

HW 11

P26.7 (a) $\Delta V = Ed$

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

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

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

(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) $\Delta V = \frac{Q}{C}$

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

P26.8 $C = \frac{\kappa \epsilon_0 A}{d} = 60.0 \times 10^{-15} \text{ F}$

$$d = \frac{\kappa \epsilon_0 A}{C} = \frac{(1)(8.85 \times 10^{-12})(21.0 \times 10^{-12})}{60.0 \times 10^{-15}}$$

$$d = 3.10 \times 10^{-9} \text{ m} = \boxed{3.10 \text{ nm}}$$

P26.16 (a) Capacitors in parallel add. Thus, the equivalent capacitor has a value of

$$C_{eq} = C_1 + C_2 = 5.00 \mu\text{F} + 12.0 \mu\text{F} = \boxed{17.0 \mu\text{F}}$$

(b) The potential difference across each branch is the same and equal to the voltage of the battery.

$$\Delta V = \boxed{9.00 \text{ V}}$$

(c) $Q_5 = C\Delta V = (5.00 \mu\text{F})(9.00 \text{ V}) = \boxed{45.0 \mu\text{C}}$

and $Q_{12} = C\Delta V = (12.0 \mu\text{F})(9.00 \text{ V}) = \boxed{108 \mu\text{C}}$

P26.21

(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)

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

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

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

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

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

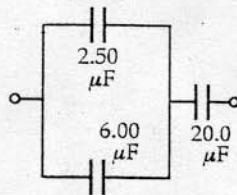
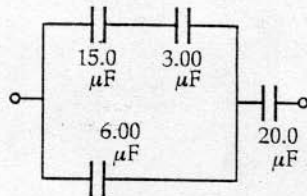


FIG. P26.21

P27.6 $q = 4t^3 + 5t + 6$

$$A = (2.00 \text{ cm}^2) \left(\frac{1.00 \text{ m}}{100 \text{ cm}} \right)^2 = 2.00 \times 10^{-4} \text{ m}^2$$

(a) $I(1.00 \text{ s}) = \left. \frac{dq}{dt} \right|_{t=1.00 \text{ s}} = (12t^2 + 5) \Big|_{t=1.00 \text{ s}} = \boxed{17.0 \text{ A}}$

(b) $J = \frac{I}{A} = \frac{17.0 \text{ A}}{2.00 \times 10^{-4} \text{ m}^2} = \boxed{85.0 \text{ kA/m}^2}$

P27.7 $I = \frac{dq}{dt}$

$$q = \int dq = \int I dt = \int_0^{1/240 \text{ s}} (100 \text{ A}) \sin\left(\frac{120\pi t}{\text{s}}\right) dt$$

$$q = \frac{-100 \text{ C}}{120\pi} \left[\cos\left(\frac{\pi}{2}\right) - \cos 0 \right] = \frac{+100 \text{ C}}{120\pi} = \boxed{0.265 \text{ C}}$$

(P27.8) (a) $J = \frac{I}{A} = \frac{5.00 \text{ A}}{\pi(4.00 \times 10^{-3} \text{ m})^2} = \boxed{99.5 \text{ kA/m}^2}$

(b) $J_2 = \frac{1}{4} J_1; \frac{I}{A_2} = \frac{1}{4} \frac{I}{A_1}$

$$A_1 = \frac{1}{4} A_2 \text{ so } \pi(4.00 \times 10^{-3})^2 = \frac{1}{4} \pi r_2^2$$

$$r_2 = 2(4.00 \times 10^{-3}) = 8.00 \times 10^{-3} \text{ m} = \boxed{8.00 \text{ mm}}$$

P27.24 $R = \frac{\rho_1 \ell_1}{A_1} + \frac{\rho_2 \ell_2}{A_2} = \frac{\rho_1 \ell_1 + \rho_2 \ell_2}{d^2}$

$$R = \frac{(4.00 \times 10^{-3} \Omega \cdot \text{m})(0.250 \text{ m}) + (6.00 \times 10^{-3} \Omega \cdot \text{m})(0.400 \text{ m})}{(3.00 \times 10^{-3} \text{ m})^2} = \boxed{378 \Omega}$$

***P27.47** The energy taken in by electric transmission for the fluorescent lamp is

$$\mathcal{P}\Delta t = 11 \text{ J/s}(100 \text{ h})\left(\frac{3600 \text{ s}}{1 \text{ h}}\right) = 3.96 \times 10^6 \text{ J}$$

$$\text{cost} = 3.96 \times 10^6 \text{ J} \left(\frac{\$0.08}{\text{kWh}} \right) \left(\frac{\text{k}}{1000} \right) \left(\frac{\text{W} \cdot \text{s}}{\text{J}} \right) \left(\frac{\text{h}}{3600 \text{ s}} \right) = \$0.088$$

For the incandescent bulb,

$$\mathcal{P}\Delta t = 40 \text{ W}(100 \text{ h})\left(\frac{3600 \text{ s}}{1 \text{ h}}\right) = 1.44 \times 10^7 \text{ J}$$

$$\text{cost} = 1.44 \times 10^7 \text{ J} \left(\frac{\$0.08}{3.6 \times 10^6 \text{ J}} \right) = \$0.32$$

$$\text{saving} = \$0.32 - \$0.088 = \boxed{\$0.232}$$

P27.60 2 wires $\rightarrow \ell = 100 \text{ m}$

$$R = \frac{0.108 \Omega}{300 \text{ m}}(100 \text{ m}) = 0.0360 \Omega$$

$$(a) \quad (\Delta V)_{\text{home}} = (\Delta V)_{\text{line}} - IR = 120 - (110)(0.0360) = \boxed{116 \text{ V}}$$

$$(b) \quad \mathcal{P} = I(\Delta V) = (110 \text{ A})(116 \text{ V}) = \boxed{12.8 \text{ kW}}$$

$$(c) \quad \mathcal{P}_{\text{wires}} = I^2 R = (110 \text{ A})^2 (0.0360 \Omega) = \boxed{436 \text{ W}}$$

$$\text{P26.3} \quad E = \frac{k_e q}{r^2} : \quad q = \frac{(4.90 \times 10^4 \text{ N/C})(0.210 \text{ m})^2}{(8.99 \times 10^9 \text{ N} \cdot \text{m}^2/\text{C}^2)} = 0.240 \mu\text{C}$$

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

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

P26.5

$$(a) \quad \frac{Q_1}{Q_2} = \frac{R_1}{R_2}$$

$$Q_1 + Q_2 = \left(1 + \frac{R_1}{R_2}\right) Q_2 = 3.50 Q_2 = 7.00 \mu\text{C}$$

$$\boxed{Q_2 = 2.00 \mu\text{C}} \quad \boxed{Q_1 = 5.00 \mu\text{C}}$$

$$(b) \quad V_1 = V_2 = \frac{Q_1}{C_1} = \frac{Q_2}{C_2} = \frac{5.00 \mu\text{C}}{(8.99 \times 10^{-12} \text{ m/F})^{-1}(0.500 \text{ m})} = 8.99 \times 10^4 \text{ V} = \boxed{89.9 \text{ kV}}$$