

Gauss's Law

Electrical Engineering

Flux through a closed surface, and the symmetry that makes it usable.

Electric flux through a closed surface depends only on the charge enclosed, not on how it is arranged.

Flux = $Q_{\text{enclosed}} / \epsilon_0$ · symmetry picks the surface

Point charge

Sphere.

$$E = Q/(4\pi\epsilon_0 r^2)$$

Infinite line, λ

Cylinder.

$$E = \lambda/(2\pi\epsilon_0 r)$$

Inside a conductor

Charge on surface.

$$E = 0$$

THE COMMON MISTAKE

× Applying Gauss's law where there is no symmetry

✓ Using it only when E is uniform on the surface

The law is always true but only useful when symmetry lets E come outside the integral. Otherwise the flux integral cannot be done.

A charge outside the surface contributes zero net flux: its field lines enter on one side and leave on the other.