

Module 7: Electricity: Electric Charge & Current

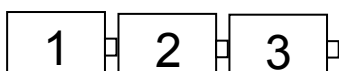
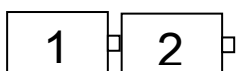
Topic 4 Content: Some Properties of Electric Circuits Answer Key

I. Observing voltage relationships



Go to the PHeT web site and use the Circuit Construction Kit simulation (CCK). Drag out three batteries. Measure the voltage of each using the voltmeter and record the voltage in a table. To use the voltmeter, drag one tip of each probe to the places between which you are measuring the voltage as shown below. The voltmeter measures the voltage from the black probe to the red probe. If you reverse the probes, the readings will have the opposite sign.

Then move the batteries end to end as below to measure combined voltage.



1+2

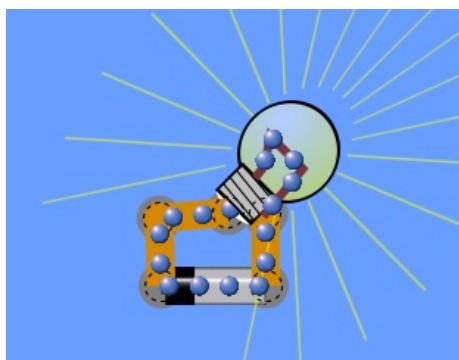
1+2+3

| Battery | Voltage (V) |
|---------|-------------|
| 1 | |
| 2 | |
| 3 | |
| 1+2 | |
| 1+2+3 | |

- a. Describe the relationship between the number of batteries and the voltage and explain what you think might be happening. This is your hypothesis.

When the batteries are placed end to end, the voltage reading across the combination is the sum of the individual voltages.

II. Using voltage



Use the Circuit Construction Kit simulation to build a circuit with a battery and a light bulb in the *Lifelike* visual mode.

- a. How does the voltage of the battery compare to the light bulb voltage? Explain what you think is happening.

The battery voltage is the same as the light bulb voltage. Explanations will vary. The light bulb uses all of the energy that the battery gives to the electrons.

- b. Vary the voltage of the battery and record your observations about how the brightness is affected by voltage.

As the voltage is increased the bulb gets brighter.

- c. Consider a real light bulb and battery; explain what you think is happening that causes the changes in brightness.

Module 7: Electricity: Electric Charge & Current

Topic 4 Content: Some Properties of Electric Circuits Answer Key

The battery gives more energy to the charges, they are moving faster in the circuit. The charges collide more with the metal atoms in the bulb filament, so more heat and light is produced.

III. Using voltage in series circuits

Use CCK to build the circuits below with a battery at about 12 volts and light bulbs. Turn on the voltmeter and ammeter to measure voltage of the battery and current into it. The *non-contact* ammeter will give the current reading when it the cross hairs are moved above the point in the circuit. Record bulb brightness as dim, bright, or very bright.

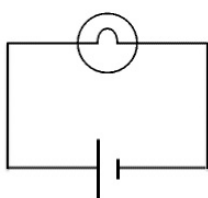


Figure 1

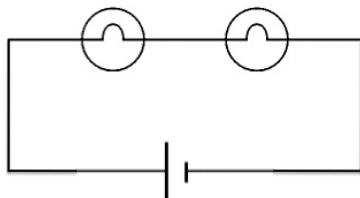


Figure 2

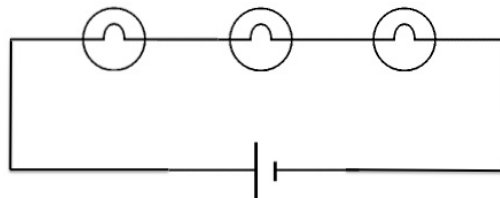


Figure 3

| # of bulbs | Battery Voltage (V) | Battery Current (A) | Bulb brightness (dim, bright, very bright) |
|------------|---------------------|---------------------|--|
| 1 | 12 | | Very Bright |
| 2 | 12 | | Bright |
| 3 | 12 | | Dim |

- a. Summarize the relationships you observed and explain what you think is happening.

Numbers in table will vary depending on values chosen by student. The battery voltage is the same for each circuit. The current gets smaller as bulbs are added. The bulbs should get dimmer as bulbs are added in series. This is because the resistance is getting larger as more bulbs are added.

- b. What happens when you take a bulb out of a circuit? Explain what you think is happening.

Taking a bulb out of the circuit stops current flow, all the bulbs go out. Charges need a complete circuit, removing a wire breaks the circuit.

IV. Using voltage in parallel circuits

Redo Part III but use figures 4-6 for the circuits. Make a new table and answer the questions.

Figure 4

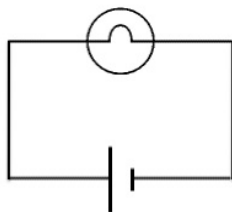


Figure 5

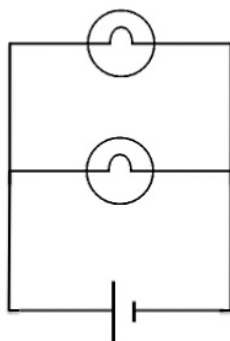
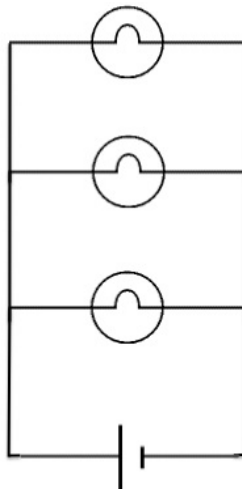


Figure 6

Module 7: Electricity: Electric Charge & Current
Topic 4 Content: Some Properties of Electric Circuits Answer Key



| # of bulbs | Battery Voltage (V) | Battery Current (A) | Brightness of bulbs (dim, bright, very bright) |
|------------|---------------------|---------------------|--|
| 1 | 12 | | Bright |
| 2 | 12 | | Bright |
| 3 | 12 | | Bright |

- a. Summarize the relationships you observed and explain what you think is happening.

As bulbs were added in parallel, the current leaving the battery got larger. The bulb brightness did not change. As bulbs are added in parallel, there is more area for current flow, this decreases resistance so current gets bigger.

- b. What happens when you take a bulb out of a circuit? Explain what you think is happening.

For this parallel circuit, removing a bulb out of the circuit does not change the brightness of the other bulbs. Only the bulb that was removed goes out. There is still a complete circuit through the other bulbs.