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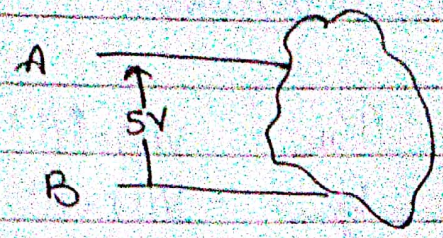
Current is a "through" variable

Potential is a "across" variable.



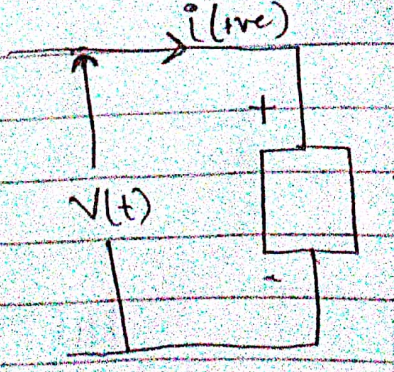
$V_{AB} = +5V$

$V_{BA} = -5V$

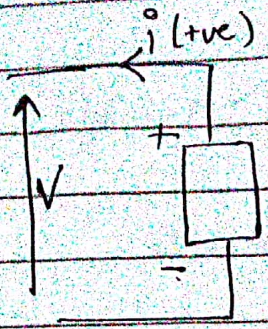
Power (P)

$$P(t) = V(t) \times i(t)$$

An circuit component can be an absorber or a generator of power.



If the situation is as this then the power is being absorbed.

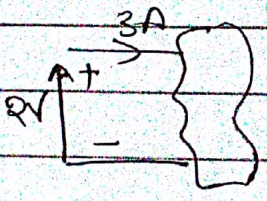


Here power is being dissipated.

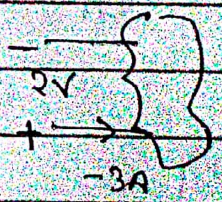
Passive Sign Convention

$P_{abs} = V(t) \times i(t)$ (it will be +ve)

$P_{gen} = -V(t) \times i(t)$ (it will be -ve)



$P = 2 \times 3$ abs.



abs -2×-3

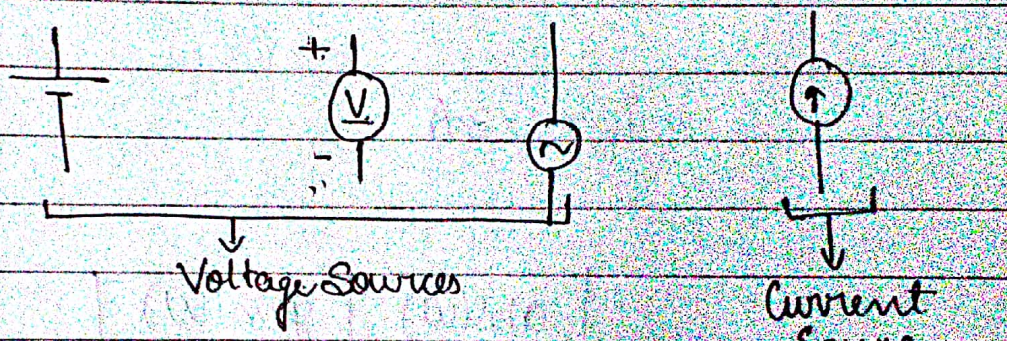
Voltage and Current Sources

Two types :- Independent
Dependent

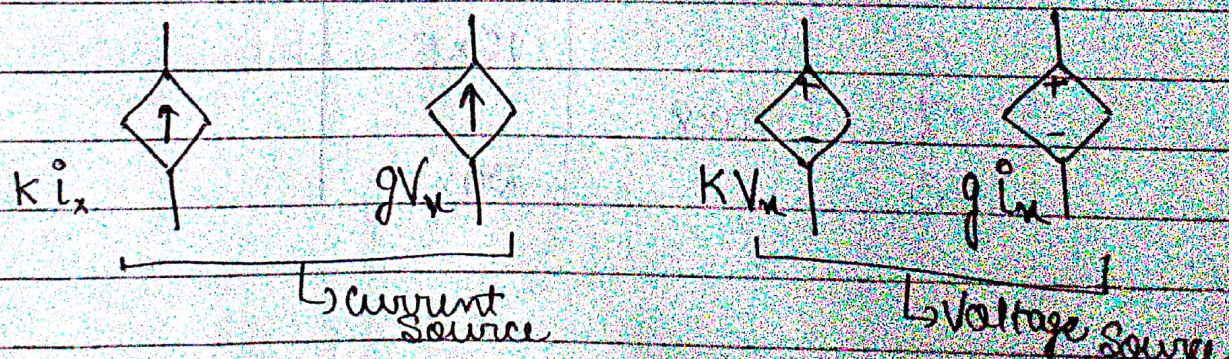
Ideal Vot. Source

Ideal Curr. Source

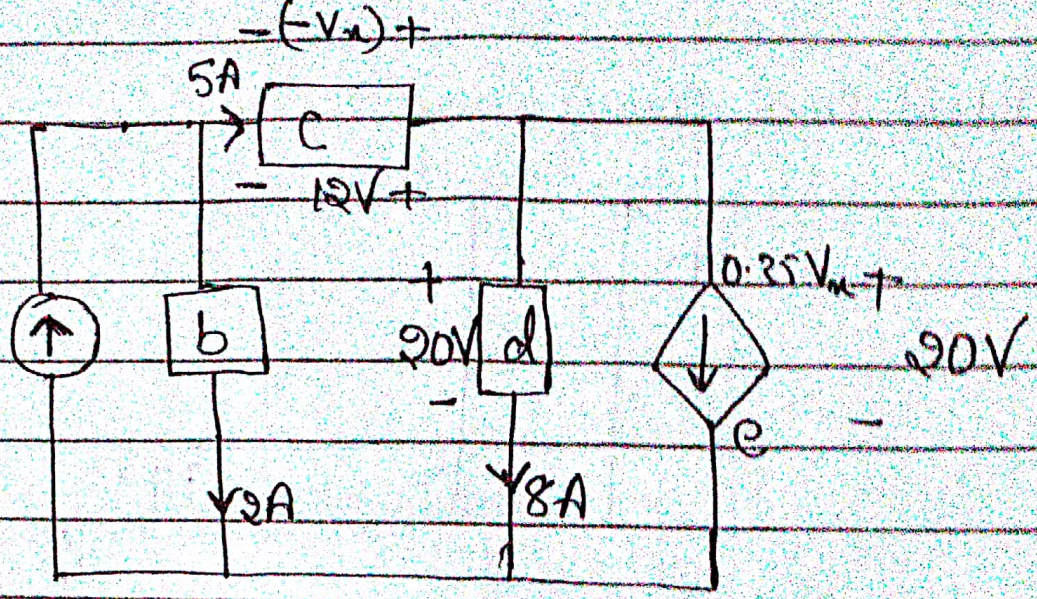
Independent



Dependent Source



K and g are const. with appr. dimensions
So, the sources are dep. on either i or V and their values equal to a const. multiple of Vol. or curr.



$i_e = 0.25 V_x$

$-V_x = 12V$

$\Rightarrow V_x = -12V$

$\Rightarrow i_e = -3A$

	abs(W)	gen(W)
a		7×8
b	8×2	
c		12×5
d	20×8	
e		20×3

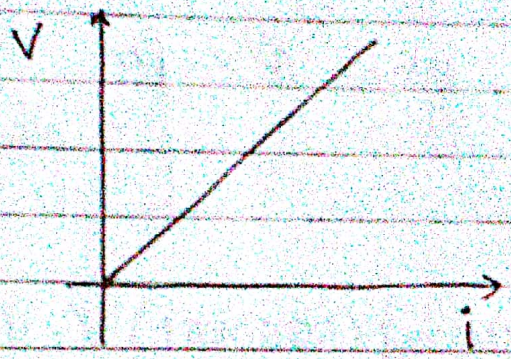
Ohm's Law

$V \propto i$

$$V = iR$$

R – resistance (Ω)

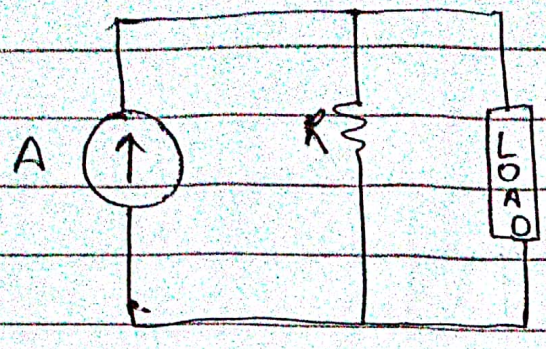
$$R = \rho l / A$$



Ideal Voltage Source

Non Ideal

Non-ideal source is like a resist. in series with the voltage source.

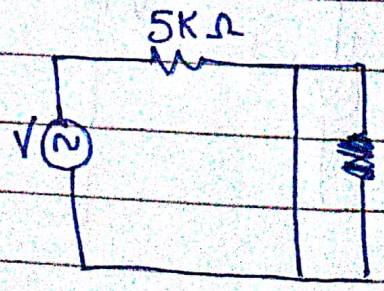


For a curr. source, R would be in ||^{al}

Short Circuit $\Rightarrow$ $R \to 0$

Open Circuit $\Rightarrow$ $R \to \infty$

Que) A voltage source of $(20\sin\pi t)$ V is connected across a 5KΩ res. Find the curr. through res. and power dissipated.



$i = 4\sin\pi t$ mA

Power (P) = $80\sin^2\pi t$ mW

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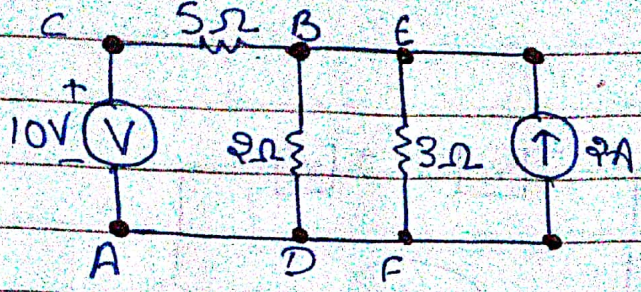


→ **Branches** :- Eg:- BC, BD, EF etc.

→ **Nodes** :-

Pt. with which all ~~~~ components are connected with a short.

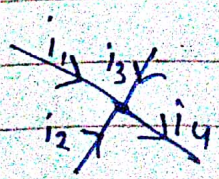
Eg:- A, B

→ **Loop**

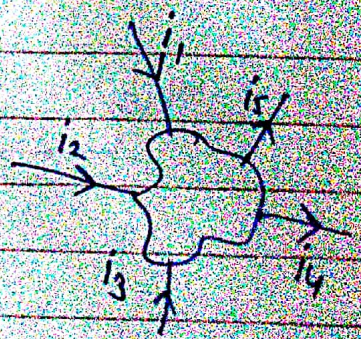
KVL & KCL

KCL :-

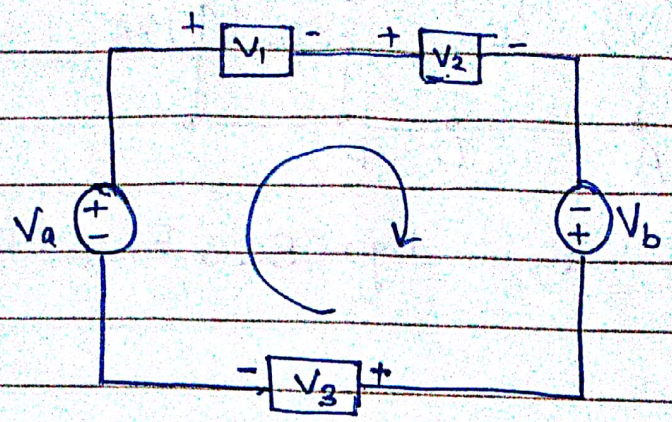
Sum of curr. coming at a pt. equal that leaving.



$$i_1 + i_2 + i_3 - i_4 = 0$$



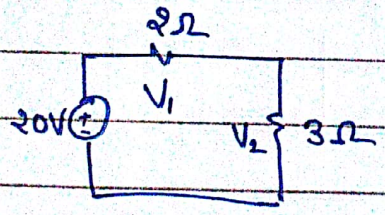
KVL



$$V_a - V_1 - V_2 + V_b - V_3 = 0$$

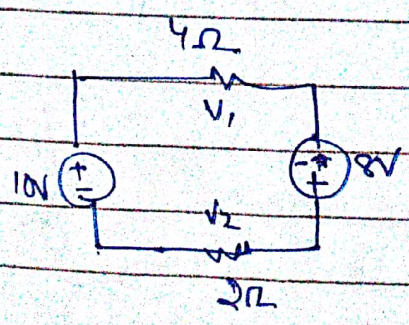
$$\Rightarrow V_a + V_b = V_1 + V_2 + V_3$$

(i)



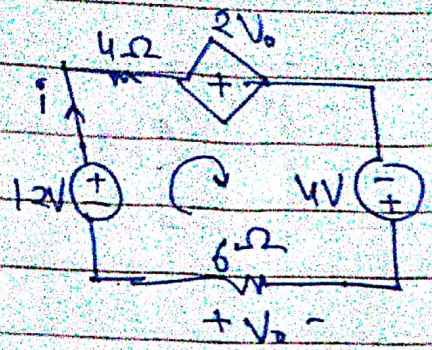
$V_1 = 8V \qquad V_2 = 12V$

(ii)



$V_1 = 12V \qquad V_2 = 6V$

Que)



$12 - 4i + 2V_o + 4 + V_o = 0$

$V_o = +6i$

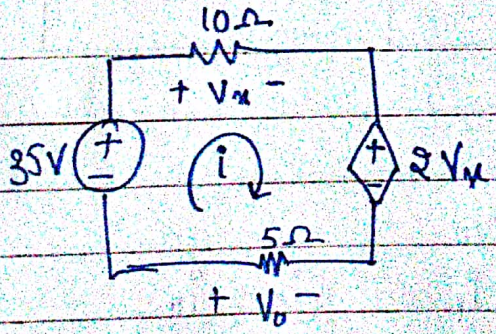
$16 = 4i + V_o$

$16 = 10i$

$i = 8/5\ A$

$\therefore V_o = 48\ V$

Que)



$V_o = +5i$

$V_x = +10i$

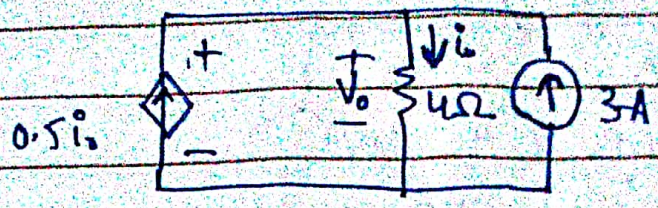
$35 - 10i - 20i + 5i = 0$

$\Rightarrow i = 1A$

$\therefore V_o = 5V$

$V_x = 10V$

Que



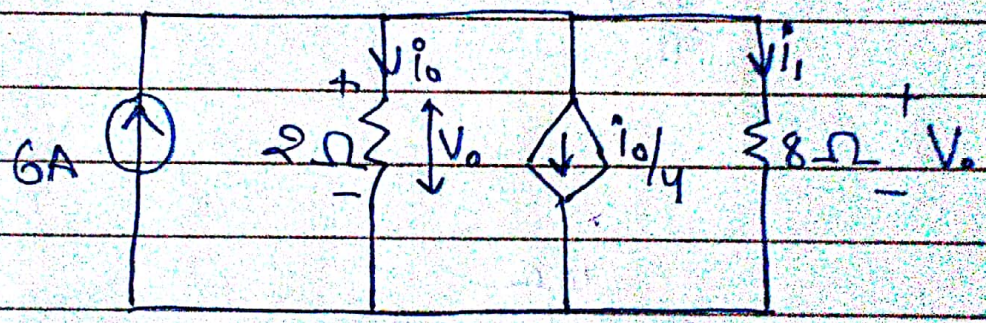
$3 - i_o + 0.5i_o = 0$

$\Rightarrow$ $i_o = 6A$

$V_o = 8 \times 4A$

$P_{gen} = V_o \times 0.5i_o$

Que)



$2i_o = V_o$

$\Rightarrow i_1 = \frac{2i_o}{8} = \frac{i_o}{4}$

$\therefore 6A = \frac{3i_o}{2}$

$i_o = 4A$

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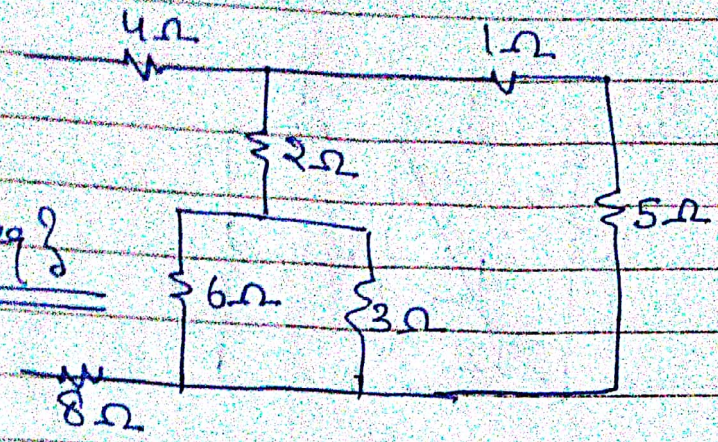
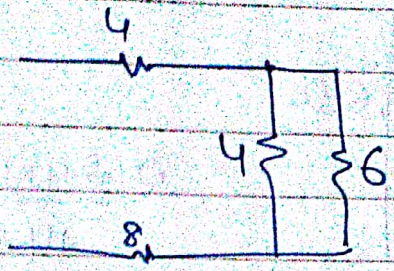
Que)



Req ?

Ans



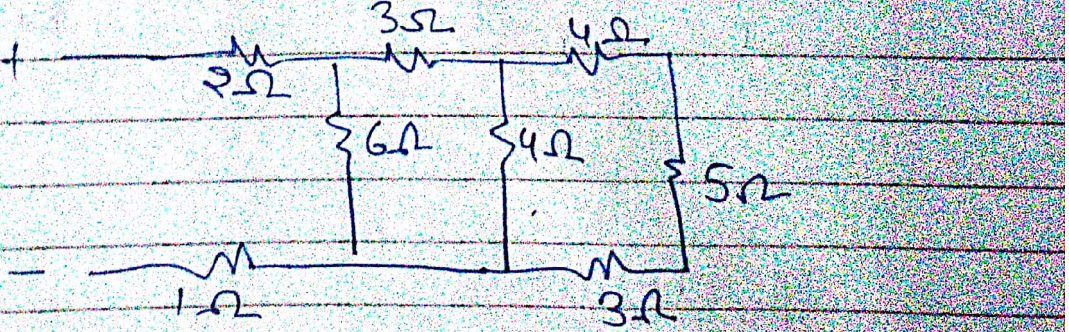
$R_{eq} = 4 + 8 + 2.4$

$= 14.4\ \Omega$

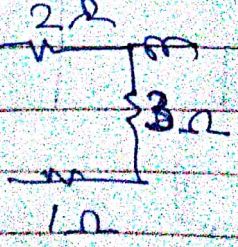
$\frac{+8}{9}\ 2$

$\frac{24}{10}$

Que)

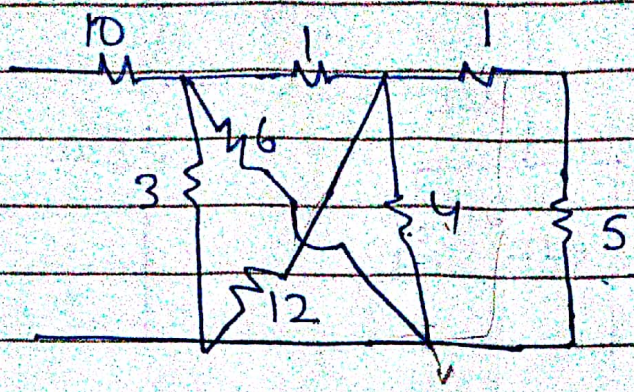


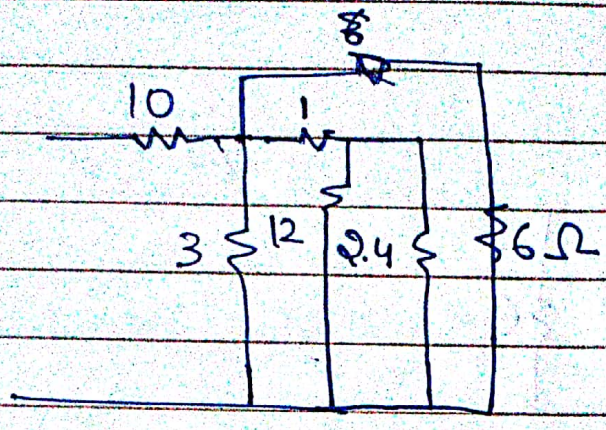
Req ?



$= R_{eq} = 6\Omega$

Que)



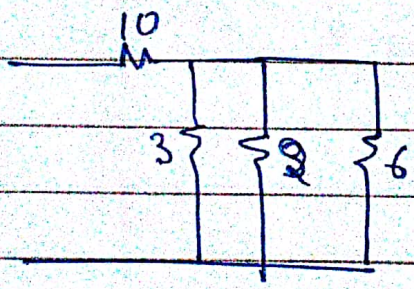


$\frac{6 \times 4}{10}$

$\frac{2.4 \times 12}{14.4}$

12

5

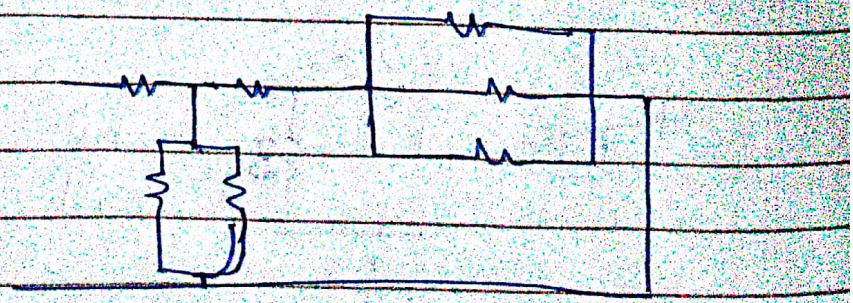


$\frac{6 \times 2}{8}$

$\frac{3/2 \times 3}{4.5}$

1

eql. circuit



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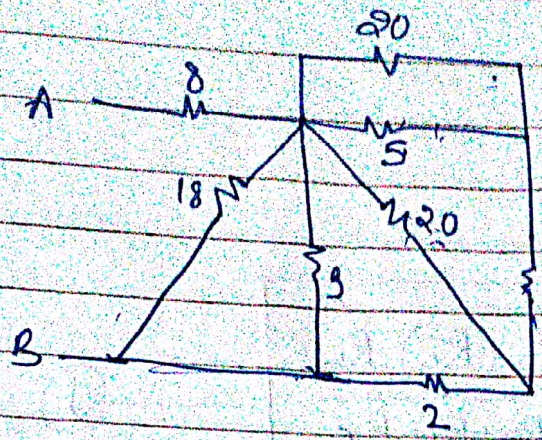
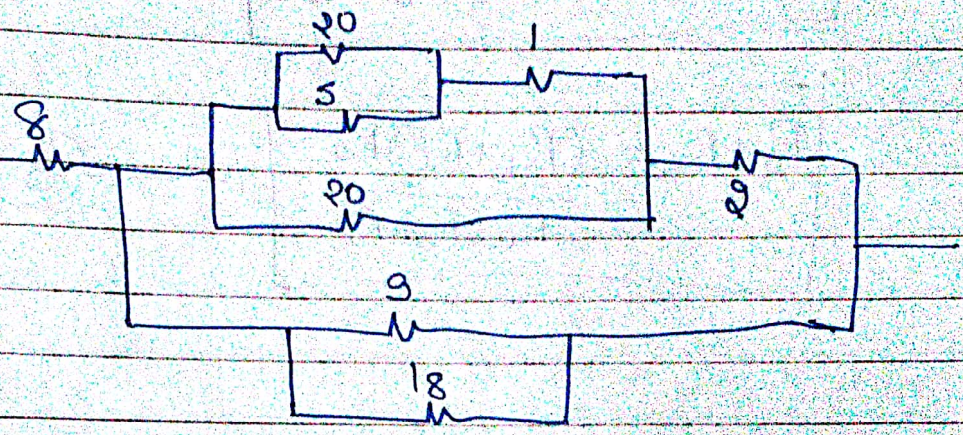
(Que)



Ans



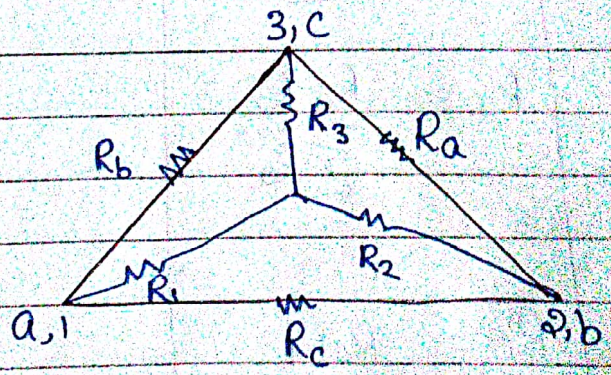
$R_{eq} = 11\ \Omega$

$\frac{20 \times 5}{25} = 4$

$\frac{6 \mid 18 \times 9 \mid}{27} = 3$

When Subst. ~~R-F~~ Δ network with the star network.

(Que)



$R_{12} = R_{ab}$

$R_1 + R_2 = R_c \,||\, R_a + R_b$

$$R_1 + R_2 = \frac{R_c(R_a + R_b)}{R_a + R_b + R_c} \quad \text{---(1)}$$

Similarly

$R_{13} = R_{ac}$

$$R_1 + R_3 = \frac{(R_a + R_c) R_b}{R_a + R_b + R_c} \quad \text{---- (1)}$$

$$R_2 + R_3 = \frac{(R_b + R_c) R_a}{R_a + R_b + R_c} \quad \text{---- (3)}$$

(1) − (3) ⇒ (4) ⇒ $R_1 - R_3 = \frac{R_b R_c - R_a R_b}{\sum R_a}$ ---- (5)

(4) + (2) ⇒

$$R_1 = \frac{R_b R_c}{\sum R_a}$$

$$R_2 = \frac{R_a R_c}{\sum R_a}$$

$$R_3 = \frac{R_a R_b}{\sum R_c}$$

$$R_a = \frac{\sum R_1 R_2}{R_1} \qquad R_b = \frac{\sum R_1 R_2}{R_2}$$

$$R_c = \frac{\sum R_1 R_2}{R_3}$$

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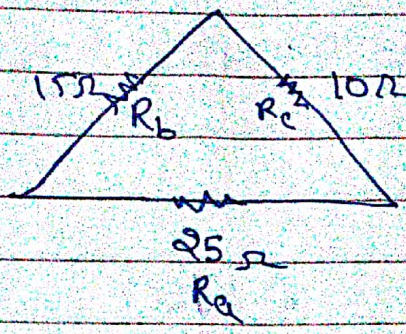
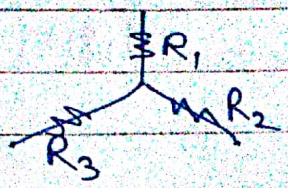
Que)



Ans)

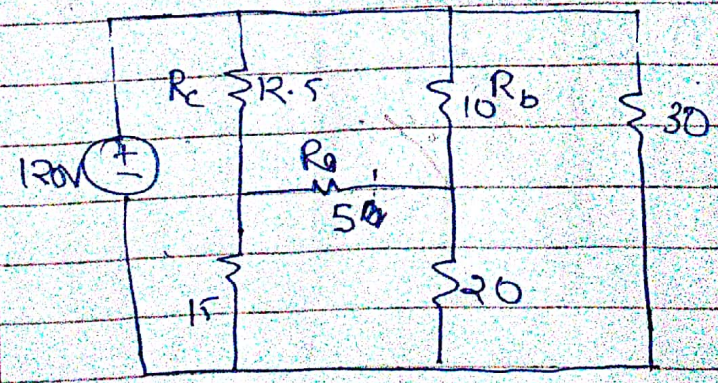


$$R_1 = \frac{150}{50} = 3$$

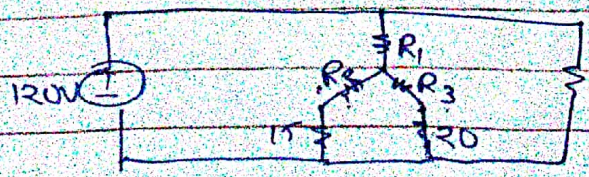
$$R_2 = \frac{250}{50} = 5\,\Omega$$

$$R_3 = \frac{375}{50} = 7.5\,\Omega$$

Que)



Ans)



$$R_1 = \frac{125}{27.5} = 4.5454$$

$$R_2 = \frac{62.5}{27.5} = 2.2727$$

$$R_3 = \frac{500}{27.5} = 1.8181$$

$$R_{eq} = \frac{(R_2+15)(R_3+20)}{R_1+R_2+35}$$

$$= \frac{(17.2727)(21.8181)}{R_1+R_2+35}$$

$$= 9.6405$$

$$\therefore R_{eq} = 9.632\ \Omega$$

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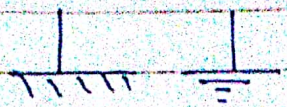
Nodal Analysis

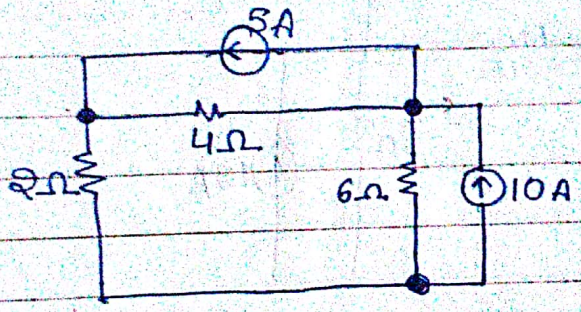
KCL

n — "node" (n no. of nodes)

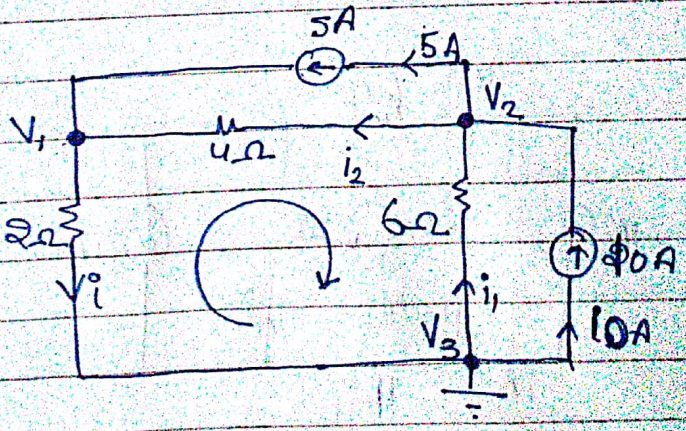
Ref-node — datum/ground



Que)



Ans)



$V_3 = 0$

$i_2 + 5 = i \quad | \quad i_1 + 10 = i$

$V_2 - V_3 = -6i_1$

$V_2 = 2i + 4i_2$

$2i + 4i_2 + 6i_1 = 0$

$\Rightarrow 2i + 4(i-5) + 6(i-10) = 0$

$\Rightarrow 12i = 80 \Rightarrow i = 20/3$

~~$i = 6.66A$~~

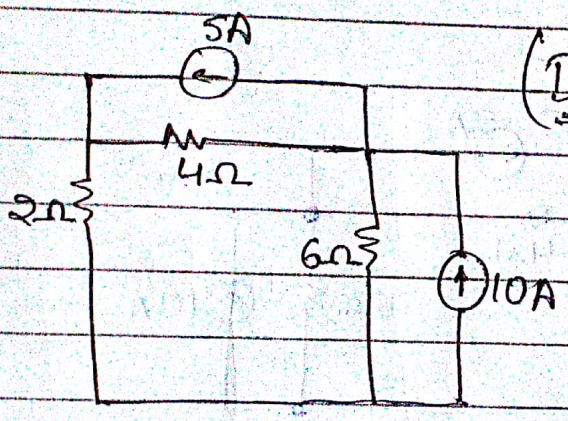
$i_1 = -10/3 A \quad i_2 = \frac{+5}{3} A$

$V_1 = 2i = 40/3 V$

$V_2 = 20V$

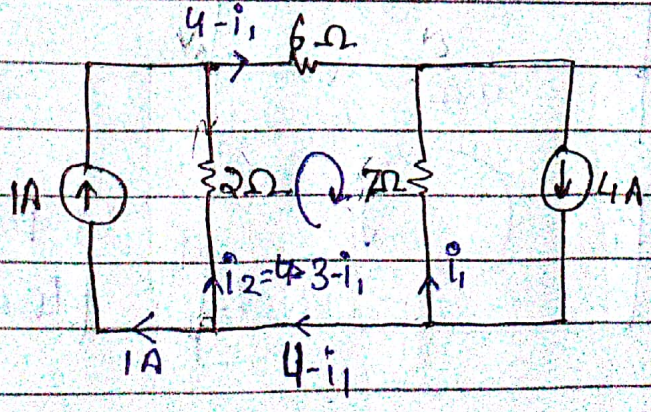
$\frac{10}{3} \times$

Que)



(Done above)

Que)



Ans)

$\Rightarrow (i_1 - 4)6 + 7i_1 + (i_1 - 3)2 = 0$

$\Rightarrow 6i_1 + 7i_1 + 2i_1 = 24 + 6$

$15i_1 = 30$

$i_1 = 2A$

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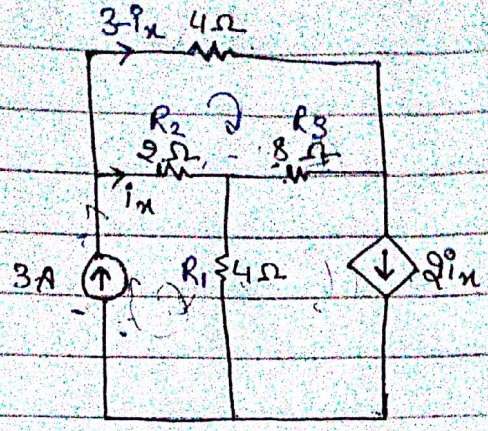
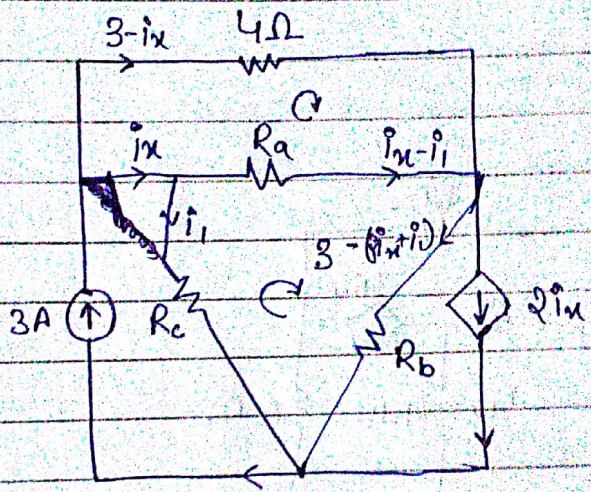
Que)



Ans)



$R_a = \frac{8+32+16}{4}$

$= 14\,\Omega$

$R_b = \frac{56}{2}$

$= 28\,\Omega$

$R_c = \frac{56}{8}$

$= 7\,\Omega$

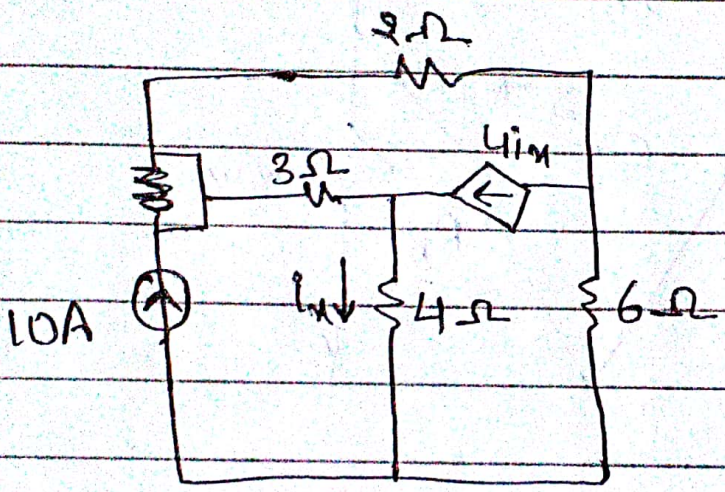
$-4(3-i_x) + (i_x - i_1)14 = 0$

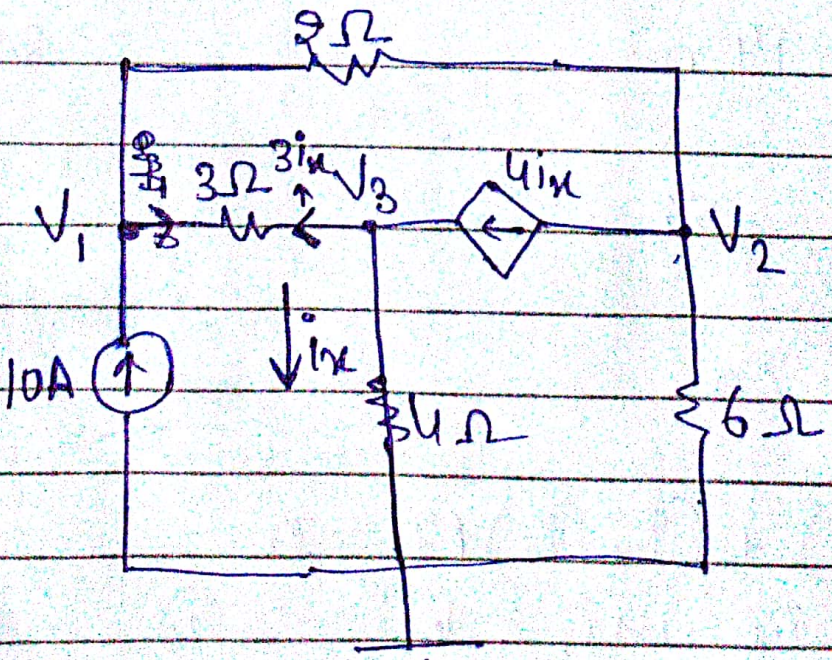
$\Rightarrow 5i_x - 14i_1 = 12 \quad (1)$

$(i_x - i_1)(-14) + \{(2i_x + i_1) - 3\}28 + 7i_1 R_a = 0$

$14i_1 + 28i_1 - 14i_x + 56i_x + 7i_1 - 84 = 0$

$49i_1 + 42i_x - 84 = 0 \Rightarrow 7i_1 + 6i_x = 12 \quad (2)$





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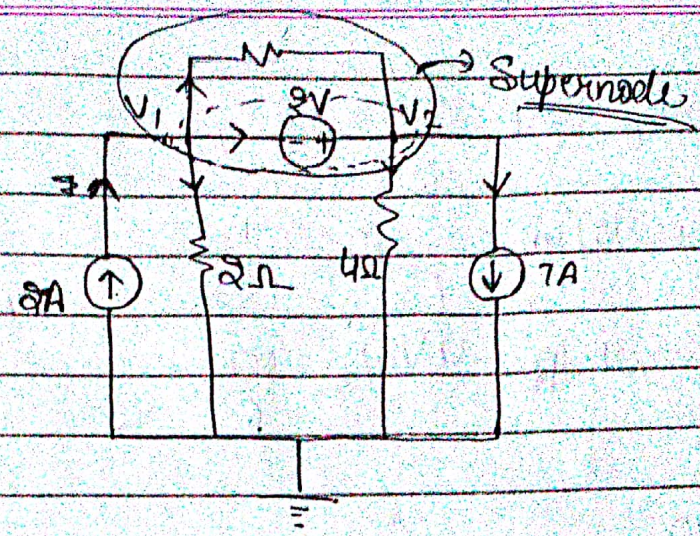
(Que)



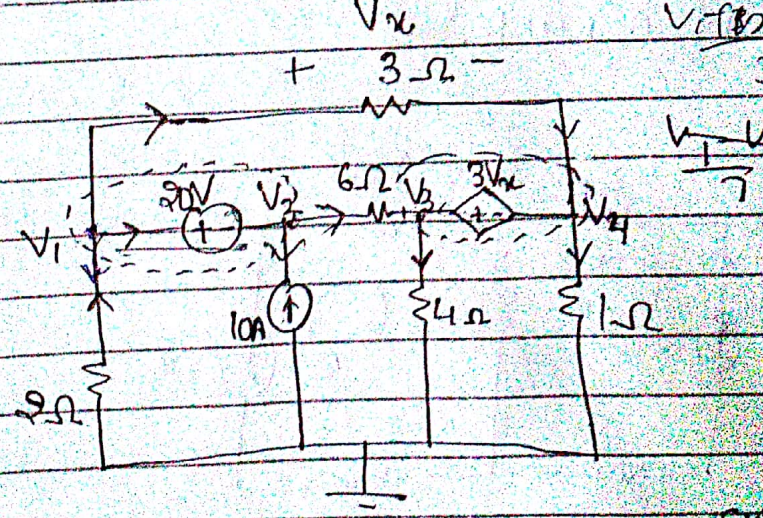
$$2 = \frac{V_1}{2} + \frac{V_2}{4} + 7 \quad \text{---} \quad (1)$$

$$V_2 = V_1 + 2 \quad \text{---} \quad (2)$$

$V_1 = -6V - 22/3\ V$

$V_2 = -8V - 16/3\ V$

(Que)



$V_1 - V_2 = 20V$

$V_3 - V_4 = 3V_x$

$V_1 - V_4 = 3V_x$

$V_x = \frac{V_1 - V_4}{3}$

$\frac{V_1 - 20 - V_3}{6} + \frac{V_1 - V_4}{3} = \frac{V_3}{4} + \frac{V_4}{1}$

Sup. KCL along nodes

$\frac{V_1}{2} + 10 = \frac{V_1 - V_4}{3}$

$\frac{V_1 - V_4}{3}$ = $(V_1 - V_4)$

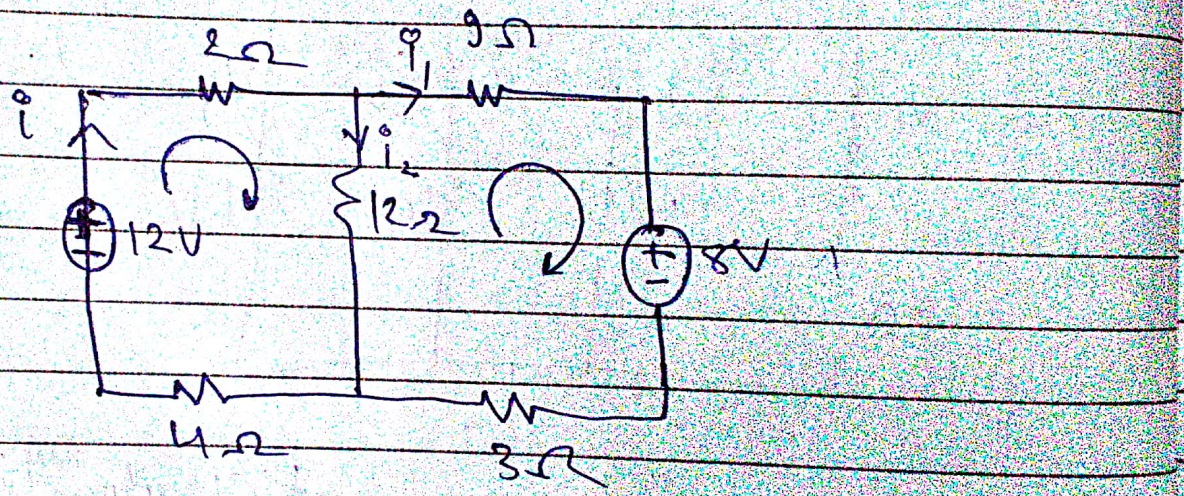
$V_x = \frac{V_1 - V_4}{3}$

$\frac{V_1 - V_4}{7} = 10$

Mesh Analysis

A loop which has no other loop is called a mesh.

Ques



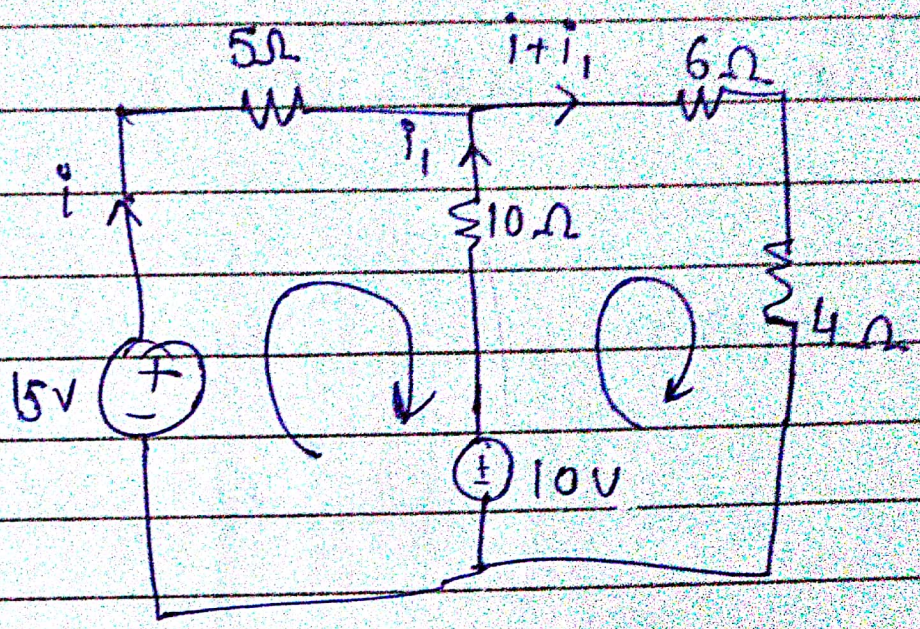
KVL $-2i - 12i_2 - 4i + 12 = 0$

$i_2 = i - i_1$

$\Rightarrow$ $6 = i + 6i - 6i_1 + 9i$

$6 = 9i - 6i_1$ $\Rightarrow$ $\boxed{2 = 3i - 2i_1}$

Q.11)



Ans

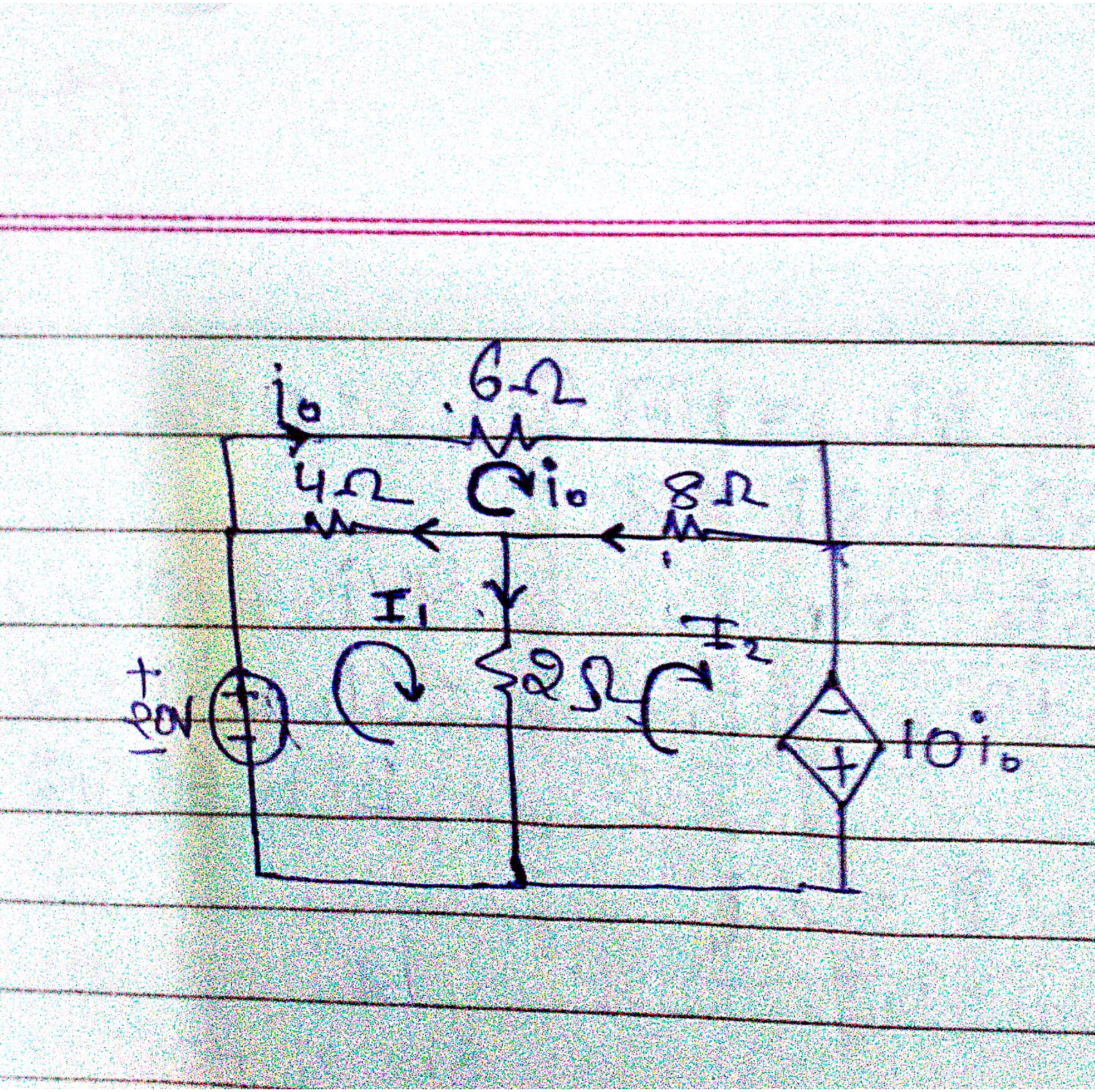
$$15 - 5i + 10i_1 - 10 = 0$$

$$\boxed{5i - 10i_1 = 5} \Rightarrow \boxed{i - 2i_1 = 1}$$

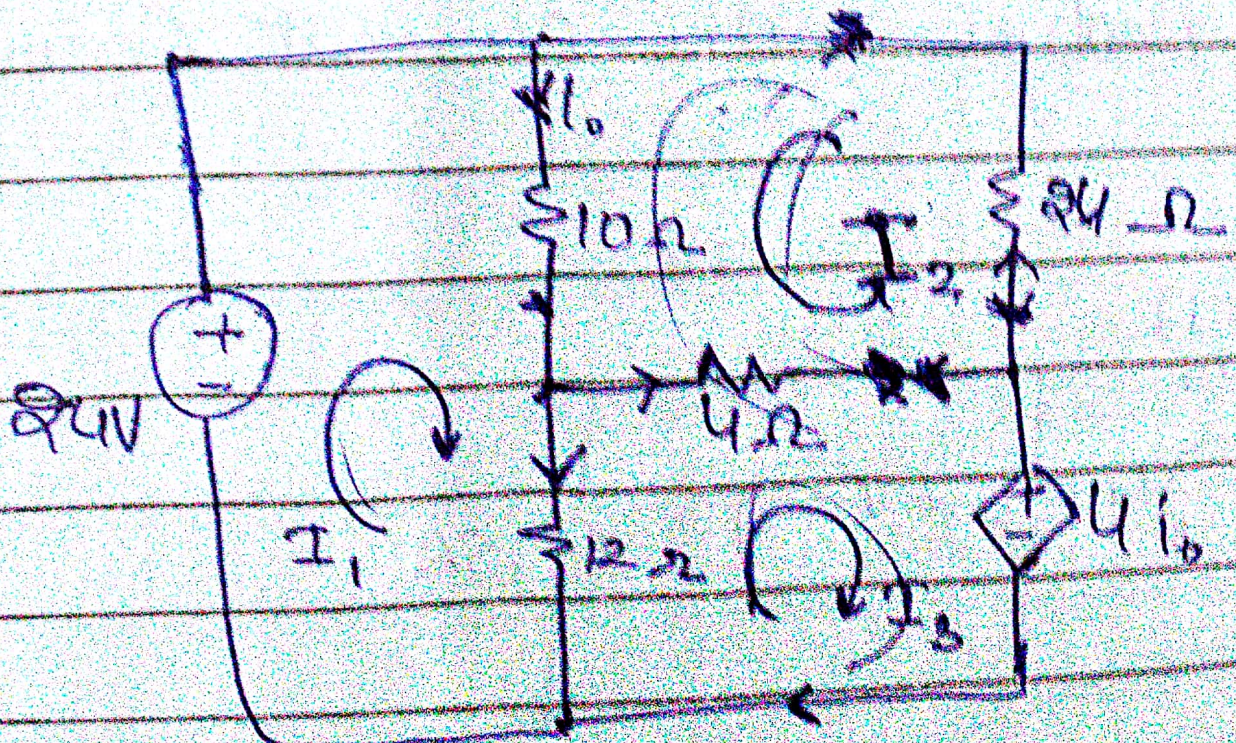
$$-(i+i_1)6 - 4(i+i_1) + 10 - 10i_1 = 0$$

$$10(i+i_1) + 10i_1 = 10$$

$$\boxed{2i_1 + i = 1} \rightsquigarrow \underline{i = 1A \; ; \; i_1 = 0}$$

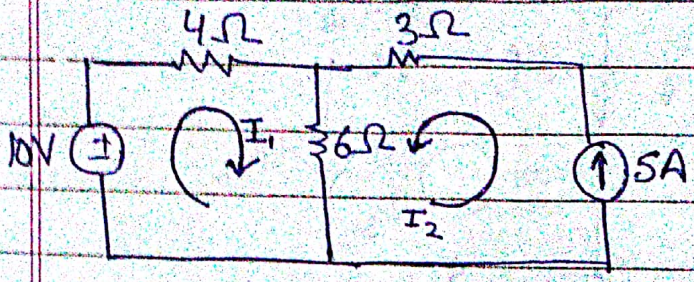


Date



Mesh Analysis with Current Sources

(1)



Here $I_2 = 5A$

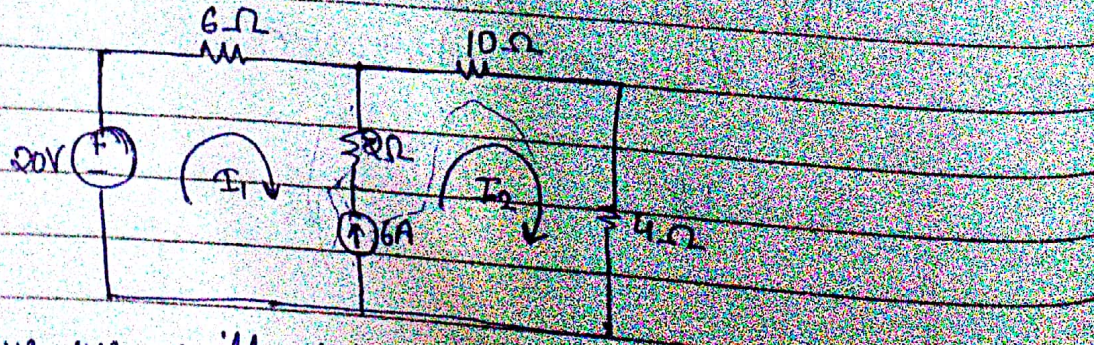
$$10V - 4I_1 - 6(I_1 + I_2) = 0$$

$$\Rightarrow 10 - 10I_1 - 30 = 0$$

$$\Rightarrow \frac{-20}{10} = I_1$$

$$\Rightarrow \underline{I_1 = -2A}$$

(2)



Here we will apply KVL for the bigger loop and the intermed. branch is ~~[illegible]~~ wise.

$$I_1 - I_2 = 6A$$

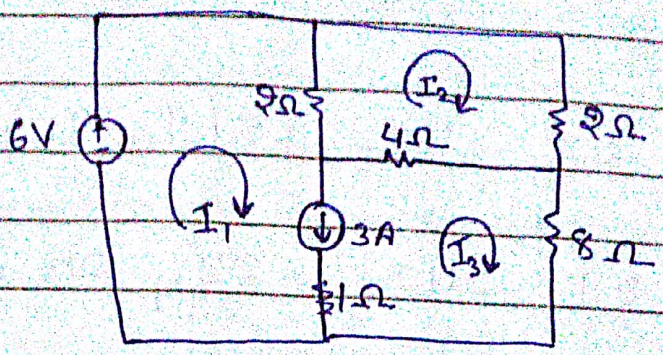
$$20 - 6I_1 - 10I_2 - 4I_2 = 0$$

$$20 = 6I_1 + 14(I_1 + 6)$$

$$20 - 84 = 20I_1$$

$$\frac{-64}{20} = I_1 \Rightarrow -3.2A = I_1$$

Que)



$I_1 - I_3 = 3A$ — ①

$2(I_1 - I_2) - 2I_2 + 4(I_3 - I_2) = 0$

$\Rightarrow 2I_1 - 8I_2 + 4I_3 = 0$ — ②

Superloop

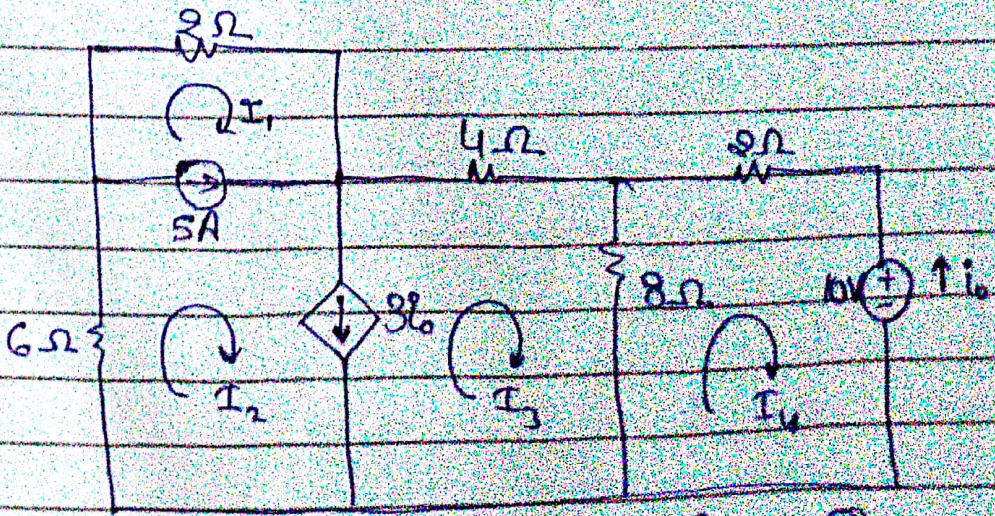
$6V - 2I_2 - 8I_3 = 0$ — ③

$I_1 = 66/19$

$I_2 = 21/19$

$I_3 = 9/19$

Que)

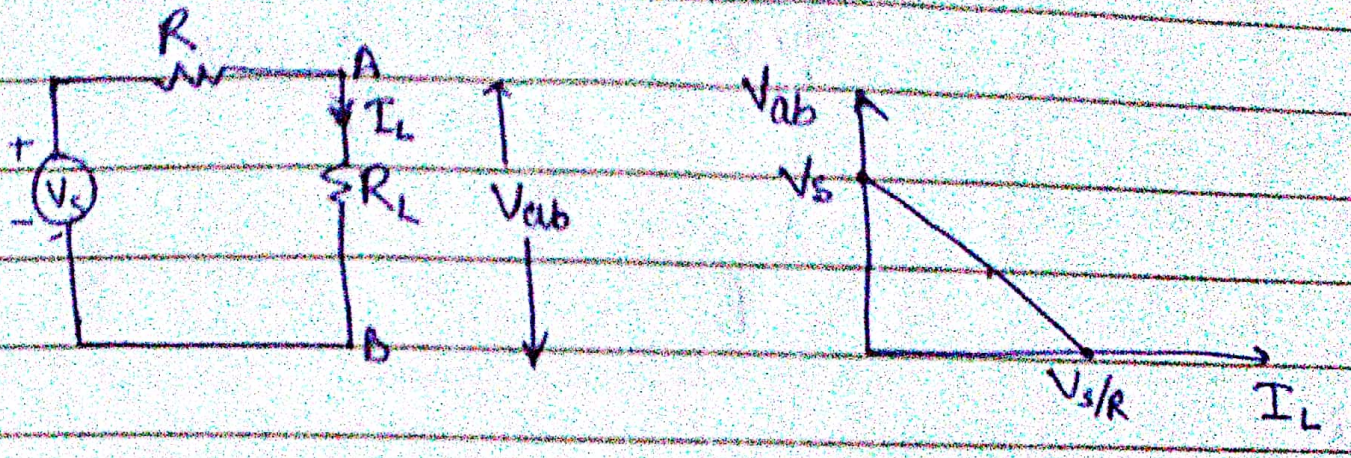


$-I_2 + I_3 = -3i_o$ — ① $I_4 = -i_o$ — ②

$\Rightarrow 3(I_4 - I_3) - 2I_4 - 10 = 0$

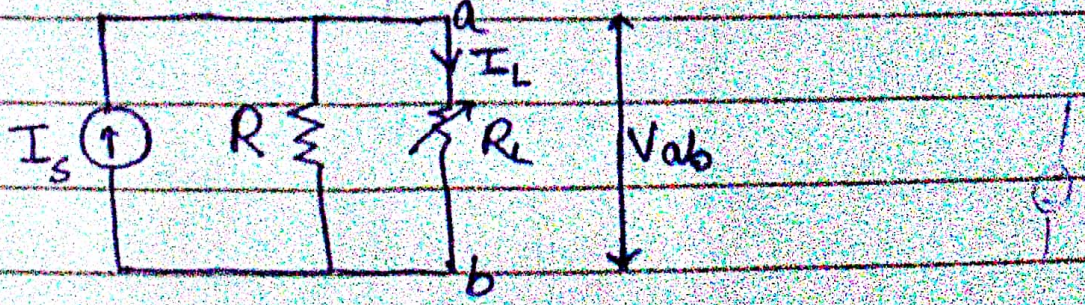
$\Rightarrow 6I_4 - 8I_3 = 10$ — ④ $\Rightarrow -2I_2 + 16I_3 = 10$ — ⑤

Source Transformation



(i) $R_L = 0 \Rightarrow V_{ab} = 0$ ∴ $I_L = V_s/R$

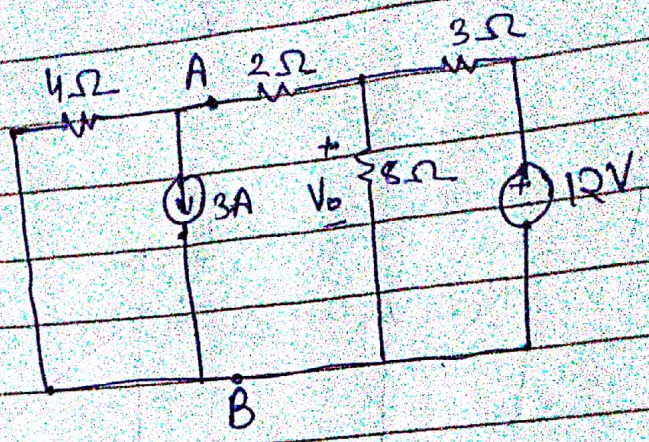
(ii) $R_L \to \infty$; $V_{ab} \to V_s$; $I_L \to 0$



(i) $R_L = 0$, $V_{ab} = 0$, $I_L = I_s$

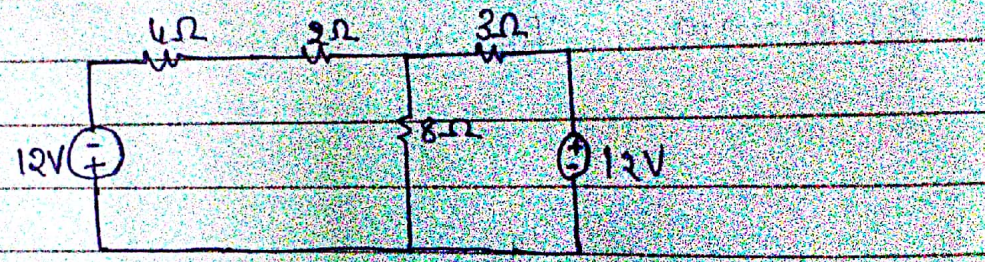
(ii) $R_L \to \infty$ $V_{ab} = I_s R$, $I_L \to 0$

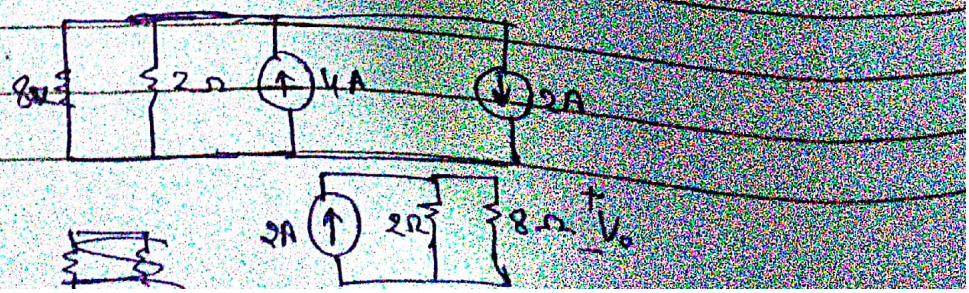
Que)



Ans)

Repl. curr. source with a volt. source





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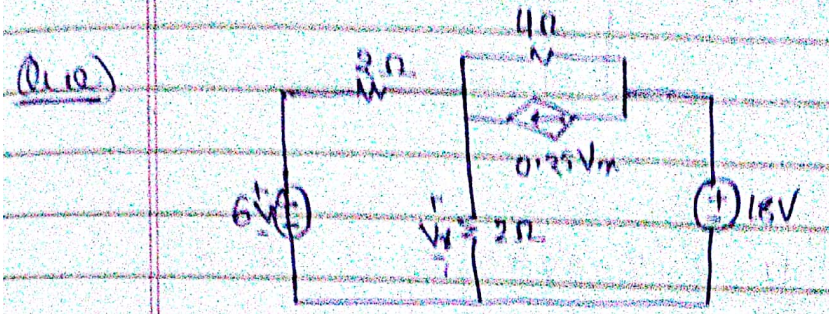
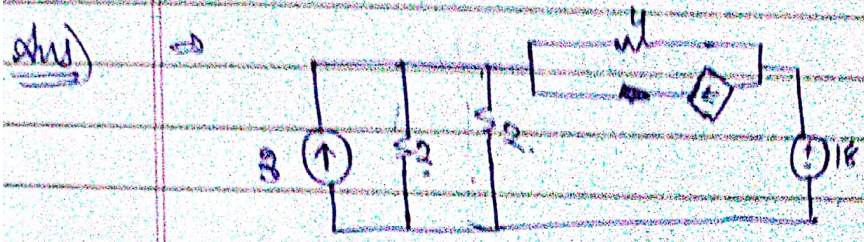
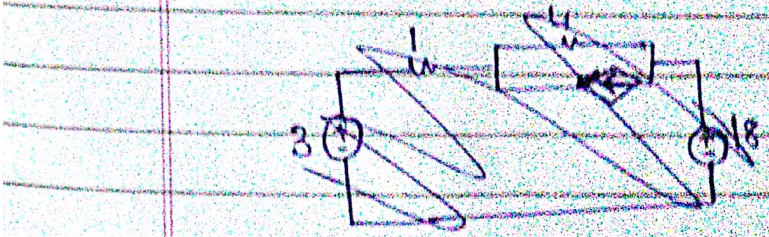
$\therefore V_o = 1.6 \times 2 = 3.2\,V$

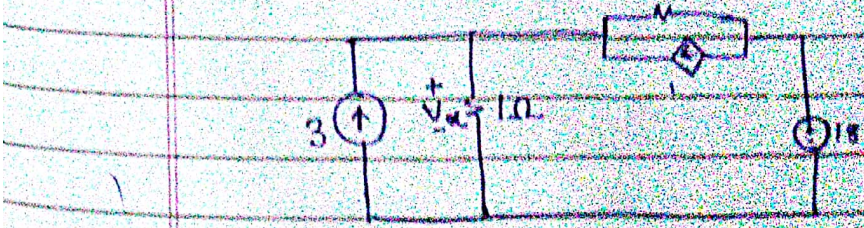
(Q.10)

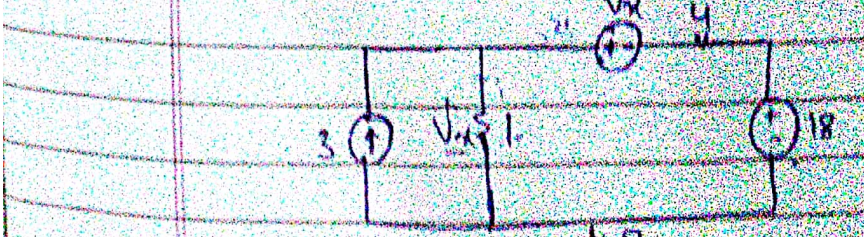


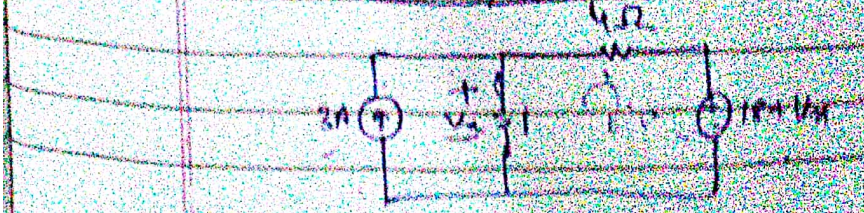
(Sol)

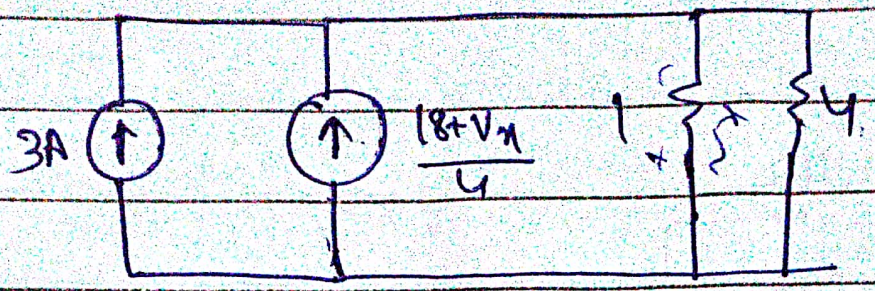












$$V_x = \frac{4}{5} \times \left(3 + \frac{18 + V_x}{4}\right)$$

$$\frac{30 + V_x}{5} = V_x$$

$$\frac{30}{4} = V_x$$