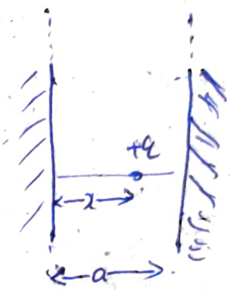
# Phy Tutorial Presentation 11/04/23

## Setup

→ Two infinite parallel grounded plates, [seperated by distance a.] a charge +q placed at a distance x from one of the charges.

→ Find the force acting on charge. general case and when $x = a/2$.

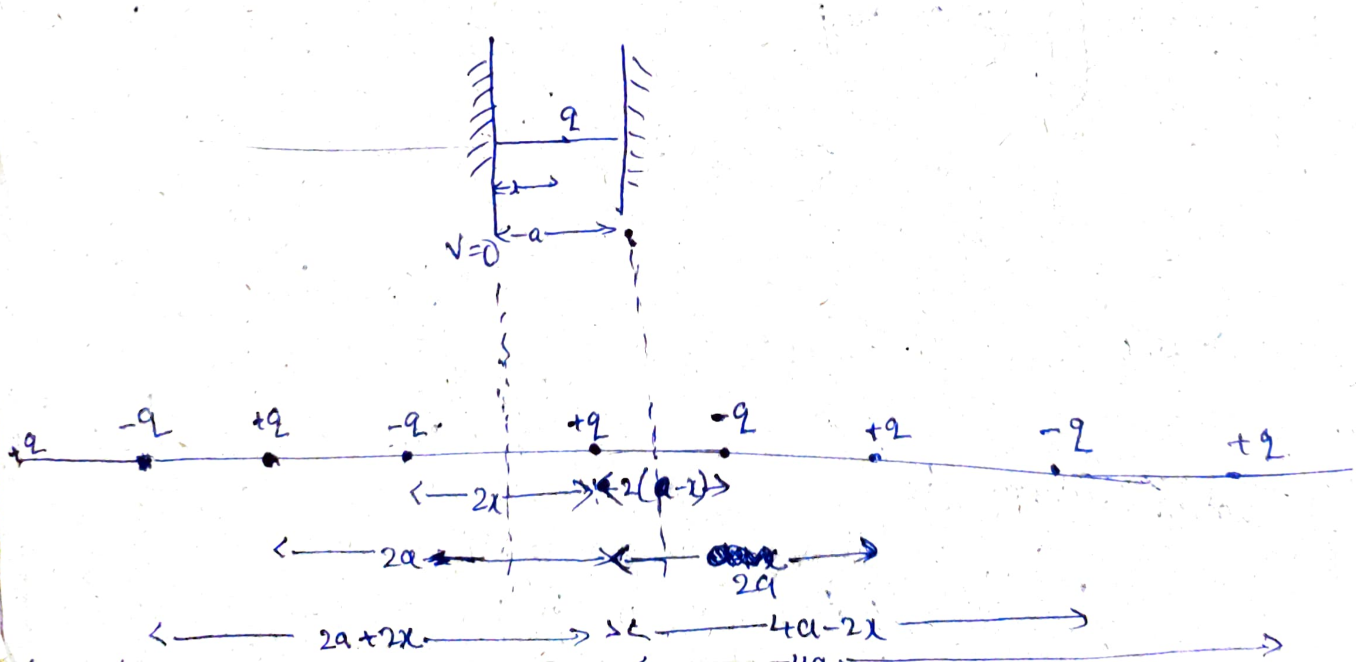



## Approach

→ We use method of images. For that we need two boundary conditions. Any system holding same boundary condition gives the same result

→ Our boundary conditions potential $V=0$ on grounded plates.
⇒ Region under consideration is space b/w the plates.

→ We obtain equivalent system by taking reflections (switching signs)



→ we observe that forces due to +ve charges cancel each other

→ F due to −ve

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

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

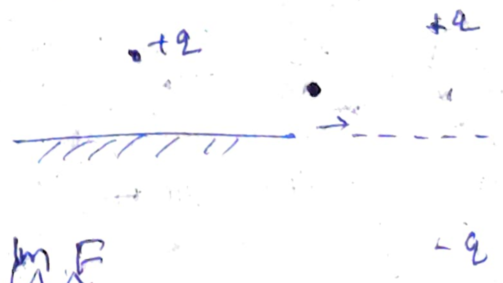
<u>when $x = a/2$</u>

$$F = \frac{1}{4\pi\varepsilon_0} \frac{q^2}{4} \left\{ \left[ \frac{1}{(a/2)^2} + \frac{1}{(3a/2)^2} + \frac{1}{(5a/2)^2} \cdots \right] - \left[ \frac{1}{(a/2)^2} + \frac{1}{(3a/2)^2} + \frac{1}{(5a/2)^2} \cdots \right] \right\} = 0$$

$$= \underline{0}$$

<u>when $a \to \infty$</u>

Situation reduces to




$$F = \frac{1}{4\pi\varepsilon_0} \frac{q^2}{(2x)^2} \quad \text{as} \quad \lim_{a\to\infty} F$$

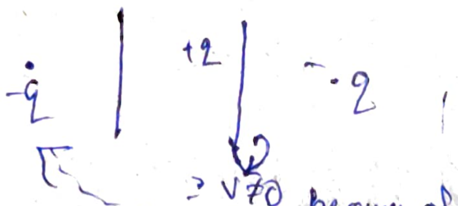
from the equation we derived

are as $a \to \infty$ $\quad F = \frac{1}{4\pi\varepsilon}\frac{q^2}{(2x)^2}$

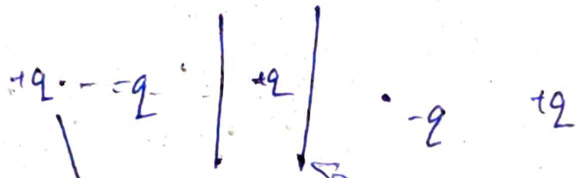
→ Explanation

→ In method of solution we take $\infty$ reflections.

→ 1) In first reflection we fix $V=0$ at either one of the plates individually but ~~but~~ but this act itself makes $V \neq 0$ on the other plate.




$V \neq 0$ because of this charge.




$V \neq 0$ at this plate due to this charge.

2) now we correct this difference by taking reflection again.

→ But when we did step 2 we got closer to 0 as $+q$ which caused the error is further away compared to $-q$ in previous step. Thus with $\infty$ terms $V=0$ at both plate.

Summarie

→ ~~the~~ In the same way we should be able to find the potential b/w the surface

→ We can view special cases as a verification that the work