Section	Group	Name	Signature
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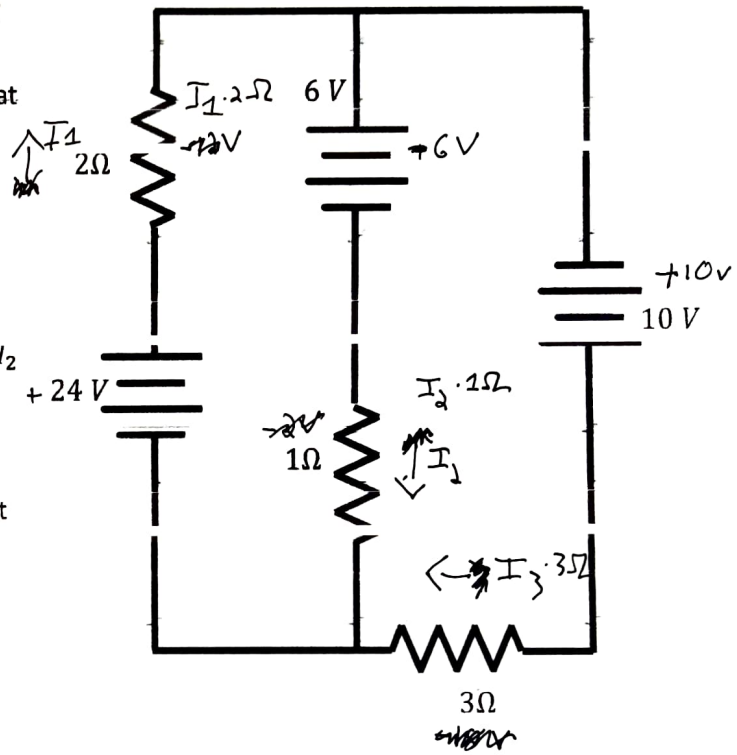
After this activity you should know: • *how to use Kirchoff's laws to solve multi-loop circuits*

We now want to use Kirchoff's laws to solve for unknown currents in a circuit. We will go through the procedure step by step



1. **Simplify the circuit (if possible).** Are there any resistors that are clearly in parallel or series? If so, replace the resistors involved with the equivalent resistor and draw the simplified circuit.

2. **Guess and draw the directions of currents.** Guess the direction of each unique current in the circuit. Label and draw arrows in the circuit indicating the direction. In this case, there will be three unique currents so label them I_1, I_2 and I_3. *If you guess the direction of a current wrong, the current will turn out negative which you can switch when you report your final answer.*

3. Apply Kirchoff's Junction law for one of the junctions to get a relation between the unknowns I_1, I_2 and I_3. Pay attention to the direction of the currents.

$I_1 = I_2 + I_3$

4. We now have one relation but three unknowns. We need two more relations to solve this problem. We will get this relation by applying Kirchoff's loop law for two different loops.

   a. Choose one loop and apply Kirchoff's loop rule to the loop. That is, start at one point in the loop and write the sum of the voltage changes (in terms of the unknown currents I_1, I_2 and I_3) until you return to where you started. Simplify the equation as much as possible.

$24V - I_1 \cdot 2\Omega - 6V - I_2 = 0$

$18V = 2I_1 + I_2$

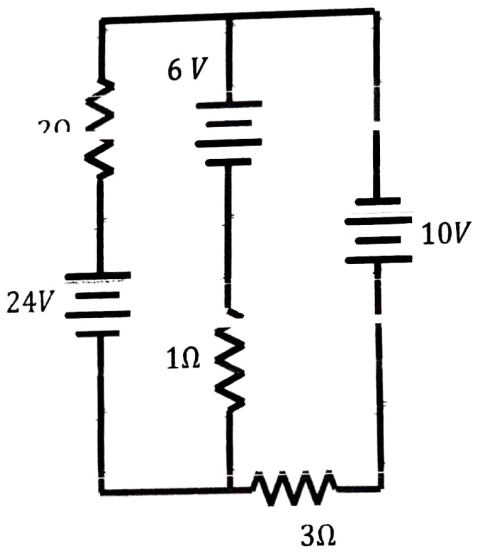
   b. Choose a second loop and apply Kirchoff's loop rule for that loop.

$24V - 2I_1 + 10V - 3I_3 = 0$

$2I_1 + 3I_3 = 34$

5. We now have three relations and three unknowns. So we should be able to determine the unknown currents. To do so follow the steps below:
   - Start with the simplest equation and solve for one of the unknown currents in terms of the other two.
   - Substitute this into the two remaining equations. You should now have two relations and two unknowns.
   - Repeat the process for the two relations and two unknowns.
   - You should now have one relation and one unknown. Solve for the unknown current and then substitute back in to solve for the other two currents.

   Don't change the sign of you get a negative current until all calculations are finished. The relations were established assuming your guess for the current direction. Changing the sign before you finish will make the other relations invalid.



$I_1 = I_2 + I_3$

$18 = 2I_1 + I_2 = 3I_1 + 2I_3$

$34 = 2I_1 + 3I_3 = 5I_3 + 2I_2$

$18 = 3I_2 + 2I_3$

$I_2 = 6 - \frac{2}{3} I_3$

$34 = 5I_3 + 2I_2$

$34 = 5I_3 + 12 - \frac{4}{3} I_3$

$I_3 = 6\ A$

$I_2 = 2\ A$

$I_1 = 8\ A$

Check your answers by substituting back into the junction rule and loop rule equations. Find and fix any mistakes.

a. What is the current (direction and magnitude) through the 2Ω resistor?

$I_1 = 8\ A$ up

b. What is the current (direction and magnitude) through the 1Ω resistor?

$I_2 = 2\ A$ down

c. What is the current (direction and magnitude) through the 3Ω resistor?

$I_3 = 6\ A$ left.