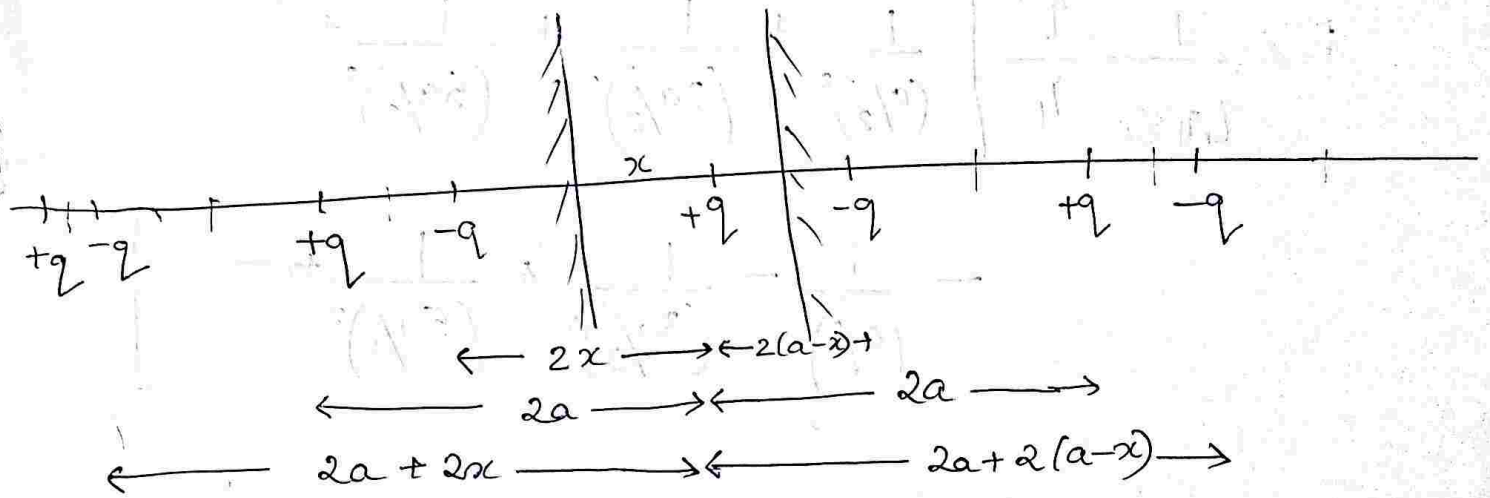
20221254

PHYSICS PRESENTATION

Q. Two infinite parallel grounded conducting plates are held at a distance 'a' apart. A point charge is placed in the region between them, a distance x from one plate. Find force on q. Find force for $x = a/2$ and

$a \longrightarrow \infty$



We see that the force on +q due to other positive charges get cancelled out. The ones that remain are due to −q.

$$\therefore F = \frac{1}{4\pi\varepsilon_0} q^2 \left(\left[\frac{1}{[2(a-x)]^2} + \frac{1}{[2a+2(a-x)]^2} + \cdots \right] - \left[\frac{1}{(2x)^2} + \frac{1}{(2a+2x)^2} + \cdots \right] \right)$$

$$F = \frac{1}{4\pi\varepsilon_0}\frac{q^2}{4}\left[\frac{1}{(a-x)^2} + \frac{1}{(2a-x)^2} + \frac{1}{(3a-x)^2} + \cdots - \frac{1}{x^2} - \frac{1}{(a+x)^2} - \frac{1}{(2a+x)^2} - \cdots\right]$$

When $x = a/2$

$$F = \frac{1}{4\pi\varepsilon_0}\frac{q^2}{4}\left[\frac{1}{(a/2)^2} + \frac{1}{(3a/2)^2} + \frac{1}{(5a/2)^2} + \cdots - \frac{1}{(a/2)^2} - \frac{1}{(3a/2)^2} - \frac{1}{(5a/2)^2} - \cdots\right]$$

$\therefore F = 0$

When q is placed midway between two grounded conducting planes, it doesn't experience any net force.

when $a \longrightarrow \infty$, $a >> x$

$$F = \frac{-1}{4\pi\varepsilon_0} \frac{q^2}{4} \left(\frac{1}{x^2} \right)$$

This is same as a plane ($V=0$), and a charge at distance $2x$.

Calculating the force between the plates helps in understanding the behaviour of a charged particle placed between two grounded plates.