

5. We put the origin of a coordinate system at the lower left corner of the square and take $+x$ rightward and $+y$ upward. The force exerted by the charge $+q$ on the charge $+2q$ is

$$\vec{F}_1 = k \frac{q(2q)}{a^2} (-\hat{j}) .$$

The force exerted by the charge $-q$ on the $+2q$ charge is directed along the diagonal of the square and has magnitude

$$F_2 = k \frac{q(2q)}{(a\sqrt{2})^2}$$

which becomes, upon finding its components (and using the fact that $\cos 45^\circ = 1/\sqrt{2}$),

$$\vec{F}_2 = k \frac{q(2q)}{2\sqrt{2}a^2} \hat{i} + k \frac{q(2q)}{2\sqrt{2}a^2} \hat{j} .$$

Finally, the force exerted by the charge $-2q$ on $+2q$ is

$$\vec{F}_3 = k \frac{(2q)(2q)}{a^2} \hat{i} .$$

- (a) Therefore, the horizontal component of the resultant force on $+2q$ is

$$\begin{aligned} F_x &= F_{1x} + F_{2x} + F_{3x} = k \frac{q^2}{a^2} \left(\frac{1}{\sqrt{2}} + 4 \right) \\ &= (8.99 \times 10^9) \frac{(1.0 \times 10^{-7})^2}{0.050^2} \left(\frac{1}{\sqrt{2}} + 4 \right) = 0.17 \text{ N} . \end{aligned}$$

- (b) The vertical component of the net force is

$$F_y = F_{1y} + F_{2y} + F_{3y} = k \frac{q^2}{a^2} \left(-2 + \frac{1}{\sqrt{2}} \right) = -0.046 \text{ N} .$$

6. (a) The individual force magnitudes (acting on Q) are, by Eq. 22-1,

$$k \frac{|q_1| Q}{\left(-a - \frac{a}{2}\right)^2} = k \frac{|q_2| Q}{\left(a - \frac{a}{2}\right)^2}$$

which leads to $|q_1| = 9|q_2|$. Since Q is located between q_1 and q_2 , we conclude q_1 and q_2 are like-sign. Consequently, $q_1 = 9q_2$.

- (b) Now we have

$$k \frac{|q_1| Q}{\left(-a - \frac{3a}{2}\right)^2} = k \frac{|q_2| Q}{\left(a - \frac{3a}{2}\right)^2}$$

which yields $|q_1| = 25|q_2|$. Now, Q is not located between q_1 and q_2 , one of them must push and the other must pull. Thus, they are unlike-sign, so $q_1 = -25q_2$.

23. Eq. 22-11 (in absolute value) gives

$$n = \frac{|q|}{e} = \frac{1.0 \times 10^{-7} \text{ C}}{1.6 \times 10^{-19} \text{ C}} = 6.3 \times 10^{11} .$$