1

4-2-14 Ch 27 continued (Test 3 Review)

ALSO: CH 28 (Later)

Ch 27 So far we covered: force on moving charge (see #8 → 3-31-14 notes) and on a wire with non-zero current.

(A) $\vec{F} = q\vec{v} \times \vec{B}$

(B) $\vec{F}$(on wire) $= I\vec{L} \times \vec{B}$

$\vec{L}$ (in meters) points along I and $|\vec{L}|$ = wire segment length section 27.3

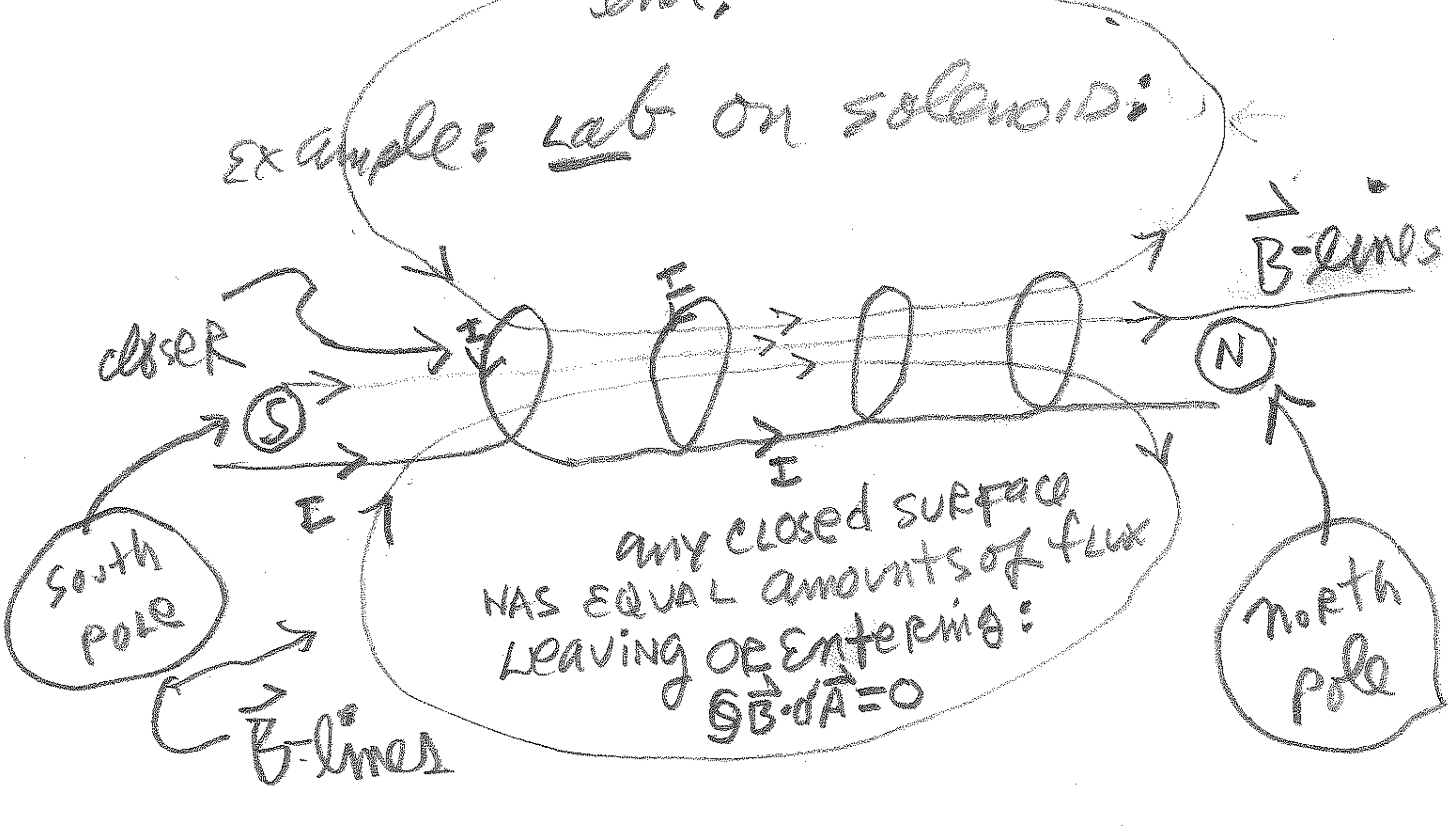
$$\oint_{G.S.} \vec{B} \cdot d\vec{A} = 0$$

G.S. = "Gaussian" closed surface

↙ G.S.

no magnetic charge inside.

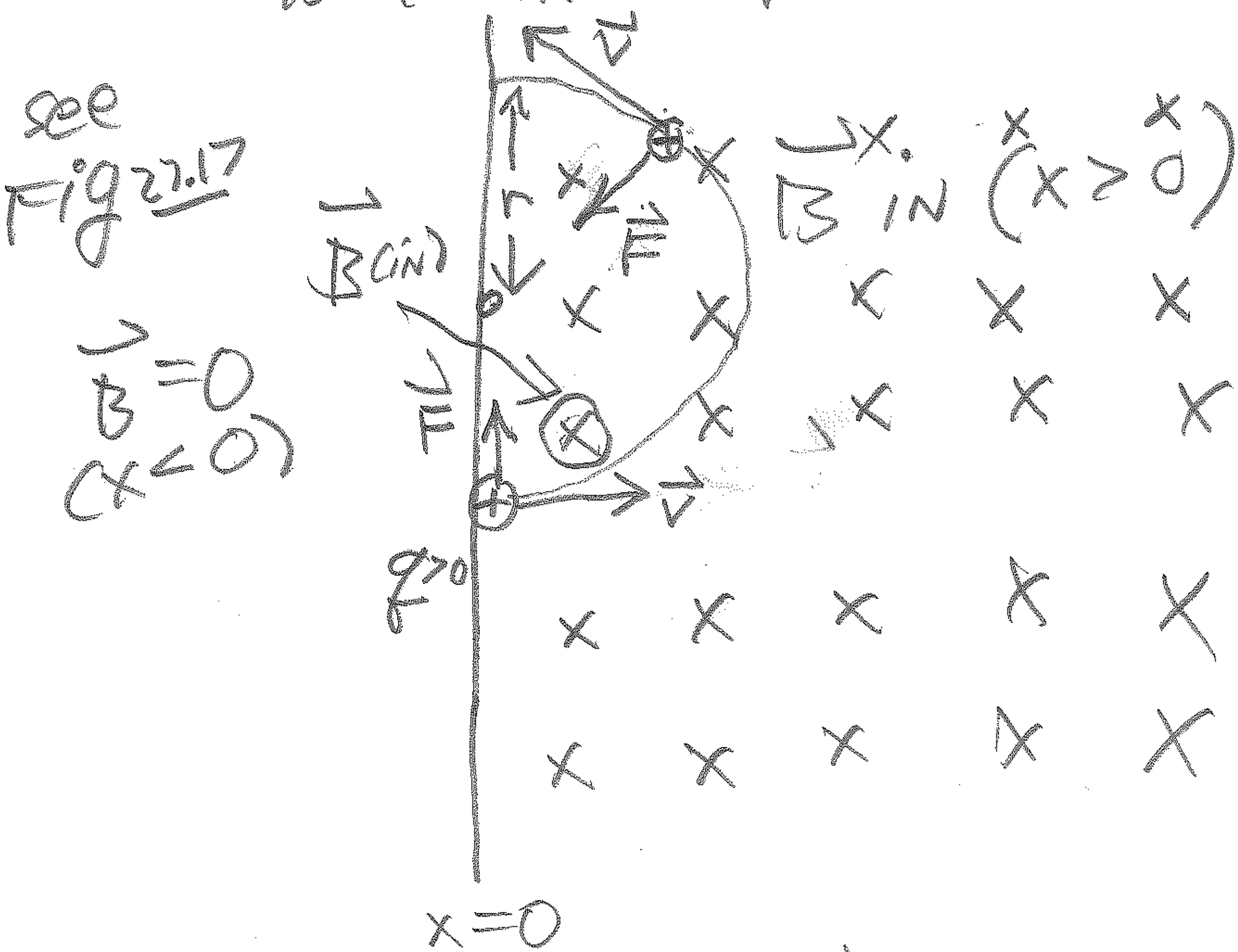
Note: $\vec{B}$ is in loops; no start or end.



Section 27.4

Motion in a circle: Application is a mass spectrometer.

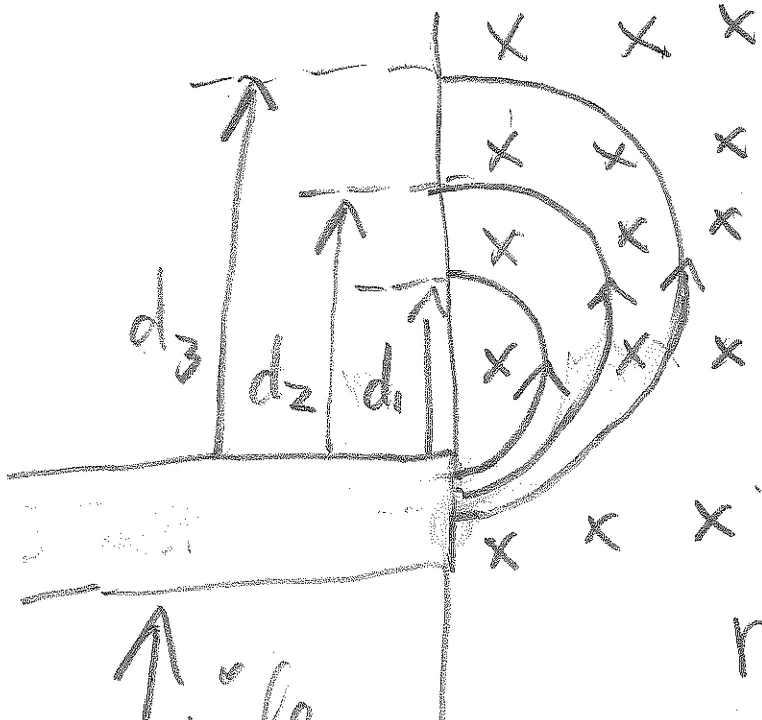
see Fig 27.17



$$F=|\vec{F}| = |q\vec{v}\times\vec{B}| = qv\cdot B\sin 90^\circ$$
$$= qvB$$

BUT ALSO, $F=\frac{mv^2}{r} \Rightarrow \frac{mv^2}{r}=qvB$

$$\rightarrow r = \frac{mv}{qB}$$



$d_1 = 2r_1$

$d_2 = 2r_2$

$d_3 = 3r_3$

$\Big\}\ m_1 < m_2 < m_3$

particle beam with various masses, same charge.

$$r_i = \frac{m_i v}{qB}$$

$$\Delta r = \frac{\Delta m v}{qB} \rightarrow \Delta m = \frac{qB\Delta r}{v}$$

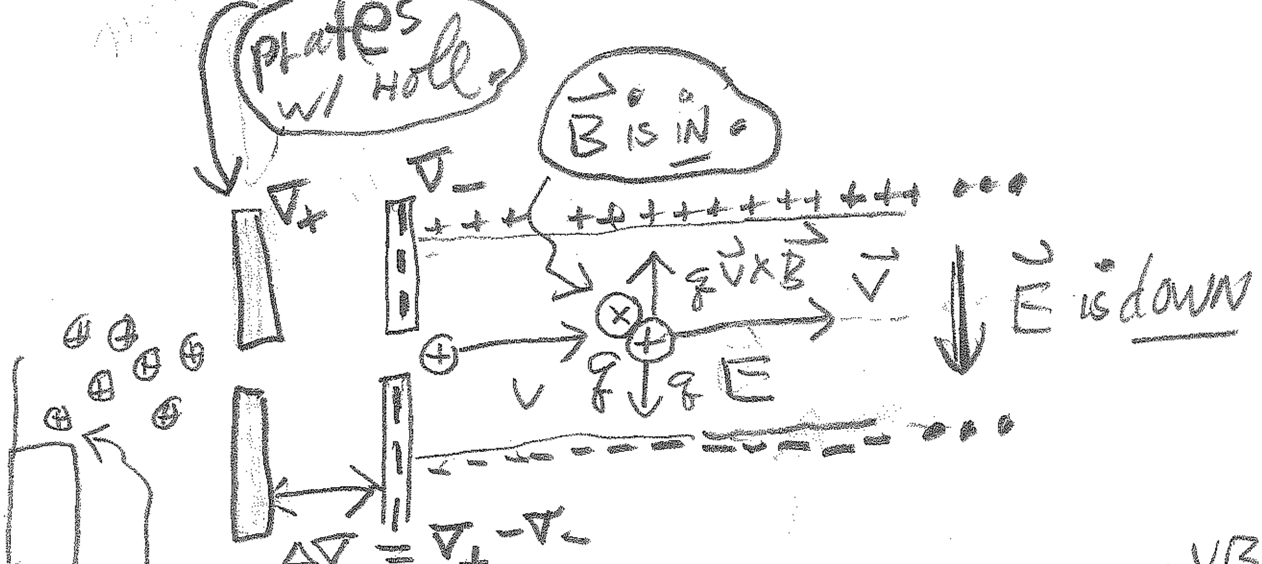
[CRUDE MASS spectrometer.]

Sec 27.5 motion applications:

high energy physics to study fundamental laws; early quantum foundation (1919)

see Fig 27.22:

- velocity selector used to measure e/m; below let $q = e$ until last step.



$$\text{net force} = 0 = qvB - qE$$

$$\Rightarrow v = \frac{E}{B}, \text{ where}$$

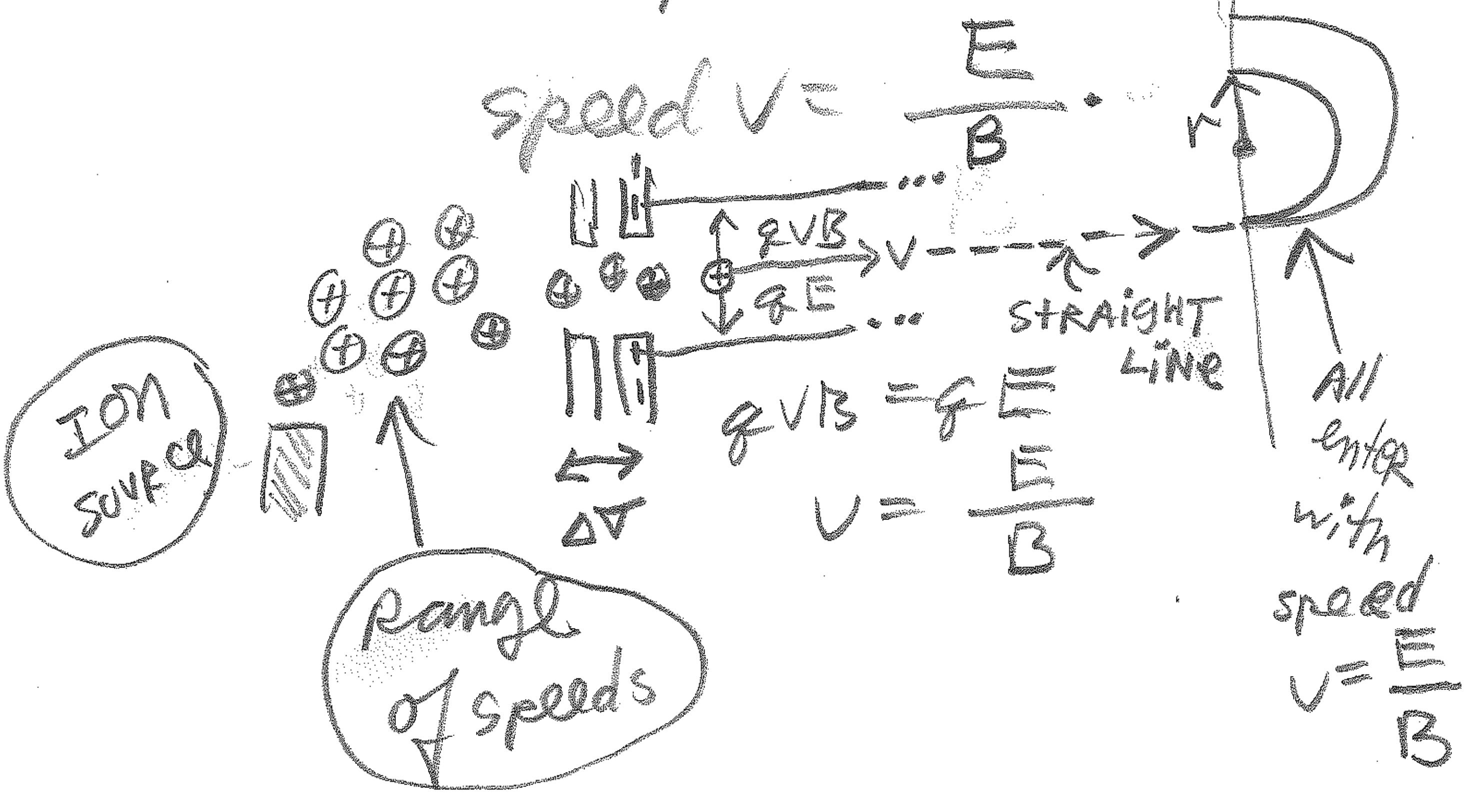
$$\frac{1}{2}mv^2 = q\Delta V \Rightarrow v = \sqrt{\frac{2\cdot\Delta V\cdot q}{m}}$$

$$v = \frac{E}{B} = \sqrt{\frac{2q\Delta V}{m}} \Rightarrow \boxed{\frac{e}{m} = \frac{E^2}{2\Delta V B^2}}$$

- MASS spectrometer

Range of speeds;

velocity selector picks particles with speed $v = \frac{E}{B}$.



$$qvB = qE$$

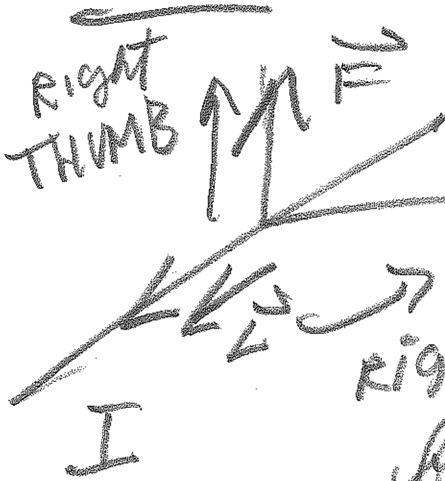
$$v = \frac{E}{B}$$

From before: $r = \frac{mv}{qB}$

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

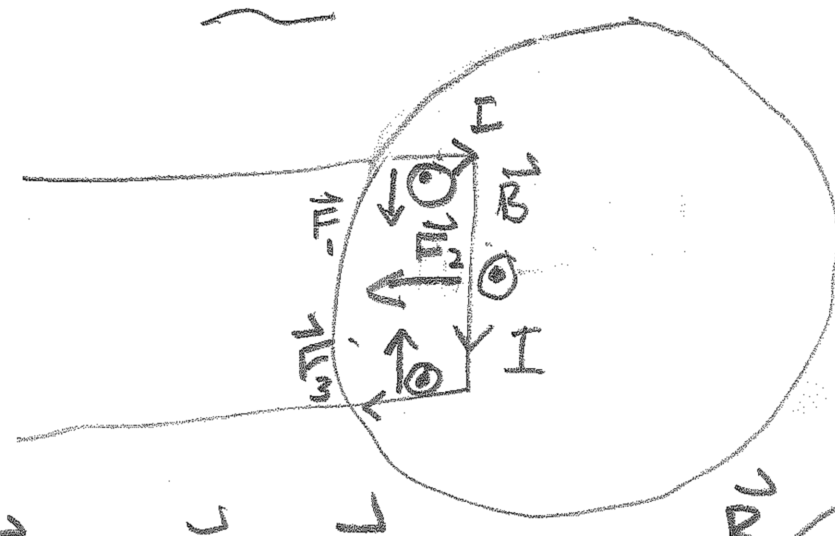
$$\Delta m = \frac{qB\Delta r}{v}$$

Sec 27.6 discussed already.

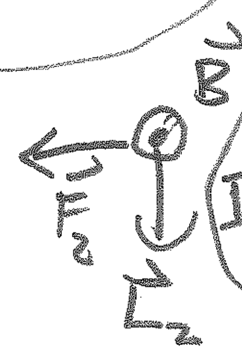


$\vec{F} = I\vec{L} \times \vec{B}$

Quiz 7
#25, ch 27:



$\vec{F}_2 = I\vec{L}_2 \times \vec{B}$



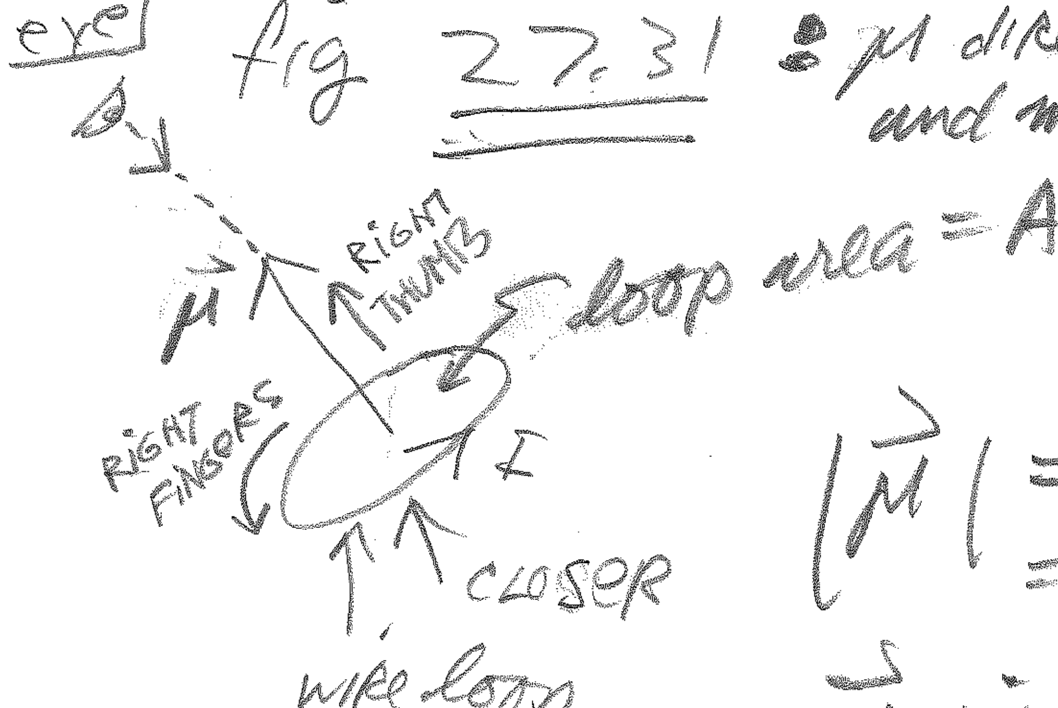
$I\vec{L}_2 \times \vec{B}$ is left

$\vec{F}_1 + \vec{F}_3 = 0$

$|\vec{F}_2| = IL_2 B \sin 90$
$= IL_2 B$

4B 4-2-14 supplement

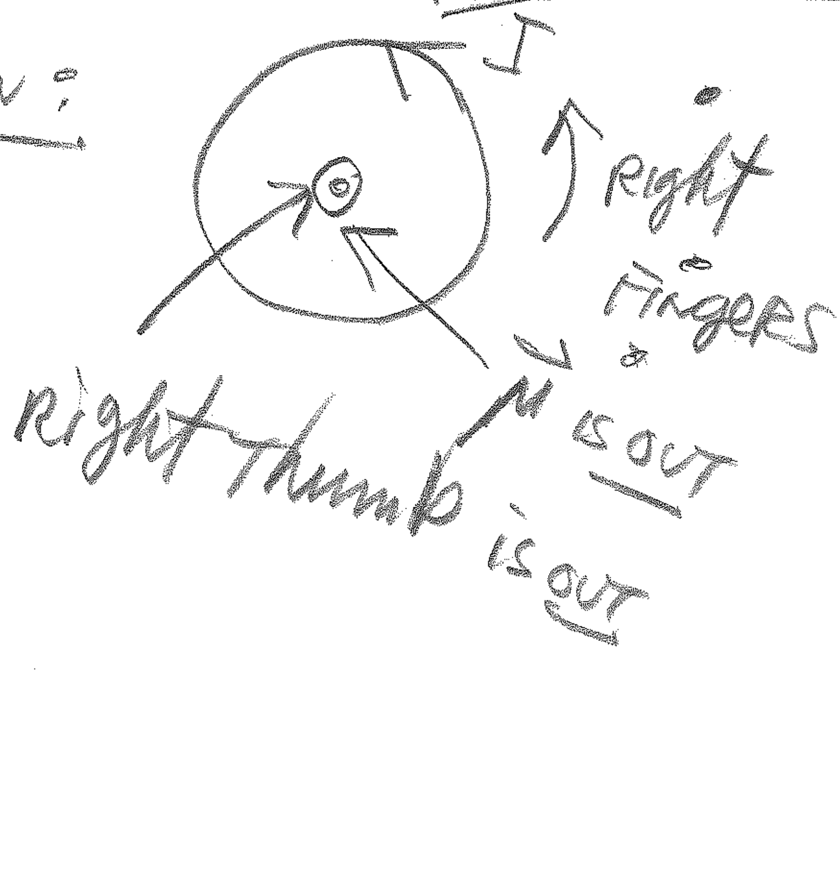
fig 27.31: $\vec{\mu}$ direction and magnitude.

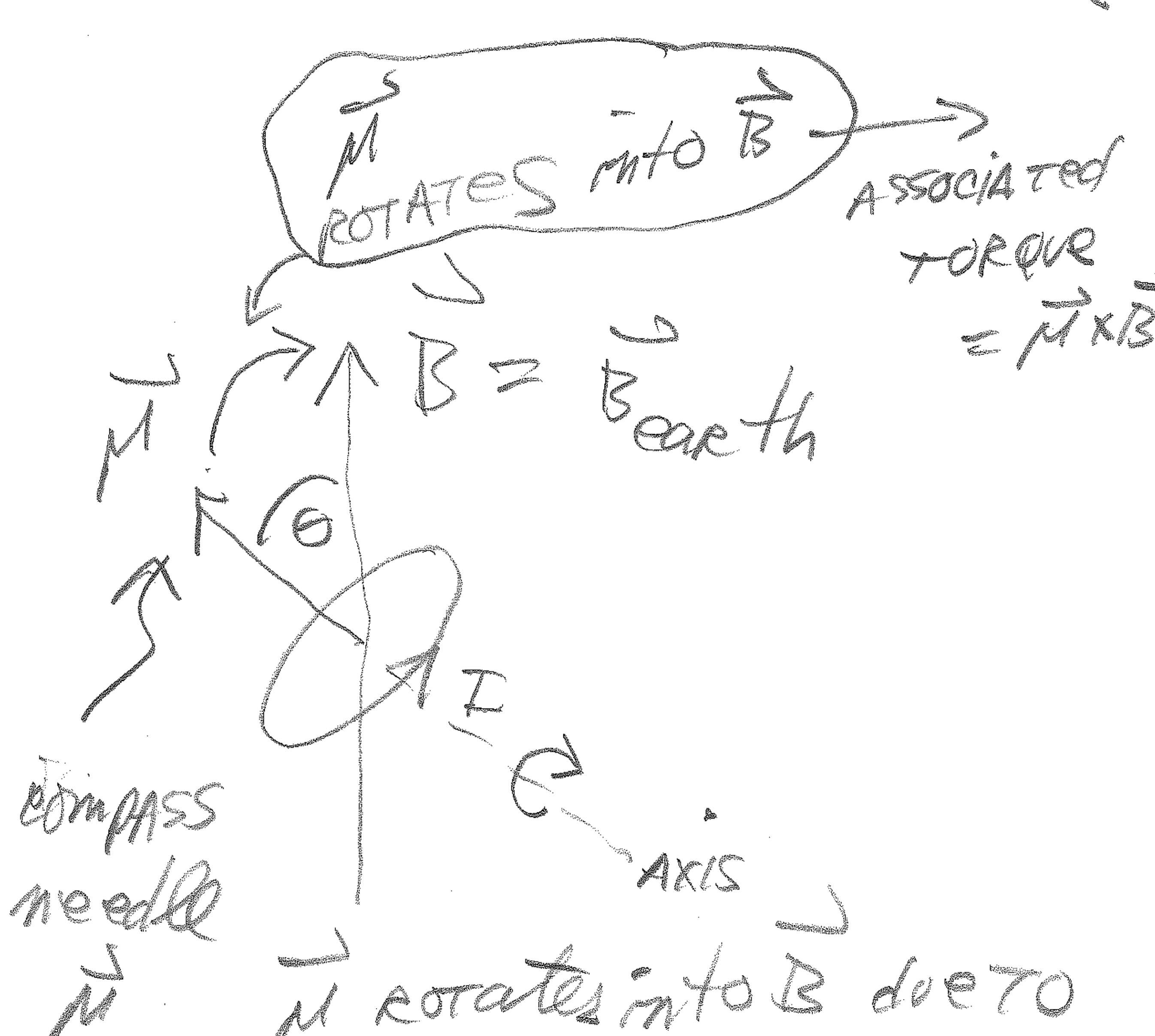


$|\vec{\mu}| = I \cdot \text{area}$
$= I \cdot A$

$\vec{\mu}$ direction from **RIGHT HAND RULE.**

eye view:





$\vec{\mu}$ rotates into $\vec{B}$ due TO a TORQUE given BY

$$\tau = |\vec{\tau}| = |\vec{\mu}| \cdot |\vec{B}| \sin\theta$$

$$\boxed{\tau = \mu B \sin\theta}$$ magnitude

Big application: everyDAY compass.