Experiment 4

Current, Voltage, and Resistance

In this experiment you will construct simple circuits and investigate the various aspects of the circuit, such as the current, voltage and resistance. With each circuit there are questions within this experiment to answer. Some of these questions will have you predict what you believe will be the answer. While others will have you calculate and answer questions pertaining to these calculations.

Part 1

A battery, a light bulb, and a switch.

Use the components available in the simulation to construct the following circuit.

Battery

Light Bulb

Switch

Prediction 1: Before you close the switch, what do you think will happen? If the copper colored end of the battery is considered the positive end, which direction will the current flow? Will it be clockwise around the circuit? Or, counter-clockwise around the circuit?

If the switch is open, nothing will happen. It will flow counter-clockwise.

Close the switch and observe what is happening with both the light bulb and the direction of the current.

Question 1: Describe what is happening with the light bulb and in what direction the current is flowing. Is it flowing in the same direction as what you stated in your prediction?

yes

Open the switch. Use the voltmeter to measure how much potential difference is across the battery. Place the red probe on the positive side of the battery, and the black probe on the negative side of the battery. Once you have done this, measure the potential difference across the light bulb in the same fashion.

Question 2: What potential difference did you measure across the battery with the switch open? What potential difference did you measure across the light bulb with the switch open?

9v, 0v

Prediction 2: If you close the switch and measure the potential difference across the battery, and across the light bulb, what values do you believe you will measure?

9v

Close the switch and measure the potential difference across the battery and the light bulb.

Question 3: What values of potential difference did you measure across the battery and across the light bulb with the switch closed?

9v

The switch is basically two pieces of metal that are joined together when it is closed. Measure the potential difference across the switch while it is closed.

Question 4: What potential difference did you measure across the closed switch? Why did you get this particular measurement?

0v, there is no resistance there

Click on the battery and you will get a slide button that allows you to change the potential difference of the battery. Change the voltage (potential difference) to 3.0 volts.

Question 5: What happened to the motion of the electrons? What happened to the “brightness” of the light bulb?

The electrons slowed down, the lightbulb dimmed.

If you pick any point in this circuit and watch the number of electrons that are passing that point per second you would be able to determine the current in the wire. Each electron has a charge of 1.602 x 10-19 Coulombs. The total number of electrons passing a particular point, multiplied by the charge of the electron, will give you the total charge that passes that point. The current would then be equal to the total amount of charge passing a point in the circuit per second. So, the faster the electrons move, the higher the current.

Part 2: A battery, two light bulbs, and a switch.

Battery

Light Bulb

Switch

Light Bulb

Add a second light bulb in your circuit as illustrated to the right. Adjust the battery back to having a 9-volt potential difference. Before you close the switch, answer the following:

Prediction 3: By adding a second light bulb into the circuit what values of potential difference do you think would be across the battery and across each of the individual light bulbs?

9v across the battery, 4.5 across each blub

Prediction 4: In comparison to how you answered question 1, what would happen to the brightness of each light bulb when the switch is closed?

They would be half as bright

Close the switch. Use the voltmeter to measure across the battery and each of the two individual light bulbs.

Question 5: What values of potential difference did you measure for each of the battery, and the two light bulbs? How do the potential differences across the light bulbs compare to the potential differences across the battery? How do these values compare to what you predicted they would be?

9v across the battery, 4.5v across each battery. It was exactly the same as the prediction

Question 6: Compare the brightness of the two light bulbs with the brightness of just one light bulb that also had a 9-volt potential difference on the battery. Are the electrons moving faster, or slower than with only one light bulb?

The two bulbs are dimmer than the one bulb. The electrons are moving slower than with only one light blub.

Part 3: A battery, two light bulbs, and a switch (but different configuration)

Instead of placing one light bulb directly after the first light bulb, in a line along one path, you will now split the circuit into two paths. Each path will have one light bulb.

Reconnect the two light bulbs, the switch, the battery, and the wires in the following configuration.

Again, the battery should have a 9-volt potential difference across it.

Battery

Light Bulb

Switch

Light Bulb

Prediction 5: If you were to close the switch, describe what would happen. Comment on the brightness of the two light bulbs, the current through the wires, and the potential differences across each of the light bulbs.

The two light bulbs would be as bright as a circuit with only one lightbulb, the current would be the same as the single lightbulb circuit, the potential differences across each light bulb would be 9v.

Close the switch and observe what happens. Measure the potential differences across each of the light bulbs. Measure the potential difference across the battery.

Question 7: How do the potential differences of each of the light bulbs compare to each other? How do the potential differences of each light bulb compare with the potential difference across the battery? Do these agree with your predictions?

All of those values are 9v, and they agree with my prediction

Question 8: Comment on how fast the electrons are moving in each branch that contains a light bulb and compare it to how fast the electrons are traveling through the branch with the battery.

the electrons are moving faster through the branch with the battery than each branch with a light bulb.

Part 4: A battery, a light bulb, and a switch (change the resistance)

In this part you will go back to the same configuration as in Part 1. This time you will change the resistance of the light bulb and observe what happens.

Close the circuit to remind yourself how bright the light bulb shines and how fast the electrons seem to move in the wires.

Now, open the switch. Your lab instructor will tell you to what resistance value to change the light bulb.

Prediction 6: State what you think will happen to the brightness of the light bulb and the speed of the electrons with this larger resistance value of the light bulb.

The brightness and speed of electrons will go down

Close the switch and observe.

Question 9: What has happened to the brightness of the light bulb and the speed of the electrons?

They both went down.

Measure the potential differences of the battery and the light bulb.

Question 10: How do the potential differences of the battery and the light bulb compare to what you answered in question 3? What seems to be the difference?

They are the same as in question 3, the only difference is the resistance of the light bulb.

Part 5: A battery, two light bulbs, and a switch (different resistances)

Open the switch and set up the circuit as you did in part 2 with the two light bulbs, one right after the other. The one light bulb from part 4 should still have a larger resistance. The new light bulb should have the default resistance of 10.0 ohms.

Prediction 7: What brightness will these light bulbs have? How will the potential differences of each light bulb compare with each other? How will they compare with the battery?

the 20ohm light bulb would be brighter and the 20ohm light bulb would be at 6v, while the 10ohm light bulb would have 3v. the battery would remain at 9v.

Close the switch.

Question 11: How do the brightness of each light bulb compare to each other? How does the speed of the electrons compare to how you answered question 6?

The 20ohm lightbulb is brighter and the electrons are slower than in question 6.

Measure the potential differences across each of the light bulbs and the battery.

Question 12: How do the potential differences of the two light bulbs compare to each other? How do these potential differences compare to the battery?

The battery remains at 9v, while the 10ohm bulb is at 3v and the 20ohm bulb is at 6v.

Question 13: Does there seem to be some relationship between the resistance of a light bulb and the potential difference across that light bulb?

Greater resistance = greater potential difference across the bulb

Part 6: A battery, two light bulbs, and a switch (different resistances and configuration)

Open the switch and set up the circuit as you did in part 3. You still have one of the light bulbs having the larger resistance from part and the other light bulb a resistance of 10.0 ohms.

Prediction 8: What brightness will each of these light bulbs have? What potential differences will they each have? How will the currents pass through each of the light bulbs and through the battery?

The 10ohm light bulb would be brighter, both the light bulbs will be at 9v, the current passes through the 10ohm path faster than the 20ohm path and fastest through the battery.

Close the switch and measure the potential differences across each of the light bulbs and the battery.

Question 14: How does the current seem to flow in the branch with the 10.0 ohm resistance light bulb compared to how they flow through the branch with the larger resistance light bulb? How do both of these compare to how the electrons flow out of the battery.

20ohm was the slowest, with 10ohm being faster, and through the battery being the fastest

Question 15: How does the brightness level of each light bulb compare to each other?

The 10ohm light bulb is brighter than the 20ohm light bulb.

Question 16: How does the potential difference across the larger resistance light bulb compare to the potential difference across the 10.0 ohm resistance light bulb? How do both of these compare with the potential difference across the battery?

All of them were 9v.

Results: Give an overall statement of how increasing and decreasing of the potential differences across a resistive element affects the current through that resistive element. Give an overall statement of how changing the resistance of a resistive element affects the current through that resistive element. Give an overall statement of how the configuration of resistive elements affect how much potential difference will appear across the resistive elements.

Higher potential difference = faster current, higher resistance = slower current, parallel = full potential difference across each resistive element, series = proportional potential difference relative to resistance across each resistive element (i.e. if there were a 90ohm and 10ohm resister connected to a 10v battery in a circuit, the 90ohm resister would have 9v and the 10ohm resister would have 1v)