2024Q10

CIRCUITS, VOLTAGE

For our third and final week introducing circuits, we'll be learning about voltage! In week 1, we learned that current is the rate of flow of electrons in a circuit. If current is described this way, voltage - measured in volts (or V) - is the force or pressure that pushes these electrons to move and create a current. This pressure is produced by creating a difference in electric charge between two points; an example of this is a battery. One battery has both a positive side and a negative side; this difference between positive and negative creates an electric pressure within the battery, so connecting the battery to a circuit forces the electrons around it to move, creating a current!

There are two main kinds of voltages within a circuit: source voltage and voltage drops. Source voltage adds voltage to the circuit and causes the electrons to flow – examples of this are batteries and even the outlet plugs in your walls! A voltage drop is the voltage felt across part of the circuit, like the resistors we learned about last week. The voltage "drops," or decreases, from its source value due to the energy it loses as the electrons try to push themselves through the circuit or its components.

One way to calculate the voltages at different parts of a circuit is to use an equation called Kirchoff's Voltage Law. This law states that **for any full loop you find in a circuit, the total sum of those voltages should equal zero**. Reminder: voltages can be negative! As seen in Figure 1 below, if you draw a clockwise circle around your chosen loop, you can add or subtract those voltage values from your total equation depending on whether you hit a positive or negative side first!

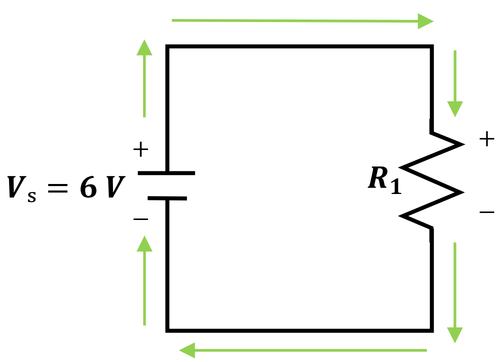

Figure 1: Diagram of a battery and resistor in series

$$Kirchoff's\ Voltage\ Law: \quad \Sigma V = 0$$

In this example, the voltage from the battery is 6 volts and we do not know the voltage drop across resistor R_1.

Since there is only one unknown resistor and we know the voltage being supplied, we can calculate the voltage drop (how much the voltage decreases) across the resistor.

$$\Sigma V = 0$$

$$V_s + R_1 = 0$$

$$6\ V + R_1 = 0$$

$$R_1 = -6\ V$$

This means the resistor must resist the flow of current by 6 volts to satisfy Kirchoff's Voltage Law.

Resistors polarize in the opposite direction to the flow of current. This means a resistor will always decrease voltage as current goes across it. When solving for the voltage drop across resistors, you will take the battery's voltage and subtract the voltage drop across resistors to get the sum of voltages, which will always equal zero.

Level 1: Calculate V_3, the voltage drop across resistor 3, using KVL and the values provided from Figure 2 below.

$V_s = 6\ V$

$V_1 = -2\ V$

$V_2 = -1.5\ V$

$V_3 =$ ___V

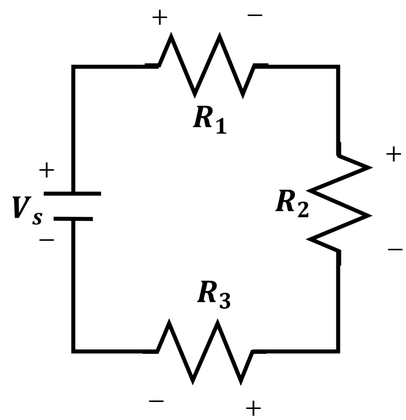

Figure 2

Level 2: Calculate V_3 and V_4, the voltage drops across resistor 3 and resistor 4, using KVL and the provided values from the circuit diagram below. Hint: note that this circuit has multiple loops, and each loop can be calculated individually!

$V_s = 12\ V$

$V_1 = -9\ V$

$V_2 = -2.5\ V$

$V_3 =$ ___V

$V_4 =$ ___V

$V_5 = -3\ V$

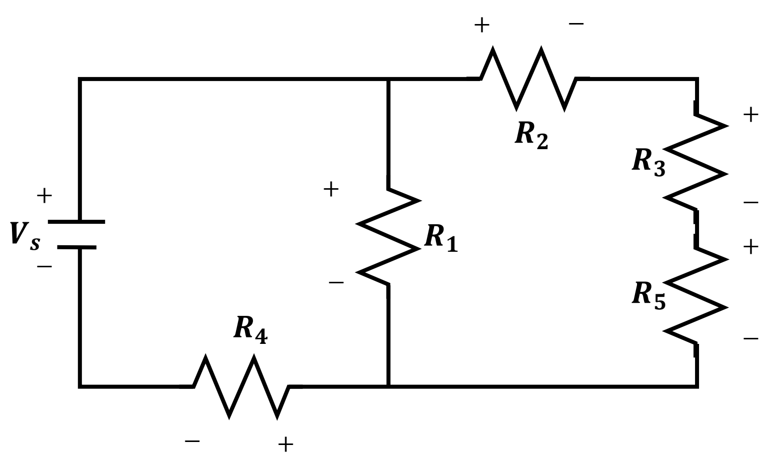

Figure 3