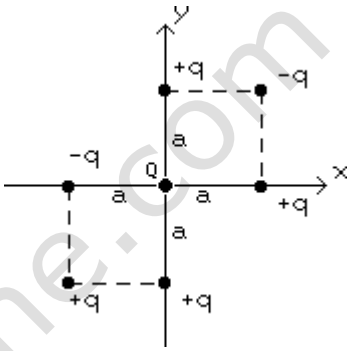
Q- Six point charges, four positive (+*q*) and two negative (-*q*), are fixed at the positions shown in the *x*-*y* plane; $q = 2 \times 10^{-6}$ C and $a = 0.88$ m. A test charge $Q = 1.5 \times 10^{-6}$ C is at the origin. Find the *x*- and *y*-components of the total force on *Q.*

The force on Q due to two +q charges on the y axis will be equal in magnitude and opposite in direction hence will result in zero.
The magnitude of the force due to the two charges on the x axis will be equal and given by

$$\frac{Qq}{4\pi \in_0 a^2}$$



As the force due to +q is repulsive and that due to -q is attractive, both will be in the same - x direction and hence their resultant is given by

$$\vec{F}_1 = 2 * \frac{Qq}{4\pi \in_0 a^2}(-\hat{i})$$

The distance of Q from both the rest two charges on the line bisecting the angle between the axes is equal to $a\sqrt{2}$ and these two charges exerts forces equal in magnitude given by

$$\frac{Qq}{4\pi \in_0 2a^2}.$$

As the +q will repel Q and -q will attract Q, the direction of both force will make 45^0 with x axis and hence magnitude of their resultant is given by

$$F_2 = 2 * \frac{Qq}{4\pi \in_0 2a^2} = \frac{Qq}{4\pi \in_0 a^2}$$

This force can be written in component form as

$$\vec{F}_2 = \frac{Qq}{4\pi \in_0 a^2}\left(\cos 45^0 \hat{i} + \sin 45^0 \hat{j}\right) = \frac{Qq}{4\sqrt{2} * \pi \in_0 a^2}\left(\hat{i} + \hat{j}\right)$$

Hence the resultant of the all forces on Q will be given by

$$\vec{F} = \vec{F}_1 + \vec{F}_2 = 2 * \frac{Qq}{4\pi \in_0 a^2}(-\hat{i}) + \frac{Qq}{4\sqrt{2} * \pi \in_0 a^2}\left(\hat{i} + \hat{j}\right)$$

Or $$\vec{F} = \frac{Qq}{4\pi \in_0 a^2}\left[2(-\hat{i}) + \frac{1}{\sqrt{2}}\left(\hat{i} + \hat{j}\right)\right]$$

Or $$\vec{F} = \frac{Qq}{4\pi \in_0 a^2}\left[\left(-2 + \frac{1}{\sqrt{2}}\right)\hat{i} + \frac{1}{\sqrt{2}}\hat{j}\right]$$

Or $$\vec{F} = \frac{\left(9 * 10^9\right)\left(2 * 10^{-6}\right)\left(1.5 * 10^{-6}\right)}{0.88^2}\left[-1.293 * \hat{i} + 0.71\hat{j}\right]$$

Or $$\vec{F} = 0.0349 * \left[-1.293 * \hat{i} + 0.71 * \hat{j}\right] = -0.045 * \hat{i} + 0.025 * \hat{j}$$

F_x = - 0.045 N
F_y = 0.025 N