P25.8 (a) $|\Delta V| = Ed = (5.90 \times 10^{3}\ \text{V/m})(0.010\ 0\ \text{m}) = \boxed{59.0\ \text{V}}$

(b) $\frac{1}{2}mv_f^2 = |q\Delta V|$: $\quad \frac{1}{2}(9.11 \times 10^{-31})v_f^2 = (1.60 \times 10^{-19})(59.0)$

$v_f = \boxed{4.55 \times 10^{6}\ \text{m/s}}$

P25.18 (a) $E_x = \frac{k_e q_1}{x^2} + \frac{k_e q_2}{(x-2.00)^2} = 0$ becomes $E_x = k_e\left(\frac{+q}{x^2} + \frac{-2q}{(x-2.00)^2}\right) = 0$.

Dividing by k_e, $\quad 2qx^2 = q(x-2.00)^2 \quad x^2 + 4.00x - 4.00 = 0$.

Therefore $E = 0$ when $x = \frac{-4.00 \pm \sqrt{16.0+16.0}}{2} = \boxed{-4.83\ \text{m}}$.

(Note that the positive root does not correspond to a physically valid situation.)

(b) $V = \frac{k_e q_1}{x} + \frac{k_e q_2}{2.00 - x} = 0$ or $V = k_e\left(\frac{+q}{x} - \frac{2q}{2.00-x}\right) = 0$.

Again solving for x, $\quad 2qx = q(2.00 - x)$.

For $0 \le x \le 2.00$ $V = 0$ when $x = \boxed{0.667\ \text{m}}$

and $\frac{q}{|x|} = \frac{-2q}{|2-x|}$. For $x < 0$ $x = \boxed{-2.00\ \text{m}}$.

P25.20 (a) $U = \frac{qQ}{4\pi \epsilon_0 r} = \frac{(5.00 \times 10^{-9}\ \text{C})(-3.00 \times 10^{-9}\ \text{C})(8.99 \times 10^{9}\ \text{V}\cdot\text{m/C})}{(0.350\ \text{m})} = \boxed{-3.86 \times 10^{-7}\ \text{J}}$

The minus sign means it takes 3.86×10^{-7} J to pull the two charges apart from 35 cm to a much larger separation.

(b)
$$V = \frac{Q_1}{4\pi \epsilon_0 r_1} + \frac{Q_2}{4\pi \epsilon_0 r_2}$$
$$= \frac{(5.00 \times 10^{-9}\ \text{C})(8.99 \times 10^{9}\ \text{V}\cdot\text{m/C})}{0.175\ \text{m}} + \frac{(-3.00 \times 10^{-9}\ \text{C})(8.99 \times 10^{9}\ \text{V}\cdot\text{m/C})}{0.175\ \text{m}}$$
$$V = \boxed{103\ \text{V}}$$

P25.37 $V = a + bx = 10.0\ \text{V} + (-7.00\ \text{V/m})x$

(a) At $x = 0$, $V = \boxed{10.0\ \text{V}}$

At $x = 3.00$ m, $V = \boxed{-11.0\ \text{V}}$

At $x = 6.00$ m, $V = \boxed{-32.0\ \text{V}}$

(b) $E = -\frac{dV}{dx} = -b = -(-7.00\ \text{V/m}) = \boxed{7.00\ \text{N/C in the } +x \text{ direction}}$

P25.42 $\Delta V = V_{2R} - V_0 = \frac{k_e Q}{\sqrt{R^2 + (2R)^2}} - \frac{k_e Q}{R} = \frac{k_e Q}{R}\left(\frac{1}{\sqrt{5}} - 1\right) = \boxed{-0.553\frac{k_e Q}{R}}$

P25.50 (a) Both spheres must be at the same potential according to $\frac{k_e q_1}{r_1} = \frac{k_e q_2}{r_2}$

where also $q_1 + q_2 = 1.20 \times 10^{-6}$ C.

Then

$$q_1 = \frac{q_2 r_1}{r_2}$$

$$\frac{q_2 r_1}{r_2} + q_2 = 1.20 \times 10^{-6} \text{ C}$$

$$q_2 = \frac{1.20 \times 10^{-6} \text{ C}}{1 + 6 \text{ cm}/2 \text{ cm}} = 0.300 \times 10^{-6} \text{ C on the smaller sphere}$$

$$q_1 = 1.20 \times 10^{-6} \text{ C} - 0.300 \times 10^{-6} \text{ C} = 0.900 \times 10^{-6} \text{ C}$$

$$V = \frac{k_e q_1}{r_1} = \frac{\left(8.99 \times 10^9 \text{ N} \cdot \text{m}^2/\text{C}^2\right)\left(0.900 \times 10^{-6} \text{ C}\right)}{6 \times 10^{-2} \text{ m}} = \boxed{1.35 \times 10^5 \text{ V}}$$

(b) Outside the larger sphere,

$$\mathbf{E}_1 = \frac{k_e q_1}{r_1^2}\hat{\mathbf{r}} = \frac{V_1}{r_1}\hat{\mathbf{r}} = \frac{1.35 \times 10^5 \text{ V}}{0.06 \text{ m}}\hat{\mathbf{r}} = \boxed{2.25 \times 10^6 \text{ V/m away}}.$$

Outside the smaller sphere,

$$\mathbf{E}_2 = \frac{1.35 \times 10^5 \text{ V}}{0.02 \text{ m}}\hat{\mathbf{r}} = \boxed{6.74 \times 10^6 \text{ V/m away}}.$$

The smaller sphere carries less charge but creates a much stronger electric field than the larger sphere.

P25.52 $V = \frac{k_e q}{r}$ and $E = \frac{k_e q}{r^2}$. Since $E = \frac{V}{r}$,

(b) $r = \frac{V}{E} = \frac{6.00 \times 10^5 \text{ V}}{3.00 \times 10^6 \text{ V/m}} = \boxed{0.200 \text{ m}}$ and

(a) $q = \frac{Vr}{k_e} = \boxed{13.3\ \mu\text{C}}$

P26.5 (a) $\frac{Q_1}{Q_2} = \frac{R_1}{R_2}$

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

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

(b) $$V_1 = V_2 = \frac{Q_1}{C_1} = \frac{Q_2}{C_2} = \frac{5.00\ \mu\text{C}}{\left(8.99 \times 10^9\ \text{m/F}\right)^{-1}(0.500\ \text{m})} = 8.99 \times 10^4\ \text{V} = \boxed{89.9\ \text{kV}}$$

P26.29 $$C_s = \left(\frac{1}{5.00} + \frac{1}{7.00}\right)^{-1} = 2.92\ \mu\text{F}$$

$$C_p = 2.92 + 4.00 + 6.00 = \boxed{12.9\ \mu\text{F}}$$

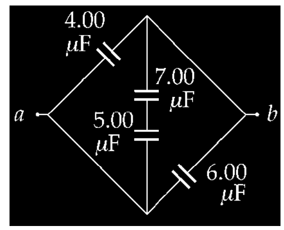

FIG. P26.29

P26.38 With switch closed, distance $d' = 0.500d$ and capacitance $C' = \frac{\in_0 A}{d'} = \frac{2 \in_0 A}{d} = 2C$.

(a) $$Q = C'(\Delta V) = 2C(\Delta V) = 2\left(2.00 \times 10^{-6}\ \text{F}\right)(100\ \text{V}) = \boxed{400\ \mu\text{C}}$$

(b) The force stretching out one spring is

$$F = \frac{Q^2}{2 \in_0 A} = \frac{4C^2(\Delta V)^2}{2 \in_0 A} = \frac{2C^2(\Delta V)^2}{(\in_0 A/d)d} = \frac{2C(\Delta V)^2}{d}.$$

One spring stretches by distance $x = \frac{d}{4}$, so

$$k = \frac{F}{x} = \frac{2C(\Delta V)^2}{d}\left(\frac{4}{d}\right) = \frac{8C(\Delta V)^2}{d^2} = \frac{8\left(2.00 \times 10^{-6}\ \text{F}\right)(100\ \text{V})^2}{\left(8.00 \times 10^{-3}\ \text{m}\right)^2} = \boxed{2.50\ \text{kN/m}}.$$