Chapter. 8 - Magnetism and Matter

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1. The bar magnet:

(i) It has been known since ancient times that magnet tend to point in the north-south direction.

(ii) There are two poles; north pole and south pole. Like magnetic poles repel and unlike ones attract.

(iii) Magnetic monopoles do not exist. If you slice a magnet in half, you get two smaller magnets.

2. Bar magnetic in external field:

(i) When a bar magnet of dipole moment m is placed in a uniform magnetic field B, the force on it is zero.

(ii) The torque on it is m × B

(iii) its potential energy is –m · B, where we choose the zero of energy at the orientation when m is perpendicular to B.

3. Field due to a small bar magnet:

Consider a bar magnet of size l and magnetic moment m, at a distance r from its mid-point, where r ≫ l, the magnetic field B due to this bar

is, $B = \frac{\mu_0 m}{2\pi r^3}$ (along axis) and $B = -\frac{\mu_0 m}{4\pi r^3}$ (along equator)

4. Gauss' law for magnetism:

Gauss's law for magnetism states that the net magnetic flux through any closed surface is zero.

5. Earth's magnetism:

(i) The earth's magnetic field resembles that of a (hypothetical) magnetic dipole located at the centre of the earth. The pole near the geographic north pole of the earth is called the north magnetic pole. Similarly, the pole near the geographic south pole is called the south magnetic pole.

(ii) Three quantities are needed to specify the magnetic field of the earth on its surface– the horizontal component, the magnetic declination, and the magnetic dip. These are known as the elements of the earth's magnetic field.

(iii) A vertical plane passing through geographic axis is called geographic meridian.

(iv) A vertical plane passing through magnetic axis is called magnetic meridian.

(v) The angle between magnetic meridian at a point with the geographical meridian is called the declination or magnetic declination.

6. Magnetisation and Magnetic Intensity:

(i) Consider a material placed in an external magnetic field B_0. The magnetic intensity is defined as, $H = \frac{B_0}{\mu_0}$

(ii) The magnetisation M of the material is its dipole moment per unit volume.

(iii) The magnetic field B in the material is, $B = \mu 0(H + M)$

(iv) For a linear material, $M = \chi H$. So that $B = \mu H$ and χ is called the magnetic susceptibility of the material.

(v) The three quantities χ, the relative magnetic permeability μr and the magnetic permeability μ are related as follows: $\mu = \mu 0 \mu r$ and $\mu r = 1 + \chi$

7. Magnetic Properties of Materials:

(i) Magnetic materials are broadly classified as: diamagnetic, paramagnetic, and ferromagnetic. For diamagnetic materials χ is negative and small and for paramagnetic materials it is positive and small. Ferromagnetic materials have large χ.

(ii) Diamagnetic substances are those which have tendency to move from stronger to the weaker part of the external magnetic field.

(iii) Paramagnetic substances are those which have tendency to move from a region of weak magnetic field to strong magnetic field.

(iv) Ferromagnetic substances are those which gets strongly magnetised when placed in an external magnetic field. They have strong tendency to move from a region of weak magnetic field to strong magnetic field.

8. Curie temperature:

(i) The temperature of transition from ferromagnetic to paramagnetism is called the Curie temperature.

(ii) Substances which at room temperature retain their ferromagnetic property for a long period of time are called permanent magnets.

9. Hysteresis:

For a given value of H, B is not unique but depends on previous history of the sample. This phenomenon is called hysteresis.