Answer on Question #69100 Physics / Electric Circuits

Two fixed charges A and B of $q = 5$ μC each are separated by a distance of $r = 6$ m. C is the mid point of the line joining A and B. A charge 'Q' of $Q = -5$ μC is shot perpendicular to the line joining A and B through C with a kinetic energy of $K = 0.06$ J. The charge Q comes to rest at a point D. Calculate the distance CD.

Solution:

The charge of kinetic energy = work done

$$\Delta K = W = Q(\varphi_1 - \varphi_2)$$

At the point C the potential of electric field is

$$\varphi_1 = k\frac{q}{\frac{r}{2}} + k\frac{q}{\frac{r}{2}} = \frac{4kq}{r}$$

At the point D

$$\varphi_2 = k\frac{q}{d} + k\frac{q}{d} = \frac{2kq}{d},$$

where $d = \text{AD} = \text{BD}$.

So

$$\Delta K = Q\left(\frac{4kq}{r} - \frac{2kq}{d}\right)$$

$$\Delta K = 2kqQ\left(\frac{2}{r} - \frac{1}{d}\right)$$

$$\frac{1}{d} = \frac{2}{r} - \frac{\Delta K}{2kqQ}$$

$$d = \frac{1}{\frac{2}{r} - \frac{\Delta K}{2kqQ}} = \frac{1}{\frac{2}{6} - \frac{-0.06}{2\times 9\times 10^9\times 5\times 10^{-6}\times(-5)\times 10^{-6}}} =$$

$$\frac{1}{\frac{1}{3} - \frac{0.06}{0.450}} = \frac{1}{\frac{1}{3} - \frac{0.4}{3}} = \frac{3}{0.6} = 5 \text{ m}.$$

Then $CD = \sqrt{AD^2 - AC^2} = \sqrt{d^2 - \left(\frac{r}{2}\right)^2} = \sqrt{5^2 - 3^2} = 4$ m.

Answer: 4 m.