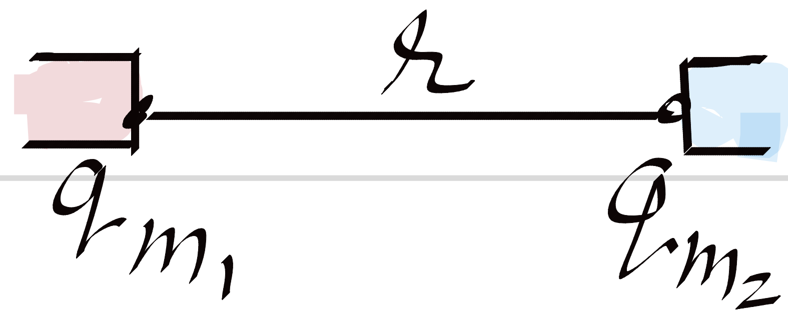
Formula Sheet
Magnetism And Matter

1. Coulomb's Law In Magnetism

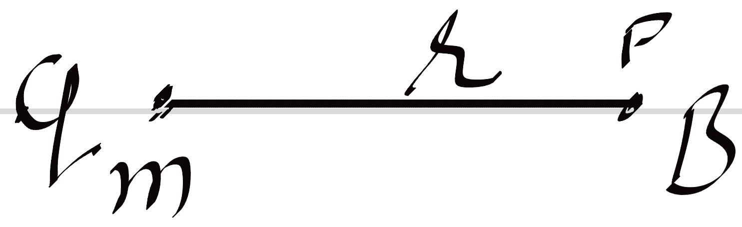
$$F = \frac{\mu_0}{4\pi} \frac{q_{m_1} \times q_{m_2}}{r^2}$$



q_{m_1} and q_{m_2} are pole strength

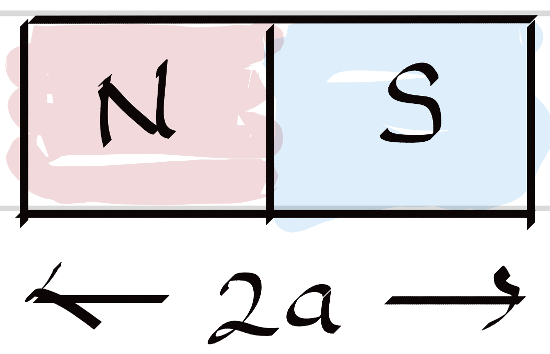
2. Magnetic Field Intensity At A Point

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



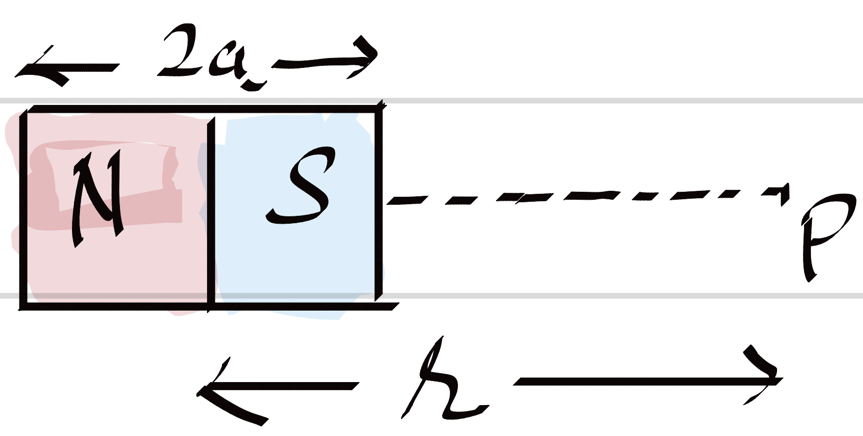
3. Magnetic Dipole Moment

$$m = 2a \times q_m$$



4. Magnetic Field At Axial Line

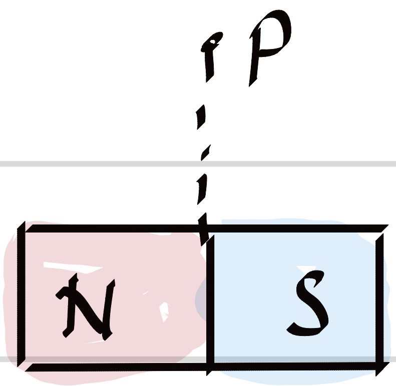
$$B_{ax} = \frac{\mu_0}{4\pi} \frac{2mr}{(r^2 - a^2)^2}$$



For short dipole

$$B_{ax} = \frac{\mu_0}{4\pi} \cdot \frac{2m}{r^3}$$

5. Magnetic Field on Equatorial Line



$$B_{eq} = \frac{\mu_0}{4\pi} \cdot \frac{m}{(r^2 + a^2)^{3/2}}$$

For short dipole, $$B_{eq} = \frac{\mu_0}{4\pi} \frac{m}{r^3}$$

6. Magnetic Moment of a Loop

$$m = NIA$$

$N \to$ no. of turns, $I \to$ current in loop, $A \to$ Area of loop

7. Magnetic field at the far axial field of a solenoid

And magnetic field at the axial point of a bar magnet

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

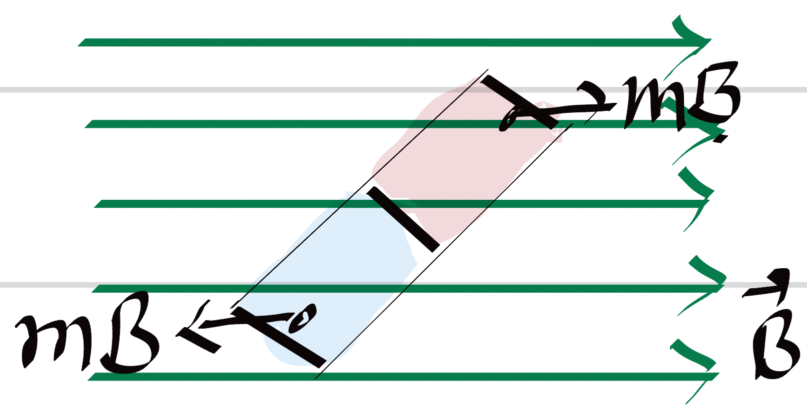
$m \to$ magnetic moment

$r \to$ distance from the centre of a solenoid or barmagnet

(This formula shows $\to$ Bar magnet as an equivalent solenoid)

8. Dipole in a uniform magnetic field

(i) Torque on the dipole -



$$\vec{\tau} = \vec{m} \times \vec{B}$$
$$= mB\sin\theta$$

(ii) Time period of the magnetic dipole

$$T = 2\pi\sqrt{\frac{I}{mB}}$$

or

$$B = \frac{4\pi^2 I}{mT^2}$$

(iii) Magnetic Potential Energy

$$U_m = -mB\cos\theta$$
$$= -\vec{m}\cdot\vec{B}$$

For $\theta = 0^\circ$, $U_m = -mB$

P.E is min^m (most stable position)

For $\theta = 180^\circ$, $U_m = +mB$

P.E is maximum (most unstable position)

9. Magnetic flux through any close surface

$$\oint \vec{B}\cdot\vec{ds} = 0$$

$B \rightarrow$ magnetic field

10. Magnetisation (M)

$$M = \frac{m_{net}}{V}$$, m → magnetic moment

V → volume

11. Magnetic Intensity (H)

$$H = \frac{B}{\mu_0} - M$$

* Unit of M and H → A/m

12. Total magnetic field

$$B = \mu_0 (H + M)$$

13. Magnetic Susceptibility (χ)

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

χ is dimensionless

For paramagnetic material χ is small and +ve

For diamagnetic material χ is small and -ve

14. Magnetic Permeability (μ)

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

$$B = \mu H$$

Or $$B = \mu_0 \mu_r H$$

μ_r → Relative permeability

here $$\mu_r = 1 + \chi = B/B_0$$

15. Curie Temperature T_c and Susceptibility χ

(The temp. of transition from ferromagnetic to paramagnetic)

$$\chi = \frac{C}{T - T_c} \quad (T > T_c)$$

where $C \rightarrow$ curie constant

$T \rightarrow$ Absolute temp.

By curie's law

$$M = C \frac{B}{T}$$

here $M \rightarrow$ magnetisation

$B \rightarrow$ magnetic field

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