Circuit Basics

Go to https://phet.colorado.edu/sims/html/circuit-construction-kit-dc-virtual-lab/latest/circuit-construction-kit-dc-virtual-lab_en.html
or Google PhET HTML5 and select – *Circuit Construction Kit: DC - Virtual lab*

The simulation has a component selection pane on the left with various circuit components such as wires, batteries and bulbs. On the right side is an *ammeter* to measure current and a *voltmeter* to measure voltage. Below that is a battery shown pictorially and as an electric symbol. The circuit components can be viewed pictorially or as symbols by selecting one of these two. The convention in circuit analysis is for current to flow out of the positive terminal of the battery and into the negative terminal of the battery. In actuality, the flow of electrons is the opposite of this. On the top right of the screen you can select to see the flow of current. The relationship between current (I), voltage (V), and resistance (R) is given by Ohm's Law V = I x R or I = V/R. Resistance value of components can be edited by a tap on the component.

1. Select 'Labels' and 'Values'. Build the circuit in figure1 to get familiar with the PhET.

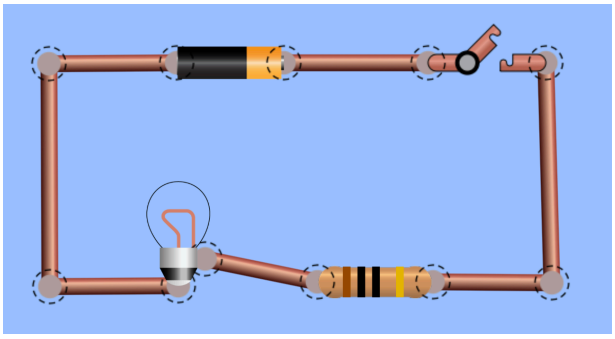


Figure 1 A pictorial representation of a circuit

2. The circuit in Fig 1 contains a battery connected to a bulb and resistor in series through a switch. Redraw this circuit in the box with the corresponding *electric component symbols*.

3. Let's start with a **simple circuit** – a 9v battery is connected to a resistor (10 Ω) through a switch. A voltmeter can be used to measure the *voltage across* any component in the circuit as shown. (Tap the battery to edit voltage)

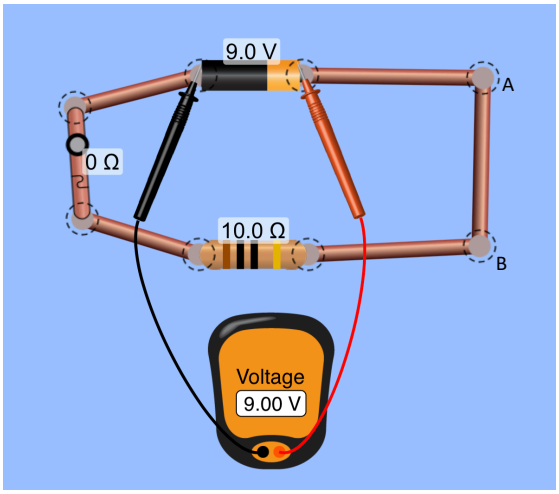


Figure 2. Simple circuit

Q1. What do you expect the voltage across the **resistor** to be? _____

4. Construct the circuit in figure 2 and measure the voltage *across the resistor*. V = _____.

5. Tap on the resistor and change the resistance to 20Ω. Now measure the voltage across the resistor. V = _____. Explain why the value is the same/different compared to #4.

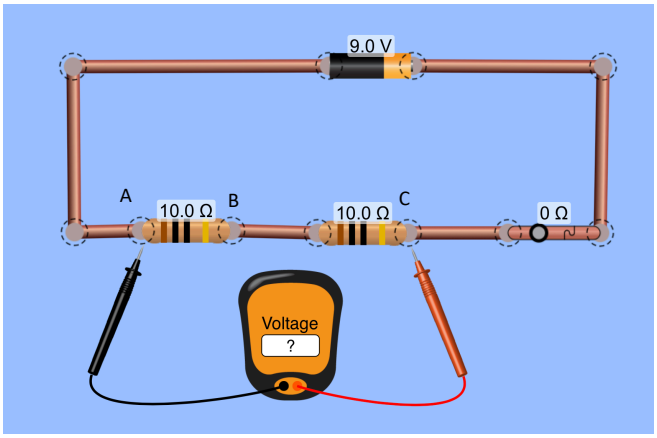
Q2. If the battery was changed into a **12v battery** what would the voltage across the resistor be? Explain.

6. Return the resistance value back to 10 Ω so that the circuit looks like figure 2 again. Now what is the *current* flowing through this circuit? Calculate it using Ohm's law. I = _____. Show calculation below (Remove the wire between terminals A and B and *connect the ammeter* between those two points and check your answer.)

7. If the battery polarity is reversed will anything change in the circuit? _____
Tap the battery and flip the polarity of the battery in the edit pane. Select '**Show Current**' on the top right and observe the flow. Return the battery polarity to the original orientation and observe the current flow again. What do you notice?

Connect two 10 Ω resistors in **series** with a 9V battery as shown in figure 3.

Q3. a) What do you expect the voltage across terminals A and C to be? _____ Why?



b) If you measure the voltage across each individual resistor what do you expect the values to be?

Figure 3 Series circuit

8. Using the voltmeter measure voltages: V_{AC} = _____; V_{AB} =_____;V_{BC} = _____.

So how has the voltage across a resistor changed when in a simple circuit (#4) to when in a series circuit (#8, V_{AB}) using the same battery voltage?

9. What is the effective resistance in the series circuit? R_{series} = _____
You know the battery voltage, so using Ohm's law calculate the battery current I = _____.

10. The current in #9 is the current flowing out of the battery. Is the current returning into the battery the same? _____
b. Is the current flowing into the first resistor the same? _____
c. Is the current flowing through the second resistor the same? _____
(You can check your answers by connecting the ammeter first at the negative terminal of the battery, and then at terminal C, and finally between B&C.)

11. Next connect 3 resistors in series as shown in figure 4.

a) What is the *voltage* across each resistor? _____

b) What is the *total resistance* of the circuit? _____

c) What is the *current* in the circuit? _____

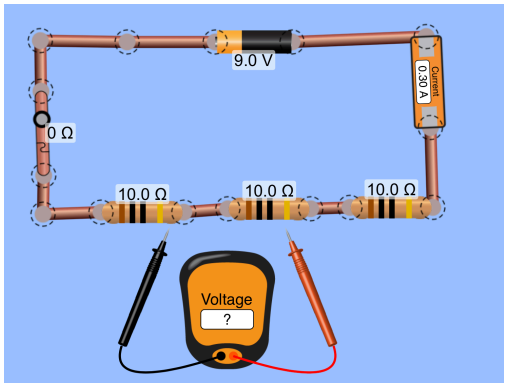


Figure 4. Three similar resistors in series

12. Using #6, 9, and 11, fill in table1.

Table1.

	Simple circuit	Series circuit	Series circuit (3 resistors)
Circuit Resistance			
Circuit Current			

13. Explain in your words how current and circuit resistance values change as you go from a simple circuit to series circuit of increasing resistors, using table1.

Q4. In figure 5, two dissimilar resistors are in series.
a) Will both resistors have the same voltage across them? _____

b) Will the current be the same through each resistor? _____

14. Construct the circuit in fig 5. V_{AC} = _____; V_{AB} =_____; V_{BC} = _____.

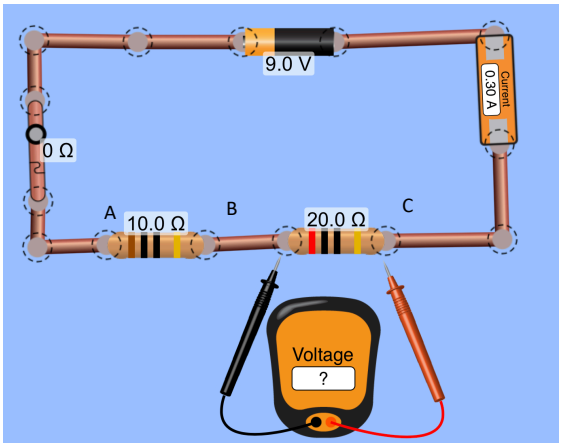


Figure 5 Series circuit with dissimilar resistors

a) Are these voltage values the same as in #8? If different explain why:

b) Move the ammeter to between the resistors and comment on the current at different points in the circuit:

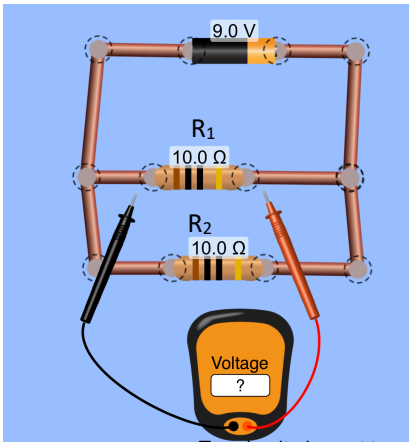


Figure 6 resistors in parallel

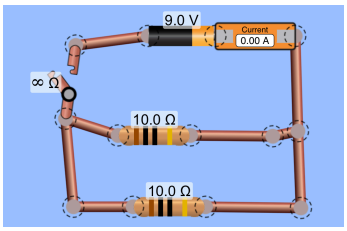
15.Connect two resistors in parallel with a 9V battery as shown in figure 6. What is the voltage across each resistor? Measure it. V_{R1} = _____; V_{R2} = _____

Q5. If the battery was changed to say a 12v battery, then how will the voltages change across each resistor?

V_{R1} = _____; V_{R2} = _____

16. You know the voltage across R_1 in fig 6, and the resistance value, so use Ohm's law to find the current through R_1. I_{R1} = _____. Compare with #6. What do you expect I_{R2} =_____.

17. Now the battery current in the parallel circuit is I_{R1}+ I_{R2} = _____. You can confirm this value by connecting the ammeter next to the battery as shown.



18. Compare this current with the current in the series circuit #9 and the simple circuit #6. Fill in values in the table 2 for current and resistance

	Simple	**Series**	**Parallel**
Battery current			
Circuit Resistance			?

What do you think the resistance of the parallel circuit will be? _____

A. greater than the simple circuit but less than the series circuit
B. greater than the simple circuit and greater than the series circuit
C. less than the simple circuit and less than the series circuit