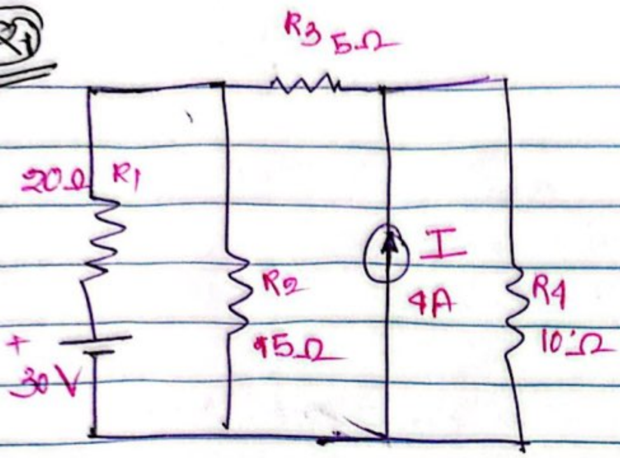
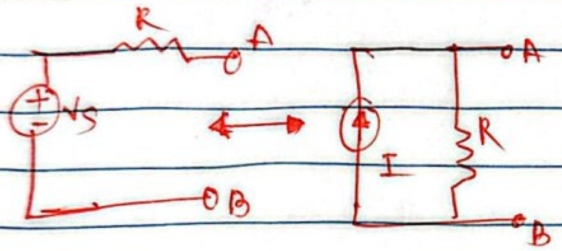
Q1



60

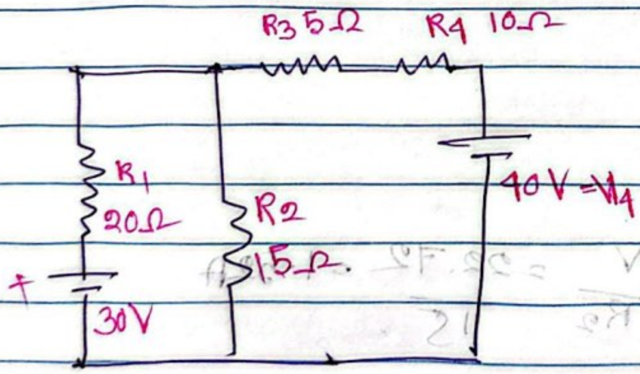
Find current accross R_2 using source transformation.



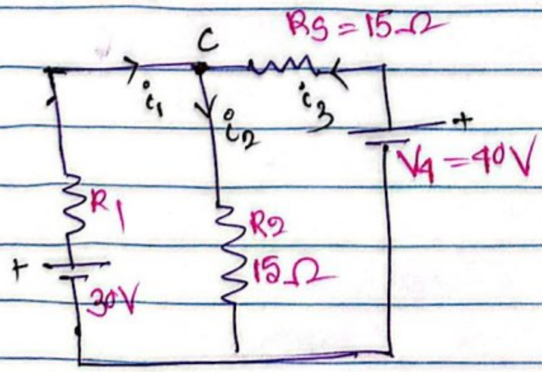
here, For $V_4 = R_4 \times I$ [transforming source].

$= (10\Omega) \times 4A$

$\therefore V_4 = 40$ Volt.



here, R_3 & R_4 are series $\therefore R_S = (R_3 + R_4) = (5+10) = 15\Omega$



applying KCL at C Node →

$I_1 + I_3 - I_2 = 0$

$I_1 + I_3 = I_2$

$$\frac{30-V}{20\Omega} + \frac{40-V}{15\Omega} = \frac{V}{15}$$

$$\frac{30-V}{20} + \frac{40-V}{15} - \frac{V}{15} = 0$$

$$\frac{30-V}{4} + \frac{40-V}{3} - \frac{V}{3} = 0$$

$$\frac{3(30-V) + 4(40-V) - 4V = 0}{12}$$

$90 - 3V - 160 + 4V - 4V = 0$

$250 - 11V$

$11V = 250$

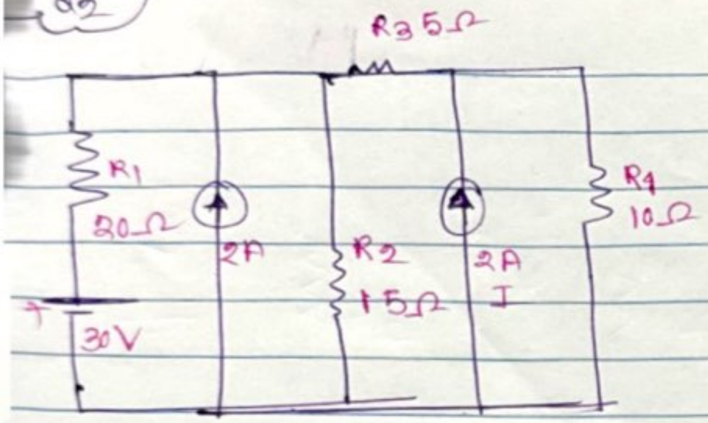
$\therefore V = 22.72V$

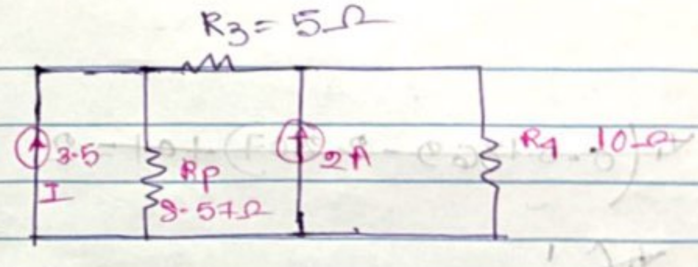
$\therefore$ current accross R_2, $i_2 = \frac{V}{R_2} = \frac{22.72}{15} = 1.52A$

$\therefore i_2 = 1.52A$

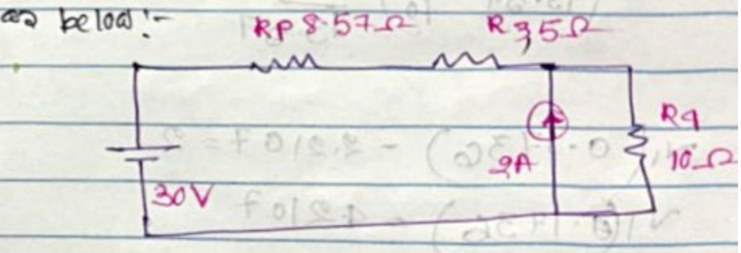
10

Q2

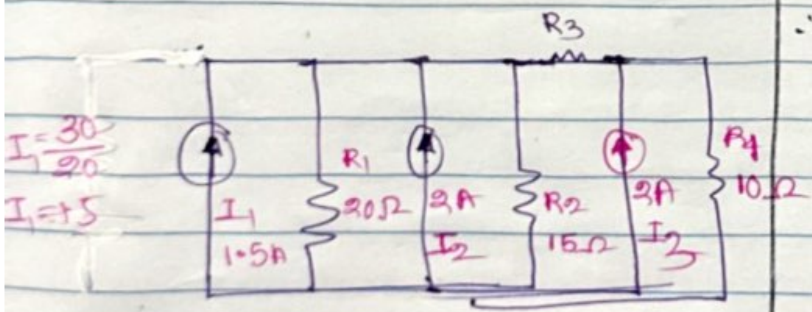




Now, left side current source will be transformed to a voltage source as below:-



Left side ~~current~~ voltage source will be transformed to a ~~voltage~~ current source as below:-



here, R_1 & R_2 is Parallel.

$\because R_1 \parallel R_2$

$\therefore R_P = (20^{-1}+15^{-1})^{-1}$

$\therefore R_P = 8.57\,\Omega$.

and,

I_1 & I_2 are same direction

So, $I = I_1 + I_2$

$\therefore I = (1.5+2)$ 3.5A

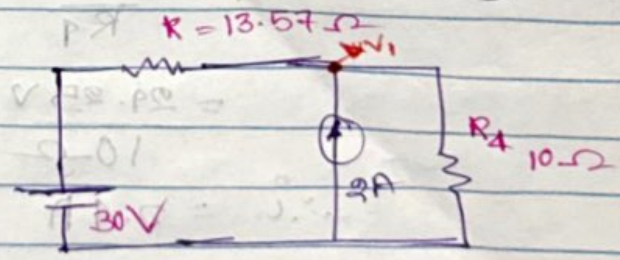
$V = I \times R_P$

$= (3.5A) \times (8.57\,\Omega)$

$\therefore V = 30V$

$\because R_P$ & R_3 Series →

So, $R = R_P + R_3 = 13.57\,\Omega$



Nodal analysis →

$$\frac{V_1-30}{R_P} - 2 + \frac{V_1}{R_4}$$

$$\frac{V_1-30}{13.57} - 2 + \frac{V_1}{10}$$

$$\frac{V_1-30}{13.57} + \frac{V_1}{10} = 2$$

$$\frac{V_1}{13.57} - \frac{30}{13.57} + \frac{V_1}{10} = 2$$

$$V_1\left(\frac{1}{13.57} - \frac{30}{13.57}\right) + \frac{1}{10} = 2$$

$$\cancel{V_1\left(0.07369-2.2107\right)+0.1=2}$$

$$V_1\left(\frac{1}{13.57}+\frac{1}{10}\right)-\frac{30}{13.57}=2$$

$$V_1\left(0.1736\right)-2.2107=2$$

$$V_1\left(0.1736\right)=4.2107$$

$$\therefore V_1=\frac{4.2107}{0.1736}$$

$$\therefore V_1=24.25\,V$$

$\therefore$ current across R_4, $i=\frac{V_1}{R_4}$

$$=\frac{24.25\,V}{10\,\Omega}$$

$$\therefore i=2.4\,A$$

$\therefore$ current across R_4 is $2.4A$.

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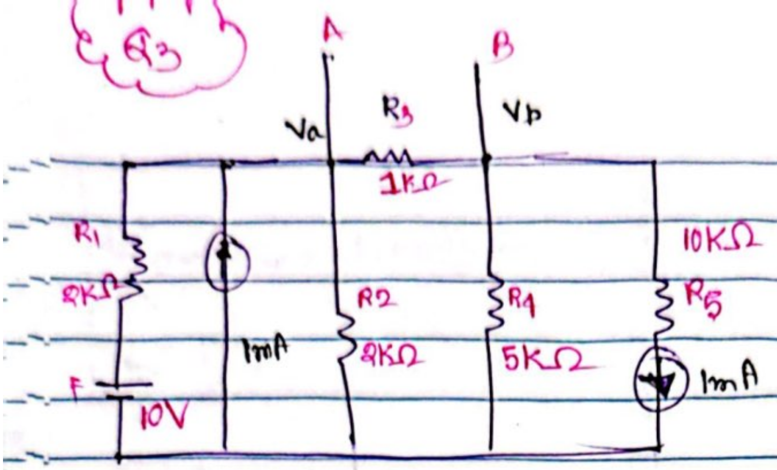


What is V_{AB} using thevenin's ~~Theoro~~ Theorem.

$$V_{Th} = V_a - V_b = V_{ab}$$

KCL at node V_a,

$$\frac{10 - V_a}{2k\Omega} + 1mA - \frac{V_a}{2k\Omega} + \frac{V_b - V_a}{1k\Omega} = 0$$

$$10 - V_a + 2 - V_a + 2V_b - 2V_a = 0$$

$$2V_b - 4V_a = -12$$

$$V_b - 2V_a = -6$$

$$2V_a - V_b = 6 \quad \text{— (i)}$$

applying KCL at node V_b,

$$\frac{V_a - V_b}{1k\Omega} - \frac{V_b}{5k\Omega} - 1mA = 0$$

$$5V_a - 5V_b - V_b - 5 = 0$$

$$5V_a - 6V_b = 5 \quad \text{— (2)}$$

~~(i×6) · (i)×6 − (2)~~

~~(i)×6 − (2)~~ · (i)×6 − 2 →

$$12V_a - \cancel{6V_b} - 5V_a + \cancel{6V_b} = 36 - 5$$

$$7V_a = 31$$

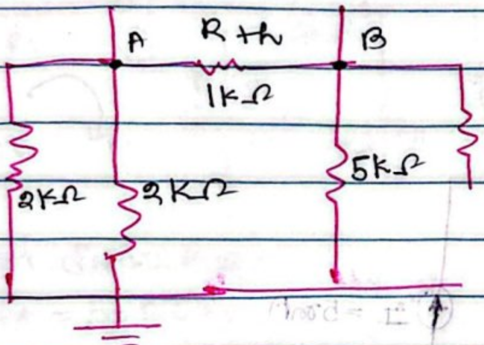
$$\therefore V_a = 31/7 = 4.428V$$

$V_b = 2 \times V_a - 6$
$= (2 \times 4.428) - 6$
$= 8.856 - 6$
$= 2.857\,V$

4

-6

$\therefore V_{Th} = V_a - V_b$
$= 4.428 - 2.857$
$= 1.57\,V$

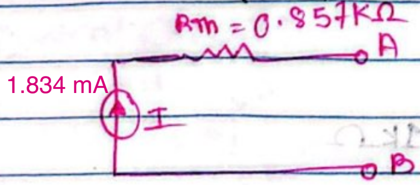


$\boxed{\cancel{\therefore 1k\Omega \parallel 5k\Omega \quad \therefore R_{th} = \left(\frac{1 \times 6}{1+6}\right) = 0.857\,k\Omega}}$

$R_{Total} = (2k\Omega \parallel 2k\Omega) + 5$
$= \left(\frac{2 \times 2}{2+2}\right) + 5k\Omega$
$= (1k\Omega) + 5k\Omega$

$\therefore R_{Total} = 6k\Omega$

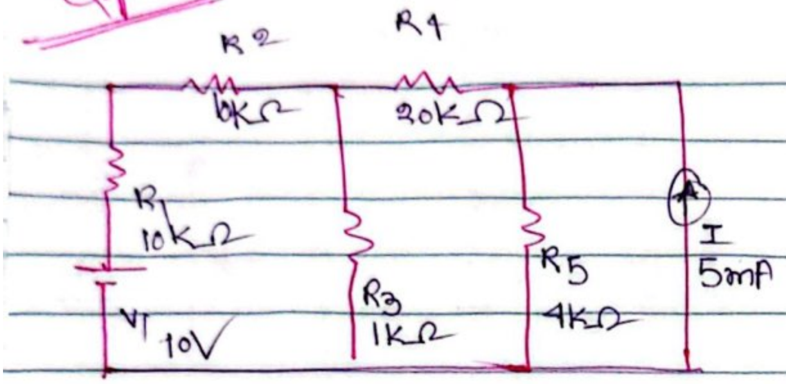
$\therefore R_{th} = \left(\frac{1 \times 6}{1+6}\right) = \frac{6}{7} = 0.857\,k\Omega$



Norton Current $= \frac{V_{Th}}{R_{th}} = \frac{1.572\,V}{0.857\,k\Omega}$

$\therefore I = 1.834\,mA$

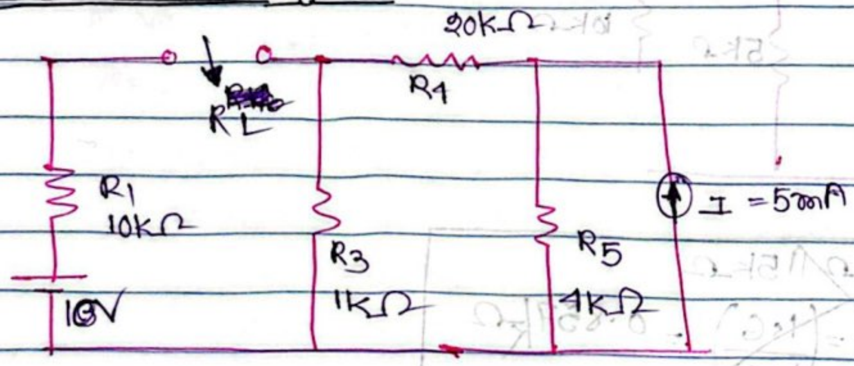
Q1



what is current of R_2, i_{R2} = ??

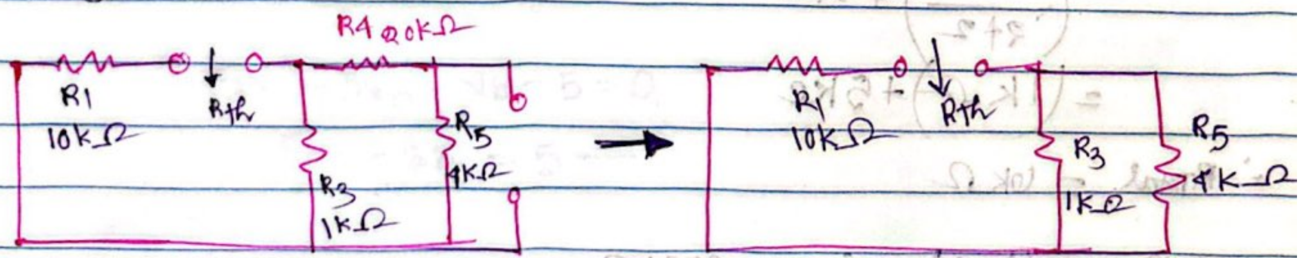
Using Thevenin Theorem.

Thevenin's ~~The~~ Voltage R_{th} :-



Calculating R_{th}, voltage source will be short circuit and current source will be open circuit

So the circuit will be like this →



here, we can see, $(R_4 + R_5) \parallel R_3$

$$\therefore R_{th} = R_1 + (R_4 + R_5) \parallel R_3$$

$$= R_1 + (20k\Omega + 4k\Omega) \parallel 1k\Omega$$

$$= (24k\Omega) \parallel 1k\Omega + R_1$$

$$= R_1 + \left(\frac{24k\Omega \times 1k\Omega}{24k\Omega + 1k\Omega}\right)$$

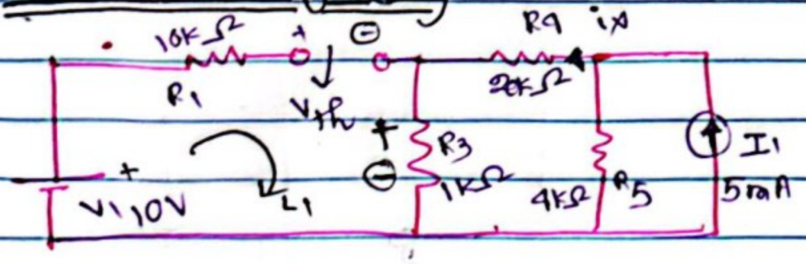
$R_1 + 960\Omega$

$= (1000 + 960)\,\Omega$

$= 10960\,\Omega$

$\therefore R_{th} = 10960\,\Omega$ or $10.96\,K\Omega$

Thevenin Voltage (V_{th}):-



Current divider Rule,

$$I_x = 5mA \times \left(\frac{R_5}{R_3 + R_4 + R_5}\right)$$

$$= 5mA \times \left(\frac{4K\Omega}{1K\Omega + 20K\Omega + 4K\Omega}\right)$$

$$= 5mA \times 0.16K\Omega$$

$$\therefore I_x = 0.8\,mA$$

applying KVL at Loop1 →

$10V - V_{th} - R_3 i_x = 0$

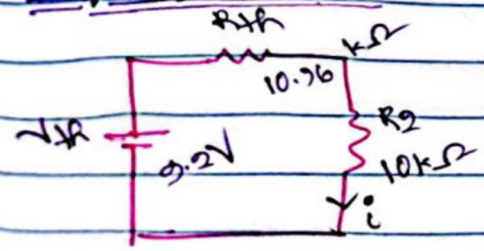
$10 - V_{th} - (1K\Omega \times 0.8mA) = 0$

$10 - (1 \times 0.8) = V_{th}$

$\therefore V_{th} = 9.2V$

10

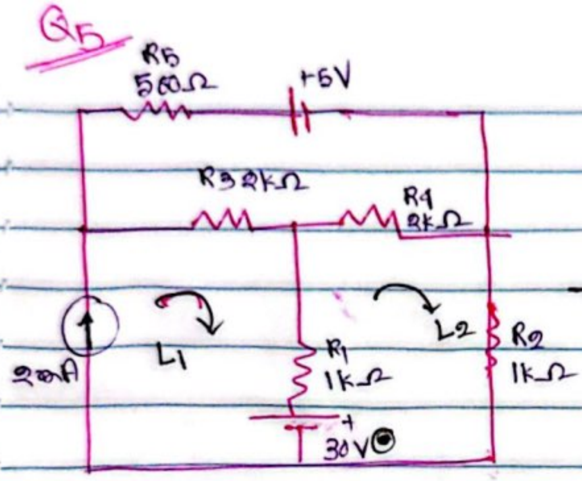
Equivalent Circuit:

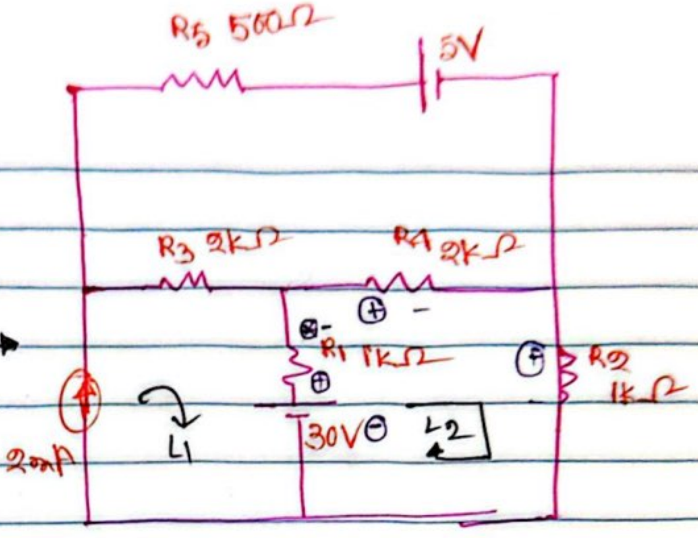


$$\therefore i = \frac{V_{th}}{R_{th}} = \frac{9.2}{(10.96K\Omega + 10K\Omega)} = 0.4389mA$$

$\therefore$ current across R_2 is $0.4389mA$.

Q5





Using mesh analysis, find V_0 across R_2.

Loop1 → $i_1 = 2mA = 0.002A$.

Loop2 applying KVL →

$$-30 + R_1(I_2 - I_1) + R_4(I_2 - I_3) + I_2 R_2 = 0$$

$$-30 + 1k\Omega(I_2 - 0.002) + 2k\Omega(I_2 - I_3) + 1k\Omega I_2 = 0$$

$$-30 + 1000 I_2 - 2 + 2000 I_2 - 2000 I_3 + 1000 I_2 = 0$$

$$4000 I_2 - 2000 I_3 = 32 \longleftarrow (i)$$

Loop 3 applying KVL →

$$5 + R_4(I_3 - I_2) + R_3(I_3 - I_1) + R_5 I_3 = 0$$

$$5 + 2000 I_3 - 2000 I_2 + 2000 I_3 - 2000 I_1 + 500 I_3 = 0$$

$$-2000 I_2 + 4500 I_3 + 1 = 0$$

$$-2000 I_2 + 4500 I_3 = -1 \longleftarrow (ii)$$

Solving (i) & (ii) → $i_2 = 0.0101 A$.

$i_3 = 0.004285 A$

∴ V_0 across $R_2 = i_2 \times R_2$

$= (0.0101 A) \times (1k\Omega)$

$= 10.1428 V.$

∴ V_0 across R_2 is $10.1428V$.

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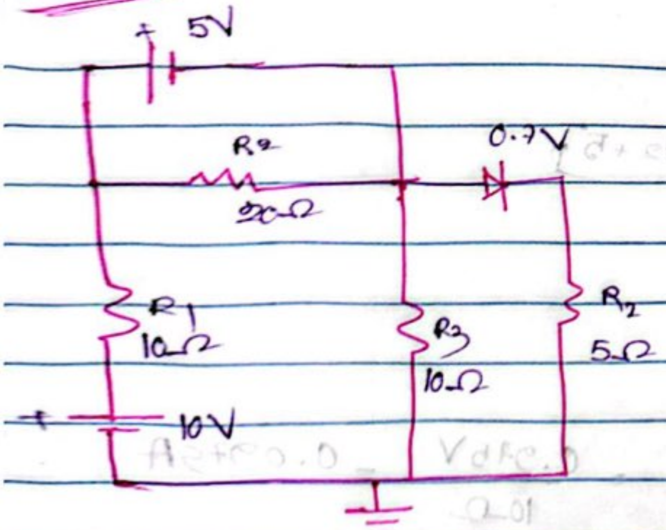
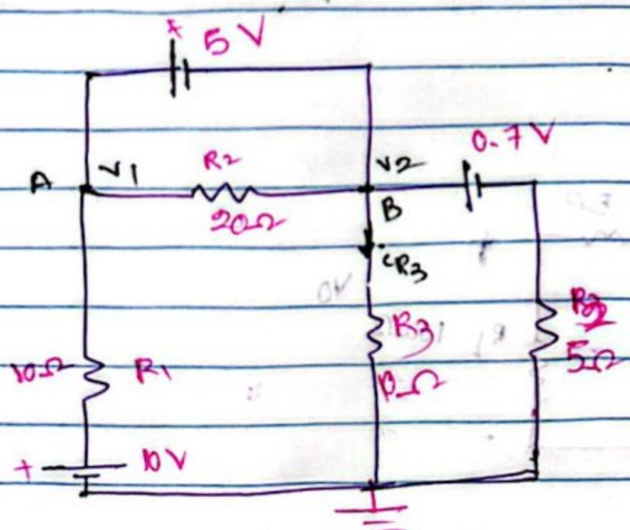
Q6



The built in voltage of diode is 0.7 V. So, replacing the diode with 0.7 V of battery:



Consider the node voltage V_1 & V_2 in the above circuit.

$$\therefore V_1 - 5 = V_2$$

$$\therefore V_1 = V_2 + 5 \quad \text{—(ii)}$$

? −4

Applying Nodal Analysis →

$$\frac{V_1-10}{10} + \frac{V_1-V_2}{20} + \frac{V_2-0}{10} + \frac{V_2-0.7}{5} = 0$$

6

$$\frac{V_1-10}{10} + \frac{V_1-V_2}{20} + \frac{V_2}{10} + \frac{V_2-0.7}{5} = 0$$

Multiply whole equation by 20,

$$2(V_1-10) + V_1 - V_2 + 2V_2 + 4(V_2 - 0.7) = 0$$

$$2V_1 - 20 + V_1 - V_2 + 2V_2 + 4V_2 - 2.8 = 0$$

$3V_1 + 5V_2 = 22.8$ —— (2)

$3(V_2+5) + 5V_2 = 22.8$ [As $V_1 = V_2 + 5$]

$3V_2 + 15 + 5V_2 = 22.8$

$8V_2 = 7.8$

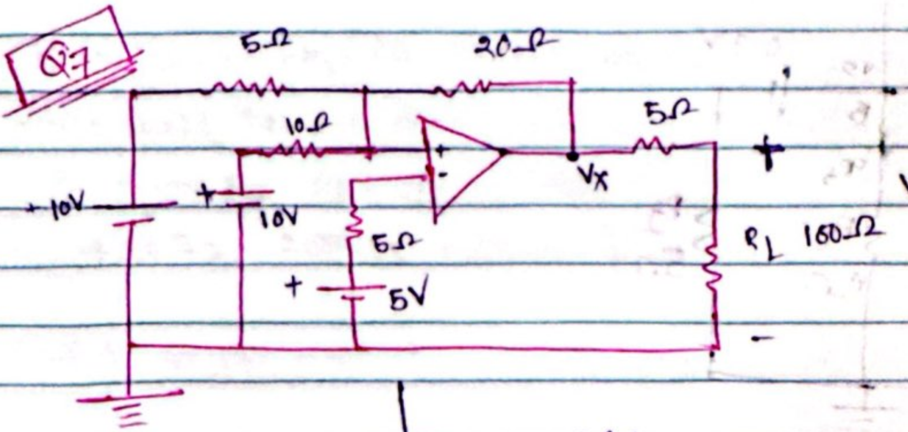
$\therefore V_2 = 0.975V$

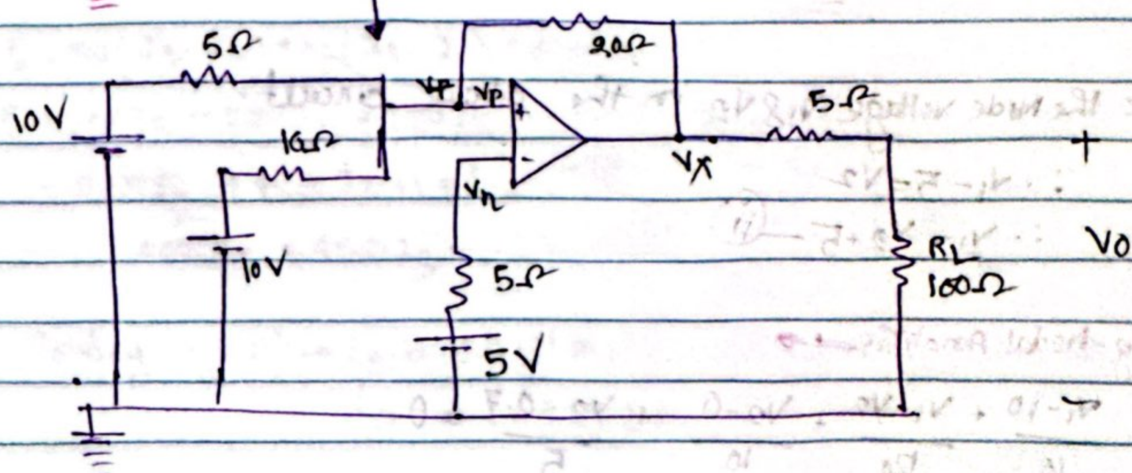
Using Ohm's law,

the current through R_3, $i_{R_3} = \frac{V_2}{R_3} = \frac{0.975V}{10\Omega} = 0.0975A$

$\therefore$ current of R_3 resistor is $0.00975A$ or $97.5mA$

Q7





here Vp & Vn are the voltages of inverting terminal & Non-inverting terminal according to the figure.

So, $V_p = V_n$

$\therefore V_n = 5V$

$\therefore V_p = 5V$

applying KCL at Vp →

$$\frac{Vp-10}{5} + \frac{Vp-10}{10} + \frac{Vp-Vx}{20} = 0$$

$$\frac{5-10}{5} + \frac{5-10}{10} + \frac{5-Vx}{20} = 0$$

$$-1 + \left(\frac{-1}{2}\right) + \frac{5-Vx}{20} = 0$$

$$\frac{-3}{2} + \frac{5-Vx}{20} = 0$$

$$\frac{5-Vx}{20} = \frac{3}{2}$$

$$2(5-Vx) = 60$$

$$5-Vx = 30$$

$$Vx = -25V$$

By Voltage Divider Rule, the voltage across R_L is given by,

$$Vo = \left(\frac{R_L}{5+R_L}\right) \times Vx$$

$$= \frac{(100) \times -25}{(5+100)}$$

$$Vo = \frac{-2500}{105}$$

$$\therefore Vo = -23.8095V.$$

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