E.3   Coulomb's Law

Coulomb's law can be used to determine the force between two charges (q_1) and (q_2) separated by a distance (r).

$$F = k \frac{q_1 q_2}{r^2}$$

Where   F is the force on the charges (N)
               q_1 and q_2 are the charges (C)
               r is the distance between the charges (m)
               $k = 9.0 \times 10^9 \, N \, m^2 \, c^{-2}$

This is another example of an inverse square law.

Example

Two small spheres A and B act as point charges separated by 10.0 cm in air. Calculate the force on the charges if A has a charge of 3.00 μC and B has a charge of 45.0 nC.

$$F = k \frac{q_1 q_2}{r^2} = 9.0 \times 10^9 \frac{3.00 \times 10^{-6} \times 45 \times 10^{-9}}{0.1^2} = 0.1215 = 0.12 \, N$$

E.4   Electric Field around a Point Charge

In section E.2.1 The force on a charge in an electric field is given by:

$$F = q E$$

Combining this with Coulomb's law we get

$$qE = k \frac{Q q}{r^2}$$

Thus $E = k \frac{Q}{r^2}$

Where   E is the strength of the electric field around a point charge (N C^{-1})
               Q is the charge on the point creating the field (C)
               R is the distance from the charge (m)
               $k = 9.0 \times 10^9 \, N \, m^2 \, c^{-2}$

Example

Calculate the magnitude and direction of the electric field at a point P at a distance of 20 cm from a charge of $- 2.0 \times 10^{-6}$ C.

$$E = k \frac{Q}{r^2} = 9.0 \times 10^9 \frac{2.0 \times 10^{-6}}{.20^2} = 4.5 \times 10^5 \ N/m$$

Direction – Towards P

Text Questions: Page 44 All Questions