Class XII: Physics
Ch5: Magnetism and Matter
Chapter Notes

Key Learnings

1. Magnetic materials tend to point in the north – south direction.

   Like magnetic poles repel and unlike ones attract.

   Cutting a bar magnet in two leads to two smaller magnets.

   Magnetic poles cannot be isolated.

2. When a bar magnet of dipole moment $\vec{m}$ is placed in a uniform magnetic field $\vec{B}$,

   a. The force on it is zero

   b. The torque on it is $\vec{m} \times \vec{B}$

   c. Its potential energy is $-\vec{m}.\vec{B}$, where we choose the zero of energy at the orientation when $\vec{m}$ is perpendicular to $\vec{B}$

3. Consider a bar magnet of size ℓ and magnetic moment $\vec{m}$, at a distance r from its mid – point, where $r >> \ell$, the magnetic field $\vec{B}$ due to this bar is,

$$\vec{B} = \frac{\mu_0 \vec{m}}{2\pi r^3} \quad \text{(along axis)}$$

$$= -\frac{\mu_0 \vec{m}}{4\pi r^3} \quad \text{(along equator)}$$

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

$$\phi_B = \sum_{\substack{\text{all area} \\ \text{elements}\, \Delta\vec{S}}} \vec{B}.\Delta\vec{S} = 0$$

5. The pole near the geographic north pole of the earth is called the north magnetic pole.

   The pole near the geographic south – pole is called the south magnetic pole.

   The magnitude of the magnetic field on the earth's surface = 4×10^{-5} T.

6. 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.

7. Consider a material placed in an external magnetic field $\vec{B_0}$.

   The magnetic intensity is defined as,

   $$\vec{H} = \frac{\vec{B}_0}{\mu_0}$$

   The magnetization $\vec{M}$ of the material is its dipole moment per unit volume.

   The magnetic field $\vec{B}$ in the material is,

   $$\vec{B} = \mu_0 \left(\vec{H} + \vec{M}\right)$$

8. For a linear material $\vec{M} = \chi \vec{H}$. So that $\vec{B} = \mu \vec{H}$ and

   χ : Magnetic susceptibility of the material.

   μ_r: Relative magnetic permeability

   μ the magnetic permeability area, related as follows:

   $\mu = \mu_0 \mu_r$

$\mu_r = 1 + \chi$

9. Magnetic materials are broadly classified as; diamagnetic, paramagnetic and ferromagnetic.

   For diamagnetic materials χ is negative and small.

   For paramagnetic materials χ is positive and small.

   For ferromagnetic materials χ lies between $\vec{B}$ and $\vec{H}$.

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