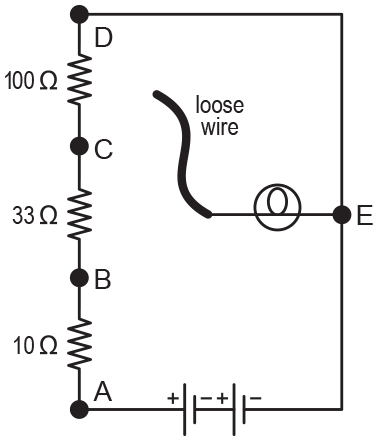
# **Investigation: Variable Resistance**

**Essential question: How does a variable resistor work?**

Common batteries provide voltages in 1.5 V increments. This is fine if you want voltages with values of 1.5 V, 3.0 V, 4.5 V, and so on, but what if you wanted a voltage in between those values? This can be done by varying the resistance in a circuit. In this investigation, you build circuits with variable resistances using a voltage divider and a variable resistor (potentiometer).



Part 1: Voltage divider

1. Build the circuit shown in the diagram.
2. Use a wire to connect the light bulb to point A and note the brightness of the bulb. Repeat for points B, C, and D, noting the brightness of the bulb in each case.
3. Open the experiment file **VariableResistance** then connect the voltage sensor to your software.
4. Connect the black probe of the Voltage Sensor to point E.
5. Connect the red probe to point A and record the voltage. Repeat for points B, C, and D.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Point | A | B | C | D |
| Voltage (V) | 3.18 | 2.96 | 2.23 | 0 |

Questions

1. What happened to the voltage as you progressed from points A through D? Why?

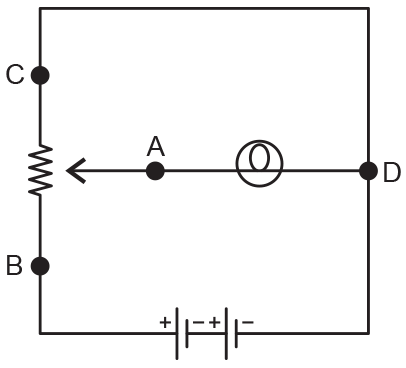
Answer: The voltage drops. As you move from A to D, there is additional resistance between the positive end of the battery which causes a larger voltage drop.

1. What happened to the brightness of the bulb as you progressed from points A through D? Why?

Answer: The bulb became dimmer as the wire was moved from points A to D. At each point, there is a different voltage which caused a change in the brightness of the bulb.

1. Mix up the order of the resistors and repeat the experiment. Try at least two different combinations. What results are similar to the original experiment? What is different? Explain.

Answer: The bulb will always get dimmer and the voltage will always drop as you progress from A to D. However, since the voltage drop is dependent on the resistance, there will be a difference in the voltage measurements depending on how the resistors are arranged.

Part 2: Variable resistor (potentiometer)

1. Build the circuit shown in the diagram.
2. Connect the black probe of the voltage sensor to point D.
3. Connect the red probe of the voltage sensor to point A. Turn the knob of the potentiometer and observe the voltage and the brightness of the bulb.
4. Repeat the experiment for points B and C.
5. Replace the bulb with the motor and repeat the experiment.
6. Remove the branch of the circuit between C and D and repeat the experiment.

Questions

1. What happened to the voltage at point A as you turned the knob of the potentiometer?

Answer: the voltage changed as the knob was turned. The voltage will range from 0 to around 2.7 volts, depending on the battery voltage.

1. What happened to the bulb as you turned the knob of the potentiometer? The motor? Why?

Answer: The bulb would gradually change its brightness. The motor would gradually change its speed. This is due to the change in the voltage as the knob is turned.

1. How does the potentiometer relate to the voltage divider? What advantages does a potentiometer have over a voltage divider?

Answer: The potentiometer is able to vary voltage. The advantage is that many different voltages are possible as opposed to a few discrete voltages.

1. What happened to the voltage at points B and C as you turned the potentiometer knob? Why?

Answer: The voltage at point C stays around 3 volts (depending on the battery voltage) and the voltage at point B stays at 0 volts. This is due to a static resistance between points b and c, which is represented in the potentiometer symbol.

1. What happened to the voltage at point A and the bulb when you removed the branch between C and D? What was the same? Different? Why does this difference exist?

Answer: While the voltage and bulb brightness still changes, the voltage no longer goes to 0, nor does the bulb completely turn off. This is due to the potentiometer no longer being connected to the negative end of the battery, which provided a 0 volt reference.

1. What other applications could a potentiometer be used for in addition to controlling light bulbs and motors?

Answers may include: sound volume, temperature on stoves/ovens, strength of electromagnets