element that has the highest conductivity is silver. On the other hand, if a material is made up of an insulating material the charge cannot be transferred anywhere, and it will remain on its location. These materials are called insulators, and examples of these are rubber, plastic, and wood.

2.5 Materials/Equipment

Simple Circuit

1	pc	layout plug-in board
1	pc	lamp holder
1	pc	type A bulb (2.5V/0.1A)
1	pc	type B bulb (12 V / 3W)
1	pc	red lead, 50 cm
1	pc	mono-cell
1	pc	mono-cell holder
1	pc	SPST
3	pcs	jumper plugs

Conductors and Insulators

1	pc	layout plug-in board
3	pcs	jumper plugs
1	pc	lamp holder
1	pc	toggle switch
1	pc	voltage source, 12 V
1	pc	type B bulb (12 V)
1	pair	plug-in clamps
1	pc	lead, red 25 cm
1	pc	lead, blue 25 cm
1	pc	47-ohm resistor
1	pc	100-ohm resistor
1	set	test materials

2.6 Procedure/s

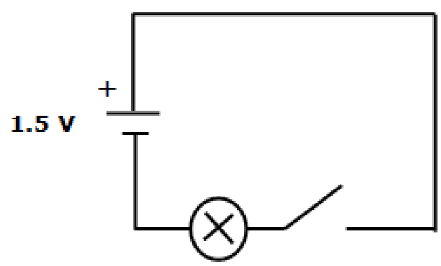


Figure 2.1

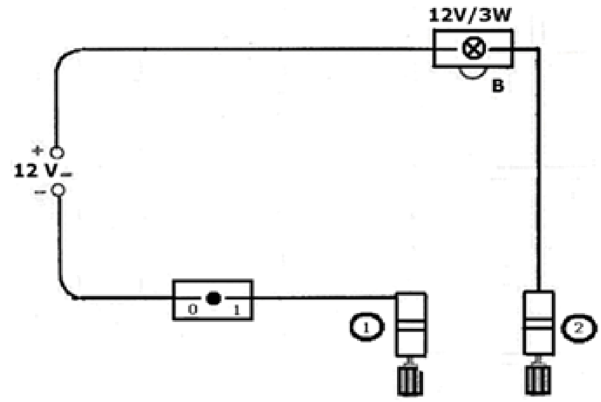


Figure 2.2

2.6.1 Simple Circuit Without a Switch

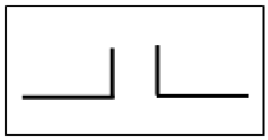
a. Fit the mono-cell to the layout plug-in board using the mono-cell holder.
b. Screw the type A bulb into the lamp holder.
c. Using the plug-in board, the lamp placed in a holder, mono-cell, and a red lead, build a circuit using the mono-cell as the power supply unit and the lamp as the current indicator. How do you turn off the lamp?
d. Using the appropriate symbols, draw the circuit diagram for the circuit you have built.

2.6.2 Simple Circuit with Switch

a. Connect the mono-cell, switch, lamp (type A), and lead together in a simple circuit. Use the diagram as shown in Figure 4.1.
b. Check whether the connections between the individual components (mono-cell, switch, and bulb) can be interchanged without affecting the brightness of the lamp.
c. Determine how many ways can you arrange the three components. Draw the circuit diagrams showing these combinations.
d. Using the bulb as your current indicator, can you see any difference in the intensity of the current if you change the order in which the components are connected?
e. Screw a type B bulb into the lamp holder instead of a type A bulb. Build a similar circuit. Actuate the switch. What do you observe?
f. Replace the lead with jumper plugs. Does the lamp change in brightness?

2.6.3 Testing Various Substances for Conductivity.

a. Build the circuit as shown in Figure 4.2.
b. Test the materials listed in Table 4.1 for conductivity. Identify which substance conducts current, and which does not conduct current. Write your observations in Table 4.1.
c. Draw the circuit diagram of the test circuit as shown in the figure. Use the symbol for the test connection below:



2.6.4 Testing Resistances

a. Modify the circuit diagram in Figure 4.2 so that you can test the conductivity of the plug-in resistors.
b. Close the circuit by inserting a 47-ohm resistor in the place of the plug-in clamps. Actuate the switch and watch bulb. Note down your observations.
c. Replace the resistor with a 100-ohm resistor. Observe and record what happens.

2.7 Data

Table 1 Testing Materials for Conductivity	
MATERIALS	**CONDUCTOR or INSULATOR**
Aluminum	**Conductor**
Brass	**Conductor**
Copper	**Conductor**
Plastic	**Insulator**
Paper	**Insulator**
Wood	**Insulator**
Stainless Steel	**Conductor**

Procedure 1

Table 2: Voltage & Resistance (No Resistor)		
MATERIALS	**VOLTAGE (V)**	**RESISTANCE(Ω)**
Aluminum	5.9	0.2
Brass	5.8	0.4
Copper	6.0	0.1
Plastic	0.0	$>10^6$
Paper	0.1	~500,000
Wood	0.2	~100,000
Stainless Steel	5.5	0.8

Procedure 2

Table 3: Voltage & Resistance (100Ω Resistor)		
MATERIALS	**VOLTAGE (V)**	**RESISTANCE(Ω)**
Aluminum	0.1	0.2
Brass	0.2	0.4
Copper	0.05	0.1
Plastic	5.9	$>10^6$
Paper	5.8	~500,000
Wood	5.7	~100,000
Stainless Steel	0.4	0.8

2.8 Calculations

$V=I\times R$
$R=V/I$

Procedure 1:

Voltage across copper = 6V
Current = 3A

$R=6/3= 2\ \Omega$

Procedure 2:

Resistor = 100Ω
Voltage across resistor = 5.8V

$I=V/R=5.8/100=0.058$ A

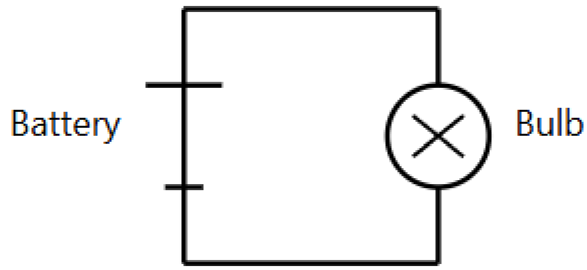
Voltage across aluminum = 0.2V

$R=0.20/0.058\approx 3.45\ \Omega$

2.9 Questions

a. How do you turn off the light in procedure 4.6.1 c?
   - *By disconnecting the wires from the power supply*.

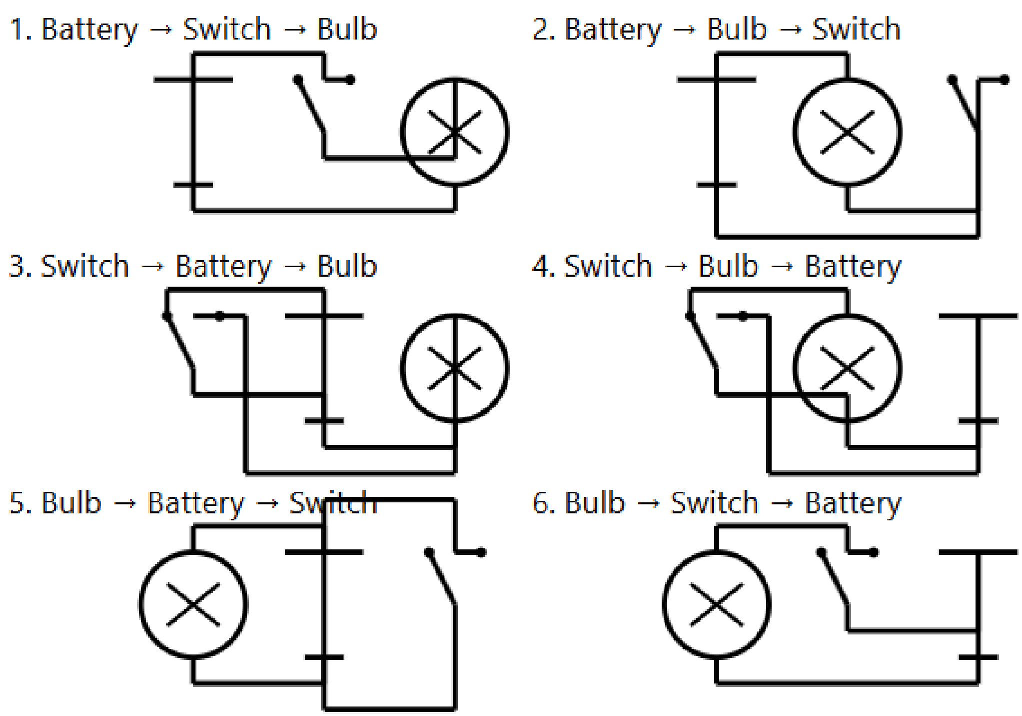
b. Draw the circuit diagram for this part of the experiment.



c. How many ways can you arrange the three components (procedure 4.6.2 c)?
- You can arrange the three components (battery, switch, and bulb) in 6 different ways.

d. Draw the circuit diagrams of the combinations you observed.

1. Battery → Switch → Bulb
2. Battery → Bulb → Switch
3. Switch → Battery → Bulb
4. Switch → Bulb → Battery
5. Bulb → Battery → Switch
6. Bulb → Switch → Battery

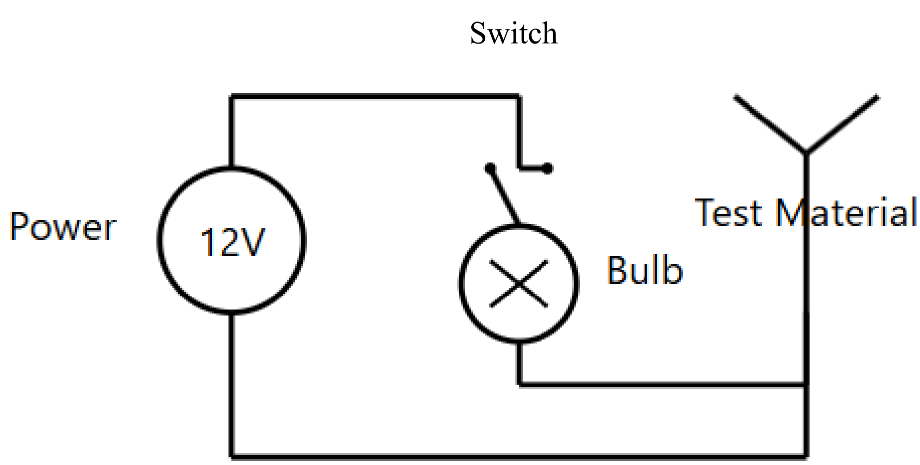


e. Is there a difference in the intensity of the current if you change the order in which the components are connected?
   - *No, as we're only changing the order and not the components itself. Therefore, no changes were made to the total resistance and voltage which are what influences the current.*

f. What happened when the type A bulb was replaced with a type B bulb (procedure 4.6.2 e)?
   - *Compared to the type A bulb, the type B bulb was significantly dimmer. Probably due to it requiring a higher voltage and power which the power supply did not meet.*

g. What happened when the leads were replaced with jumper plugs?
   - *There was a slight increase in its brightness due to the lower resistance of the jumper plugs.*

h. Draw the Circuit Diagram for Figure 4.2.



i. Does more current flow through the 100-ohm resistor, compared to the 47-ohm resistor? Explain
   - *No, as the 100-ohm resistor actually allows less current to pass through than the 47-ohm resistor per the Ohm's law which states*

$$V = IR \quad \text{or} \quad I = \frac{V}{R} \quad \text{or} \quad R = \frac{V}{I}$$

Where:

- *I is current in amperes (A)*
- *V is voltage in volts (V)*
- *R is resistance in ohms (Ω)*

For the 47-ohm resistor:

If we assume the voltage source is 12V (as given in the materials list):

$$I_{47\Omega} = \frac{12V}{47\Omega} \approx 0.255A$$

For the 100-ohm resistor:

With the same voltage source:

$$I_{100\Omega} = \frac{12V}{100\Omega} = 0.12A$$

As shown by the calculations, significantly more current (approximately 2.13 times more) flows through the 47-ohm resistor than through the 100-ohm resistor. This is because current is inversely proportional to resistance when voltage remains constant. This relationship is fundamental to electrical circuits and explains why higher resistance components limit current flow more than lower resistance components.

The experimental observations in the lab should confirm this mathematical relationship, as the bulb would appear brighter with the 47-ohm resistor in the circuit compared to when the 100-ohm resistor is used.

2.10 Discussion

On this activity, we have tested different scenarios by changing up the material we conduct electricity to, and also applying a resistor. First is the following:

Part 1, No resistor

Regarding the available materials we tested (Aluminum, Brass, Copper, Plastic, Paper, Wood, Stainless Steel), we can see the trend that the organic materials which are plastic, paper and wood are good for insulating electricity as they have higher resistance than the others on the table.On the other hand, we can see the metals have lower resistance and it made them better for conducting electricity.

Part 2, with 100Ω Resistor

When testing with the 100Ω Resistor, we have observed that for the organic materials, we saw more voltage flowing to the resistor. On the other hand, when testing the metals with the resistor, we can see that there is very little voltage flowing to the resistor.

2.11 Conclusion

This laboratory experiment successfully achieved its objectives of building simple circuits, drawing corresponding circuit diagrams, and testing various materials and electrical components for conductivity. Through hands-on investigations, we were able to verify fundamental electrical principles and make several key observations:

1. **Conductors vs. Insulators**: The experiment clearly demonstrated the distinction between conductors and insulators. Materials like aluminum, brass, copper, and stainless steel showed low resistance values (0.1-0.8Ω) and allowed current to flow easily, confirming their status as good conductors. Conversely, plastic, paper, and wood exhibited extremely high resistance values (100,000Ω and above), preventing significant current flow and confirming their insulating properties. This aligns with theoretical expectations that metals generally serve as conductors while organic or carbon-based compounds typically function as insulators.
2. **Effect of Resistance**: The testing of different resistors (47Ω and 100Ω) demonstrated Ohm's Law in action. As resistance increased from 47Ω to 100Ω, the current decreased proportionally, following the inverse relationship described by $I = V/R$. This was visibly apparent in the decreased brightness of the bulb when using the higher resistance component.
3. **Circuit Configurations**: We verified that the arrangement order of components in a series circuit does not affect the circuit's operation or the current flowing through it. All six possible arrangements of the battery, switch, and bulb functioned identically, confirming that current is constant throughout a series circuit regardless of component sequence.

4. **Voltage Distribution**: When testing materials with the 100Ω resistor in the circuit, we observed that conductors carried minimal voltage drop (0.05-0.4V) while allowing most of the voltage to appear across the resistor. In contrast, insulators caused most of the voltage drop to occur across themselves (5.7-5.9V) rather than the resistor, effectively demonstrating voltage division principles in series circuits.
5. **Component Selection**: The experiment demonstrated the importance of matching components to power sources, as evidenced when replacing the type A bulb (2.5V/0.1A) with the type B bulb (12V/3W), resulting in significantly dimmer illumination due to inadequate voltage.

In conclusion, this experiment successfully reinforced theoretical electrical concepts through practical application, allowing direct observation of how electrical current behaves in simple circuits and how different materials and components affect this behavior. The results confirm Ohm's Law relationships and provide a clear visual demonstration of the properties of conductors and insulators, fundamental concepts for understanding electrical systems.

2.12 References

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