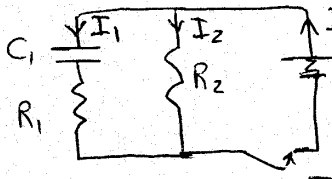
Pink

8. The capacitor is uncharged initially. The switch is then closed at $t = 0$. Let $\mathcal{E} = 4$ V, $r = 6\ \Omega$, $R_1 = 12\ \Omega$, $R_2 = 24\ \Omega$, $C_1 = 6\ \mu$F.

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



$Q_1 = 0$ at $t = 0$

$r \to R_1$ and R_2 in parallel: $R' = \left(\frac{1}{R_1} + \frac{1}{R_2}\right)^{-1} = 8\ \Omega$

Then $I = \mathcal{E}/(r + R') = 0.29\ A$

$$I_2 = \frac{\mathcal{E} - rI}{R_2} = 0.094\ A, \quad I_1 = \frac{\mathcal{E} - rI}{R_1} = 0.188\ A$$

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

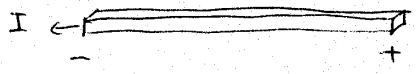
$I_1 \to 0$ as $t \to \infty$

$$I = I_2 = \frac{\mathcal{E}}{r + R_2} = 0.133\ A$$

$$Q_1 = C_1 \Delta V = C_1 I_2 R_2 = (6\mu F)(0.133\ A)(24\ \Omega) = 19.2\ \mu C$$

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

9. (15 pts) A 15 cm long rod with 4 mm-by-4 mm cross-section carries 1.1 A when a voltage difference of 0.44 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 $n = 2.8 \times 10^{28}/\text{m}^3$.



$$R = \frac{\Delta V}{I} = \frac{0.44}{1.1} = 0.4\ \Omega$$

Resistivity: $\rho = \frac{RA}{L} = \frac{(0.4\ \Omega)(4 \times 10^{-3})^2}{0.15\ m} = 4.27 \times 10^{-5}\ \Omega\text{m}$

Electric field: $E = \frac{\Delta V}{L} = \frac{0.44\ V}{0.15 m} = 2.93\ V/m$

Drift velocity: $V_d = I/enA = (\Delta V/R)/enA$

$= 1.5 \times 10^{-5}\ m/s$