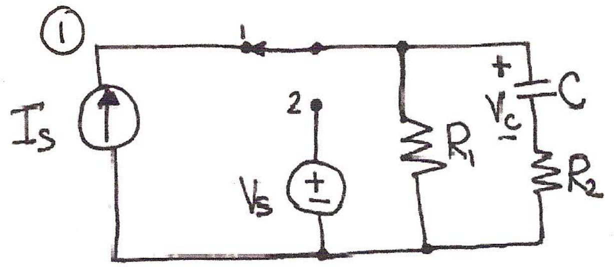
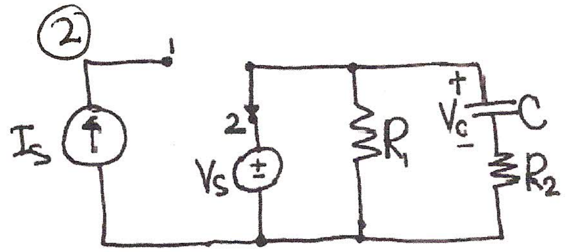
5.



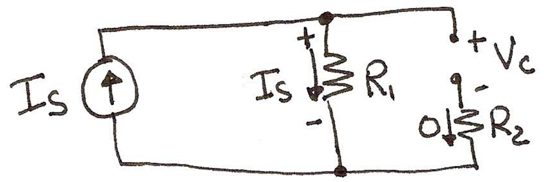


After being in position 1(left circuit) for a long time, the switch moves to position 2 at t=0(right circuit).

a) Write an expression for $v_C(t > 0)$ in terms of no more than R_1, R_2, V_s, I_s, and C.

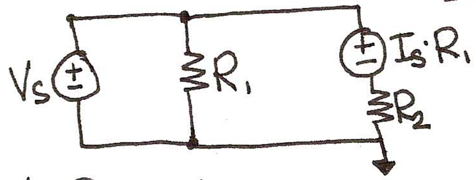
b) Write an expression for the energy stored on the capacitor as $t \to \infty$ in terms of no more than R_1, R_2, V_s, I_s, and C.

circuit ① at $(t=0^-)$: · cap open, find V_c



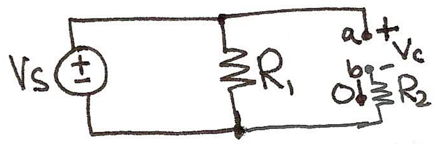
$V_c = I_s \cdot R_1$

circuit ② at $(t=0^+)$: · cap keeps value at $(t=0^-)$ {V src.}
· INITIAL VALUE from this circuit



$V_c = I_s R_1$

circuit ② at $(t \to \infty)$: · cap open , · tau, τ, found for this circuit



$V_c = V_s$

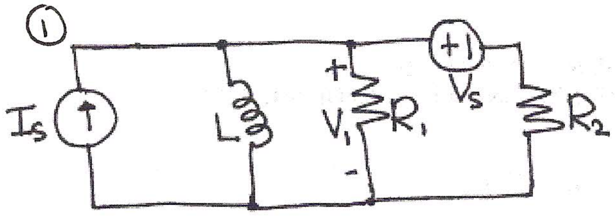
$R_{th} = R_2$ (V_s becomes short)

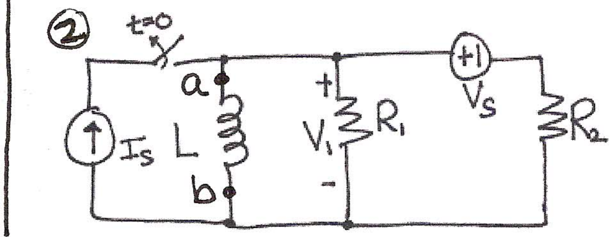
$\tau = R_2 C$

a) $\boxed{V_c(t \geq 0) = \left[V_s + (I_s R_1 - V_s) e^{-t/R_2 C}\right] V}$

b) $w_c(t \to \infty) = \boxed{\frac{1}{2} C V_s^2}$

6.



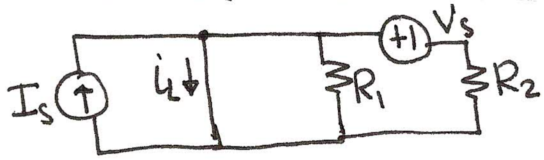


After being closed(left circuit) for a long time, the switch opens at $t = 0$(right circuit).

a) Write an expression for $v_1(t > 0)$ in terms of no more than R_1, R_2, V_S, I_S, and L.

b) Write an expression for the energy stored on the inductor as $t \to \infty$ in terms of no more than R_1, R_2, V_S, I_S, and L.

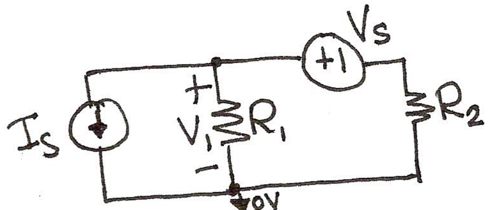
circuit ① at $(t=0^-)$: • inductor wire, find i_L



$i_L = I_s$

circuit ② at $(t=0^+)$: • inductor currents, i_L, remains same {I src.}

• Find INITIAL VALUE at this time



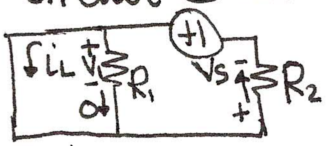
$$+I_s + \frac{V_1}{R_1} + \frac{(V_1 - V_s)}{R_2} = 0 \rightarrow V_1\left(\frac{1}{R_1} + \frac{1}{R_2}\right) = -I_s + \frac{V_s}{R_2}$$

$$\therefore V_1 = \left[-I_s + \frac{V_s}{R_2}\right](R_1 \| R_2)$$

circuit ② at $(t \to \infty)$: • inductor becomes wire

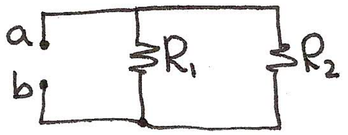
• find FINAL VALUE at this time

• find τ " " "



$V_1 = 0$

$$-i_L R_2 + V_s = 0$$
$$i_L = \frac{V_s}{R_2}$$



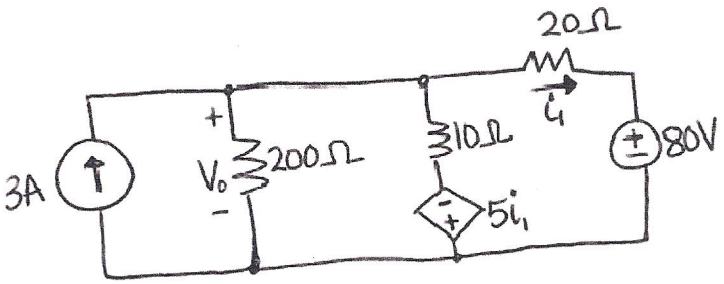
$R_{Th} = (R_1 \| R_2)$

$\tau = L/(R_1 \| R_2)$

a) $\boxed{V_1(t \geq 0) = \left[-I_s + \frac{V_s}{R_2}\right](R_1 \| R_2) e^{-t/\left[\frac{L}{R_1 \| R_2}\right]} \text{ V}}$

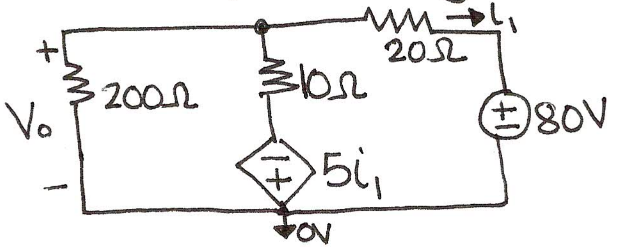
b) $w_L(t \to \infty) = \frac{1}{2} L i_L^2(t \to \infty) = \boxed{\frac{1}{2} L \cdot \frac{V_s^2}{R_2^2}}$

7.



Using superposition, derive a value for i_1.

Case I: Turn 3A off, 80V stays on. Dependent source ALWAYS stays.



$$i_1 = \frac{(V_0 - 80)}{20}$$

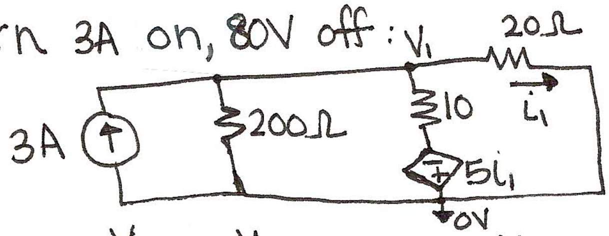
$$\frac{V_0}{200} + \frac{(V_0 + 5i_1)}{10} + \frac{(V_0 - 80)}{20} = 0$$

$$\frac{V_0}{200} + \frac{V_0(20)}{200} + \frac{10V_0}{200} + \frac{1}{2}\left(\frac{V_0 - \cancel{80}}{20}\right) = +4 + 2$$

$$V_0\left(\frac{1}{200} + \frac{20}{200} + \frac{10}{200} + \frac{5}{200}\right) = +6\left(\frac{200}{36}\right) \Rightarrow V_0 = \frac{100}{3}\,V$$

$$① \; i_1 = \frac{10\cancel{0}}{6\cancel{0}} - \frac{80}{20} = \frac{5}{3} - \frac{12}{3} = -\frac{7}{3}\,A$$

Case II: Turn 3A on, 80V off:



$$-3 + \frac{V_1}{200} + \frac{(V_1 + 5i_1)}{10} + \frac{V_1}{20} = 0$$

$$i_1 = \left[\frac{V_1}{20}\right]$$

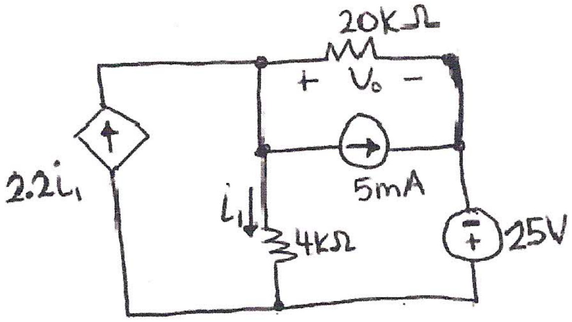
$$-3 + \frac{V_1}{200} + \frac{V_1}{10} + \frac{1}{2}\left[\frac{V_1}{20}\right] + \frac{V_1}{20} = 0$$

$$V_1\left[\frac{1}{200} + \frac{20}{200} + \frac{5}{200} + \frac{10}{200}\right] = 3\left[\frac{200}{36}\right] = \frac{200}{12} = \frac{50}{3}\,V$$

$$② \; i_1 = \frac{V_1}{20} = \frac{5}{6}\,A$$

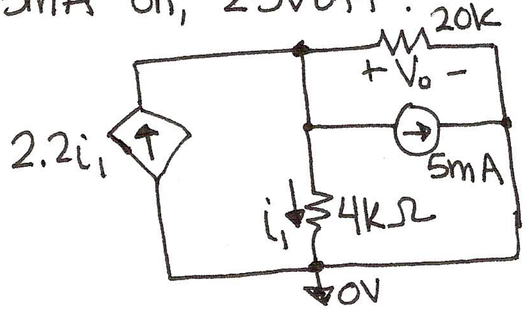
$$\text{Total } ① + ② = -\frac{7}{3} + \frac{5}{6} = \frac{-14 + 5}{6} = \frac{-9}{6} = \boxed{-\frac{3}{2}\,A}$$

8.



Case I: Using superposition, derive an expression for V_O.

5mA on, 25V off:



$$-2.2i_1 + i_1 + 5m + \frac{V_o}{20k} = 0$$

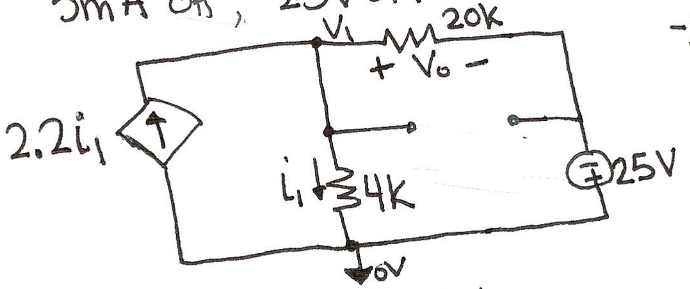
$$i_1 = \frac{V_o}{4k}$$

$$-1.2\left(\frac{V_o}{4k}\right) + 5m + \frac{V_o}{20k} = 0$$

$$V_o\left[\frac{-1.2}{4k} + \frac{1}{20k}\right] = -5m\left[\frac{20k}{1-1.2(5)}\right] = \underline{+20V}$$

Case II:

5mA off, 25V on:



$$-2.2\left[\frac{V_1}{4k}\right] + \left[\frac{V_1}{4k}\right] + \frac{(V_1+25)}{20k} = 0$$

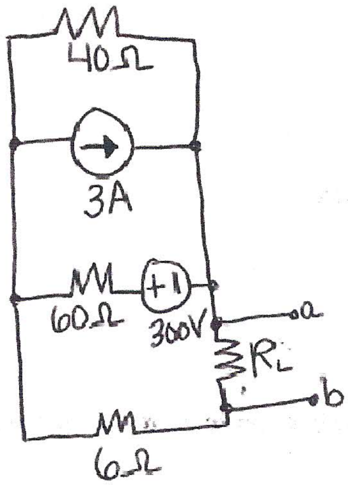
$$V_1\left[\frac{-2.2(5)+5+1}{20k}\right] = \frac{-25}{20k}$$

$$\therefore V_1 = \frac{-25}{20k}\left[\frac{20k}{-5}\right] = \underline{+5V}$$

$$V_o = V_1 + 25 = 30V$$

$$\text{Total } V_o = +20+30 = \boxed{+50V}$$

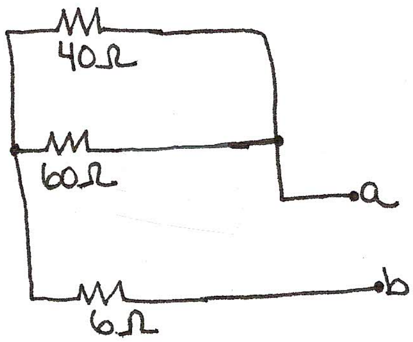
9.



a) Calculate the value of R_L that would absorb maximum power.

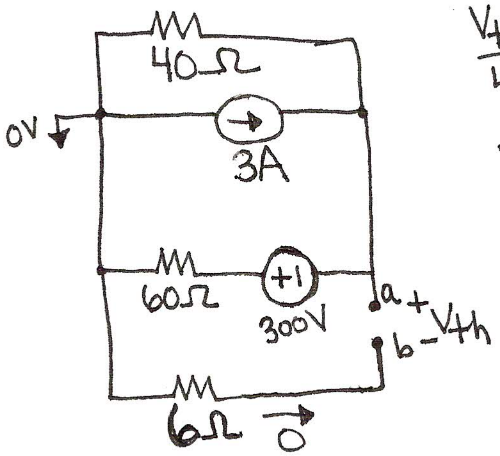
b) Calculate that value of maximum power R_L could absorb.

$R_L = R_{th}$



$$R_{th} = [60 \| 40] + 6 = 24 + 6 = 30\Omega$$

$$\boxed{R_L = 30\Omega}$$



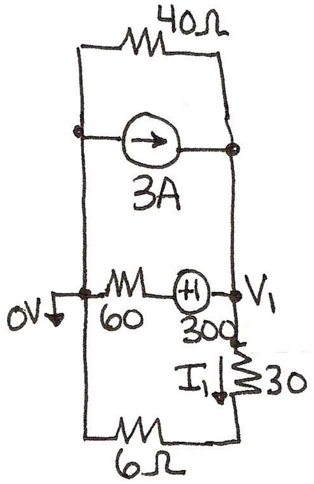
$$\frac{V_{th}}{40} - 3 + \frac{(V_{th} + 300)}{60} = 0$$

$$V_{th}\left[\frac{3+2}{120}\right] = \left[+3 - \frac{30}{6}\right]$$

$$V_{th} = \left[\frac{18-30}{6}\right]\left[\frac{120}{5}\right] = \frac{-240}{5} V$$

$$\text{power} = \frac{V_{th}^2}{4 \cdot R_{th}} = \left(\frac{-240}{5}\right)^2 \cdot \left(\frac{1}{4(30)}\right) = \boxed{19.2W}$$

9. OR



power $= [I_1^2 \cdot 30]$

Using node-V:

$$\frac{V_1}{40} - 3 + \left[\frac{V_1 + 300}{60}\right] + \frac{V_1}{36} = 0$$

$$V_1\left[\frac{1}{40} + \frac{1}{60} + \frac{1}{36}\right] = \left[+3 - \frac{30}{6}\right]$$

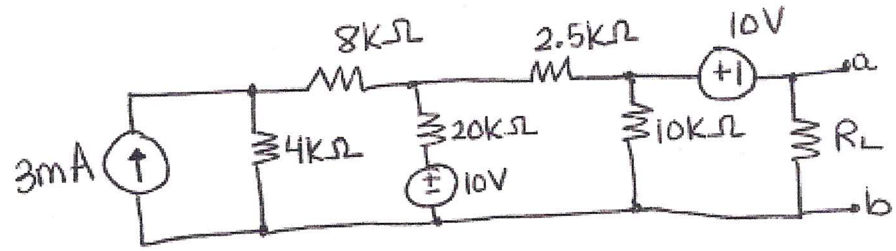
$$V_1[69.4m] = \left[\frac{18-30}{6}\right]$$

$$V_1 = -28.8V$$

$$I_1 = \frac{V_1}{36} = -0.8A$$

$$\text{power} = (-.8)^2 \cdot 30 = \boxed{+19.2W}$$

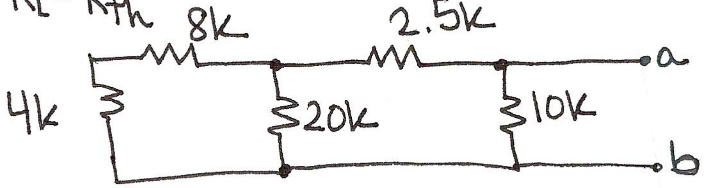
10.



a) Calculate the value of R_L that would absorb maximum power.

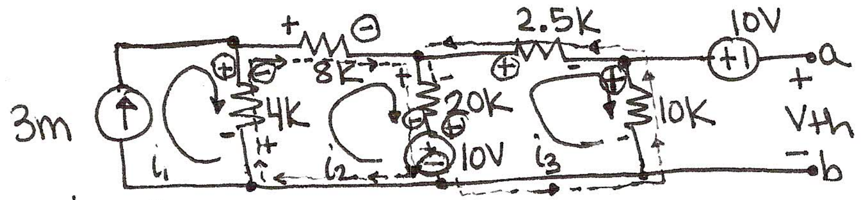
b) Calculate that value of maximum power R_L could absorb.

$R_L = R_{Th}$



$$R_{th} = 10K \| [2.5K + 12K \| 20K] = 10K \| (\underbrace{2.5K + 7.5K}_{10K}) = 5K\Omega$$

$$\boxed{R_L = 5K\Omega}$$



$V_{th} = i_3(10K) - 10$

$i_1 = 3m$

Eq 1: $4K(3m - i_2) - 8K i_2 + 20K(i_3 - i_2) - 10 = 0$

$$i_2(-4K - 8K - 20K) + 12 - 10 + 20K i_3 = 0$$

$$i_2(\cancel{32K}) = (+2 + 20K i_3)/32K$$

Eq. 2: $+20K(-i_2 + i_3) - 10 + i_3(12.5K) = 0$

$$+20K i_3 + 12.5K i_3 - 10 - 20K\left[\frac{2 + 20K i_3}{32K}\right] = 0$$

$$i_3\left(32.5K - 20K\left(\frac{20K}{32K}\right)\right) = +10 + 20K\left(\frac{2}{32K}\right)$$

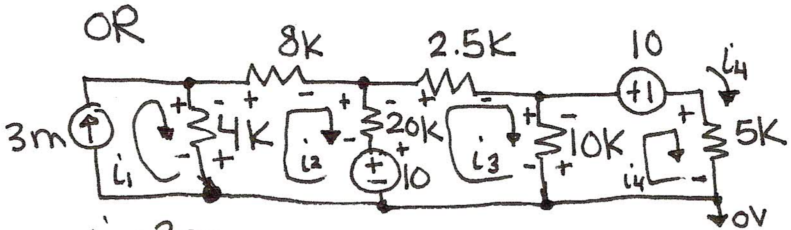
#10. $i_3(20K) = 11.25$

$i_3 = 562.5\mu A$

$V_{th} = 562.5\mu(10K) - 10V \cong -4.4$

$\text{power} = \frac{V_{th}^2}{4R_{th}} = \boxed{956\mu W}$

OR



$\text{power} = i_4^2 \cdot 5K$

$i_1 = 3m$

Eq 1: $4K(3m - i_2) - 8Ki_2 + 20K(i_3 - i_2) - 10 = 0$

$$i_2 = \left[\frac{2 + 20Ki_3}{32K}\right]$$

Eq. 2: $+20K(i_3 - i_2) - 10 + 2.5Ki_3 + 10K(i_3 - i_4) = 0$

$$-10Ki_4 + i_3(20K + 2.5K + 10K) - 20K\left[\frac{2 + 20Ki_3}{32K}\right] = +10$$

$$-10Ki_4 + i_3\left(32.5K - \frac{20K(20K)}{32K}\right) = \left[+10 + \frac{20K(2)}{32K}\right]$$

$$-10Ki_4 + i_3(20K) - 11.25 = 0$$

$$\cancel{10K}\, i_4 = \frac{-11.25 + i_3(20K)}{10K}$$

Eq. 3: $+10K(i_3 - i_4) - 10 - i_4(5K) = 0$

$$10Ki_3 - 10 - 15K\left[\frac{-11.25 + 20Ki_3}{10K}\right] = 0$$

$$i_3\left(10K - \frac{15K(20K)}{10K}\right) = +10 + 15K\left[\frac{-11.25}{10K}\right]$$

#10.

$$i_3(-20K) = +10K - 16.875$$

$$i_3 = \frac{-6.875}{-20K} = +343.75\mu A$$

$$i_4 = \frac{-11.25 + i_3(20K)}{10K} = \frac{-11.25 + (343.75\mu)20K}{10K}$$

$$i_4 = -437.5\mu A$$

$$\text{power} = (-437.5\mu)^2 \cdot 5K = \boxed{957\mu W}$$