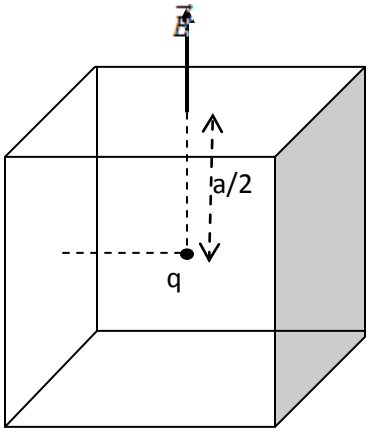
Q- A +1 μC point charge is at the center of a cubical box 0.5m on an edge.

(a) Calculate the magnitude of the electric field at the center of each face.

(b) Compute the outward electric flux through each face of the box.

The side of the cube is a = 0.5 m

a) The center of any face will be at a distance of a/2 = 0.25 m



The magnitude of electric field E at a distance r from a charge q is given by

$$E = \frac{1}{4\pi\epsilon_0}\frac{q}{r^2}$$

Substituting values, the magnitude of field at the center of each face will be

$$E = 9 * 10^9 * \frac{1*10^{-6}}{0.25^2} = 1.44 * 10^5 \text{ N/c}$$

b) The outward electric flux for any closed surface is given by Gauss's law.

According to the law the flux coming out of any closed surface (surface integral of electric field ($\oint \vec{E} \cdot d\vec{s}$) is equal to the charge enclosed by the surface divided by permittivity constant.

$$\emptyset_E = \oint \vec{E} \cdot d\vec{s} = \frac{q}{\epsilon_0}$$

Substituting values the outward flux Through all the six surfaces of the cube is given by

$$\emptyset_E = \frac{1*10^{-6}}{8.85*10^{-12}} = 1.13 * 10^5 \text{ N.m}^2\text{/C}$$

As the charge is placed at the center of the cube, the flux is symmetrically distributed from the six surfaces and thus the flux through one surface of the cube is given by

$$\emptyset_{E1} = \frac{\emptyset_E}{6} = \frac{1.13*10^5}{6} = 1.88 * 10^4 \text{ N.m}^2\text{/C}$$