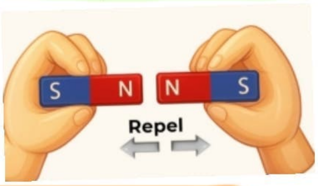
MAGNETIC EFFECTS OF ELECTRIC CURRENT

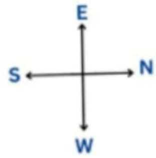
MAGNET:-

An object which attracts pieces of iron, nickel and cobalt.
Bar Magnet - Rectangular, permanent magnet with two poles.
Two poles of a magnet: North pole and south pole.
A freely suspended magnet rests in the north-south direction.

like poles → Repel



Unlike poles → Attract



MAGNETIC COMPASS :-

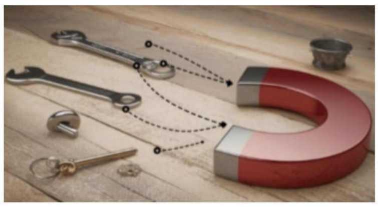
- A compass is a small magnet in shape of a needle.
- it detects the presence of a magnet or magnetic field.
- When a magnet or magnetic field is around it deflects.
- stronger the magnet / field, more is deflection.

When free, the ends of the compass needle point nearly towards north and south directions.
End pointing towards North —— North pole
End pointing towards south —— south pole

↗N
S

MAGNETIC FIELD (B) - MAGNET KA DABDABA

The space surrounding a magnet in which other magnets or magnetic materials feels a - force.
it is a Quantity that has both direction and magnitude.

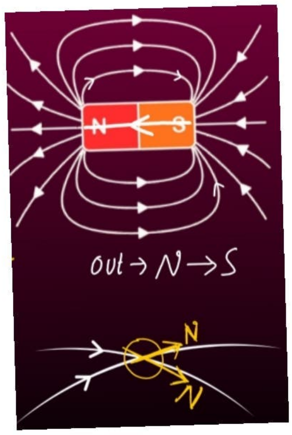


Direction of Magnetic field (B)

The path along which a free North pole moves
OR
Direction in which a North pole of compass Needle moves.

B → vector

MAGNETIC FIELD LINES



- Imaginary lines along which a free North pole or North pole of compass Needle moves.
- Gives the direction of Magnetic field at a point.

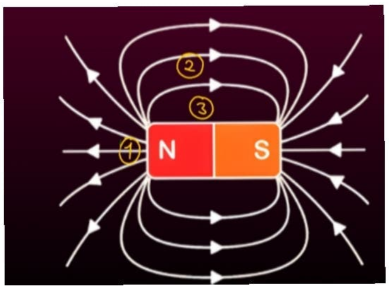
Properties of magnetic field lines

- Emerge from North pole and merge at south pole
- Outside Magnet N→S ; Inside Magnet S→N
- Magnetic field lines are closed curves.
- Two field lines cannot cross / intersect each other

  Because if they do, at the point of intersection, North poles of Magnetic needle will point towards two directions which is impossible.

MAGNITUDE OF MAGNETIC FIELD (B)

field lines closer (more crowded) → strong Magnetic field
field lines far (less crowded) → Weak Magnetic field



strong of Magnetic field (B)

① > ② > ③

for a bar Magnet — Field lines crowd

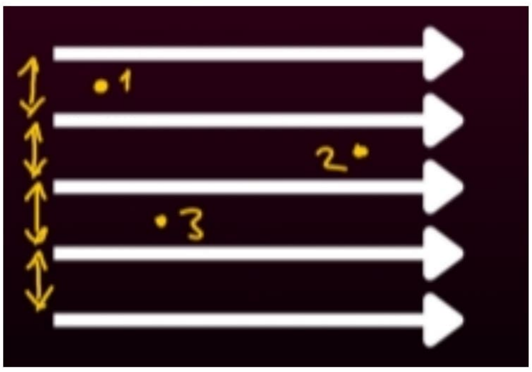
- Around the poles → B - strongest ↑
- far away → B - weak → lines separated

Uniform AND Non-Uniform Magnetic Field

Uniform Magnetic field

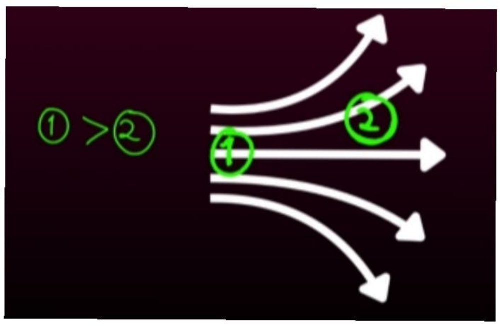
- field is same everywhere
- field lines are parallel
- field lines are at equal distance.

① = ② = ③

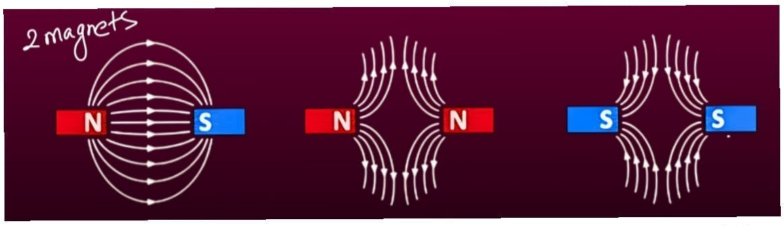


Non-Uniform Magnetic field

- field is different at different at different places
- field lines are not parallel
- field lines are at unequal distances



Magnetic field lines Due to Two bar Magnets



lines are dense between opposite poles ⟶ Attraction between opposite poles

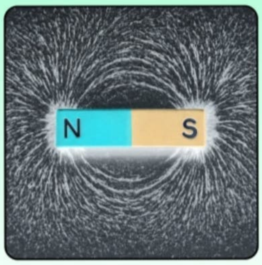
lines are repelling from two same poles ⟶ Repulsion between same poles.

Activity 12.2 - Field lines By Iron Filings

⟶ Chooran

Steps:
1. Place a bar magnet on a white paper & Sprinkle iron filings evenly around it
2. Tap the board gently and observe the pattern formed.

Observation:
- Iron filings arrange themselves in curved lines around the magnet.
- The lines are dense near the poles and spread out in the middle.

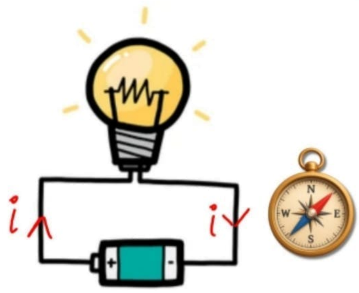


Conclusion:
- Iron filings show magnetic field lines.
- The field is strongest at the poles

OERSTED DISCOVERY – MAGNETIC EFFECT OF CURRENT

A compass Needle Deflects When placed near a current carrying wire.

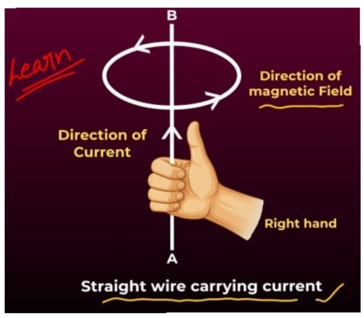
current carrying wire produces Magnetic field. ↑i

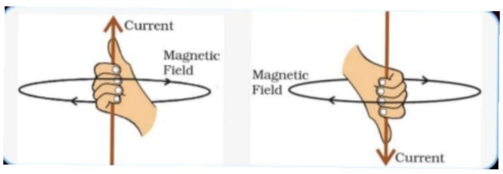


MAXWELL's RIGHT HAND THUMB RULE

Finding the direction of Magnetic field

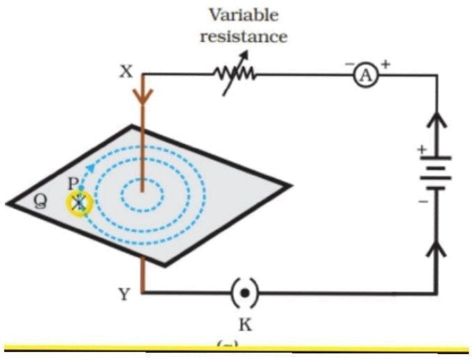
Hold a current – carrying wire in your right hand. keep your thumb pointing in the direction of current.
The direction in which your fingers wraps (curl) around the wire gives the direction of magnetic field lines. CBSE





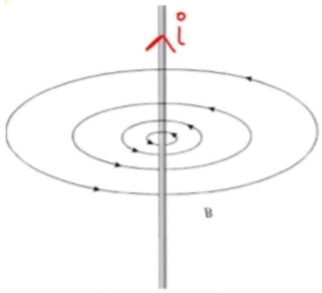
MAGNETIC FIELD DUE TO A CURRENT THROUGH A STRAIGHT CONDUCTOR

(1) A straight current-carrying wire passes perpendicularly through a white cardboard sheet. iron fillings are spread evenly on the cardboard.
(2) On gently tapping, the fillings from Concentric Circles around the wire, showing magnetic field lines.



factors on which magnetic field Due to straight wire depends

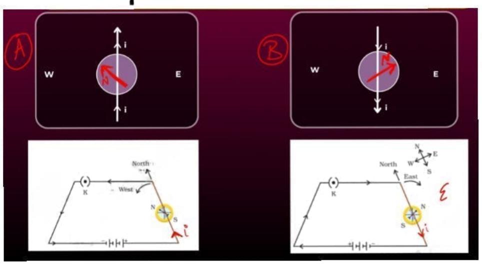
1. current (i) ⟶ Current increases ⟶ stronger Magnetic field ⟶ Direction increases
2. distance (d) ⟶ Distance increases ⟶ Weaker Magnetic field ⟶ Deflection decrease.
3. Reverse the direction of current ⟶ Direction of Magnetic field Reverse.

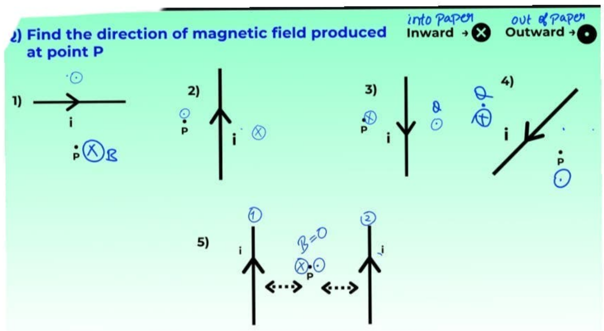


Note :– field Is inversaly proportions to distance from wire.
closeness of lines decreases as we move away from wire

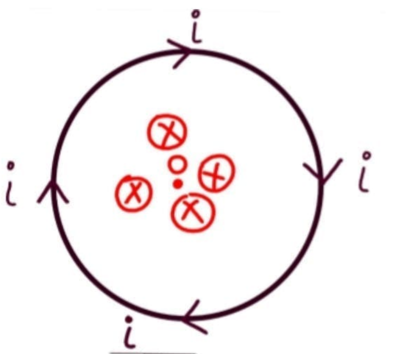
Activity 12.4

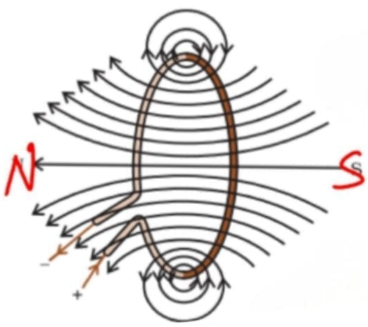
current wire placed over compass

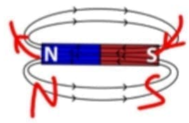




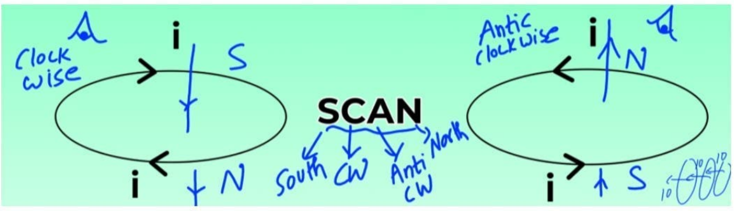
Magnetic field due to a current through a circular loop



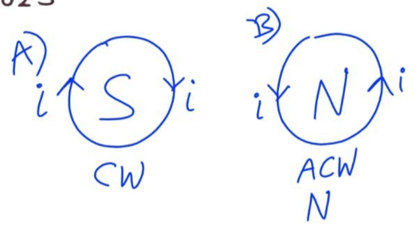




1. At every point on a current-carrying circular loop, the magnetic field lines from concentric circles around the wire.
2. Each small part of the wire produces a magnetic field at the center in same direction. This makes a strong magnetic field at the center.

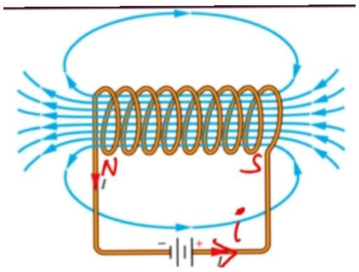


If the wire is coiled in many turns (n turns), the total magnetic field also becomes 'n' times stronger than that of a single loop. This happens because the current in each circular turn has the same direction and the magnetic field due to each turn adds up. CBSE 2023

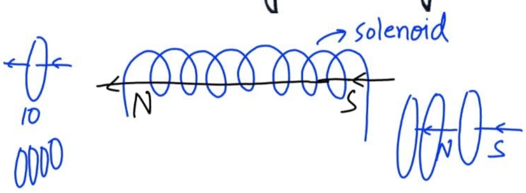


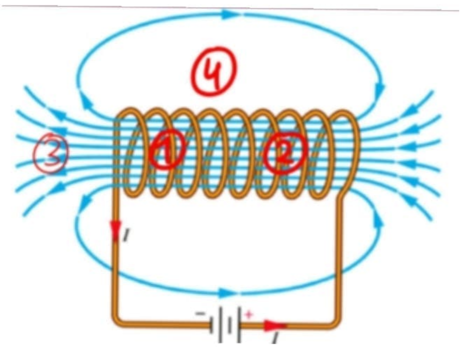
MAGNETIC FIELD LINES DUE TO A SOLENOID

A coil of many circular turns of insulated copper wire wrapped closely in the shape of a cylinder is called a solenoid. CBSE 2023



1. Magnetic field lines due to a solenoid is similar to those of a bar magnet.
   out → N → S   Inside → S → N
2. field lines inside the lines → uniform magnetic field → magnetic field is the same at all points inside the solenoid.
3. it's polarity can be reversed by reversing current direction.



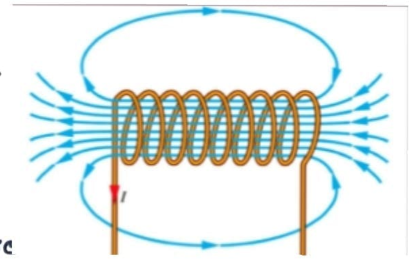


Strength of Magnetic field

① = ② > 3 > 4
inside

STRENGTH OF MAGNETIC FIELD DUE TO A SOLENOID DEPENDS ON

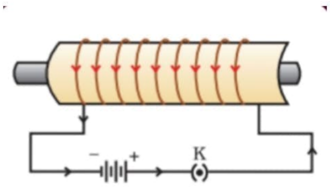
1. Number of turns :- larger the number of turns → stronger than magnetic field.
2. Current:- larger the current → stronger the magnetic field
3. length of air gap :- lesser gap → more turns → more magnetic field.
4. Nature of core :- The use of soft iron rod as core in a solenoid produces the stronger magnetic field.



ELECTROMAGNET

A long coil of insulated wire wrapped around a soft iron core forms an electromagnet.

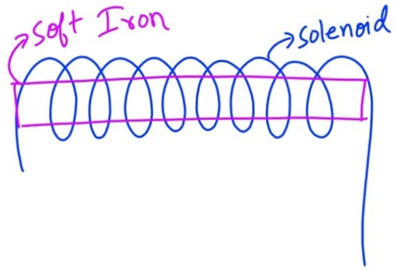
1) Electromagnet is a temporary magnet.
2) current magnetise soft iron core temporarly.
3) it's polarity can be reversed.



Simple Electromagnet

strength of an electromagnet

(1) Number of turns : larger the number of turns → stronger the magnetic field
(2) current : larger the current → stronger the magnetic field.
(3) length of airgap : lesser gap → more turns → more magnetic field.



$B = 20$

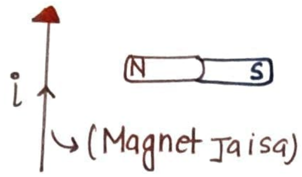
$B = 50$

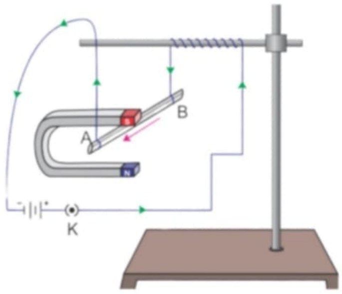
Total $B = 70$

PROPERTIES	BAR MAGNET	SOLENOID	ELECTROMAGNET
Definition	A permanent magnet with fixed poles	A coil of wire wound in a cylindrical shape	A solenoid with a soft iron core
Source of Magnetism	Natural magnetic properties of the material	Electric current flowing through the wire	Electric current and soft iron core
Magnetic Field	Permanent and fixed	Temporary, exists only when current flows	Temporary but stronger than solenoid
Polarity	Fixed, cannot be changed	Can be reversed by changing current direction	Can be reversed by changing current direction

Force (F) on current-carrying conductor placed in a magnetic field

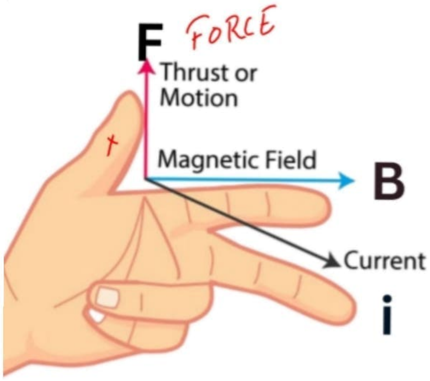
When a current-carrying conductor is placed in a magnetic field, a force is exerted on the conductor which can make the conductor move.





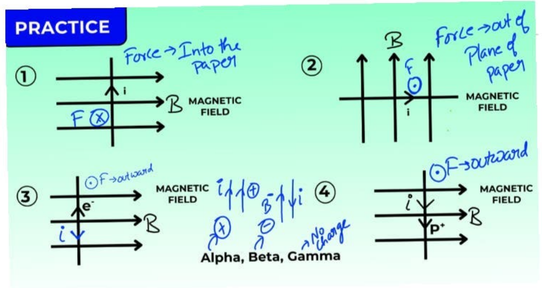
Fleming's left-Hand Rule

For the Direction of force



According to fleming's left hand Rule - stretch your left hand so that your thumb, fore finger, and middle finger are at right angles (90°) to each other

- point your fore finger in the direction of the magnetic field (B)
- point your middle finger in the direction of the current (I).
- Then your thumb will show the direction of the force (motion) on the wire.



factors on which force on current wire depends

current (i) ↑ force ↑

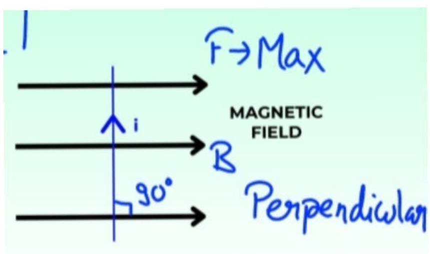
$F = iBl$

$= Bil$

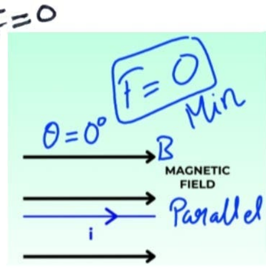
Magnetic Field (B) ↑ force ↑

length (l) ↑ force ↑

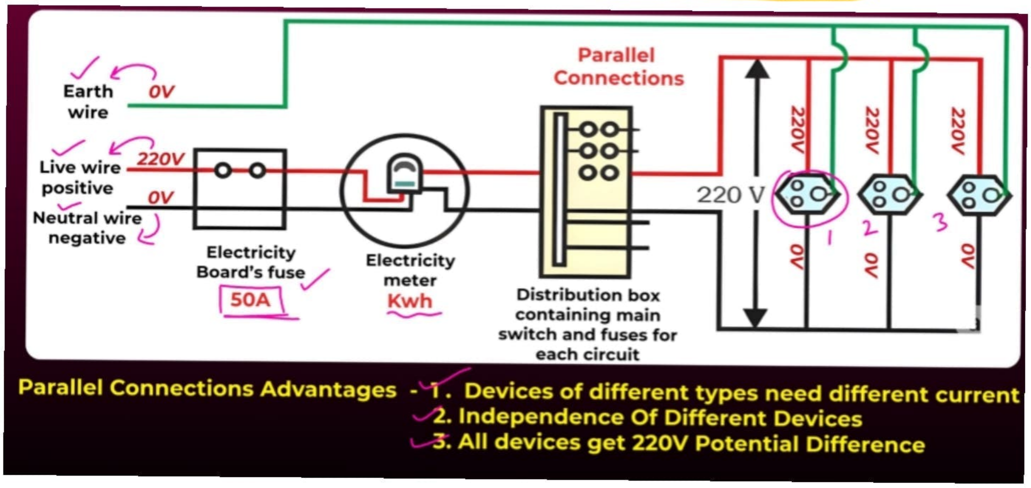
Angle



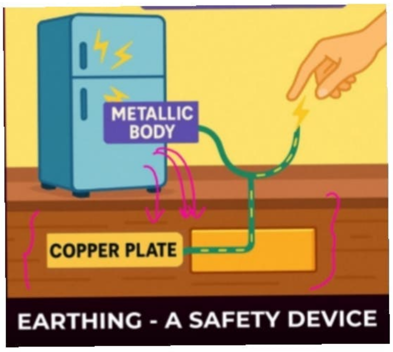
F = 0



Domestic Electric circuits (or Domestic wiring)



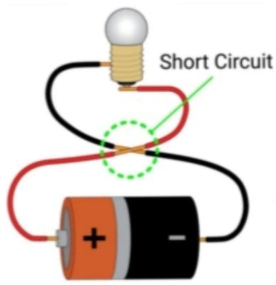
Earthing of electrical appliances



Earthing is used as safety device -
for appliances that have a metallic body, like electric press, toaster, table, fan refrigerator, etc.
The metallic body is connected to the earth wire if there is any leakage of current to metallic body of appliance due to poor insulation of wire, Earth wire gives a low resistance path to current and a huge current flows from metal body to ground.
Due to this huge current flow, fuse blows off and supply is cut off.
This prevents anyone who is touching the appliance from an electric shock and protects.
damage to appliances.

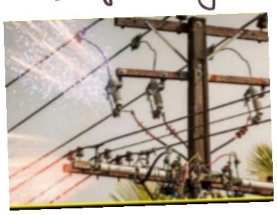
Overloading - Excess current

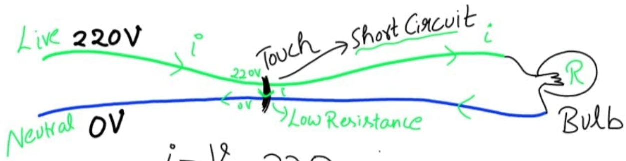
When an electrical circuit has more current than it can safely handle, it is called Overloading. overloading can occur due to -
shortcircuit - when the live wire and the neutral wire comes in direct (if insulation of wires is damaged), a high current flows and this is called short circuit.



2. Too many appliances connected to a single socket

3. sudden hike in supply voltage $V = Ri$ $\uparrow i = \frac{V\uparrow}{P}$





ex $i = \frac{V}{R} = \frac{220}{0.001\Omega} = 220\,000A$

Heat $H = i^2Rt$ Joule's Low

Heat ↑ ⇒ Fire

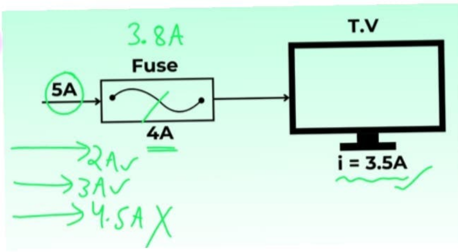
fuse- Safety Device :-

Electrical fuse is used to prevent overloading (short circuit mostly) fuse has low melting point so when high current passes through, it melts due to heat produced given by Joule's law ($H = i^2Rt$) and stop the flow of current. fuse wire is connected in series with the appliance.

fuse wire is connected in series with the appliance.

fuse wire Is made from alloy of :

- Copper (Cu) and Tin (Sn) or
- lead (Pb) and Tin (Sn)



fuse wire has –

- low meltings points
- High Resistance

A 15A Fuse (fuse Rating) – heavy appliances like irons geysers, and toasters.
A 5A fuse - bulbs, fans, telivision, etc


IRON


TOASTER


GEYSERS