5.4. MAGNETIC FEILDS

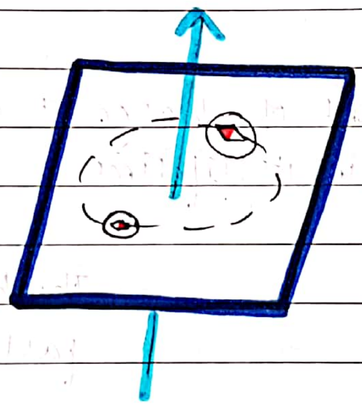
→ Magnets have 2 poles < North / South

→ Like poles repel. Unlike poles attract.

→ The needle of a compass aligns itself in an approximately north south direction. It can be used to investigate the presence of magnets ~~because~~ & direction of magnetic feild because the direction in which the needle is pointing defines the direction of the magnetic feild at the location of the compass.

→ Magnetic feild lines always exit from a north pole & enter a south pole.

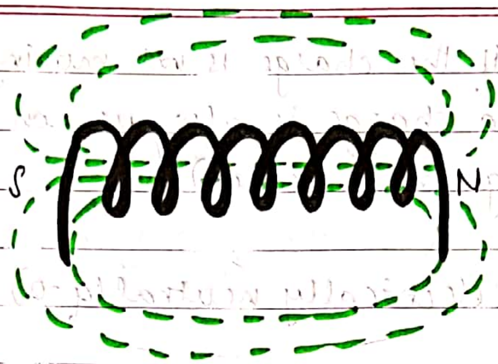
→ Electric currents can produce magnetic feilds, B, which is a vector quantity.



The direction of the needle gives the direction of the magnetic feild.

A circle could be made through the needles.

The magnetic feild is a tangent to this circle. The tangent lines are the magnetic feild lines.



feild lines are no longer circular.

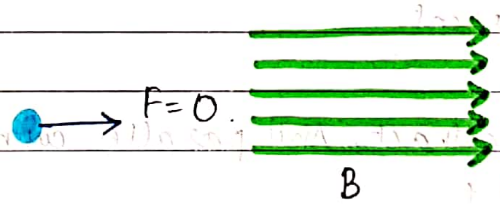
feild lines are fairly uniform. So, the feild is roughly constant. (in both magnitude & direction)

RIGHT HAND RULE (direction of feild around a straight wire)

Grip the wire with the fingers of the right hand such that
→ Thumb points in the direction of the current.
→ Fingers curl in the direction of the flow of magnetic feild vectors.

MAGNETIC FORCE ON A MOVING CHARGE.

If the velocity of the charge is parallel to the direction of the feild, the magnetic force is zero.



In any other direction, there will be a force on the charge.
~~Then, magnetic~~
Then, the magnitude of the feild/magnetic flux density is:

$$B = \frac{F}{qv\sin\theta}$$

θ → angle between charge & direction of feild.

Unit = Tesla.

There is no magnetic force if the charge is not moving (Electric force on a charge is always non zero, whether the charge moves or not).

Magnetic force on electrically neutral $(q=0)$ is zero.

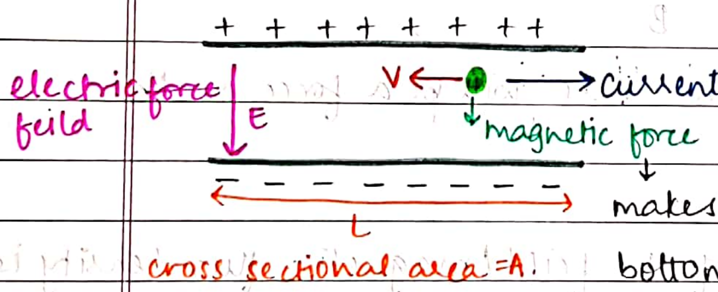
Again the right hand rule (FBI) is used to give the direction of the force.

MAGNETIC FORCE ON A CURRENT CARRYING WIRE:
A current in a wire consists of moving charges. So it will experience a magnetic force when placed in a magnetic feild.

$$F = BIL \sin\theta$$

Here, to find the direction of the force, use the right hand rules for the force on charge q, replace the velocity by the current.

Parallel currents attract. Anti-parallel currents repel.



makes electrons accumulate at the bottom & excess positive charge is left at the top.

These charges exert an electric force on the electrons so no new electrons move towards the bottom. → Magnetic force on electrons is balanced by an electric force.

$$qE = qvB$$

Since these forces are balanced, neither of this forces is responsible for the force on the entire wire.

The electric field E between the top & the bottom charges exerts an electric force on the protons. & then this force acts on the wire.

$$F = BIL$$

When the velocity of a charge is at right angles to the magnetic feild, the path followed by the charge is a circle.

The centripetal force is provided by the magnetic force which is ⊥ to the velocity.

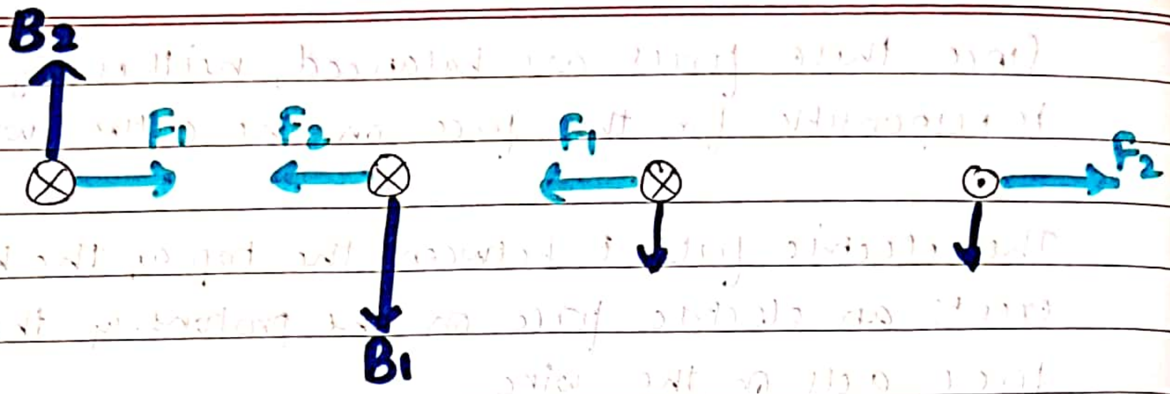
$$qvB = \frac{mv^2}{R}$$

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

$$T = \frac{2\pi R}{v} = \frac{2\pi}{v} \cdot \frac{mv}{qB}$$

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

Time is independent of speed



The forces on parallel currents are equal & opposite

The ampere is defined through the magnetic force between 2 parallel wires. If the force on a 1 m ~~wire~~ length of 2 wires that are 1 m apart & carrying equal currents is 2×10^{-7} N, then current in each wire is 1A.