Relation between μ_0, ϵ_0 and c :-

$$\frac{1}{4\pi\epsilon_0} = 9 \times 10^9$$

$$\frac{\mu_0}{4\pi} = 10^{-7}$$

$$\mu_0\epsilon_0 = \frac{\mu_0}{4\pi} \times \frac{4\pi\epsilon_0}{1} = 10^{-7} \times \frac{1}{9\times10^9}$$

$$\Rightarrow \mu_0\epsilon_0 = \frac{1}{9\times10^{16}} = \left(\frac{1}{3\times10^8}\right)^2$$

$$\Rightarrow \mu_0\epsilon_0 = \frac{1}{c^2} \Rightarrow c^2 = \frac{1}{\mu_0\epsilon_0} \Rightarrow \boxed{c = \sqrt{\frac{1}{\mu_0\epsilon_0}}}$$

OMR, SHORT QUESTION

(1) Write Biat savart law.
(2) Write Relation between c, μ_0 and ϵ_0.
(3) Find value of μ_0 and $\frac{\mu_0}{4\pi}$
(4) Write unit of magnetic field.
(5) Define one tesla.

OMR

(1) (i) $\frac{\mu_0}{4\pi} = 10^{-7}\ T\,m\,A^{-1}$ (ii) $\mu_0 = 4\pi \times 10^{-7}\ T\,m\,A^{-1}$.

(2) Biat Savart law is applicable only for Current element.

(3) Magnetic field at points on the axis of Carret element is zero.

(4) Magnetic field due to a current element is maximum in a plane passing through the element and perpendicular to its axis.

(5) $\vec{dB} = \frac{\mu_0}{4\pi} I \frac{\vec{dl} \times \vec{r}}{r^3}$.

(6) Dimension of μ_0 (Permeability, ~~चुम्बकशीलता~~) $= [MLT^{-2}A^{-2}]$

BIOT SAVART LAW

(17)

Let XY is a conductor carrying current I. Take a current element of dl. Let P is a point at a distance r. We have to find magnetic field due to current element dl.
According to Biot Savart magnetic field at point P depends upon following factors

(i) $dB \propto I$

(ii) $dB \propto dl$

(iii) $dB \propto \sin\theta$

(iv) $dB \propto \frac{1}{r^2}$

[⊗ → ⊥ inward
⊙ → ⊥ to plane of paper outward]

Combining all the four

$$dB \propto \frac{I\,dl\sin\theta}{r^2}$$

$$\Rightarrow dB = \frac{K\,I\,dl\sin\theta}{r^2} \Rightarrow \boxed{dB = \frac{\mu_0}{4\pi}\frac{I\,dl\sin\theta}{r^2}}$$

K is constant of proportionality. It depends upon following factors. (i) Medium surrounding the observation point P and current element. (ii) System of unit.

In S.I. system

$$K = \frac{\mu_0}{4\pi} = 10^{-7}\ T\,m\,A^{-1} \text{ or } Wb\,m^{-1}A^{-1}$$

Where μ_0 is called permeability of free space.

* Direction of dB is perpendicular to the plane of $\vec{dl}$ and $\vec{r}$. It is given by right handed screw rule.

UNIT OF MAGNETIC FIELD: — S.I. unit of magnetic field is tesla.

ONE TESLA: — If $I = 1A$, $r = 1$ met, $\theta = 90^\circ$, $dl = 1m$

$$\therefore dB = \frac{\mu_0}{4\pi} = 10^{-7}\ \text{tesla}.$$

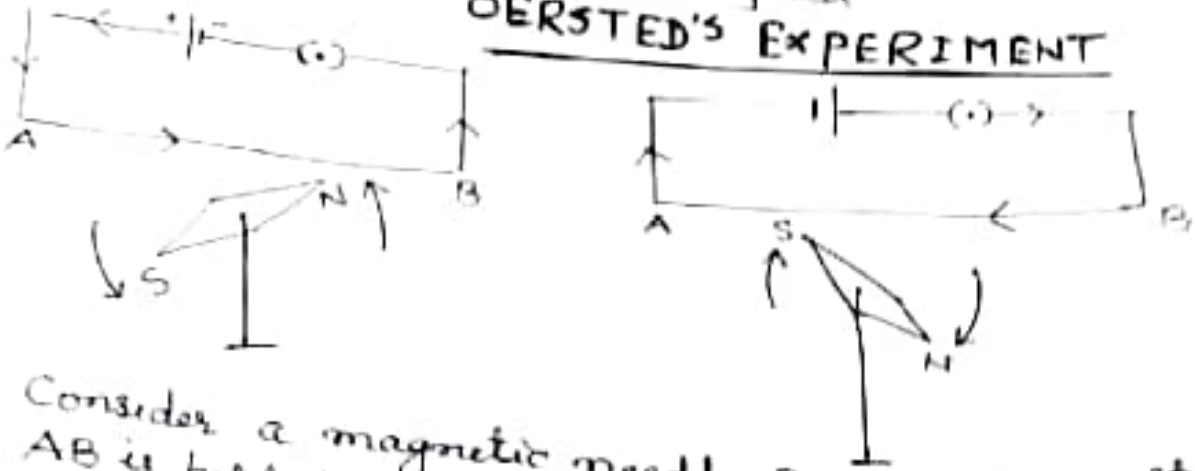
Hence one tesla is 10^{7} times the magnetic field produced by a conductoring wire of length one metre and carrying current 1 amp at distance 1 met perpendicular to it.

MAGNETIC FIELD

(1) A moving charge or a current sets up a magnetic field.

(2) The magnetic field exerts a force on a moving charge or a current in the field.

OERSTED'S EXPERIMENT



Consider a magnetic needle Pivated over a stand. A wire AB is held parallel to needle. Following observations are found -

(i) When Current in the wire flows from south to North then North pole of needle gets deflected towards west.

(ii) When direction of Current is reversed then deflection is also reversed.

(iii) When wire is placed below the needle then direction of deflection is also reversed.

Since magnetic needle is only deflected by magnet this shows that Current Carrying wire produces magnetic field.

AMPERE'S SWIMMING RULE

Direction of deflection of magnetic needle in oersted experiment is given by Ampere's swimming rule.

" Imagine a man swimming along the wire in the direction of the flow of current with his face always turned towards the needle then north pole of needle deflected towards left hand.