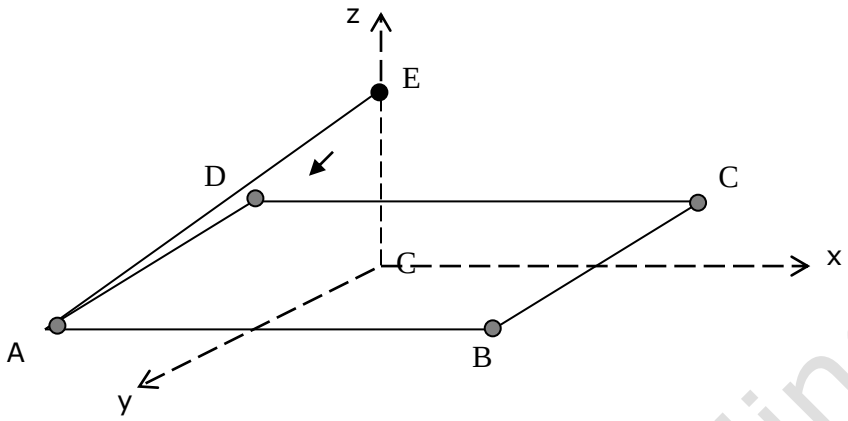
Q- Four equal charges of + 3.0 x 10^{-7} C are placed on the corners of one face of a cube of edge length 10.0 cm. A charge of -3.0 x 10^{-7} C is placed at the center of the cube. What are the magnitude and the direction of the force on the charge at the center of the cube?



Let the positive charges at A, B, C and D are Q and charge at the center of the cube E is - q. Let the side of the cube is a. The magnitude of the force acting on the charge –q at point E due to charge Q at A is given by

$F_1 = \frac{1}{4\pi\varepsilon_0}\frac{4qQ}{3a^2}$ because AE= $\sqrt{3}a/2$ (half of the body diagonal of the cube)

As all the four forces are equal in magnitude and symmetrically placed the components along z direction are added up but the resultant of components in x and y direction will become zero.

Component of force due to Q at A along –ve z axis and its magnitude is given by

$F_z = \frac{1}{4\pi\varepsilon_0}\frac{4qQ}{3a^2}\cos\angle AEC = \frac{1}{4\pi\varepsilon_0}\frac{4qQ}{3a^2}\frac{1}{\sqrt{3}}$

Therefore due to all four charges the total force on –q will be 4times of Fz and is

$F = \frac{16}{4\pi\varepsilon_0}\frac{qQ}{3\sqrt{3}a^2}$ along – ve z direction

substituting the values and solving for F

$F = 16 * 9 * 10^9 * \frac{3*10^{-7}*(-3*10^{-7})}{3\sqrt{3}*(0.10)^2} = -144\sqrt{3} * 10^{-7} = -0.25N$