

Physics 251 Laboratory

DC Circuits I: Simulation

Pre-Lab:

Do the lab prep on the web. Please bring in the equations you derive in question #2 on the lab prep (or section 3 of this lab) to turn in at the beginning of the lab. This homework will be worth 4 of the 10 points for this lab.

Introduction

This lab deals with direct-current circuits that consist of different combinations of batteries and resistors. Specifically, you will be using Kirchoff's Laws to study two simulated direct-current circuits. You will use what you have learned about spreadsheets in the previous lab to make calculations of circuit behavior for various values of these resistances, voltages, etc., in these circuits.

Equipment/Supplies

Macintosh computer with Microsoft Excel software
 Simulations are in the 251 folder in a file labeled: "Kirchoff Simulation."

Section 1

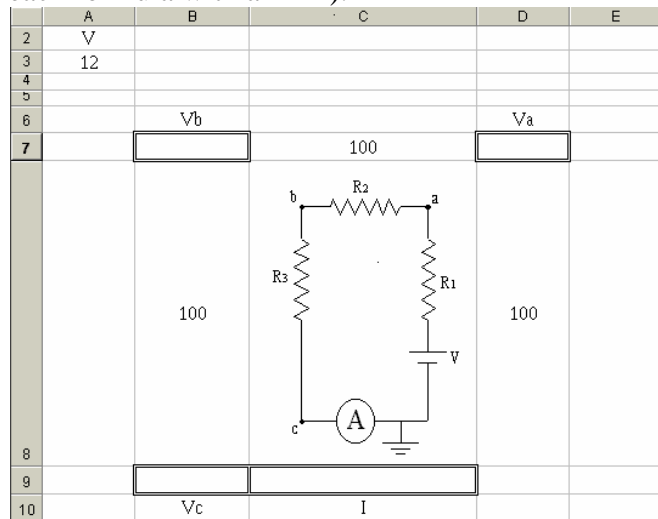
Open the file "Kirchoff Simulation." You will see two separate areas, each with its own circuit diagram, and cells for values of source voltage, relative voltage, resistance, and current. Some of these cells are already filled in. The ones that are not filled in have a double border. You will need to write a formula for each of these double-bordered cells that calculates the appropriate value of relative voltage or current (remember to begin each formula with an "=").

Look at the first area. It has a diagram of a circuit consisting of one battery, three resistors, and an ammeter. The symbol in the bottom right hand corner is ground (this denotes the arbitrarily chosen location where the voltage is 0).

The source voltage is set at 12 volts (cell A3). The three resistances are all set at 100 ohms (cells D8,C7,and A8).

➤ Create a formula that will calculate the current through the circuit, given the source voltage and the values of the resistors, and enter this formula in cell C9.

➤ Test your formula by changing the given values of source voltage and resistance. Do the values you obtain for the current make sense?



Section 2

Continue to work with the first circuit, focusing on the three empty cells available for voltage calculations (D7, B7, and B9). Create a formula for each of these cells that calculates the voltage relative to ground at points a, b, and c. These formulas should all depend on the source voltage, the individual resistance values, and the value of the current.

- Again, test your formulas by changing the given values.
- Before moving ahead please answer the questions on the back page referring to Section 2.

Section 3

The second area has a circuit that is somewhat more complicated than the previous one. A branch has been added as well as two additional batteries. **There are now three currents present that you will need to create formulas for (cells H3, I3, and J3).** These are the formulas that you calculated before class and should be in terms of the three source voltages and the three resistance values.

- Once again, test your formulas by varying the values for the source voltages and resistances. Do your formulas hold up?

H	I	J
I1	I2	I3
V1	V2	V3
6	12	10
R1	R2	R3
75	75	75

- Create a few more cells that calculate other testable values.
- Calculate the voltage difference between the bottom wire and the node at the top-center using three different paths.
- Please answer the questions on the back page that refer to Section 3.

Physics 251 Laboratory

DC Circuits - 2

Pre-Lab: Please do the lab prep on the web.

Introduction

In this lab, you will set up a real two loop circuit consisting of three resistors and three batteries. You will use a voltmeter, an ammeter, Ohm's law and Kirchoff's laws to find values of resistance and current.

Equipment/Supplies

- | | |
|-------------------|------------|
| 3 voltage sources | Wires |
| 3 resistors | Multimeter |

Section 1

Use your multimeter to measure the resistances of the three resistors, and the voltages provided by the three voltage sources. The actual values may differ from the nominal values by several percent.

Section 2

Now set up a two loop circuit as shown in the picture, using the three batteries and the three resistors. Be mindful of the polarity of the batteries. Be sure your circuit duplicates the one in the diagram. Using the spreadsheet you developed last week, calculate the current in each branch of the circuit, including the direction, as well as the voltage across each resistor. Record these values. Now use the multimeter to directly measure the current and voltage through each resistor. Do these values agree with the ones you obtained using Kirchoff's laws?

H	I	J
I1	I2	I3
V1	V2	V3
6	12	10
R1	R2	R3
75	75	75

Section 3

Use your multimeter to measure the voltages provided by the three sources **without removing them from the circuit**. Do your new values agree with you old values? If not, use your new values in the spreadsheet, and see if the agreement between calculated and measured currents has improved.

Name _____ Date _____

Lab Partners _____

DC Circuits I - Simulation Results

Section 2

1. What is the current through the circuit? I : _____

What relative voltages did you obtain for points a, b, and c, using the given values?

$V(a)$: _____ $V(b)$: _____ $V(c)$: _____

2. Now, double the source voltage and halve the value of the first resistor.

What is the current through the circuit? I : _____

What are the relative voltages?

$V(a)$: _____ $V(b)$: _____ $V(c)$: _____

3. Is there anything unique about any of the relative voltages at point a, b, or c? Why is this so?

Section 3

1. What values did you obtain for the three currents, using the given quantities?

I_1 : _____ I_2 : _____ I_3 : _____

2. What is the difference in voltage between the bottom wire and the top/center node, using the given values? _____

3. Now, change the values of the three resistors to what ever you want and report the currents again.

R1: _____

R2: _____

R3: _____

I1: _____

I2: _____

I3: _____

Overall – DC Circuits 1

Explain to “the Boss” why we want to use excel to simulate this circuit before we actually build it? What happens to I1 when we change the value of R1?

What was good about this lab and what would you do to improve it? _____

Name _____ Date _____

Lab Partners _____

DC Circuits - 2 Results

Section 1

Make these measurements before you build the circuit.

1. What are the measured values of the resistors?

R1_____ R2_____ R3_____

2. What are the measured values of the voltage sources?

V1_____ V2_____ V3_____

Section 2

Input the above values into your spreadsheet to obtain calculated values.

1. What are the **calculated** values of current?

I1_____ I2_____ I3_____

2. What are the **measured** values of current?

I1_____ I2_____ I3_____

3. What are the **calculated** values of voltage drop across each resistor?

V(R1)_____ V(R2)_____ V(R3)_____

4. What are the **measured** values of voltage drop across each resistor?

V(R1)_____ V(R2)_____ V(R3)_____

5. Do the calculated values agree with the directly measured ones? _____

Section 3

1. What are the measured values of the voltage sources while they are in the circuit?

V1_____ V2_____ V3_____

2. Use the new values for voltages V1, V2 and V3 in the spreadsheet to calculate current and voltage drop across R1, R2 and R3
3. Explain to “the boss” why the measured values of the voltages and currents in the circuit are different than the calculated values.

Overall – DC Circuits 2

What was good about this lab and what would you do to improve it?_____
