Chapter 27 :- Circuits

Electromotive force ($\mathcal{E}$) :-

→ Work done by the Power Source (s.a battery) in moving +1 C from (−) terminal to (+) positive terminal.

$$\mathcal{E} = \frac{dW}{dq} \quad V \quad (J/C)$$

ideal emf device is a device that lacks any internal resistance

A real emf device has an internal resistance

Calculating I in a single-loop Circuit

$$\mathcal{E}\, dq = dW$$

derivation to dt

$$\mathcal{E} I = \frac{dW}{dt} \rightarrow P_{\mathcal{E}}$$

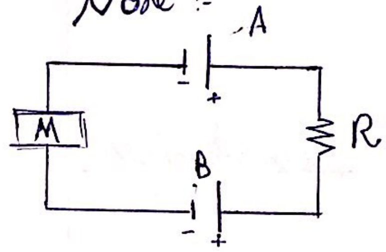
$$P_{\mathcal{E}} = P_R \quad \text{Conservation of Energy}$$

$P_{\mathcal{E}}$ ← $\mathcal{E}I$; P_R ← thermal energy

$$\mathcal{E} I = I^2 R$$

$$\boxed{I = \frac{\mathcal{E}}{R}}$$ for an ideal battery and $\boxed{V = \mathcal{E}}$

Note :-



$\mathcal{E}_B > \mathcal{E}_A$

• So B is charging A

→ loop Rule : $\sum V = 0$ in a closed loop
↳ (Kirchhoff's voltage law)

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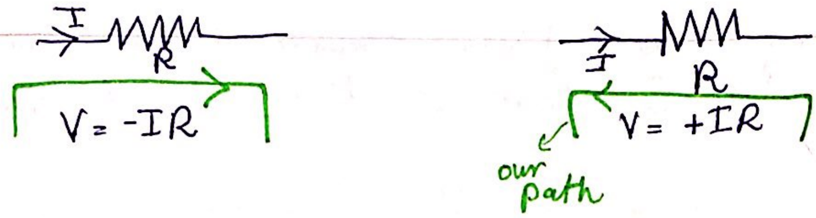
In a loop :- If the move through the Resistance is the same as the direction of I The potential change $= -IR$ if opposite it equals $+IR$



If the battery is not ideal and $r_{in} \neq 0$

Then

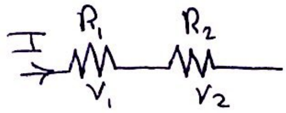
$$I = \frac{\mathcal{E}}{R + r_{in}}$$ and $$V = \mathcal{E} - i r_{in}$$

Resistances

→ on series :-

I is the same for All R

V is not the same $V_{applied} = V_1 + V_2$



$$R_{eq} = R_1 + R_2$$

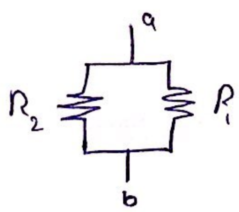
$R_{eq} > R_1$

$R_{eq} > R_2$

→ on parallel :

V is the same for all R

I is not the same $I_{app} = I_1 + I_2$



$$R_{eq} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$R_{eq} = \frac{R_1 R_2}{R_1 + R_2}$$

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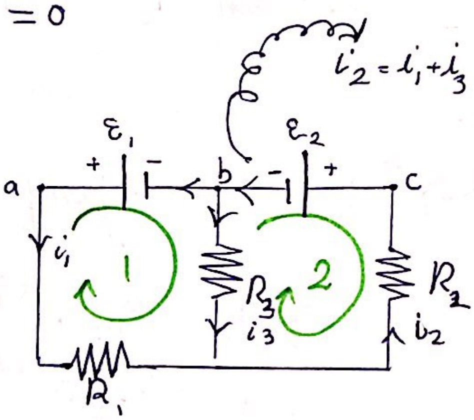
Multiloop Circuits

At Any Junction

$\sum I_{in} = \sum I_{out}$

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



1- $V_a - \mathcal{E}_1 - i_3 R_3 + i_1 R_1 = V_a$

$\mathcal{E}_1 + i_3 R_3 - i_1 R_1 = 0$

$\mathcal{E}_1 = i_1 R_1 - i_3 R_3$ —— ①

2- $V_b + \mathcal{E}_2 + i_2 R_2 + i_3 R_3 = V_b$

$\mathcal{E}_2 = -i_2 R_2 - i_3 R_3$ - - - ②

solve 1 & 2 by substituting $i_1 = i_2 - i_3$

$\mathcal{E}_1 = R_1 i_2 - R_1 i_3 - i_3 R_3$

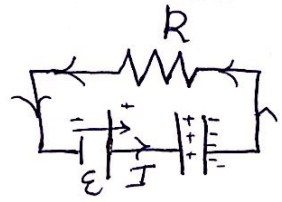
$\mathcal{E}_1 = R_1 i_2 - i_3 (R_1 + R_3)$

$\mathcal{E}_2 = -i_2 R_2 - i_3 R_3$

→ You Can solve them Knowing R & $\mathcal{E}$

RC- Circuits

Charging a Capacitor :-



$t=0 \longrightarrow q=0$

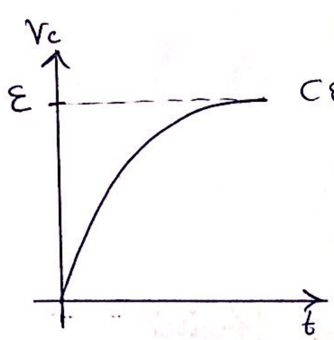
After a long time q is max $= \mathcal{E} C$

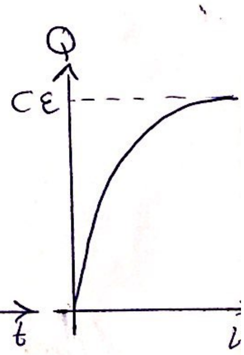
At Any time $\mathcal{E} = V_R + V_C$

$Q(t) = C\mathcal{E}\,(1 - e^{-t/RC})$

$V_C(t) = \mathcal{E}\,(1 - e^{-t/RC})$

$V_R(t) = \mathcal{E}\, e^{-t/RC}$





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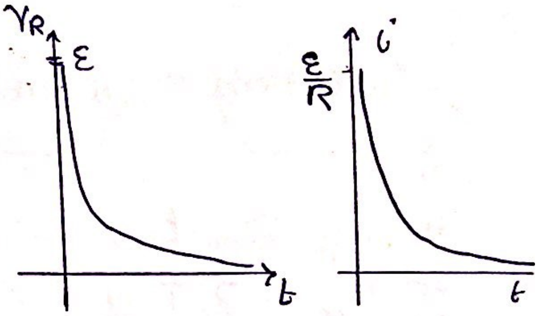
- Generally :-

$$i_0 = \frac{\mathcal{E}}{R} \quad \text{and} \quad \tau = RC$$

→ when $V_c = 0.63\,\mathcal{E} \rightarrow t = \tau$



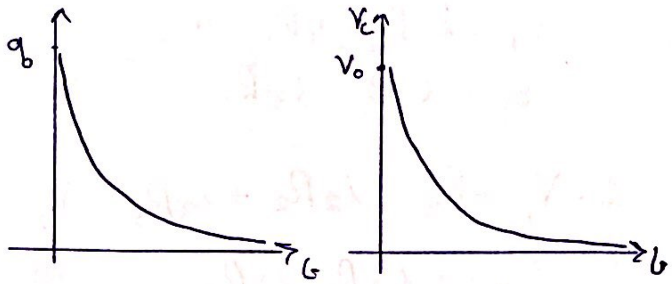
↳ Discharging A Capacitor

$$Q(t) = q_0\, e^{-t/RC}$$

$$V_C(t) = V_0\, e^{-t/RC}$$

$$i(t) = \frac{-q_0}{RC}\, e^{-t/RC}$$

→ The rest Charge (الشحنة المتبقية)



- Stored energy

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