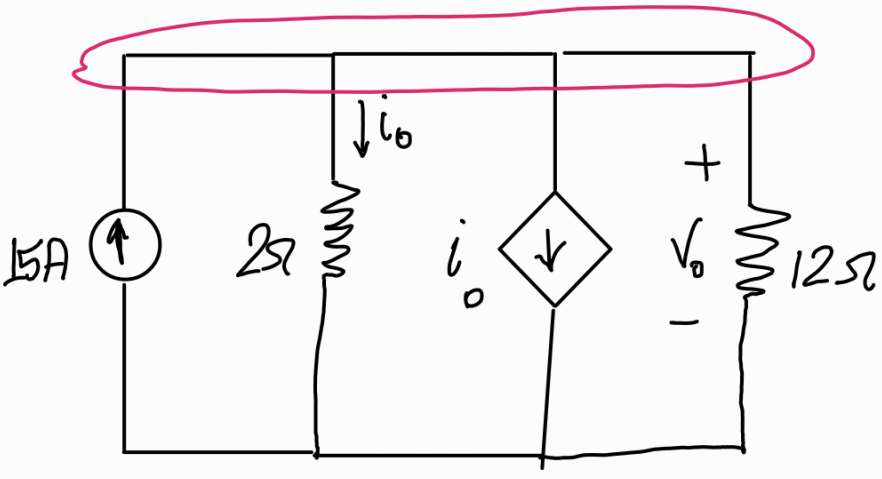
Problem 1



Determine V_o & i_o

KCL —

$$15 - i_o - i_o - \frac{V_o}{12} = 0$$

$$\Rightarrow 15 = 2i_o + \frac{V_o}{12} \quad \text{— (i)}$$

Since the ckt is a parallel ckt, voltage drop across the 2Ω resistor = V_o

$$\therefore i_o = \frac{V_o}{2} \quad \text{— (ii)}$$

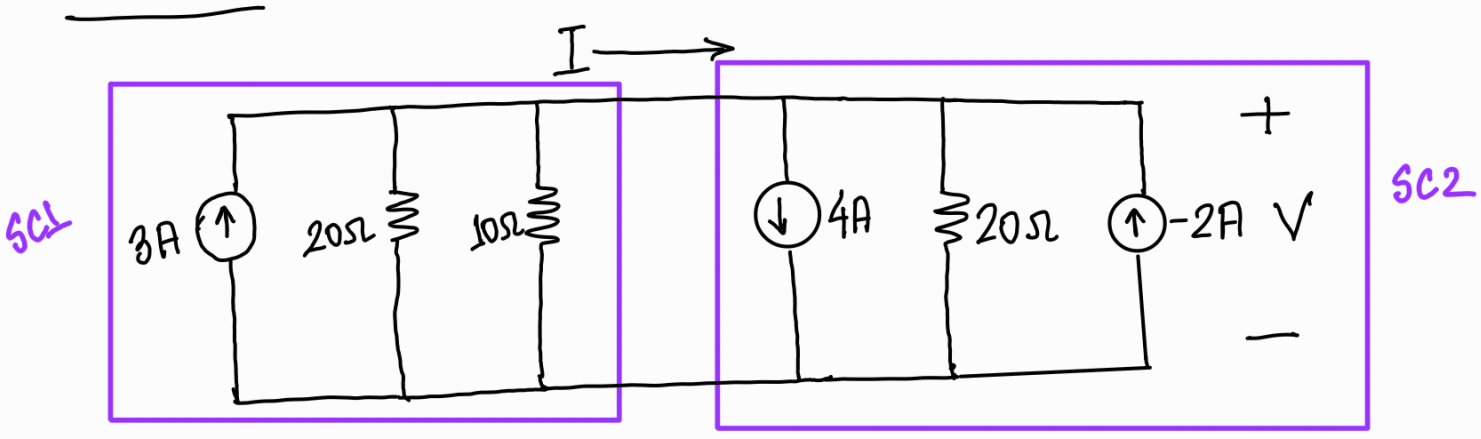
$$\therefore \text{(i)} \Rightarrow 15 = 2i_o + \frac{i_o}{6}$$

$$\Rightarrow 90 = 13\, i_o$$

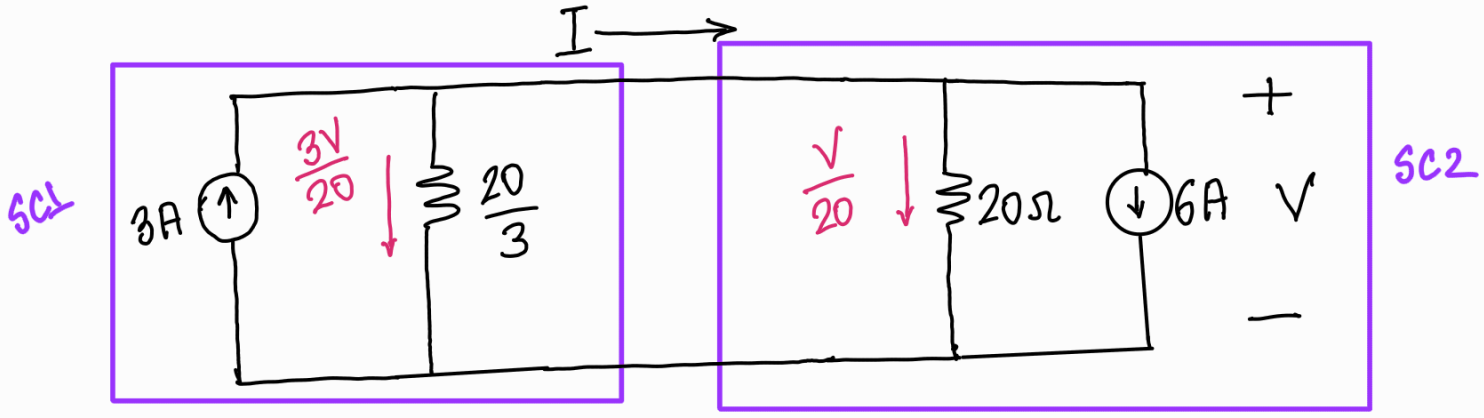
$$\Rightarrow i_o = \frac{90}{13}\,A = 6.923\,A$$

$$\therefore \text{(ii)} \Rightarrow V_o = 2i_o = 13.846\,V$$

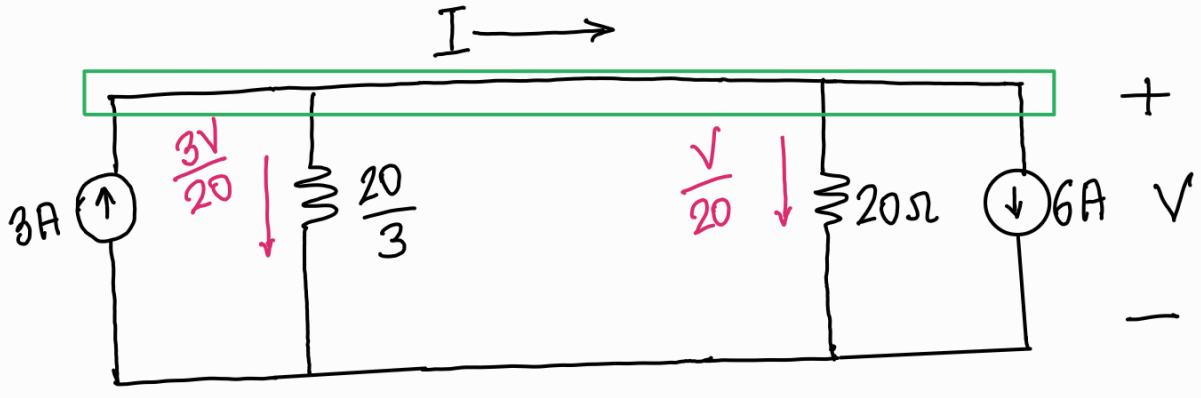
Problem 2



Find I & V



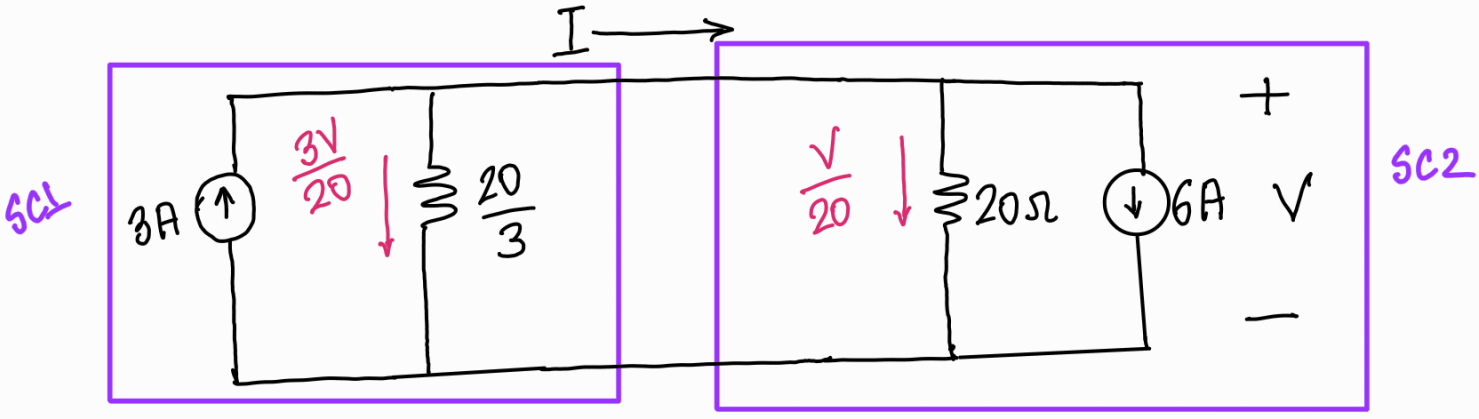
Direction placed according to passive sign convention.



KCL — $3 - \frac{3V}{20} - \frac{V}{20} - 6 = 0$

$\Rightarrow -3 = \frac{V}{5}$

$\Rightarrow V = -15V$



From the perspective of SC1—

$$3 - \frac{3V}{20} = I$$

$$\Rightarrow 3 - \frac{3\times(-15)}{20} = I$$

$$\Rightarrow I = 3 + \frac{9}{4}$$

$$= 5.25\,A$$

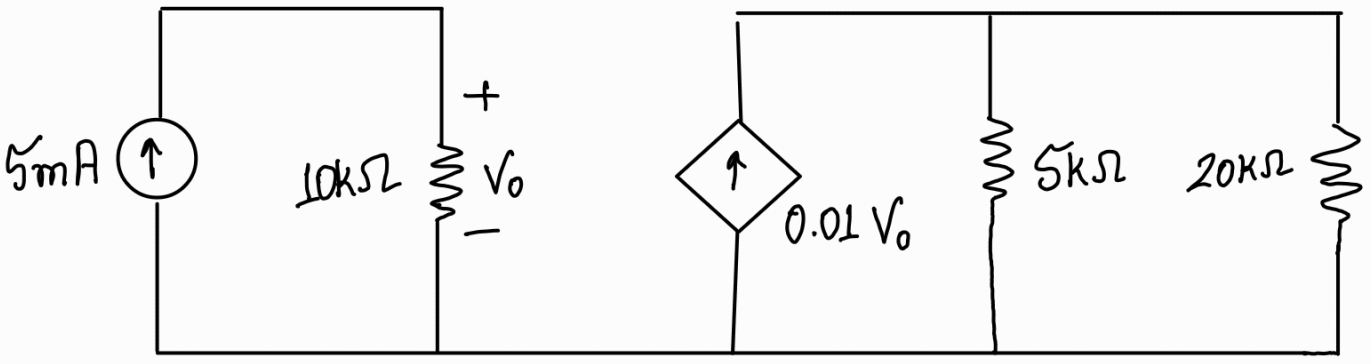
From the perspective of SC2—

$$I = \frac{V}{20} + 6$$

$$= \frac{-15}{20} + 6$$

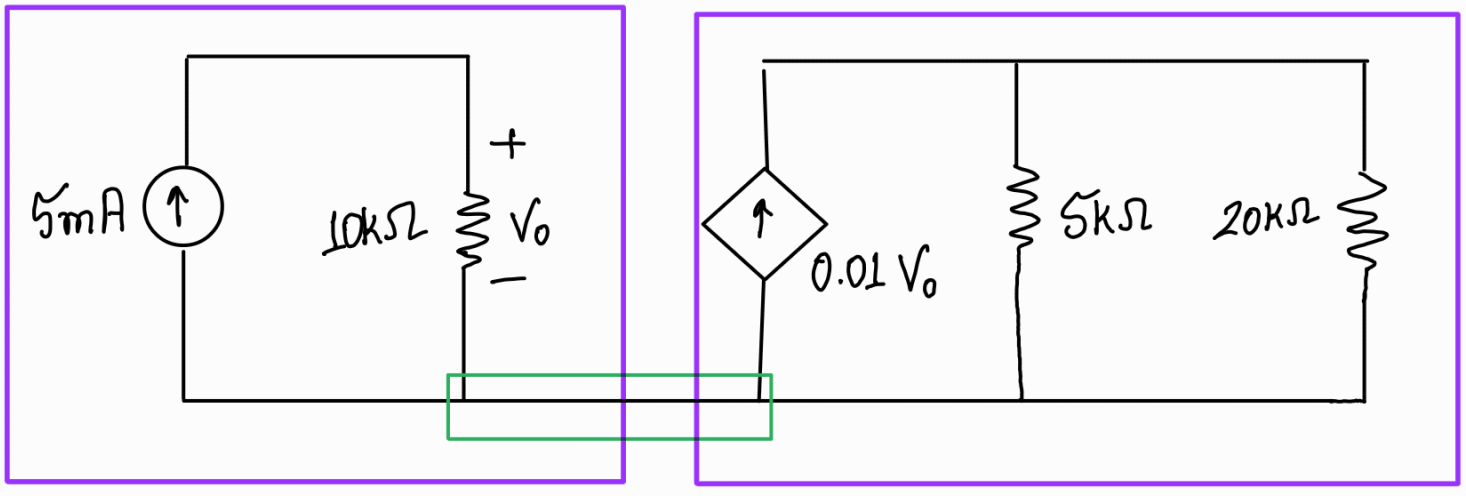
$$= 5.25\,A$$

Problem 3



Find current, voltage and power associated with 20kΩ resistor

These type of circuits are special.



Primary circuit

Secondary circuit

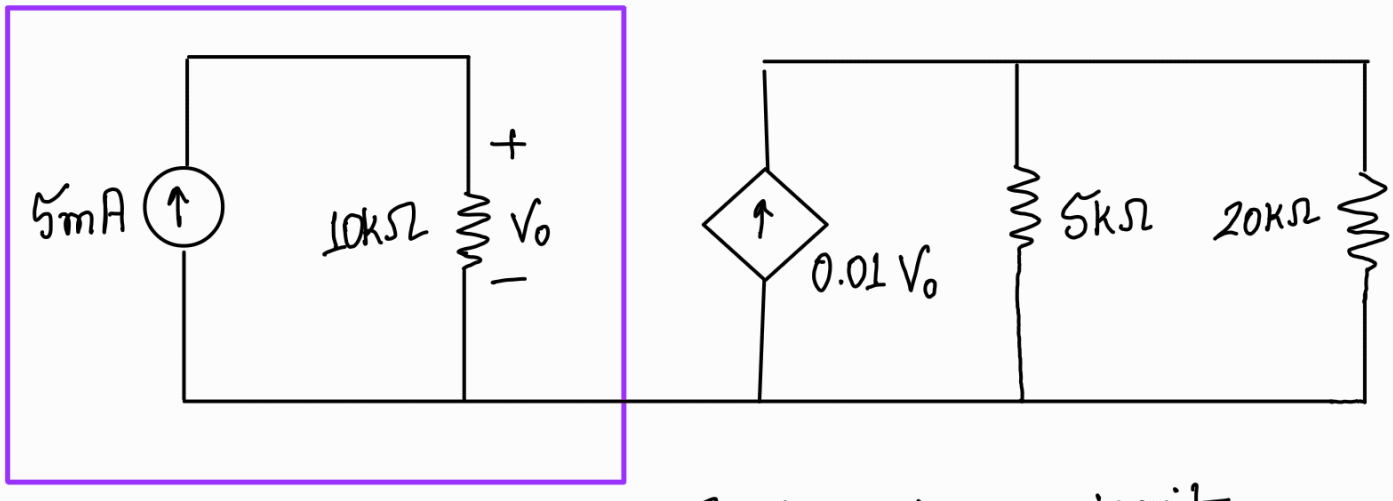
The primary circuit controls the state of the secondary circuit by propagating some parameters. The propagation is done indirectly.

No current passes directly through the green wire. That means primary circuit and secondary circuits are electrically isolated. The wire is placed to represent that there is a functional

dependency of the secondary side on the primary side.

You will learn more about the implementation of such circuits in CSE251 (through op-amps)

Lets solve the problem now —

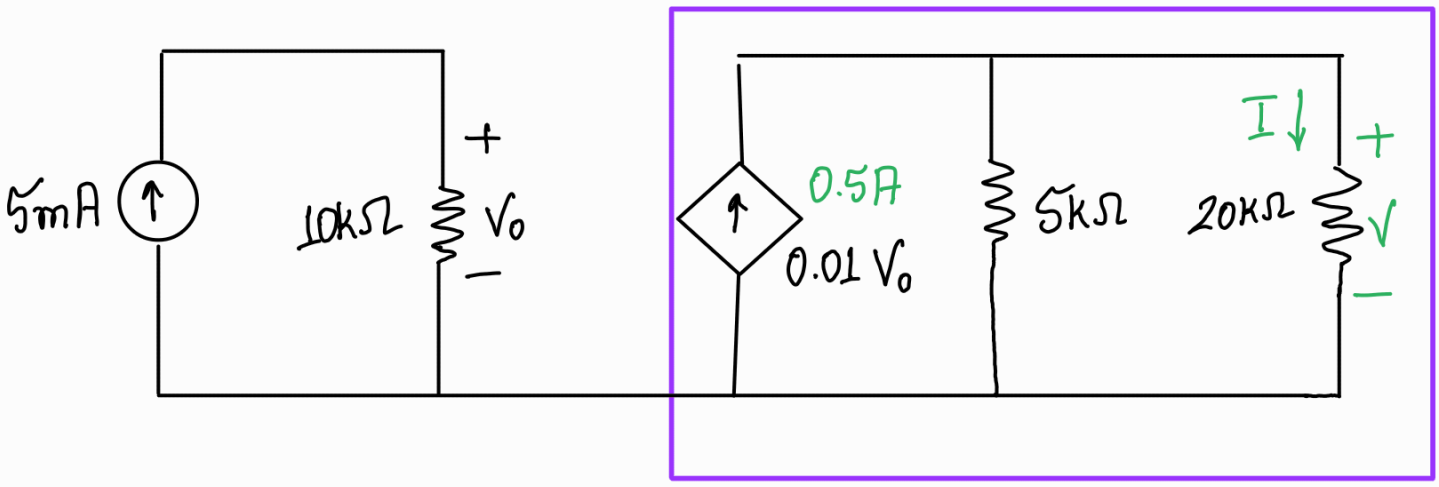


Primary circuit

In the primary circuit

$$V_o = \underbrace{5\times10^{-3}}_{I} \times \underbrace{10\times10^{3}}_{R}\ V$$

$$= 50\ V$$



Secondary circuit

$\therefore V_o = 50\ V$

$\therefore$ in secondary circuit $0.01\,V_o = 0.5\ A$

$$I = \frac{5K \,||\, 20K}{20K} \times 0.5\ A \quad [\text{current divider}]$$

$$= \frac{4K}{20K} \times 0.5\ A$$

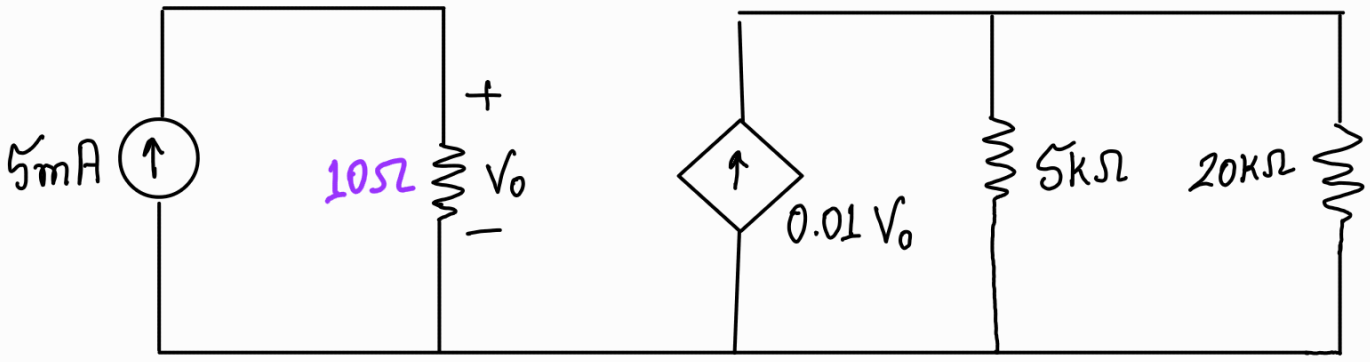
$$= 0.1\ A$$

$$\therefore V = 0.1 \times 20 \times 10^3 = 2\ KV$$

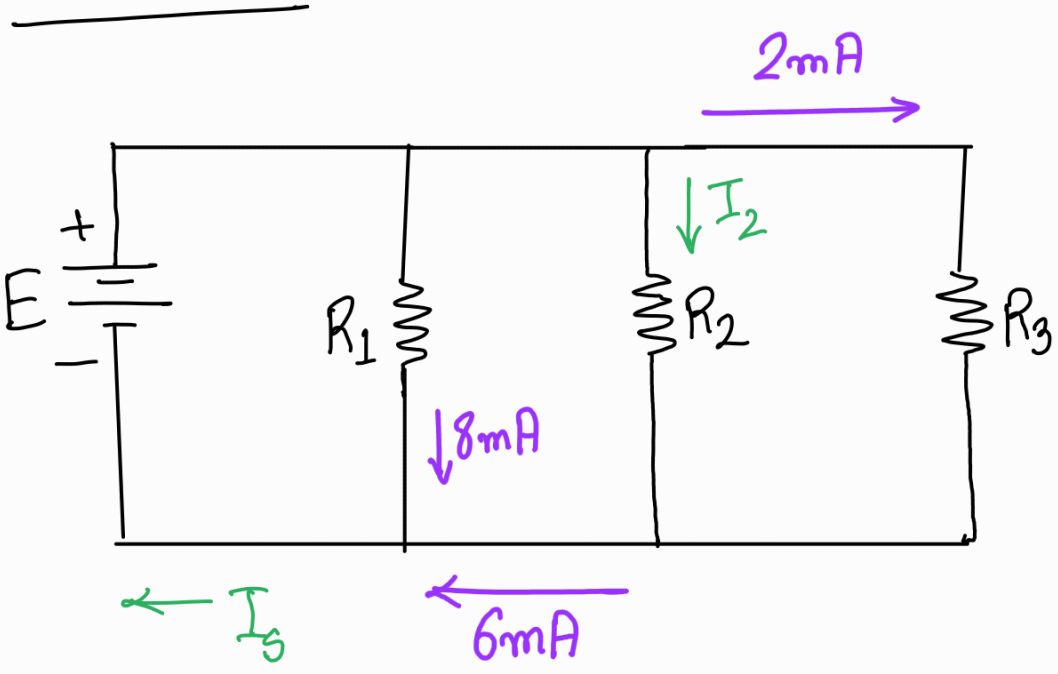
and power associated with the resistor $= \overbrace{0.1}^{I} \times \overbrace{2K}^{V}\ W$

$$= 200\ W$$

You will see that the answer doesn't match because there is a mistake in the question. The correct question will be—

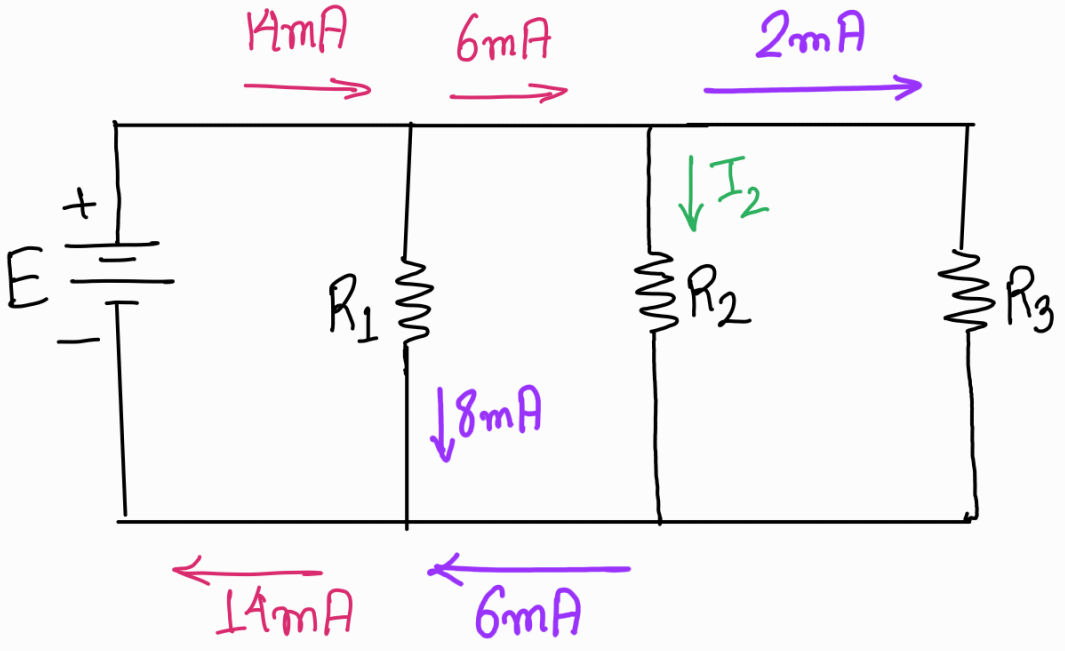


Problem 4



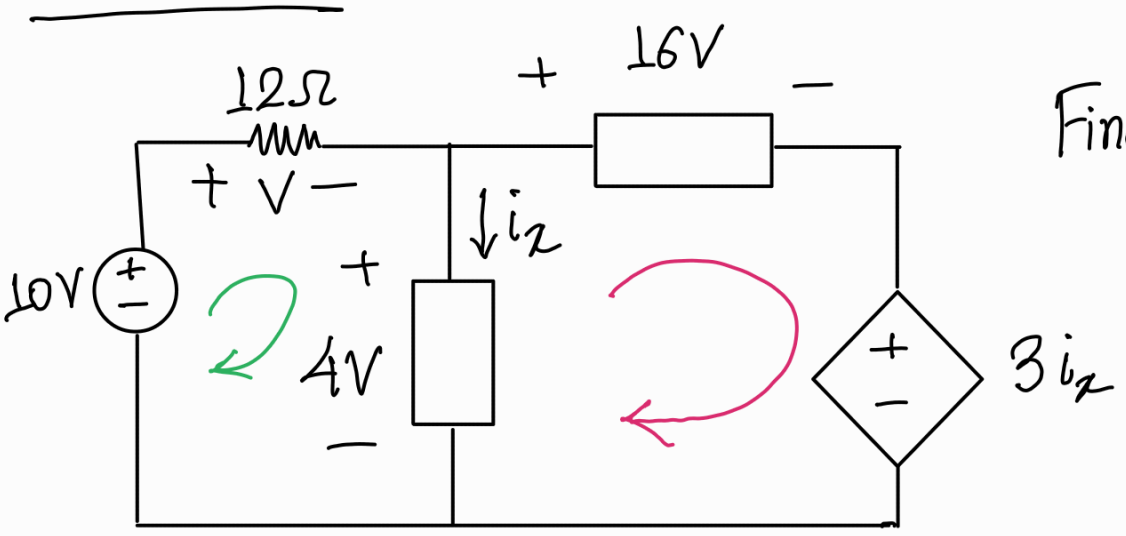
Find I_s & I_2 using KCL

$$I_s = 8mA + 6mA = 14mA$$



$$I_2 = 6 - 2\ mA$$
$$= 4\ mA$$

Problem 5



Find V and i_x

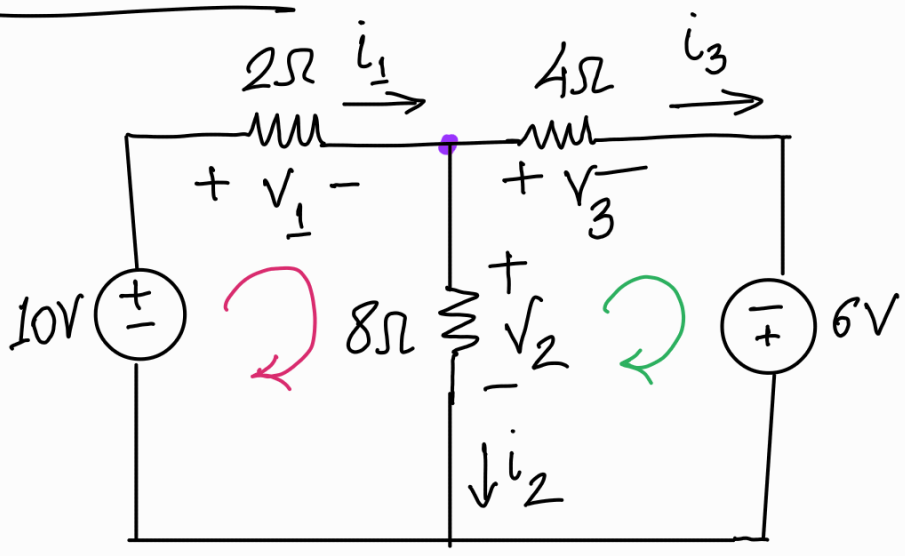
KVL $\rightarrow 16 + 3i_x - 4 = 0$

$\Rightarrow i_x = -4\,A$

KVL $\rightarrow \quad -10 + V + 4 = 0$

$\Rightarrow V = 6V$

Problem 6



KVL → $-10 + V_1 + V_2 = 0$

$\Rightarrow V_1 + V_2 = 10$ — (i)

KVL → $-V_2 + V_3 - 6 = 0$

$\Rightarrow -V_2 + V_3 = 6$ — (ii)

KCL → $i_1 = i_2 + i_3$

$\Rightarrow \frac{V_1}{2} = \frac{V_2}{8} + \frac{V_3}{4}$

$\Rightarrow 4V_1 - V_2 - 2V_3 = 0$ — (iii)

$\therefore V_1 = 6V$

$V_2 = 4V$

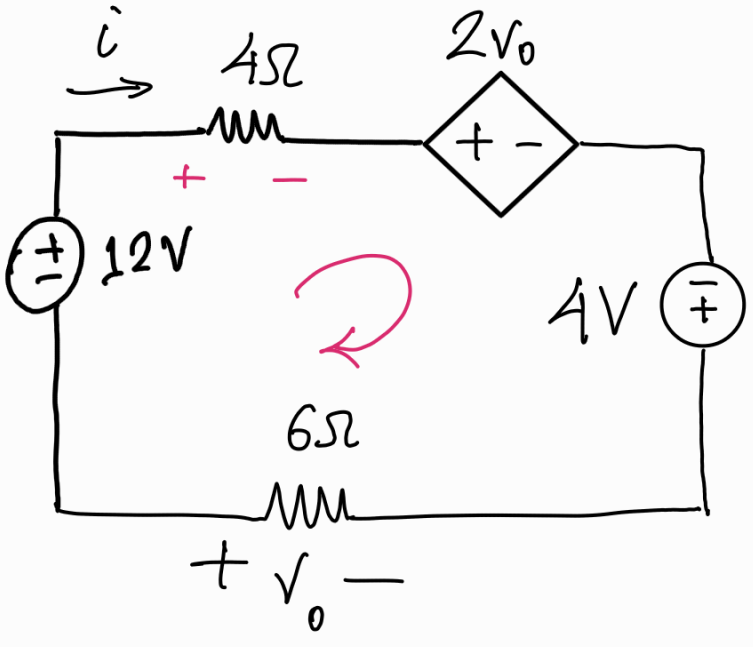
$V_3 = 10V$

$i_1 = \frac{V_1}{2} = 3A$

$i_2 = \frac{V_2}{8} = 0.5A$

$i_3 = \frac{V_3}{4} = 2.5A$

Problem 7



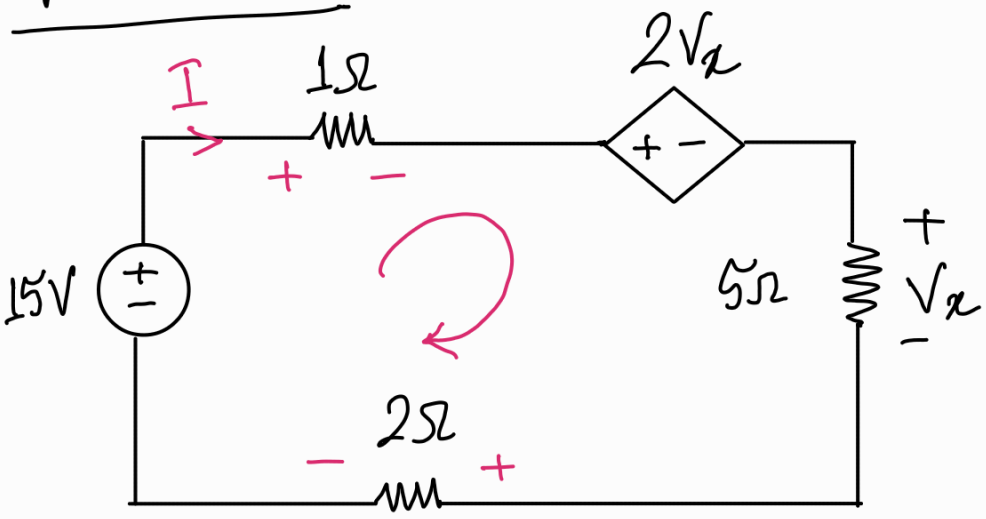
KVL $\Rightarrow -12 + 4i + 2V_0 - 4 - V_0 = 0$

$\Rightarrow 4i + V_0 = 16$ ——— (i)

$V_0 = -6i$ ——— (ii)

$\therefore$ (i) $\rightarrow$ $i = -8A$ and (ii) $\rightarrow$ $V_0 = 48V$

Problem 8



KVL $\Rightarrow -15 + I + 2V_x + V_x + 2I = 0$

$\Rightarrow 3V_x + 3I = 15$

$\Rightarrow V_x + I = 5$ ——— (i)

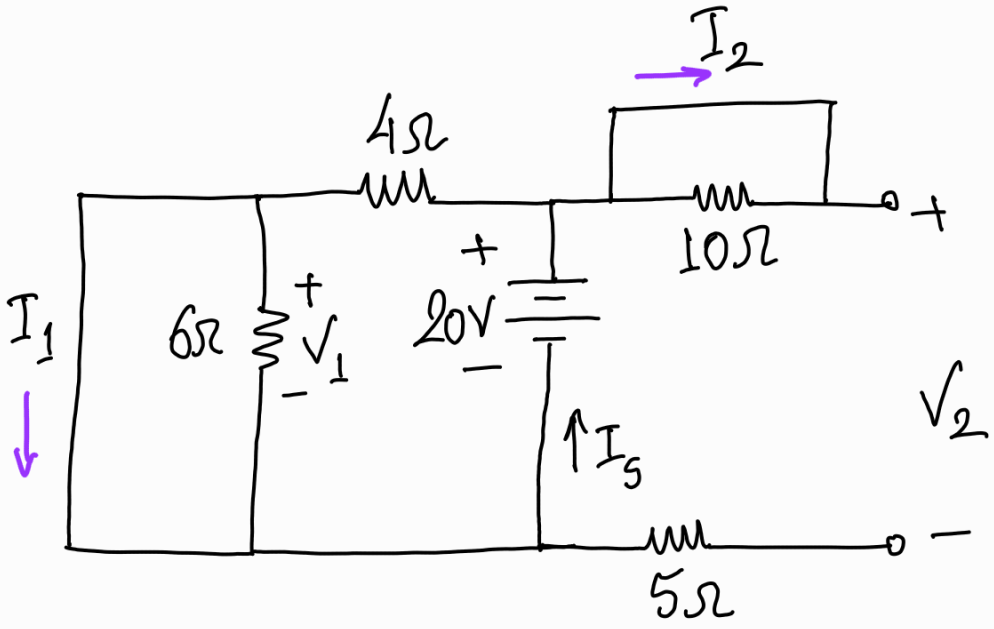
here, $5I = V_x \Rightarrow I = \frac{V_x}{5}$

$\therefore$ (i) $\Rightarrow V_x + \frac{V_x}{5} = 5$

$\Rightarrow 6V_x = 25$

$\Rightarrow V_x = 4.167\ V$

Problem 9



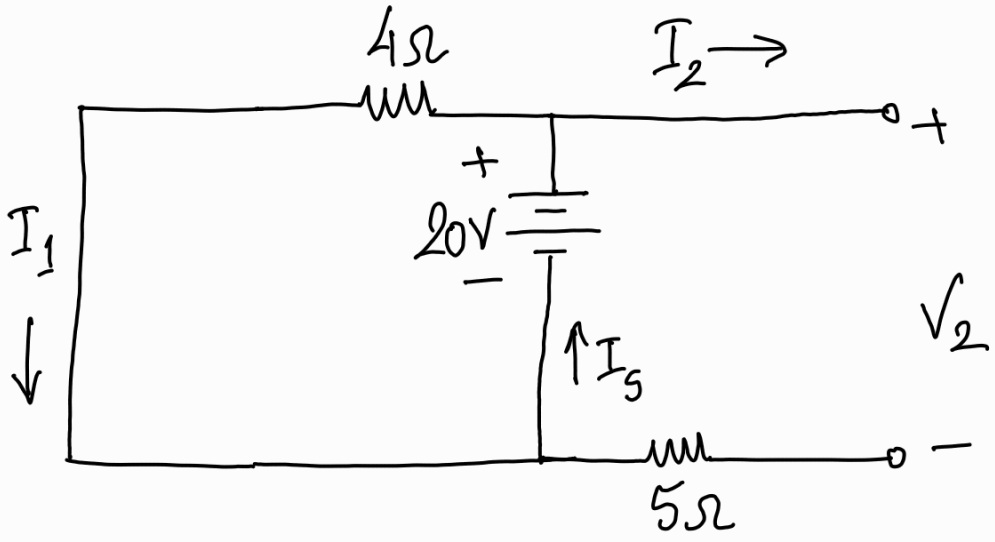
purple represents missing arrows

(a) Determine I_1 & I_2

(b) Find V_1 & V_2

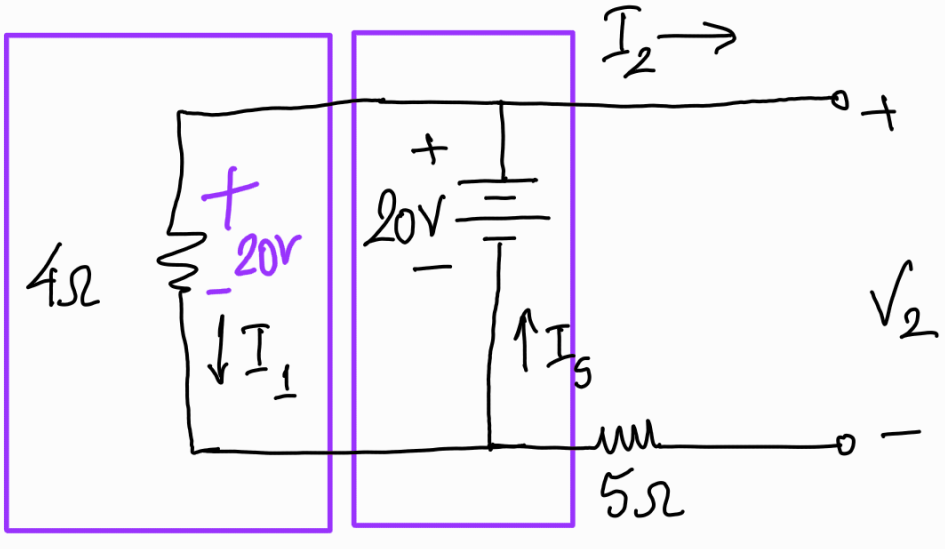
(c) Find I_5

Lets find I_1 and I_2 at first. Lets simplify the circuit a little.



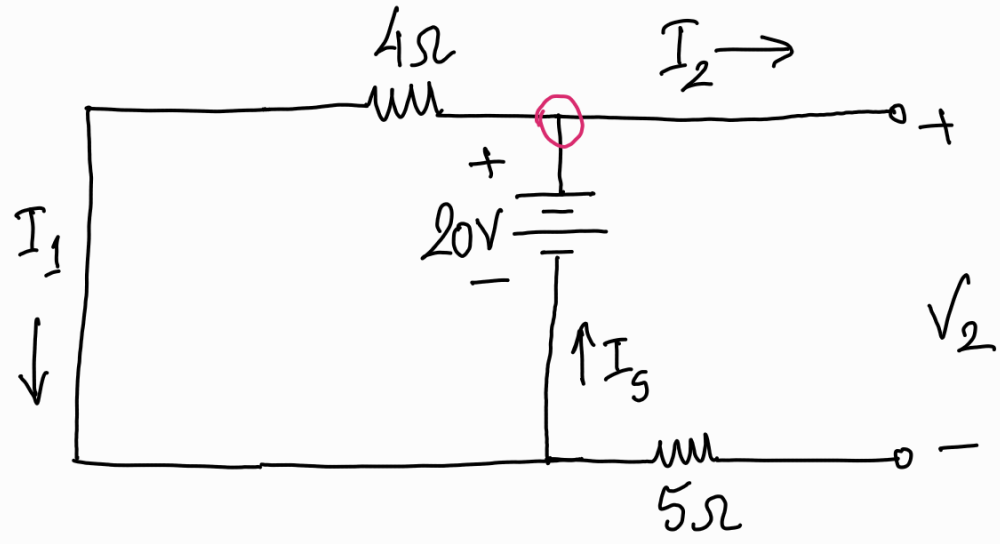
Here, $I_2 = 0A$ because the right side ckt is open.

and $I_1 = \frac{20}{4} A = 5A$. Why? Lets redraw the left side a bit



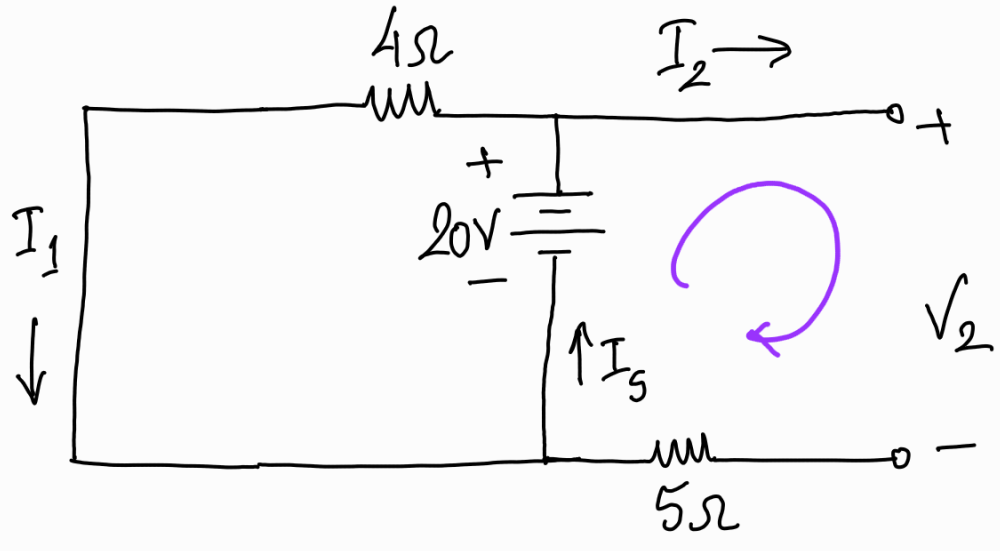
parallel branches

We can find I_s now.



KCL → $I_5 = I_1 + I_2 = 5A$

Now lets find V_2

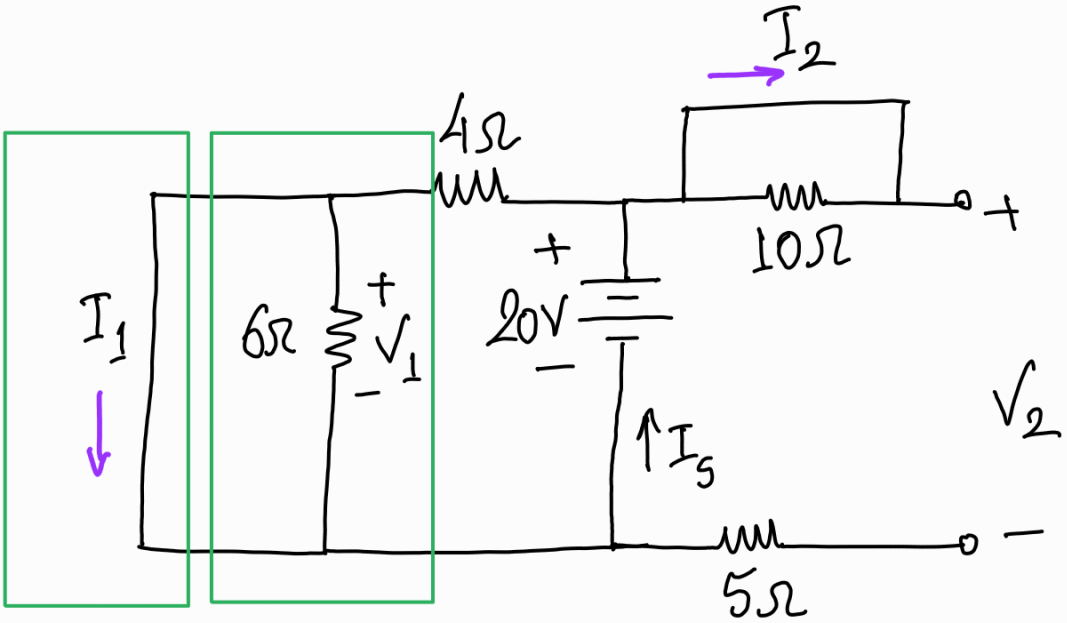


0 ← open ckt

KVL ⇒ $-20 + V_2 + I \times 5 = 0$

$\therefore V_2 = 20V$

All we are left with is V_1. Lets look at the original ckt ——



parallel branches

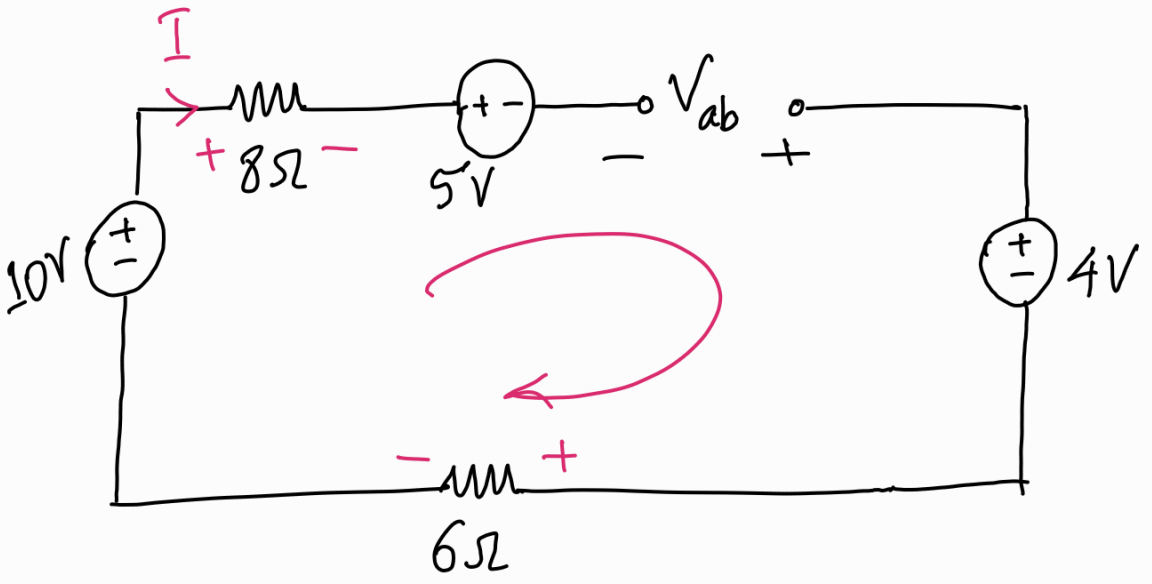
Voltage drop across a short ckt is always 0V

$\therefore V_1 = 0V$

you can also think of this from the perspective of $V = IR$. Since the 6Ω resistor is parallel to a short ckt, all current will flow through the short ckt and current through the 6Ω resistor = 0A

So, $V_{6\Omega} = I_{6\Omega} \times 6 = 0 \times 6 = 0V$

Problem 10



Find V_{ab}

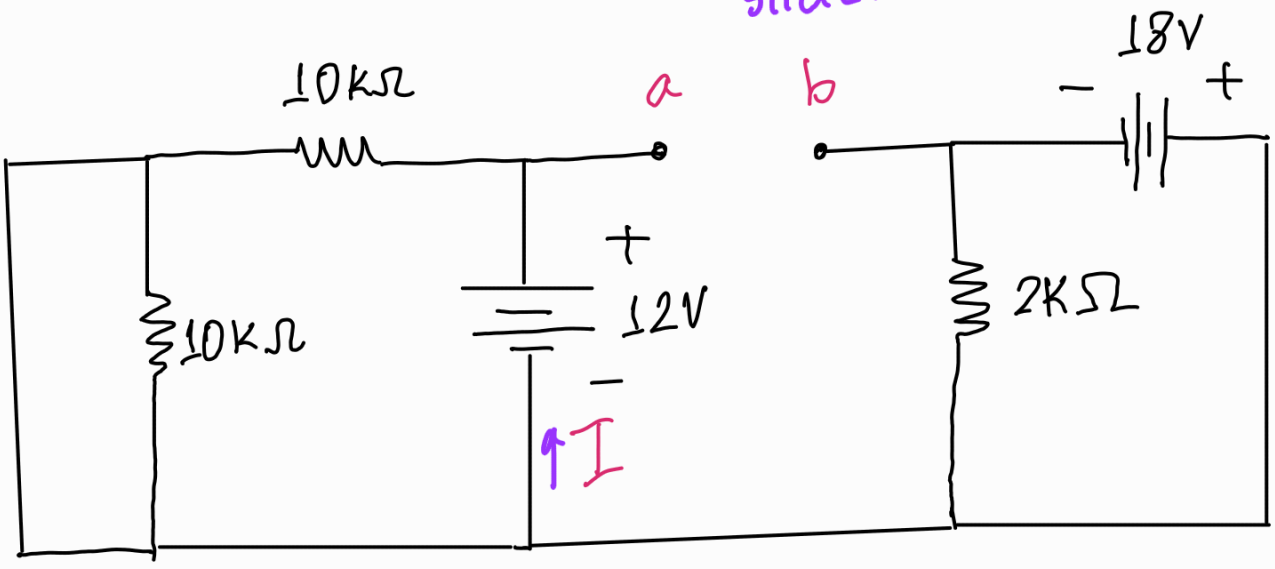
$$-10 + 8I + 5 - V_{ab} + 4 + 6I = 0$$

BUT, $I = 0$ since open ckt.

$$\Rightarrow V_{ab} = -1\,V$$

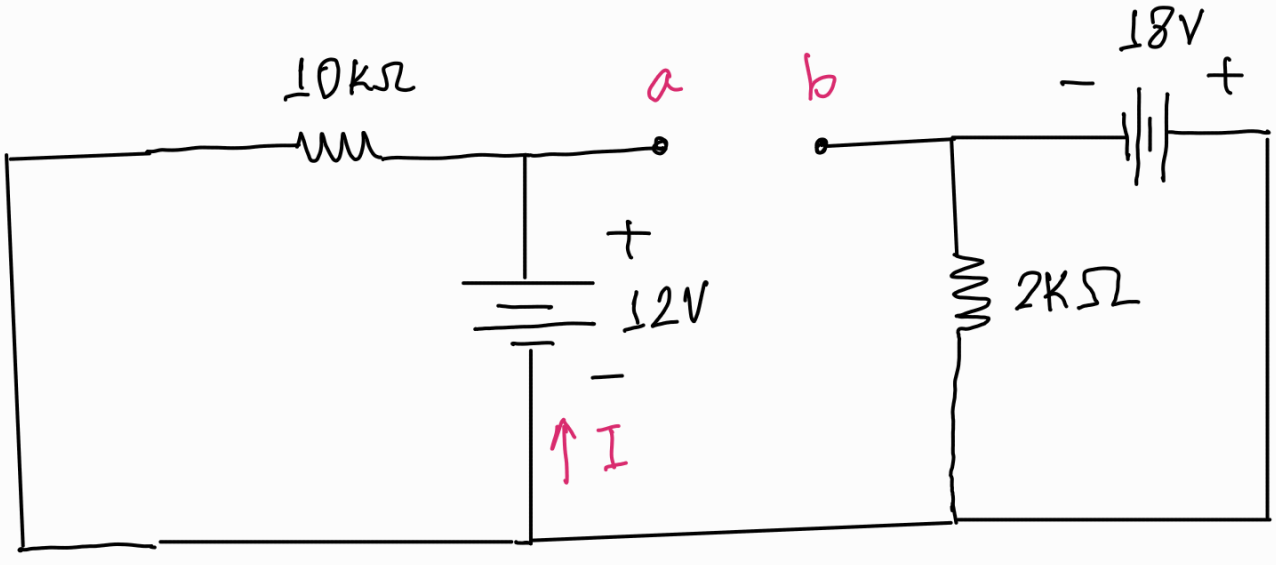
Problem 11

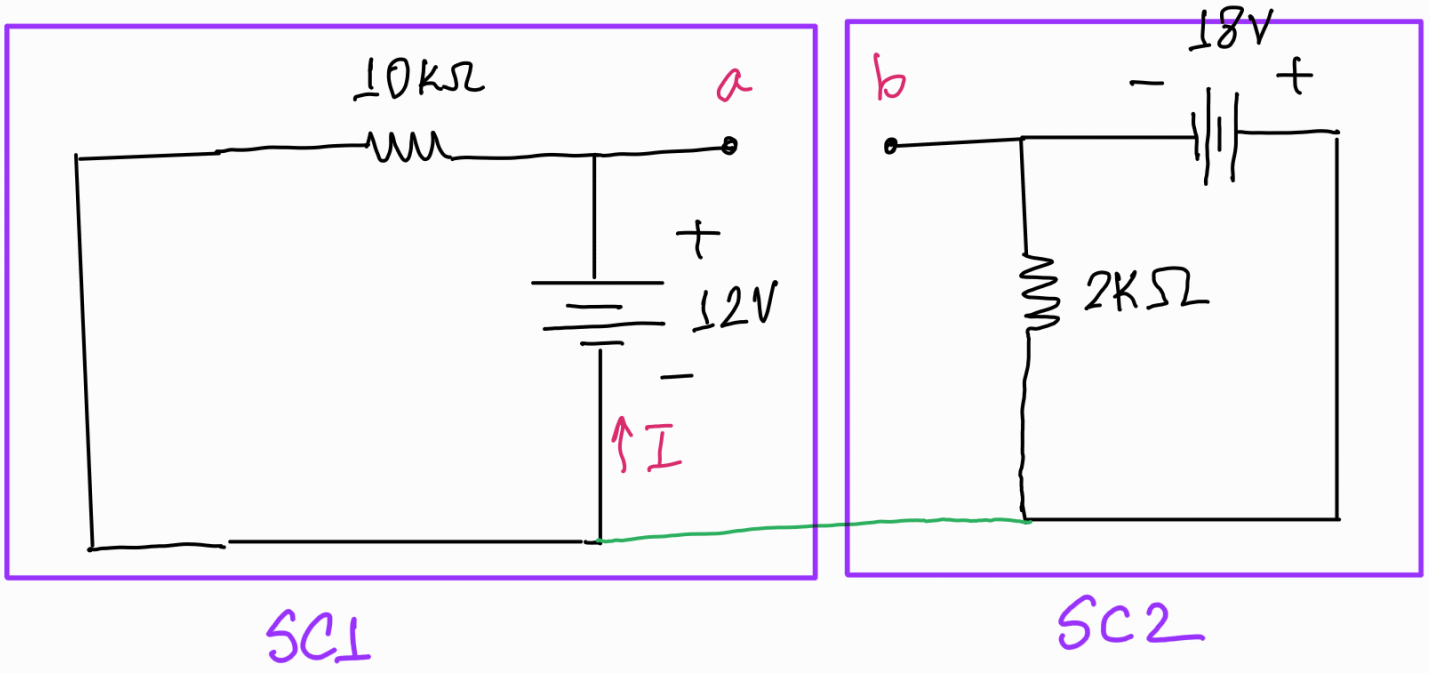
Purple direction missing in slide.



Find V_{ab} and I.

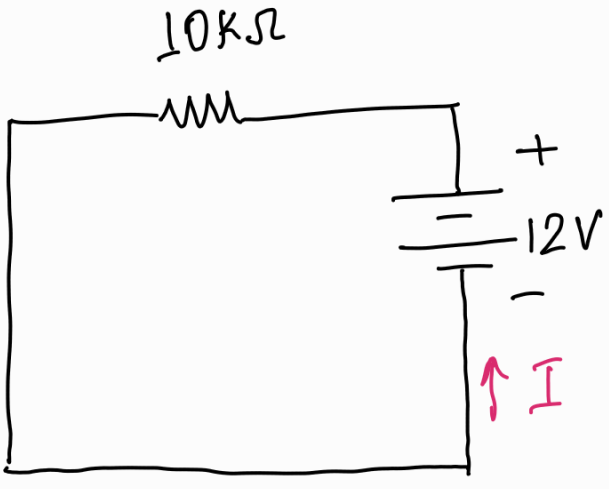
At first lets simplify the ckt ——





Here SC1 & SC2 are connected using only wire. This means there will be no current flowing through the green wire.

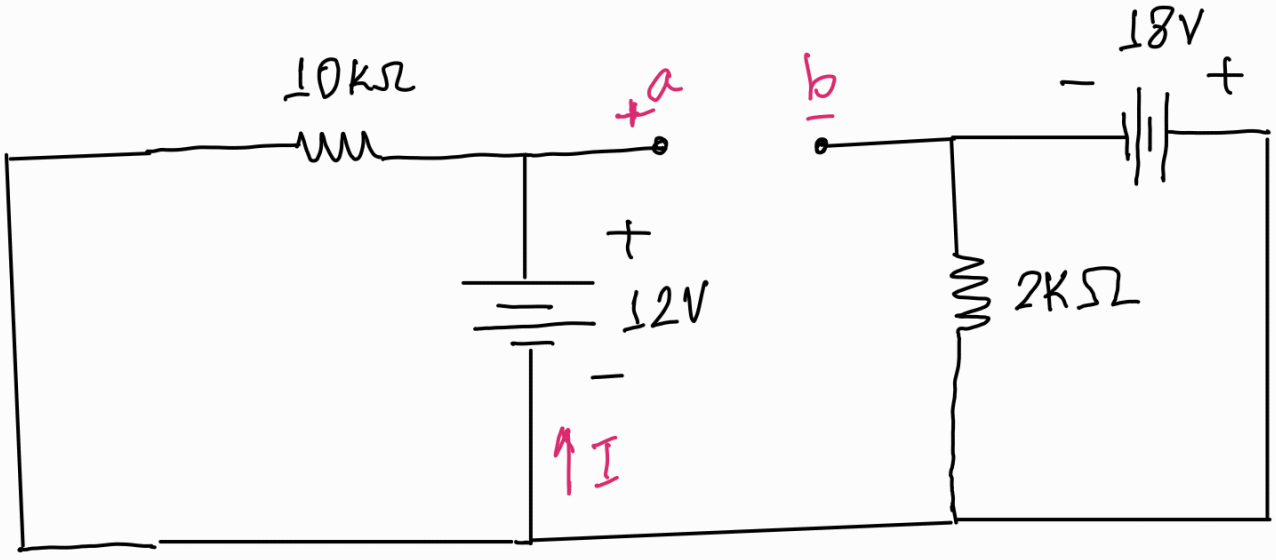
Lets take SC1 only —



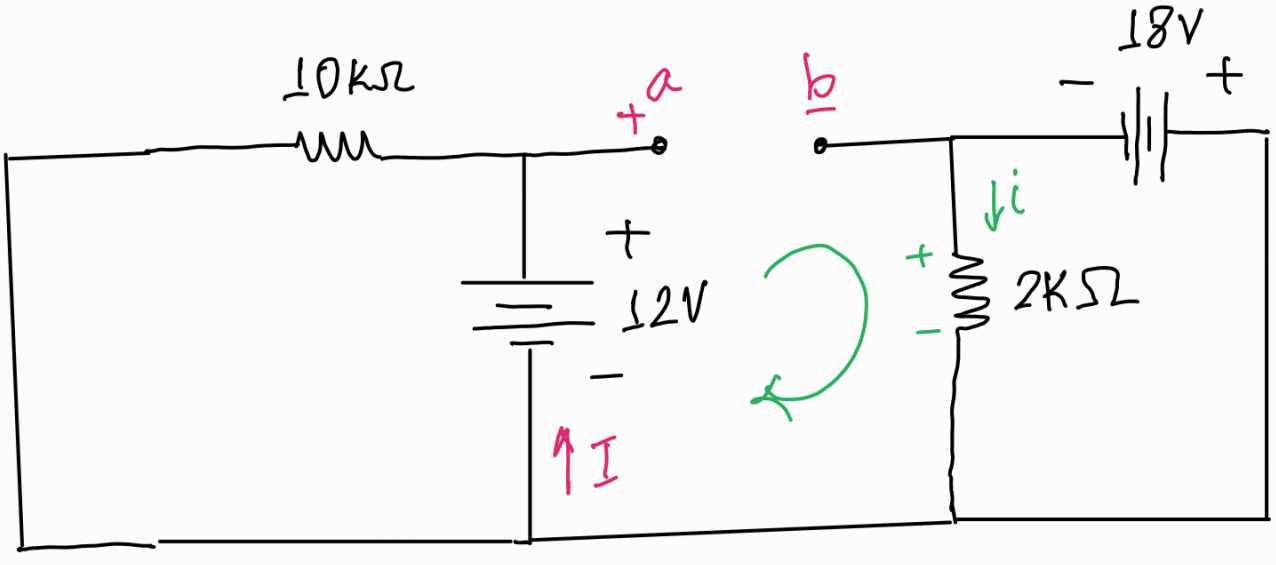
$I = \frac{12}{10}\ mA$

$= 1.2\ mA$

Now lets get back to the complete circuit and solve for V_{ab}



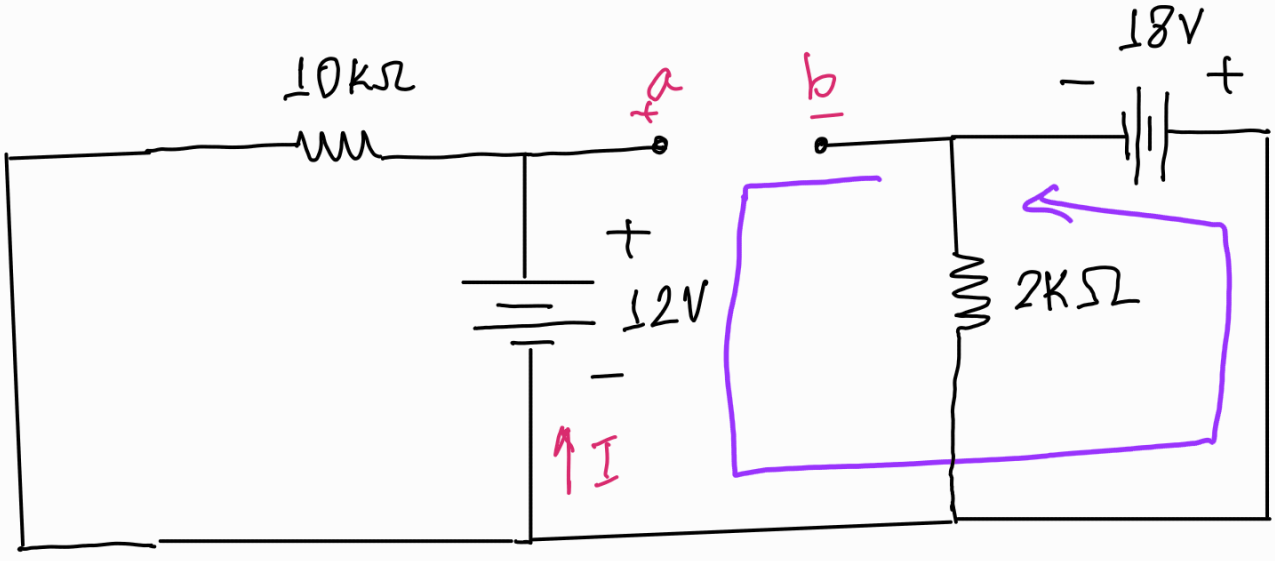
Now the problem is which loop do we consider? Lets take the most obvious loop and see where it leads us.



$$-12 + V_{ab} + i \times 2K = 0$$

Here we do not know the value of i and so we cannot solve for V_{ab}.

Takeaway — Take a loop where you know the voltage values



$$\text{KVL} \Rightarrow +12 + 18 - V_{ab} = 0$$

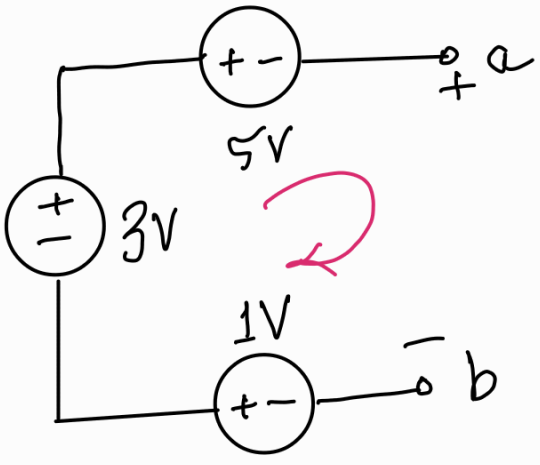
$$\Rightarrow V_{ab} = 30\,V$$

In the previous equation you could have obviously solved for i & then proceeded to find V_{ab}, but why do one extra unnecessary step?

Problem 12

Find V_{ab} for all configurations –

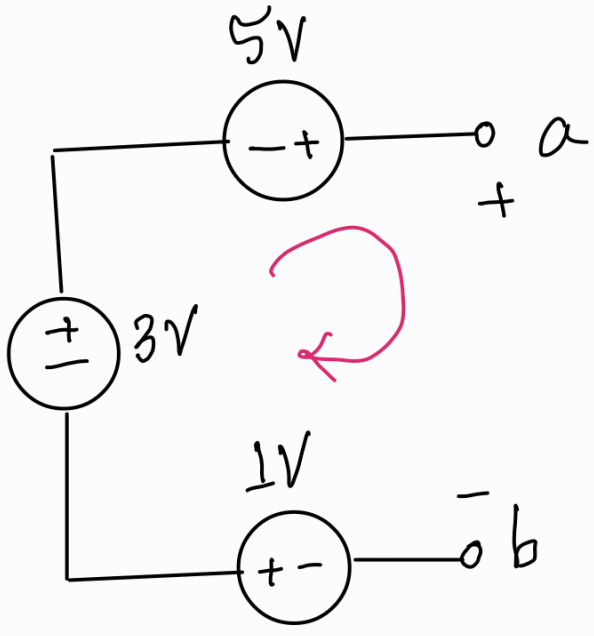
(a)



$V_{ab} - 1 - 3 + 5 = 0$

$\Rightarrow V_{ab} = -1V$

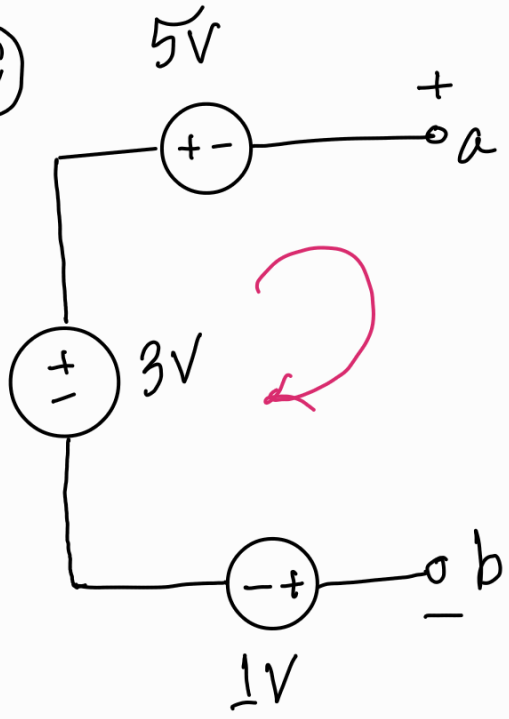
(b)



$V_{ab} - 1 - 3 - 5 = 0$

$\Rightarrow V_{ab} = 9V$ (mistake in slide)

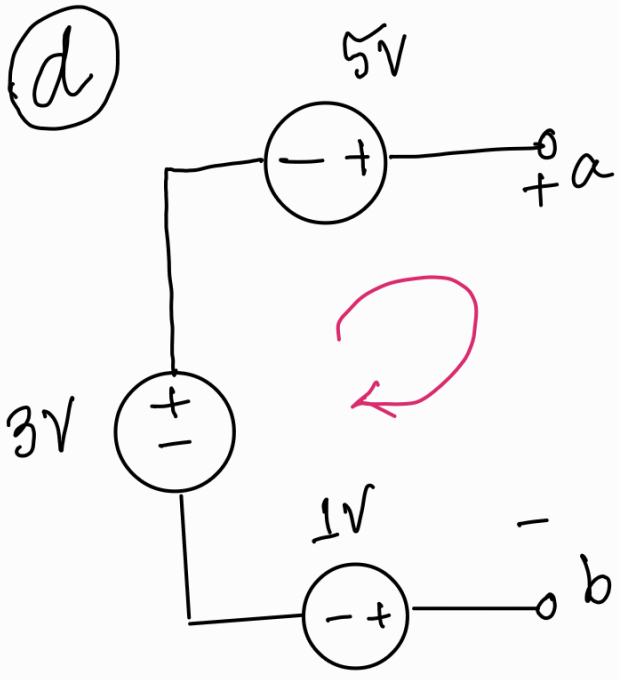
(c)



$V_{ab} + 1 - 3 + 5 = 0$

$\Rightarrow V_{ab} = -3V$

(d)

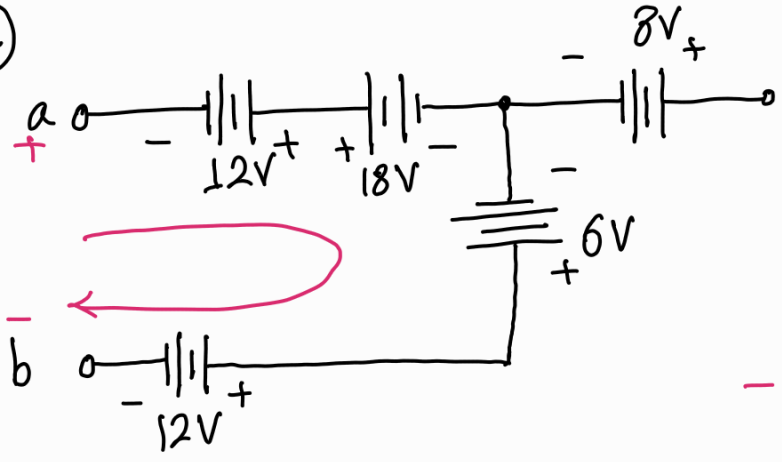


$V_{ab} + 1 - 3 - 5 = 0$

$\Rightarrow V_{ab} = 7V$

Problem 13

(a)

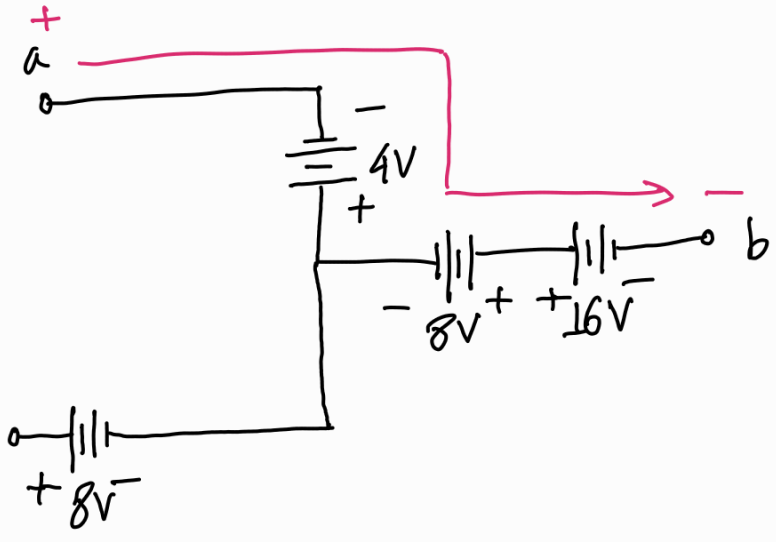


Find V_{ab}

$$-12+18-6+12-V_{ab}=0$$

$$\Rightarrow V_{ab}=12V$$

(b)



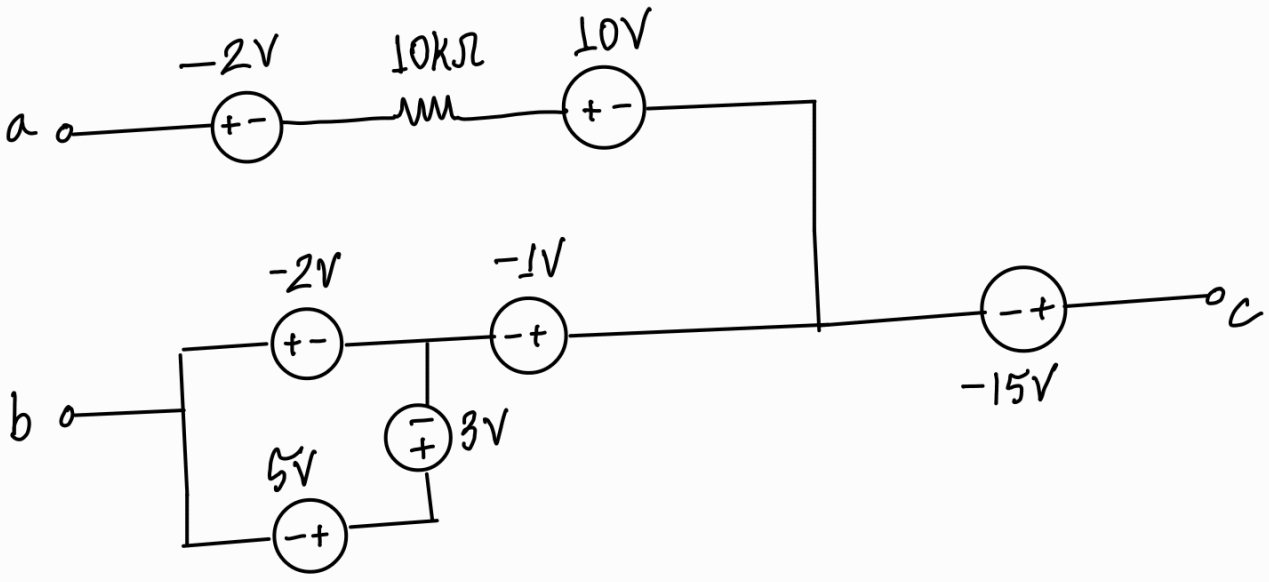
Find V_{ab}

$$-4-8+16-V_{ab}=0$$

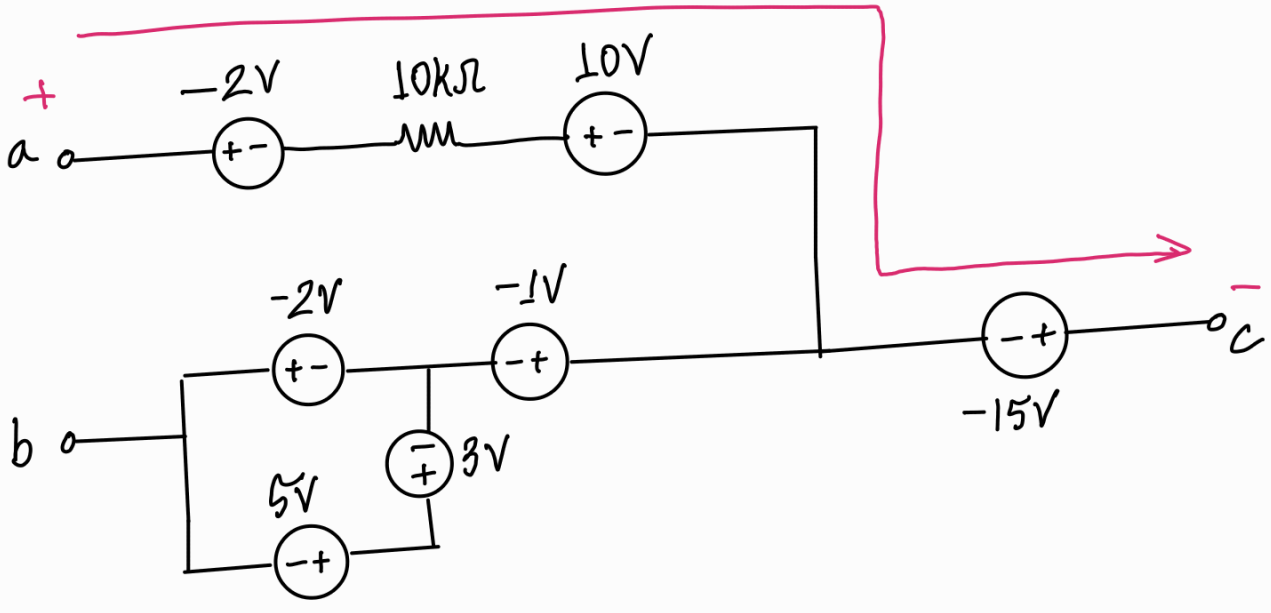
$$\Rightarrow V_{ab}=4V$$

Problem 14

Find V_{ac} & V_{bc}



For V_{ac} —

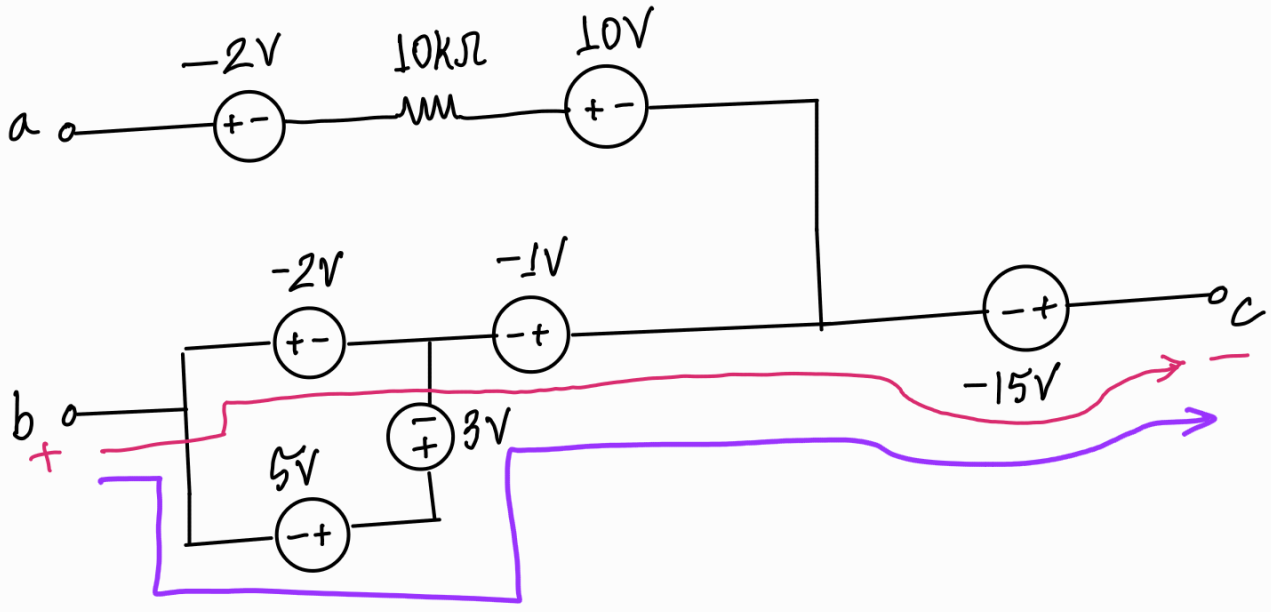


$$-2 + I \times 10K + 10 - (-15) - V_{ac} = 0$$

$$\Rightarrow V_{ac} = 23 + I \times 10K$$

but here $I = 0A$ since open ckt $\therefore V_{ac} = 23V$

For V_{bc} —

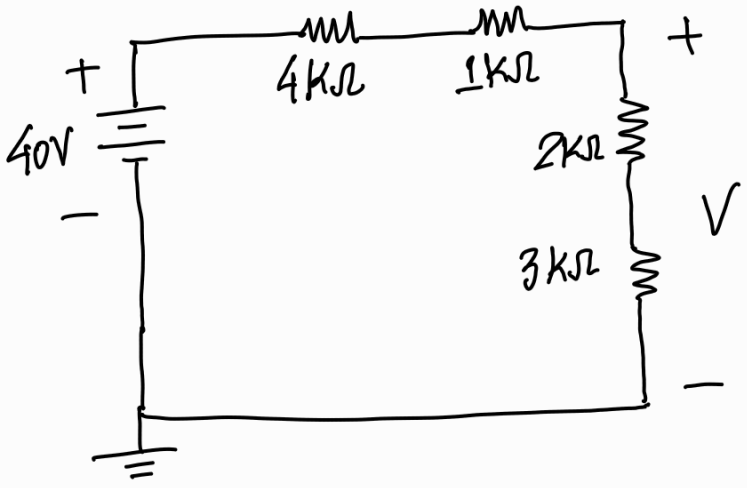


$-2+1+15 = V_{bc}$

$\Rightarrow V_{bc} = 14V$

KVL is path invariant and so taking the purple path would have given the same result.

Problem 15



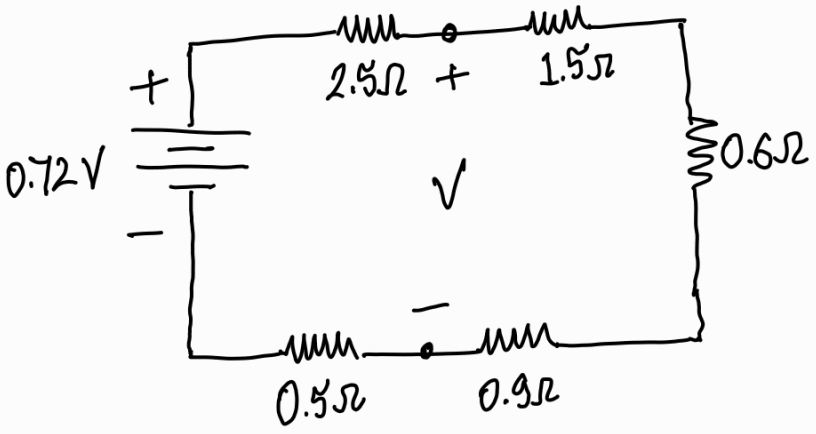
Find V

$$V = \frac{2+3}{4+1+2+3} \times 40 \quad \text{[Voltage divider]}$$

$$= \frac{5}{10} \times 40\ V$$

$$= 20V$$

Problem 16

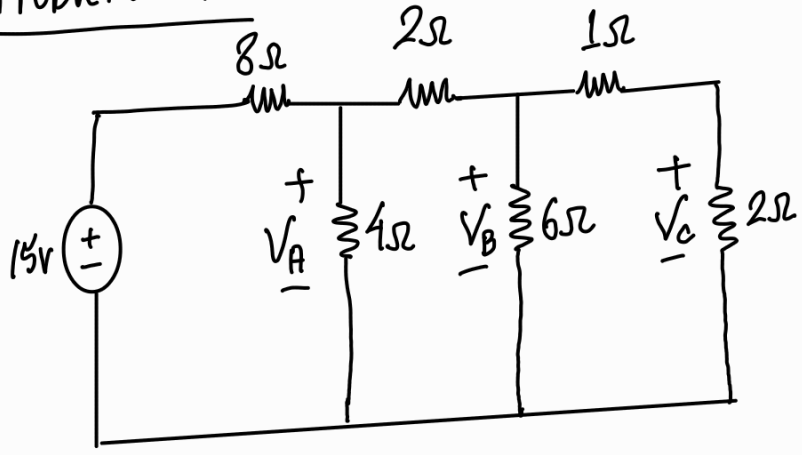


Find V

$$V = \frac{1.5+0.6+0.9}{1.5+0.6+0.9+2.5+0.5} \times 0.72$$

$$= 0.36\ V$$

Problem 17



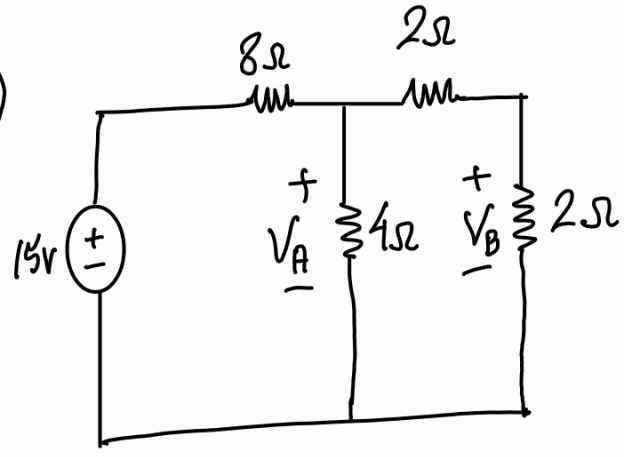
Find V_A, V_B & V_C

$V_c = \frac{2}{3} \times 1.5 = 1V$

expand (4)

First we compress —

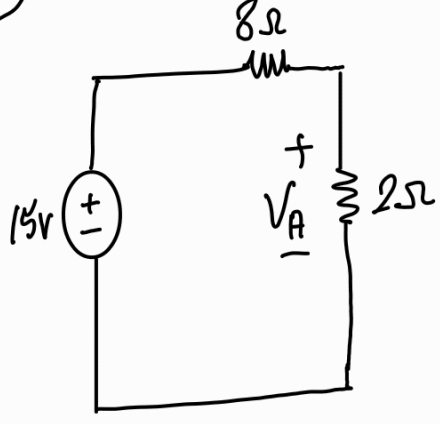
(1)



$V_b = \frac{2}{4} \times 3 = 1.5V$

expand (3)

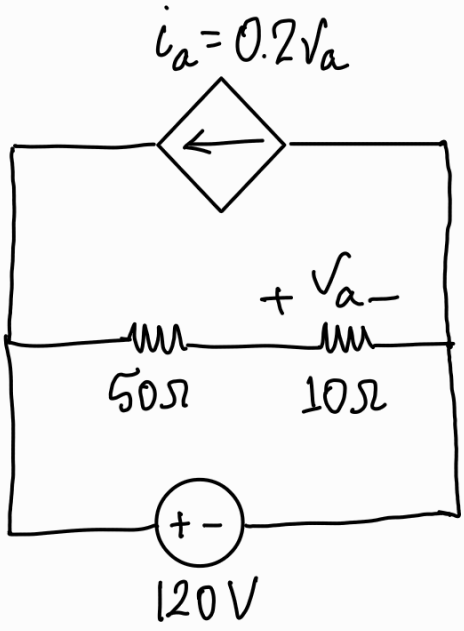
(2)



$V_a = \frac{2}{10} \times 15$

$= 3V$

Problem 18



Determine the power of the dependent source.

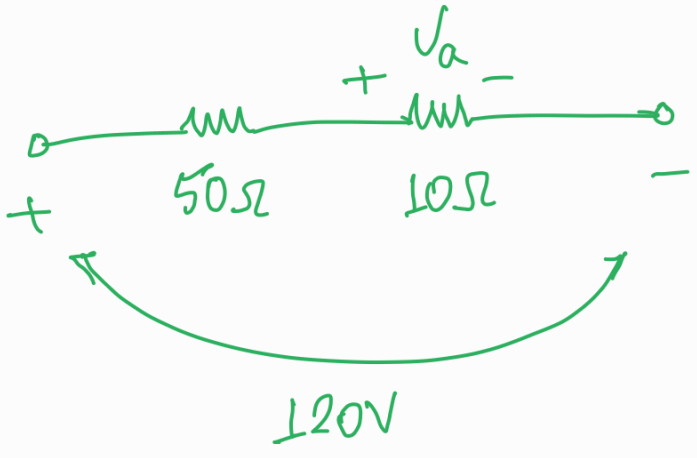
here $V = 120V$ since parallel circut.

and $I = 0.2\,V_a$

Power = $\pm VI$

passive sign convention

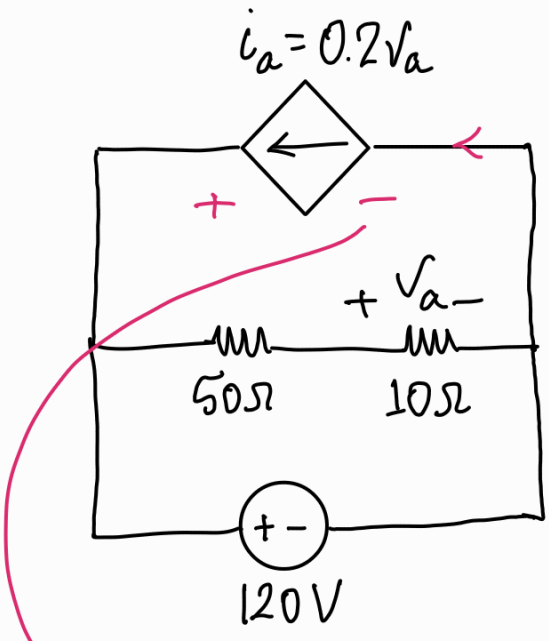
to find V_a let us look at the middle segment



$\therefore V_a = \frac{10}{60} \times 120 = 20V$

$\therefore I = 4A$

$\therefore$ Power = $\pm$ 480 W

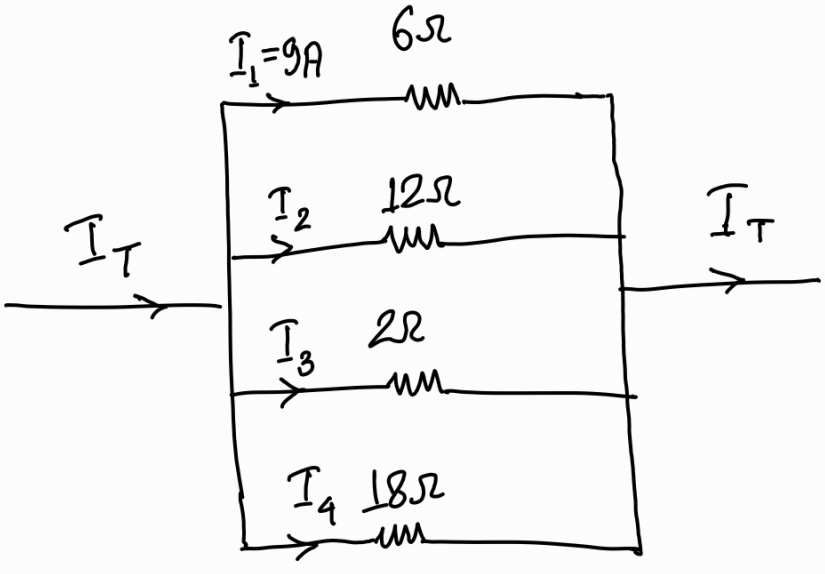


Now let us look at the original ckt to find the sign of the power

current entering −ve terminal

$\therefore P = -480\,W$ [supplying]

Problem 19



Find I_T, I_2, I_3 & I_4

$R_{eq} = \frac{36}{29}\,\Omega$

According to current divider —

$$I_1 = \frac{36/29}{6} \times I_T$$

$$\Rightarrow I_T = \frac{29}{6} I_1$$

$$= 43.5\,A$$

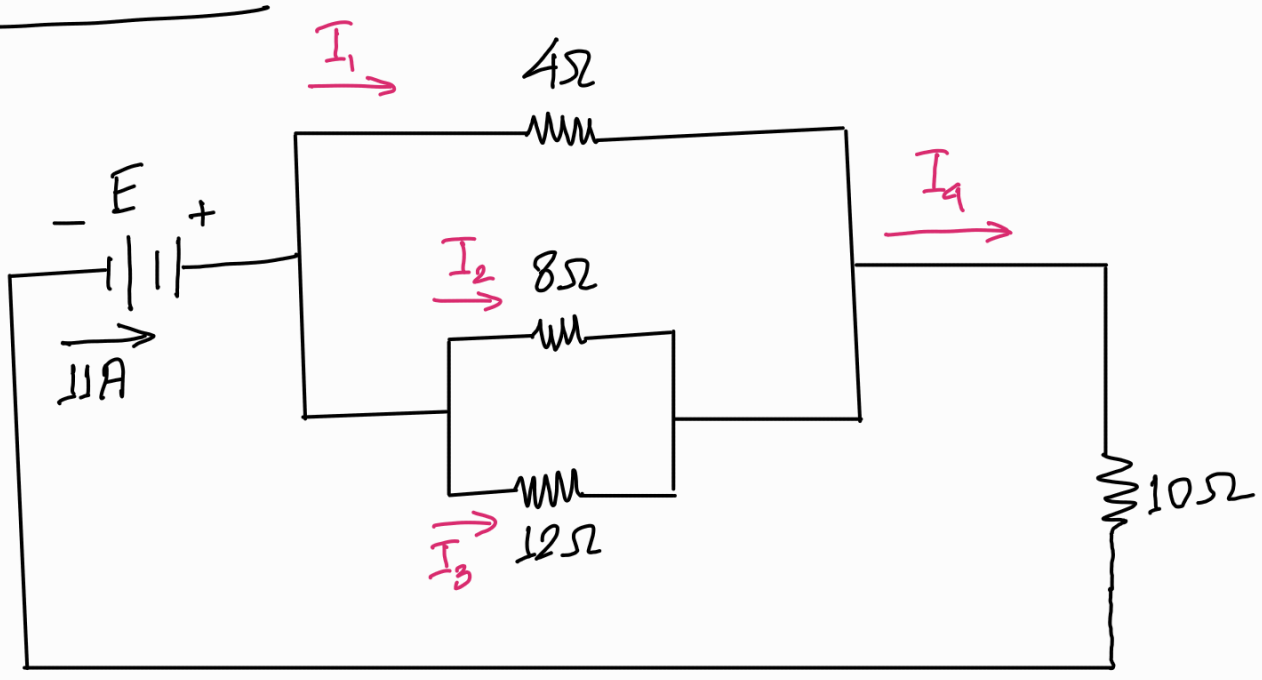
$$\therefore I_2 = \frac{36/29}{12} \times 43.5$$

$$= 4.5A$$

$$I_3 = \frac{36/29}{2} \times 43.5 = 27A$$

$$I_4 = \frac{36/29}{18} \times 43.5 = 3A$$

Problem 20



Find I_1, I_2, I_3 & I_4

Here $4\Omega \,||\, 8\Omega \,||\, 12\Omega$

$I_4 = 11A$

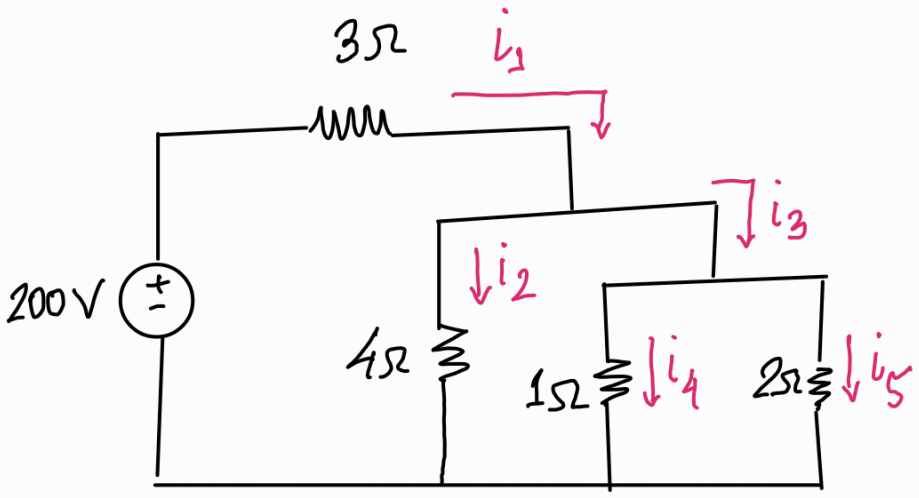
Applying current divider ; $R_{eq} = \frac{24}{11}$

$$I_1 = \frac{24/11}{4} \times 11 = 6A$$

$$I_2 = \frac{24/11}{8} \times 11 = 3A$$

$$I_3 = 11 - 6 - 3 = 2A$$

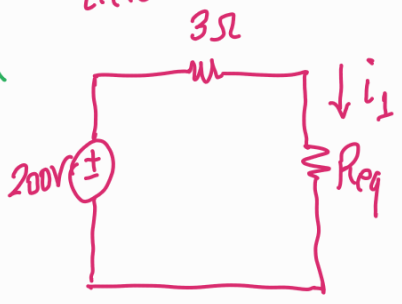
Problem 21



Find i_1, i_2, i_3, i_4 & i_5

Here only if we knew i_1, we could find all other currents using current divider.

To find i_1, we need a ckt like

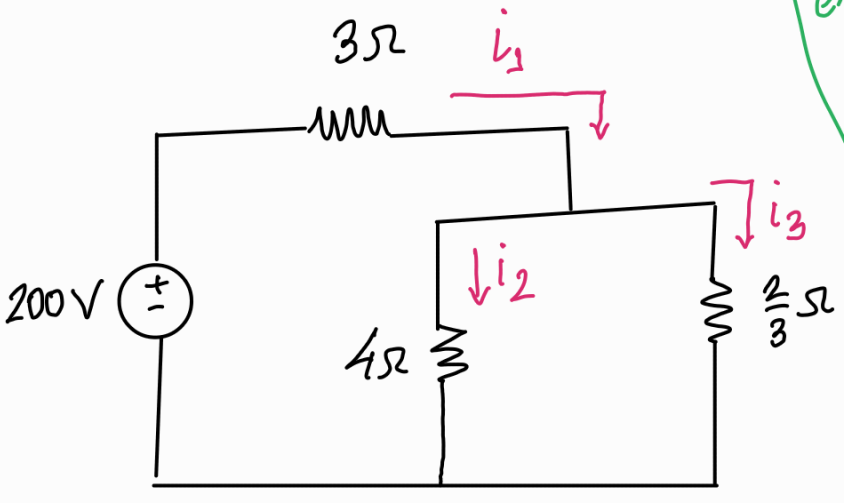


compress

$i_4 = \frac{2/3}{1} \times 48 = 32A$

$i_5 = 48 - 32 = 16A$

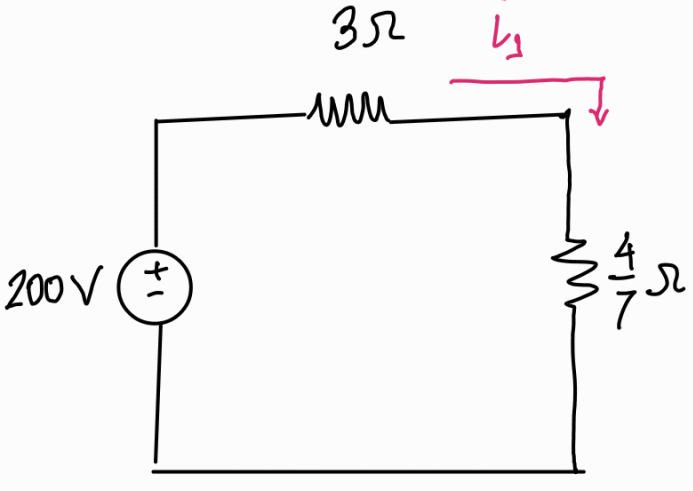
expand



$i_2 = \frac{4/7}{4} \times 56 = 8A$

$i_3 = 56 - 8 = 48A$

compress



$i_1 = \frac{200}{3 + 4/7}$ A

$= 56A$

expand