1 lec/2 magnetism

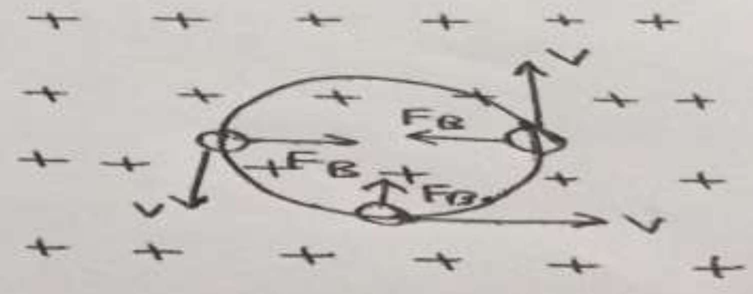
Motion of charged particle in a Uniform Magnetic field

2/ زكتني
٢٠ مست

The particle moves in acircular because the magnetic force $\vec{F_B}$ is perpendicular to $\underline{\underline{V}}$ and $\underline{\underline{\vec{B}}}$ and has constant magnitude $\underline{\underline{qVB}}$.

As active in figure illustrates, the rotation is counter clockwise for apositive charge in amagnetic field directed into the page. If (If) $\underline{\underline{q}}$ were negative, the rotation would be clockwise. We use the particle under anet force model to write Newton's second law for the particle

$$\sum F = F_B = ma$$



Because the particle moves in ~~circular~~ a circle we also model it as particle in uniform circular motion and we replace the acceleration with centripetal acceleration.

$$F_B = qvB = \frac{mv^2}{r}$$

This expression leads to the following equation for the radius of the circular path $r = \frac{mv}{qB}$

That is the radius of the path is propertional to the linear momentum $\underline{\underline{mv}}$ of the particle and inversely propertional to the charge on the particle and to the magnitude of the magnetic field.

The angular speed of the particle (ω)

$$\omega = \frac{v}{r} = \frac{qB}{m}$$

period of the motion (the time interval the particle requires to complete one revolution). is equal to the circumference of the circle divided by the speed of the particle.

$$T = \frac{2\pi r}{v} = \frac{2\pi}{w} = \frac{2\pi m}{qB}$$

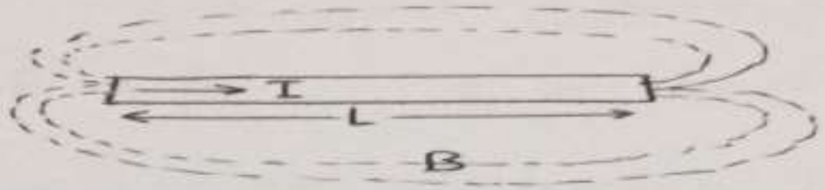
Ex: A protor is moving in a circular orbit of radius 14 cm in auniform 0.35T magnetic field perpendicular to the velocity of the protor Find the speed of the proton (v = ?).

Solution:

$r = 14\,cm = 0.14\,m$
$B = 0.35$ Tesla
$m_p = 1.67 \times 10^{-27}$ Kgm
$q_p = 1.6 \times 10^{-19}$ coul.
$v = ?$

$$v = \frac{qBr}{m_p} = \frac{1.6 \times 10^{-19} \times 0.35 \times 0.14}{1.67 \times 10^{-27}} = 4.7 \times 10^{6}\ m/sec$$

Magnetic Force on a Current - Carrying conductor.



$F = qVB$

$F = eVB$

$F = eV_d\ B$ .... (1)

$V_d = \dfrac{I}{enA}$ ......(2) [V_d = drift velocit]

سرعة الانجراف

from equ (1) and (2)

$F = e\dfrac{I}{enA}B \Longrightarrow F = \dfrac{I}{nA}B$

number of electrons carring conductor equal (nAL

$F = nAL\ \dfrac{I}{nA}\ B \Longrightarrow F = LIB$ ------- (3)

$\vec{F} = \vec{IL} \times \vec{B}$

$F = ILB \sin\theta$

if the wire not rights

$d\vec{F} = I d\vec{l} \times \vec{B}$ [differentional element]

If a straight conductor of length $\underline{L}$ carries curren $\underline{I}$ the magnetic force on that conductor when it placed in a uniform external magnitude field $\vec{B}$ is

$F = ILB \sin\theta$

where $\underline{\theta}$ is the angle between the direction of the current and the direction of the magnetic field $\vec{B}$

Ex : A wire carries of 220 Amp. the magnetic field of manitude 0.500×10^{-4} Tesla.

Find : ⓐ the magnetic force ($F = ?$).

ⓑ Gravitational Force ($F_g = ?$).

if $\theta = 90^{\circ}$

$L = 36$ m

$A = 2.50 \times 10^{-6}\ m^2$

$\rho = 8.92 \times 10^{3}\ Kg/m^3$

Solution : (a) $F = BIL \sin\theta$

$$F = 0.500 \times 10^{-4} \times 220 \times 36 \times \sin 90$$

$$F = 3.96 \times 10^{-2}\ Nt.$$

(b) نستخرج $m = \underset{\text{كثافة}}{\rho} \overset{\text{حجم}}{V} = \rho (AL)$

~~$m = 2.50 \times 10$~~

$$m = 8.92 \times 10^{3} \times 2.50 \times 10^{-6} \times 36$$

$$m = 0.803\ Kg$$

$$F_g = mg$$

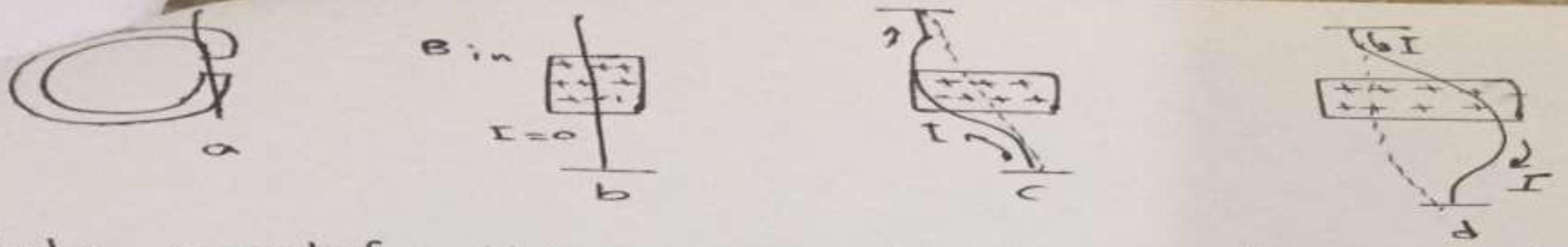
$$F_g = 0.803 \times 9.8 = 7.87\ Nt.$$

Magnetic Force Acting on a Current - Carrying conductor

One can demonstrate the magnetic force acting on a current carrying conductor by hanging a wire between the poles of amagnetic as in Figure, apart of the horesshone magnet in apart (a) is removed to show the end face of the south pole in part (b), (c) and (d).

Magnetic field is directed into the page and covers the region with the shaded squares, when acurrent in the wire is zero, the wire remains vertical in Figure (b). when the wire carries acurrent directed up word as in Figure (c). however the wire deflected to the ~~right~~ left. If the current is reversed as in figure (d).

the wire deflects to the right.



Lets quantify this discussion by considering a straight segment of wire of length L and cross-sectional area A carrying a current I in a uniform magnetic field $\vec{B}$ as in

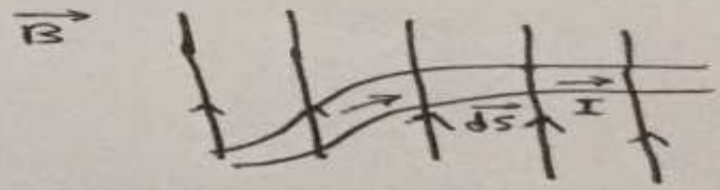
$$\vec{F_B} = (q\vec{v_d} \times \vec{B})\, nAL$$

$$I = nqv_d A$$

$$F_B = I\vec{L} \times \vec{B}$$

n: is the number of charges per unit volume

L: is a vector that points in the direction of the current I and has a magnitude equal to the length L of the segment.



$$d\vec{F_B} = I\, d\vec{s} \times \vec{B}$$

$$\vec{F_B} = I\int_a^b d\vec{s} \times \vec{B}$$