Experiment 5 Voltages Currents Resistances and Ohms Law

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We used a phet to create many different circuits as shown and answered questions about them. In part 5, the calculated resistance was 49.45 ohms while the actual was 49.50 ohms resulting in a percent error of 0.1%.

Experiment 5

Voltages, Currents, Resistances, and Ohm’s Law

Equipment List: Website (phet.colorado.edu), simulation (Circuit Construction Kit DC Virtual lab)

In this experiment you will continue to explore the various aspects of a few simple circuits. This time, instead of using virtual light bulbs, you will use virtual resisters in your circuits. In addition to the voltmeter that you used last time, you will also use the ammeter to measure current.

Part 1

Current

1-A

Amm. 1

R1

Resistors in Series

Using the components

Available in the

simulation, construct

the circuit 1-A.

In the simulation, click on the battery and adjust the voltage to 10 volts. The resistor should be 10 Ohms. In the upper right-hand box, change from “Electrons” to “Conventional”. Close the switch and record the amount of current showing in the ammeter on to your Excel worksheet. Measure the potential difference across the resistor and record this value on the Excel worksheet.

Resistors resist the flow of current in a circuit. The electrons flowing in the circuit interact with the molecules of the resistor, causing the resistor to warm slightly. Too much current will cause the resistor to get hot.

Prediction 1: Since there is this energy lost to heat is the current going into the resistor different from the current leaving the resistor?

The current going into the resistor is the same as the current leaving the resistor.

Current

Current

1-B

Amm. 1

Amm. 2

R1

On the simulation, add

in another ammeter just

after the resistor, as

shown in 1-B.

Question 1: What did you discover about the amount of current going into a resistor compared to the amount of current leaving a resistor?

It was the same going in as it was leaving.

Record the amounts of current in ammeter 1 and ammeter 2 on the Excel worksheet.

Question 2: Using your answer to question 1, state how much current is leaving the battery to how much current is returning to the battery.

1A of current is leaving the battery and returning to the battery

Prediction 2: By adding in another 10 Ohm resistor, in line with the other 10 Ohm resistor, what changes, if any, will occur?

The current will be as if there were a 20ohm resistor present giving us 0.5A of current.

On the simulation, add in another 10 Ohm resistor and another ammeter, as shown in 1-C. Close the switch and record the current values on the Excel worksheet. Measure the potential differences of each of the resistors and record these values in the Excel worksheet. Record the currents for each of the 3 ammeters.

Current

Current

Current

1-C

R1

R2

Amm. 1

Amm. 2

Amm. 3

Question 3: Comment on the results of adding in a second 10 Ohm resistor in “Series” with the first 10 Ohm resistor. Was your prediction correct? If your prediction was not correct, what reasoning did you have for your prediction?

The prediction was correct, the current was 0.5A.

Finally, add in a third 10 Ohm resistor and another ammeter, as shown in 1-D.

Current

Current

Current

Current

1-D

R1

R2

R3

Amm. 1

Amm. 2

Amm. 3

Amm. 4

Again, record the current values for all of the ammeters, and the potential difference values for each of the resistors on the worksheet.

Question 4: What can be said about the current being drawn from the battery as more and more resistors are added in series? How do the currents through each of the resistors compare to what is being drawn from the battery?

The current being drawn from the battery decreases as more resistors are added in series. The currents going through each resistor are the same as the current being drawn from the battery.

Question 5: What can be said about the potential differences of the resistors compared to the potential difference of the battery?

The potential difference of the battery stays the same, but the potential difference of each resistor decreases as more resistors are added.

Part 2

Single Resistor, Changing Resistance

1. Construct the circuit in 1-A again for this part of the experiment. Make sure that the battery is adjusted to 10 volts, and the resistor is at 10 Ohms. Record the potential difference and the current of the resistor on the worksheet.
2. Click on the resistor and adjust the resistance to 20 Ohms. Record the potential difference and the current of the resistor on the worksheet.
3. Click on the resistor and adjust the resistance to 30 Ohms. Record the potential difference and the current of the resistor on the worksheet.

Question 6: In Part 1 you added resistors in series with each other. First, you had only one 10 Ohm resistor. Then, you had two in series. Finally, you had three in series. How do the potential differences and the currents for each of these circuits compare to a single resistor with 10 Ohms, 20 Ohms, and 30 Ohms of resistance?

The potential difference for each resistor in part 2 remained constant, while the potential difference for each resistor in part 1 decreased with the addition of each resistor. The current for part 1b is the same as part 2a, as well for part 1c and 2b, and for part 1d and 2c.

Part 3

Resistors in Parallel

In this part of the experiment you will explore the potential differences across resistors, and currents through these resistors, but with the resistors in a parallel configuration.

To begin with, set up the circuit as you did in 1-B, and call it 3-A.

Current

Current

3-A

Amm. 1

Amm. 2

R1

Again, have the potential difference of the battery equal to 10 volts, and the resistance of the resistor equal to 10 Ohms. Record the potential difference and the current of the resistor on the worksheet.

Prediction 3: In a parallel configuration, another branch of the circuit is added containing a circuit element, such as a resistor. Looking at illustration 3-B, what do you think the potential differences and currents are for each of R1 and R2?

I think the potential difference for both r1 and r2 will be 10v and the currents for both will be 1A.

Current

Current

3-B

Amm. 1

Amm. 2

R1

Current

Amm. 3

R2

In the simulation, construct this circuit, having R1 and R2 each having a resistance of 10 Ohms. Close the switch. Measure the potential differences across each of R1 and R2 and record these on the worksheet. Also record the currents through each of the resistors on the worksheet.

Question 6: Are the values for the potential differences of each resistor, and the currents through each resistor, what you predicted? If not, what misconception did you have?

The values were exactly as I predicted, with the potential differences being 10v and the currents both being 1A.

Question 7: Look at the current being drawn from the battery. How does it relate to each of the currents through the resistors?

The current being drawn from the battery is the sum of the currents going through each resistor.

Prediction 4: With the results of 3-B in mind, what do you think will be the respective potential differences and currents of three 10 Ohm resistors in parallel? What current will be drawn from the battery?

I expect the potential differences to all still be 10v and the current of the three resistors to be 1A while the current being drawn from the battery is 3A.

Current

Current

3-C

Amm. 1

Amm. 2

R1

Current

Amm. 3

R2

Current

Amm. 4

R3

In the simulation, construct the circuit in illustration 3-C. Close the switch. Measure the potential differences across each resistor, and the currents through each resistor, and record these on the worksheet. Record the current being drawn from the battery on the worksheet.

Question 7: What did you discover about the potential differences across each of the resistors?

They were all the same and the same as the potential difference of the battery.

Question 8: What did you discover about the amount of current drawn from the battery as more resistors are added in parallel?

The current being drawn from the battery increases as more resistors are added in parallel.

Part 4

Three resistors in Parallel, Different Resistances

Keep the same configuration of resistors in parallel as you have for 3-C. Click on R2 and adjust the resistance to 20 Ohms. Click on R3 and adjust the resistance to 30 Ohms.

Prediction 5: With this new set of resistances, but same parallel configuration as in 3-C, what changes will you expect to occur, if any at all?

The currents being drawn by the greater ohm resistors will decrease which will make the overall current decrease, while the current being drawn from the battery will still be the sum of those currents.

Question 9: By increasing the resistances of two of these resistors, what has happened to the current being drawn from the battery?

The current being drawn decreased.

Measure the potential differences across each of the resistors and record these on the worksheet.

Question 10: Did the potential differences across the resistors change compared to the potential differences recorded for 3-C (when they each had 10 Ohms resistance)?

The potential difference did not change.

Question 11: What has happened to each of the currents through each of the resistors?

The current being drawn decreased due to the greater resistance.

Question 12: How do these currents relate to the current being drawn from the battery?

The sum of currents in a parallel circuit equals the current being drawn from a battery.

Part 5

Ohm’s Law

You have been measuring the potential differences across resistors, and currents through resistors, in this experiment. You have recorded these values for circuit configurations involving resistors in a series combination, and for resistors in a parallel combination. The current through an individual resistor in a configuration is related to the potential difference across that resistor, and the resistance of that resistor.

In the simulation, construct the same configuration as in 1-A, a single battery, a single ammeter, a single switch, and a single resistor. Adjust the battery to a starting value of 5 volts. Adjust the resistor to a value of 49.5 Ohms.

Close the switch.

Record the potential difference of the resistor, and the current through the resistor on your worksheet.

Increase the potential difference of the battery to 10 Ohms, as shown on the worksheet, and record the current. Continue this process until you have completed the table on the worksheet.

Plot the points on a graph. Currents are on the x-axis, and Voltages are on the y-axis. Add a trendline and the equation of the trendline.

Question 13: What kind of a trendline best fits the data points?

A linear trendline best fits the data.

Question 14: What does the slope of the line represent?

The slope represents the resistance on the resistor.

Question 15: From the slope of the trendline compare the graphically determined resistance to the value that you set for the resistor (49.5 Ohms). Use the percent error equation for this comparison.

The experimental value had a percent error of 0.1% which means the experimental value was very similar to the actual value.

Results

In your results section write about:

1. The relationship between the potential difference of the battery and the potential differences across resistors in a series configuration.

The potential difference of the battery is split proportionally between resistors in series.

1. The current being drawn from the battery and the currents through the resistors in a series configuration.

The current being drawn from the battery is the same as the current going through the resistors in a series.

1. The relationship between the potential difference of the battery and the potential differences across resistors in a parallel configuration.

The potential difference of the battery is the same as the potential differences across each resistor in a parallel configuration.

1. The current being drawn from the battery and the currents through the resistors in a parallel configuration.

The current being drawn from the battery is the sum of the currents going through the resistors.

1. The relationship of the potential difference across a single resistor and the current through the resistor as the potential difference is changed across that resistor (Ohm’s Law).

Potential difference=current\*resistance (V=IR)