D2

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1 Conservation of Charge

The sum of currents into a junction is equal to the sum of the currents away from the junction.

2 Electrostatics

2.1 Charge by Friction

- Two materials charged by friction end up with opposite charges.
- Friction, rubbing; electrons move

2.2 Charge by Contact

Contact between a charge and an uncharged object. Then, both have the same sign.

2.3 Charge by Induction

Opposite charges are induced in a neutral object by bringing a charged object close to it. Will have opposite signs after. Electrons don't move from one object to another.

3 Forces Between Charged Objects

For radial fields only:

$$F = \frac{kq_1q_2}{r^2} = \frac{q_1q_2}{4\pi\epsilon_0 r^2}$$

where $k = 8.99 \times 10^9 \mathrm{N\,m^2\,C^{-2}}$, ϵ is the permittivity of free space. Also

$$k = \frac{1}{4\pi\epsilon_0}$$

and $F_e = qE$

4 Electric Field Strength

The electric field strength E at a distance r from an isolated point charge q is

$$E = \frac{F}{q_2} = k\frac{q_1}{r^2} = \frac{q_1}{4\pi\epsilon_0 r^2}$$

4.1 Electric Fields Lines

- The lines start and end on charges of opposite sign.
- An arrow is essential to show the direction in which a positive charge would move (that is, away from positive charge and towards negative charge).
- Where the field is strong, the lines are close together
- The lines act to repel each other
- The lines never cross
- The lines meet a conducting surface at 90°

4.2 P.d. Between Parallel Plates

$$V = \frac{\text{work done in a moving charge}}{\text{magnitude of a charge}} = \frac{W}{q} = Ed$$

where d is the separation between the plates. Also

$$E = \frac{V}{d}$$

4.3 The Electronvolt

$$1\text{eV} = 1.6 \times 10^{-19}\text{J}$$

$$1\text{J} = 6.24\text{eV}$$

4.4 Field close to a conductor

$$q \propto \frac{VA}{d}$$

$$q = \frac{VA}{4\pi kd}$$

$$E = 4\pi k\sigma \text{ for two plates}$$

$$E = 2\pi k\sigma \text{ for one plate}$$

where

- $d =$ plate separation
- $V =$ p.d. between plates
- $A =$ area of the plates
- $\sigma =$ surface charge density
- $k = \frac{1}{4\pi\epsilon_0}$

4.5 Two Wires

$$\frac{F}{L} = \mu_0 \frac{I_1 I_2}{2\pi r}$$