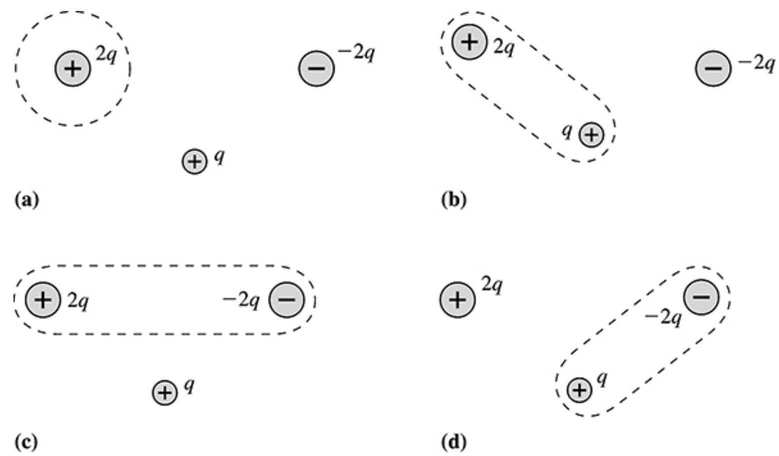
28.17. Visualize:



For *any* closed surface that encloses a total charge Q_{in}, the net electric flux through the closed surface is $\Phi_e = Q_{\text{in}}/\varepsilon_0$.

28.19. Visualize: Please refer to Figure EX28.19.

Solve: For *any* closed surface that encloses a total charge Q_{in}, the net electric flux through the surface is $\Phi_e = Q_{\text{in}}/\varepsilon_0$. We can write three equations from the three closed surfaces in the figure:

$$\Phi_A = -\frac{q}{\varepsilon_0} = \frac{q_1 + q_3}{\varepsilon_0} \Rightarrow q_1 + q_3 = -q \qquad \Phi_B = \frac{3q}{\varepsilon_0} = \frac{q_1 + q_2}{\varepsilon_0} \Rightarrow q_1 + q_2 = 3q$$

$$\Phi_C = \frac{-2q}{\varepsilon_0} = \frac{q_2 + q_3}{\varepsilon_0} \Rightarrow q_2 + q_3 = -2q$$

Subtracting third equation from the first,

$$q_1 - q_2 = +q$$

Adding second equation to this equation,

$$2q_1 = +4q \Rightarrow q_1 = 2q$$

That is, $q_1 = +2q$, $q_2 = +q$, and $q_3 = -3q$.

28.26. Model: The excess charge on a conductor resides on the outer surface.
Visualize: Please refer to Figure EX28.26.
Solve: Point 1 is at the surface of a charged conductor, hence

$$\vec{E}_{\text{surface}} = \left(\frac{\eta}{\varepsilon_0}, \text{ perpendicular to surface}\right) \Rightarrow E_{\text{surface}} = \frac{\left(5.0\times10^{10}\right)\left(1.60\times10^{-19}\ \text{C/m}^2\right)}{8.85\times10^{-12}\ \text{C}^2\text{/N m}^2} = 904\ \text{N/C}$$

At point 2 the electric field strength is zero because this point lies inside the conductor. The electric field strength at point 3 is zero because there is no excess charge on the interior surface of the box. This can be quickly seen by considering a Gaussian surface just inside the interior surface of the box as shown in Figure 28.31.

28.28. Visualize: Please refer to Figure EX28.28.

Solve: For *any* closed surface that encloses a total charge Q_{in}, the net electric flux through the closed surface is $\Phi_e = Q_{\text{in}}/\varepsilon_0$. In the present case, the conductor is neutral and there is a point charge Q inside the cavity. Thus $Q_{\text{in}} = Q$ and the flux is

$$\Phi_e = \frac{Q}{\varepsilon_0}$$