Theorems :-

Superposition Theorem :-

R — $V = IR$; I, $+ V -$

R — $V' = (I_1+I_2)R$; (I_1+I_2)

$= I_1R + I_2R$

$= V_1 + V_2$

it follows law of additivity

R — $V_1 = I_1R$; I_1, $+V_1-$

R — $V'' = (\alpha I)R$; αI

$= \alpha(IR)$

$= \alpha V$

it follows law of homogeinity so it is linear.

R — $V_2 = I_2R$; I_2, $+ V_2 -$

R — $P = I^2R$; I

Non Linear due to NL operator (square)

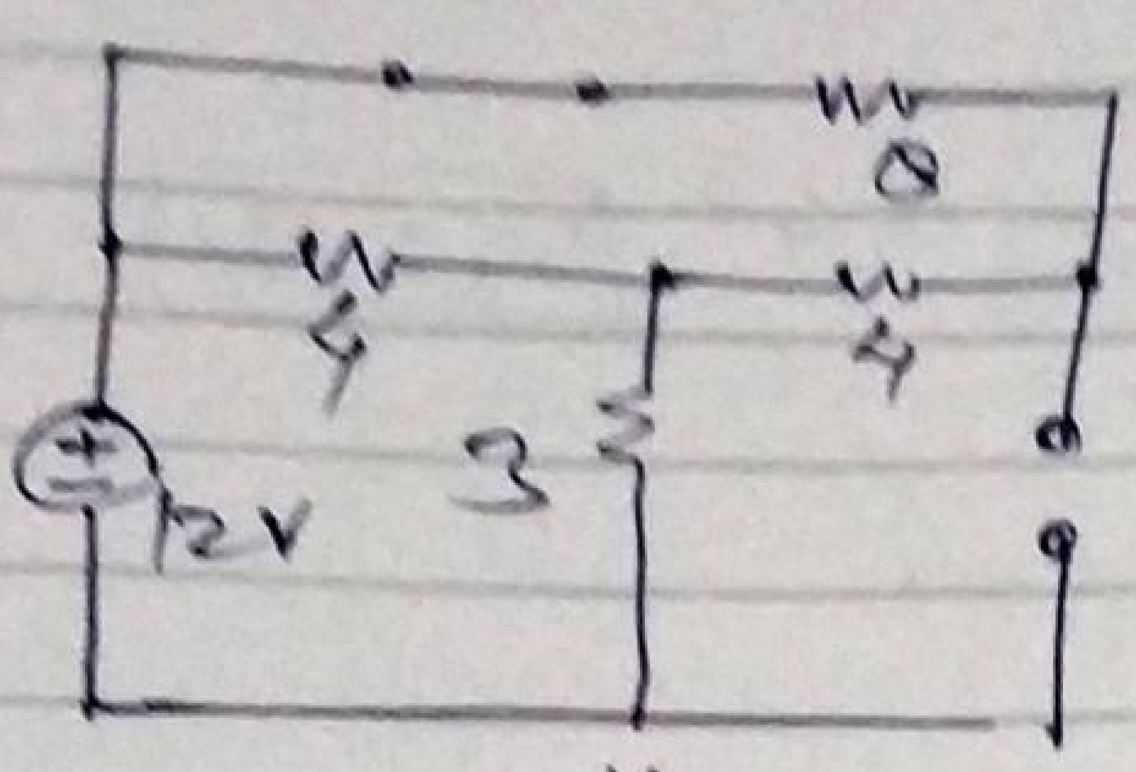
→ In a Linear Bilateral N/W containing more than one independent voltage and current source, the response in any element is the sum of the responses obtained with one source acting at a time and other sources be deactivated.

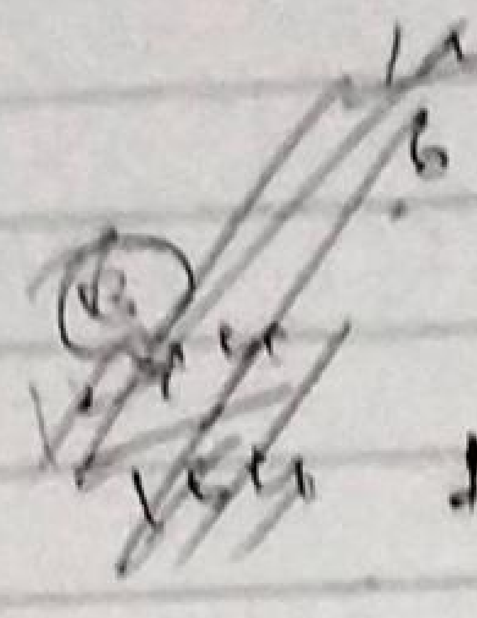
→ Deactivation means all independent sources are replaced by their internal resistance i.e voltage source is replaced by S.C. and current source by O.C.

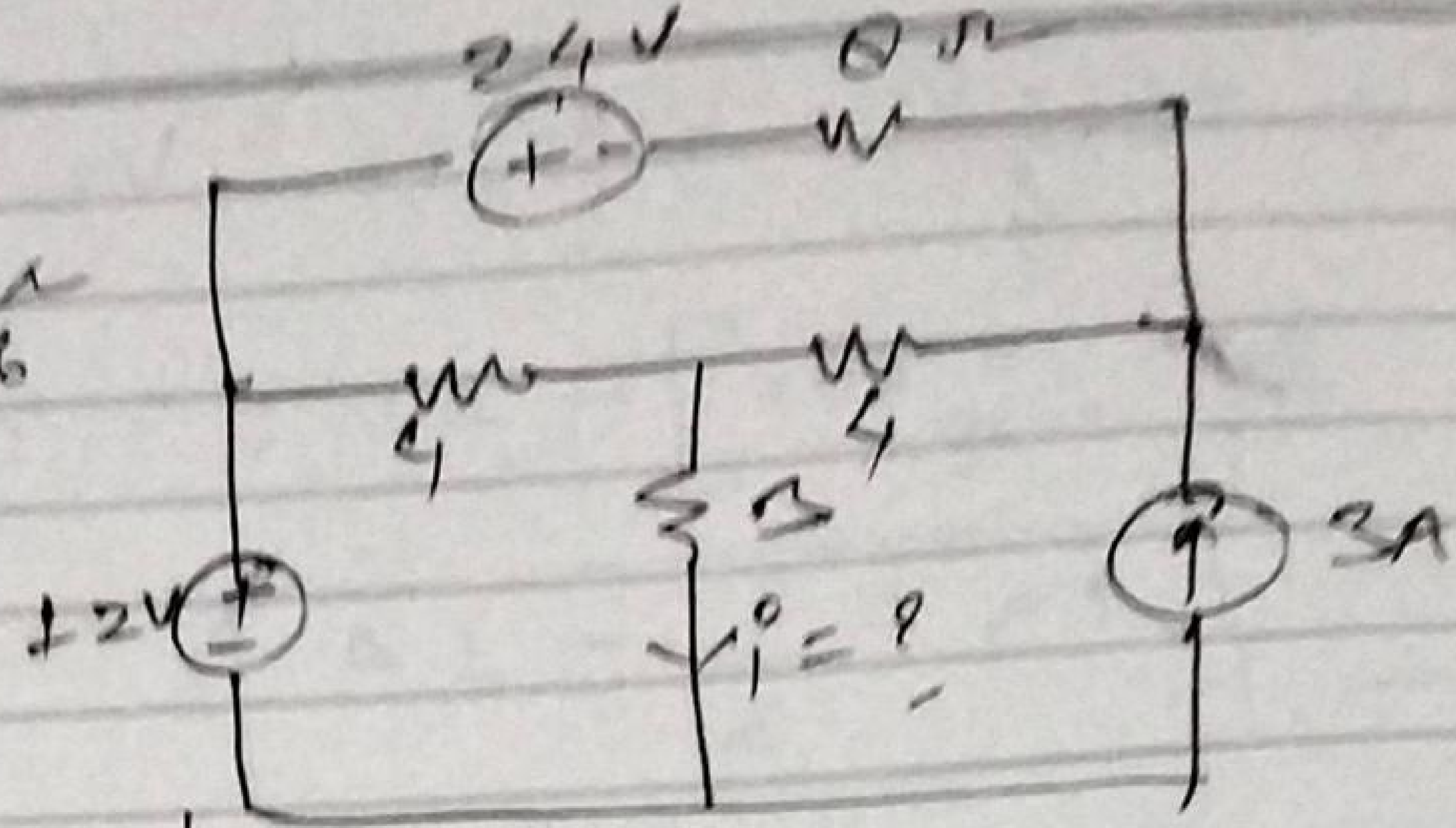
(Dependent sources remain as it is.)

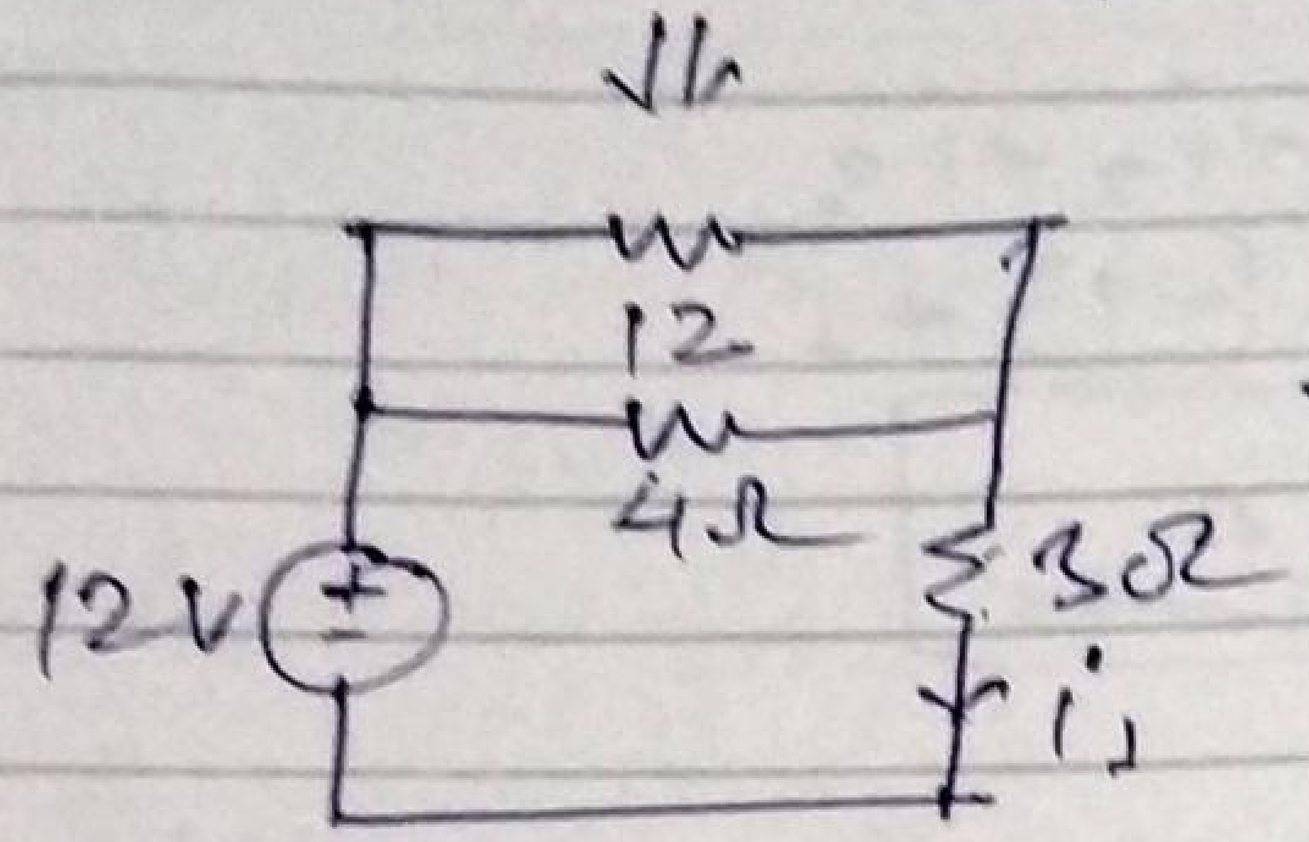
Ques:- Find the current flow in 3 Ω resistor by the use of superposition theorem.

Case 1 :- 12 V





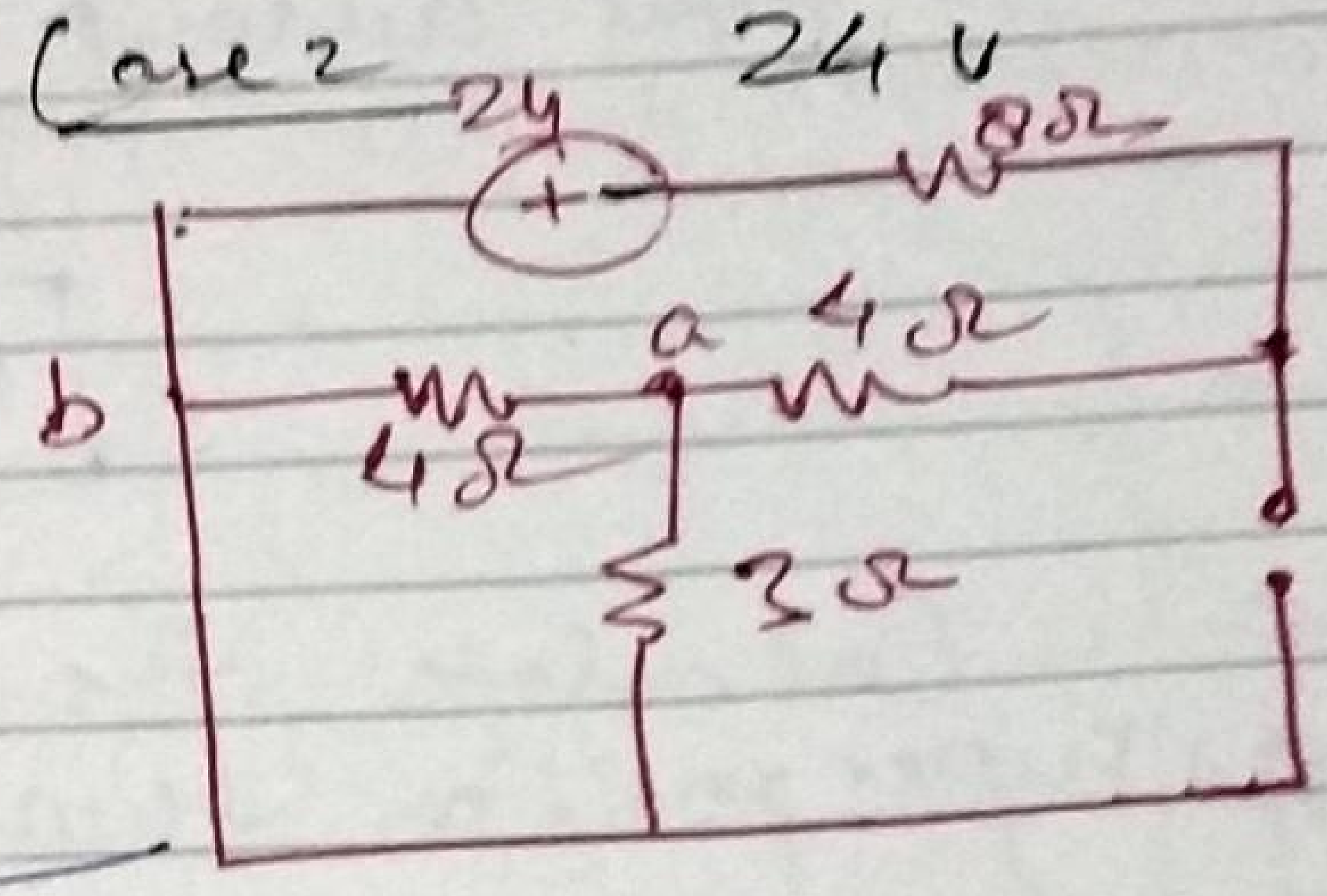


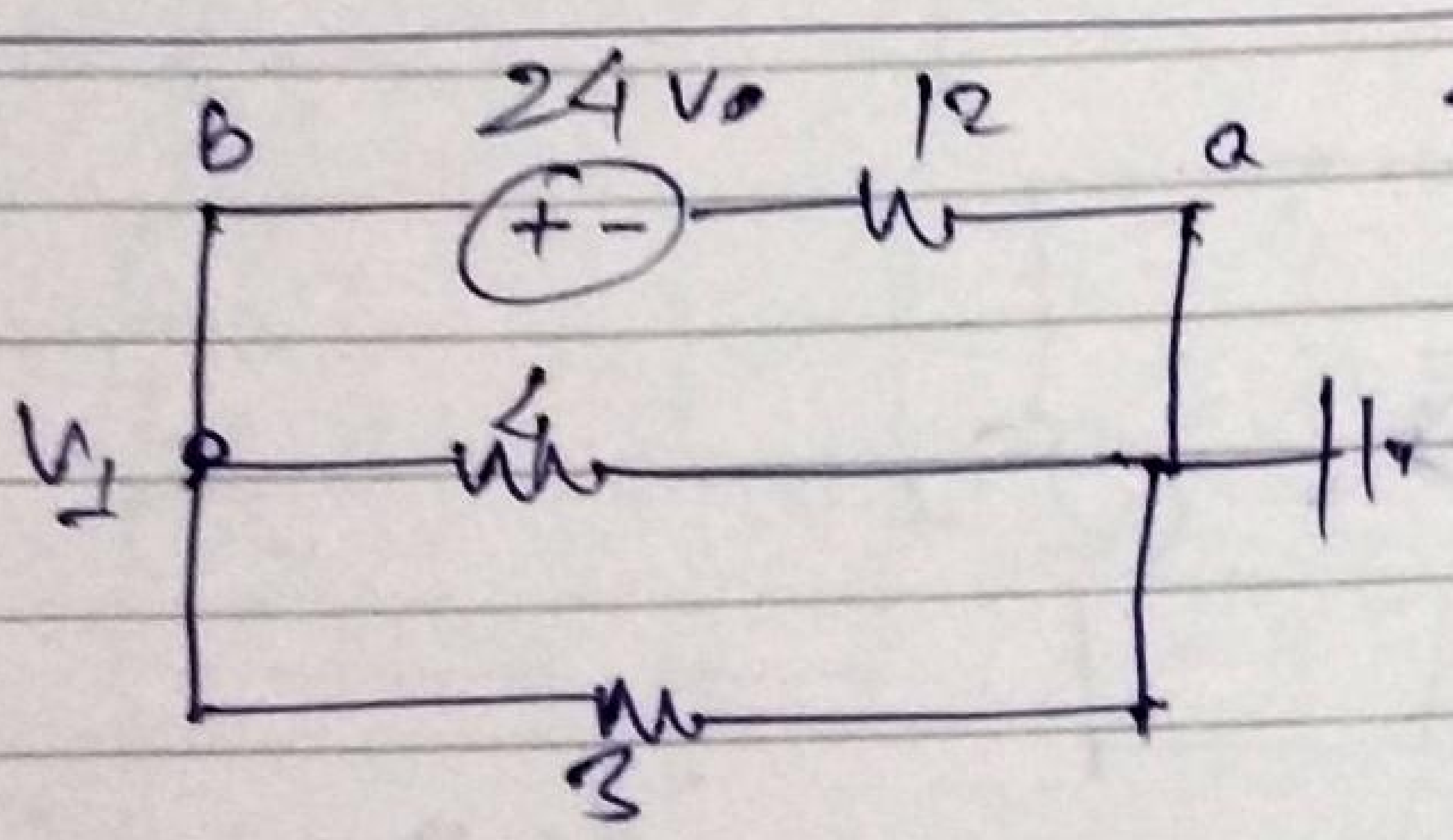


$$i_1 = \frac{12}{6}$$

$$\boxed{i_1 = 2A}$$

Case 2 24 V





Apply Nodal

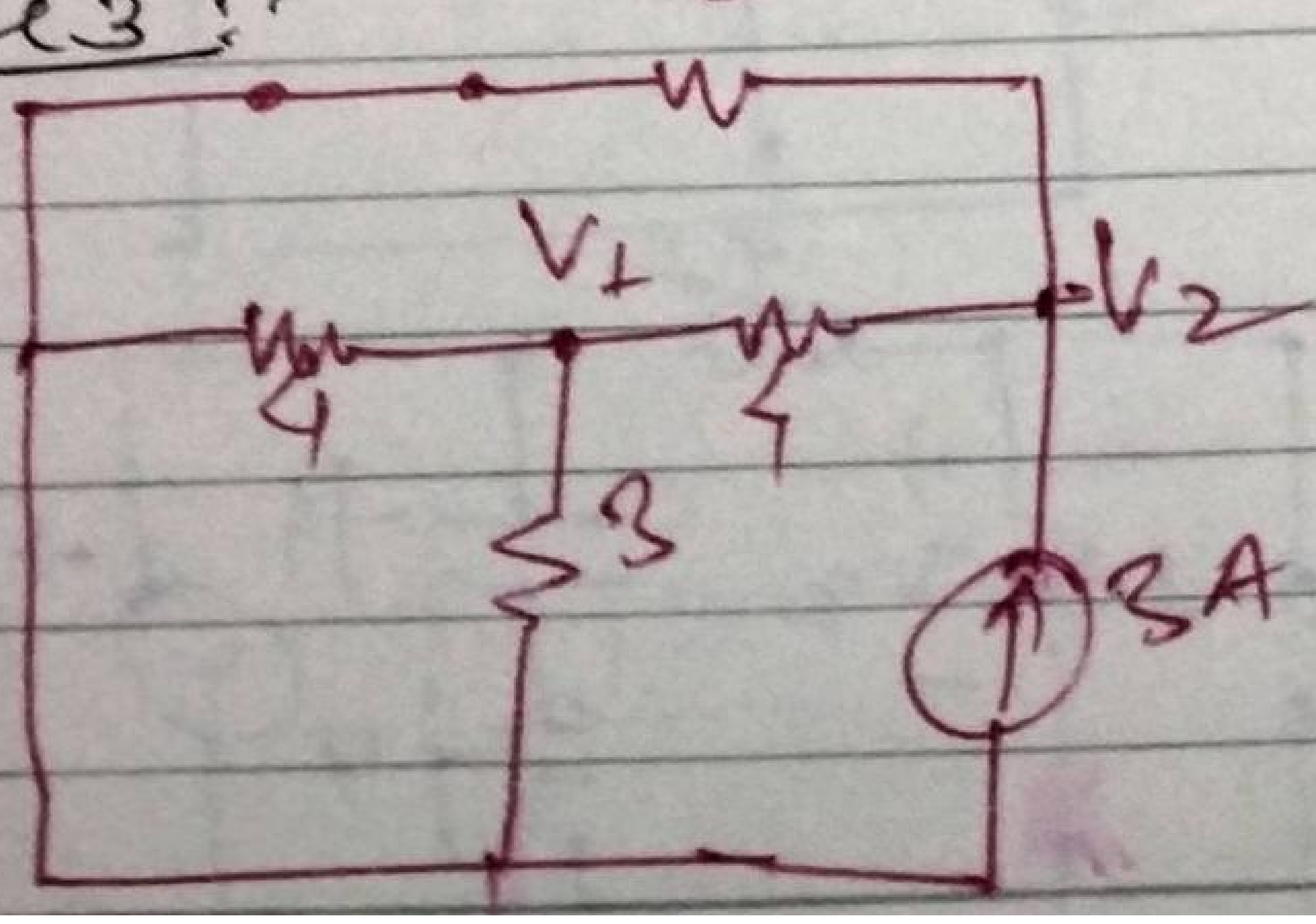
$$\frac{V_1 - 24}{12} + \frac{V_1}{4} + \frac{V_1}{3} = 0$$

$$V_1 - 24 + 3V_1 + 4V_1 = 0$$

$$\boxed{V_1 = 3V}$$

$$i_2 = \frac{0 - V_1}{3} = \frac{0-3}{3} \quad \boxed{i_2 = -1 \ A}$$

Case 3 :



$$\frac{V_1}{4} + \frac{V_1}{3} + \frac{V_1 - V_2}{4} = 0$$

$$V_1\left(\frac{10}{12}\right) = \frac{V_2}{4}$$

$$V_2 = \frac{10}{3} V_1 \quad \text{--- (1)}$$

$\frac{V_2}{8} + \frac{V_2 - V_1}{4} = 3$ $\quad$ $V_2 + 2V_2 - 2V_1 = 24$

$3\left[\frac{10}{3} V_1\right] - 2V_1 = 24$ $\quad$ $8V_1 = 24$ $\quad$ $\boxed{V_1 = 3V}$

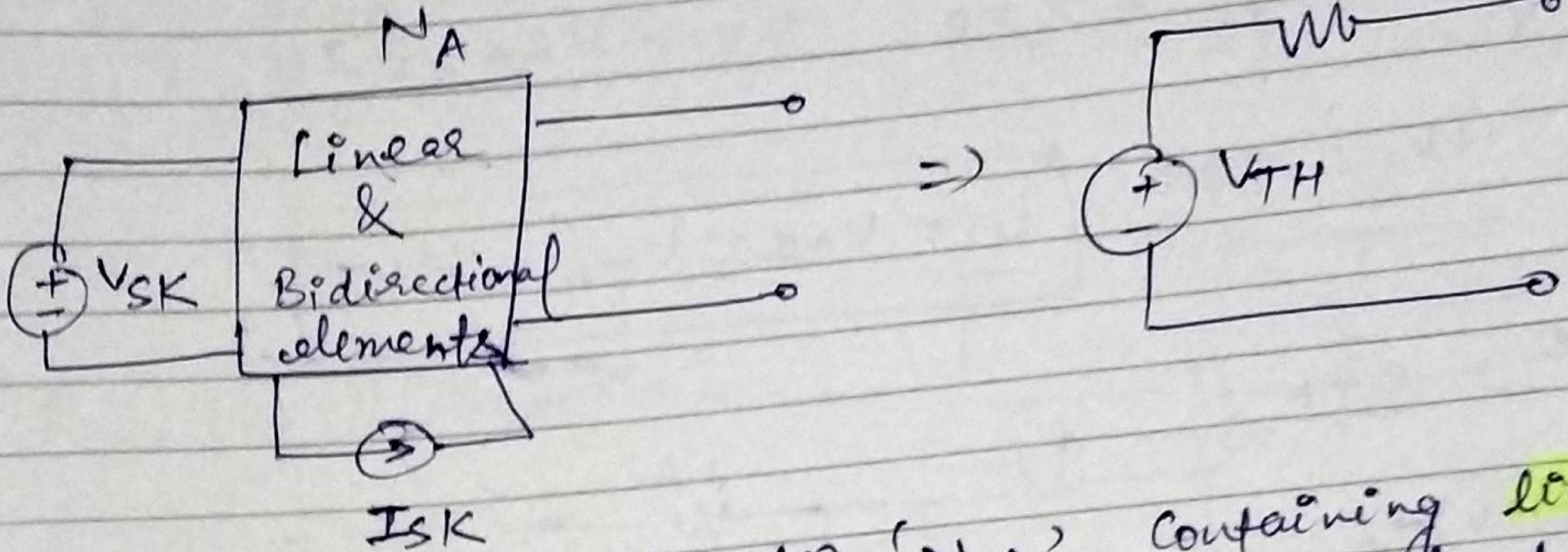
$$\boxed{i_3 = \frac{3}{3} = 1A}$$

So total current $\quad$ $i = i_1 + i_2 + i_3$

$= 2 + (-1) + 1$

$$\boxed{i = 2A}$$

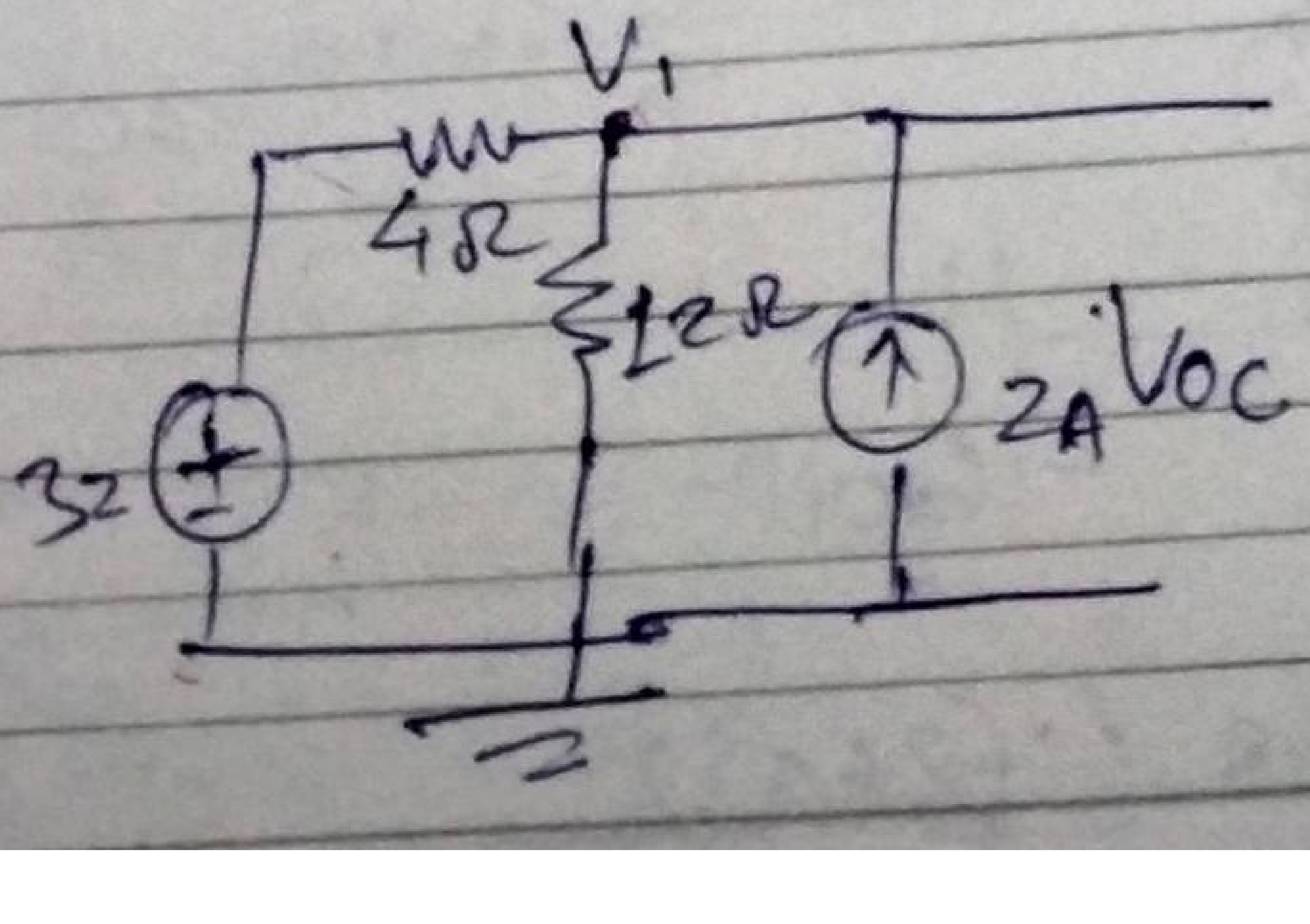
Thevenin's Theorem:-



→ A Two terminal N/ω 'N_A' containing linear and bidirectional element and independent source is equivalent to a single N/ω containing an equivalent voltage source 'V_{TH}' in series with the resistance 'R_{TH}'.

→ The source voltage is the open CKt voltage across the terminals of the N/ω (N_A) and resistance 'R_{TH}' is the O/P resistance of 'N_A' measured at its terminals after deactivating or independent sources in 'N_A'.

Ques:- Find the current through (R_L) when 'R_L' is 6Ω and 36Ω by using Thevenin's Theorem



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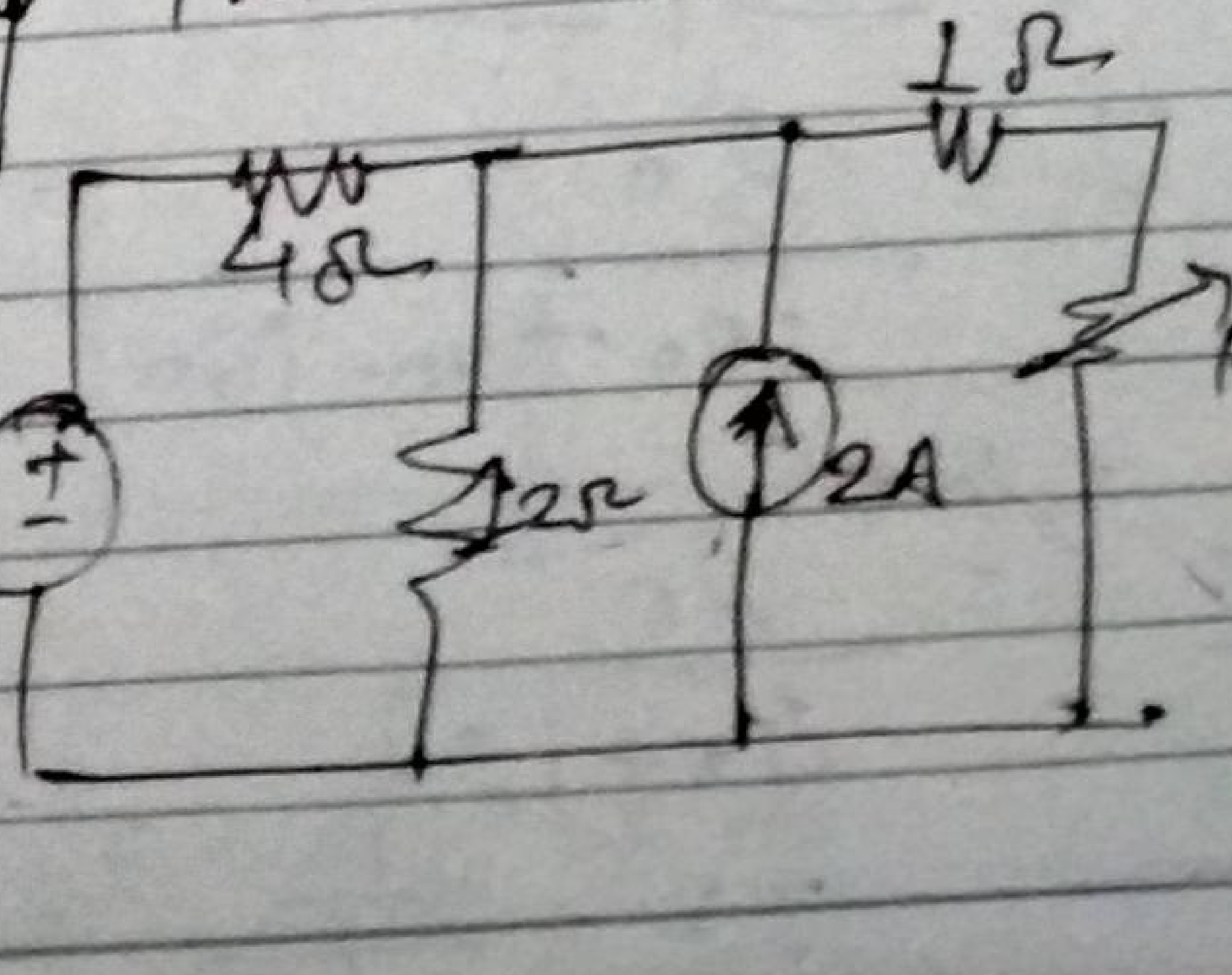
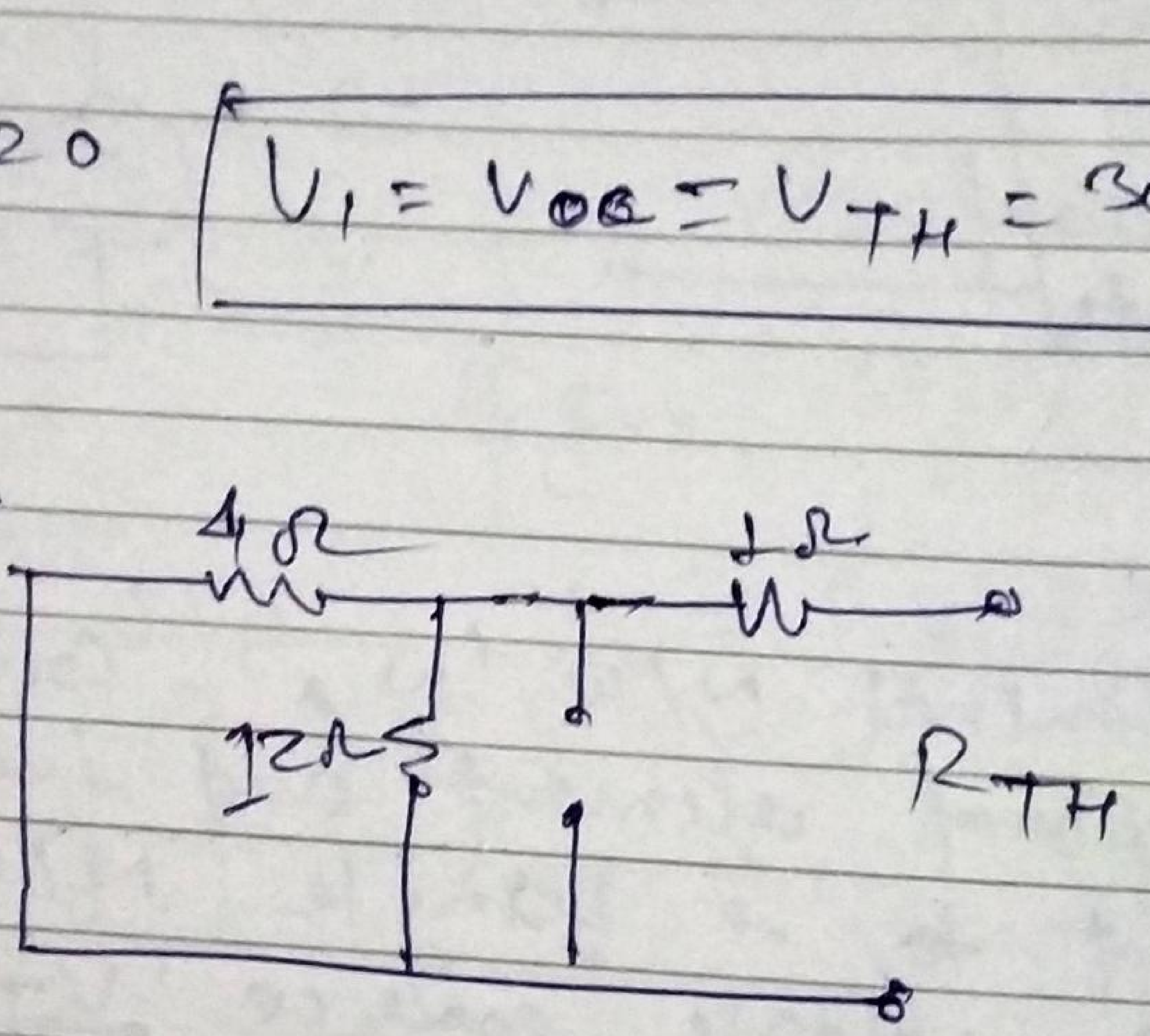


Case 1 V_{TH}

$$\frac{V_1-32}{4}+\frac{V_1}{12}-2=0 \qquad 3V_1-96+V_1=24$$

$$4V_1=120 \qquad \boxed{V_1=V_{OC}=V_{TH}=30\,V}$$

Case 2 R_{TH}

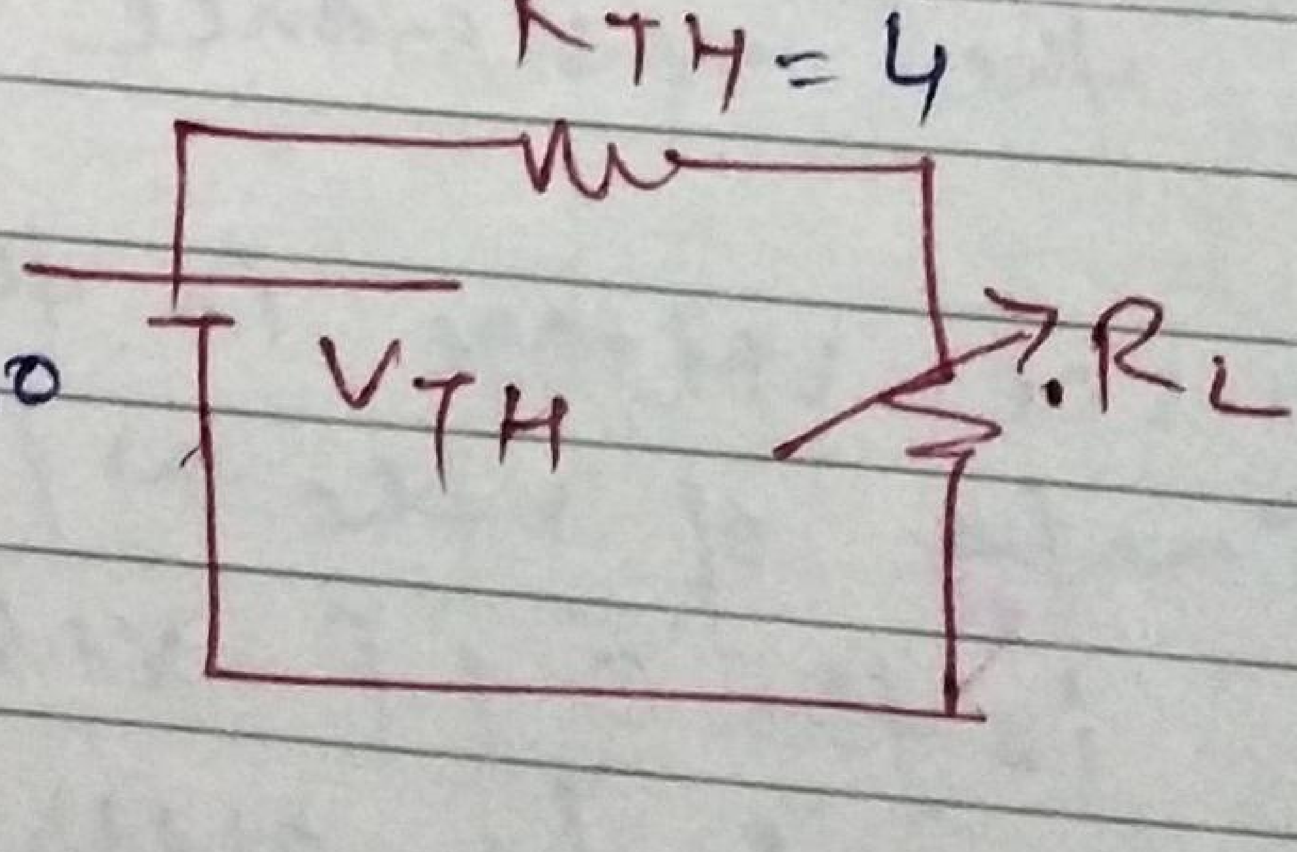


$R_{TH}=(12\|4)+1$

$\boxed{R_{TH}=4\Omega}$

(a) $R_L=6\Omega$

$$I=\frac{30}{4+6}=3A$$

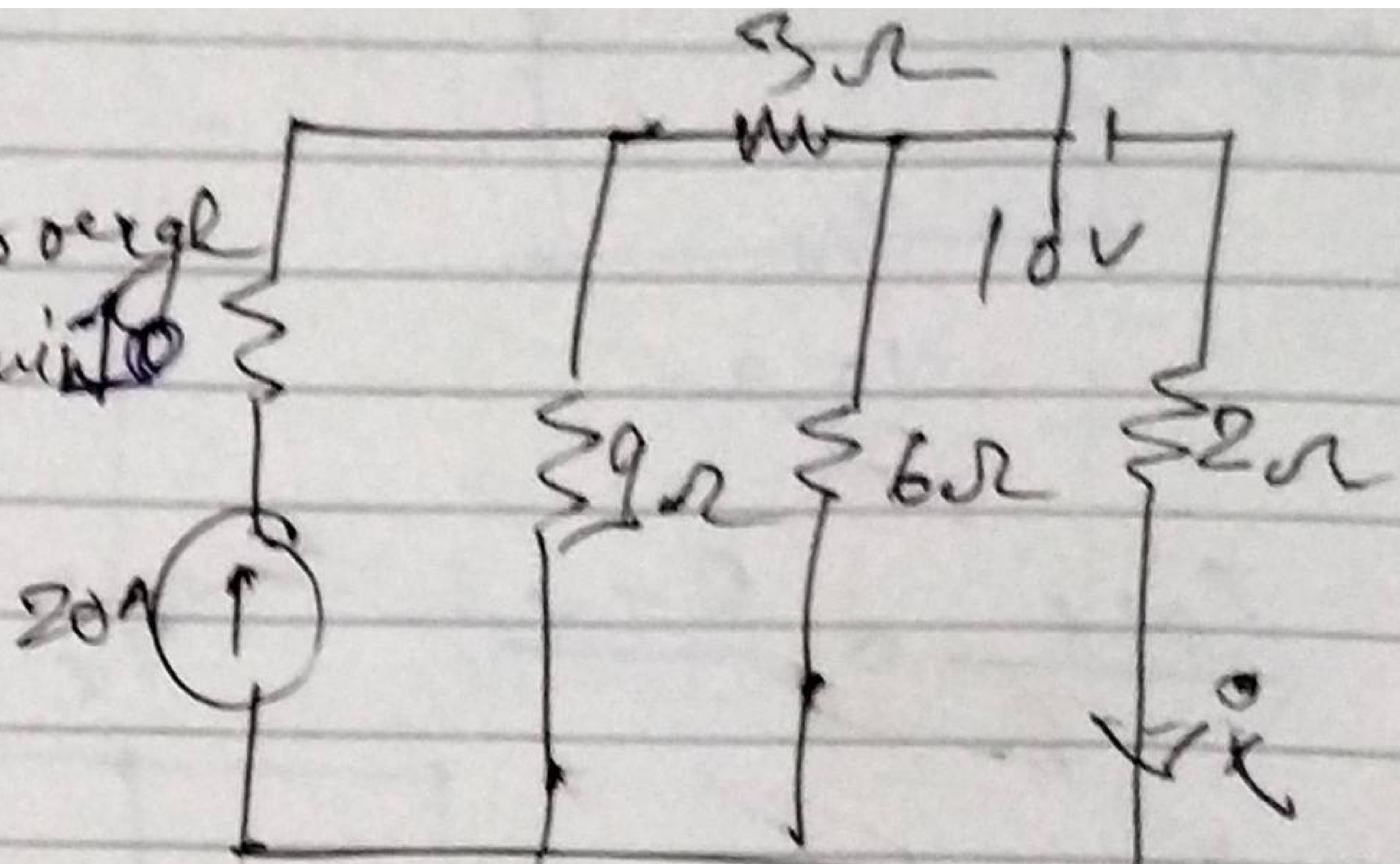


(b) $R_L=36\Omega$

$$I=\frac{30}{40}=0.75A$$

Ques :-

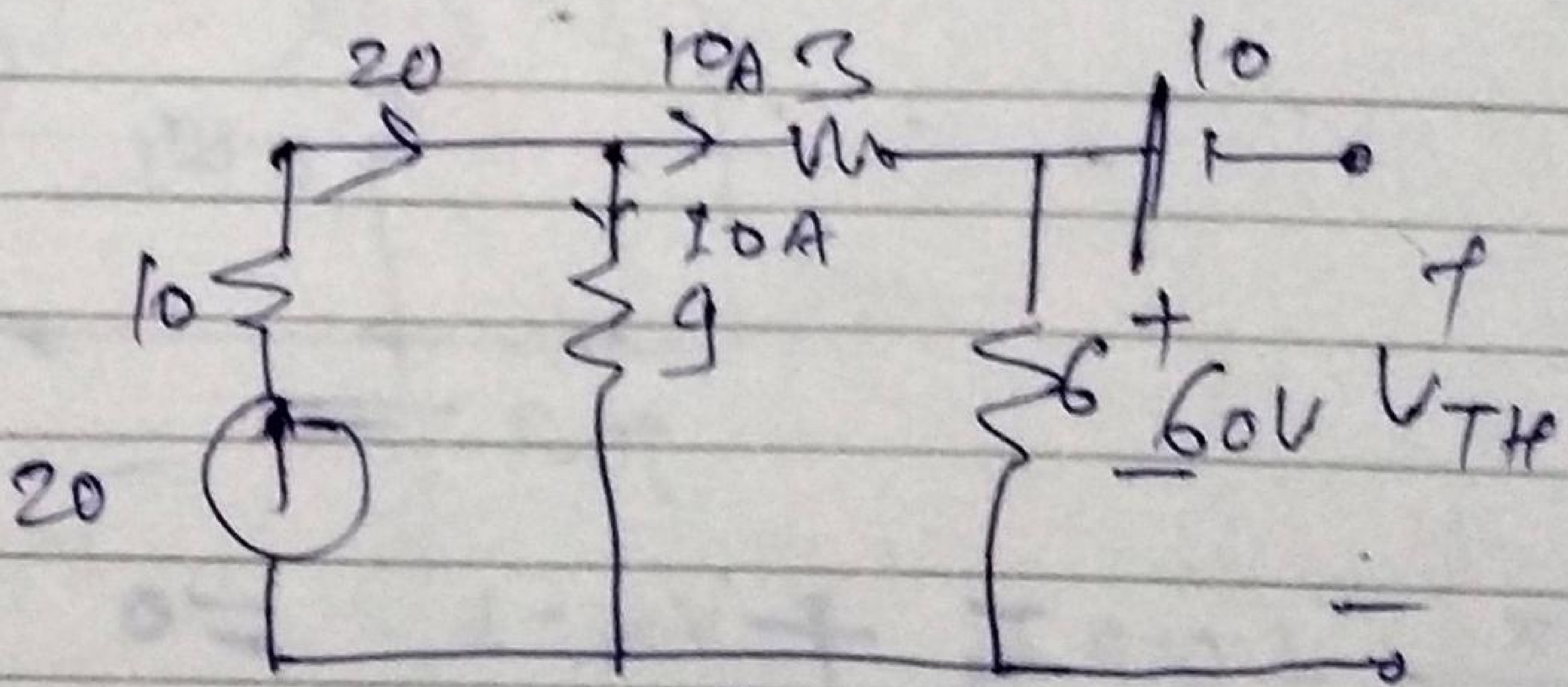
Find current flowing through 2Ω resistor by using thevenin's theorem.



Case :- V_{TH}

$-V_{TH} - 10 + 60 = 0$

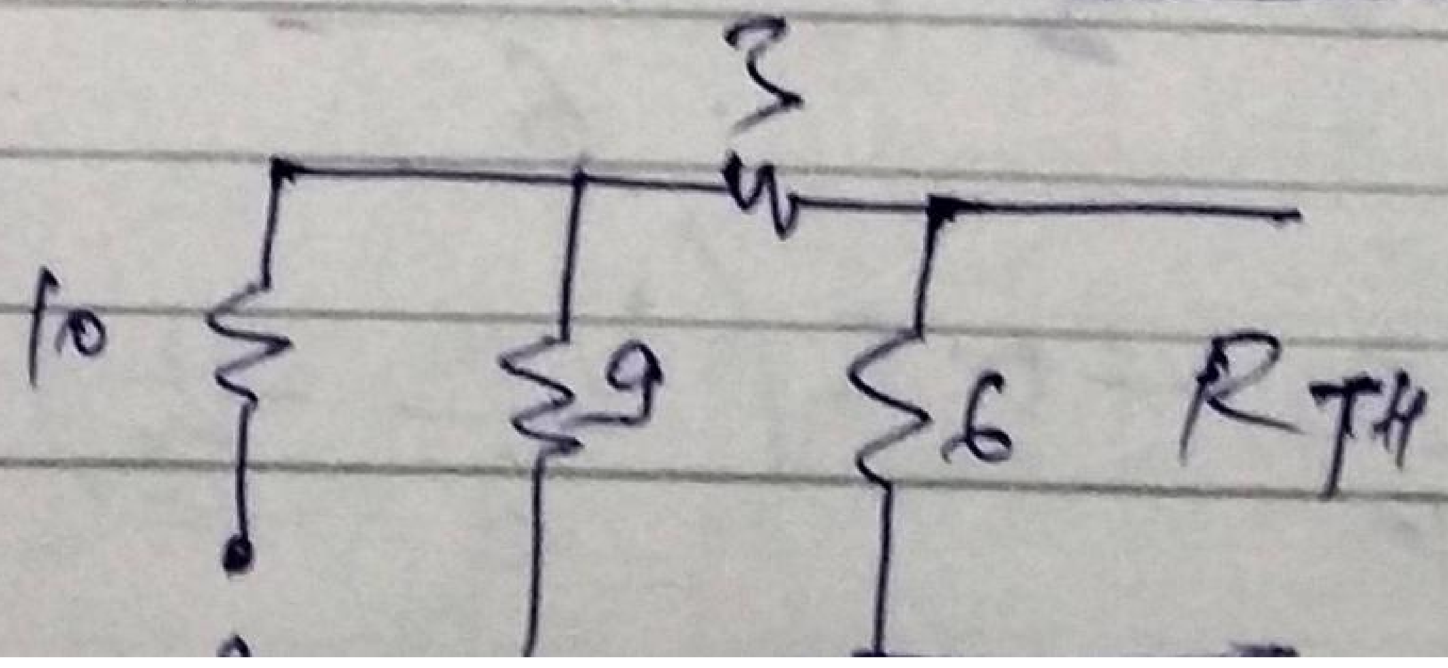
$\boxed{V_{TH} = 50 \text{ Volts}}$



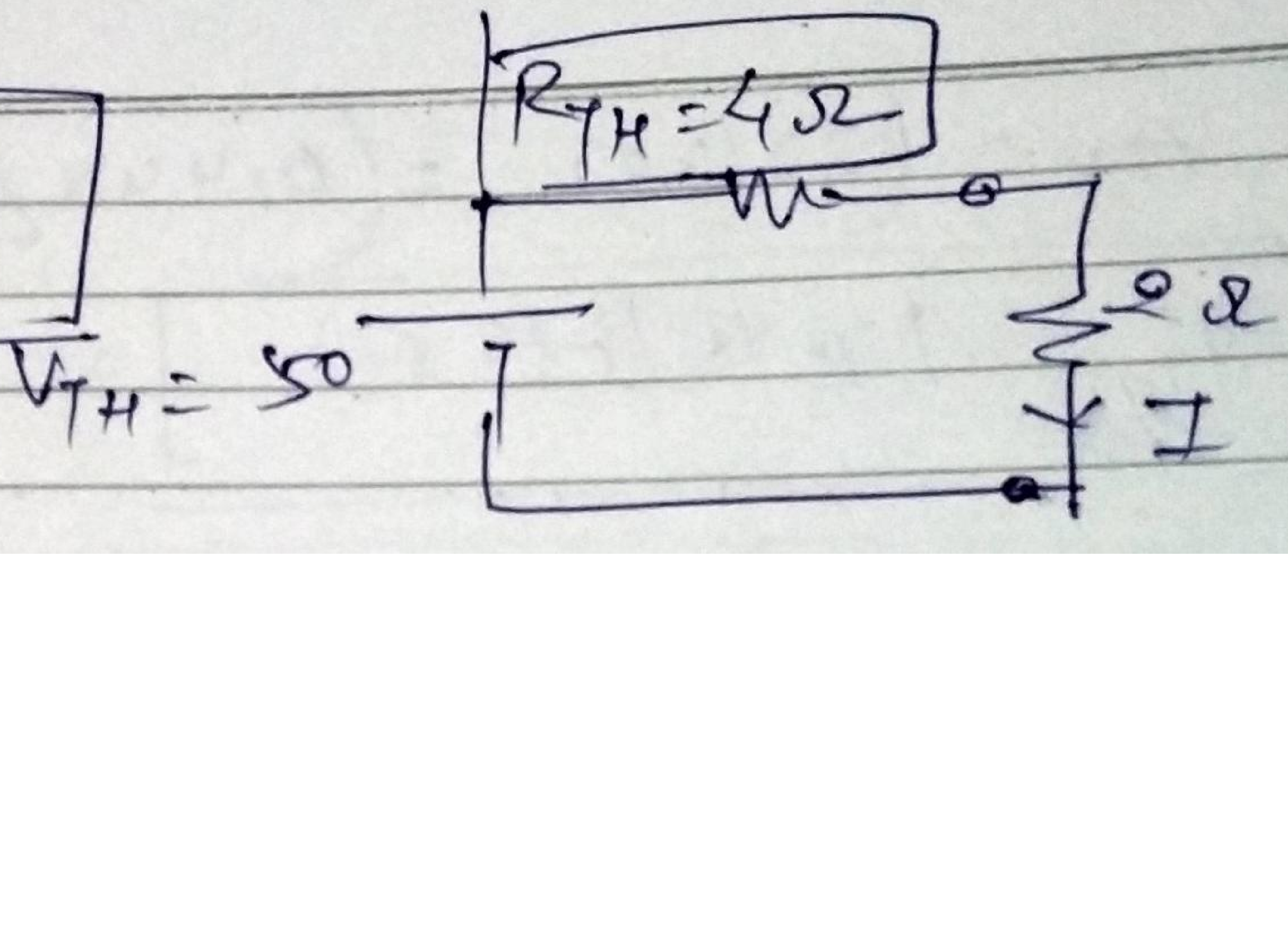
Case : R_{TH} :-

$(9+3) \parallel 6$

$\boxed{R_{TH} = 4\Omega}$



$$\boxed{I = \frac{50}{6} = 8.33A}$$



NORTON'S THEOREM :-

→ ~~A~~ a two terminal N/W 'NA' containing linear, Bidirecti element and independent sources is equivalent to a simple ~~singular~~ N/W containing an independent current source 'IN' in parallel with a Resistanc 'RN'.

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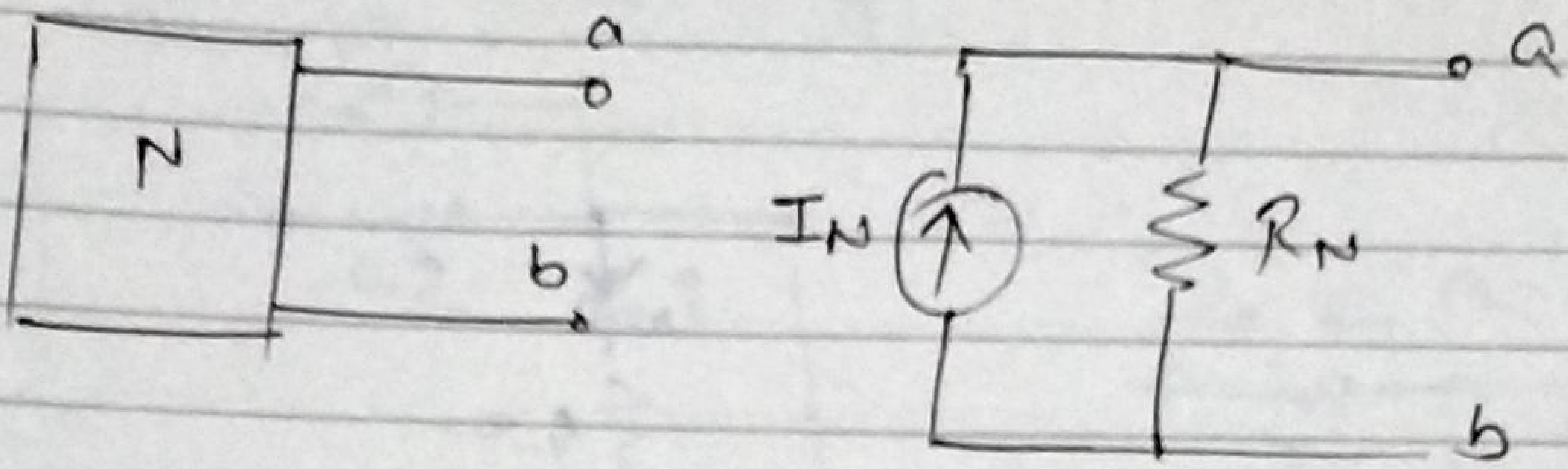
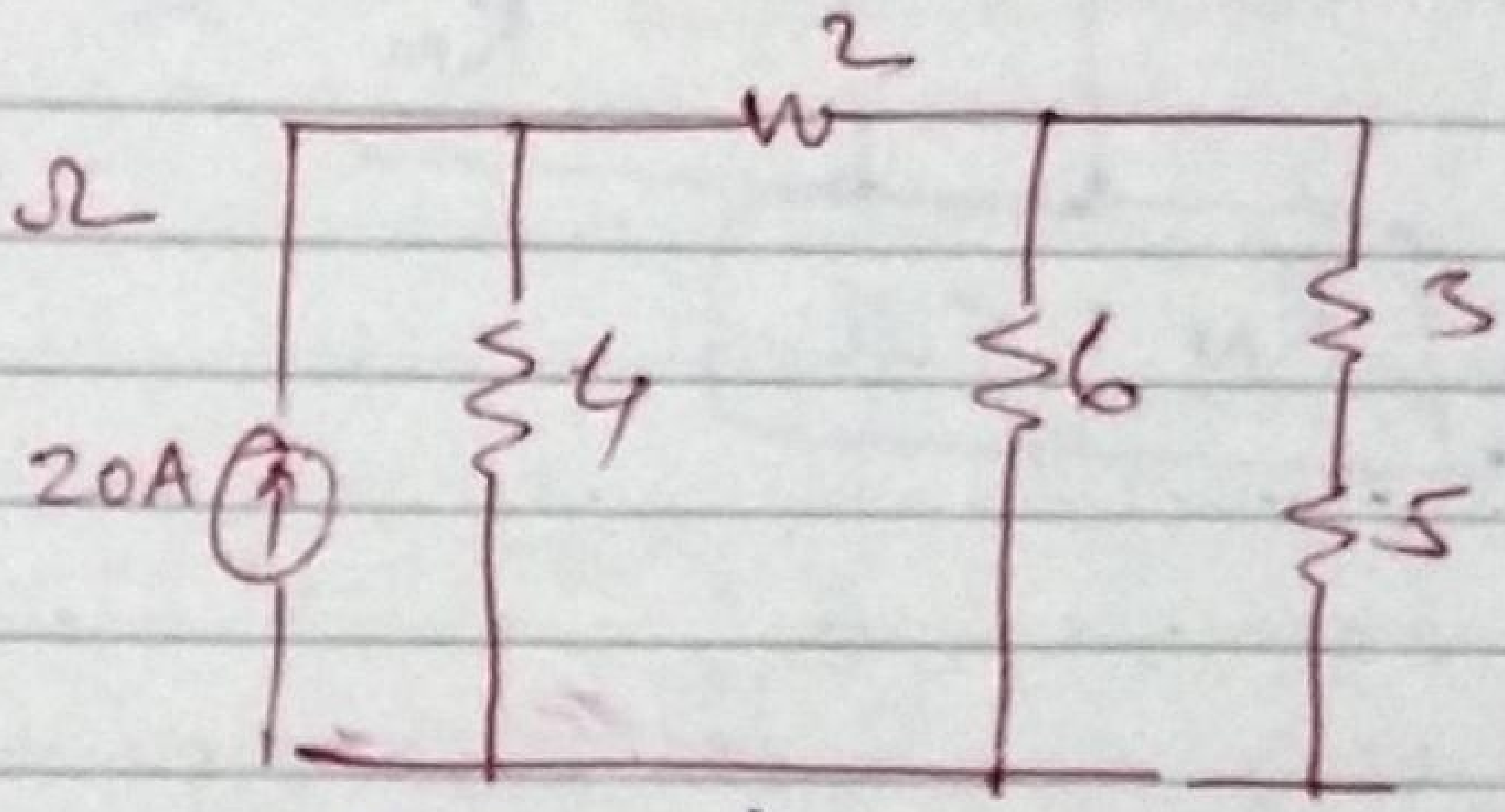
→ Source current is a S.C. current across 'N_A' and 'R_N' is the resistance looking into the terminals after deactivating all independent sources in the N/W 'N_A'.



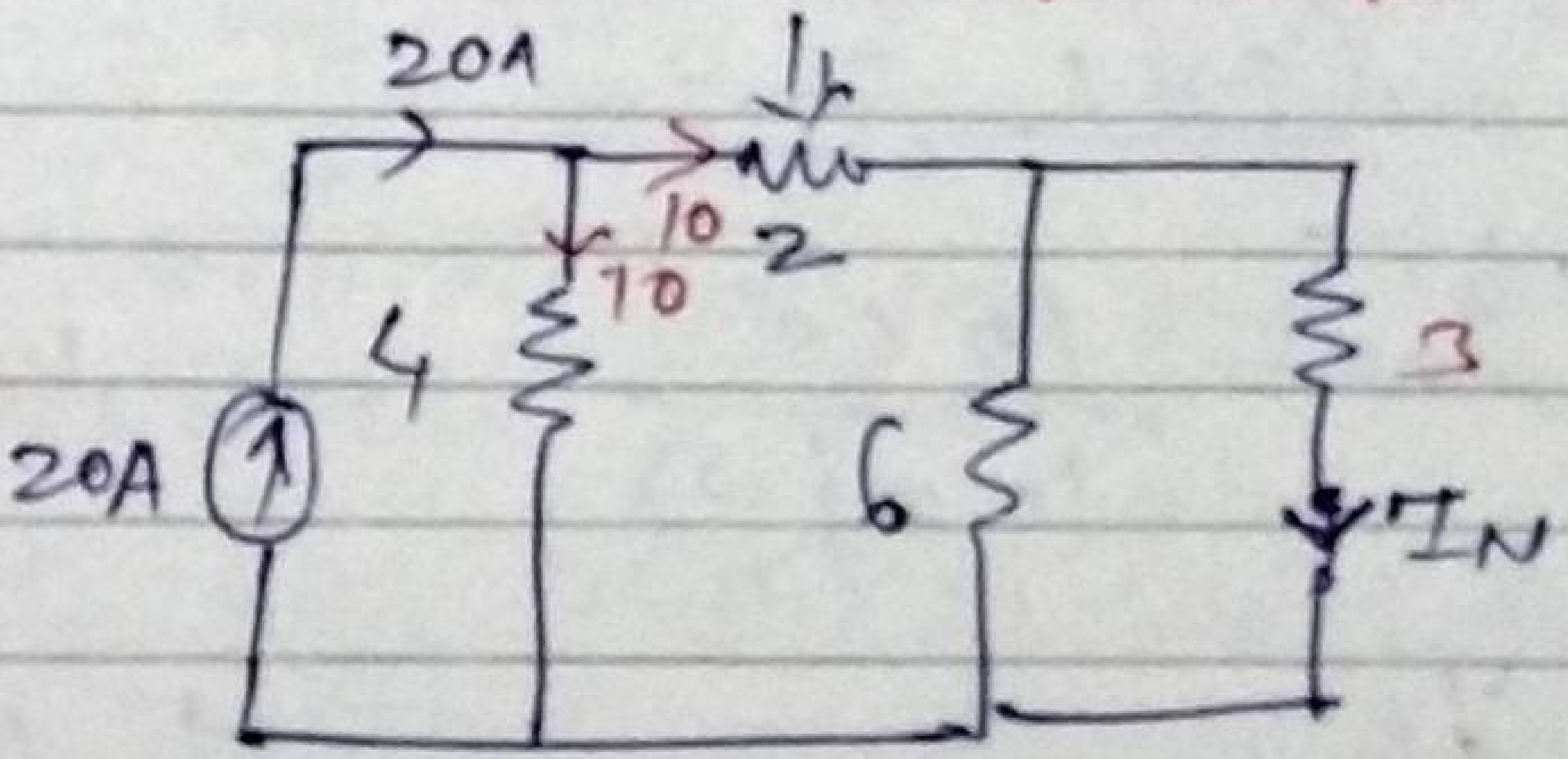
Ques :-
Find the current in 5Ω by using Norton's theorem.



Case 1 :- I_N

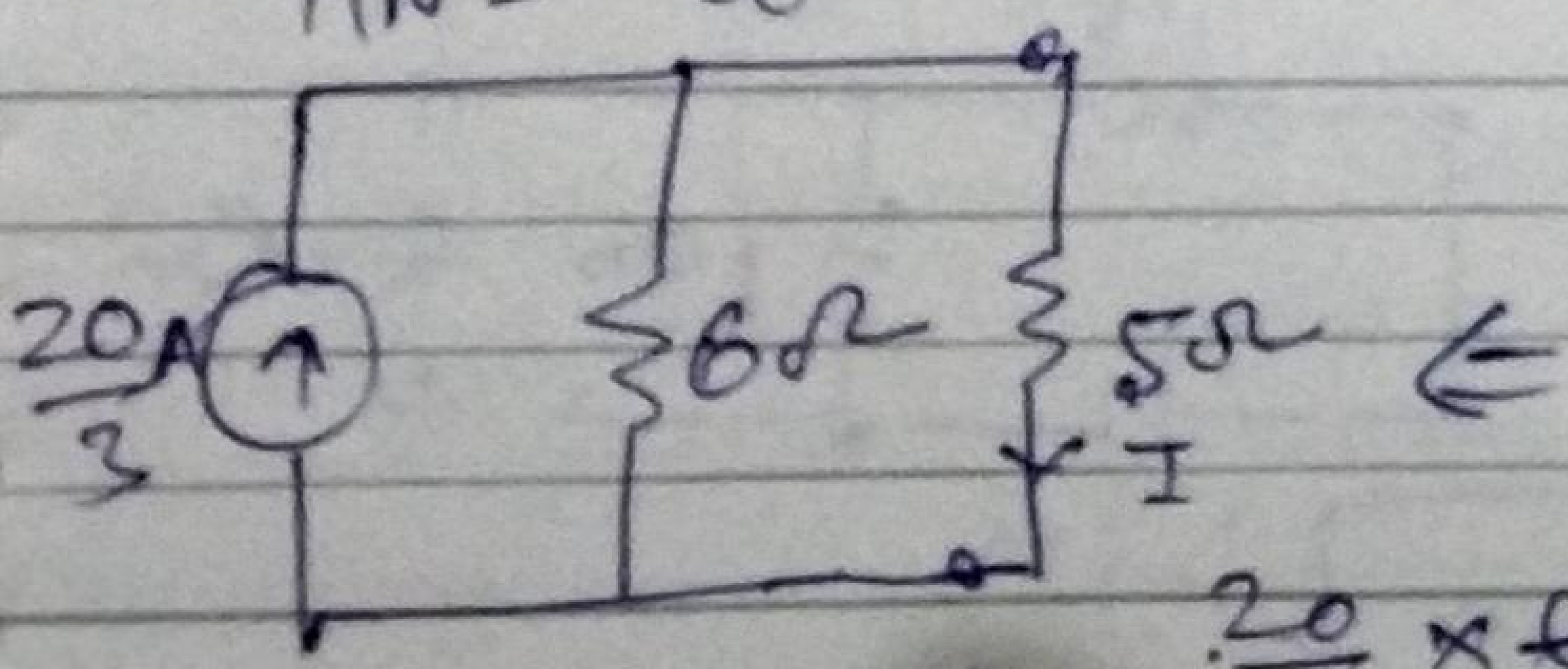
$$I_N = \frac{10 \times \cancel{6}\,2}{\cancel{9}\,3}$$

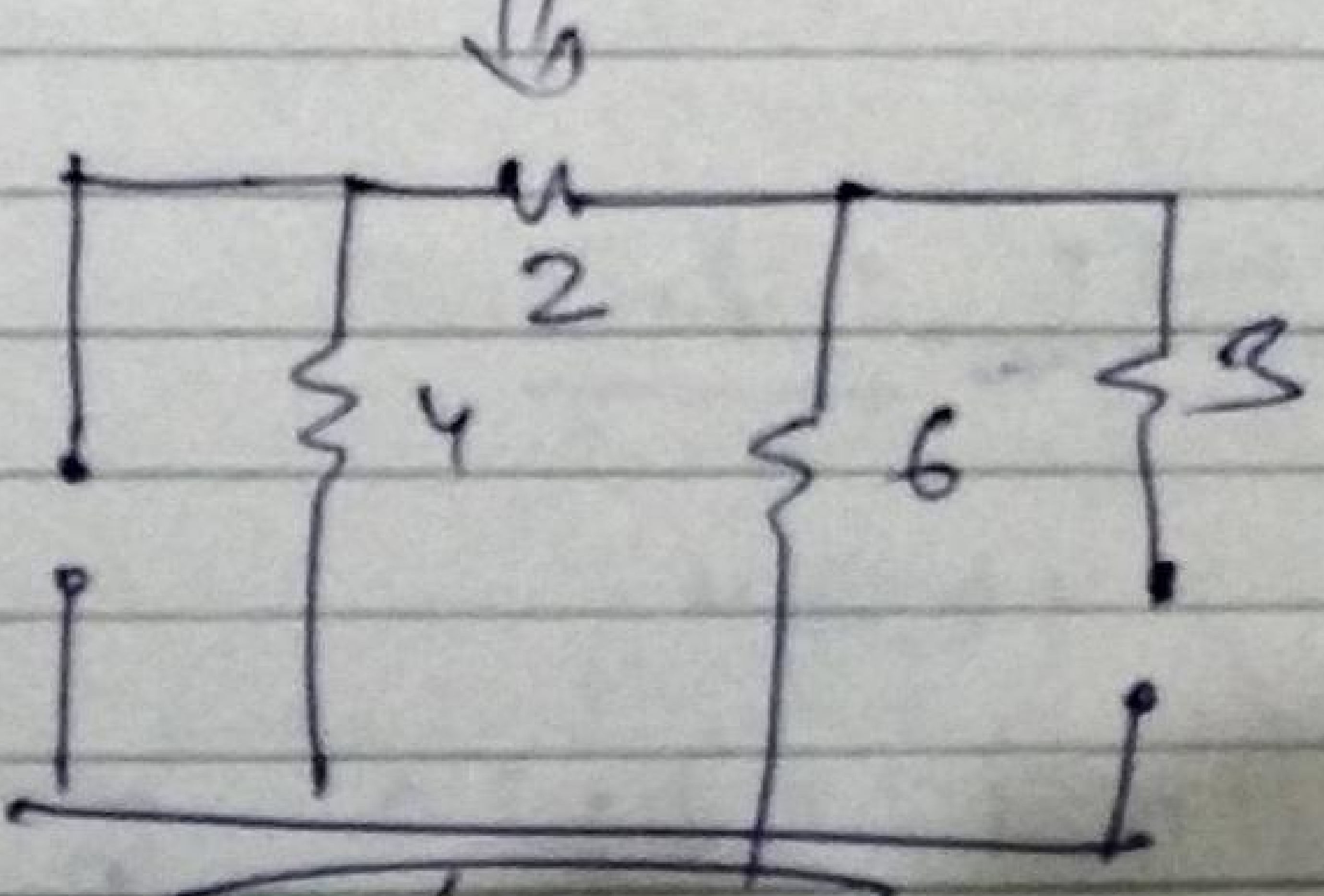
$$I_N = \frac{20}{3} A$$



Case 2 :- R_N

$R_N = 6\Omega$





$$I = \frac{\frac{20}{\cancel{3}} \times \cancel{6}\,2}{11}$$

$\boxed{I = \frac{40}{11} A}$

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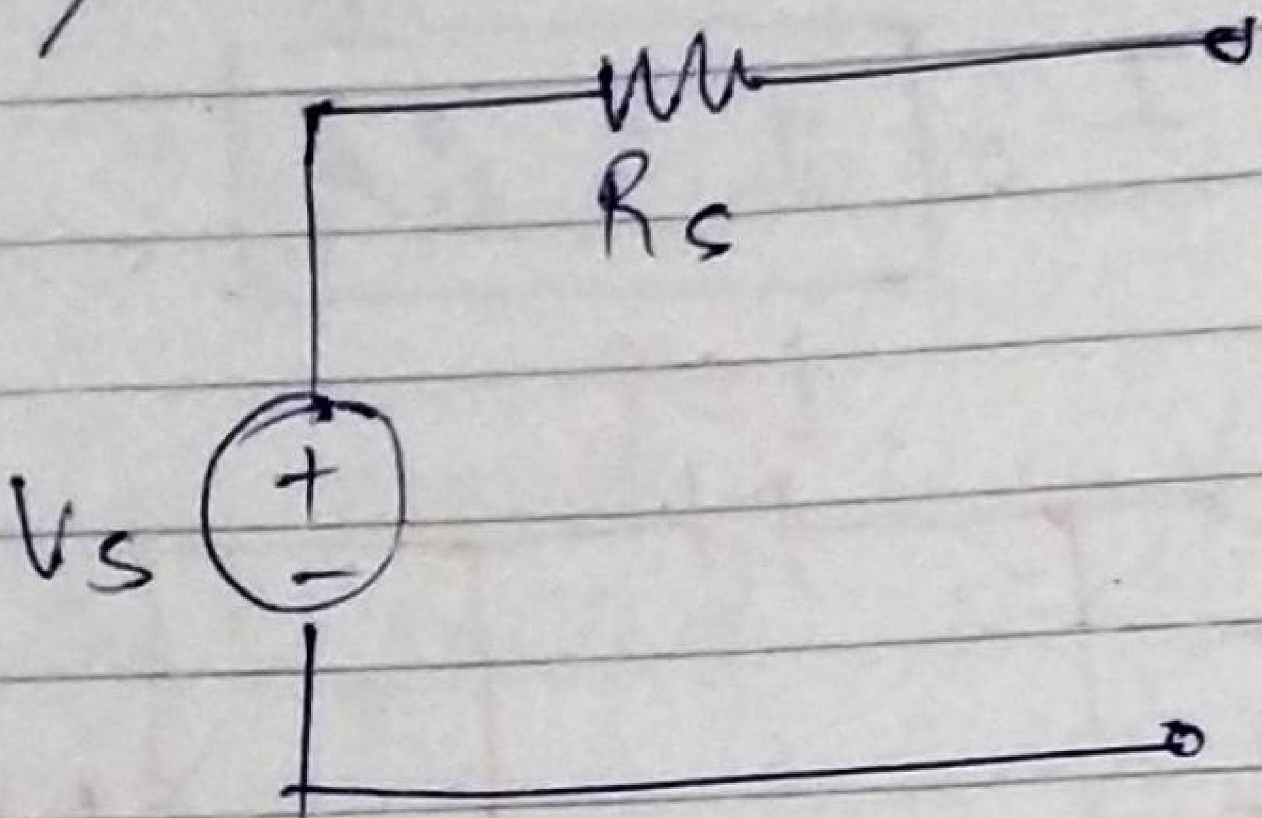
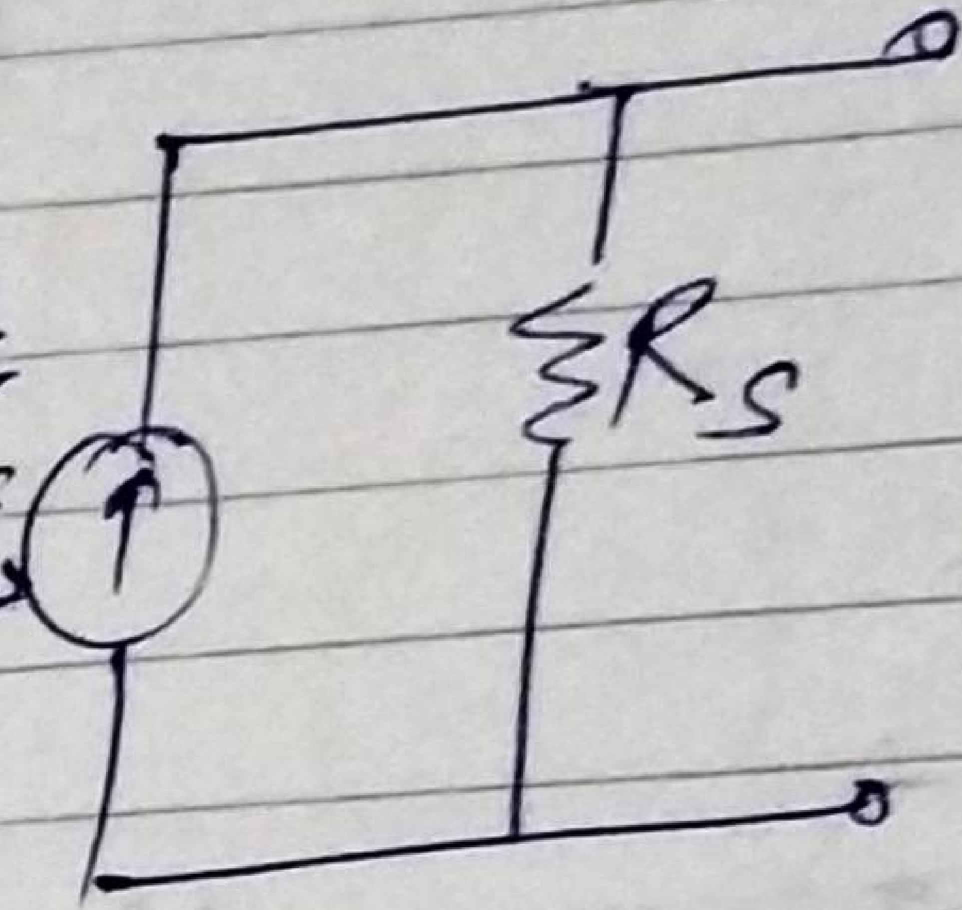
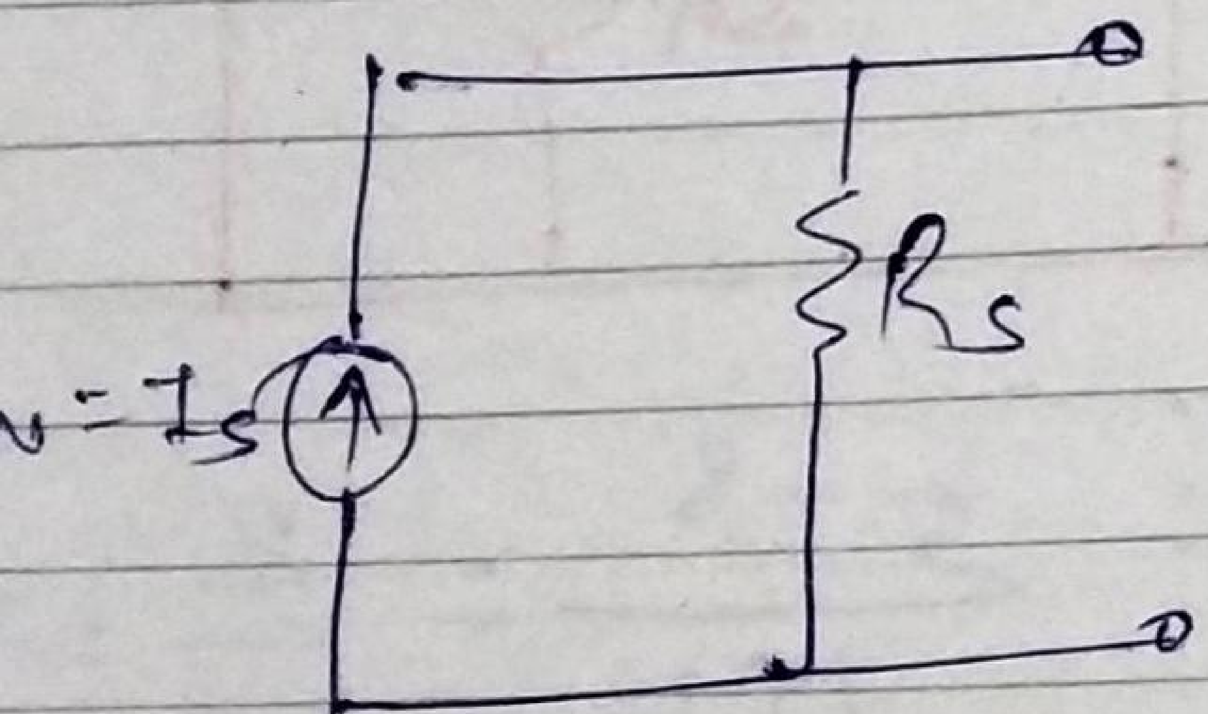
Source Transformation :-

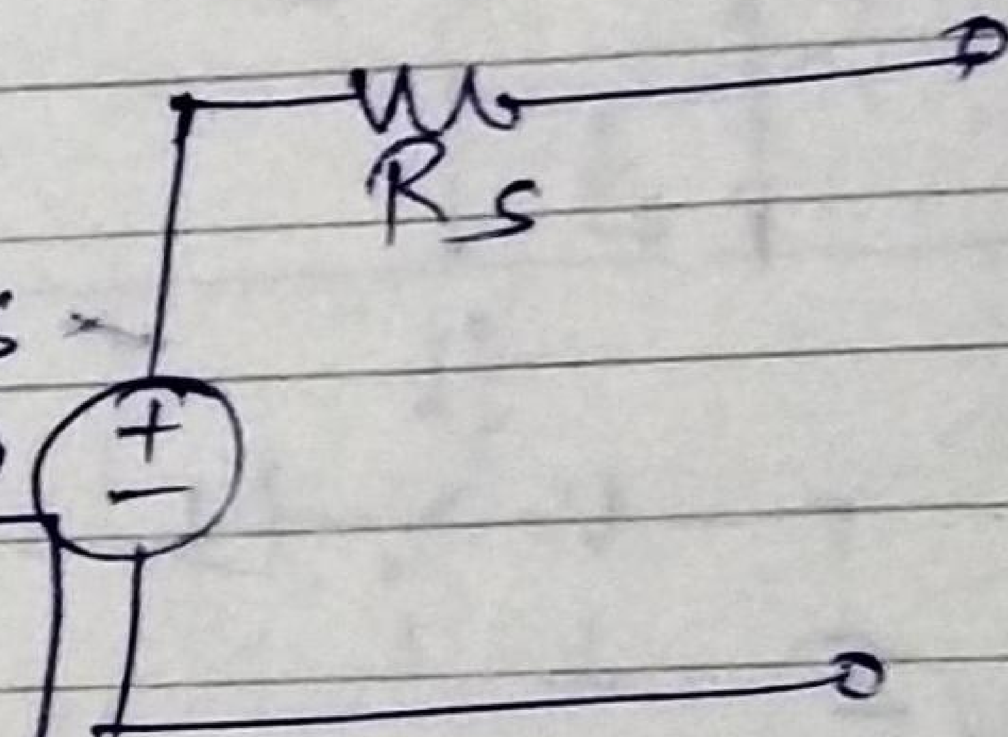


$= \quad I_N = \frac{V_S}{R_S}$





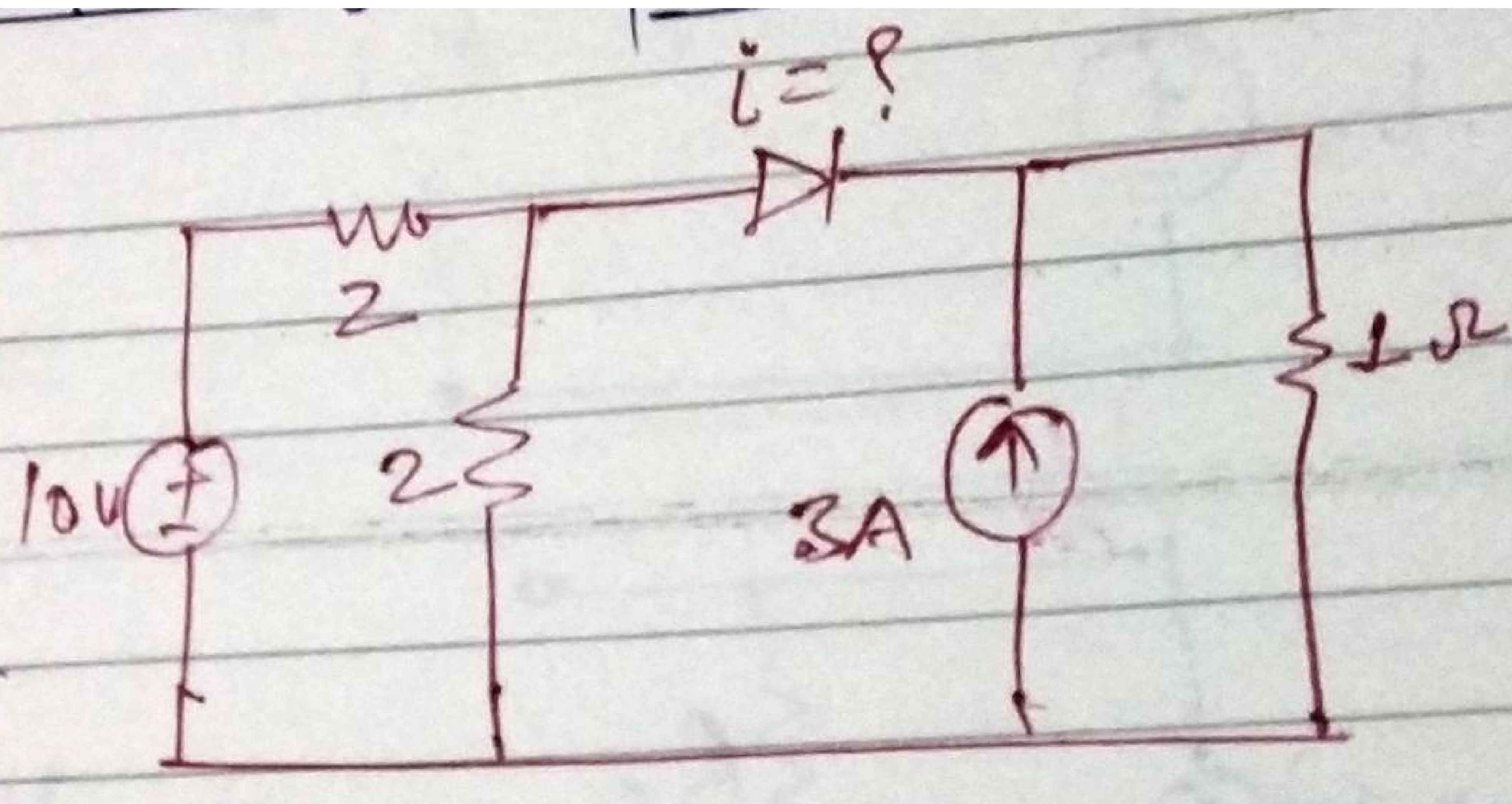
$= \quad V_{TH} = I_S R_S$

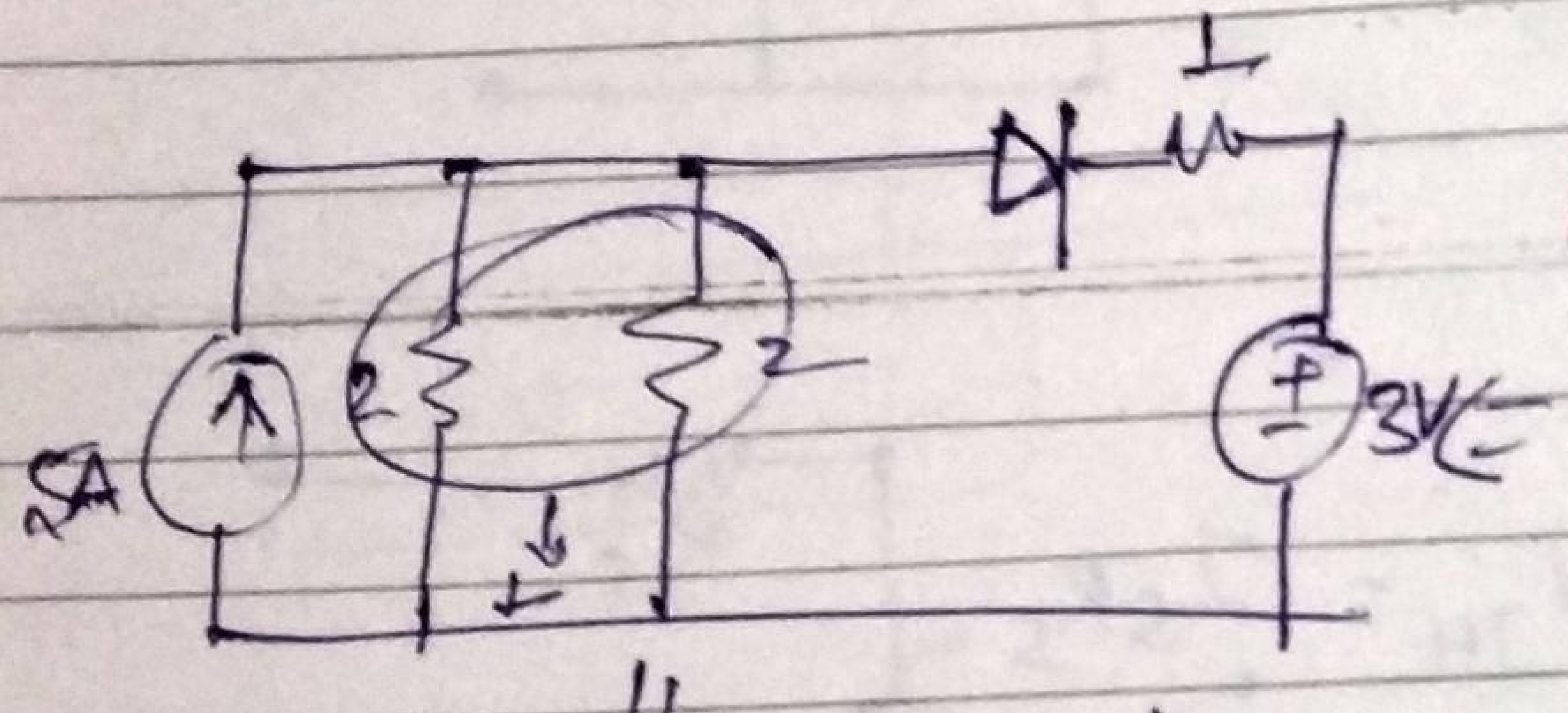


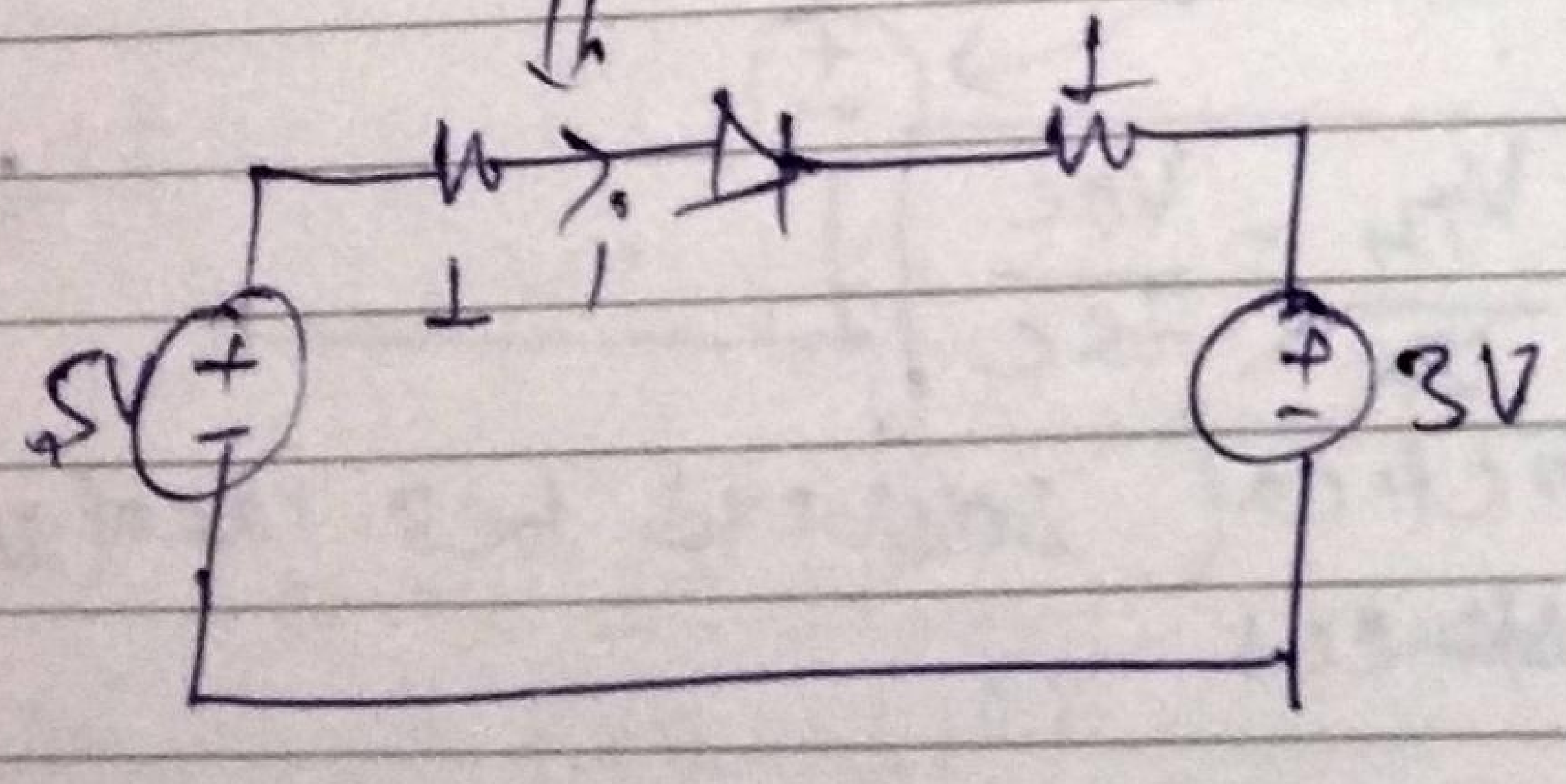
$$\boxed{R_{TH} = \frac{V_{TH}}{I_N} = \frac{V_{OC}}{I_{SC}}}$$

* applicable only for practical sources bcz ideal sources have zero internal resistances.

Ques :-







$$i = \frac{5-3}{1+1} = \frac{2}{2} = 1A$$

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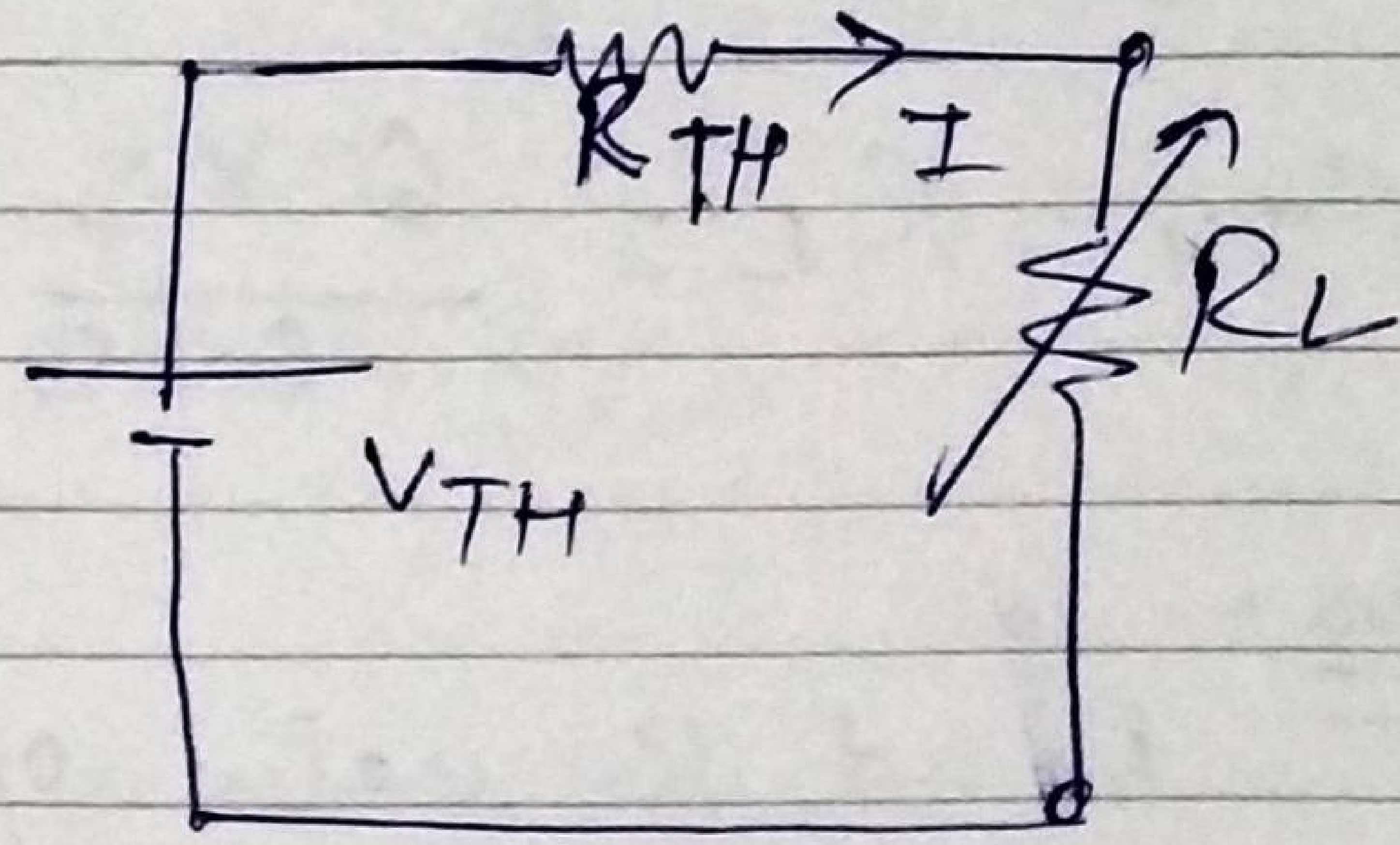
Maximum power Transfer Theorem:-



$$I = \frac{V_{TH}}{(R_{TH}+R_L)}$$

$$P = I^2 R_L$$

$$P = \left(\frac{V_{TH}}{R_{TH}+R_L}\right)^2 \cdot R_L$$

$$\frac{dP}{dR_L} = V_{TH}^2 \left[\frac{(R_{TH}+R_L)^2 - R_L \cdot 2(R_{TH}+R_L)}{(R_{TH}+R_L)^4}\right] =$$

$$R_{TH} + R_L - 2R_L = 0 \qquad \boxed{R_{TH} = R_L}$$

$$P_{max} = \frac{V_{TH}^2}{(R_{TH}+R_{TH})^2} R_{TH}$$

$$\boxed{P_{max} = \frac{V_{TH}^2}{4R_{TH}}}$$

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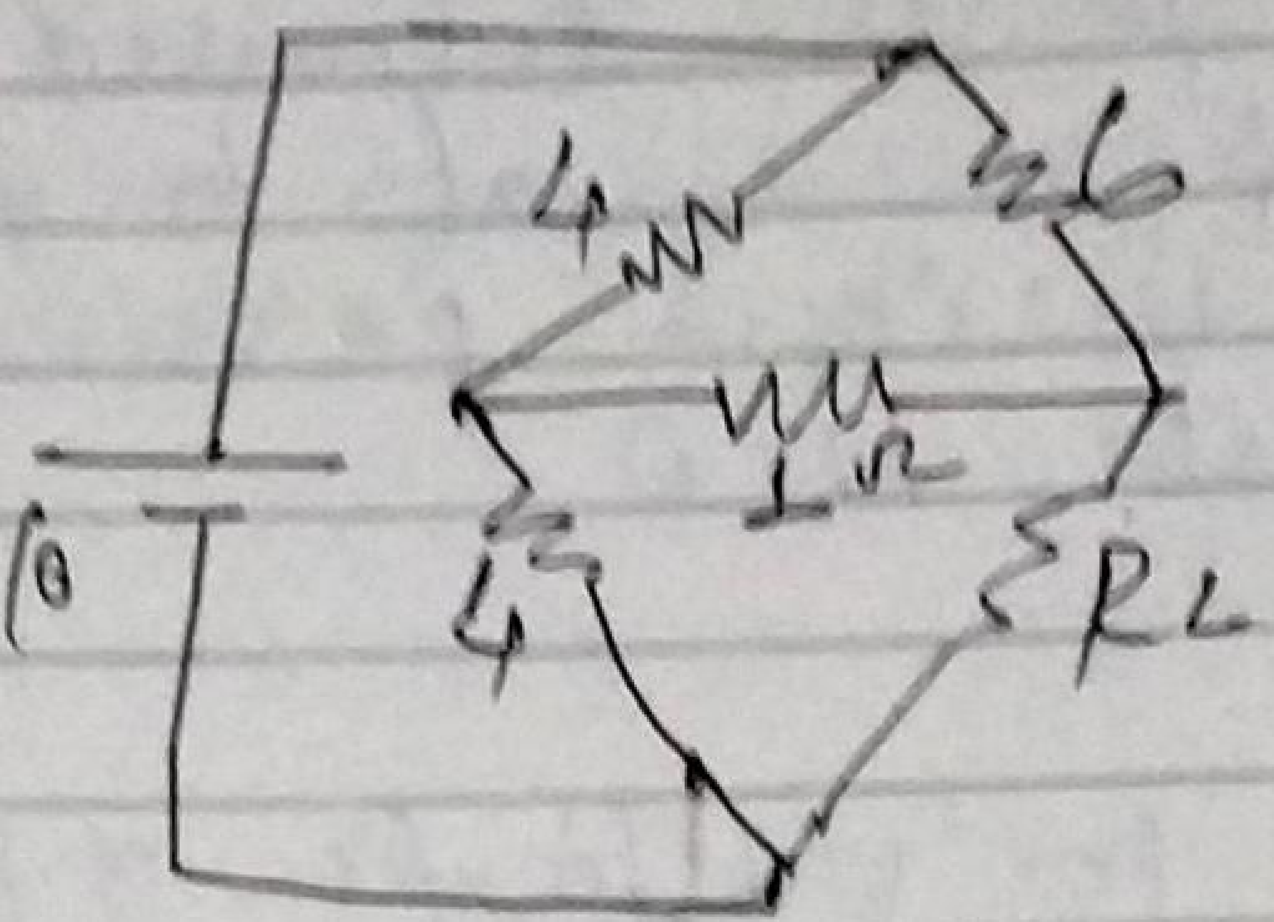
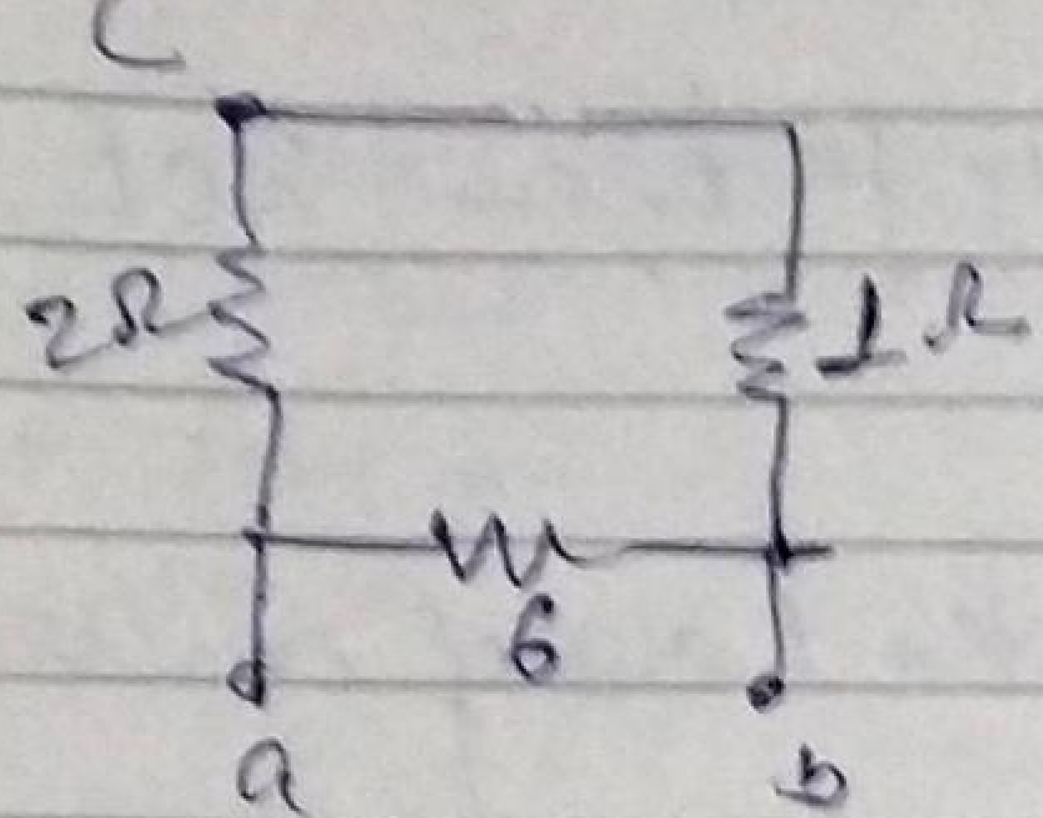
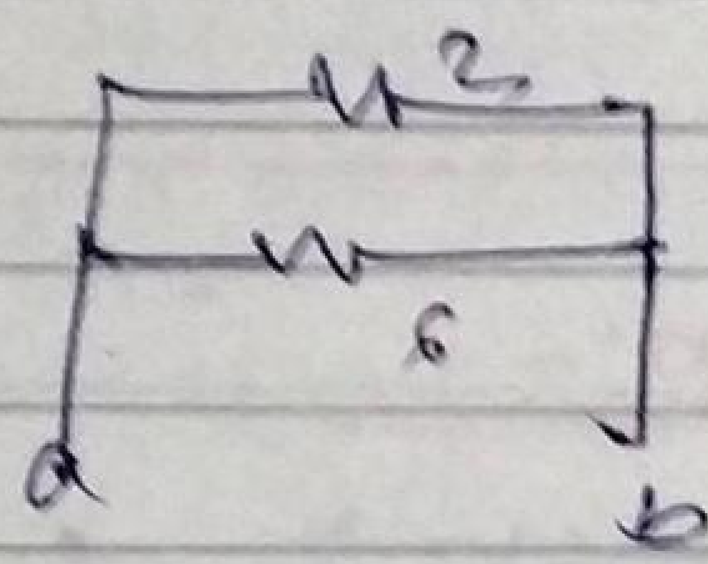
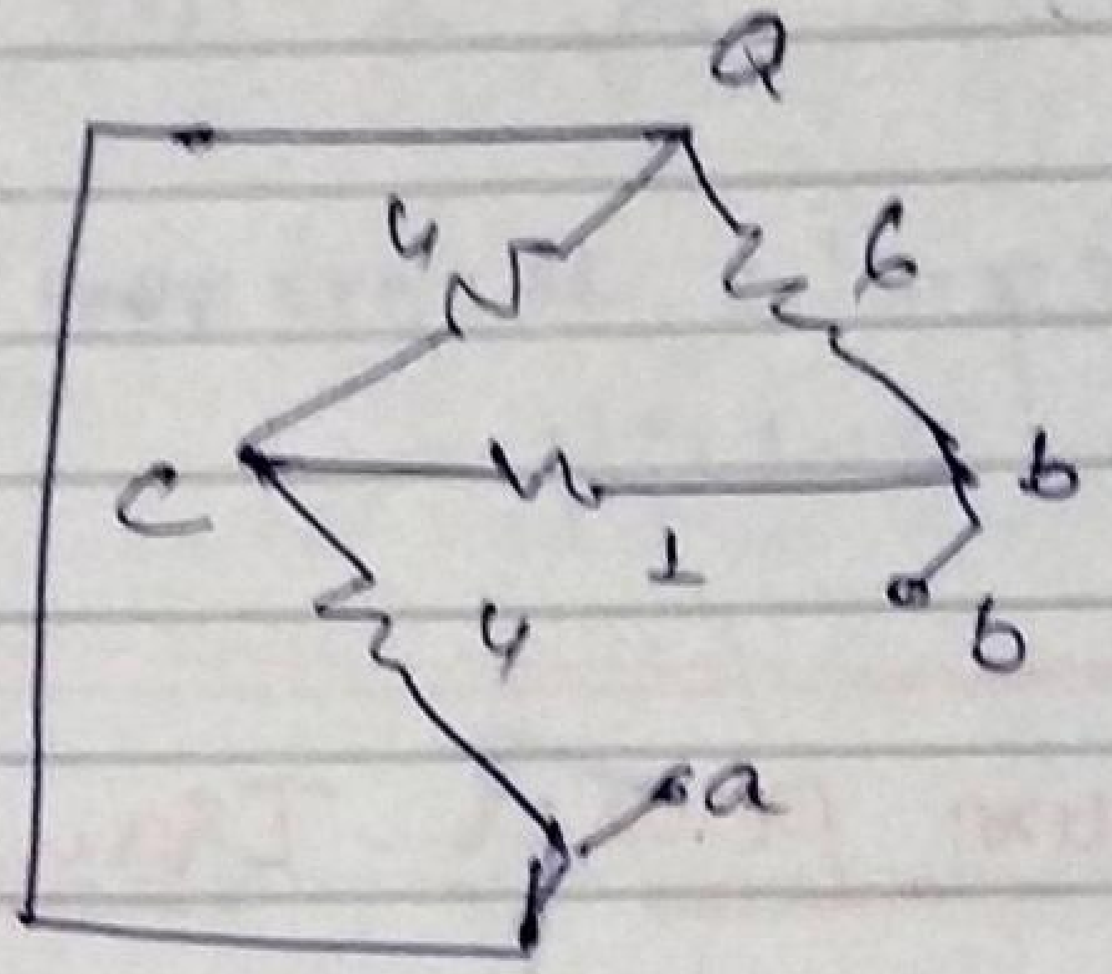
Ques: For what value of R_L max power is transferred to it.



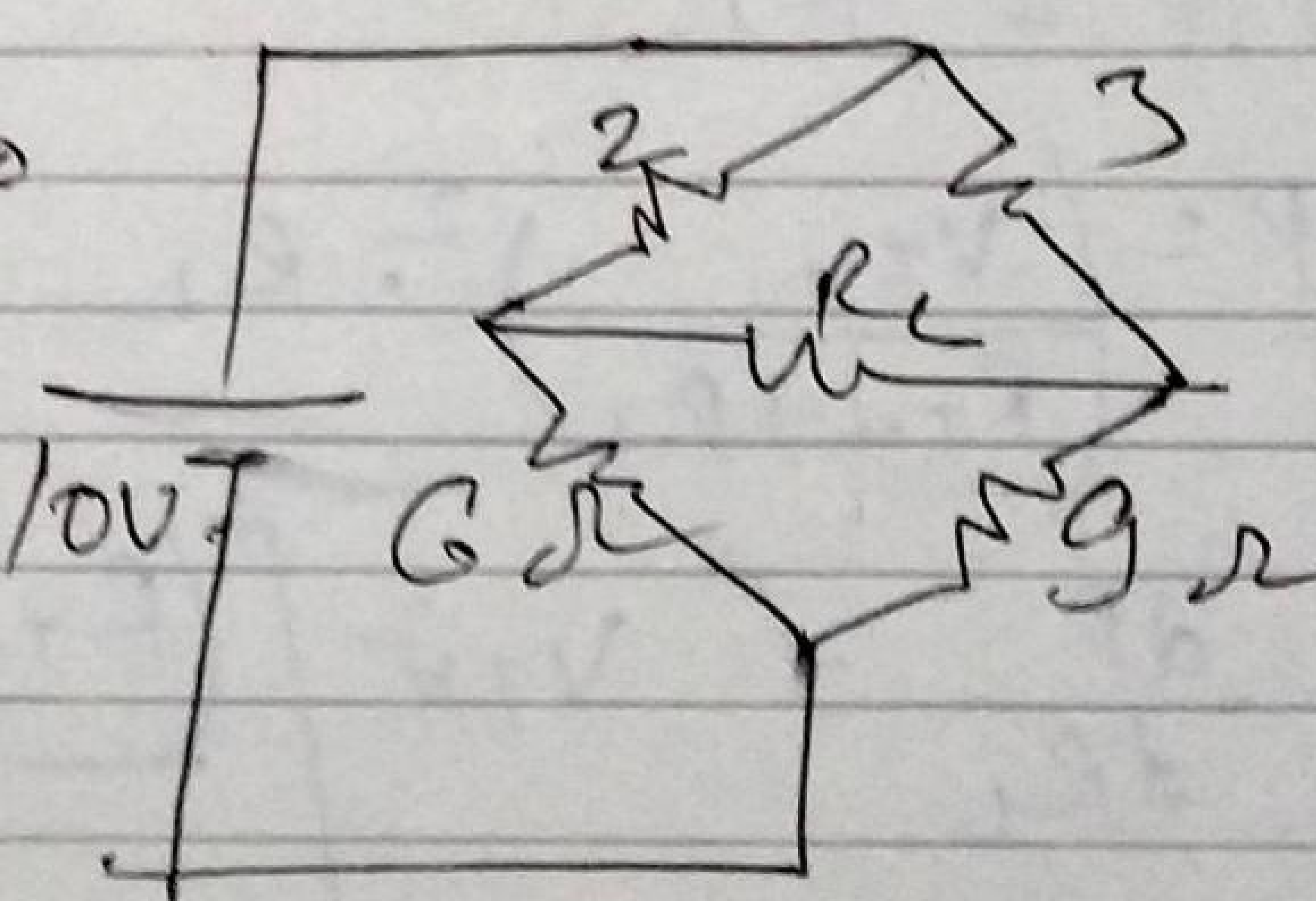






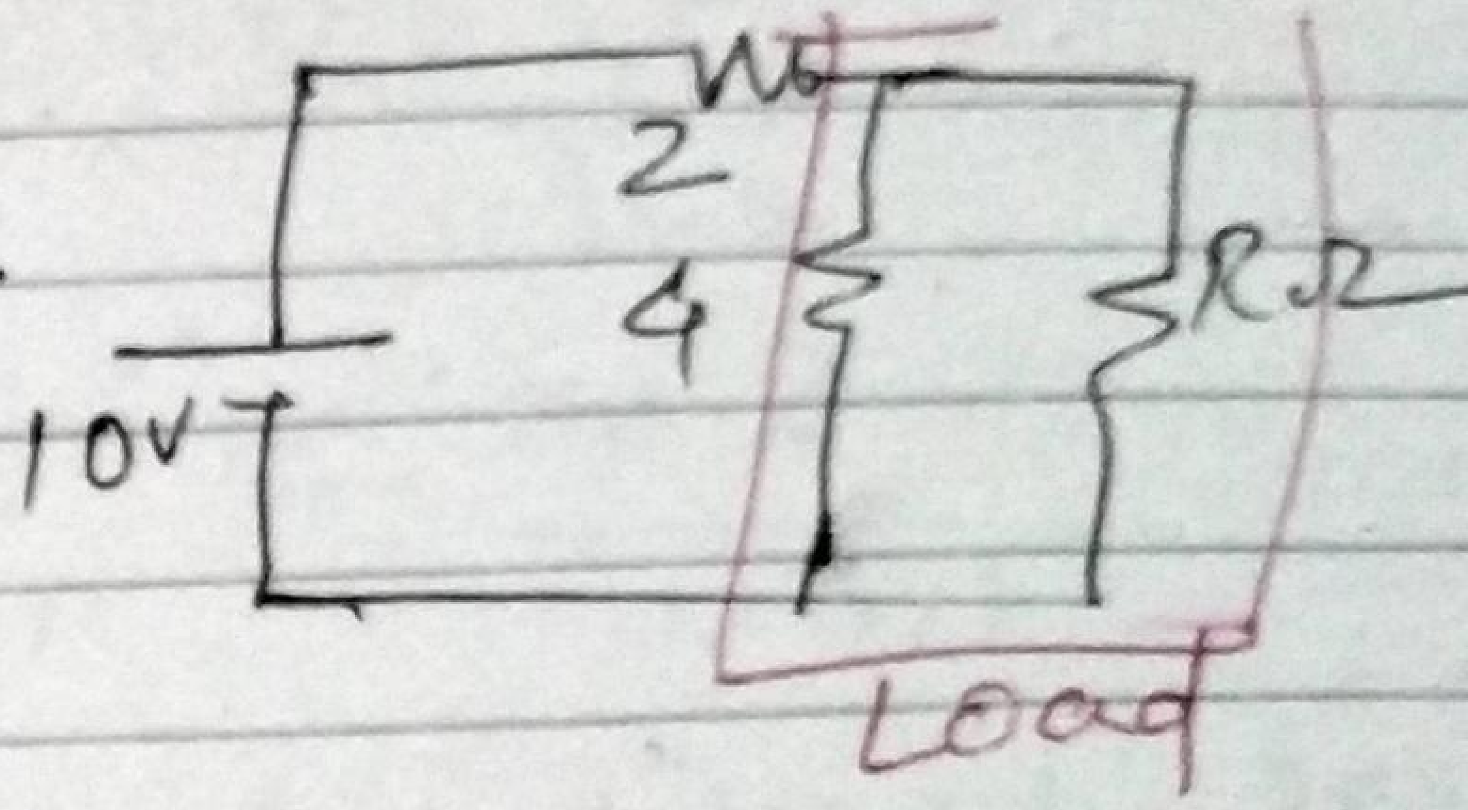
$$R_{TH} = R_L = \frac{6 \times 3}{6+3} = \underline{\underline{2\Omega}}$$

Ques:- Find the value of R_L so that the max power can be transferred and max power.



As the bridge is balanced
∴ No current is flowing through R_L and hence power dissipation will be zero.

Find the value of R so that max power can be transferred.



$R_L = R_{TH}$

$(4 \parallel R) = 2$

$\frac{4 \times R}{4 + R} = 2$

$\boxed{R = 4\Omega}$