



Challenge #4 Electrical Circuits

Due Tuesday, April 21

On November 23, 2019 Occidental College hosted the First Technical Workshop. During the Electrical Circuits Workshop, students used electrical components and multimeters supplied by the Oxy students to build electrical circuits. You analyzed the circuits using Ohm's law to determine some basics about series and parallel circuits.

This challenge will review those concepts, and then go on to assemble some slightly more complicated circuits.

Challenge details:

- **Utilize the PhET Circuit Construction Simulator:**
 - For this challenge, you need to use the link below to access materials from PhET Circuit Construction Simulator to answer questions on the attached worksheets.
 - https://phet.colorado.edu/sims/html/circuit-construction-kit-dc/latest/circuit-construction-kit-dc_en.html
- **Use the circuit simulator to complete the worksheets**
- **Feel free to build additional circuits using the other components and meters supplied.**
- **Bonus points available at the bottom of the last worksheet**

This activity is worth 100 points. You will earn points based on the percentage of answers you get correct.

Responses can be emailed to Julie Miller Kalbacher at jamiller@mwdh2o.com Make sure to include your name and school name on your responses.

Good luck with this challenge and with all of your schoolwork.

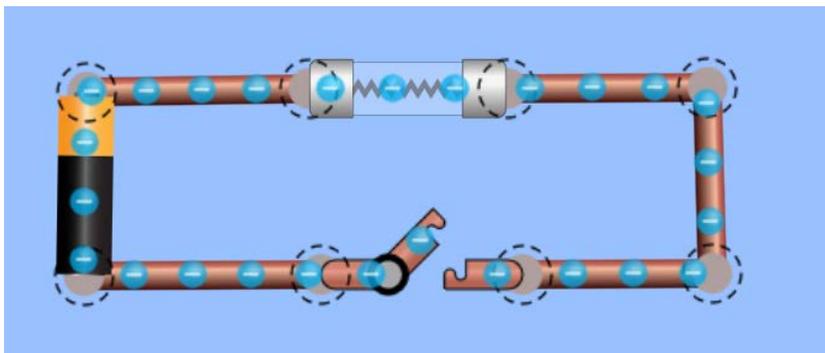
Challenge #4 Worksheets

Due Tuesday, April 21

Use the PhET Circuit Construction Simulator at:

https://phet.colorado.edu/sims/html/circuit-construction-kit-dc/latest/circuit-construction-kit-dc_en.html

Let's get used to the layout by having some fun! First build the circuit shown below:



- What happens when you close the switch? Why? _____
- What happens when you take the fuse out of the circuit and close the switch? _____
Why? _____
- How does changing the battery internal resistance change what happens in the circuit? _____
- Try adding some of the other elements to the circuit to see what happens.
- You can change the value of any component by clicking on it and adjusting the slider. Try this out to see how changing the values changes the flow of electrons in the circuit.
- Why can't you hurt the dog? (click on the "values" check box in the upper right for a clue.) _____

Now for the real challenge!

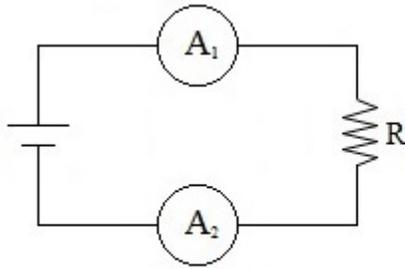


Figure 1

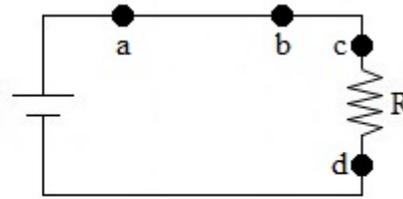


Figure 2

1) Use the simulator to build the circuit shown in Figure 1. Set the value of the resistor R to 100 ohms. Check the "Ammeter" box in the "Tools" section to add ammeters. Measure the current through the circuit with one ammeter at position A_1 and another ammeter at position A_2 at the same time.

a) What is the current value from each meter?

(a) $A_1 =$ _____

(b) $A_2 =$ _____

b) Is there any significant difference between the current measured on the two sides of the resistor? _____

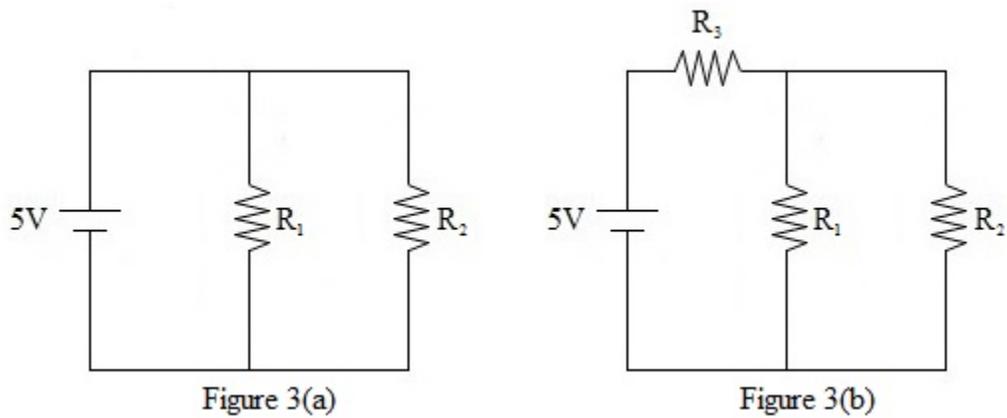
2) Use the simulation to create the circuit shown in Figure 2. Set the value of the resistor R to 100 ohms. Check the "Voltmeter" box in the "Tools" section to add a voltmeter. Measure the potential differences between the points by touching the appropriate pairs of points with the voltmeter probes and record your values:

i) $\Delta V_{ab} =$ _____

ii) $\Delta V_{bc} =$ _____

iii) $\Delta V_{cd} =$ _____

iv) $\Delta V_{da} =$ _____



Consider the circuits shown in Figures 3(a) and 3(b). Given $V = 5.0 \text{ V}$, $R_1 = 30 \Omega$, $R_2 = 40 \Omega$, and $R_3 = 50 \Omega$. Measure the current through each resistor and the voltage across each resistor with the simulator.

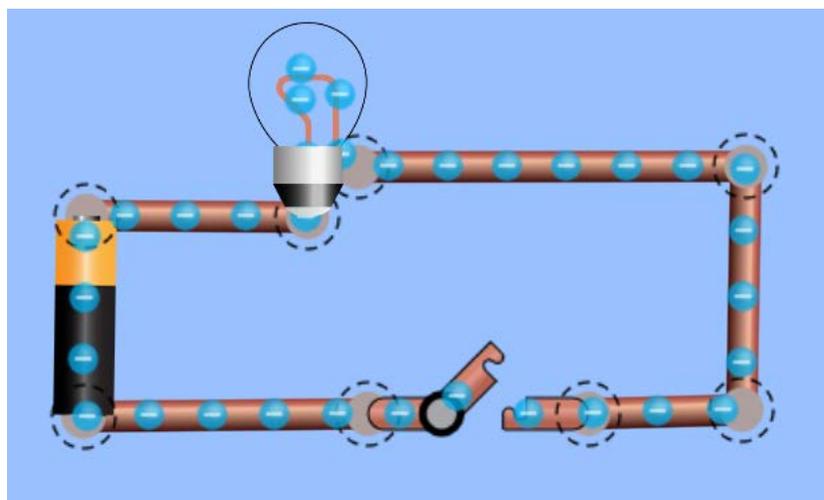
- v) R1 Current = _____ R1 Voltage = _____
- vi) R2 Current = _____ R2 Voltage = _____
- vii) R3 Current = _____ R3 Voltage = _____

What happens to the voltage and current if you change the resistor values? _____

What happens to the voltage and current if you change the battery voltage? _____

Experiment II: Illuminate a Light Bulb

1) In this experiment you have to illuminate a light bulb using a 9 V battery. Design the circuit shown below. Use a 9 V battery in the circuit.



2) What happens when you close the switch? Does the bulb light up? Why?

3) There are different bulbs in the parts selector bar on the left. Why?

4) Try substituting and changing the values of the bulbs and see what happens?

5) When you succeed in illuminating the bulb, use a voltmeter to measure and record the voltages across the battery and the bulb. Do the measured values make sense? Explain why or why not. _____

a) V across battery = _____

b) V across resistor = _____

c) V across Bulb = _____

d) Make Sense? _____

e) Current in the circuit? _____

f) Explain how changing all of the different values changes the brightness of the bulb. _____

6) Try adding two batteries in series. What happens? _____

7) Try adding two bulbs in series. What happens? _____

8) What happens to the voltage and current when you make these changes? _____

Bonus Points:

This circuit simulator is very basic, there are many more advanced simulators on the Internet. One that is slightly more advanced but still simple to use is at: www.circuitlab.com Get 10 bonus points if you send a screen shot of the circuit shown in 3a above in the CircuitLab simulator!

Becoming familiar with a more advanced simulator is a good job skill to have. I use one called TINA which is more difficult to use but very powerful. They have a free demo available if you are interested. However please don't ignore your schoolwork to play with this, it's very addictive.