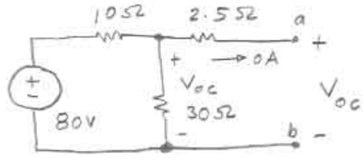
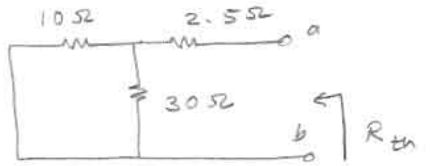
4.59



VDR ⇒

$$V_{oc} = \frac{30}{10+30} \times 80 = 60V = V_{th}$$

Set all independent sources to zero ⇒

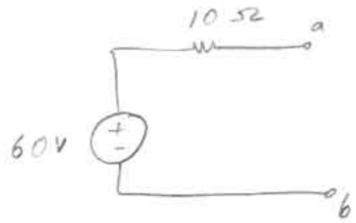


$$R_{th} = 10 // 30 + 2.5$$

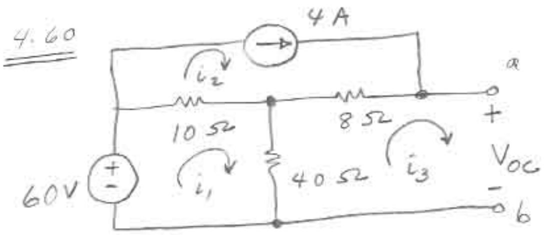
$$= \frac{300}{40} + 2.5$$

$$= 7.5 + 2.5 = 10\,\Omega$$

∴ Thevenin's Equivalent Circuit:



4.60



$$V_{oc} = ?$$

Use mesh analysis: $i_3 = 0$ A (because of the open circuit).

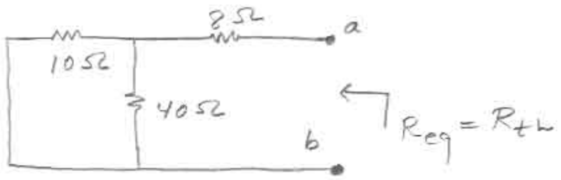
$i_2 = 4$ A

KVL around mesh 1 ⇒ $-60 + 10(i_1 - 4) + 40 i_1 = 0$

$\therefore\ i_1 = 2\text{ A}$

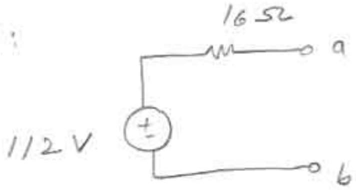
$V_{oc} = 4 \times 8 + 40 i_1 = 32 + 40 \times 2 = 112\text{ V} = V_{th}$

To find R_{th}, set all independent sources to zero:

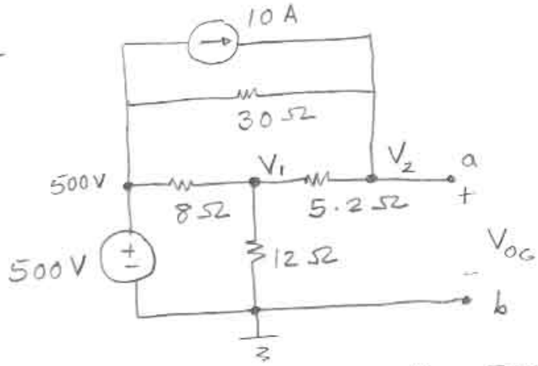


$R_{th} = 10 /\!/ 40 + 8 = \frac{400}{50} + 8 = 8 + 8 = 16\,\Omega$

Ans:



4.61



KCL at node 1 $\Rightarrow$ $\frac{V_1 - 500}{8} + \frac{V_1}{12} + \frac{V_1 - V_2}{5.2} = 0$

$15.6(V_1 - 500) + 10.4 V_1 + 24(V_1 - V_2) = 0$

$50V_1 - 24V_2 = 7800$

$25V_1 - 12V_2 = 3900$ (1)

KCL at node 2 $\Rightarrow$

$$\frac{V_2 - V_1}{5.2} + \frac{V_2 - 500}{30} - 10 = 0$$

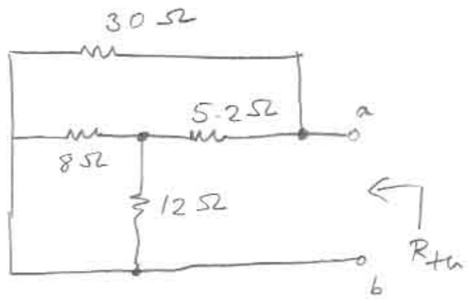
$$30(V_2 - V_1) + 5.2(V_2 - 500) - 1560 = 0$$

$$-30V_1 + 35.2V_2 = 4160$$

$150V_1 - 176V_2 = -20800$ (2)

solving for $V_2 = 425 = V_{th}$

Set all independent sources to zero $\Rightarrow$

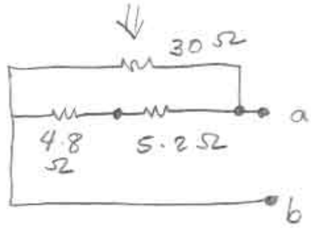


8 Ω & 12 Ω are in parallel

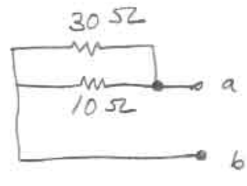
$\Downarrow$

$$\frac{8 \times 12}{8+12} = 4.8\ \Omega$$

$\Downarrow$

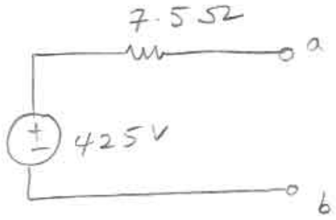


$\Rightarrow$



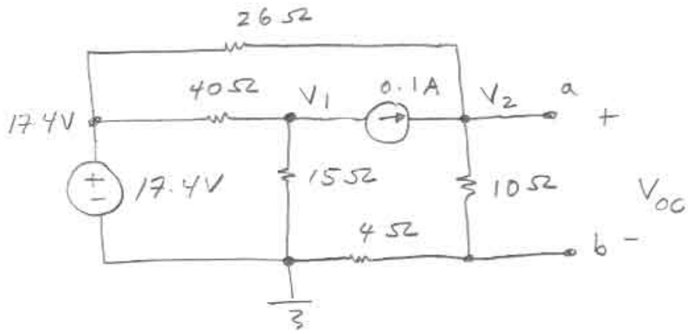
$\therefore R_{th} = 30 // 10 = \frac{300}{40} = 7.5\,\Omega$.

Ans:



4.64

a)

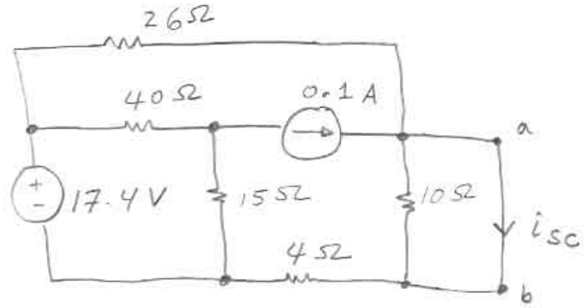


KCL at node 2 $\Rightarrow$ $-0.1 + \frac{V_2}{14} + \frac{V_2 - 17.4}{26} = 0$

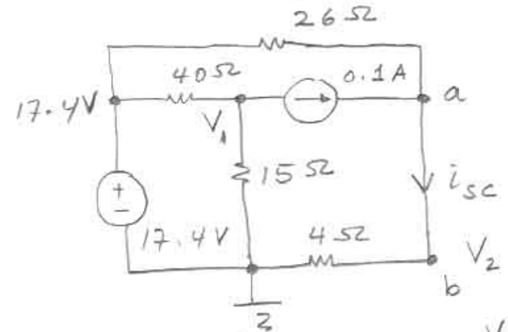
(Decoupled equation)

$\Rightarrow V_2 = 7\,V$, Use VDR $\Rightarrow$

$$V_{oc} = \frac{10}{4+10} \times V_2 = \frac{10}{14} \times 7 = 5\,V = V_{th}$$



$\Downarrow$



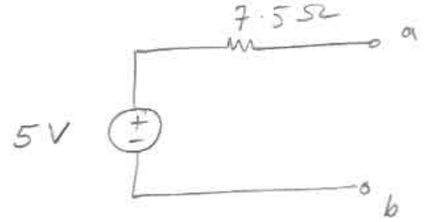
KCL at node 2 $\Rightarrow$ $\dfrac{V_2}{4} + \dfrac{V_2 - 17.4}{26} - 0.1 = 0$

(Decoupled eqn.) $\Rightarrow$ $V_2 = \dfrac{8}{3}$ V

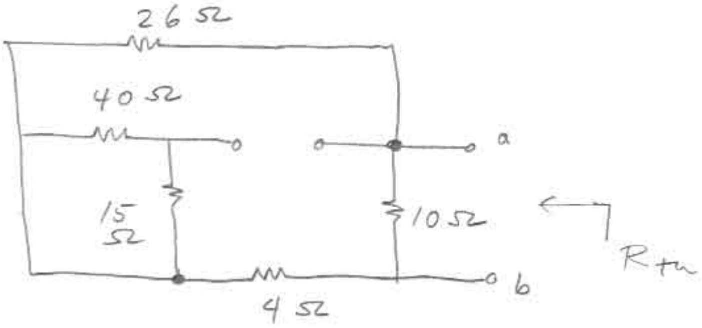
$\therefore\ i_{sc} = \dfrac{V_2}{4} = \dfrac{8/3}{4} = \dfrac{8}{12} = \dfrac{2}{3}$ A.

$\therefore\ R_{th} = \dfrac{V_{oc}}{i_{sc}} = \dfrac{5}{2/3} = \dfrac{15}{2} = 7.5\,\Omega$

Ans.



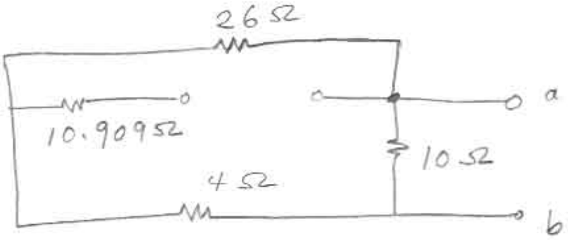
b) To find R_{th} by removing the independent sources $\Rightarrow$



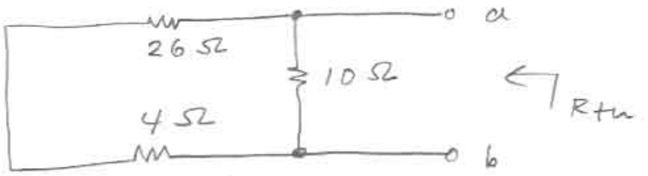
$\Downarrow$

40 Ω & 15 Ω are in parallel

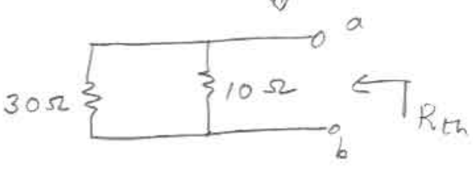
$$\frac{40 \times 15}{40+15} = 10.909\ \Omega$$



$\Downarrow$



$\Downarrow$

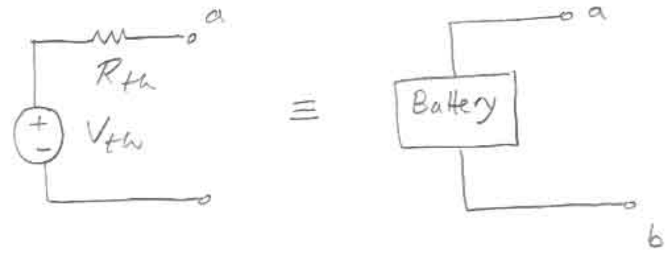


$R_{th} = 30 // 10 = 7.5\ \Omega$

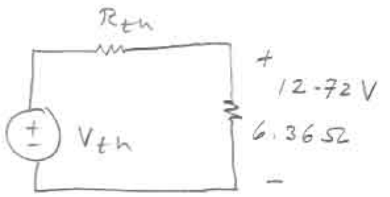
(Same answer)

4.66

Model the battery using a Thevenin model:



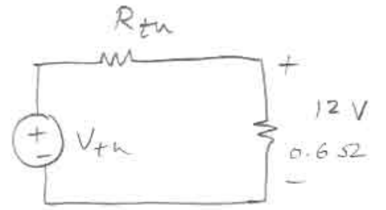
Then use the given information to find V_{th} & R_{th}.



⇐ Radio connected

$$12.72 = \frac{6.36}{R_{th} + 6.36} \times V_{th}$$

$$\therefore \; 12.72\, R_{th} + 80.899 = 6.36\, V_{th} \quad (1)$$

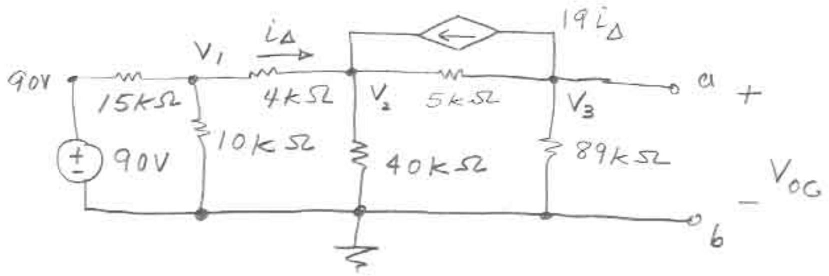


⇐ Headlight connected

$$12 = \frac{0.6}{R_{th} + 0.6} \times V_{th} \Rightarrow 12 R_{th} + 7.2 = 0.6\, V_{th} \quad (2)$$

solve (1) & (2) $\Rightarrow V_{th} = 12.8\text{ V}$ & $R_{th} = 40\text{ m}\Omega$

Use source transformation to find Norton Equivalent $\Rightarrow I_N = \dfrac{V_{th}}{R_{th}} = \dfrac{12.8}{40 \times 10^{-3}} = 320\text{ A}$, $R_N = 40\text{ m}\Omega$.



KCL at nodes 1, 2, and 3 ⟹

$$\frac{V_1 - 90}{15k} + \frac{V_1}{10k} + \frac{V_1 - V_2}{4k} = 0 \quad (1)$$

$$\frac{V_2 - V_1}{4k} + \frac{V_2}{40k} + \frac{V_2 - V_3}{5k} - 19 i_\Delta = 0 \quad (2)$$

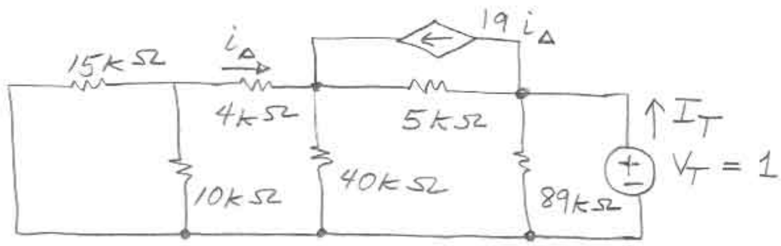
$$19 i_\Delta + \frac{V_3 - V_2}{5k} + \frac{V_3}{89k} = 0 \quad (3)$$

subtitute $i_\Delta = \frac{V_1 - V_2}{4k}$ into eqns. (2) & (3), then solve.

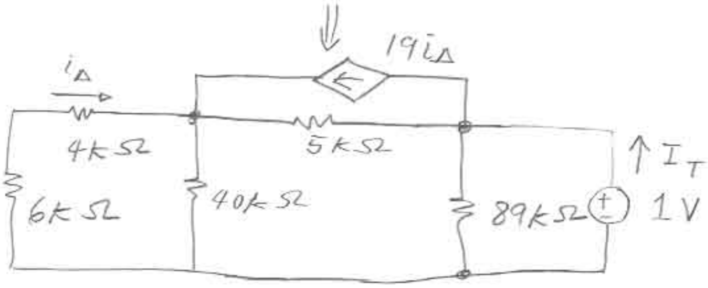
$V_1 = 32.75V$, $V_2 = 30.58 V$, $V_3 = V_{OC} = V_{th} = -19.8V$

To find R_{th}, you <u>can</u> use the short circuit method and solve for i_{sc} using mesh analysis.

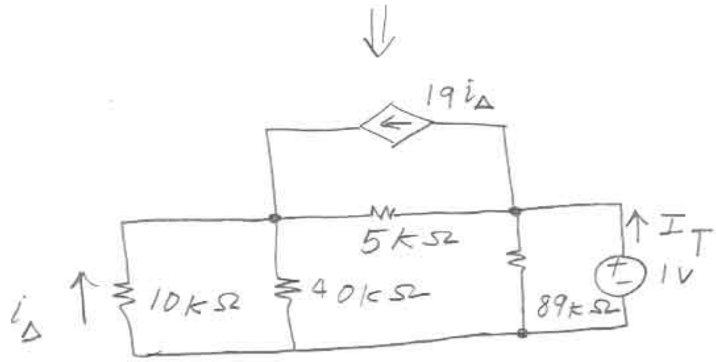
Alternatively, you can set all independent sources to zero and use a test voltage source ⟹

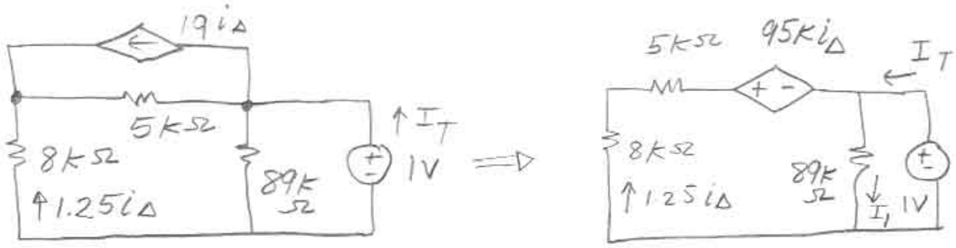


⇓



⇓





$$KVL \Rightarrow -1 - 95k\, i_\Delta - 13k(1.25 i_\Delta) = 0$$

$$i_\Delta = -8.989\ \mu A, \quad i_1 = \frac{1}{89K} = 11.24\ \mu A$$

$$\therefore\ I_T = -1.25 i_\Delta + I_1 = 22.476\ \mu A, \quad R_{th} = \frac{1}{22.476\mu}$$

$$= 44.49\ k\Omega$$