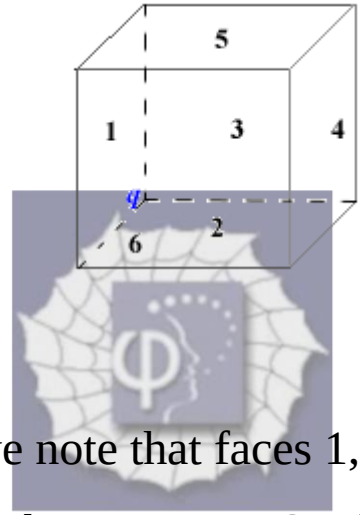
316.

Problem 29.12 (RHK)

A point charge q is placed at one corner of a cube of edge a. We have to find the flux through each of the cube faces.



Solution:

From the figure we note that faces 1, 2, and 3 have charge q at one of their corners. On the faces 1, 2, and 3 of the cube electric field vectors and the normal vectors to these faces will be orthogonal. Therefore, the flux of the electric field due to the charge q through faces 1, 2, and 3 of the cube will be zero.

The other three faces of the cube 4, 5, and 6 are symmetrically placed with respect to the charge q. For calculating the flux through these surfaces, we consider a cubic Gaussian surface in which the q is at the cubic centre. It is clear that surface area of the faces of this

cube will be four times that of the original cube shown in the figure. By symmetry flux through each of the six faces of the bigger cube will be equal and by Gauss' theorem will be

$$\Phi'_E = \frac{q}{\varepsilon_0} \ .$$

And, therefore, the flux of the electric filed through faces 4, 5, and 6 of the cube due to the charge q will be

$$\Phi_E = \frac{1}{6\times 4} \times \frac{q}{\varepsilon_0} = \frac{q}{24\varepsilon_0}.$$