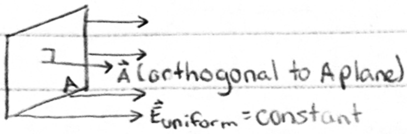
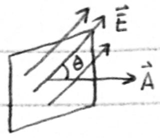
Gauss' Law

Flux - how much something is passing through some surface

Number per unit area or number passing through area of interest



$\angle \vec{A}\vec{E} = 0$ $\quad \Phi = \vec{E}\vec{A}$ in Wb



$\Phi = \vec{E}\vec{A}\cos\theta = \vec{E}\cdot\vec{A}$

Nonconstant E $\quad \Phi = \oint \vec{E}\, dA$

$E = \frac{1}{4\pi\varepsilon_0}\frac{Q}{R^2}$ at R $\qquad \Phi = \oint_s E\,dA = E\oint_s dA = EA$

$\Phi = EA = 4\pi R^2 \cdot \frac{1}{4\pi\varepsilon_0}\frac{Q}{R^2} = \frac{Q}{\varepsilon_0}$

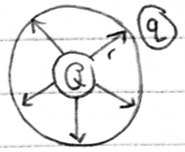
Superposition Principle

$\Phi_{tot} = \Phi_1 + \Phi_2 = \frac{Q_1}{\varepsilon_0} + \frac{Q_2}{\varepsilon_0} = \frac{1}{\varepsilon_0}\Sigma Q_i$

Works with any shape/surface (must be closed)

Only counting for inside charges

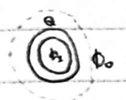
Example #1



$\Phi = \frac{Q}{\varepsilon_0} = EA$ $\qquad F = qE = \boxed{\frac{1}{4\pi\varepsilon_0}\frac{Qq}{r^2}}$

$E = \frac{Q}{A\varepsilon_0} = \frac{Q}{4\pi r^2\varepsilon_0}$

Example #2



$\Phi_0 = \frac{Q}{\varepsilon_0} = EA$ $\qquad \Phi_I = \frac{Q}{\varepsilon_0} = 0$

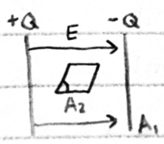
$E_0 = \frac{Q}{4\pi r^2\varepsilon_0} = \boxed{\frac{1}{4\pi\varepsilon_0}\frac{Q}{r^2}}$ $\qquad E_I = \boxed{0}$

* Example #3

$(A_1 = 100\ cm^2 \quad A_2 = 1\ cm^2) \times 10^{-2}$ m

$Q = 5\ nC \times 10^{-9}$ C $\quad \theta = 45°$

$\Phi_2 = ?$



$\Phi = EA_2\cos\theta = \frac{5}{100\varepsilon_0}(1)\cos 45 = \boxed{4\ Wb}$

$E = \frac{\sigma}{\varepsilon_0} = \frac{Q}{\varepsilon_0 A_1} = \frac{5}{100\varepsilon_0}$