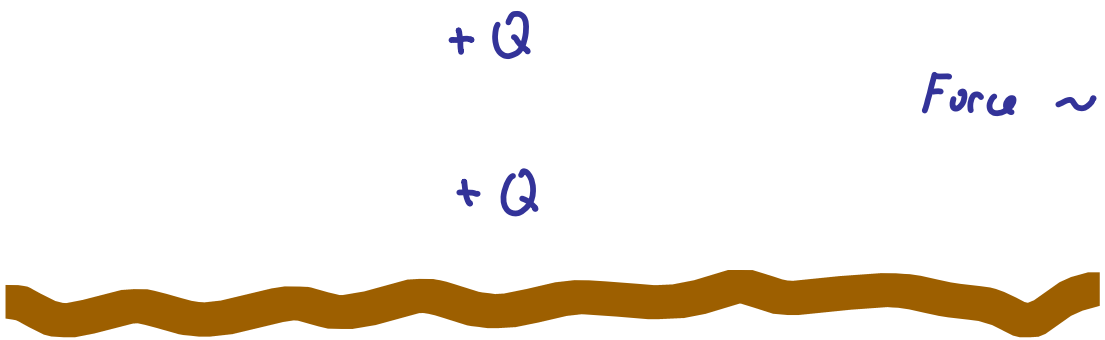
Physics 142 – October 19, 2010

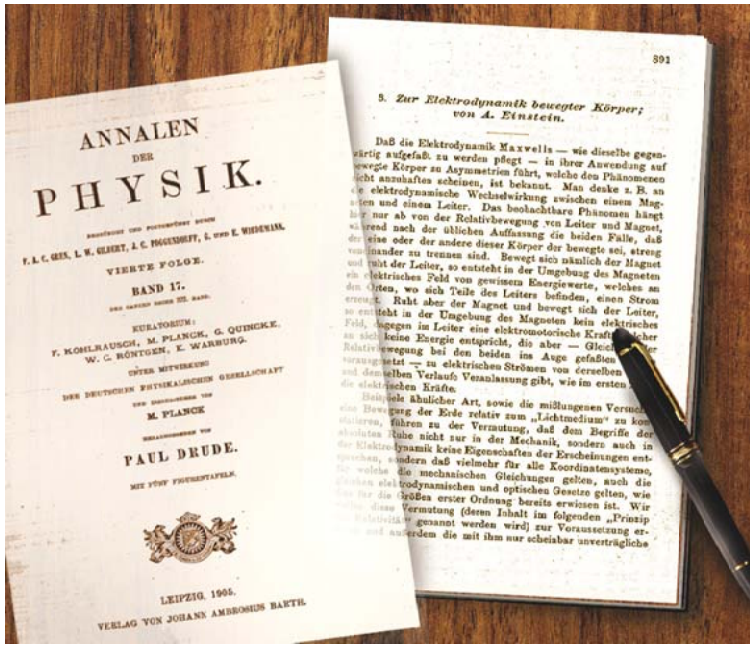
Presentation topics

(3) 1. Particle detectors
(1) 2. Superconductivity
3. Particle accelerators
(4) 4. Pacemakers
(5) 5. Animals + Magnetism
⋮
(2) 22. Relativity and Electromagnetism

Hand in to me at end of class Thursday (or today ... or slip under my door by Thursday)



Einstein's 1905 paper on Special Relativity was entitled "On the electrodynamics of Moving Bodies"



Magnetism

Magnetic field $\equiv \vec{B}$

MKS units
Tesla

Lorentz Force law

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

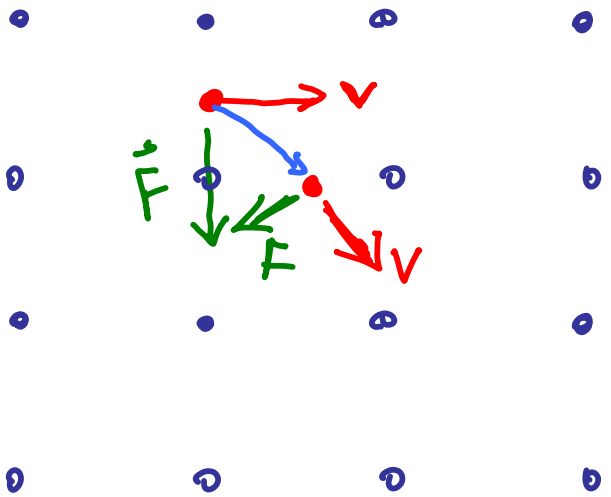
Force on charged particle
Moving w/ velocity $\vec{v}$ in
region of electric field $\vec{E}$
and Magnetic field $\vec{B}$

Evaluation of cross Product

$$\vec{A}\times\vec{B} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ A_x & A_y & A_z \\ B_x & B_y & B_z \end{vmatrix} = \hat{i}(A_yB_z - A_zB_y) - \hat{j}(A_xB_z - A_zB_x) + \hat{k}(A_xB_y - A_yB_x)$$

$$|\vec{A}\times\vec{B}| = |\vec{A}||\vec{B}|\sin\theta$$

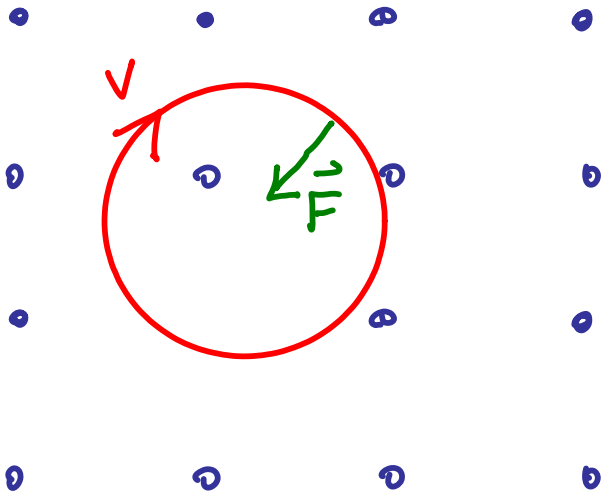
Uniform $\vec{B}$



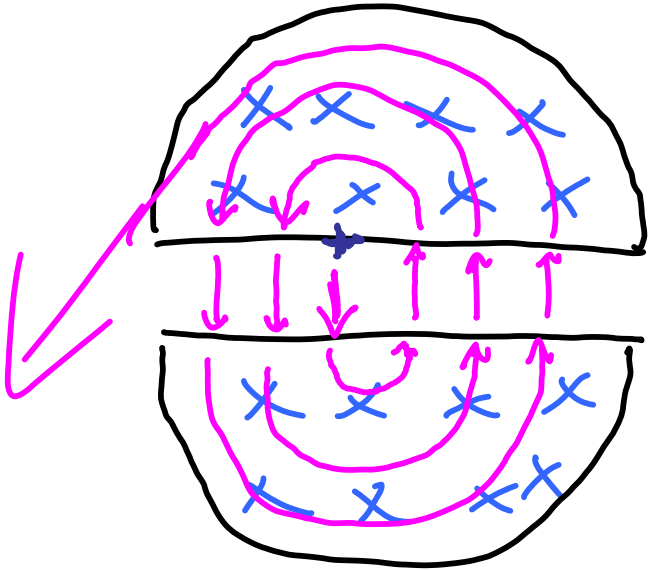
$$F_c = \frac{mv^2}{R} = qvB$$

$$R = \frac{mv}{qB}$$

Uniform $\vec{B}$

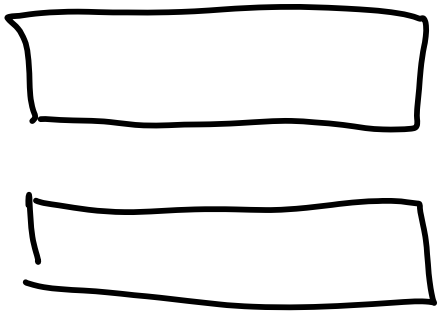


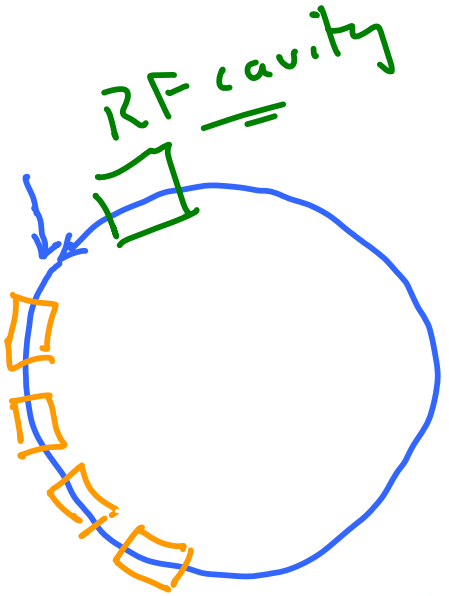
$$\vec{F} = q\vec{v} \times \vec{B}$$



Cyclotron

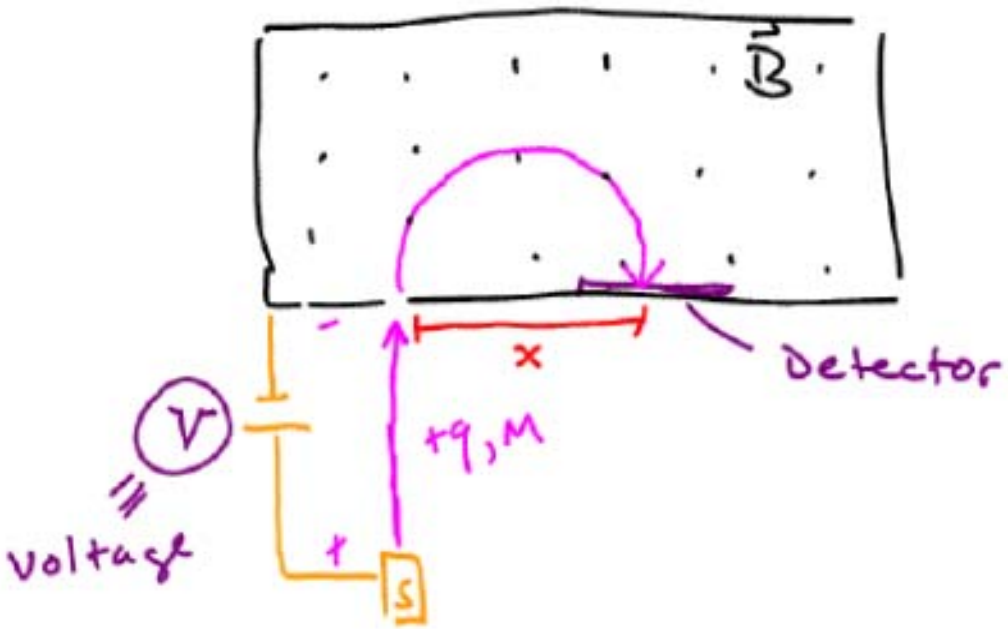
× uniform $\vec{B}$





Synchrotron

Mass Spectrometer



$F = qvB \qquad F = \frac{mv^2}{R}$

v = velocity

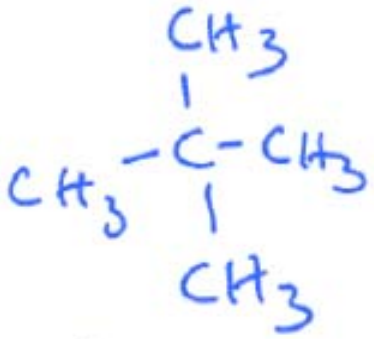
$qvB = \frac{mv^2}{R} \qquad m = \frac{qRB}{v}$

$KE = +qeV = \frac{1}{2}mv^2$

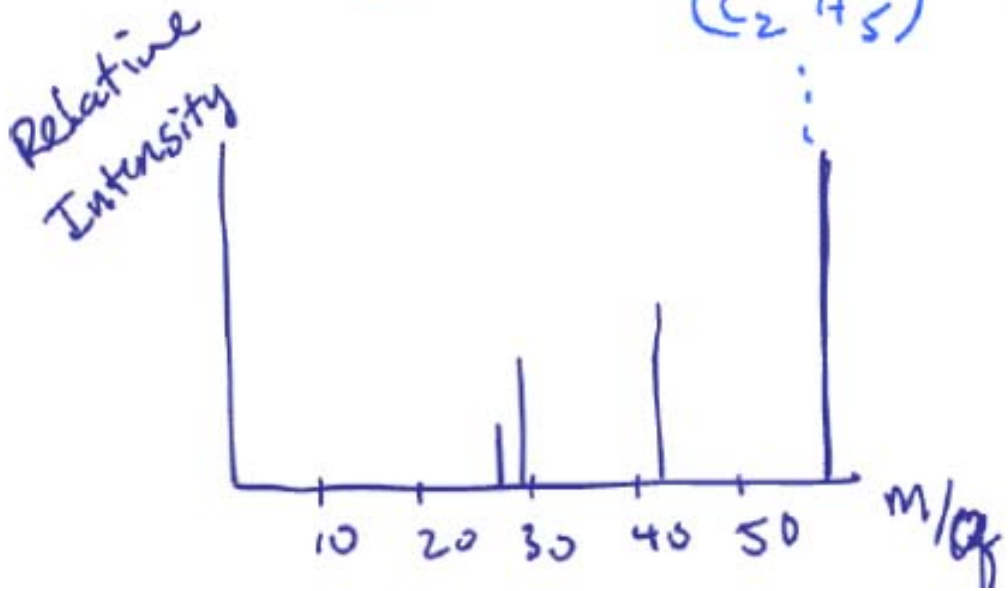
$$v = \left(\frac{2qV}{m}\right)^{1/2}$$

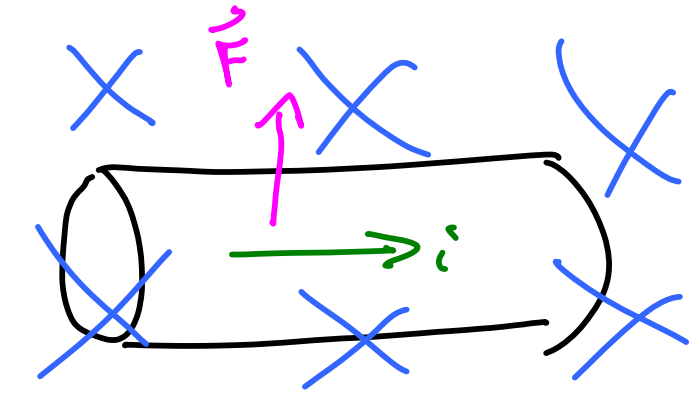
$x = 2R$

$$m = \frac{1elq_B R^2 B^2}{2V} = \frac{1elq_B B^2 x^2}{8V}$$

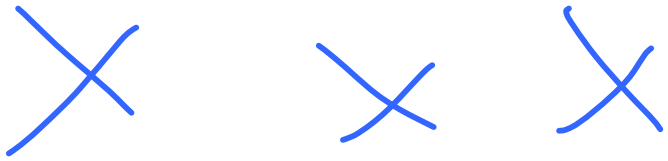


	m/q	Rel int.
$(C_4H_9)^+$	57	100
$(C_3H_5)^+$	41	41.5
$(C_2H_5)^+$	29	38.5
⋮	⋮	⋮





uniform B



$$\vec{F}_{wire} = (q\vec{V}_d \times \vec{B})\, n A L$$

cross sectional area

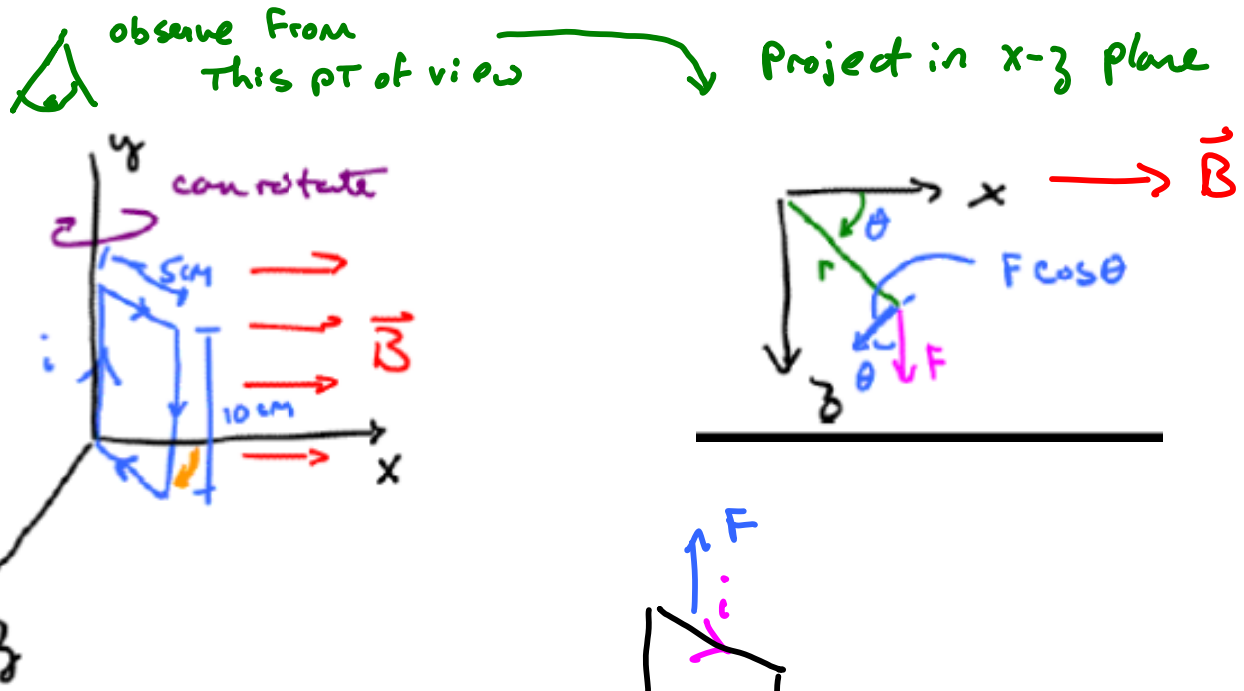
drift velocity

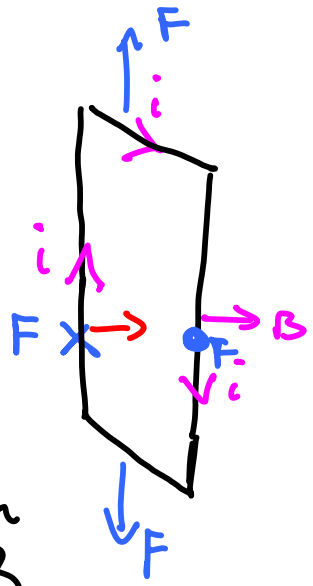
charges / volume

$$i = nqV_d A$$

$$F_{wire} = L\vec{i} \times \vec{B} \quad \text{or} \quad i\vec{L} \times \vec{B}$$

Current loop in $\vec{B}$ – what is torque about y axis?





$\vec{L} = \vec{r} \times \vec{F}$ 10cm

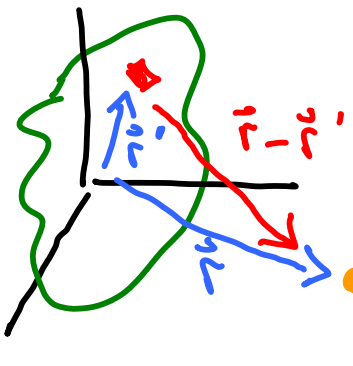
$r F \cos\theta \; i \; L B$ in $-\hat{z}$

Electrostatics

Coulomb's Law

$$\vec{E} = \frac{kQ}{r^2}\hat{r}$$

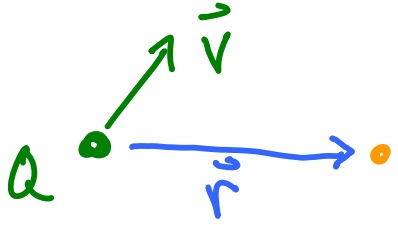
$$\vec{F} = q\vec{E}$$



$$d\vec{E}_P = \frac{k\,dq}{|r - r'|^2}(\hat{r - r'})$$

Magnetostatics

Law of Biot-Savart

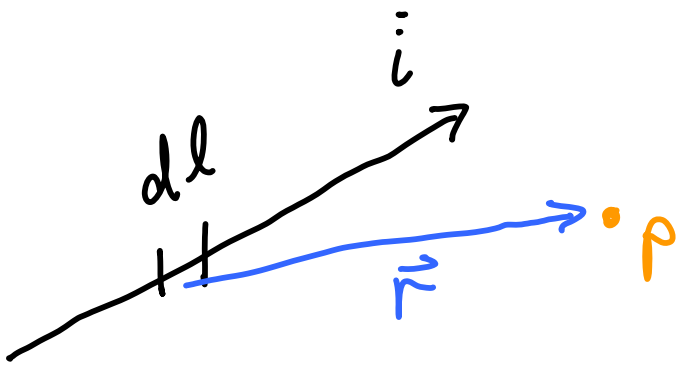


$$\vec{B}_{at\,P\ due\ to\ Q} = \frac{\mu_0}{4\pi}\frac{Q\vec{v}\times\hat{r}}{r^2}$$

$\mu_0 \equiv$ CONSTANT

Permeability of Free Space

$= 4\pi \times 10^{-7}\ \frac{T \cdot M}{A}$



$$d\vec{B}_P = \frac{\mu_0}{4\pi} \frac{i\, d\vec{l} \times \hat{r}}{r^2}$$

Biot-Savart

$$\vec{B}_P = \frac{\mu_0}{4\pi} \int \frac{i\, d\vec{l} \times \hat{r}}{r^2}$$

current distr.

Determines $\vec{B}$ at P due to current distribution.