DC CIRCUIT : ELECTRICITY

KIRCHHOFF'S LAWS

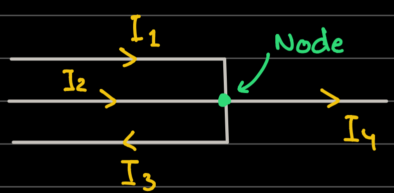
Purpose : To help us determine the value of current in electrical circuits involving multiple batteries

2 laws :

1. KCL (Kirchhoff's Current Law)

This law states that current arriving at a node or junction must be equal to the current leaving the node or junction

Note / junction refers to any point in a circuit where multiple wires meet or intersect

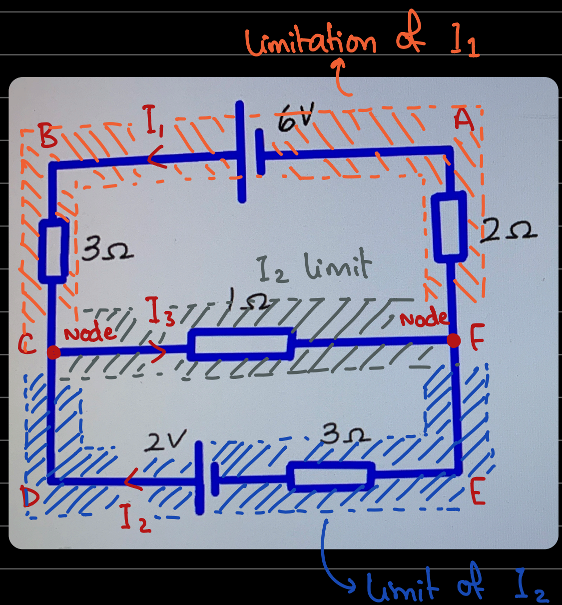


Forming an equation according to KCL

Current arriving = Current leaving

$$I_1 + I_2 = I_3 + I_4$$

Note : This law is based on law of conservation of charge, which states that charges can neither be created nor destroyed



KCL

1. Label Circuit (A, B, C ...)
2. Identify nodes
3. Randomly mark direction of current in all branches and based on that, form an equation for current.

$$I_1 + I_2 = I_3$$

Note : Every current is limited in it's respective branch extending from one node to the other node

2. KVL (Kirchhoff's Voltage Law)

- Consider any closed loop and imagine that you are moving in that loop

1. If you see a battery such that you observe the negative terminal first and then the positive terminal, assume that the voltage is getting raised and write down this voltage as a positive value

2. If instead, you observe the positive terminal of the battery first and then the negative terminal, assume that the voltage is getting dropped and write down this voltage as a negative value

- If, while moving in the circuit, you come across a resistor, use rule 3 and 4:

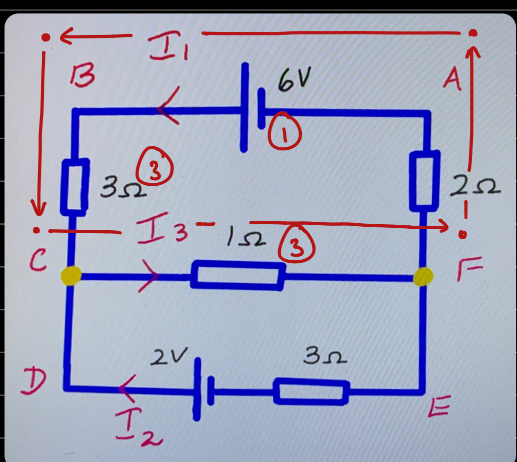
3. If your direction of movement is the same as the direction of current in that branch, then write down the voltage of the resistor with a negative sign. (ie. $-IR$)

4. If your direction of movement is opposite to the direction of current in that branch, then write down the voltage of the resistor with a positive sign ($+IR$)

- When you return back to your starting point equate your equation to 0.

- This law is based on the law of conservation of energy which states that the voltage provided by the battery is consumed by the resistor.

  $\therefore$, sum of voltage in a closed loop is equal to 0.



Closed loop : ABCFA

A → B

$+6$

B → C

$+6 - I_1(3)$

C → F

$+6 - I_1(3) - I_3(1)$

F → A

$+6 - I_1(3) - I_3(1) - I_1(2) = 0$

1 $6 - 5I_1 - I_3 = 0$

2^{nd} Closed loop : ABCDEFA

$$+6 - I_1(3) - 2 + I_2(3) - I_1(2) = 0$$

② $4 - 5I_1 + 3I_2 = 0$

Note: Positive ans. for current would mean that the direction for current marked on the diagram is the correct direction whereas a negative answer, if obtained, implies that actual current is opposite to the direction marked

And remember... $I_1 + I_2 = I_3$

And then solve simultaneously

$$4 - 5I_1 + 3I_2 = 6 - 5I_1 - (I_1 + I_2)$$
$$4 - 5I_1 + 3I_2 = 6 - 5I_1 - I_1 - I_2$$
$$4I_2 = 2 - I_1$$