

6. For ease of presentation (of the computations below) we assume $Q > 0$ and $q < 0$ (although the final result does not depend on this particular choice).

(a) The x -component of the force experienced by $q_1 = Q$ is

$$F_{1x} = \frac{1}{4\pi\epsilon_0} \left(-\frac{(Q)(Q)}{(\sqrt{2}a)^2} \cos 45^\circ + \frac{(|q|)(Q)}{a^2} \right) = \frac{Q|q|}{4\pi\epsilon_0 a^2} \left(-\frac{Q/|q|}{2\sqrt{2}} + 1 \right)$$

which (upon requiring $F_{1x} = 0$) leads to $Q/|q| = 2\sqrt{2}$, or $Q/q = -2\sqrt{2} = -2.83$.

(b) The y -component of the net force on $q_2 = q$ is

$$F_{2y} = \frac{1}{4\pi\epsilon_0} \left(\frac{|q|^2}{(\sqrt{2}a)^2} \sin 45^\circ - \frac{(|q|)(Q)}{a^2} \right) = \frac{|q|^2}{4\pi\epsilon_0 a^2} \left(\frac{1}{2\sqrt{2}} - \frac{Q}{|q|} \right)$$

which (if we demand $F_{2y} = 0$) leads to $Q/q = -1/2\sqrt{2}$. The result is inconsistent with that obtained in part (a). Thus, we are unable to construct an equilibrium configuration with this geometry, where the only forces present are given by Eq. 21-1.