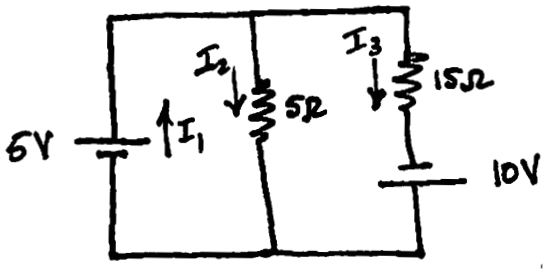
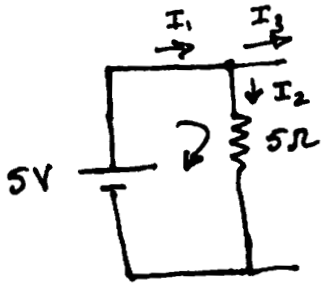
Physics 11
Lecture Problem 1 solution

Label the currents:



Look at the left loop:



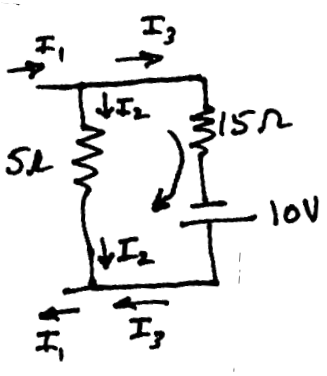
Sum voltages:

$$5 - 5I_2 = 0$$

Conserve current:

$$I_1 = I_2 + I_3$$

Look at the right loop:



Sum voltages:

$$10 + 5I_2 - 15I_3 = 0$$

Conserve current:

$$I_2 + I_3 = I_1$$

Notice the second junction relationship is the same as the first. We have three equations and three unknowns:

$$5 - 5I_2 = 0$$

$$10 + 5I_2 - 15I_3 = 0$$

$$I_1 = I_2 + I_3$$

Notice I_1 only enters due to the current relationship–it does not correlate to any voltage drop in a resistor.

The first equation gives

$$\longrightarrow I_2 = 1 \text{ A}$$

Using this in the second equation yields

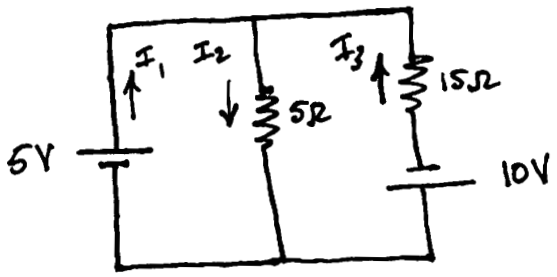
$$10 + 5(1) - 15I_3 \longrightarrow I_3 = 15/15 = 1 \text{ A}$$

Finally, current conservation gives:

$$I_1 = I_2 + I_3 = 1 + 1 = 2 \text{ A}$$

The current through the 5Ω resistor is 1 A (down). The current through the 15Ω resistor is 1 A (down). The current flows through both batteries from the low to the high side. Thus, both batteries provide energy to the circuit.

QUERY What if we had guessed I_3 in the other direction? Label the currents:



Applying the rules:

$$5 - 5I_2 = 0$$

$$10 + 5I_2 + 15I_3 = 0$$

$$I_1 + I_3 = I_2$$

As before,

$$I_2 = 1 \text{ A}$$

However,

$$10 + 5(1) + 15I_3 \longrightarrow I_3 = -1 \text{ A}$$

What does the minus sign mean? It means the current goes the opposite way as drawn. So I_3 heads down in the 15Ω resistor, the opposite sense as drawn. Notice I still get the same I_1

$$I_1 = I_2 - I_3 = 1 - (-1) = 2 \text{ A}$$