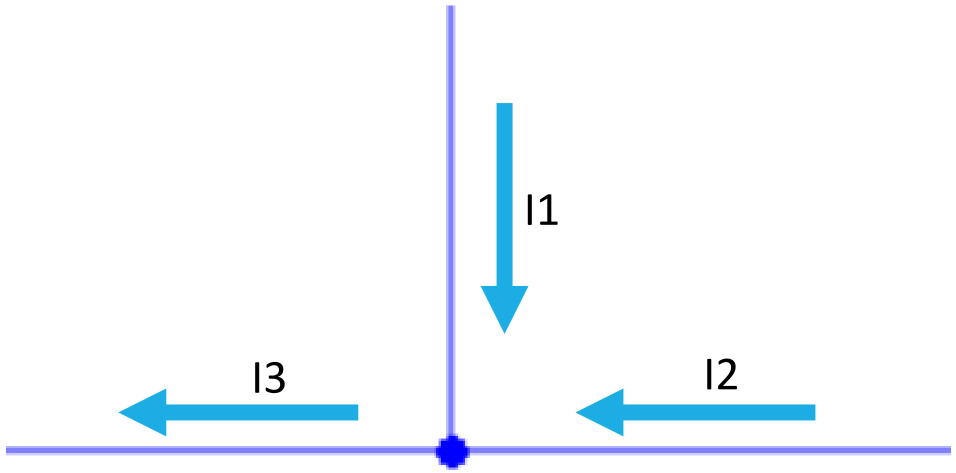
Mesh Analysis

York College & University Centre

Kirchoff’s Current Law

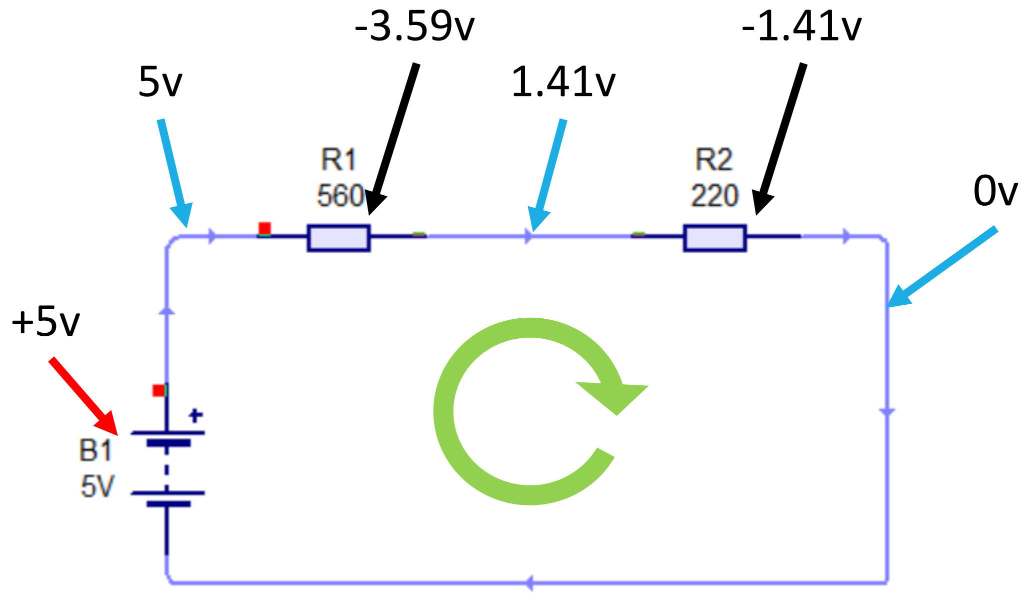
- **Definition:** At any junction, the total current entering = total current leaving
- **Equation form:** $\sum I_{in} = \sum I_{out}$
- **Basis:** Conservation of charge



$$I1 + I2 = I3$$

Kirchoff's Voltage Law

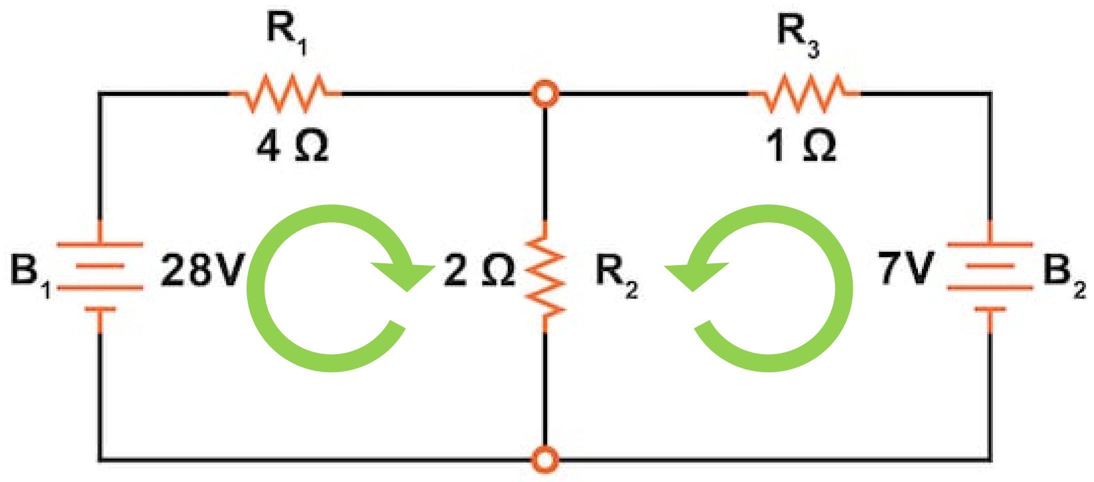
- **Definition:** The sum of all voltages around any closed loop in a circuit is zero.
- **Equation form:** $\sum V = 0$
- **Meaning:** Energy is conserved—voltage rises (sources) are balanced by voltage drops (loads).
- **Rule of thumb:** When you go around a loop, add rises as positive, drops as negative.



$$5v - 3.59v - 1.41v = 0v$$

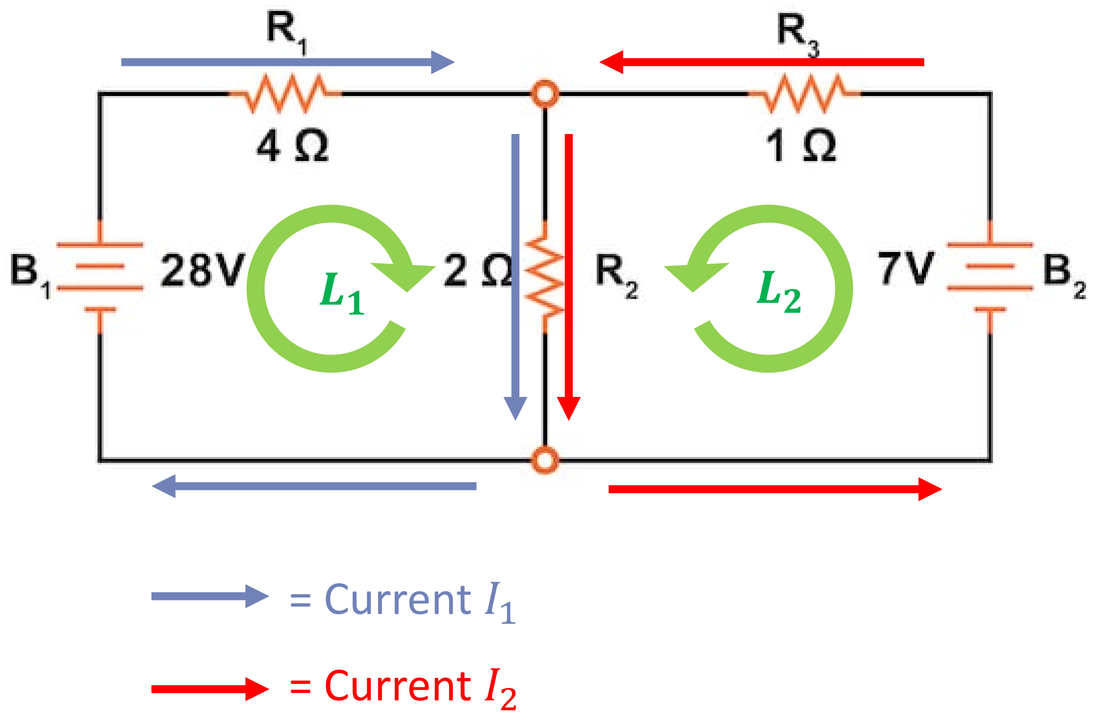
Let's Solve this together

- We can would out the current and voltage drop across every part of this
- Our first step is to split our circuit into loops
- We usually put the direction for our loops based on the sources in it



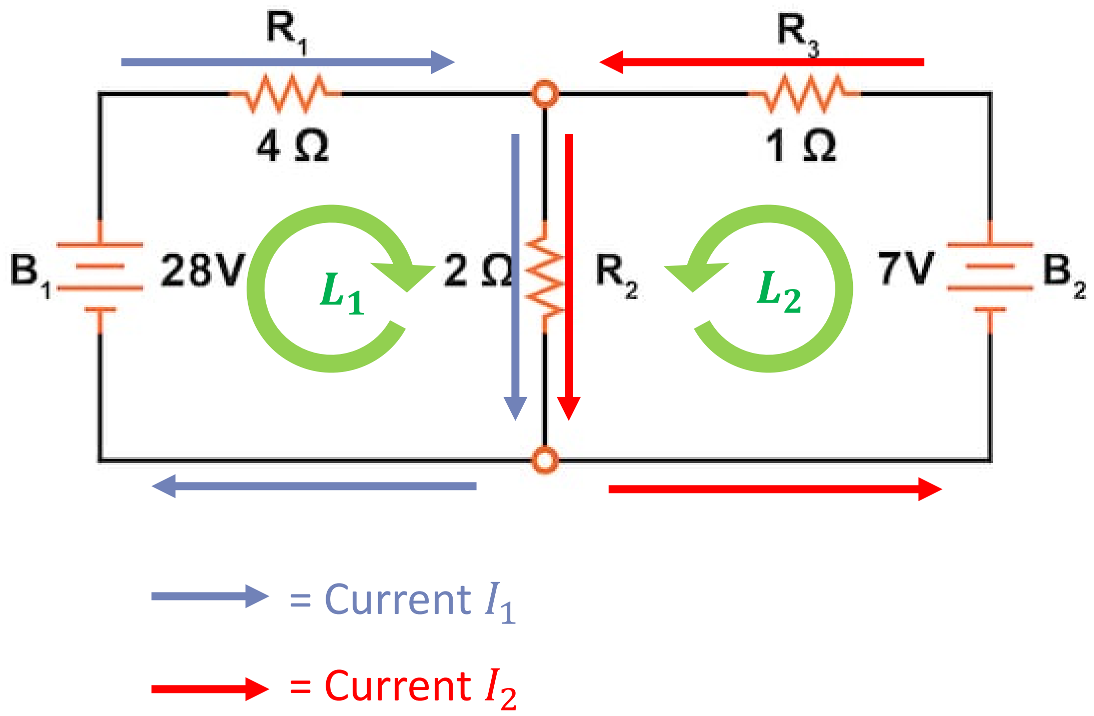
Let's Solve this together

- Each of these loops has their own current, so we can assign a current to each loop:
  - L_1 has I_1 in the loop
  - L_2 has I_2 in the loop
- We can draw on our circuit the current flows
- We know where both loops interact, we must add the current according to KCL
- This means:
  - R_1 has I_1 going through it
  - R_3 has I_2 going through it
  - R_2 has $I_1 + I_2$ going through it



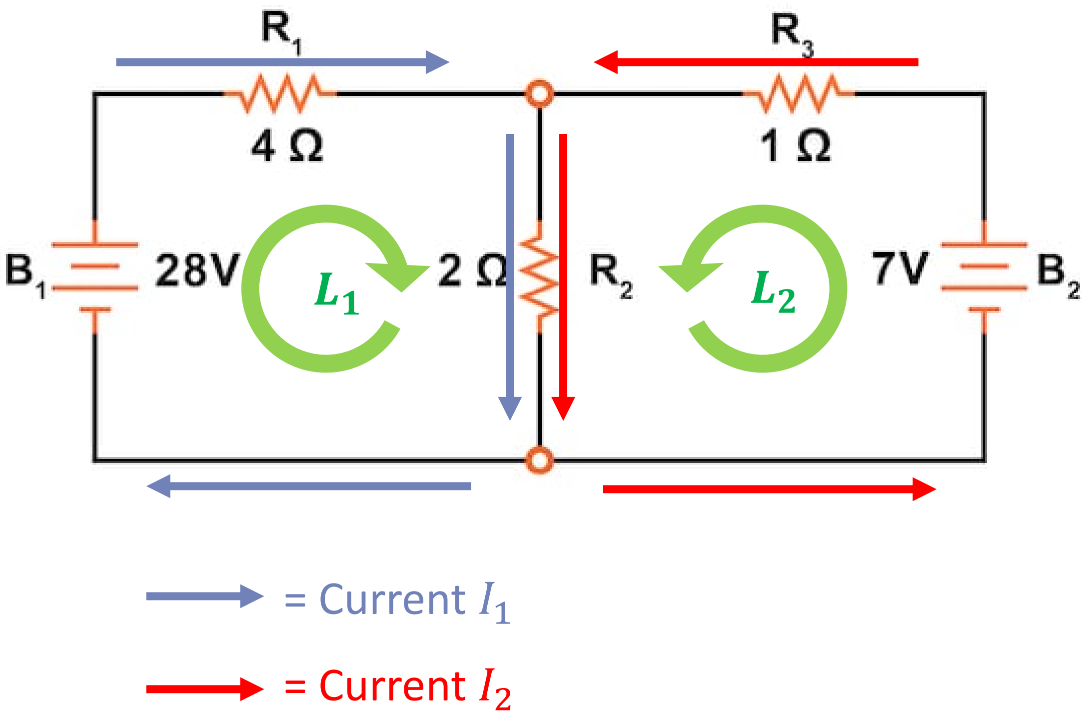
Let's Solve this together

- Based on Kirchoff's Voltage Law we know that the voltage drop across all the components in a loop must equal the voltage we put in
- We also know that $V = IR$
- Therefore, we can make an equation for the voltage drop across both loops



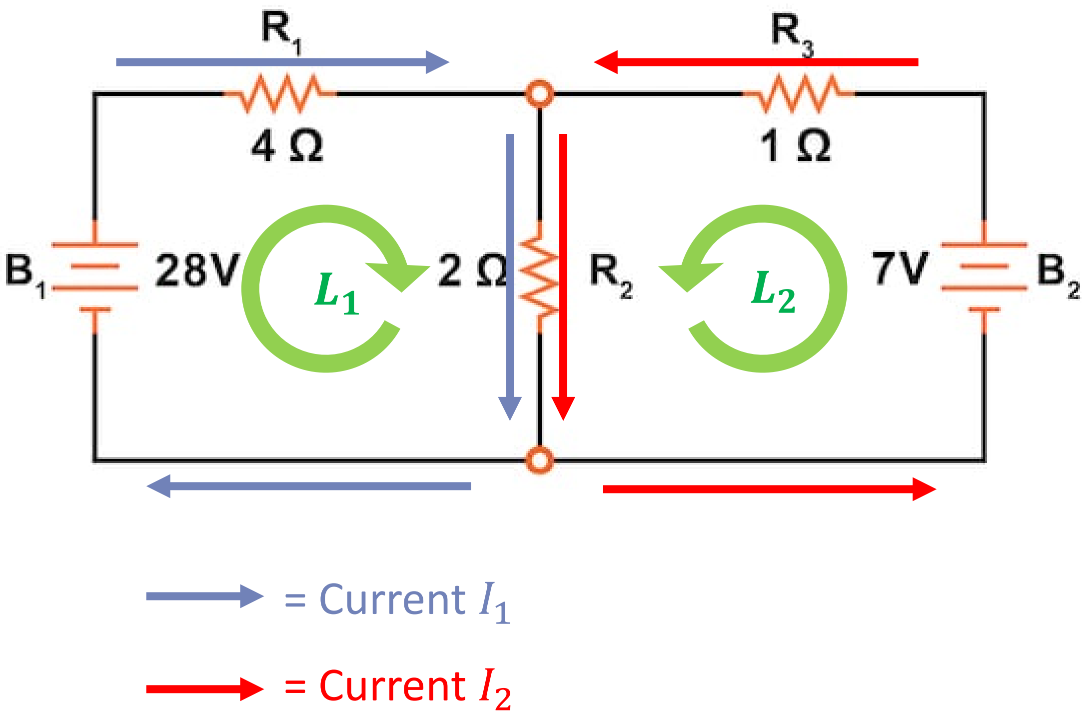
Let's Solve this together

- For Loop L1:
- We have a 28v source, and 2 resistors in the loop
- So we can write this for the loop:
- $\sum V_{source} = \sum V_{drop}$
- $B_1 = I_1 R_1 + (I_1 + I_2) R_2$
- $28 = 4I_1 + 2(I_1 + I_2)$



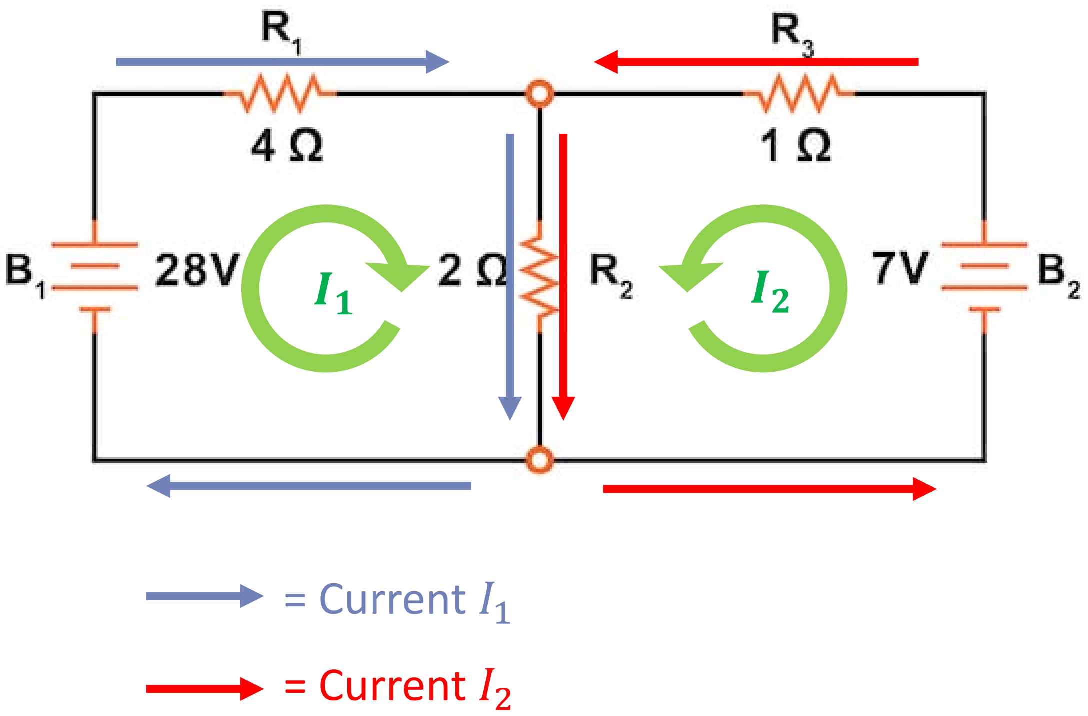
Let's Solve this together

- For Loop L2:
- We have a 7v source, and 2 resistors in the loop
- So we can write this for the loop:
- $\sum V_{source} = \sum V_{drop}$
- $B_2 = I_2 R_3 + (I_1 + I_2) R_2$
- $7 = 1I_2 + 2(I_1 + I_2)$



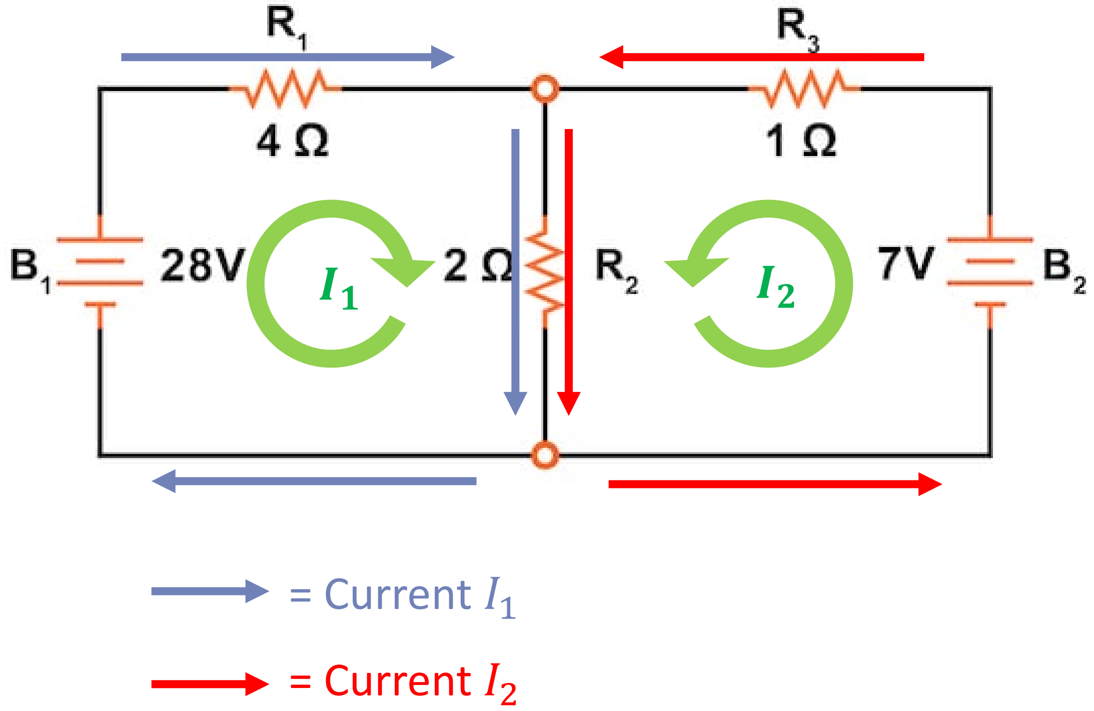
Let's Solve this together

- $L_1: 28 = 4I_1 + 2(I_1 + I_2)$
- $L_2: 7 = 1I_2 + 2(I_1 + I_2)$
- This leaves us two simultaneous equations meaning we can then work out I_1 and I_2
- You can solve these how you like but for this example I'm using substitution



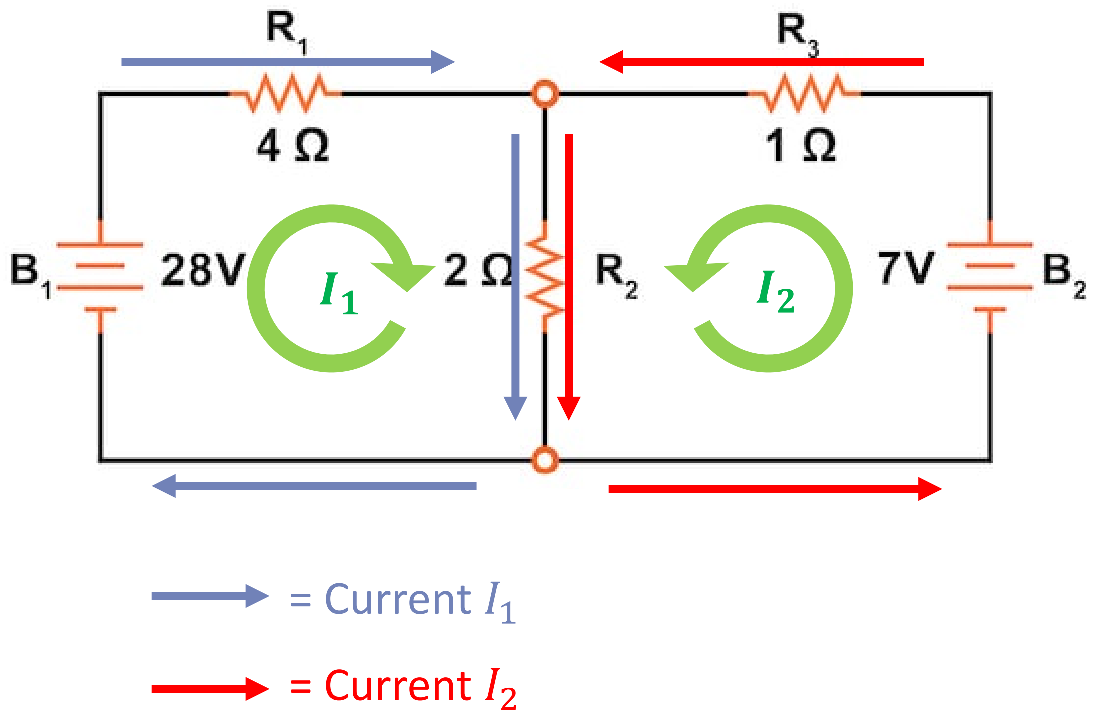
Let's Solve this together

- We start by rearranging L_1 to give us one of the current values (either I_1 or I_2)
- $L_1: 28 = 4I_1 + 2(I_1 + I_2)$
- We can expand out our brackets and then combine like terms
- $L_1: 28 = 4I_1 + 2I_1 + 2I_2$
- $L_1: 28 = 6I_1 + 2I_2$



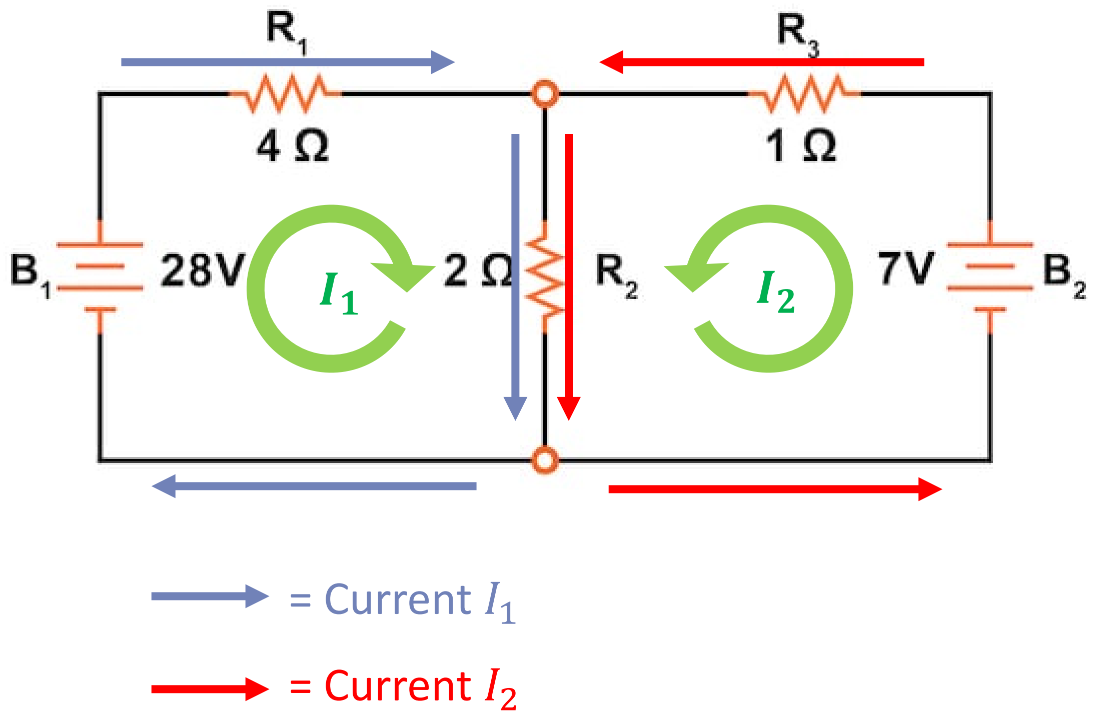
Let's Solve this together

- $L_1: 28 = 6I_1 + 2I_2$
- Let's make this all equal to I_1:
- $L_1: 28 - 2I_2 = 6I_1$
- $L_1: \frac{28-2I_2}{6} = I_1$
- We can now plug this into L_2



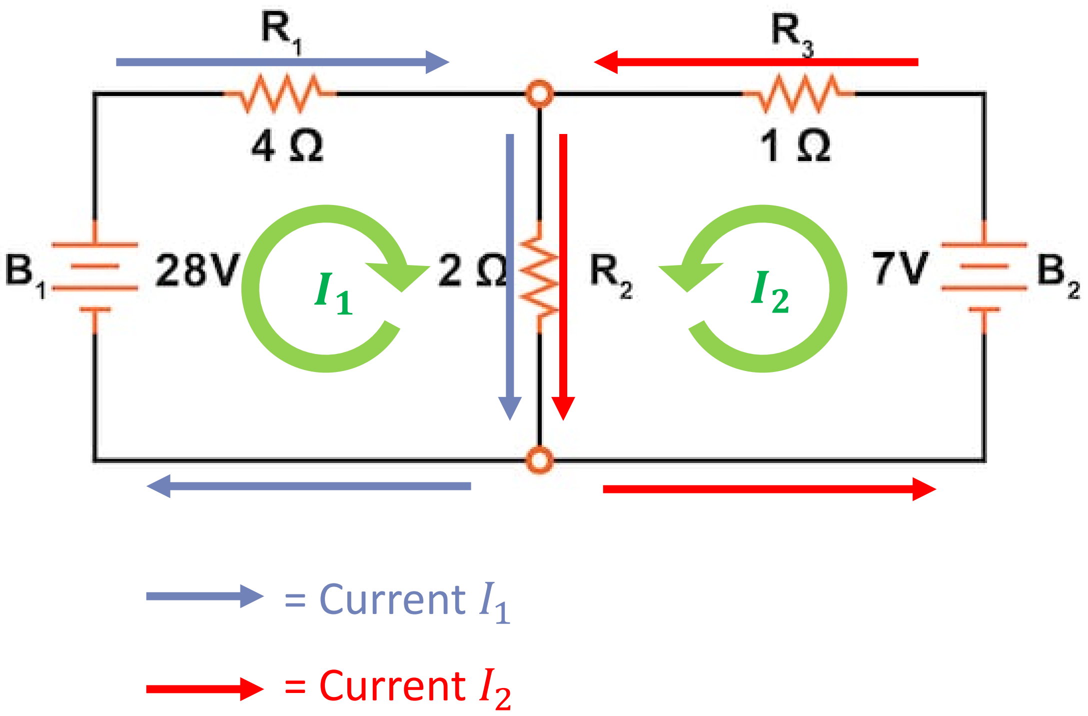
Let's Solve this together

- $L_1: \frac{28-2I_2}{6} = I_1$
- $L_2: 7 = 1I_2 + 2(I_1 + I_2)$
- First let's expand the brackets again and collect like terms
- $L_2: 7 = 1I_2 + 2I_1 + 2I_2$
- $L_2: 7 = 2I_1 + 3I_2$



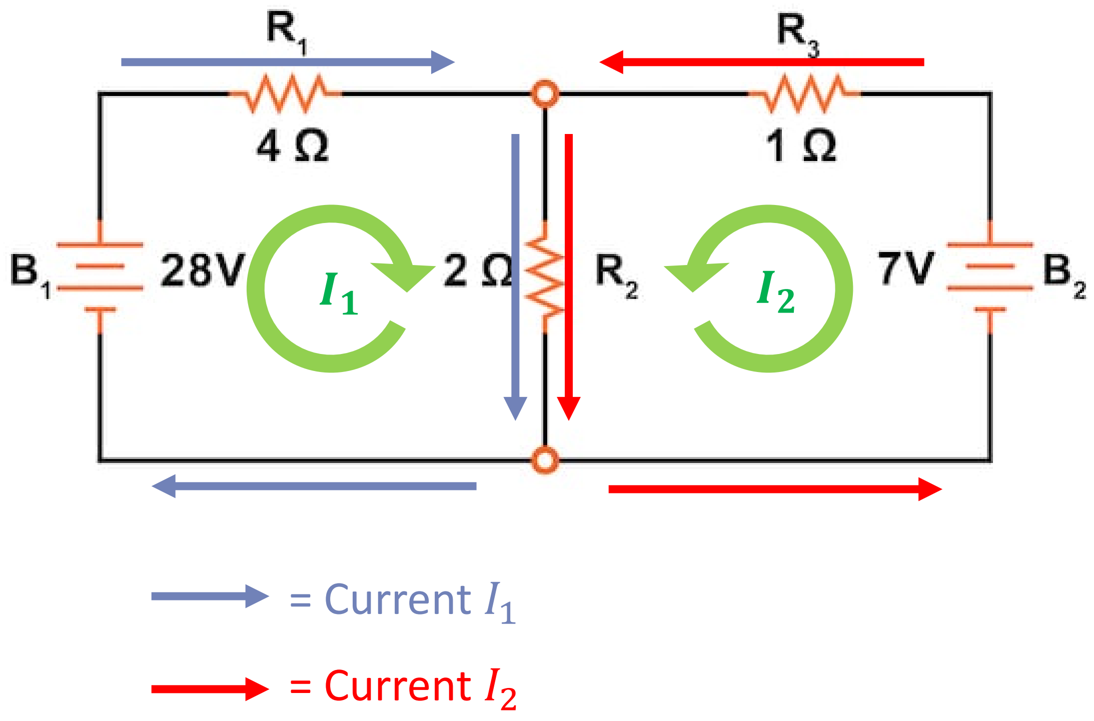
Let's Solve this together

- $L_1: \frac{28-2I_2}{6} = I_1$
- $L_2: 7 = 3I_2 + 2I_1$
- Let's plug it in
- $L_2: 7 = 3I_2 + 2(\frac{28-2I_2}{6})$
- Then let's expand the brackets
- $L_2: 7 = 3I_2 + \frac{56-4I_2}{6}$



Let's Solve this together

- $L_2: 7 = 3I_2 + \frac{56-4I_2}{6}$
- Let's get I_2 by itself by rearranging the equation
- $42 = 18I_2 + 56 - 4I_2$
- $-14 = 14I_2$
- $I_2 = -1A$
- Having a negative current is fine, it just means its flowing the opposite way



Let's Solve this together

- $I_2 = -1A$
- We can plug this value back into the other equation we have
- $\frac{28-2(-1)}{6} = I_1$
- $\frac{30}{6} = I_1$
- $I_1 = 5A$