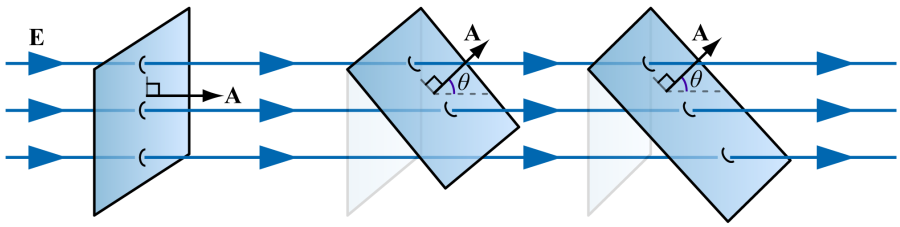
Gauss's law

The number of electric field lines coming out of a closed containing surface is proportional to the net positive charge contained by that surface.

Electric flux



Uniform electric field through finite planar area

$$\Phi_{\mathrm{E}} = \vec{\mathbf{E}} \cdot \vec{\mathbf{A}} = \left(\left|\vec{\mathbf{E}}\right| \cos\theta\right)\left|\vec{\mathbf{A}}\right|$$

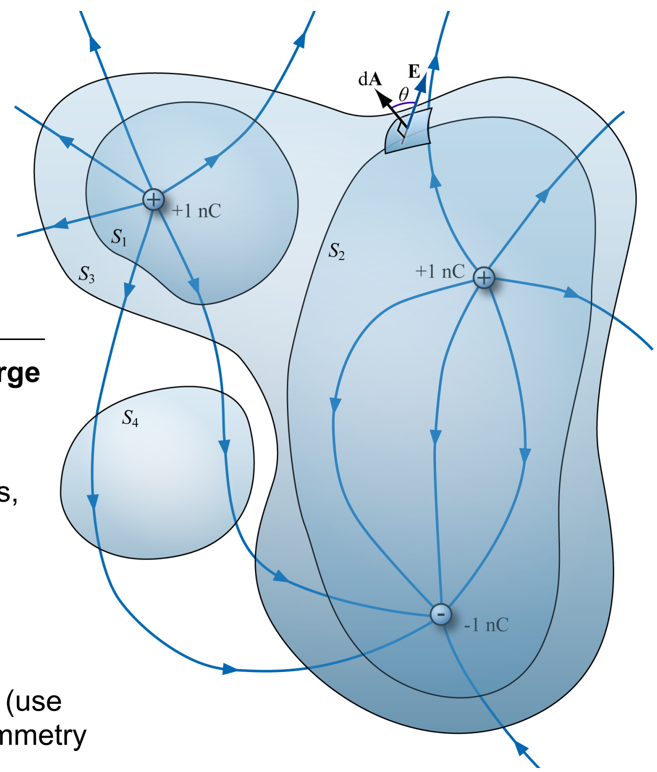
$$\mathrm{d}\Phi_{\mathrm{E}} = \vec{\mathbf{E}} \cdot \mathrm{d}\vec{\mathbf{A}} = \left(\left|\vec{\mathbf{E}}\right| \cos\theta\right) \mathrm{d}A$$

Gauss's law

$$\int_{\substack{\text{SEALED}\\\text{CONTAINING}\\\text{BAG}}} \vec{\mathbf{E}} \cdot \mathrm{d}\vec{\mathbf{A}}_{\mathrm{OUT}} = \frac{Q_{\mathrm{ENCL}}}{\epsilon_0}$$

Q_{ENCL} is the net enclosed charge.

Scale: $+1\ \mathrm{nC}$ radiates 6 $\vec{\mathbf{E}}$-field lines



Gauss's law problem solving steps for charge distributions exhibiting useful symmetry

1. Draw large diagram of charge distribution.
2. Label any known charges, charge densities, and dimensions of charge distribution.
3. Draw point of observation, P.
4. State symmetry of charge distribution (see chart).
5. Draw $\vec{\mathbf{E}}$-field vector at P.
6. Draw Gaussian surface passing through P (use chart to choose surface appropriate for symmetry of charge distribution).
7. Label any known dimensions of Gaussian surface.
8. Draw differential patch $\mathrm{d}\vec{\mathbf{A}}_{\mathrm{OUT}}$.
9. Write Gauss's law.
10. Use illustration to substitute expressions into Gauss's law.
11. Use symmetry to simplify $\vec{\mathbf{E}} \cdot \mathrm{d}\vec{\mathbf{A}}_{\mathrm{OUT}}$.
12. Solve.

Convenient Gaussian surfaces

symmetry of charge distribution		
planar	spherical	cylindrical
Gaussian surface		
pillbox	sphere	soup can