5. (a) The capacitance of a parallel-plate capacitor is given by $C = \varepsilon_0 A/d$, where A is the area of each plate and d is the plate separation. Since the plates are circular, the plate area is $A = \pi R^2$, where R is the radius of a plate. Thus,

$$C = \frac{\varepsilon_0 \pi R^2}{d} = \frac{(8.85 \times 10^{-12}\,\mathrm{F/m})\pi(8.2 \times 10^{-2}\,\mathrm{m})^2}{1.3 \times 10^{-3}\,\mathrm{m}} = 1.4 \times 10^{-10}\,\mathrm{F} = 140\ \mathrm{pF}\ .$$

(b) The charge on the positive plate is given by $q = CV$, where V is the potential difference across the plates. Thus, $q = (1.4 \times 10^{-10}\,\mathrm{F})(120\,\mathrm{V}) = 1.7 \times 10^{-8}\,\mathrm{C} = 17\,\mathrm{nC}$.

13. The equivalent capacitance is

$$C_{\text{eq}} = \frac{(C_1 + C_2)C_3}{C_1 + C_2 + C_3} = \frac{(10.0\,\mu\text{F} + 5.00\,\mu\text{F})(4.00\,\mu\text{F})}{10.0\,\mu\text{F} + 5.00\,\mu\text{F} + 4.00\,\mu\text{F}} = 3.16\,\mu\text{F}\ .$$

28. (a) The potential difference across C_1 (the same as across C_2) is given by

$$V_1 = V_2 = \frac{C_3 V}{C_1 + C_2 + C_3} = \frac{(4.00\,\mu\text{F})(100\,\text{V})}{10.0\,\mu\text{F} + 5.00\,\mu\text{F} + 4.00\,\mu\text{F}} = 21.1\ \text{V}\ .$$

Also, $V_3 = V - V_1 = V - V_2 = 100\,\text{V} - 21.1\,\text{V} = 78.9\,\text{V}$. Thus,

$$\begin{aligned} q_1 &= C_1 V_1 = (10.0\,\mu\text{F})(21.1\,\text{V}) = 2.11 \times 10^{-4}\ \text{C} \\ q_2 &= C_2 V_2 = (5.00\,\mu\text{F})(21.1\,\text{V}) \ = 1.05 \times 10^{-4}\ \text{C} \\ q_3 &= q_1 + q_2 = 2.11 \times 10^{-4}\,\text{C} + 1.05 \times 10^{-4}\,\text{C} = 3.16 \times 10^{-4}\ \text{C}\ . \end{aligned}$$

(b) The potential differences were found in the course of solving for the charges in part (a).

(c) The stored energies are as follows:

$$\begin{aligned} U_1 &= \frac{1}{2} C_1 V_1^2 = \frac{1}{2}(10.0\,\mu\text{F})(21.1\,\text{V})^2 = 2.22 \times 10^{-3}\ \text{J}\ , \\ U_2 &= \frac{1}{2} C_2 V_2^2 = \frac{1}{2}(5.00\,\mu\text{F})(21.1\,\text{V})^2 = 1.11 \times 10^{-3}\ \text{J}\ , \\ U_3 &= \frac{1}{2} C_3 V_3^2 = \frac{1}{2}(4.00\,\mu\text{F})(78.9\,\text{V})^2 = 1.25 \times 10^{-2}\ \text{J}\ . \end{aligned}$$

36. (a) We use $C = \varepsilon_0 A/d$ to solve for d:

$$d = \frac{\varepsilon_0 A}{C} = \frac{\left(8.85 \times 10^{-12}\,\frac{\mathrm{C}^2}{\mathrm{N}\cdot\mathrm{m}^2}\right)(0.35\,\mathrm{m}^2)}{50 \times 10^{-12}\,\mathrm{F}} = 6.2 \times 10^{-2}\,\mathrm{m}\ .$$

(b) We use $C \propto \kappa$. The new capacitance is $C' = C(\kappa/\kappa_{\mathrm{air}}) = (50\,\mathrm{pf})(5.6/1.0) = 280\,\mathrm{pF}$.