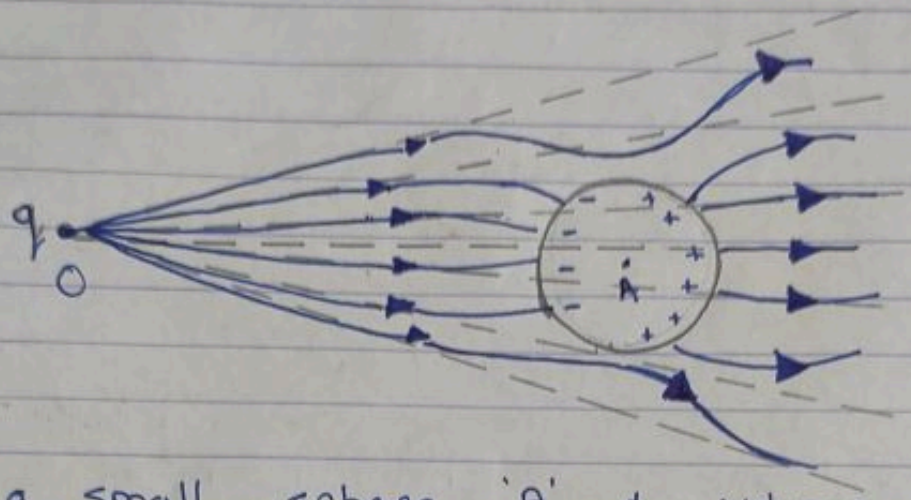
FORCE ON AN UNCHARGED CONDUCTOR PLACED IN ELECTRIC FIELD



- Let a small sphere 'A' of volume V is placed at a distance of r from a point charge 'q' at O.

- In the image, dotted lines depict the direction of lines of electric force when sphere was absent.

- Full lines (Pen ink) represent direction of lines of forces when sphere is placed in the field.

- Let us assume that there is no distortion of the field due to the presence of sphere.

According to given conditions, the intensity of electric field at the centre of Sphere is given by,

$$E = \left[\frac{1}{4\pi\varepsilon_0 K}\right]\frac{q}{r^2}$$

where K is the dielectric constant of the medium between O and A.

- By concept of Energy Density, the potential energy which is confined in volume V,

$$U = \frac{1}{2} \varepsilon_0 K E^2 V$$

Mechanical Force

$$F = -\frac{dU}{dx}$$

$$= -\frac{d}{dx}\left(\frac{1}{2} \varepsilon_0 K E^2 . V\right)$$

$$= -\frac{d}{dx}\left(\frac{1}{2} \varepsilon_0 K \left(\frac{1}{4\pi\epsilon_0 K}\frac{q}{x^2}\right)^2 V\right)$$

$$= -\frac{d}{dx}\left(\frac{q^2 V}{32\pi^2 \varepsilon_0 K x^4}\right)$$

$$\boxed{F = \frac{q^2 V}{8\pi^2 \varepsilon_0 K x^5}}$$

Thus force on uncharged conductor placed in an electric field will be

$$F = \frac{q^2 V}{8\pi^2 \varepsilon_0 K x^5}$$