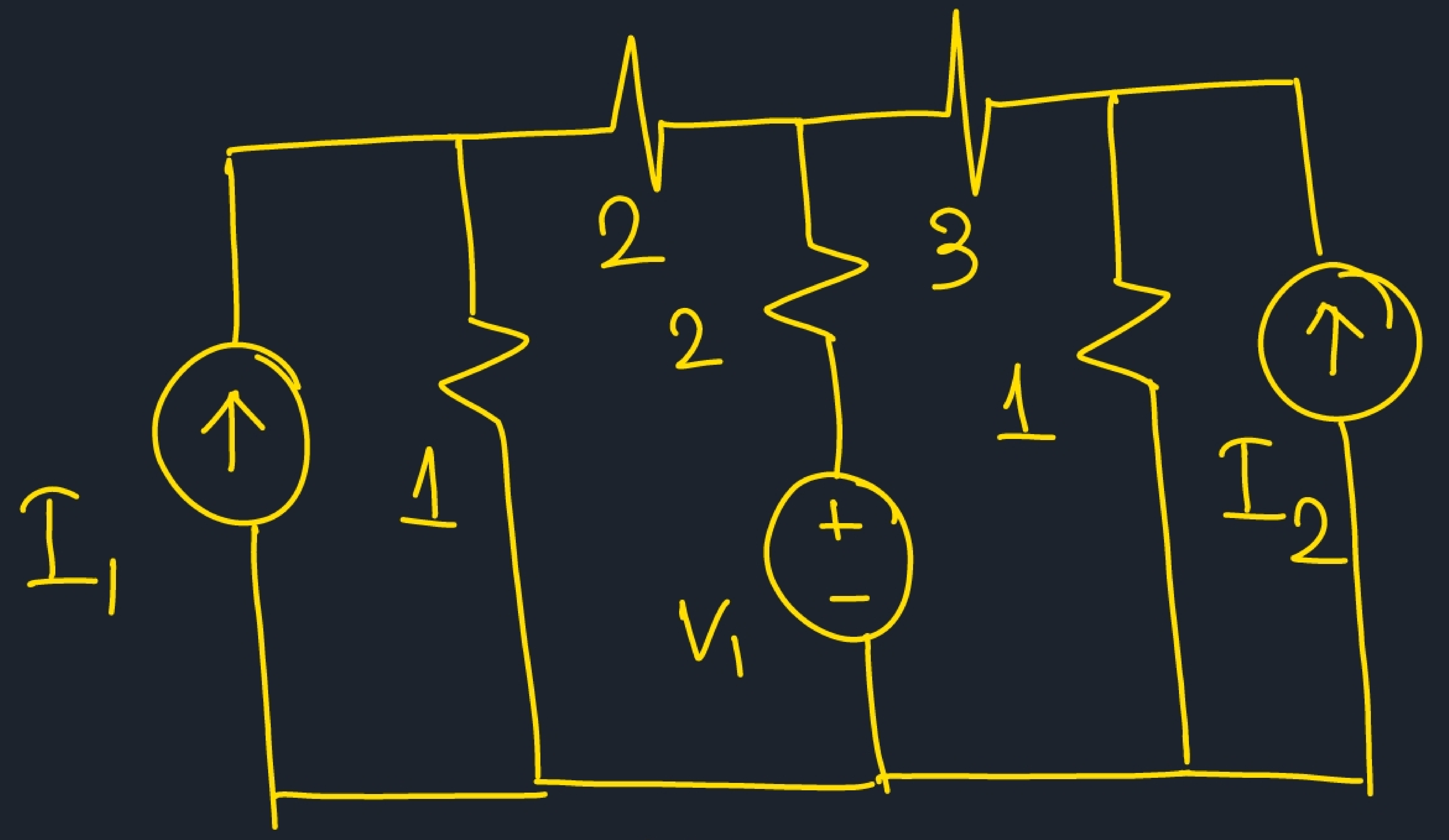
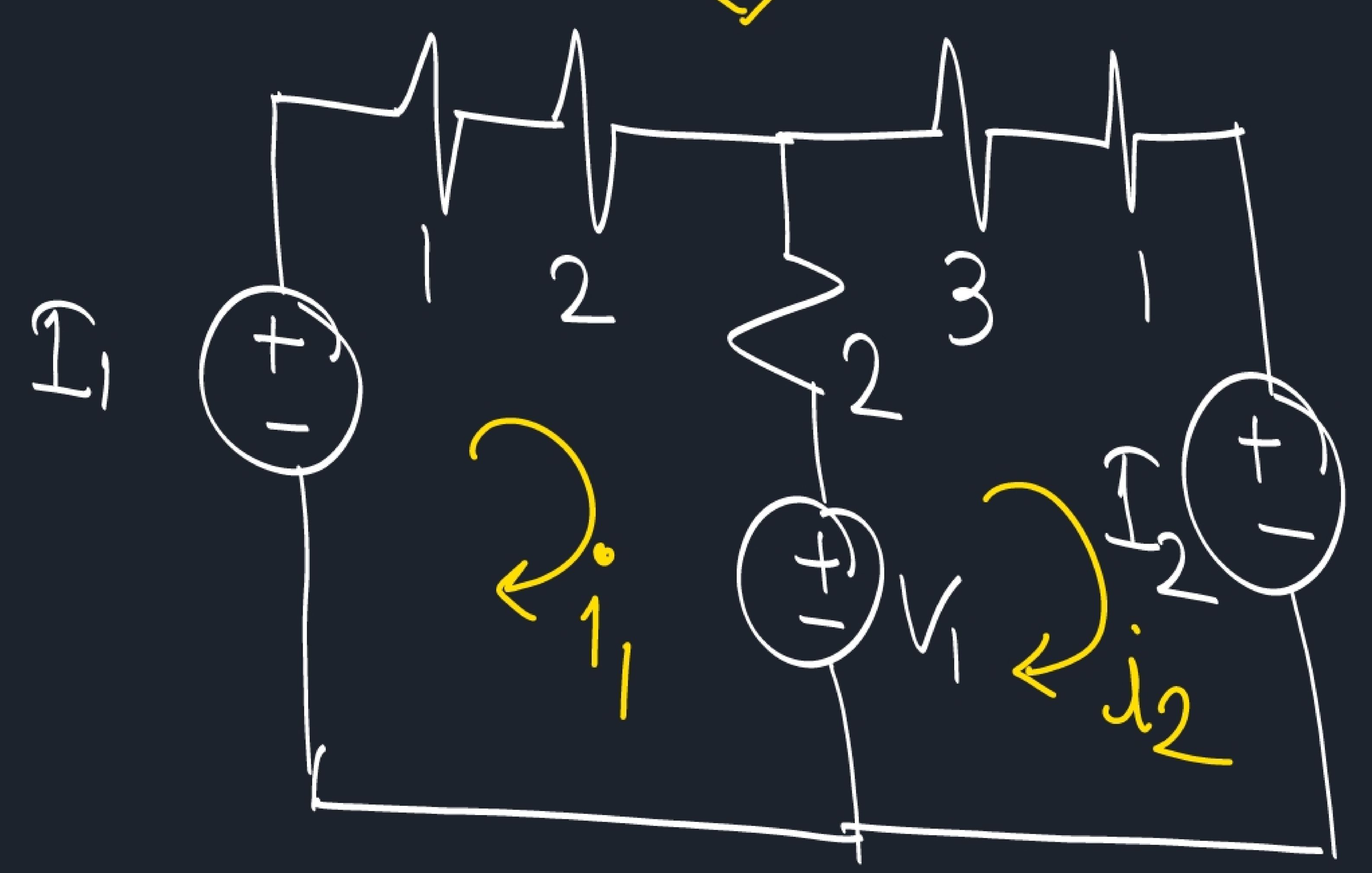
SUPERPOSITION :-





$$\begin{bmatrix} 5 & -2 \\ -2 & 6 \end{bmatrix}\begin{bmatrix} i_1 \\ i_2 \end{bmatrix} = \underbrace{\begin{bmatrix} I_1 - V_1 \\ -I_2 + V_1 \end{bmatrix}} = \begin{bmatrix} 1 & 0 & -1 \\ 0 & -1 & 1 \end{bmatrix}\begin{bmatrix} I_1 \\ I_2 \\ V_1 \end{bmatrix}$$

$$\begin{bmatrix} i_1 \\ i_2 \end{bmatrix} = \underbrace{\begin{bmatrix} 5 & -2 \\ -2 & 6 \end{bmatrix}^{-1}\begin{bmatrix} 1 & 0 & -1 \\ 0 & -1 & 1 \end{bmatrix}}\begin{bmatrix} I_1 \\ I_2 \\ V_1 \end{bmatrix}$$

$$\begin{bmatrix} i_1 \\ i_2 \end{bmatrix} = \begin{bmatrix} \frac{3}{13} & -\frac{1}{13} & -\frac{2}{13} \\ \frac{1}{13} & -\frac{5}{26} & \frac{3}{26} \end{bmatrix}\begin{bmatrix} I_1 \\ I_2 \\ V_1 \end{bmatrix}$$

$$i_1 = \left(\frac{3}{13}\right) I_1 - \left(\frac{1}{13}\right) I_2 - \left(\frac{2}{13}\right) V_1$$

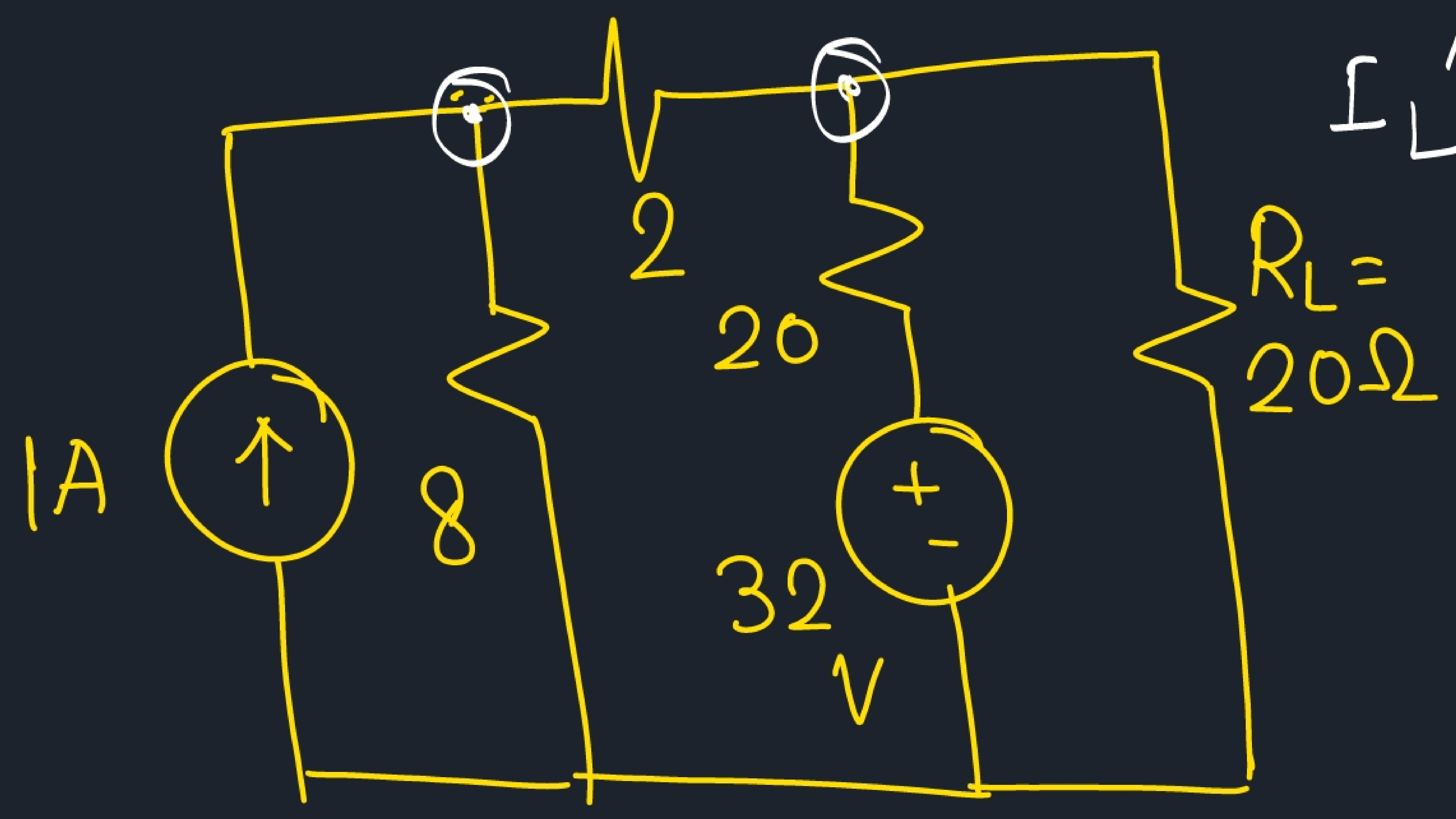
$$i_2 = \left(1/13\right) I_1 - \left(\frac{5}{26}\right) I_2 + \left(\frac{3}{26}\right) V_1$$

$$I_{2\Omega} = i_1 - i_2$$

$$= \left(\frac{2}{13}\right) I_1 + \left(\frac{3}{26}\right) I_2 - \left(\frac{7}{26}\right) V_1$$

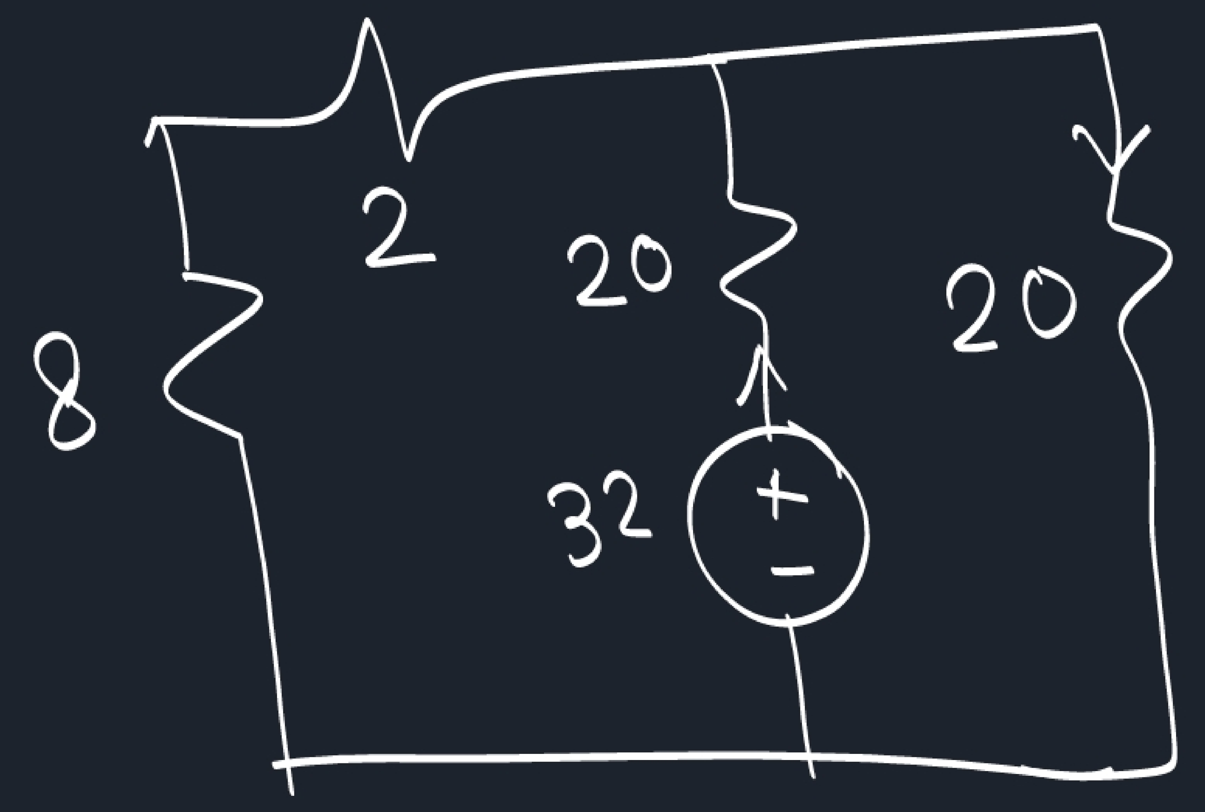
$$= I'_{2\Omega} + I''_{2\Omega} + I'''$$

Problem:-



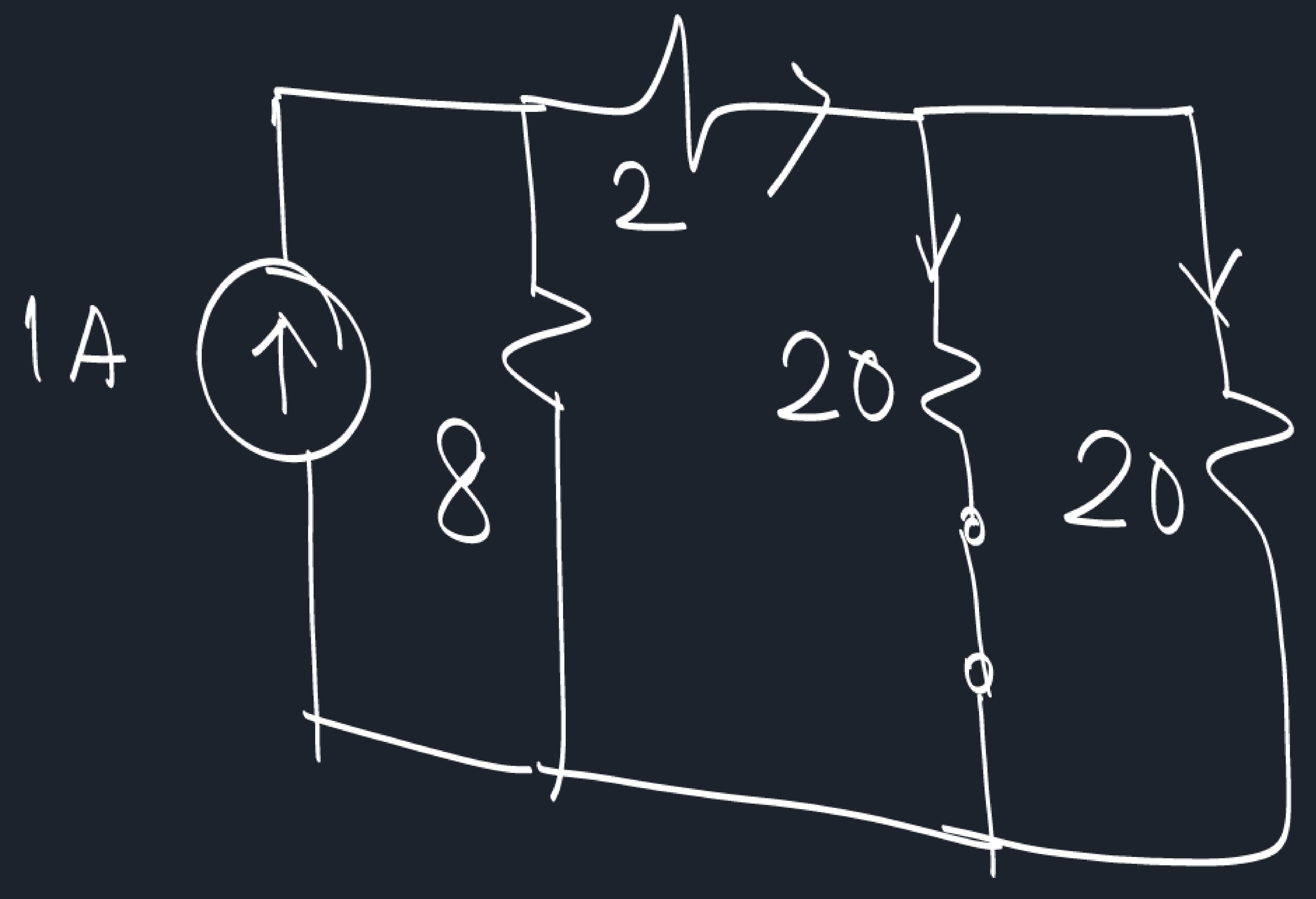
$$I_L' = \left(1 \times \frac{8}{8+12}\right) \times \frac{1}{2}$$

$$I_L'' = \left(\frac{32}{20+10\|20}\right) \times \frac{10}{10+20}$$

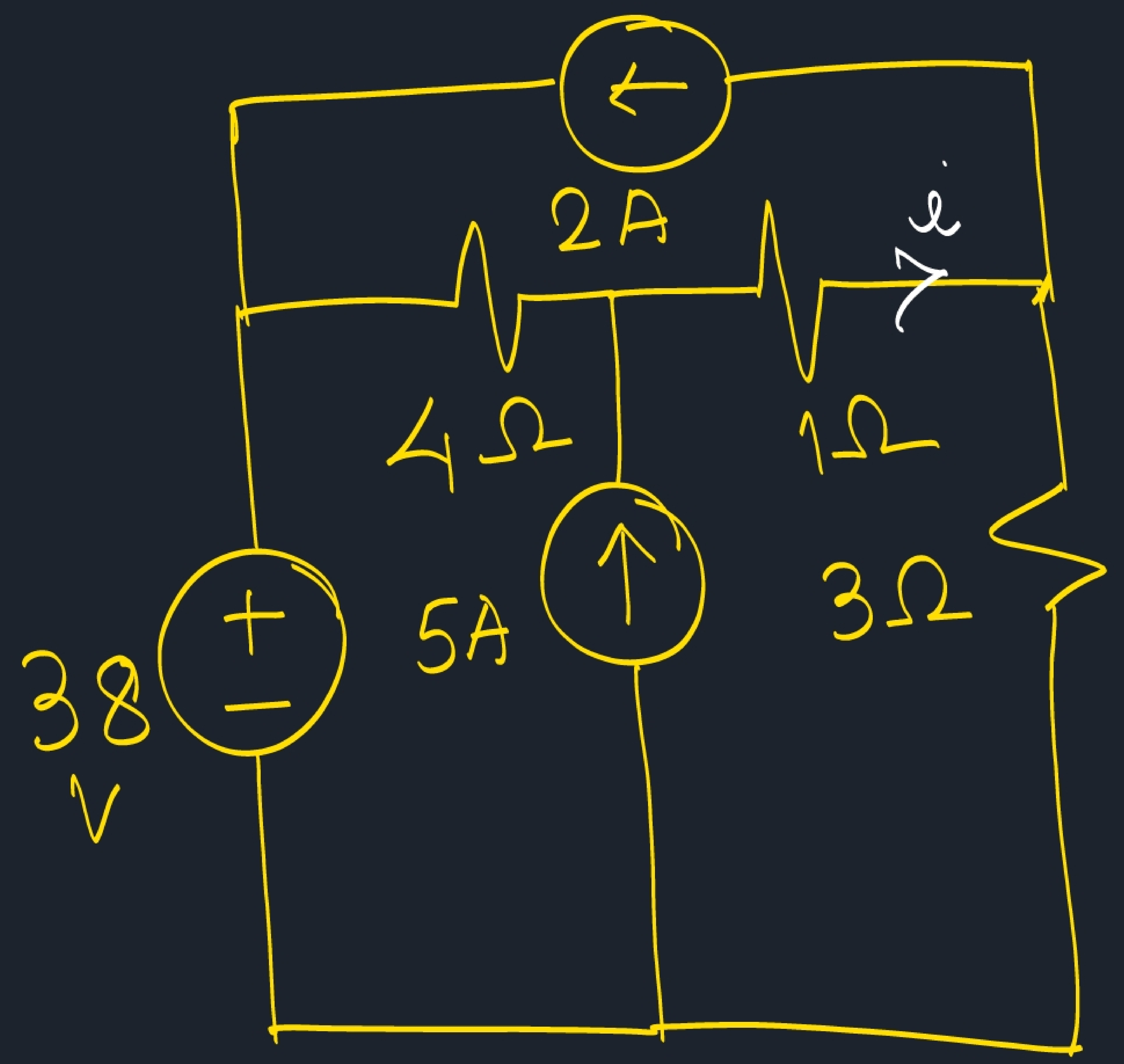


$$I_L = I_L' + I_L''$$

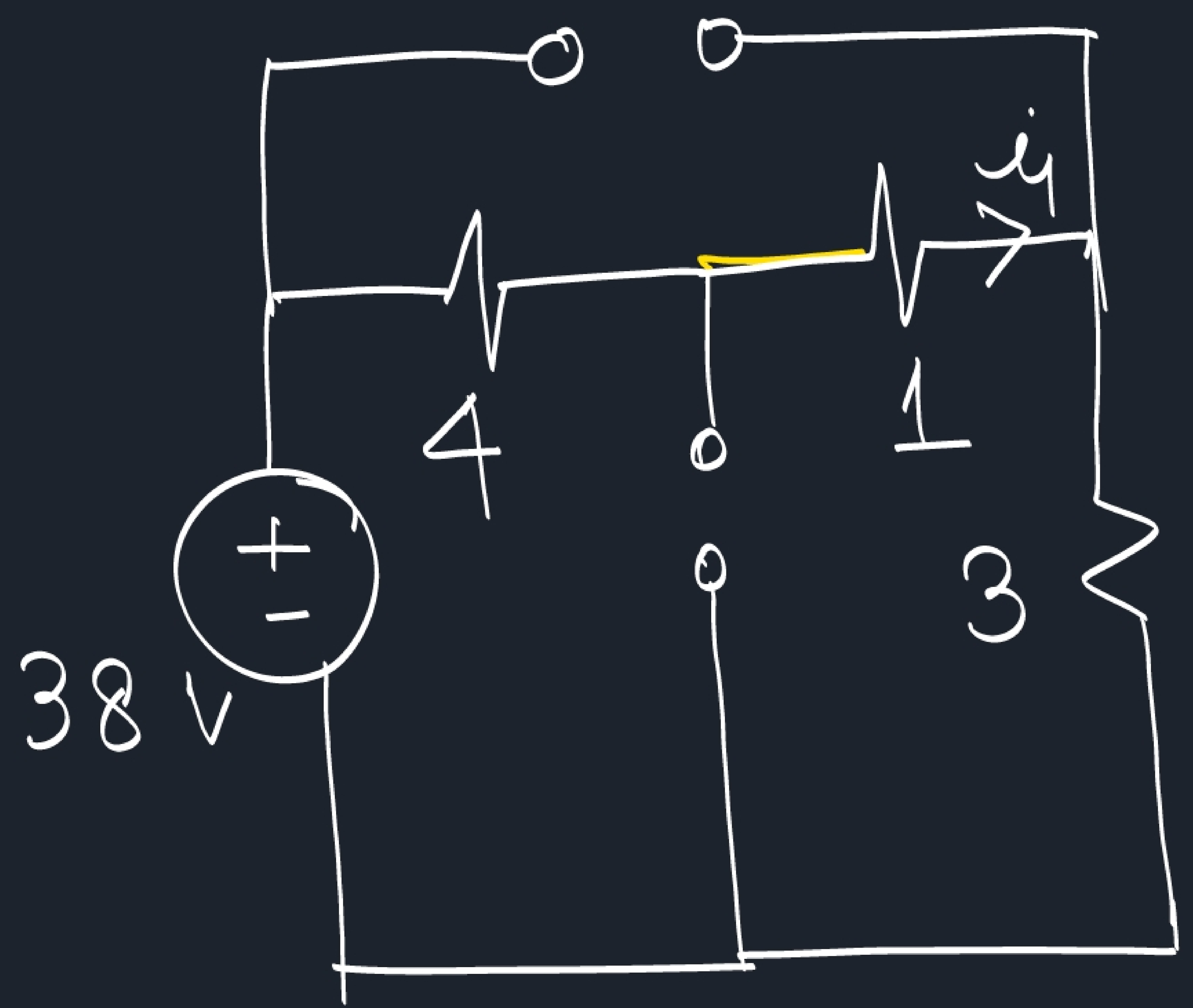
$$= \underline{0.6 \text{ Amps.}}$$



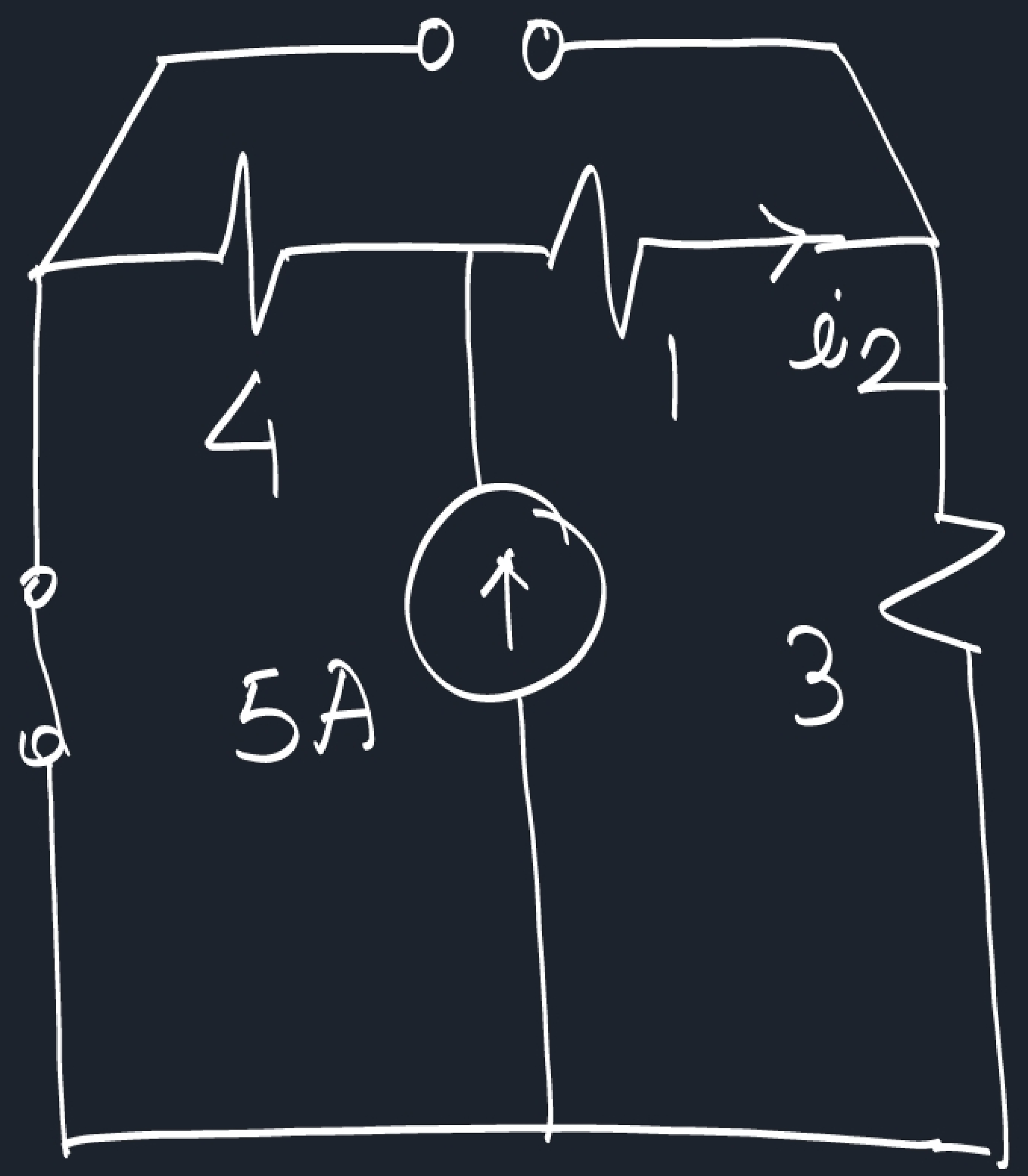
Problem:-



find i using Superposition.



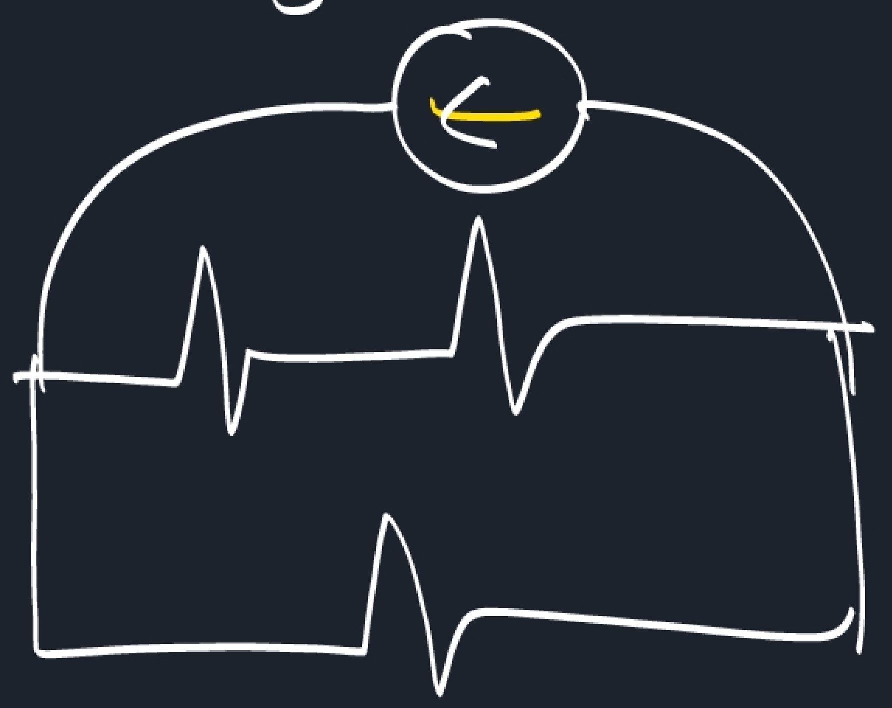
$$i_1 = \frac{38}{8} A$$



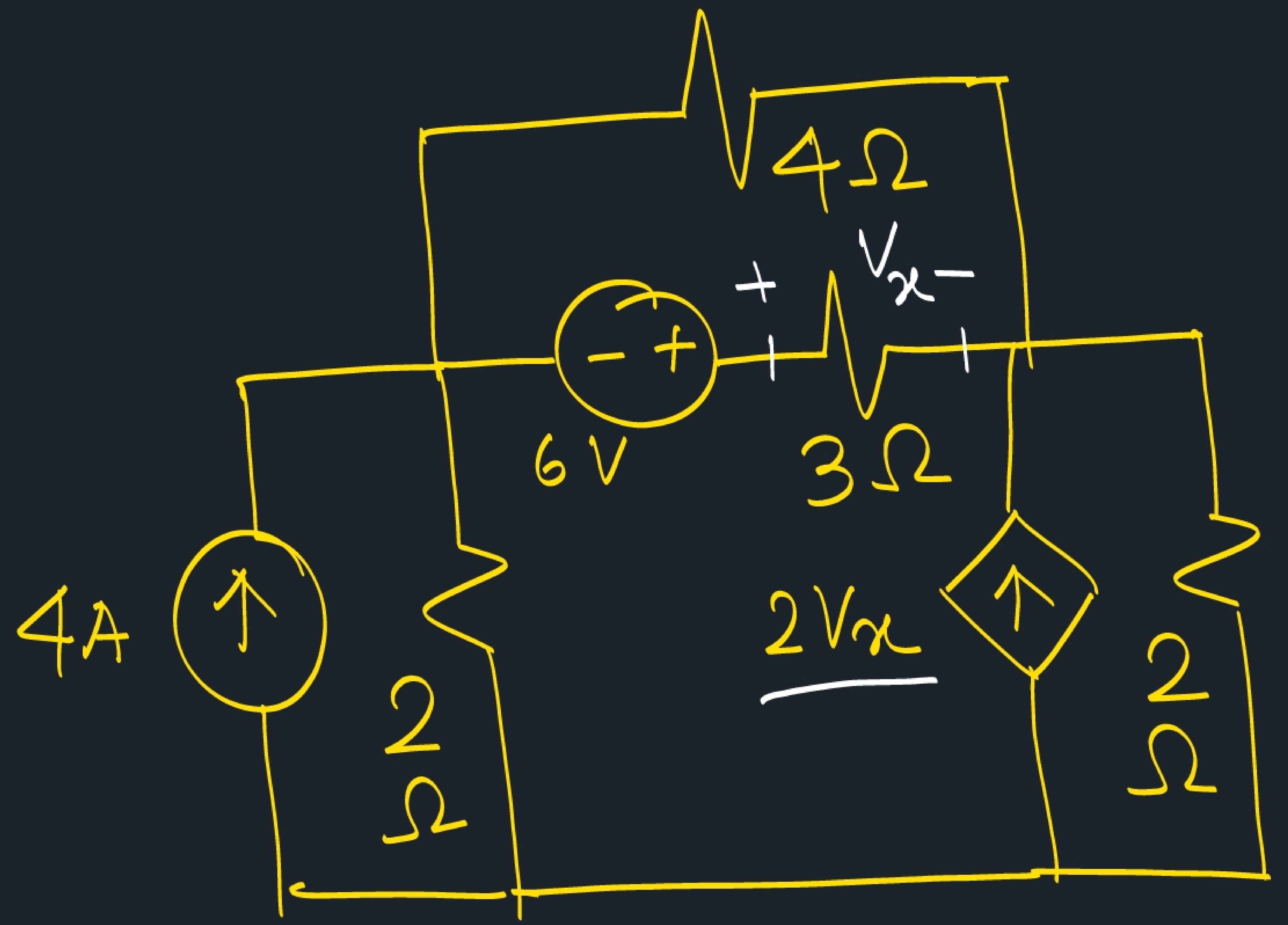
$$i_2 = 5 \times \frac{4}{8} = \frac{20}{8} A$$

$$i_3 = 2 \times \frac{3}{8} = \frac{6}{8}$$

$$i = i_1 + i_2 + i_3 = \frac{38}{8} + \frac{20}{8} + \frac{6}{8} = 8 \text{ Amps.}$$

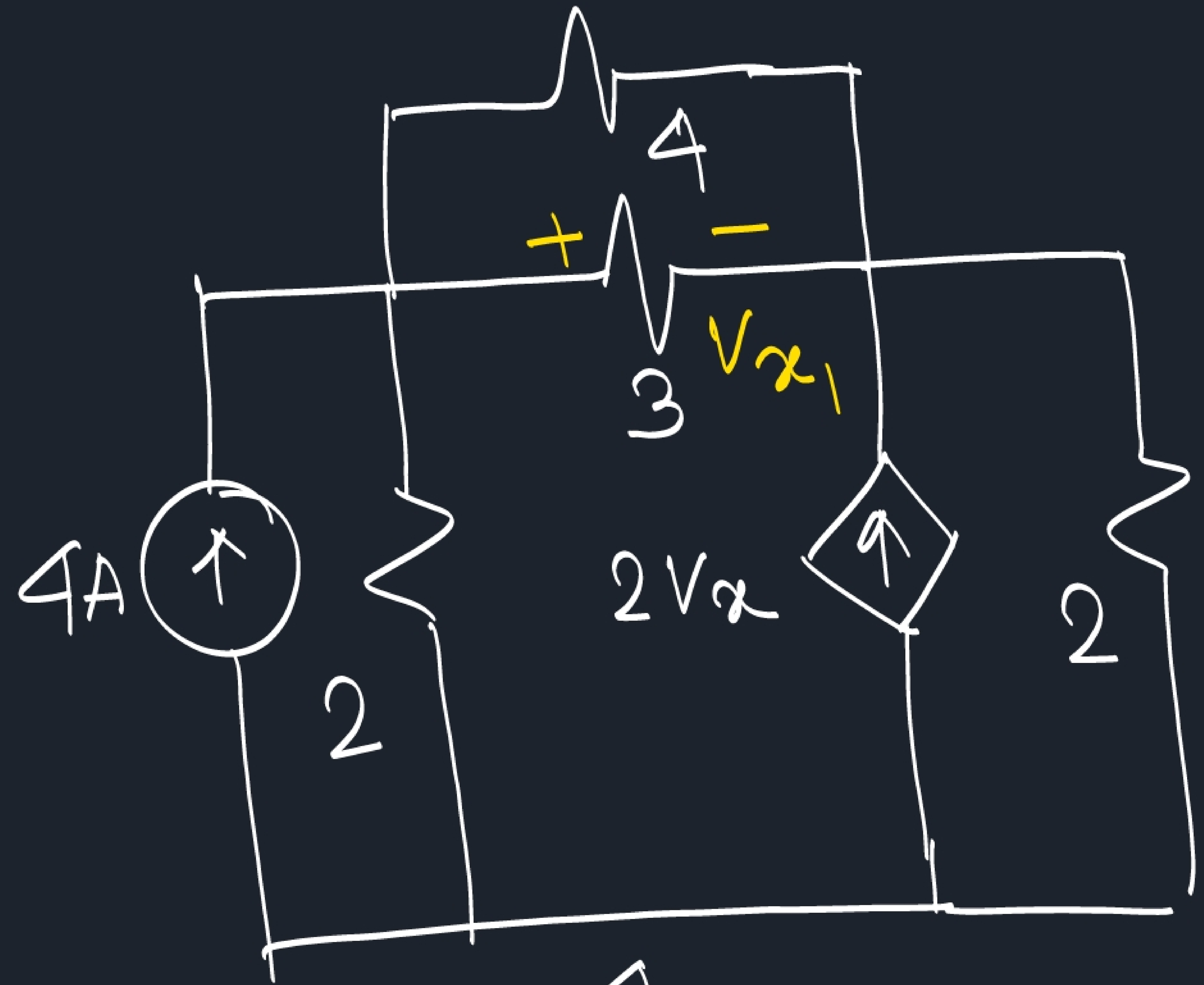


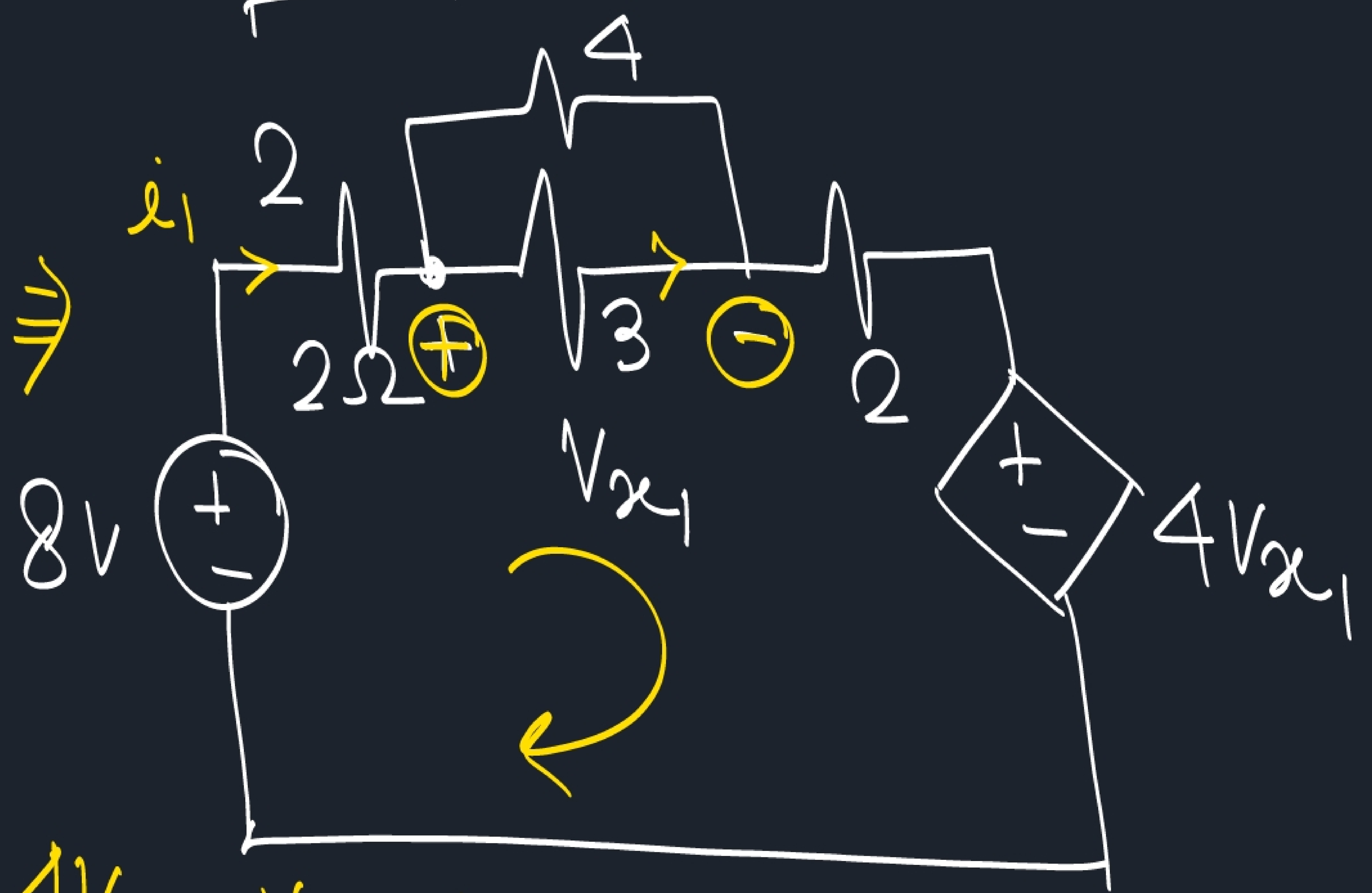
Problem:-



find V_x using superposition

$V_x = 3 \times i$

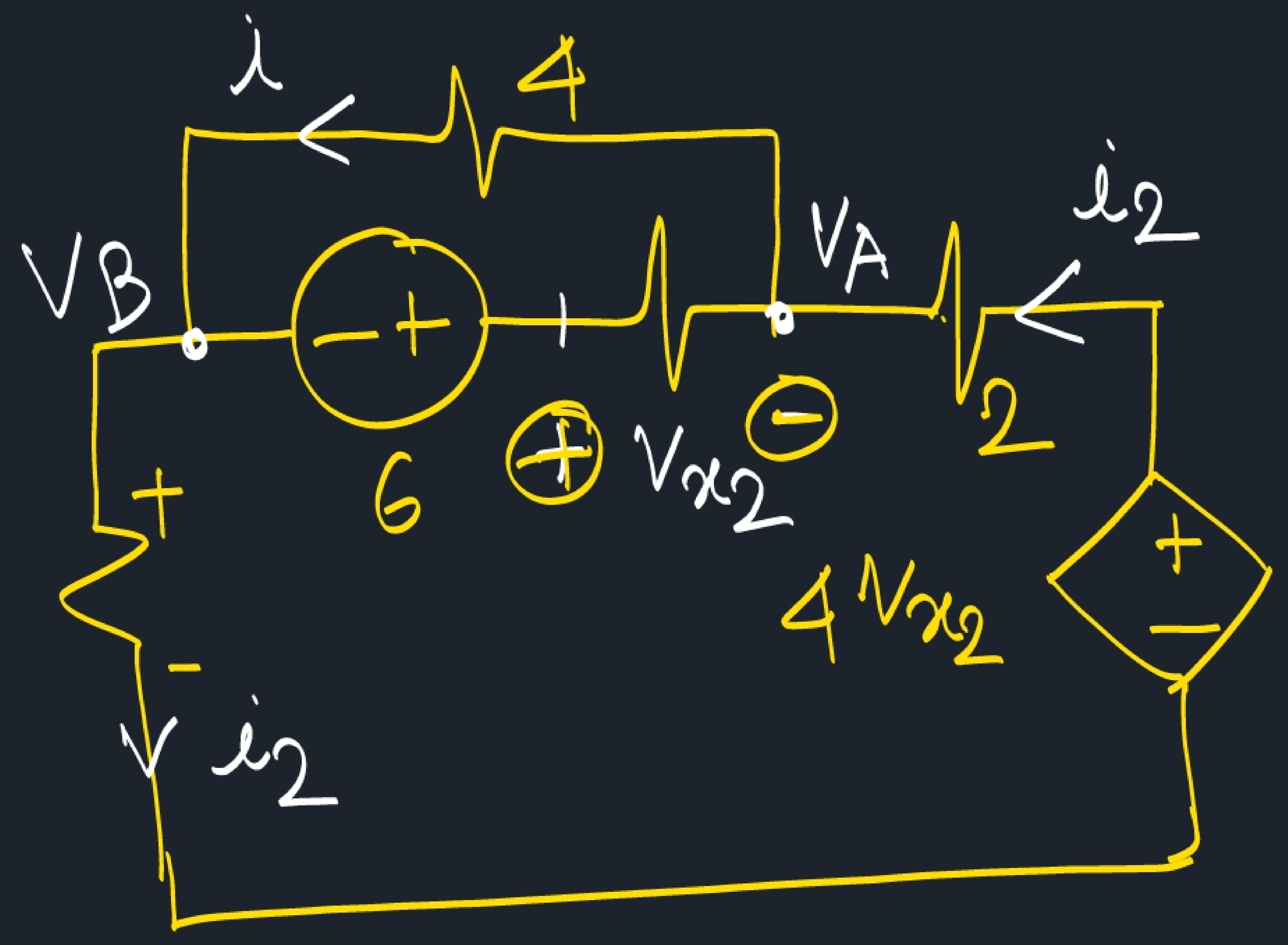




$8 - 4i_1 - 4V_{x_1} - V_{x_1} = 0$

$V_{x_1} = ?$ $\quad i_1 \times \frac{4}{7} \times 3 = V_{x_1}$

2



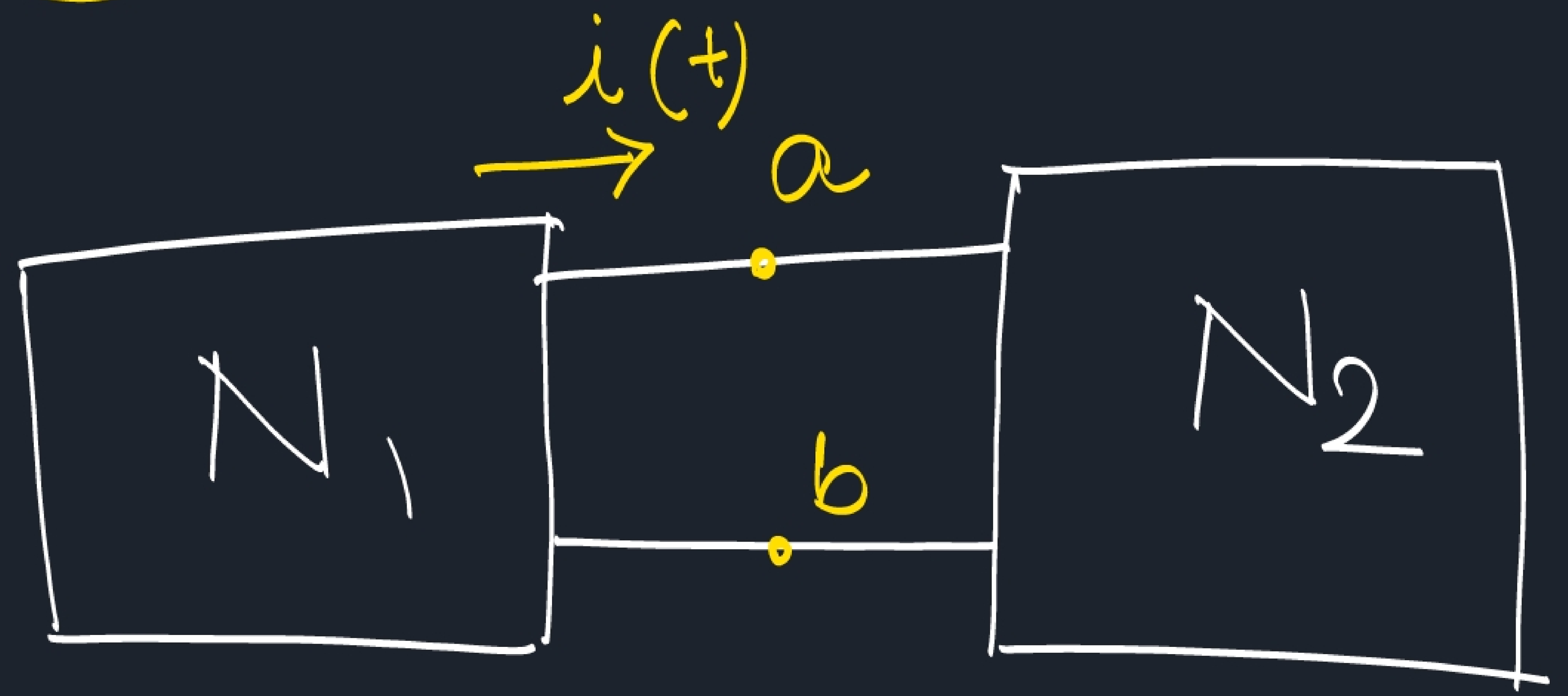
$4V_{x_2} - 4i_2 + V_{x_2} - 6 = 0$

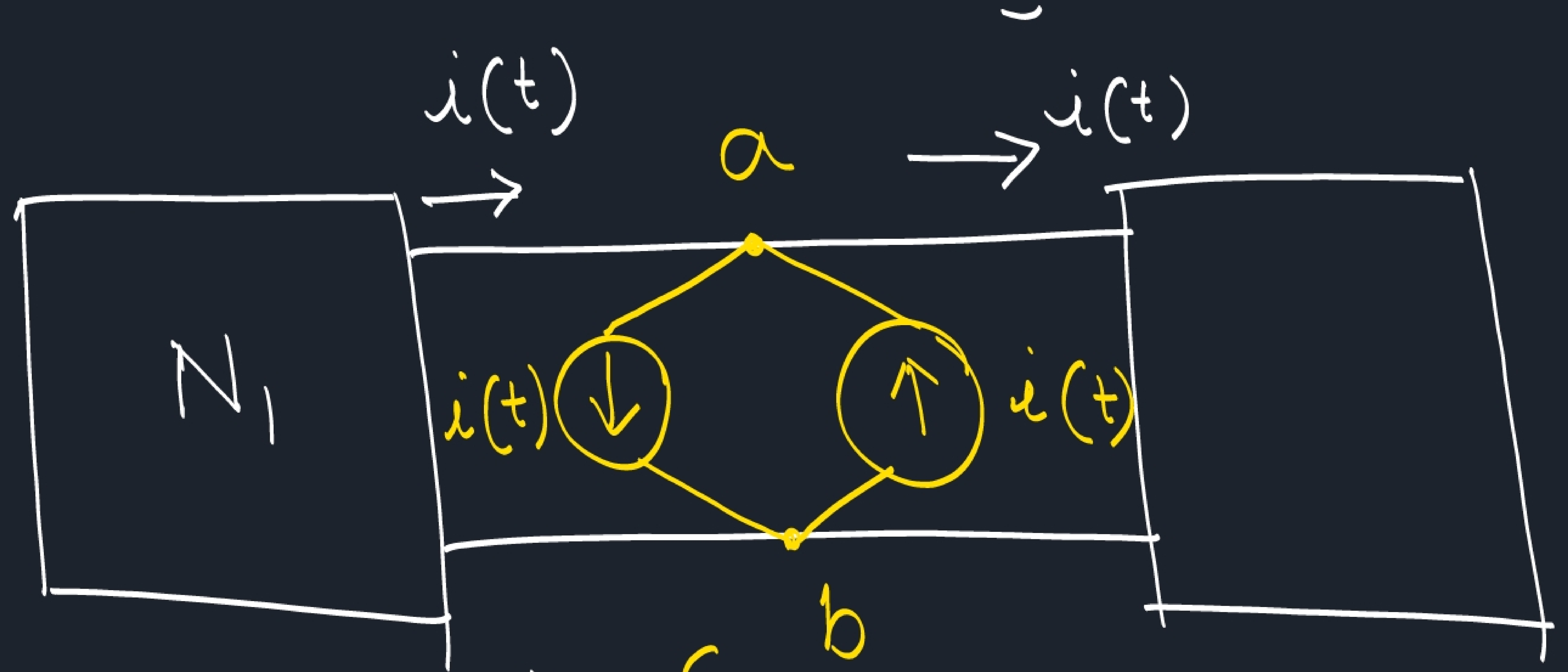
$i = \frac{V_A - V_B}{4} = \frac{6 - V_{x_2}}{4}$

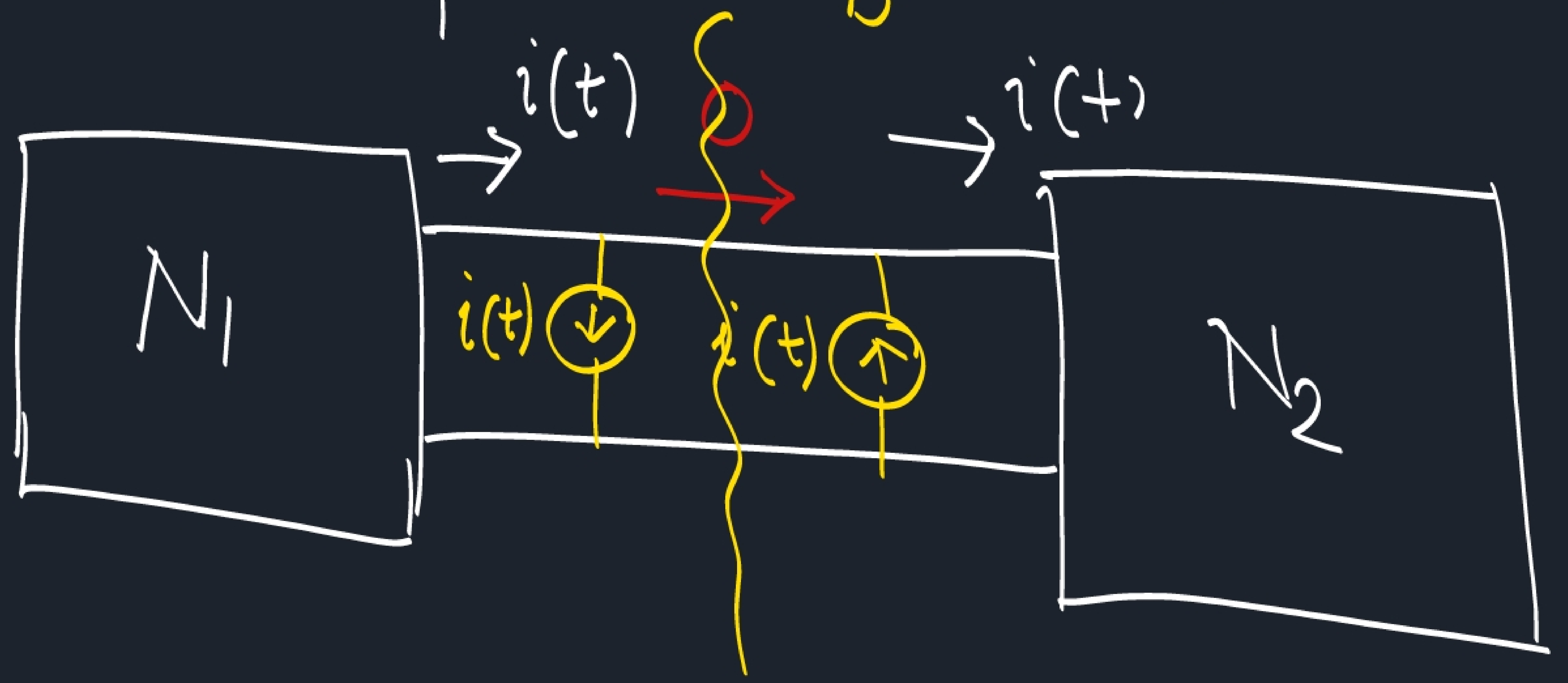
$i_2 = \left(\frac{6 - V_{x_2}}{4} + \frac{V_x}{3} \right)$

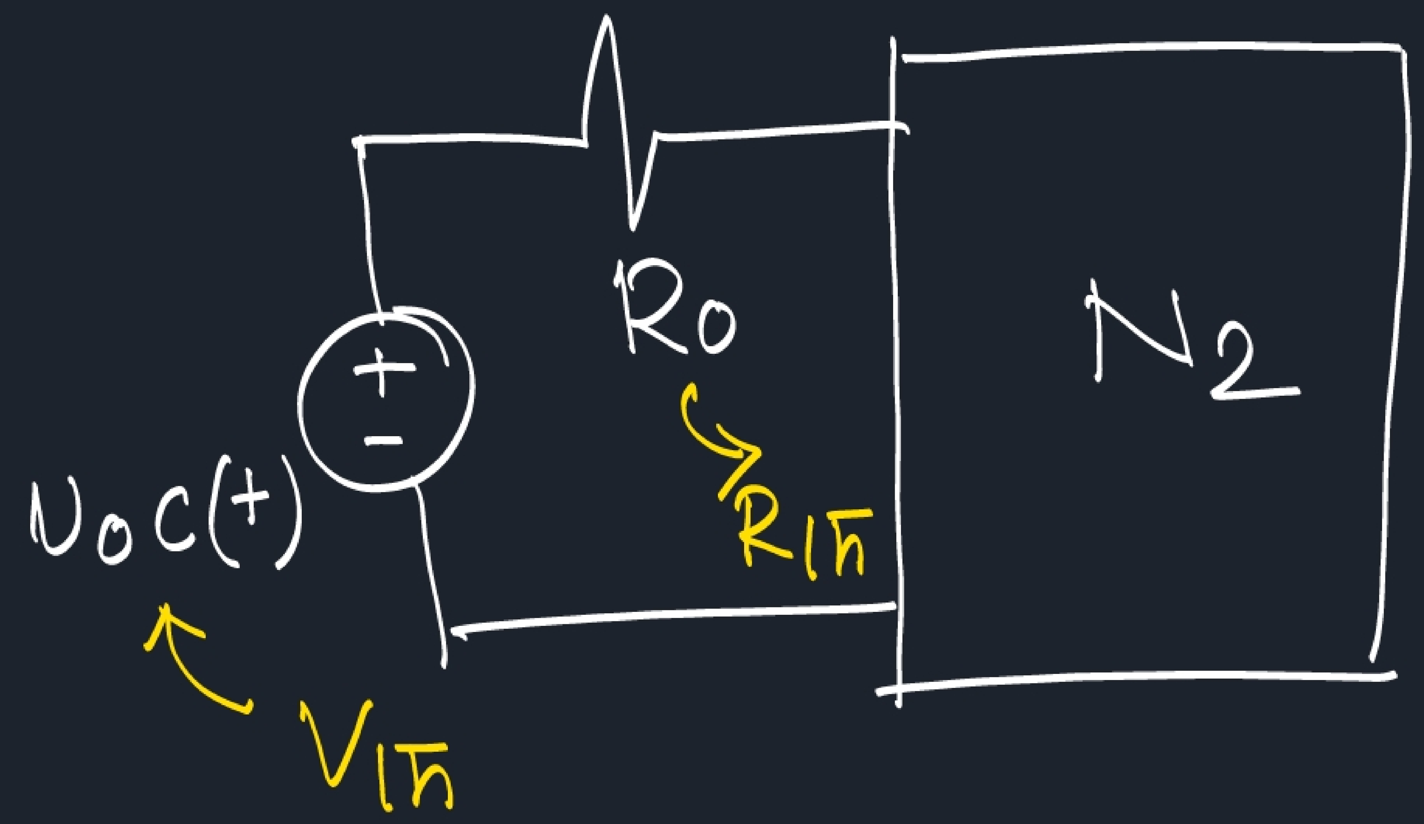
$\boxed{2.727\ V \text{ is the } V_x}$

THEVENIN'S THEOREM:-









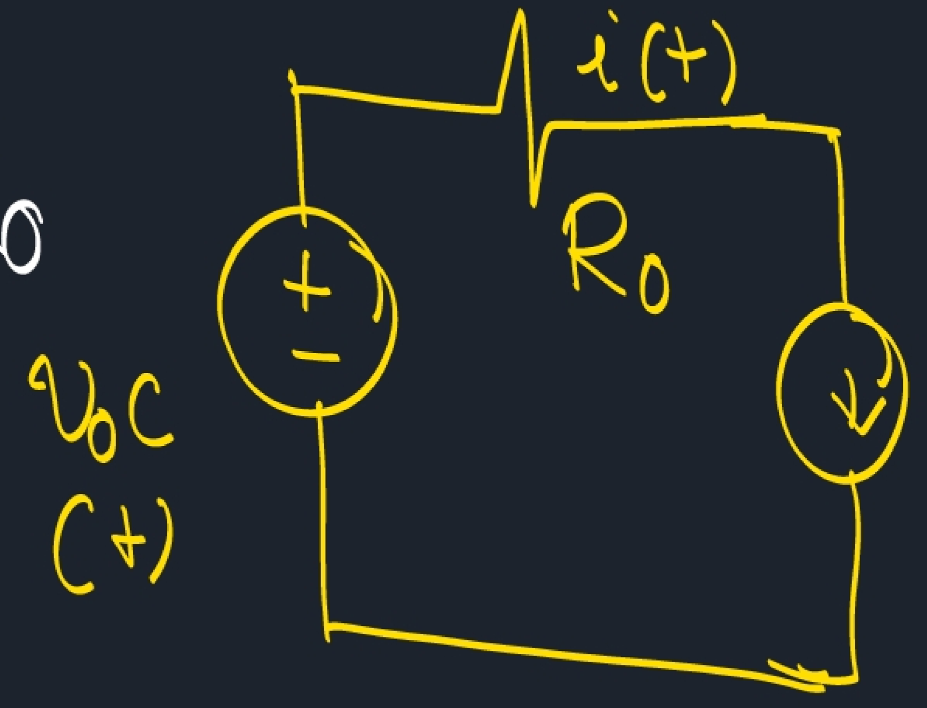
$$v(t) = \underbrace{\sum_{i=1}^{n} a_i V_{si} + \sum_{j=1}^{m} b_j I_{sj}} + a_0 i(t)$$

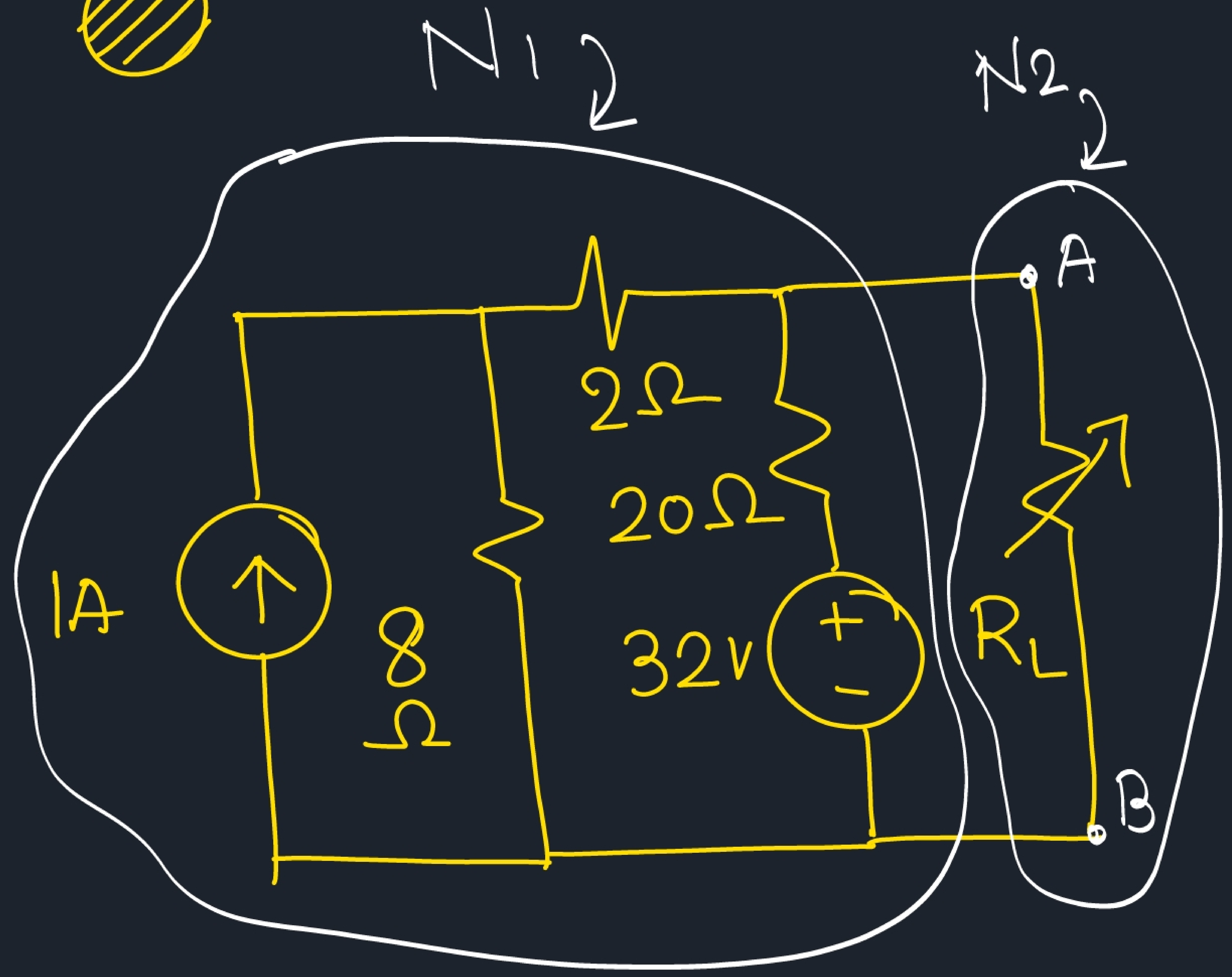
when $i(t) = 0$ $\rightarrow$ $V_{oc}(t) = V_{Th}(t)$

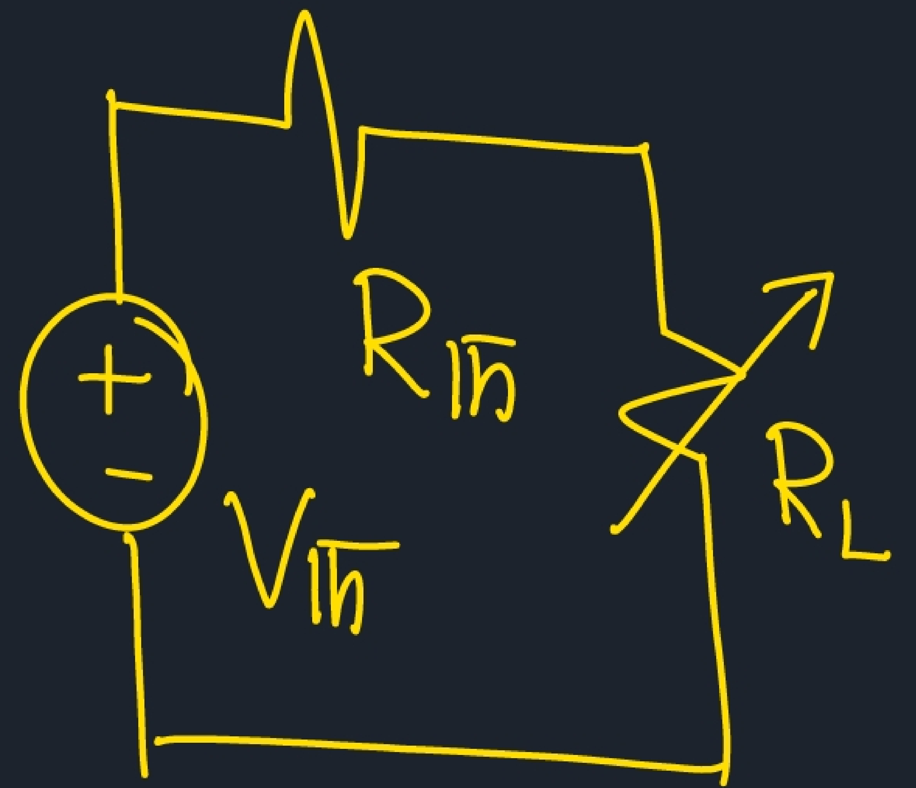
$$v(t) = V_{oc}(t) + a_0 i(t)$$

$$v(t) = V_{oc}(t) - R_0 i(t)$$

$$a_0 = \frac{v(t)}{i(t)} = -R_0$$



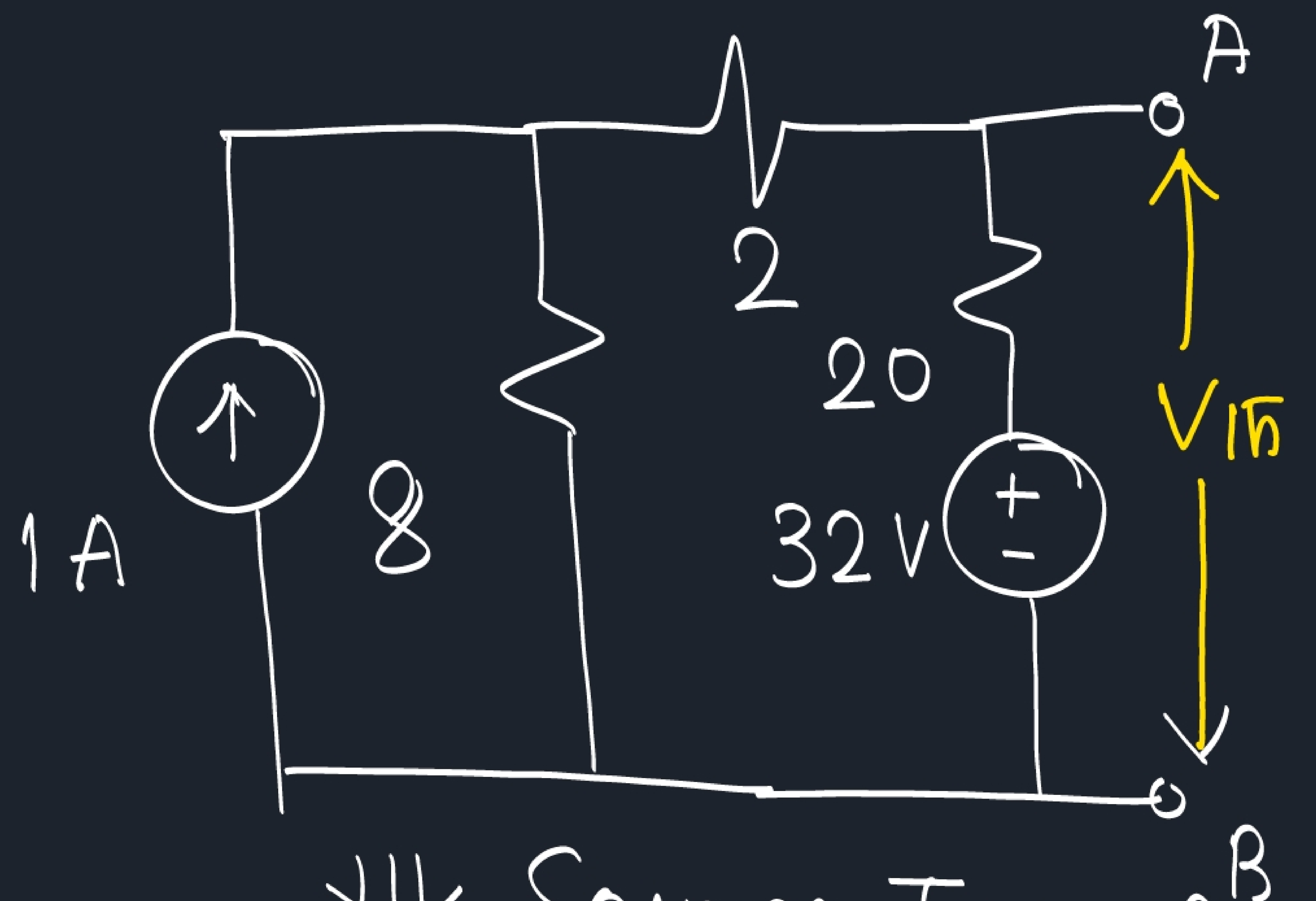




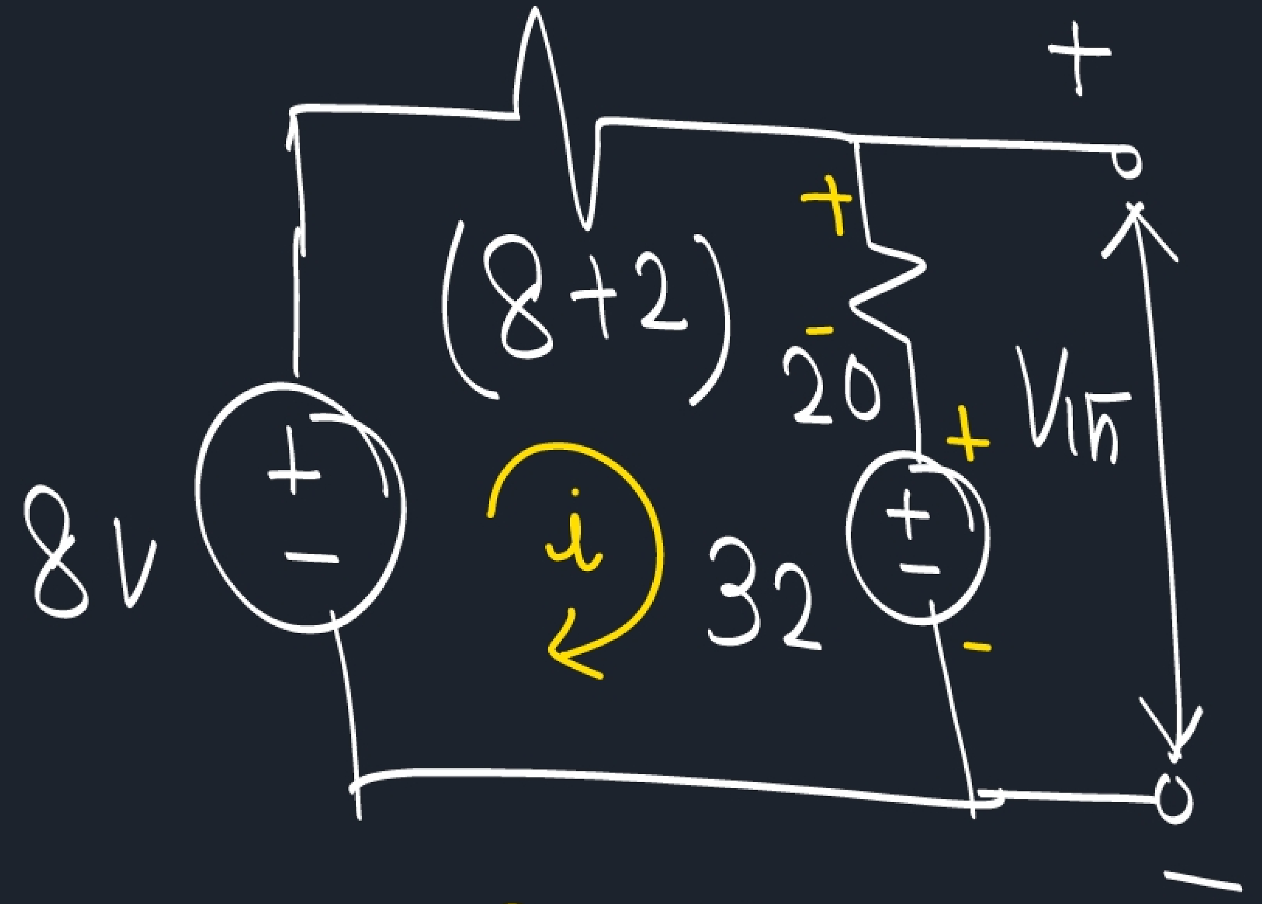
Objective

$V_{Th} = ?$

$R_{Th} = ?$

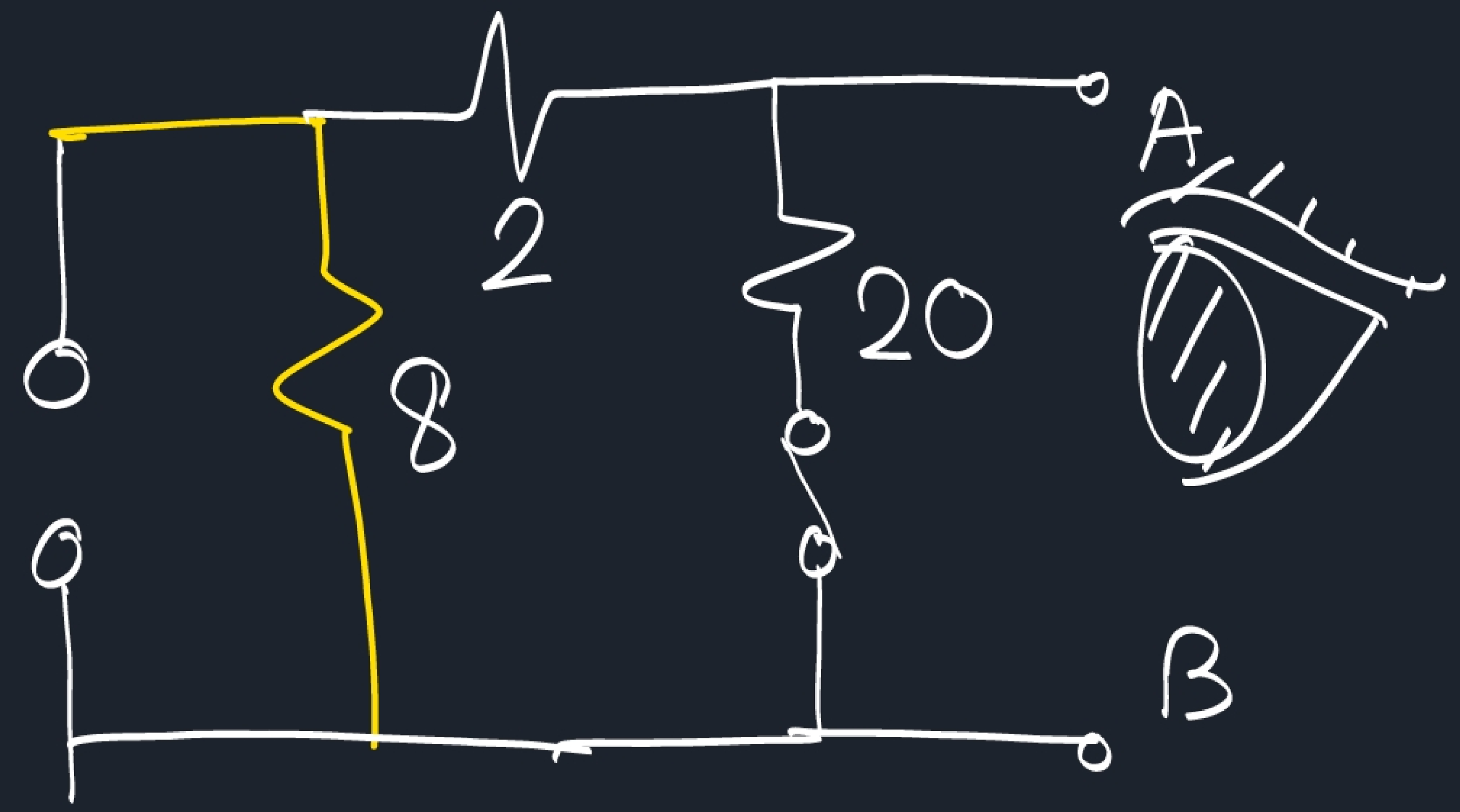


⇓ Source Transform

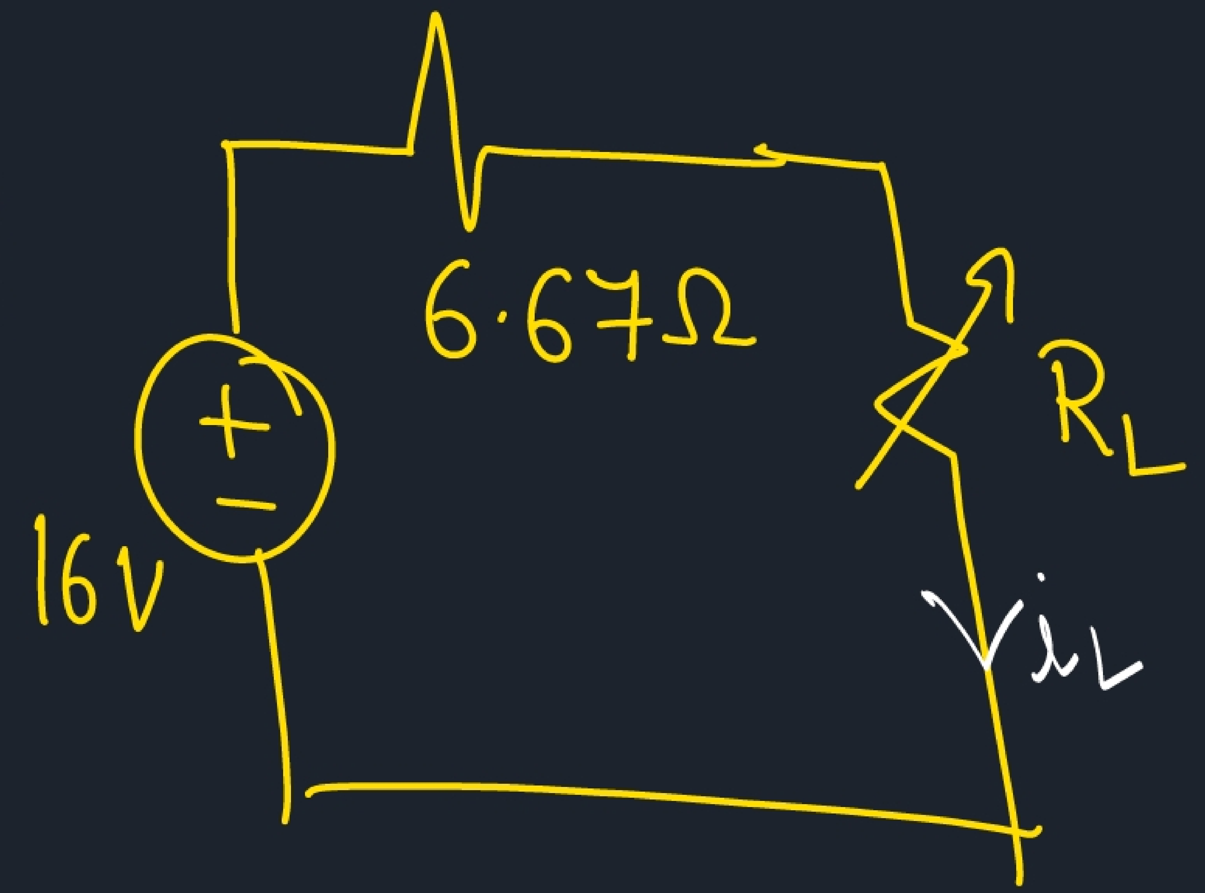


$$i = \frac{8-32}{10+20}$$

$$V_{Th} = 20i + 32 = 16\ V$$

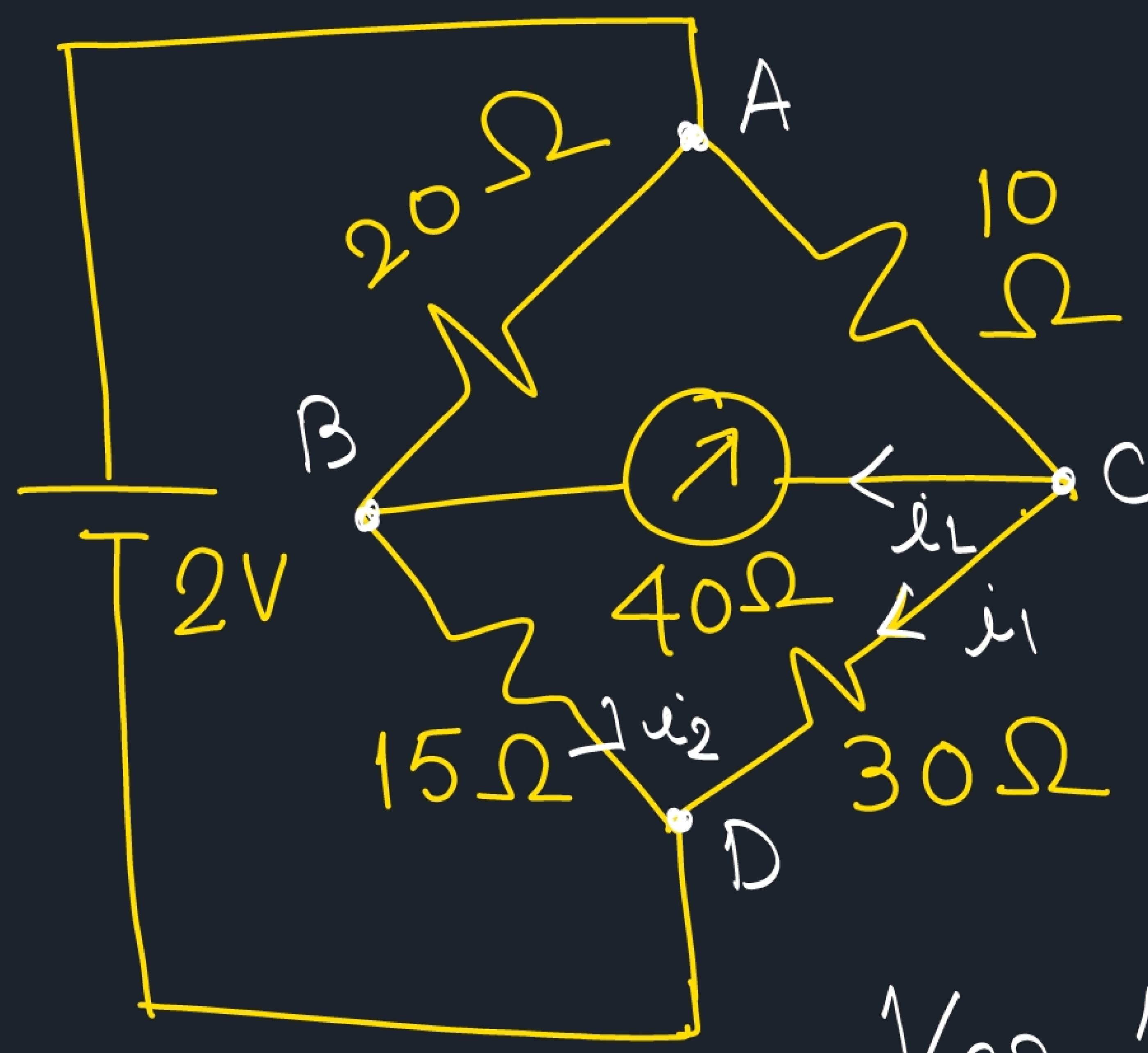


$$R_{Th} = (8+2) \parallel 20 = 10 \parallel 20 = \frac{10 \times 20}{10+20} = 6.67\ \Omega$$



$$i_L = \frac{16}{6.67 + R_L}$$

Problem:-



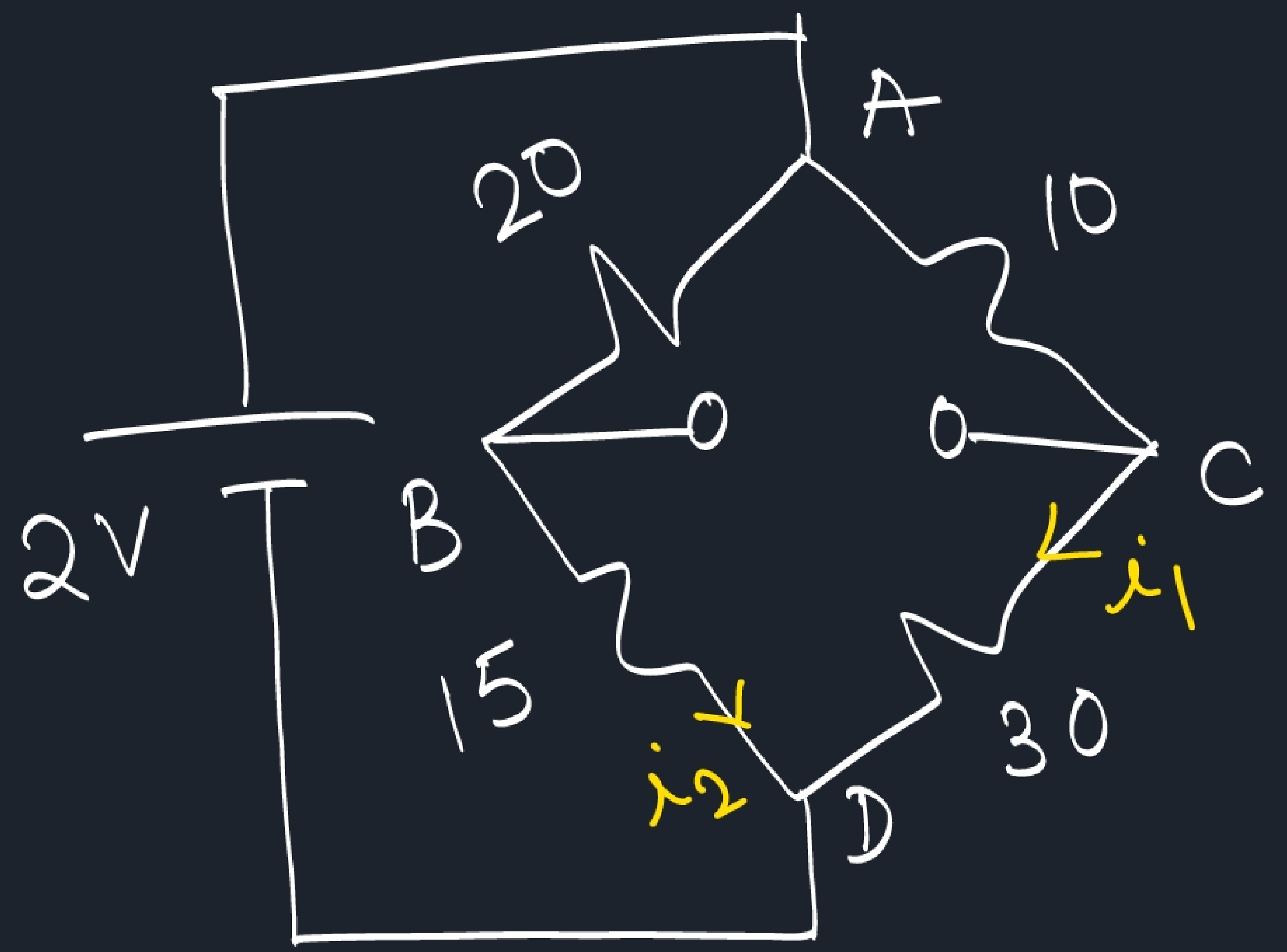
$\boxed{i_L = 11.46\,mA}$

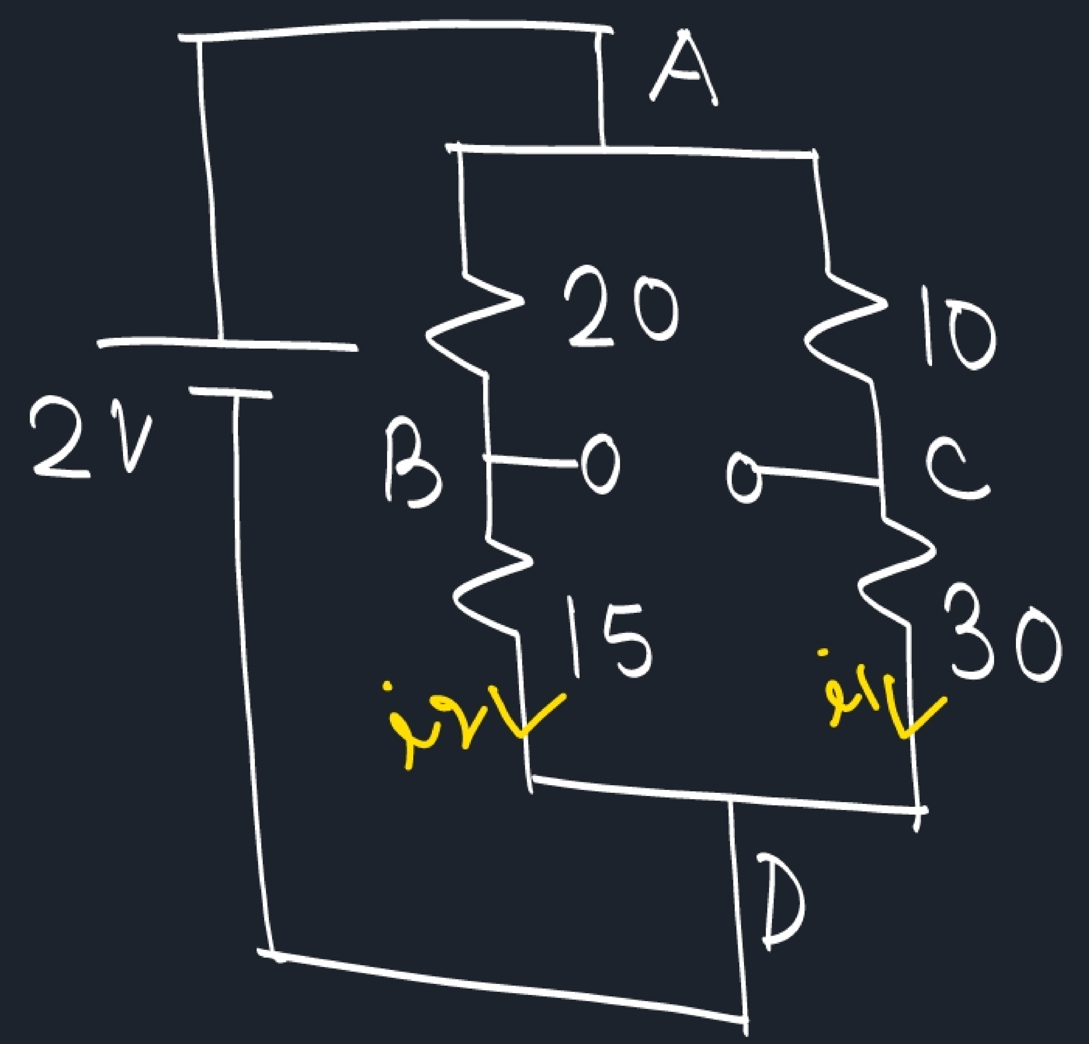
$V_{CB} = V_{CD} - V_{BD}$

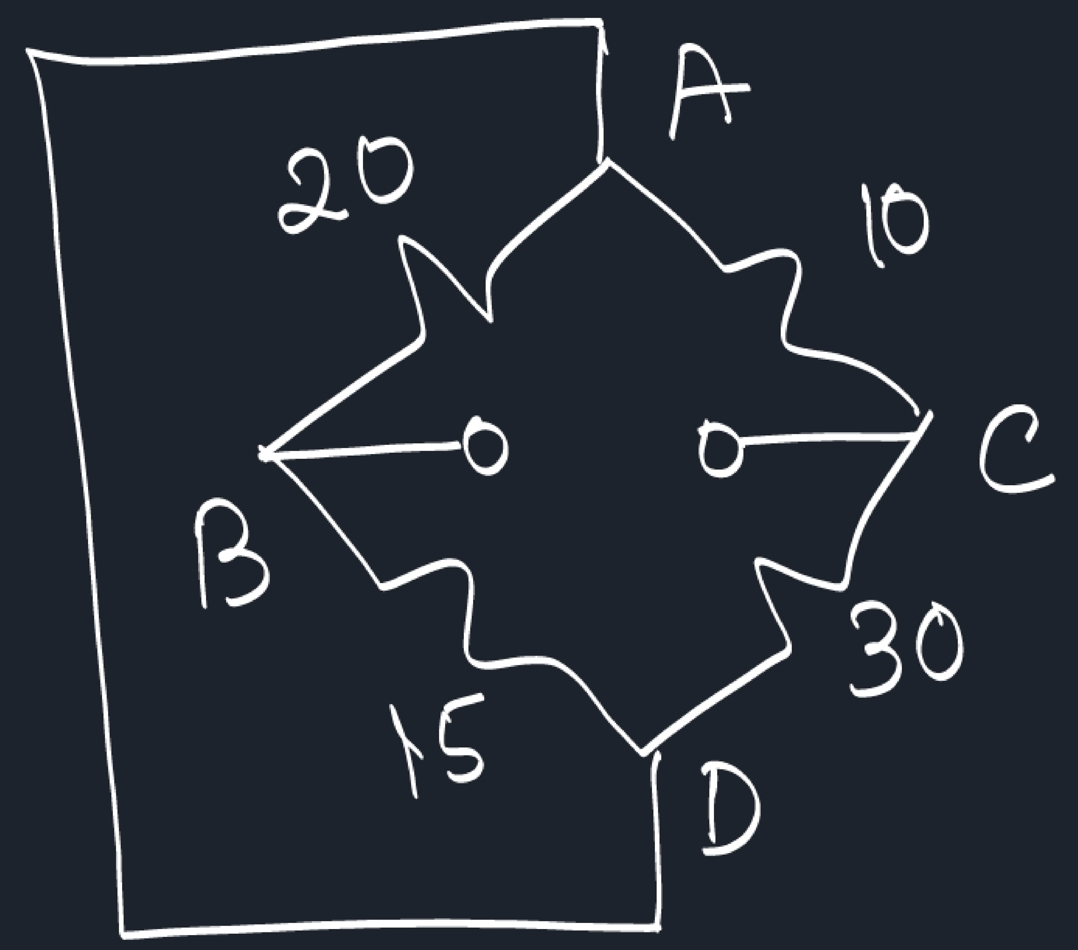
$V_{Th} = i_1 \times 30 - i_2 \times 15$

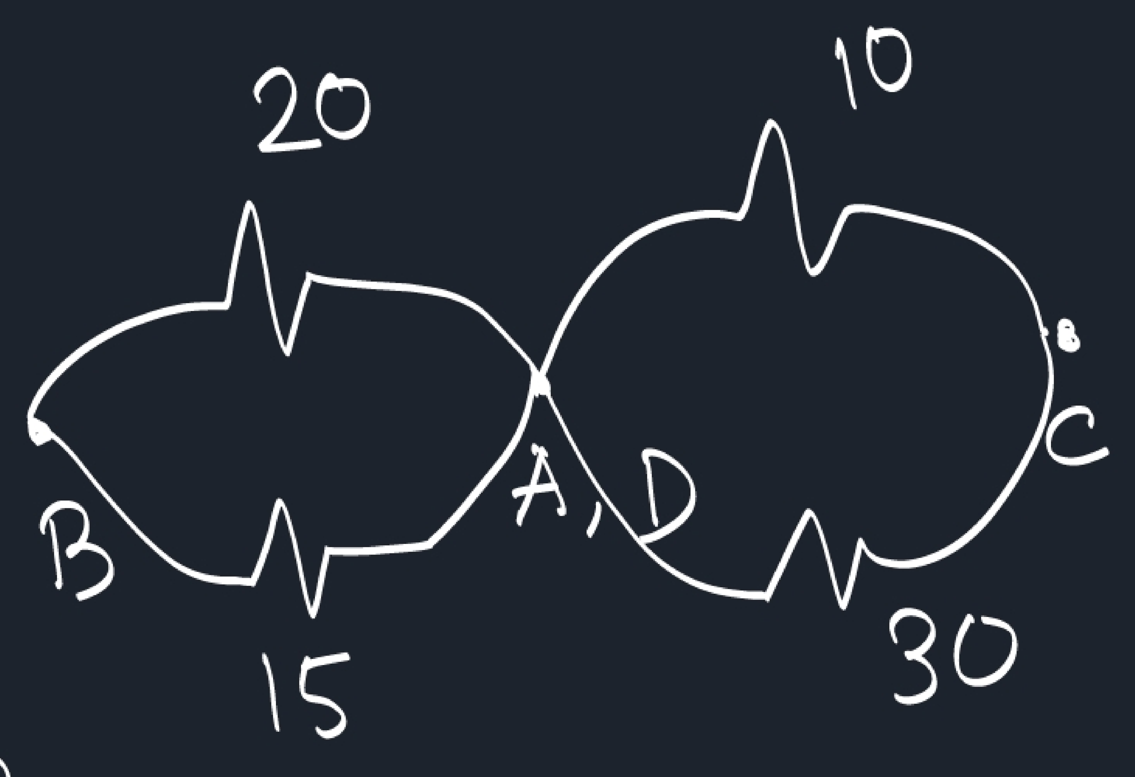
$= \frac{2}{10+30} \times 30 - \frac{2}{20+15} \times 15$

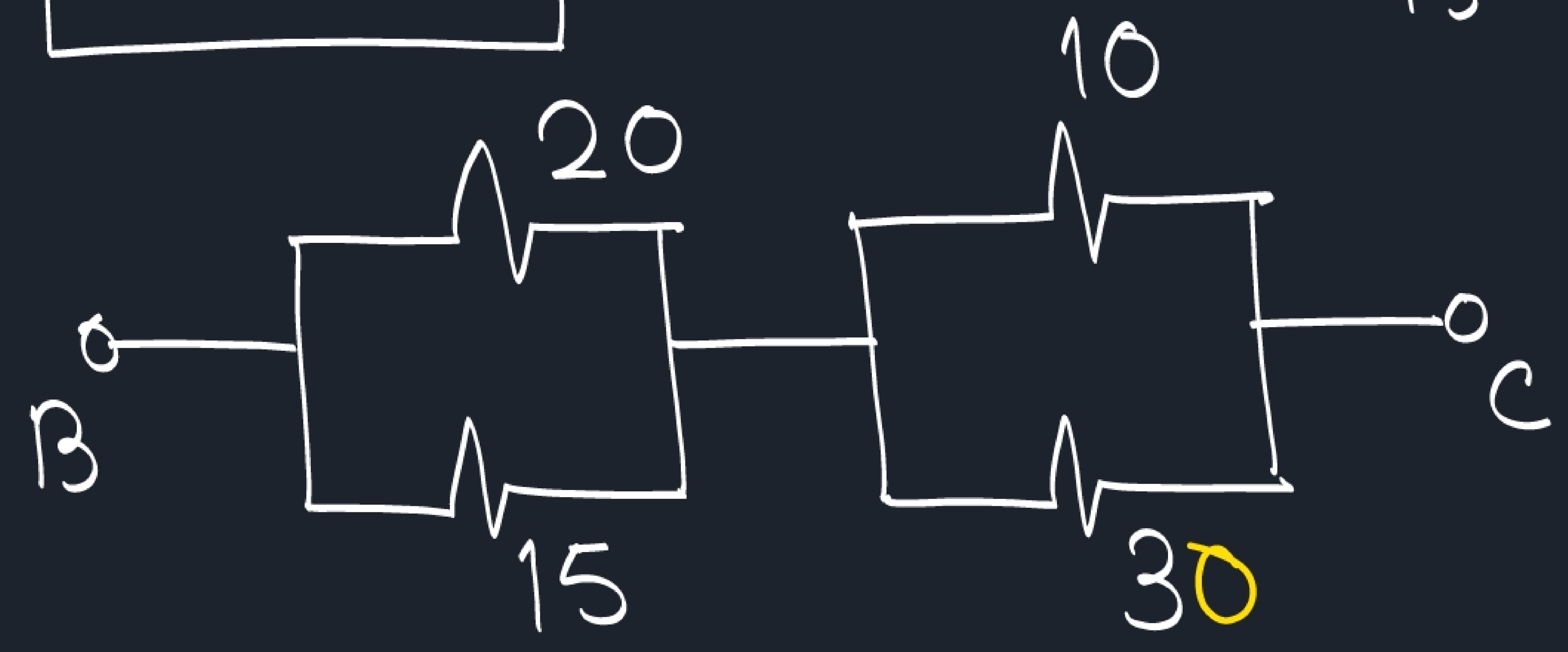
$= 0.6428$ volt.











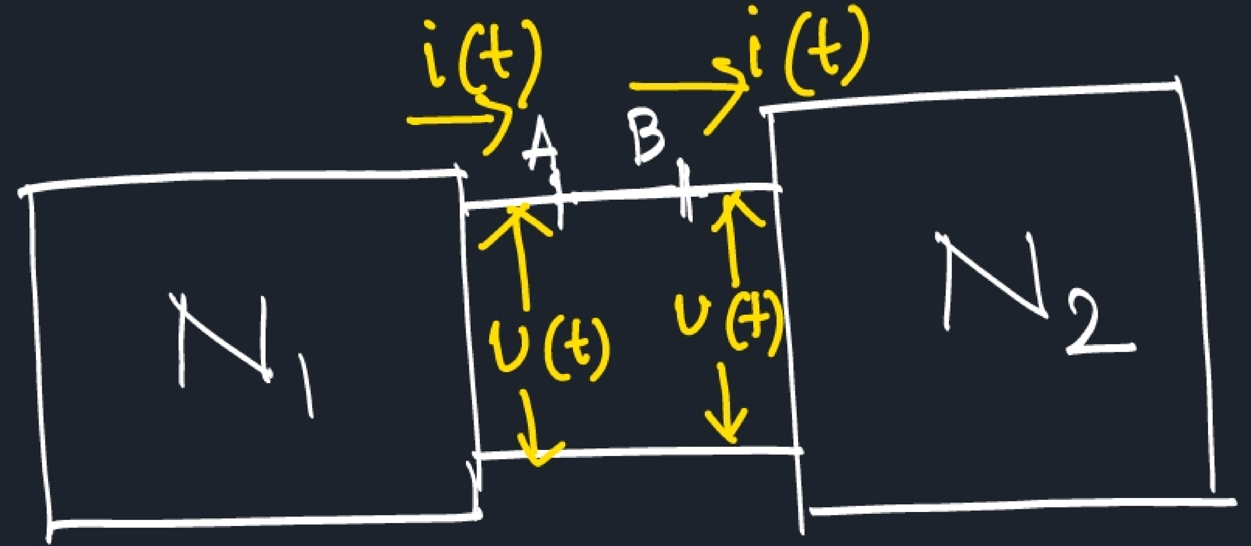
$R_{Th} = ?\ (20 \| 15) + (10 \| 30) = 16.071$

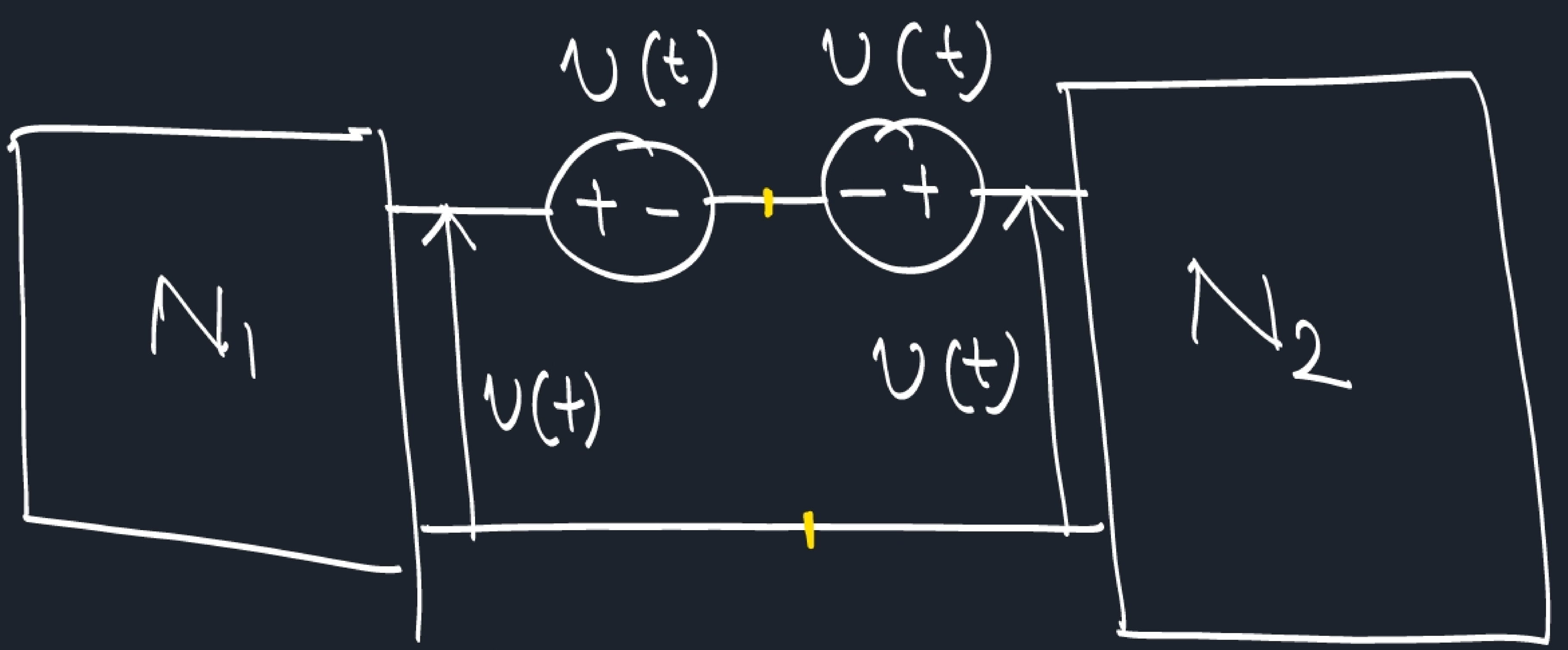
$i_L = \frac{0.6428}{40 + 16.071}$ Amp.

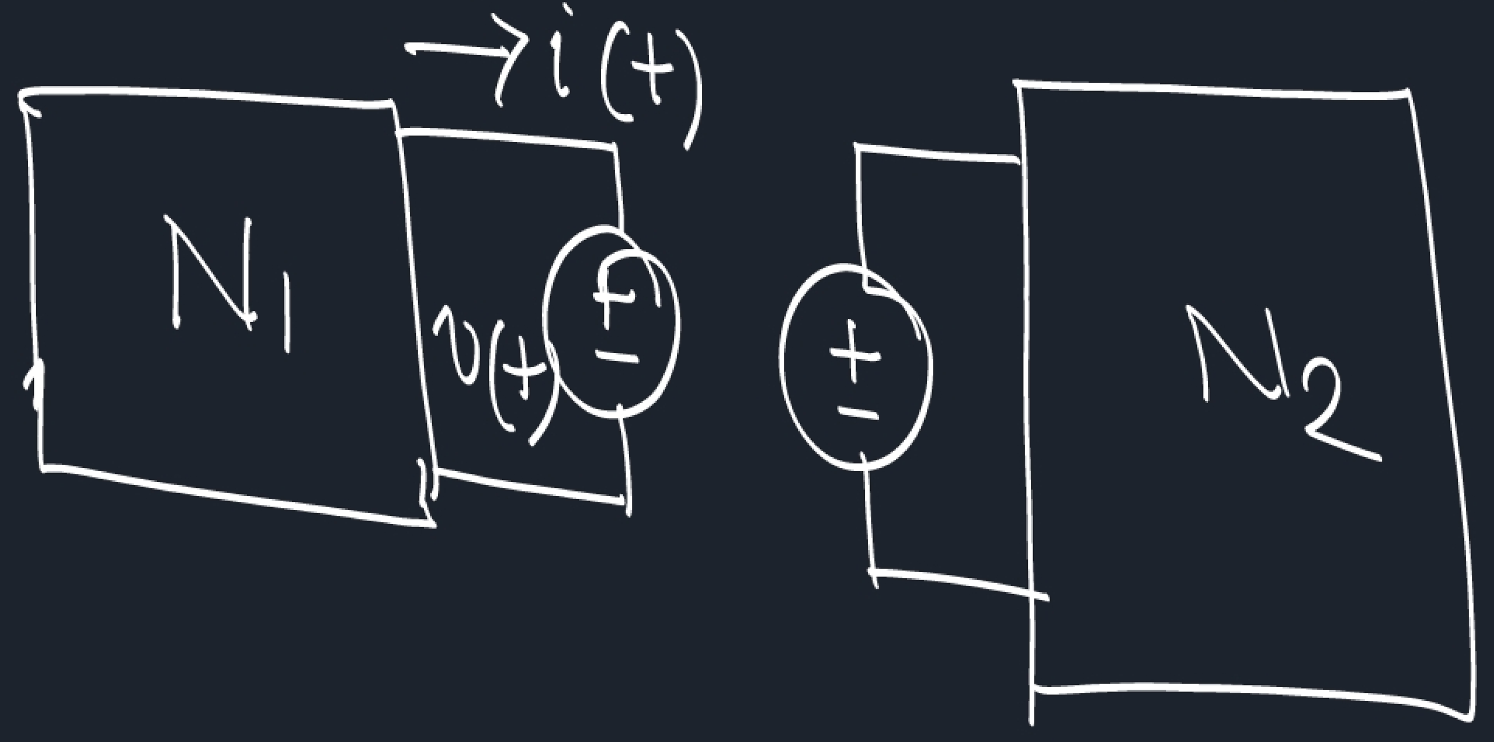
$=$

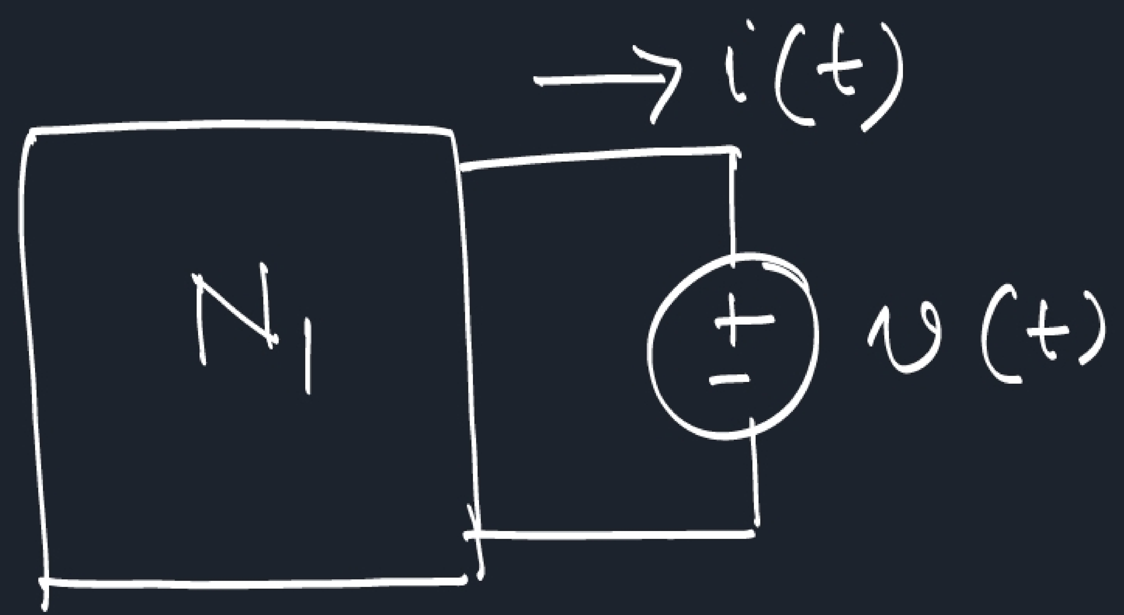
8593

NORTONS THEOREM:-









find out $i(t) = ?$

m no of indep. Voltage Sour

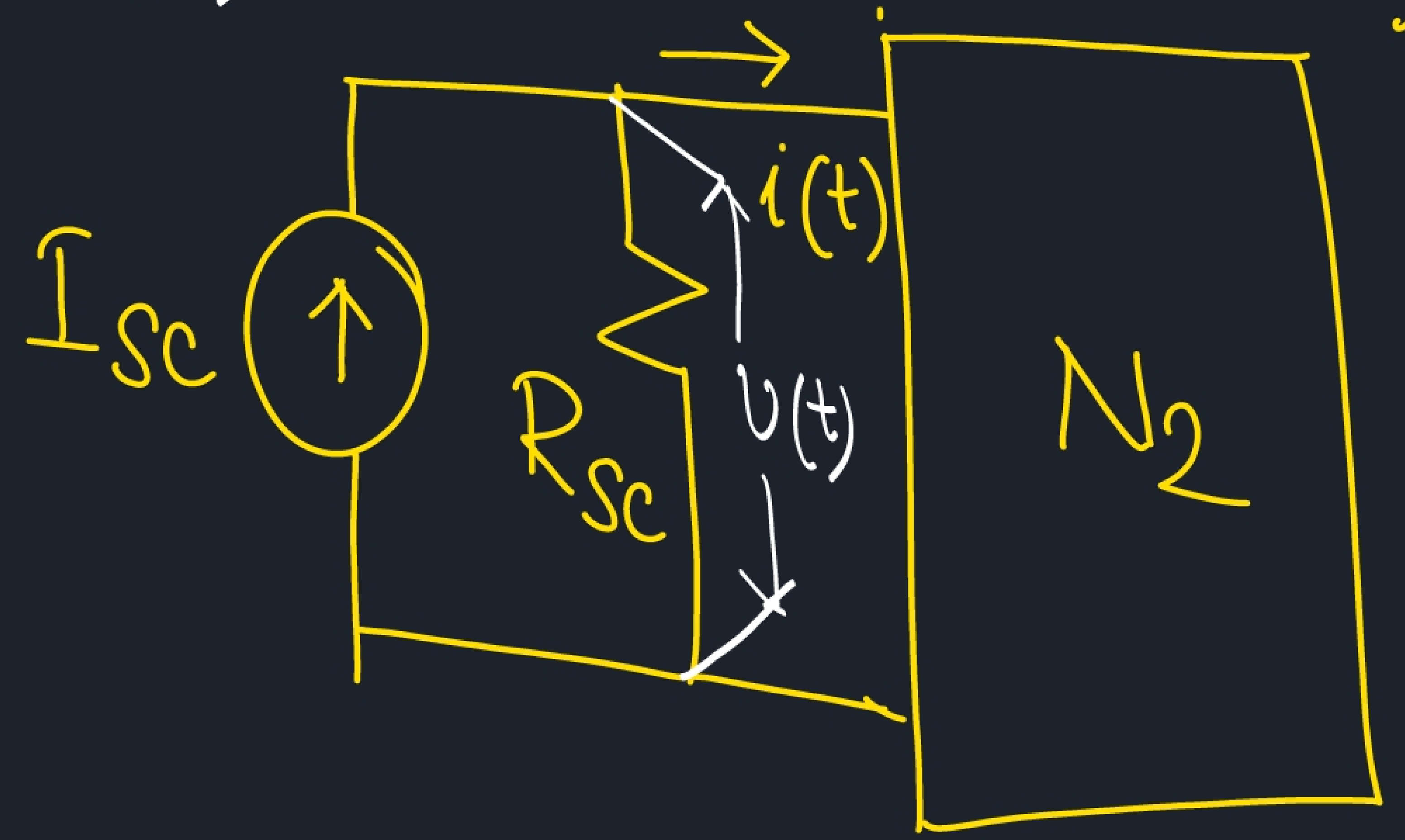
n " " " Current "

$$i(t) = \sum_{i=1}^{m} C_i v_{si}(t) + \sum_{j=1}^{n} d_j I_{sj} + C_0 v(t)$$

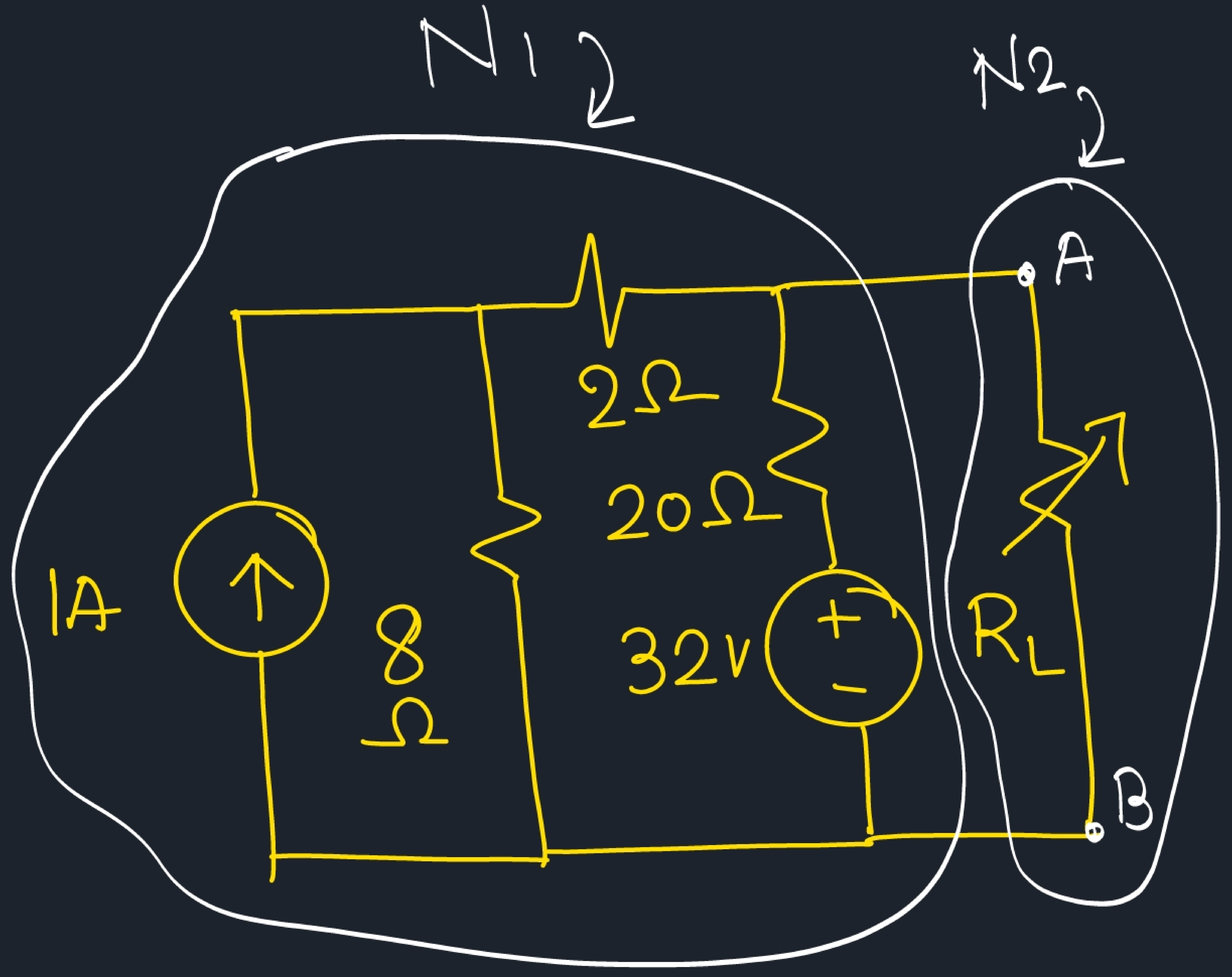
make $v(t) = 0$ $\quad i(t) = I_N = I_{sc} = \sum_{i=1}^{m} C_i v_{si}(t) + \sum_{j=1}^{n} d_j I_{sj}$

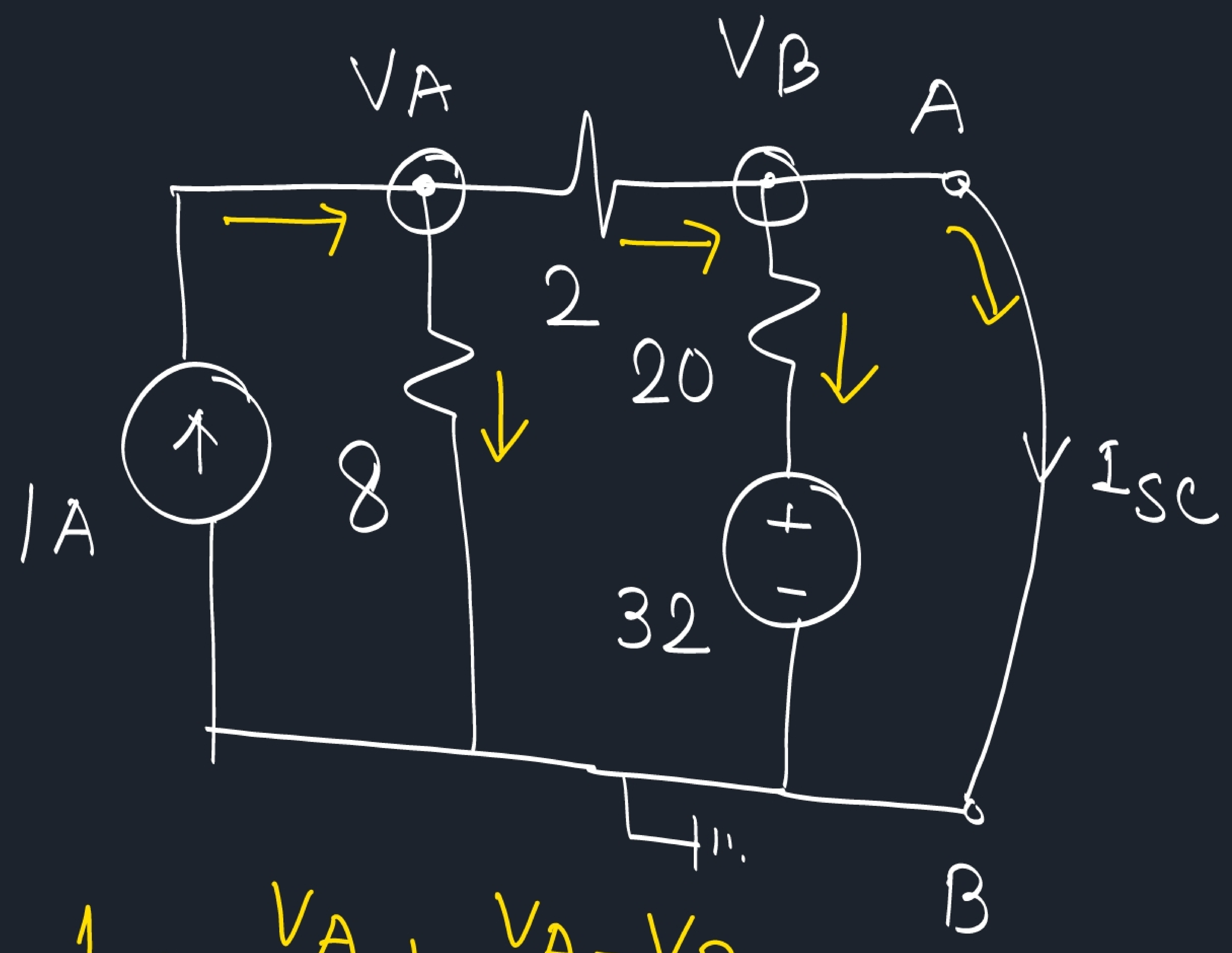
$$C_0 = \frac{i(t)}{v(t)} = -G_{sc} = -G_N$$

$$i(t) = I_{sc} - G_{sc}\, v(t)$$



Problem:-





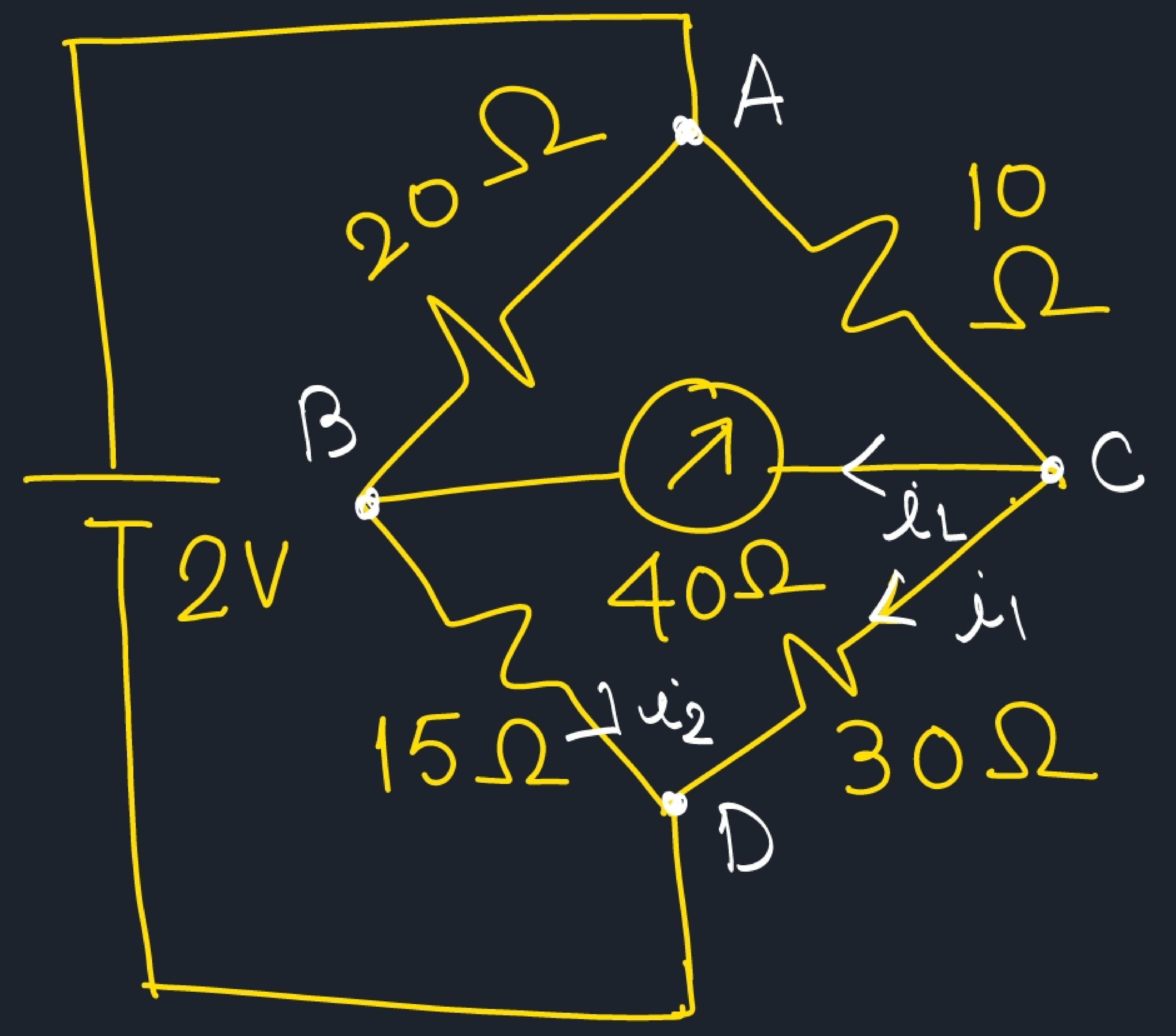
$$1 = \frac{V_A}{8} + \frac{V_A - V_B}{2}$$

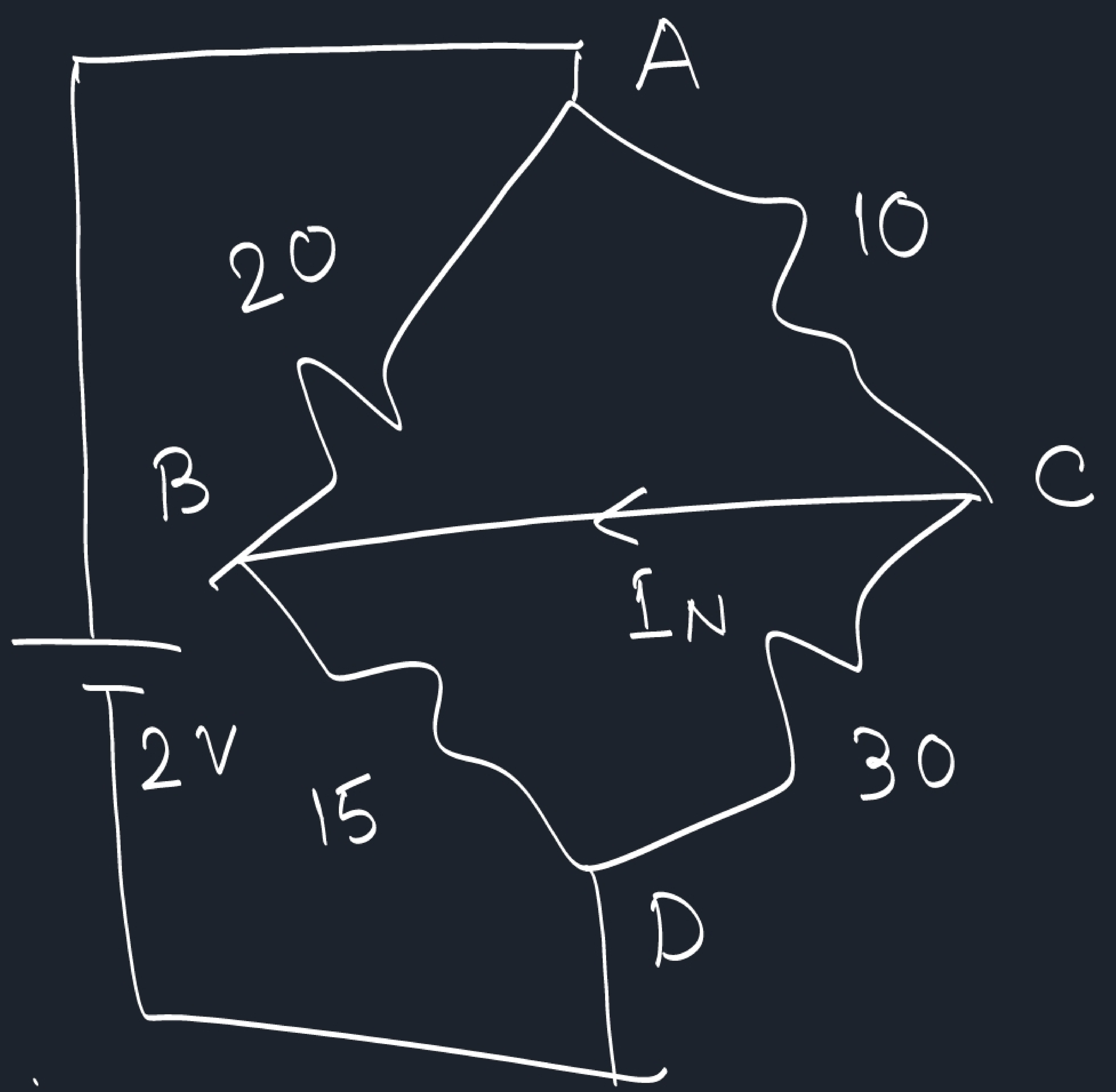
$V_B = 0$

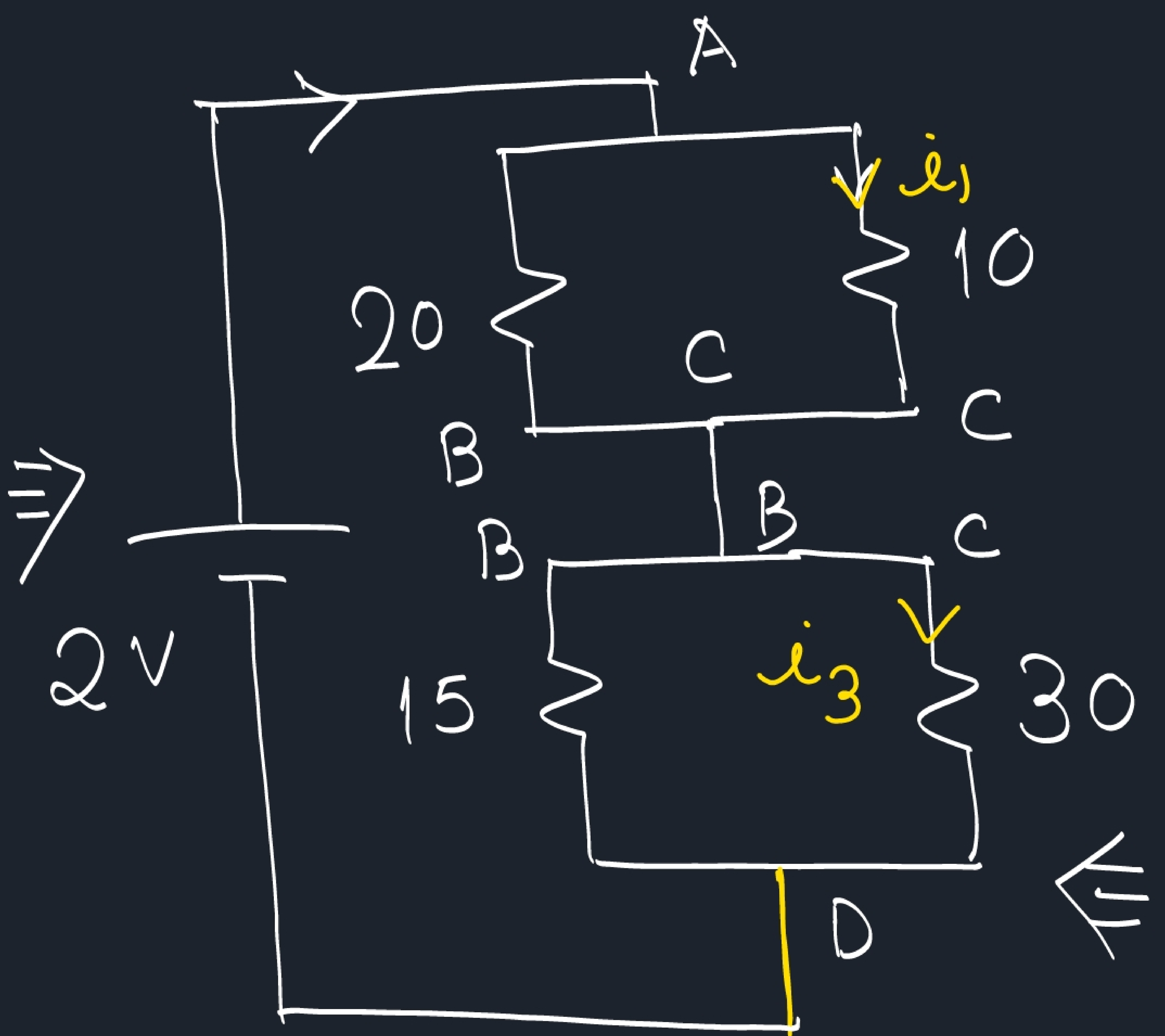
$$\frac{V_A - V_B}{2} = \frac{V_B - 32}{20} + I_N$$

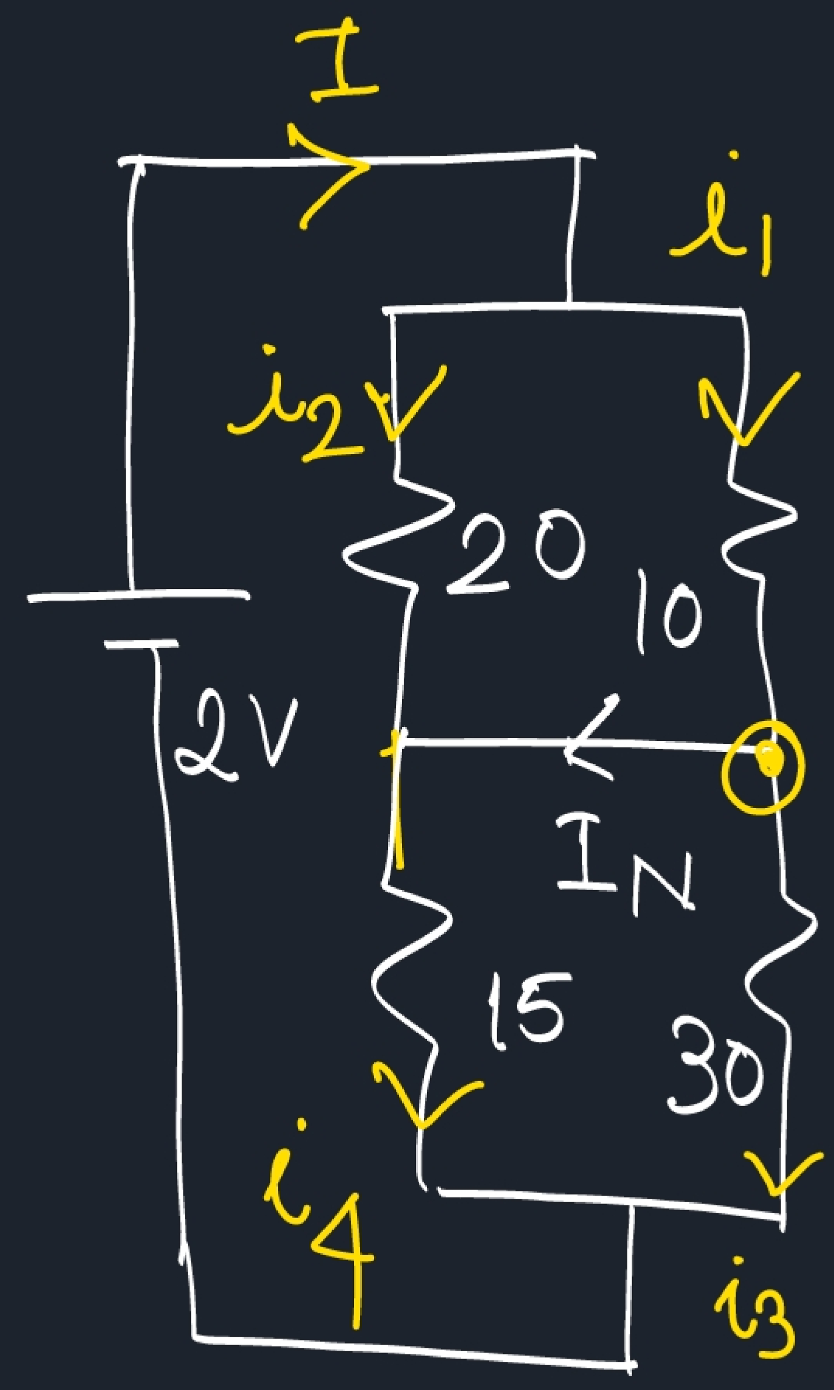
$$\underline{I_N = 2.4 \text{ Amps.}}$$

Problem:-



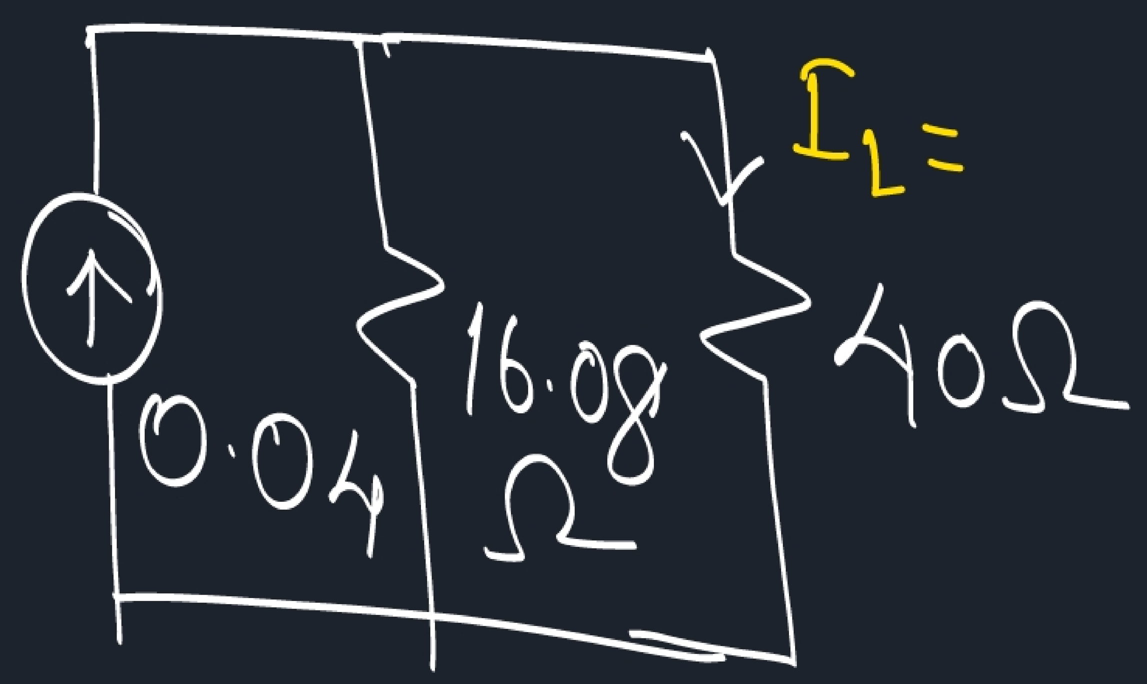






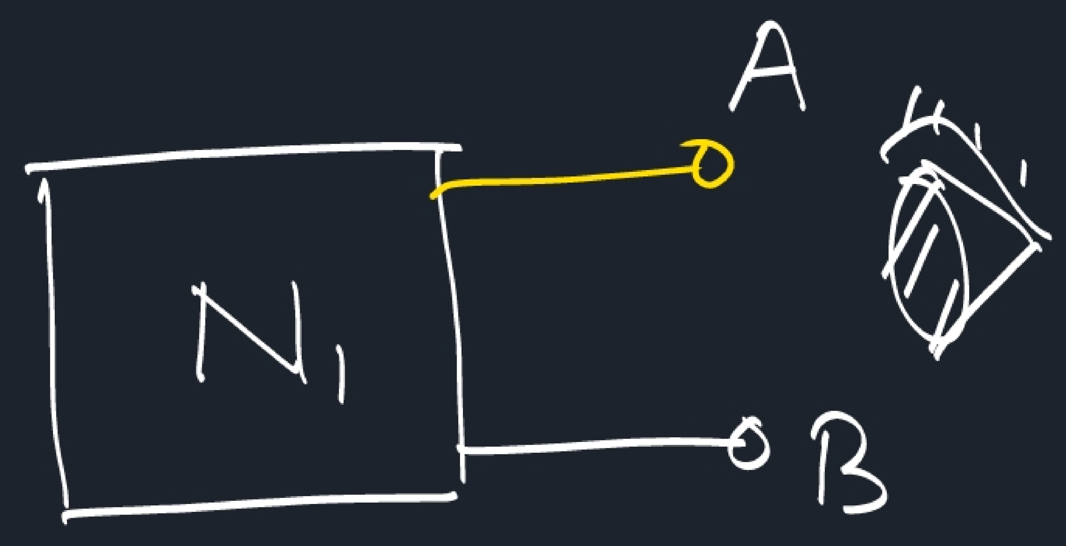
$R_N = 16.08\,\Omega$ $\quad I_N = i_1 - i_3$

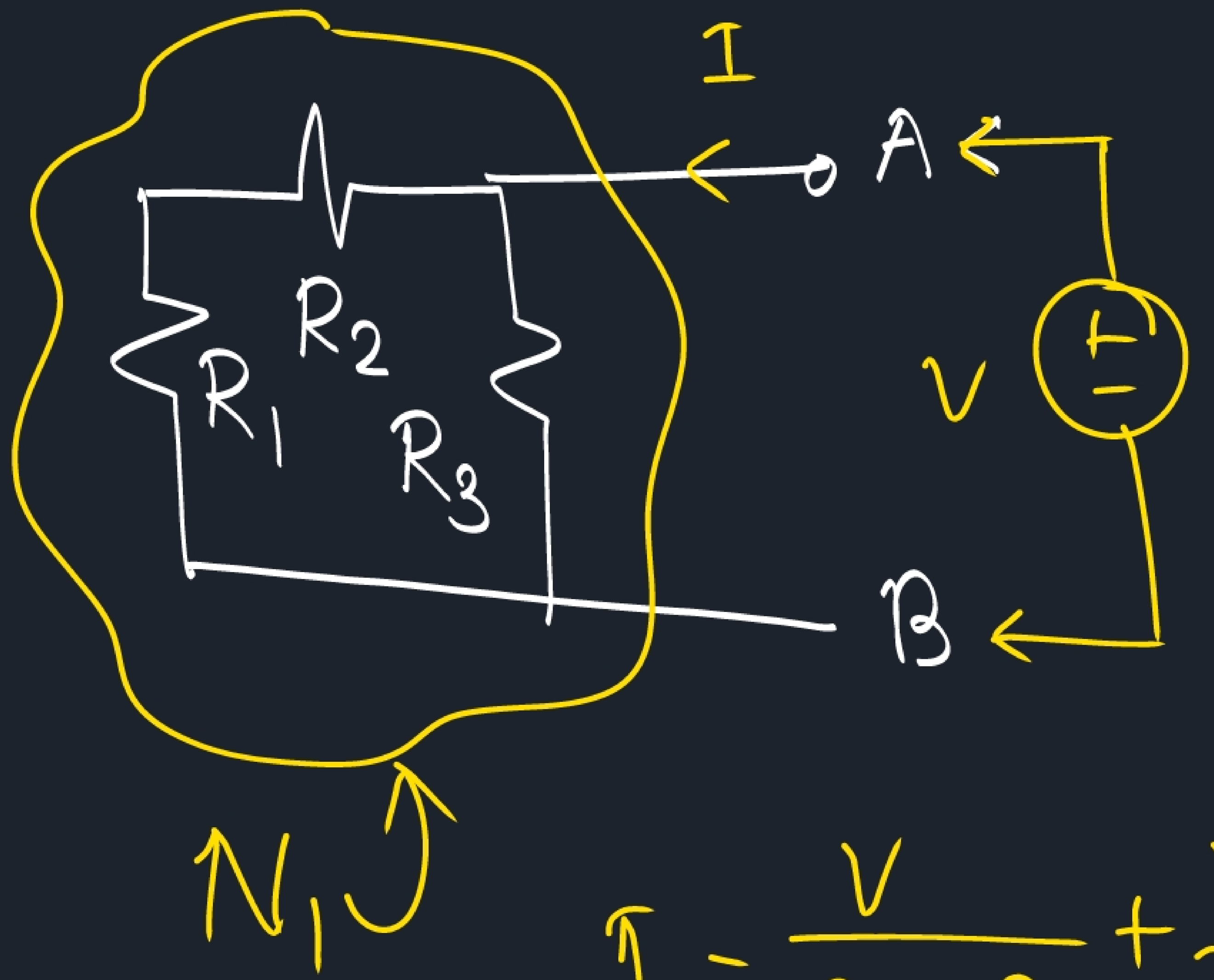
$$I = \frac{2}{(20\|10)+(15\|30)}\ \text{Amp} = 0.12\,A$$



$$I_L = \left\{ I \times \frac{20}{30} - I \times \frac{15}{45} \right\} = \boxed{0.04\ \text{Amp.}}$$

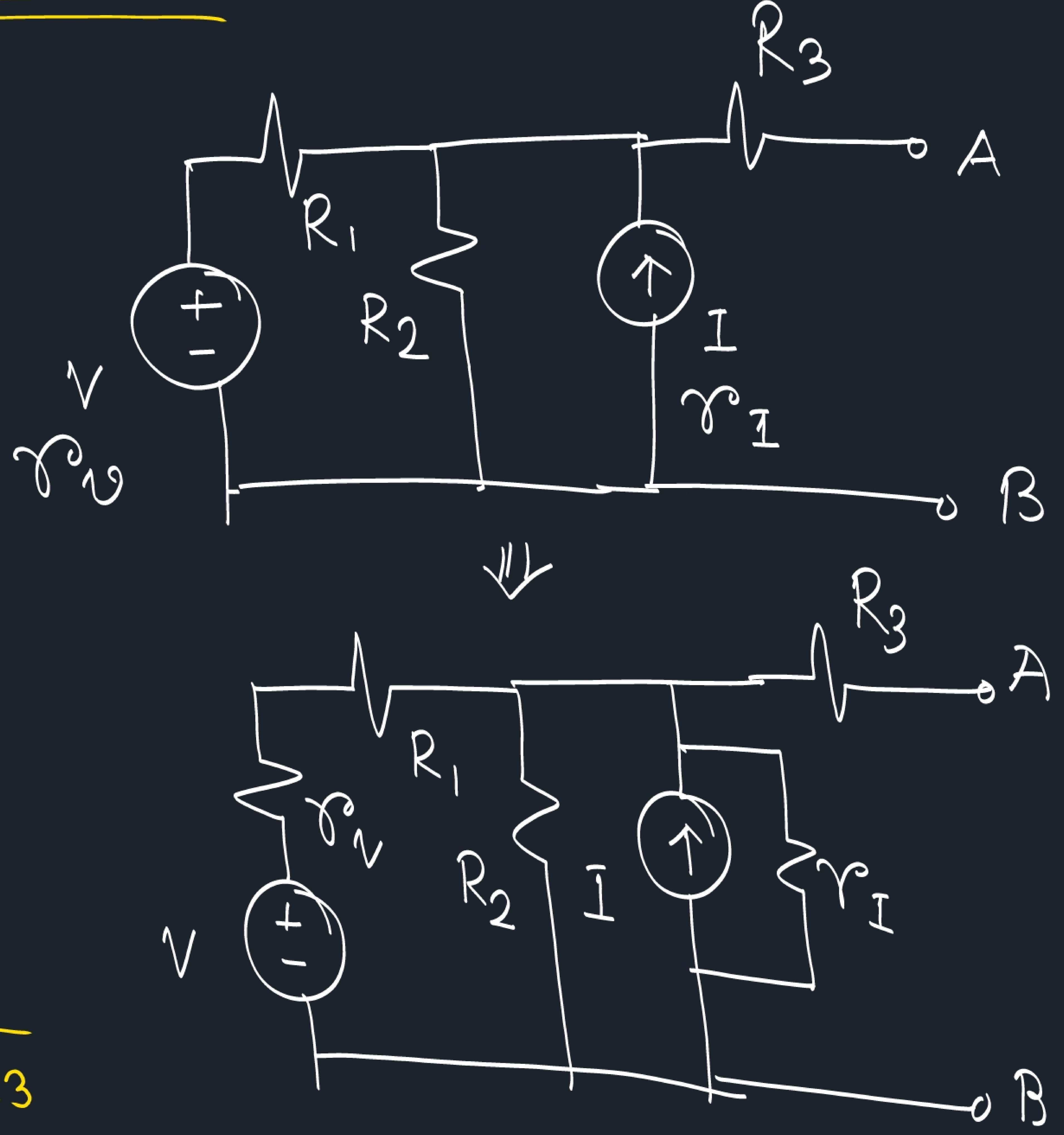
Equivalent Resistance

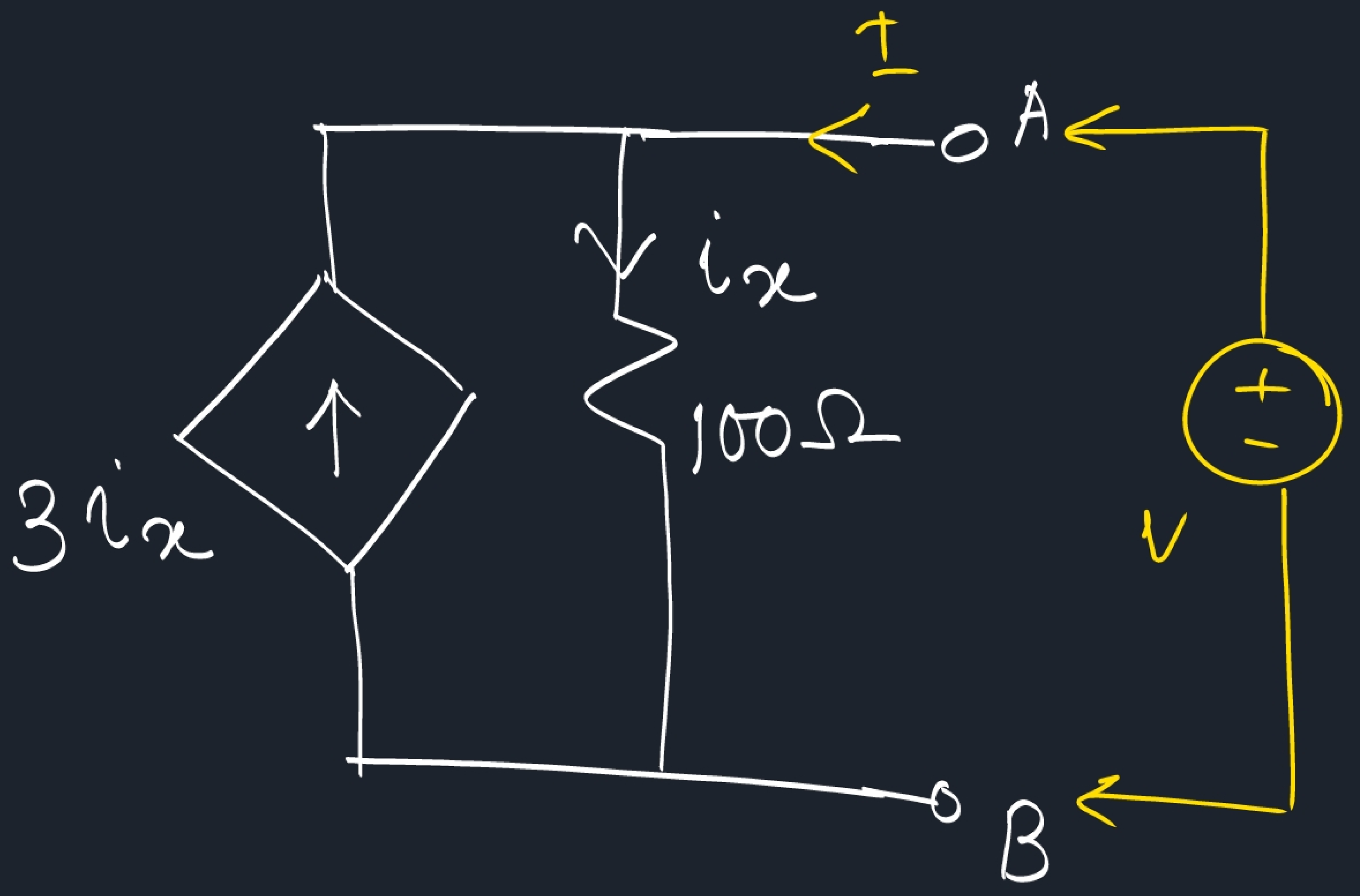




$$I = \frac{V}{R_1+R_2} + \frac{V}{R_3}$$

$$\frac{V}{I} = R_{eq} = \frac{1}{\frac{1}{R_1+R_2} + \frac{1}{R_3}}$$

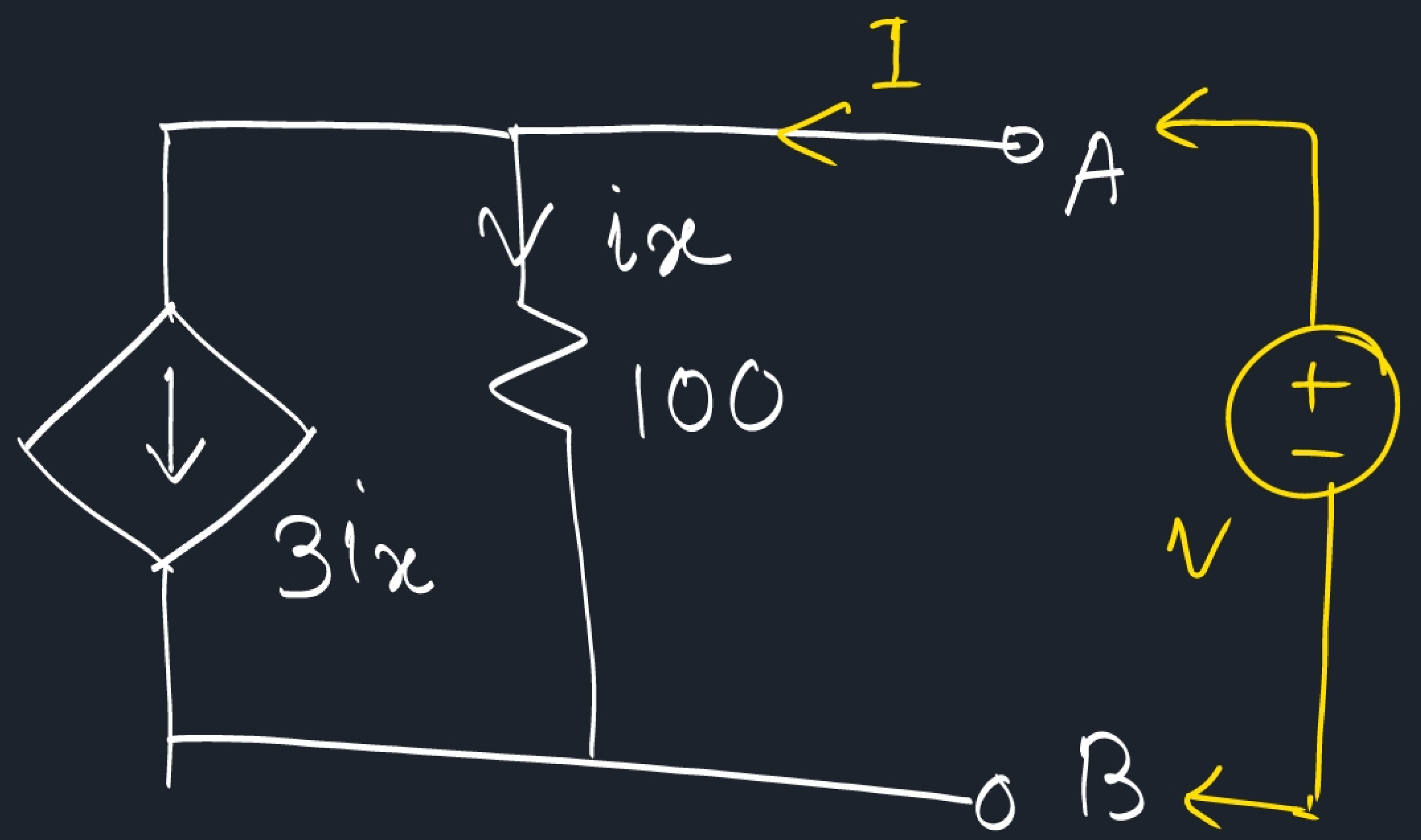




$$I = i_x - 3i_x = -2i_x$$

$$= -\frac{2V}{100}$$

$$\frac{V}{I} = -50\,\Omega$$



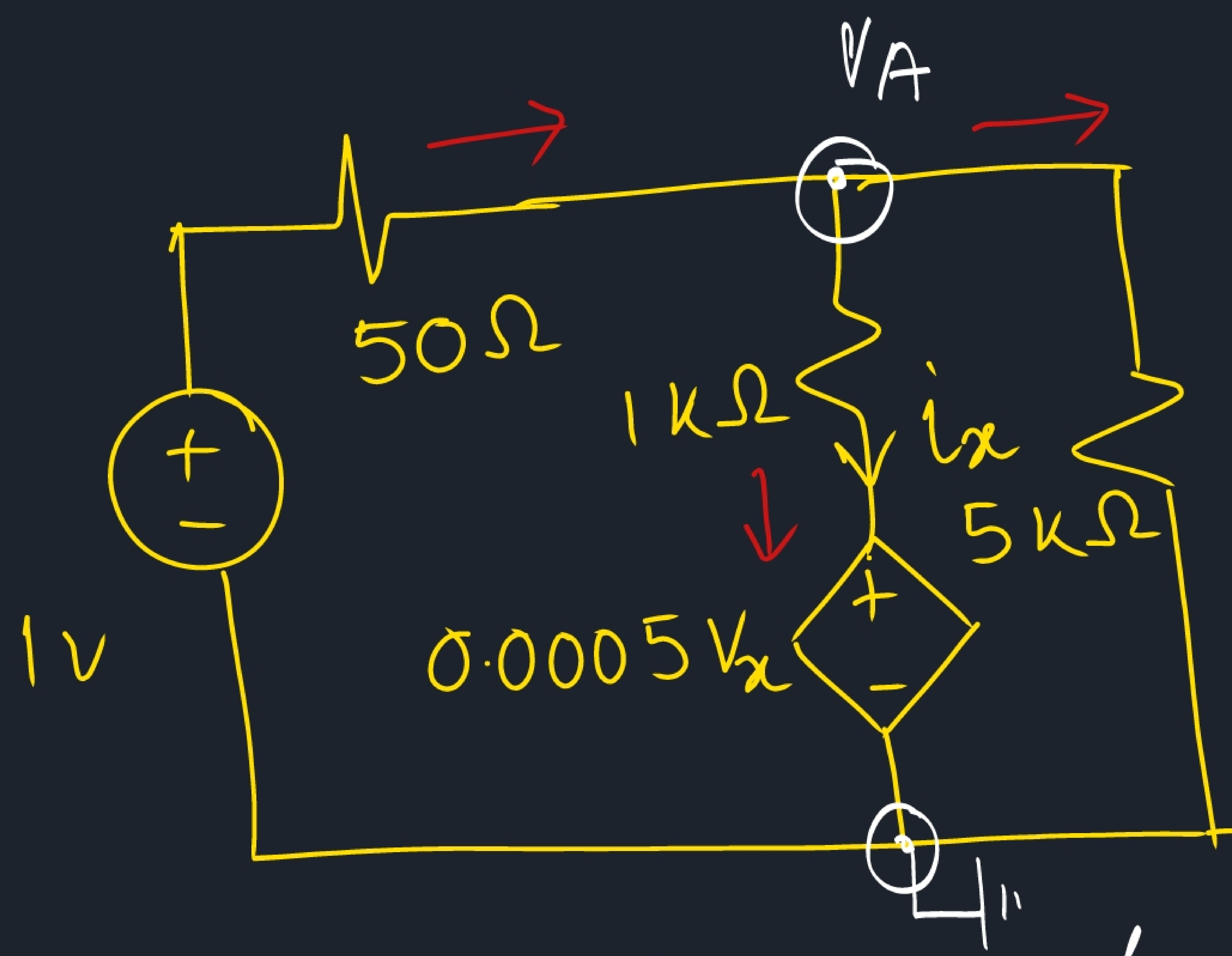
$$I = 3i_x + i_x$$

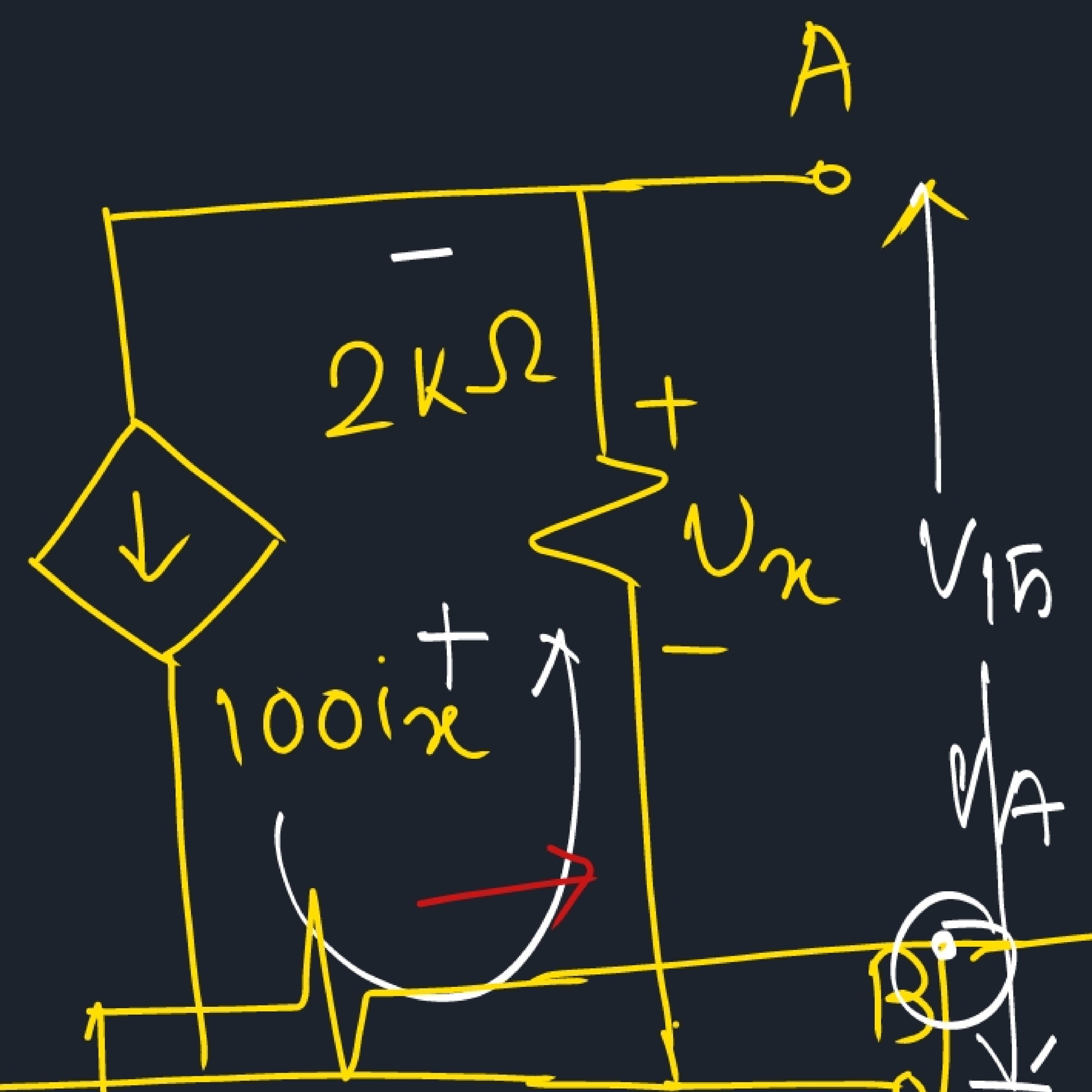
$$= 4i_x$$

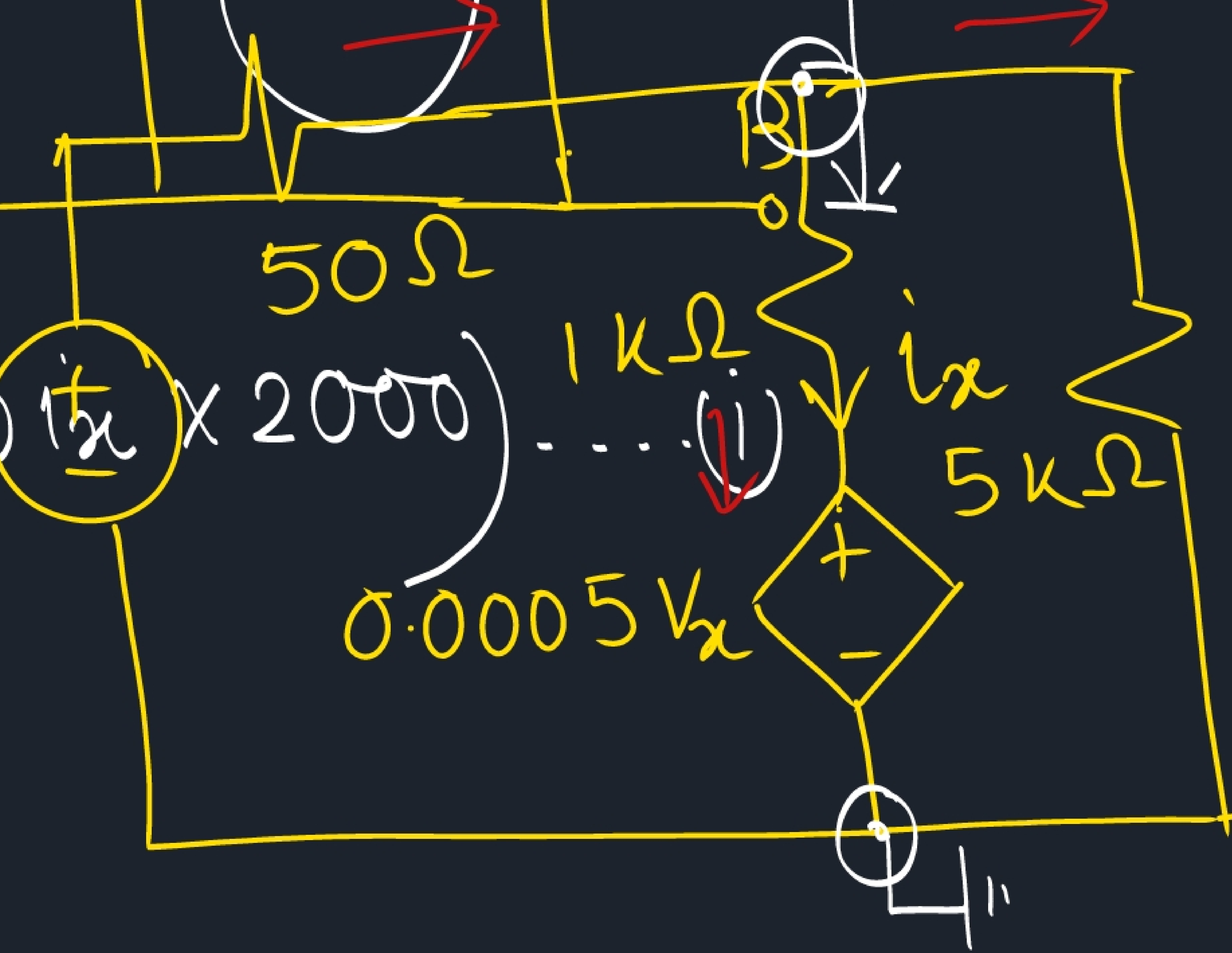
$$= \frac{4 \times V}{100}$$

$$\frac{V}{I} = 25\,\Omega$$

Problem:-







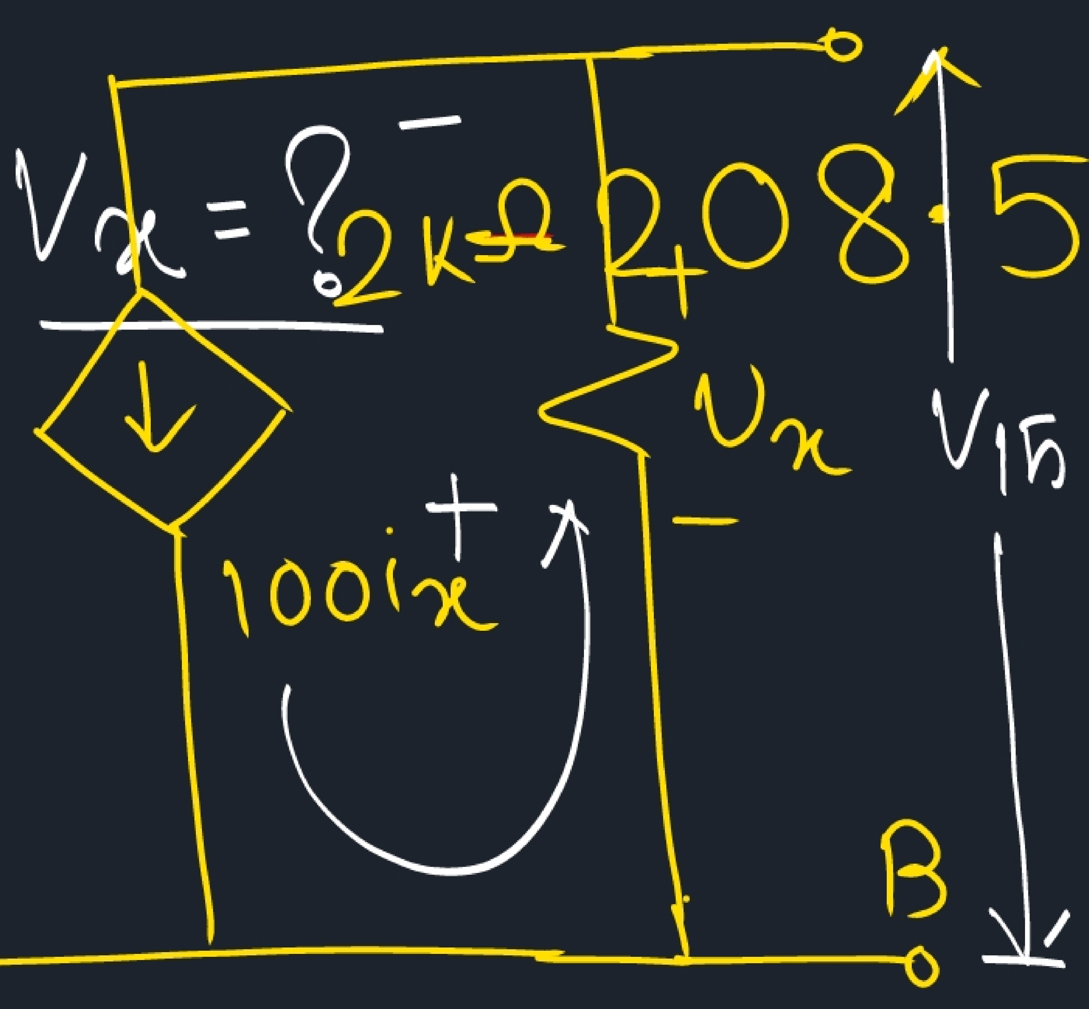
$V_x = V_{Th}$

$$V_x = (-100\, i_x \times 2000) \quad \ldots\ldots (i)$$

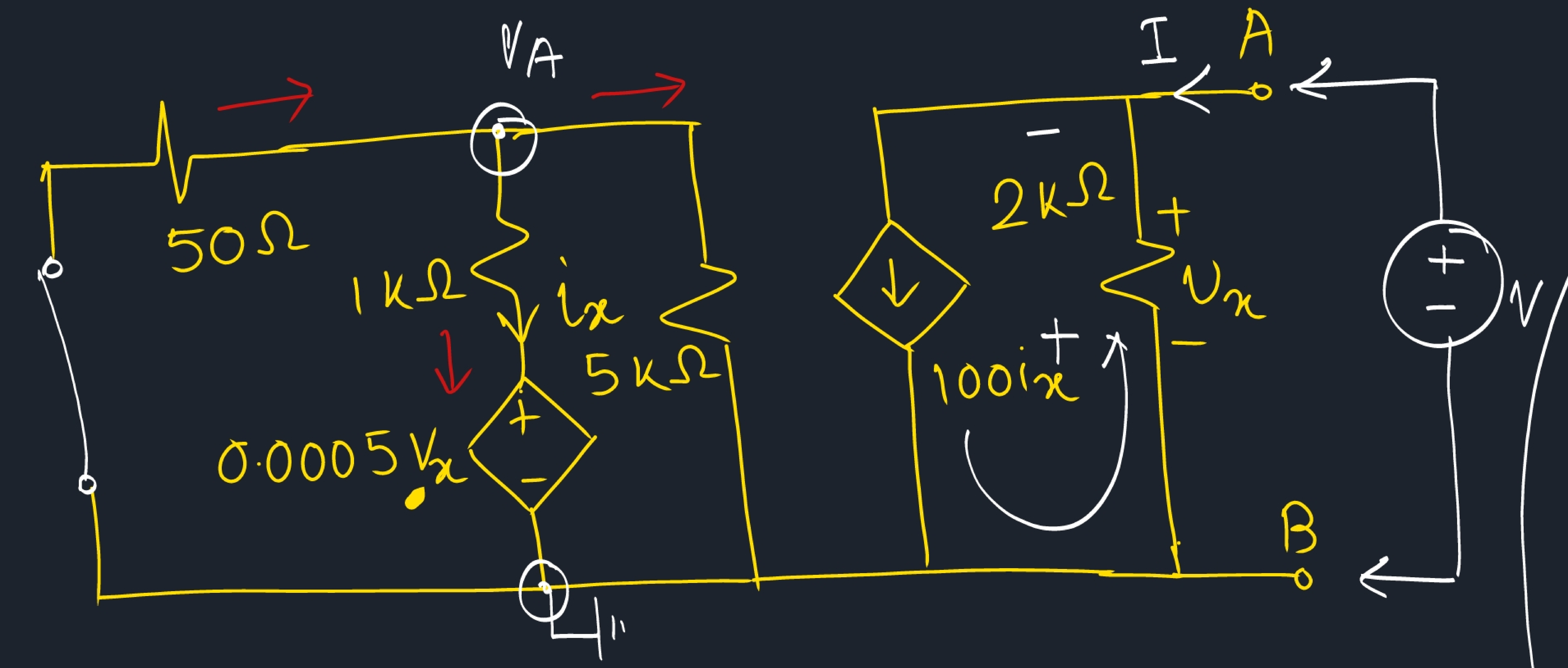
$$\frac{1 - V_A}{50} = \frac{V_A - 0.0005\,V_x}{1000} + \frac{V_A}{5000} \quad \ldots\ldots (ii)$$

$$i_x = \frac{V_A - 0.0005\,V_x}{1000}$$

$$\Rightarrow V_A = 1000\, i_x + 0.0005\, V_x \quad \ldots\ldots (iii)$$



$V_x = ?$ 208.5 Volt



$$\frac{V}{I} = R_{Th} = \text{Internal equiv. Resistance from A-B terminal}$$

$$V_x = V$$

$$I = \frac{V}{2000} + 100\, i_x \quad ---(i)$$

$$\frac{0 - V_A}{50} = \frac{V_A}{5000} + \frac{V_A - 0.0005V}{1000}$$

$$i_x = \frac{V_A - 0.0005V}{1000} \quad ---(ii)$$

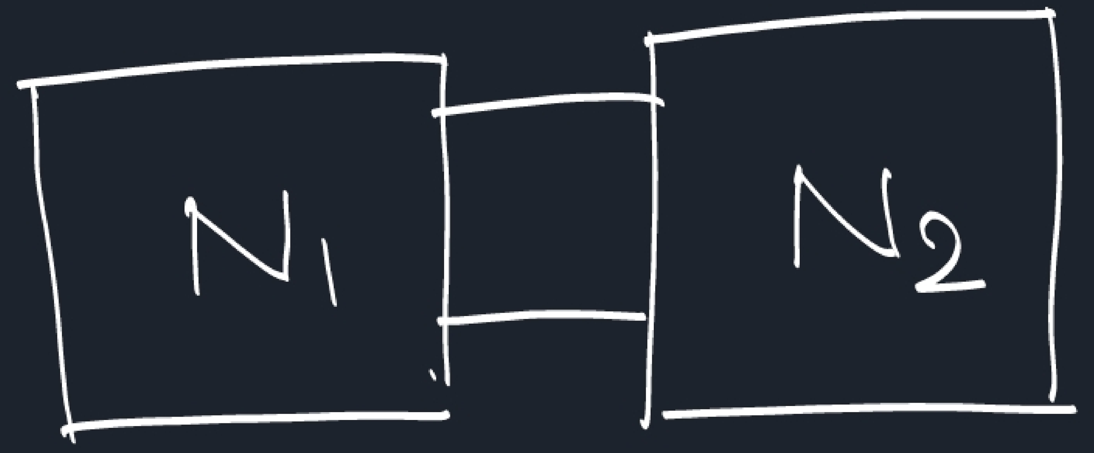
$$\frac{0.0005}{1000} V = V_A\left(\frac{1}{1000} + \frac{1}{5000} + \frac{1}{50}\right) \quad ---(iii)$$

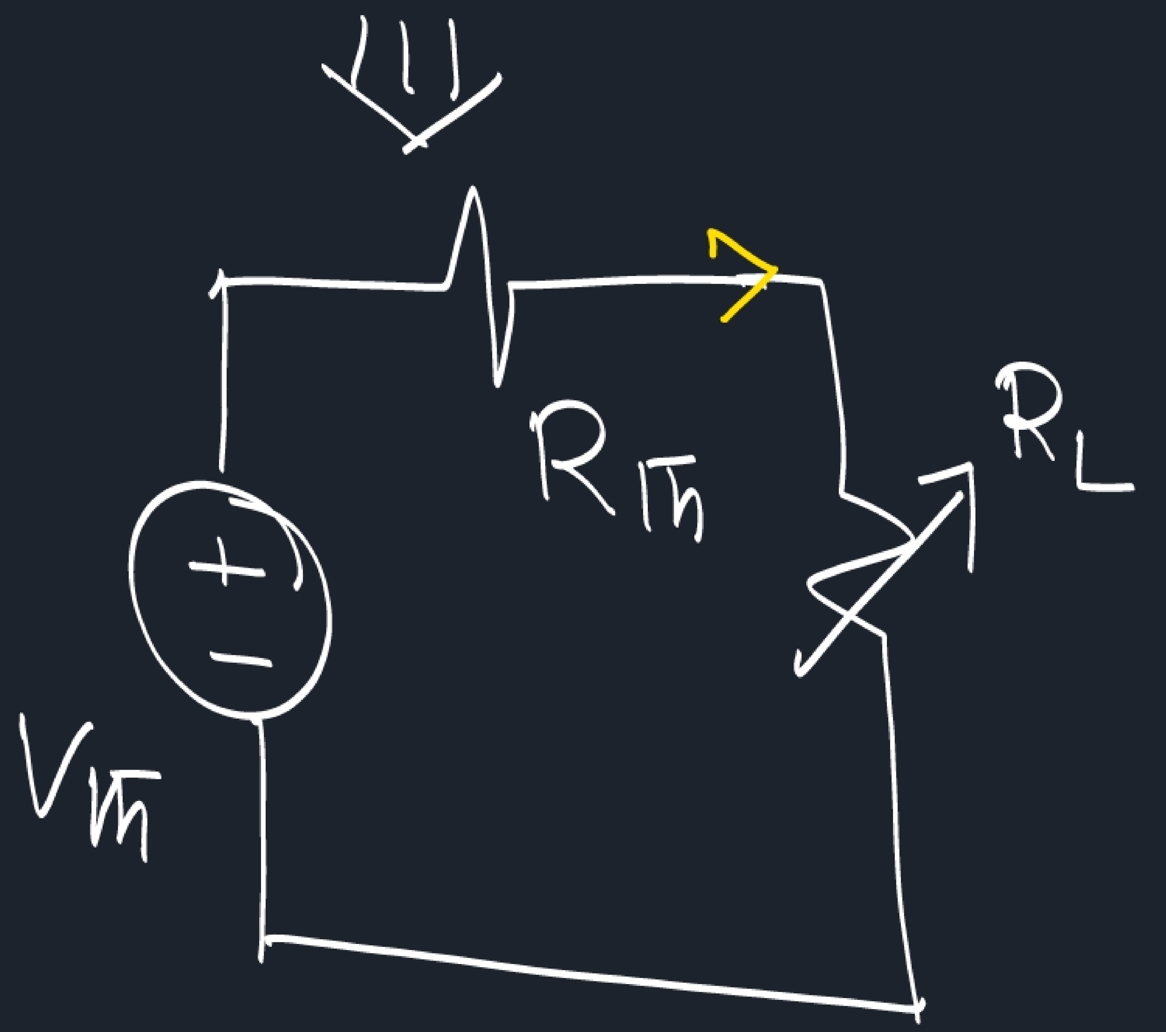
$$\boxed{\frac{V}{I} = ?}$$

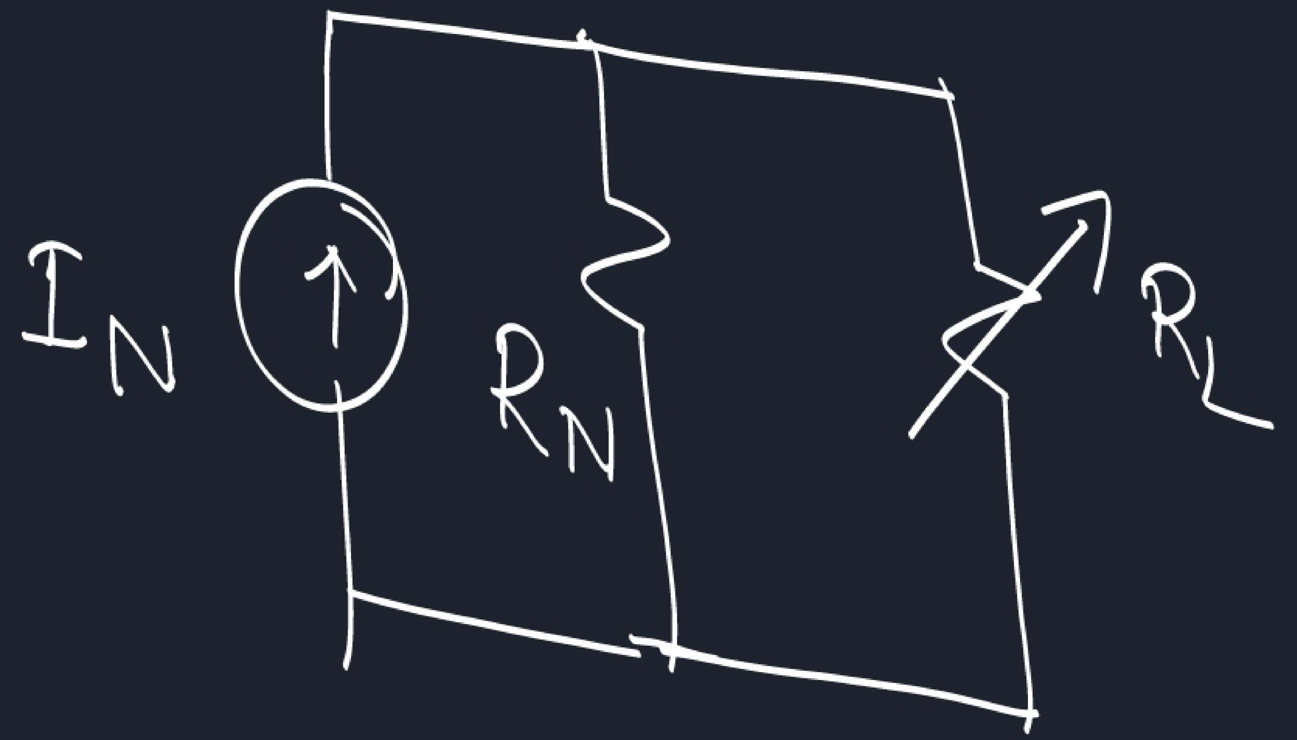
$$\frac{I}{V} = \frac{1}{2000} + 100\left(\frac{i_x}{V}\right)$$

$$\underbrace{2.21\ \text{k}\Omega}$$

Max. Power Transfer Theorem:-





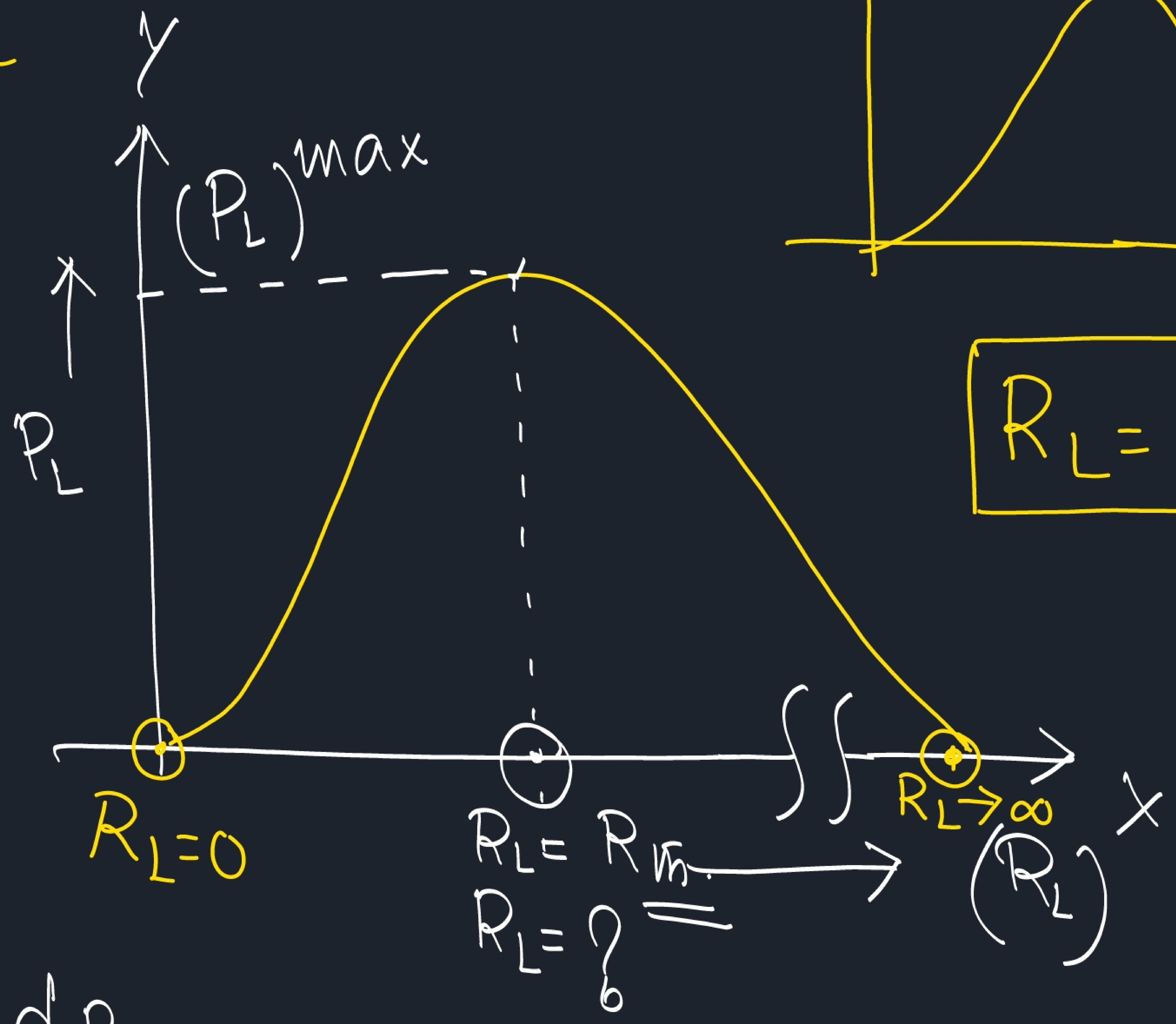


$$I_L = \frac{V_{Th}}{(R_{Th} + R_L)}$$

$$P_L = I_L^2 R_L$$

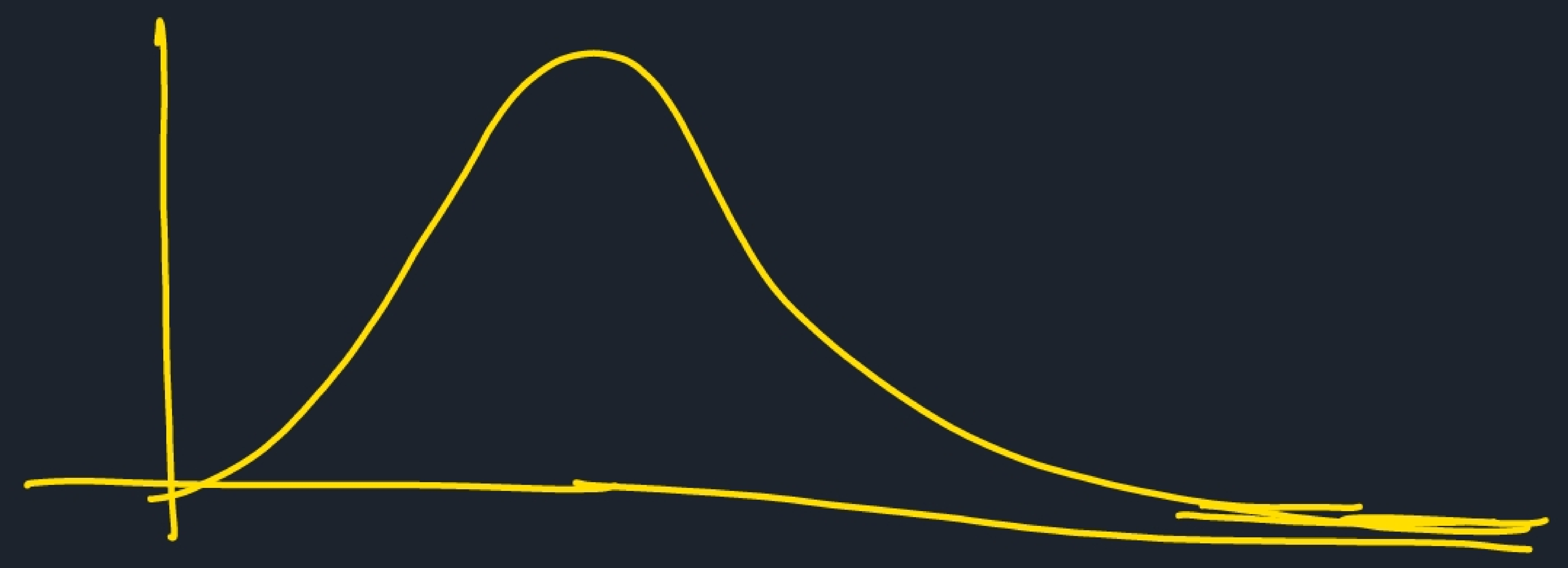
$$= \left\{ \frac{V_{Th}}{R_{Th} + R_L} \right\}^2 R_L$$

$$(P_L)^{max} = \frac{V_{Th}^2}{4R_{Th}}$$

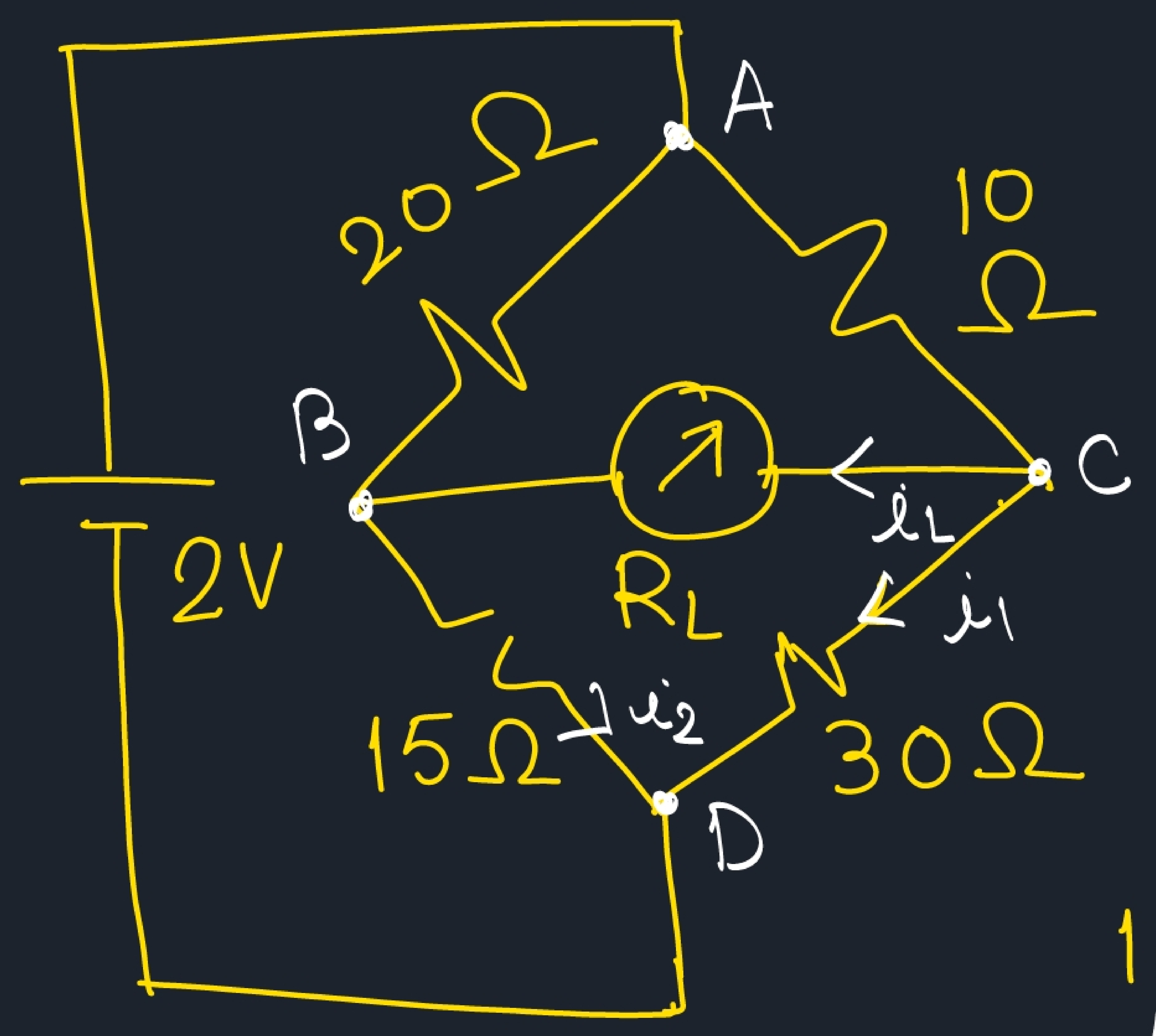


$$\frac{dP_L}{dR_L} = ?$$

$$\boxed{R_L = R_{Th}}$$

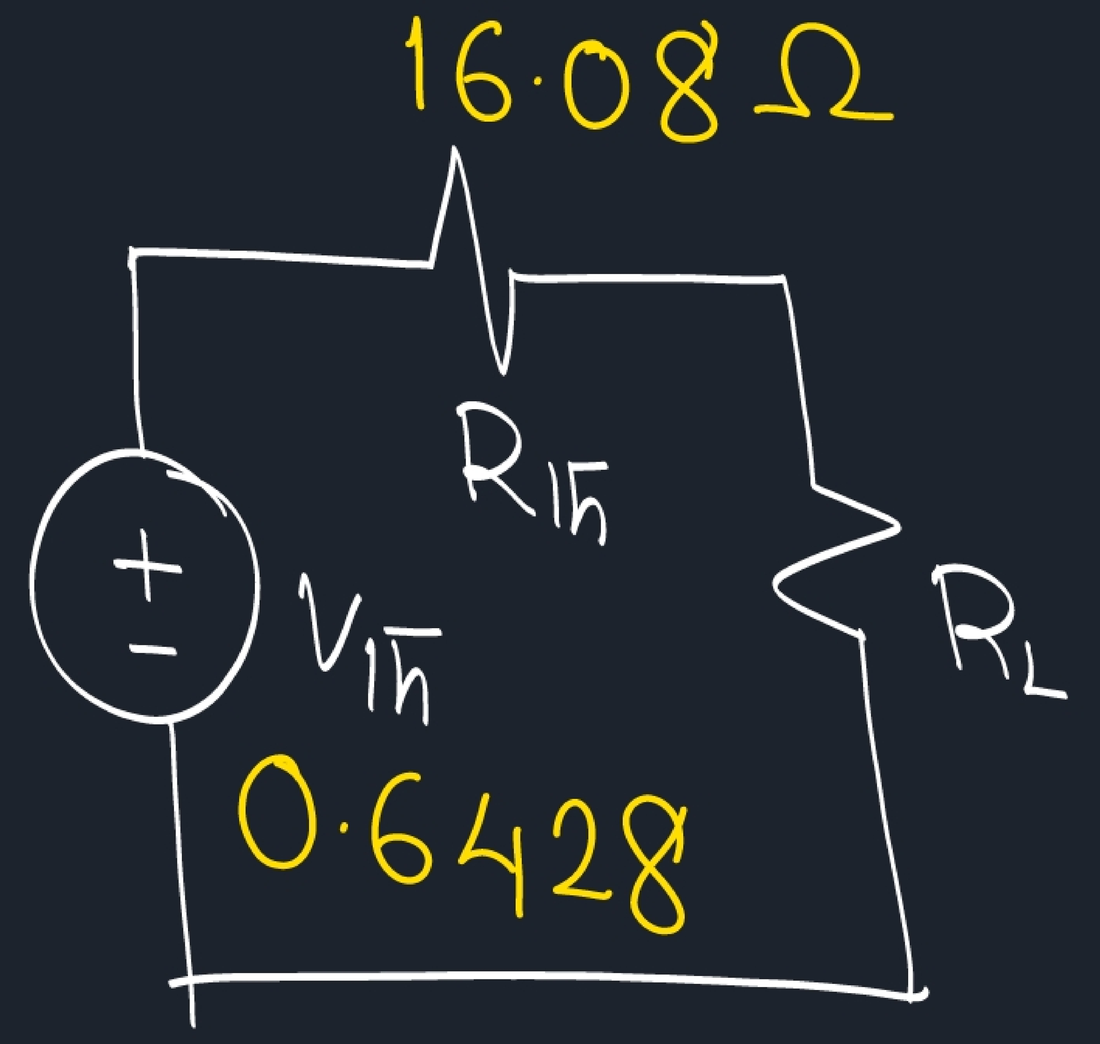


$$\boxed{R_L = R_{Th} = R_N}$$



$R_L = ?$

16.08Ω

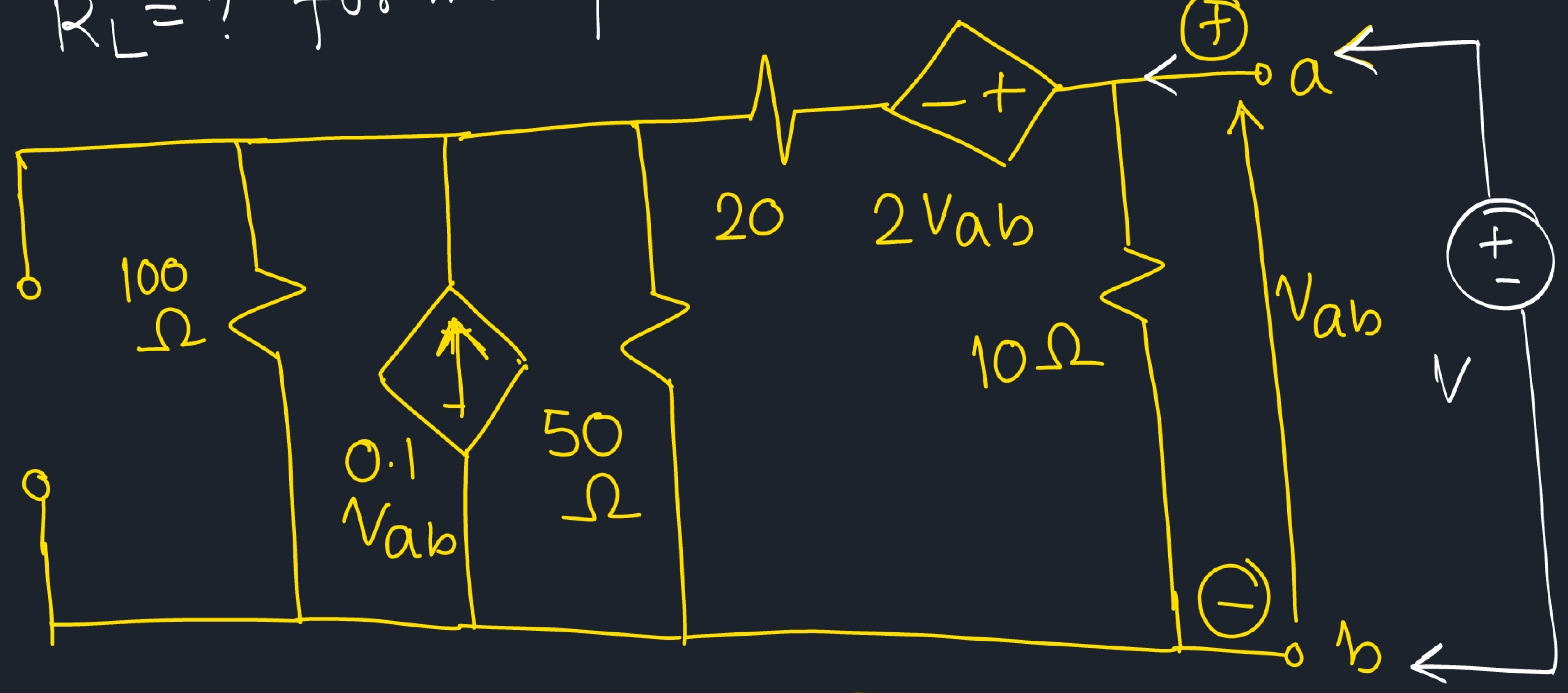


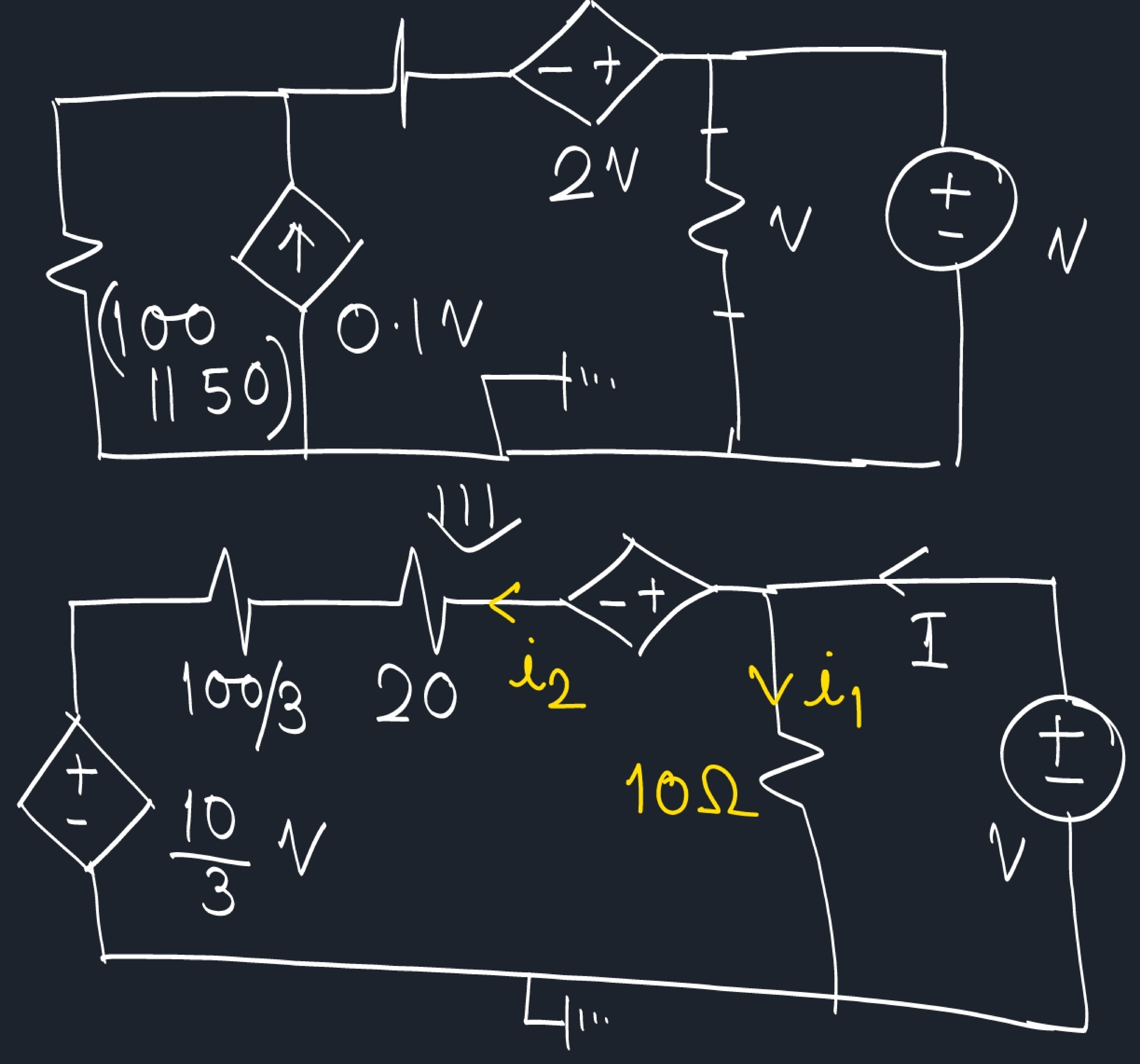
$$\frac{(V_{Th})^2}{4R_{Th}} = \left\{\frac{0.6428^2}{4 \times 16.08}\right\} \text{Watt}$$

$$= \underline{6.428\,\text{mW}}.$$

Problem:-

$R_L = ?$ for max power transfer.





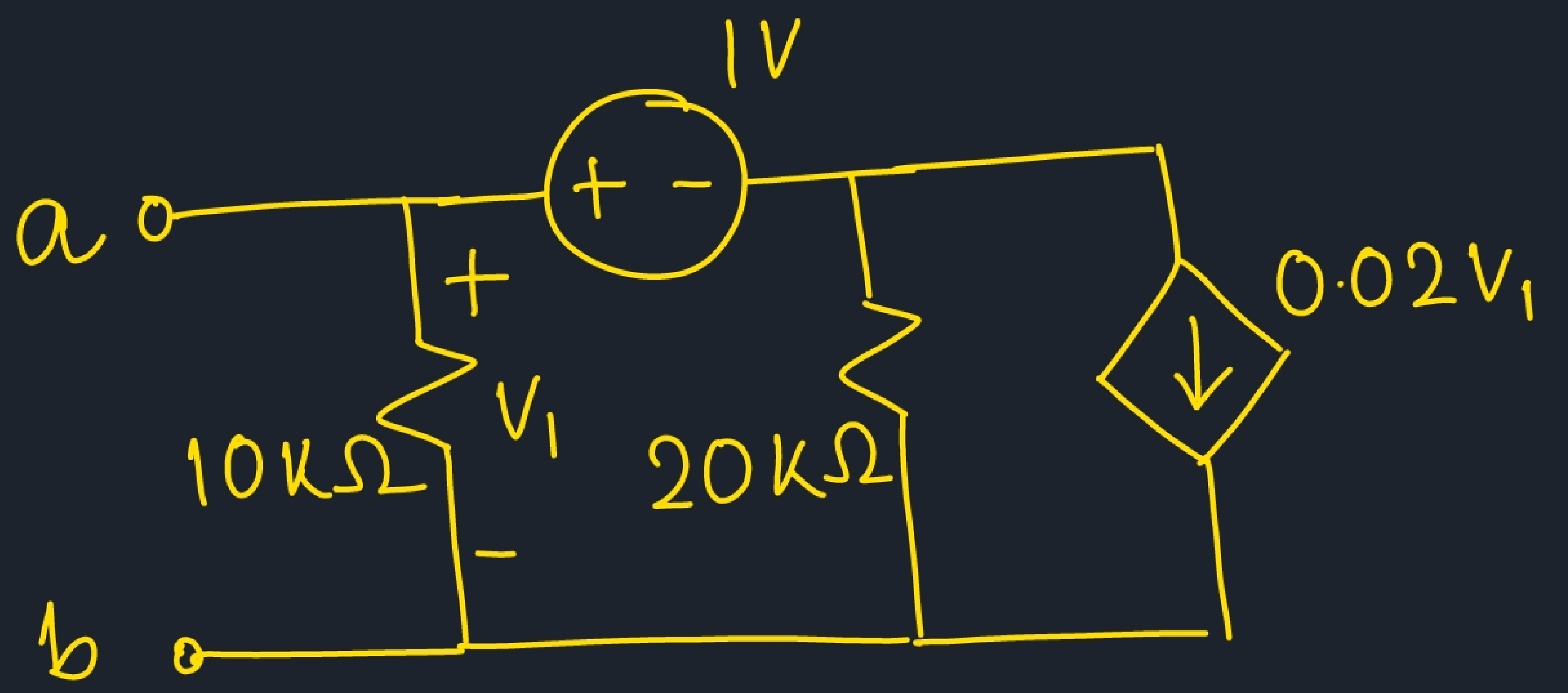
Test source method.

$$I = i_1 + i_2$$

$$= \frac{V}{10} + \frac{V - 2V - \frac{10}{3}V}{100/3 + 20}$$

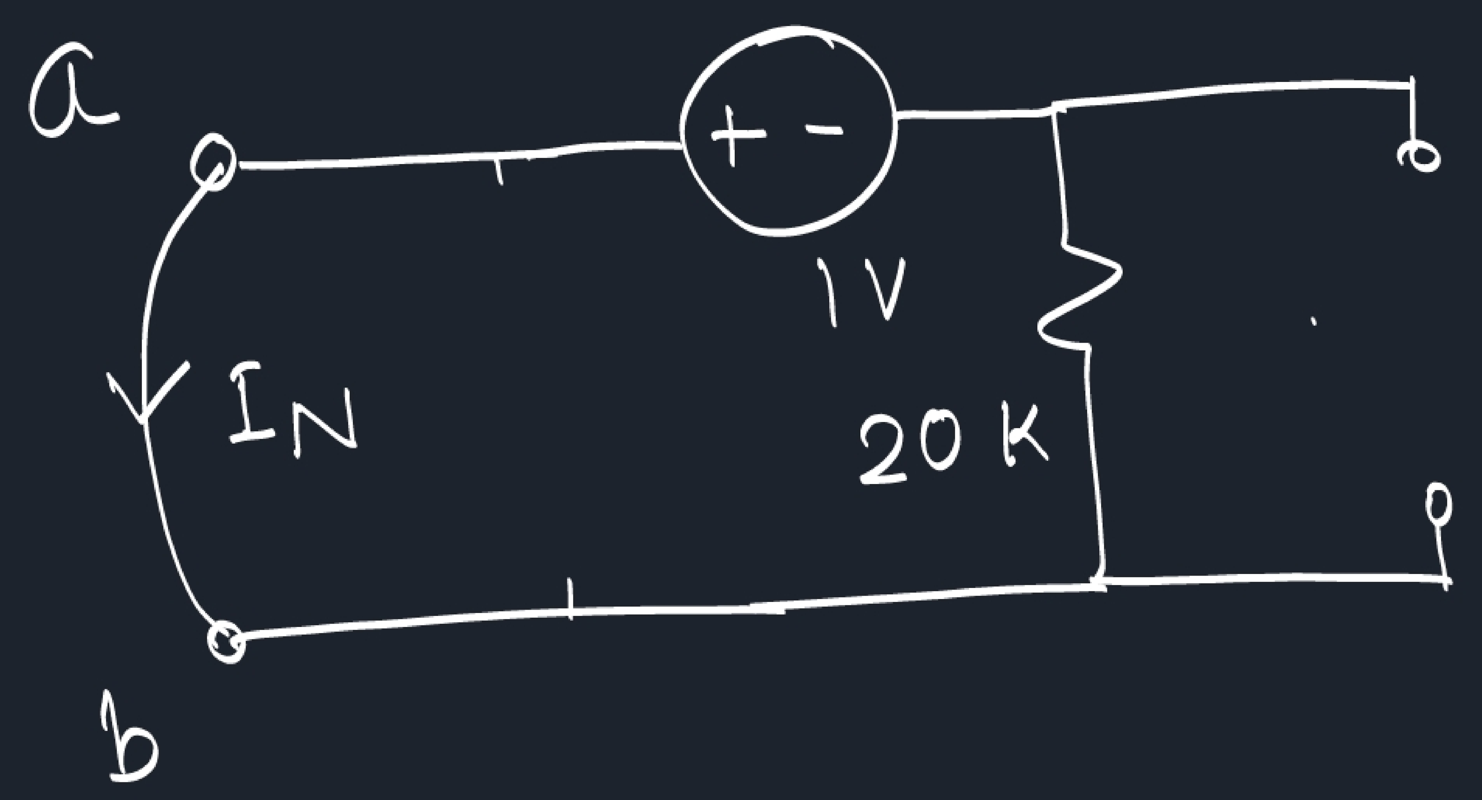
$$\left(\frac{V}{I}\right) = ? \quad \boxed{53.33\,\Omega}$$

Problem:-



i) Find Power dissipated when 1 kΩ resistance is connected b/w a-b terminal

ii) Find max power extracted from the ckt.



$$I_N = \frac{1}{20\times10^{3}} \text{ Amp}$$

$$I = i_1 + i_2$$

$$= \frac{V}{10{,}000} + \frac{V + \left(\frac{0.02\times20\times}{1000}\right)V}{20{,}000}$$

$$\left(\frac{V}{I}\right) = ?$$