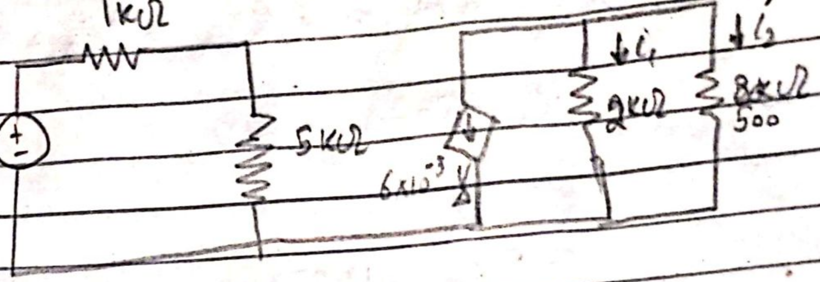
P 2.29:-



(a) $i_0 = 0$

(b)

$60 = 6000\, i_g \qquad i_g = 10mA$

$V_\Delta = 5000\, i_g = 50V \qquad 6\times10^{-3} V_\Delta = 300mA$

$2000\, i_1 = 500 i_2 \qquad So\ i_1 + 4i_1 = -300\ mA$

$\therefore\ i_1 = -60 mA$

(c) $300 - 60 + i_2 = 0,$

$\Rightarrow i_2 = -240 mA$

P 2.30:-

$50 i_2 + \frac{0.250}{50} + \frac{0.250}{12.5} = 0 \qquad i_2 = -0.5mA$

$V_1 = 100 i_2 = -50mV$

$20 i_1 + \frac{(-0.050)}{25} + (-0.0005) = 0 \qquad i_1 = 125\mu A$

$V_g = 10 i_1 + 40 i_1 = 50 i_1$

$\therefore\ V_g = 6.25mV$

P 2.31:-

(a) $-50 - 20 i_\sigma + 18 i_\Delta = 0$

$-18 i_\Delta + 5 i_\sigma + 40 i_\sigma = 0 \qquad So\ 18 i_\Delta = 45 i_\sigma$

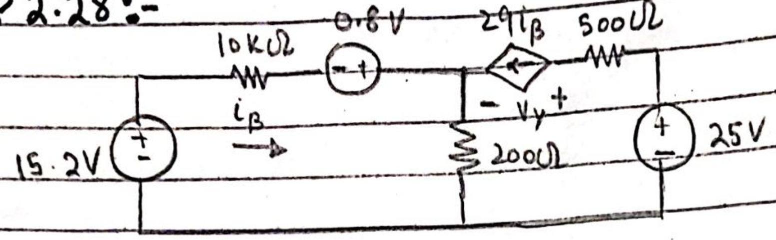
$\therefore\ -50 - 20 i_\sigma + 45 i_\sigma = 0, \quad So\ i_\sigma = 2A$

$V_0 = 40 i_\sigma = 80V$

Scanned with CamScanner

$$\therefore\ i_B = \frac{\left[V_{cc}R_2 / (R_1 + R_2)\right] - V_0}{(1+\beta)R_E + R_1R_2/(R_1+R_2)}$$

P2.28:-



$$i_\beta + 29\, i_\beta = i_{200\Omega} = 30\, i_\beta$$

(a)

$$-15.2\,V + 10{,}000\, i_1 - 0.8V + 6000\, i_\beta = 0$$

Solving for i_β

$$10{,}000\, i_\beta + 6000\, i_\beta = 16V$$

$$i_\beta = \frac{16}{16{,}000} = \boxed{1\,mA}$$

$$-V_y - 14{,}500\, i_\beta + 25 - 6000\, i_\beta = 0$$

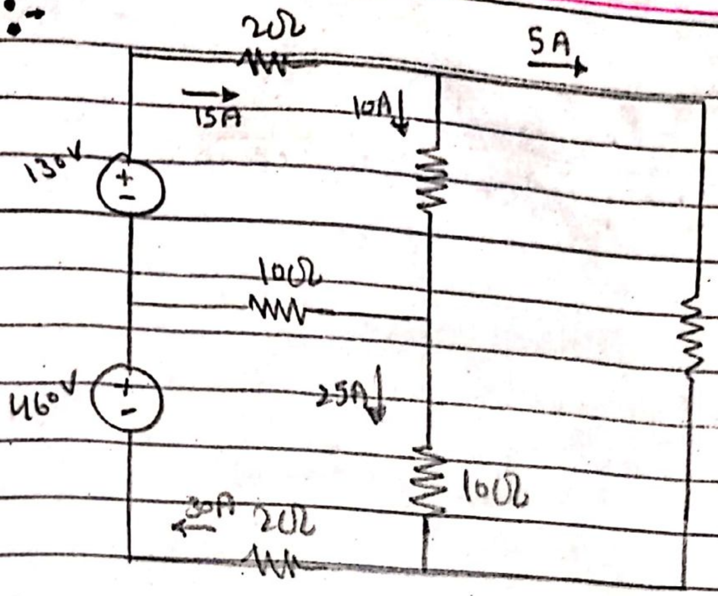
$$V_y = 25 - 20{,}5000\, i_\beta = 25V - 20{,}500(10^{-3})$$

$$= 25V - 20.5V = 4.5V$$

(b) The total power generated in the circuit is the sum of the -ve power values in the power table

$$-15.2mW + -0.8mW + -725mW = -741mW$$

P 2.26:-



(a)

$$P_{130} = -(130)(15) = -1950\ W$$

$$P_{460} = -(460)(30) = -13,800\ W$$

(b)

$$P_{dis} = (15)^2(2) + (15)^2(10) + (30)^2(2) + (10)^2(25) + (25)^2(10) + (5)^2(100)$$

$$P_{dis} = 15,750$$

$$P_{del} = 1950 + 13,800 = 15,750\ W$$

P 2.27:-

Sol:

$$i_E - i_B - i_C = 0$$

$$i_C = \beta i_B$$

$$i_2 = -i_B + i_1$$

$$V_0 + i_E R_E - (i_1 - i_B) R_2 = 0$$

$$-i_1 R_1 + V_{CC} - (i_1 - i_B) R_2 = 0$$

$$V_0 + i_E R_E + i_B R_2 - \frac{V_{CC} + i_B R_2}{R_1 + R_2} = 0$$

Scanned with CamScanner

$P_{5k\Omega} = (5000)(0.06667)^2 = 22.22\,W$

$P_{10k\Omega} = (10{,}000)(0.03333)^2 = 11.11\,W$

$P_{7.5k\Omega} = (7500)(0.06667)^2 = 33.33\,W$

$P_{15k} = (15{,}000)(0.03333)^2 = 16.67\,W$

$P_{4k\Omega} = (4000)(0)^2 = 0\,W$

(b) $V_{ad} = 5000\,i_{ab} + 7500\,i_{bd} = 5000(0.067) + 7500(0.067)$

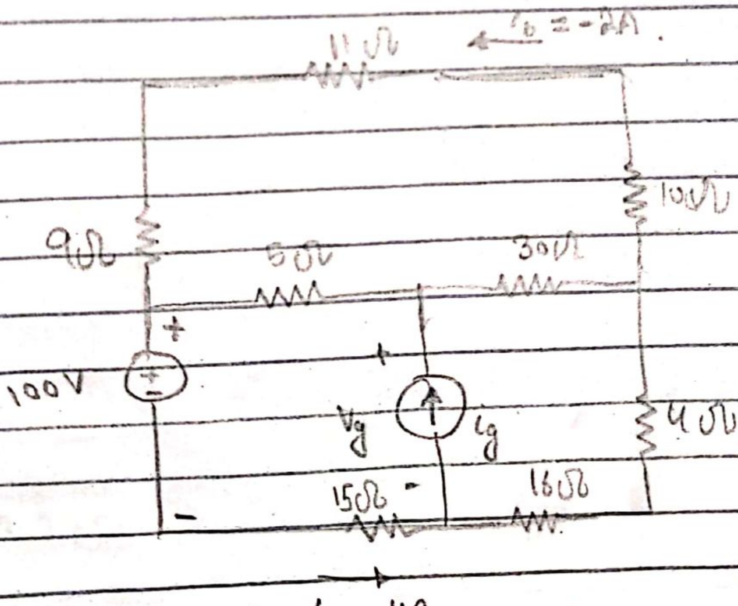
$V_{ad} = 833.33\,V$

$P_{cs} = -833.33\,(0.1) = -83.33\,W$

(c) $P_{ab} / P_{dis} = 22.22 + 33.33 + 11.11 + 16.67 + 0$

$\quad\quad\quad\;\; " \;= 83.33\,W$

2.25 :-



hence $i_a = V_{bd}/180 = \frac{180}{180} = 1\,A$

$i_e = i_a + i_c = \boxed{4A}$

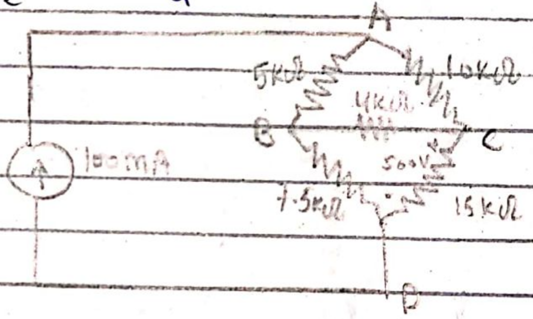
$-240 + V_{ab} + V_{bd} = 0$

$V_{ab} = 240 - 180 = 60V$

Using ohm's law.

$R = \frac{V_{ab}}{i_e} = \frac{60}{4} = \boxed{15\,\Omega}$

PROBLEM 2.24:-



$i_{cd} = \frac{500}{15000} = 33.33\ mA$

$i_{bd} + i_{cd} = 0.1$

$\Rightarrow i_{bd} + 33.33 \times 10^{-3} = 0.1$

$i_{bd} = 66.67\ mA$

Using kvl

$4000\, i_{bc} + 500 - 7500\, i_{bd} = 0$

$\Rightarrow i_{bc} = 0$

$i_{ac} = i_{cd} - i_{bc} = 33.33 - 0 = 33.33mA$

$0.1 = i_{ab} + i_{ac}$

$\Rightarrow i_{ab} = 0.1 - 33.33 = 66.67\ mA$

Scanned with CamScanner

hence $i_a = V_{bd}/180 = \frac{180}{180} = 1\,A$

$i_e = i_a + i_c = \boxed{4A}$

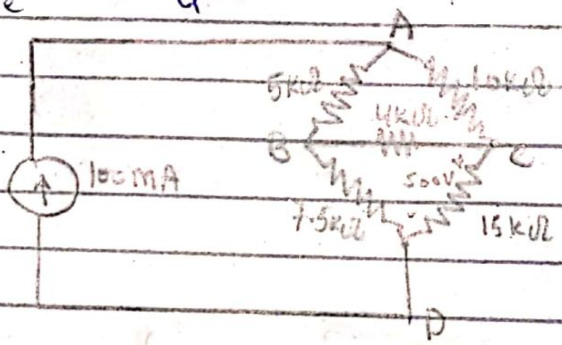
$-240 + V_{ab} + V_{bd} = 0$

$V_{ab} = 240 - 180 = 60V$

Using ohm's law.

$R = \frac{V_{ab}}{i_e} = \frac{60}{4} = \boxed{15\,\Omega}$

PROBLEM 2.24:-



$i_{cd} = \frac{500}{15000} = 33.33\ mA$

$i_{bd} + i_{cd} = 0.1$

$\Rightarrow i_{bd} + 33.33 \times 10^{-3} = 0.1.$

$i_{bd} = 66.67\ mA$

Using kvl

$4000\, i_{bc} + 500 - 7500\, i_{bd} = 0$

$\Rightarrow i_{bc} = 0.$

$i_{ac} = i_{cd} - i_{bc}$

$i_a = i_d + i_c = 5A$

$R = V_d / i_a = 35/5 = 7\Omega$

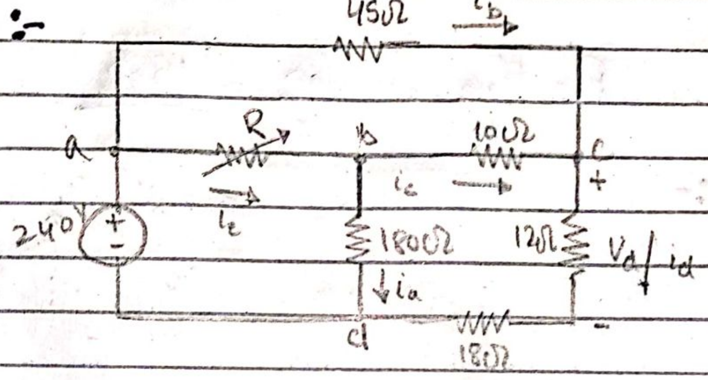
(b)

$P_{del} = -vi$

$P_{del} = -125(i_a + 3A)$

$P_{del} = -125(5+3) = -125(8) = -1000\ W$

PROBLEM 2.23:-



Sol:-

$i_d = \frac{60}{12} = \boxed{5A}$

$V_{cd} = 60 + 18(5) = 60 + 90 = 150V$

Using KVL

$-240 + V_{ac} + V_{cd} = 0$

$V_{ac} = 240 - 150$

$V_{ac} = \boxed{90V}$

$i_b = \frac{V_{ac}}{45} = \frac{90}{45} = \boxed{2A}$

Hence $i_c = i_d - i_b = 5 - 2 = \boxed{3A}$

$V_{bd} = 10 i_c + V_{cd} = 10(3) + 150 = \boxed{180V}$

Scanned with CamScanner

(e) $P_{del} = -vi$

$P_{del} = -(80)(i_1 + i_6)$

$P_{del} = -80(7+2)$

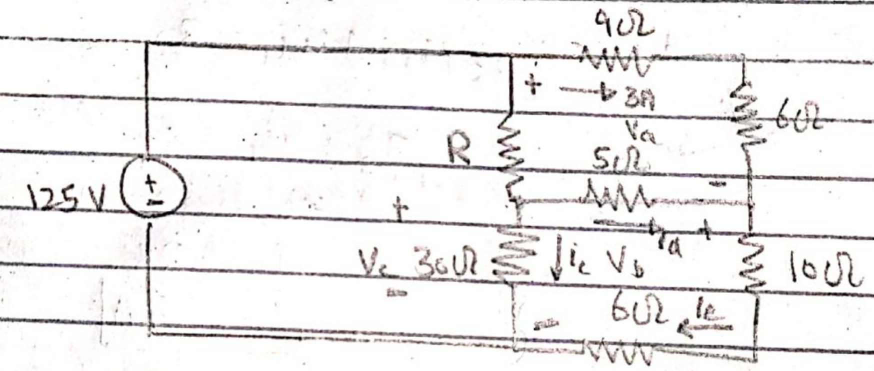
$P_{del} = -80(9)$

$P_{del} = -720\ W$

Hence verified

PROBLEM 2.22 :-

(a)



$V_a = (9+6)(3) = 45\ V$

$-125 + V_a + V_b = 0$

$V_b = 125 - V_a = 80V$

$i_e = \frac{80}{16} = 5A$

$i_d = i_e - 3 = 2A$

$V_c = 5i_d + V_b = 10 + 80 = 90V$

$i_c = \frac{V_c}{30} = \frac{90}{30} = 3A$

$V_d = 125 - V_c = 125 - 90 = 35V$

$-i_2 = -3$

$\boxed{i_2 = 3}$

Put in (ii)

$4(3) - 13 i_3 = -40$

$12 - 13 i_3 = -40$

PROBLEM ~~2.22~~ :-

$12 + 40 = 13 i_3$

$52 = 13 i_3$

$\boxed{i_3 = 4A}$

Put in (i)

$13(4) + 4i_1 = 80$

$52 + 4i_1 = 80$

$4i_1 = 80 - 52$

$4i_1 = 28$

$\boxed{i_1 = 7A}$

(b)

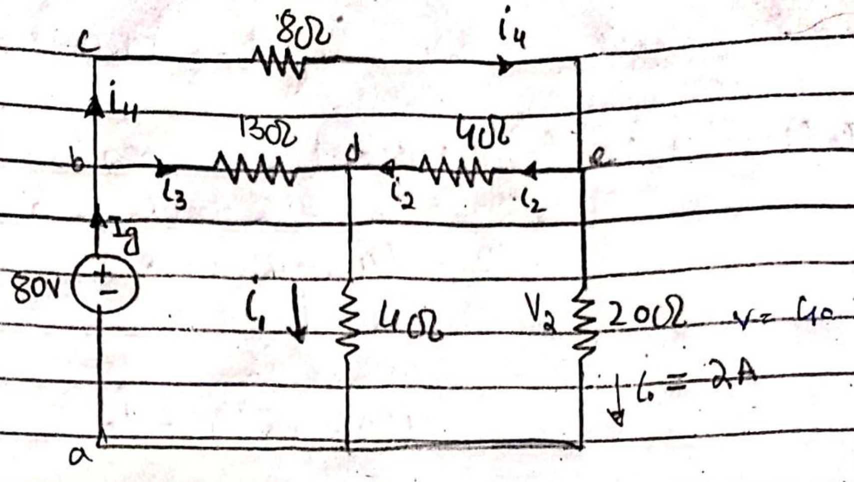
$P_{8\Omega} = ?$	$P_{13\Omega} = ?$	$P_{4\Omega i_1} = ?$	$P_{4\Omega i_2} = ?$
$P_{8\Omega} = (5)^2(8)$	$P_{13\Omega} = (4)^2(13)$	$P_{4\Omega i_1} = (7)^2(4)$	$P_{4\Omega i_2} = (3)^2(4)$
$P_{8\Omega} = 25 \times 8$	$'' = 16 \times 13$	$P_{4\Omega i_1} = 49 \times 4$	$P_{4\Omega i_2} = 9 \times 4$
$\boxed{P_{8\Omega} = 200\,W}$	$\boxed{'' = 208}$	$\boxed{'' = 196\,W}$	$\boxed{P_{4\Omega i_2} = 36}$

$P_{20\Omega} = (2)^2\, 20 = 4 \times 20$

$P_{20\Omega} = 80\,W$

Total power absorbed $= 200 + 208 + 196 + 36 + 80$

$= 720\,W$



(a)

$V_2 = (2)(20) = 40$ volts

Using KVL on left branch,

$-80 + 13 i_3 + 4 i_1 = 0$

$\boxed{13 i_3 + 4 i_1 = 80}$ — (i)

Using KVL on another loop

$-80 + 40 + 4 i_2 - 13 i_3 = 0$

$40 + 4 i_2 - 13 i_3 = 0$

$\boxed{4 i_2 - 13 i_3 = -40}$ — (ii)

Using KCL at node e

$-i_2 - 2 + \overset{i_4}{\cancel{5}} = 0$

$\boxed{-i_2 + i_4 = 2}$ — (iii)

The voltage drop accross 8Ω resistor is 40 V

$\therefore \; i_4 = \frac{40}{8} = 5$ A put in (iii)

$-i_2 + 5 = 2$

$-i_2 = 2 - 5$

Scanned with CamScanner

Using KVL on right branch.

$$i_a(1000) + 4000(i_a) + 3000(i_a) - 2000\, i_o = 0$$

$$8000\, i_a - 2000\, i_o = 0$$

$$2000\,(4 i_a - i_o) = 0$$

$$4 i_a - i_o = 0$$

$$4 i_a = i_o$$

$$4(2 \times 10^{-3}) = i_o$$

$$\boxed{i_o = 8 \times 10^{-3}\, A = 8\, mA} \quad \text{---(ii)}$$

(b) $i_g = ?$

Put (ii) in (i)

$$i_g - 8 \times 10^{-3} = 2 \times 10^{-3}$$

$$i_g = 2 \times 10^{-3} + 8 \times 10^{-3}$$

$$\boxed{i_g = 10\, mA}$$

(c) $P_{dev} = ?$

Using KVL for V_o

$$-V_o + (8 \times 10^{-3})(2 \times 10^{3}) = 0$$

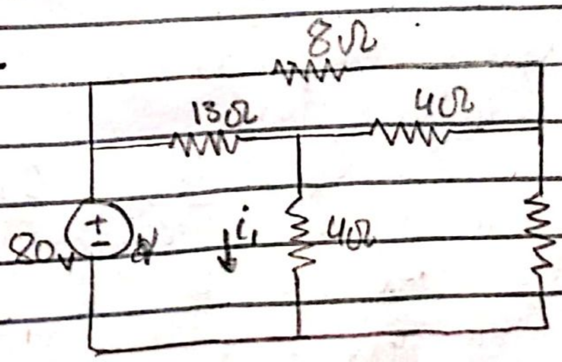
$$-V_o + 16 = 0$$

$$\boxed{V_o = 16\, V}$$

$$P = -V_o\, i_g = -16 \times 10 \times 10^{-3}\, W$$

$$\boxed{P = -160\, mW}$$

PROBLEM 2.21 :-



(b) $V_o = ?$

Using KVL on left branch

$$V_o + (80)(2.4) = 0$$

$$-V_o + 192 = 0$$

$$-V_o = -192$$

$$-V_o = -192$$

$$\boxed{V_o = 192\ V}$$

(c) $P_{del} = (192)(4) = \boxed{768\ W}$

$$P_{80\Omega} = (2.4)^2(80) = 460.8\ W$$

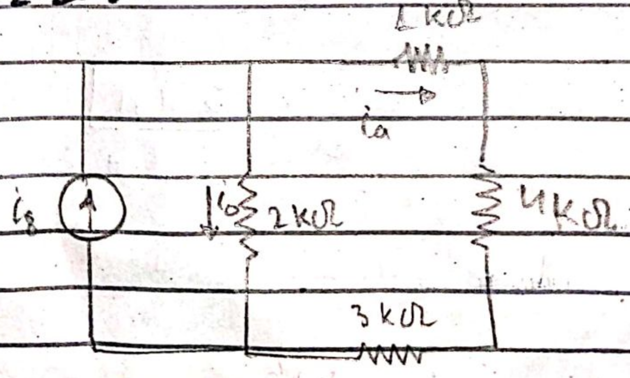
$$P_{30\Omega} = (1.6)^2(30) = 76.8\ W$$

$$P_{90\Omega} = (1.6)^2(90) = 230.4\ W$$

$$P_{abs} = \boxed{768\ W}$$

PROBLEM 2.20:-

Sol:-



(a) $i_g = i_a + i_o$

$$i_g = (2 \times 10^{-3}) + i_o$$

$$i_g - i_o = 2 \times 10^{-3} \quad \text{—(i)}$$

(a) $i_T = i_1 + i_2$

$$\boxed{4A = i_1 + i_2} \text{ --- (i)}$$

Using KVL for branch 2

$$30 i_2 + 90 i_2 - 80 i_1 = 0$$

$$120 i_2 - 80 i_1 = 0$$

$$12\cancel{0} i_2 = 8\cancel{0} i_1$$

$$i_2 = \frac{8}{12} i_1$$

$$\boxed{i_2 = \frac{2}{3} i_1}$$

Put in (i)

$$4 = \frac{i_1}{1} + \frac{2}{3} i_1$$

$$4 = \frac{3i_1 + 2i_1}{3}$$

$$\frac{4}{1} = \frac{5}{3} i_1$$

$$5 i_1 = 12$$

$$i_1 = \frac{12}{5} = \boxed{2.4A}$$

Put in (i)

$$4 = 2.4 + i_2$$

$$4 - 2.4 = i_2$$

$$\boxed{i_2 = 1.6A}$$

$$5 i_a = 2$$

$$i_a = 2/5 = \boxed{0.4\,A}$$

(b) Put $i_a = 0.4\,A$ in (i)

$$i_b = (0.4)(4) = \boxed{1.6\,A}$$

(c) $V_o = ?$

$$V_o = i_b R_{75\Omega}$$

$$V_o = (1.6)(75)$$

$$\boxed{V_o = 120\,V}$$

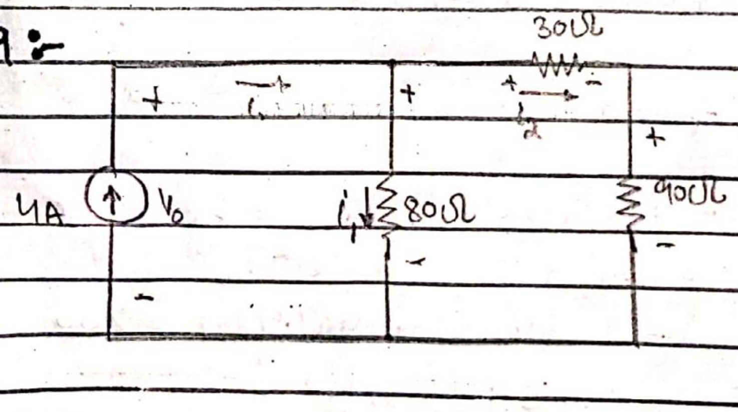
(d) $P_{40\Omega} = ?$, $P_{300\Omega} = ?$, $P_{75\Omega} = ?$

$P_{40\Omega} = i_1^2 (40)$	$P_{300\Omega} = i_a^2 (300)$	$P_{75\Omega} = i_b^2 (75)$
$P_{40\Omega} = (2)^2 (40)$	$P_{300\Omega} = (0.4)^2 (300)$	$P_{75\Omega} = (1.6)^2 (75)$
$P_{40\Omega} = 160\,W$	$P_{300\Omega} = 48\,W$	$P_{75\Omega} = 192$

(e) $P_{dev} = ?$

$$P_{dev} = (200)(2) = 400\,W$$

PROBLEM 2.19 :-



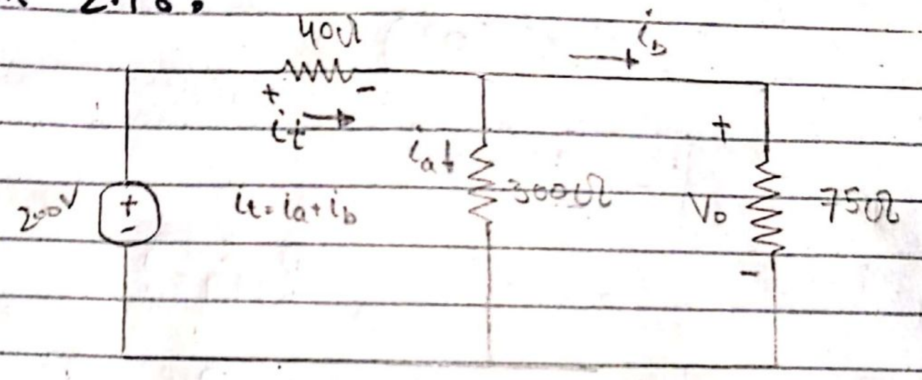
$$i_s = \frac{75}{200} = 375 \times 10^{-3} A = 375\,mA$$

(e) The short circuit current is $i_{sc} = 500\,mA$

(f) The answer to (d) and (e) is not same b/c of non linearity in the graph.

PROBLEM 2.18:

Sol:



$$V_{300\Omega} = V_{75\Omega}$$

$$\frac{300\Omega \cdot i_a}{75} = \frac{75\Omega\, i_b}{75}$$

$$\boxed{i_b = 4 i_a} \text{—(i)}$$

Now applying KVL on R.H.S loops.

$$-200 + i_t(40) + 300\, i_a = 0$$

$$-200 + (i_a + i_b)\,40 + 300\, i_a = 0$$

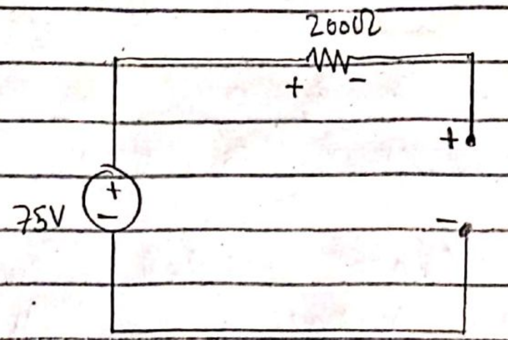
$$-200 + 40\, i_a + 40\, i_b + 300\, i_a = 0$$

$$-200 + 340\, i_a + 40\, i_b = 0$$

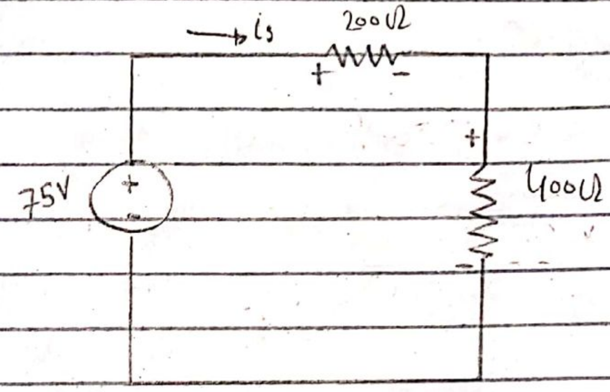
$$340\, i_a + 40(4 i_a) = 200$$

$$340\, i_a + 160\, i_a = 200$$

$$500\, i_a = 200$$



(c)



The total voltage drop across ~~600~~ resistor is equal to the sum of voltage drop across each resistor.

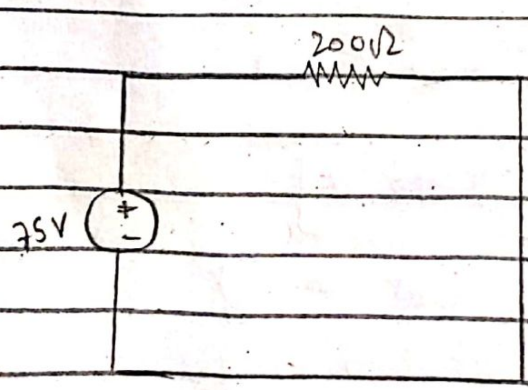
i.e $V_s = V_{200\Omega} + V_{400\Omega}$

$$75 = i_s(200) + i_s(400)$$

$$75 = i_s\, 600$$

$$i_s = \frac{75}{600} = 0.125\,A = 125\,mA$$

(d)



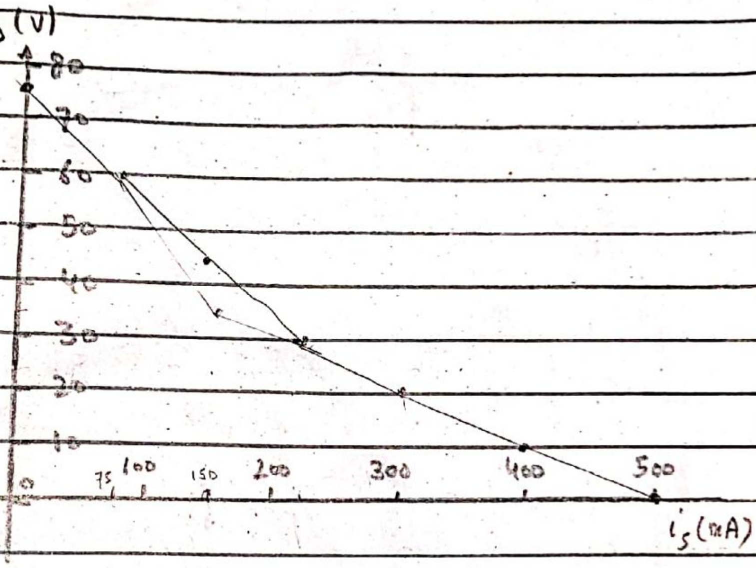
(d) For open circuit, $V_s = (40\times10^{-3})(2\times10^{3}) = 80\ V$

(e) When the current $i_s = 0$, the actual open-circuit voltage is 55 V.

(f) It is b/c ~~linear~~ linear model cannot predict the non linear behaviour of the practical current source.

PROBLEM 2.17:-

Sol:- (a)



(b)

$$R = \frac{30-75}{225-0} = \frac{-45}{225\times10^{-3}} = \frac{-1}{5\times10^{-3}} = -0.2\Omega\times10^{3}\ \Omega$$

$$V_s = -200\Omega\, i_s + C \quad \text{— (i)}$$

When $i_s = 0$, $V_s = 75$ put in (i)

$$75 = -200(0) + C$$

$$\boxed{C = 75\ V}$$

Put in (i)

$$V_s = -200\Omega\, i_s + 75$$

$$V_s + 200\Omega\, i_s - 75 = 0$$

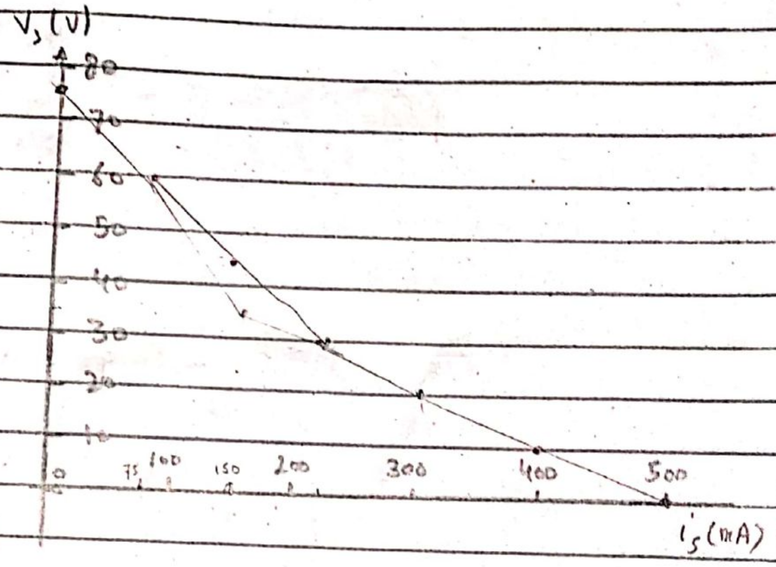
(d) For open circuit, $V_s = (40\times10^{-3})(2\times10^{3}) = 80\ V$

(e) When the current $i_s = 0$, the actual open-circuit voltage is 55 V.

(f) It is b/c linear model cannot predict the non linear behaviour of the practical current source.

PROBLEM 2.17:-

Sol: (a)



(b)

$$R = \frac{30-75}{225-0} = \frac{-45}{225\times10^{-3}} = \frac{-1}{5\times10^{-3}} = -0.2\Omega \times 10^{3}\ \Omega$$

$$V_s = -200\Omega\, i_s + C \quad \text{— (i)}$$

When $i_s = 0$, $V_s = 75$ put in (i)

$$75 = -200(0) + C$$

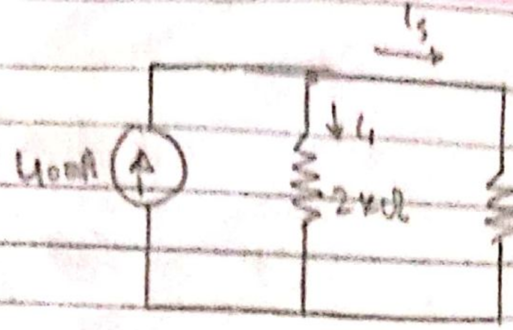
$$\boxed{C = 75\ V}$$

Put in (i)

$$V_s = -200\Omega\, i_s + 75$$

$$V_s + 200\Omega\, i_s - 75 = 0$$

(c)



$40 \times 10^{-3} = i_s + i_1$ — (ii) (Total current in the circuit)

Also the potential drop across the terminals of resistor is same.

$\therefore V_s = V_1$

$(3 \times \cancel{10^3})\, i_s = (2 \times \cancel{10^3})\, i_1$

$3 i_s = 2 i_1$

$\boxed{i_s = \frac{2}{3} i_1}$ — (i')

Put in (i)

$40 \times 10^{-3} = \frac{2}{3} i_1 + i_1$

$40 \times 10^{-3} = \frac{2 i_1 + 3 i_1}{3} = \frac{5 i_1}{3}$

$\frac{3}{\cancel{5}} \times \cancel{40}^{8} \times 10^{-3} = \frac{\cancel{5} i_1}{\cancel{3}} \times \frac{\cancel{3}}{\cancel{5}}$

$i_1 = 24 \times 10^{-3}$ A

$\boxed{i_1 = 24 \text{ mA}}$

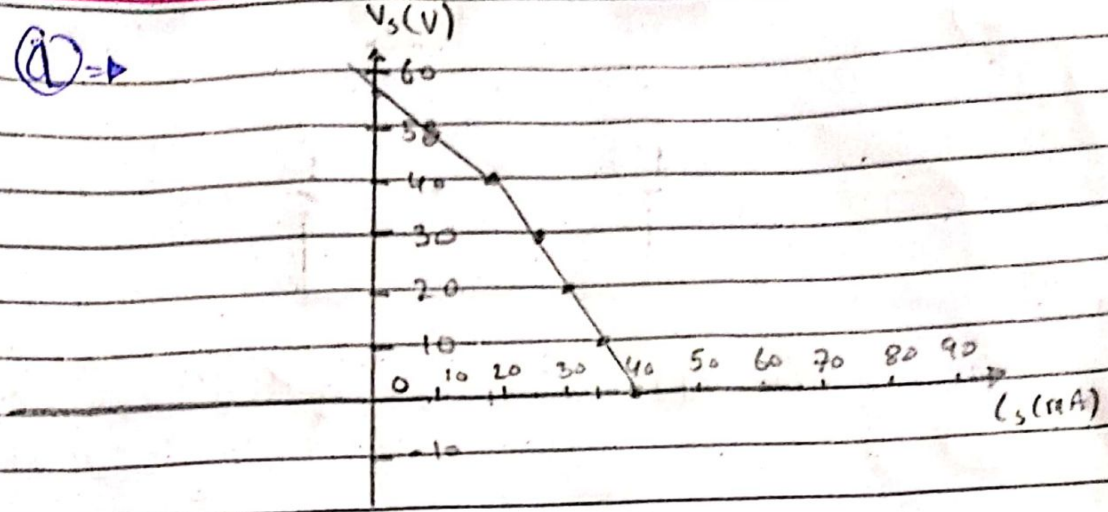
Put in (ii)

$i_s = \frac{2}{\cancel{3}} (\cancel{24}^{8} \times 10^{-3})$ A

$\boxed{i_s = 16 \text{ mA}}$ Ans

Scanned with CamScanner

Sol:- (a) =>



(b)

$$\cancel{R = \frac{55}{-40\times10^{-3}}} = \cancel{-1.375\times10^{3}\,\Omega}$$

For $0V < V_s \le 30V$

$$R = \frac{30-0}{(25-40)\times10^{-3}} = \frac{30}{-15\times10^{-3}} = -2\times10^{3}\,\Omega$$

$$\therefore \quad V_s = -2\times10^{3}\, i_s + C \quad \text{---} (i)$$

When $V_s = 0$, $i_s = 40\times10^{-3}$ A

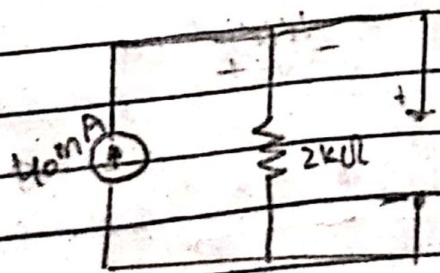
$$0 = (-2\times10^{3})(40\times10^{-3}) + C$$

$$0 = -80 + C$$

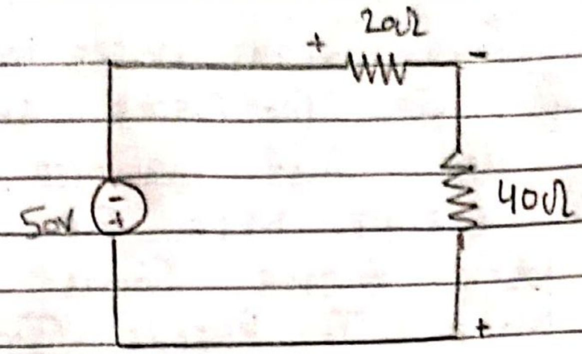
$\boxed{C = 80}$ Put in (i)

$$V_s = -2\times10^{3}\, i_s + 80$$

$$V_s + 2\times10^{3}\, i_s - 80 = 0$$



(b)



$50 + 20 i_t + 40 i_t = 0$ (using kvl)

$50 + \cancel{20} i_t \; 60 i_t = 0$

$60 i_t = -50$

$i_t = -5/6 = \boxed{-0.83A}$

$P_{40\Omega} = R I^2$

$P_{40\Omega} = (40)(-0.83)^2 = \boxed{27.556\ W}$.

P2.16:- THE TABLE BELOW GIVES THE RELATIONSHIP B/W THE TERMINAL CURRENT AND VOLTAGE OF THE PRACTICAL CONSTANT CURRENT SOURCE

a) PLOT i_s versus V_s.

b) CONSTRUCT A CIRCUIT MODEL FOR THIS SOURCE THAT IS VALID FOR $0 \le V_s \le 30V$ BASED ON THE EQUATION OF THE LINE PLOTTED.

(c) USE YOUR CIRCUIT MODEL TO PREDICT THE CURRENT DELIVERED TO A 3kΩ RESISTOR?

d) . . —

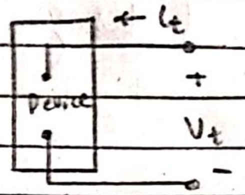
e) . . —

f) . . . .

P2.15: The Voltage And Current were measured At The Terminals Of The Device Shown Below The Results Are Also Tabulated Below.

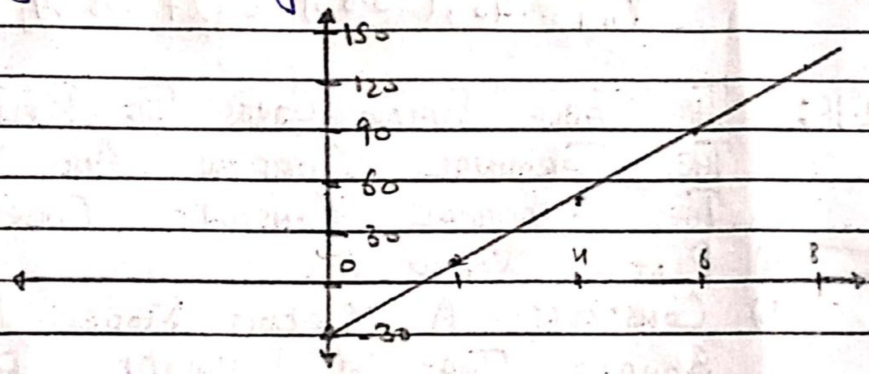
a) Construct A Circuit Model For This Device Using An Ideal Voltage Source And A Resistor

b) Use The Model To Predict The Amount Of Power The Device Will Deliver To A 40Ω Resistor.



V_t (V)	i_t (A)
-30	0
10	2
50	4
90	6
130	8

(a) Plotting the graph of i_t Vs V_t



$R = \frac{160}{8} = 20\,\Omega$

When $i_t = 0$, then $V_t = -30$

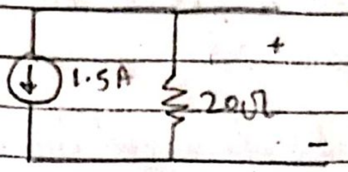
∴ $V = -30$ volts Ideal Voltage Source

$$R = \frac{\text{total change in } V_t}{\text{total change in } i_t} = \frac{160}{8} = 20\,\Omega$$

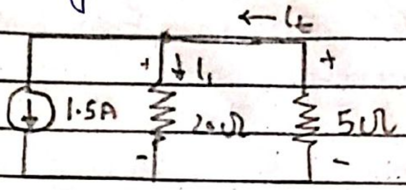
When $i_t = 0$, then $V_t = -30$

$\therefore \quad i = \frac{-30}{20} = -1.5\,A$

$\therefore$ A current source of $1.5A$ must be connected opposite to the applied voltage V_t.



(b) Attaching a $5\,\Omega$ resistor



$-1.5 + i_t = i_1$ — (i) (By using KCL)

$20 i_1 - 5 i_t = 0$ — (ii) (By using KVL)

(i) ⟹ $-1.5 + i_t = i_1$

$-1.5 = i_1 - i_t$

$i_1 - i_t = -1.5$ — (iii)

(ii) ⟹ $20 i_1 - 5 i_t = 0$

$5(4 i_1 - i_t) = 0$

$4 i_1 - i_t = 0$ — (iv)

(iii) ⟹ $i_1 - i_t = -1.5$

(iv) ⟹ $+4 i_1 - i_t = +0$

$-3 i_1 = -1.5 \longrightarrow \boxed{i_1 = +0.5A}$ put in (iv)

$4(+0.5) - i_t = 0$

$2 - i_t = 0$

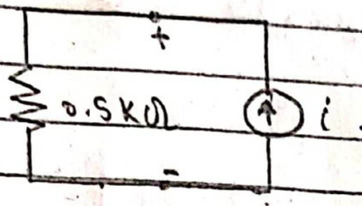
$\boxed{i_t = 2A}$

$P_{5\Omega} = (5)(2)^2$

$\boxed{P_{5\Omega} = 20W}$

$$R = \frac{(0.5 \times 10^3)}{1^2} = R = 0.5 \times 10^3 \, \Omega$$

$$R = \frac{2.0 \times 10^3}{(2)^2} = \frac{2.0 \times 10^3}{4} = 0.5 \times 10^3 \, \Omega$$

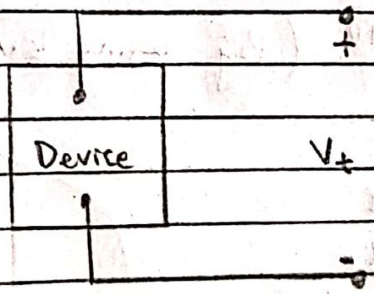


→ Circuit Model

P 2.14: THE VOLTAGE AND CURRENT WERE MEASURED AT THE TERMINALS OF THE DEVICE SHOWN BELOW. THE RESULTS ARE TABULATED BELOW.

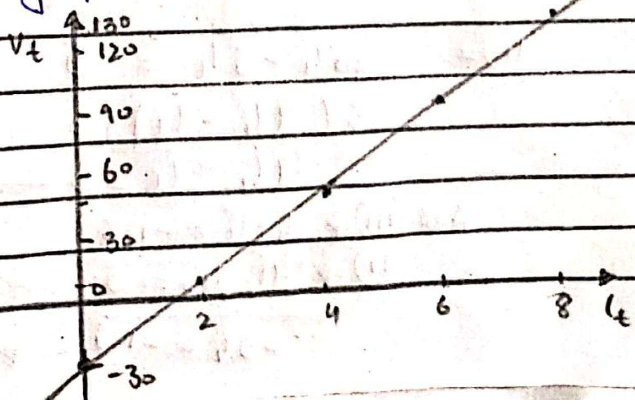
a) CONSTRUCT A CIRCUIT MODEL FOR THIS DEVICE USING AN IDEAL CURRENT SOURCE AND A RESISTOR.

b) USE THE MODEL TO PREDICT THE AMOUNT OF POWER THE DEVICE WILL DELIVER TO A 5Ω RESISTOR.

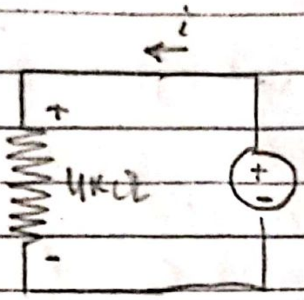


V_t (V)	i_t (A)
-30	0
10	2
50	4
90	6
130	8

(a) Plotting graph of i_t vs V_t

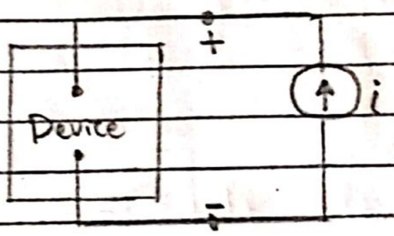


The circuit model is given below



P2.12:- A VARIETY OF CURRENT SOURCE VALUES WERE APPLIED TO THE DEVICE SHOWN BELOW. THE POWER ABSORBED BY THE DEVICE FOR EACH EACH VALUE OF CURRENT IS RECORD IN THE TABLE GIVEN BELOW. USE THE VALUES IN THE TABLE TO CONSTRUCT A MODEL FOR THE DEVICE CONSISTING OF A SINGLE RESISTOR.

Sol:-



i (A)	P (kW)
1	0.5
2	2.0
3	4.5
4	8.0
5	12.5
6	18.0

We know that

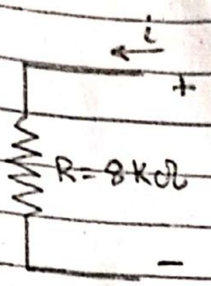
$$P = \frac{V^2}{R} = \frac{(IR)^2}{R} = \frac{I^2R^{\cancel{2}}}{\cancel{R}}$$

$$P = I^2R$$

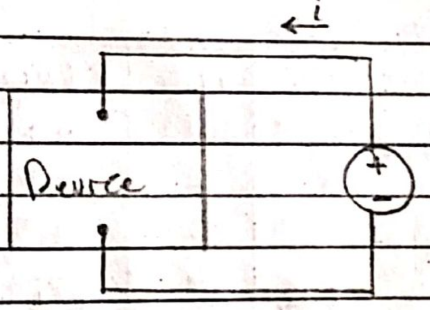
$$\Rightarrow R = P/I^2$$

Putting values from table.

The circuit model is given below.



P2.11:- A VARIETY OF Voltage SOURCES WERE APPLIED TO THE DEVICE SHOWN BELOW. THE POWER ABSORBED BY THE DEVICE FOR EACH VALUE OF VOLTAGE IS RECORDED IN THE TABLE GIVEN BELOW. USE THE VALUES IN THE TABLE TO CONSTRUCT A CIRCUIT MODEL FOR THE DEVICE CONSISTING OF A SINGLE RESISTOR.



v (V)	p (mW)
−10	25.0
−5	6.25
5	6.25
10	25.0
15	56.25
20	100

Sol:-

The equation for resistance in term of power and voltage is given by:

$$P = V^2/R \Rightarrow PR = V^2$$

$$R = V^2/P$$

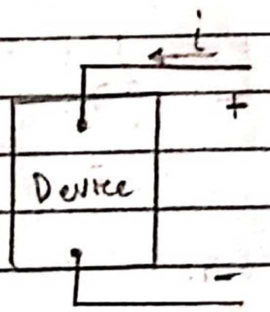
Put $V = -10$; $P = 25 \times 10^{-3}$ W

$$R = \frac{(-10)^2}{25\times10^{-3}} = \frac{100}{25\times10^{-3}} = 4\times10^{+3}\ \Omega = \boxed{4\,k\Omega}$$

Scanned with CamScanner

P

P2.10: THE TERMINAL VOLTAGE AND TERMINAL CURRENT WERE MEASURED ON THE DEVICE SHOWN BELOW. THE VALUES OF V AND i ARE GIVEN IN THE TABLE BELOW. USE THE VALUES IN THE TABLE TO CONSTRUCT A CIRCUIT MODEL FOR THE DEVICE CONSISTING OF A SINGLE RESISTOR.



i (mA)	v (V)
-20	-160
-10	-80
10	80
20	160
30	240

Ans:-

The Slope is given by:

$$m = R = \frac{(-160) - (-80)}{(-20 \times 10^{-3}) - (-10 \times 10^{-3})}$$

$$R = \frac{-160 + 80}{-20 \times 10^{-3} + 10 \times 10^{-3}}$$

$$R = \frac{\cancel{-160}\ -80}{-10 \times 10^{-3}} = \boxed{8 \times 10^{3}\,\Omega}$$

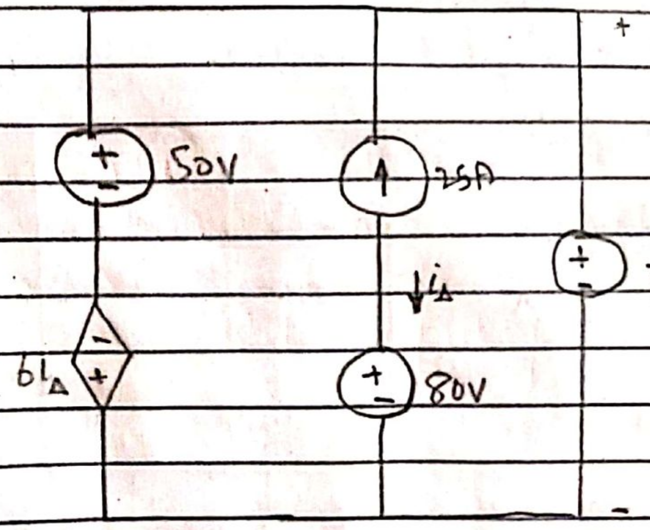
$-V_3 - V_2 + 100 = 0$

$-V_3 - V_2 = -100$

$V_3 - V_2 = 100 \quad \text{---(iii)}$

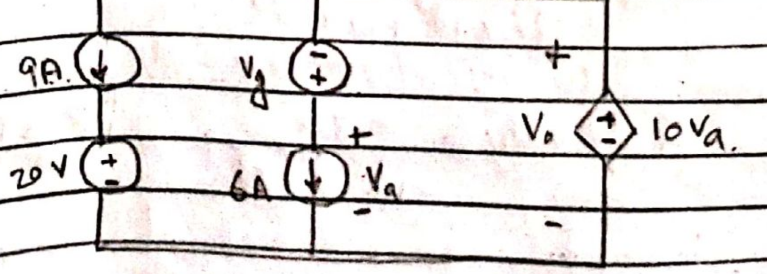
eq(i) and eq(ii) cannot be solved as it includes 3 unknown voltages.
So the power cannot be determined and hence energy of this system cannot be determined.

P2.8: IF THE INTERCONNECTION IN GIVEN FIGURE IS VALID. FIND THE TOTAL POWER DEVELOPED IN THE CIRCUIT. IF THE INTERCONNECTION IS NOT VALID. EXPLAIN WHY?



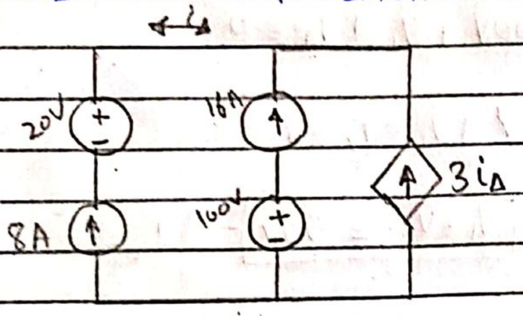
Sol:- The interconnection is invalid because the voltage drop across each branch is different.

P2.9:- FIND THE TOTAL POWER DEVELOPED IN THE CIRCUIT IN GIVEN FIGURE IF $V_o = 5V$.

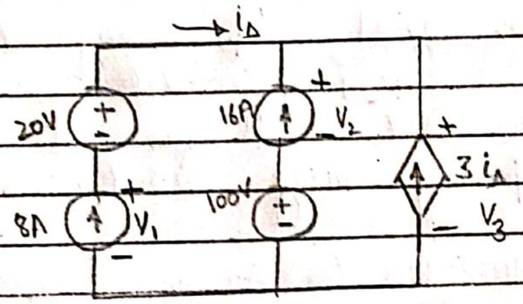


Sol: The interconnection is invalid b/c the voltage drop on R.H.S is not equal to L.H.S. More over, the central junction is also not valid according to KCL. The sum of entering current is not equal to sum of leaving current.

P2.7:- a) IS THE INTERCONNECTION IN GIVEN FIGURE VALID?
b) CAN YOU FIND THE TOTAL ENERGY DEVELOPED IN THE CIRCUIT? EXPLAIN.



Sol:-



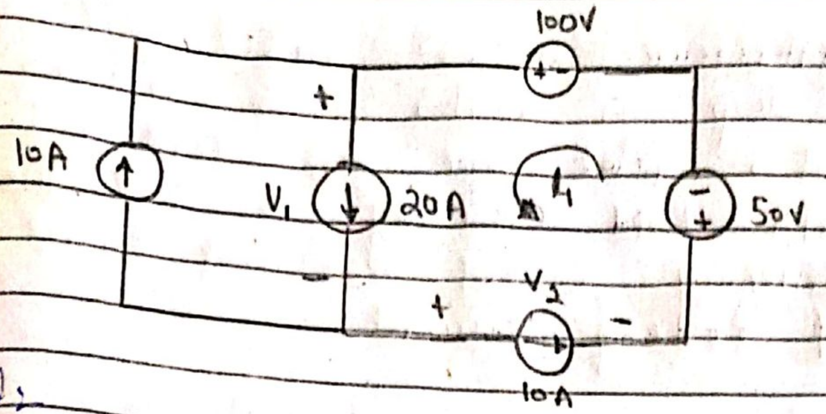
ⓐ ⇒ Yes the interconnection is valid. The current flowing in each loop is same. And the voltage drop at the end points is also same.

ⓑ ⇒ First we will use KVL to find unknown voltage drop, V_1, V_2 and V_3.

$$-V_1 - 20 + V_2 + 100 = 0$$

$$-V_1 + V_2 + 80 = 0$$

$$V_1 - V_2 = 80 \quad -(i)$$



Sol:

Using KVL for loop I1.

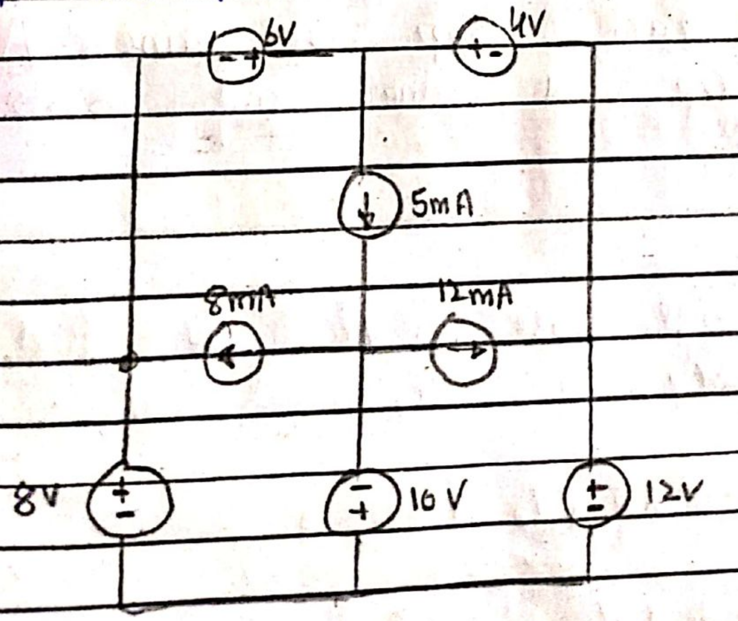
$$50V - 100V + V_1 + V_2 = 0$$

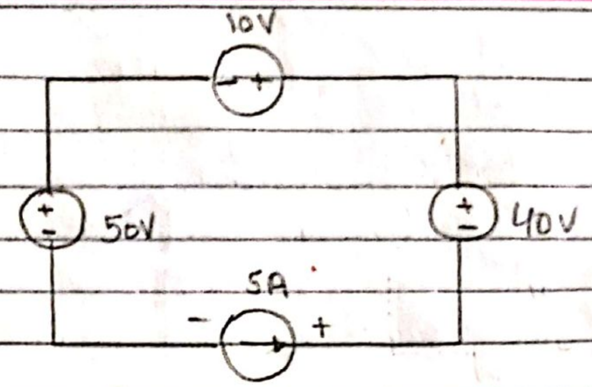
$$-50V + V_1 + V_2 = 0$$

$$\boxed{V_1 + V_2 = 50V} \text{ —(i)}$$

Equation (i) shows that for any value of V1 and V2 the circuit is valid and their sum is equal to 50 V. ∴ It has no unique Solution but infinitely many solutions.

P2.6:- IF THE INTERCONNECTION IN GIVEN FIGURE IS VALID FIND THE TOTAL POWER DEVELOPED IN THE CIRCUIT. IF THE INTERCONNECTION IS NOT VALID. EXPLAIN WHY?





Sol:- First we need to find voltage drop accross 5A source.

By using KVL;

$$-40 + 10 + 50 - V_{5A} = 0$$

$$20 - V_{5A} = 0$$

$$\boxed{20 = V_{5A}}$$

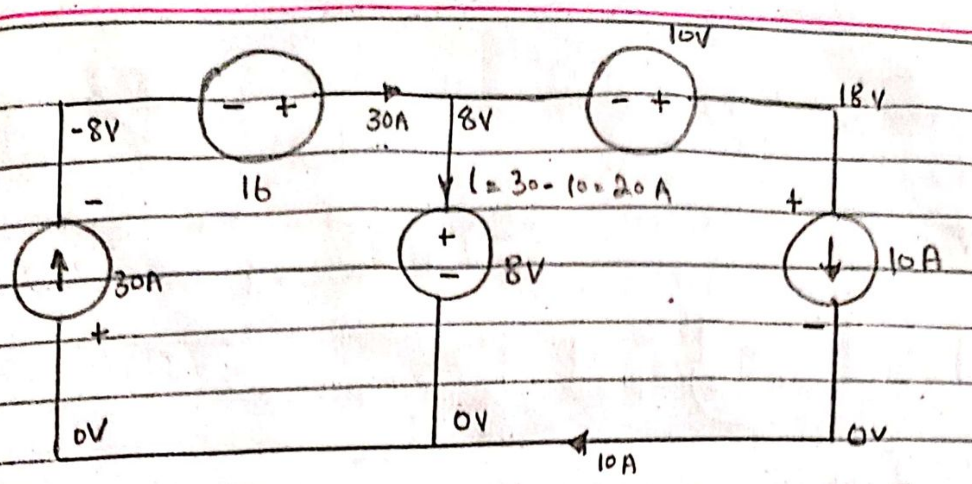
Power associated with each circuit element is.

$P_{50V} = Vi = (50)(5)$	$P_{10V} = (10)(5)$	$P_{40V} = -(40)(5)$	$P_{5A} = -(2\ldots$
$\boxed{P_{50V} = 250\ W}$	$\boxed{P_{10V} = 50\ W}$	$\boxed{P_{40V} = -200\ W}$	$\boxed{P_{5A} = -10\ldots$
Absorbing	Absorbing	delivering	deliver…

Hence, total power absorbed = 300 watt

total power delivered = -300 watt

P2.5:- THE INTERCONNECTION OF IDEAL SOURCES CAN … TO AN INDETERMINATE SOLUTION. WITH THIS … IN MIND EXPLAIN WHY THE SOLUTIONS FOR V_1 AND V_2 IN THE CIRCUIT IN GIVEN FIG … ARE NOT UNIQUE.

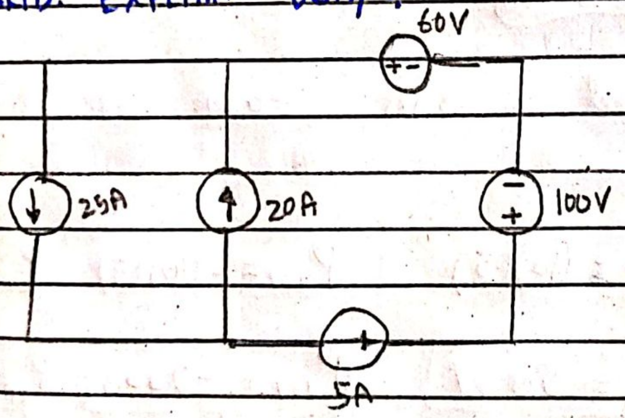


$$P_{30A} = vi = (30)(8) = \boxed{240\ W}$$

$$P_{10A} = vi = (10)(18) = \boxed{180\ W}$$

→ Absorbing

P2.3: IF THE INTERCONNECTION IN GIVEN FIGURE IS VALID FIND THE TOTAL POWER DEVELOPED BY THE VOLTAGE SOURCES. IF THE INTERCONNECTION IS NOT VALID. EXPLAIN WHY?



Ans:- The interconnection is invalid b/c the two current sources supply different amount of current through 100V source.

P2.4: IF THE INTERCONNECTION IN THE GIVEN FIGURE IS VALID. FIND THE TOTAL POWER DEVELOPED IN THE CIRCUIT. IF THE INTERCONNECTION IS NOT VALID. EXPLAIN WHY?

Sol:- P-T-O

$P_{18V} = -vi$ | $P_{5mA} = +vi$ | $P_{7V} = +vi$

$P_{18V} = -(18)(5\times10^{-3})$ | $P_{5mA} = (\overset{11}{\cancel{20}})(5\times10^{-3})$ | $P_{7V} = +(7)(5\times10^{-3})$

$\boxed{P_{18V} = -90\times10^{-3}\ W}$ | $\boxed{P_{5mA} = \overset{55}{\cancel{105}}\times10^{-3}\ W}$ | $\boxed{P_{7V} = +35\times10^{-3}\ W}$

Delivering Power | Absorbing Power | ~~Delivering~~ Absorbing Power

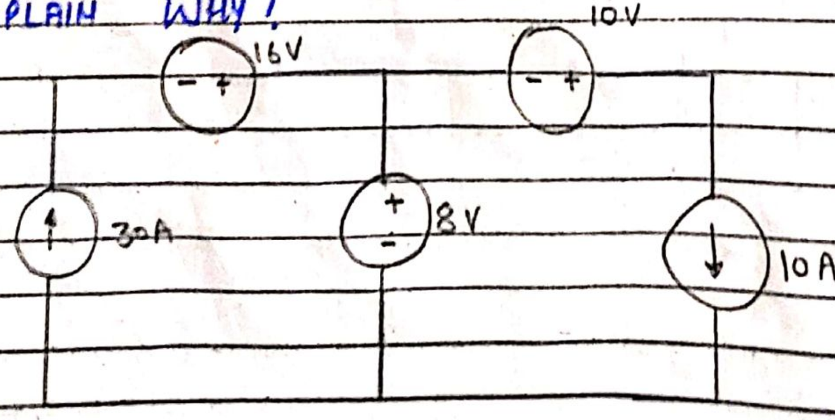
c $\longrightarrow$ Total power absorbed, $\sum P_{abs} = \boxed{\overset{}{\cancel{125}}\ 90 \times 10^{-3}\ W}$ ---(i)

Total power delivered, $\sum P_{del} = (-90\times10^{-3})$ ~~(ii)~~

" " " , " = ~~-125×10^{-3}~~ ---(ii)

As eq(i) + eq(ii) = 0 $\therefore$ The power delivered is equal to power absorbed.

P2.2: IF THE INTERCONNECTION IN BELOW FIGURE IS VALID, FIND THE POWER ~~P~~ DEVELOPED BY THE CURRENT SOURCES. IF THE INTERCONNECTION IS NOT VALID. EXPLAIN WHY?



Sol:- The circuit connection is valid.

The detailed diagram is given on next page.

The expressions for power associated with each element is given by.

$P_{18V} = iv$	$P_{5mA} = -iv$	$P_{7V} = iv$
$P_{18V} = (5\times10^{-3})(18)$	$P_{5mA} = -(5\times10^{-3})(25)$	$P_{7V} = (5\times10^{-3})(7)$
$\boxed{P_{18V} = 90\times10^{-3}\ \text{Watts}}$	$\boxed{P_{5mA} = -125\times10^{-3}\ \text{Watt}}$	$\boxed{P_{7V} = 35\times10^{-3}\ \text{Watts}}$
Absorbing Power	delivering Power	Absorbing Power

(C) ⟹ Total power absorbed, $\sum P_{abs} = (90\times10^{-3}) + (35\times10^{-3})$

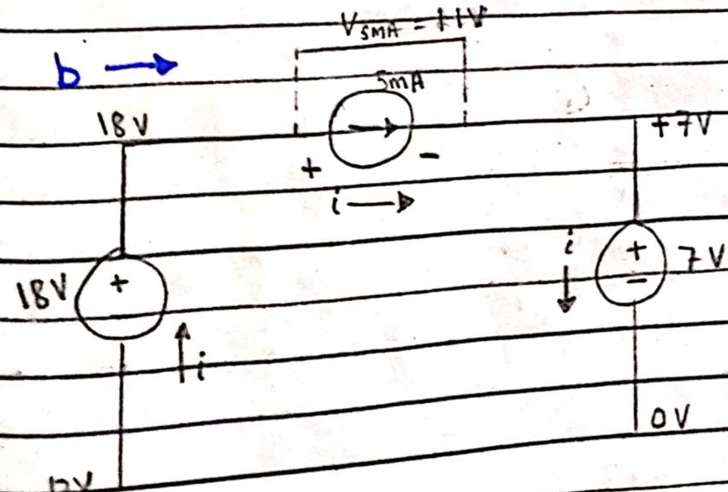
" , $\sum P_{abs} = \boxed{125\times10^{-3}\ \text{Watts}}$ — (i)

Total Power delivered, $\sum P_{del} = \boxed{-125\times10^{-3}\ \text{Watts}}$ — (ii)

As eq(i) + eq(ii) = 0 ∴ The power delivered is equal to power absorbed.

(d) ⟹ a → Yes, the circuit is valid.

b →



The expression for power associated with each element is given by

P-T-O

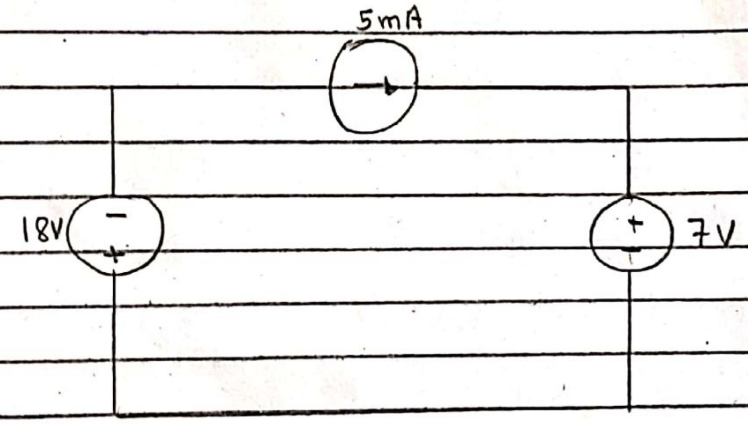
Section 2.1 :-

P 2.1 :- a) IS THE INTERCONNECTION OF IDEAL SOURCES IN THE CIRCUIT IN FIG VALID? EXPLAIN:

b) IDENTIFY WHICH SOURCES ARE DEVELOPING POWER AND WHICH SOURCES ARE ABSORBING POWER.

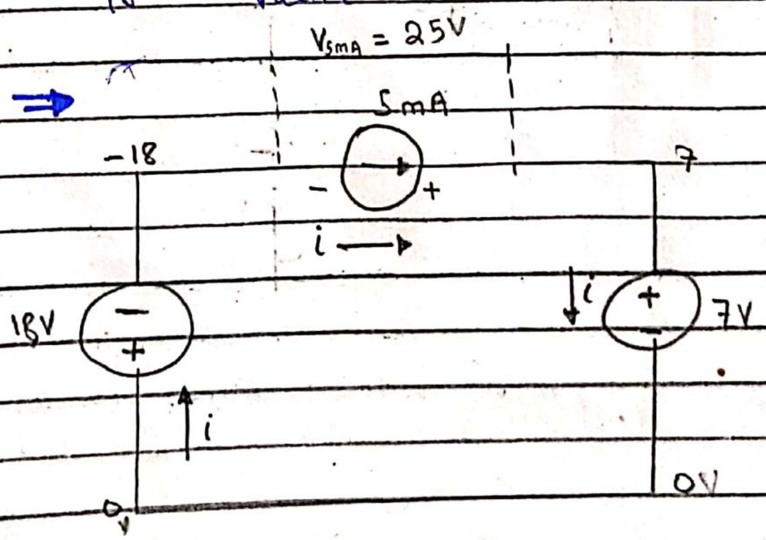
c) VERIFY THAT THE TOTAL POWER DEVELOPED IN CIRCUIT EQUALS THE TOTAL POWER ABSORBED.

d) REPEAT (a)-(c). REVERSING THE POLARITY OF THE 18V SOURCE



Sol:- **(a)** ⇒ Yes, by definition of independant voltage sources, the interconnection is valid.

(b) ⇒



(b) $i_g = i_\Delta + i_8 + 8i_\Delta = 9i_\Delta + i_8 = 47\,A$

$V_d = 80 - 20 = 60V$

$\sum P_{diss} = -4230W$

$\sum P_{gen} = 4230W$

P 2.32:-

Sol:- $i_B = \dfrac{(V_{cc} R_2)/(R_1 + R_2) - V_0}{(R_1 R_2)/(R_1 + R_2) + (1+\beta)R_E}$

$\dfrac{V_{cc} R_2}{R_1 + R_2} = \dfrac{(15)(80)}{100} = 12$

$\dfrac{R_1 R_2}{R_1 + R_2} = \dfrac{20 \times 80}{100} = 16000\Omega = 16k\Omega$

$i_B = \dfrac{12 - 0.2}{16 + 40(0.1)} = \dfrac{11.8}{20} = 0.59mA$

$i_c = \beta i_B = 39 \times 0.59 = 23.01mA$

$i_E = i_c + i_B = 23 + 0.59 = 23.6mA$

$V_{3d} = (23.6)(0.1) = 2.36V$

$V_{bd} = V_0 + V_{3d} = 2.56V$

$i_2 = \dfrac{V_{bd}}{R_2} = \dfrac{2.56}{80} \times 10^{-3} = 32\mu A$

$i_{1d} = i_2 + i_B = 32 + 590 = 622\mu A$

$V_{ab} = 20(0.622) = 12.44\,V$

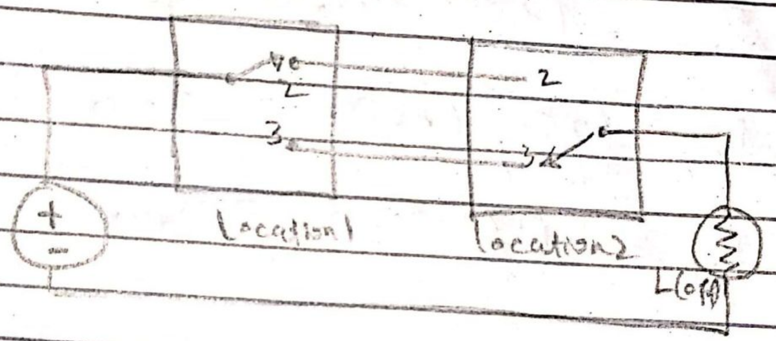
$i_{cc} = i_c + i_1 = 23.01 + 0.622 = 23.632\,mA$

$V_{13} + 23.01(0.5) + 2.36 = 15$

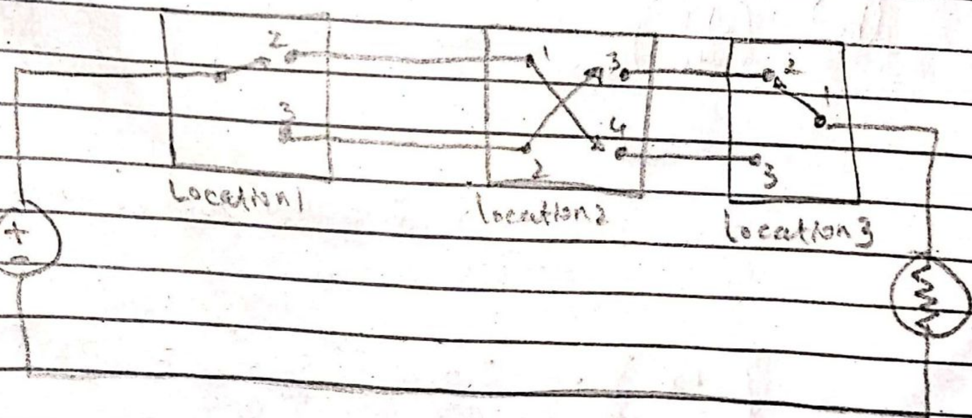
$\boxed{V_{13} = 1.135\,V}$

PROBLEM 2.33:-

(a)



(b)



P 2.34:-

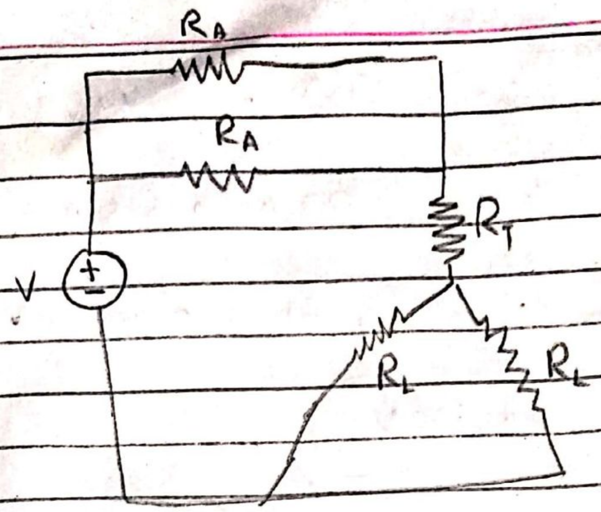
Sol: Using ohm's law and KVL.

$400i + 50i + 200i - 250 = 0$

hence $i = \frac{250}{650} = 385\,mA$

This current is nearly enough to stop the heart so a warning sign should be posted at the 250 V source.

P 2.35 :-



P 2.36 :-

(a) $P_{arm} = \left(\frac{250}{650}\right)^2 (400) = 59.17\ W$

$P_{leg} = \left(\frac{250}{650}\right)^2 (200) = 29.59\ W$

$P_{trunk} = \left(\frac{250}{650}\right)^2 (50) = 7.40 W$

(b) $\left(\frac{dT}{dt}\right)_{arm} = \frac{2.39 \times 10^{-4}\ P_{arm}}{4} = 35.36 \times 10^{-4}\ °C/s$

$t_{arm} = \frac{5}{35.36} \times 10^4 = 1414.23 s$ or 23.57 min

$\left(\frac{dT}{dt}\right)_{leg} = \frac{2.39 \times 10^{-4}}{10} P_{leg} = 7.07 \times 10^{-4}\ °C/s$

$t_{leg} = \frac{5 \times 10^4}{7.07} = 7{,}071.13 s$ or 117.85 min

$\left(\frac{dT}{dt}\right)_{trunk} = \frac{2.39 \times 10^{-4} (7.4)}{25} = 0.71 \times 10^{-4}\ °C/s$

$t_{trunk} = \frac{5 \times 10^4}{0.71} = 70{,}422.54 s$ or $1{,}173.71$ min

(c) They are all much greater than a few minutes.

P 2.37 :- (a) $R_{arms} = 400 + 400 = 800\Omega$

$i_{letgo} = 50\,mA$ (min)

$V_{min} = 800 \times 50 \times 10^{-3} = 40V$

(b) No, $12/800 = 15mA$. This current is sufficient to give a perceptible shock.

P 2.38 :-

$R_{space} = 1\,M\Omega$

$i_{space} = 3mA$

$V = i_{space} R_{space}$

$$\boxed{V = 3000V}$$

Scanned with CamScanner