22.2: Calculating Electric Flux

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Definition: (Forumla for Electric Flux) The formula for uniform electric flux flowing through a flat surface is

$$\Phi_E = \vec{E} \cdot \vec{A}$$

where $\vec{A} = a\hat{n}$, or the area of the s8rface times a unit vector normal to the area. A surface has two sides, and by convention, we define outward flux to be positive, and inward flux to be negative.

Proposition: The flux of a nonuniform electric field is given by

$$\Phi_e = \int \vec{E} \cdot d\vec{A}$$

We call this integral the surface integral over $\vec{A}$.

Example: A disk of radius .10m is oriented with unit vector $\hat{n}$ 30° to a uniform electric field with magnitude 2000N/C.

1. What is the flux through the disk?
2. What is the flux through the disk if $\hat{n}$ is perpendicular to the field?
3. What is the flux through the disk if $\hat{n}$ is parallel to the field?

Solution:

1. Lets figure out the area vector first: the area of the disk is $.01\pi$, and that is the magnitude of the area vector. Then,
$$\vec{E} \cdot \vec{A} = |\vec{E}||\vec{A}| \cos 30° = .01\pi * 2000 * \frac{\sqrt{2}}{2} = 44.42 \ Nm^2C^{-1}$$
2. If a surface is parallel to the field, or in other words, the normal vector is perpendicular to the field, then flux will be 0
3. This is equal to the previous scenario, but now $\cos\theta = 1$, so we have $.01\pi * 2000 = 62.83 \ Nm^2C^{-1}$