- Magnetic materials tend to point in the north – south direction.
- Like magnetic poles repel and unlike ones attract.
- Magnetic poles cannot be isolated.
- When a bar magnet of dipole moment $\vec{m}$ is placed in a uniform magnetic field $\vec{B}$, then,
  a) The force on it is zero
  b) The torque on it is $\vec{m}x\vec{B}$
  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 $\vec{B}$.
- Consider a bar magnet of size l and magnetic moment $\vec{m}$, at a distance r from its mid – point, where r >>l, the magnetic field $\vec{B}$ due to this bar is,

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

$$= \frac{\mu_0 \vec{m}}{4\Pi r^3} \qquad \text{(along equator)}$$

- **Gauss's Law for Magnetism:**
  It states that the net magnet flux through any closed surface is zero

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

- **Poles:**
  a) The pole near the geographic north pole of the earth is called the north magnetic pole.
  b) The pole near the geographic south – pole is called the south magnetic pole.
  c) The magnitude of the magnetic field on the earth's surface = 4 x 10^{-5} T.
- **Elements of the Earth's Magnetic Field:**
  Three quantities are needed to specify the magnetic field of the earth on its surface,
  a) The horizontal component
  b) The magnetic declination
  c) The magnetic dip.

  These are known as the elements of the earth's magnetic field.
- **Magnetic Intensity:**
  Consider a material placed in an external magnetic field $\vec{B_0}$. The magnetic intensity is,

$$\vec{H} = \frac{\vec{B_0}}{\mu_0}$$

  If the magnetization $\vec{M}$ of the material is its dipole moment per unit volume, then the magnetic field $\vec{B}$ in the material will be,

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

For a linear material,

$$\vec{M} = \chi\vec{H}$$

So that,

$$\vec{B} = \mu\vec{H}$$

Where χ is the magnetic susceptibility of the material and μ_r is the relative magnetic permeability.

- **Relationship between $\mu, \mu_0 and \mu_r$:**

  The magnetic permeability area, μ is related as,

  $$\mu = \mu_0\mu_r$$

  $$\mu_r = 1 + \chi$$

- **Classification of Magnetic Materials:**

  Magnetic materials are broadly classified as,

  a) Diamagnetic
  b) Paramagnetic
  c) Ferromagnetic

- **Magnetic Susceptibility of the Material for Magnetic Materials:**

  a) For diamagnetic materials χ is negative and small.
  b) For paramagnetic materials χ is positive and small.
  c) For ferromagnetic materials χ lies between $\vec{B}$ and $\vec{H}$

- **Permanent Magnets:**

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