

Electric Charges and Fields

Coulomb, superposition and Gauss, with the integrals done

Charge, and the three properties it has

- **quantised** : every charge is a whole number multiple of $e = 1.6 \times 10^{-19} \text{ C}$, so a charge of half an electron does not exist
- **conserved** : the total charge of an isolated system never changes, however the charge is redistributed
- **additive** : charges add algebraically, with sign, which is what makes superposition possible
- charging happens by friction, conduction or induction, and induction is the one that leaves the inducing body unchanged
- like charges repel and unlike attract, and the force acts along the line joining them

Coulomb's law and the field it defines

force between point charges

$$F = (1/4\pi\epsilon_0) q_1 q_2 / r^2$$

the constant

$$1/4\pi\epsilon_0 = 9 \times 10^9 \text{ N m}^2 \text{ per C}^2, \text{ with } \epsilon_0 = 8.854 \times 10^{-12} \text{ in SI}$$

in a medium

divide by the dielectric constant K, so the force falls by that factor

electric field

$$E = F/q_0, \text{ the force per unit POSITIVE test charge}$$

field of a point charge

$$E = (1/4\pi\epsilon_0) q / r^2, \text{ directed away from a positive charge}$$

superposition

the net force or field is the VECTOR sum of the individual ones, each computed as if alone

Coulomb's law holds for POINT charges at rest; for anything extended the charge must be broken up and the contributions integrated

