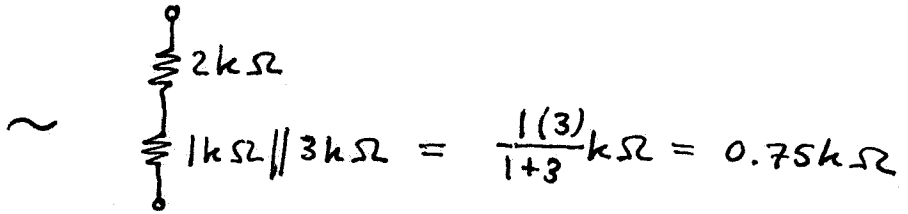
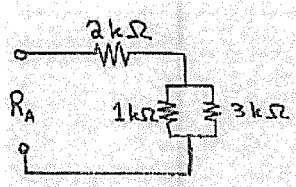


Please work each problem in the white space provided. Attach additional sheets if necessary. Print this one-sided and staple in the top left corner with a metal staple once complete. Each team turns in one document.

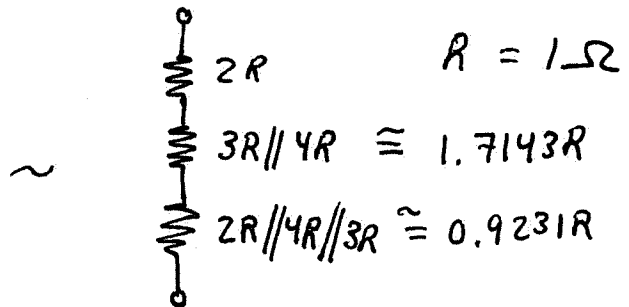
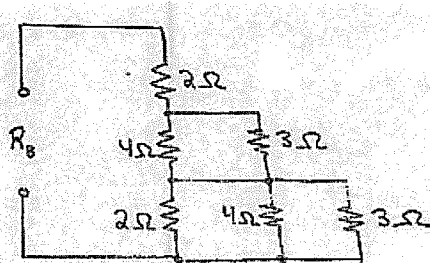
**Problem 22** Find the equivalent resistance to each network of resistors pictured below:

(a.)



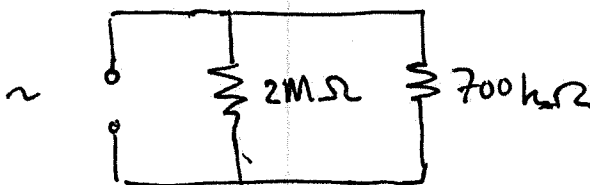
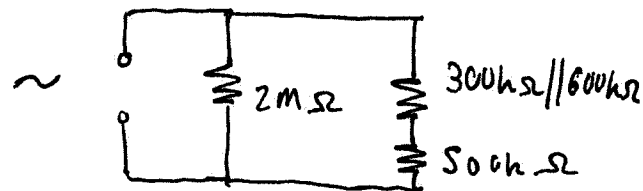
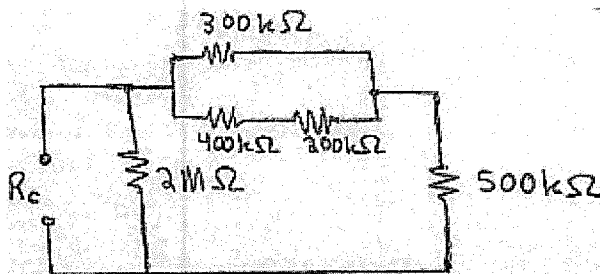
$$R_{eq} = 2k\Omega + 0.75k\Omega = \boxed{2.75k\Omega}$$

(b.)



$$R_{eq} = 2R + 1.7143R + 0.9231R = \boxed{4.637\Omega}$$

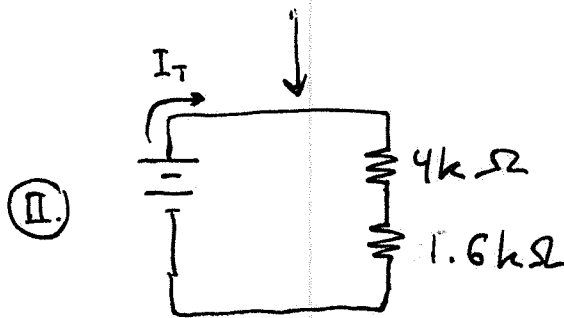
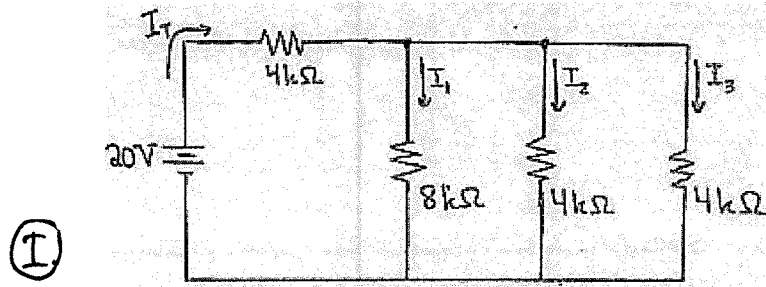
(c.)



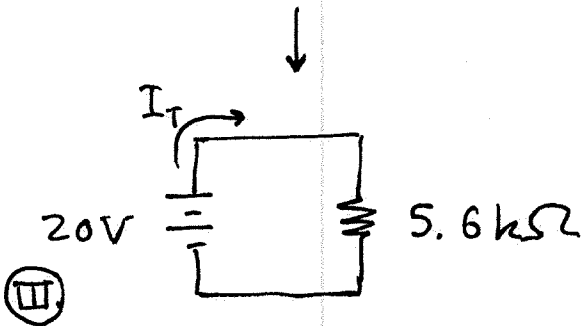
$$\Rightarrow R_{eq} = \frac{(2000)(700)}{2700} k\Omega$$

$$\therefore \boxed{R_{eq} = 518.5k\Omega}$$

Problem 23 Find the currents in the circuit pictured below:



$8k\Omega // 4k\Omega // 4k\Omega$  gives  
 $R_{eq} = \left(\frac{1}{8} + \frac{1}{4} + \frac{1}{4}\right)^{-1} k\Omega$   
 $R_{eq} = 1.6k\Omega$



$\therefore I_T = \frac{20V}{5.6k\Omega} \approx \boxed{3.571 mA = I_T}$

Notice  $I_T(1.6k\Omega) = (3.571mA)(1.6k\Omega) = 5.714V$  is the voltage dropped on  $8k\Omega$ ,  $4k\Omega$  and  $4k\Omega$

Thus,

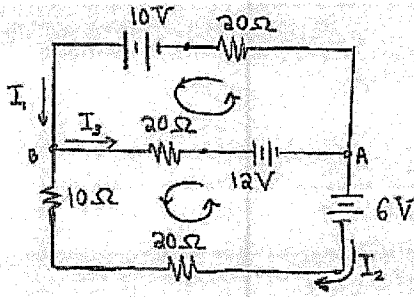
$$I_1 = \frac{5.714V}{8k\Omega} = \underline{0.7143mA}$$

$$I_2 = I_3 = \frac{5.714V}{4k\Omega} = \underline{1.429mA}$$

$\therefore$

$I_1 = 0.7143mA$   
 $I_2 = 1.429mA = I_3$   
 $I_T = 3.571mA$

Problem 24 Find the currents in the circuit pictured below:



$$I_1 + I_2 = I_3 \quad (\text{at B})$$

$$10 - 20 I_3 - 12 - 20 I_1 = 0 \quad (\text{upper loop, KVL})$$

$$20 I_3 + 10 I_2 + 20 I_2 + 6 + 12 = 0 \quad (\text{lower loop KVL})$$

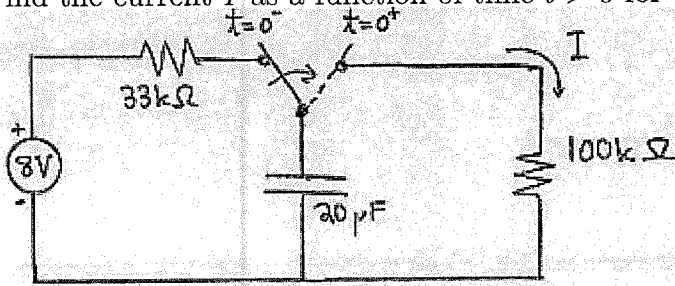
Work out the algebra,

$$I_1 = 0.1625 \text{ A}$$

$$I_2 = -0.425 \text{ A}$$

$$I_3 = -0.2625 \text{ A}$$

Problem 25 Find the current  $I$  as a function of time  $t > 0$  for the circuit below:



$$Q_0 = C V_0 = (20 \mu\text{F})(8 \text{V}) = 160 \mu\text{C} \quad (\text{from before switch flips})$$

$$\frac{Q}{C} = IR \Rightarrow \frac{Q}{RC} = I = -\frac{dQ}{dt} \quad \text{for } t > 0$$

$$\frac{dQ}{Q} = -\frac{dt}{RC}$$

$$\ln|Q| - \ln|Q_0| = -t/RC$$

$$\Rightarrow Q(t) = Q_0 e^{-t/RC}$$

$$\Rightarrow I = -\frac{dQ}{dt} = -Q_0 \left( \frac{-1}{RC} \right) e^{-t/RC}$$

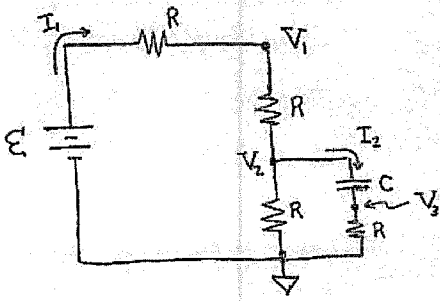
$$\therefore \underline{I(t) = \frac{Q_0}{RC} e^{-t/RC}}$$

Notice  $\frac{Q_0}{C} = 8 \text{V}$  and  $\frac{Q_0}{RC} = \frac{8 \text{V}}{100 \text{k}\Omega} = 80 \mu\text{A}$

and  $RC = (100 \text{k}\Omega)(20 \mu\text{F}) = 2000 \text{ms} = 2.0 \text{s}$

$$\therefore \boxed{I(t) = (80 \mu\text{A}) \exp\left(\frac{-t}{2.0 \text{s}}\right)}$$

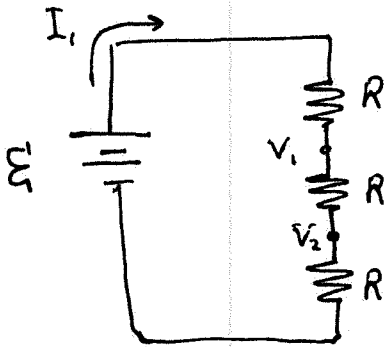
Problem 26 Find the currents and voltages (measured relative to the ground) in the circuit below:



We assume  $t \rightarrow \infty$  thus  $I_2 \rightarrow 0$  since C behaves like an open circuit (a break in the wire)

Thus  $I_2 \approx 0$  which gives  $V_3 = I_2 R = 0 \therefore V_3 \approx 0$

Since  $I_2 \approx 0$  the circuit is equivalent to



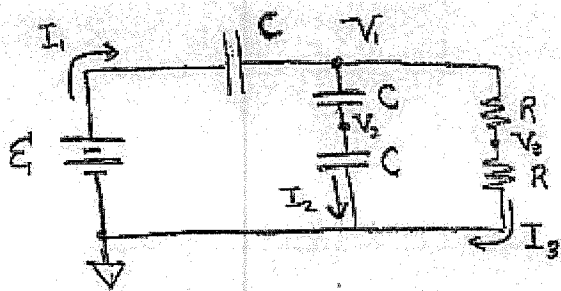
$$I_1 = \frac{\mathcal{E}'}{3R} \quad (R_{eq} = 3R)$$

Then  $I_1 R = \frac{\mathcal{E}'}{3R} R = \frac{\mathcal{E}'}{3}$  is voltage dropped on each of the three pictured resistors,

$$V_2 = \mathcal{E}'/3$$

$$V_1 = \mathcal{E}' - \mathcal{E}'/3 = \frac{2\mathcal{E}'}{3} \Rightarrow V_1 = \frac{2\mathcal{E}'}{3}$$

Problem 27 Find the currents and voltages (measured relative to the ground) in the circuit below:



Assuming  $t \rightarrow \infty$  we treat  $\parallel_C$  as open circuit thus  $I_1 = 0$ . Now  $I_2 = 0$  since both capacitors by  $V_2$  are also effectively an open circuit.

Notice  $I_1 = I_2 + I_3 \Rightarrow I_3 = 0$

Thus  $V_3 = I_3 R = 0$  and  $V_1 = I_3 R + I_3 R = 0$

Hence,  $V_1 = V_3 = 0$ . In summary,

the voltage on  $\parallel_C$  is zero  $\Rightarrow V_2 = 0$

Remark: I should have asked what charge is stored on  $\parallel_C$  on the top of the circuit.

$\mathcal{E} - V_1 = \text{voltage on } C = \mathcal{E}$  then

as  $C = \frac{Q}{\mathcal{E}} \hookrightarrow \underline{Q = C \mathcal{E}}$ .