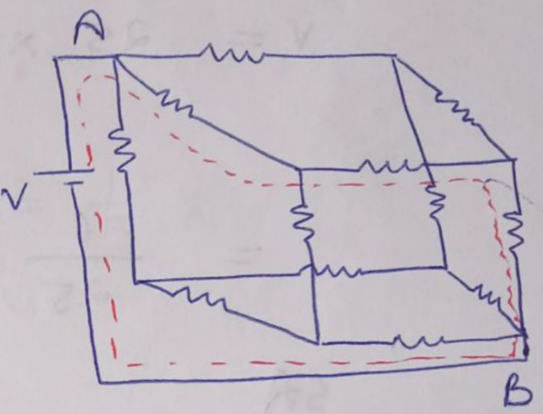
Practice set 1 Answer

1.
$$-V + \frac{I}{3}\times 6 + \frac{I}{6}\times(6) + \frac{I}{3}(6) = 0$$

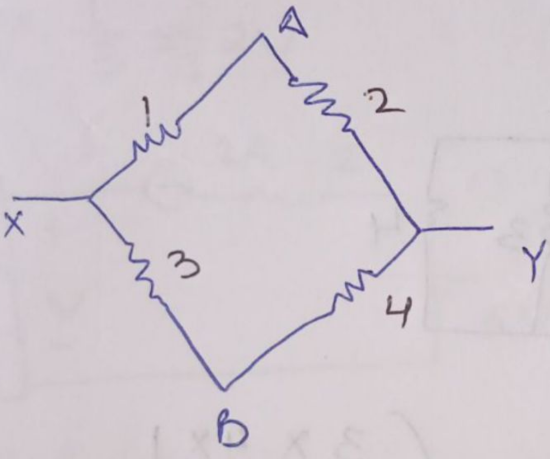
$$\Rightarrow V = I\,(2 + 1 + 2)$$

$$\Rightarrow \frac{V}{I} = R_{AB} = 5\ \Omega.$$



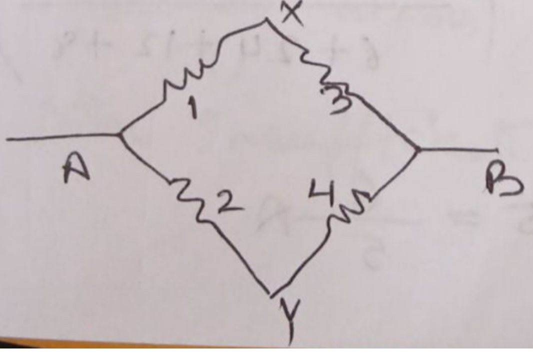
2. $R_{AB} = 0\ \Omega$

3. R_{XY}



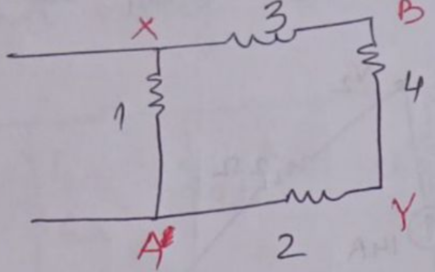
$$R_{XY} = 3 \,||\, 7 = \frac{21}{10}$$

R_{AB}



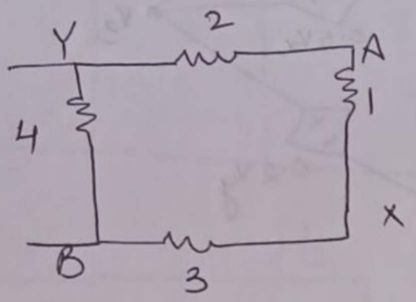
$$R_{AB} = 4 \,||\, 6 = \frac{12}{5}$$

R_{XY}



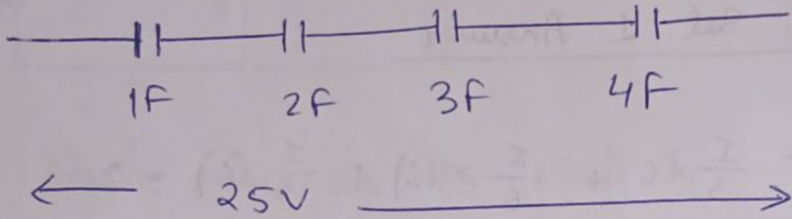
$$R_{XY} = 1 \,\|\, (3+4+2) = \frac{9}{10}.$$

R_{YB}



$$R_{YB} = 4 \,\|\, (2+3+1) = \frac{12}{5}$$

4.



$$V = 25 \times \left[\frac{1/2}{1/1 + 1/2 + 1/3 + 1/4} \right]$$

$$= \frac{6}{25} \times 25 = 6\ V$$

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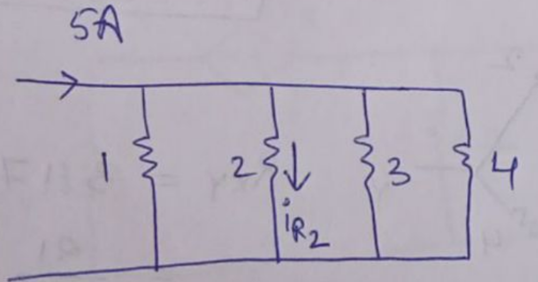
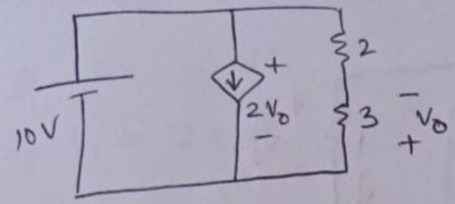


$$i_{R_2} = 5 \times \left(\frac{3 \times 4 \times 1}{6 + 24 + 12 + 8} \right)$$

$$= \frac{6}{25} \times 5 = \frac{6}{5} A$$

7.

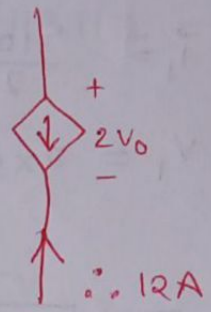


$$V_0 = -10\left(\frac{3}{2+3}\right)$$

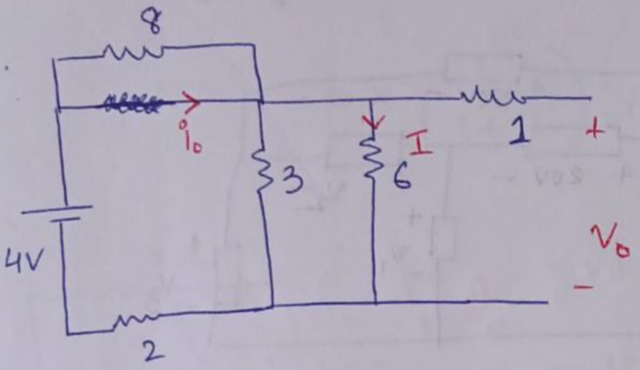
$$= -6V$$

$$P = V \times I$$

$$= 10 \times 12 = 120\ W$$



8.



$6 \parallel 3 = 2\Omega$

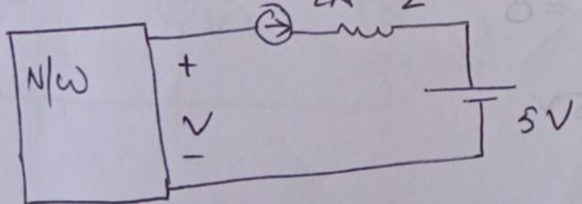
8Ω is redundant (useless)

$$i_0 = \frac{V}{R} = \frac{4}{2+2} = 1\ A$$

$$I = 1\left(\frac{3}{6+3}\right) = \frac{3}{9} = \frac{1}{3}\ A$$

$$V_0 = 6 \times \frac{1}{3} = 2V$$

9.



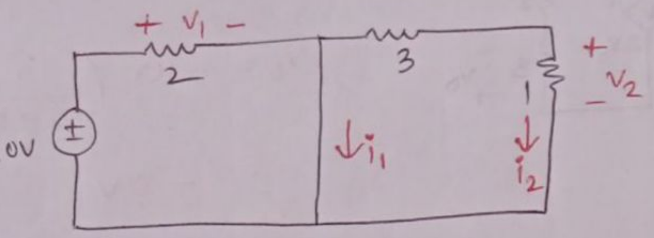
$$\frac{V-5}{2} = 2$$

$$\Rightarrow V = 9V$$ ✗

voltage across I source not given

Data insufficient.

10.



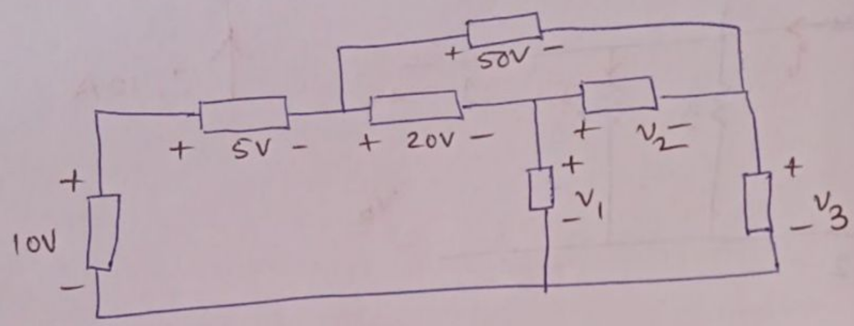
$i_1 = \frac{10}{2} = 5A$

$i_2 = 0$

$V_2 = 0$

$V_1 = 2 \times 5 = 10V$

11.



$-10 + 25 + V_1 = 0$

$\Rightarrow V_1 = -15V$

$-20 + 50 - V_2 = 0$

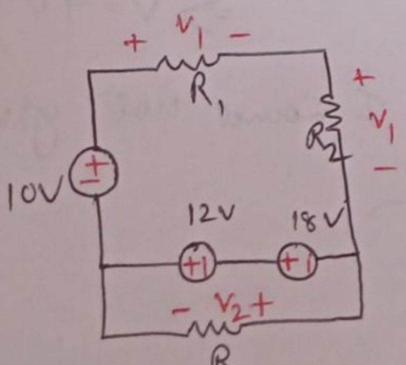
$\Rightarrow -V_2 = -30$

$\Rightarrow V_2 = 30V$

$+15 + 30 + V_3 = 0$

$\Rightarrow V_3 = -45V$

12.



$V_2 + 12 + 18 = 0$

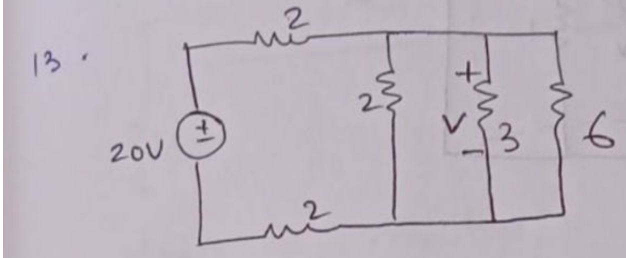
$\Rightarrow V_2 = -30V$

$$-10 + 2V_1 - 18 - 12 = 0$$

$$\Rightarrow 2V_1 = 40$$

$$\Rightarrow V_1 = 20\,V$$

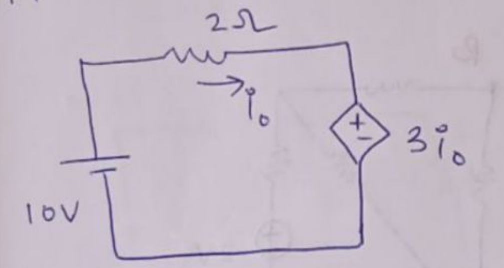
13.



$$6 \,||\, 3 \,||\, 2 = 1\,\Omega$$

$$\therefore V = 20 \times \left(\frac{1}{1+4}\right) = 5V.$$

14.



$$-10 + 2i_o + 3i_o = 0$$

$$\Rightarrow 5i_o = 10$$

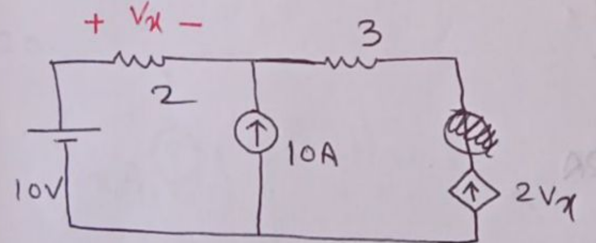
$$\Rightarrow i_o = 2A$$

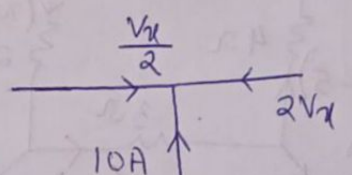
$\therefore P_{absorbed} = + 6 \times 2 = 12W$

since i flowing inwards [sink)

$P_{delivered} = - 6 \times 2 = 12W$

15.

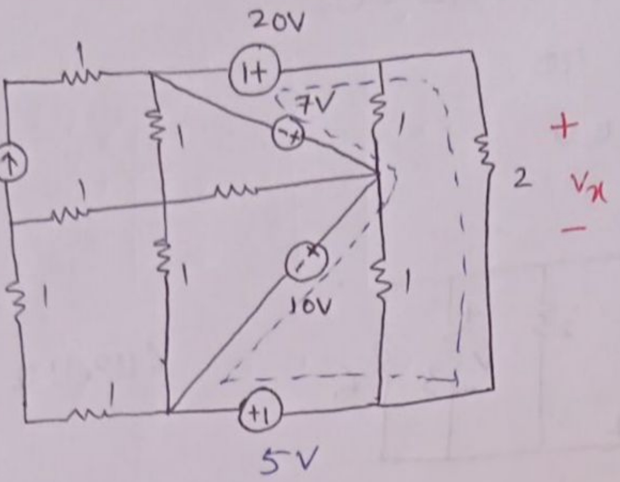




$$\frac{V_x}{2} + 10 + 2V_x = 0$$

$$\Rightarrow V_x = -4V$$

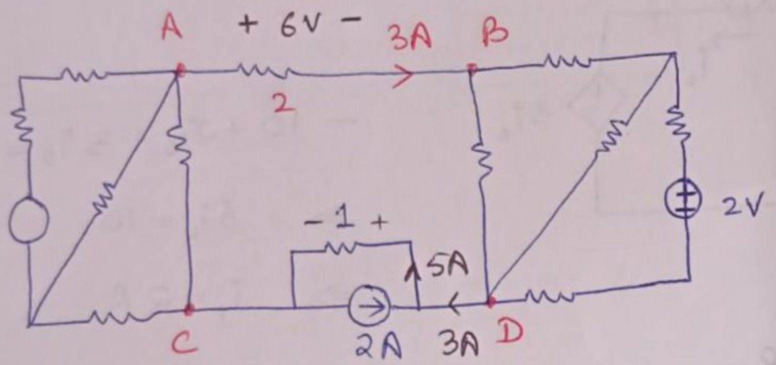
16.



$$-5-10+7-20+V_x=0$$

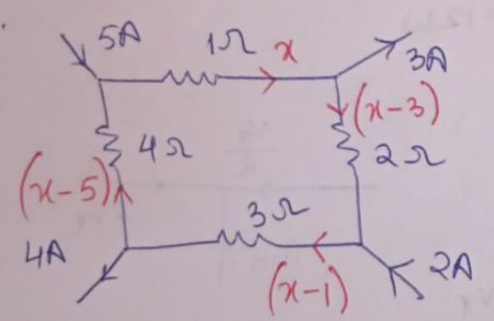
$$\Rightarrow V_x = 28V.$$

17.



$$V_C - V_D = -5V$$

18.



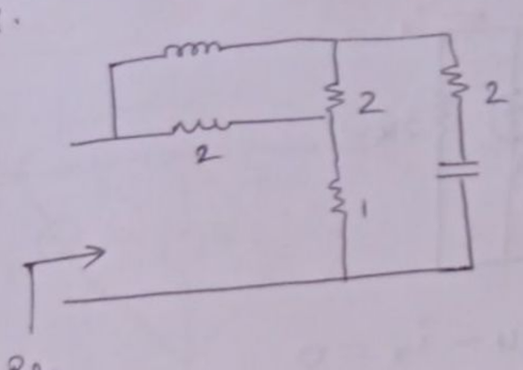
$$x + (x-3)2 + (x-1)3 + (x-5)4 = 0$$

$$\Rightarrow x = 2.9\,A$$

$$\cancel{P_T = (2.9)^2(1) + (2.9-1)^2(2) + (2.9-5)^2}$$

$$P_T = (2.9)^2(1) + (0.1)^2 2 + (1.9)^2 3 + (2.1)^2 4 = 36.9W$$

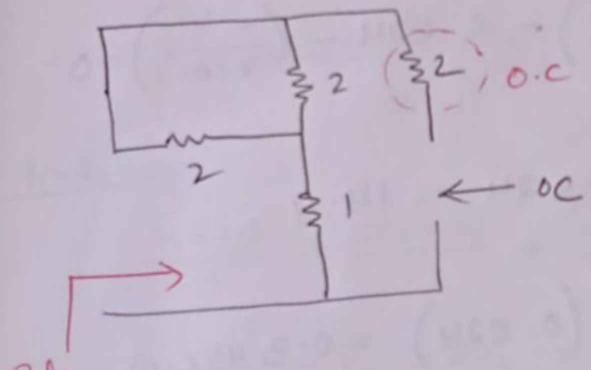
19.



under dc condition,

inductor becomes S.C.

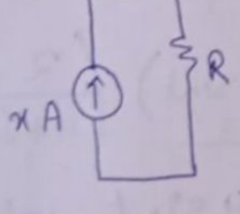
capacitor becomes O.C.

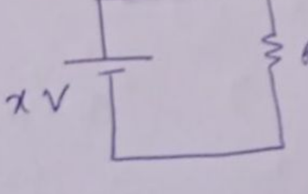


$2 \| 2 = 1$

$\therefore R_{dc} = 1 + 1 = 2\,\Omega$

20.





$P = I^2 R = x^2 R = 18 \rightarrow (2)$

$P = \frac{V^2}{R} = \frac{x^2}{R} = 4.5$

$\Rightarrow x^2 = 4.5R \rightarrow (1)$

Put (1) in (2),

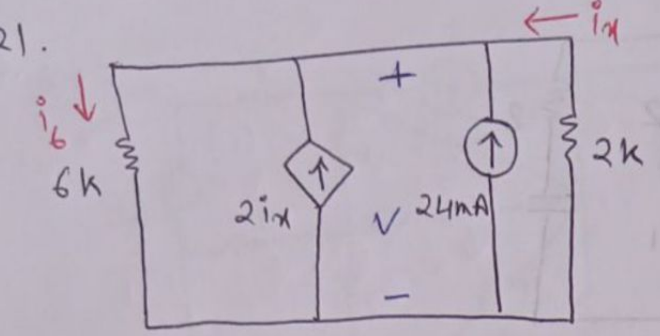
$(4.5R)\, R = 18$

$\Rightarrow R = \sqrt{\frac{180}{45}} = \boxed{2\,\Omega}$

$(2) \Rightarrow x^2 \times 2 = 18$

$\Rightarrow \boxed{x = 3}$

21.



KCL

$$i_6 - 2i_x - 0.024 - i_x = 0 \longrightarrow (1)$$

we can write,

$$i_6 = \frac{V}{6000} \qquad i_x = -\frac{V}{2000}$$

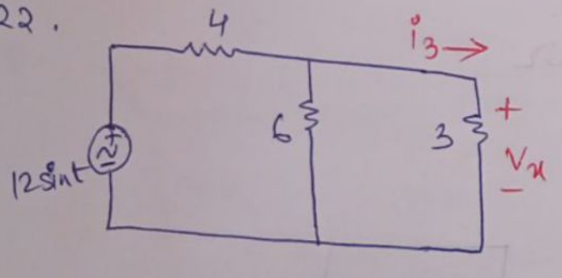
Replacing in (1),

$$\frac{V}{6000} - 2\left(\frac{-V}{2000}\right) - 0.024 - \left(\frac{-V}{2000}\right) = 0$$

$$\Rightarrow V = 600 \times 0.024 = 14.4$$

$$\therefore \text{Power} = \underset{V}{14.4} \times \underset{I}{(0.024)} = 0.3456 \text{ W}$$

22.



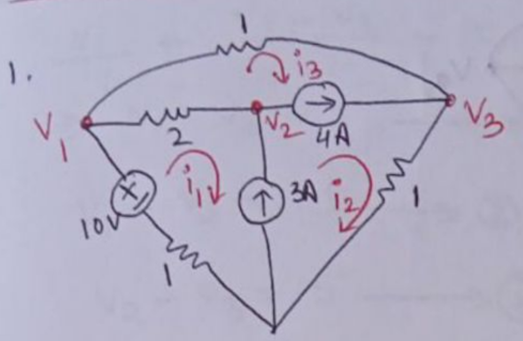
$$6 \| 3 = 2\,\Omega$$

$$V_x = (12\sin t)\left(\frac{2}{4+2}\right)$$

$$= 4\sin t \text{ volts.}$$

Practice set 2 answers

1.



Mesh

$$i_1 - 10 + \cancel{} i_3 + i_2 = 0$$

$$\Rightarrow i_1 + i_2 + i_3 = 10 \longrightarrow (1)$$

$$i_2 - i_1 = 3\cancel{A} \longrightarrow (2)$$

$$i_2 - i_3 = 4 \longrightarrow (3)$$

Solving we get, $i_1 = \frac{8}{3}$

$$\therefore P_{delivered} = 10 \times \frac{8}{3} = \frac{80}{3} \text{ W}$$

Nodal

$$\frac{V_1 - 10}{1} + \frac{V_1 - V_2}{2} + \frac{V_1 - V_3}{1} = 0$$

$$\Rightarrow 5V_1 - V_2 - 2V_3 = 20 \longrightarrow (1)$$

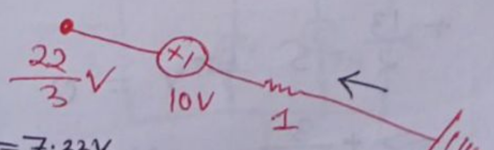
$$\frac{V_2 - V_1}{2} - 3 + 4 = 0$$

$$\Rightarrow V_2 - V_1 = -2 \longrightarrow (2)$$

$$\frac{V_3}{1} + \frac{V_3 - V_1}{1} - 4 = 0$$

$$\Rightarrow -V_1 + 2V_3 = 4 \longrightarrow (3)$$

$$\therefore V_1 = \frac{22}{3}$$

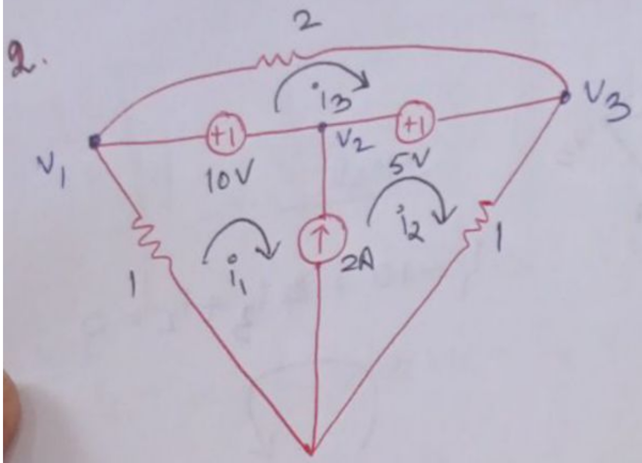


$$= 7.33\text{V}$$

$$\therefore I = \frac{10 - \frac{22}{3}}{1} = 8/3 \text{ A}$$

$$P = 10 \times 8/3 = \frac{80}{3} \text{W}$$

2.



<u>Mesh</u>

$$i_1 + 2i_3 + i_2 = 0 \longrightarrow (1)$$

$$-5 - 10 + 2i_3 = 0$$

$$\Rightarrow 2i_3 = 15$$

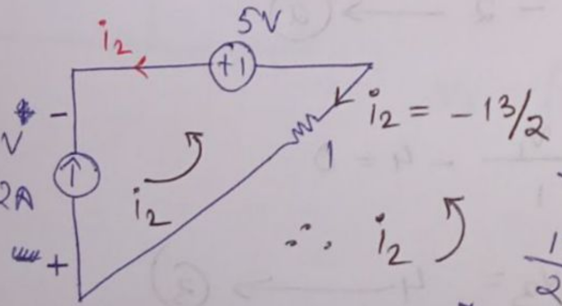
$$\Rightarrow i_3 = \frac{15}{2} \longrightarrow (2)$$

$$\therefore (1) \Rightarrow i_1 + i_2 + 2 \times \frac{15}{2} = 0$$

$$\Rightarrow i_1 + i_2 = -15 \longrightarrow (3)$$

Also, $i_2 - i_1 = 2 \longrightarrow (4)$

$$\therefore \quad i_2 = -\frac{13}{2} \qquad i_1 = -\frac{17}{2}$$



$\therefore$ i_2 $\frac{13}{2}$ V

$$+\frac{13}{2} - 5 - V = 0$$

$$\Rightarrow +\frac{3}{2} = V$$

$$\therefore P_{del} = -2 \times \frac{3}{2}$$

$$= -3W$$

Nodal

$$\frac{V_1}{1} + \frac{V_1 - V_3}{2} - 2 + \frac{V_3}{1} + \frac{V_3 - V_1}{2} = 0$$

$$\Rightarrow V_1 + V_3 = 2 \longrightarrow ①$$

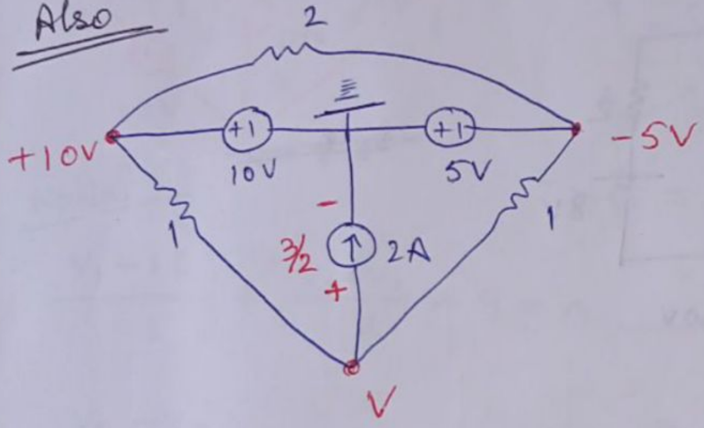
$$V_1 - V_2 = 10 \longrightarrow ②$$

$$V_2 - V_3 = 5 \longrightarrow ③$$

$$\therefore V_1 = \frac{17}{2} V \qquad V_2 = \frac{17}{2} - 10 = -\frac{3}{2} V$$

$$P_{del} = -\frac{3}{2} \times 2 = -3W.$$

Also

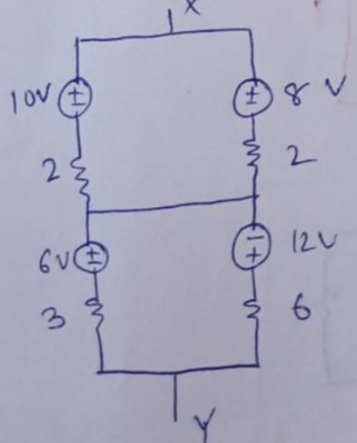


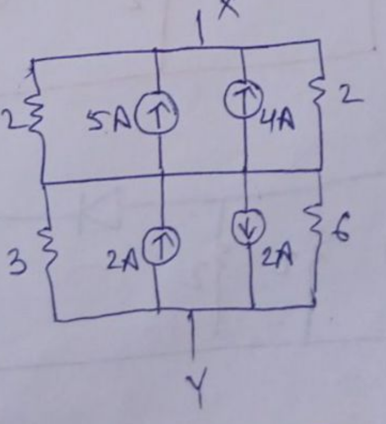
$$\frac{V - 10}{1} + \frac{V + 5}{1} + 2 = 0$$

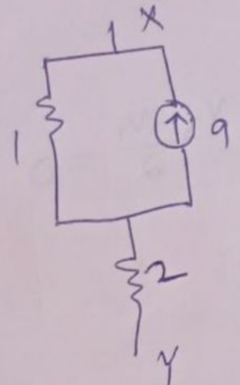
$$\Rightarrow V = \frac{3}{2} V$$

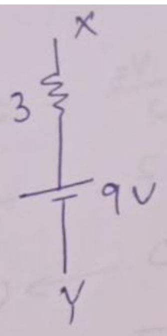
$$\therefore P_{del} = -\frac{3}{2} \times 2 = -3W$$

4Q.

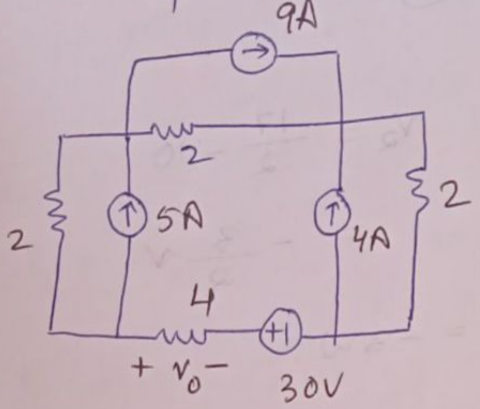


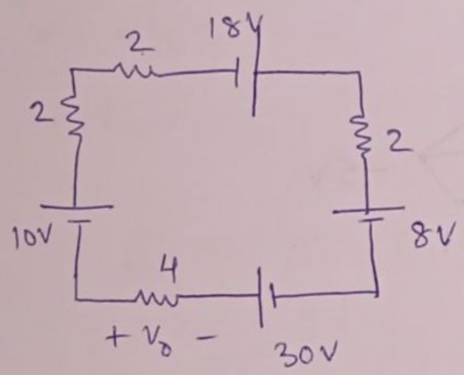




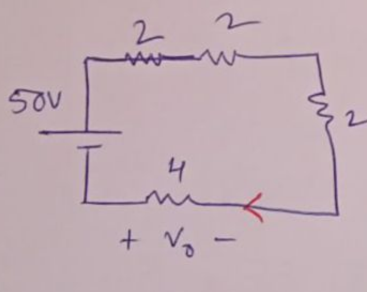


5.





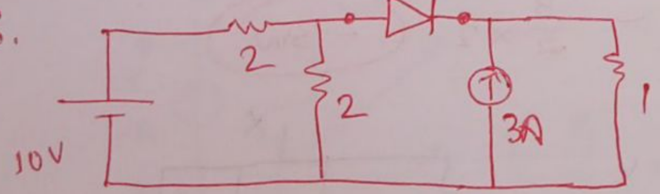
~~$-V_0 = 10$~~

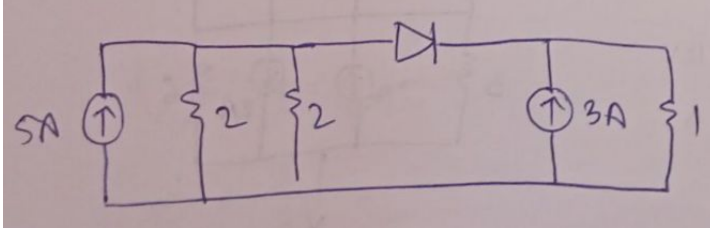


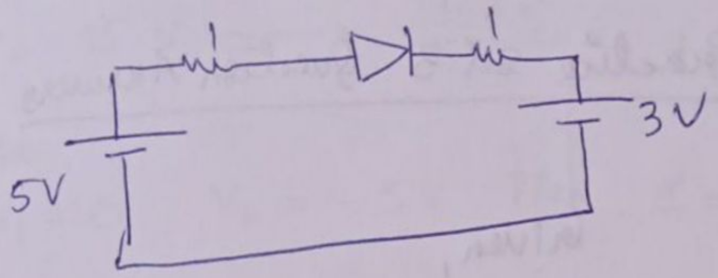
$$V_0 = -50\left(\frac{4}{4+6}\right)$$

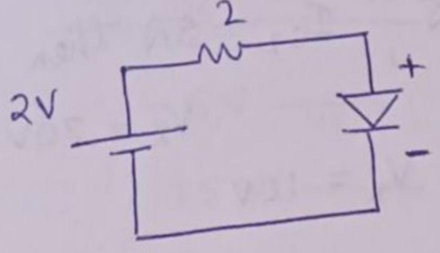
$$= -20V$$

6.





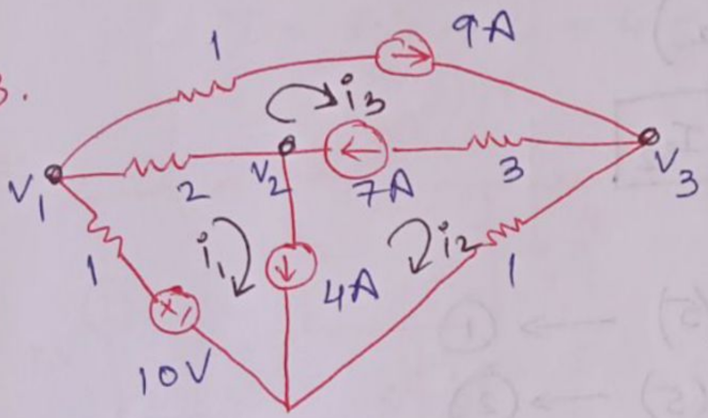




Forward bias $\therefore R = 0$

$$\therefore I_D = \frac{2}{2} = 1A$$

3.



Mesh

$i_1 - i_2 = 4 \longrightarrow ①$

$i_3 - i_2 = 7 \longrightarrow ②$

$i_3 = 9 \longrightarrow ③$

Nodal

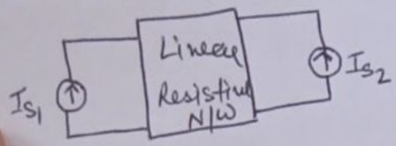
$$\frac{V_1 - 10}{1} + \frac{V_1 - V_2}{2} + 9 = 0 \longrightarrow ①$$

$$\frac{V_2 - V_1}{2} + 4 - 7 = 0 \longrightarrow ②$$

$$\frac{V_3}{1} - 9 + 7 = 0 \longrightarrow ③$$

Practice set 3 Question Answers

1.



Given,

$I_{S_1} = 10A$, $I_{S_2} = 5A$ then $V_x = 20V$

$I_{S_1} = 20A$, $I_{S_2} = -5A$ then $V_x = 10V$

If $I_{S_1} = I_{S_2} = 15A$ then $V_x = ?$

Now,

$V_x = f(I_{S_1}, I_{S_2})$

$\Rightarrow \boxed{V_x = \alpha I_{S_1} + \beta I_{S_2}}$

$20 = \alpha(10) + \beta(5) \longrightarrow (1)$

$10 = \alpha(20) - \beta(5) \longrightarrow (2)$

solving (1) and (2) $\Rightarrow 30 = 30\alpha$

$\Rightarrow \boxed{\alpha = 1}$

$\therefore \boxed{\beta = 2}$

Again,

$V_x = 1\, I_{S_1} + 2\, I_{S_2}$

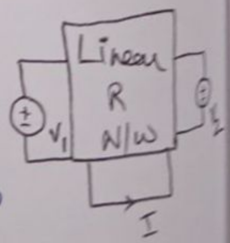
$= 1 \times 15 + 2 \times 15 = 45$

$\boxed{V_x = 45V}$

~~Given~~,

~~$V_1 = 10V, V_2 = 0V$ and $I = 5A$~~ then

~~Also, $V_1 = 0V$~~, $V_2 = -5V$ then ~~$I = 1A$~~



To find : If $V_1 = V_2 = 15V$, $I = ?$

$V_1 = 10$, $V_2 = 0V$ then $I = 5A$

If V_1 act alone $\longrightarrow$ $10 \longrightarrow 5A$

$\therefore$ $15\,V \longrightarrow \dfrac{15\times 5}{10} = 7.5\,A$ (Homogenity)

Also,

$V_1 = 0$, $V_2 = -5V$ then $I = 1A$

<u>If V_2 act alone</u>

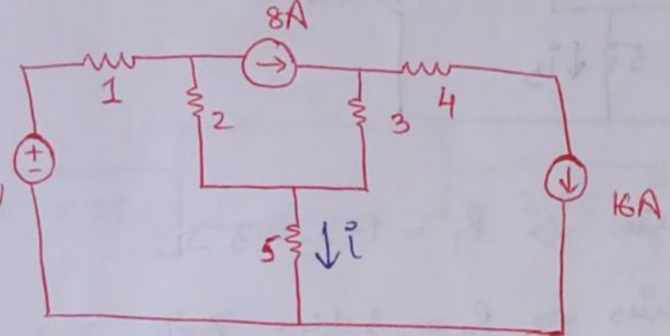
$-5V \longrightarrow 1A$

$15V \longrightarrow \dfrac{15\times 1}{-5} = -3A$ (Homogenity)

<u>By S.P.T</u>

$I = 7.5 - 3 = 4.5A$.

3.

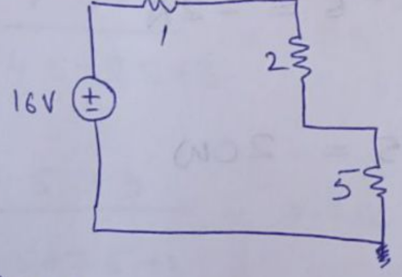


Find P_{lost} in $5\,\Omega$ resistor using SPT and KVL.

NOTE : Power is a non linear parameter and hence can't be calculated directly using SPT.

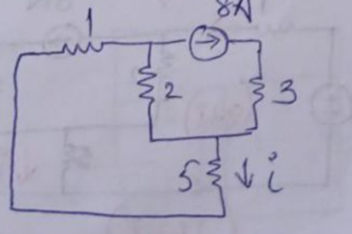
<u>Sol^n</u>

<u>Step 1: 16 V only</u>

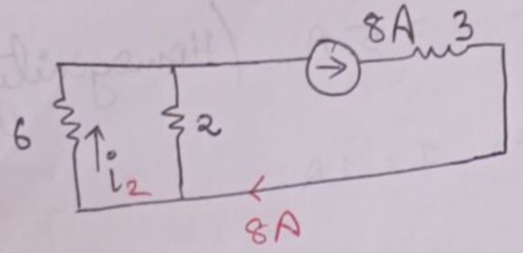


$i_1 = \dfrac{16}{8} = 2A$

<u>Step 2</u> : <u>8A only</u>

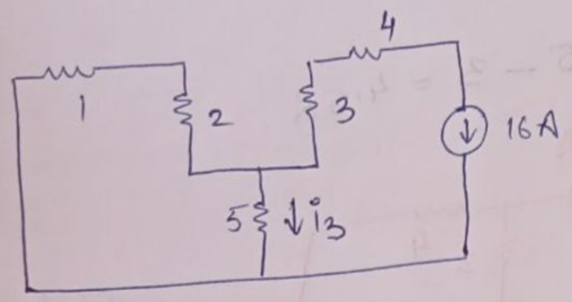


5 and 1 in series $R = 5+1$
$= 6$



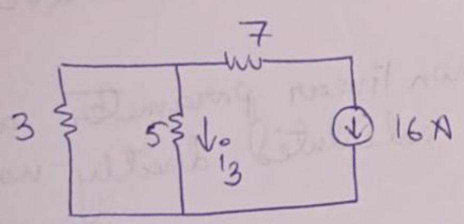
$\therefore \; i_2 = 8\left(\frac{2}{6+2}\right) = 2A$.

step 3 : 16 A only



1 and 2 in series $\Rightarrow R_1 = 1+2 = 3\,\Omega$

3 and 4 in series $\Rightarrow R_2 = 3+4 = 7\,\Omega$



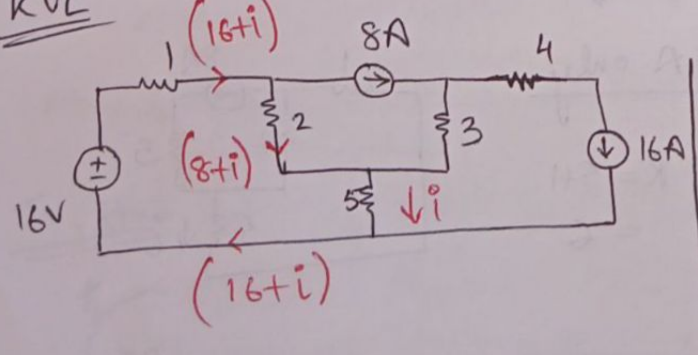
$$i_3 = -16\left(\frac{3}{5+3}\right)$$

$$= -6A$$

$\therefore \; i = i_1 + i_2 + i_3 = 2 + 2 - 6 = -2A$

$P_{Lost} = I^2 R = 2^2 \times 5 = 20W$

KVL



$-16 + 1(16+i) +$

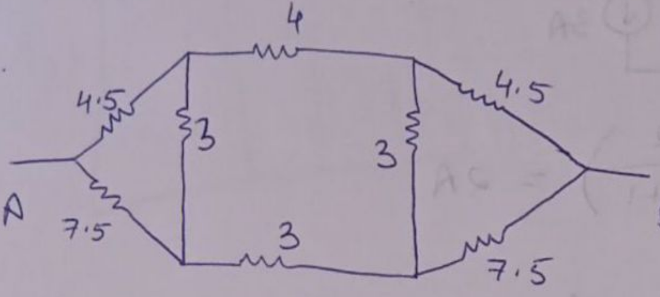
$2(8+i) + 5i = 0$

$\Rightarrow 8i = -16$

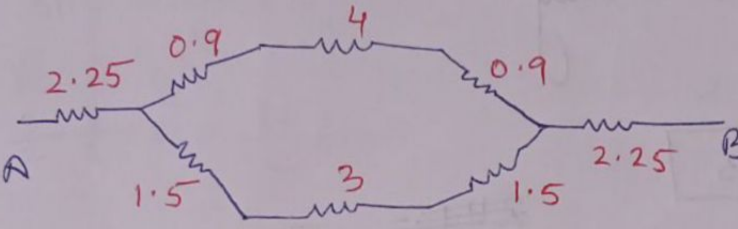
$\Rightarrow i = -2A$

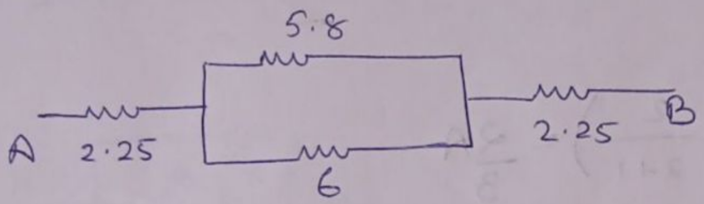
$$\therefore P_{lost} = i^2 R$$
$$= 4 \times 5 = 20W$$

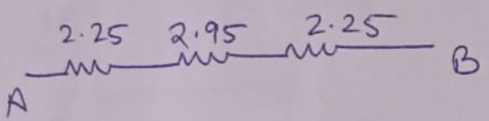
4.



Find R_{AB}







$R_{AB} = 7.45\,\Omega.$

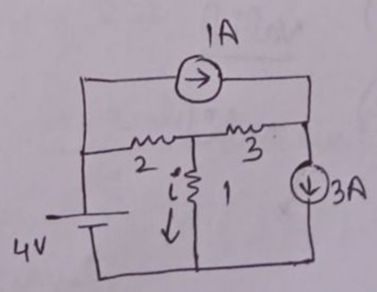
Delta to Star

$$\frac{4.5 \times 7.5}{4.5 + 7.5 + 3} = 2.25\,\Omega$$

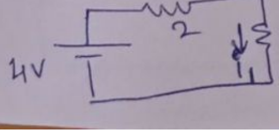
$$\frac{7.5 \times 3}{4.5 + 7.5 + 3} = 1.5\,\Omega$$

$$\frac{4.5 \times 3}{4.5 + 7.5 + 3} = 0.9\,\Omega$$

5. Find i in 1Ω using SPT

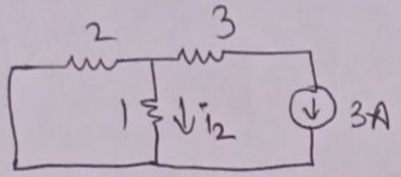


sol^n step 1: 4 V only



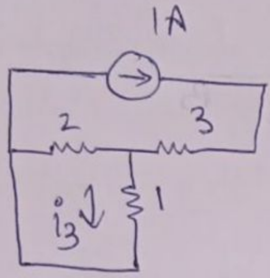
$i_1 = \frac{4}{3}$ A

Step 2 : 3A only



$$i_2 = 3\left(\frac{2}{2+1}\right) = 2A$$

Step 3 : 1 A only



$$i_3 = 1\left(\frac{2}{2+1}\right) = \frac{2}{3}A$$

$$\therefore\ i = i_1 + i_2 + i_3$$

$$= \frac{4}{3} + 2 + \frac{2}{3}$$

$$i = 4A$$

6. (a) 2 voltage of different values → violates KVL.

(b) Valid as resistor in b/w.

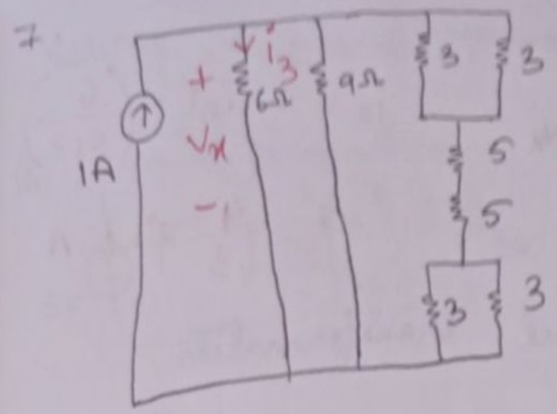
(c) unclear what current flows through R.

$I = 1 - 1 = 0$ → invalid

(d) Valid.

(e) valid

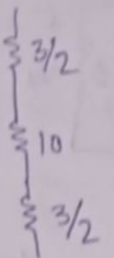
7.



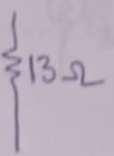
Find V_x.

$$3 \| 3 = \frac{9}{6} = \frac{3}{2}$$

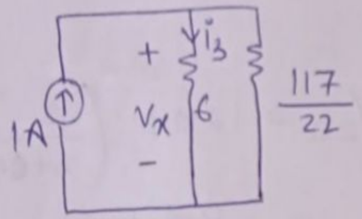
$$\frac{3}{2} + \frac{3}{2} + 10 = \frac{26}{2} = 13\,\Omega$$



=



$$13 \| 9 = \frac{13 \times 9}{22} = \frac{117}{22}$$



$$i_3 = 1\left(\frac{117/22}{\frac{117}{22} + 6}\right)$$

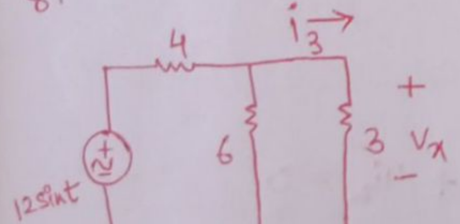
$$= \frac{117}{22} \times \frac{22}{249}$$

$$= 0.4698$$

$$\therefore V_x = 6 \times 0.4698$$

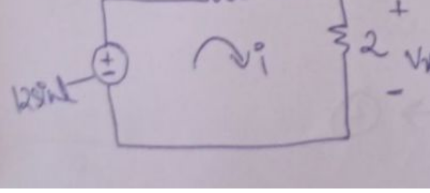
$$= 2.8188 \approx 2.819\ V$$

8.



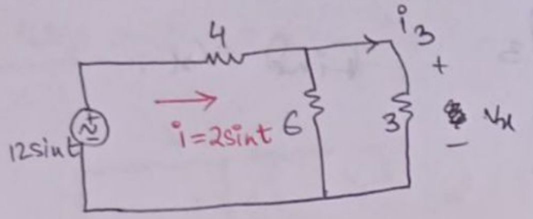
Find i_3.

$$3 \| 6 = 2\,\Omega$$



$$i = \frac{12 \sin t}{6} = 2 \sin t\ A$$

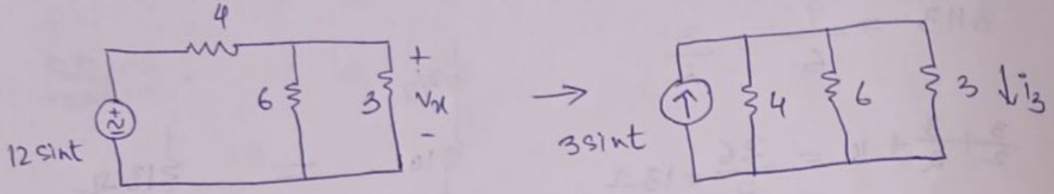
total current



$$i_3 = 2\sin t\left(\frac{6}{6+3}\right)$$

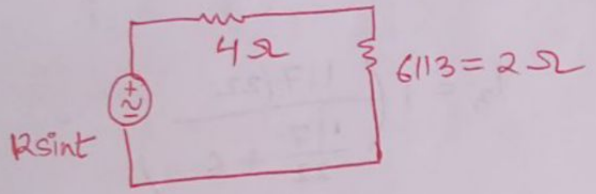
$$= \frac{4}{3}\sin t \text{ A}$$

Method 2 : Source transformation



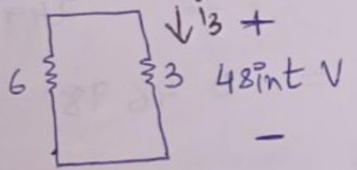
$$i_3 = 3\sin t \frac{6\times 4}{24+18+12} = \frac{4}{3}\sin t \text{ A}$$

Method 3 : voltage division



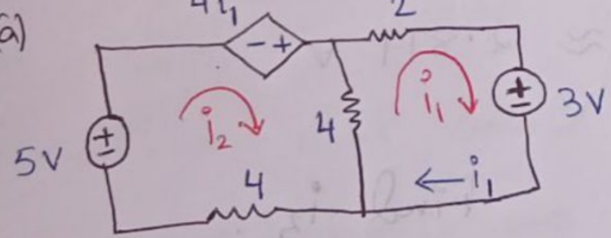
$$V_{2\Omega} = 12\sin t\left(\frac{2}{2+4}\right)$$

$$= 4\sin t \text{ V}$$



$$i_3 = \frac{4\sin t}{3} \text{ A}.$$

9(a)



KVL

$$-5 - 4i_1 + 4(i_2 - i_1) + 4i_2 = 0$$

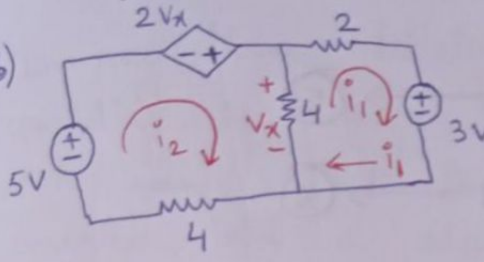
$$\Rightarrow -8i_1 + 8i_2 = 5 \longrightarrow (1)$$

$$4(i_1 - i_2) + 2i_1 + 3 = 0$$

$$\Rightarrow 6i_1 - 4i_2 = -3 \longrightarrow (2)$$

solving, $i_1 = -250\,mA$ $\quad i_2 = 375\,mA$

(b)



$$-5 - 2V_x + 4(i_2 - i_1) + 4i_2 = 0 \longrightarrow (1)$$

$$\cancel{-4(i_1-i_2)} \quad 4(i_1 - i_2) + 2i_1 + 3 = 0 \longrightarrow (2)$$

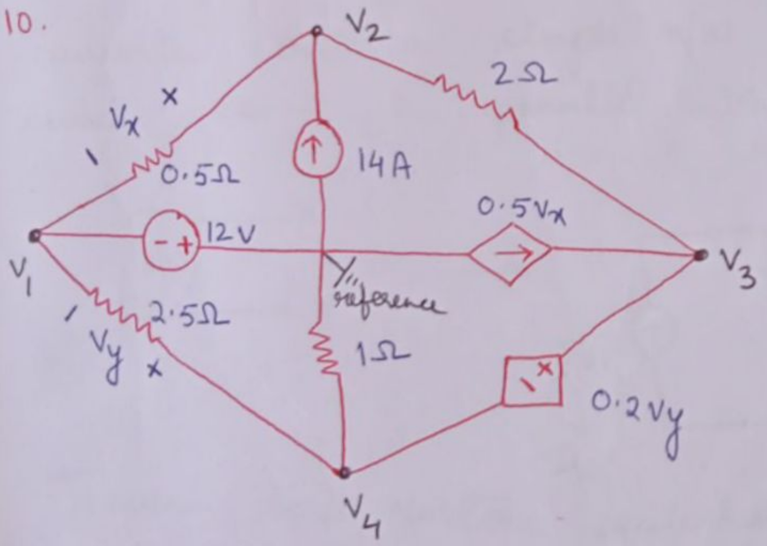
$$V_x = 4(i_2 - i_1) \longrightarrow (3)$$

Put (3) in (1),

$$4i_1 = 5$$

$$\Rightarrow \boxed{i_1 = 1.25\ A}$$

10.



$$V_1 = -12 \longrightarrow (1)$$

$$\frac{V_2 - V_1}{0.5} - 14 + \frac{V_2 - V_3}{2} = 0$$

$$\Rightarrow \frac{V_2 - V_1}{0.5} + \frac{V_2 - V_3}{2} = 14 \longrightarrow (2)$$

$$\frac{V_3 - V_2}{2} + \frac{V_4}{1} + \frac{V_4 - V_1}{2.5} - 0.5V_x \cancel{=0} \longrightarrow (3)$$

$v_3 - v_4 = 0.2\, v_y \longrightarrow$ (4)

$0.2 v_y = 0.2\,(v_4 - v_1) \longrightarrow$ (5)

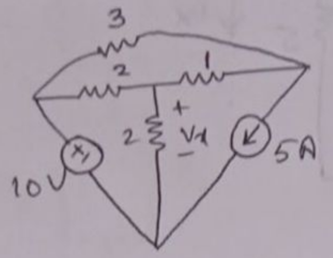
$0.5\, v_x = 0.5\,(v_2 - v_1) \longrightarrow$ (6)

$\therefore$ solving, we get

$v_1 = -12\,V$, $v_2 = -4V$, $v_3 = 0V$, $v_4 = -2V$

PRACTICE SET 4

1. Find V_x with the help of SPT



Solⁿ **Step 1 :** 10V only

$4 \| 2 = \frac{8}{6} = \frac{4}{3}$

$$V_{x_1} = 10 \left(\frac{2}{2+4/3} \right)$$

$$= 6V$$

Step 2 : 5A only

$$V'_{x_2} = -2 \left[5 \left(\frac{3}{3+2} \right) \times \frac{2}{4} \right]$$

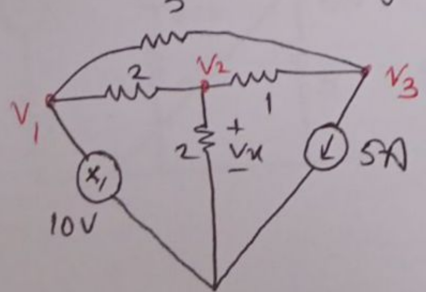
$$= -3V$$

$2 \| 2 = 1$

∴ Using SPT,

$$V_x = V_{x_1} + V_{x_2} = 6 - 3 = 3V.$$

2. Find V_x using Nodal Analysis



$V_1 = 10 \longrightarrow ①$

$$\frac{V_2 - 10}{2} + \frac{V_2}{2} + \frac{V_2 - V_3}{1} = 0 \longrightarrow ②$$

$$\Rightarrow 4V_2 - 2V_3 = 10$$

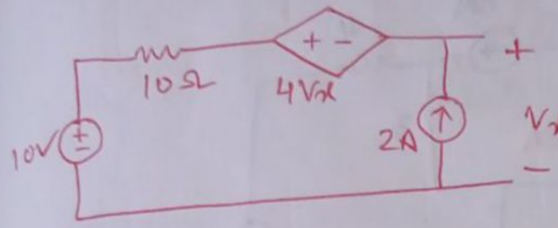
$$5 + \frac{V_3 - V_2}{1} + \frac{V_3 - 10}{3} = 0$$

$$\Rightarrow -3V_2 + 4V_3 = -5 \longrightarrow (3)$$

$V_2 = 3$

$\therefore \boxed{V_x = 3V}$

3. Find V_x using SPT



Step 1: 10V only.

$$V_{x_1} = 10 - 4V_{x_1}$$

$$\Rightarrow V_{x_1} = 2 \text{ V}$$

Step 2: 2 A only

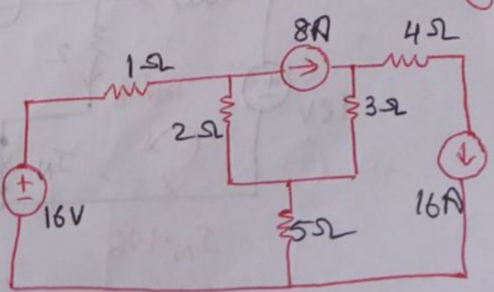
$$-V_x - 4V_{x_2} + 10(2) = 0$$

$$\Rightarrow 5V_{x_2} = 20$$

$$\Rightarrow V_{x_2} = 4V$$

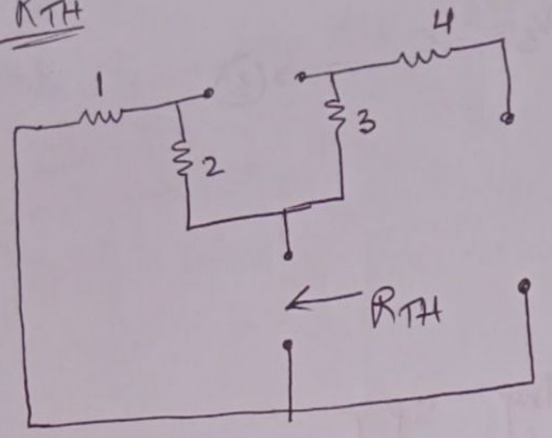
$$\therefore V_x = V_{x_1} + V_{x_2} = 2 + 4 = 6V$$

4. Find power lost in 5Ω resistor using Thevenin and Norton



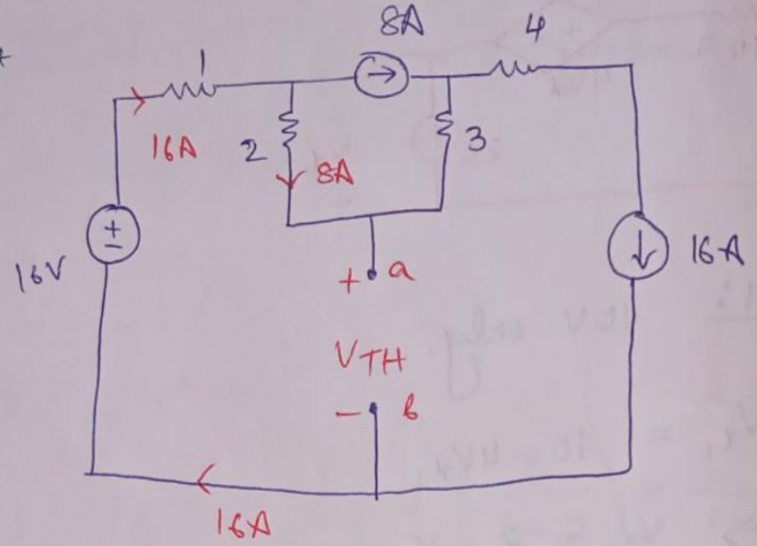
Sol^n **Thevenin**

R_{TH}



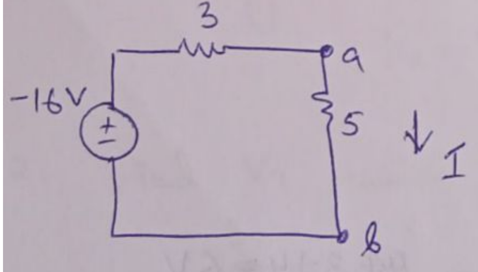
$$R_{TH} = 2 + 1 = 3\,\Omega$$

V_{TH}



$$-16 + 16 + 16 + V_{TH} = 0$$

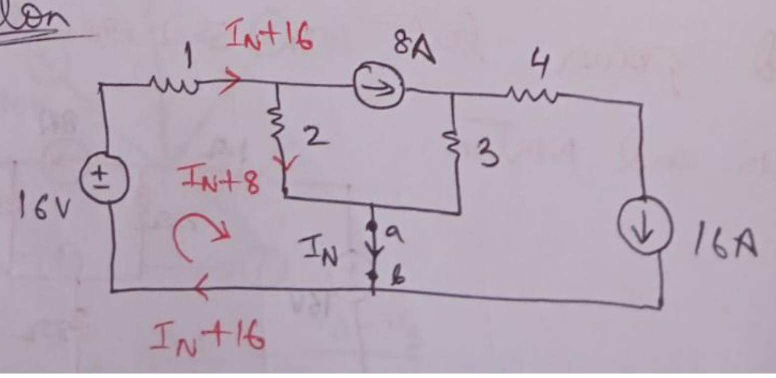
$$\Rightarrow V_{TH} = -16\,V$$



$$I = -\frac{16}{8} = -2A$$

$$P_{lost} = (-2)^2 \times 5 = 20W$$

Norton

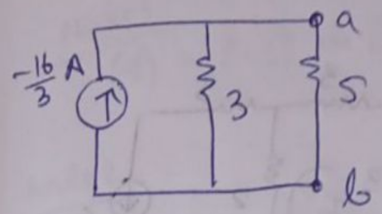


KVL

$$-16 + (I_N + 16) + 2(I_N + 8) = 0$$

$$\Rightarrow \quad 3I_N = -16$$

$$\Rightarrow \quad I_N = \frac{-16}{3} \text{ A}$$

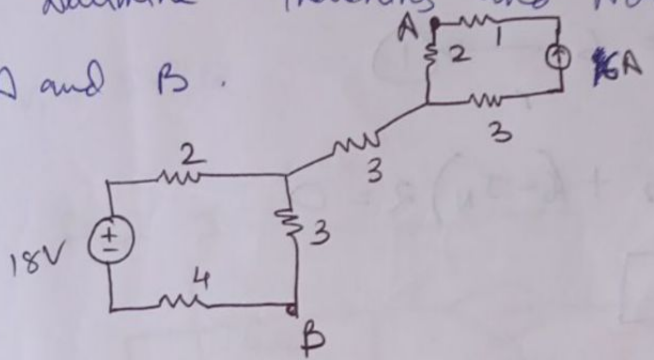


$$I = -\frac{16}{3}\left(\frac{3}{3+5}\right)$$

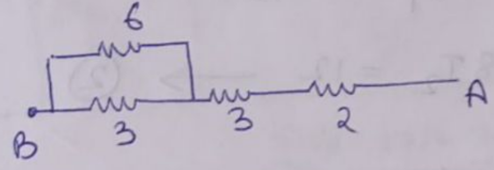
$$= -2\text{A}$$

$$P_{lost} = (-2)^2 \times 5 = 20\text{W}$$

5. Determine Thevenin's and Norton equivalent b/w A and B.

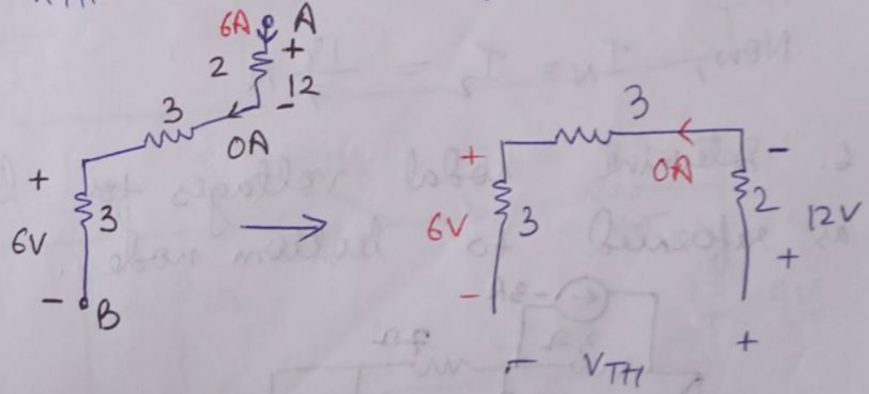


Sol^n $\quad R_{TH}$

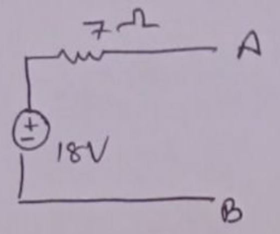


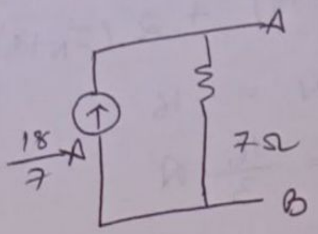
$$R_{TH} = 2 + 3 + (3 \| 6) = 2 + 3 + 2 = 7\,\Omega$$

V_{TH}



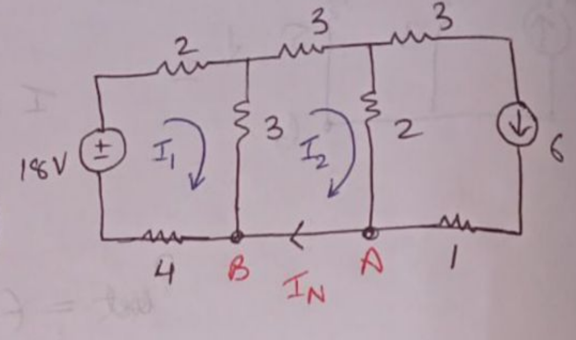
$$V_{TH} - 6 - 12 = 0 \Rightarrow V_{TH} = 18\text{ V}$$





Nortons

$R_N = R_{TH} = 7\,\Omega$



KVL

$$-18 + 2I_1 + 3(I_1 - I_2) + 4I_1 = 0$$

$$\Rightarrow 9I_1 - 3I_2 = 18$$

$$\Rightarrow 3I_1 - I_2 = 6 \longrightarrow (1)$$

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

Here $\boxed{I_N = I_2}$

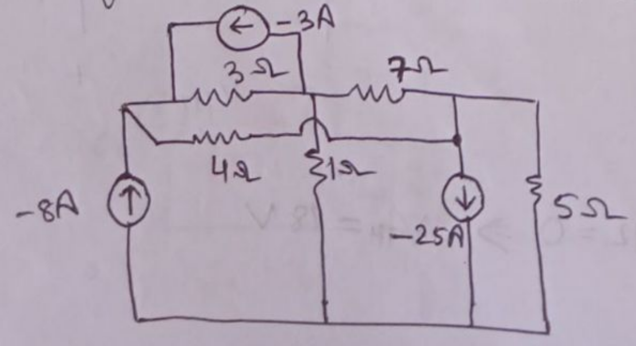
$$\Rightarrow 8I_2 - 3I_1 = -12$$

$$\Rightarrow 3I_1 - 8I_2 = 12 \longrightarrow (2)$$

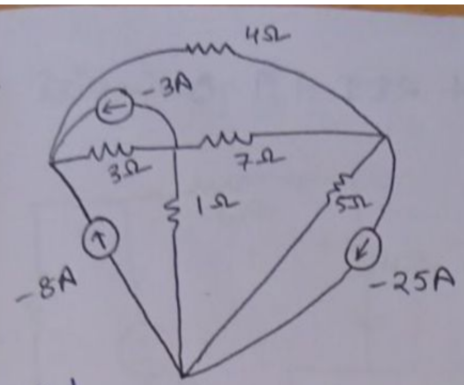
$$\therefore \quad I_2 = \frac{18}{7}\,A$$

Now, $I_N = I_2 = \frac{18}{7}\,A$

6. Determine nodal voltages for the circuit, as referenced to bottom node.



Sol^n



Node 1

$$-(-8) - (-3) + \frac{V_1 - V_2}{3} + \frac{V_1 - V_3}{4} = 0 \longrightarrow (1)$$

Node 2

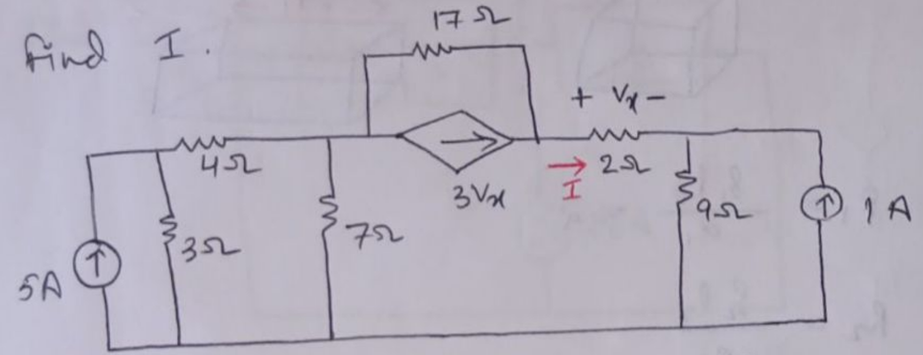
$$(-3) + \frac{V_2 - V_1}{3} + \frac{V_2}{1} + \frac{V_2 - V_3}{7} = 0 \longrightarrow (2)$$

Node 3

$$(-25) + \frac{V_3}{5} + \frac{V_3 - V_2}{7} + \frac{V_3 - V_1}{4} = 0 \longrightarrow (3)$$

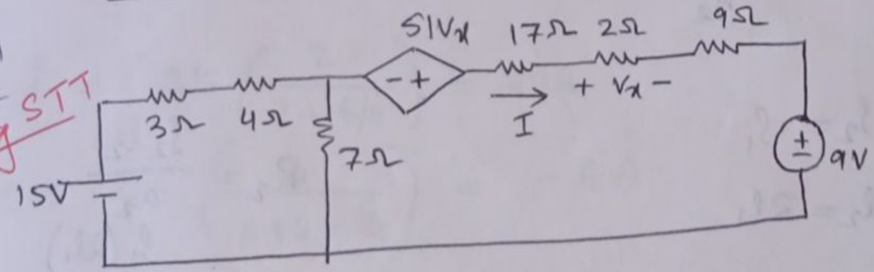
$V_1 = 5.412$, $V_2 = 7.736$, $V_3 = 46.32V$

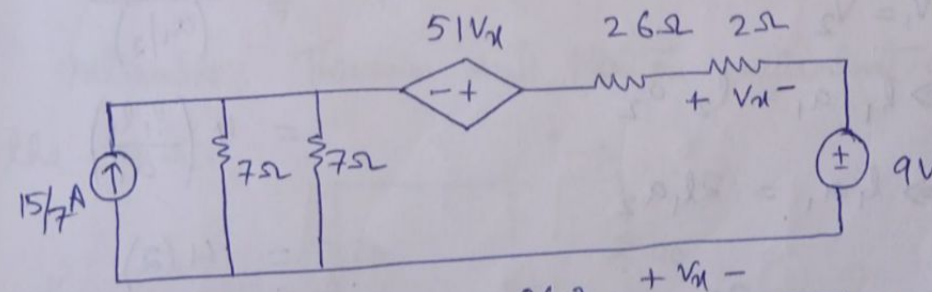
7. find I.

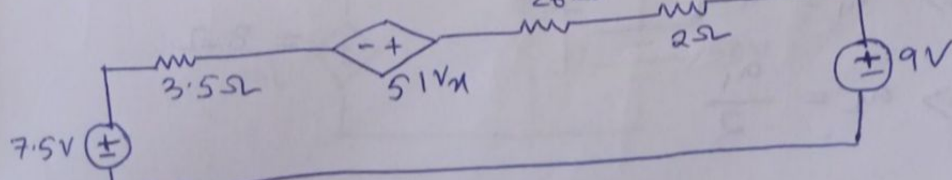


Sol^n

using STT







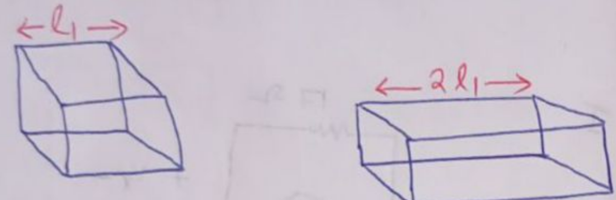
$$-7.5 + 3.5I - 51V_x + 28I + 9 = 0$$

$$V_x = 2I$$

$$\Rightarrow I = 21.28\,mA$$

8. A cube shaped material has a resistance of 2Ω b/w any of its opposite faces. Now if this material is stretched in one direction by applying linear force to double its original length, then the resistance b/w the opposite stretched face is ______

Sol



$$R_1 = \frac{\rho_1 l_1}{a_1} = 2$$

$$R_2 = \frac{\rho_2 l_2}{a_2}$$

$\rho_2 = \rho_1$

$l_2 = 2l_1$

$V_1 = V_2$

$\Rightarrow l_1 . a_1 = l_2 . a_2$

$\Rightarrow l_1 a_1 = 2l_1 a_2$

$\Rightarrow a_1 = 2a_2$

$\Rightarrow a_2 = \frac{a_1}{2}$

$$R_2 = \frac{\rho_2 l_2}{a_2}$$

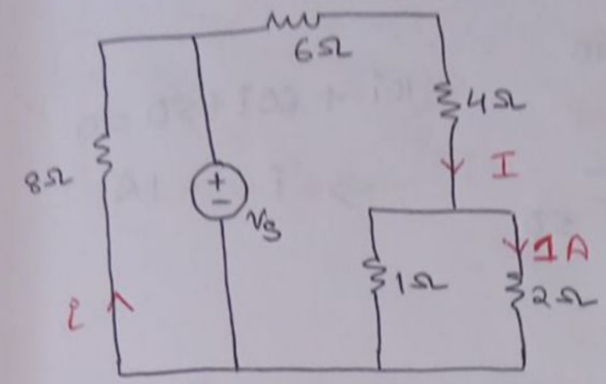
$$= \frac{\rho_1 (2l_1)}{(a_1/2)}$$

$$= 4\left(\frac{\rho_1 l_1}{a_1}\right)$$

$$= 4(2)$$

$$= 8\Omega.$$

9. Determine i.



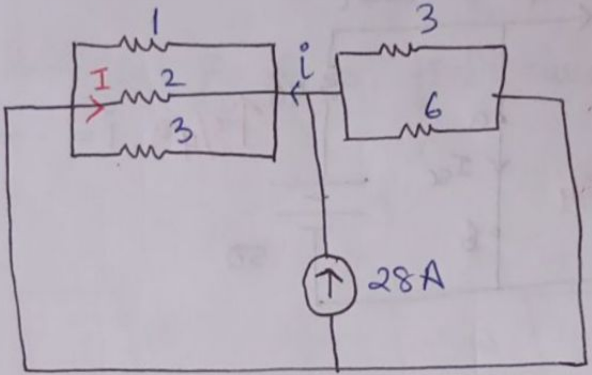
30/4

$$1 = I \times \frac{1}{3} \Rightarrow I = 3$$

$$V_S = 3\left(10 + \frac{2}{3}\right) = 32V$$

$$i = -\frac{32}{8} = -4A$$

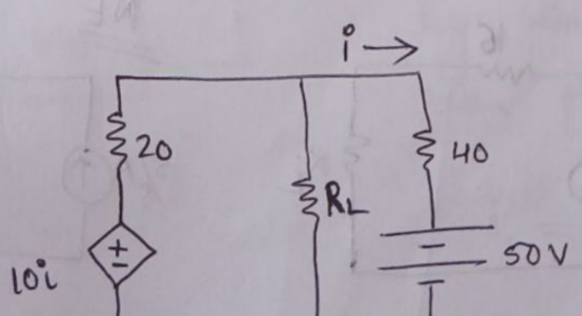
10. find I



$$i = 28\left(\frac{2}{2 + 6/11}\right) = 22A$$

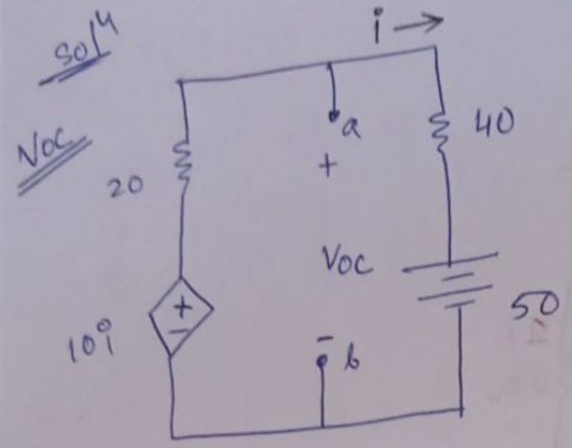
$$I = 22\left(\frac{3}{6+2+3}\right) = -6A.$$

11. Determine Thevenin and Norton equivalent across the load.



Sol^n

Voc



$$-10i + 60i + 50 = 0$$

$$\Rightarrow i = -1A$$

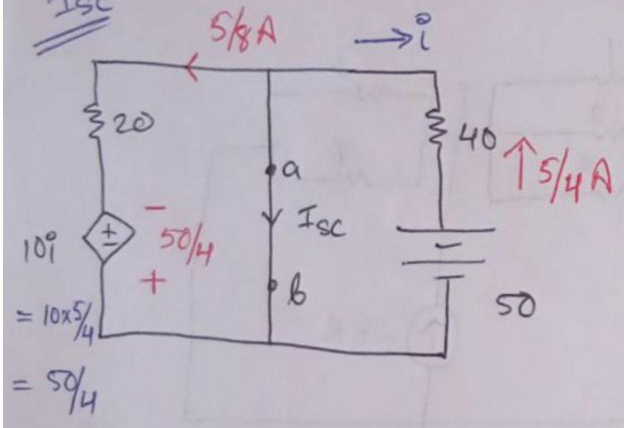
KVL

$$-V_{oc} \cancel{+40} + 40i + 50 = 0$$

$$\Rightarrow -V_{oc} - 40 + 50 = 0$$

$$\Rightarrow \boxed{V_{oc} = 10V}$$

Isc



$$i = \frac{50}{40} = 5/4$$

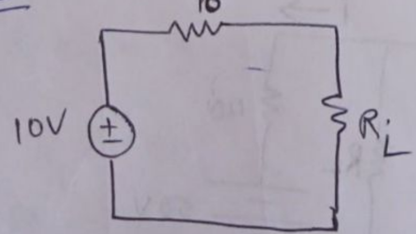
KCL

$$-\frac{5}{4} = \frac{5}{8} + I_{sc}$$

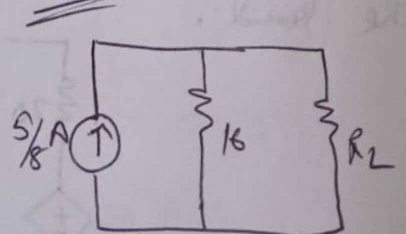
$$\Rightarrow I_{sc} = -5/8 \text{ A}$$

$$R_{TH} = R_N = \frac{V_{oc}}{I_{sc}} = \frac{10 \times 8}{5} = 16\Omega$$

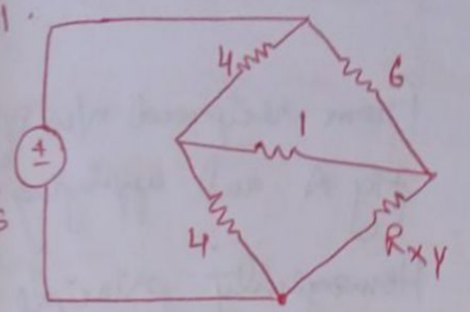
TE



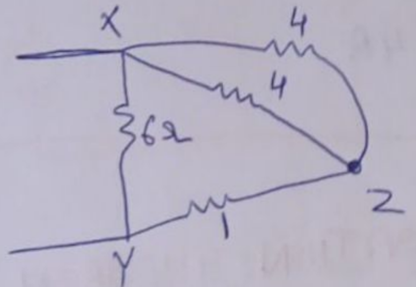
NE



11.



what is the value of R_x for which P_{max} occurs.



$4 \| 4 = 2$

$2+1 = 3$

$$R_{XY} = R_{TH} = 3 \| 6 = 2\Omega.$$

12. Use the data in fig A to find current 'i' in fig. B.

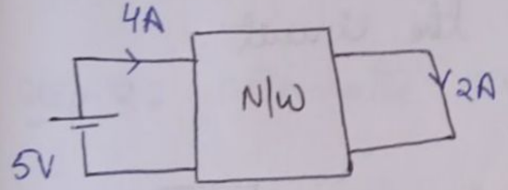


fig A

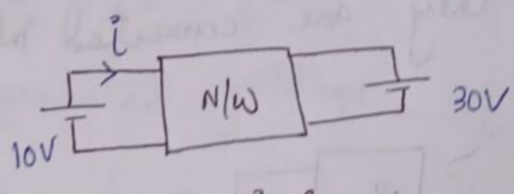
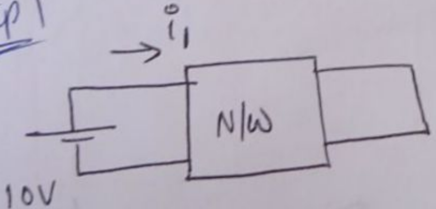


fig B

sol^n

Apply Superposition

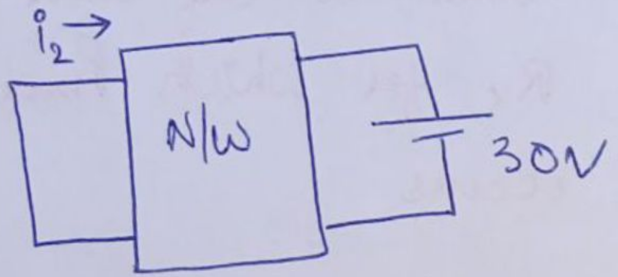
step 1



By homogenity principle from fig A.

$i_1 = 8A$

Step 2 :



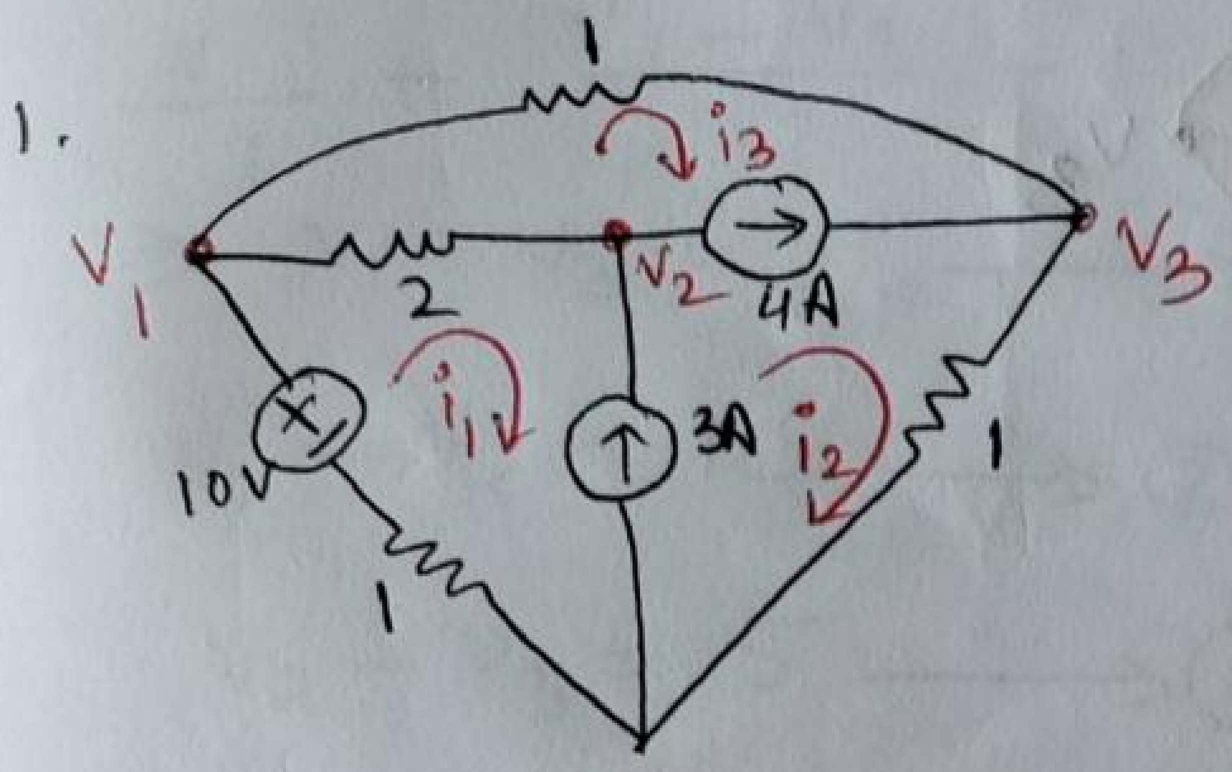
From reciprocal n/w of fig A and applying Homogenity principle

$i_2 = -12A$

$i = i_1 + i_2 = 8 - 12 = -4A$

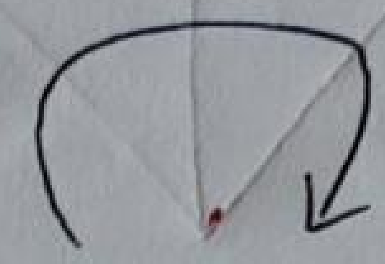
Practice set 2 answers

1.



Mesh

$$i_1 - 10 + i_3 + i_2 = 0$$



$$\Rightarrow i_1 + i_2 + i_3 = 10 \longrightarrow (1)$$

$$i_2 - i_1 = 3 \longrightarrow (2)$$

$$i_2 - i_3 = 4 \longrightarrow (3)$$

Solving we get, $i_1 = \frac{8}{3}$

$\therefore P_{delivered} = 10 \times \frac{8}{3} = \frac{80}{3}$ W

Nodal

$$\frac{V_1 - 10}{1} + \frac{V_1 - V_2}{2} + \frac{V_1 - V_3}{1} = 0$$

$$\Rightarrow 5V_1 - V_2 - 2V_3 = 20 \longrightarrow (1)$$

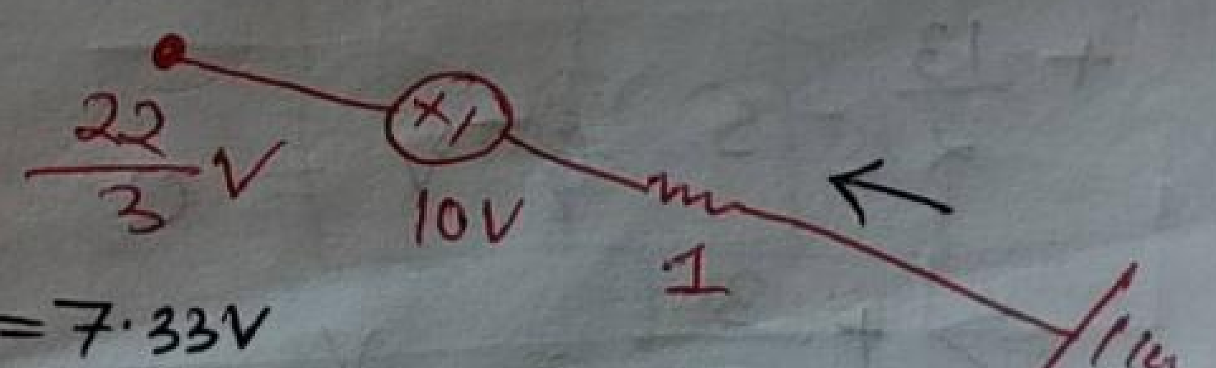
$$\frac{V_2 - V_1}{2} - 3 + 4 = 0$$

$$\Rightarrow V_2 - V_1 = -2 \longrightarrow (2)$$

$$\frac{V_3}{1} + \frac{V_3 - V_1}{1} - 4 = 0$$

$$\Rightarrow -V_1 + 2V_3 = 4 \longrightarrow (3)$$

$\therefore V_1 = \frac{22}{3}$

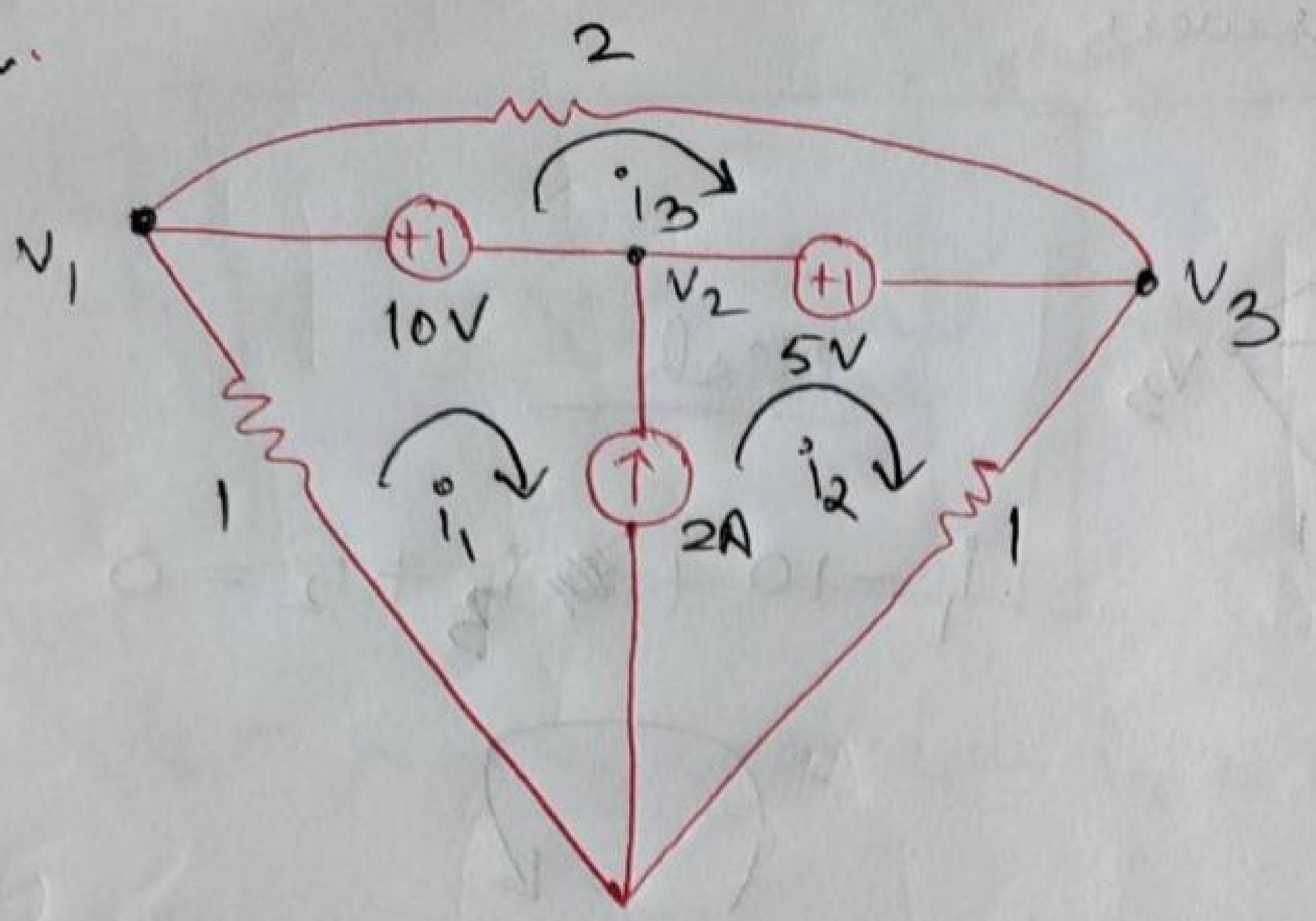


$= 7.33$V

$\therefore I = \frac{10 - \frac{22}{3}}{1} = 8/3$ A

$P = 10 \times 8/3 = \frac{80}{3}$ W

2.



Mesh

$$i_1 + 2i_3 + i_2 = 0 \longrightarrow (1)$$

$$-5 - 10 + 2i_3 = 0$$

$$\Rightarrow 2i_3 = 15$$

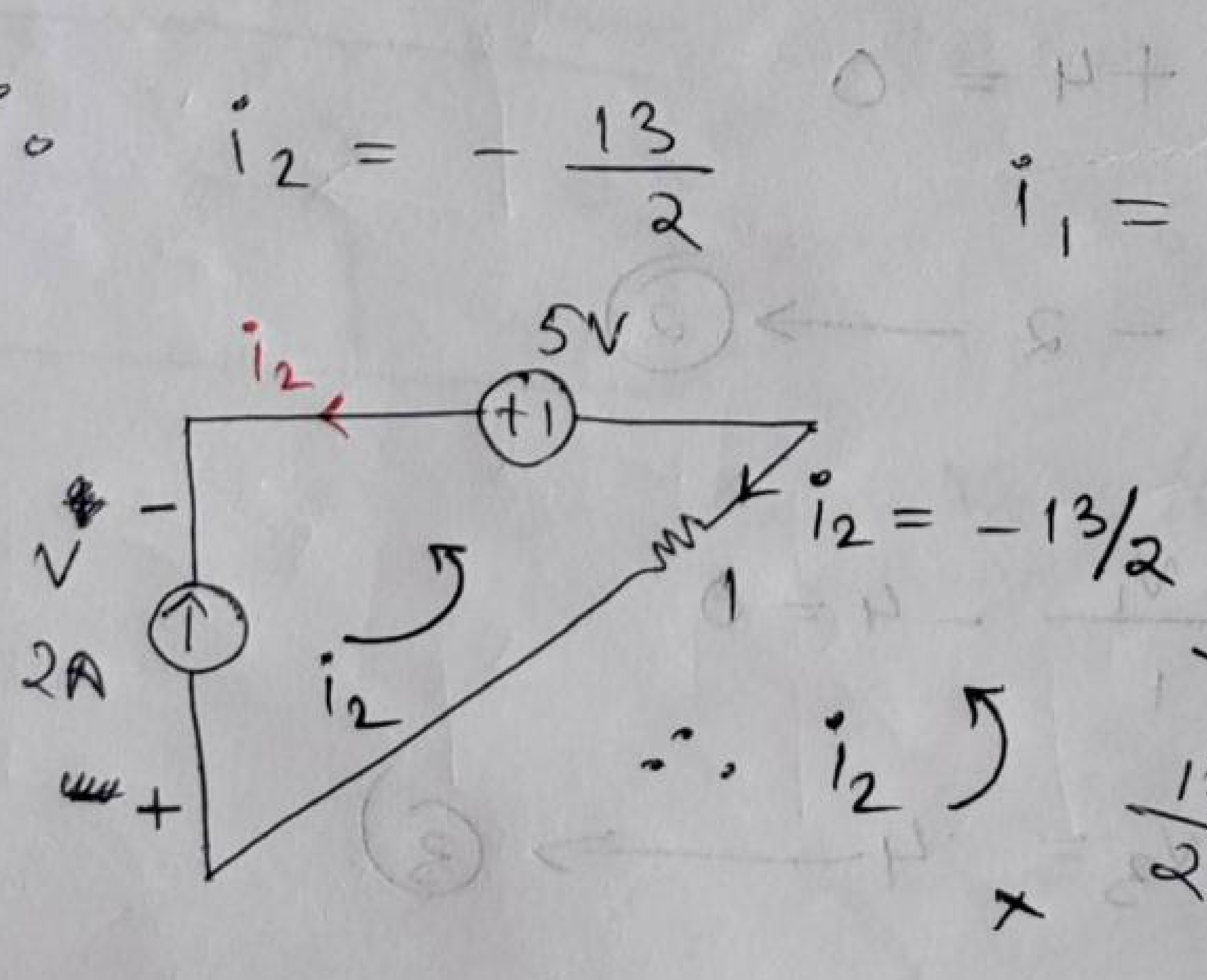
$$\Rightarrow i_3 = \frac{15}{2} \longrightarrow (2)$$

$$\therefore (1) \Rightarrow i_1 + i_2 + 2 \times \frac{15}{2} = 0$$

$$\Rightarrow i_1 + i_2 = -15 \longrightarrow (3)$$

Also, $i_2 - i_1 = 2 \longrightarrow (4)$

$$\therefore i_2 = -\frac{13}{2} \qquad i_1 = -\frac{17}{2}$$



$\therefore i_2 \circlearrowright \frac{13}{2}$ V

$$+\frac{13}{2} - 5 - V = 0$$

$$\Rightarrow +\frac{3}{2} = V$$

$$\therefore P_{del} = -2 \times \frac{3}{2} = \boxed{-3W}$$

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Nodal

$$\frac{V_1}{1} + \frac{V_1 - V_3}{2} - 2 + \frac{V_3}{1} + \frac{V_3 - V_1}{2} = 0$$

$$\Rightarrow V_1 + V_3 = 2 \longrightarrow (1)$$

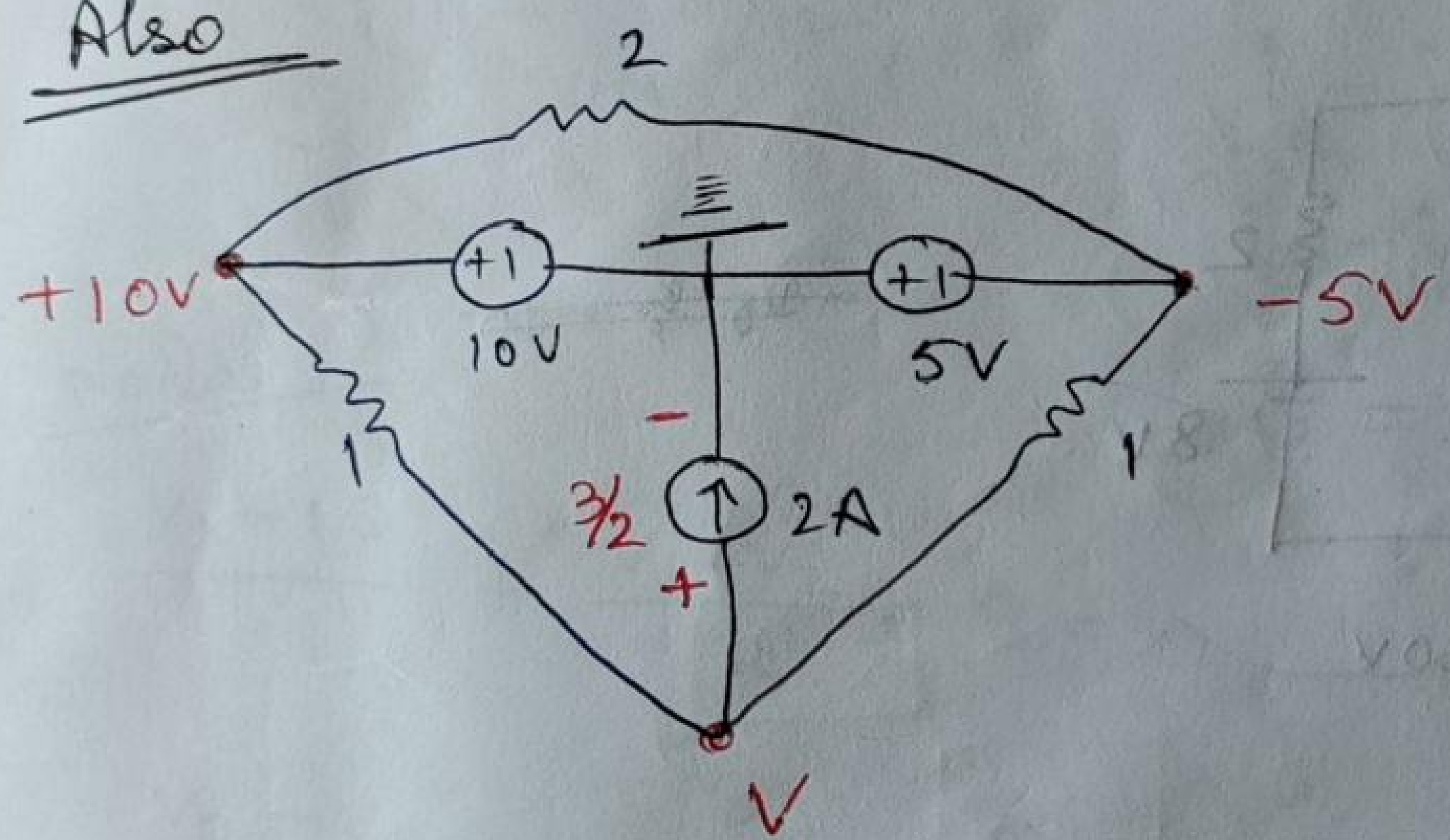
$$V_1 - V_2 = 10 \longrightarrow (2)$$

$$V_2 - V_3 = 5 \longrightarrow (3)$$

$$\therefore V_1 = \frac{17}{2} V \qquad V_2 = \frac{17}{2} - 10 = -\frac{3}{2} V$$

$$P_{del} = -\frac{3}{2} \times 2 = -3W.$$

Also

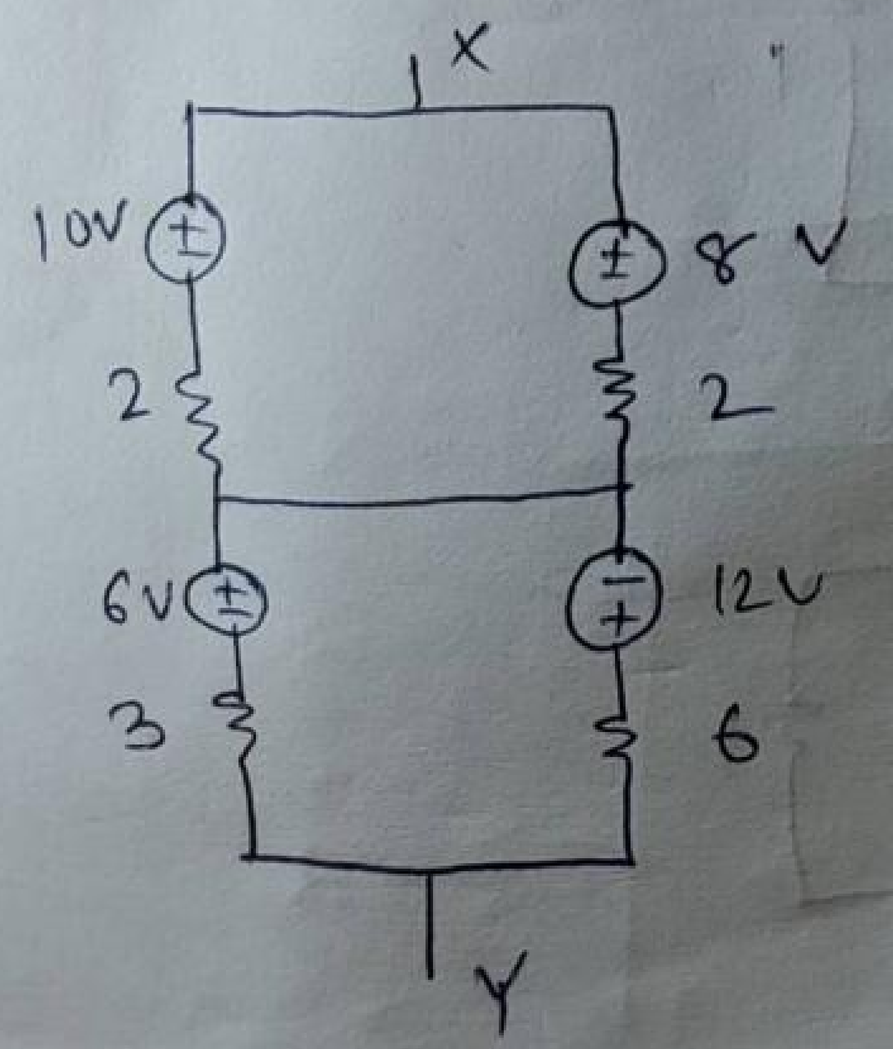


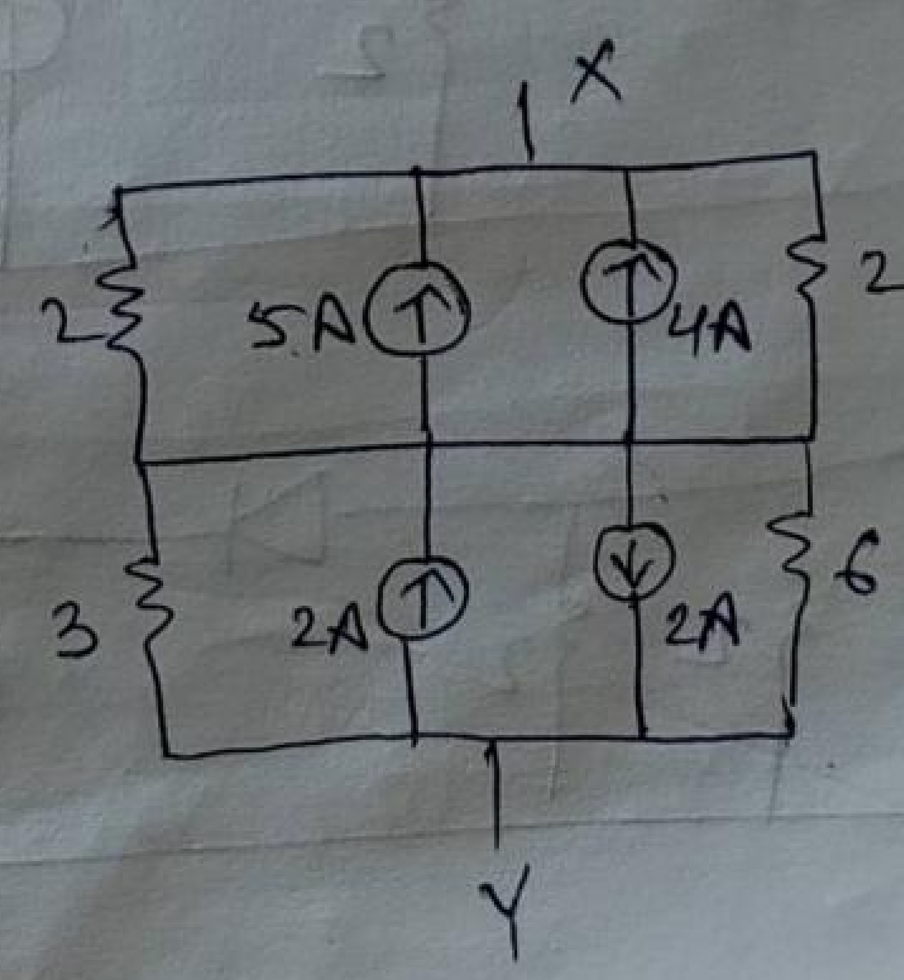
$$\frac{V - 10}{1} + \frac{V + 5}{1} + 2 = 0$$

$$\Rightarrow V = \frac{3}{2} V$$

$$\therefore P_{del} = -\frac{3}{2} \times 2 = -3W$$

4.





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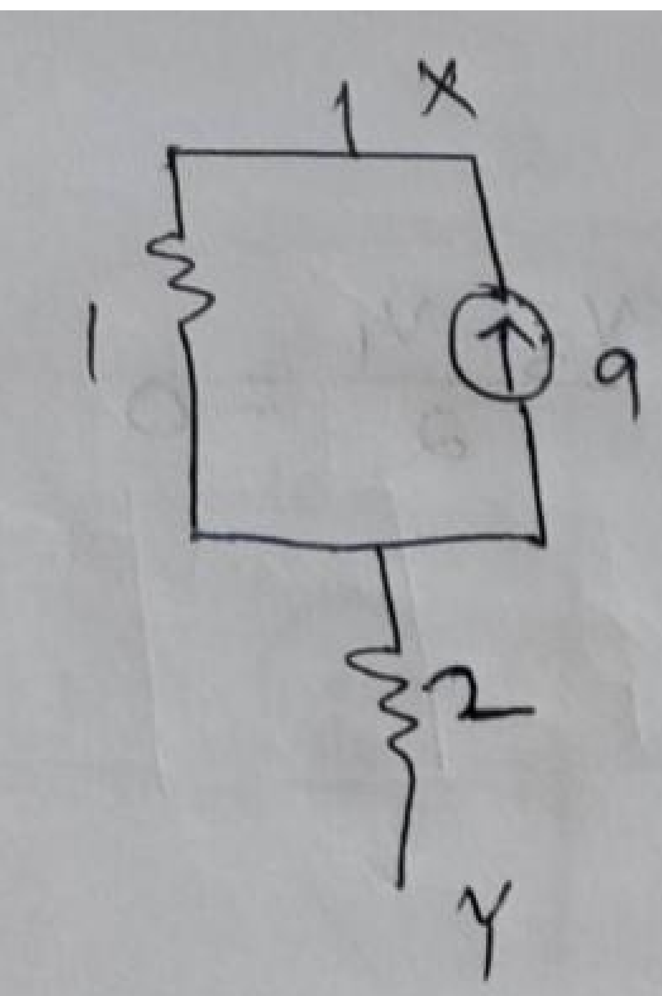
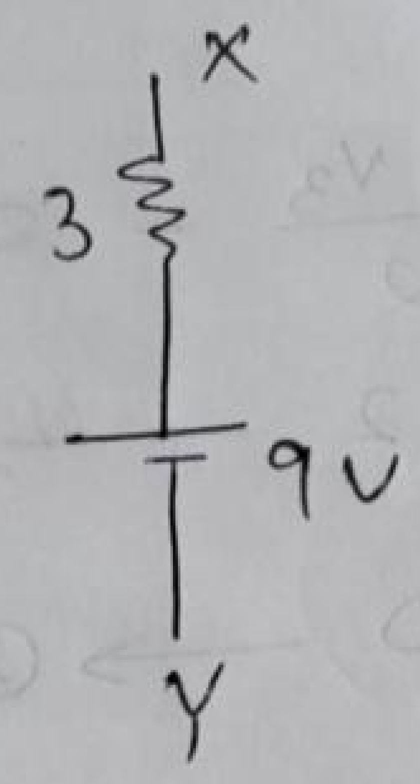
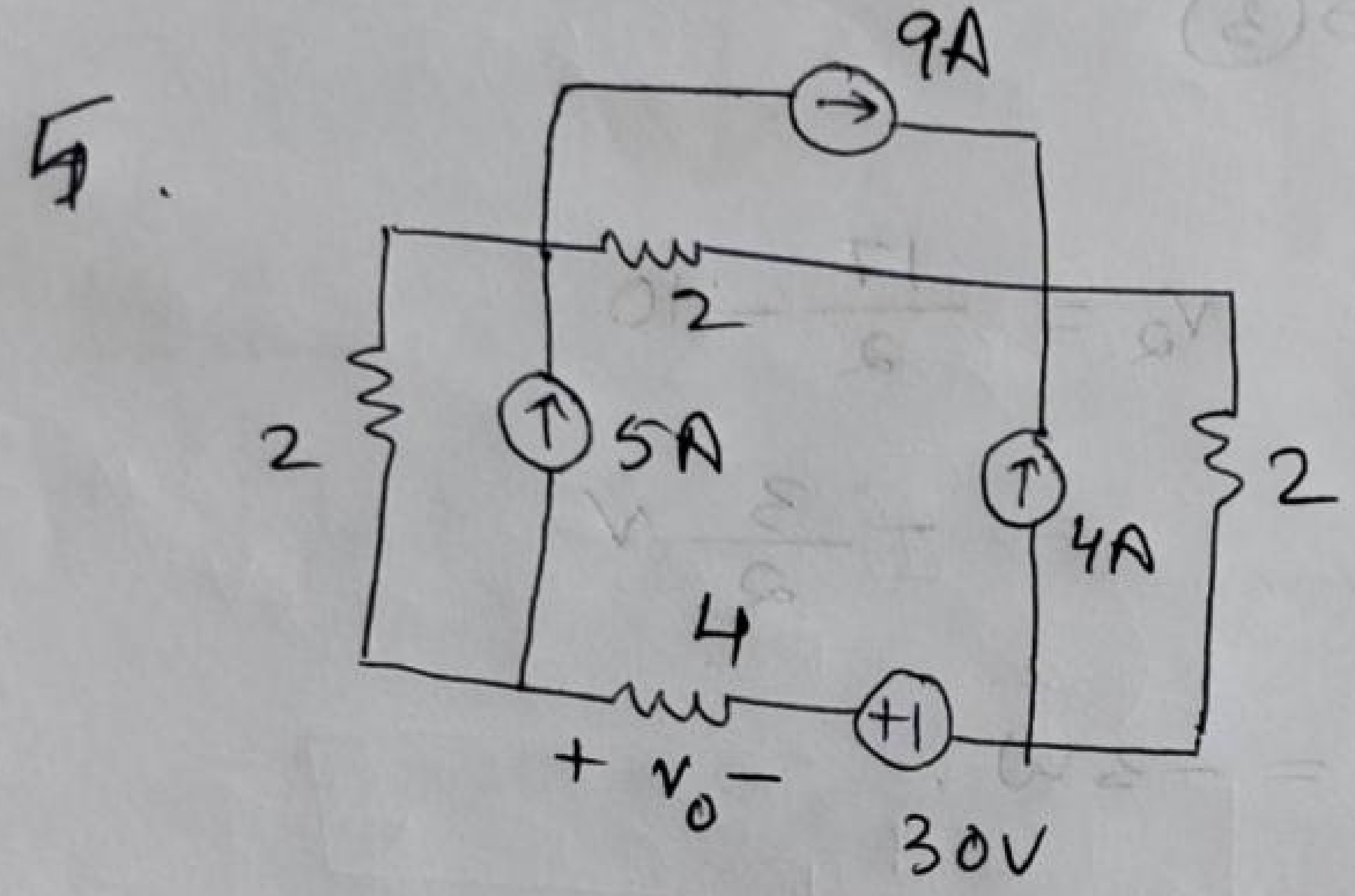
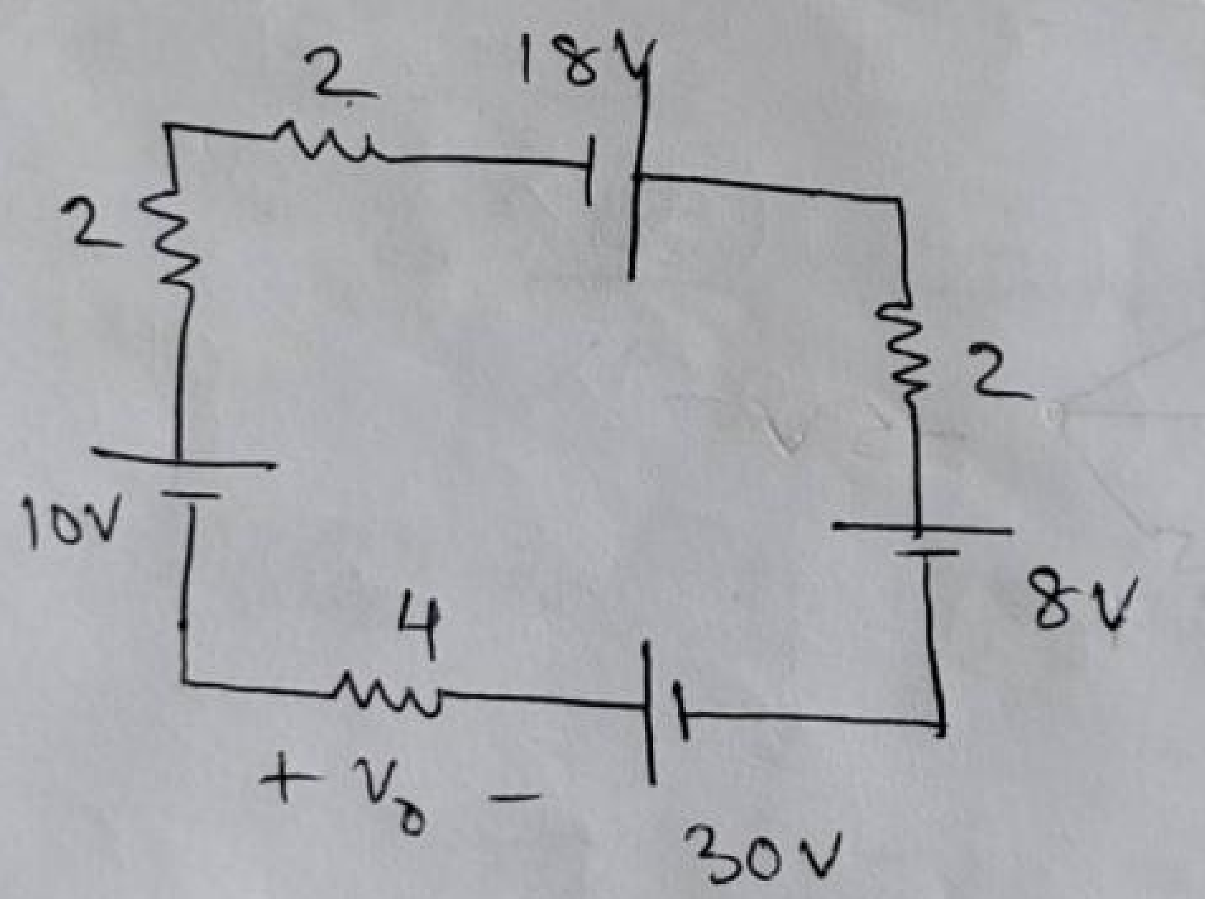


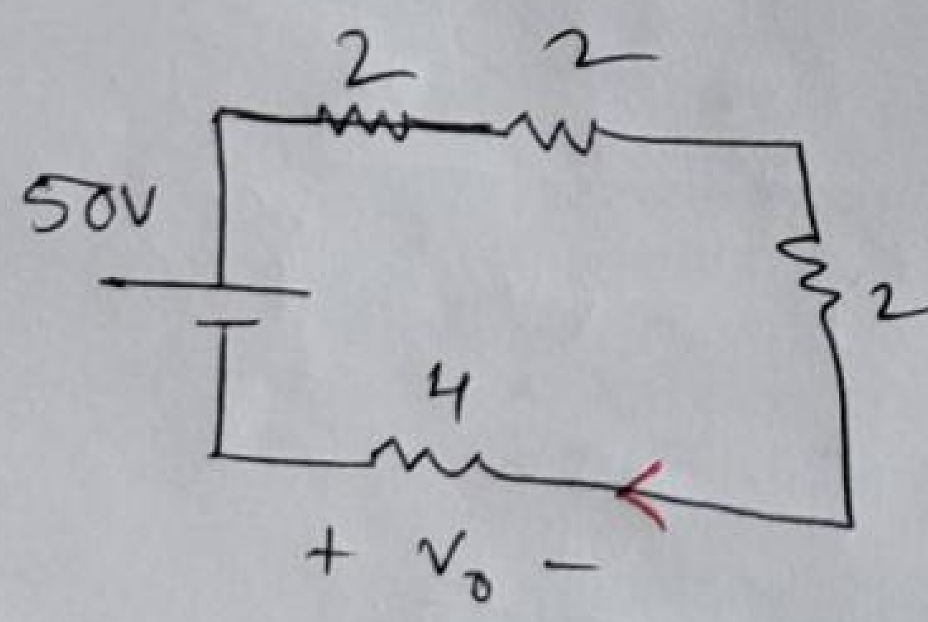


5.





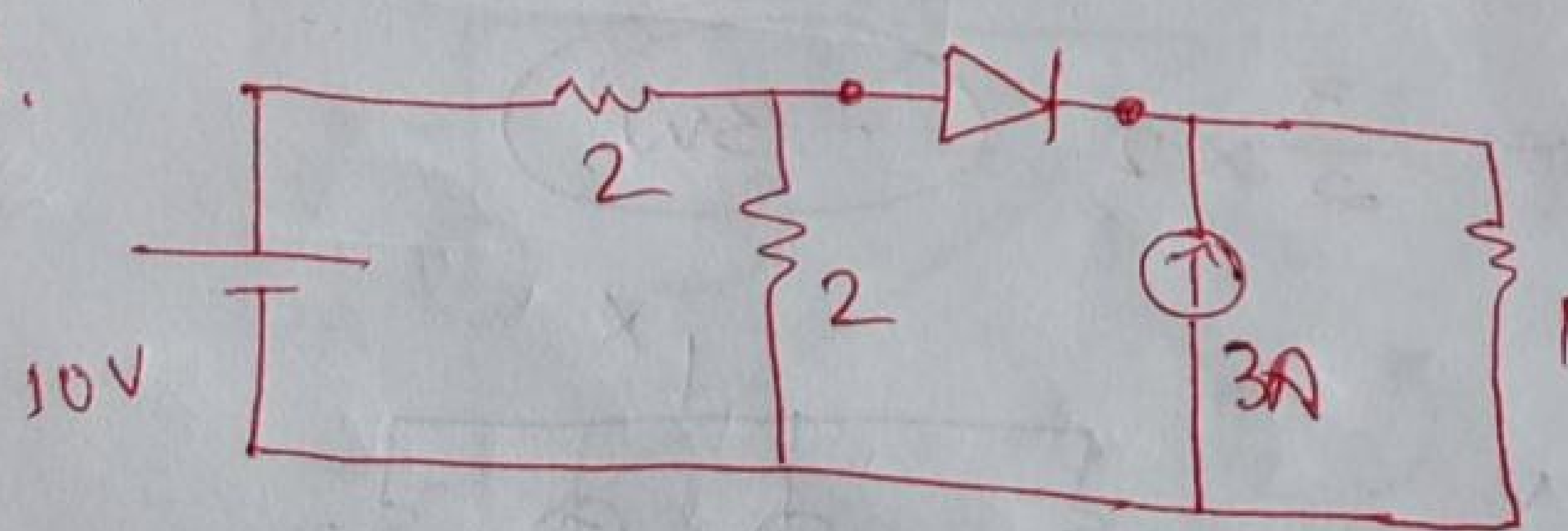
$\cancel{V_0 = -10}$

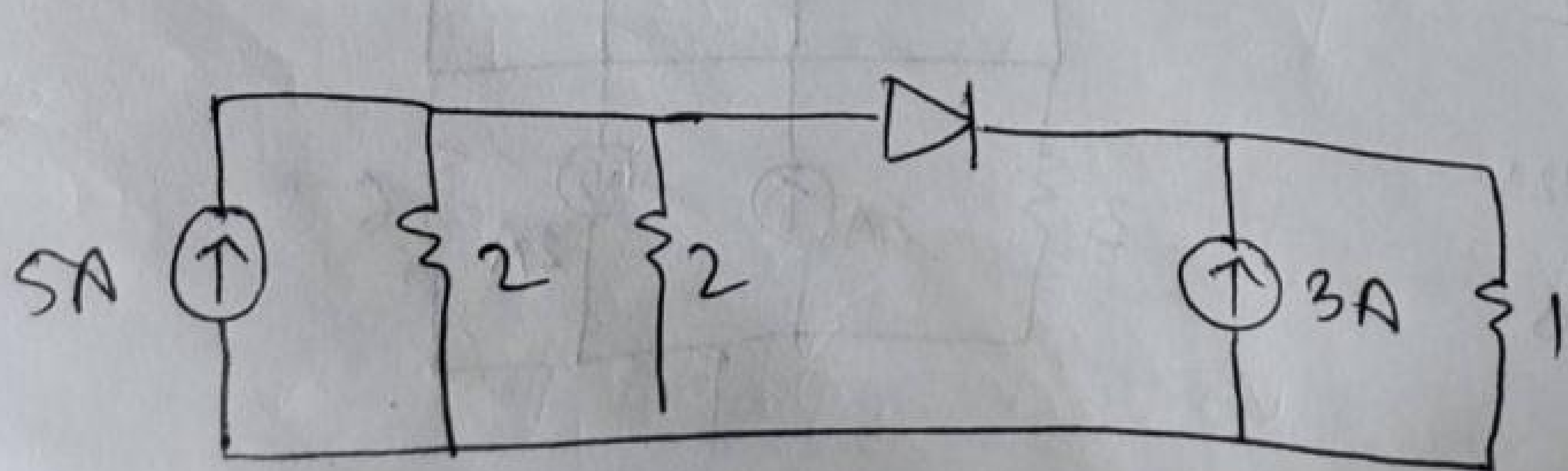


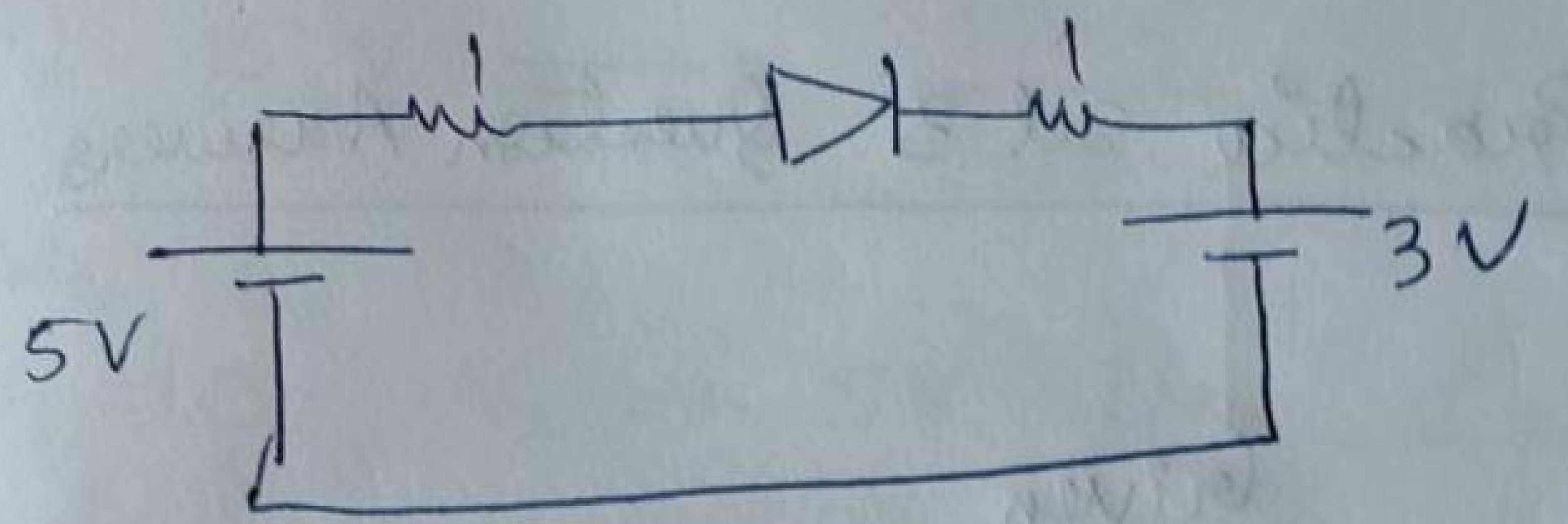
$$V_0 = -50\left(\frac{4}{4+6}\right)$$

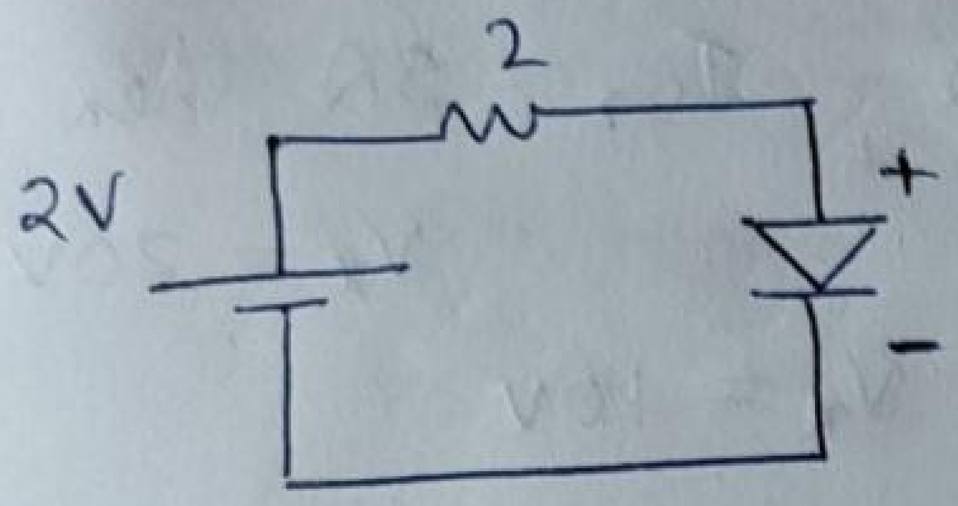
$$= -20V$$

6.





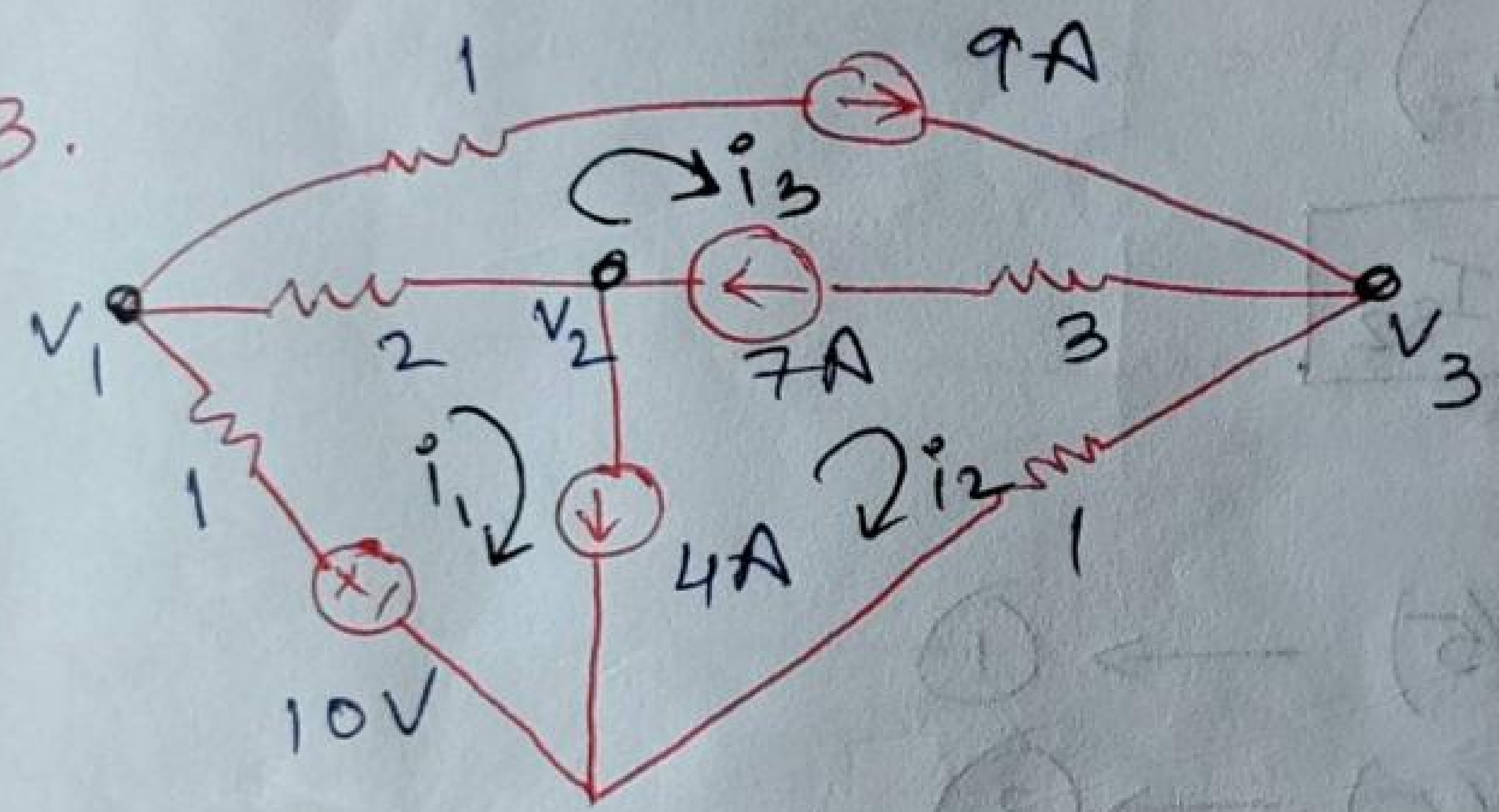




Forward bias $\therefore R = 0$

$$\therefore I_D = \frac{2}{2} = 1A$$

3.



Mesh

$i_1 - i_2 = 4 \longrightarrow (1)$

$i_3 - i_2 = 7 \longrightarrow (2)$

$i_3 = 9 \longrightarrow (3)$

Nodal

$$\frac{V_1 - 10}{1} + \frac{V_1 - V_2}{2} + 9 = 0 \longrightarrow (1)$$

$$\frac{V_2 - V_1}{2} + 4 - 7 = 0 \longrightarrow (2)$$

$$\frac{V_3}{1} - 9 + 7 = 0 \longrightarrow (3)$$

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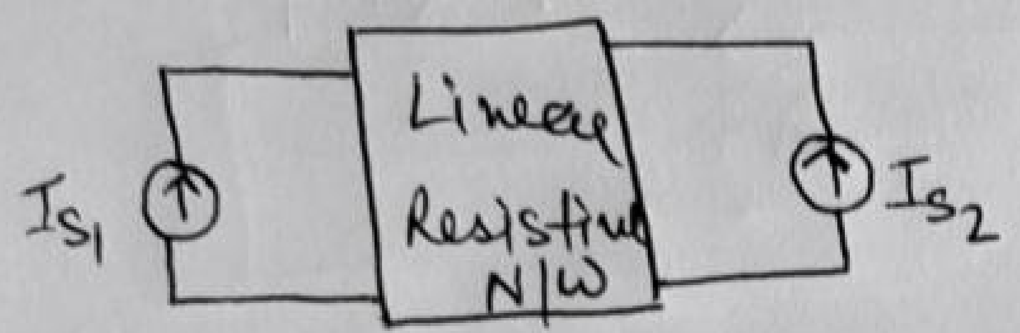
Practice set 3 Question Answers

1.



Given,

$I_{S_1} = 10A$, $I_{S_2} = 5A$ then $V_x = 20V$

$I_{S_1} = 20A$, $I_{S_2} = -5A$ then $V_x = 10V$

If $I_{S_1} = I_{S_2} = 15A$ then $V_x = ?$

Now,

$$V_x = f(I_{S_1}, I_{S_2})$$

$$\Rightarrow \boxed{V_x = \alpha I_{S_1} + \beta I_{S_2}}$$

$$20 = \alpha(10) + \beta(5) \longrightarrow 1$$

$$10 = \alpha(20) - \beta(5) \longrightarrow 2$$

solving 1 and 2 $\Rightarrow 30 = 30\alpha$

$$\Rightarrow \boxed{\alpha = 1}$$

$$\therefore \boxed{\beta = 2}$$

Again,

$$V_x = 1\, I_{S_1} + 2\, I_{S_2}$$

$$= 1 \times 15 + 2 \times 15 = 45$$

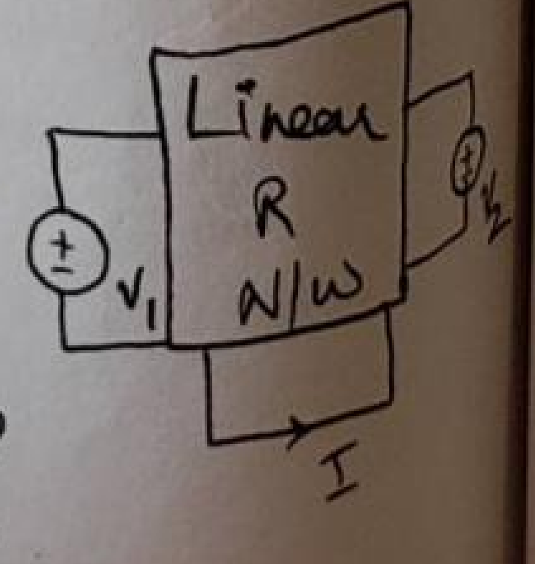
$$\boxed{V_x = 45V}$$

~~Sol~~ ~~Given~~,

~~$V_1 = 10V$, $V_2 = 0V$ and then $I = 5A$~~

~~Also, $V_1 = 0V$, $V_2 = -5V$ then $I = 1A$~~

2.



To find : If $V_1 = V_2 = 15V$, $I = ?$

~~If~~ $V_1 = 10$, $V_2 = 0V$ then $I = 5A$

If V_1 act alone $\rightarrow$

$10 \longrightarrow 5A$

$\therefore$ $15\text{ V} \longrightarrow \dfrac{15\times5}{10} = 7.5\text{ A}$ (Homogenity)

Also,

$V_1 = 0$, $V_2 = -5\text{V}$ then $I = 1\text{A}$

If V_2 act alone

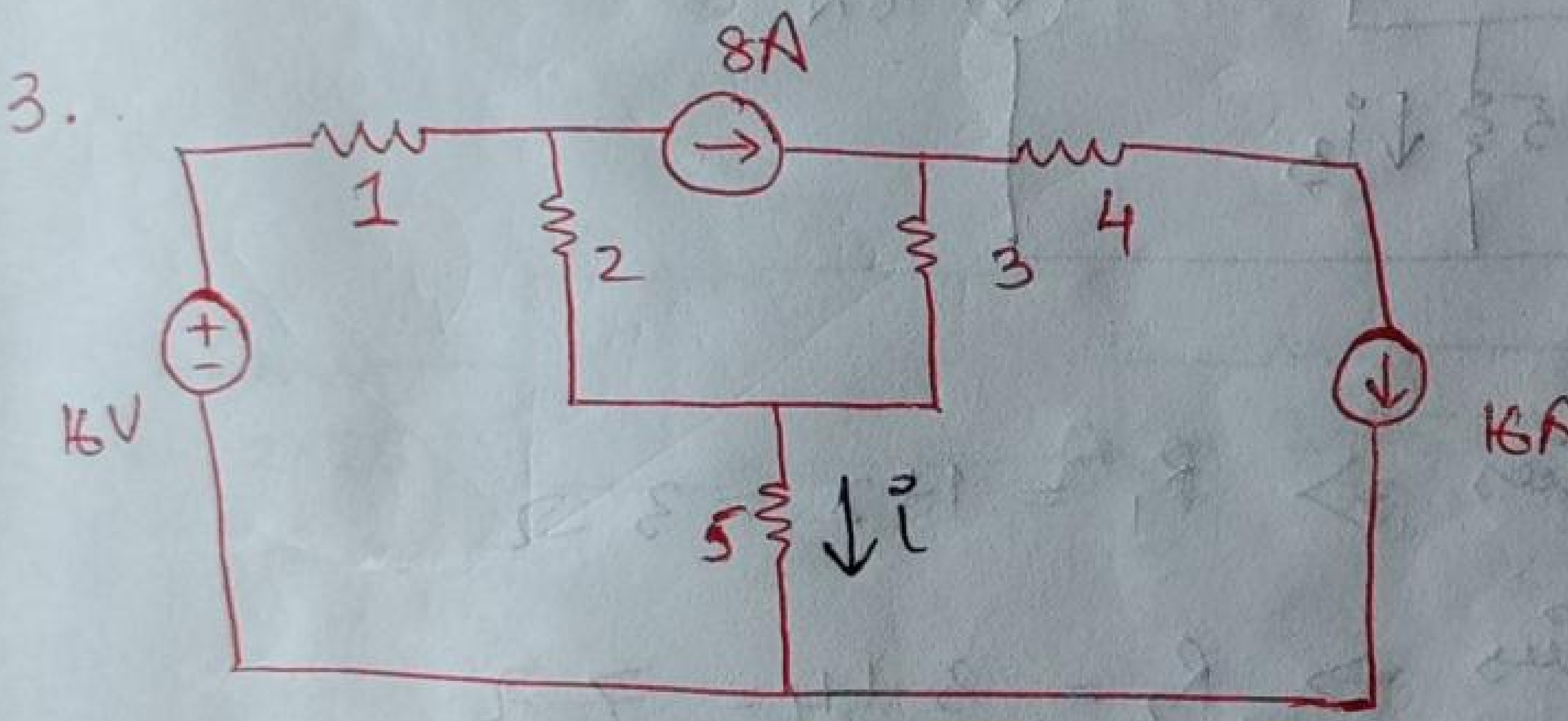
$-5\text{V} \longrightarrow 1\text{A}$

$15\text{V} \longrightarrow \dfrac{15\times1}{-5} = -3\text{A}$ (Homogenity)

By S.P.T

$$I = 7.5 - 3 = 4.5\text{A}.$$

3.

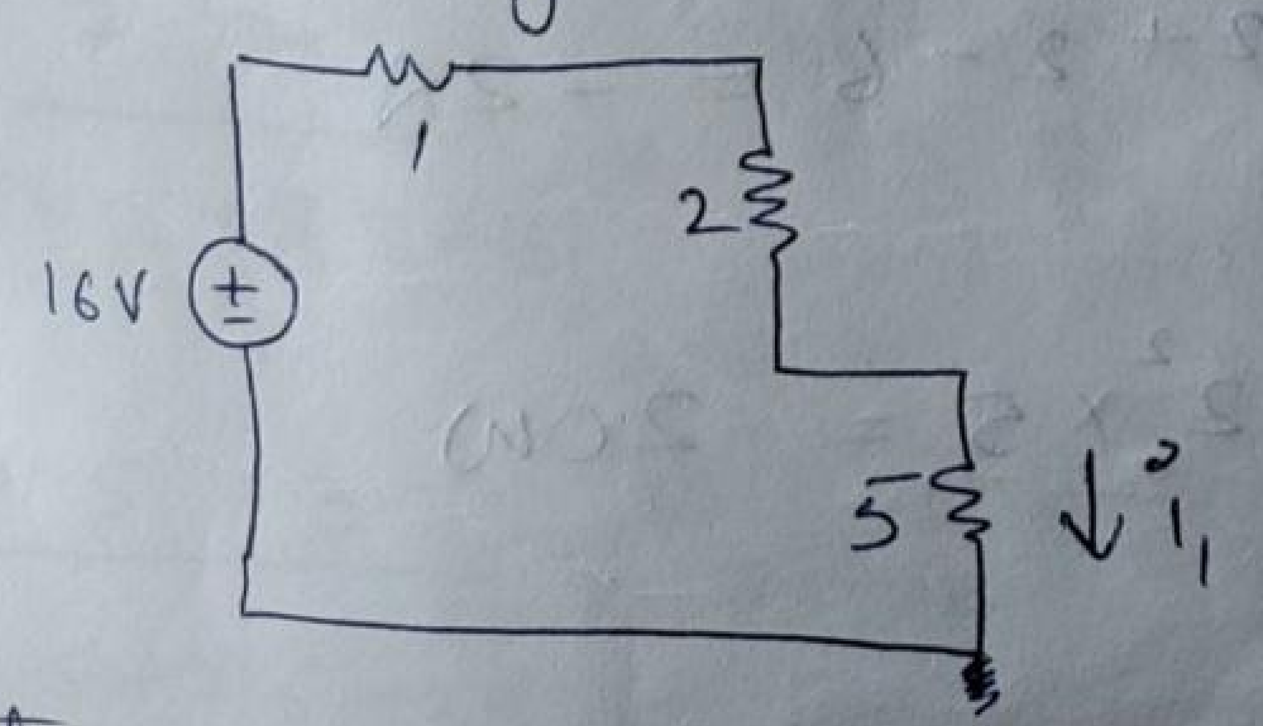


Find P_{lost} in $5\,\Omega$ resistor using SPT and KVL.

NOTE : Power is a non linear parameter and hence can't be calculated directly using SPT.

Sol^n

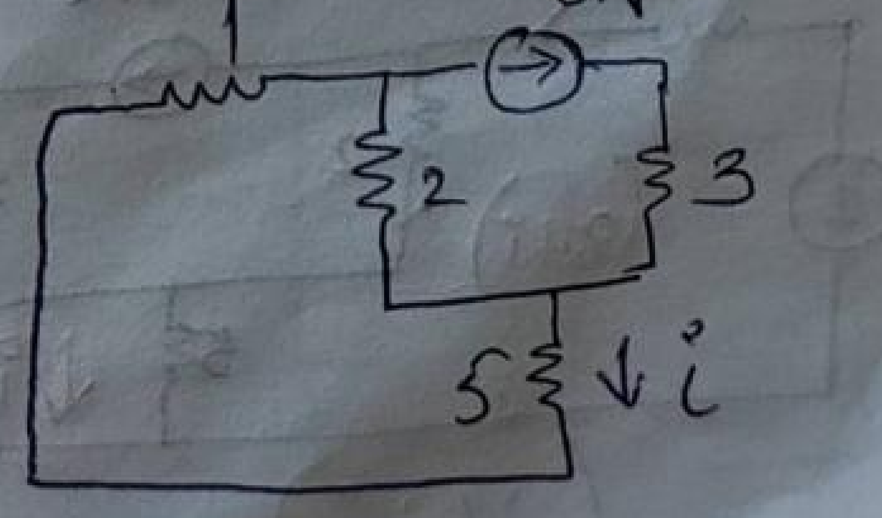
Step 1: 16 V only

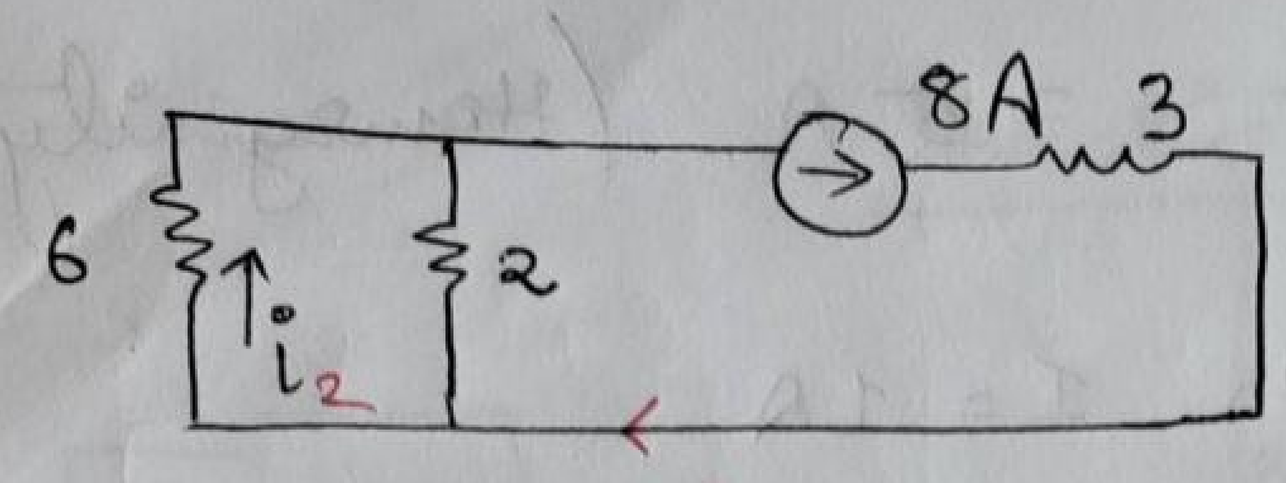


$$i_1 = \frac{16}{8} = 2\text{A}$$

Step 2 : 8A only

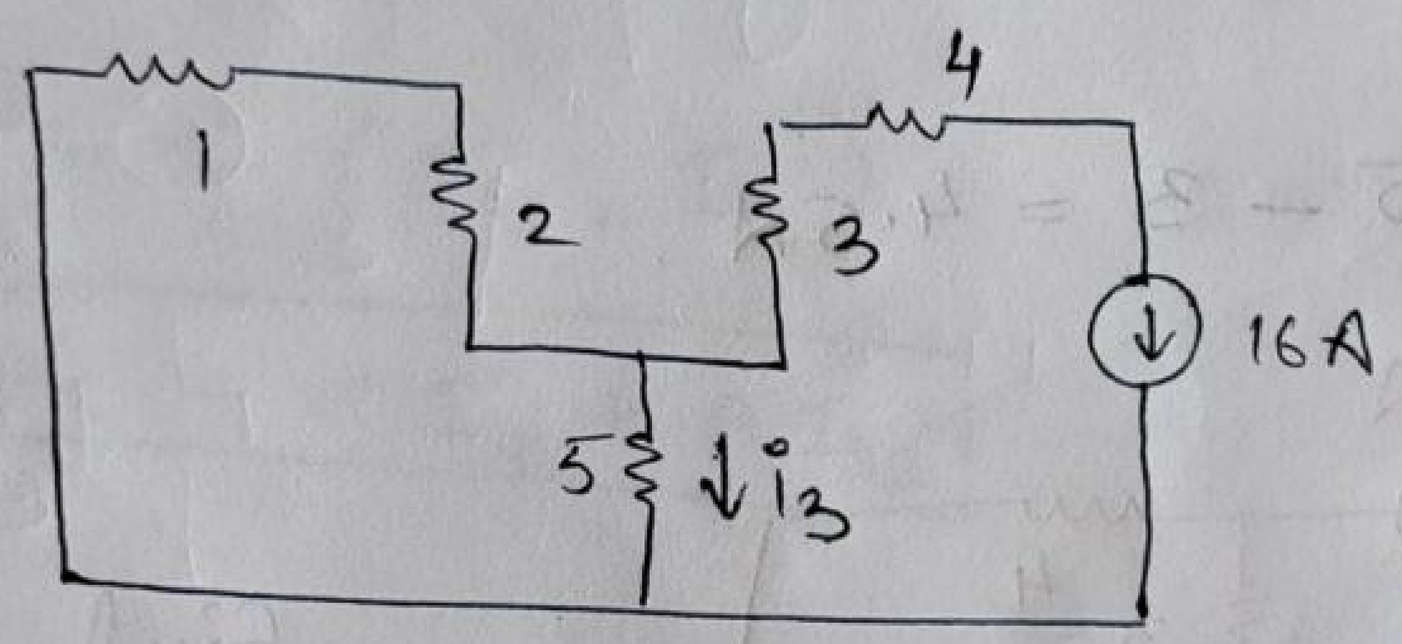
5 and 1 in series $R = 5+1$
$= 6$





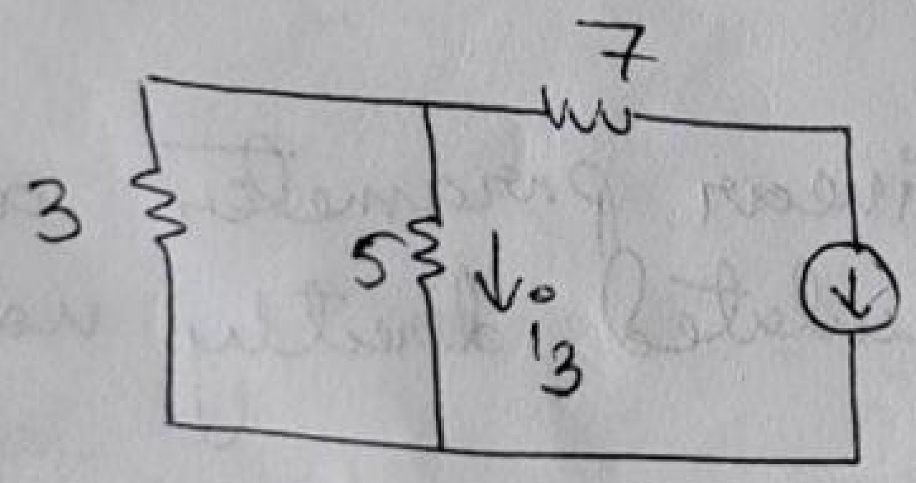
$$\therefore \; i_2 = 8\left(\frac{2}{6+2}\right) = 2A.$$

<u>step 3</u> : 16A only



1 and 2 in series ⇒ $R_1 = 1+2 = 3\ \Omega$

3 and 4 in series ⇒ $R_2 = 3+4 = 7\ \Omega$



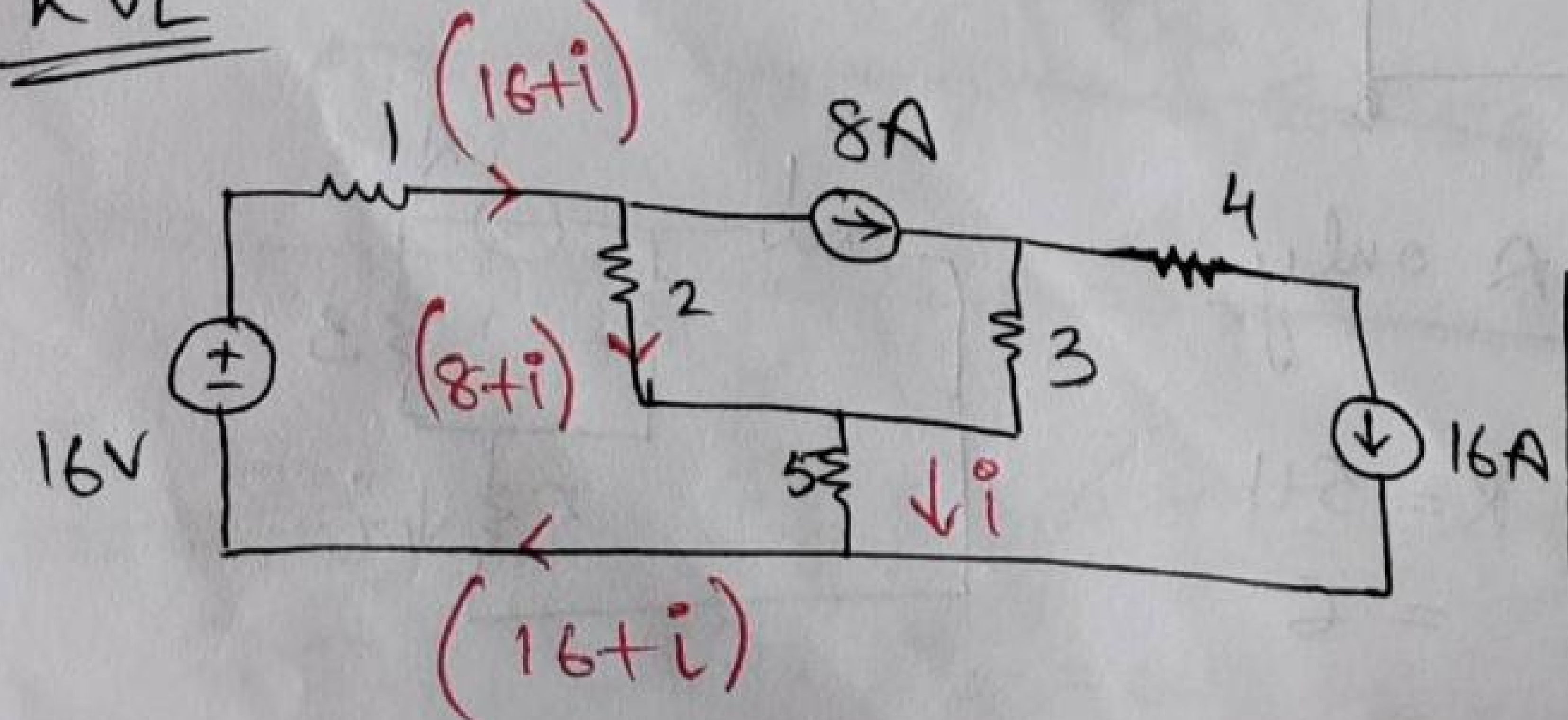
$$i_3 = -16\left(\frac{3}{5+3}\right)$$

$$= -6A$$

$$\therefore \; i = i_1 + i_2 + i_3 = 2+2-6 = -2A$$

$$P_{Lost} = I^2 R = 2^2 \times 5 = 20W$$

<u>KVL</u>



$-16 + 1(16+i) + 2(8+i) + 5i = 0$

$\Rightarrow 8i = -16$

$\Rightarrow i = -2A$

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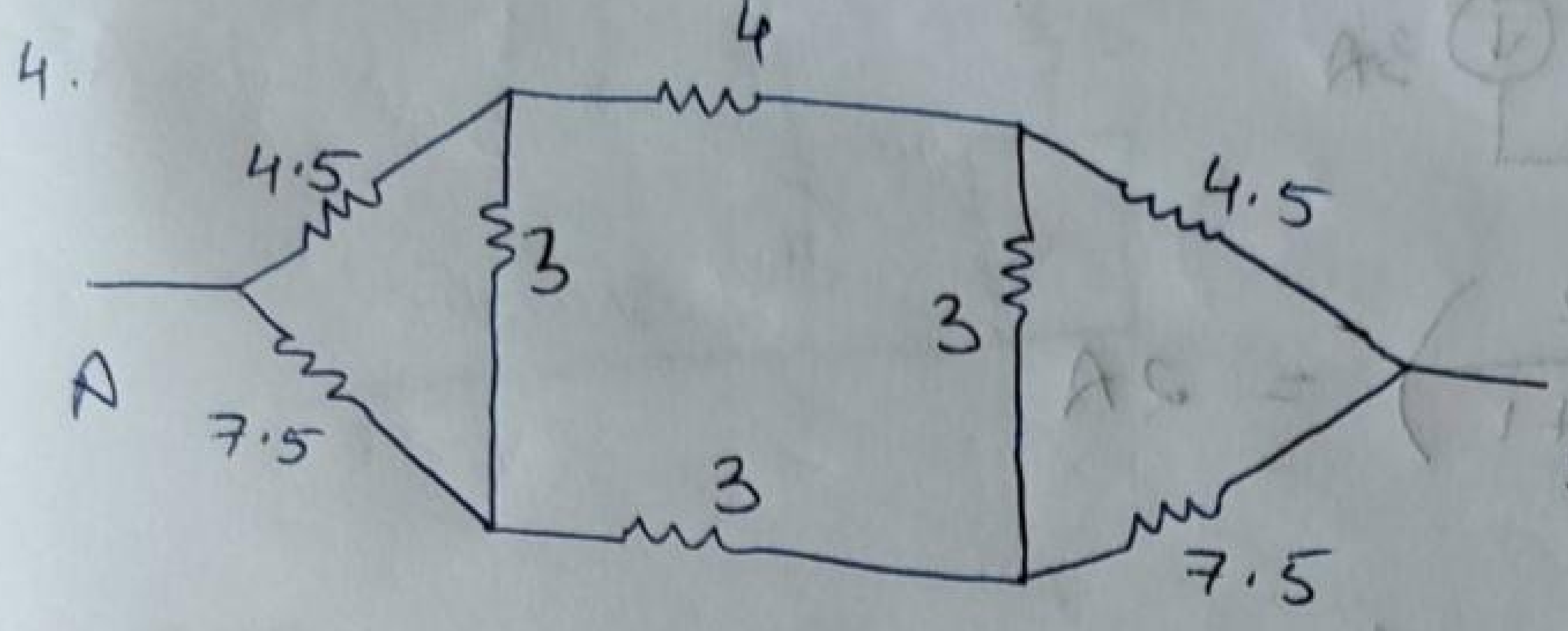
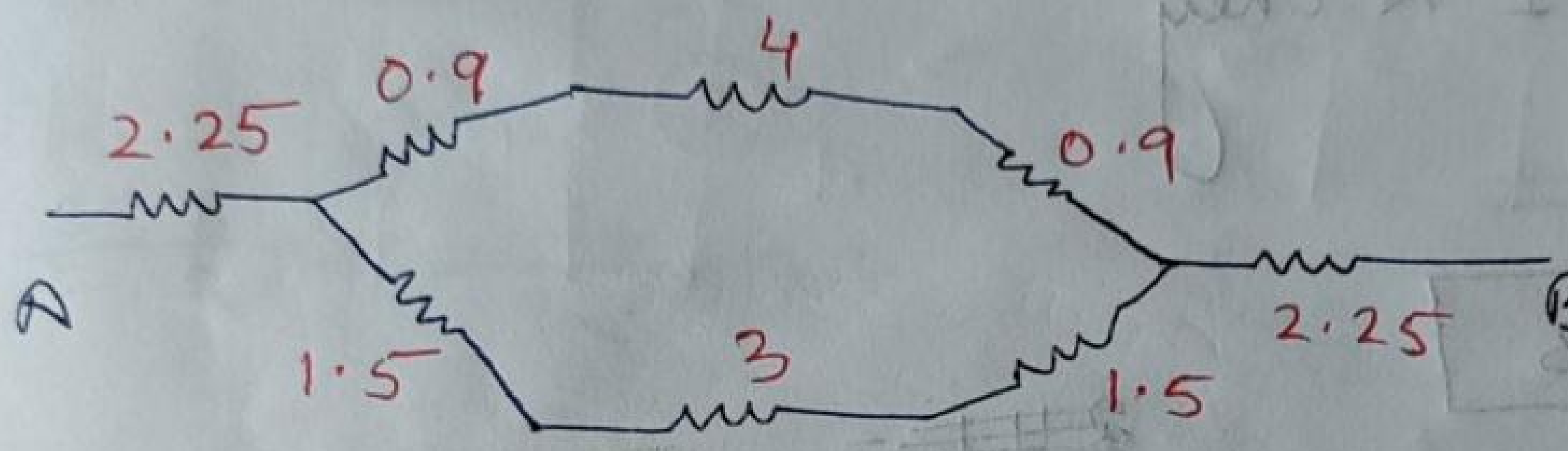
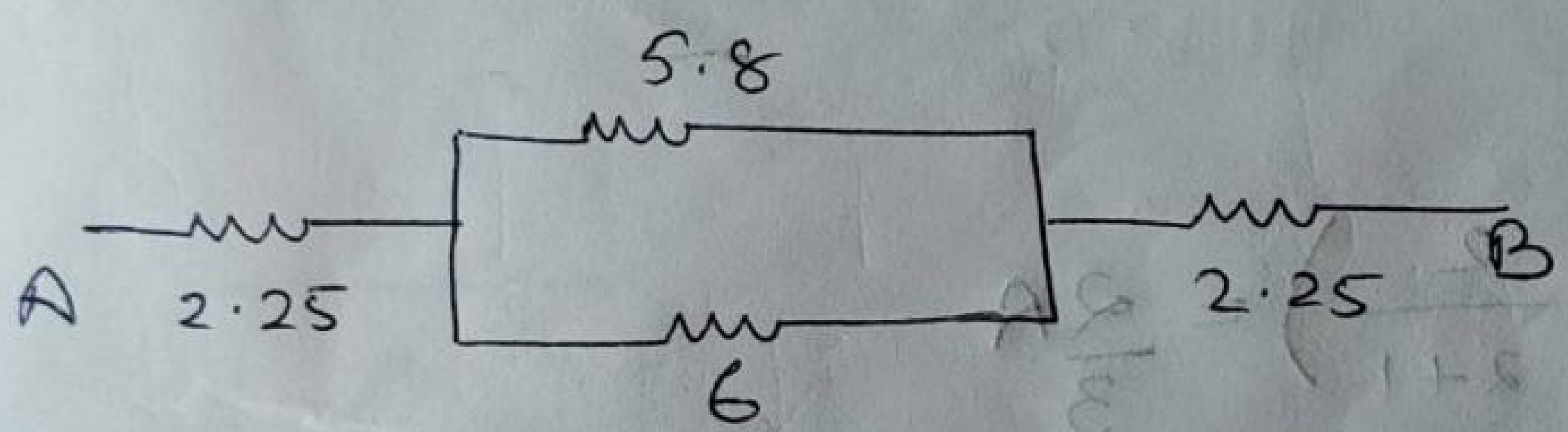
$\therefore P_{lost} = i^2 R$

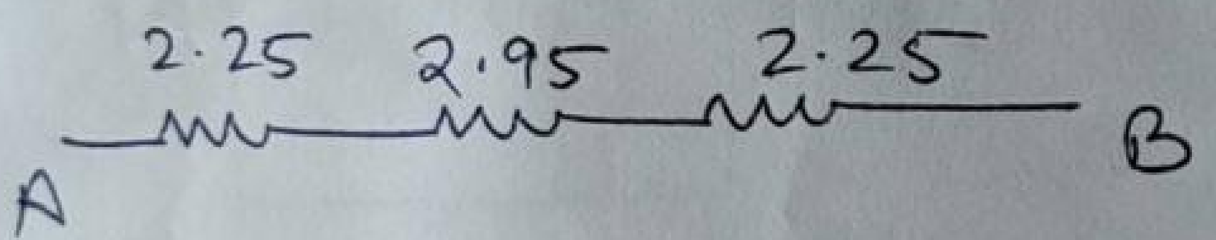
$= 4 \times 5 = 20W$

4. Find R_{AB}









$R_{AB} = 7.45\,\Omega.$

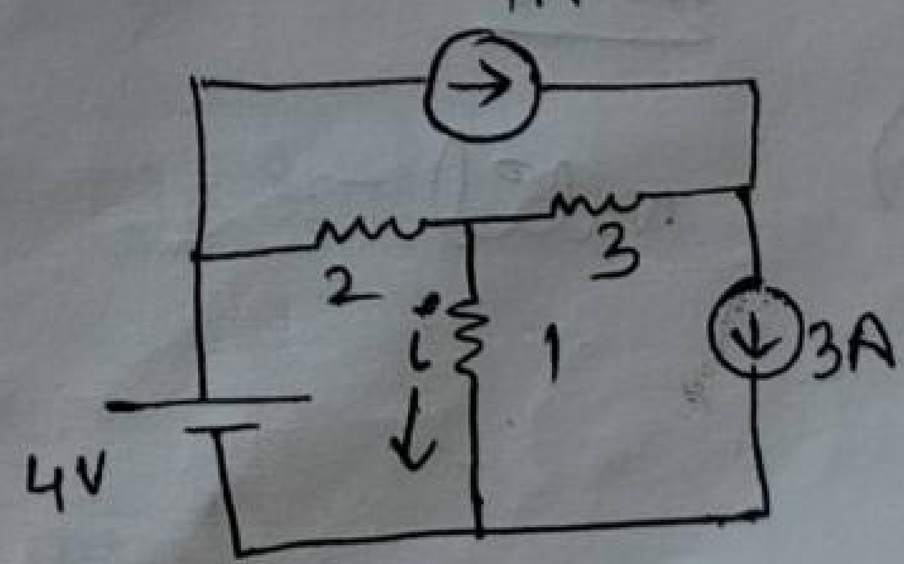
Delta to Star

$$\frac{4.5 \times 7.5}{4.5 + 7.5 + 3} = 2.25\,\Omega$$

$$\frac{7.5 \times 3}{4.5 + 7.5 + 3} = 1.5\,\Omega$$

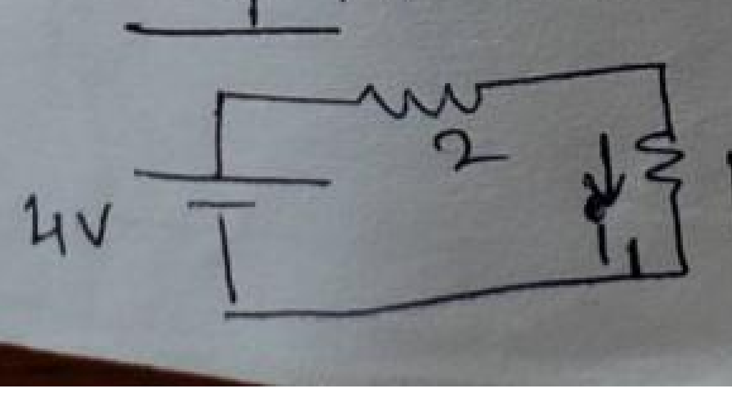
$$\frac{4.5 \times 3}{4.5 + 7.5 + 3} = 0.9\,\Omega$$

5. Find i in 1Ω using SPT



sol^n

step 1: 4V only



$i_1 = \frac{4}{3}$ A

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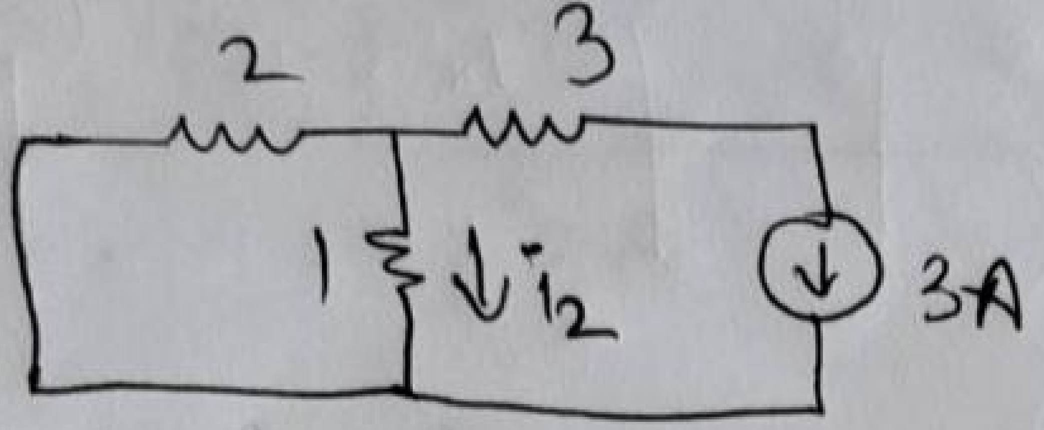
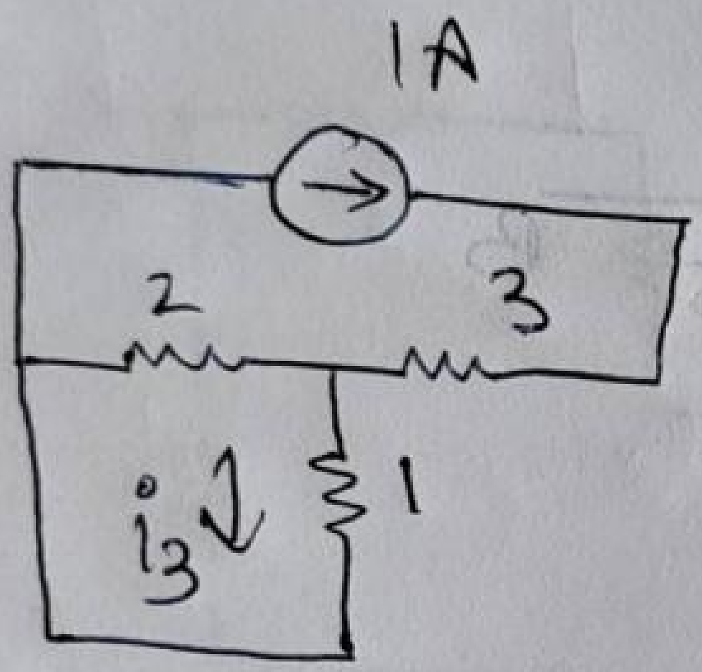
Step 2 : 3A only



$$i_2 = 3\left(\frac{2}{2+1}\right) = 2A$$

Step 3 : 1 A only



$$i_3 = 1\left(\frac{2}{2+1}\right) = \frac{2}{3}A$$

$$\therefore\ i = i_1 + i_2 + i_3$$

$$= \frac{4}{3} + 2 + \frac{2}{3}$$

$$i = 4A$$

6. (a) 2 voltage of different values → violates KVL.

(b) Valid as resistor in b/w.

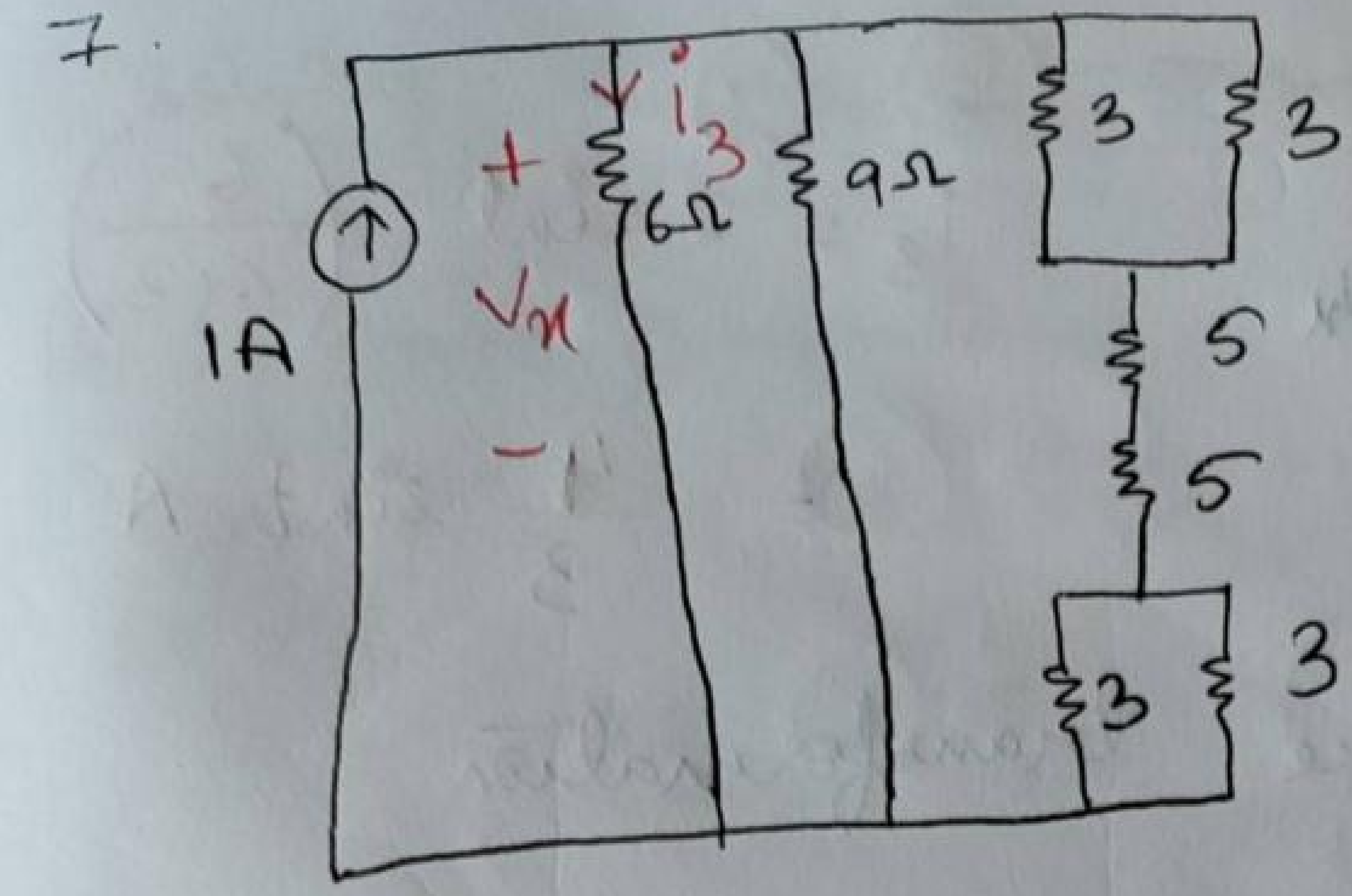
(c) unclear what current flows through R.

$I = 1 - 1 = 0$ → invalid

(d) Valid.

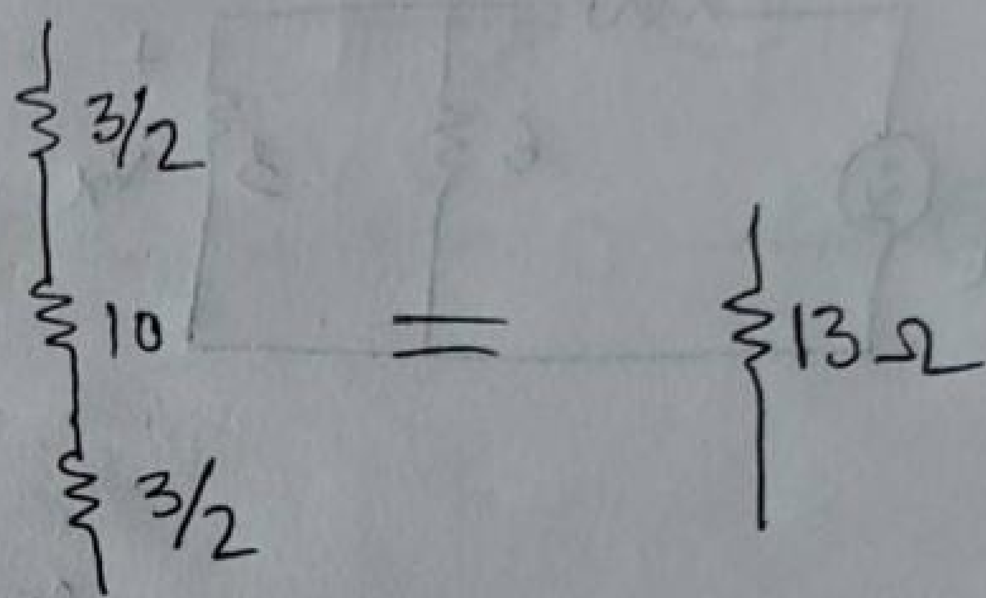
(e) Valid

7.



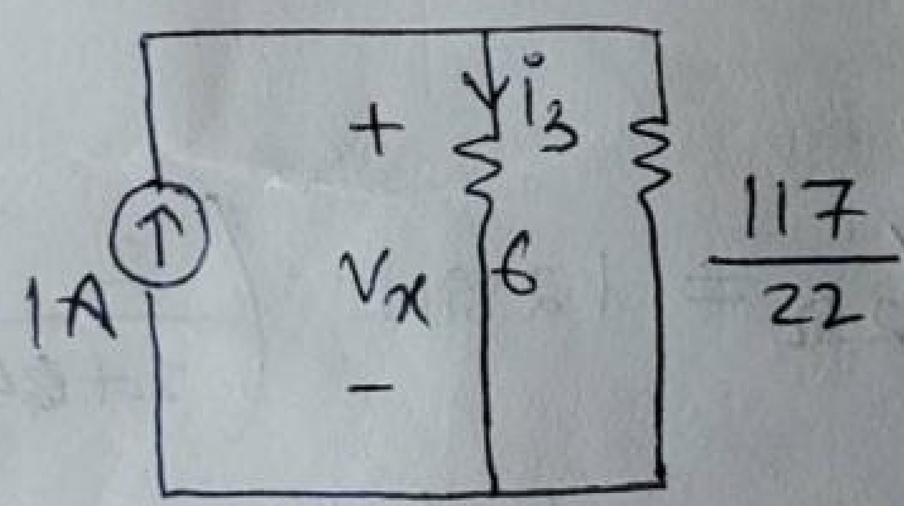
Find V_x.

$$3 \| 3 = \frac{9}{6} = \frac{3}{2}$$



$$\frac{3}{2} + \frac{3}{2} + 10 = \frac{26}{2} = 13\,\Omega$$

$$13 \| 9 = \frac{13 \times 9}{22} = \frac{117}{22}$$



$$i_3 = 1\left(\frac{117/22}{\frac{117}{22} + 6}\right)$$

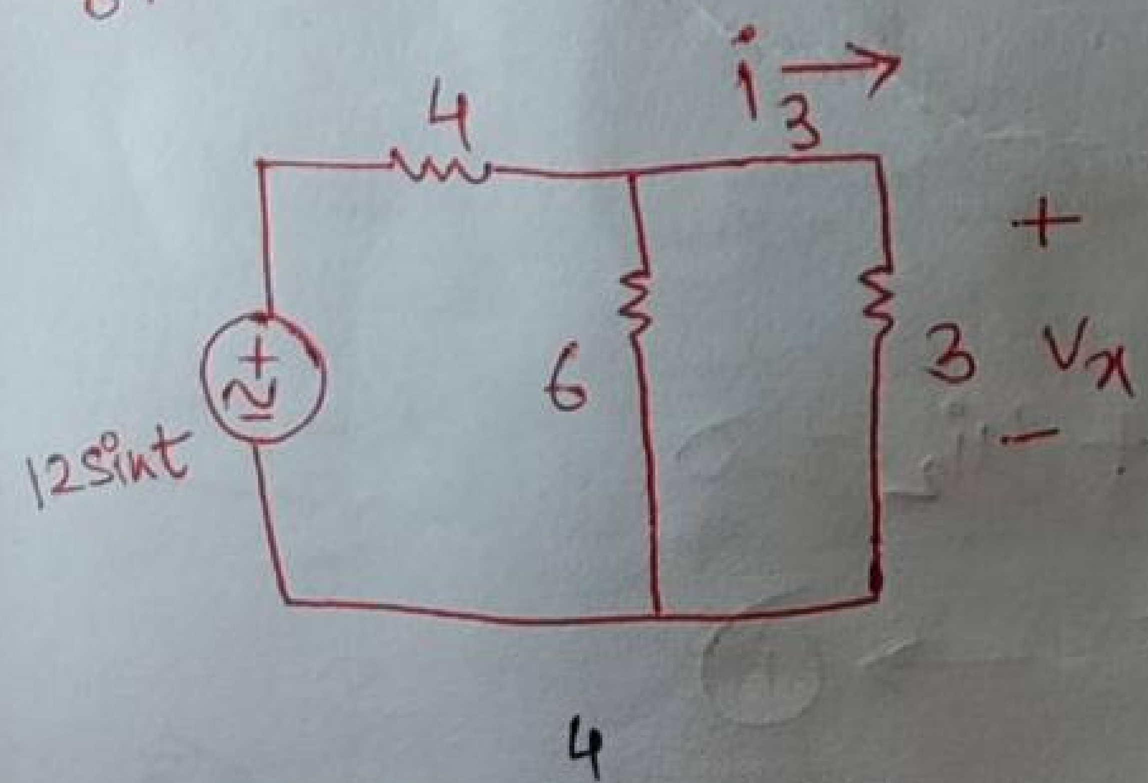
$$= \frac{117}{22} \times \frac{22}{249}$$

$$= 0.4698$$

$$\therefore V_x = 6 \times 0.4698$$

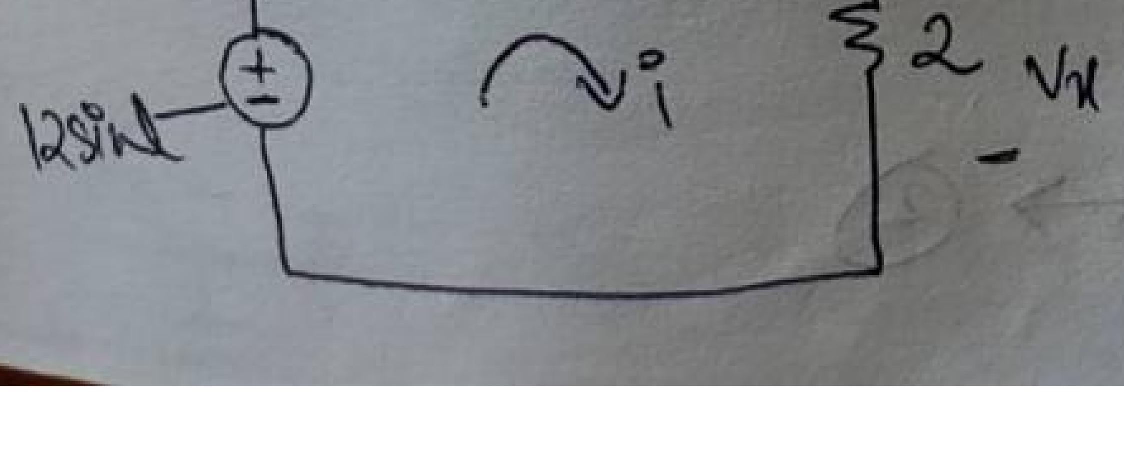
$$= 2.8188 \approx 2.819\ V$$

8.



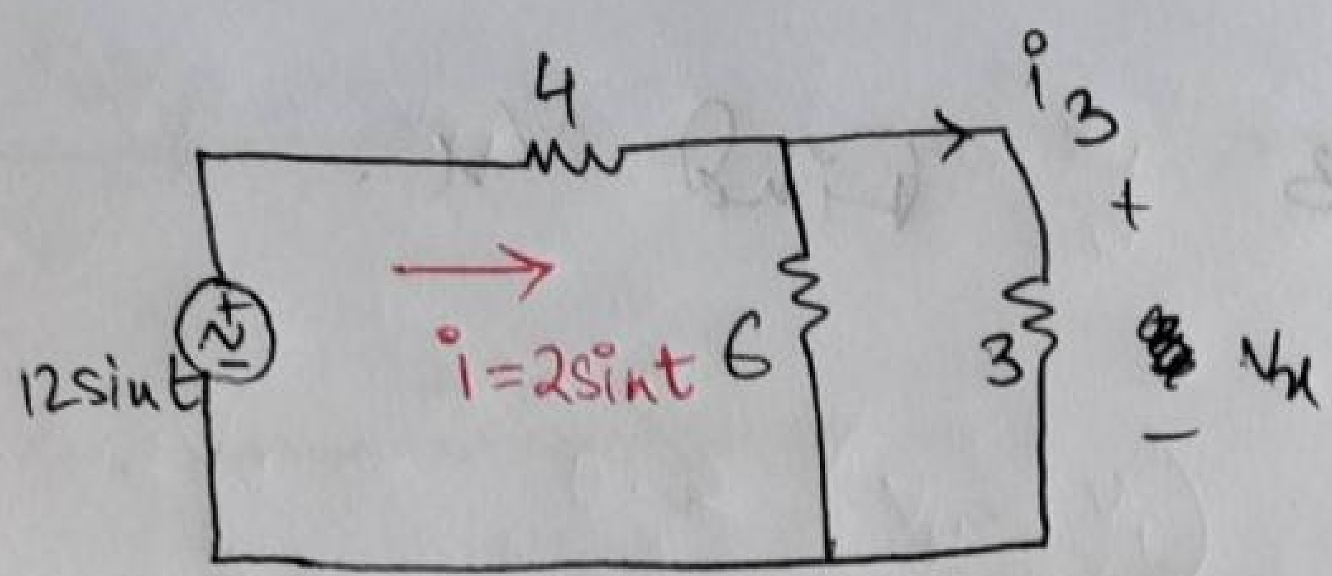
Find i_3.

$$3 \| 6 = 2\,\Omega$$



$$i = \frac{12 \sin t}{6} = 2 \sin t\ A$$

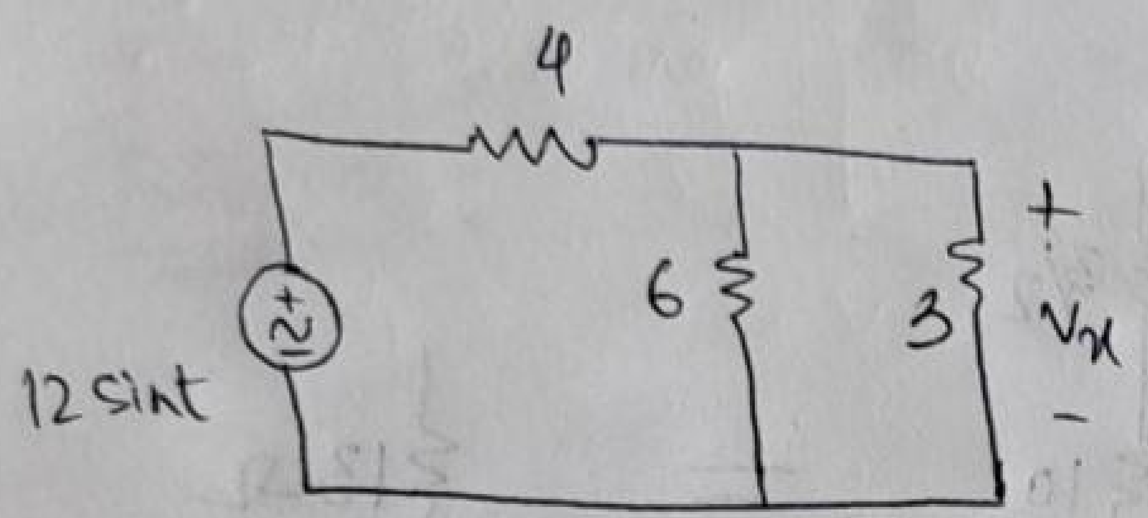
total current.



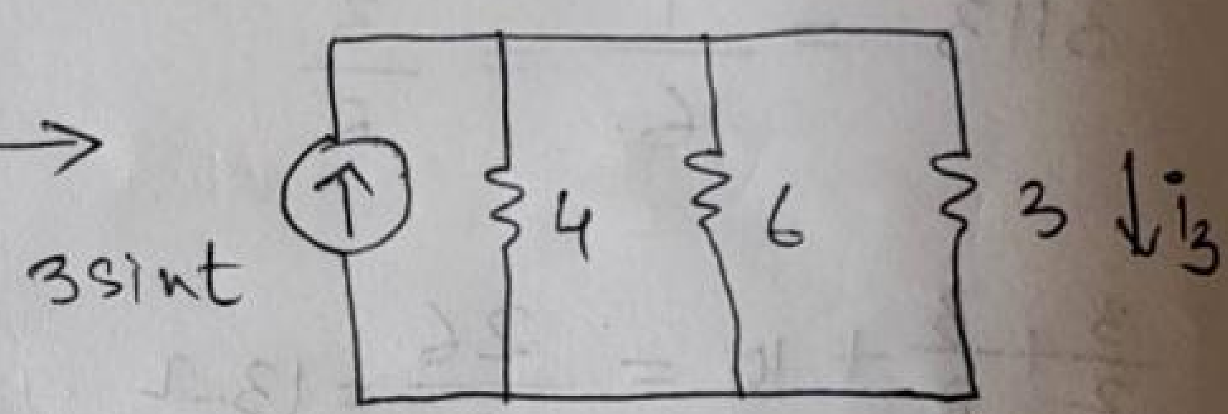
$$i_3 = 2\sin t\left(\frac{6}{6+3}\right)$$

$$= \frac{4}{3}\sin t \text{ A}$$

Method 2 : Source transformation

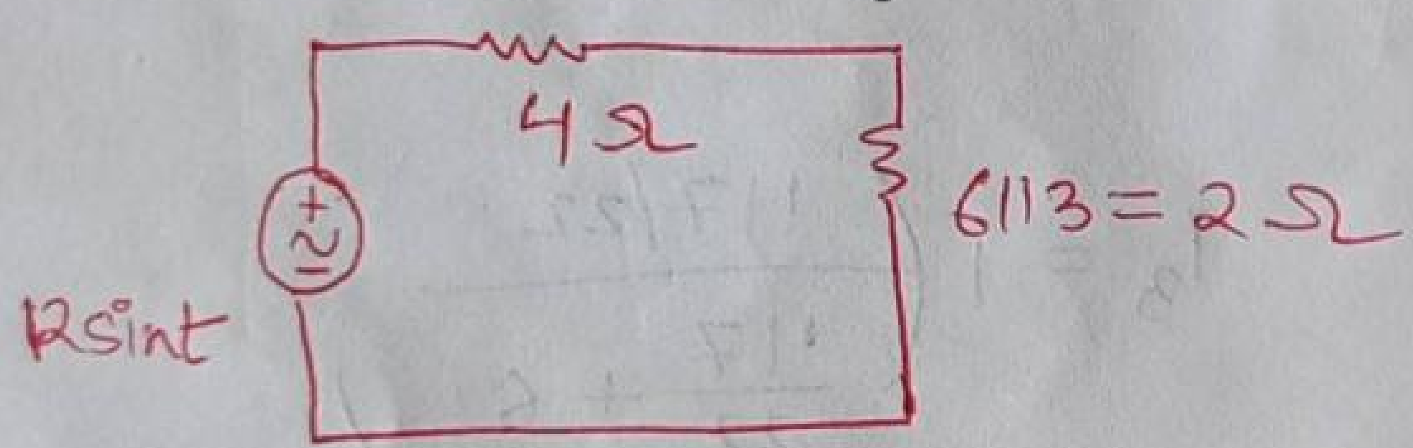


→



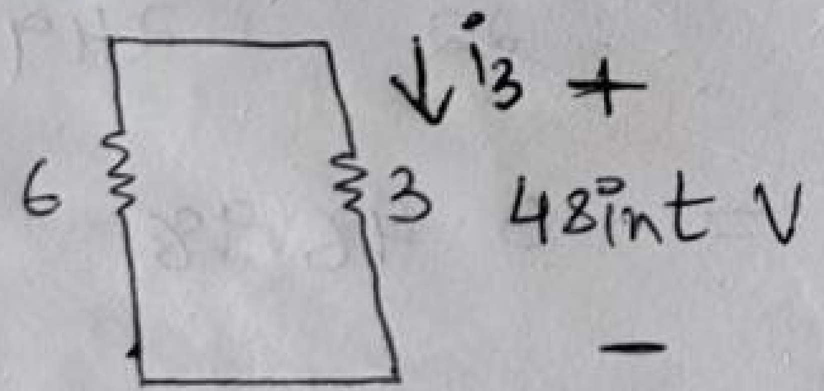
$$i_3 = 3\sin t \frac{6\times4}{24+18+12} = \frac{4}{3}\sin t \text{ A}$$

Method 3 : Voltage division



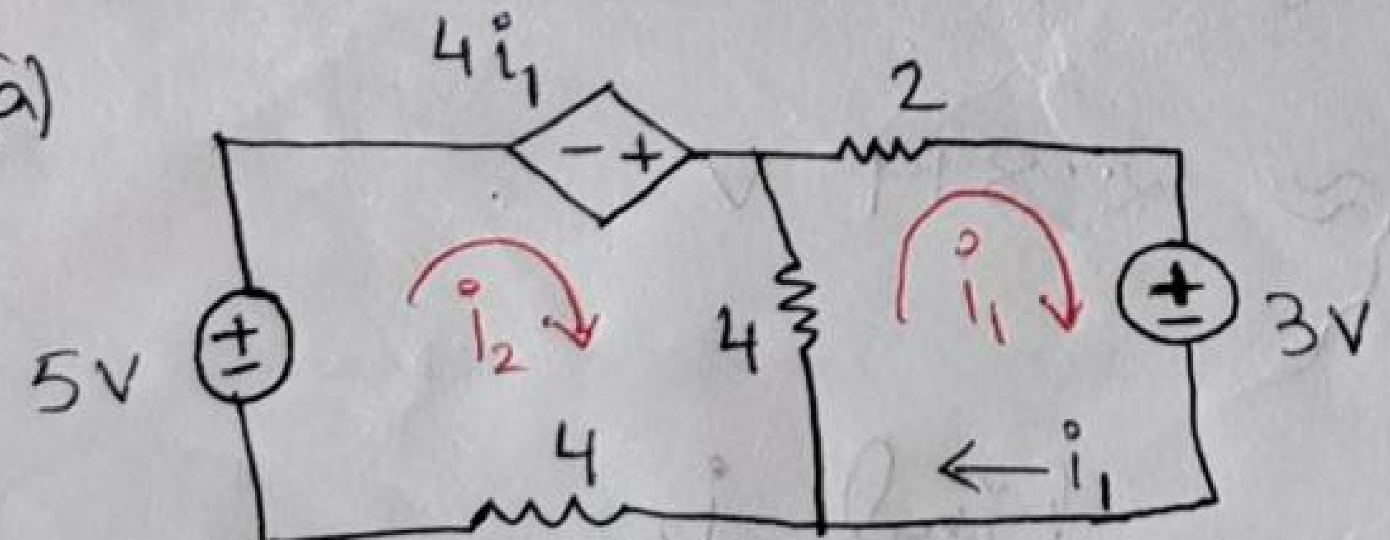
$$V_{2\Omega} = 12\sin t\left(\frac{2}{2+4}\right)$$

$$= 4\sin t \text{ V}$$



$$i_3 = \frac{4\sin t}{3} \text{ A}.$$

9(a)



KVL

$$-5 - 4i_1 + 4(i_2 - i_1) + 4i_2 = 0$$

$$\Rightarrow -8i_1 + 8i_2 = 5 \longrightarrow (1)$$

$$4(i_1 - i_2) + 2i_1 + 3 = 0$$

$$\Rightarrow 6i_1 - 4i_2 = -3 \longrightarrow (2)$$

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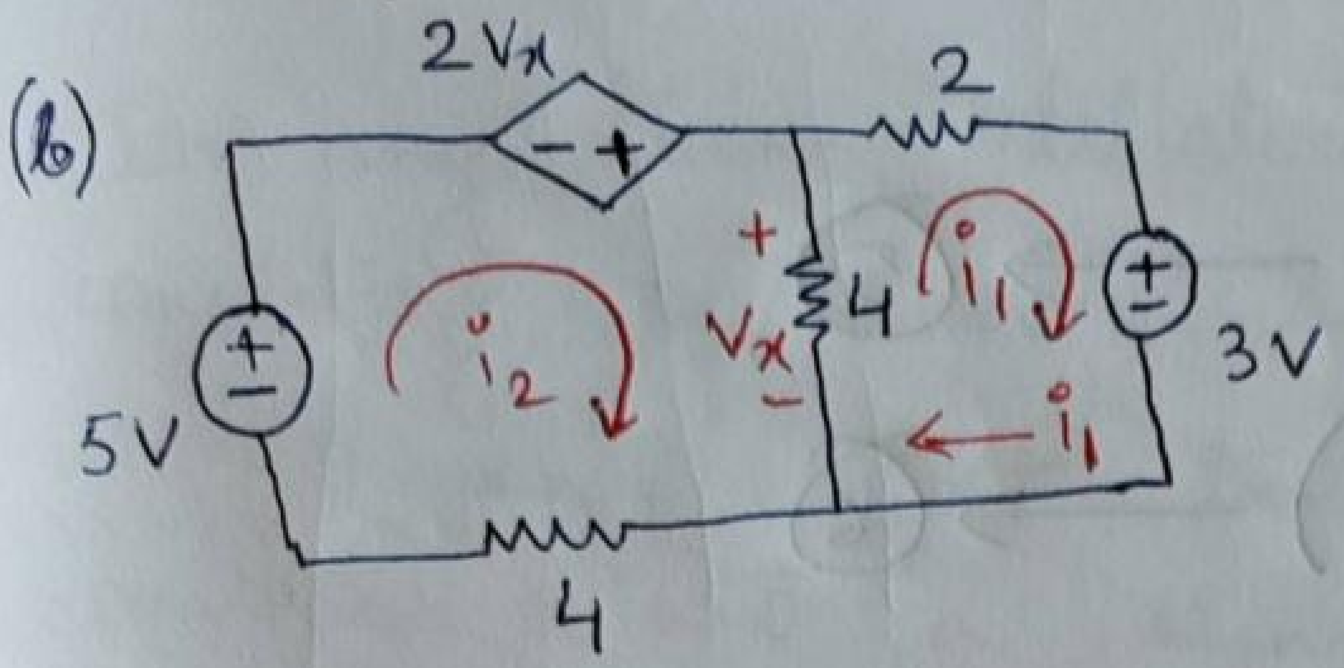
solving , $i_1 = -250\,mA$ $i_2 = 375\,mA$

(b)



$$-5 - 2V_x + 4(i_2 - i_1) + 4i_2 = 0 \longrightarrow (1)$$

$$\cancel{-4(i_1 - i_2)} \quad 4(i_1 - i_2) + 2i_1 + 3 = 0 \longrightarrow (2)$$

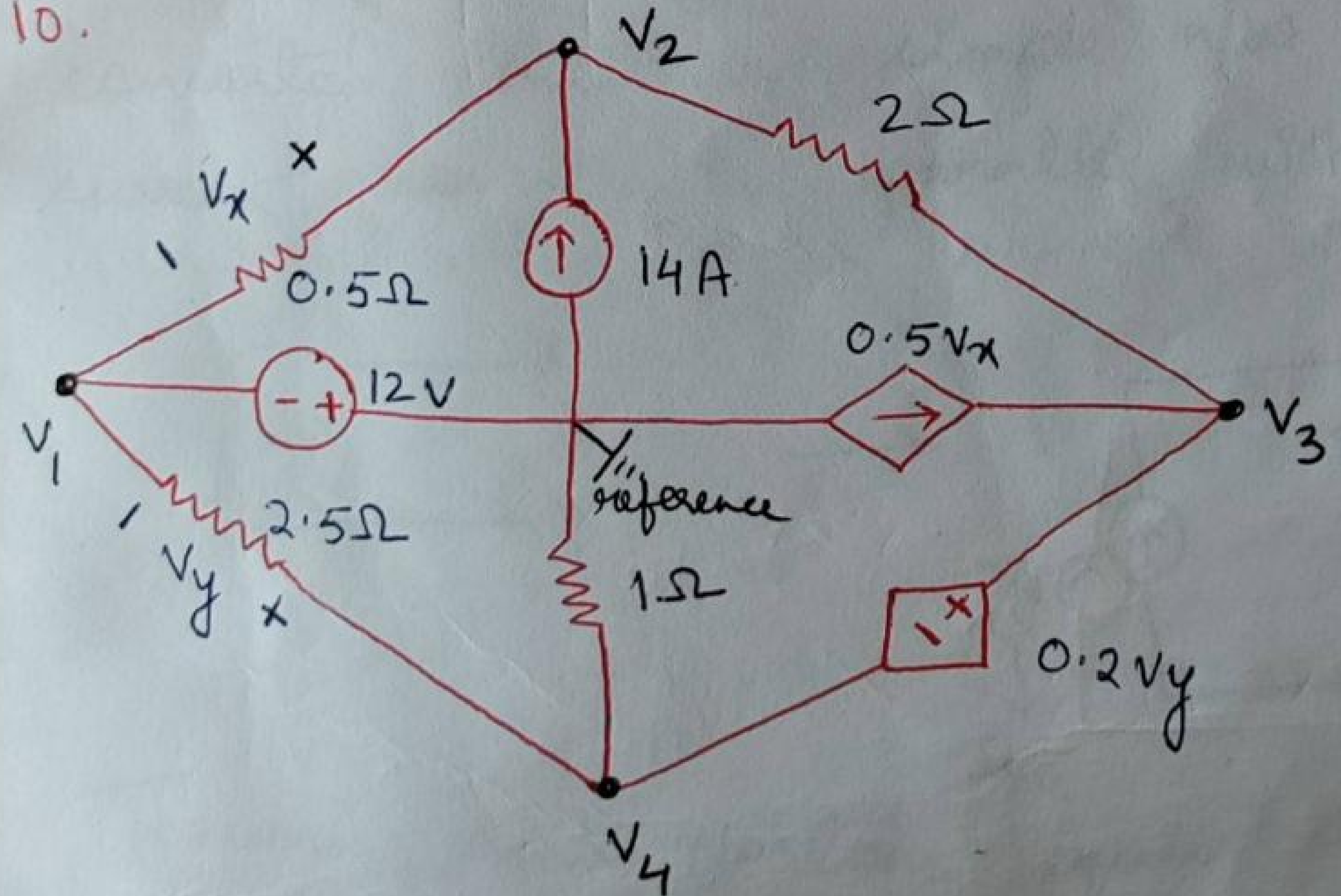
$$V_x = 4(i_2 - i_1) \longrightarrow (3)$$

Put (3) in (1),

$$4i_1 = 5$$

$$\Rightarrow \boxed{i_1 = 1.25\ A}$$

10.



$$V_1 = -12 \longrightarrow (1)$$

$$\frac{V_2 - V_1}{0.5} - 14 + \frac{V_2 - V_3}{2} = 0$$

$$\Rightarrow \frac{V_2 - V_1}{0.5} + \frac{V_2 - V_3}{2} = 14 \longrightarrow (2)$$

$$\frac{V_3 - V_2}{2} + \frac{V_4}{1} + \frac{V_4 - V_1}{2.5} - 0.5V_x = 0 \longrightarrow (3)$$

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$V_3 - V_4 = 0.2 V_y \longrightarrow$ (4)

$0.2V_y = 0.2 (V_4 - V_1) \longrightarrow$ (5)

$0.5 V_x = 0.5 (V_2 - V_1) \longrightarrow$ (6)

$\therefore$ Solving, we get

$V_1 = -12V$, $V_2 = -4V$, $V_3 = 0V$, $V_4 = -2V$

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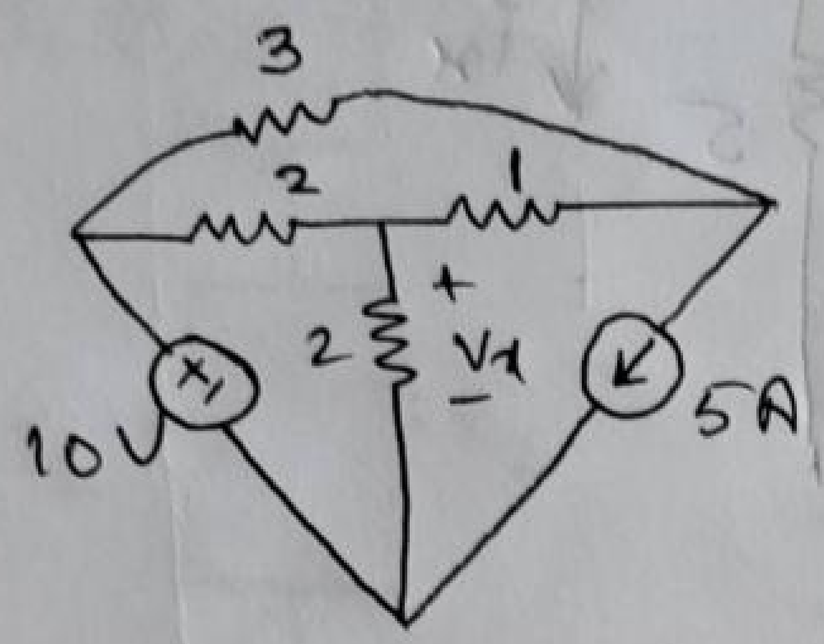
PRACTICE SET 4

1. Find V_x with the help of SPT



Soln

Step 1 : 10V only

$$V_{x_1} = 10\left(\frac{2}{2+4/3}\right) \qquad 4\|2 = \frac{8}{6} = \frac{4}{3}$$

$$= 6V$$

Step 2 : 5A only

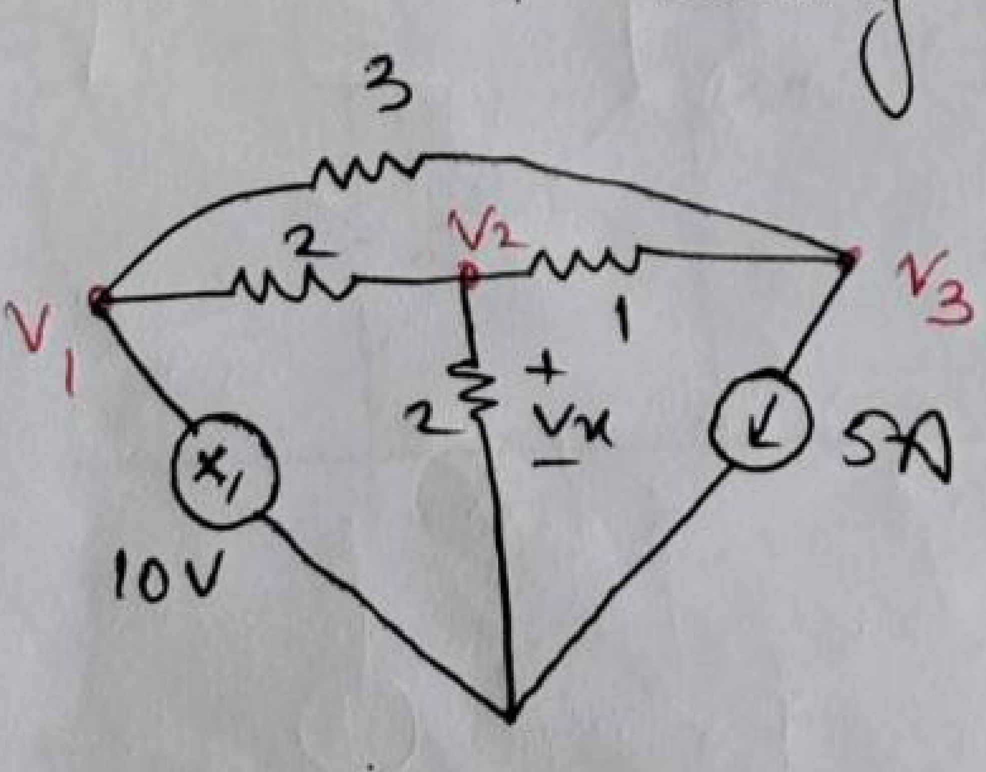
$$V_{x_2}' = -2\left[5\left(\frac{3}{3+2}\right)\times\frac{2}{4}\right]$$

$$2\|2 = 1 \qquad = -3V$$

$\therefore$ Using SPT,

$$V_x = V_{x_1} + V_{x_2} = 6 - 3 = 3V.$$

2. Find V_x using Nodal Analysis



$$V_1 = 10 \longrightarrow (1)$$

$$\frac{V_2 - 10}{2} + \frac{V_2}{2} + \frac{V_2 - V_3}{1} = 0 \longrightarrow (2)$$

$$\Rightarrow 4V_2 - 2V_3 = 10$$

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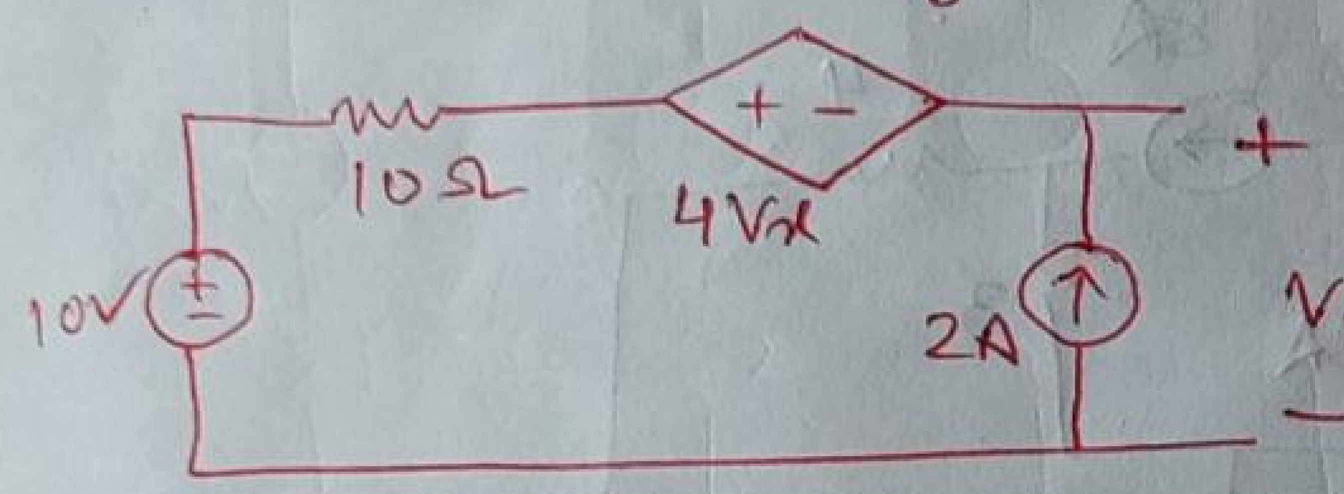
$$5 + \frac{V_3 - V_2}{1} + \frac{V_3 - 10}{3} = 0$$

$$\Rightarrow -3V_2 + 4V_3 = -5 \longrightarrow (3)$$

$V_2 = 3$

$\therefore \boxed{V_x = 3V}$

3. Find V_x using SPT



Step 1: 10V only

$$V_{x_1} = 10 - 4V_{x_1}$$

$$\Rightarrow V_{x_1} = 2 \text{ V}$$

Step 2 : 2 A only

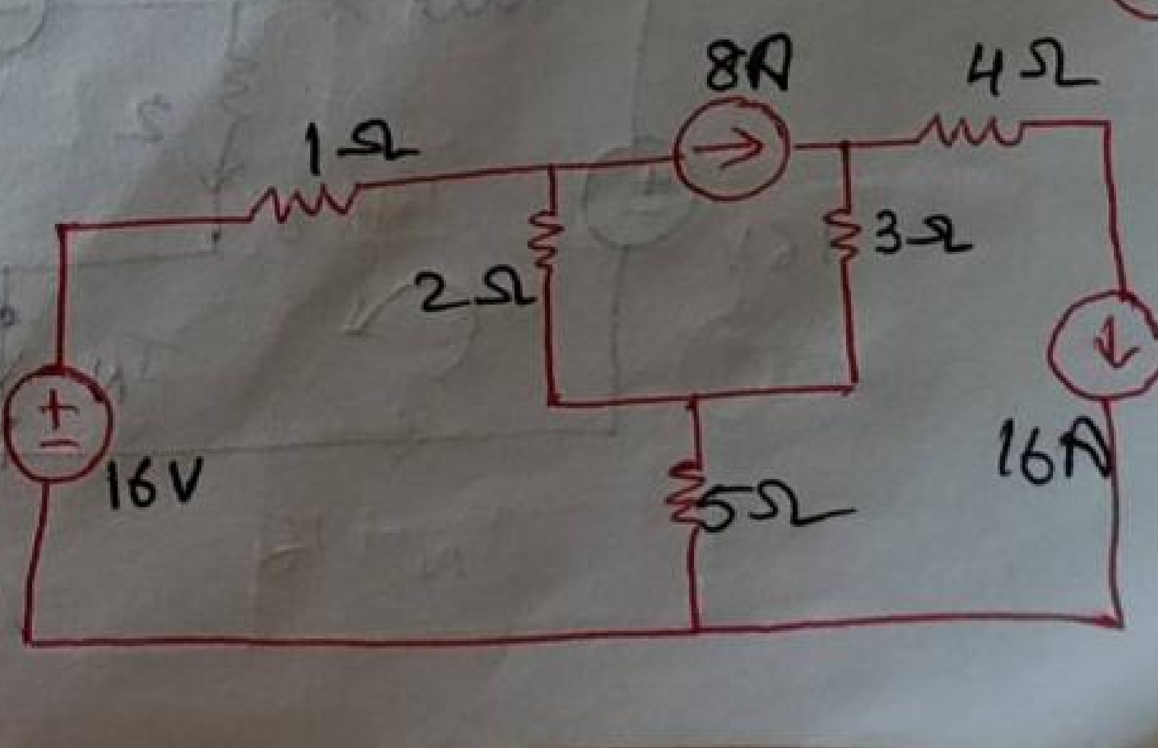
$$-V_x - 4V_{x_2} + 10(2) = 0$$

$$\Rightarrow 5V_{x_2} = 20$$

$$\Rightarrow V_{x_2} = 4V$$

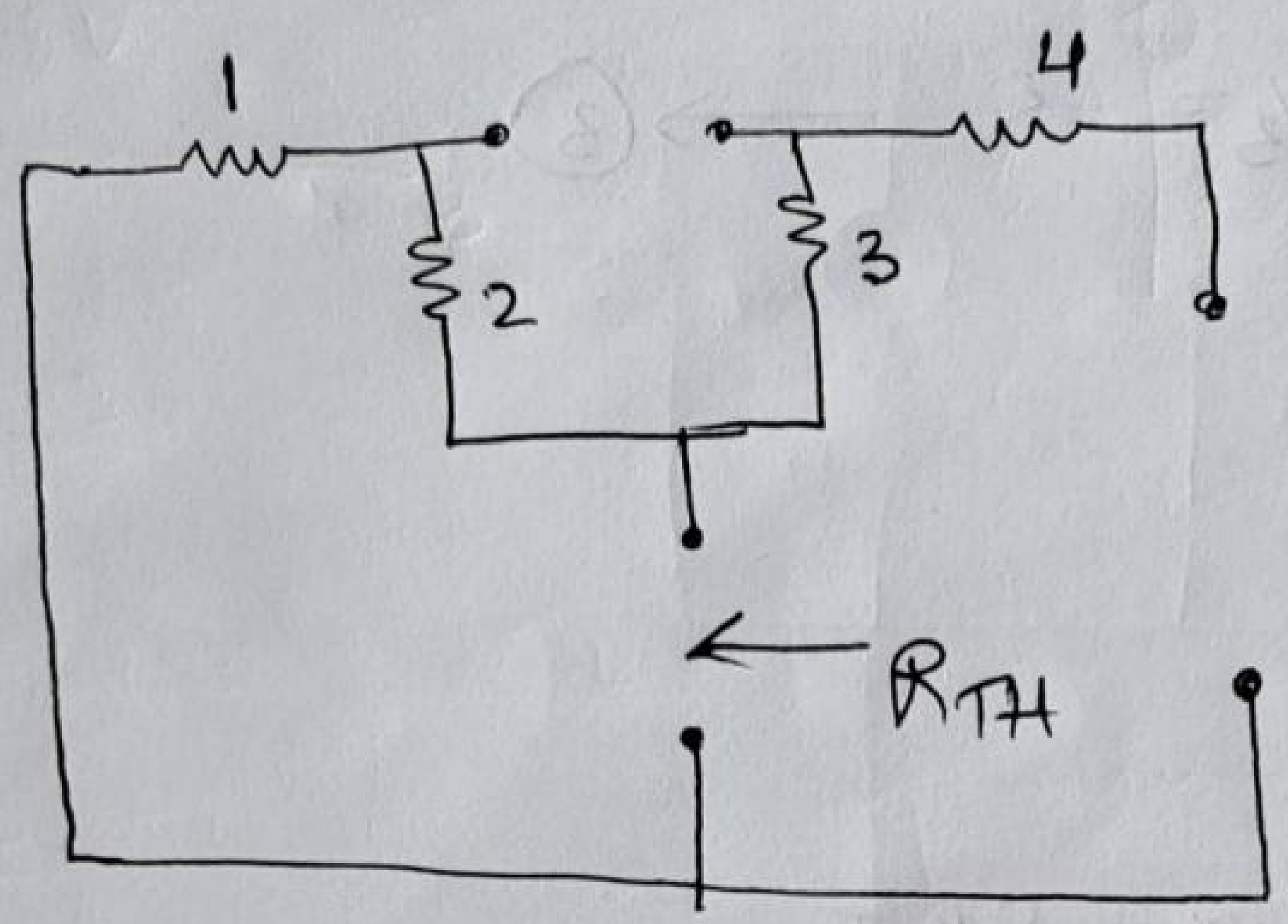
$$\therefore V_x = V_{x_1} + V_{x_2} = 2 + 4 = 6V$$

4. Find power lost in 5 Ω resistor using Thevenin and Norton



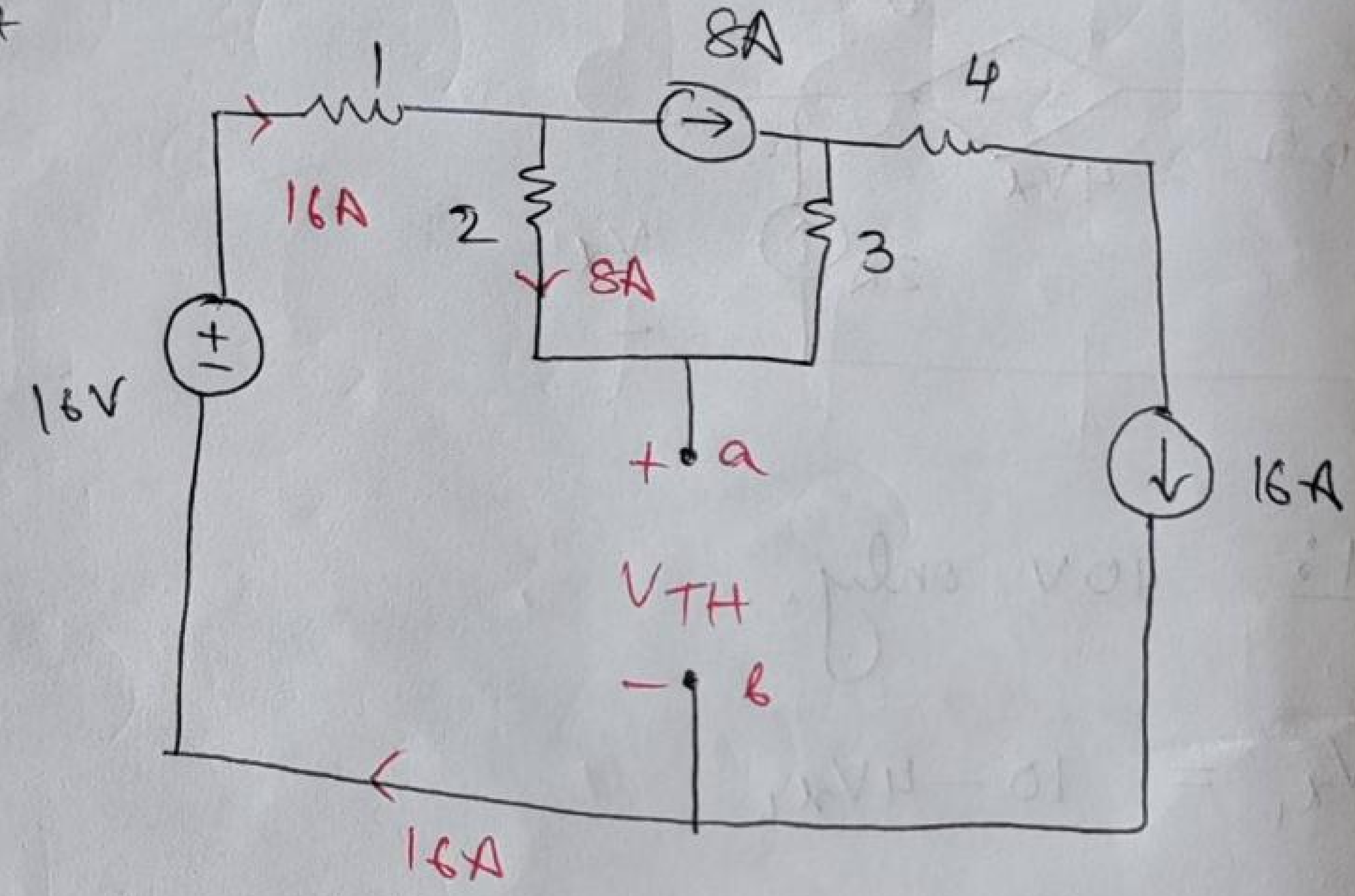
Sol^n Thevenin

R_{TH}



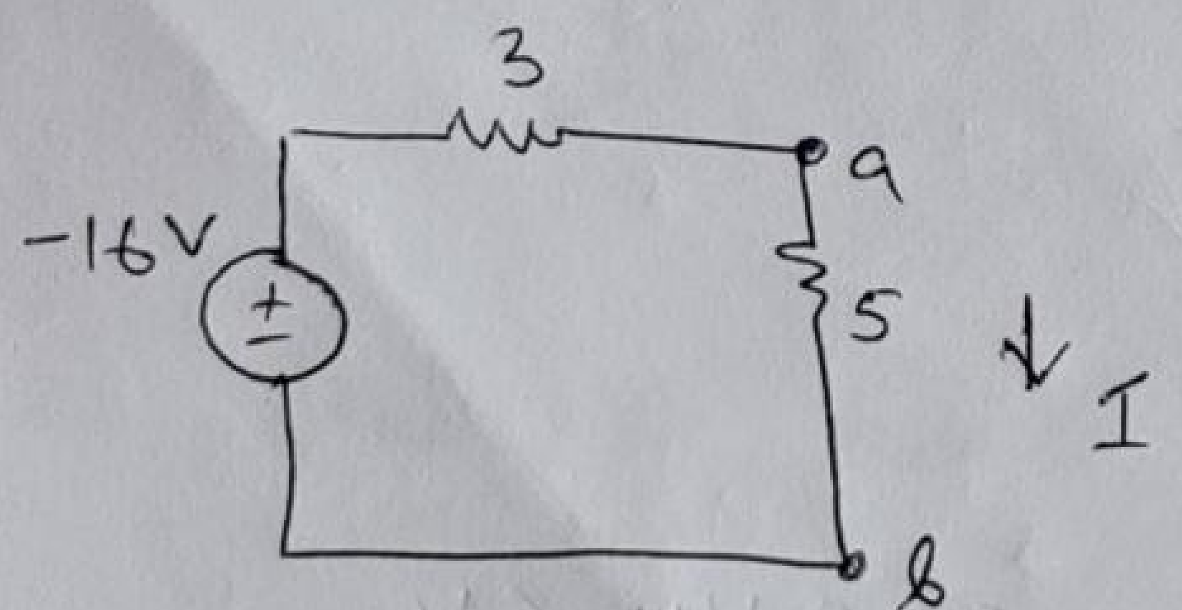
$$R_{TH} = 2 + 1 = 3\,\Omega$$

V_{TH}



$$-16 + 16 + 16 + V_{TH} = 0$$

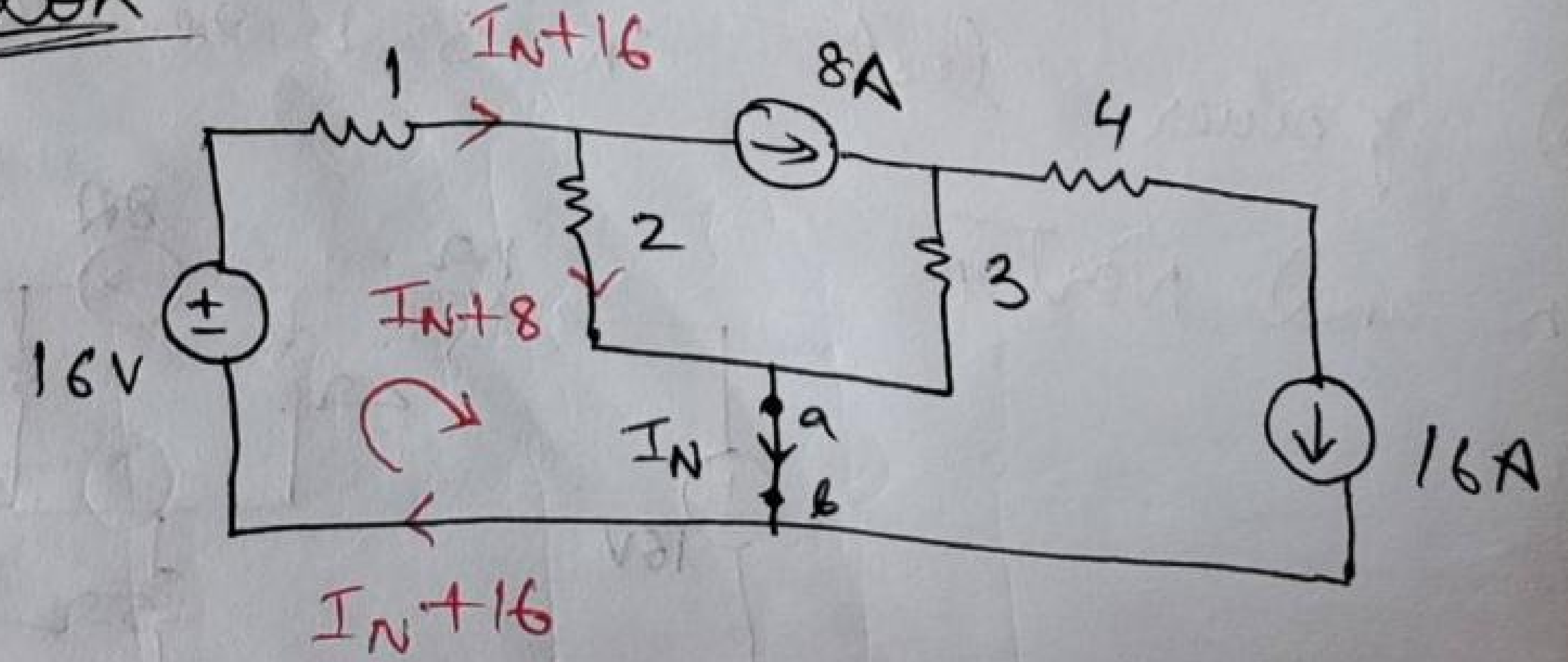
$$\Rightarrow V_{TH} = -16\,V$$



$$I = -\frac{16}{8} = -2A$$

$$P_{lost} = (-2)^2 \times 5 = 20W$$

Norton



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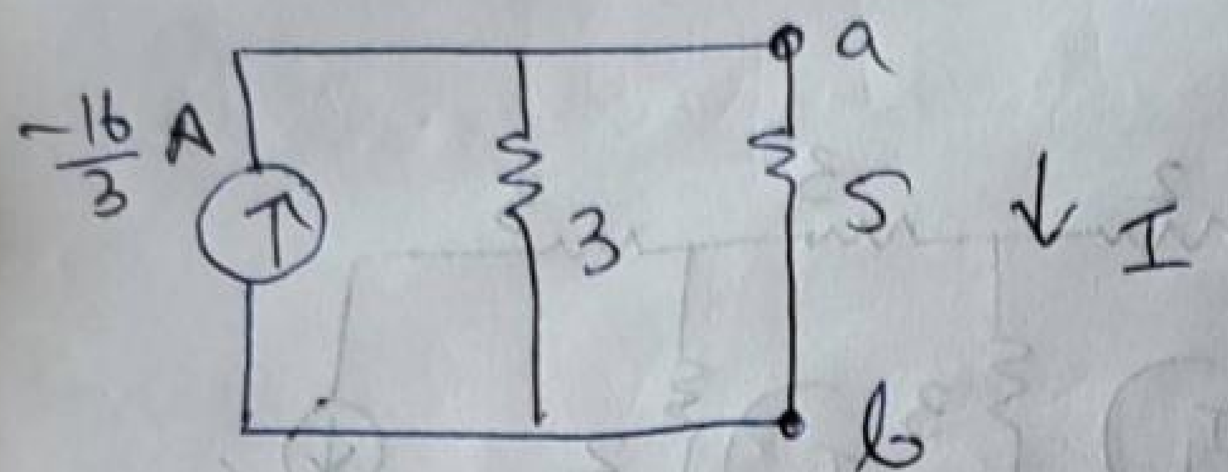
KVL

$-16 + (I_N+16) + 2(I_N+8) = 0$

$\Rightarrow \quad 3I_N = -16$

$\Rightarrow \quad I_N = \frac{-16}{3}$ A

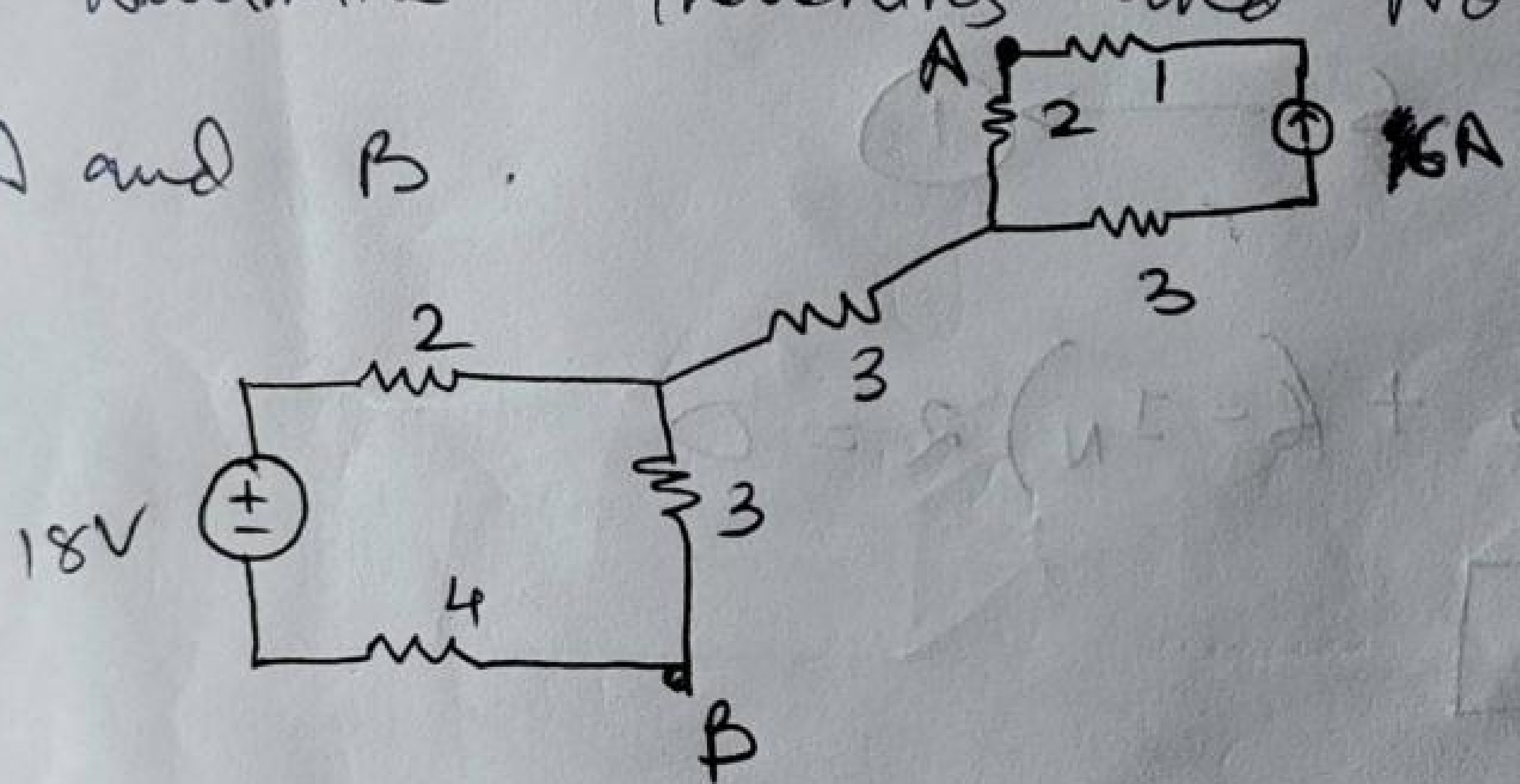


$I = -\frac{16}{3}\left(\frac{3}{3+5}\right)$

$= -2A$

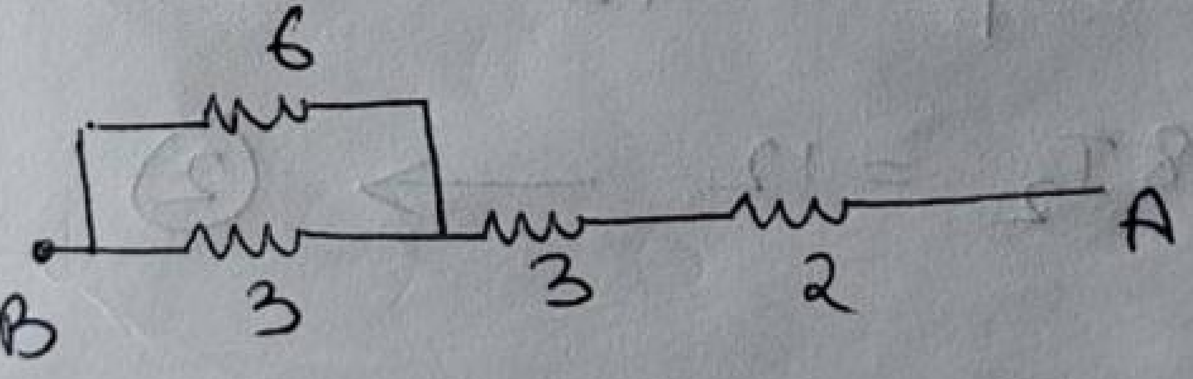
$P_{lost} = (-2)^2 \times 5 = 20W$

5. Determine Thevenins and Norton equivalent b/w A and B.



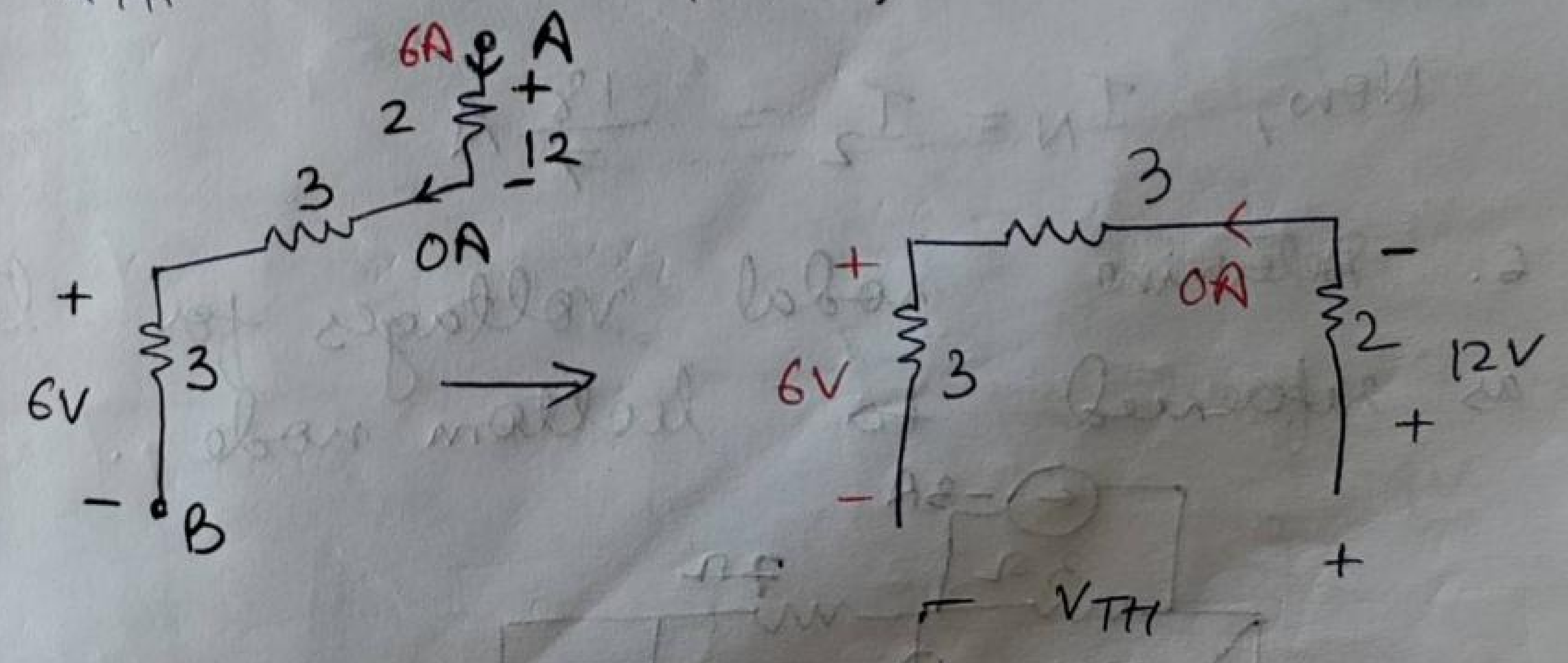
Sol^n

R_{TH}



$R_{TH} = 2+3+(3||6) = 2+3+2 = 7\Omega$

V_{TH}



$V_{TH} - 6 - 12 = 0 \Rightarrow V_{TH} = 18V$

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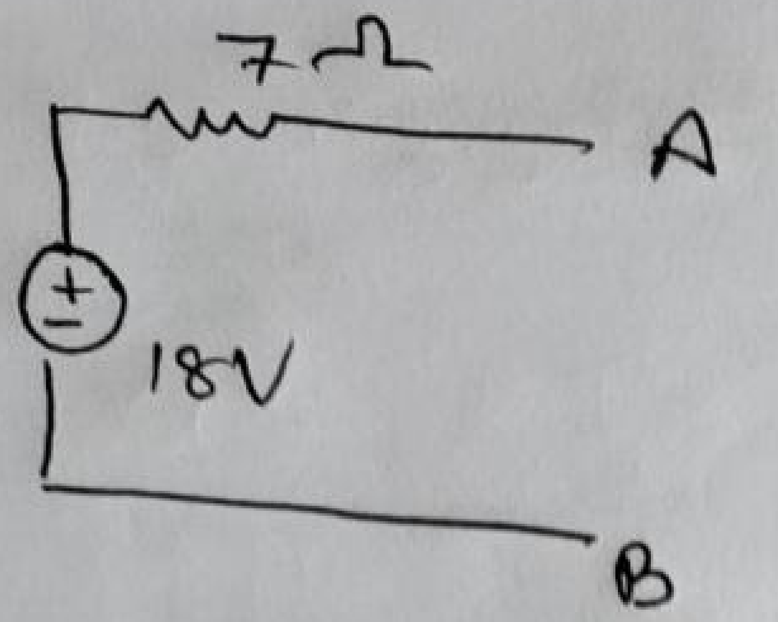
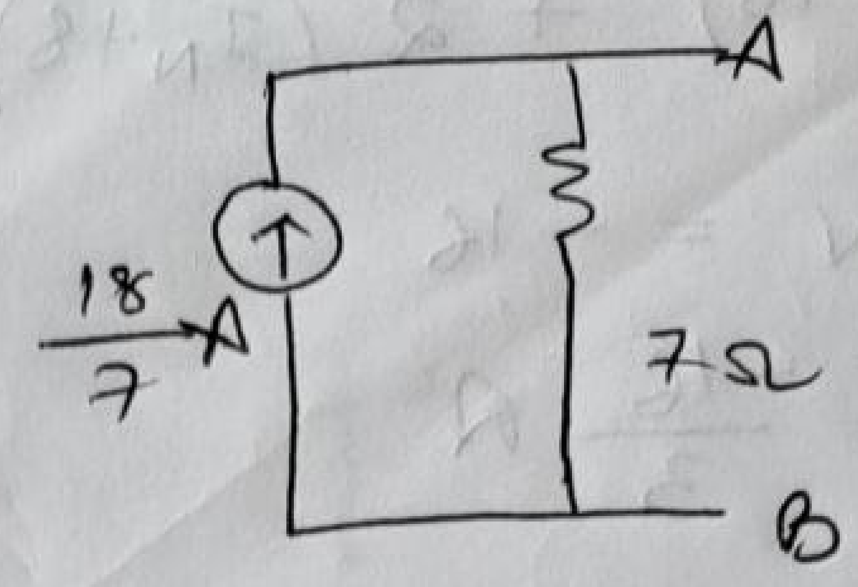
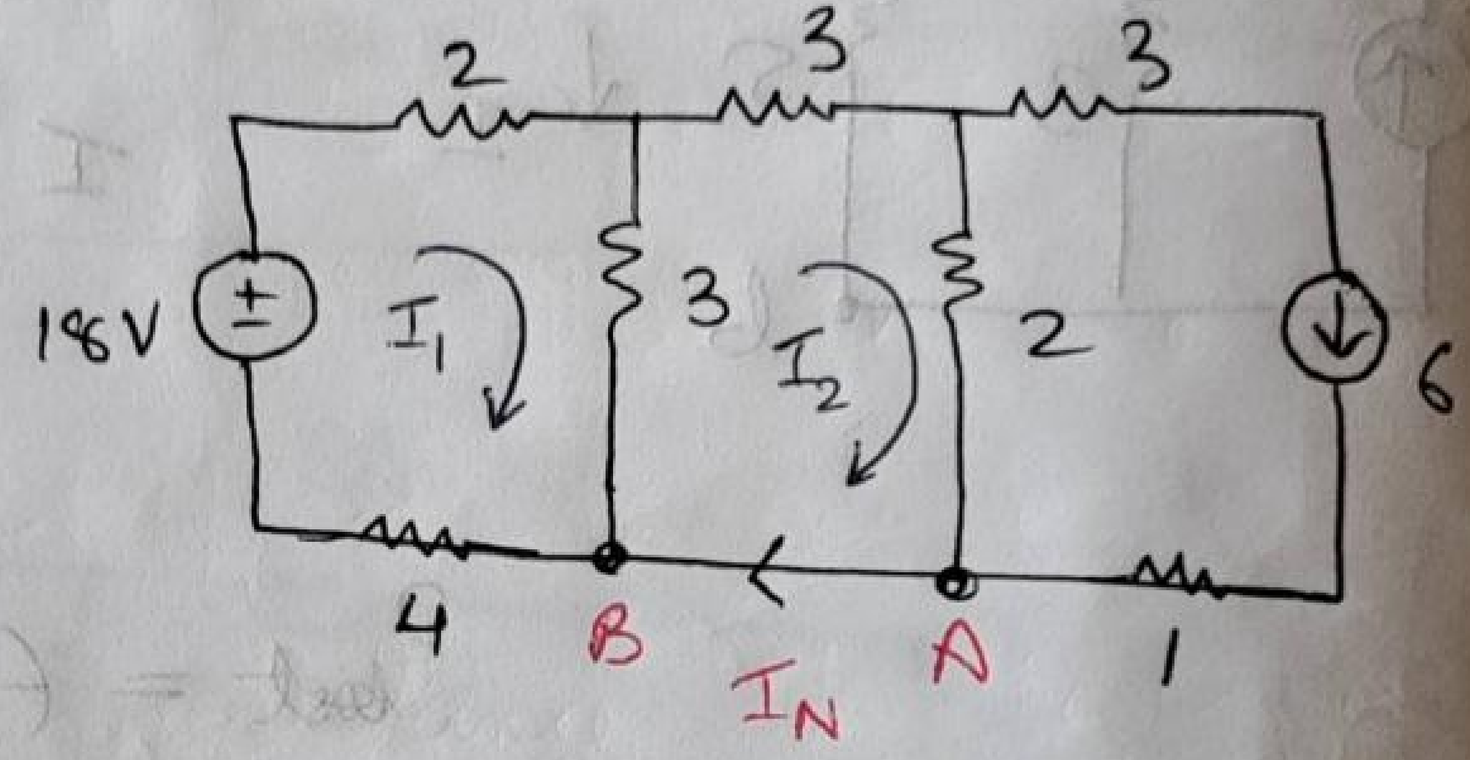




Nortons

$R_N = R_{TH} = 7\Omega$

KVL



$-18 + 2I_1 + 3(I_1 - I_2) + 4I_1 = 0$

$\Rightarrow 9I_1 - 3I_2 = 18$

$\Rightarrow 3I_1 - I_2 = 6 \longrightarrow (1)$

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

Here $\boxed{I_N = I_2}$

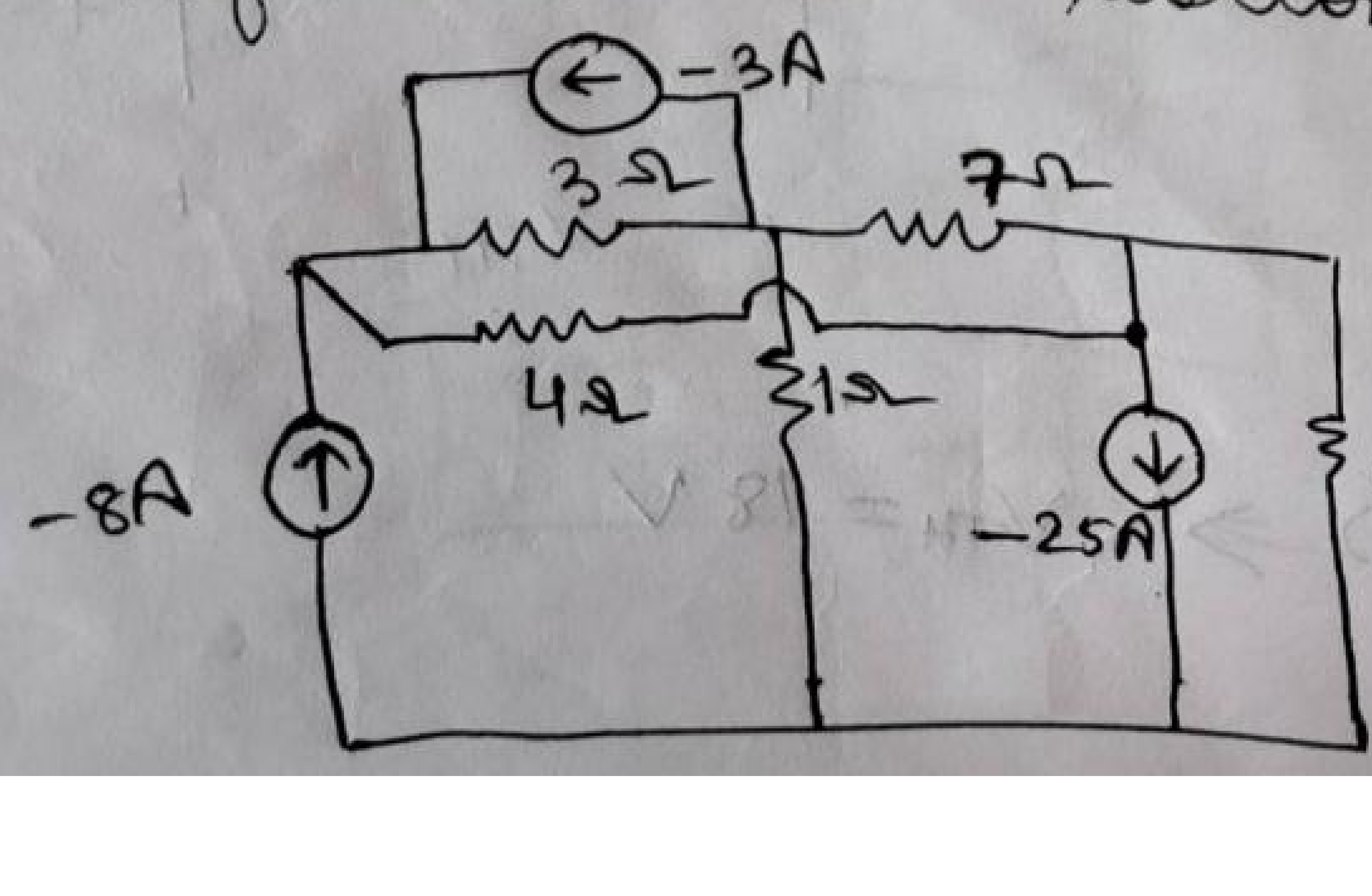
$\Rightarrow 8I_2 - 3I_1 = -12$

$\Rightarrow 3I_1 - 8I_2 = 12 \longrightarrow (2)$

$\therefore \quad I_2 = \frac{18}{7} A$

Now, $I_N = I_2 = \frac{18}{7} A$

6. Determine nodal voltages for the circuit, as referenced to bottom node.



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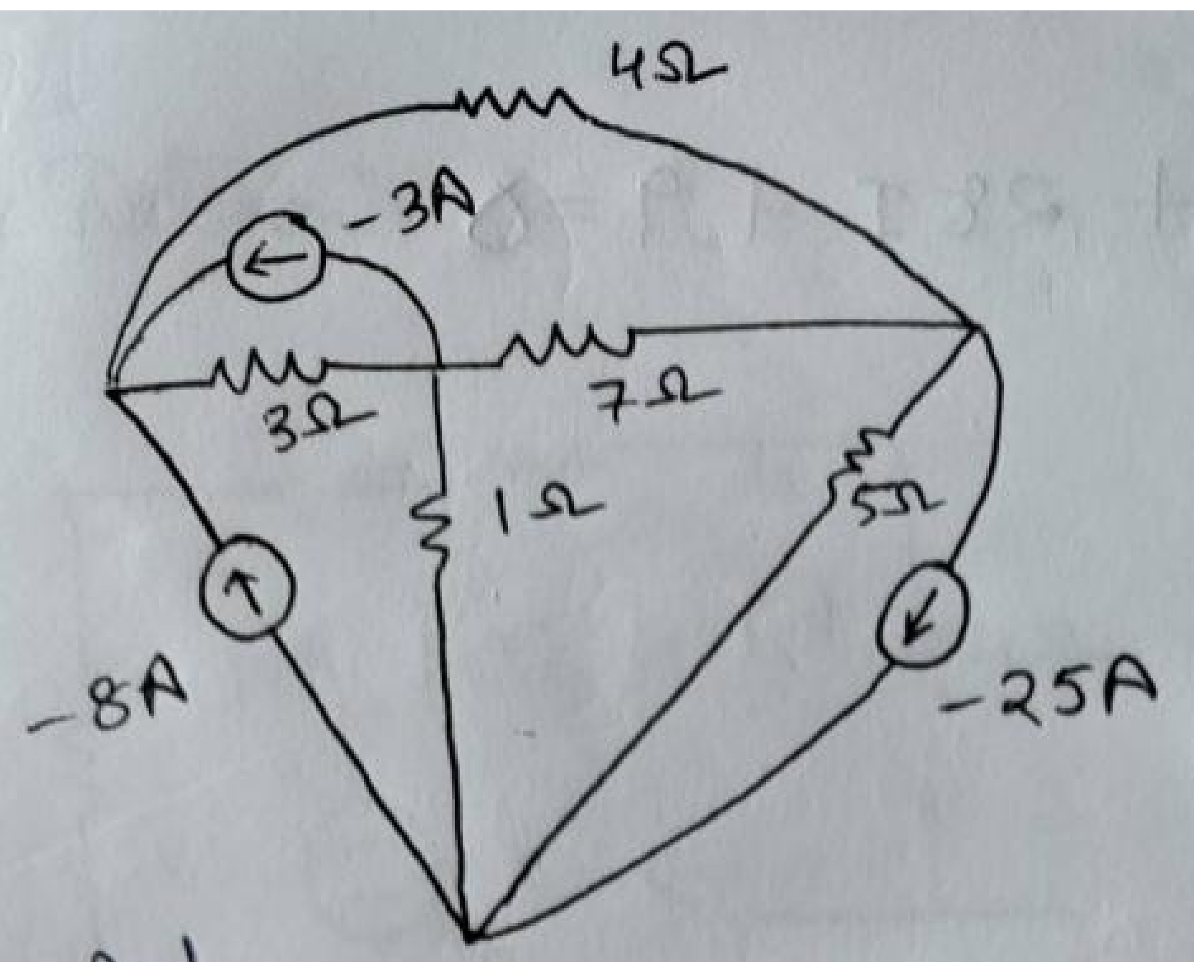
Sol^n



Node 1

$$-(-8) - (-3) + \frac{V_1 - V_2}{3} + \frac{V_1 - V_3}{4} = 0 \longrightarrow (1)$$

Node 2

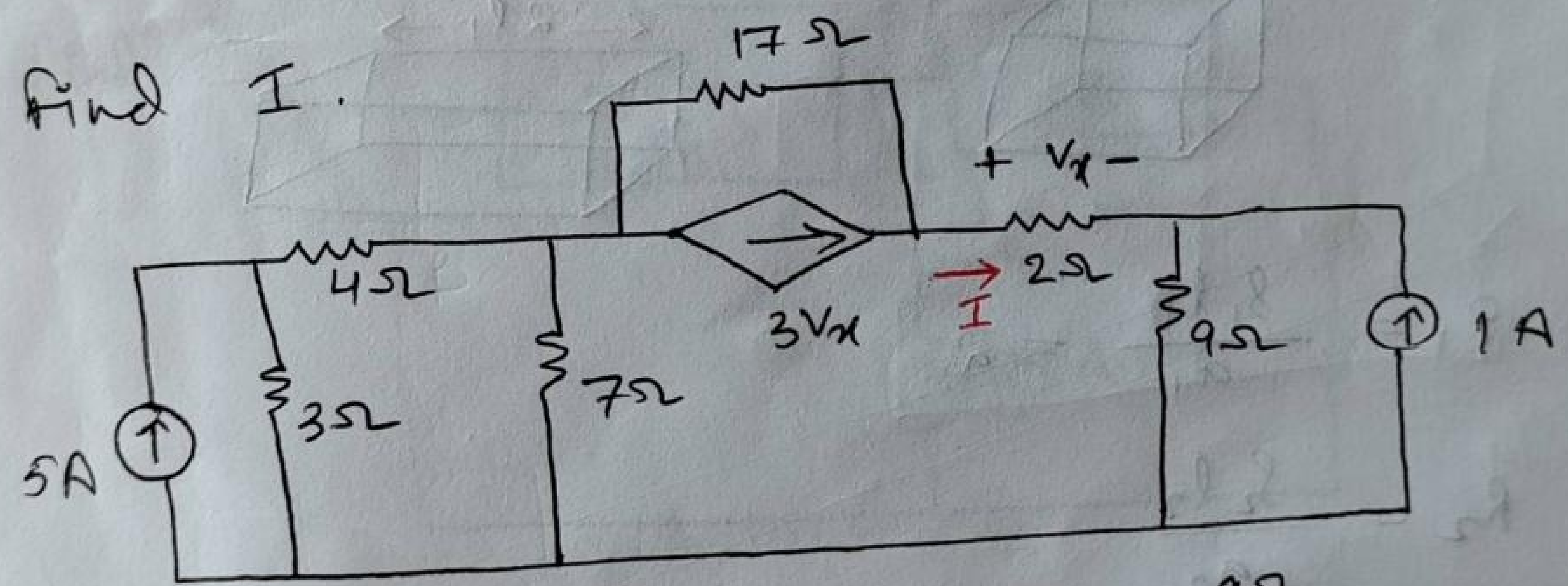
$$(-3) + \frac{V_2 - V_1}{3} + \frac{V_2}{1} + \frac{V_2 - V_3}{7} = 0 \longrightarrow (2)$$

Node 3

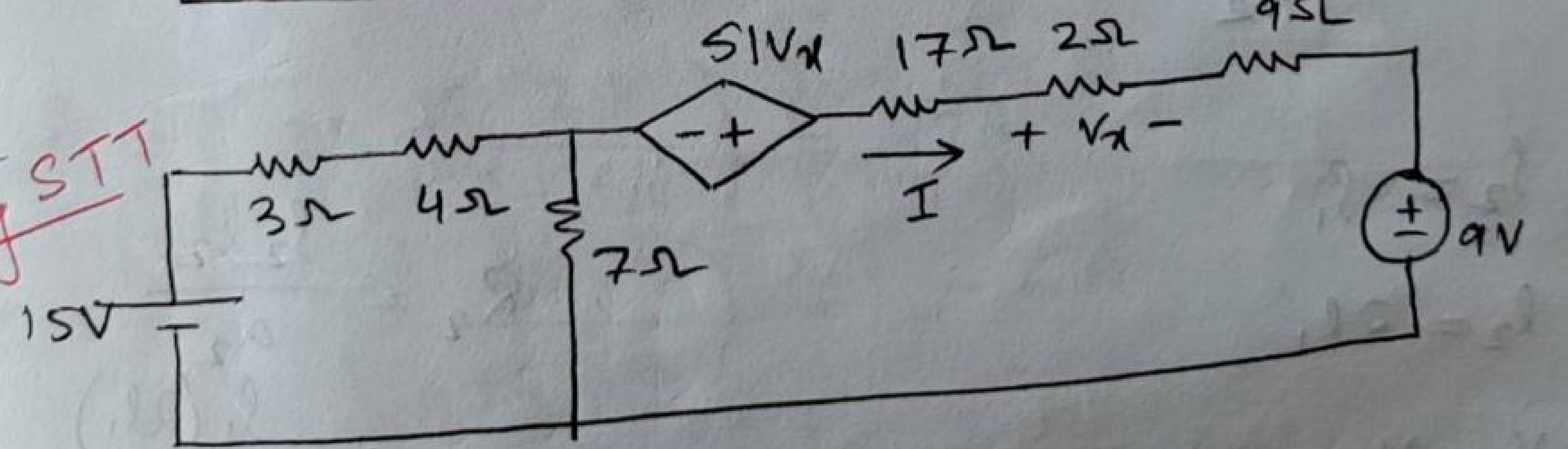
$$(-25) + \frac{V_3}{5} + \frac{V_3 - V_2}{7} + \frac{V_3 - V_1}{4} = 0 \longrightarrow (3)$$

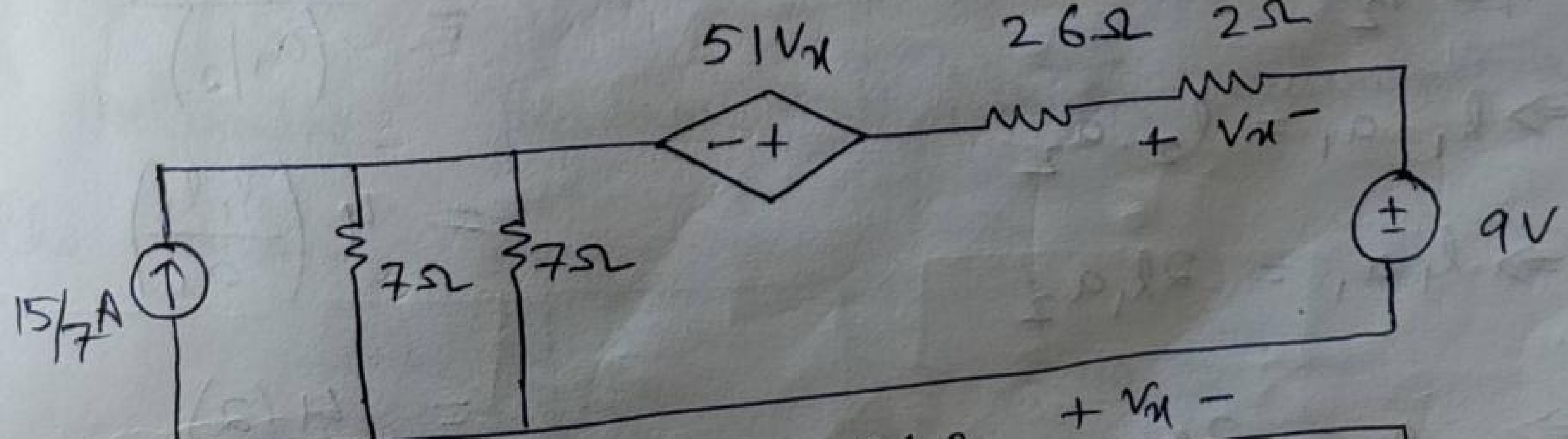
$V_1 = 5.412$, $V_2 = 7.736$, $V_3 = 46.32\,V$

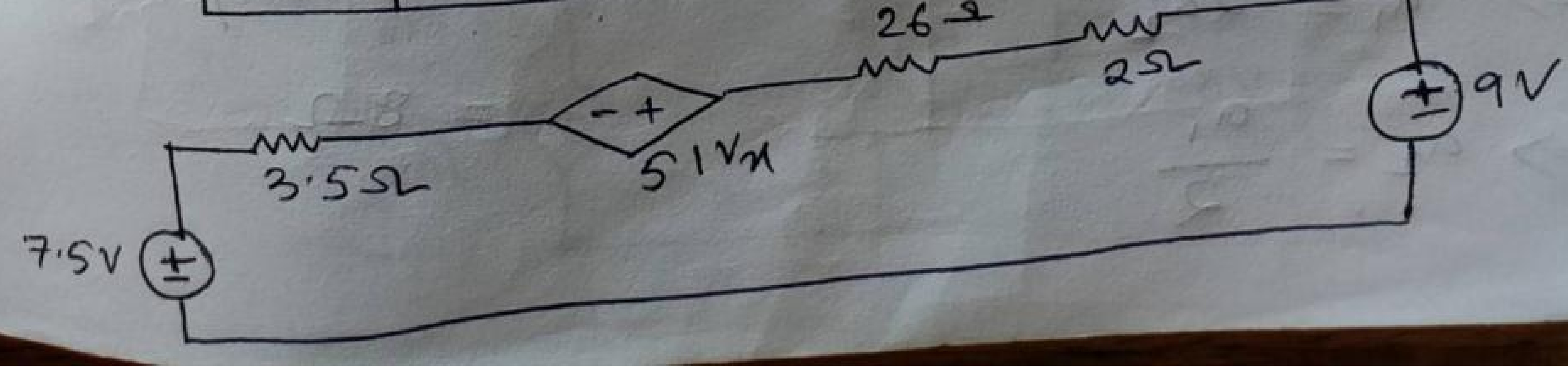
7. find I.



Sol^n using STT







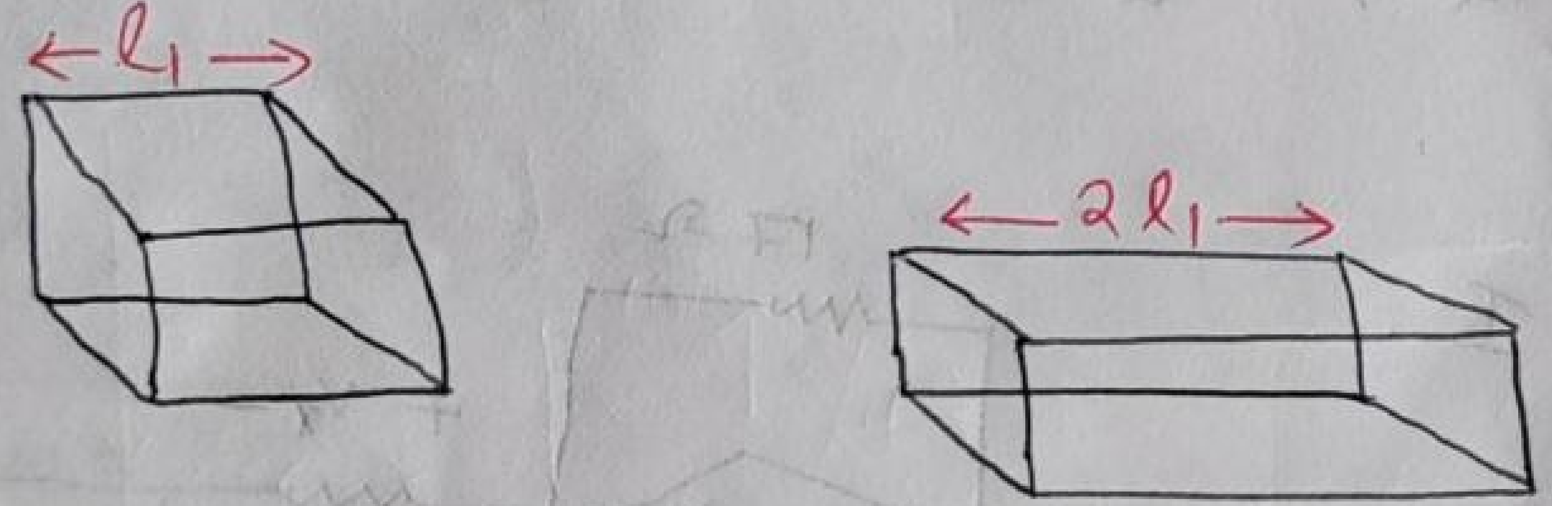
$$-7.5 + 3.5I - 51V_x + 28I + 9 = 0$$

$$V_x = 2I$$

$$\Rightarrow I = 21.28\,mA$$

8. A cube shaped material has a resistance of 2Ω b/w any of its opposite faces. Now if this material is stretched in one direction by applying linear force to double its original length, then the resistance b/w the opposite stretched face is ______

Sol^n



$$R_1 = \frac{\rho_1 l_1}{a_1} = 2$$

$$R_2 = \frac{\rho_2 l_2}{a_2}$$

$$\rho_2 = \rho_1$$

$$l_2 = 2l_1$$

$$V_1 = V_2$$

$$\Rightarrow l_1 . a_1 = l_2 . a_2$$

$$\Rightarrow l_1 a_1 = 2l_1 a_2$$

$$\Rightarrow a_1 = 2a_2$$

$$\Rightarrow a_2 = \frac{a_1}{2}$$

$$R_2 = \frac{\rho_2 l_2}{a_2}$$

$$= \frac{\rho_1 (2l_1)}{(a_1/2)}$$

$$= 4\left(\frac{\rho_1 l_1}{a_1}\right)$$

$$= 4(2)$$

$$= 8\Omega.$$

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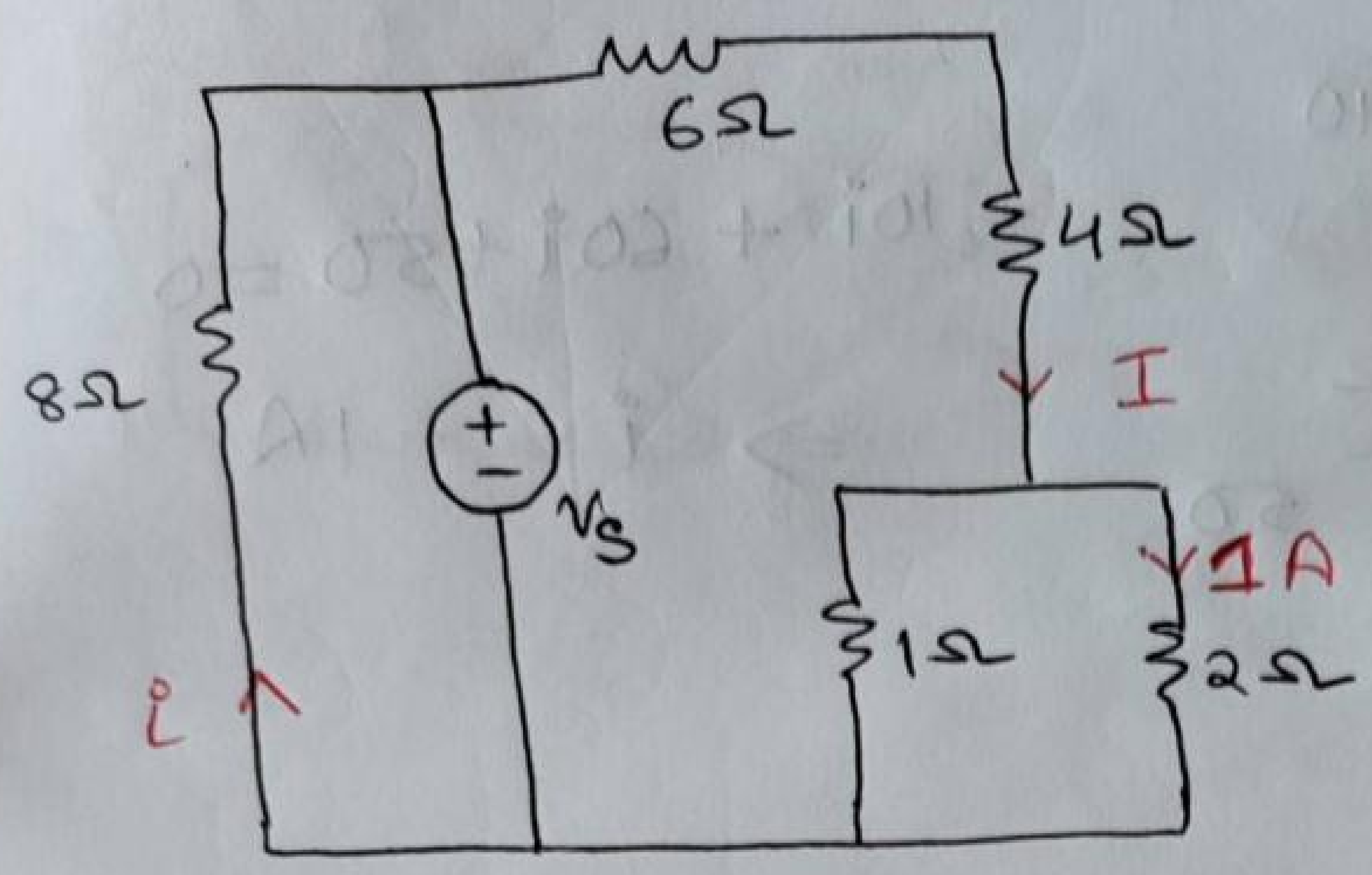
9. Determine i.



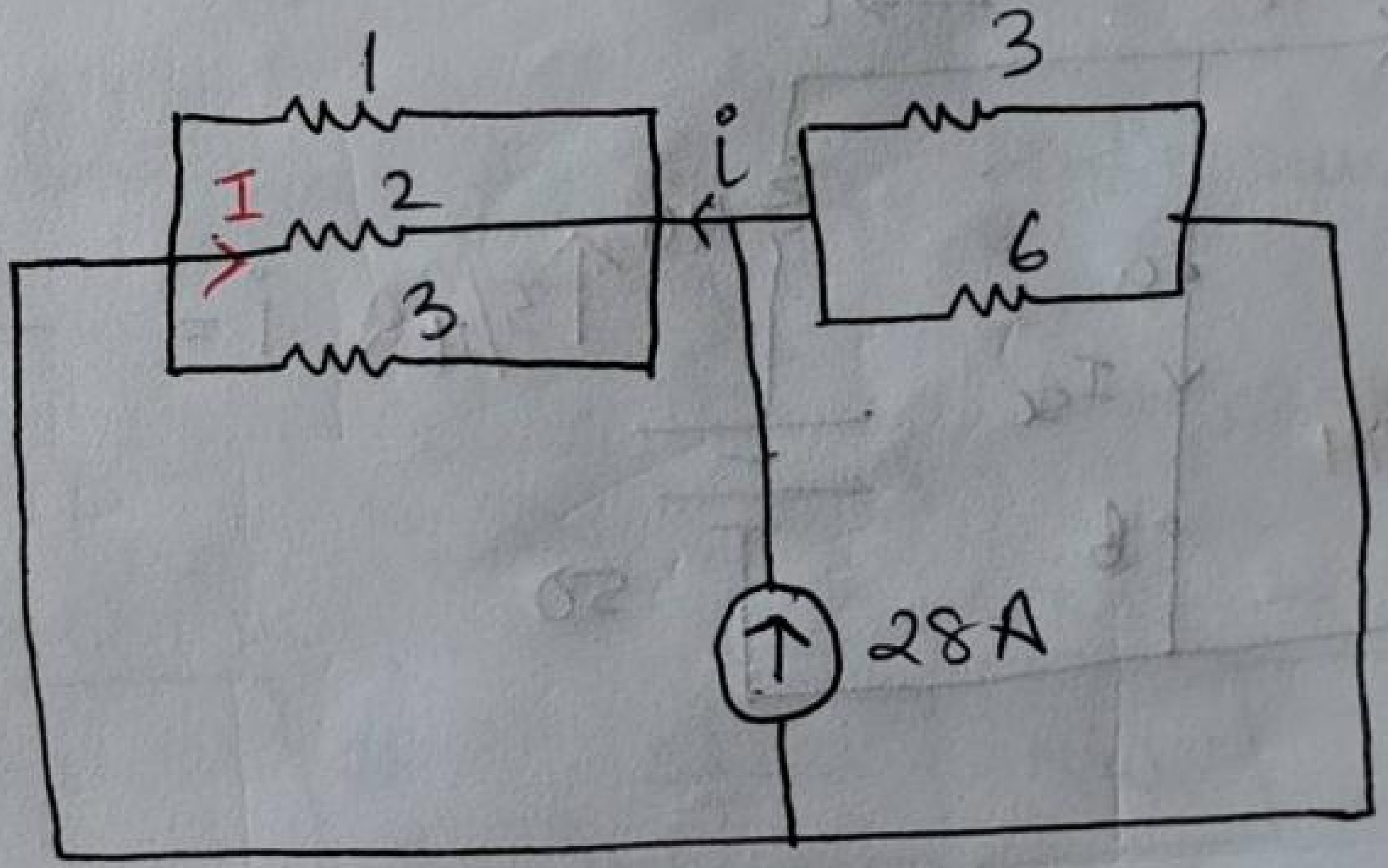
Sol^n

$$1 = I \times \frac{1}{3} \Rightarrow I = 3$$

$$V_S = 3\left(10 + \frac{2}{3}\right) = 32V$$

$$i = -\frac{32}{8} = -4A$$

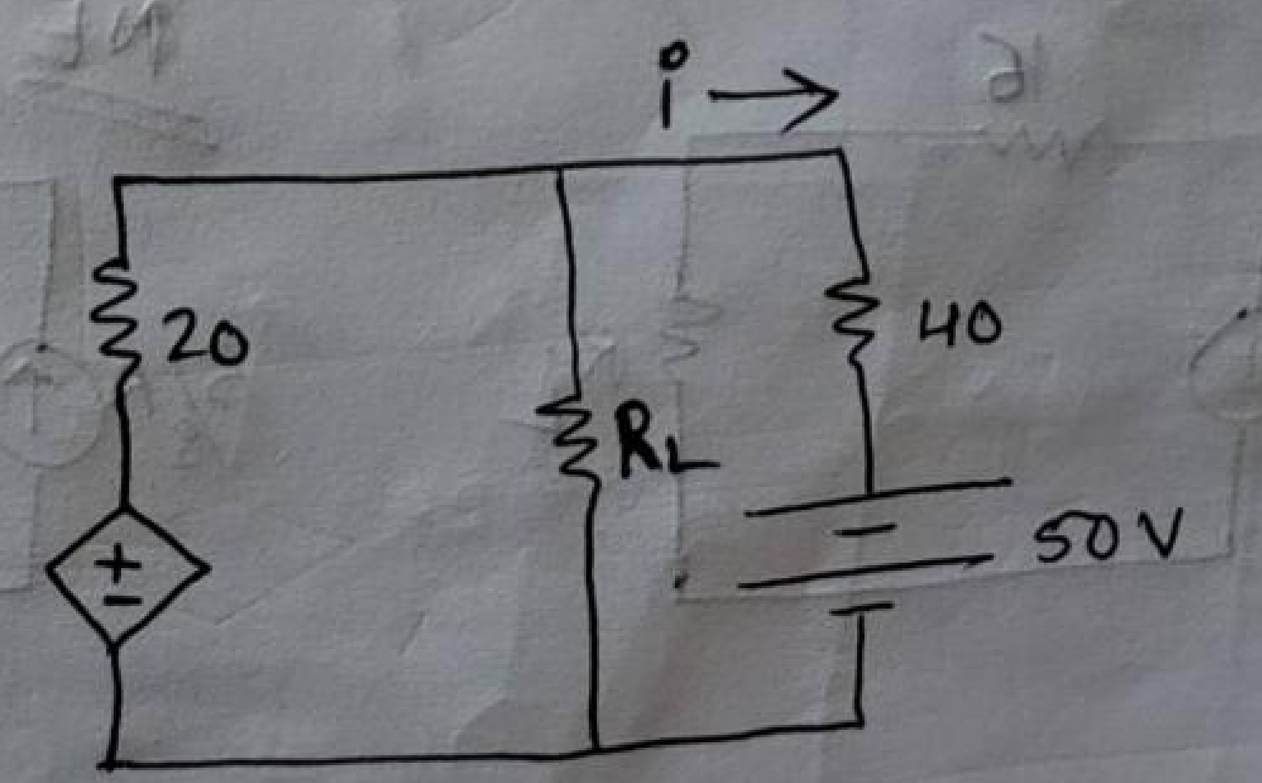
10. Find I



$$i = 28\left(\frac{2}{2 + 6/11}\right) = 22A$$

$$I = 22\left(\frac{3}{6+2+3}\right) = -6A.$$

11. Determine Thevenin and Norton equivalent across the load.



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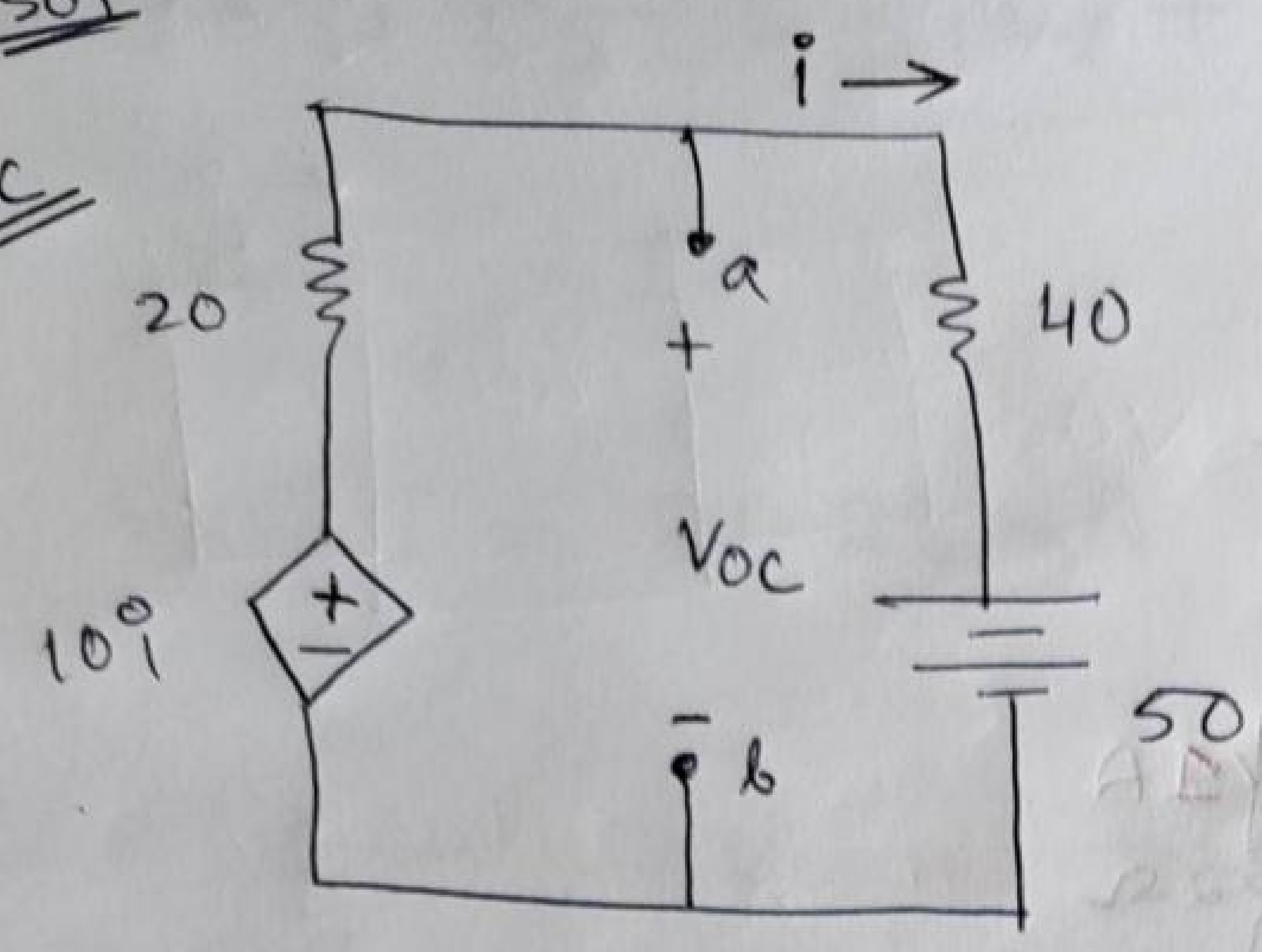
Sol^n

Voc



$$-10i + 60i + 50 = 0$$

$$\Rightarrow i = -1A$$

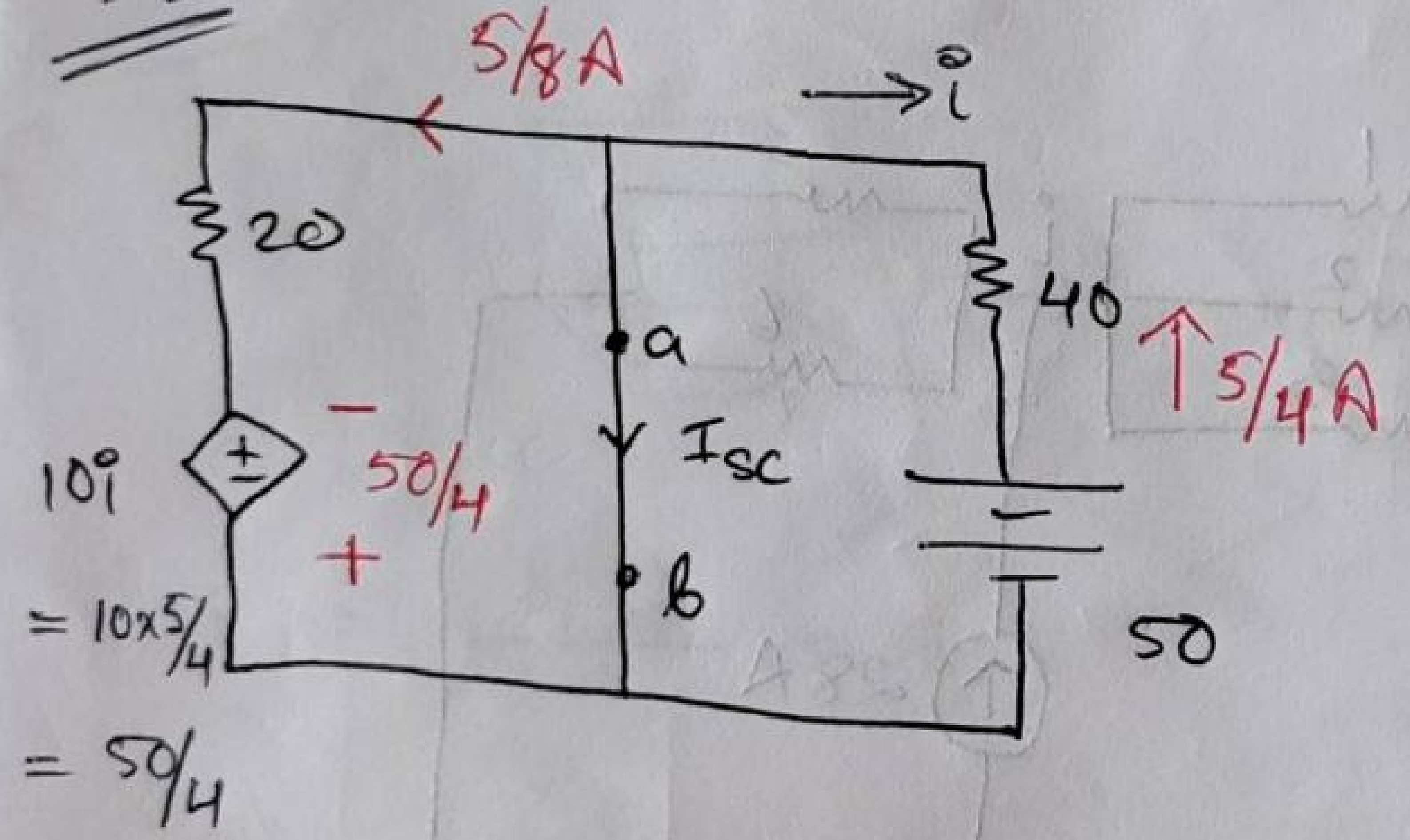
KVL

$$-V_{oc} \cancel{E40} + 40i + 50 = 0$$

$$\Rightarrow -V_{oc} - 40 + 50 = 0$$

$$\Rightarrow \boxed{V_{oc} = 10V}$$

Isc



$$i = \frac{50}{40} = 5/4$$

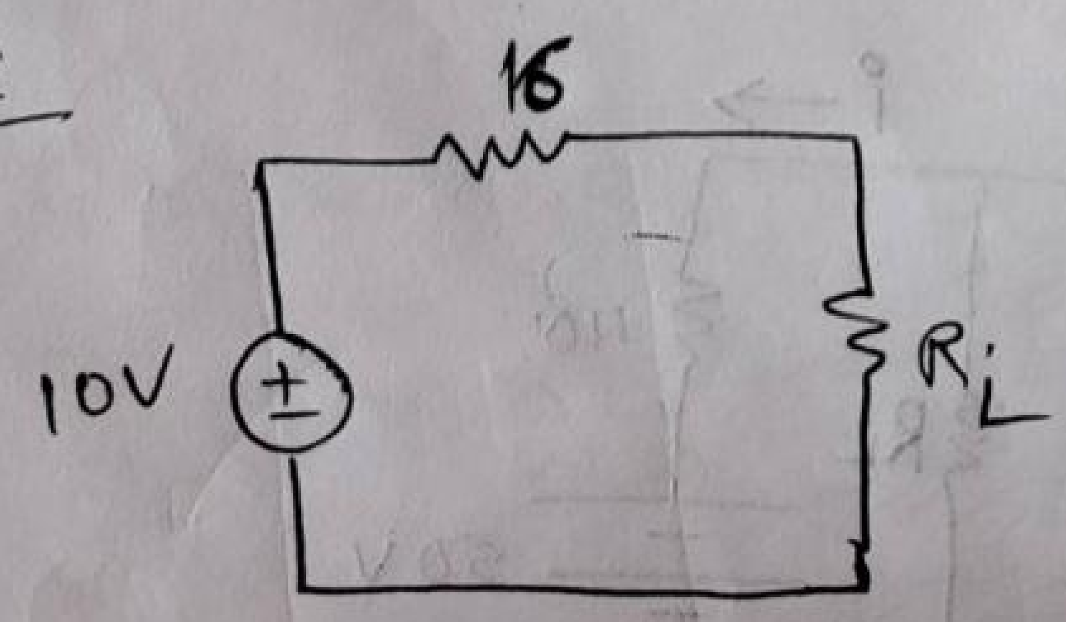
KCL

$$-\frac{5}{4} = \frac{5}{8} + I_{sc}$$

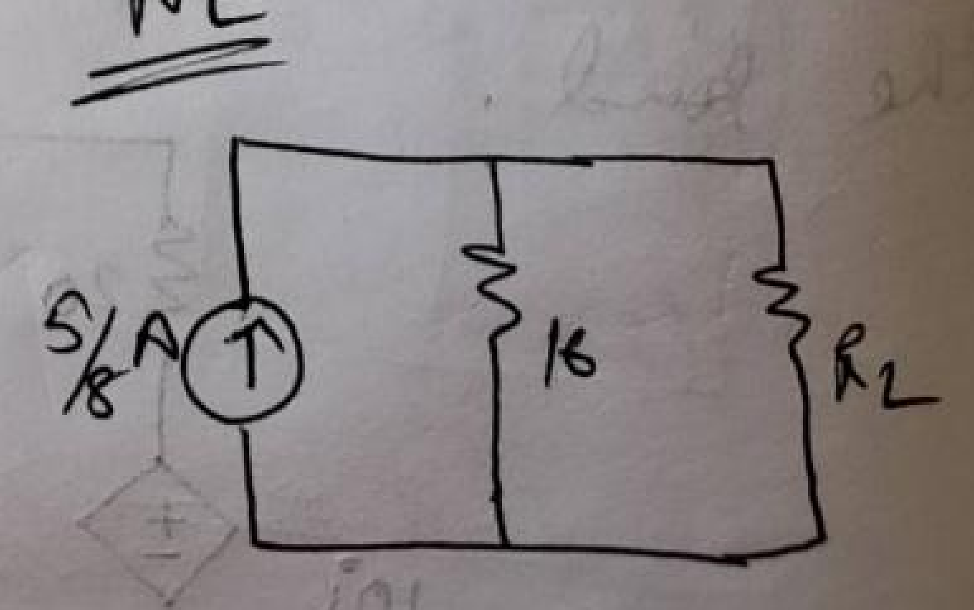
$$\Rightarrow I_{sc} = -5/8 \text{ A}$$

$$R_{TH} = R_N = \frac{V_{oc}}{I_{sc}} = \frac{10 \times 8}{5} = 16\Omega$$

TE



NE



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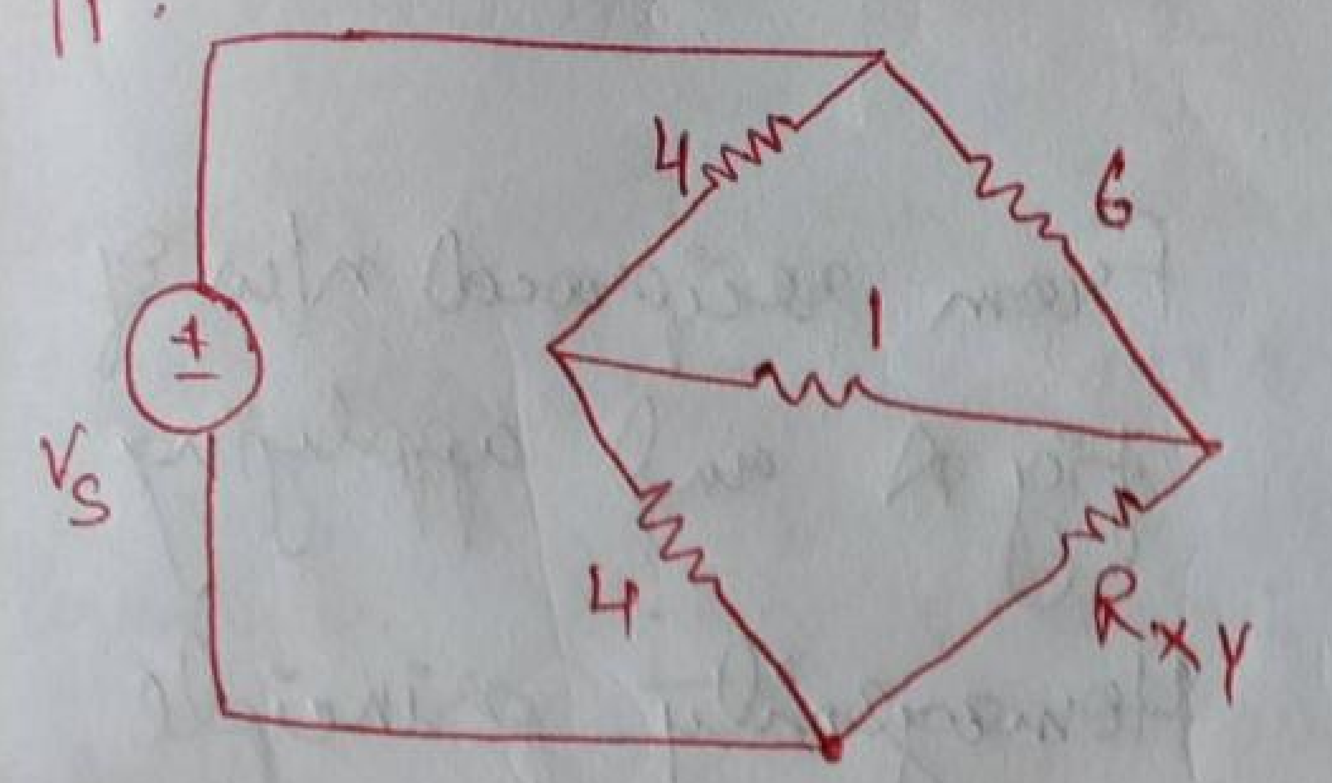
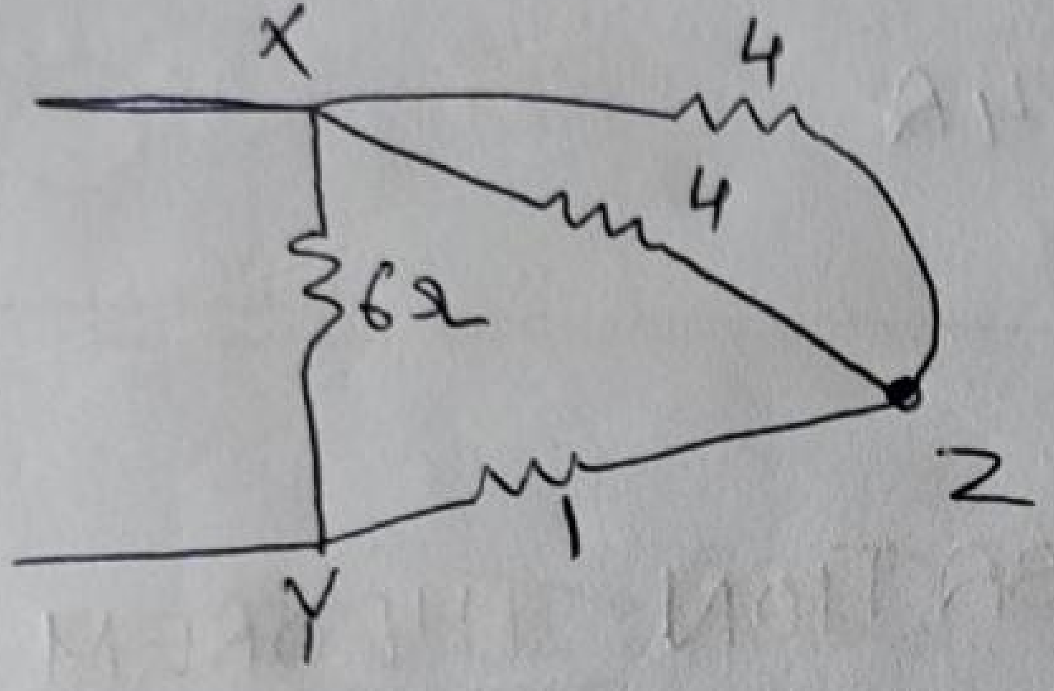
11. 

what is the value of R_x for which P_{max} occurs.



$4 \| 4 = 2$

$2 + 1 = 3$

$R_{XY} = R_{TH} = 3 \| 6 = 2\Omega$.

12. Use the data in fig A to find current 'i' in fig. B.

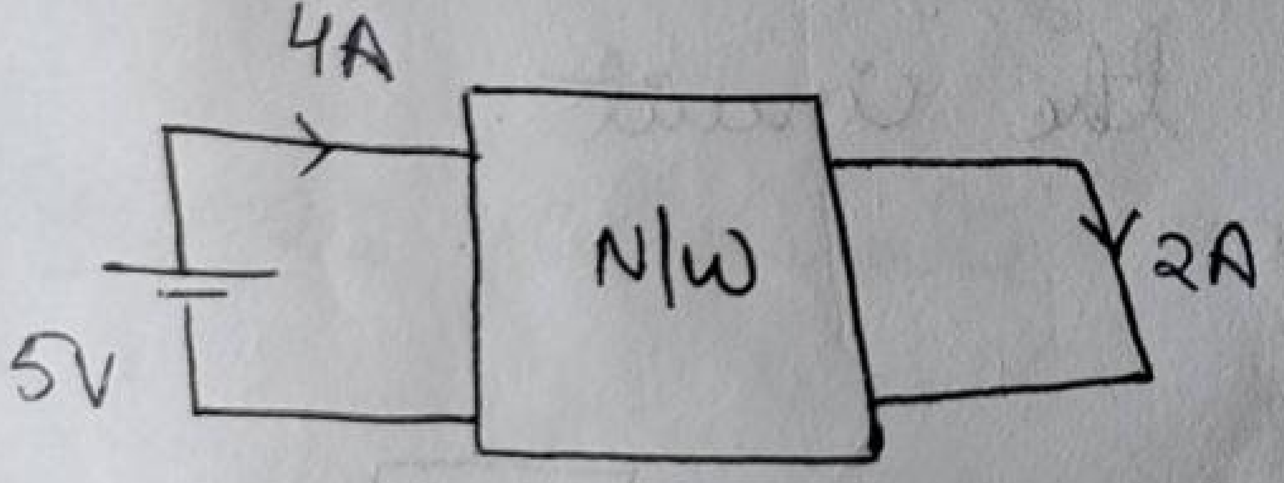


fig A

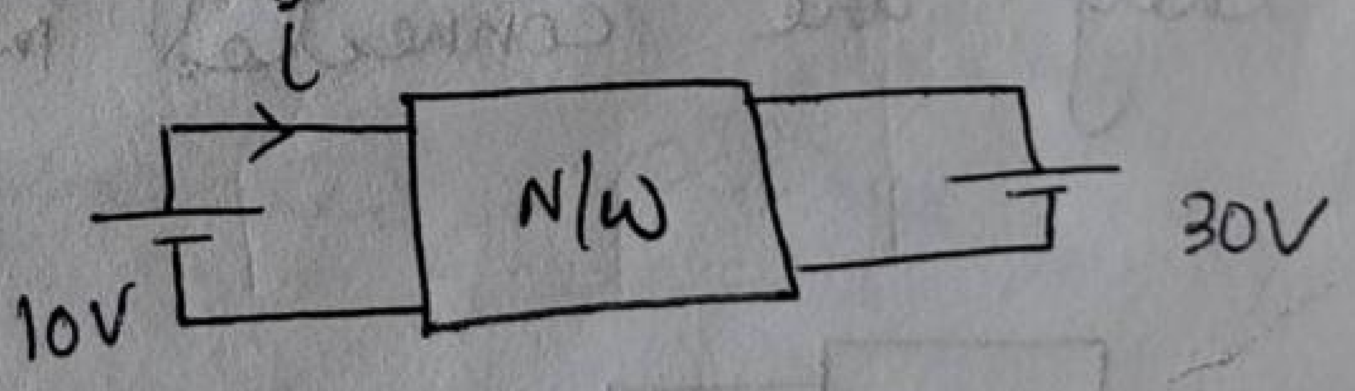
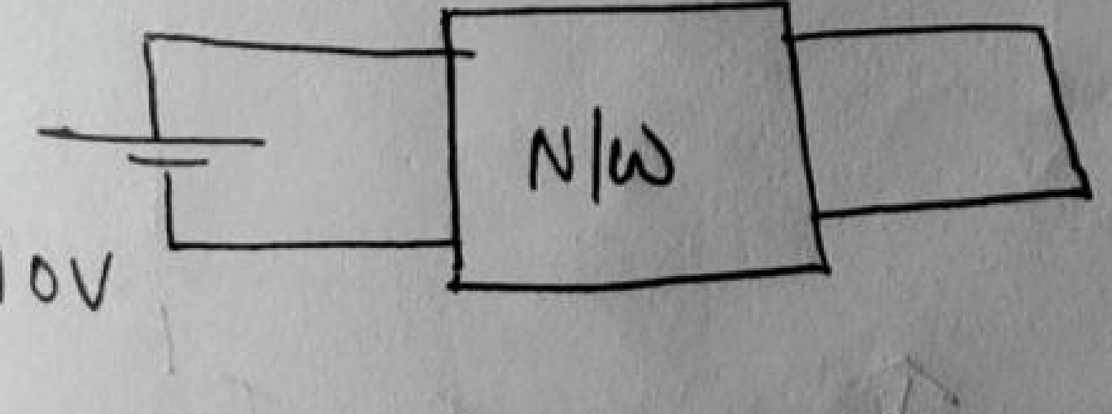


fig B

sol^n

Apply Superposition

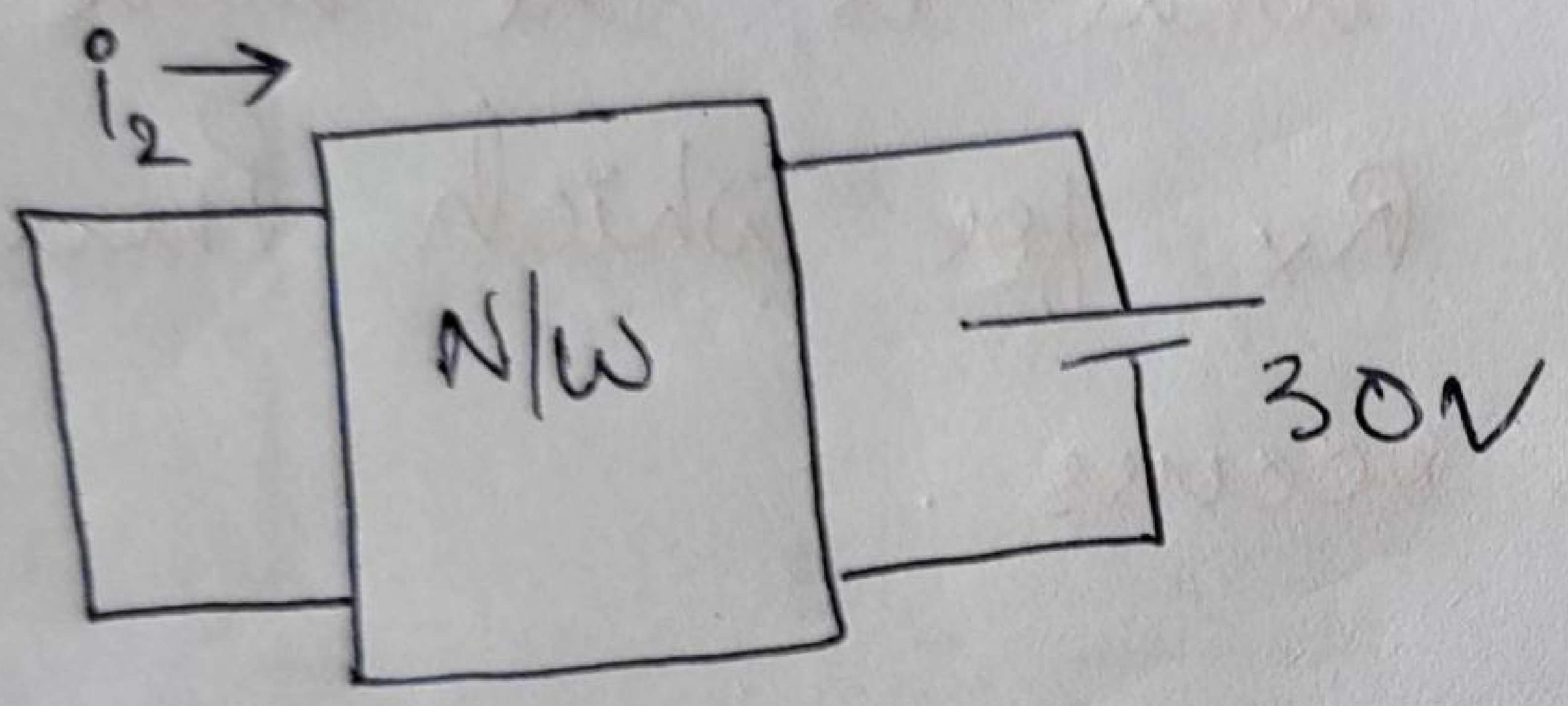
step 1



By homogenity principle from fig A.

$i_1 = 8A$

Step 2 :



From reciprocal n/w of fig A and applying Homogenity principle

$$i_2 = -12A$$

$$i = i_1 + i_2 = 8 - 12 = -4A$$

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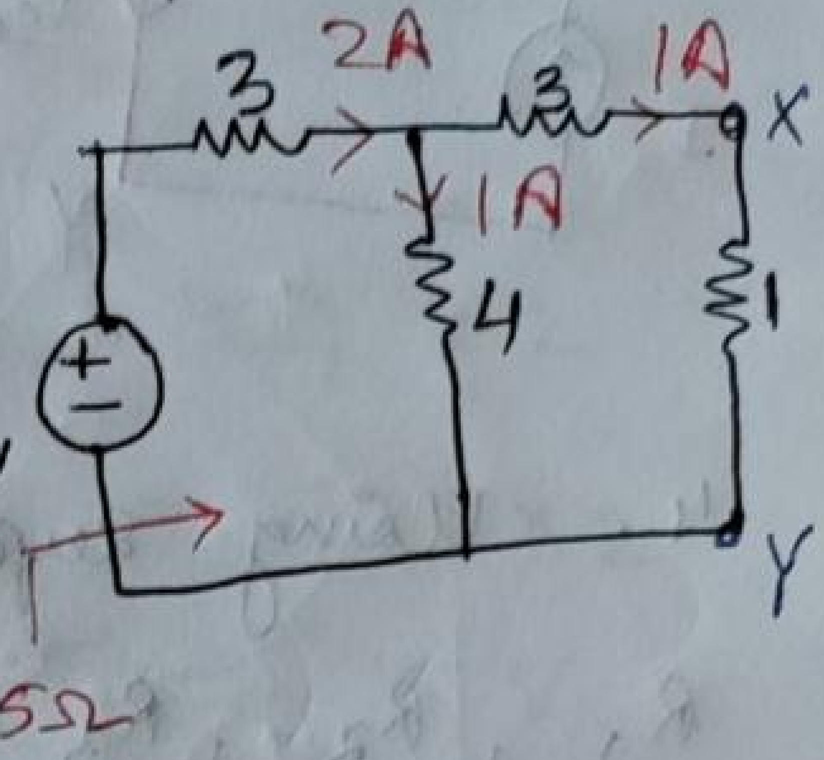
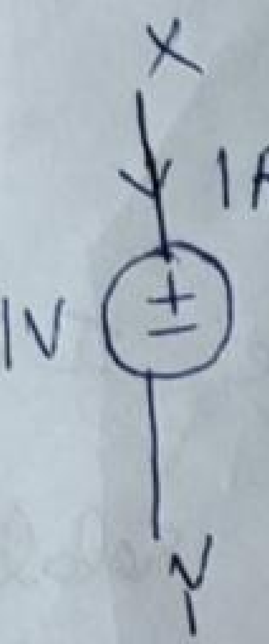
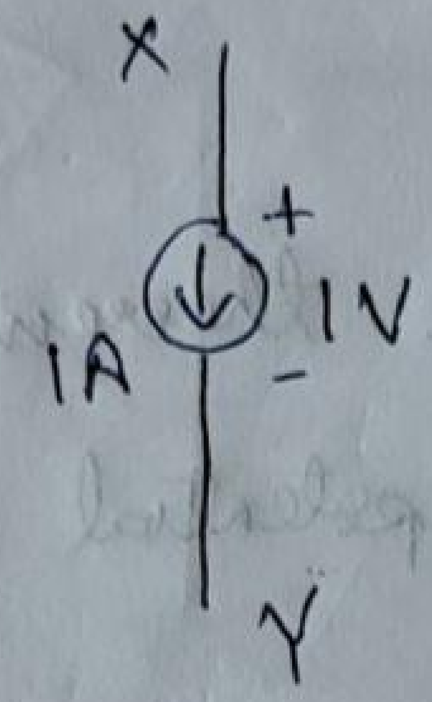
Practice set 5 Answers

① Use substitution theorem to substitute 1Ω branch in ~~8~~ 4 diff. ways.

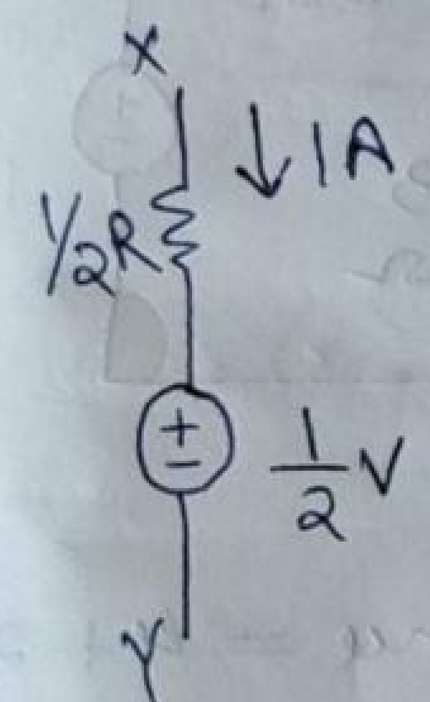


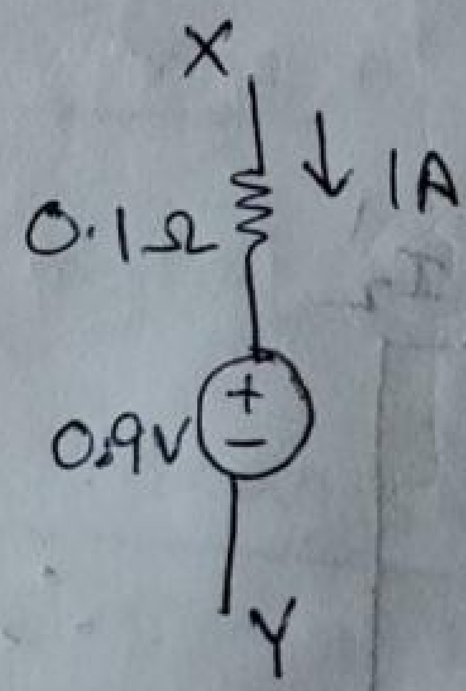
Solⁿ





$P_{abs} = 1W$ $\qquad$ $P_{abs} = 1W$

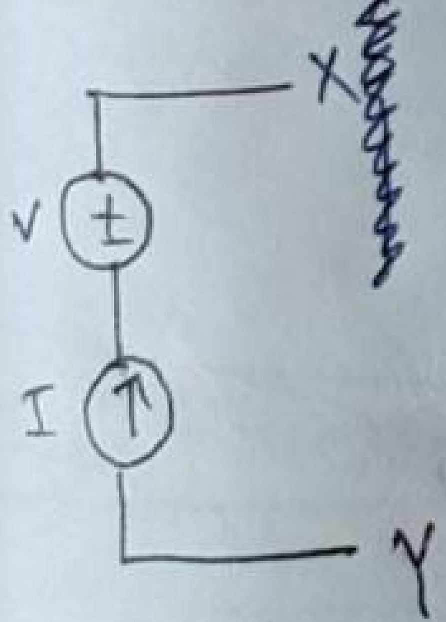




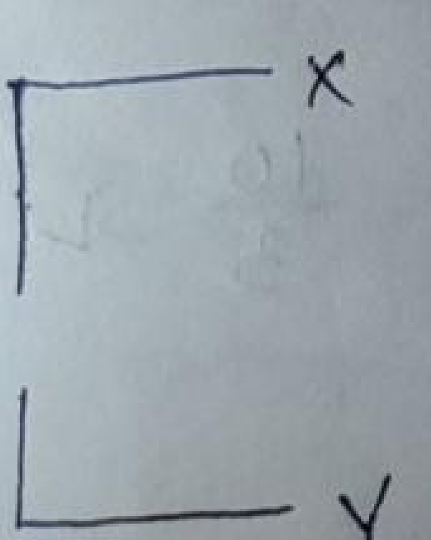
$P_{abs} = 1^2 \times (0.1) + 0.9$
$= 1W$

$P_{abs} = (1)^2 \times \frac{1}{2} + \frac{1}{2} \times 1$
$= 1W$

2. which theorem is applicable (a) Thevenin
✓(b) Norton
(c) Both (d) None

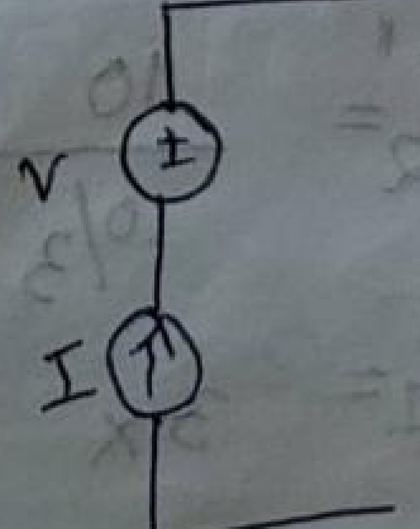


Thevenin



$R_{TH} = R_N = \infty$

V_{TH}



V_{TH} = can't be determined

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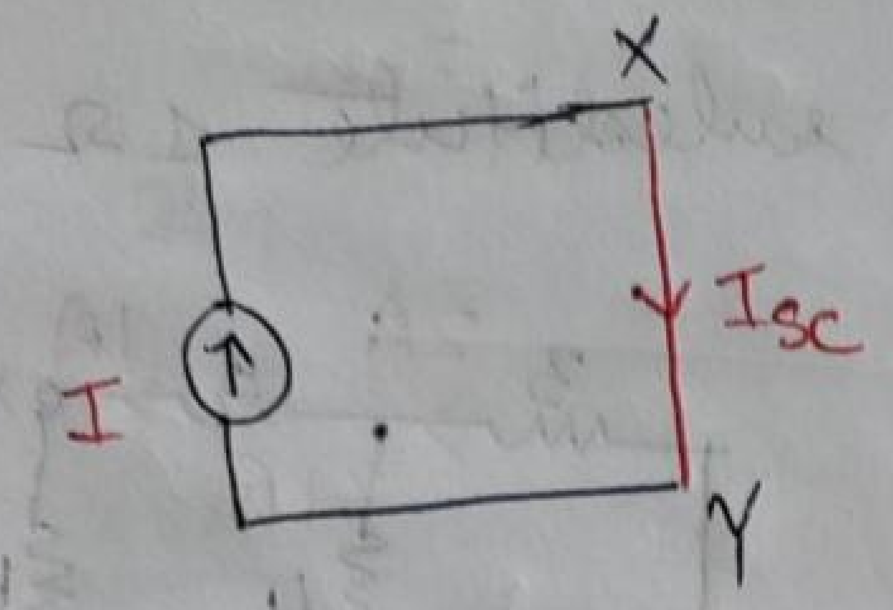
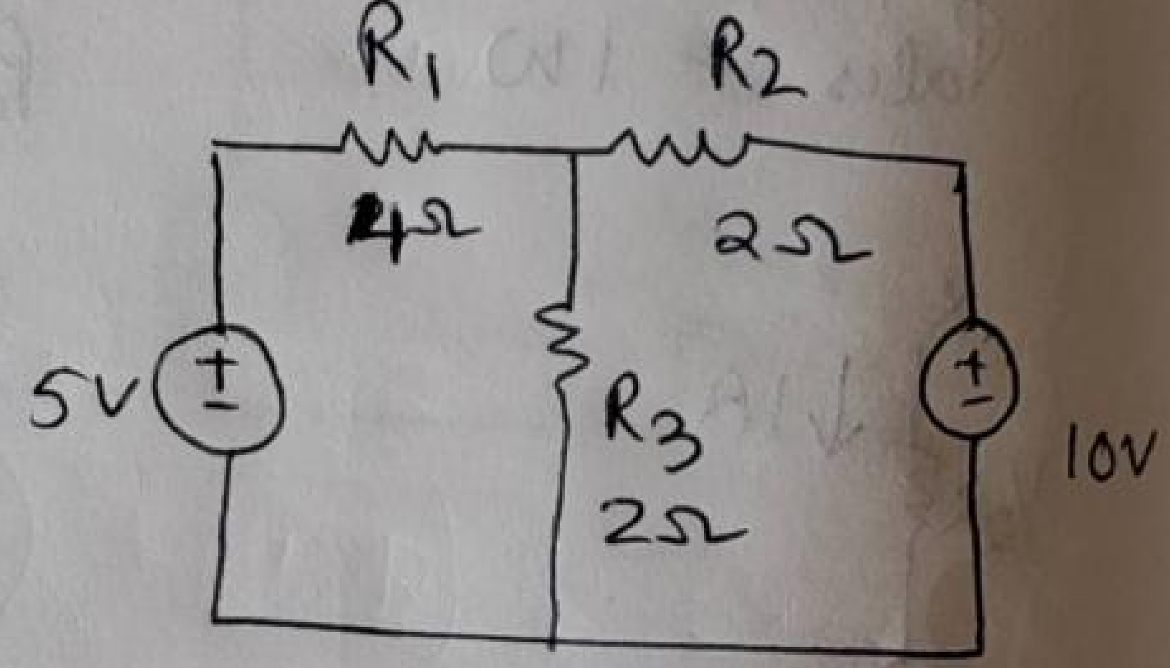
Norton



$I_N = I_{sc} = I$

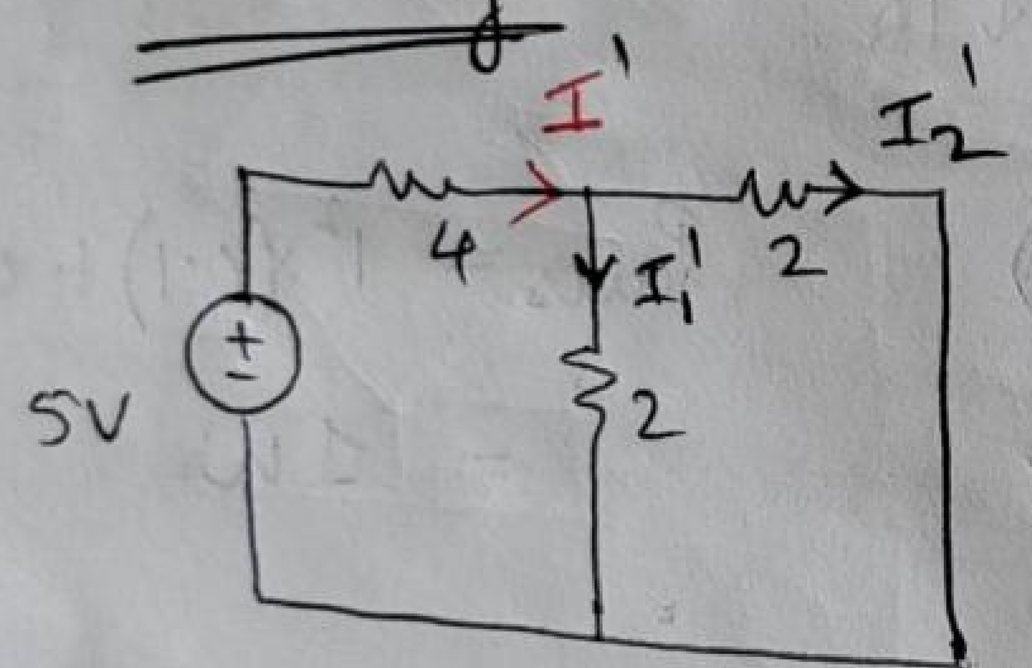
$R_N = \infty$

4. Using superposⁿ. theorem determine I in R_1, R_2, R_3 and potential of pt. A relative to point B.



Solⁿ

5V only

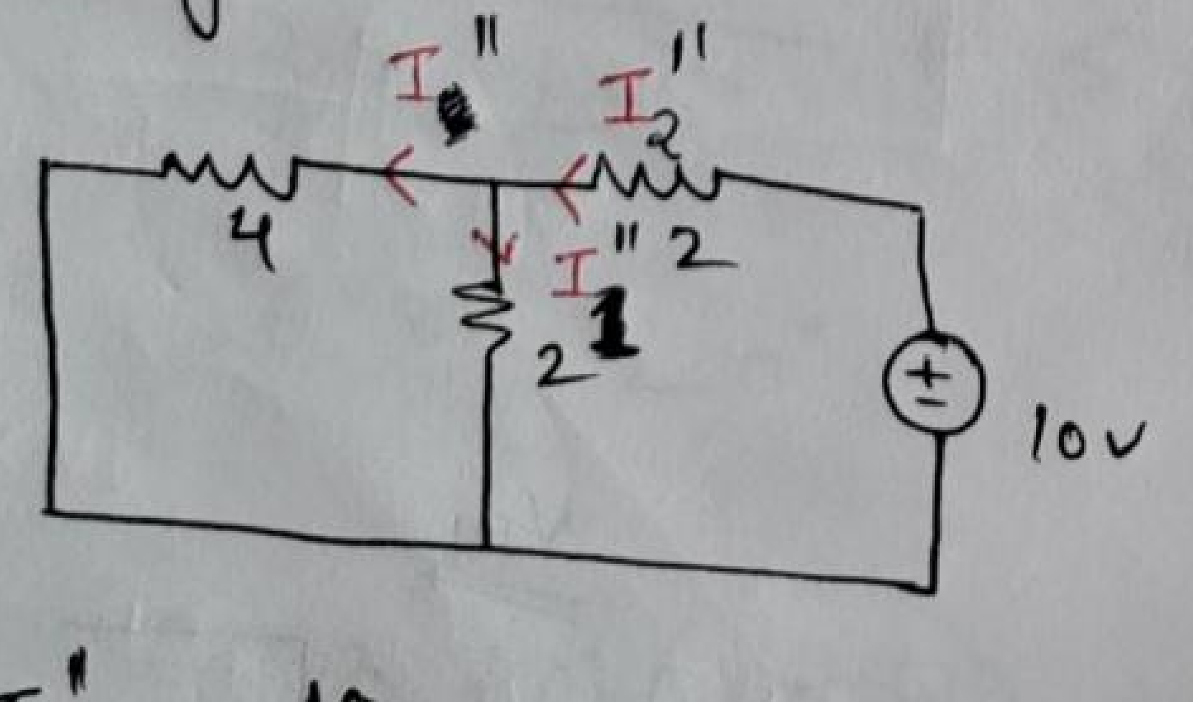


∴ Total resistance $= 4 + 2 \| 2$
$= 5\Omega$

∴ $I' = \frac{5\,V}{5\Omega} = 1A$

$I_1' = 0.5\,A \quad I_2' = 0.5\,A$

10V only



Total resistance
$= 2 + (4 \| 2)$
$= \frac{10}{3}\,\Omega$

$I_2'' = \frac{10}{10/3} = 3A$

$I_1'' = 3 \times \frac{4}{6} = 2A$

$I'' = 3 \times \frac{2}{6} = 1A$

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$\therefore \quad I = I' + I'' = 1 - 1 = 0A$

$I_1 = I_1' + I_1'' = 0.5 + 2 = 2.5A$

$I_2 = 3 - 0.5 = 2.5A$

$\therefore$ Potential of A wrt B $= I_1 \times 2$

$= 2.5 \times 2$

$= 5\,V$

5. Using Millman, find I in R_3.

$$V' = \frac{V_1 \cdot 1/R_1 + V_2\, 1/R_2 + V_3 \cdot 1/R_3}{1/R_1 + 1/R_2 + 1/R_3}$$

$$= \frac{(4 \times 0.5) + (0 \times 1) + (10 \times 0.5)}{0.5 + 1 + 0.5}$$

$V' = 3.5\,V$

$$R' = \frac{1}{1/R_1 + 1/R_2 + 1/R_3} = 0.5$$

$\frac{2}{3} + 2 = \frac{8}{3}$

$\frac{8}{3} \times \frac{2}{3} = \frac{16}{9}$

$\frac{16}{9} + \frac{16}{9} = \frac{32}{9} \times 1$

$\therefore$ Voltage across $R_3 = \frac{3.5}{1} = 3.5A$.

Check Nodal

$$\frac{V_1 - 4}{2} + \frac{V_1}{1} + \frac{V_1 - 10}{2} = 0$$

$\Rightarrow V_1 - 4 + 2V_1 + V - 10 = 0$

$\Rightarrow 4V_1 = +14$

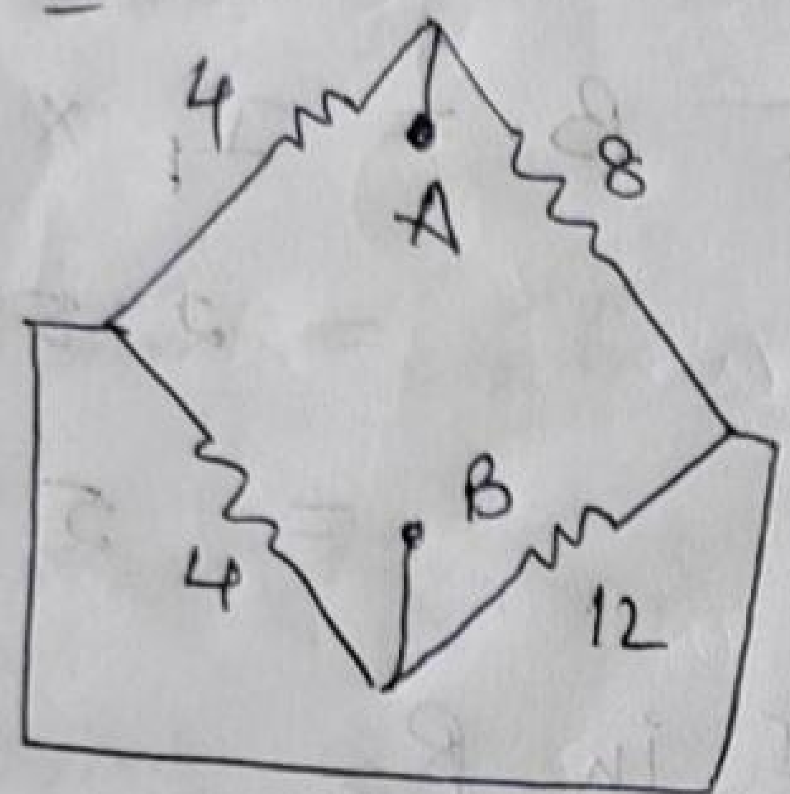
$\Rightarrow \cancel{V_1 = \frac{14}{4} = 3.5V}$

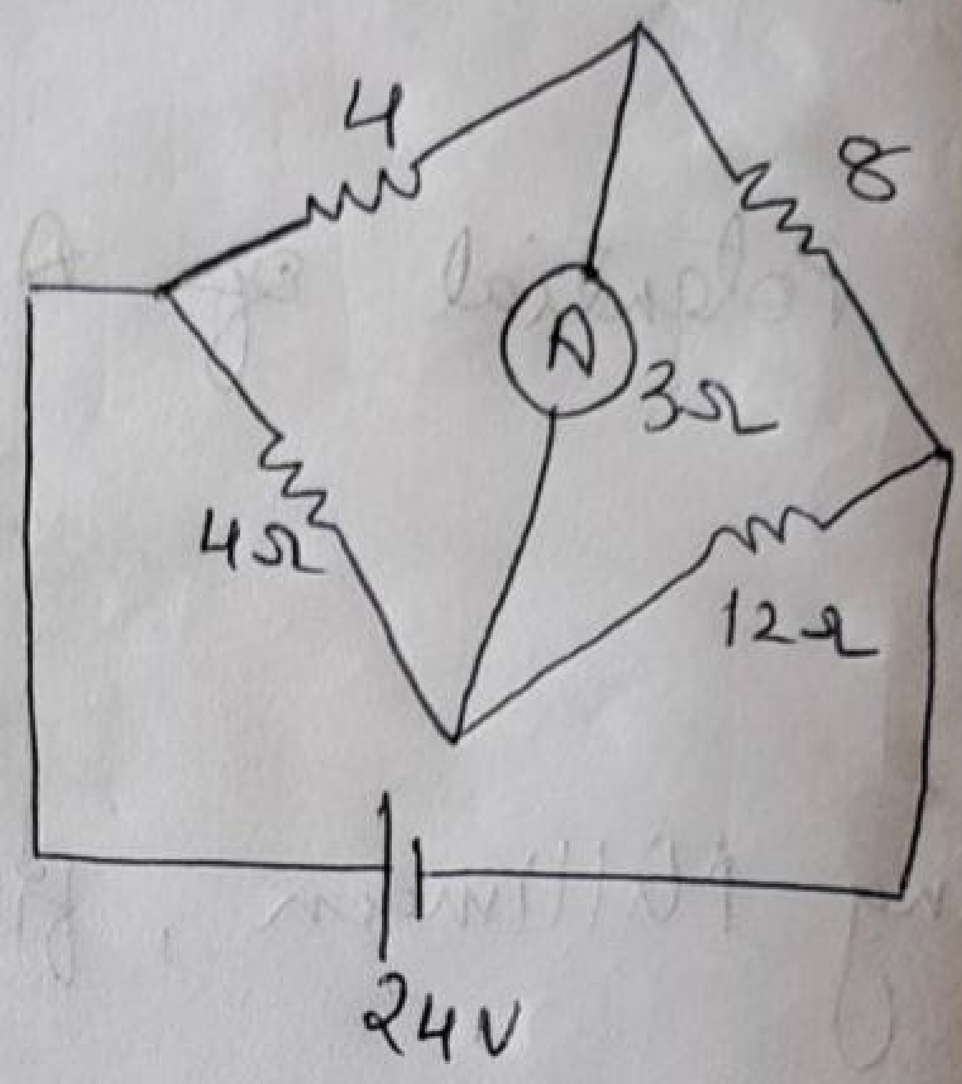
$\Rightarrow V_1 = \frac{14}{4} = 3.5V$

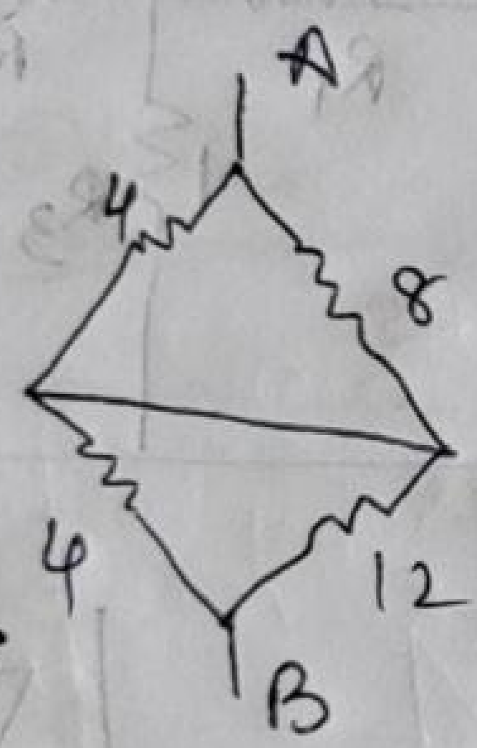
6. Find I in ammeter A of $R = 3\Omega$ connected in unbalanced wheatstone bridge

Sol^n Using Thevenin

$R_{TH} =$

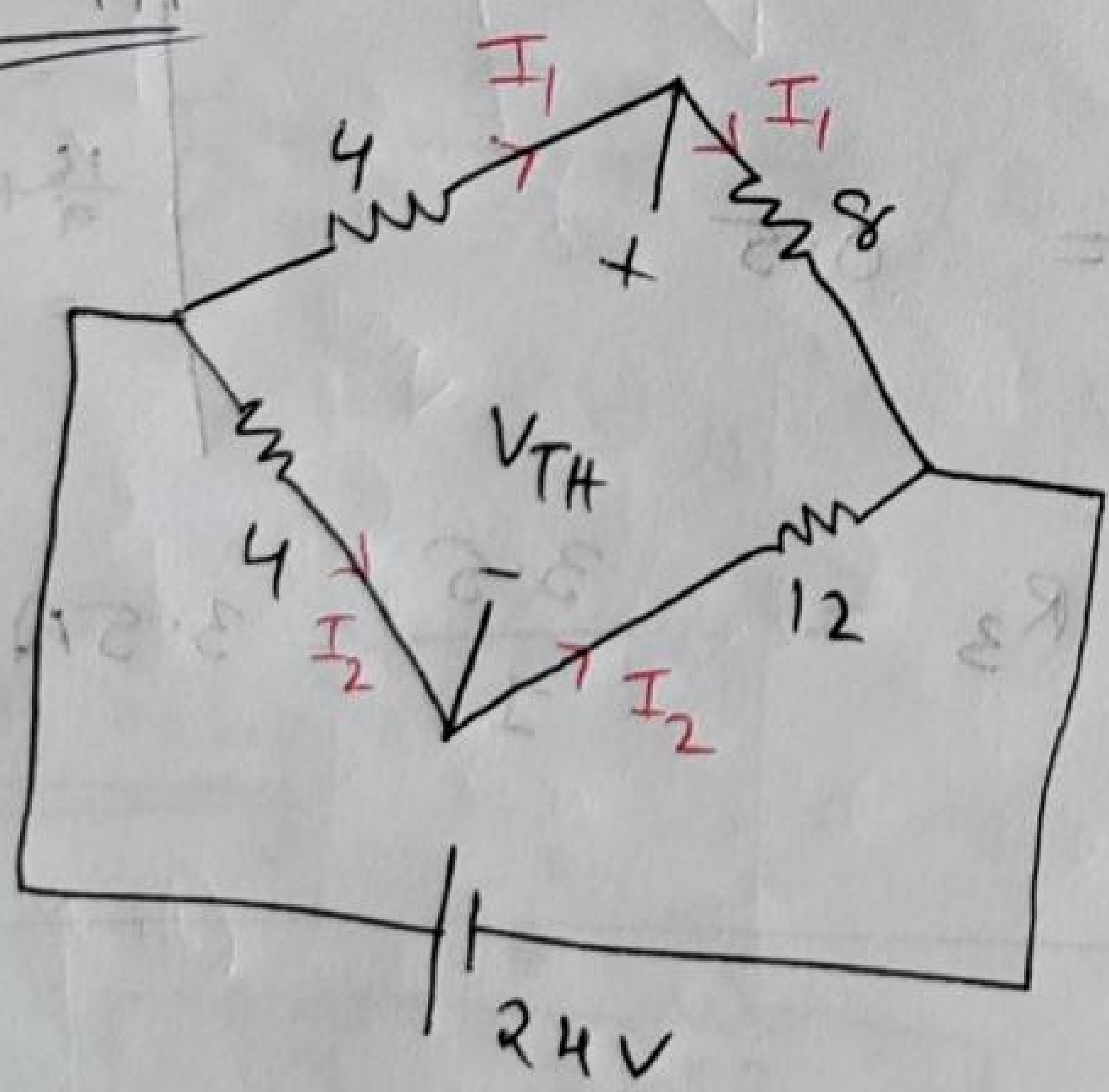






$R_{TH} = (8 \| 4) + (4 \| 12) = 5.66\ \Omega.$

V_{TH}



$I_1 = \dfrac{24}{4+8} = 2A$

$I_2 = \dfrac{24}{4+12} = 1.5A$

KVL

$4I_1 + V_{TH} - 4I_2 = 0$

$\Rightarrow 8 + V_{TH} - 6 = 0$

$\Rightarrow V_{TH} = -2V$

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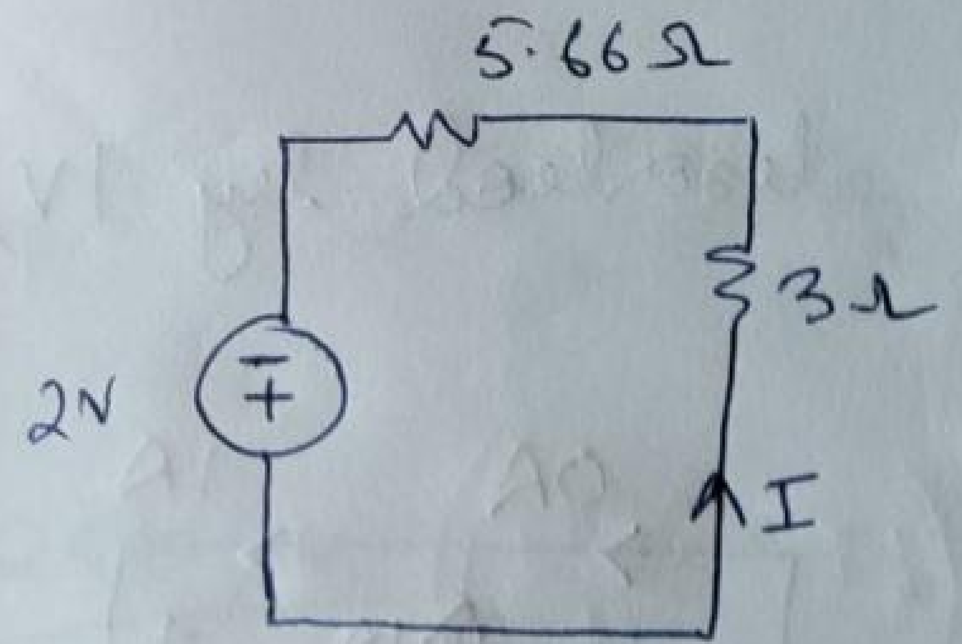
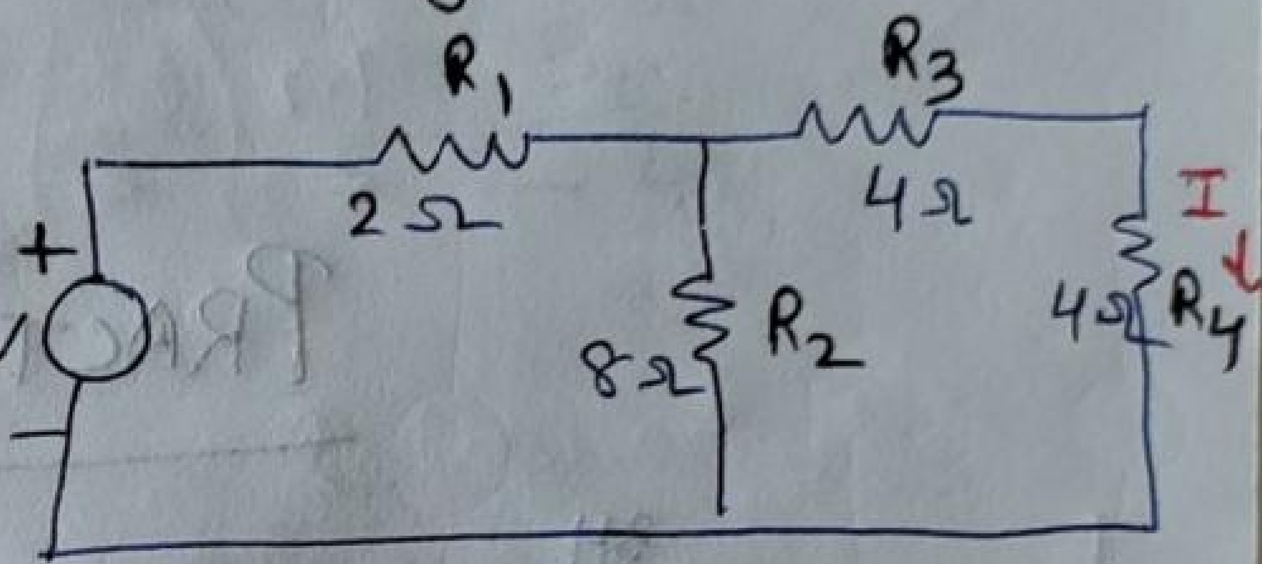


$$I = \frac{2}{5.66+3} = 0.23\ A$$

7. Find current in R_4 if ammeter have internal resistance of 1Ω is inserted in series with R_4, what reading will ammeter show?



Sol^n

Compensation theorem

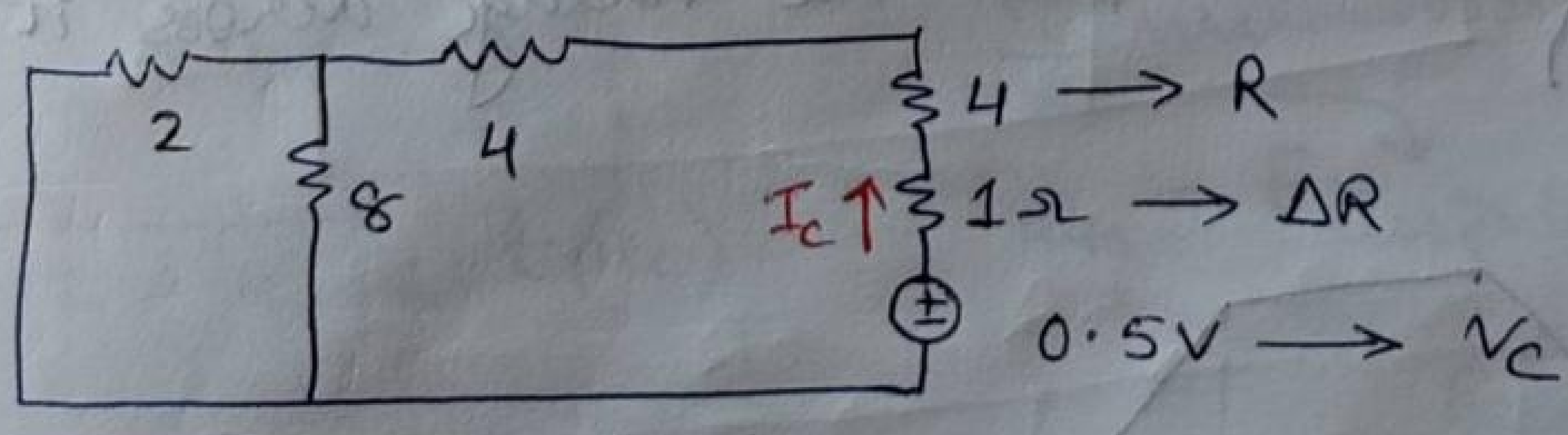
$$\text{Total current} = \frac{6}{2+(8\|8)} = 1\ A$$

$$I = 1 \times \frac{8}{8+8} = 0.5\ A.$$

Compensated voltage, $V_c = I(\Delta R)$

$$= 0.5 \times 1 = 0.5\ V$$

Compensated N/W



$$I_c = \frac{0.5}{5+4+(8\|2)} = \frac{0.5}{9+1.6} = \frac{0.5}{10.6}$$

$$= 0.0471\ A$$

∴ I_c is opposite to I caused by 6V.

∴ Ammeter reading $= (0.5 - 0.0471)\ A$

$= 0.45\ A$

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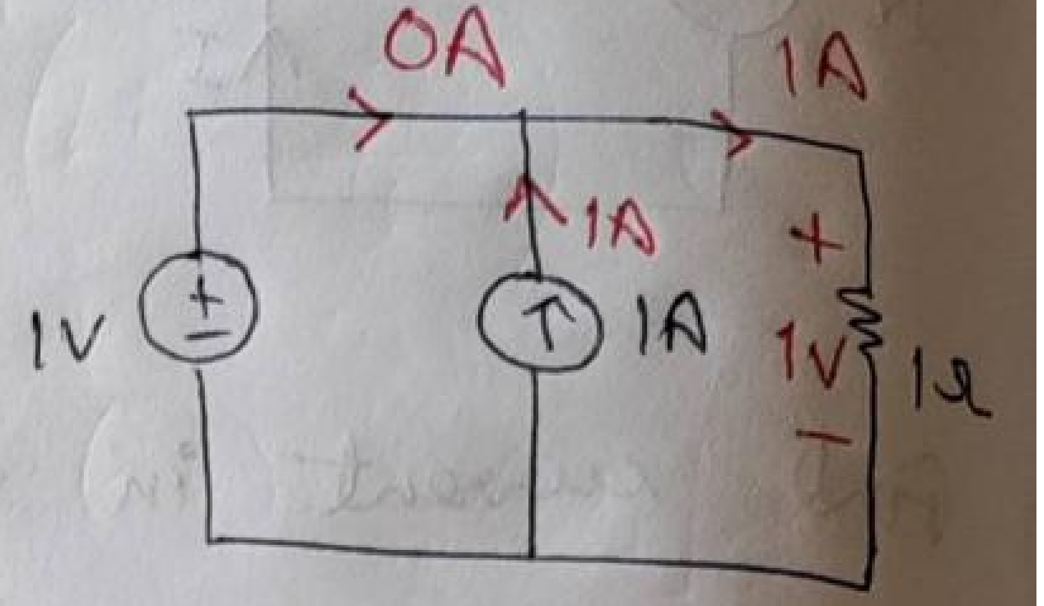
3. Find power delivered or absorbed by 1V, 1A, 1Ω.



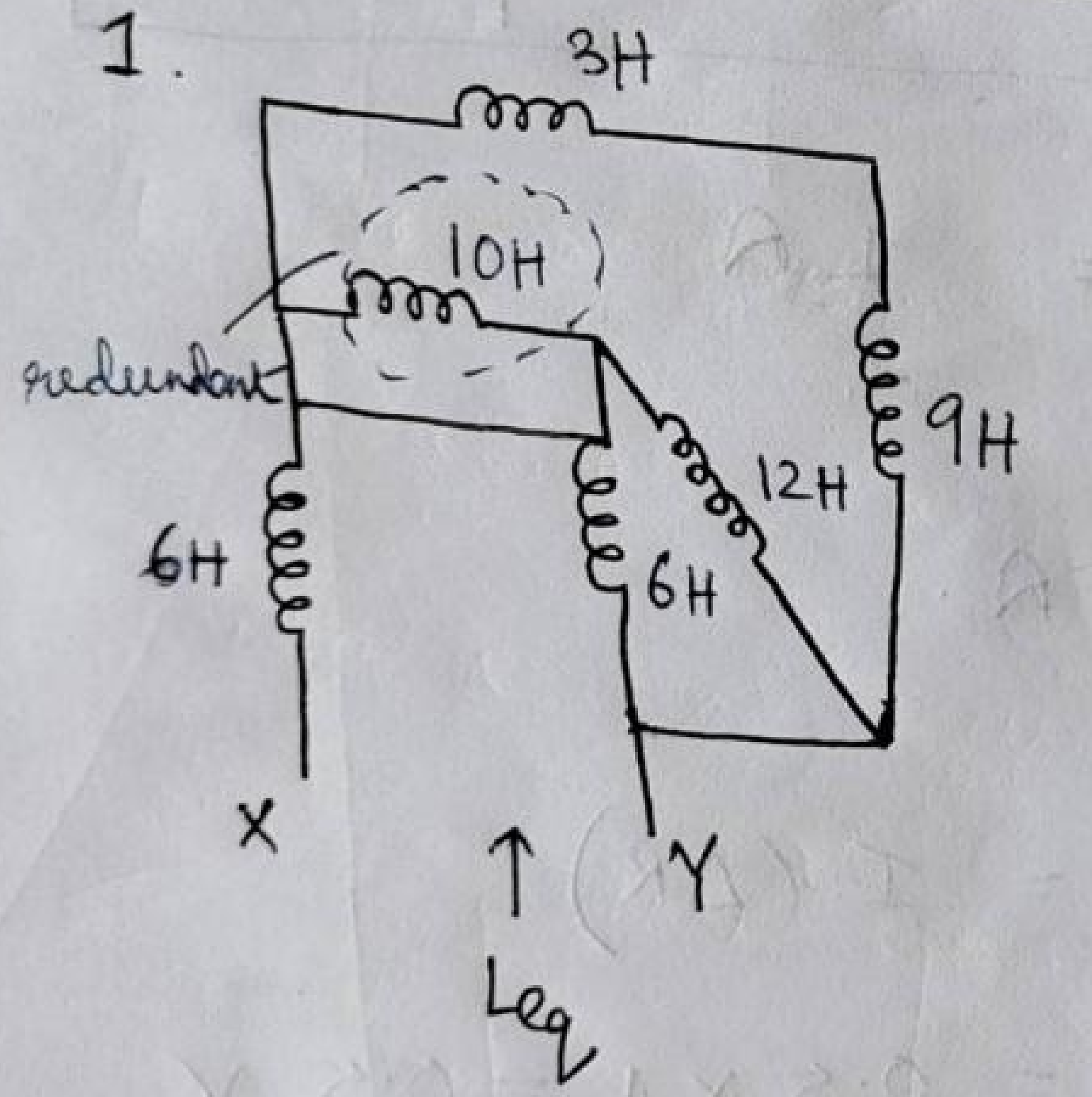
$P_{delivered\ 1V} = 0W$

$P_{del\ 1A} = 1W$.

$P_{abs\ 1Ω} = 1W$

PRACTICE SET 6

1.

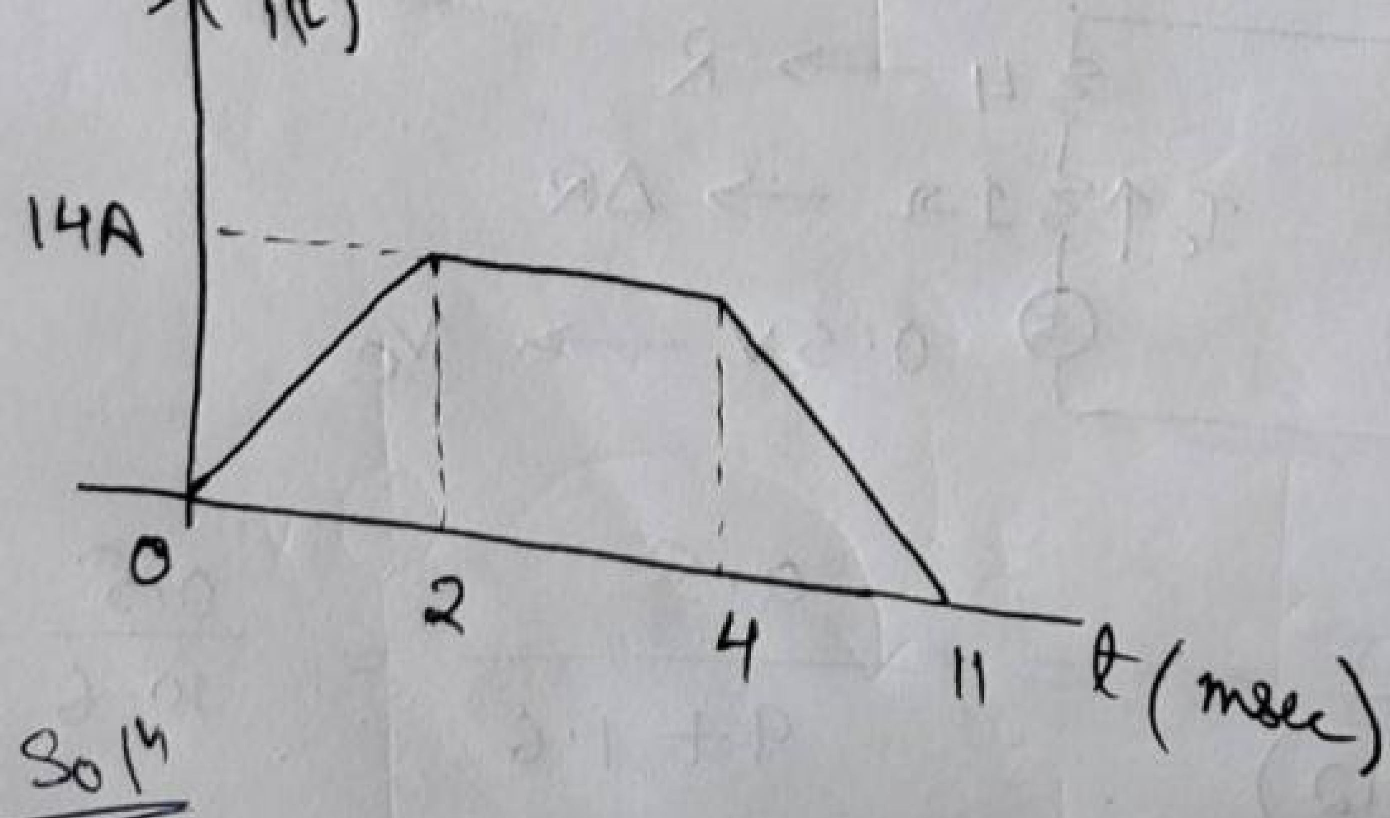


Find Leq.

$$L_{eq} = 6 + (6 \| 12 \| 12)$$

$$= 6 + 3 = 9H$$

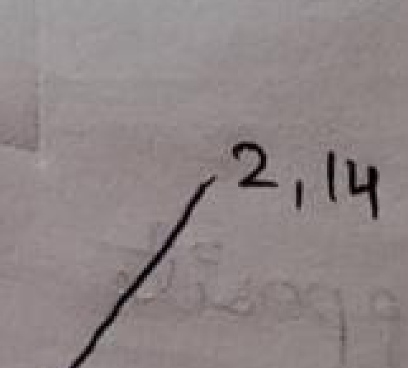
2. If the current flowing through 2H inductor is as shown, plot the voltage across it.



Sol^n

0<t<2

$i(t) = 7t$



$\frac{14-0}{2-0} = \frac{14}{2} = 7$

$$\therefore \; V = L\frac{di}{dt} = 2\frac{d}{dt}(7t) = +14V$$

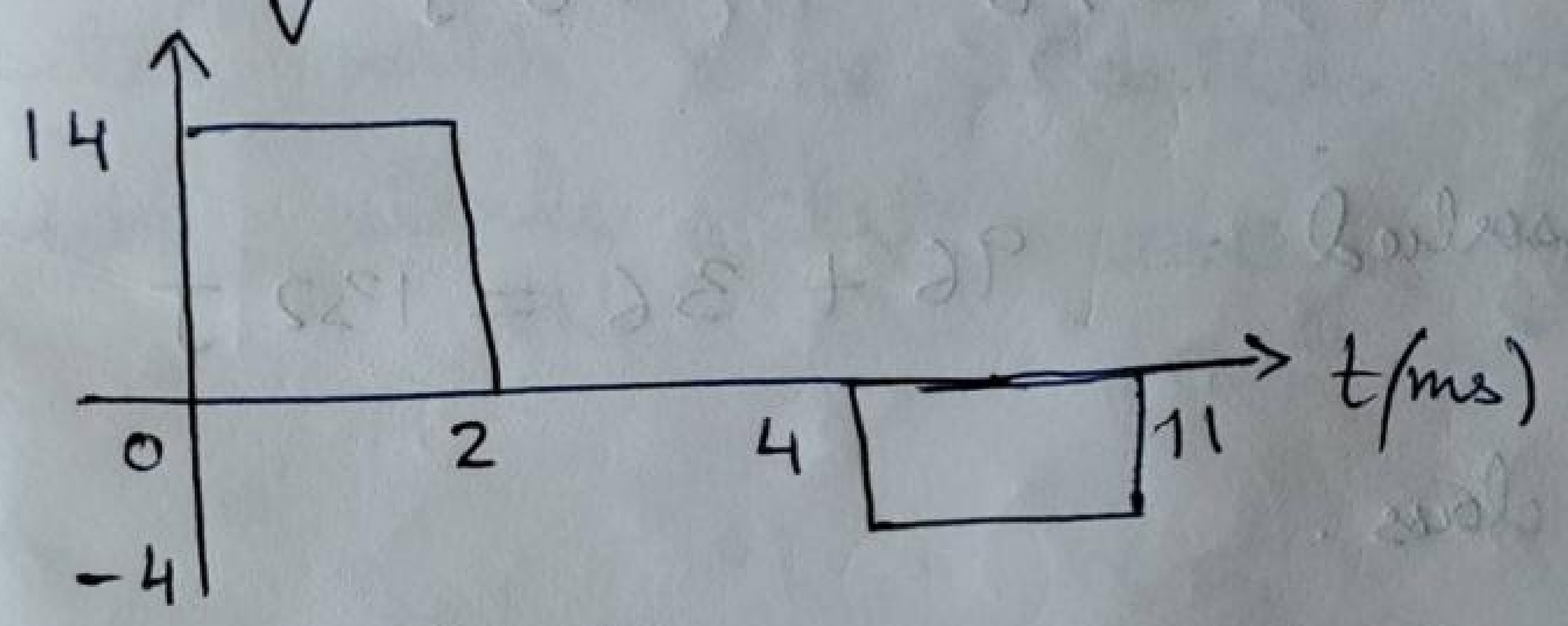
$2 < t < 4$

$$i(t) = 14 \Rightarrow V = L\frac{di}{dt} = 2\frac{d}{dt}(14) = 0V$$

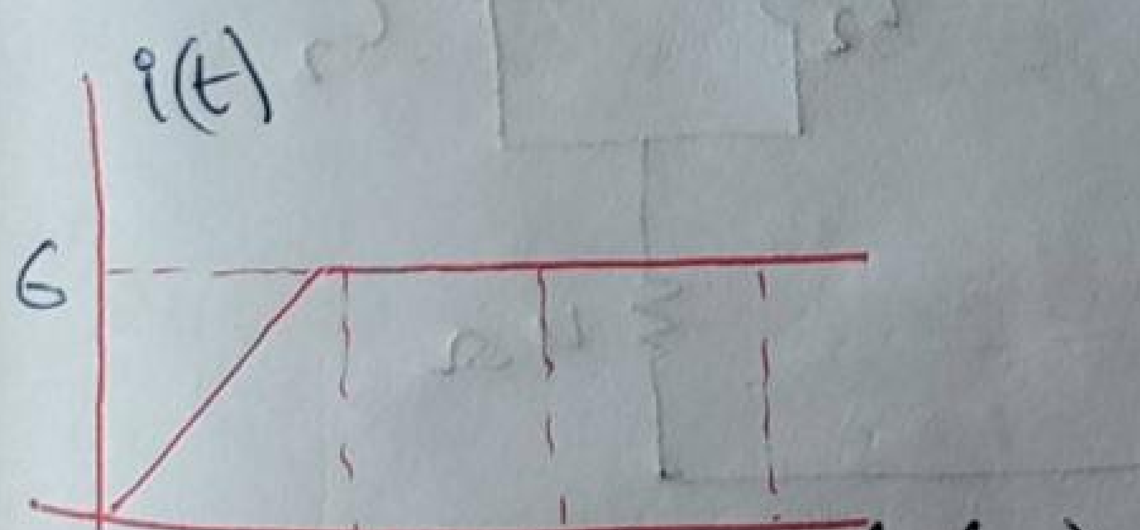
$4 < t < 11$

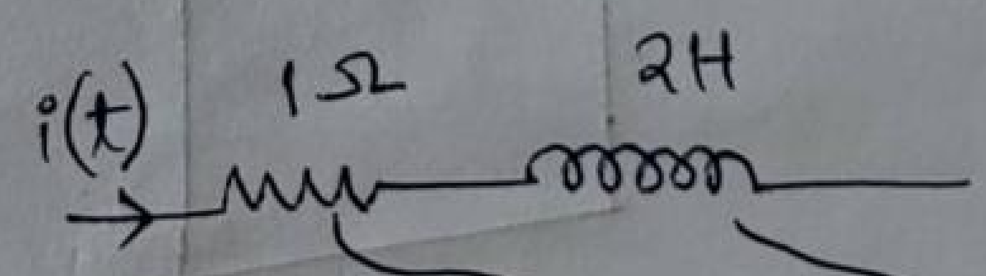
$$i(t) = -2t \Rightarrow V = L\frac{di}{dt} = 2\frac{di}{dt}(-2t)$$

$$= -4V$$



3. A practical coil has an inductance of 2H and resistance of 1Ω. If this coil is excited with current as shown below. Find total energy absorbed by the coil upto 1st 4 seconds.





$E_{abs} = E_{dissipated} + E_{stored}$

$$E_{dissipated} = \int P_R \, dt$$

$$= \int_0^4 [i(t)]^2 R \, dt$$

$$= \int_0^2 (3t)^2 \times 1 \, dt + \int_2^4 6^2 \, dt$$

$$= \frac{9}{3}\left[t^3\right]_0^2 + 36(4-2)$$

$= 24 + 72 = 96\ J$

$$E_{stored} = \int P_L\, dt = \int_0^4 \left(Li \frac{di(t)}{dt}\right) dt$$

$$= \int_0^2 \left[2(3t)\frac{d}{dt}(3t)\right] dt \;+$$

$$\int_2^4 \left[2 \cdot 6 \frac{d}{dt}(6)\right] dt$$

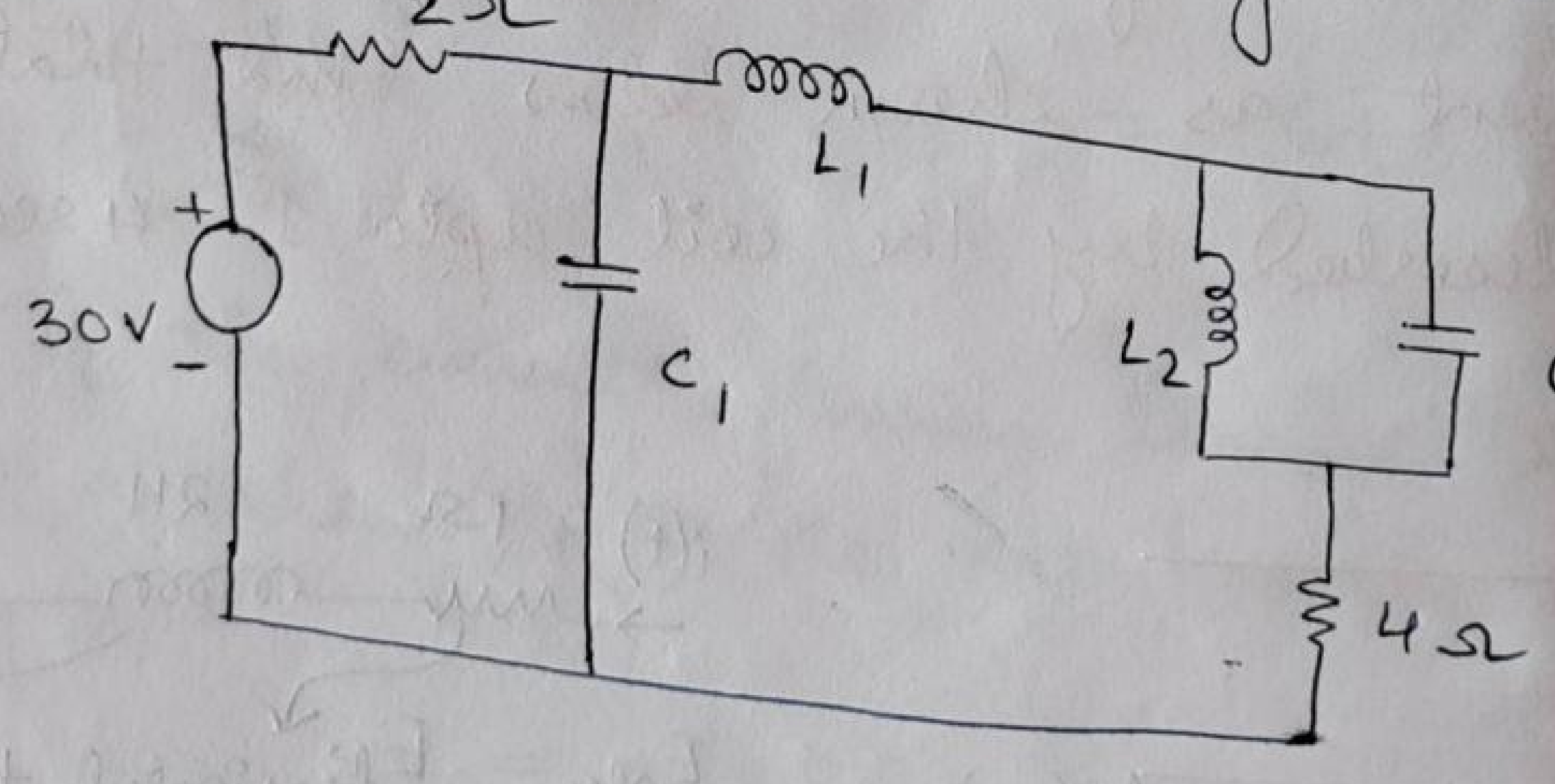
$$= \frac{9 \times 2}{2}\left(\cancel{\tfrac{t^2}{2}}\right)_0^2 = 36\ J$$

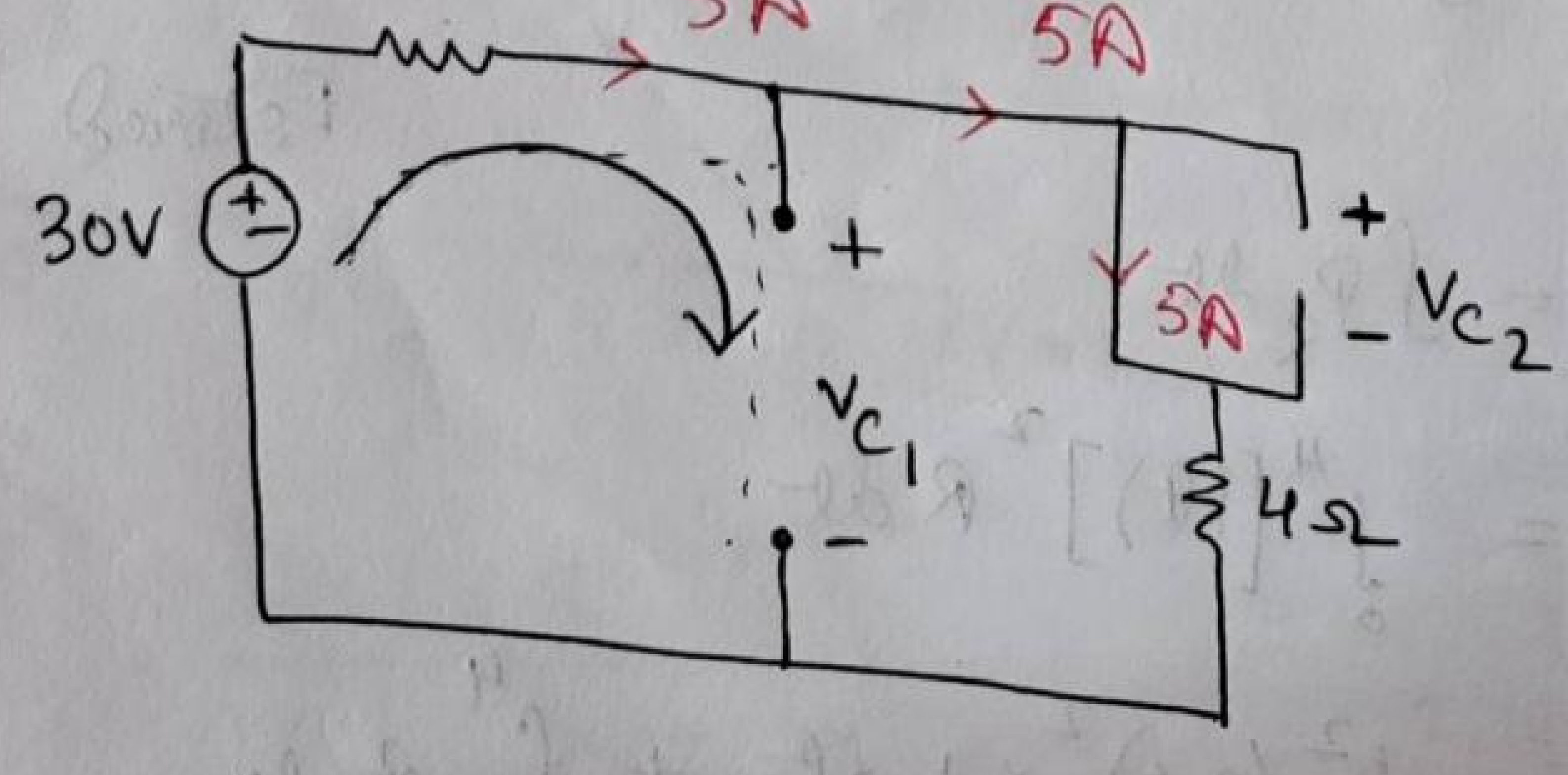
$\therefore E_{absorbed} = 96 + 36 = 132\ J$

4. done in class.

5. Determine steady state voltage across capacitor and current through inductor.

Sol^n





$R_{total} = 2 + 4 = 6\Omega$

$i = \frac{30}{6} = 5A$

$\therefore I_{L_1} = I_{L_2} = 5A.$

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KVL

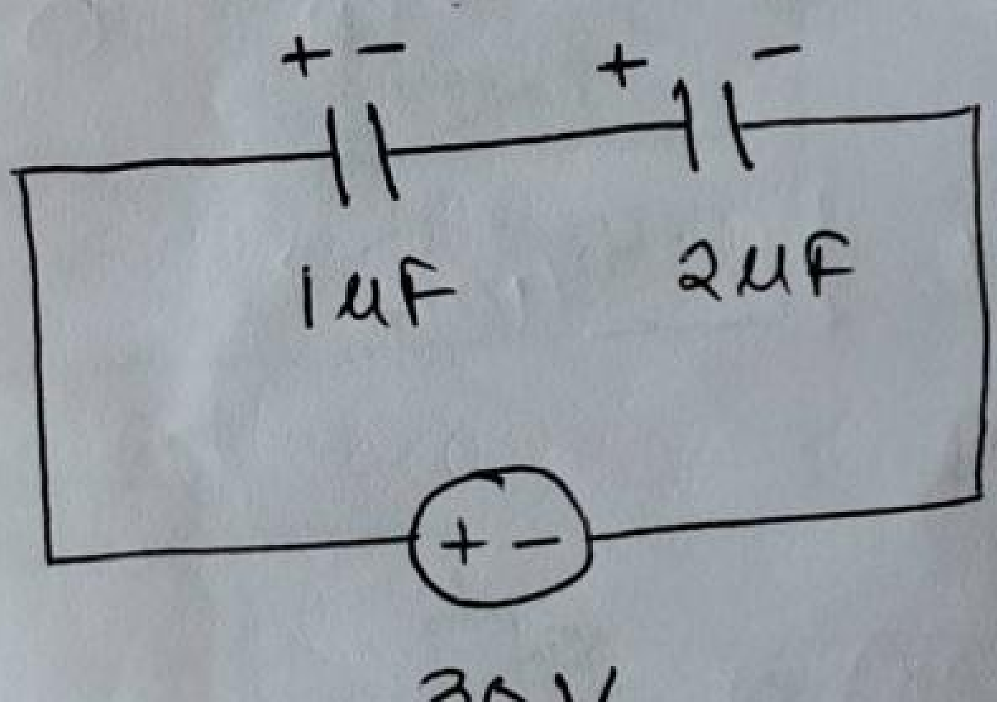
$$-30 + 10 + V_{C_1} = 0$$

$$\Rightarrow V_{C_1} = 20V$$

$$V_{C_2} = 0V \text{ [across S.C.]}$$

6. Two capacitors of 1 μF and 2 μF are connected in series across a 30V DC source. Find their steady voltages and charge on each. Now if these 2 capacitors are disconnected from supply and connected with like polarities together, now determine steady state voltage and charge on them.

Solⁿ



$$V_{1\mu} = 30\left(\frac{2}{2+1}\right) = 20V$$

$$V_{2\mu} = 30\left(\frac{1}{2+1}\right) = 10V$$

$$q_{1\mu} = CV = 1 \times 20 = 20\mu C$$

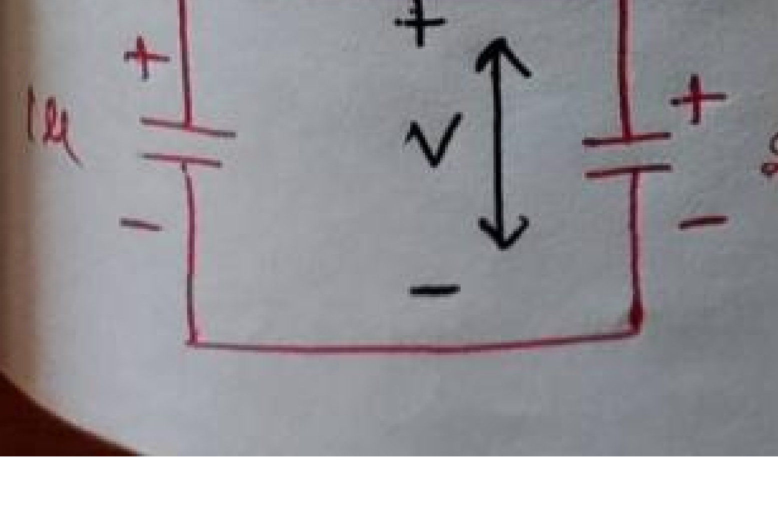
$$q_{2\mu} = 2 \times 10 = 20\mu C$$

NOTE

In series, current is equal so charge will be same in series connected capacitors

$$\therefore q_{1\mu} = q_{2\mu} = 20\mu C$$

Like polarities



Here $V_{1\mu} = V_{2\mu} = V$

$$\Rightarrow \frac{q_1}{C_1} = \frac{q_2}{C_2} \Rightarrow \frac{q_1}{1} = \frac{q_2}{2}$$

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$\therefore \quad q_2 = 2q_1$

From law of conservation of charge

$$q_1 + q_2 = 20 + 20 = 40$$

$$\therefore \quad q_1 + 2q_1 = 40$$

$$\Rightarrow \quad q_1 = \frac{40}{3}\,\mu C$$

$$\therefore \quad q_2 = 2q_1 = \frac{80}{3}\,\mu C$$

$$\therefore \quad V_1 = V_2 = \frac{q_1}{C_1} = \frac{q_2}{C_2} = \frac{40}{3} \text{ volts}$$