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

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

\[
\text{I}_1 = \frac{\mathcal{E}}{r+R_1} = 0.094 \, \text{A} \quad \text{and} \quad \text{I}_2 = \frac{\mathcal{E}}{R_2} = 0.188 \, \text{A}
\]

\[
\text{Then} \quad \text{I} = \frac{\mathcal{E}}{(r+R_1)} = 0.29 \, \text{A}
\]

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

\[
\text{I}_1 \rightarrow 0 \quad \text{as} \quad t \rightarrow \infty
\]

\[
\text{I} = \text{I}_2 = \frac{\mathcal{E}}{r+R_2} = 0.133 \, \text{A}
\]

\[
\text{Q}_1 = C_1 \Delta \mathcal{V} = C_1 \text{I}_2 R_2 = 6 \, \mu\text{F} \times 0.133 \, \text{A} \times 24 \, \Omega = 19.2 \, \mu\text{C}
\]

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 \( n = 2.8 \times 10^{28} / \text{m}^3 \).

\[
\Delta \mathcal{V} = \frac{\mathcal{E}}{r+R_2} = 0.44 \, \text{V}
\]

\[
R = \frac{\Delta \mathcal{V}}{I} = \frac{0.44 \, \text{V}}{1.1 \, \text{A}} = 0.4 \, \Omega
\]

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

\[
\text{Electric field:} \quad E = \frac{\Delta \mathcal{V}}{L} = \frac{0.44 \, \text{V}}{0.15 \, \text{m}} = 2.93 \, \text{V/m}
\]

\[
\text{Drift velocity:} \quad V_d = \frac{I}{enA} = \frac{(\Delta \mathcal{V} / R)}{enA} = 1.5 \times 10^{-5} \, \text{m/s}
\]