Investigation 17F: Compound circuits

Essential question: How can voltage, current, and power be used to predict the behavior of electric circuits?

In the first part of this investigation, you will predict the brightness of bulbs in a circuit. Bulb brightness is a measure of the dissipation of power. In the second part, you will explore the properties of a commonly used kind of circuit called a voltage divider.

Part 1: Power dissipated by elements in a compound circuit

1. Open the experiment file **17F_CompoundCircuits**, and then power-on the Current and Voltage sensors and connect them to your software.
2. For the circuit at right, predict the relative brightness of the bulbs when the switch is closed and when it is open.
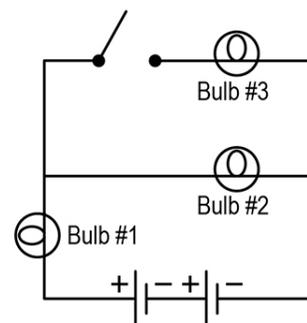
   Prediction of relative brightness when switch is closed:

   Prediction of relative brightness when switch is open:

   Prediction: Will bulb #1 get brighter, dimmer, or stay the same when the switch is closed?

   Prediction: Will bulb #2 get brighter, dimmer, or stay the same when the switch is closed?

3. Construct the circuit.
4. Note the brightness of the bulbs when the switch is open.
5. Close the switch and note how each bulb's brightness changes.

Questions

   a. Using Kirchhoff's laws or an equation for power, justify your prediction for the relative brightness of the bulbs when the switch is closed.

$$P = IV = \frac{V^2}{R} = I^2 R$$

b. Did the brightness of bulb #1 change when the switch was closed? Provide an explanation.

c. Add a voltage and current sensor to your circuit. Measure the voltage across and current through bulb #1 with the switch open and closed then calculate the power. How do the measurements justify your explanation?

Switch	V (V)	I (A)	P (W)
open			
closed			
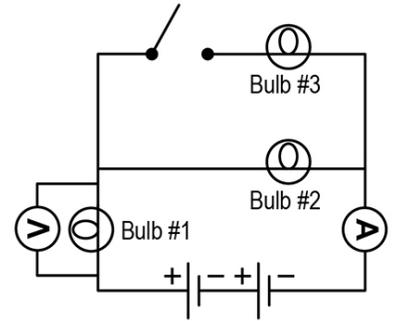
d. Did the brightness of bulb #2 change when the switch was closed? Provide an explanation.

e. Add a voltage and current sensor to your circuit. Measure the voltage across and current through bulb #2 with the switch open and closed. Calculate the power. How do the measurements justify your explanation?
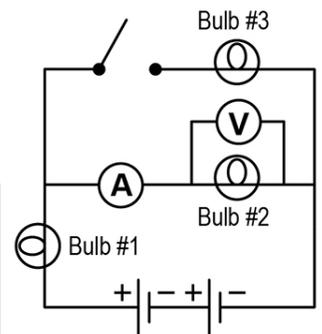
| Switch	V (V)	I (A)	P (W)
open			
closed			

Part 2: Voltage divider

1. Construct the circuit shown using the resistor values in Table 1.
2. Measure the input voltage and the output voltage for each resistor combination in the table.
3. Record your measurements in Table 1.

Table 1: Voltage divider measurements

Resistor R_1	Resistor R_2	Input voltage (V)	Output voltage (V)
100 Ω	10 Ω		
33 Ω	10 Ω		
10 Ω	10 Ω		
10 Ω	33 Ω		
10 Ω	100 Ω		
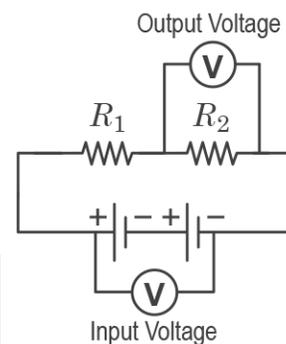
Questions

  a. How does the output voltage vary with R_1?

  b. How does it vary with R_2?

  c. Create a mathematical model to predict the output voltage using the values of the input voltage and the two resistances.

  d. Why is this circuit called a voltage divider?

Applying new knowledge

This circuit contains three bulbs, each with a different resistance.

1. Calculate the equivalent resistance of the circuit.

2. Calculate the total current through the circuit.

3. Calculate the current through each bulb.

4. Calculate the power of each bulb and list them in order of brightness.