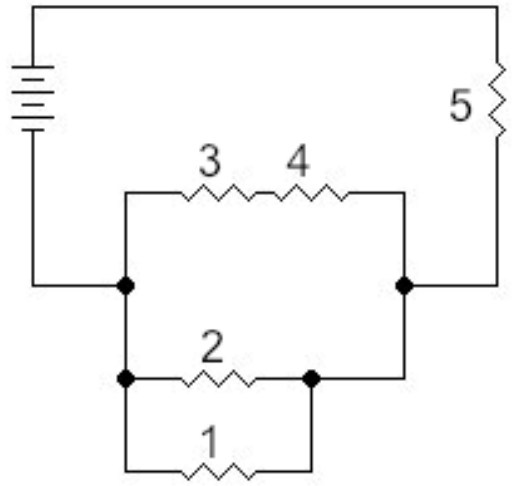
Module 7: Electricity: Electric Charge & Current
Topic 5: Combination Circuits Practice Answer Key

Procedure: Open *Circuit Construction Kit* from the PhET website

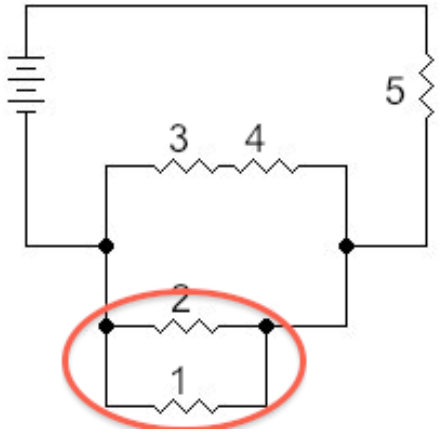
1. Put five resistors on the work area. Right click on each to change the resistances to the values in the table. Use a battery voltage of 12 volts.

Calculations			
Resistor	Individual resistance (ohms)	Current (amps)	Voltage (Volts)
1	5	**0.846**	**4.23**
2	10	**0.423**	**4.23**
3	5	**0.282**	**1.41**
4	10	**0.282**	**2.82**
5	5	**1.55**	**7.75**
	Total Resistance (calculated) **7.73**	Battery Current **1.55**	Battery Voltage 12

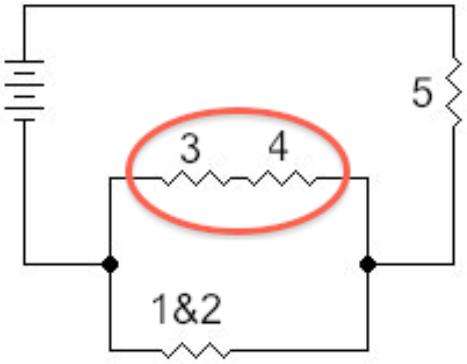


2. Use the procedures learned in this topic to calculate: the total resistance of the circuit, the current delivered by the battery, and the current and voltage for each resistor. Show your work below and record your results in the table above in the shaded cells.

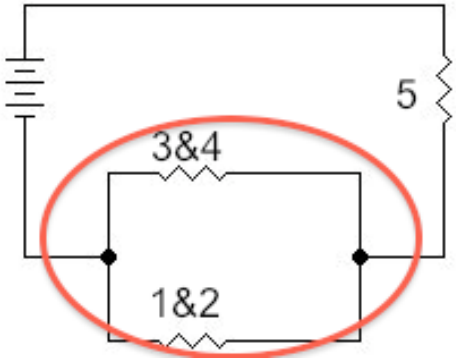
Solution:
Calculation of Total Resistance:



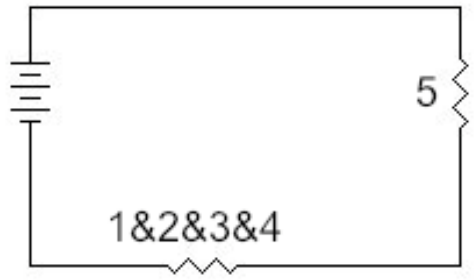
- **Combine 1 & 2 in parallel. 1/5 + 1/10 = 1/Req; Req = 10/3 = 3.33 Ω**



- **Combine 3 & 4 in series. 5 + 10 = 15 Ω**



- **Combine 1&2 with 3&4 in parallel. 1/3.33 + 1/15 = 1/Req; Req = 2.73 Ω**



- **Combine this result with 5 in series. 2.73 + 5 = 7.73 Ω; this is the total resistance**

Battery Current (Using Ohm's Law):

- **I = V/R; I = 12/7.73 = 1.55 A**

Resistor 5 is in series with the battery, its current is 1.55 A.
Using Ohm's Law, V=IR; V = 1.55A(5Ω)=7.75 V

The three branches in parallel have the same voltage; $V_1 = V_2 = V_{3+4}$
The three branches have an equivalent resistance of 2.73 Ω
The three branches have a total current of 1.55 A (the entire current of the battery)
Find voltage from Ohm's Law, V=IR; V=(1.55A)(2.73Ω)=4.23 V

Now find the current through each branch using Ohm's Law, I=V/R
For resistor 1, I = 4.23 V/5 Ω = 0.846 A
For resistor 2, I = 4.23 V/10 Ω = 0.423 A
For the combination of 3&4, I = 4.23 V/15 Ω = 0.282 A

Finally, the voltage across resistor 3; V = IR; V = 0.282 A(5Ω) = 1.41 V
And the voltage across resistor 4; V = IR; V = 0.282 A (10 Ω) = 2.82 V

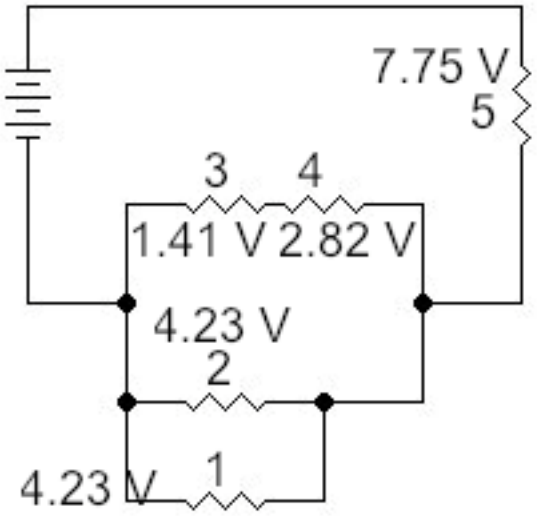
3. Build the circuit given using the Circuit Construction Kit. Complete the table below by measuring the voltages and currents using the voltmeter and ammeter. Find the total resistance of your circuit using Ohm's Law. Show your work. (Values should be very close to calculations)

$$R_T = \frac{V_T}{I_T}$$

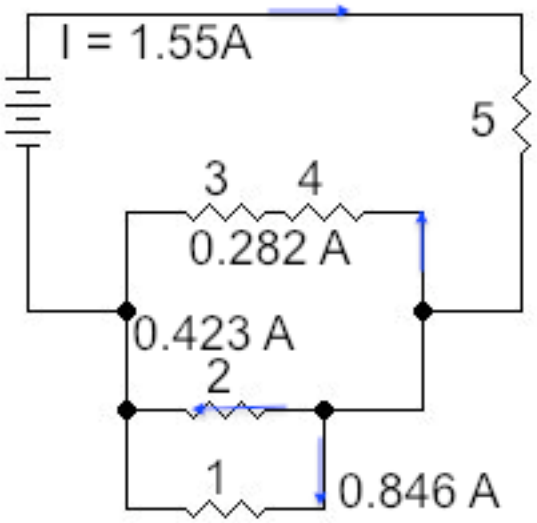
Measurements			
Resistor	Individual resistance (Ω)	Current (A)	Voltage (V)
1			
2			
3			
Battery			

3. Provide evidence that your table information is reasonable. Before you take apart your experiment, take a screenshot of your circuit and insert it into this document. Use Kirchoff's Loop Rule and Kirchoff's Junction Rule to justify your results.

Solution:



Kirchoff's Loop Rule states that when you go around a circuit the sum of the voltage drops must equal the voltage of the battery. There are three different paths.
Resistor 5 + Resistor 1; 7.75 + 4.23 = 11.98 pretty close to 12 V
Resistor 5 + Resistor 2; 7.75 + 4.23 = 11.98
Resistor 5 + Resistor 3 + Resistor 4; 7.75 + 1.41 + 2.82 = 11.98



Kirchoff's Junction Rule states that the current that goes into a junction must equal what comes out.
1.55 A goes into the junction; 0.846 + 0.423 + 0.282 comes out
1.55 is very close to 1.551