

15. (a) The electric potential V at the surface of the drop, the charge q on the drop, and the radius R of the drop are related by $V = q/4\pi\epsilon_0 R$. Thus

$$R = \frac{q}{4\pi\epsilon_0 V} = \frac{(8.99 \times 10^9 \text{ N} \cdot \text{m}^2 / \text{C}^2)(30 \times 10^{-12} \text{ C})}{500 \text{ V}} = 5.4 \times 10^{-4} \text{ m}.$$

(b) After the drops combine the total volume is twice the volume of an original drop, so the radius R' of the combined drop is given by $(R')^3 = 2R^3$ and $R' = 2^{1/3}R$. The charge is twice the charge of original drop: $q' = 2q$. Thus,

$$V' = \frac{1}{4\pi\epsilon_0} \frac{q'}{R'} = \frac{1}{4\pi\epsilon_0} \frac{2q}{2^{1/3}R} = 2^{2/3}V = 2^{2/3}(500 \text{ V}) \approx 790 \text{ V}.$$

16. In applying Eq. 24-27, we are assuming $V \rightarrow 0$ as $r \rightarrow \infty$. All corner particles are equidistant from the center, and since their total charge is

$$2q_1 - 3q_1 + 2q_1 - q_1 = 0,$$

then their contribution to Eq. 24-27 vanishes. The net potential is due, then, to the two $+4q_2$ particles, each of which is a distance of $a/2$ from the center:

$$V = \frac{1}{4\pi\epsilon_0} \frac{4q_2}{a/2} + \frac{1}{4\pi\epsilon_0} \frac{4q_2}{a/2} = \frac{16q_2}{4\pi\epsilon_0 a} = \frac{16(8.99 \times 10^9 \text{ N} \cdot \text{m}^2 / \text{C}^2)(6.00 \times 10^{-12} \text{ C})}{0.39 \text{ m}} = 2.21 \text{ V}.$$

20. Since according to the problem statement there is a point in between the two charges on the x axis where the net electric field is zero, the fields at that point due to q_1 and q_2 must be directed opposite to each other. This means that q_1 and q_2 must have the same sign (i.e., either both are positive or both negative). Thus, the potentials due to either of them must be of the same sign. Therefore, the net electric potential cannot possibly be zero anywhere except at infinity.