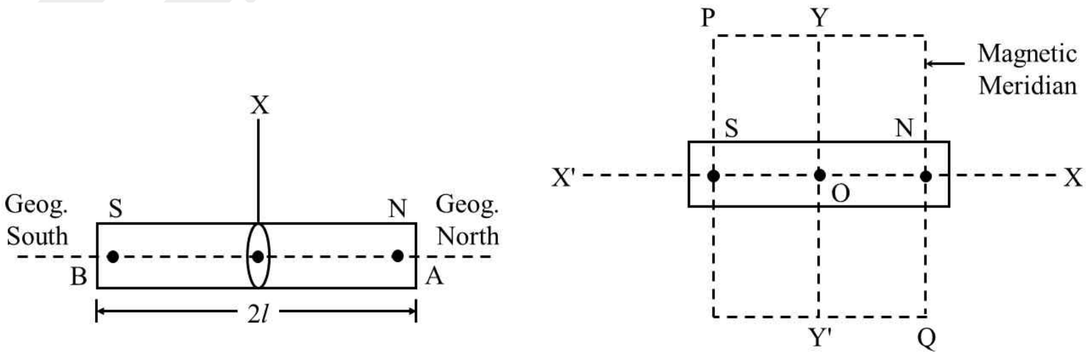
PHYSICS

CLASS NOTES FOR CBSE

Chapter 21. Magnetism and Matter

01. The Bar Magnet

(i) **The Bar Magnet**
It is the most commonly used form of an artificial magnet.



(i) (ii)

$$F = \frac{\mu_0}{4\pi}\frac{m_1 m_2}{r^2}$$

It is the most commonly used form of an artificial magnet.

Basics of Magnetism

(i) The earth behaves as a magnet.
(ii) Every magnet attracts small pieces of magnetic substances like iron, cobalt, nickel and steel towards it.
(iii) When a magnet is suspended freely with the help of an unspun thread, it comes to rest along the north south direction.
(iv) Like poles repel each other and unlike poles attract each other.
(v) The force of attraction or repulsion F between two magnetic poles of strengths m_1 and m_2 separated by a distance r in space is directly proportional to the product of pole strengths and inversely proportional to the square of the distance between their centres.

$$F = \frac{\mu_0}{4\pi}\frac{m_1 m_2}{r^2}$$

02. The Magnetic Field Lines

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The path along which the compass needles are aligned is known as magnetic field line.

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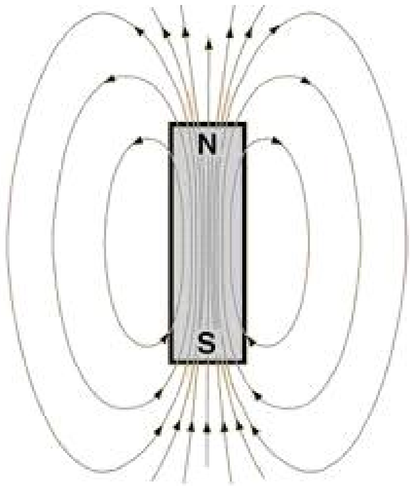
Properties of Magnetic Field Lines

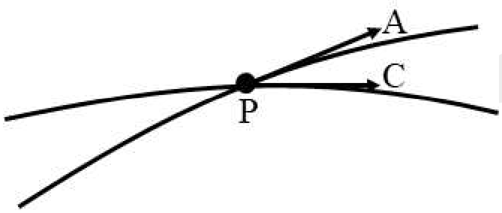
(i) The magnetic field lines of a magnet (or of a solenoid carrying current) form closed continuous loops. We imagine magnetic field lines to be extending through the body of the magnet/solenoid from south pole to north pole, as shown in Fig. below.



(ii) Outside the body of the magnet, the direction of magnetic field lines is form north pole to south pole.

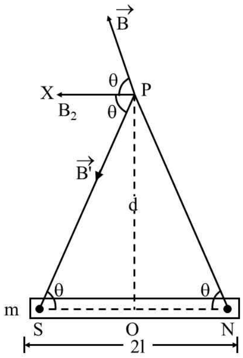
(iii) At any given point, tangent to the magnetic field line represents the direction of net magnetic field $(\vec{B})$ at that point.

(iv) Magnetic field lines have a tendency to contract longitudinally indicating attraction between unlike magnetic poles. The lines also have a tendency to dilate laterally, indicating repulsion between like magnetic poles.



03. Magnetic Field Strength At a Point Due to Bar Magnet

The strength of magnetic field at any point is defined as the force experienced by a hypothetical unit north pole placed at that point. It is a vector quantity. The direction of magnetic field ($\vec{B}$) is the direction along which hypothetical unit north pole would tend to move if free to do so.



$$B_1 = \frac{\mu_0}{4\pi}\frac{2Md}{d^4} = \frac{\mu_0}{4\pi}\frac{2M}{d^3}$$

04. Current Loop As a Magnetic Dipole

The magnetic dipole moment of the current loop M is directly proportional to (a) strength of current I through the loop and (b) area A enclosed by the loop.

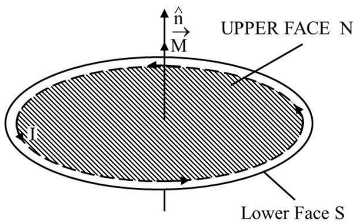
i.e., $M \propto I$ and $M \propto A$

$\therefore$ $M = K\ I\ A$

Where K is a constant of proportionality.

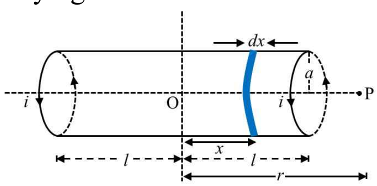
For N such turns, $M = NIA$

The SI unit of M is **ampere metre^2**.



05. Bar magnet As An Equivalent Solenoid

To demonstrate the similarity of a current carrying solenoid to a bar magnet, let us calculate axial field of a finite solenoid carrying current.



$$dB = \frac{\mu_0\, i\, a^2\ (n\, dx)}{2\,[(r-x)^2 + a^2]^{3/2}}$$ if $r >> a$ and $r >> x$ then $[(r-x)^2 + a^2]^{3/2} \approx r^3$

$$B = \frac{\mu_0}{4\pi}\frac{2M}{r^3}$$