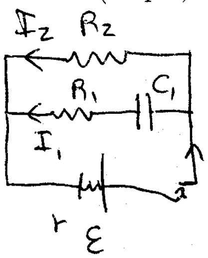
Yellow

8. The capacitor is uncharged initially. The switch is then closed at $t = 0$. Let $\mathcal{E} = 4$ V, $r = 12\ \Omega$, $R_1 = 24\ \Omega$, $R_2 = 48\ \Omega$, $C_1 = 12\ \mu$F.

   a. (10 pts) Find I, Q_1, I_1, and I_2 just after the switch is closed. Explain.



$Q = 0$ at $t = 0^+$. Thus $\Delta V_C = Q/C = 0$ at $t = 0^+$.

Then have R_1 & R_2 in parallel, so $R' = (R_1^{-1} + R_2^{-1})^{-1} = 16\Omega$.

Then $I = \frac{\mathcal{E}}{r+R'} = \frac{4}{12+16} = \frac{4}{28} = 0.1429$ A

$Ir = 1.714$ V, so $I = \frac{\mathcal{E} - \Delta V}{r}$ gives

$\Delta V = \mathcal{E} - Ir = 4 - 1.714 = 2.286$ V

$I_1 = \frac{\Delta V}{R_1} = 0.0952$ A, $I_2 = \frac{\Delta V}{R_2} = 0.0476$ A; $I_1 + I_2 \approx I$

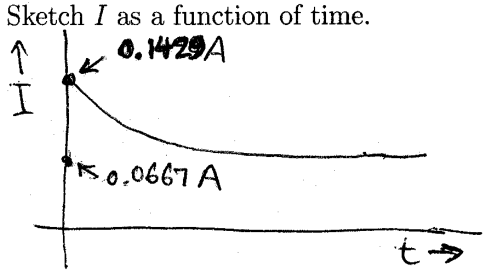
   b. (10 pts) Find I, Q_1, I_1, and I_2 a long time after the switch is closed. Explain.

$I_1 \to 0$ as $t \to \infty$.

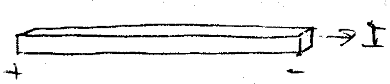
Then $I_2 = I = \frac{\mathcal{E}}{r+R_2} = \frac{4}{12+48} = \frac{4}{60} = 0.0667$ A

$\Delta V = \frac{Q_1}{C_1} = I_2 R_2$, so $Q_1 = (I_2 R_2) C_1 = 3.84 \times 10^{-5}$ C $= 38.4\ \mu$C

   c. (5 pts) Sketch I as a function of time.



9. (15 pts) A 17 cm long rod with 5 mm-by-5 mm cross-section carries 1.8 A when a voltage difference of 0.51 V is placed across its ends. Find the resistivity. Find the electric field within the rod. Estimate the drift velocity of the charge-carriers, taken to be of density $n = 2.8 \times 10^{28}/\text{m}^3$.



$R = \frac{\Delta V}{I} = \frac{0.51\text{V}}{1.8\text{A}} = 0.283$

Also $R = \rho \frac{l}{A}$, so $\rho = R\frac{A}{l} = 4.17 \times 10^{-4}\ \Omega\text{-m}$

$E = \frac{\Delta V}{l} = 30 \frac{\text{V}}{\text{m}}$ • $I = \frac{Q}{T} = e\frac{nAl}{T} = enAv_d$ (l/T)

Thus $v_d = \frac{I}{enA} = 1.607 \times 10^{-5} \frac{\text{m}}{\text{s}}$