

Chapter 26 Solutions

26.3 $E = \frac{k_e q}{r^2} : \quad q = \frac{(4.90 \times 10^4 \text{ N/C})(0.210 \text{ m})^2}{8.99 \times 10^9 \text{ N} \cdot \text{m}^2 / \text{C}^2} = 0.240 \mu\text{C}$

(a) $\sigma = \frac{q}{A} = \frac{0.240 \times 10^{-6}}{4\pi(0.120)^2} = \boxed{1.33 \mu\text{C}/\text{m}^2}$

(b) $C = 4\pi\epsilon_0 r = 4\pi(8.85 \times 10^{-12})(0.120) = \boxed{13.3 \text{ pF}}$

26.7 (a) $\Delta V = Ed$

$$E = \frac{20.0 \text{ V}}{1.80 \times 10^{-3} \text{ m}} = \boxed{11.1 \text{ kV/m}}$$

(b) $E = \frac{\sigma}{\epsilon_0}$

$$\sigma = (1.11 \times 10^4 \text{ N/C})(8.85 \times 10^{-12} \text{ C}^2/\text{N} \cdot \text{m}^2) = \boxed{98.3 \text{ nC}/\text{m}^2}$$

(c) $C = \frac{\epsilon_0 A}{d} = \frac{(8.85 \times 10^{-12} \text{ C}^2/\text{N} \cdot \text{m}^2)(7.60 \text{ cm}^2)(1.00 \text{ m}/100 \text{ cm})^2}{1.80 \times 10^{-3} \text{ m}} = \boxed{3.74 \text{ pF}}$

(d) $\Delta V = \frac{Q}{C} \quad Q = (20.0 \text{ V})(3.74 \times 10^{-12} \text{ F}) = \boxed{74.7 \text{ pC}}$

26.21 (a) $\frac{1}{C_s} = \frac{1}{15.0} + \frac{1}{3.00}$ $C_s = 2.50 \mu\text{F}$

$$C_p = 2.50 + 6.00 = 8.50 \mu\text{F}$$

$$C_{eq} = \left(\frac{1}{8.50 \mu\text{F}} + \frac{1}{20.0 \mu\text{F}} \right)^{-1} = \boxed{5.96 \mu\text{F}}$$

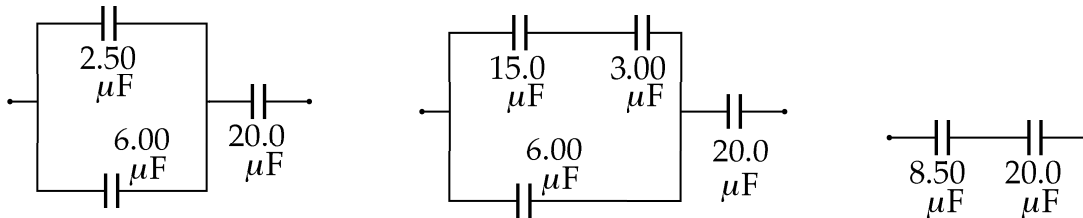
(b) $Q = (\Delta V)C = (15.0 \text{ V})(5.96 \mu\text{F}) = \boxed{89.5 \mu\text{C}}$ on $20.0 \mu\text{F}$

$$\Delta V = \frac{Q}{C} = \frac{89.5 \mu\text{C}}{20.0 \mu\text{F}} = 4.47 \text{ V}$$

$$15.0 - 4.47 = 10.53 \text{ V}$$

$$Q = (\Delta V)C = (10.53)(6.00 \mu\text{F}) = \boxed{63.2 \mu\text{C}}$$
 on $6.00 \mu\text{F}$

$$89.5 - 63.2 = \boxed{26.3 \mu\text{C}}$$
 on $15.0 \mu\text{F}$ and $3.00 \mu\text{F}$

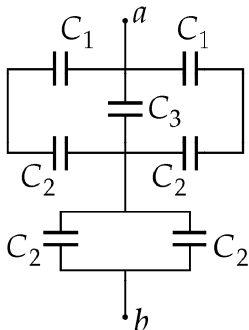


26.28 $C_s = \left(\frac{1}{5.00} + \frac{1}{10.0} \right)^{-1} = 3.33 \mu\text{F}$

$$C_{p1} = 2(3.33) + 2.00 = 8.66 \mu\text{F}$$

$$C_{p2} = 2(10.0) = 20.0 \mu\text{F}$$

$$C_{eq} = \left(\frac{1}{8.66} + \frac{1}{20.0} \right)^{-1} = \boxed{6.04 \mu\text{F}}$$



***26.32** $U = \frac{1}{2} C(\Delta V)^2$

The circuit diagram is shown at the right.

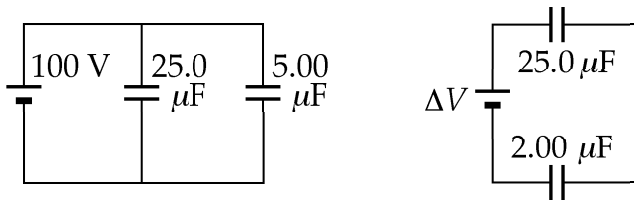
(a) $C_p = C_1 + C_2 = 25.0 \mu\text{F} + 5.00 \mu\text{F} = 30.0 \mu\text{F}$

$$U = \frac{1}{2} (30.0 \times 10^{-6})(100)^2 = \boxed{0.150 \text{ J}}$$

(b) $C_s = \left(\frac{1}{C_1} + \frac{1}{C_2}\right)^{-1} = \left(\frac{1}{25.0 \mu\text{F}} + \frac{1}{5.00 \mu\text{F}}\right)^{-1} = 4.17 \mu\text{F}$

$$U = \frac{1}{2} C(\Delta V)^2$$

$$\Delta V = \sqrt{\frac{2U}{C}} = \sqrt{\frac{(0.150)(2)}{4.17 \times 10^{-6}}} = \boxed{268 \text{ V}}$$



***26.42** $Q_{\text{max}} = C(\Delta V_{\text{max}})$, but $\Delta V_{\text{max}} = E_{\text{max}} d$

$$\text{Also, } C = \frac{\kappa \epsilon_0 A}{d}$$

$$\text{Thus, } Q_{\text{max}} = \frac{\kappa \epsilon_0 A}{d} (E_{\text{max}} d) = \kappa \epsilon_0 A E_{\text{max}}$$

- (a) With air between the plates, $\kappa = 1.00$ and $E_{\text{max}} = 3.00 \times 10^6 \text{ V/m}$.
Therefore,

$$Q_{\text{max}} = \kappa \epsilon_0 A E_{\text{max}} = (8.85 \times 10^{-12} \text{ F/m})(5.00 \times 10^{-4} \text{ m}^2)(3.00 \times 10^6 \text{ V/m}) = \boxed{13.3 \text{ nC}}$$

- (b) With polystyrene between the plates, $\kappa = 2.56$ and $E_{\text{max}} = 24.0 \times 10^6 \text{ V/m}$.

$$Q_{\text{max}} = \kappa \epsilon_0 A E_{\text{max}} = 2.56(8.85 \times 10^{-12} \text{ F/m})(5.00 \times 10^{-4} \text{ m}^2)(24.0 \times 10^6 \text{ V/m}) = \boxed{272 \text{ nC}}$$