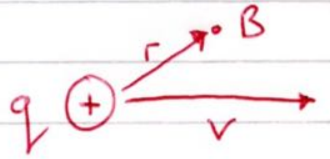
Electromagnetism

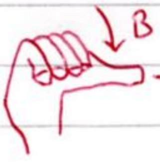
- Vector Field eg Field of Force

- Magnetic field from moving charge.

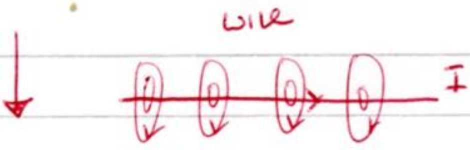


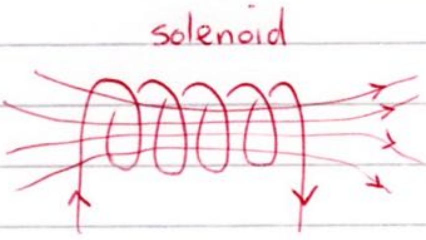
$B \propto \frac{qv}{r^2} \sin\theta$ max at $90°$

or 

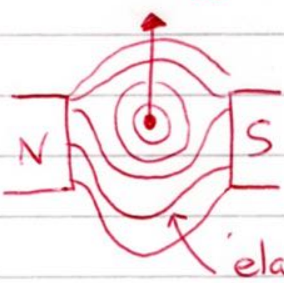
RHR 

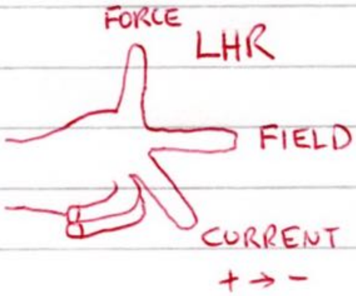
→ motion of charge (current)





- Motor effect : force on conductor in B field





$F = B I l$

Magnitude of field (perpendicular to current/conductor) in Tesla

current / A

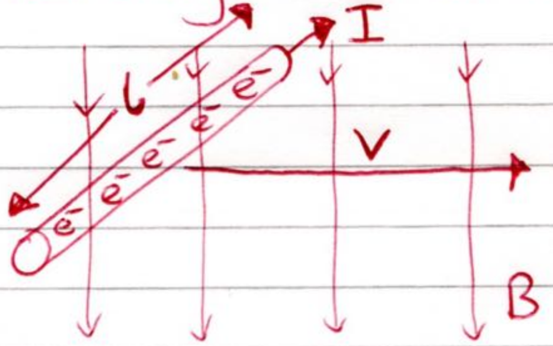
length of conductor in field / m

"Magnetic Field Strength."

- Magnetic Flux & Magnetic Flux Density
  Φ in Wb — Weber; Magnetic Field Strength, B in T $= Wbm^{-2}$

  'Flux per unit area'

- Electromagnetic Induction



Charged electrons move in field so experience a force which generates an emf.

LHR gives current direction

emf = rate at which flux is cut $= \frac{-d\Phi}{dt}$ or $\frac{-d\Phi N}{dt}$ for N 'loops'

$\Phi = BA$ and in time t $A = v \times t \times l$

so $emf = \frac{Bvtl}{t} = Blv$

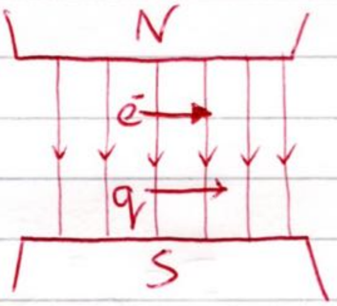
$emf = Blv$ for conductor moving in magnetic field.

The current generated will have its own magnetic field so there will be a force - this must oppose the motion to conserve energy - Lenz's Law.

- BIl to Bev (Bqv)

For charged particle moving in magnetic field

eg.



$F = BIl$

$I = q/t \qquad l = vt$

$\therefore F = B\frac{q}{t} \times vt$

$F = Bqv$ or

for e^- or p^+

$F = Bev$

with the force always at 90° to the motion.

↓

A recipe for circular motion

$$F = Bqv = \frac{mv^2}{r}$$

$$B = \frac{mv}{qr}$$

Transformers

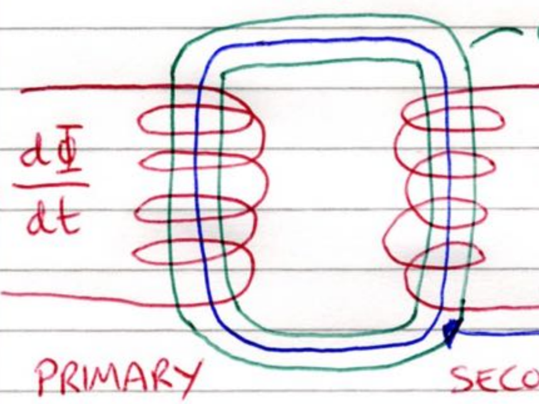
Laminated soft iron core with large cross-sectional area

high permeability

reduce eddy currents

high permeance → lots of flux

Flux is same in all of core but changing all the time



$$V_P = N_P \frac{d\Phi}{dt} \qquad V_S = N_S \frac{d\Phi}{dt} \Rightarrow \frac{V_P}{V_S} = \frac{N_P}{N_S}$$

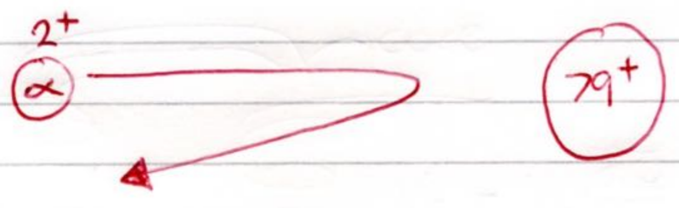
also VI in = VI out to conserve energy

Particle Collisions

e.g. ${}^{4}_{2}He^{2+}$ with gold nucleus ${}^{197}_{79}Au^{79+}$

principle is E_K of α ends up as E_{elec} at closest approach.

$$E_K = \frac{mv^2}{2} \qquad E_{elec} = \frac{KQ_1Q_2}{r}$$



could be given E_K directly in eV or could be given m and v.

Charges = $2+ \times e$ & $79+ \times e$
where $e = 1.6 \times 10^{-19}$ C

e.g. Calc. How close can α with velocity of 2.5×10^{6} ms^{-1} approach a gold nucleus.
$M_\alpha = 6.65 \times 10^{-27}$ kg $\quad K = 8.98 \times 10^{9}$ Nm^{2}C^{-2}

$$\frac{mv^2}{2} = \frac{KQ_1Q_2}{r}$$

$$\therefore r = \frac{2KQ_1Q_2}{mv^2} = \frac{2 \times 8.98 \times 10^{9} \times 2 \times 1.6 \times 10^{-19} \times 79 \times 1.6 \times 10}{6.65 \times 10^{-27} \times (2.5 \times 10^{6})^2}$$

$$= \underline{\underline{1.75 \times 10^{-12} \text{ m}}}$$

Electric & Gravitational Fields & Potential

Field = Force per kg or C

Potential = Energy per kg or C

$\xrightarrow{\div m}$

$\times r \downarrow$

$F = \frac{-GMm}{r^2}$	$g = \frac{-GM}{r^2}$
$E_{grav} = \frac{-GMm}{r}$	$V_{grav} = \frac{-GM}{r}$

$\div q$

$\downarrow \times r$

$F = \frac{kQq}{r^2}$	$E = \frac{kQ}{r^2}$
$E_{elec} = \frac{kQq}{r}$	$V_{elec} = \frac{kQ}{r}$