4-3)

The real world is never as kind as our Physics approximations would have you believe. The dielectrics between the plates of capacitors are not perfect insulators, and so charges actually leak from one plate to the other, thereby discharging the capacitor. Consider a parallel plate capacitor of area A and separation d filled with a dielectric of constant κ and resistivity ρ .

A) Show that the current between the plates is given by

$$I = \frac{Q}{\kappa \rho \varepsilon_o} \; .$$

B) Further, show that the charge on the capacitor follows

$$Q(t) = Q_0 e^{-t/\kappa \rho \varepsilon_0},$$

where Q_0 is the charge at time t = 0.