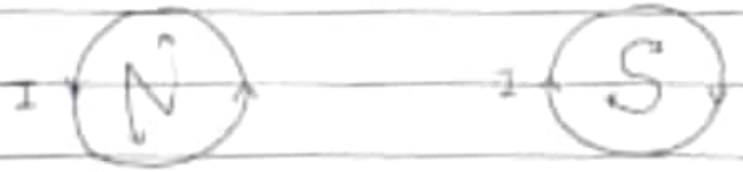
Magnetism and Matter

Circular current loop as a magnetic dipole.

Show that a current carrying loop behaves as a magnetic dipole. Hence write an expression for the magnetic dipole moment.

When current flows in a circular loop, magnetic field is set up around the loop. Looking at the upper face, current is anticlockwise and therefore it has a north polarity. Looking at the lower face of the loop, the current is clockwise and hence, it has a south polarity. The current loop thus behaves as a magnetic dipole.



Upper face Lower face

Magnetic dipole moment:-

Magnetic field on the axis of a circular is given by,

$$B = \frac{\mu_0 I R^2}{2(x^2+R^2)^{3/2}}$$

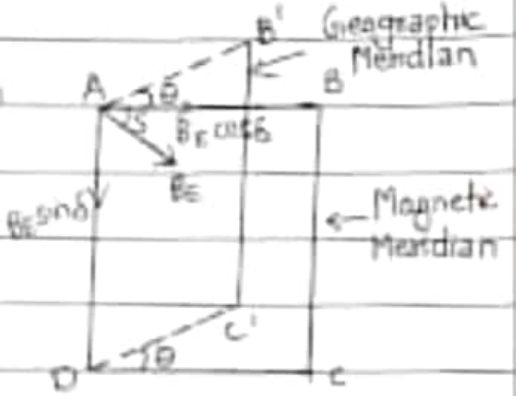
For $R \ll x$, $B = \frac{\mu_0 I R^2}{2x^3}$

$$\therefore B = \frac{\mu_0 I \times R^2}{2\pi x^3}$$

Multiplying & dividing by π

1) Magnetic declination -

The angle between the geographic meridian and the magnetic meridian at a place is called the magnetic declination.



2) Angle of dip (or magnetic inclination).

The angle made by the earth's total magnetic field B_E with the horizontal direction in the magnetic meridian is called angle of dip (δ) at any place.

NOTE:-

→ The angle of dip is zero at the magnetic equator.

→ The angle of dip is 90° at the magnetic pole.

→ At other places, the dip angle lies b/w 0° and 90°

3) Horizontal component of earth's magnetic field -

It is the component of the earth's total magnetic field (B_H) in the horizontal direction in the magnetic meridian.

For figure.

Horizontal component, $B_H = B_E \cos\delta$

Vertical component, $B_V = B_E \sin\delta$

B_E = Earth's magnetic field.

δ = Angle of dip or inclination.

θ = Magnetic declination.