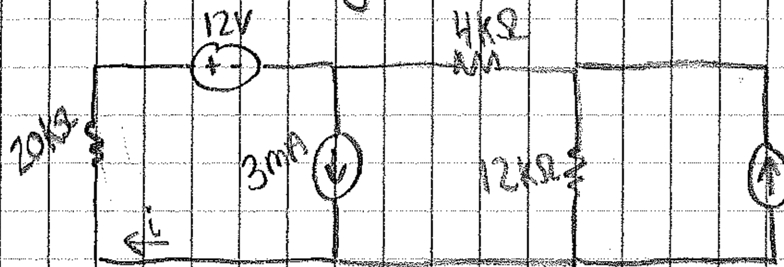
HW # 5

Jared Fowler

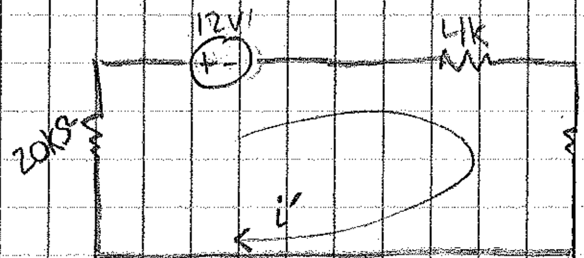
1) Find i using superposition.



3 Sources

12V, 3mA, 9mA

Keep 12V, Kill others



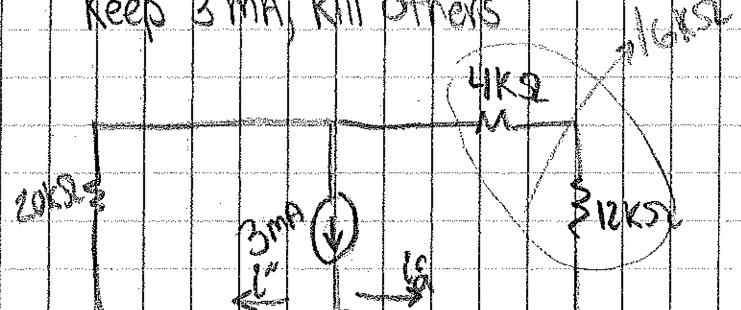
Using KVL:

$$20k(i') + 12V + 4k(i') + 12k(i') = 0$$

$$i' = -12/(20k + 4k + 12k)$$

$$i' = -\tfrac{1}{3}\,mA \quad (1)$$

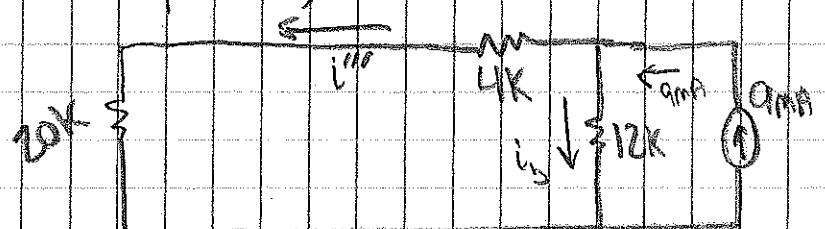
Keep 3 mA, Kill others



Use Current Division:

$$i'' = 3mA\left(\frac{16k}{36k}\right) = \cancel{3}mA\left(\frac{4}{\frac{\cancel{9}}{3}}\right) = \tfrac{4}{3}\,mA \quad (2)$$

Keep 9 mA, kill others



Use Current Division

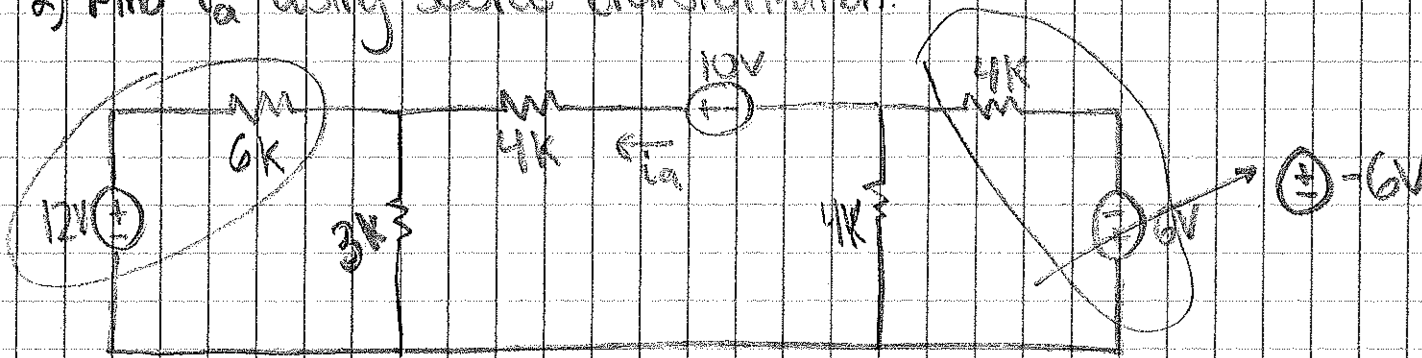
$$i''' = 9mA\left(\frac{12K}{36K}\right) = 9mA\left(\frac{1}{3}\right) = 3mA \quad (3)$$

So: $i = i' + i'' - i'''$

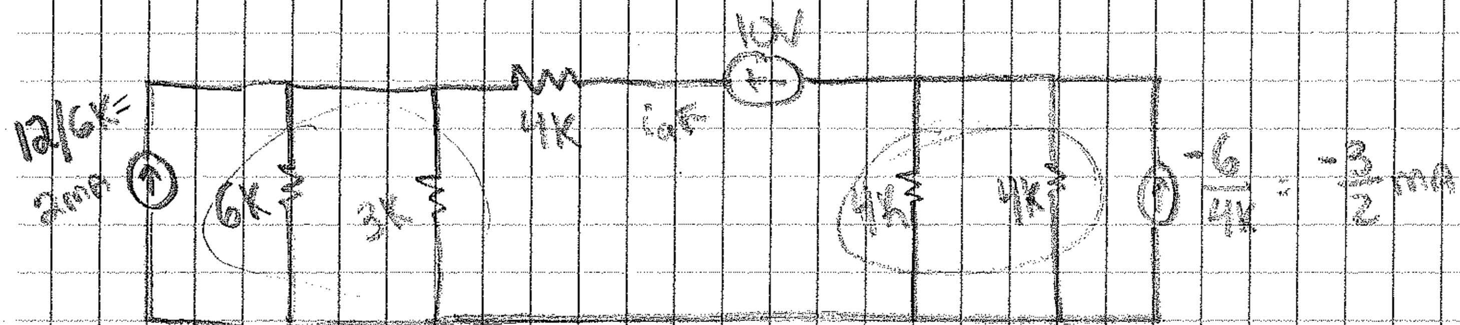
$$= -\tfrac{1}{3}mA + \tfrac{4}{3}mA - 3mA$$

$$\boxed{i = -2\,mA}$$

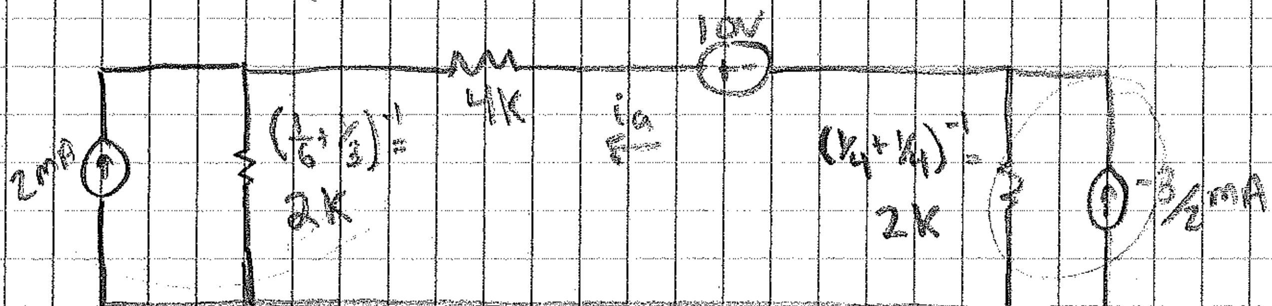
2) Find i_a using source transformation.



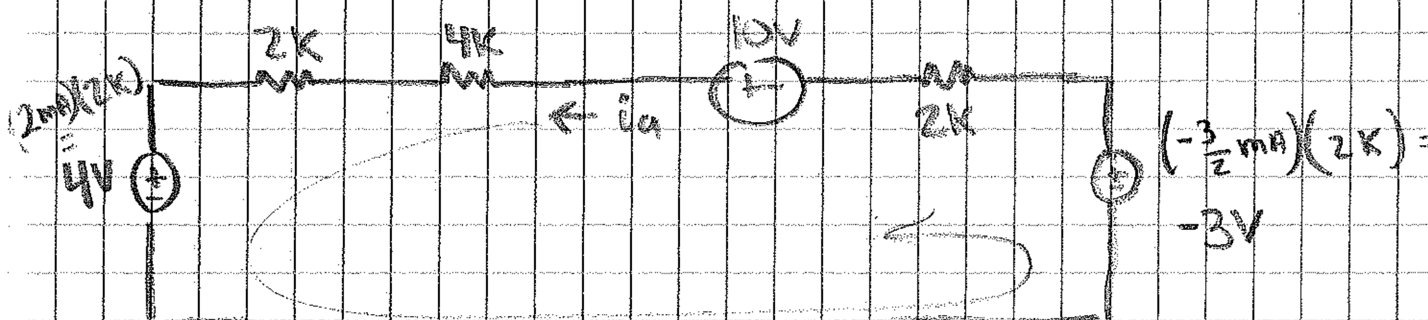
T → N T → N



use equivalance rule for parallel resistors



N → T N → T

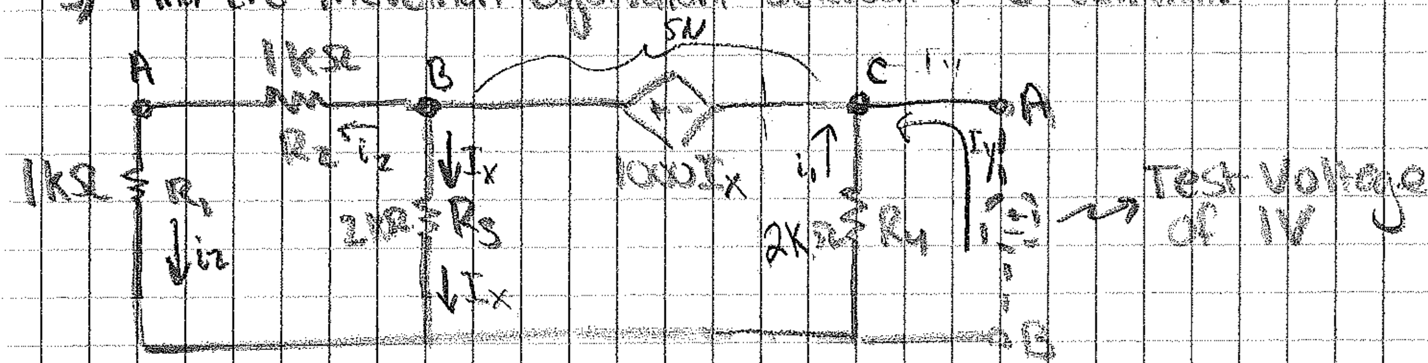


Use KVL:

$$(4K)(i_a) + (2k)(i_a) + 4V - (-3V) + (2K)(i_a) - 10V = 0$$

$$(8K)(i_a) - 3V = 0 \rightarrow \boxed{i_a = 3/8 \text{ mA}} = \boxed{375 \mu A}$$

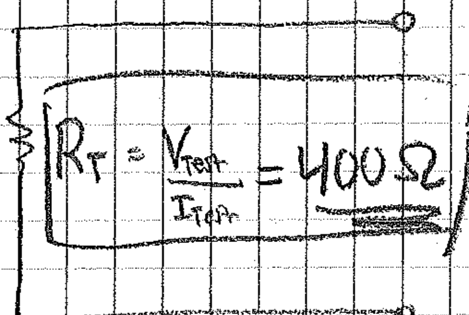
3) Find the Thevienen equivalent between A-B terminal.



Note: In a all dependent circuit, there is no voltage output in the Thevenin equivalent. What we are trying to find is the equivalent resistance of the entire circuit, R_T, such that I_T is the same regardless of voltage

For example: if $(V_M/I_M) = R_T \rightarrow (V_N/I_N) = R_T$

So, want to find:



Let $V_{Test} = V_o = 1V$

Note: $i_2 = i_2 \Rightarrow \frac{V_A - \cancel{0}}{\cancel{1k}} = \frac{V_B - V_A}{\cancel{1k}} \Rightarrow 2V_A = V_B$ (1)

KCL @ Super Node:

Note: $V_B - V_c = 1000I_x$ & $I_x = \frac{V_B}{2K}$

$I_y + i_1 = I_x + i_2$

$V_B - V_c = \frac{1k}{2k}V_B$

$I_y + \frac{0 - V_c}{2k} = \frac{V_B - 0}{2k} + \frac{V_B - V_A}{1k}$

$\frac{1}{2}V_B = V_c$ (2) $\rightarrow V_c = V_A$

$I_y - \frac{V_c}{2k} = \frac{V_B}{2k} + \frac{V_B}{1k} - \frac{V_A}{1k}$

& $V_c = 1V$... (4)

& $V_B = 2V$

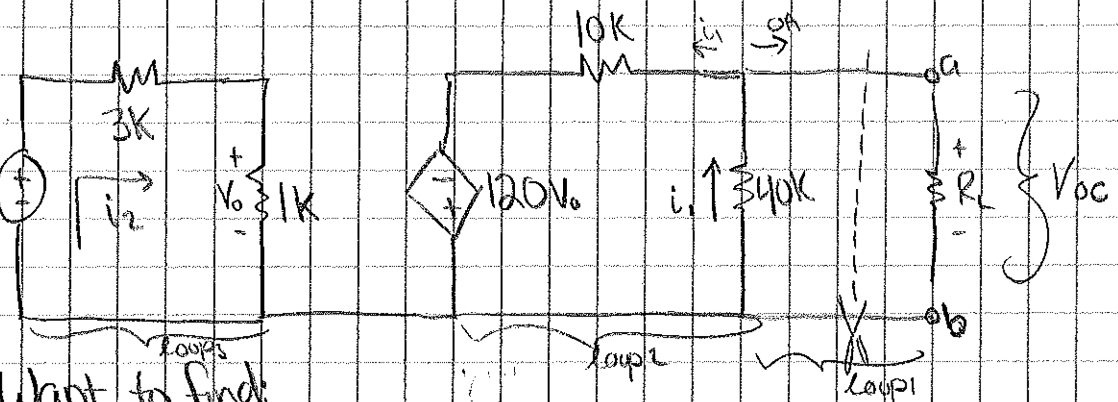
$(2k)I_y - V_c = \cancel{V_B + 2V_B}^{3V_B} - 2V_A$ (3)

$\therefore I_y = \frac{1}{400}A$ & $R_T = \frac{1}{1/400} = \boxed{400\Omega}$

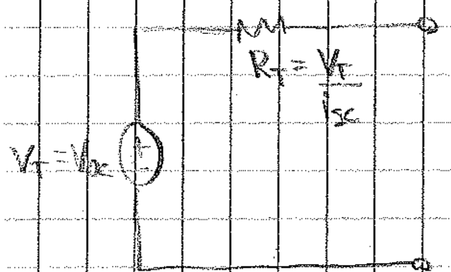
(1,2,3) $\Rightarrow (2k)I_y - (1V) = (6\cancel{V_c}^{1V}) - 2(1V)$

$(2k)I_y = 5V \Rightarrow I_y = 5V/2k$

4) For the circuit below, what resistor connected across terminals a-b will absorb maximum power from the circuit? What is that power?



Want to find:



KVL @ Loop1

(1) $V_{oc} + (40k)(i_1) = 0$

KVL @ loop2

$((40k)i_1) + (10k)i_1 - 120V_o = 0$

(2) $(50k)i_1 - 120V_o = 0$

KVL @ loop3

$-8V + 3K(i_2) + 1K(i_2) = 0$

$-8V + 4K(i_2) = 0$ where $V_o = (1K)\overset{2mA}{i_2}$

$4Ki_2 = 8$

$\underline{i_2 = 2mA}$ (3)

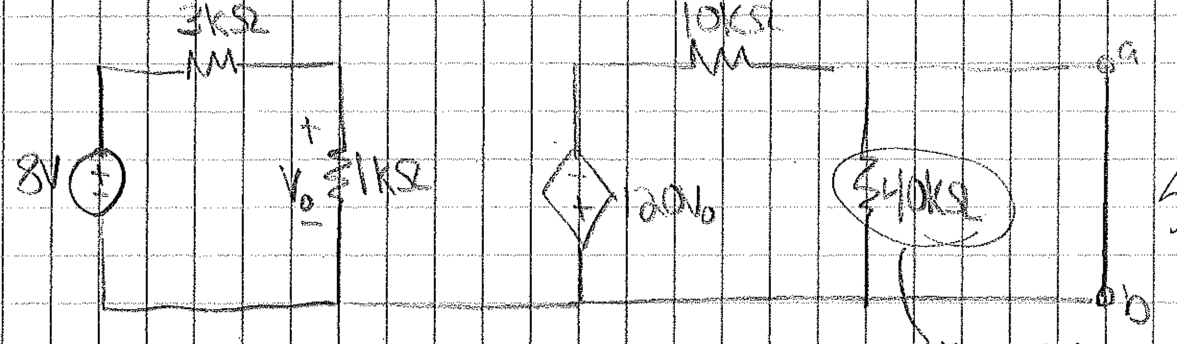
$\underline{V_o = 2V}$ (4)

$(2,4) \rightarrow (50k)i_1 - 120(2) = 0$

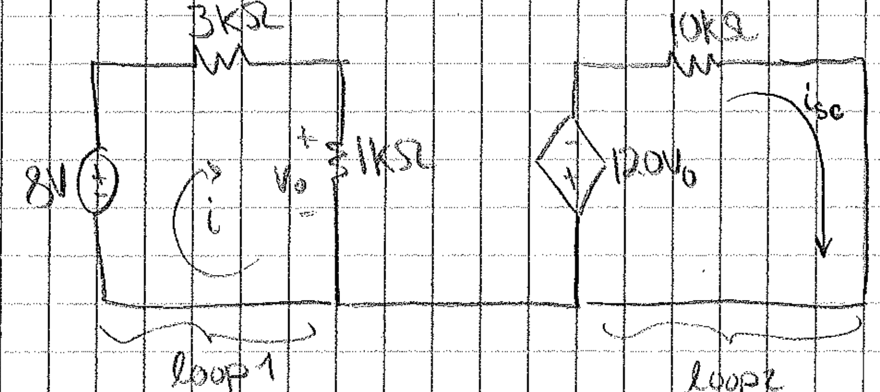
$\underline{i_1 = 24/5 \text{ mA}}$ (5)

$(5,1) \rightarrow V_{oc} + \overset{8}{\cancel{40}}K(24/\cancel{5}\text{ mA}) = 0 \rightarrow \boxed{V_{oc} = -192V}$

continue



Now 0V accross... so just a wire



KVL @ loop 1:

$-8V + 3Ki + 1Ki = 0$; $V_o = 1Ki$

$8V = +4Ki$

$\underline{i = +2mA}$; $\underline{V_o = +2V}$

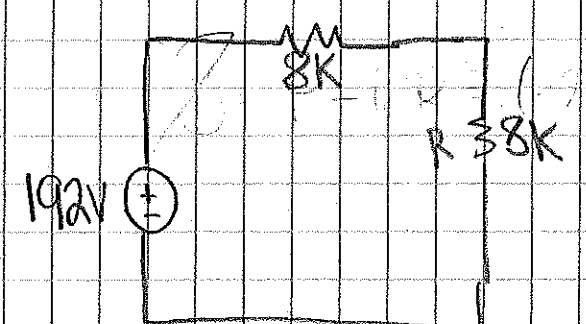
KVL @ loop 2:

$120V_o + 10K i_{sc} = 0$

$120(+2) + 10K i_{sc} = 0$

$\underline{i_{sc} = -24mA}$

$\therefore \quad R_T = \dfrac{V_T}{i_{sc}} = \dfrac{-192V}{-24mA} = \boxed{8K\Omega}$



Max power absorbed when $R = R_T$

$V = iR$

$192 = i(16K)$

$i = 192/16K = \dfrac{96}{8K} = \dfrac{12}{K} = \underline{12mA}$

Note: $P_{max} = \dfrac{V_{Th}^2}{4R_{Th}}$ $P = \dfrac{192^2}{4(8K)} = \boxed{1.152W}$