Magnetic Fields - Applications

Applications of these ideas:

(a) Qualitative discussion
- e-beam evaporation:
-electrons in semiconductors
-aurora Borealis and Aurora Australis.
-Cyclotron: or particle accelerators

(b) Velocity Selector: $E \neq 0$; $B \neq 0$; $E \perp B$

Sine F_E & F_B are opposite to each other there is a possibility that they can cancel each other.

$\vec{F}_E = qE\hat{j}$

$\vec{F}_B = -qVB\hat{j}$

$F_E = F_B \Rightarrow qE=qVB$ or $V=\left(\frac{E}{B}\right)$

-For this velocity the particle passes through
-the "charge" of the particle does not matter!
-neither does the mass!
-crossed fields are used in such devices as vacuum gauges
-This discussion is useful for (e/m) of election

$$\frac{1}{2}mV^2 = qV \Rightarrow V = \sqrt{\frac{2qV}{m}} = \left(\frac{E}{B}\right)$$

(c) Mass spectrometer: to get the mass information, one has to apply E-field (or B-field) separately and use a velocity selector separately.

$$F_y = qE = a_y m \text{ or } a_y = \left(\frac{qE}{m}\right)$$

$$\therefore y = \frac{1}{2}ayt^2 = \frac{1}{2}\left(\frac{qE}{m}\right)\left(\frac{L^2}{V^2}\right)$$

(d) e/m of election: Accelerate in E-field first

$$\frac{a}{m} = \left(\frac{1}{2}\frac{v^2}{V}\right) \Leftarrow \frac{1}{2}mv^2 = q \cdot V$$

But: $v = \frac{E}{B} = \sqrt{\frac{2qV}{m}}$ Or $\left(\frac{q}{m}\right) = \frac{E^2}{2B^2}$

This is an example of "the null method".