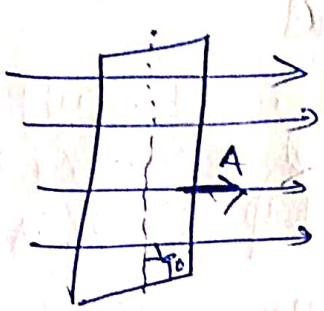
Ex.1. A flat sheet of paper measuring 22cm x 27cm is placed in a uniform electric field of 100 N/C. What is the electric flux through the paper if paper makes an angle of 90° ~~and~~ with the electric field? If the paper makes an angle of 30°?

Solution

(a) When paper makes an angle of 90° with electric field.



Here Electric field makes an angle 90° with paper. But angle between $\vec{A}$ and $\vec{E}$ is 0°.

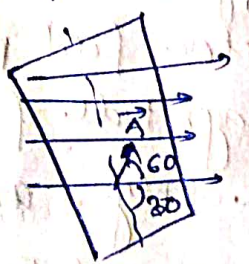
$$\phi_E = \vec{E} \cdot \vec{A} = |\vec{E}||\vec{A}| \cos\theta$$

$$= 100\ N/C \times \frac{22cm \times 27cm}{100 \times 100} \times \cos 0°$$

$$= \frac{100 \times 22 \times 27}{100 \times 100} \times 1 \quad \frac{N}{C} m^2$$

$$= 6.2\ \frac{N m^2}{C}$$

(b) When paper makes an angle 30° with electric field.



Here angle between Electric field and area vector is 60°. as shown in figure.

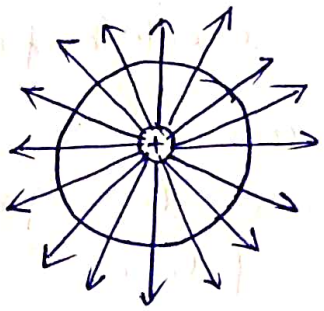
$$\therefore \phi_E = \vec{E} \cdot \vec{A} = 100\ N/C \cdot \frac{22cm \times 27cm}{100 \times 100} \cos 60°$$

$$= 8.1\ N m^2/C$$

Ex. 2 Consider a point charge 'q' is placed at the center of sphere of radius 'r'. Find out the electric flux through surface of sphere.

Solution:

The positive point charge q produces a radial, outward electric field of magnitude $E = \frac{q}{4\pi\epsilon_0 r^2}$. that



crosses the spherical surface everywhere perpendicularly.

Area of sphere $4\pi r^2$

$$\phi_E = \vec{E} \cdot \vec{A} = |\vec{E}|\,|\vec{A}| \cos\theta$$

$$\theta = 0^\circ$$

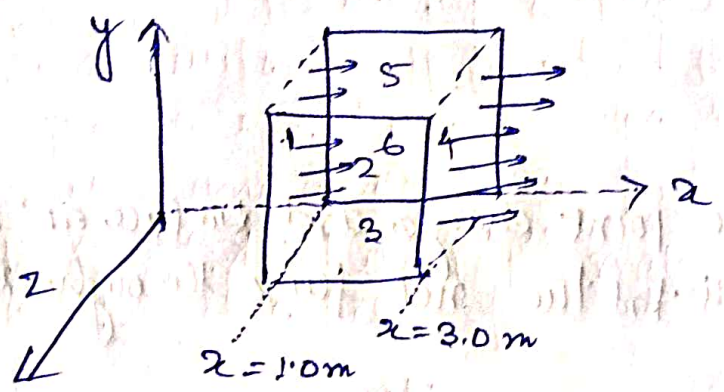
$$\Rightarrow \phi_E = \frac{q}{4\pi\epsilon_0 r^2} \times 4\pi r^2 \times 1$$

$$\Rightarrow \phi_E = \frac{q}{\epsilon_0}$$

Ex. 3 Consider a cube of side $a = 2.0\,m$ with one corner at $(x, y, z) = (1.0m, 0, 0)$ and its sides parallel to the axes as shown in figure below. The cube is in a region where the electric field points everywhere in the +x direction. the magnitude of this electric field varies as function of x only, and has the values $E_x = 5.0\,N/C$ at $x = 1.0m$ and $E_x = 15\,N/C$ at $x = 3.0m$

What is the electric flux through the cube?

Solution:



Electric field points everywhere in the +x direction.
Electric field has different values at x=1.0m and x=3.0m.

~~Fate~~ cubic face parallel to y-z plane is plane '1' and plane '4'.

Through plane '1' and plane '4' Electric field pass, so, these two plane will contribute in flux.

$$\phi_E = \int_0 \vec{E} \cdot d\vec{S}$$

$$= \phi_1 + \phi_2 + \phi_3 + \phi_4 + \phi_5 + \phi_6$$

Since plane 1 and plane 4 contribute in flux.

$$\text{so } \phi_E = \phi_1 + \phi_4$$

$$\phi_1 = \int \vec{E} \cdot d\vec{S}_1 = -5.0\ N/C \times (2.0m)^2$$

$$= -5 \times 4 \ N \cdot m^2/C = 20\ N \cdot m^2/C$$

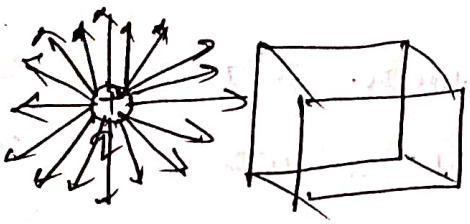
$$\phi_4 = \int \vec{E} \cdot d\vec{S}_4 = 15.0\ N/C \times (2.0m)^2$$

$$= 60\ N \cdot m^2/C^2$$

ϕ_1 has negative sign due to it has inward direction
ϕ_4 has positive sign due to it has outward ...

$$\phi_E = (20 + 60)\ N \cdot m^2/C = 40\ N \cdot m^2/C$$

Eg. 4 Consider the point charge and surface as shown in figure below. Find the net flux through this surface?



Solution: Zero

Since all the field lines that enter the surface also leave it, the net flux through the surface is zero.