LECTURE 2/25/09

MAGNETIC FIELDS CH 29

I. FIELDS AND FORCES 29.1

II MOTION OF CHARGED PARTICLES IN $\vec{B}$ 29.2-3

III $\vec{B}$ FORCE ON A WIRE CARRYING CURRENT 29.4-5

IV HALL EFFECT

EQUATIONS DERIVED

$$\vec{F} = q\vec{v} \times \vec{B}$$

$$\vec{\tau} = \vec{\mu} \times \vec{B} \qquad \text{WHERE } \vec{\mu} = I\vec{A}$$

I. FORCES ON MOVING CHARGE

(EM 388 COMPASS => SHOWS MAGNETIC FORCES AFTER WARDS)

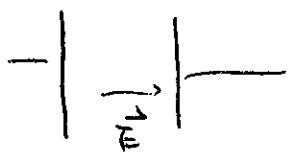
EM 394 $F = q\vec{v} \times \vec{B}$

$$\boxed{\vec{F}_q = q\vec{E} + q\vec{v} \times \vec{B}}$$

So WHAT IS COMING FROM MAGNETS

EM 3F7 BAR MAGNETS

- MAGNETIC POLES ALWAYS FOUND IN PAIRS
- ELECTRIC CURRENT GENERATES CURRENT
-

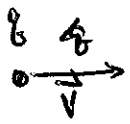


$\frac{d\vec{E}}{dt}$ ~ $\vec{B}$ AC S GENERATES $\vec{B}$

UNITS TESLA

STRONG MAGNET	30 T (SUPERCONDUCT
CONVENTIONAL MAGNET	2 T
MEDICAL MRI	1.5 T
BARMAGNET	0.01 T
SURFACE OF SUN	0.01 T
SURFACE OF EARTH	0.5×10^{-4}
INSIDE HUMAN BRAIN	10^{-13} T

EXAMPLE



$\odot \vec{B}$

$$\vec{F}_B = q\vec{v} \times \vec{B}$$

FORCE DIAGRAM

$\downarrow \vec{F}_B$ $\quad |\vec{F}_B| = qvB$

$B = 0.01\ T$

$q = 1.6 \times 10^{-19}\ C$

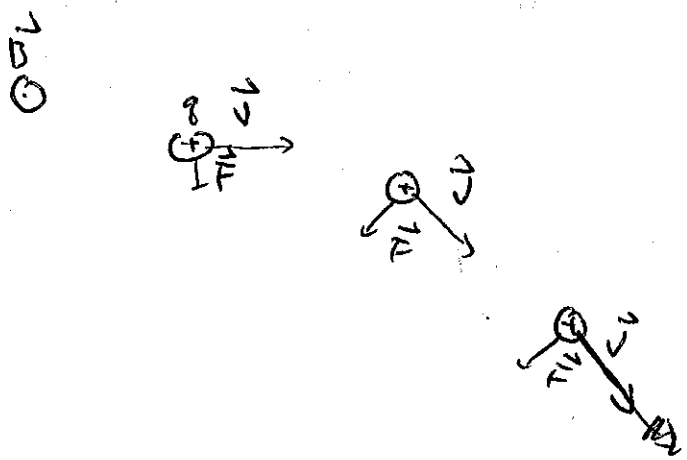
$\vec{v} = 10^7\ m/s$

$F = (0.01)(1.6 \times 10^{-19})(10^7)$

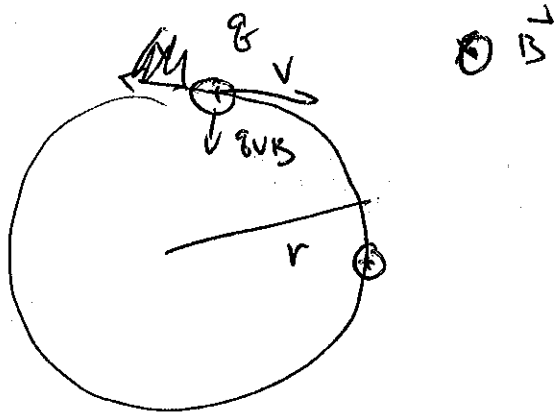
$= 1.6 \times 10^{-21}\ N$

SMALL COMPARED TO E.

NET RESULT



EXAMPLE 2



$$F = ma \qquad a = \frac{v^2}{r}$$

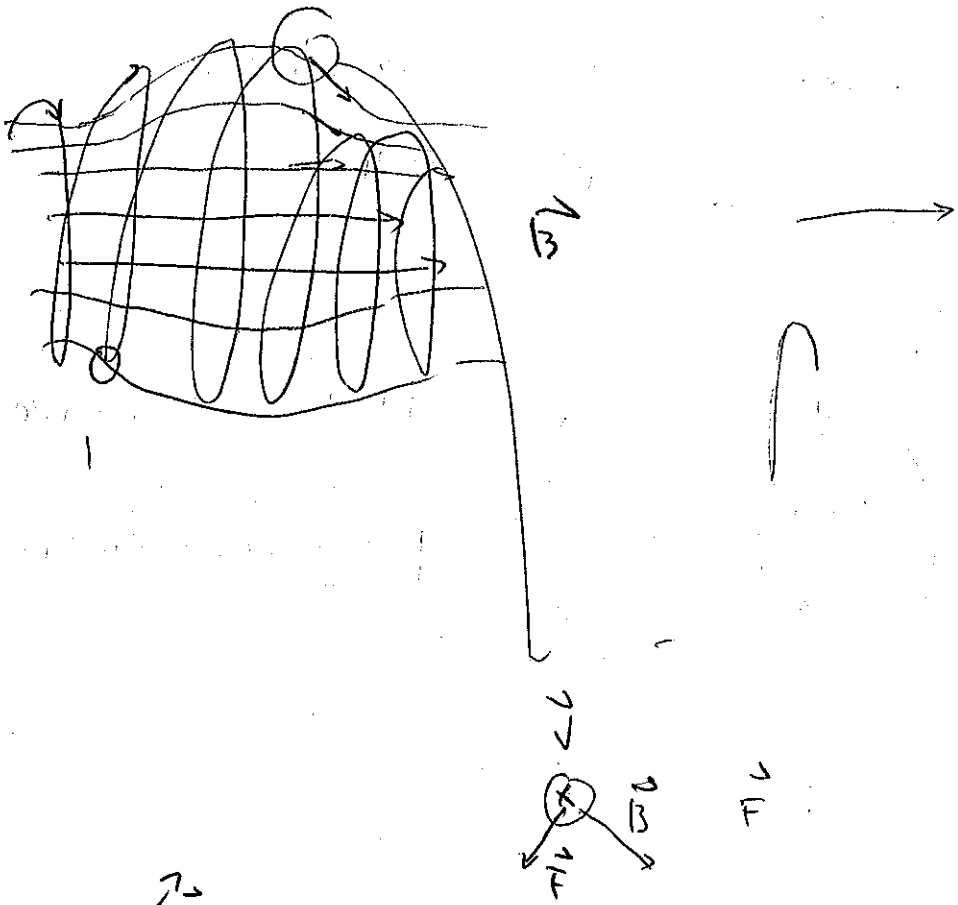
$$\frac{mv^2}{r} = qvB$$

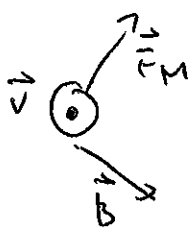
$$r = \frac{mv^2}{qvB} = \frac{mv}{qB}$$

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

ω : CYCLOTRON FREQUENCY

NON UNIFORM MAGNETIC FIELD





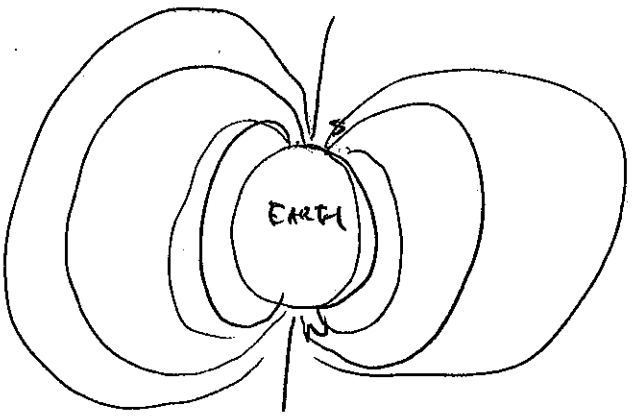
CONFUSED.

EXAMPLE

EXAMPLE ASIDE

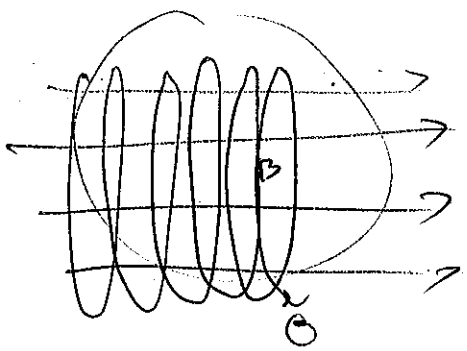
SOLAR WIND: PLASMA EJECTED BY SUN

e^-, p^+ ~1 keV



EM 388: COMPASS

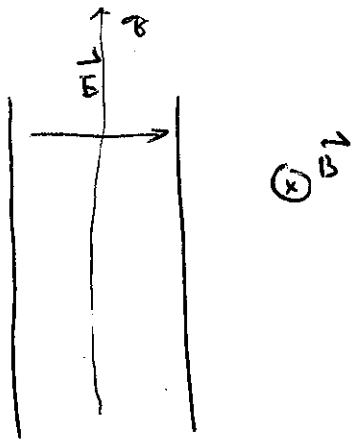
EM 390: DIP NEEDLE



APPLICATION

$$\vec{F} = q\vec{E} + q\vec{v} \times \vec{B}$$

VELOCITY SELECTOR



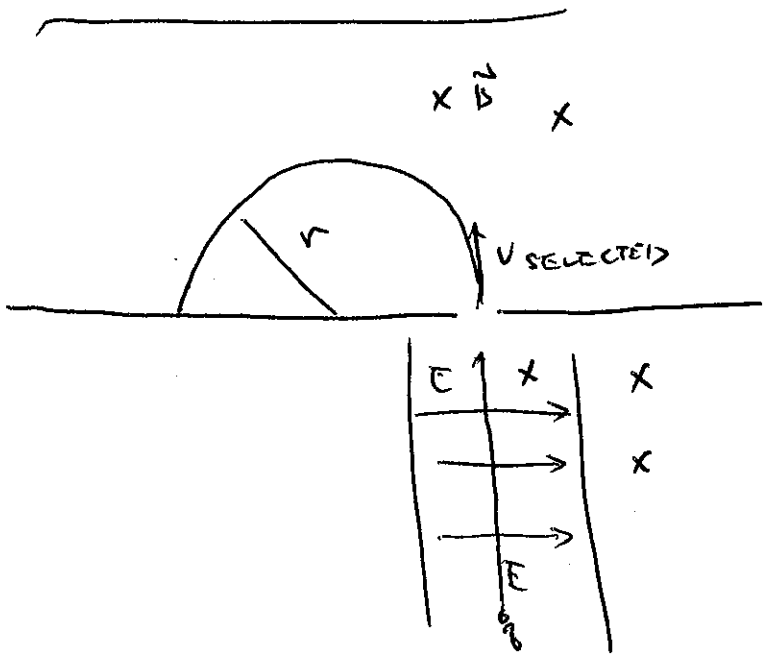
$$F_e = F_B$$

$$q\vec{E} = q\vec{v} \times \vec{B}$$

$$\vec{E} = vB$$

$$|\vec{v}| = \frac{\vec{E}}{B}$$

MASS SPECTOMETER



$$V = \frac{E}{B}$$

$$r = \frac{mV}{qB}$$

$$\frac{m}{q} = \frac{Br}{V}$$

$$V = \frac{E}{B}$$

$$\frac{m}{q} = \frac{rB^2}{E}$$

CYCLOTRON

STORY