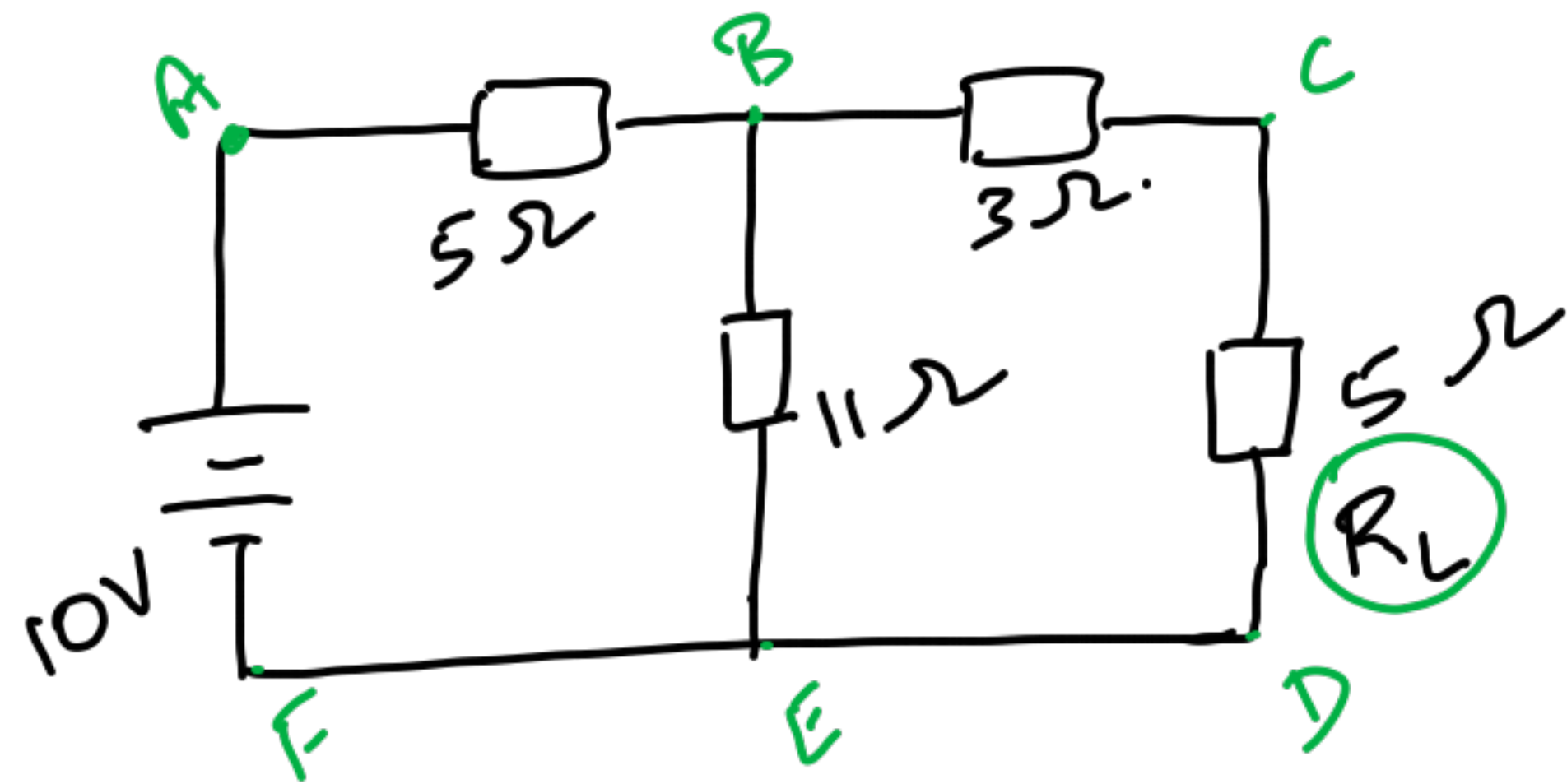


1) Determine the Thevenin's equivalent circuit for the following circuit and find the load current.

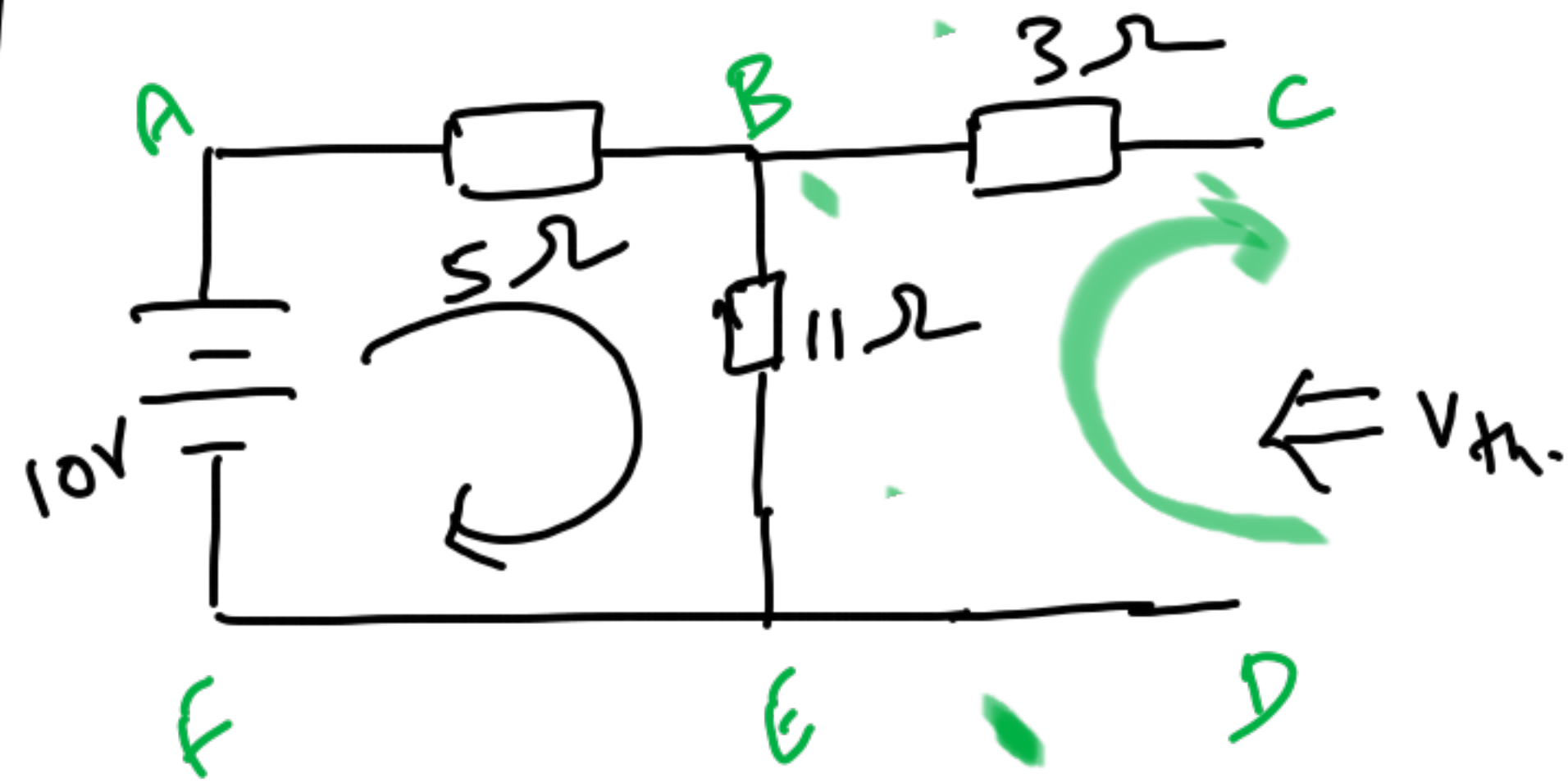


V_{th}

R_{th}

I_L

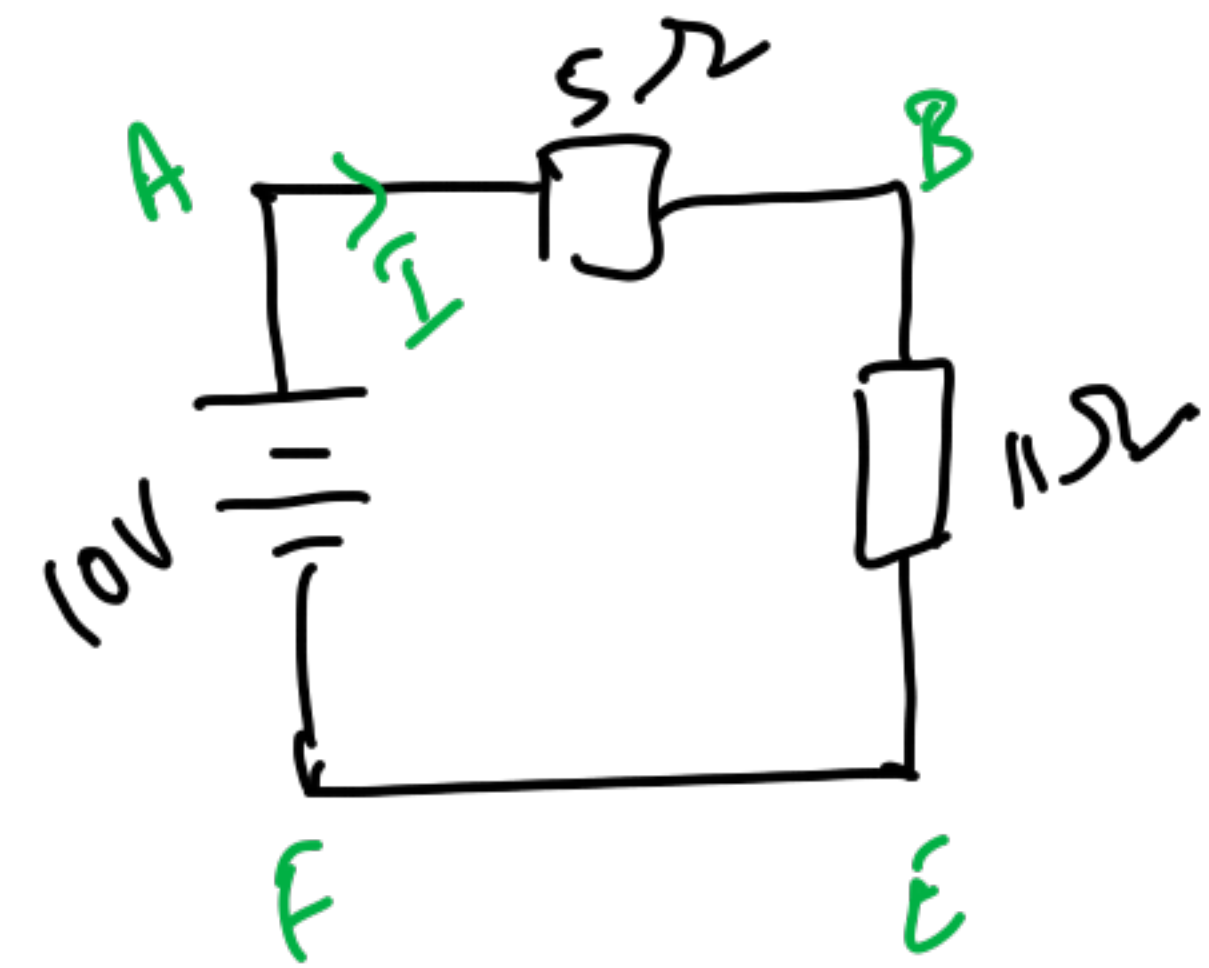
To find V_{th} :



$$V_{th} = V_{DC} = V_{DE} + V_{EB} + V_{BC}$$

$$V_{th} = 0 + V_{EB} + 0$$

$$V_{th} = V_{EB}$$



$$I = \frac{V}{R} = \frac{10}{5+11}$$

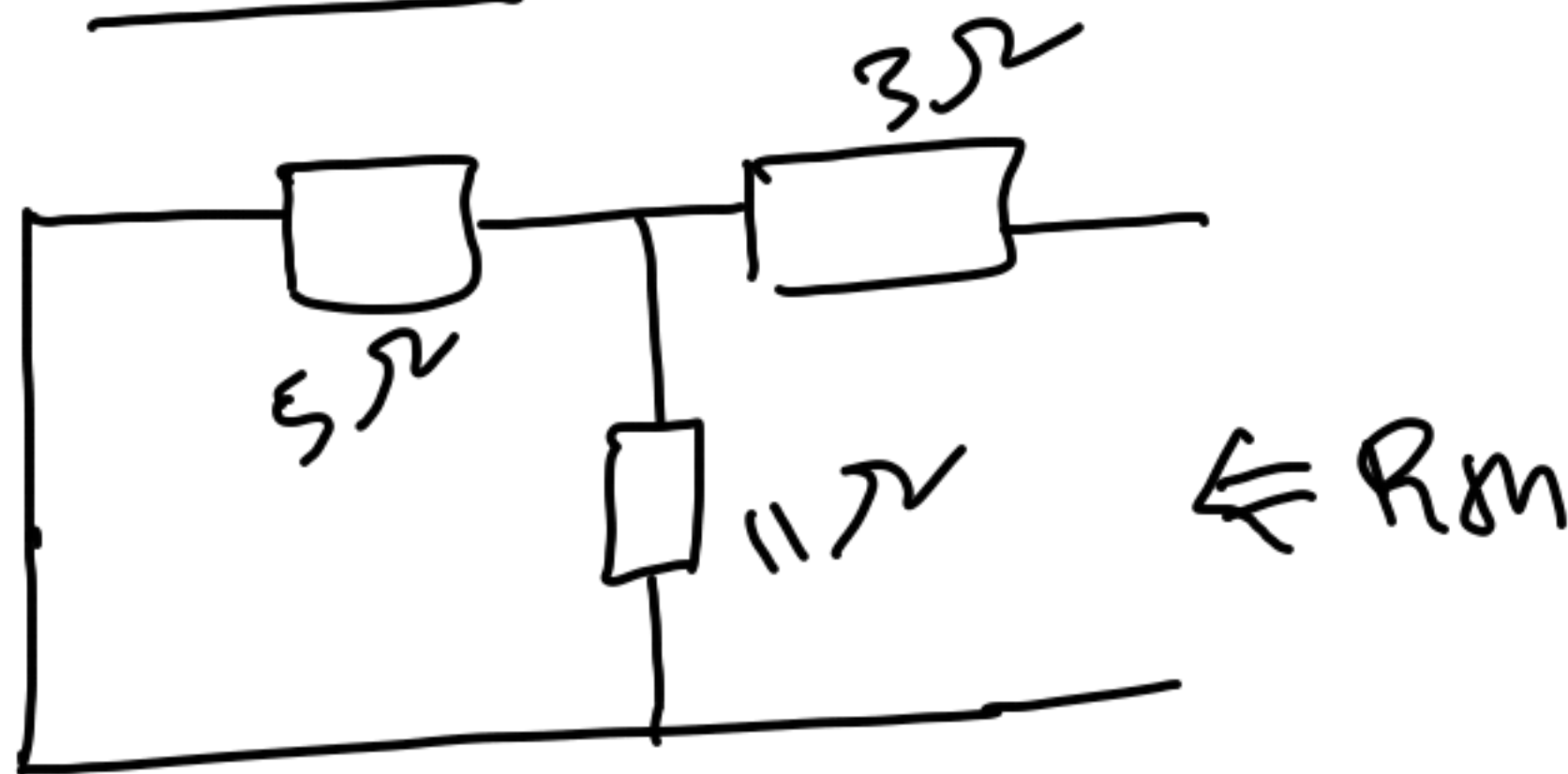
$$I = 0.625 \text{ A}$$

$$V_{EB} = I \times 11$$

$$V_{EB} = 6.9 \text{ V}$$

$$V_{th} = V_{EB} = 6.9 \text{ V}$$

To find R_{th} :



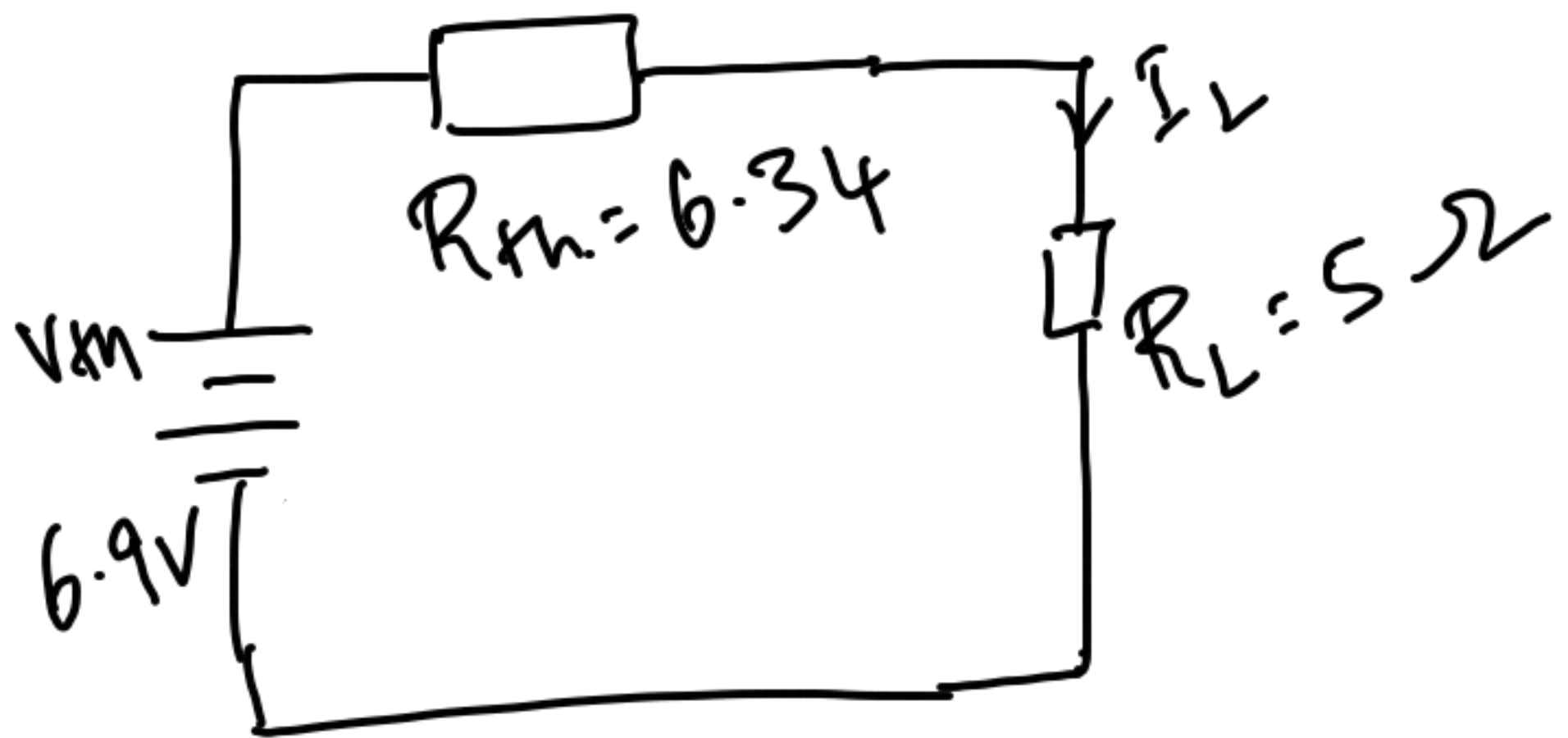
$$R_{eq1} = \frac{1}{\frac{1}{5} + \frac{1}{11}}$$

$$R_{eq1} = 3.43 \Omega$$

$$R_{eq} = 3.43 + 3$$

$$R_{th} = R_{eq} = 6.43 \Omega$$

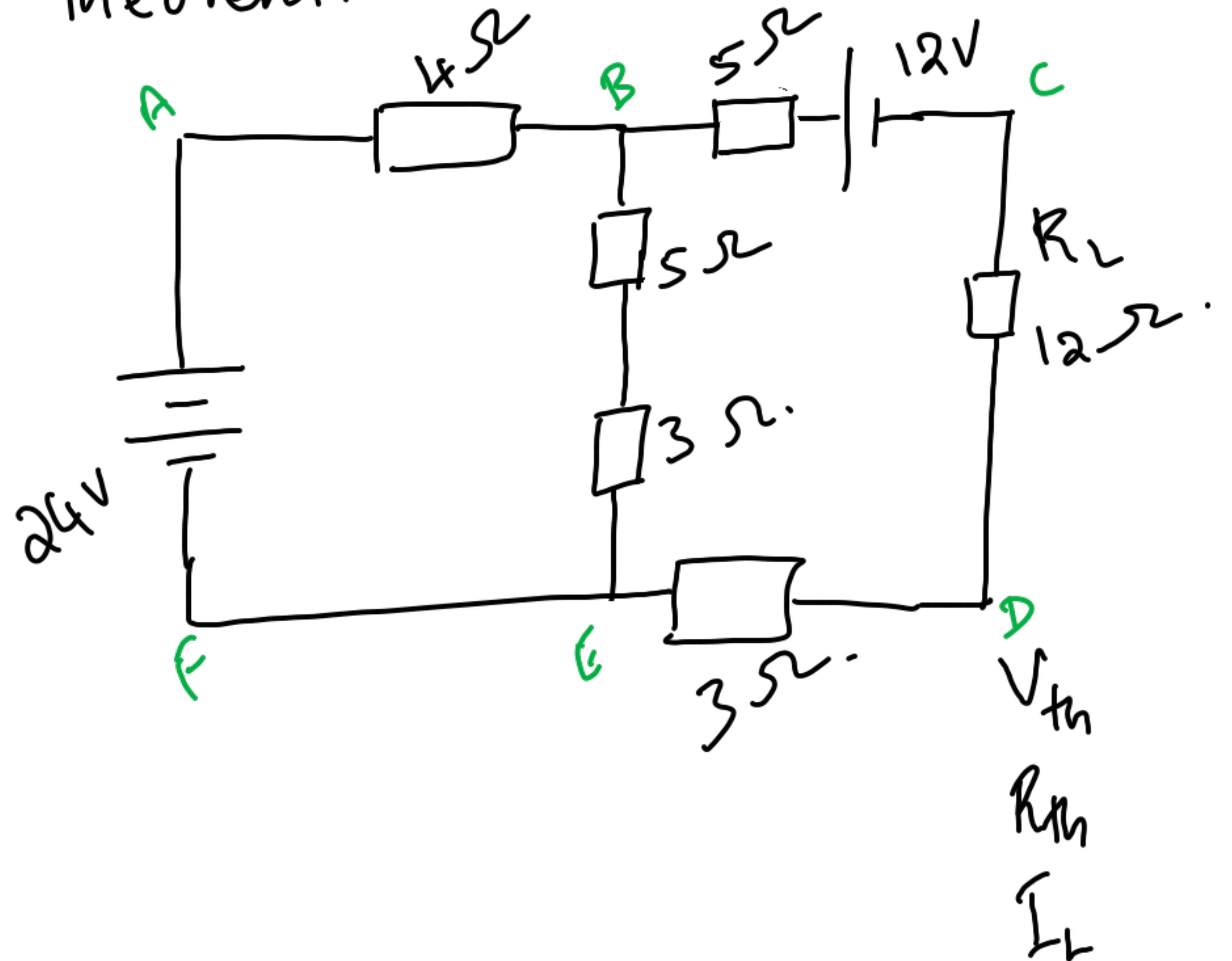
Thevenin's Equivalent Circuit



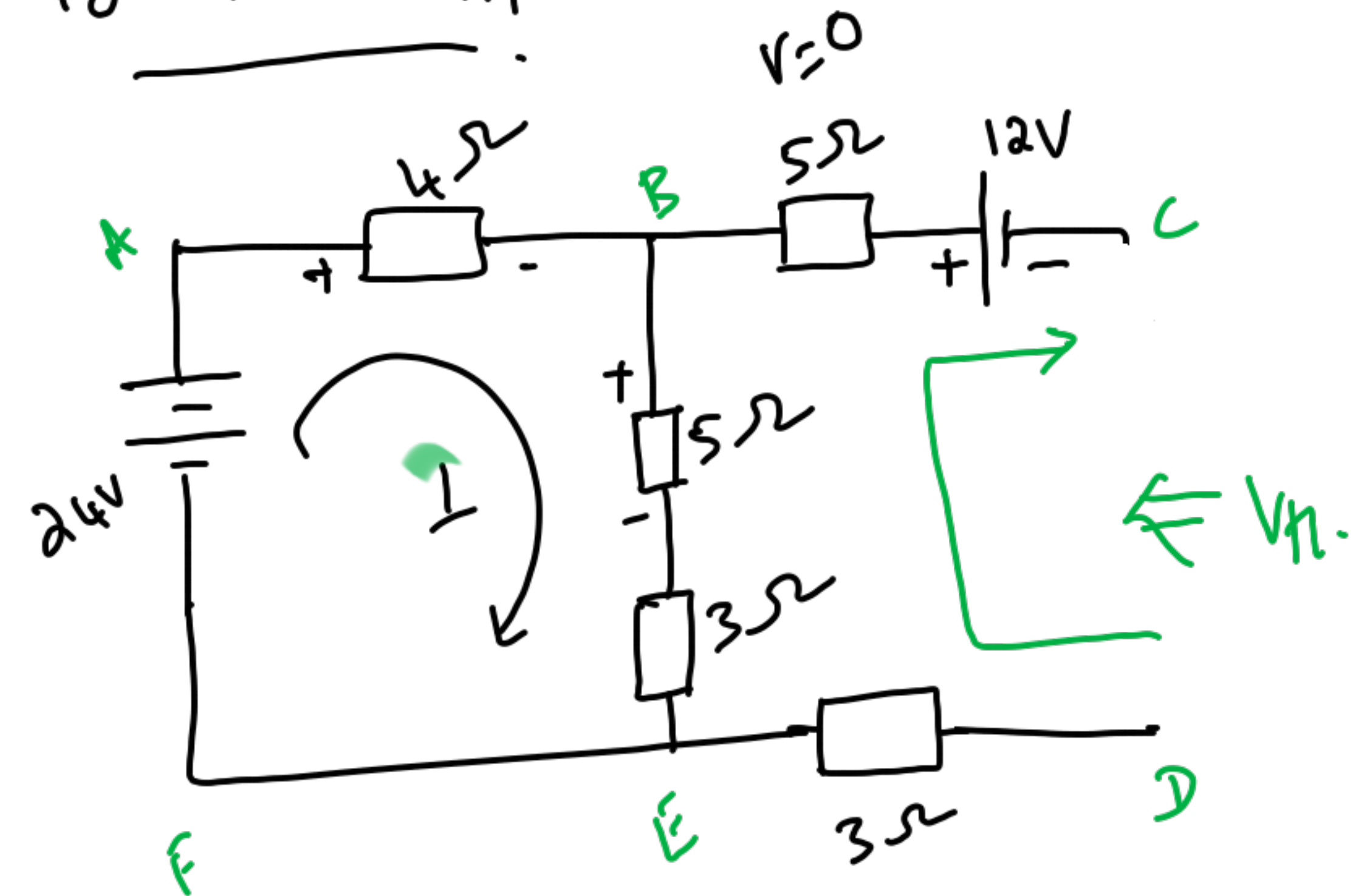
$$I_L = \frac{V_{th}}{R_{th} + R_L} = \frac{6.9}{6.3 + 5}$$

$$I_L = 0.6A$$

2) Determine the Load Current for the following circuit Using Thevenin's theorem.

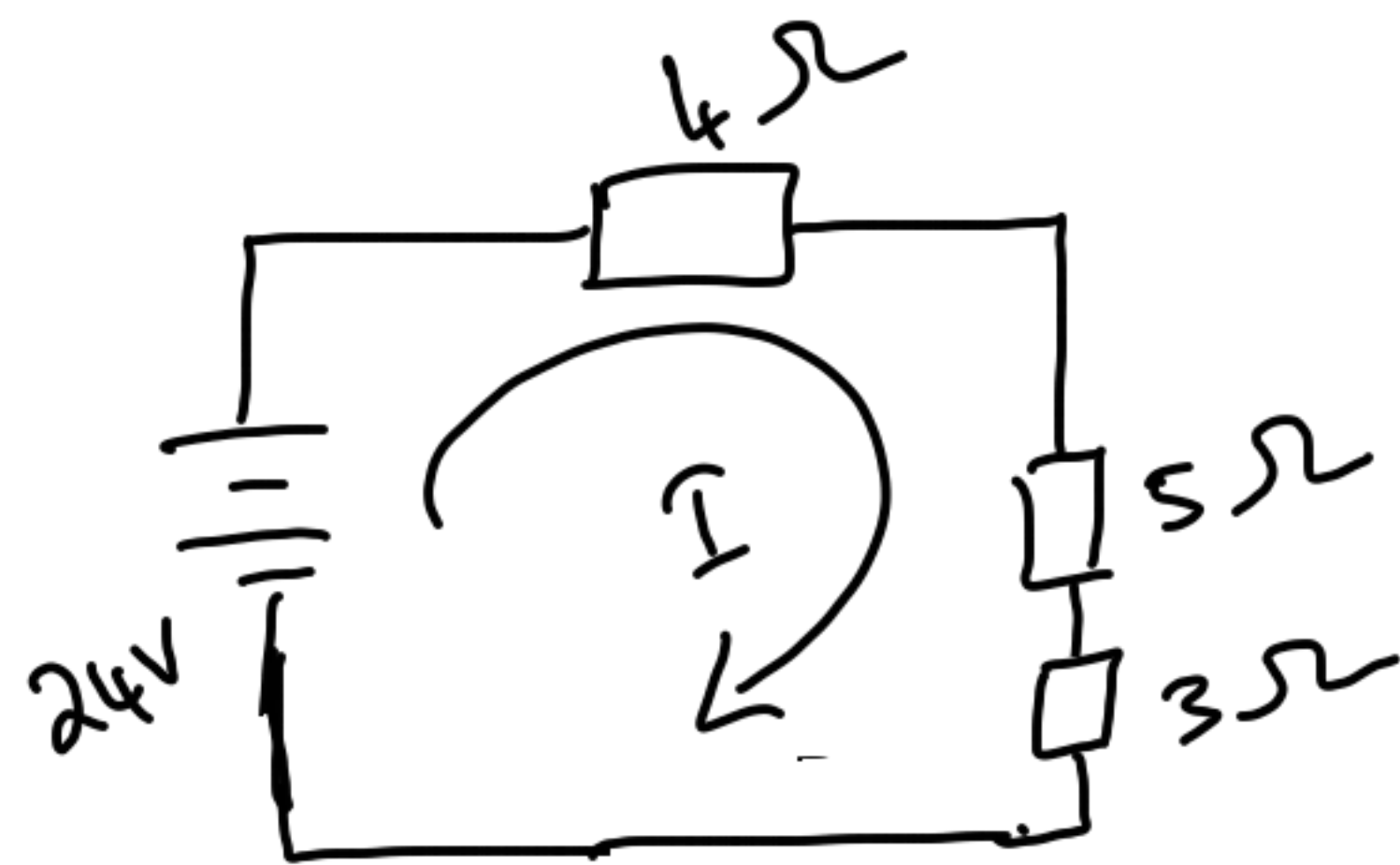


To find V_{th} !!



$$V_{th} = V_{DC} = V_{DE} + V_{EB} + V_{BC}$$

$$V_{th} = 0 + V_{EB} + V_{BC}$$



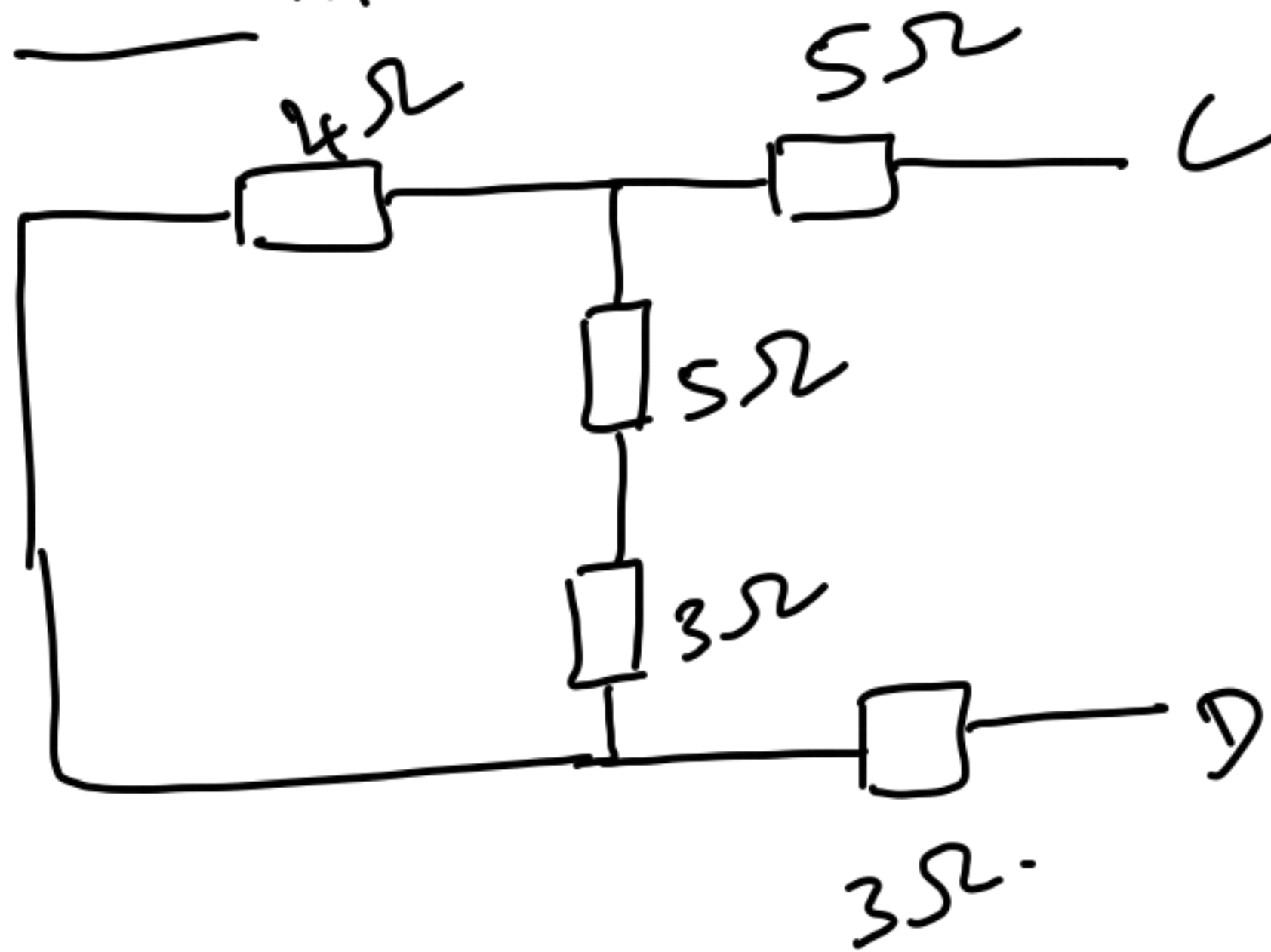
$$I = \frac{V}{R} = \frac{24}{12} = 2A$$

$$V_{EB} = 2 \times 8 = 16V$$

$$V_{th} = 16 - 12 = 4V$$

$$V = IR$$

To find R_{th} :



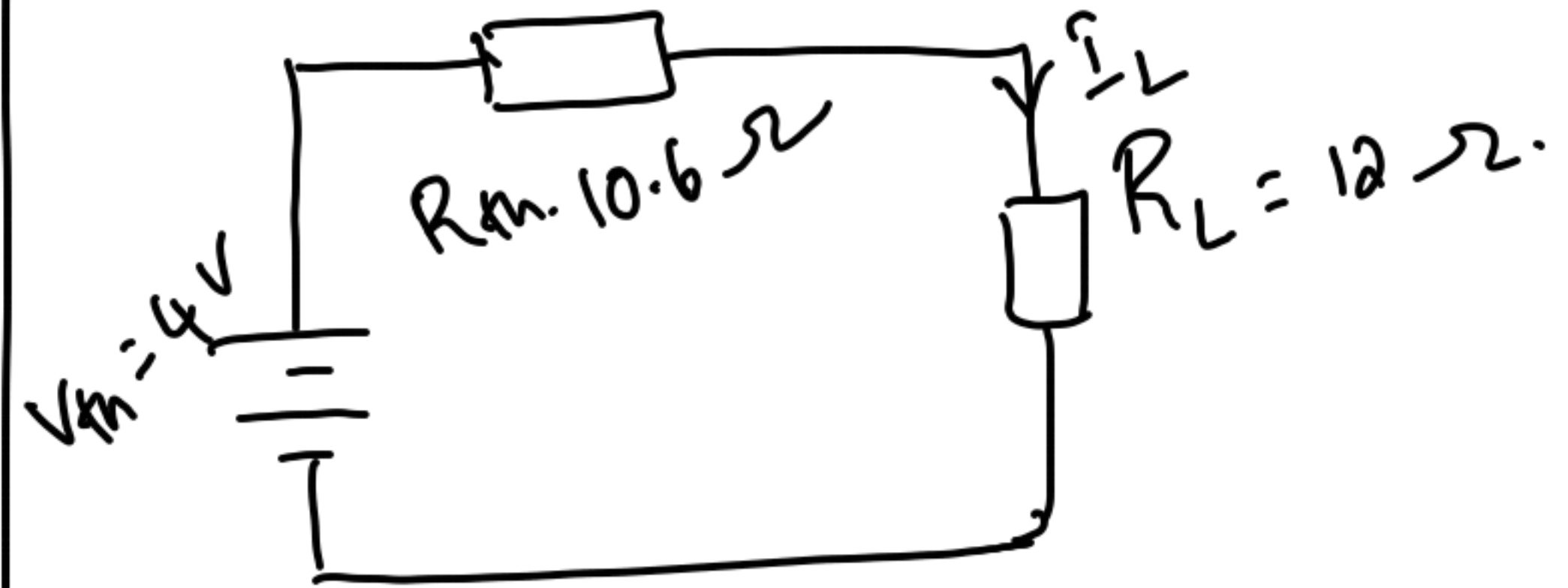
$$R_{eq} = \frac{1}{\frac{1}{(5+3)} + \frac{1}{4}}$$

$$R_{eq} = 2.6\Omega$$

$$R_{th} = 3 + 2.6 + 5$$

$$R_{th} = 10.6\Omega$$

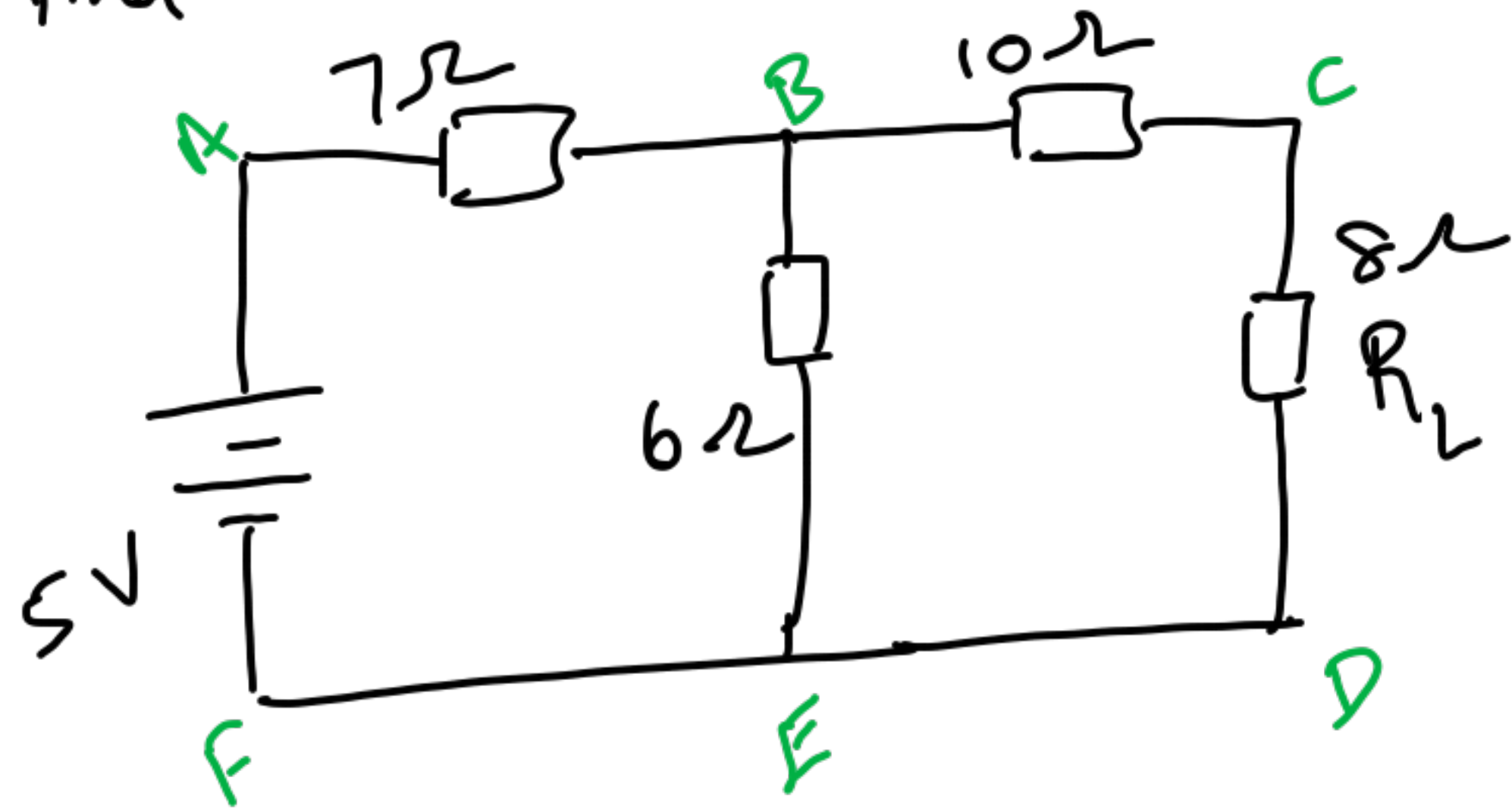
Thevenin's equivalent circuit.



$$I_L = \frac{V_{th}}{R_{th} + R_L} = \frac{4}{10.6 + 12}$$

$$I_L = 0.18A$$

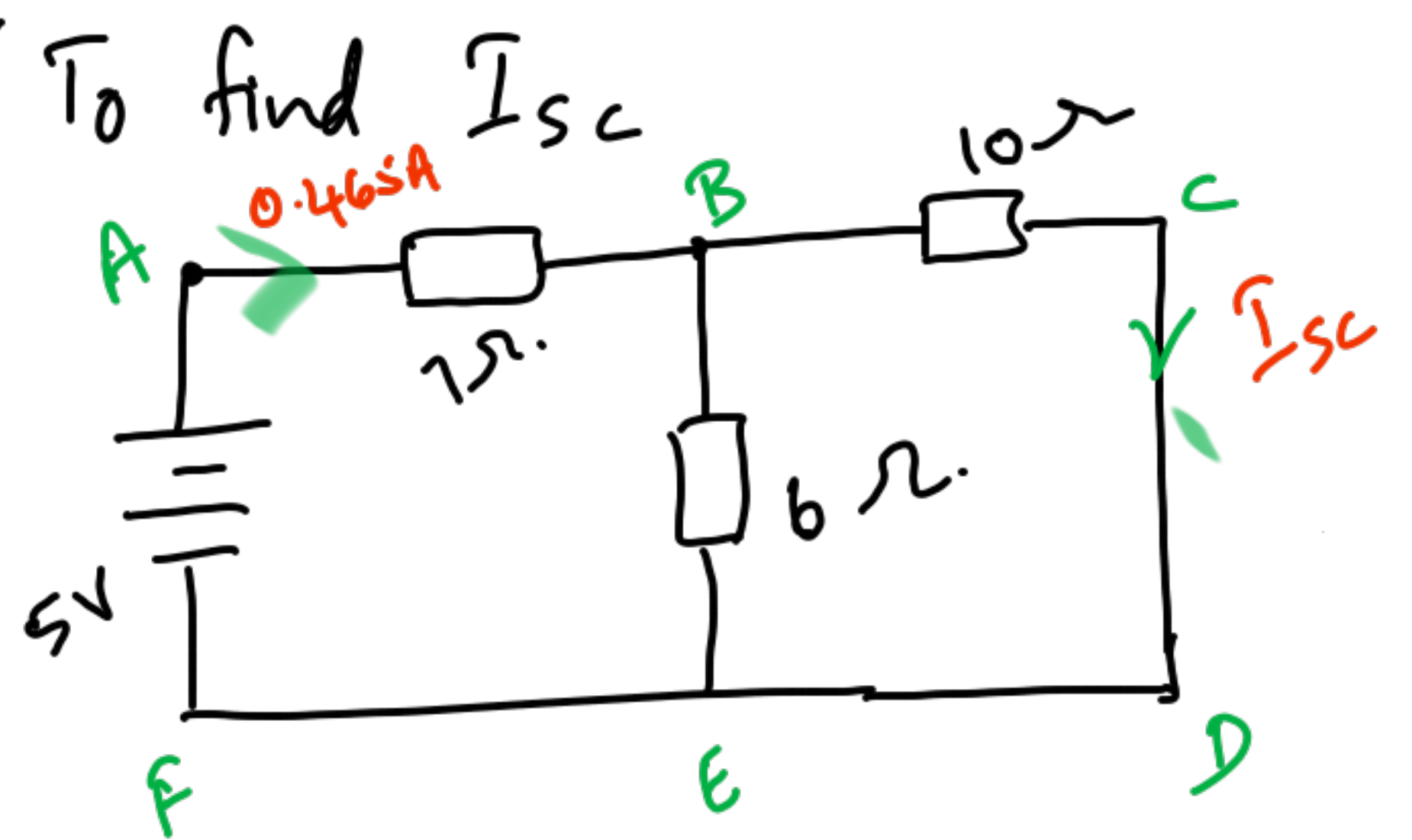
3) Determine the Norton's equivalent circuit for the following circuit and find the load current.



I_{sc}

R_{th}

I_L

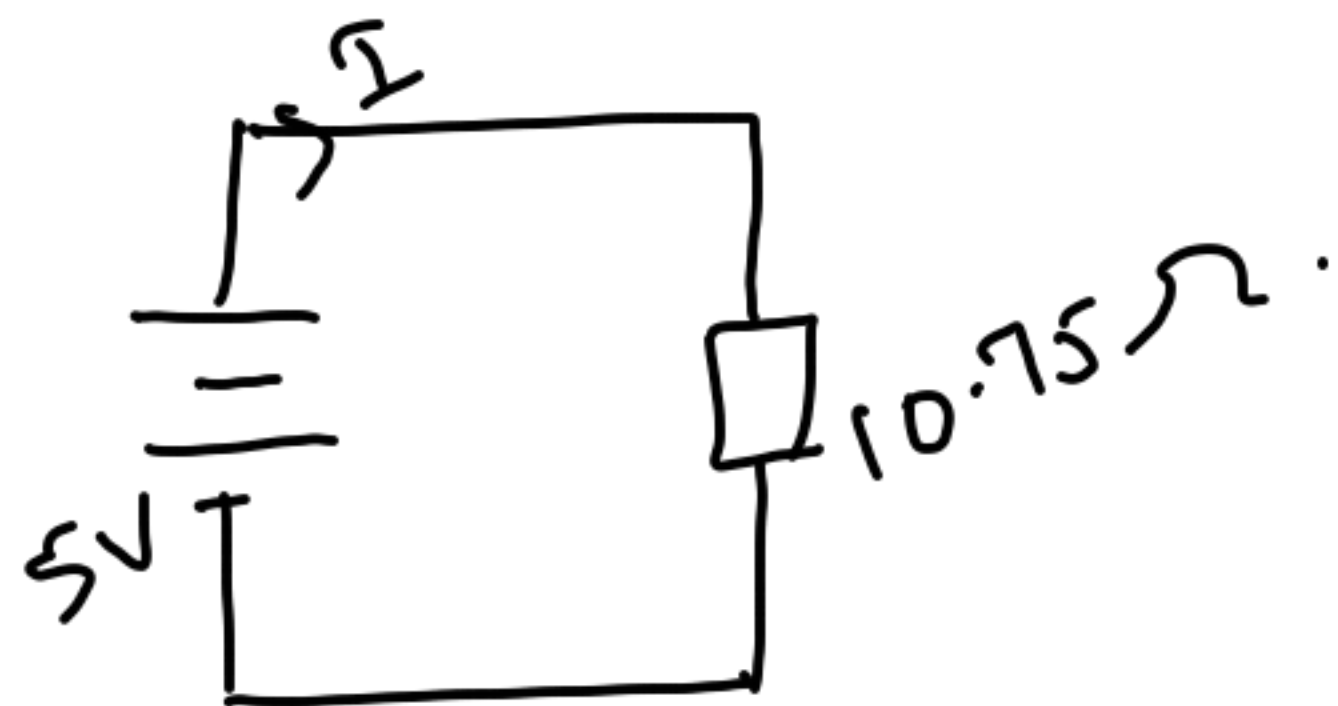


$$R_{tot1} = \frac{1}{\left(\frac{1}{6}\right) + \left(\frac{1}{10}\right)} = 3.75 \Omega.$$

3.75Ω is series with 7Ω .

$$R_{tot} = 7 + 3.75 = 10.75 \Omega.$$

$$R_{tot} = 10.75 \Omega$$



$$\hat{I} = \frac{V}{R} = \frac{5}{10.75}$$

$$\hat{I} = 0.465 \text{ A}$$

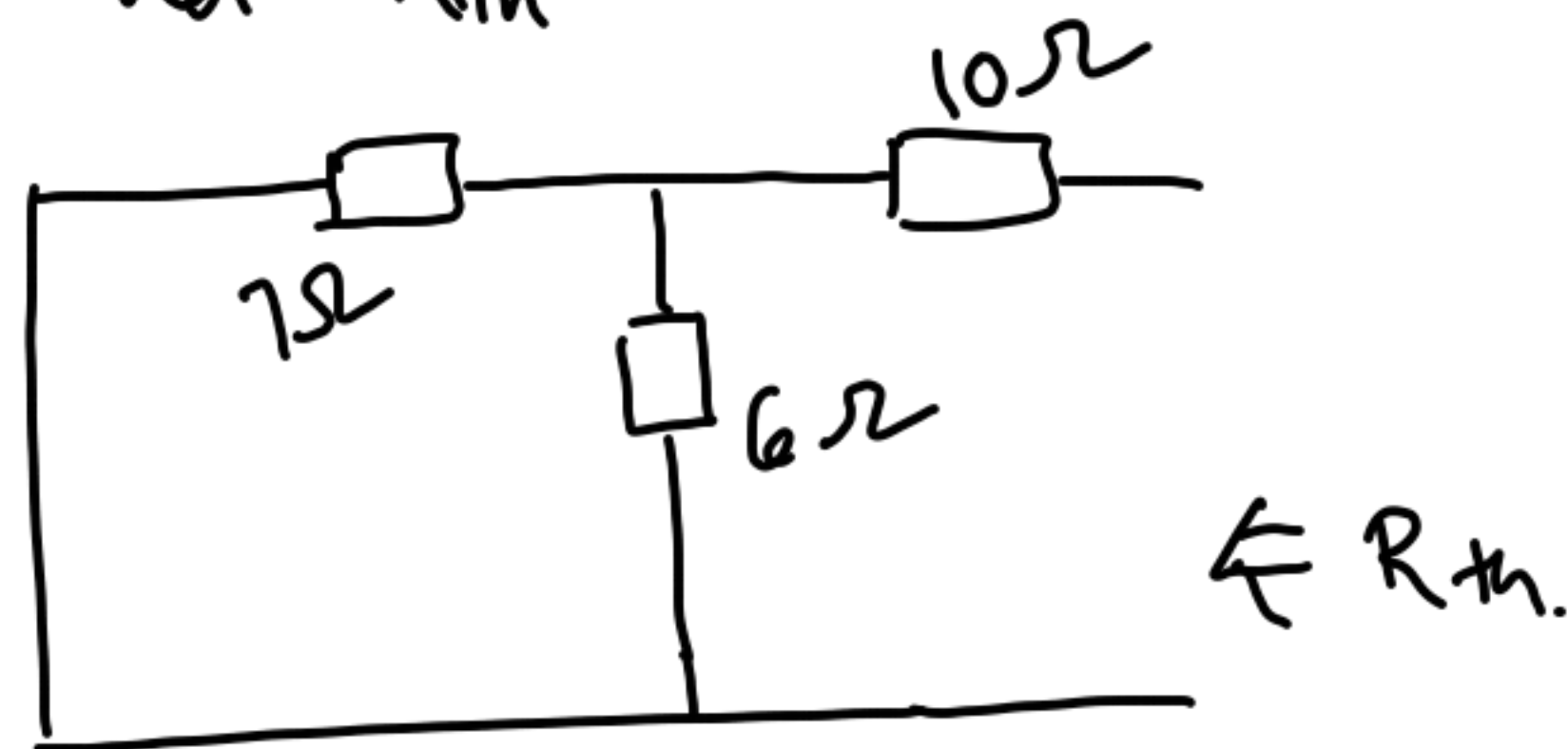
To find $\hat{I}_{sc}$

$$\hat{I}_{sc} = \hat{I} \cdot \left(\frac{6}{6+10} \right)$$

$$\hat{I}_{sc} = 0.465 \left(\frac{6}{16} \right) = 0.174 \text{ A}$$

$$\hat{I}_{sc} = \hat{I} \cdot \left(\frac{1}{\frac{1}{6} + \frac{1}{10}} \right) \left(\frac{1}{10} \right)$$

To find R_{th} :



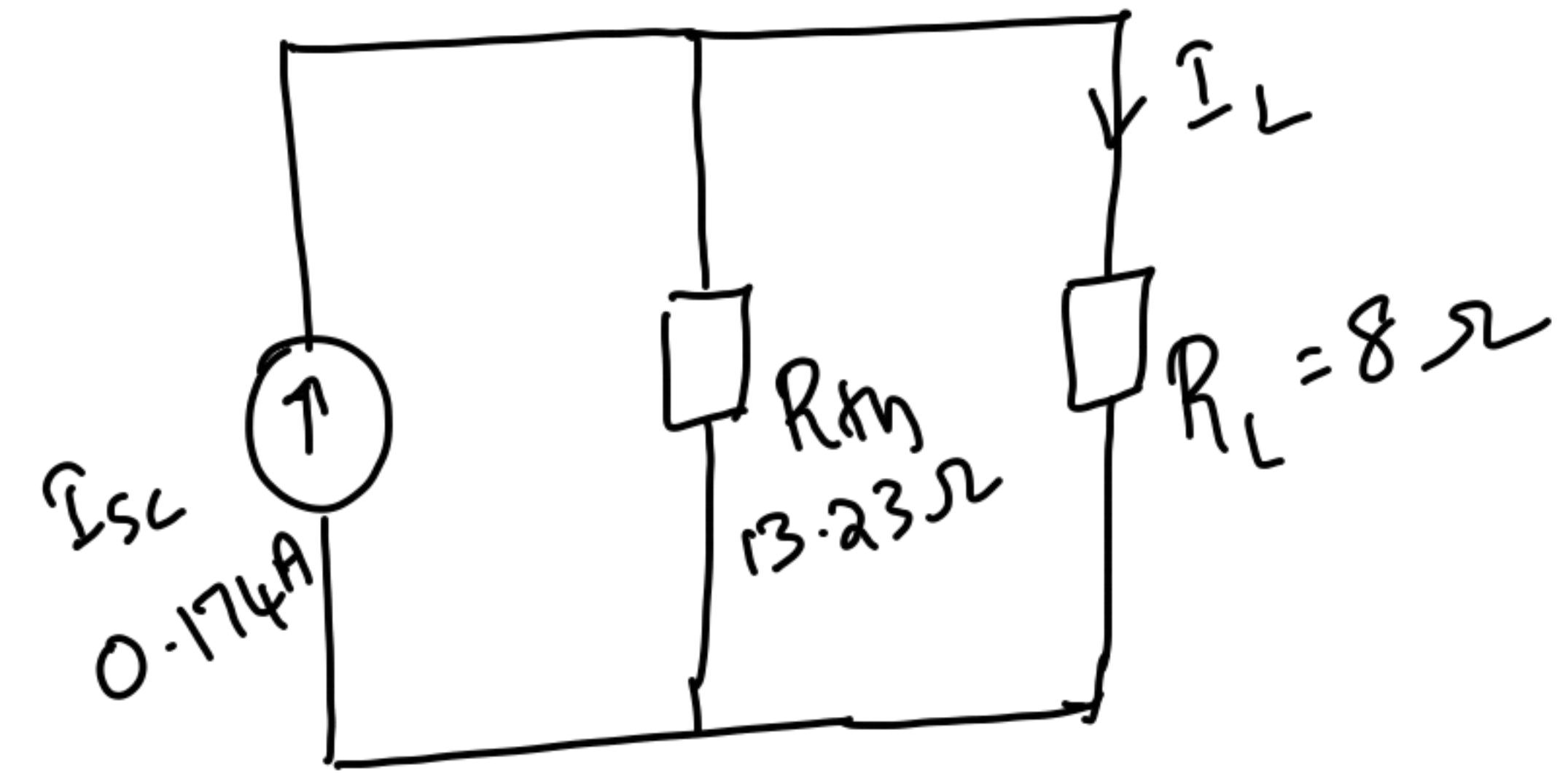
$$R_{eq1} = \left(\frac{1}{\frac{1}{7} + \frac{1}{6}} \right)$$

$$R_{eq1} = 3.23 \Omega$$

$$R_{th} = 3.23 + 10 \Omega$$

$$R_{th} = 13.23 \Omega$$

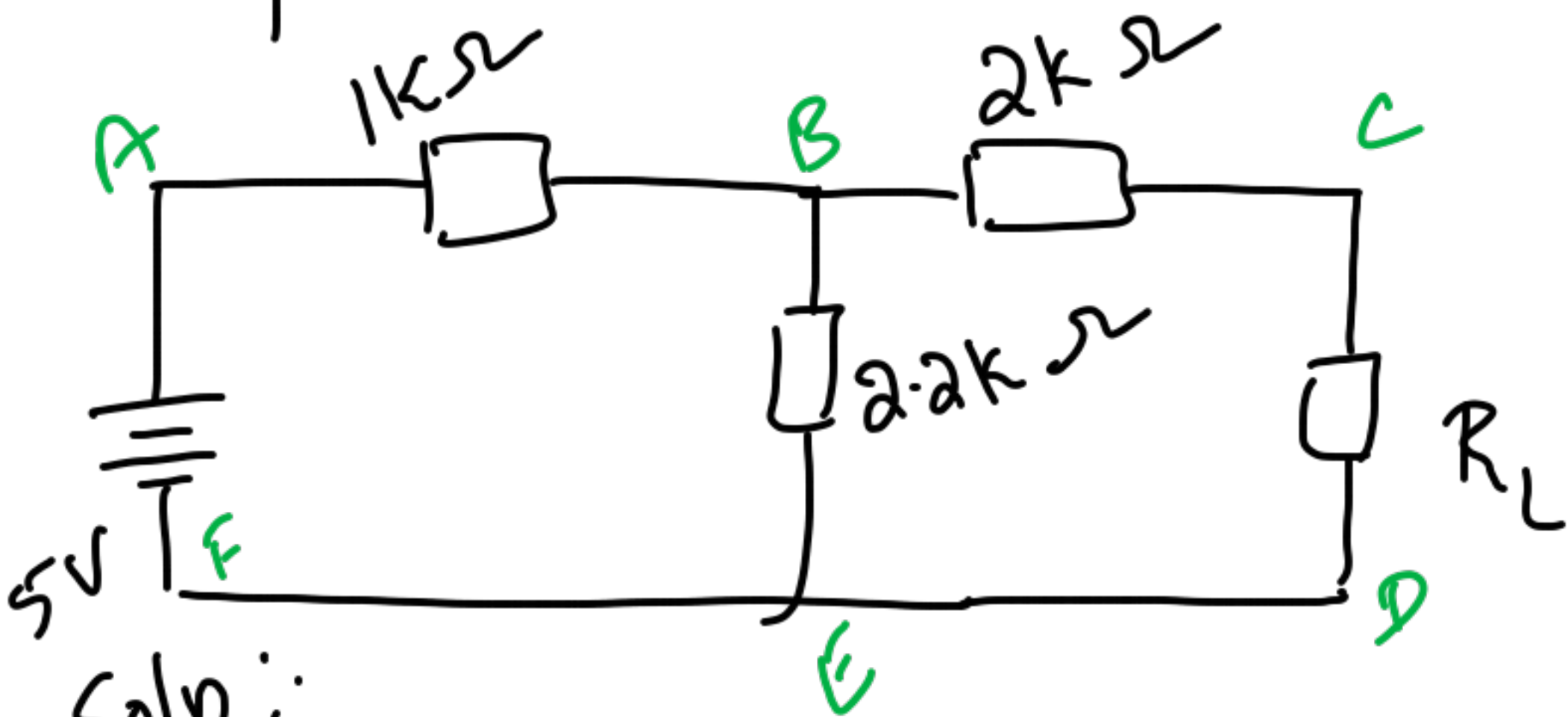
Norton's Equivalent Circuit.



$$I_L = \frac{I_{SC} \cdot R_{th}}{R_{th} + R_L} = \frac{0.174 \times 13.23}{8 + 13.23}$$

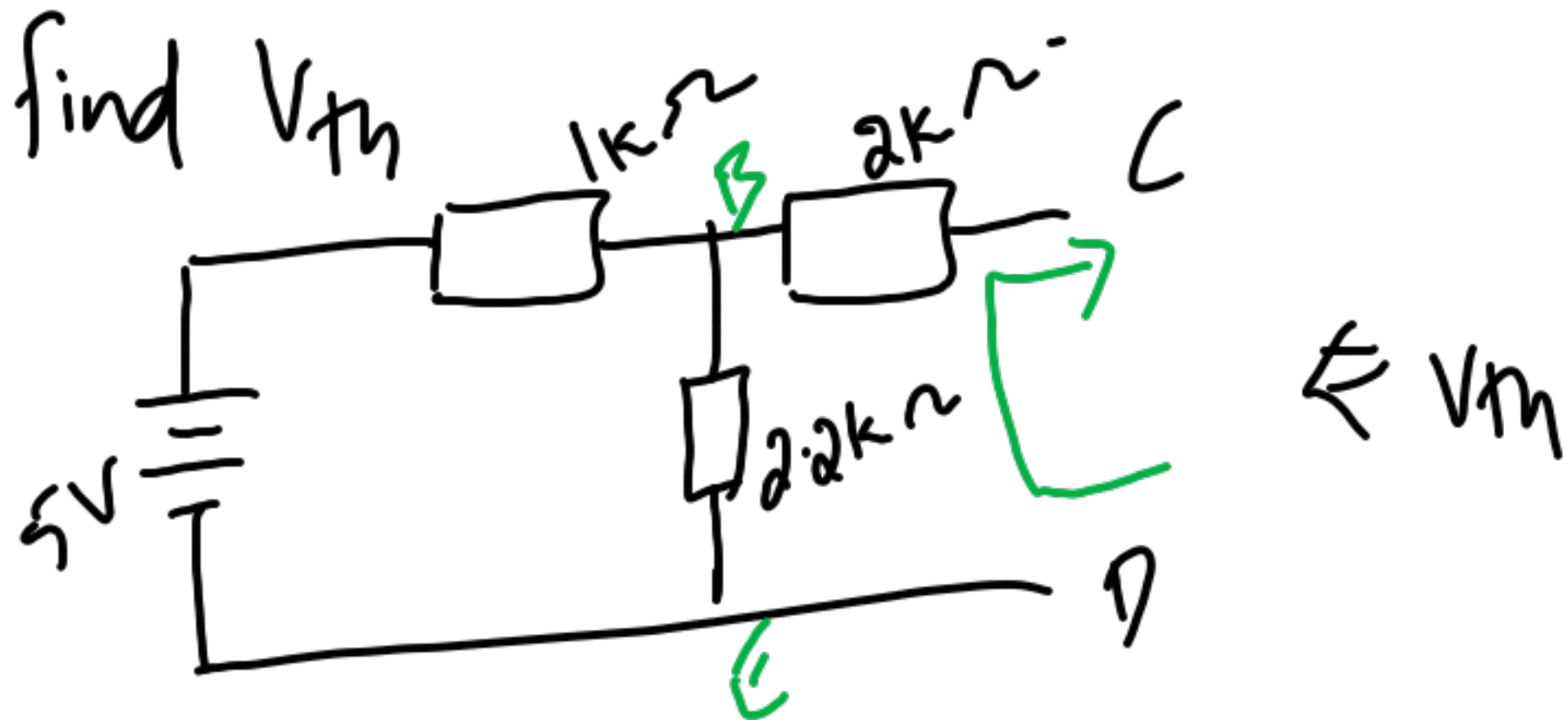
$$I_L = 0.11A$$

4) In the following circuit, determine the value of the Load Resistor, when maximum power is transferred. Also, Calculate the power transferred.



Soln:

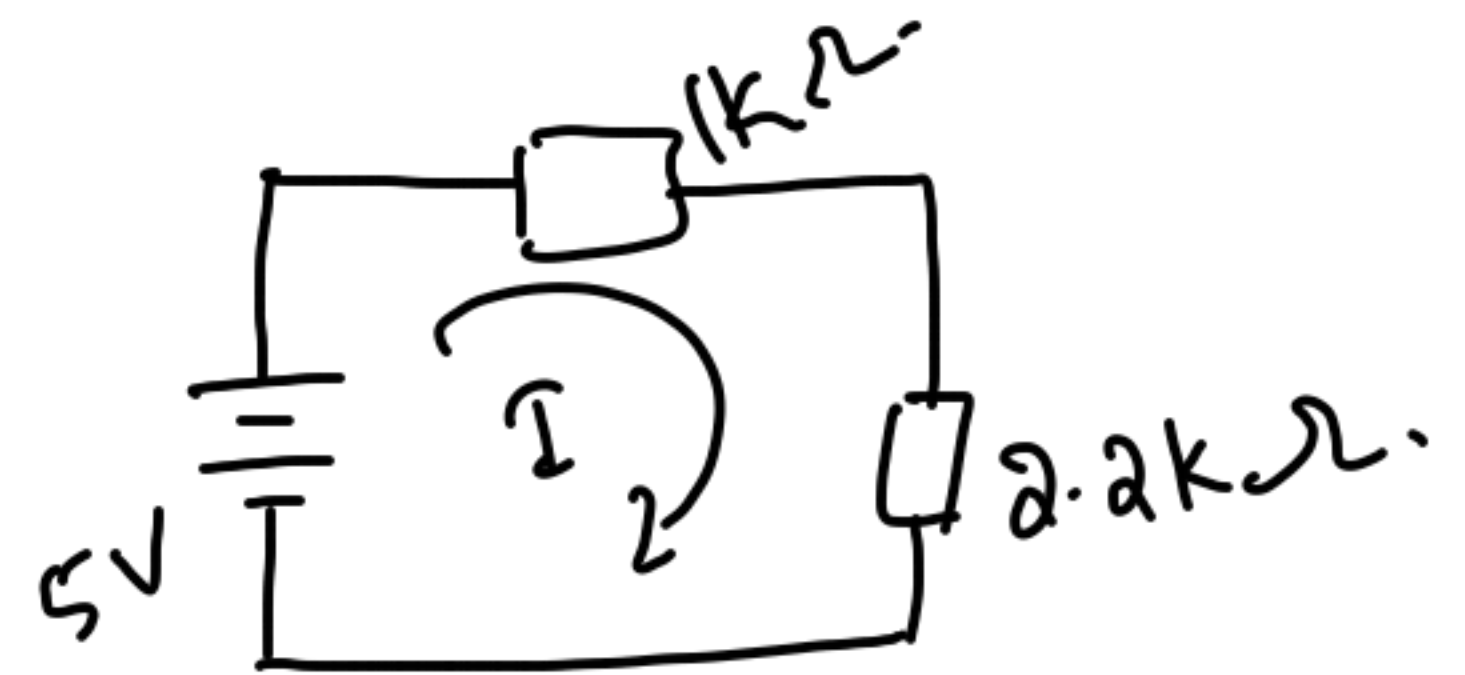
To find V_{th}



$$V_{th} = V_{DE} + V_{EB} + V_{BC}$$

$$= 0 + V_{EB} + 0$$

$$V_{th} = V_{EB}$$



$$I = \frac{V}{R} = \frac{5}{1k + 2.2k} = \frac{5}{3.2k}$$

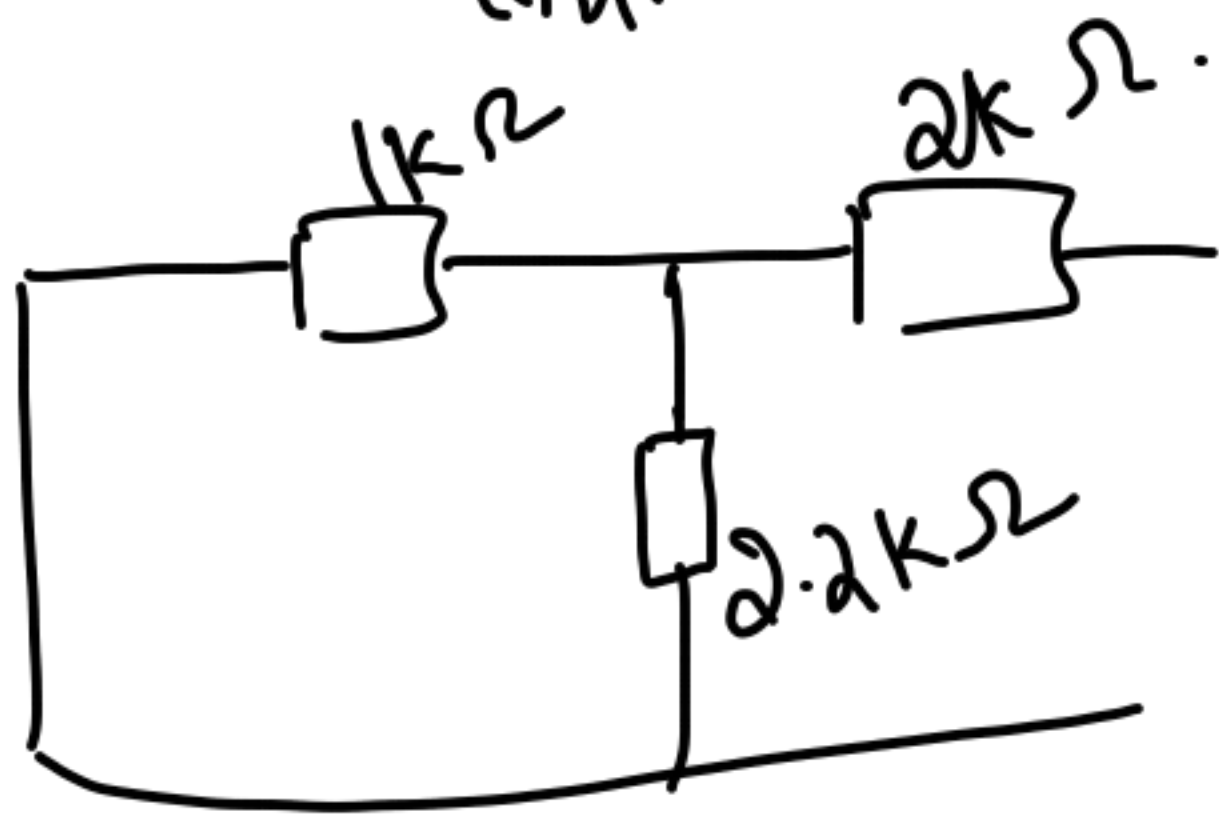
$$I = 1.56 \times 10^{-3} A$$

$$I = 1.56 mA$$

$$V_{EB} = 1.56 \times 10^3 \times 2.2 \times 1000$$

$$V_{th} = V_{EB} = 3.43 \text{ V}$$

To find R_{th} .

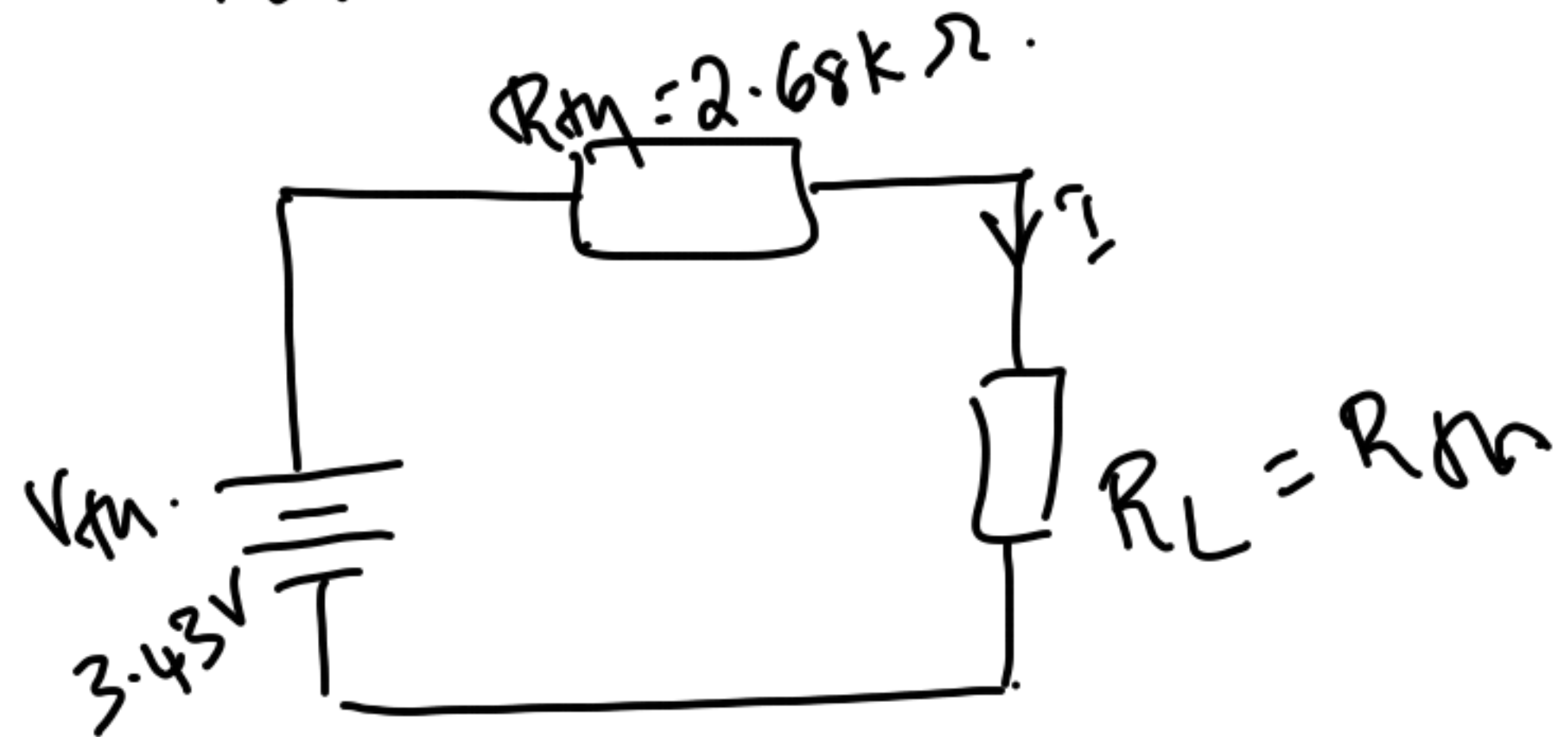


$$R_{eq1} = \frac{1}{\frac{1}{1000} + \frac{1}{2200}} = 689.66 \Omega$$

$$R_{th} = 689.66 + 2000$$

$$R_{th} = \underline{\underline{2.68 \text{ k}\Omega}}$$

Thévenin's theorem equivalent circuit.



For maximum power to be transferred, R_L should be equal to R_{th}

$$R_L = R_{th} = 2.68 \text{ k}\Omega$$

Maximum power.

$$P = I^2 R_L$$

$$I = \frac{V_{th}}{R_{th} + R_L}$$

$$I = \frac{3.43}{2 \times 2680}$$

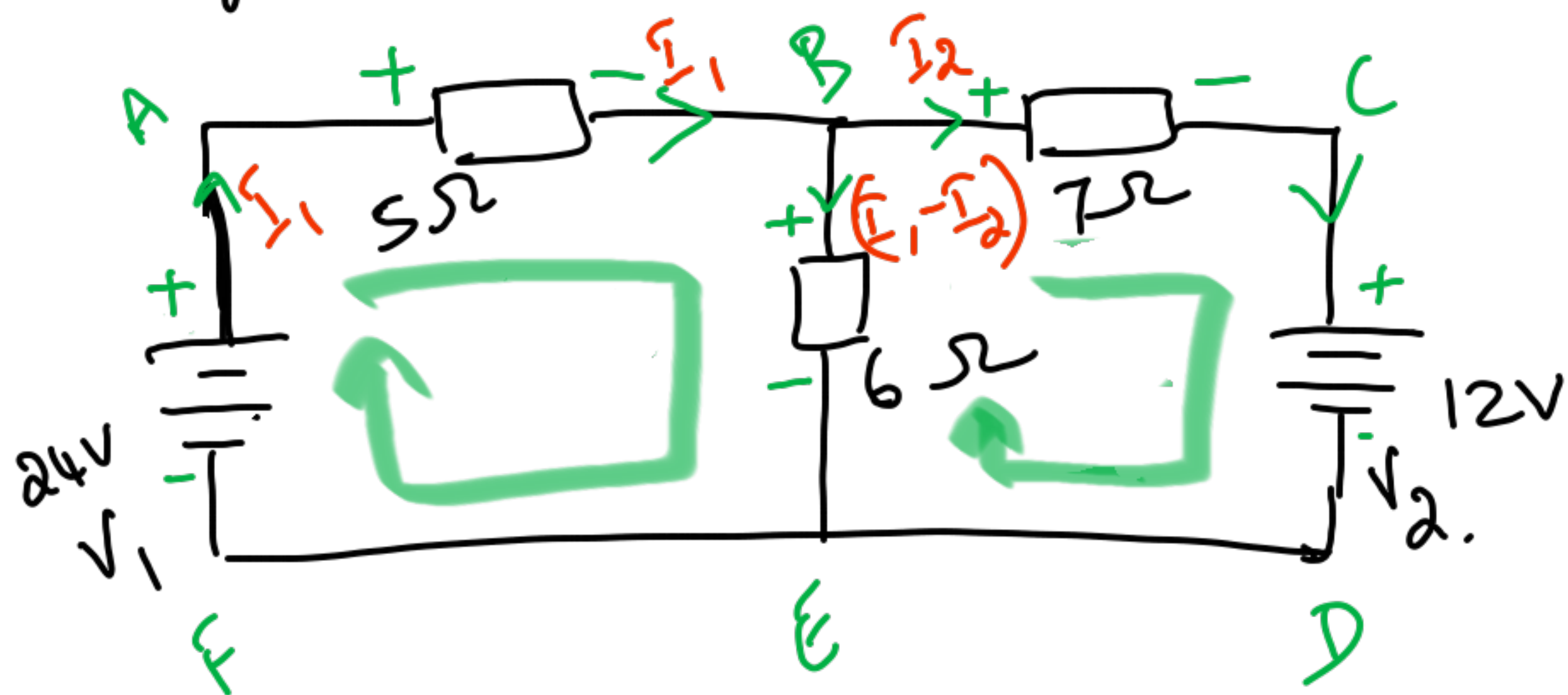
$$I = 0.64 \times 10^{-3} \text{ A}$$

$$I = 0.64 \text{ mA}$$

$$P = (0.64 \times 10^{-3})^2 \times 2.68 \times 10^3$$

$$P = 1.1 \text{ mW}$$

5) Verify if the following circuit obeys Superposition theorem.



Apply KVL in ABEFA

$$-5I_1 - 6(I_1 - I_2) + 24 = 0$$

$$-5I_1 - 6I_1 + 6I_2 = -24$$

$$-11I_1 + 6I_2 = -24 \quad \text{--- (1)}$$

Apply KVL in BCDEB

$$-7I_2 - 12 + 6(I_1 - I_2) = 0$$

$$-7I_2 + 6I_1 - 6I_2 = 12$$

$$6I_1 - 13I_2 = 12 \quad \text{--- (2)}$$

Solve eq (1) and (2)

$$\text{(1)} \Rightarrow -11I_1 + 6I_2 = -24$$

$$\text{(2)} \Rightarrow 6I_1 - 13I_2 = 12$$

$$6 \times \text{(1)} \Rightarrow -66I_1 + 36I_2 = -144 \quad \text{--- (+)}$$

$$11 \times \text{(2)} \Rightarrow 66I_1 - 143I_2 = 132$$

$$\hline -107I_2 = -12$$

$$\hat{I}_2 = \frac{-12}{-107}$$

$$\hat{I}_2 = 0.11 \text{ A}$$

Sub. $\hat{I}_2$ in eq ①.

$$\textcircled{1} \Rightarrow -11\hat{I}_1 + 6(0.11) = -24$$

$$-11\hat{I}_1 + 0.66 = -24$$

$$-11\hat{I}_1 = -24 - 0.66$$

$$-11\hat{I}_1 = -24.66$$

$$\hat{I}_1 = \frac{24.66}{11}$$

$$\hat{I}_1 = 2.24 \text{ A}$$

Current across 6Ω

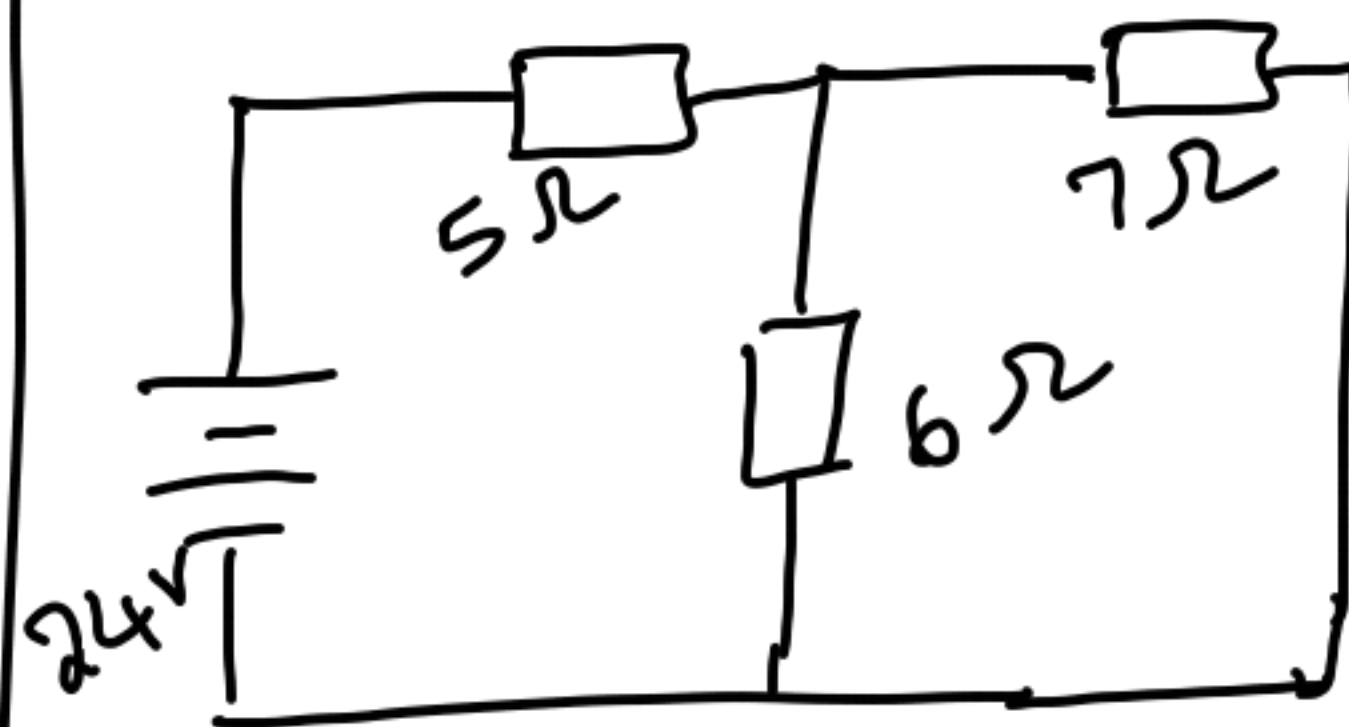
$$\begin{aligned}\hat{I}_1 - \hat{I}_2 &= 2.24 - 0.11 \\ &= 2.13 \text{ A}\end{aligned}$$

$$\hat{I}_{A1} = 2.24 \text{ A}$$

$$\hat{I}_{A2} = 0.11 \text{ A}$$

$$\hat{I}_{A3} = 2.13 \text{ A}$$

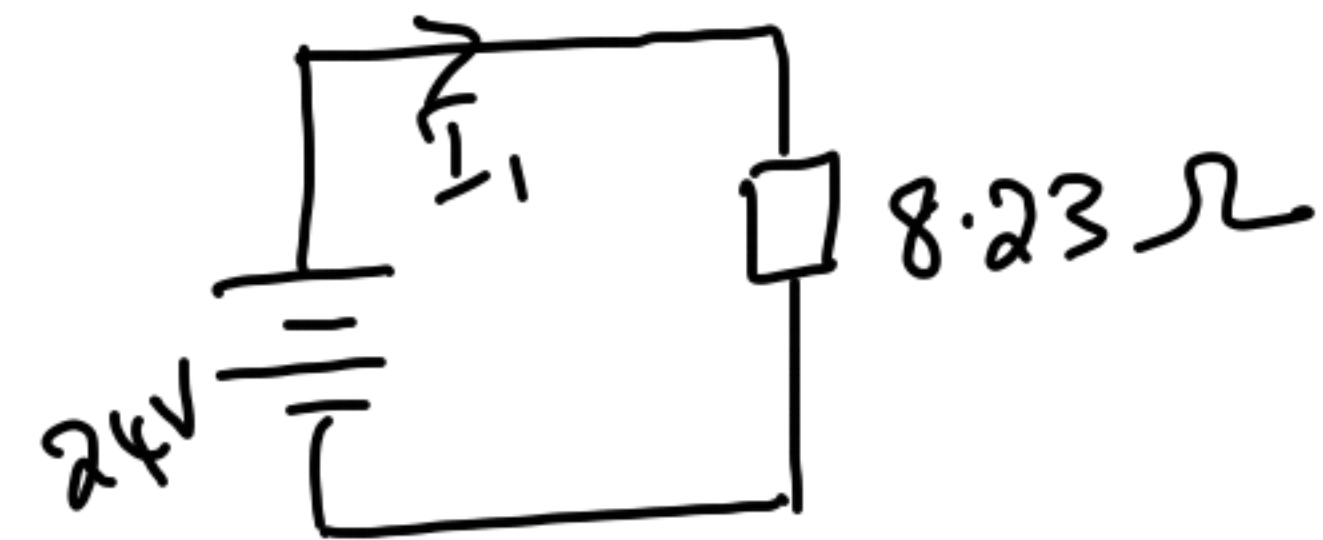
Circuit with V_1



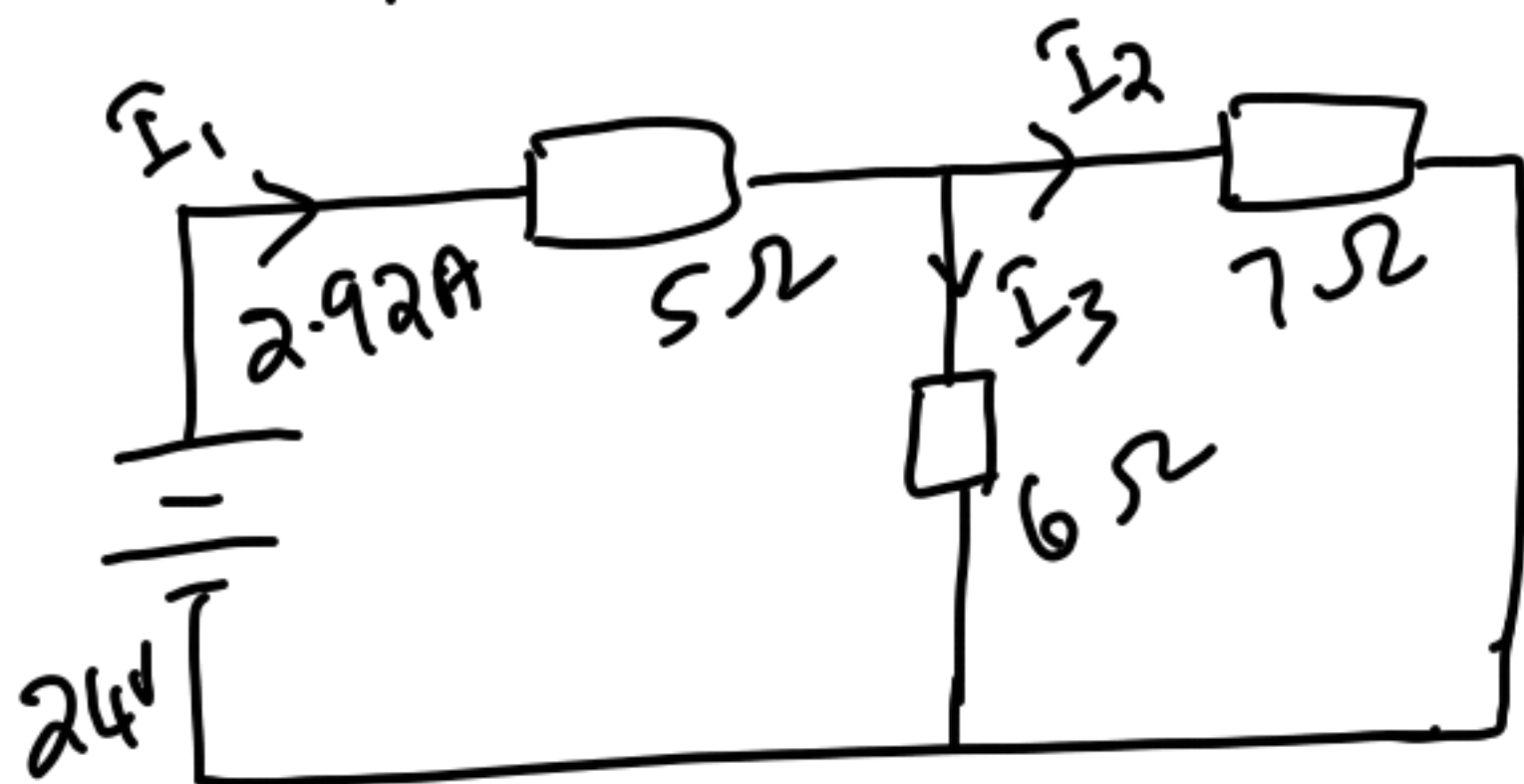
6Ω and 7Ω are in parallel.

$$R_{eq1} = \frac{1}{\left(\frac{1}{6}\right) + \left(\frac{1}{7}\right)} = 3.23 \Omega$$

$$\begin{aligned}R_{eq} &= 3.23 + 5\Omega \\ &= 8.23 \Omega\end{aligned}$$



$$I_1 = \frac{V}{R} = 2.92 \text{ A}$$



CPR

$$I_2 = \frac{I_1 \cdot 6}{6 + 7} = \frac{2.92 \times 6}{13}$$

$$I_2 = 1.35 \text{ A}$$

$$I_3 = \frac{I_1 \cdot 7}{6 + 7}$$

$$I_3 = \frac{2.92 \times 7}{13}$$

$$I_3 = 1.57 \text{ A}$$

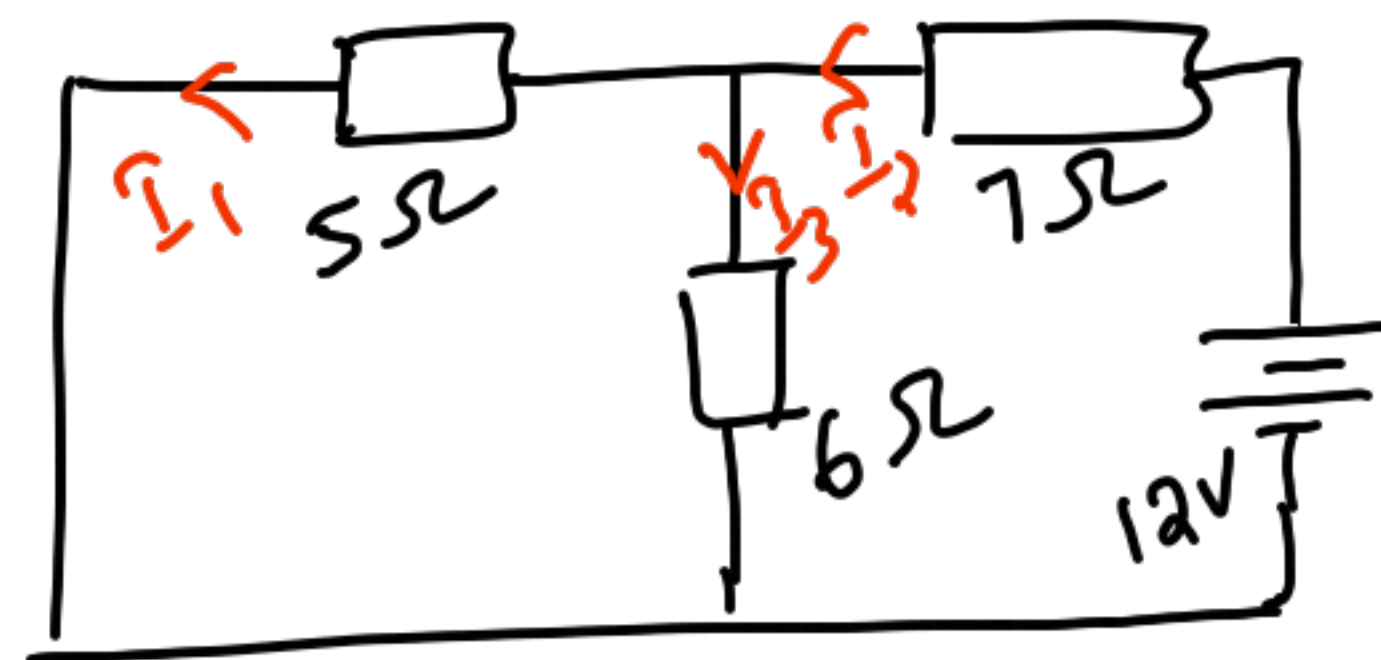
II

$$I_{B1} = 2.92 \text{ A}$$

$$I_{B2} = 1.35 \text{ A}$$

$$I_{B3} = 1.57 \text{ A}$$

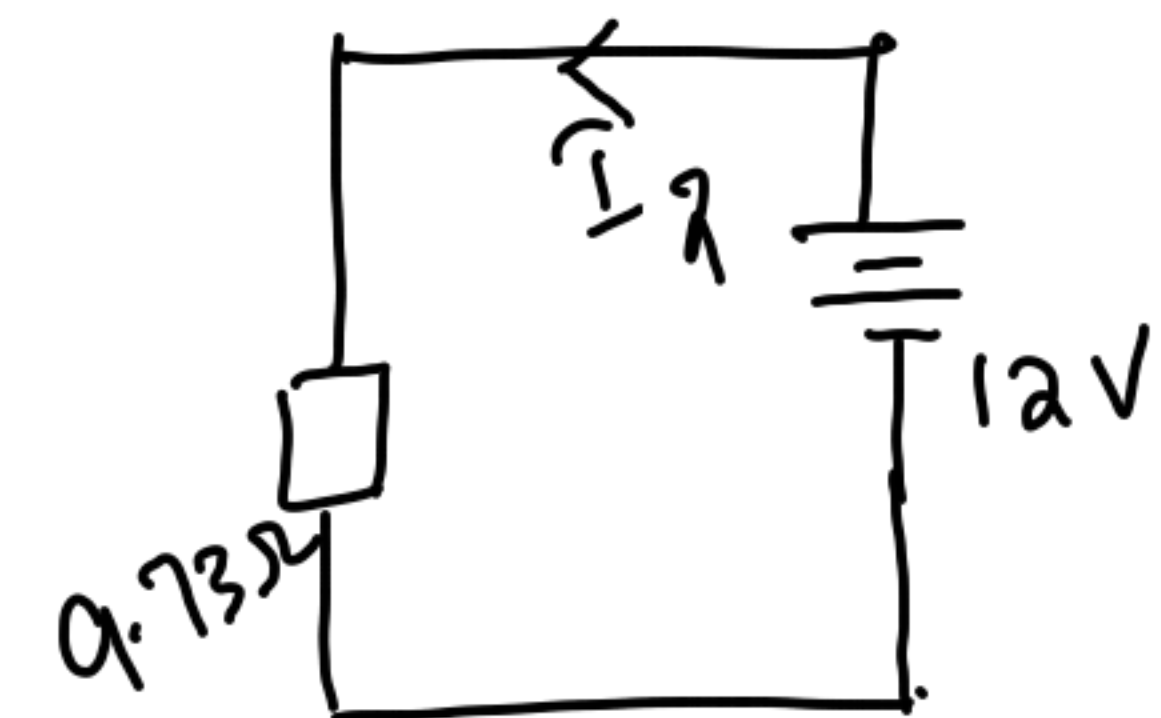
Circuit with V_2 .



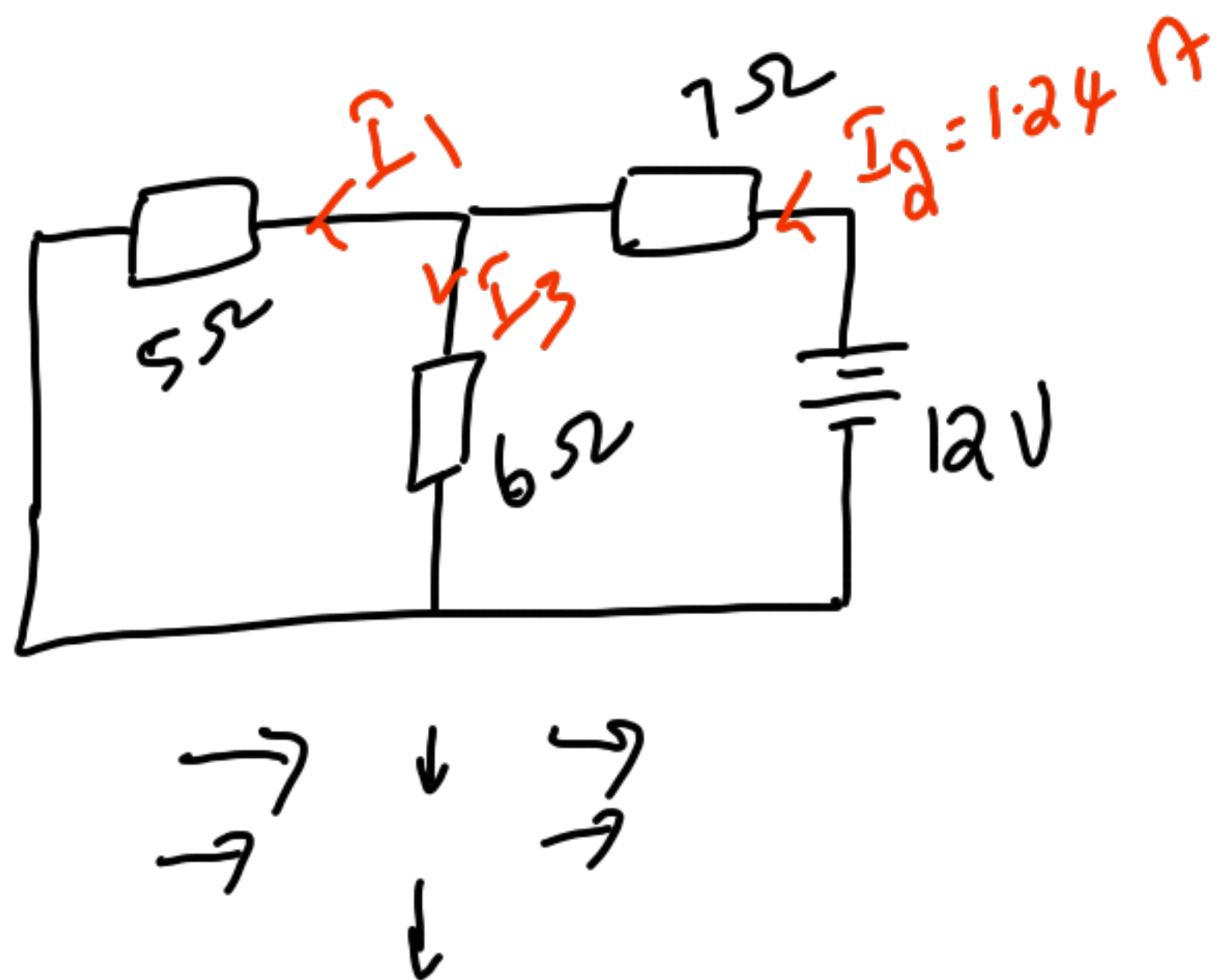
5 ohm and 6 ohm are Parallel.

$$R_{eq1} = \frac{1}{\frac{1}{5} + \frac{1}{6}} = 2.73 \text{ ohm}$$

$$R_{eq} = 2.73 + 7 = 9.73 \text{ ohm}$$



$$I_2 = \frac{12}{9.73} = 1.24 \text{ A}$$



$$I_1 = \frac{1.24 \times 6}{5 + 6} = 0.67 \text{ A}$$

$$I_3 = \frac{1.24 \times 5}{5 + 6} = 0.56 \text{ A}$$

III.

$$I_{C1} = 0.67 \text{ A}$$

$$I_{C2} = 1.24 \text{ A}$$

$$I_{C3} = 0.56 \text{ A}$$

(A) $\Rightarrow V_1$ & V_2

(B) $\Rightarrow V_1$

(C) $\Rightarrow V_2$

$$\begin{aligned}\hat{I}_{A1} &= \hat{I}_{B1} + \hat{I}_{C1} \\ &= 2.92 + (-0.67)\end{aligned}$$

$$\hat{I}_{A1} = 2.25 \text{ A}$$

$$\boxed{\hat{I}_{A1} \approx 2.24 \text{ A}}$$

$$\begin{aligned}\hat{I}_{A2} &= \hat{I}_{B2} + \hat{I}_{C2} \\ &= 1.35 + (-1.24)\end{aligned}$$

$$\hat{I}_{A2} = 0.11 \text{ A}$$

$$\boxed{\hat{I}_{A2} = 0.11 \text{ A}}$$

$$\begin{aligned}\hat{I}_{A3} &= \hat{I}_{B3} + \hat{I}_{C3} \\ &= 1.57 + 0.56\end{aligned}$$

$$\hat{I}_{A3} = 2.12 \text{ A}$$

$$\boxed{\hat{I}_{A3} \approx 2.13 \text{ A}}$$

