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CLASS X - SCIENCE

Magnetic Effects of Electric Current

PRASHANT KIRAD

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PK HITS🔥

- Fleming's left hand rule (Numerical) ← Mix
- Solenoid (Diagram)
- Properties of Magnetic field lines →
- Live wire, Neutral and earth wire.


LAST CHAPTER!
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MAGNETISM

Magnetism is mainly defined as the property to attract or repel a material; materials that show this property are known as magnets.

Magnetism in our Nature:

Magnetic Rocks: Certain rocks, like lodestone, are naturally magnetic due to iron and other magnetic minerals.

Human Body: The human body produces weak magnetic fields due to electrical activity in nerves and the heart.

Earth's Magnetic Field: The Earth itself acts like a giant magnet, with a magnetic field surrounding it.

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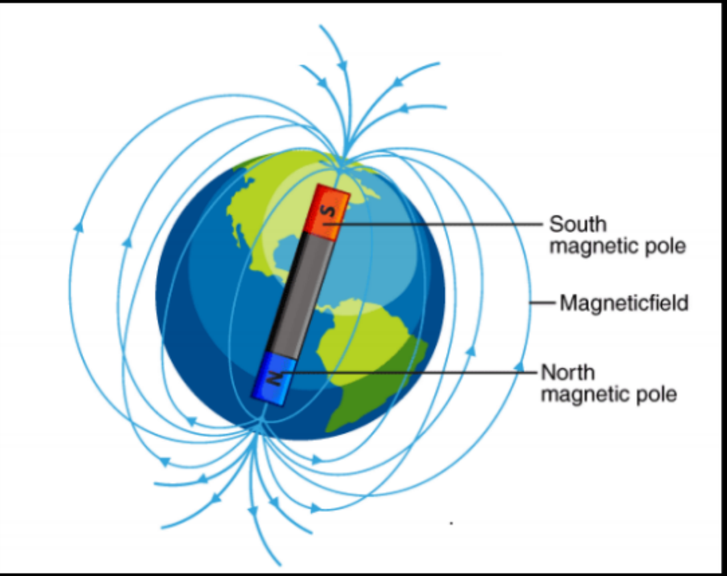
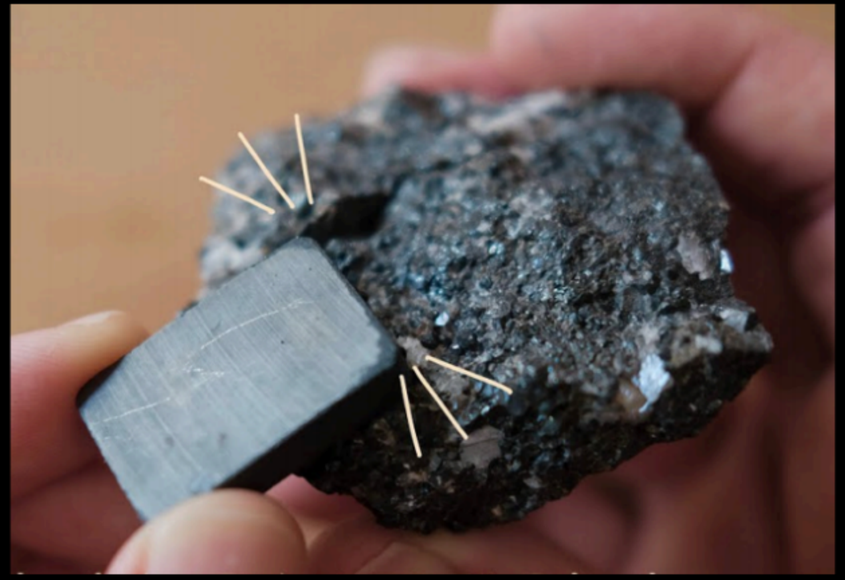
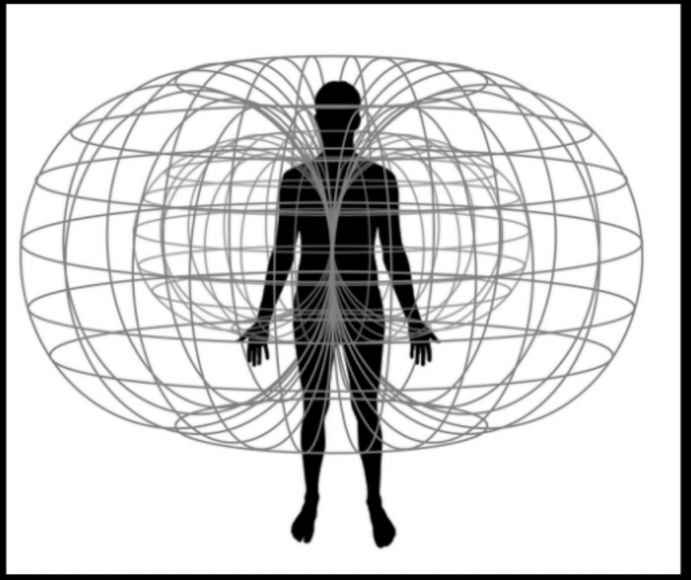
MAGNETISM IN OUR NATURE



Earth's Magnetic Field



Magnetic Rock {Magnetite}



Magnetism in human beings

HANS CHRISTIAN OERSTED

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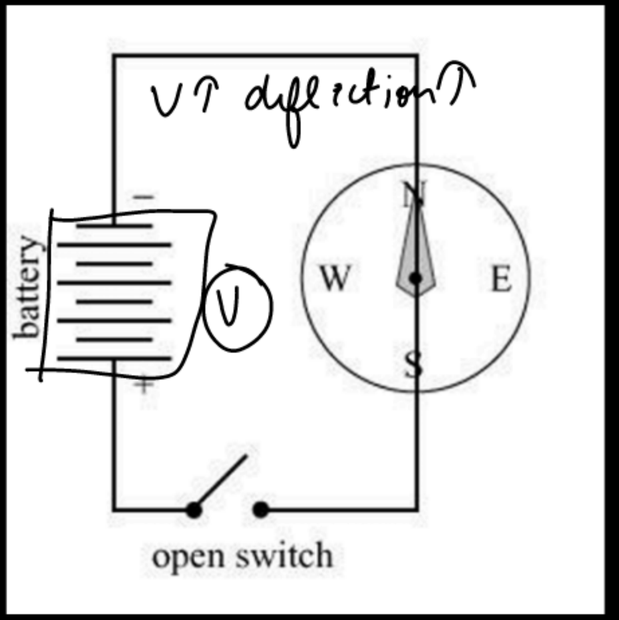
Hans Christian Oersted was a Danish physicist and chemist, best known for his discovery of the relationship between electricity and magnetism, which marked the beginning of the field of electromagnetism.

OERSTED'S EXPERIMENT

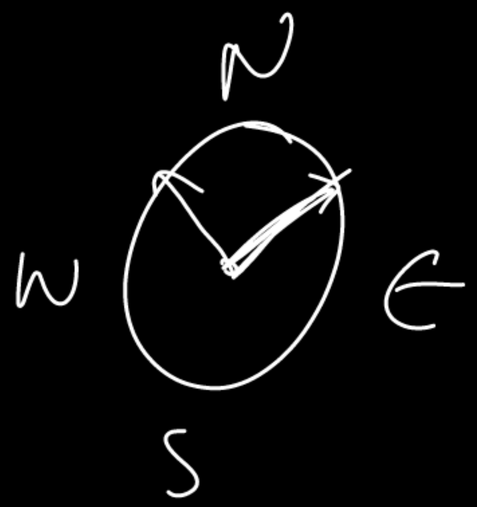
Oersted's experiment demonstrated that electric current produces a magnetic field.

In his experiment, Oersted connected a wire to a battery and placed a compass near it. When the current flowed, the compass needle deflected, showing a magnetic field around the wire, and reversed direction when the current was reversed.



Observations:

1. The compass needle deflected when the current was switched on.
2. The direction of deflection changed when the direction of the current was reversed.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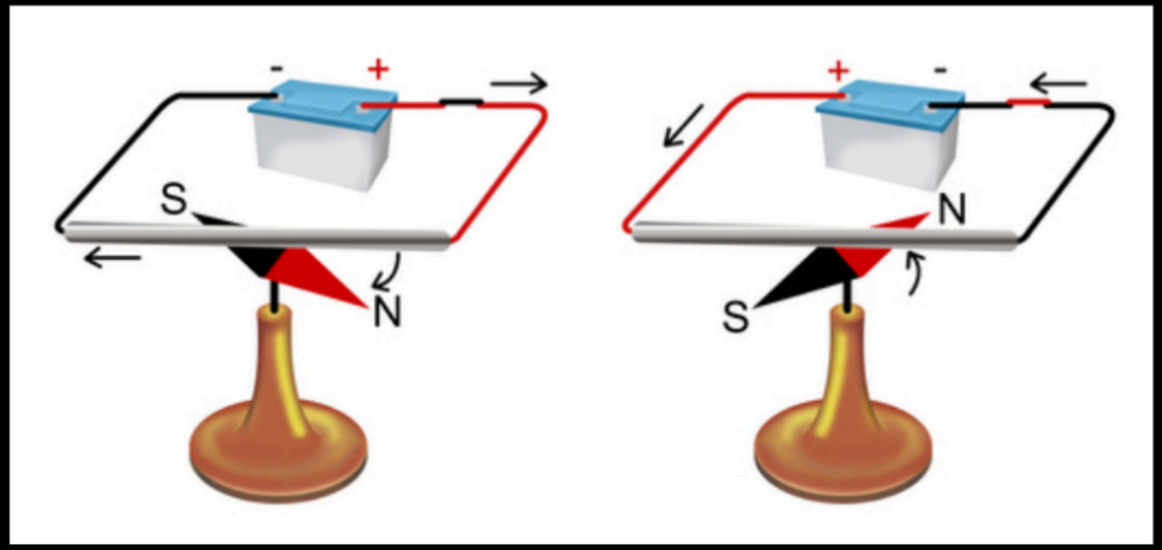
Conclusions:

1. **Electric Current Creates a Magnetic Field:** The deflection of the compass needle proved that a magnetic field is produced around a current-carrying wire.

2. **Magnetic Field Direction:** The direction of the magnetic field depends on the direction of the electric current.



A current-carrying wire creates a magnetic field around it.

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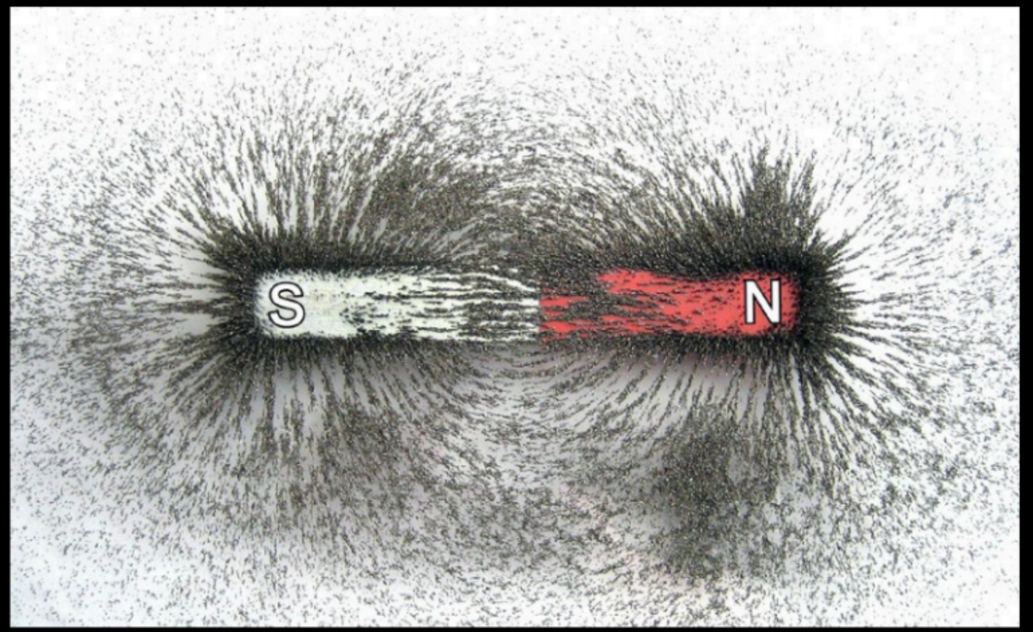
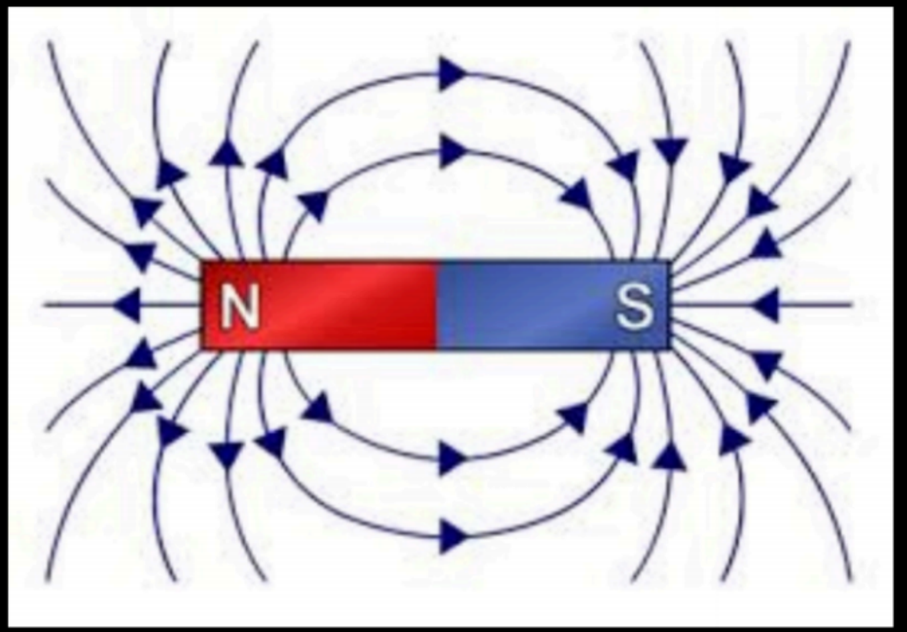
MAGNETIC FIELD AROUND A MAGNET

When the iron filings are sprinkled, those very close to the magnet, where the magnetic force is the strongest, will cling to the magnet. The iron fillings are arranged in the form of concentric circles.



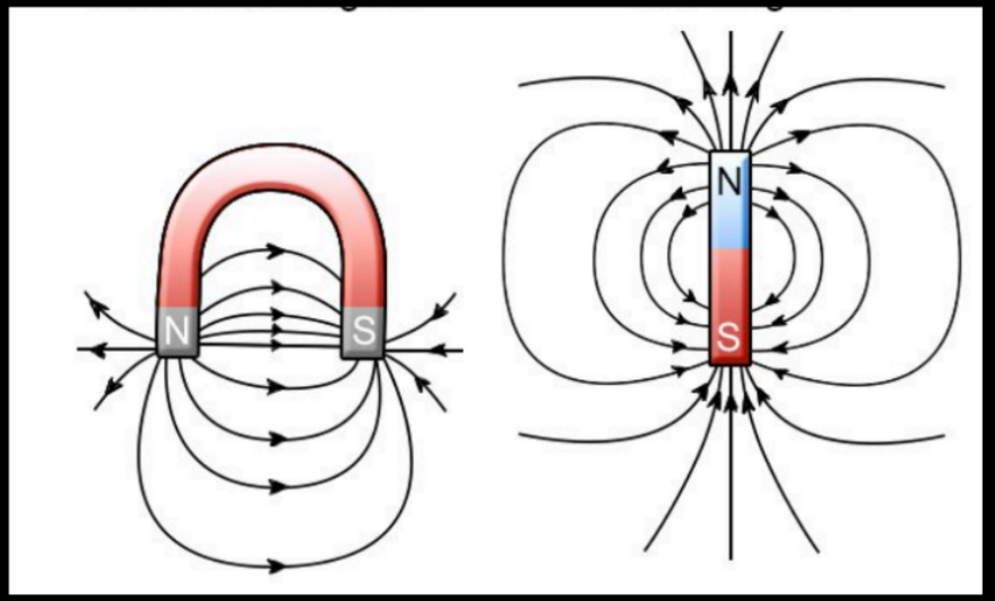


MAGNETIC FIELD

A magnetic field is a region around a magnet or a current-carrying conductor where magnetic forces can be experienced. It is represented by magnetic field lines that show the direction and strength of the magnetic field.

Magnetic Field Lines:

Magnetic field lines are imaginary lines, which depict the strength and direction of the magnetic field.



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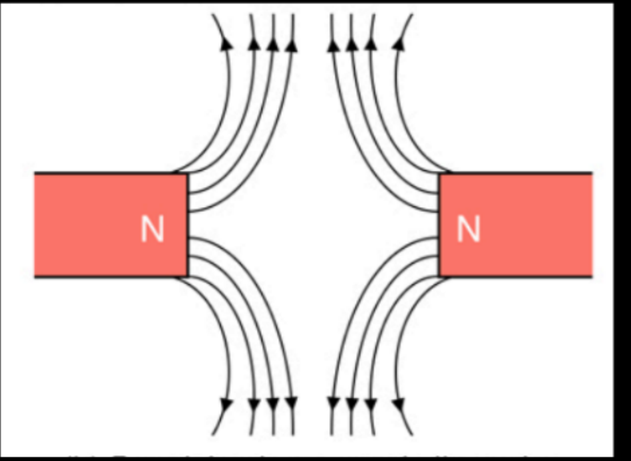
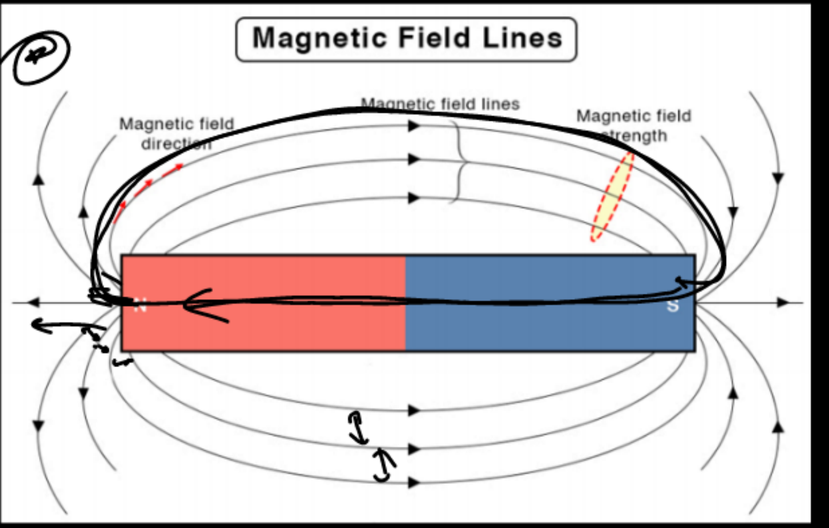
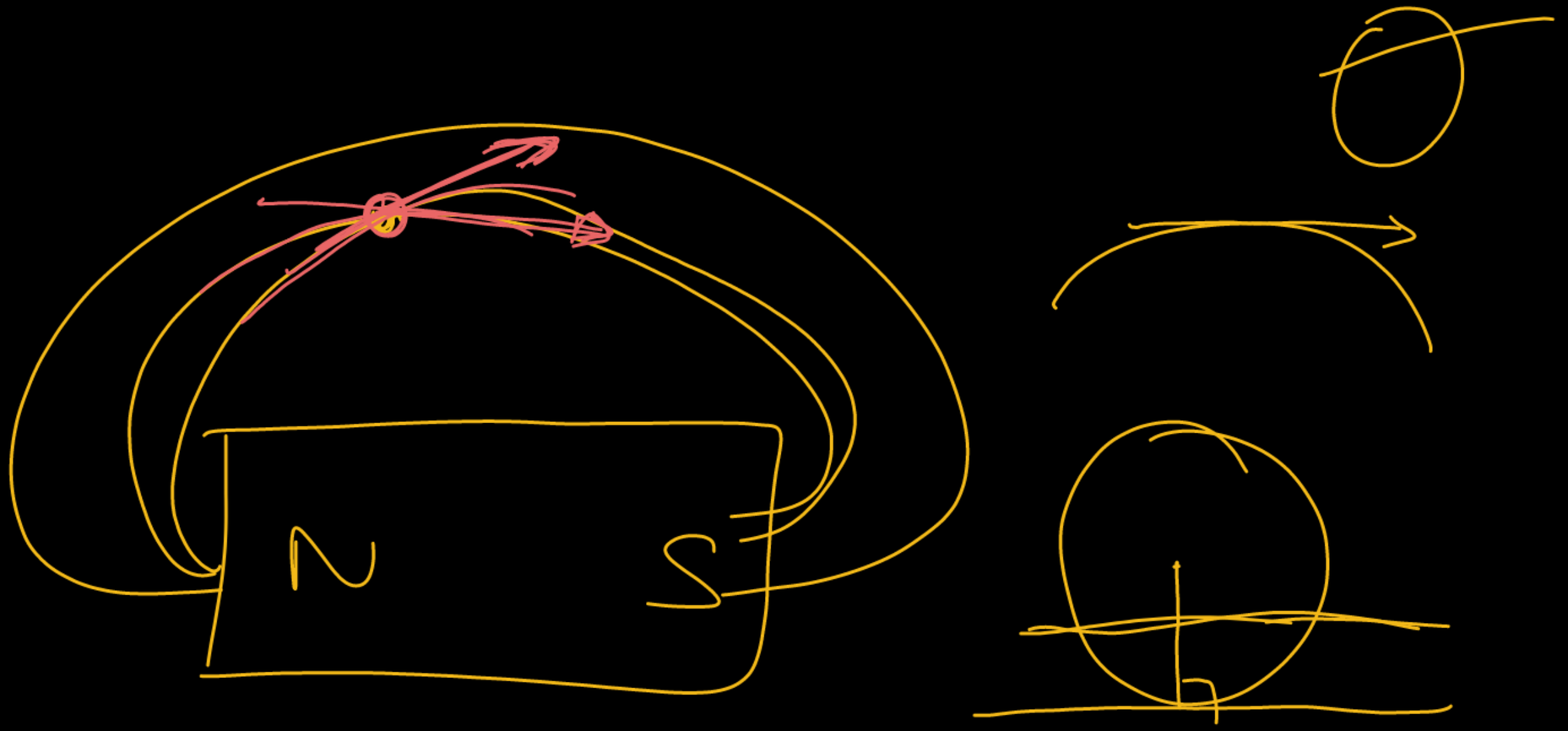
Properties of Magnetic Field Lines:

- By convention, field lines emerge from the north pole and merge at the south pole. Inside the magnet, the direction of field lines is from its south pole to its north pole.
- They form closed loops.
- They never intersect with each other.
- The magnetic field lines are crowded near the pole where the field is strong and spread apart from each other where the field is weak.



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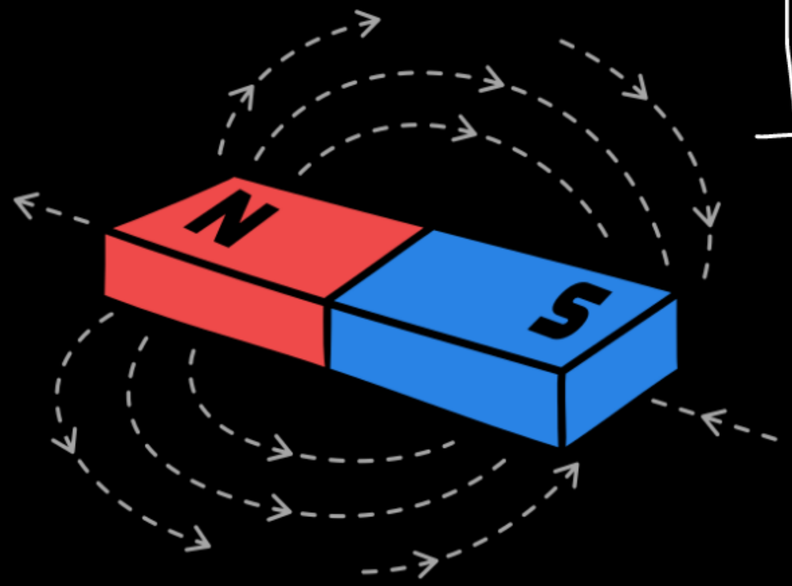
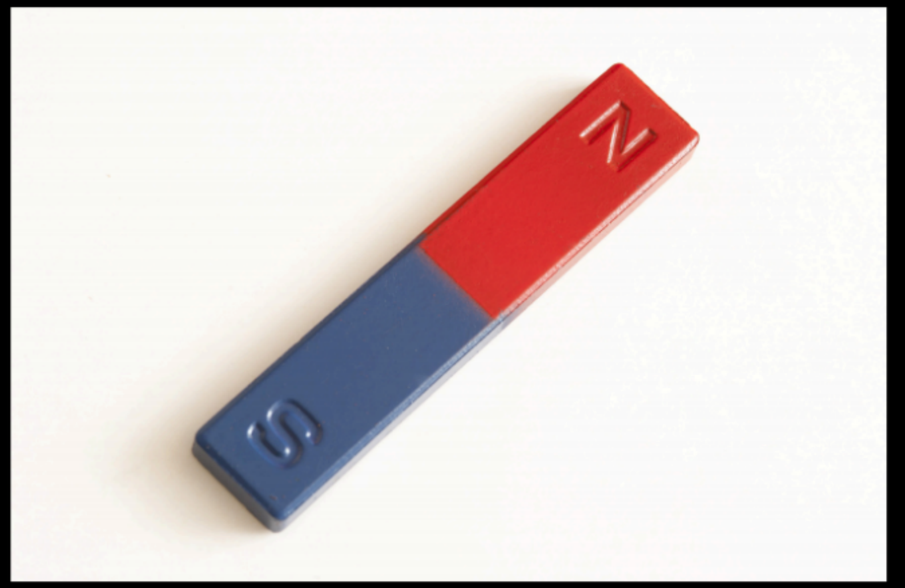
BAR MAGNET

A bar magnet is a rectangular piece of an object, made up of iron, steel or any other ferromagnetic substance or ferromagnetic composite, that shows permanent magnetic properties

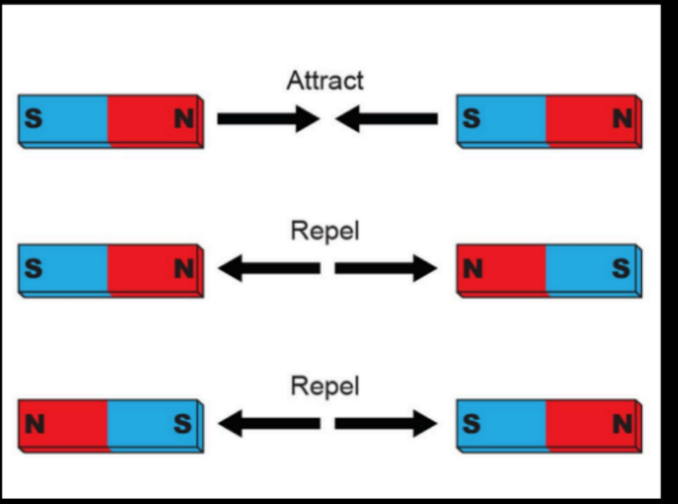




- A Bar Magnet has a north pole and a south pole at two ends.
- Even if you break a bar magnet from the middle, both the pieces will still have a north pole and a south pole, no matter how many pieces you break it in.

Properties of Bar Magnet:

- A bar magnet will attract all ferromagnetic materials such as iron, nickel and cobalt.
- If two bar magnets are placed close to each other, their unlike poles will attract and like poles will repel each other.
- Its magnetic force is the strongest at the poles.
- If this magnet is suspended freely in the air with a thread, it will not come to rest until the poles are aligned in a north-south position.



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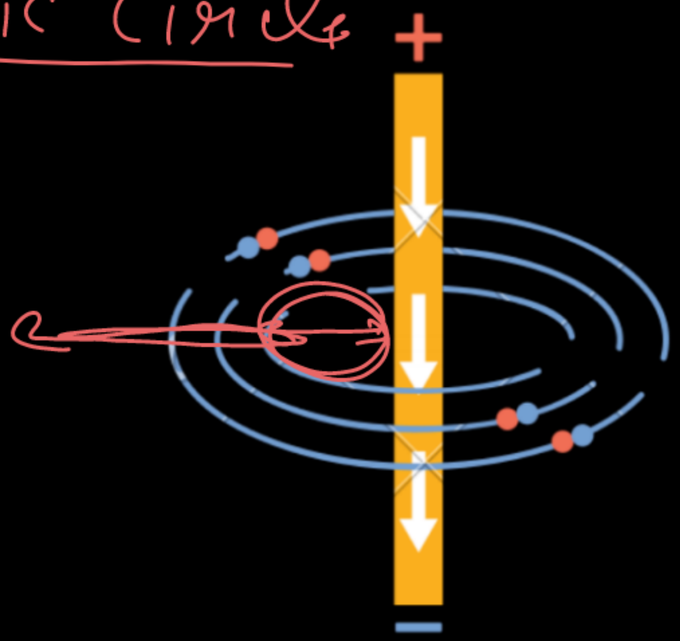
MAGNETIC FIELD DUE TO STRAIGHT CURRENT CARRYING CONDUCTOR

When electric current flows through a straight conductor (like a wire), it produces a magnetic field in the surrounding space.

→ Concentric circles

Shape of Magnetic Field Lines:

- The magnetic field lines around the conductor are circular and centred on the conductor.
- The lines are closer to the conductor and spread out as the distance increases.



MAXWELL'S RIGHT HAND THUMB RULE

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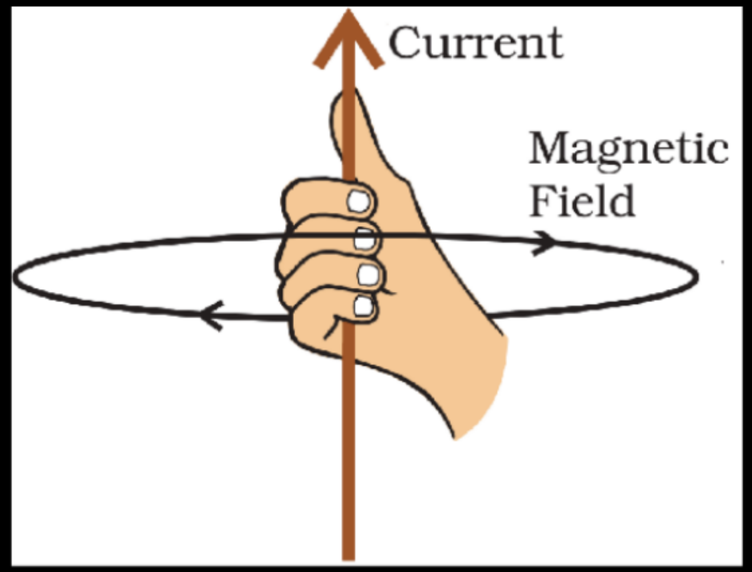
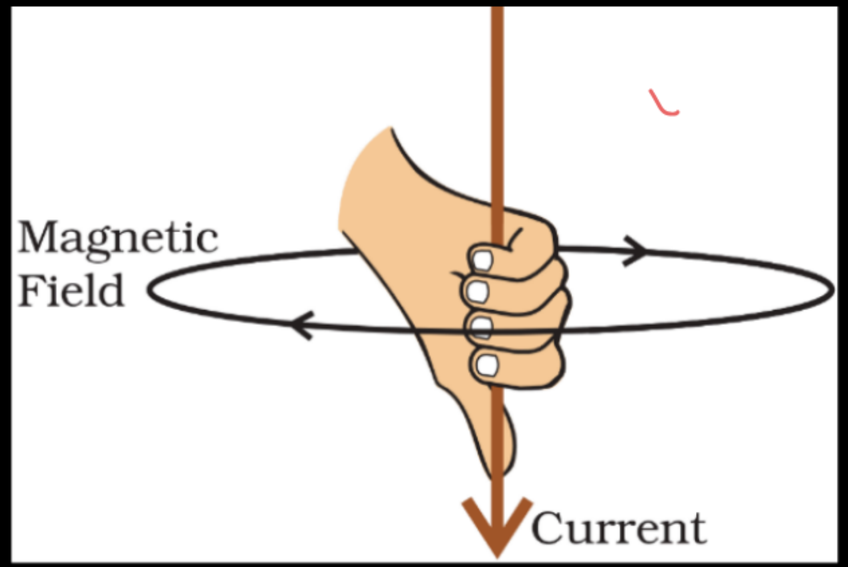
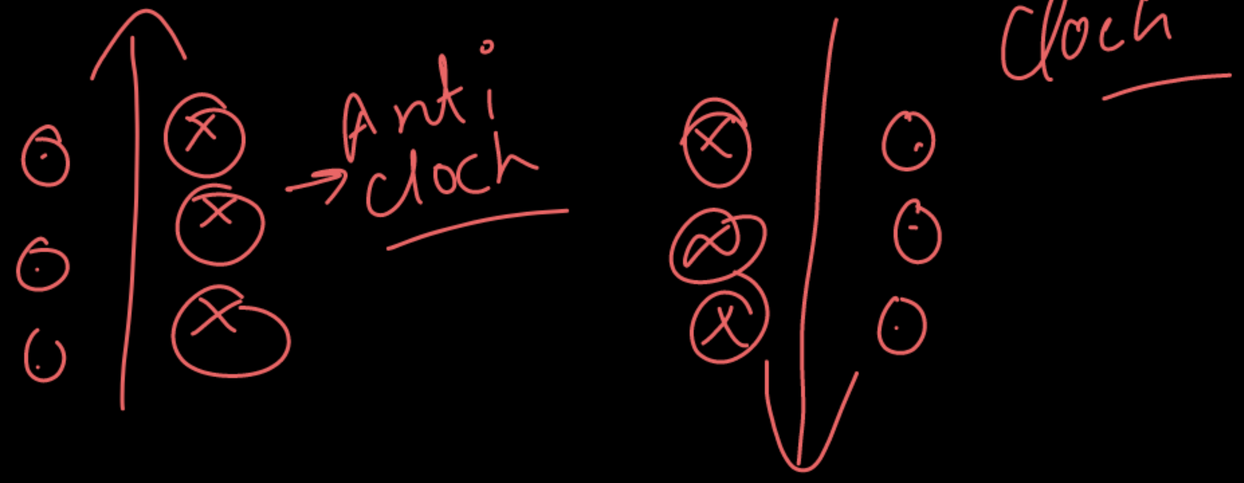
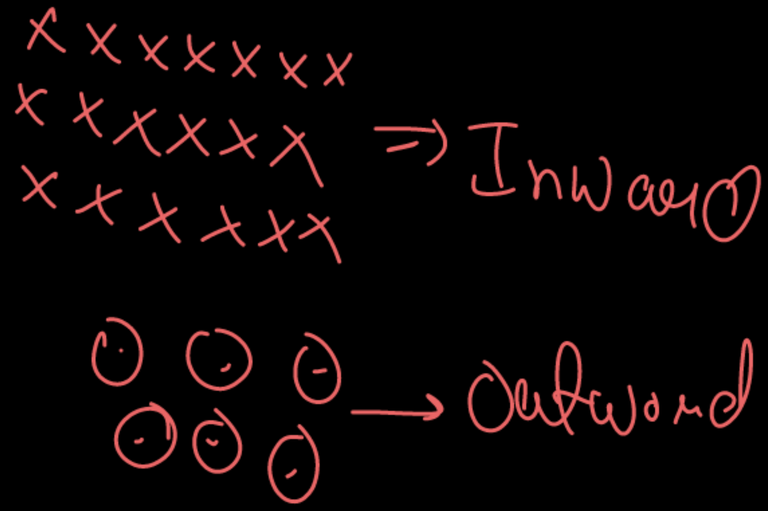
Imagine holding the current-carrying conductor in your right hand, with your thumb pointing in the direction of the current. The way your fingers curl gives the direction of the magnetic field around the conductor.






Anti
clock
clock


⇒ Inward
→ Outward

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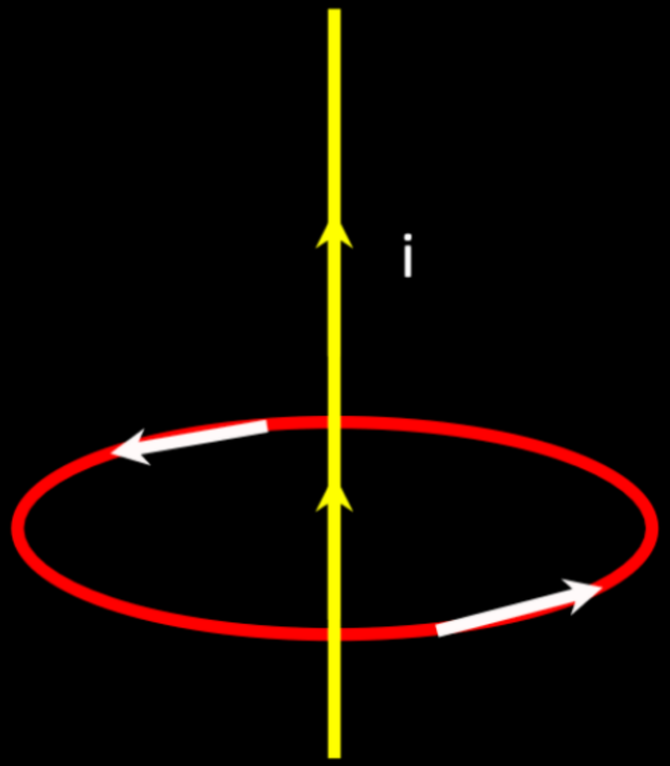
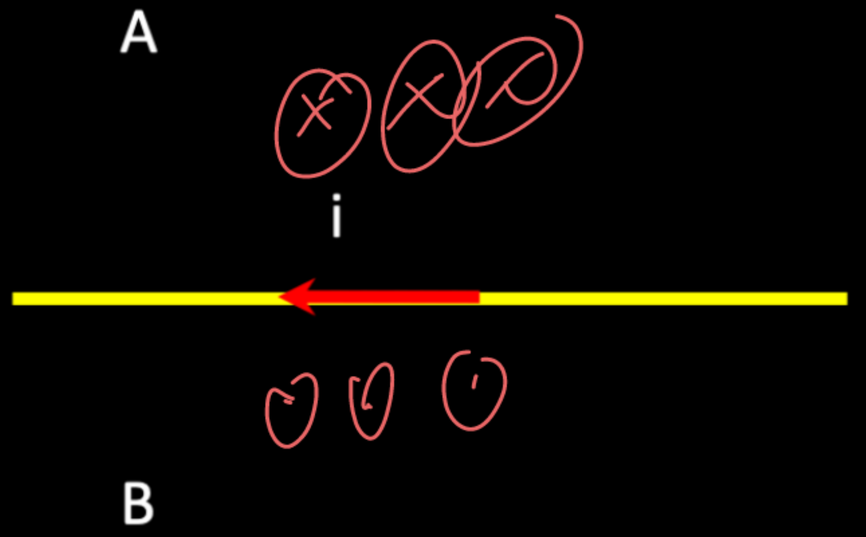
MAGNETIC FIELD LINES AROUND A STRAIGHT CONDUCTOR / MOVING CONDUCTOR





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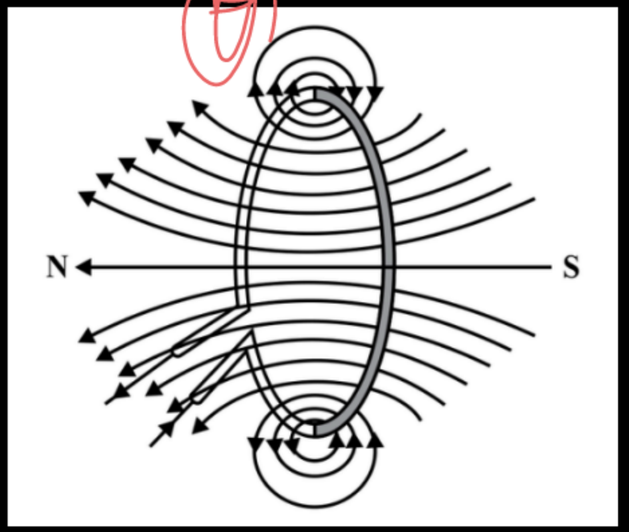
MAGNETIC FIELD DUE TO A CURRENT THROUGH A CIRCULAR LOOP

When an electric current flows through a circular loop, it produces a magnetic field around the loop. The field has unique characteristics due to its circular geometry.

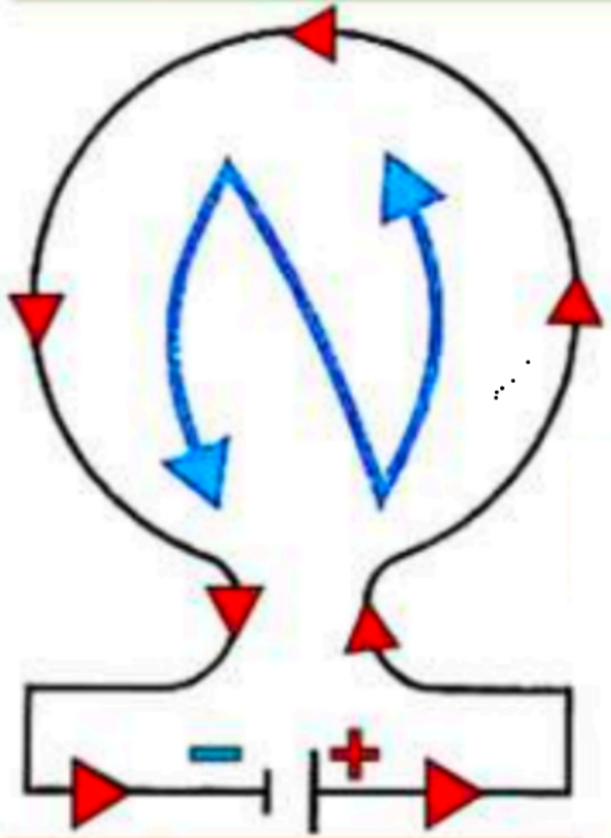
Shape of Magnetic Field Lines:

- The magnetic field lines near the wire are concentric circles.
- At the centre of the loop, the magnetic field lines are almost straight and uniform.

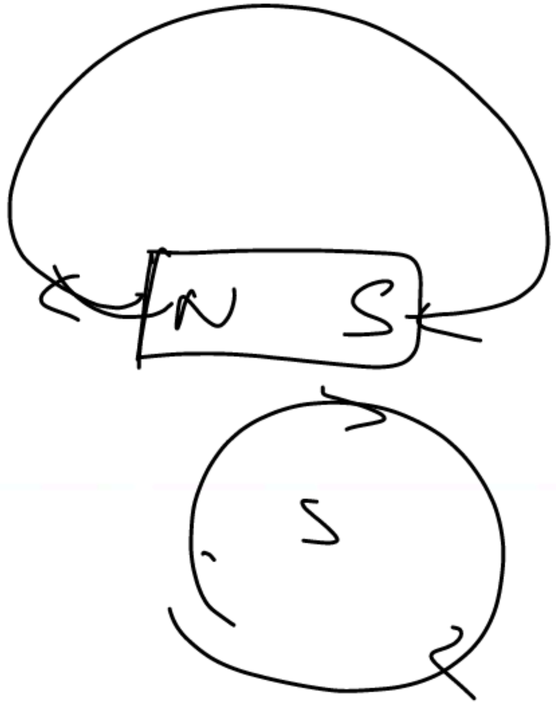



(Ulta kudo)

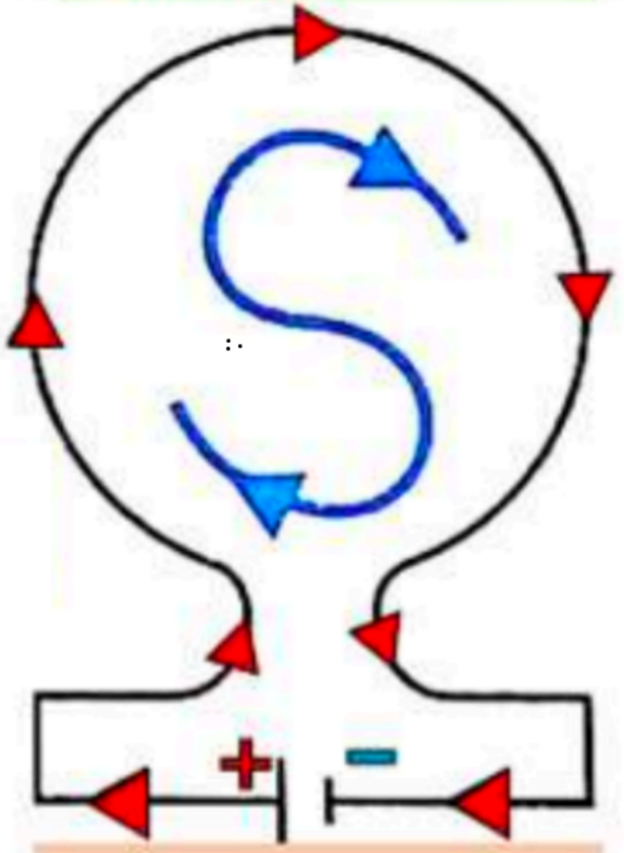
Anti-clockwise Current



North Magnetic Pole



Clockwise Current



South Magnetic Pole

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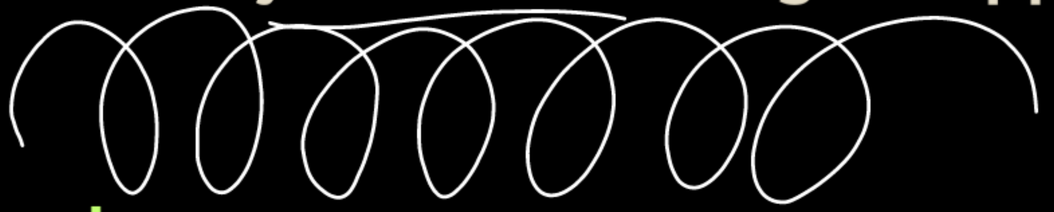
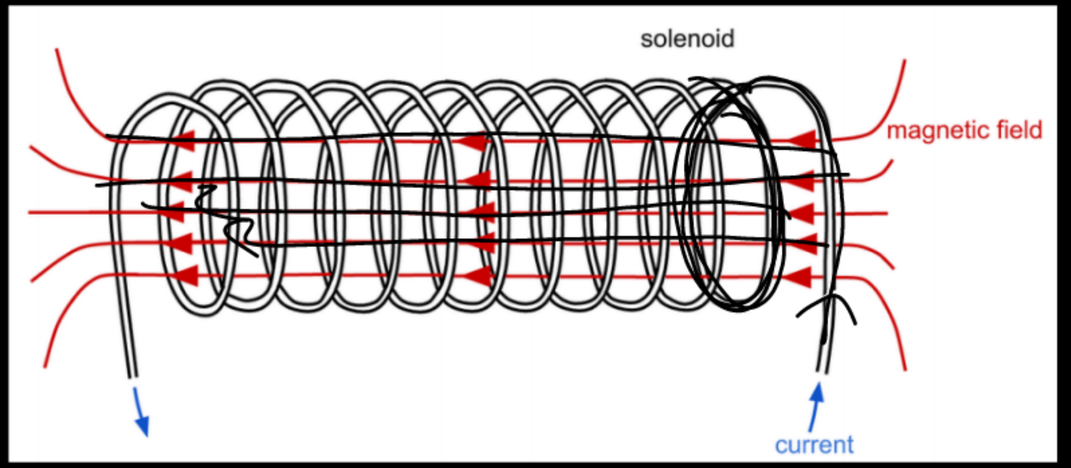
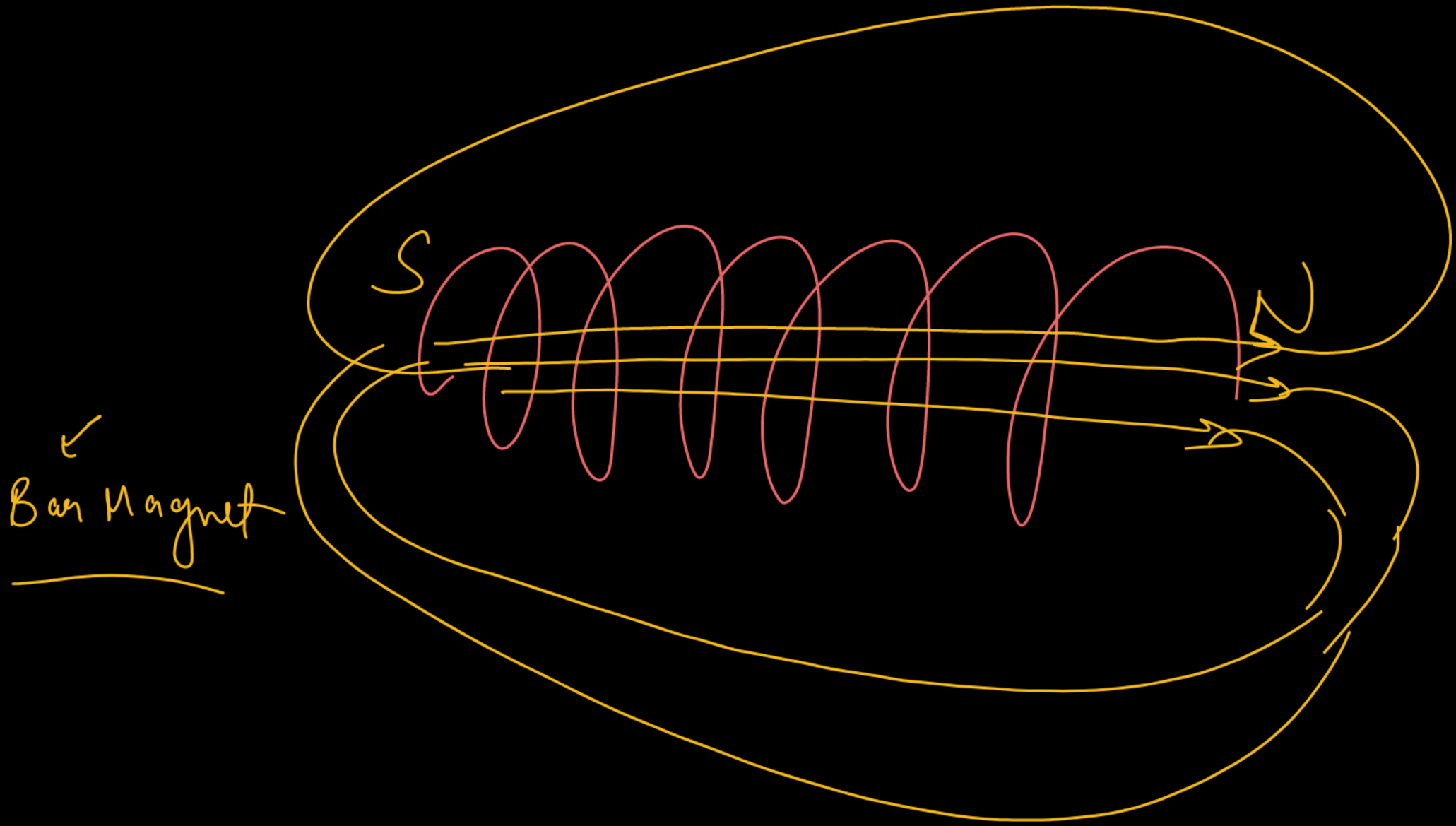
MAGNETIC FIELD DUE TO CURRENT IN A SOLENOID

Solenoid: A solenoid is a coil of many circular windings wrapped in the shape of a cylinder.



When current is passed through it, it behaves similarly to a bar magnet, producing a very similar field pattern as that of a bar magnet. To increase the strength, a soft iron core is used.




S
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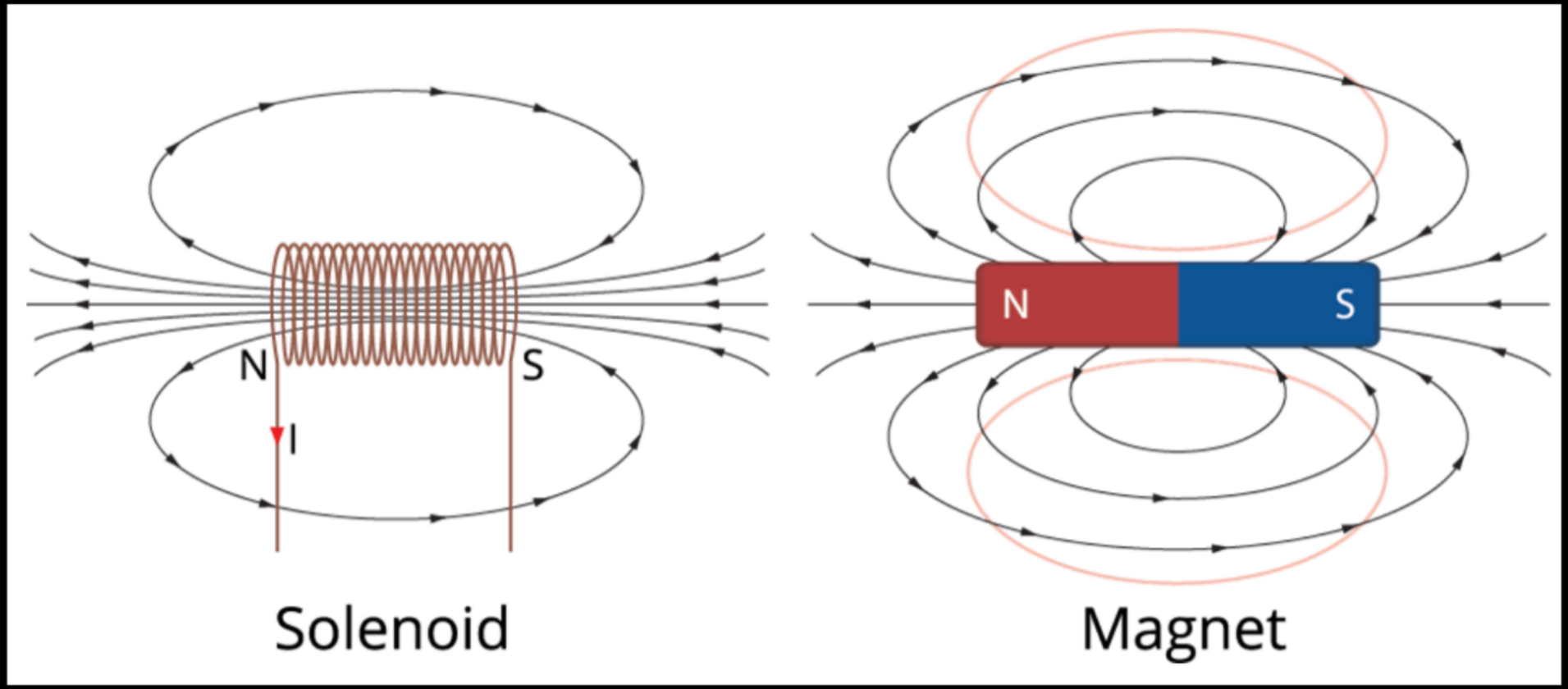
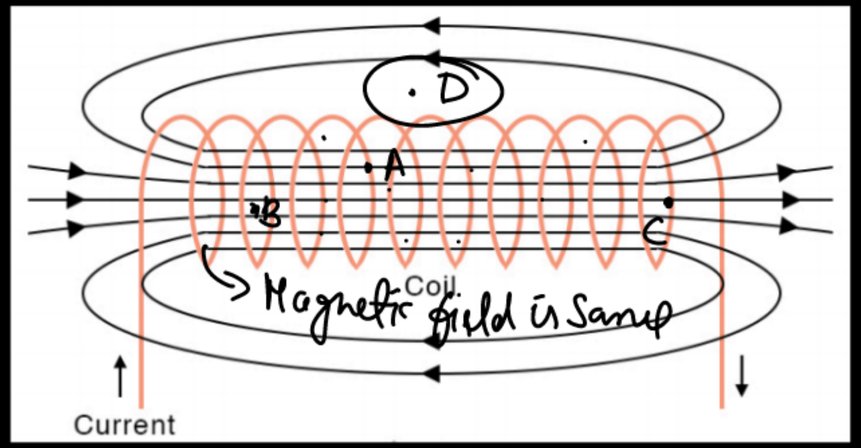
Bar Magnet



When Current is passed through a Solenoid,
it behaves like a bar magnet

Factors on which Magnetic Field of Solenoid depends:

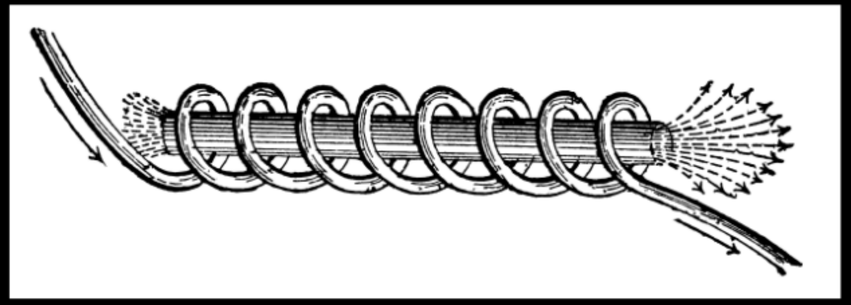
- **Number of turns per unit volume in the solenoid:** The more number of turns, the greater the magnetic field.
- **Strength of current in the solenoid:** The more current, the more the magnetic field.
- **Nature of Core Material Used Inside the Solenoid:** If we insert soft iron inside the solenoid, it produces the strongest magnetism.

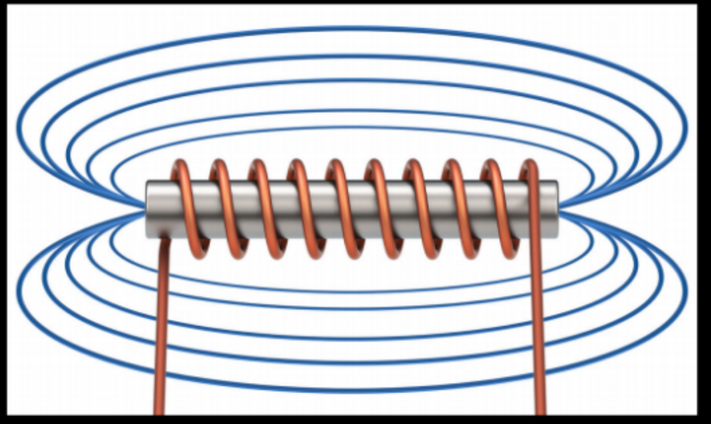


APPLICATIONS OF CURRENT-CARRYING SOLENOID

A solenoid is used as an electromagnet. → Temporary

A soft piece of iron is placed inside the solenoid. When an electric current is passed, a strong magnetic field is created. The iron becomes magnetic due to the strong magnetic field of the solenoid. The magnet so produced is called an electromagnet.





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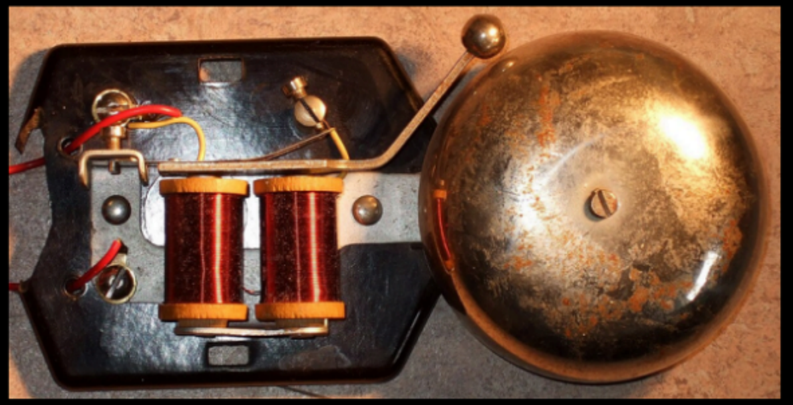
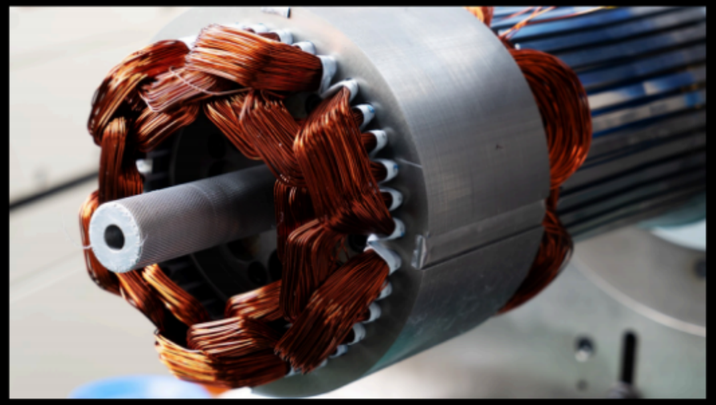
Electromagnets are Used in:

- Generators, motors, and transformers
- Electric buzzers and bells
- Headphones and loudspeakers
- MRI Machines
- Data storage devices like VCRs, tape recorders, hard discs, etc.





Electromagnet Vs Normal Magnet

↳ Current ↑ (strength)

↳ Polarity can be changed

↳ Temporary

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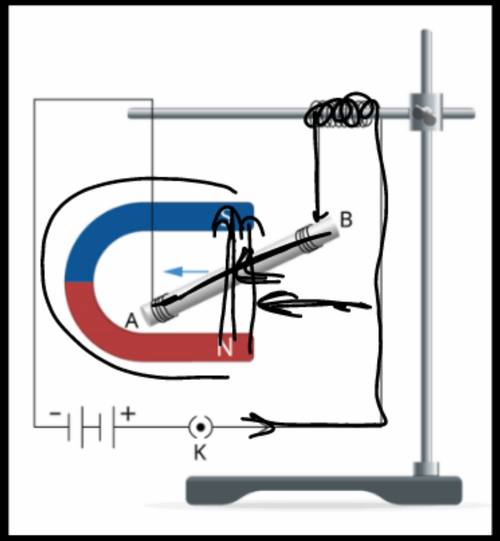
FORCE ON A CURRENT-CARRYING CONDUCTOR IN A MAGNETIC FIELD

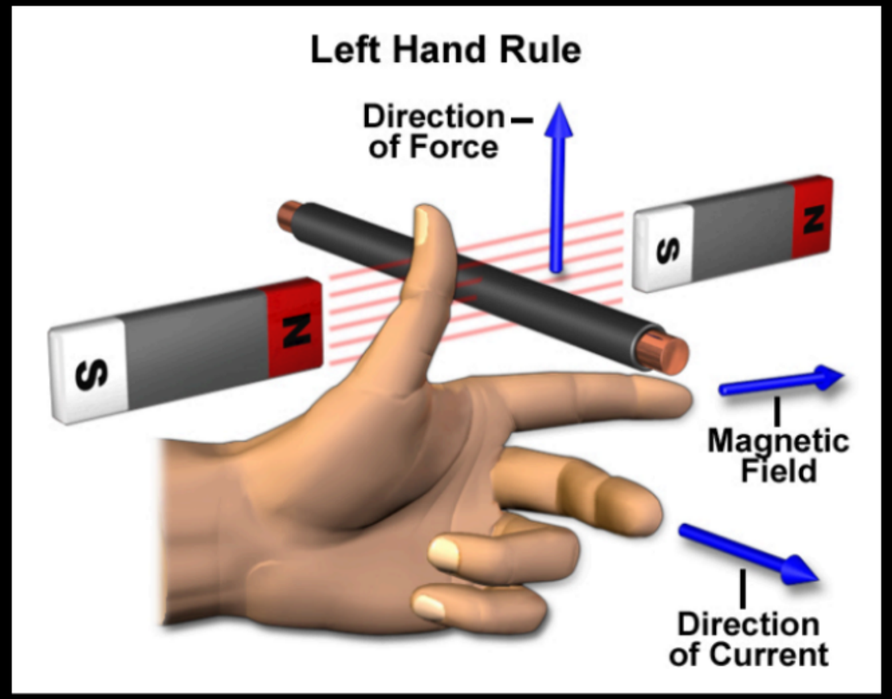
When a current-carrying conductor is placed in a magnetic field, the magnetic field exerts a force on the moving charges inside the conductor. This causes the conductor to experience a force.

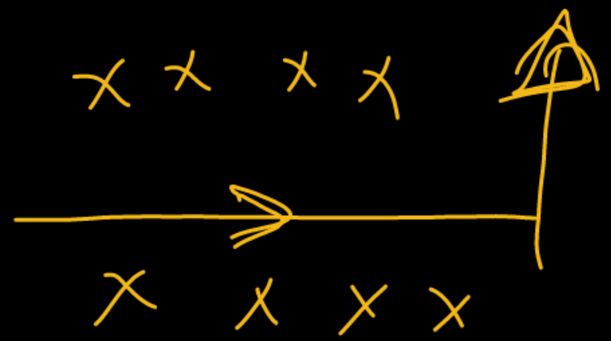


FLEMING'S LEFT HAND RULE

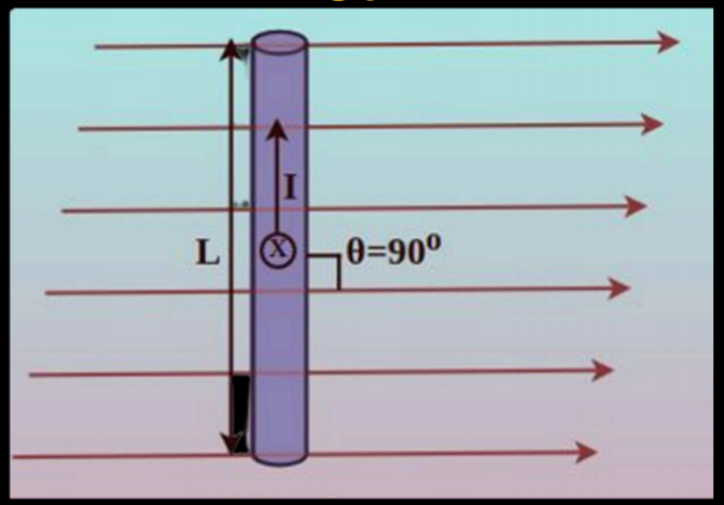
According to Fleming's Left-hand rule, the thumb, forefinger, and middle finger of the left hand are stretched perpendicular to each other.

- **Forefinger:** Points in the direction of the magnetic field (B).
- **Middle finger:** Points in the direction of the current (I) in the conductor.
- **Thumb:** Points in the direction of the force (F) or motion of the conductor.

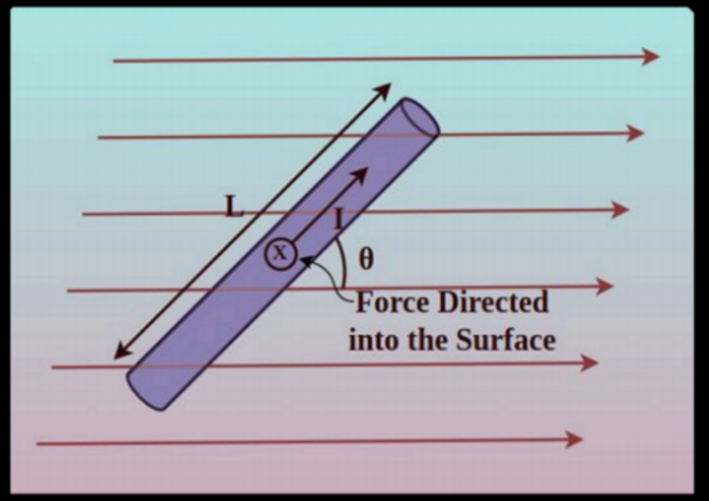




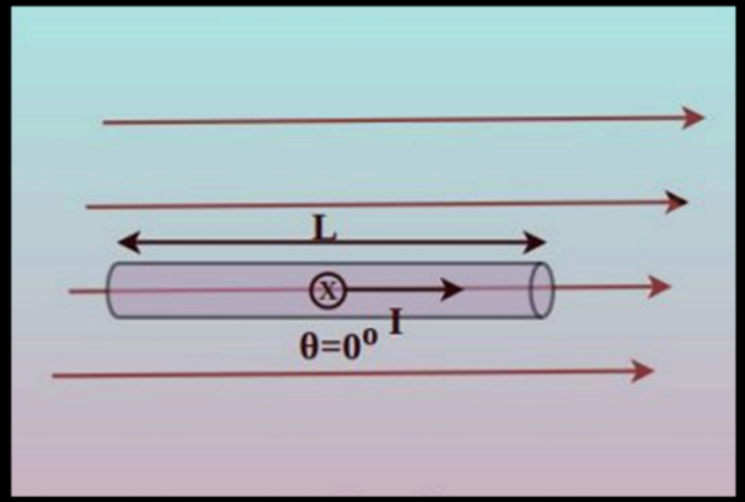
Variation in force due to the Change Orientation of Straight Conductor



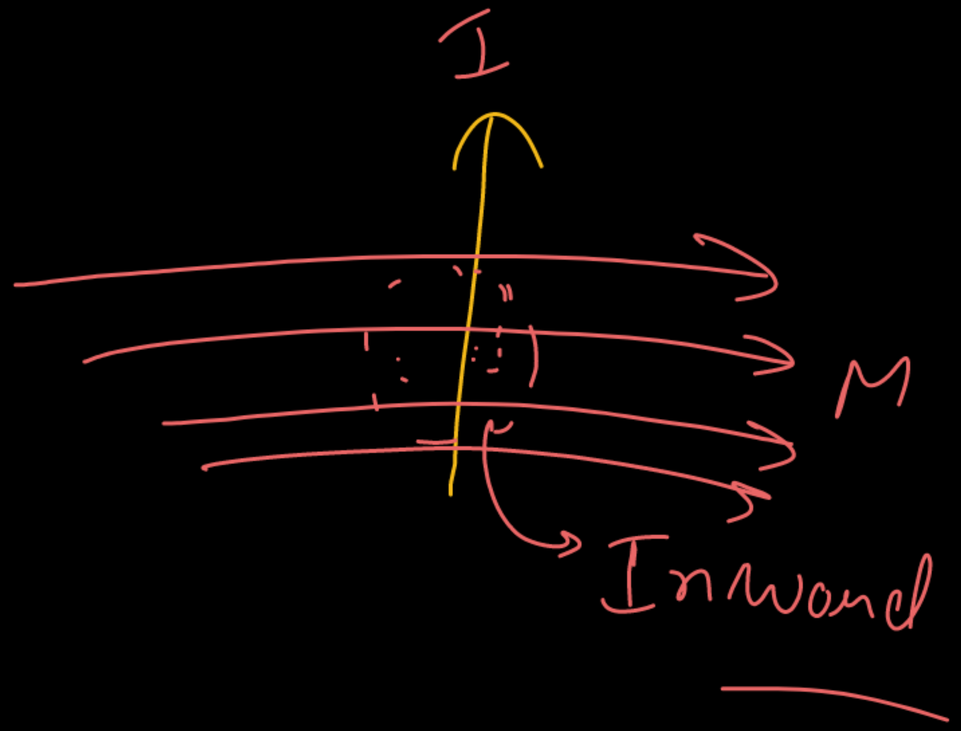
Wire at Right angle θ = 90°
Force = maximum



Wire at any acute angle
0 < Force < Maximum



Wire is parallel or non-parallel
θ = 0° or 180°
Force = 0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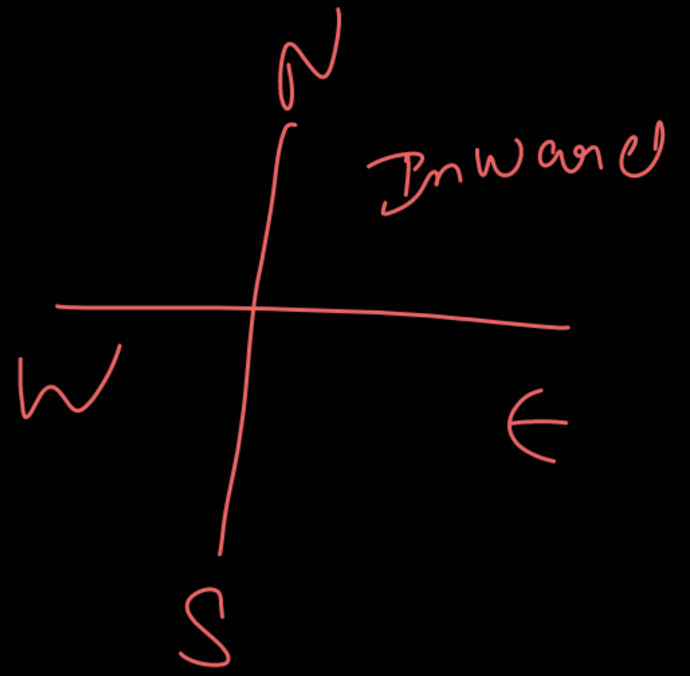
Inward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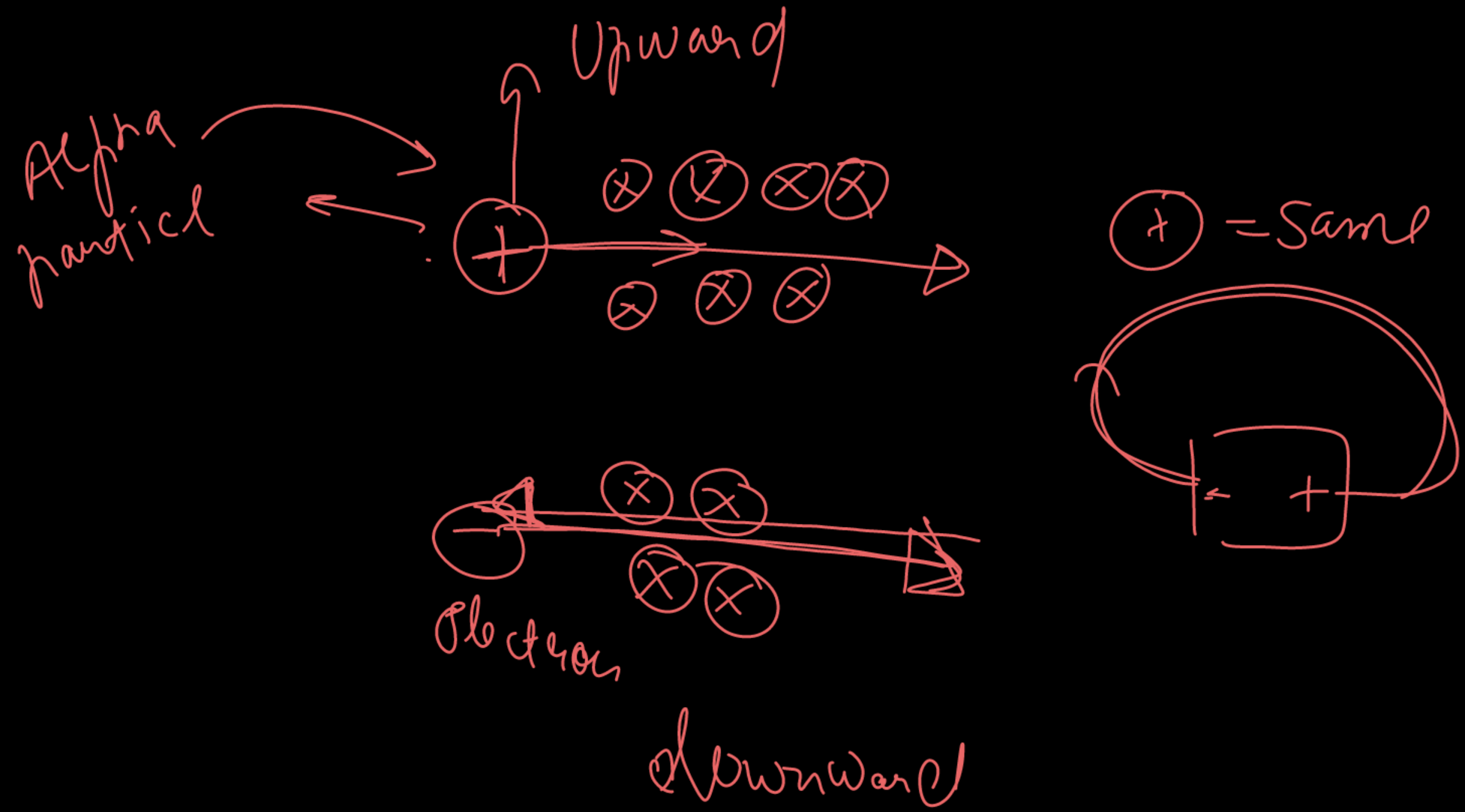
Upward
Alpha particle
= Same
Electron
downward

Abhay Premier League

Q.The pattern of the magnetic field produced inside a current carrying solenoid is:(2024)