

Question #77465, Physics / Electric Circuits

Two fixed point charges $+4e$ and $+e$ units are separated by a distance a where should the third charge be placed for it to be in equilibrium

Solution

For the charge to be in equilibrium, the net electric field strength due to both charges must be zero.

$$\sum E_i = 0$$

The electric field strength due to a point charge is $E = \frac{q}{4\pi\epsilon_0 r^2}$.

Considering the placement of the 3rd charge between the two given charges. Let x represent the distance from the larger charge. Then the distance to the smaller charge is $(a - x)$.

$$E_{4e} = \frac{4e}{4\pi\epsilon_0 x^2}; E_e = \frac{e}{4\pi\epsilon_0 (a-x)^2}$$

$$\frac{4e}{4\pi\epsilon_0 x^2} - \frac{e}{4\pi\epsilon_0 (a-x)^2} = 0;$$

$$\frac{4}{x^2} = \frac{1}{(a-x)^2};$$

$$4(a-x)^2 = x^2$$

$$4a^2 - 8ax + 3x^2 = 0;$$

Solving for x , $x = \frac{2}{3}a$

Answer: the charge must be placed at the distance $\frac{2}{3}a$ from the larger charge.

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