14. Magnetism

Current carrying loop as magnetic dipole

Its upper face has current flowing in anti-clockwise direction. It has North polarity.
Its lower face has current flowing in clockwise direction. It has South polarity.
Magnetic dipole moment of current loop (M) is given by M=NIA.

Magnetic dipole moment of a revolving electron

An electron is in uniform circular motion in an orbit around nucleus constitutes current.

The current in atom has a magnetic dipole moment(μ) associated with it.

Magnetic dipole moment of revolving electron is given by μ=e2ml

where l = the angular momentum of the electron around the nucleus

e = charge on electron

m = mass of electron

Minimum value of the magnetic moment is given by μ_{min}

μmin=eh4πm

μ_{min} is also known as Bohr magneton.

Magnetic Intensity: It is given by

H=B0μ0

Intensity of magnetisation − It is defined as the magnetic moment developed per unit volume when a magnetic specimen is subjected to magnetising field. It is denoted by I.

I=MV

Magnetic Induction − It is defined as the number of magnetic lines of induction crossing per unit area through the magnetic substance. It is denoted by B.

$B = \mu_0 (H + I)$

Magnetic susceptibility − The magnetic susceptibility of a magnetic substance is defined as the ratio of the intensity of magnetisation to the magnetic intensity. It is denoted by χ_m.

$$\chi m=IH$$

Magnetic permeability − The magnetic permeability of a magnetic substance is defined as the ratio of the magnetic induction to the magnetic intensity. It is denoted by μ.

$$BH=\mu 0(1+\chi m)$$

or,

$$\mu=\mu 0(1+\chi m)$$

Relation between magnetic intensity (*H*) and magnetic field (*B*):

$$B = \mu_0(1+\chi)H$$

Where, χ is the magnetic susceptibility

Classification of magnetic materials:

- **Diamagnetic substances:** When such substances are placed in an external magnetic field, they get feebly magnetised in the direction opposite to the field.
- **Paramagnetic substances:** When such substances are placed in an external magnetic field, they get feebly magnetised in the direction of the field.
- **Ferromagnetic substances:** When such substances are placed in an external magnetic field, they get strongly magnetised in the direction of the field.