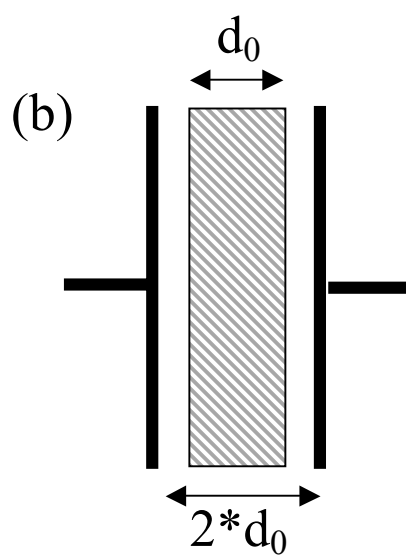
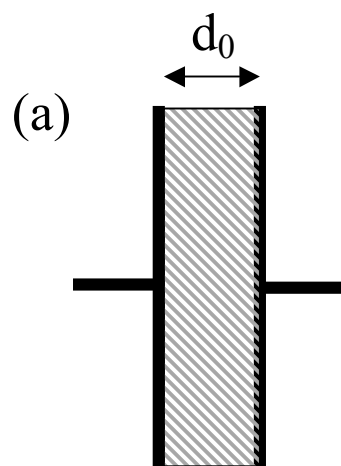


**Problem 2 (25 points)**

**A glass plate with dielectric constant  $K=2$  is inserted into a parallel plate capacitor with area  $A$  and distance  $d_0$  between plates. Using a power supply, the capacitor is charged to a charge  $Q$ . The power supply is NOT disconnected.**

**(a) What is the energy stored in the capacitor?**

**(b) The separation between the plates is increased to  $d=2d_0$ , but the glass plate remains in the same position. What is  $U_{\text{stored}}$  now?**



# Practice (a)

1.

(a)  ~~$I_1 = I_2 = I_3$~~

~~$I_1 > I_2, I_1 > I_3$~~

~~$P = I^2 R$~~

~~So bulb 1 is ~~lightest~~ brightest~~

~~(b) bulb 1 is brighter, bulb 3 is less brighter.~~

~~The resistance of bulb 2 is reduced to  $\frac{1}{2}$ ,~~

~~Then ~~the~~  $I_1$  increases,  $V_1$  increases,  $V_3$  decreases.~~

~~$P_1 = I_1^2 R_1$ ,  $P_3 = \frac{V_3^2}{R_3}$ , so bulb 1 is brighter, bulb 3 is less brighter.~~

2.

(a)  $C = \frac{2\epsilon_0 A}{d_0}$

$E = \frac{1}{2} \frac{Q^2}{C} = \frac{d_0}{4\epsilon_0 A} Q^2$

(b)  $U = \frac{1}{2} QV = \frac{d_0 Q^2}{4\epsilon_0 A}$  is unchanged

After separating,

~~$\frac{1}{C'}$~~   $= \frac{1}{C_{\text{glass}}} + \frac{2}{C_{\text{air}}} = \frac{d_0}{2\epsilon_0 A} + \frac{2}{\frac{\epsilon_0 A}{d_0/2}} = \frac{3d_0}{2\epsilon_0 A}$

②

$$U_{\text{stored}} = \frac{1}{2} C V^2$$

$$= \frac{1}{2} \frac{2\epsilon_0 A}{3d_0} \left( \frac{d_0 Q}{2\epsilon_0 A} \right)^2$$

$$= \frac{d_0}{12\epsilon_0 A} Q^2$$

3.

(a)

$$\Delta V = U_c$$

$$= I_c r$$

$$= -C \frac{dU_c}{dt} r$$

$$\Delta V - I_c r = U_c$$

$$\Delta V - C \frac{dU_c}{dt} r = U_c$$

$$\Rightarrow U_c = \Delta V (1 - e^{-\frac{t}{Cr}})$$

$$U_c = I_c r$$

$$U_c = C \frac{dU_c}{dt} r$$

$$\Rightarrow U_c = U_0 (1 - e^{-\frac{t}{Cr}})$$

$$Q = C U_c = C \Delta V (1 - e^{-\frac{t}{Cr}})$$

