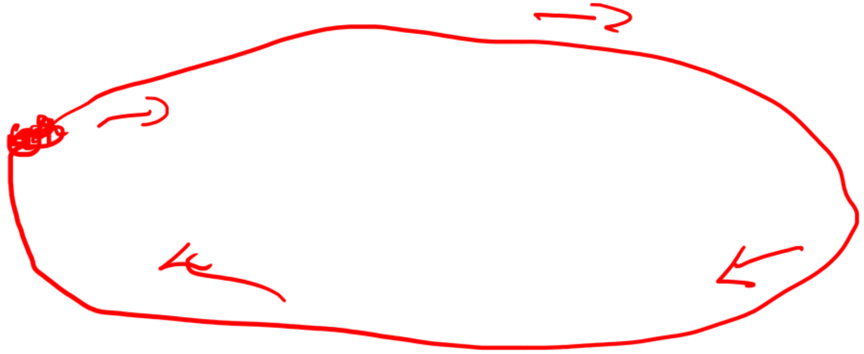
ELECTRIC CIRCUITS



KIRCHOFF'S RULES

Rule:

1. Junction Rule

→ The sum of the currents entering the junction is equal to the current leaving the junction

Entering the junction = Leaving junction

$$I + I_4 = I_1 + I_2 + I_3$$

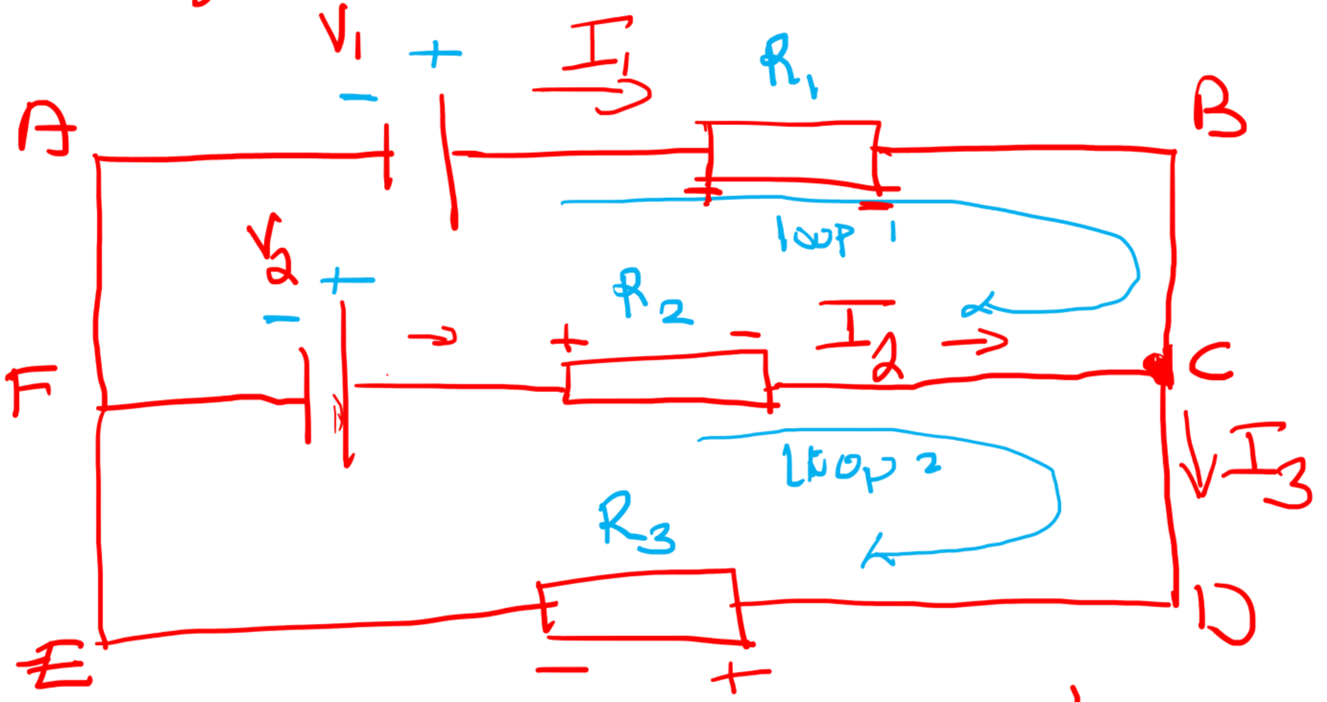
$$\sum I_{\text{entering junction}} = \sum I_{\text{leaving the junction}}$$

2. Loop Rule

The algebraic sum ~~the changes~~ in Potential (voltage changes) around a loop must be equal to zero

$$\sum V_{loop} = 0$$

Demonstration of Kirchoff's Rule on a circuit



1. The junction Rule

Entering Leaving

$$I_1 + I_2 = I_3$$

2. Loop Rule

Loop 1

→ If a resistor is traversed in the direction of current, then the change in electric potential is negative −IR

→ If a resistor is traversed in the direction opposite the current, then the electric potential across the resistor is positive +IR

A B C D F A → loop 1

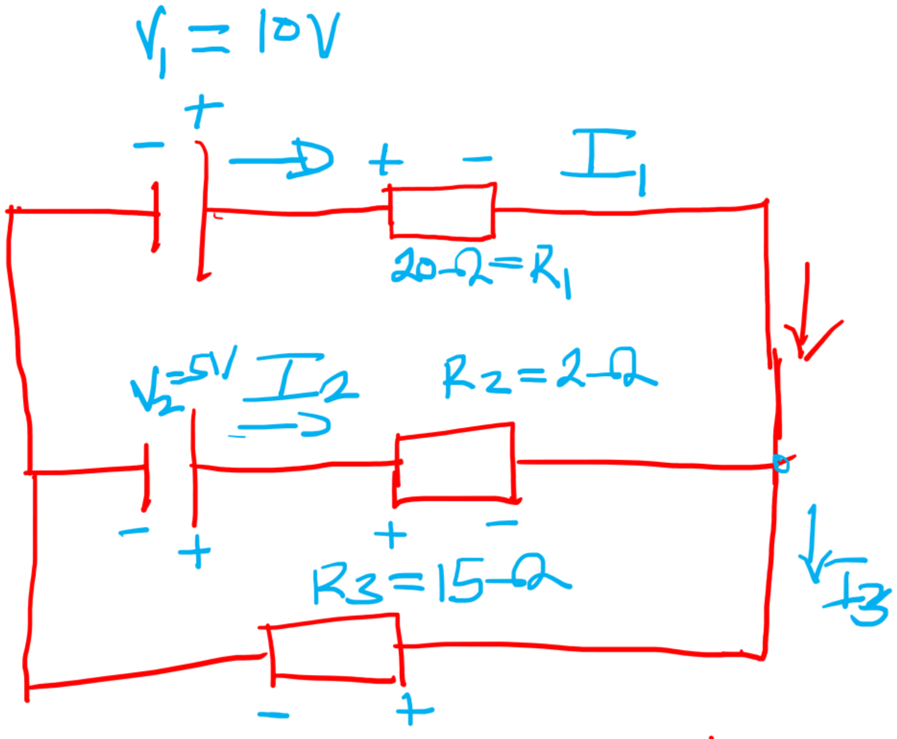
$$V_1 - R_1 I_1 + R_2 I_2 - V_2 = 0$$

Loop 2

$$V_2 - R_2 I_2 - R_3 I_3 = 0$$

→ If a source of emf is traversed in the direction of emf (from −ve to +ve) on the terminals, then the change in electric potential is +V

→ If a source of emf is traversed in the direction opposite the emf (from +ve to −ve) on the terminal then the change in electric potential is −V



Junction Rule

$$I_1 + I_2 = I_3 \quad \text{— (i)}$$

Loop 1

$$V_1 - I_1 R_1 + R_2 I_2 - V_2 = 0$$

$$10 - I_1 20 + 2 I_2 - 5 = 0$$

$$-20 I_1 + 2 I_2 = -5$$

divide by -1

$$20 I_1 - 2 I_2 = 5 \quad \text{(ii)}$$

Loop 2

$$V_2 - R_2 I_2 - R_3 I_3 = 0$$

$$5 - 2 I_2 - 15 I_3 = 0$$

$$-2 I_2 - 15 I_3 = -5$$

divide by -1

$$2 I_2 + 15 I_3 = 5 \quad \text{— (iii)}$$

$$2I_2 + 15I_3 = 5$$

but $I_1 + I_2 = I_3$ eqn (i)

$$2I_2 + 15(I_1 + I_2) = 5$$

$$2I_2 + 15I_1 + 15I_2 = 5$$

$$15I_1 + 17I_2 = 5$$

$$20I_1 - 2I_2 = 5$$

$$15I_1 + 17I_2 = 5 \quad \times 4$$

$$20I_1 - 2I_2 = 5 \quad \times -3$$

$$60I_1 + 68I_2 = 20$$

$$-60I_1 + 6I_2 = -15$$

$$74I_2 = 5$$

$$I_2 = \frac{5}{74} = 0.0676A$$

$$20I_1 - 2I_2 = 5$$

$$20I_1 - 2 \times 0.0676 = 5$$

$$I_1 = \frac{5.1352}{20}$$

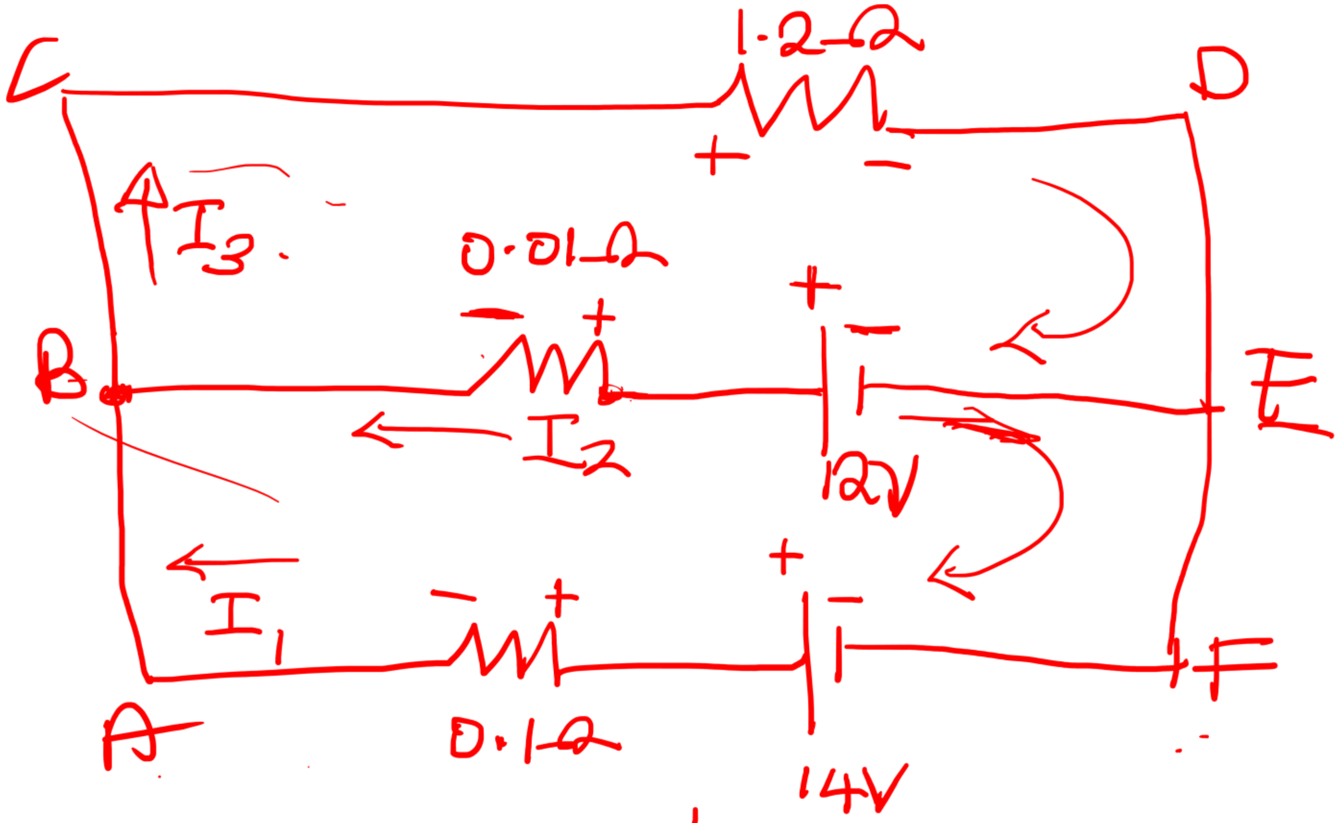
$$I_1 = 0.25676A$$

$$I_1 + I_2 = I_3$$

$$0.25676 + 0.0676 = I_3$$

$$I_3 = 0.32436\,A$$

Q.



Junction Rule

Current into junction = Current out of junction

$$I_1 + I_2 = I_3 \quad \text{—(i)}$$

Loop Rule

BEFA

$0.01I_2 - 12 + 14 - 0.1I_1 = 0$

$0.01I_2 - 0.1I_1 = -2$ —— (ii)

Loop Rule ; CDEB

$-1.2I_3 + 12 - 0.01I_2 = 0$

$-1.2I_3 - 0.01I_2 = -12$ —— (iii)

$-1.2(I_1 + I_2) - 0.01I_2 = -12$

$-1.2I_1 - 1.2I_2 - 0.01I_2 = -12$

$-1.2I_1 - 1.21I_2 = -12$ —— (iv)

$$-1.2I_1 - 1.21I_2 = -12 \quad | \times 1$$

$$-0.1I_1 + 0.01I_2 = -2 \quad | \times -12$$

$$-1.2I_1 - 1.21I_2 = -12$$

$$+1.2I_1 - 0.12I_2 = 24$$

$$0 \quad -1.33I_2 = 12$$

$$I_2 = \frac{12}{-1.33} = -9\,A$$

$$-1.2I_1 - 1.21(-9) = -12$$

$$-1.2I_1 + 10.89 = -12$$

$$I_1 = \frac{-12 - 10.89}{-1.2} = \frac{-22.89}{-1.2} = 19.1A$$

$$I_1 + I_2 = I_3 \quad eqn\ (i)$$

$$19.1 - 9 = I_3$$

$$I_3 = \underline{\underline{10.1\,A}}$$

<u>Note:</u> The negative answer for I_2 indicates that the current through the cell is not directed from right to left as shown, but the 9A current is directed from left to right