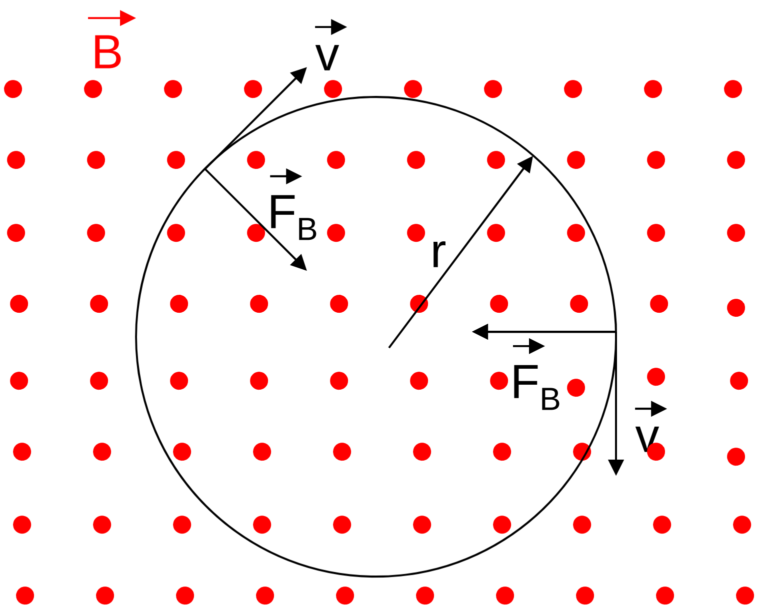
Test 3 Next Wednesday (Nov 1)

1. Chapters 9, 10 and possibly 11.
2. 45 minutes sharp.
3. 4 multiple choices and 2 long problems.
4. Formula sheet provided.
5. Contact me before next Monday for prearrangement if you need special accommodation.

Magnetic force acting on a moving point charge

Motion of Charge Particle in a Uniform B field
$\Rightarrow$ Circular Motion of Constant Speed



1. $\vec{F}_B$ always perpendicular to $\vec{v} \Rightarrow$ Centripetal force

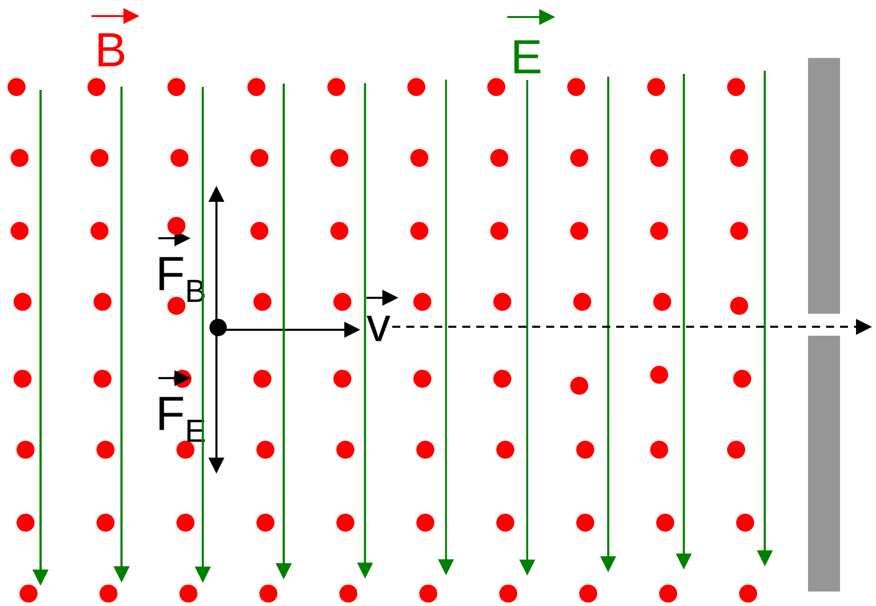
2. Magnetic force does no work $\Rightarrow$ Constant speed

Equation of motion:

$$q|v \times B| = m\frac{v^2}{r} \Rightarrow \boxed{qvB = m\frac{v^2}{r}} \quad \Rightarrow \frac{v}{r} = \frac{q}{m}B$$

$$\Rightarrow \omega = \frac{q}{m}B \qquad \leftarrow \text{Cyclotgron frequency}$$

Velocity Selector



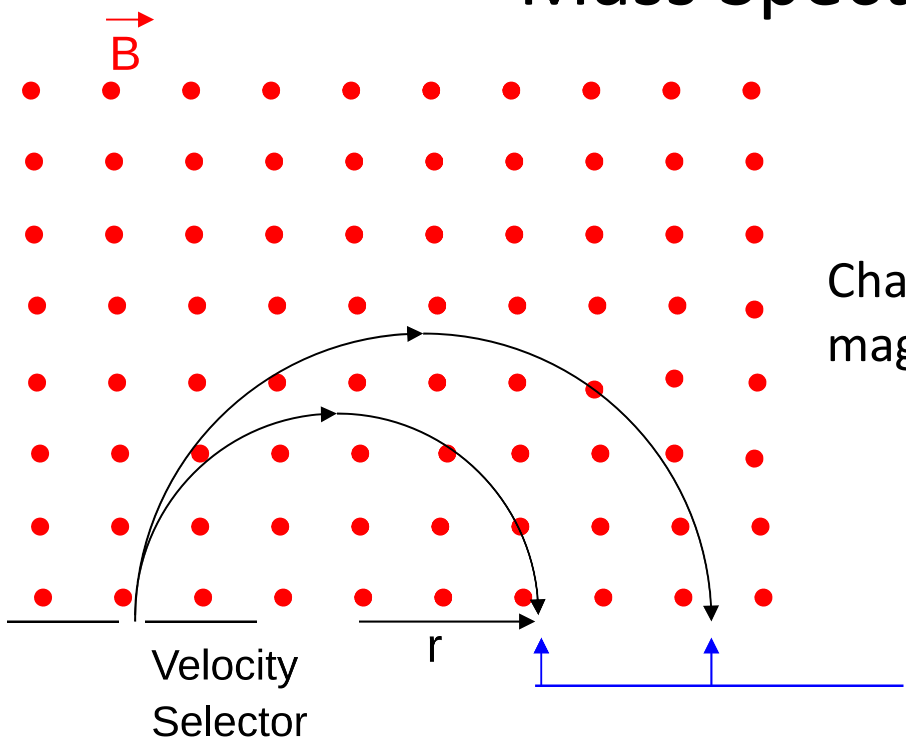
If we can balance $\vec{F}_B$ and $\vec{F}_E$, the charge particle will move in a constant speed.

Equation of motion: $$F_B - F_E = 0 \Rightarrow qvB - qE = 0$$

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

Only particles with v = E/B will move with constant velocity.

Mass Spectrometer

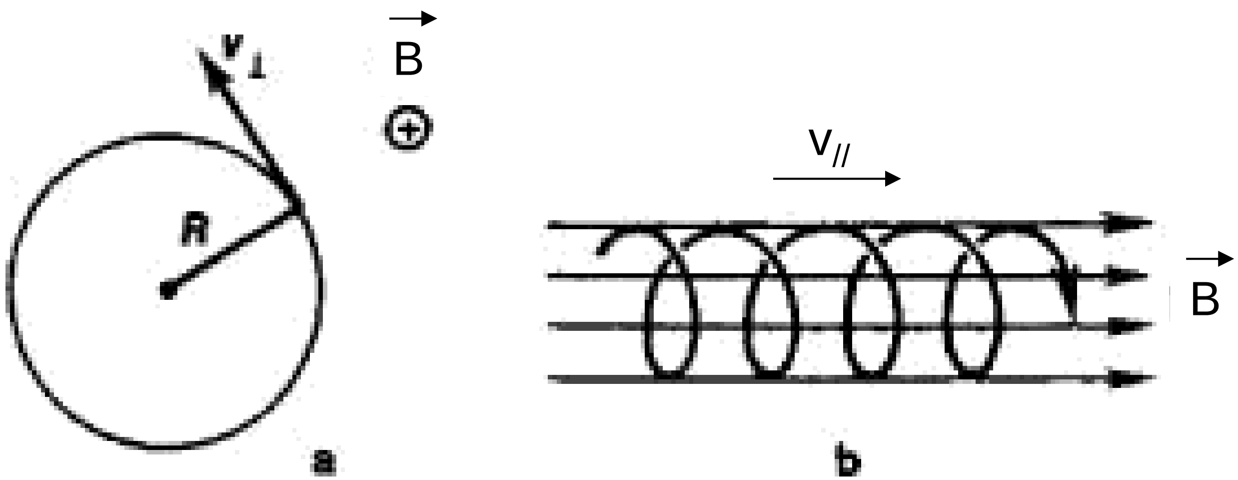


Charge particle enter the uniform magnetic field with the same velocity.

Different q/m ratio

$$qvB = m\frac{v^2}{r} \quad \Rightarrow r = \left(\frac{q}{m}\right) vB$$

If there is velocity component parallel to the uniform magnetic field



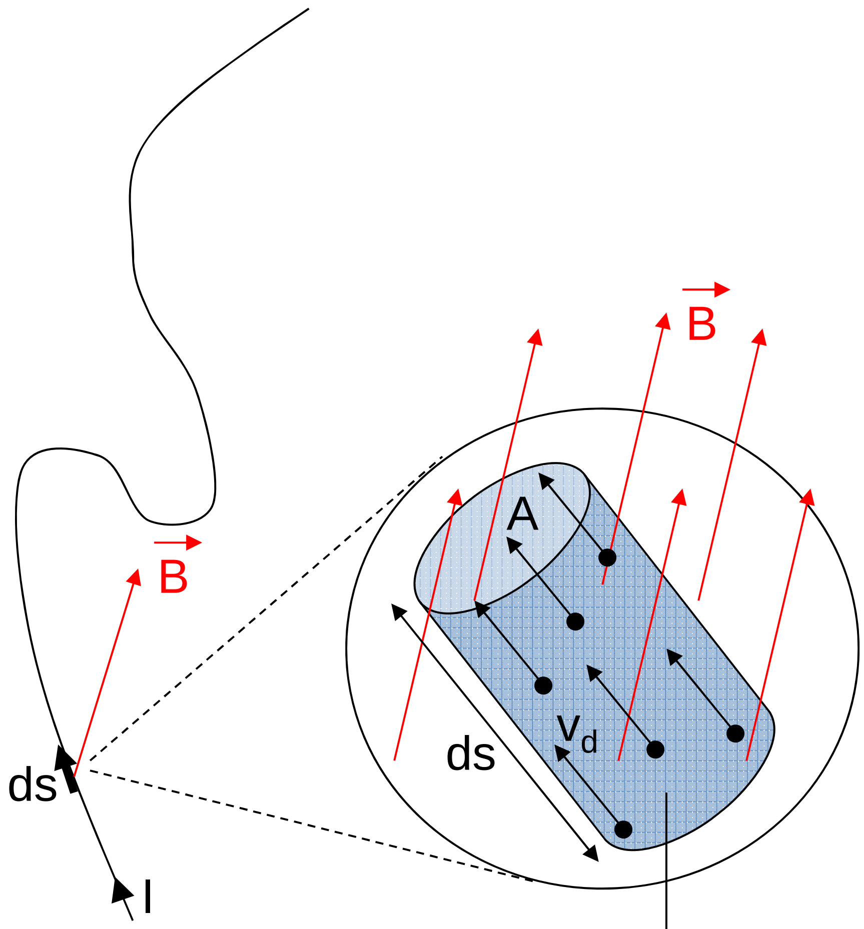
The particle will perform circular motion in the plane perpendicular to the magnetic field, but at the same time moves in parallel (or antiparallel) to the magnetic field.

$$\frac{v_\perp}{r} = \frac{q}{m} B$$

$$v_{//} = \text{constant}$$

Class 28. Magnetic force on a current and a current loop

Magnetic Force Acting on a Current



Force acting on one electron (note that in a current electron is considered as positive in charge):

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

Force acting on the infinitesimal element:

$$d\vec{F}_B = (e\,\vec{v}_d \times \vec{B})\,(nAds)$$

$$\Rightarrow \boxed{d\vec{F}_B = I\,d\vec{s} \times \vec{B}}$$

Force on the whole wire:

$$\vec{F}_B = \int_{\text{wire}} d\vec{F}_B = I \int_{\text{wire}} d\vec{s} \times \vec{B}$$