

$$E_2/E_1 = C_1 d_1 / C_2 d_2 = \epsilon_0 A / K \epsilon_0 A = 1/K$$

For a parallel-plate capacitor, we have $Q = C_1 V_1 = C_1 E_1 d_1 = C_2 E_2 d_2$, or $E_2/E_1 = C_1 d_1 / C_2 d_2 = \epsilon_0 A / K \epsilon_0 A = 1/K$.

The uniform electric field between the plates is related to the potential difference across the plates: $E = V/d$. energy decreases.

induced charges on the dielectric are attracted to the plates; again work is done by the field and the separation is halved, work is done by the field, so the energy decreases. When the dielectric is inserted, the stored energy decreases from two factors. Because the plates attract each other, when the separation

$$U_2/U_1 = C_1/C_2 = (\epsilon_0 A/d_1)/(K \epsilon_0 A/d_2) = d_2/Kd_1 = \frac{2}{3}/K = \frac{1}{2K}$$

For the ratio of stored energies, we have $C_2 = K \epsilon_0 A/d_2$.

The changes will change the capacitance:

$$U_1 = \frac{1}{2} C_1 V_1^2 = \frac{1}{2} Q^2 / C_1, \text{ with } C_1 = \epsilon_0 A/d_1.$$

48. Because the capacitor is isolated, the charge will not change. The initial stored energy is

$$U_2/U_1 = C_2/C_1 = (2)^2 = d_1/d_2 = \frac{1}{2} \times$$

For the stored energy we have $U = \frac{1}{2} C V^2$, so we get

From $C = \epsilon_0 A/d$, we see that separating the plates will change C

(c) Because the battery is still connected, the potential difference will not change.

$$U_2/U_1 = (Q^2/Q^2) = (2)^2 = 4 \times$$

(b) For the stored energy we have $U = \frac{1}{2} C V^2 = \frac{1}{2} Q^2/C$. The capacitance does not change, so we have

$$U_2/U_1 = (V_2/V_1)^2 = (2)^2 = 4 \times$$

47. (a) For the stored energy we have $U = \frac{1}{2} C V^2$. Because the capacitance does not change, we have

$$U_2/U_1 = C_1/C_2 = d_2/d_1 = 2.$$

Because the charge is constant, for the two conditions we have

$$U = \frac{1}{2} C V^2 = \frac{1}{2} Q^2/C.$$

46. From $C = \epsilon_0 A/d$, we see that separating the plates will change C . For the stored energy we have

will change capacitance, charge, and work done by the battery.

(e) Because the battery is still connected, the electric field will not change. Insertion of the dielectric

$$W = U = \frac{1}{2} C V^2 = \frac{1}{2} (3.6 \times 10^{-12} \text{ F})(9.0 \text{ V})^2 = 1.5 \times 10^{-10} \text{ J}.$$

(d) The work done by the battery is the energy stored in the capacitor:

$$E = V/d = (9.0 \text{ V})/(0.10 \text{ m}) = 90 \text{ V/m}.$$

(c) We assume that the electric field is uniform, so we have

$$Q = CV = (3.6 \text{ pF})(9.0 \text{ V}) = 32 \text{ pC}.$$

(b) We find the charge on each plate from

$$C = \epsilon_0 A/d = \epsilon_0 \pi r^2/d = (8.85 \times 10^{-12} \text{ C}^2/\text{N} \cdot \text{m}^2) \pi (0.114 \text{ m})^2 / (0.10 \text{ m}) = 3.6 \times 10^{-12} \text{ F} = 3.6 \text{ pF}.$$

If we assume that it approximates a parallel-plate capacitor, we have

$$r = \frac{1}{2} (9.0 \text{ in})(2.54 \times 10^{-2} \text{ m/in}) = 0.114 \text{ m}.$$

45. (a) The radius of the pie plate is