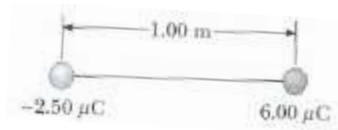
Q- Two point charges of magnitude – $2.50*10^{-6}$ C and $6.00*10^{-6}$ C are placed at a distance of 1.00 m. Determine the point(s) (other than infinity) at which the electric field is zero.



Electric field strength at a point in electric field is the force experienced per unit charge at that point.

Electric field strength at a distance r from a point charge q is given by

$$\vec{E} = \frac{q}{4\pi \in_0 r^2}\hat{r}$$

Here $\hat{r}$ is the unit vector in the direction of the line joining the charge to the point.

The field strength at a point due to number of point charges is given by the superposition law means is resultant of the field strengths due to individual charges.

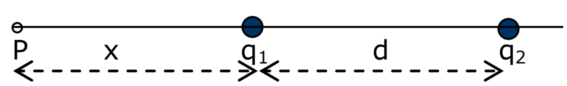
For the resultant field to be zero due to the two charges the point must be on the line joining the two charges.

As the two charges are unlike, the point of zero-field must be in the same side of the two charges and towards the charge of less magnitude.

Let the electric field is zero at point P at a distance x from the charge q_1 = - 2.50 μC then its distance from q_2 = 6.00 μC will be (d + x)

Field due to the charge q_1 at P will be

$$\vec{E}_1 = \frac{q_1}{4\pi \in_0 r_1^2}\hat{r} = \frac{q_1}{4\pi \in_0 x^2}\hat{r}$$



And the field due to charge q_2 will be

$$\vec{E}_2 = \frac{q_2}{4\pi \in_0 r_2^2}\hat{r} = \frac{q_2}{4\pi \in_0 (d+x)^2}\hat{r}$$

The resultant field at point P will be

$$\vec{E} = \vec{E}_1 + \vec{E}_2 = \frac{q_1}{4\pi \in_0 x^2}\hat{r} + \frac{q_2}{4\pi \in_0 (d+x)^2}\hat{r} = 0$$

Gives $\frac{q_1}{x^2} + \frac{q_2}{(d+x)^2} = 0$

Or $\frac{-2.5*10^{-6}}{x^2} + \frac{6.00*10^{-6}}{(1+x)^2} = 0$

Or $\frac{6.00}{(1+x)^2} = \frac{2.5}{x^2}$

Or $6.00\ x^2 = 2.5(1+2x+x^2)$

Or $3.5\ x^2 - 5\ x - 2.5 = 0$

Or $7\ x^2 - 10\ x - 5 = 0$

Gives $x = \frac{10 \pm \sqrt{100 + 4*7*5}}{2*7} = \frac{10 \pm 4\sqrt{15}}{14}$

Hence $x = 1.821$ m or $x = -0.392$ m

Here the second answer is not correct because this point is between the two charges where both fields will be equal but in the same direction hence other is the correct answer for the point where the fields are equal and opposite.

Hence the point of zero-field is at a distance **1.821 m** from q_1 on the other side of q_2 or at **2.821** from q_2 on the same side of q_1.