Nishant Jindal

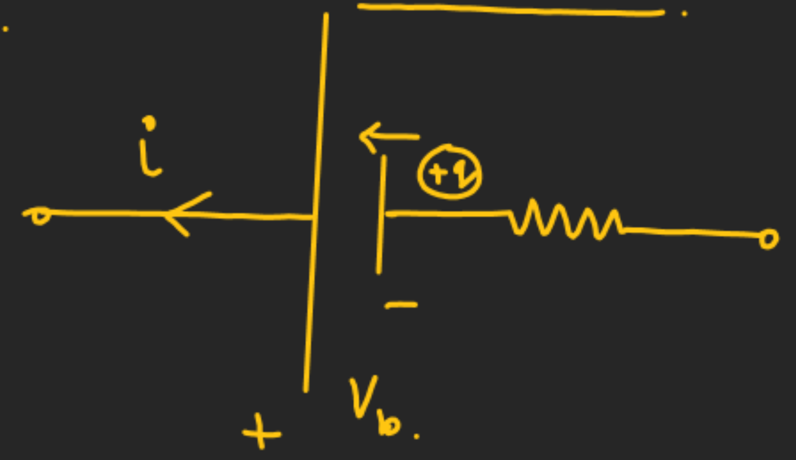
CURRENT ELECTRICITY

Battery :-

- Combination of many cells.
- It act's as a external agent in the Ckt.
- It works in two mode:-
  1. Charging mode.
  2. Discharging mode.

$i = \frac{dq}{dt}$.

Discharging mode



Work done by battery $= (qV_b)$

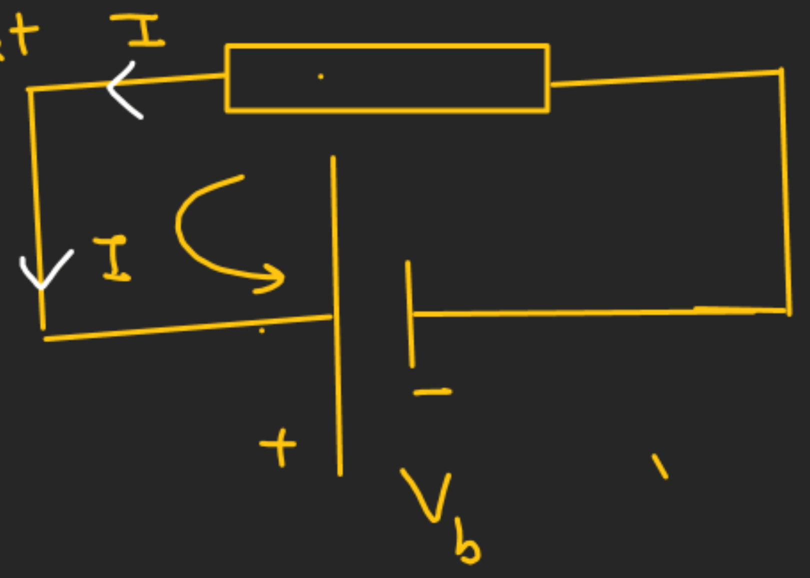
Charging Mode

(Current flow from Ckt to battery)

⇓

Work done on the battery.

$= -(qV_b)$



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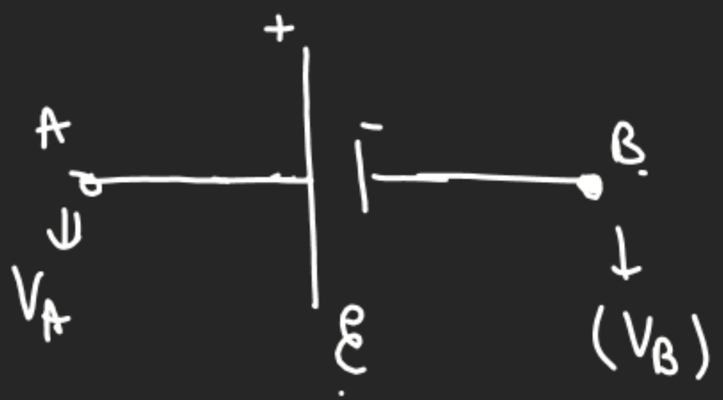
CURRENT ELECTRICITY

Battery

Ideal battery

↳ Internal resistance neglected.

↳ E.M.f → [Electromotive force] is equal to terminal potential drop.



$$\boxed{V_A - V_B = \mathcal{E}}$$

$\boxed{r = 0}$

Non-Ideal battery

↳ (Internal resistance) not zero.

↳ Terminal potential drop not equal to E.M.f.

→ Internal resistance of the battery.

$$V_B - ir + \mathcal{E} = V_A$$

$$\boxed{V_A - V_B = \mathcal{E} - ir}$$

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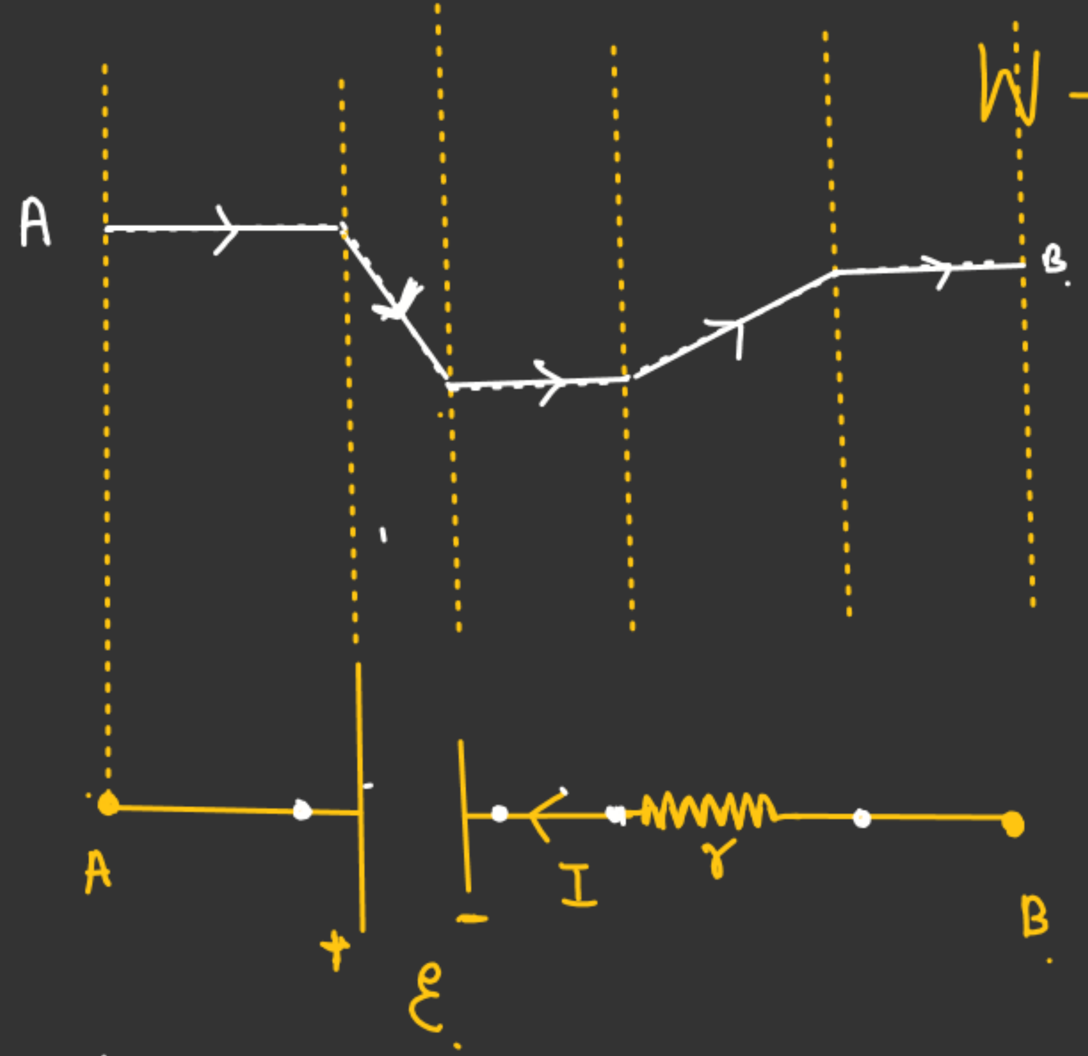
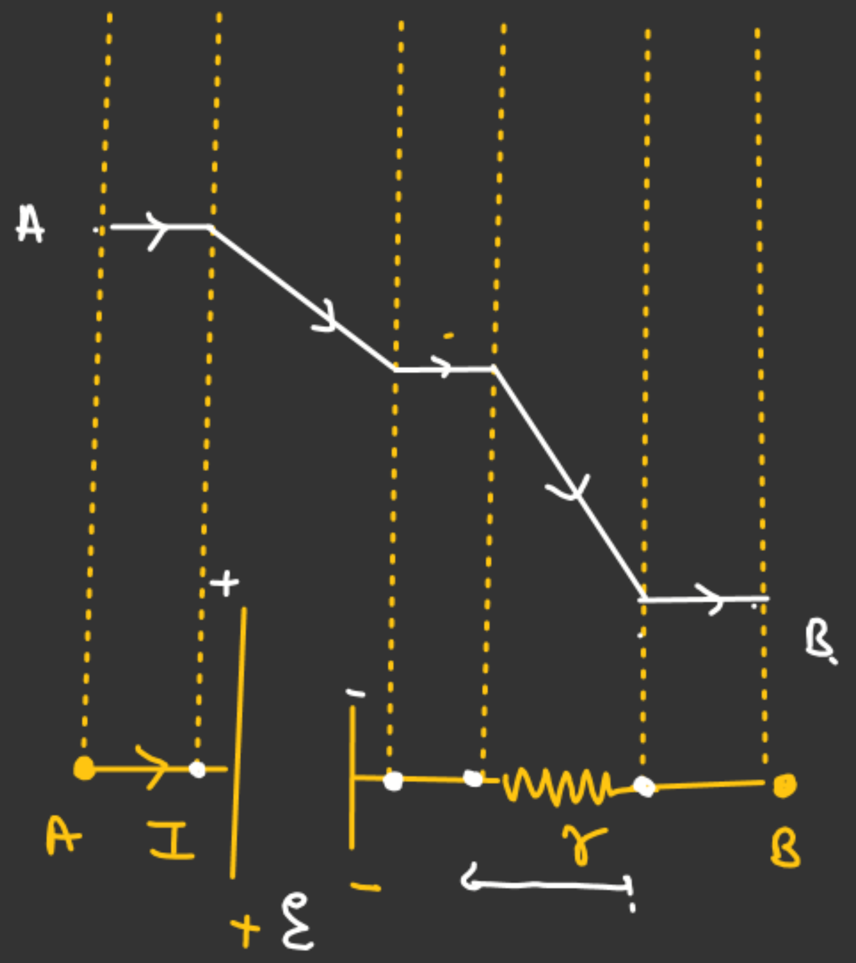
$\underline{\mathcal{E}.M.f}$:- $\left(\frac{\text{Work done}}{q}\right) = \left(\frac{W}{q}\right)$



$W \rightarrow$ work done in moving the ~~cations~~ and anions on the respective electrode

Charging mode :-



$V_A - \mathcal{E} - ir = V_B$.

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⇒ Combination of battery

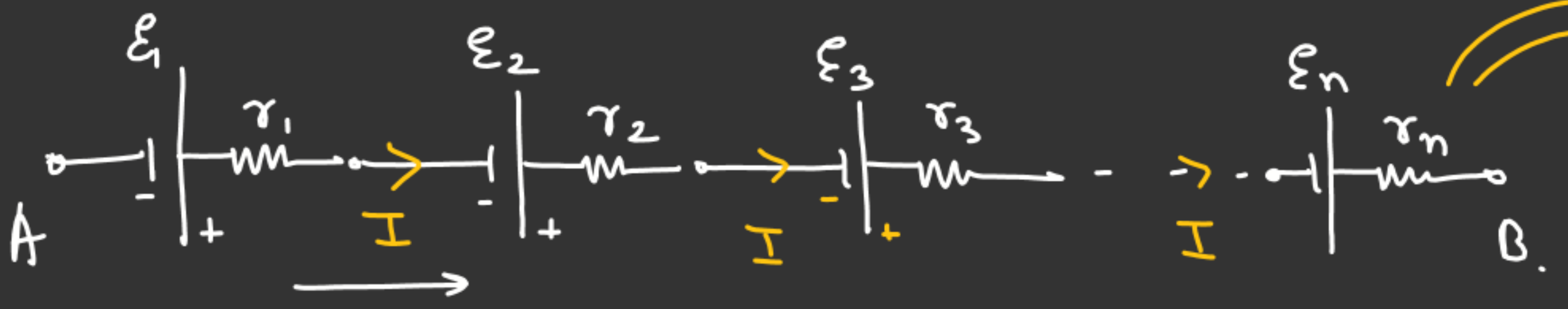
$$\mathcal{E}_{eq} = \left[\sum_{i=1}^{n} \mathcal{E}_i\right]$$

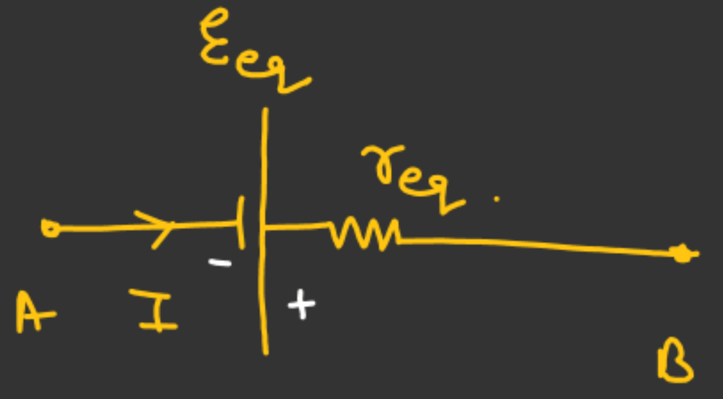
$$r_{eq} = (r_1 + r_2 - \cdots + r_n)$$

Series Combination

↳ Current in all the battery must be Same.

E_{eq} in Series Combination





$$V_A + \mathcal{E}_1 - Ir_1 + \mathcal{E}_2 - Ir_2 - \cdots + \mathcal{E}_n - Ir_n = V_B.$$

$$V_B - V_A = (\mathcal{E}_1 + \mathcal{E}_2 - \cdots + \mathcal{E}_n) - I(r_1 + r_2 - \cdots + r_n) \quad -(1)$$

$$V_A + \mathcal{E}_{eq} - Ir_{eq} = V_B.$$

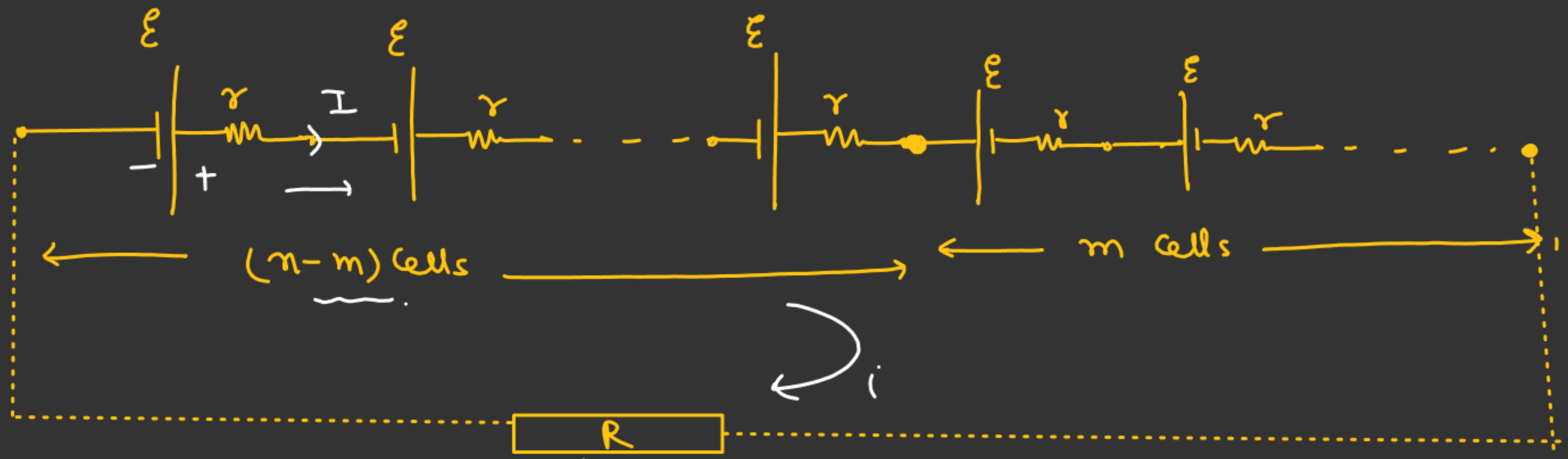
$$V_B - V_A = (\mathcal{E}_{eq} - Ir_{eq}) \quad -(2)$$

* Total no of Cells = n.
  m cells of opposite polarity.
  $\mathcal{E}$ = Emf of each cells.
  r = Internal resistance.

$$\mathcal{E}_{eq} = [(n-m)\mathcal{E} - m\mathcal{E}]$$

$$r_{eq} = nr$$

$$I = \frac{\mathcal{E}[n-2m]}{(nr+R)}$$ ✓



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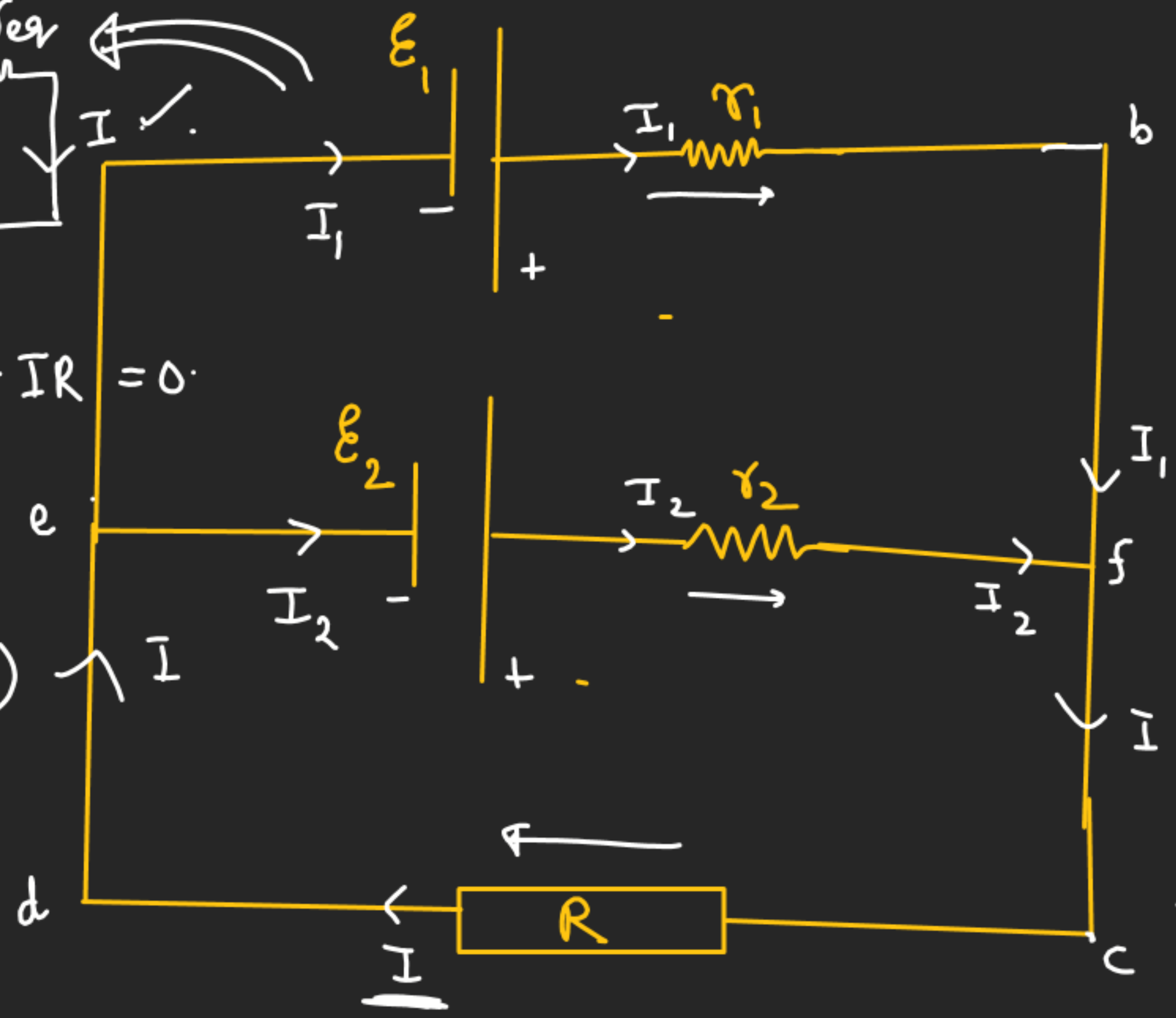
CURRENT ELECTRICITY

Parallel Combination of battery :-

$$\mathcal{E}_{eq} - I r_{eq} - IR = 0$$

$$I = \frac{\mathcal{E}_{eq}}{(R + r_{eq})}$$



K.V.L in loop abcda :-

$$\mathcal{E}_1 - I_1 r_1 - IR = 0$$

$$I_1 = \left(\frac{\mathcal{E}_1 - IR}{r_1}\right)$$

K.V.L in loop cdefc

$$\mathcal{E}_2 - I_2 r_2 - IR = 0$$

$$I_2 = \left(\frac{\mathcal{E}_2 - IR}{r_2}\right)$$

$$I = I_1 + I_2$$

$$I = \left(\frac{\mathcal{E}_1}{r_1} + \frac{\mathcal{E}_2}{r_2}\right) - IR\left(\frac{1}{r_1} + \frac{1}{r_2}\right)$$

$$I\left[1 + R\left(\frac{1}{r_1} + \frac{1}{r_2}\right)\right] = \left(\frac{\mathcal{E}_1}{r_1} + \frac{\mathcal{E}_2}{r_2}\right)$$

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CURRENT ELECTRICITY

$$I = \left[\frac{\varepsilon_1/r_1 + \varepsilon_2/r_2}{1 + R\left(\frac{1}{r_1} + \frac{1}{r_2}\right)}\right]$$

$$I = \frac{\varepsilon_1/r_1 + \varepsilon_2/r_2}{\left(\frac{1}{r_1} + \frac{1}{r_2}\right)\left[\frac{1}{\left(\frac{1}{r_1} + \frac{1}{r_2}\right)} + R\right]}$$

$$I = \frac{\left(\frac{\varepsilon_1/r_1 + \varepsilon_2/r_2}{1/r_1 + 1/r_2}\right)}{\left(R + \frac{1}{(1/r_1 + 1/r_2)}\right)}$$

$$I = \left(\frac{\varepsilon_{eq}}{r_{eq} + R}\right)$$

$$\boxed{\varepsilon_{eq} = \frac{\frac{\varepsilon_1}{r_1} + \varepsilon_2/r_2}{1/r_1 + 1/r_2}}$$

$$r_{eq} = \frac{1}{\frac{1}{r_1} + \frac{1}{r_2}} = \left(\frac{r_1 r_2}{r_1 + r_2}\right)$$

$$\frac{1}{r_{eq}} = \frac{1}{r_1} + \frac{1}{r_2}$$

For n- battery

$$\boxed{\varepsilon_{eq} = \frac{\sum_{i=1}^{n} \frac{\varepsilon_i}{r_i}}{\sum_{i=1}^{n} \frac{1}{r_i}}}$$

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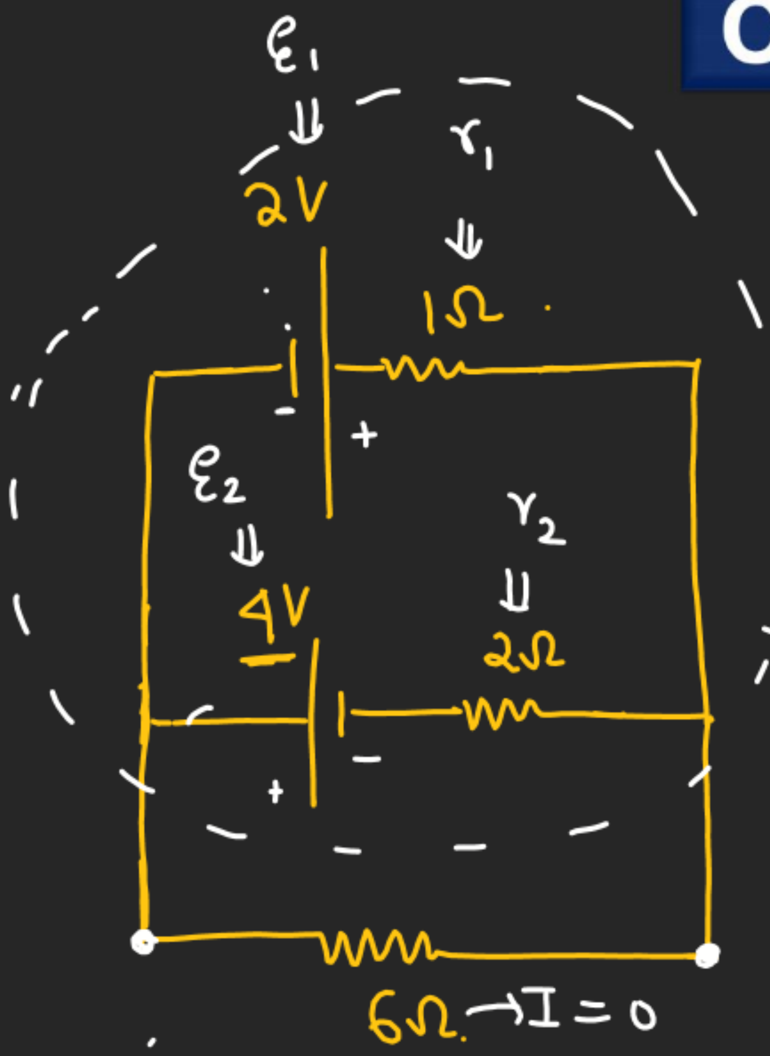
CURRENT ELECTRICITY

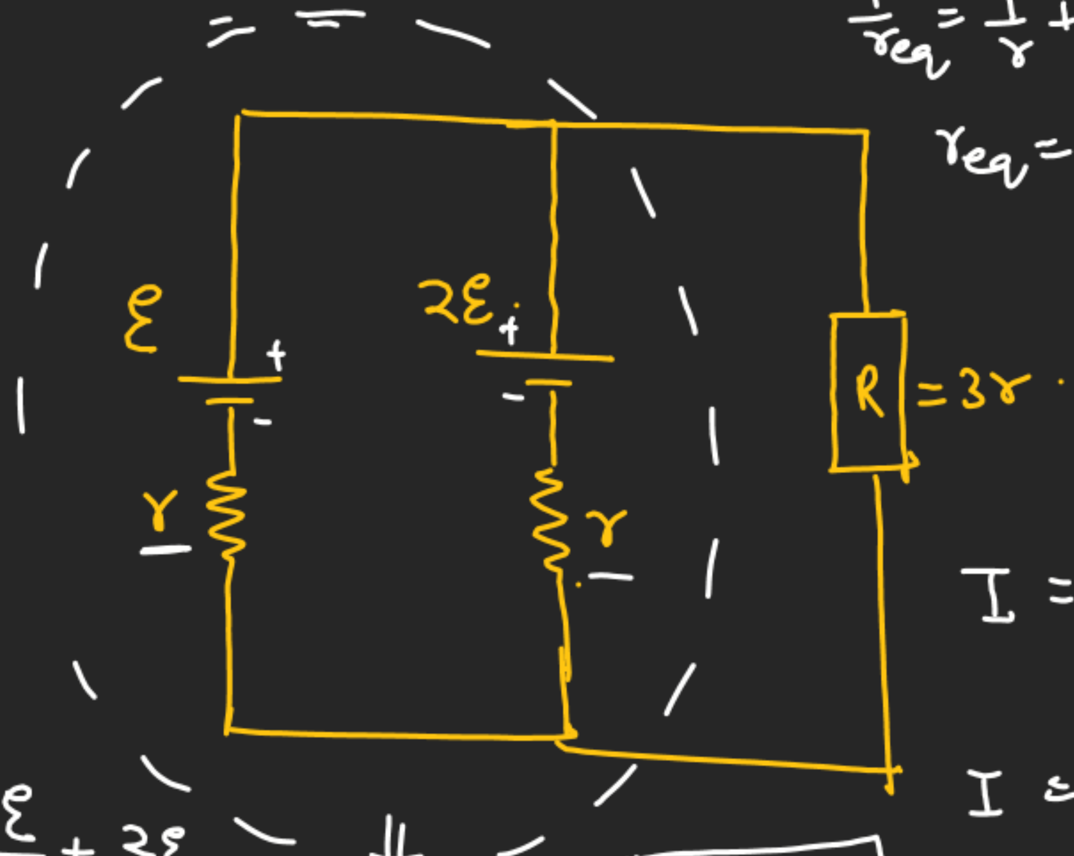
Find Current in 6Ω.



$$\varepsilon_{eq} = \frac{\left(-\frac{2}{1}+\frac{4}{2}\right)}{\left(1+\frac{1}{2}\right)}$$

$$\boxed{\varepsilon_{eq} = 0}$$

Find Current in R = ??

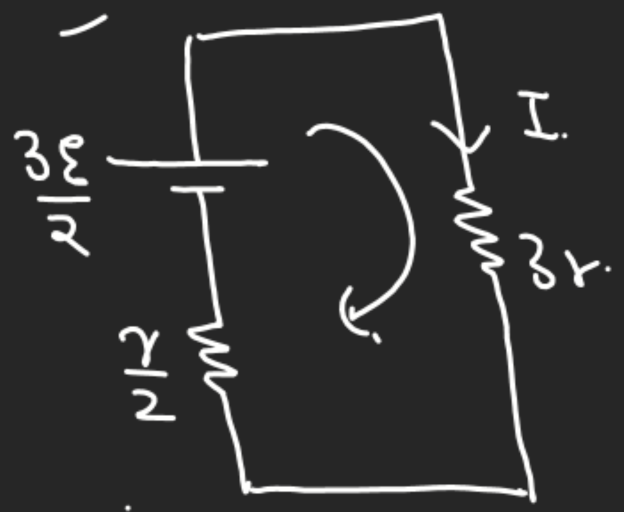


$$\frac{1}{r_{eq}} = \frac{1}{r}+\frac{1}{r}$$

$$r_{eq} = \frac{r}{2}$$

$$\varepsilon_{eq} = \frac{\frac{\varepsilon}{r}+\frac{2\varepsilon}{r}}{\frac{1}{r}+\frac{1}{r}}$$

$$\varepsilon_{eq} = \frac{3\varepsilon/r}{2/r} = \left(\frac{3\varepsilon}{2}\right)$$



$$I = \frac{\frac{3\varepsilon}{2}}{3r+\frac{r}{2}}$$

$$I = \left(\frac{3\varepsilon}{7r}\right)$$