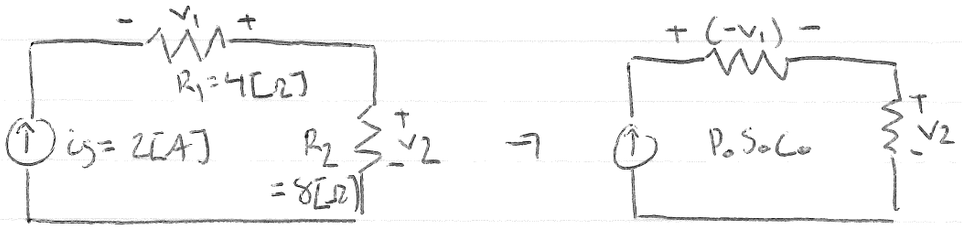
MEMS 0031 - Electrical Circuits - Homework #2 Solutions

#1:



Note: $i_S = i_1 = i_2$

$V_1 = (-R_1)\,i_1 = (-4[\Omega])(2[A]) = -8[V] = V_1$

$V_2 = R_2 \cdot i_2 = (8[\Omega])(2[A]) = 16[V] = V_2$ } P.S.C.

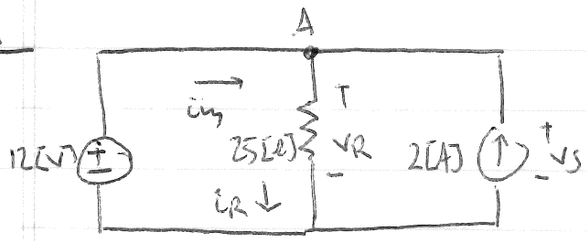
$P_1 = V_1 \cdot i_1 = (8[V])(2[A]) = 16[W] = P_1$

$P_2 = V_2 \cdot i_2 = (16[V])(2[A]) = 32[W] = P_2$

Sanity check: ΔV across current source $= 8 + 16 = 24[V]$

$P_{source} = \Delta V \cdot i_S = 24[V] \cdot 2[A] = 48[W]$ ✓

#2:



$V_R = V_S = 12[V]$

i_m: KCL @ Node A

$i_m + 2[A] = i_R$

$\rightarrow i_m = i_R - 2[A]$

$\therefore i_m = -1.52[A]$

Apply Ohm's Law: $(V = iR)$

$i_R = \frac{V_R}{R} = \frac{12[V]}{25[\Omega]} = 0.48[A]$

$P_{absorbed,R} = i_R V_R = (0.48[A])(12[V]) = 5.76[W]$

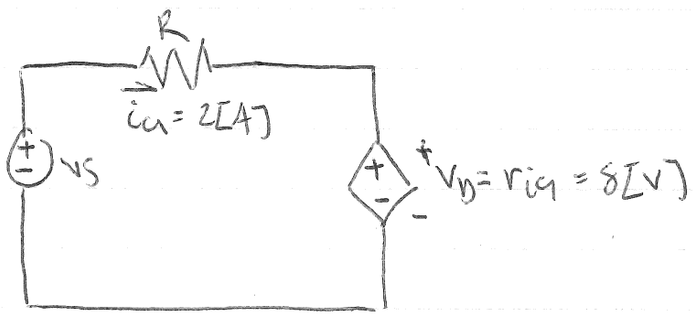
$P_{supplied,R} = -5.76[W]$

$P_{supplied,CS} = i_{CS} V_S = (2[A])(12[V]) = 24[W]$

$P_{supplied,VS} = i_m \cdot V = (-1.52[A])(12[V]) = -18.24[W]$

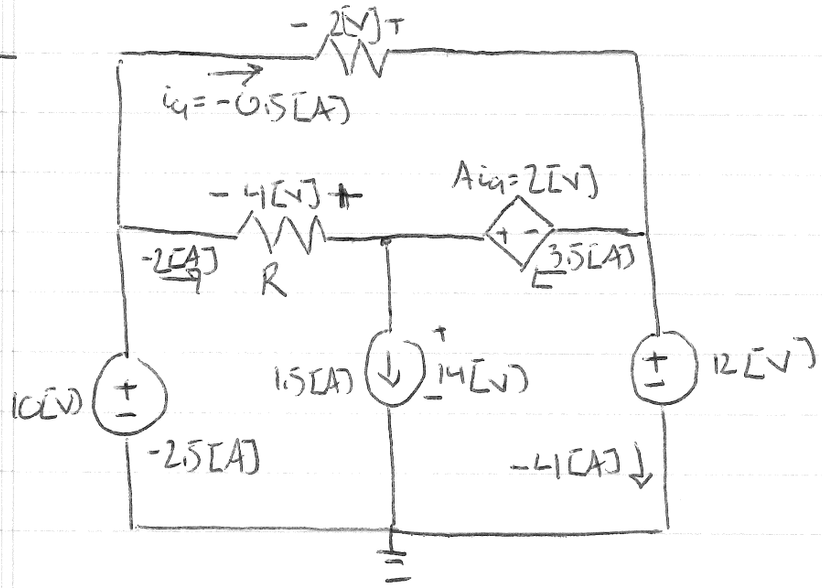
$\therefore \sum P_{supplied} + \sum P_{absorbed} = 0$

#3:

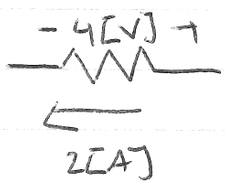


$$r = \frac{v_D}{i_q} = \frac{8[V]}{2[A]} = \boxed{4[\Omega]}$$

#4:



R: Apply Ohm's law: $V = iR$ (& P.S.C.)



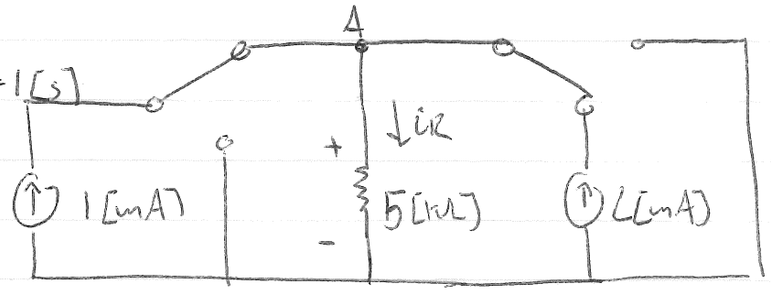
$$R = \frac{V}{i} = \frac{4[V]}{2[A]} = \boxed{2[\Omega] = R}$$

A: Have i_q and voltage potentials:

$$A(-0.5[A]) = 2[V]$$

$$A = \frac{2[V]}{(-0.5[A])} = \boxed{-4[\Omega] = A}$$ ($4[\Omega]$ acceptable if i_q drawn to follow P.S.C.)

#5:

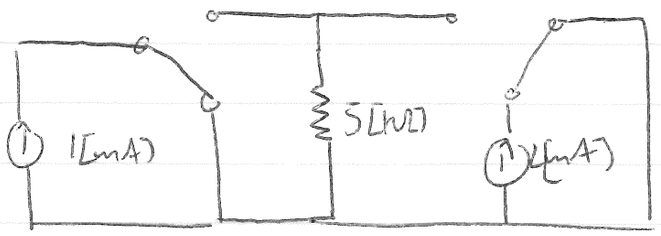


KCL @ Node A:

$i_R = 1[mA] + 2[mA] = 3[mA]$

$V = i_R \cdot R = 3[mA] \cdot 5[k\Omega] = \boxed{15[V] \text{ @ } t=1[s]}$

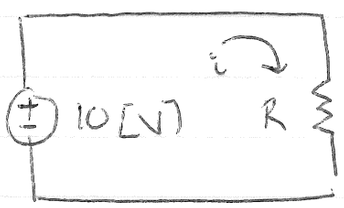
t=4 [s]



No current flowing through

$\boxed{V = 0[V] \text{ @ } t=4[s]}$

#6:



Constraints

$i \geq 40[mA]$

$P < 0.5[W]$

$\therefore 200 \leq R[\Omega] \leq 250$

Ohm's law: $V = iR \rightarrow i = \frac{V}{R} \geq 40[mA] \rightarrow R \leq \frac{10[V]}{40[mA]}$

$\therefore \boxed{R \leq 250[\Omega]}$

Power equation: $P = i^2 R < 0.5[W] \rightarrow (0.04[A])^2 \cdot R < 0.5[W]$

$\rightarrow R < \frac{0.5[A^2 \cdot \Omega]}{(0.04[A])^2} < 312.5[\Omega]$ not much use

$P = \frac{V^2}{R} \leq 0.5[W] \rightarrow R \geq \frac{V^2}{0.5[W]} \rightarrow R \geq \frac{10[V^2]}{0.5\left[\frac{V^2}{\Omega}\right]} \rightarrow \boxed{R \geq 200[\Omega]}$