Gauss' Law

If an arbitrary closed surface has a net electric charge Q_{inside} within it, then the electric flux through the surface is Q_{inside}/ϵ_0, that is,

$$\phi_E = \oint \vec{E} \cdot d\vec{A} = \frac{Q_{inside}}{\epsilon_0}$$

Gauss' Law says that the total electric flux through any closed surface is determined solely by the amount of charge inside the surface.

* The individual electric field of a point charge within the surface does contribute to the flux.

* The individual electric field of a charge outside the closed surface generates no net flux through the closed surface because it enters it at one point and leaves at another.

* positive charges generate positive flux
* Negative charges generate negative flux.
* Net flux proportional to the net number of field lines crossing the surface, is equal to the net charge inside the closed surface divided by ϵ_0.

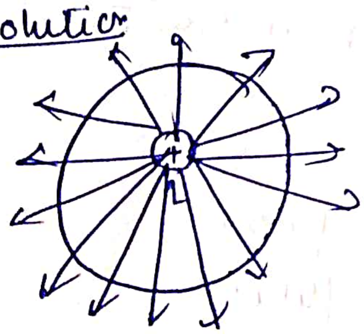
Gauss'

Importance of Gauss Law

Gauss' Law can be used to calculate the electric field, provided that the charge distribution has a high degree of symmetry. Gauss' Law relates the normal component of electric field on a closed surface to the total charge inside the surface.

ex. Find electric field due to a point charge using Gauss' Law?

Solution



Now consider a spherical Gaussian surface of radius 'r' centered on the charge q, as shown in figure. According to the symmetry arguments, at all points on this surface, the electric field must be radial and constant. On this Gaussian surface, the normal component of the electric field is the same as the total field $E_{\perp} = E$ (normal component)

$$\therefore \phi_E = \oint \vec{E}\cdot d\vec{A} = \oint E\, dA \cos 0^{\circ} = E \oint dA$$

$$= E \times 4\pi r^2$$

$$\phi_E = E 4\pi r^2 = \frac{q_{inside}}{\epsilon_0}$$

$$\boxed{E = \frac{q}{4\pi r^2 \epsilon_0}}$$