Summary of chapter 28

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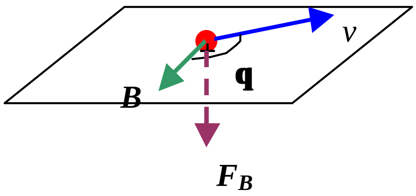
1. The magnetic force that acts on a charged particle of charge ***q*** moving with a velocity ***v*** in an external magnetic field ***B*** is given by;

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

where $\boldsymbol{F_B}$ is in Newton (N), ***q*** is in coulomb(C), ***v*** is in m/s and ***B*** is in Tesla (T).

Important:

The magnetic force is **perpendicular** to both ***v*** and ***B***. The magnitude of the force is given by;



$$F_B = qvB\,sinq$$

where *q* is the angle between the velocity **v** and the magnetic field ***B***.

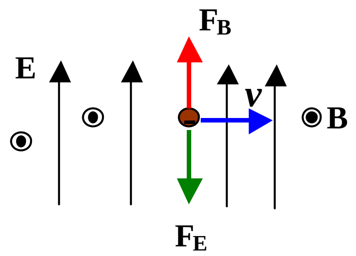
To find the direction of the magnetic force, use the **RIGHT HAND RULE**.

If the charge is negative, use the opposite of the right hand rule to find the direction of the magnetic force.

2. The velocity selector

A charged particle is moving through crossed fields, that is an ~~electric field~~ and a ~~magnetic field~~ perpendicular to each other. There will be two forces on the charged particle. The particles that pass through undeflected, that is the net force is zero, have a velocity given by

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



3. If a charged particle moves in a uniform magnetic field ***B*** such that ***B*** is perpendicular to ***v***, then the particle will move in a **circle** whose plane is perpendicular to ***B***.

- The radius r of the circle is:

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

where ***m*** is mass of the charged particle, ***v*** is velocity of the charged particle and ***B*** is magnetic field. The radius ***r*** is in meters.

- The period ***T*** of revolution is

$$T = \frac{2p\ m}{qB}$$

The period is in seconds.

- The angular frequency ***w*** of he particle is:

$$w = \frac{qB}{m}$$

The angular frequency is in rad/s.

4. If a straight conductor of **length *l*** carries a **current *I***, the force on that conductor in the external **magnetic field *B*** is given by;

$$\vec{F}_B = I\left(\vec{L} \times \vec{B}\right)$$

where F_B s in Newton(N), I is in Ampere(A), L is in meters(m) and *B* is in Tesla(T).

Special case: ***For a closed wire carrying a current I in a magnetic field B, the net force is ZERO.***

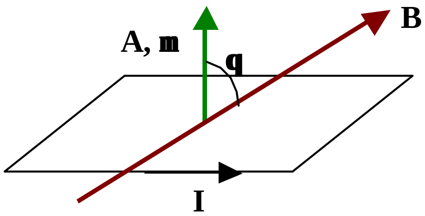
5. The magnetic moment μ of a current loop carrying a current I is:

$$\vec{\mu} = I\vec{A}$$

where $\boldsymbol{\mu}$ is magnetic moment (A.m^2), ***I*** is current (A) and ***A*** is vector area (m^2) perpendicular to the plane of the loop.

6. The torque $\boldsymbol{\tau}$ on a current loop placed in a uniform magnetic field **B** is:

$$\vec{\tau} = I\,\vec{A}\times\vec{B} = \vec{\mu}\times\vec{B}$$



where τ is magnetic torque (N.m), μ is magnetic moment (A.m^2) and B is magnetic field (T).

- Magnitude of the torque is:

$$\tau = \mu B \sin\theta$$

where θ s the angle between μ and B or A and B.

If there are **N** loops then the torque is

$$\tau = N \mu B \sin\theta$$

- Direction: *Use the right hand rule*.

Special cases:

$\boldsymbol{\tau_{max} = N I A B = N \mu B}$ when θ = 90°. The loop will rotate until the torque is zero.

$\boldsymbol{\tau = 0}$ when θ = 0 or θ = 180°. The loop will not rotate.