GOVERNMENT POLYTECHNIC LOHAGHAT, CHAMPAWAT

SUBJECT: PHYSICS **SEMESTER : SECOND**

ELECTROMAGNETISM

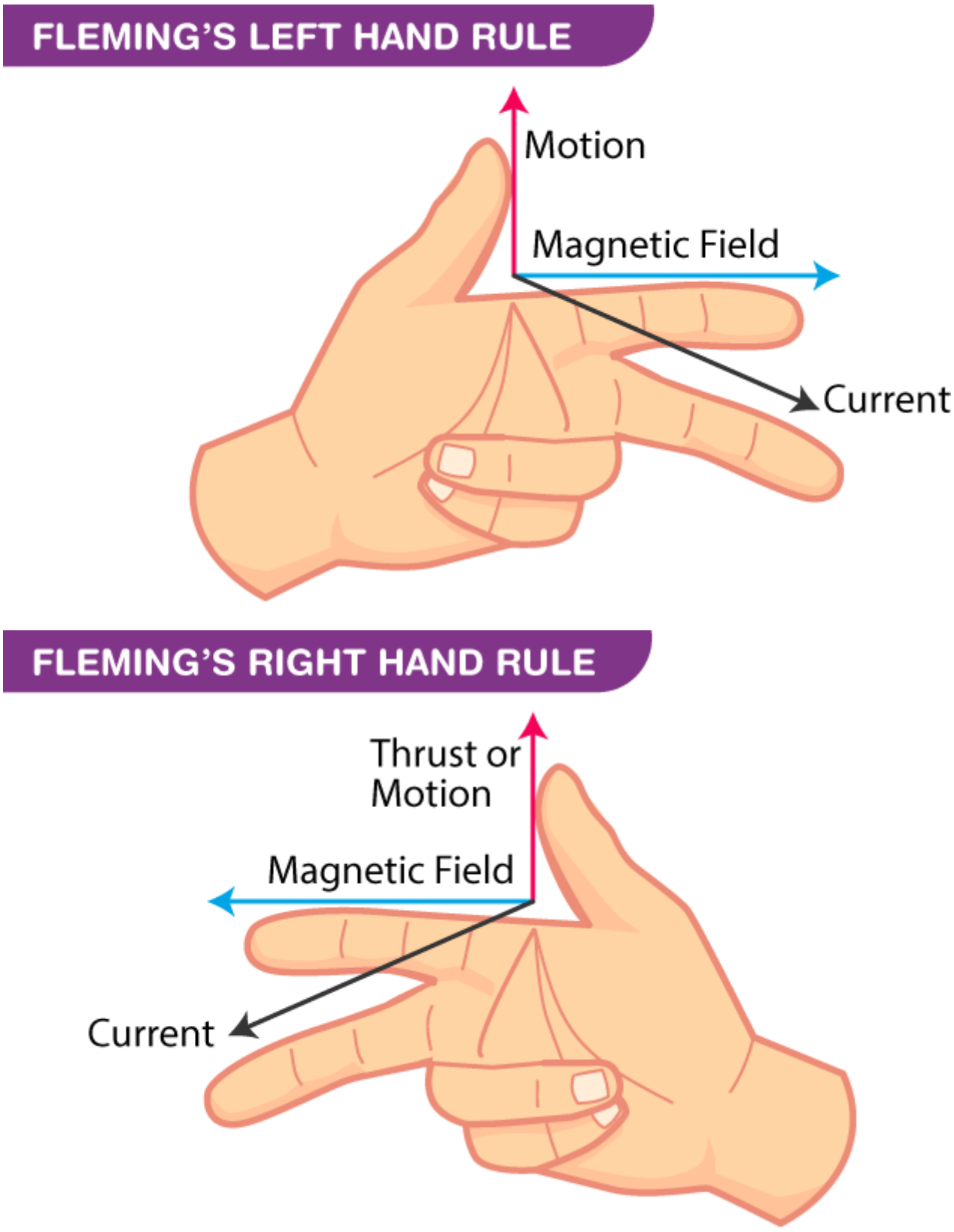
Electromagnetism is a branch of Physics, deals with the electromagnetic force that occurs between electrically charged particles. The electromagnetic force is one of the four fundamental forces and exhibits electromagnetic fields such as magnetic fields, electric fields, and light. It is the basic reason electrons bound to the nucleus and responsible for the complete structure of the nucleus.

What is Electromagnetic Force?

Electromagnetic force ia a type of physical interaction that occurs between electrically charged particles. It acts between charged particles and is the combination of all magnetic and electrical forces. The electromagnetic force can be attractive or repulsive.

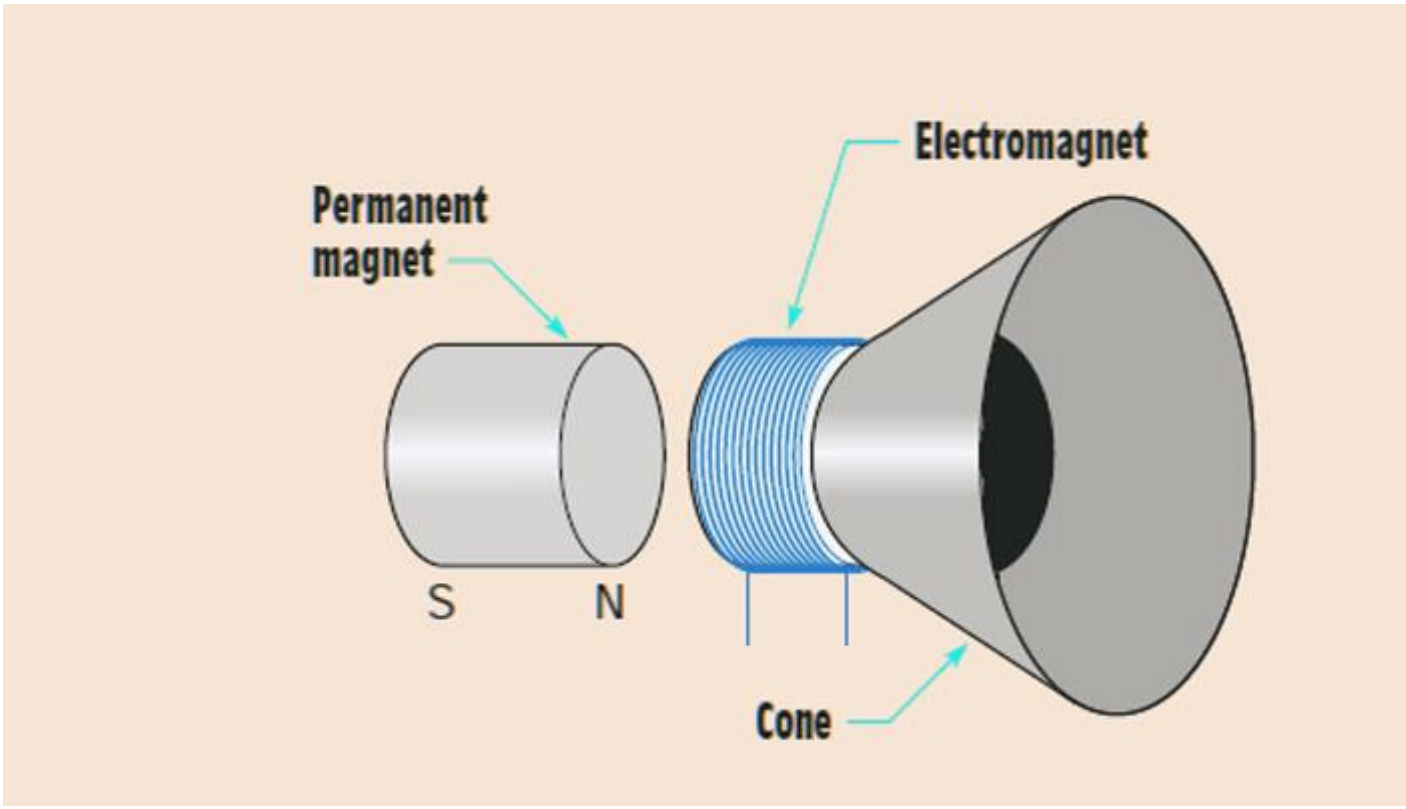
What is Electromagnetism?

Electromagnetism is a process where a magnetic field is created by introducing the current in the conductor. When a conductor is electrically charged it generates magnetic lines of force of conductor. For example, if current i.e., positive charges moving in a wire, it produces the magnetic field along the wire and the direction of magnetic lines, and force can be determined using Right Hand Rule. Refer to the image for a detailed explanation.



Explanation of Electromagnetism with an Example

Permanent Magnetic speakers commonly used in TV's and Radios are perfect examples of Electromagnetic devices. Let's see the operation of these devices which are based on the principle of electromagnetism. See the picture below.



In order to convert electrical waves into an audible sound, the speakers are designed. A metal coil is attached to a permanent magnet and when current passes through the coil it generates a magnetic field. The newly formed magnetic field is repelled by the permanent magnetic field resulting in the vibrations. These vibrations are amplified by the cone-like structure causing the sound. This is how speakers work based on electromagnetism

MAGNETIC FIELD PATTERN DUE TO STRAIGHT CURRENT-CARRYING CONDUCTOR

The region around a magnet where magnetism acts is represented by the magnetic field.
The force of magnetism is due to moving charge or some magnetic material.
Like stationary charges produce an electric field proportional to the magnitude of charge, moving charges produce magnetic fields proportional to the current. In other words, a current carrying conductor produces a magnetic field around it. The sub-atomic particles in the conductor like the electrons moving in atomic orbitals are responsible for the production of magnetic field.

The magnetic field lines around a straight conductor (straight wire) carrying current are concentric circle whose centres lie on the wire.

DISCOVERY OF MAGNETIC FIELD BY CURRENT CARRYING CONDUCTOR

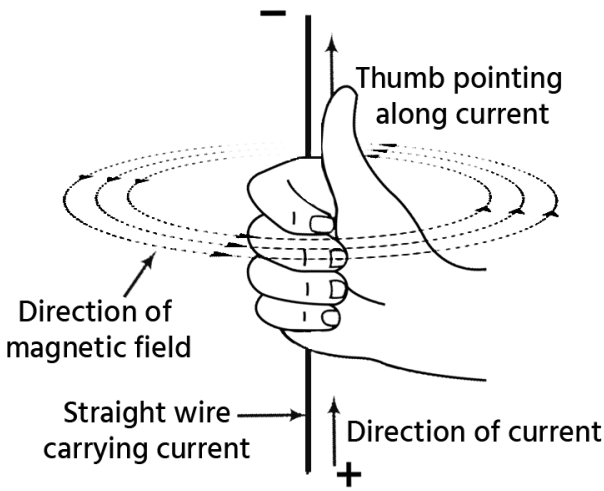
During the early 19th century, a scientist named H. C. Oersted discovered that a current carrying conductor produces magnetic effect around it.
Also, effect of lightning striking a ship caused the malfunctioning of compass needles, disrupting the navigation system. This was the basis for establishment of a relationship between moving electric charge or current and magnetic field.

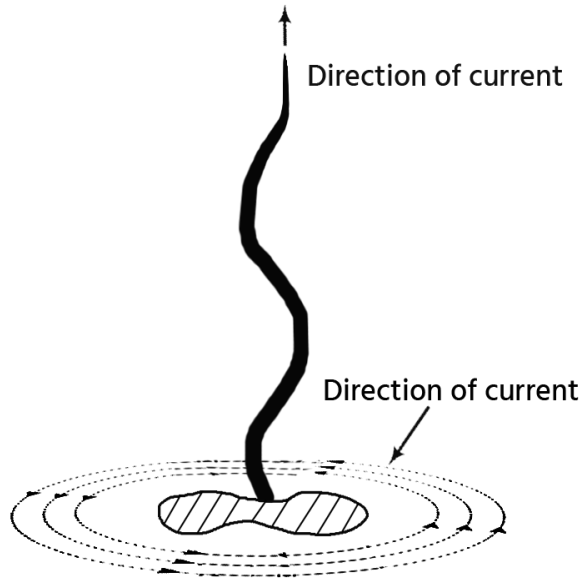
FACTOR ON WHICH THE MAGNETIC FIELD PRODUCED:

Magnetic field is directly proportional to the current passing through the wire and it is inversely proportional to the distance from the wire.

DETECTING DIRECTION OF MAGNETIC FIELD: RIGHT HAND THUMB RULE

While grasping (or holding) the current-carrying wire in your right hand so that your thumb points in the direction of current, then the direction in which your fingers encircle the wire will give the direction of magnetic field lines around the wire.

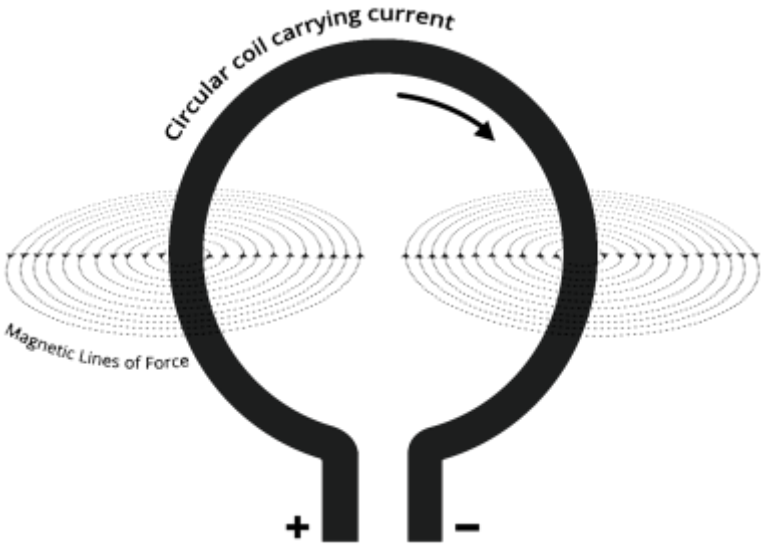




CHARACTERISTICS OF MAGNETIC FIELD

The magnetic field produced has the following characteristics:
It encircles the conductors and lies in a plane perpendicular to the conductor.
If the direction of current in the conductor is reversed then the direction of magnetic field also reverses.
Application: The motors used in toy cars or bullet train or aircraft or spaceship use similar magnetic effects.

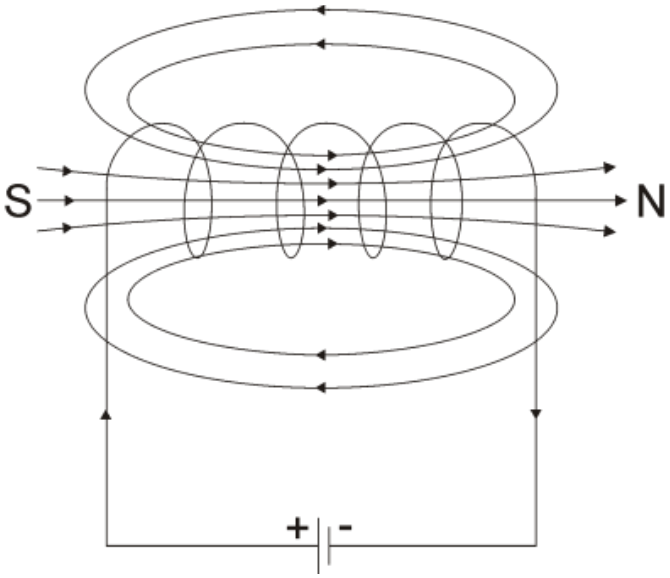
MAGNETIC FIELD PATTERN DUE TO CIRCULAR LOOP (OR CIRCULAR WIRE) CARRYING CURRENT

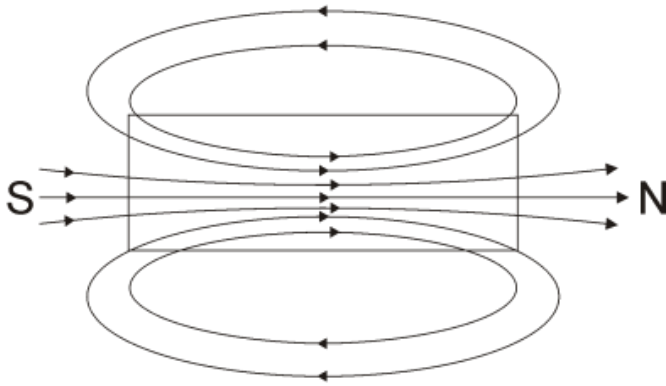


The lines of force near the wire are almost concentric circles.
Moving towards the centre of loop, the concentric circles become larger and larger.
Near the centre of the loop, the arcs of these big circles appear as parallel straight lines.
The magnetic field is almost uniform at the centre of the loop.
The magnitude of magnetic field produced by a current-carrying circular loop (or circular wire) at its centre is:
(i) Directly proportional to the current passing through the circular loop (or circular wire), and
(ii) Inversely proportional to the radius of circular loop (or circular wire).

MAGNETIC FIELD DUE TO SOLENOID

Solenoid: A long cylindrical coil of insulated copper wire of large number of circular turns is called a solenoid.





The magnetic field produced by a current-carrying solenoid is similar to the magnetic field produced by a bar magnet.
The strength of magnetic field produced by a current carrying solenoid depends on:
(i) Number of turns in the solenoid: Larger the number of turns in the solenoid, greater will be the magnetism produced.
(ii) Strength of current in the solenoid: Larger the current passed through solenoid, stronger will be the magnetic field produced.
(iii) Nature of the core material: The use of soft iron rod as core in a solenoid produces the strongest magnetism.

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