Thursday

Page No. | Date

MAGNETIC EFFECTS OF ELECTRIC CURRENT

MAGNETIC FIELD

>>> The space around a magnet in which its effect can be experienced or its force can be detected is called magnetic field.

>>> Magnetic field is a vector quantity.
>>> Its SI unit is tesla. (T)

PROPERTIES OF MAGNETIC FIELD LINES

(i) They originate from North Pole of a magnet and end at its South Pole.
[N → S]
[outside = N → S
inside = S → N]

(ii) These lines are closed and continuous curves.

(iii) They are crowded near the poles, where the magnetic field is strong and separated far from the poles, where magnetic field is weak.

(iv) Close lines = more strength

Page No.
Date

(iv) Field lines never intersect with each other. If they do, that would mean that there are two directions of the magnetic field at the point of intersection, which is impossible.

MAGNETIC FIELD DUE TO CURRENT THROUGH A STRAIGHT CONDUCTOR

>>> The magnetic field lines around a current carrying straight conductor are concentric circles, whose centers lie on the wire.

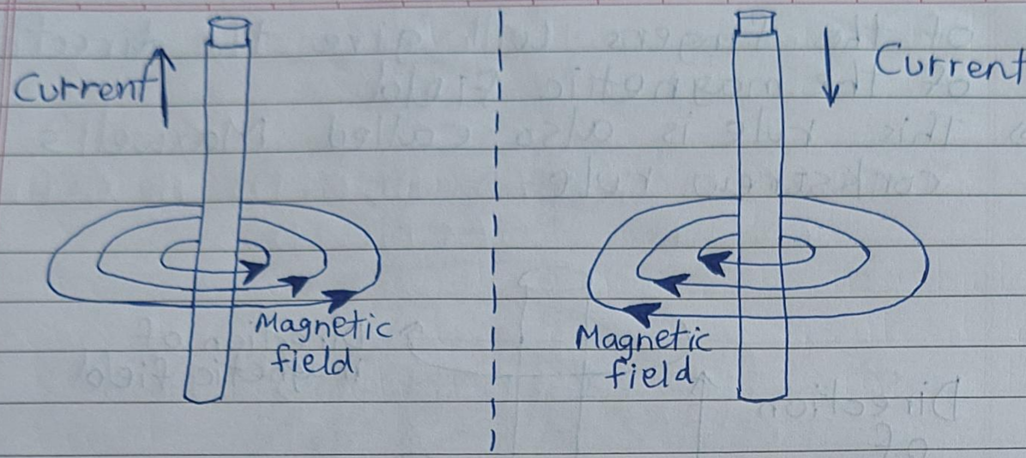
>>> The magnitude of magnetic field 'B' produced by a straight current carrying wire at a given point is :

(i) Directly proportional to the current I passing through the wire,

$$B \propto I$$

If current is increased, then the magnetic field produced is stronger and vice-versa.

$I\uparrow \sim B\uparrow$ & $I\downarrow \sim B\downarrow$



(ii) Inversely proportional to the distance from the current carrying conductor.

Magnetic field is stronger at a point which is nearer to the conductor and goes on decreasing on moving away from the conductor

$$B \propto \frac{1}{r}$$

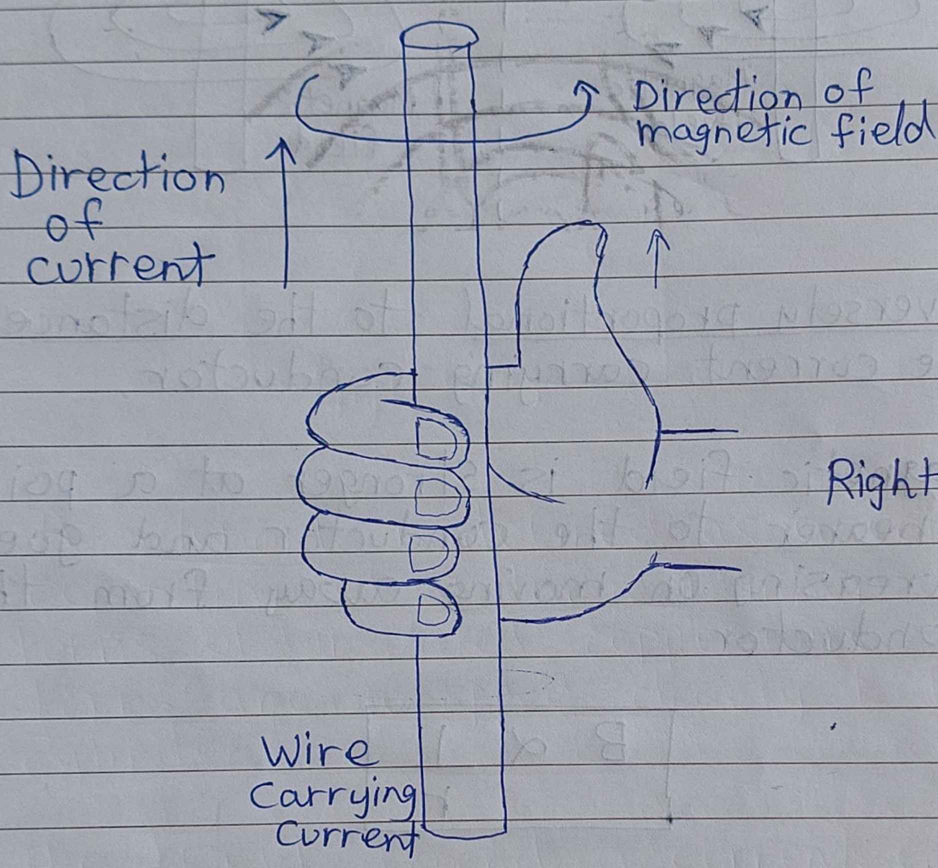
If distance is increased, then the magnetic field produced is weaker and vice-versa

$r \uparrow \rightarrow B \downarrow$ & $r \downarrow \rightarrow B \uparrow$

MAXWELL'S RIGHT HAND THUMB RULE

→ It states that if you hold the current carrying straight wire in the grip of your right hand in such a way that the stretched thumb points in the direction of current, then the direction of the curl of the fingers will give the direction of the magnetic field.

- This rule is also called Maxwell's corkscrew rule.

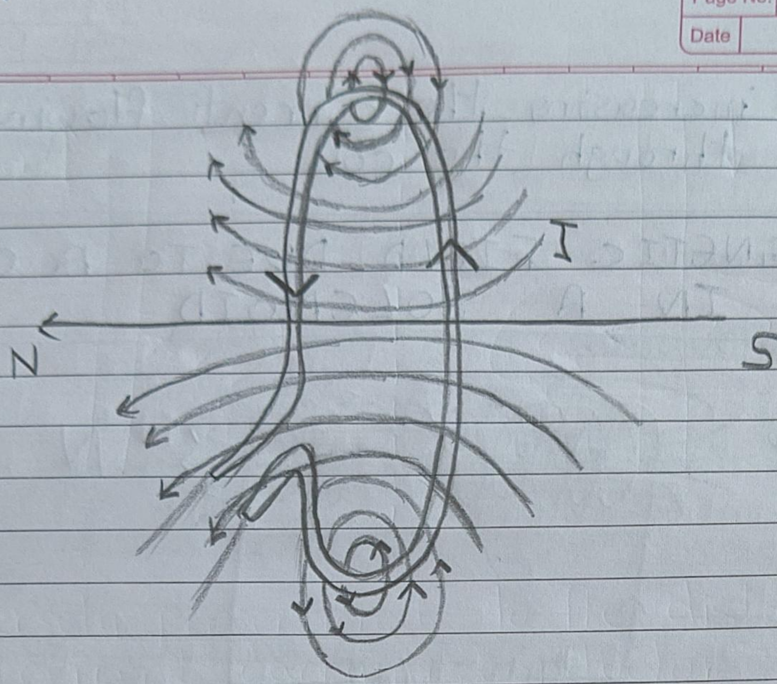


MAGNETIC FIELD DUE TO A CURRENT THROUGH A CIRCULAR LOOP

- At every point on a current carrying circular loop, the magnetic field is in the form of concentric circles around it. As we move away from it, the circles would become larger and larger.

- When we reach the centre of loop, the field appears to be a straight line.

Anti clockwise - North
Clockwise - South



» The magnetic field produced by current carrying circular wire at a given point is :

(i) Directly proportional to the amount of current passing through it
[$B \propto I$]

(ii) Directly proportional to the number of turns (N) of wire
[$B \propto N$]

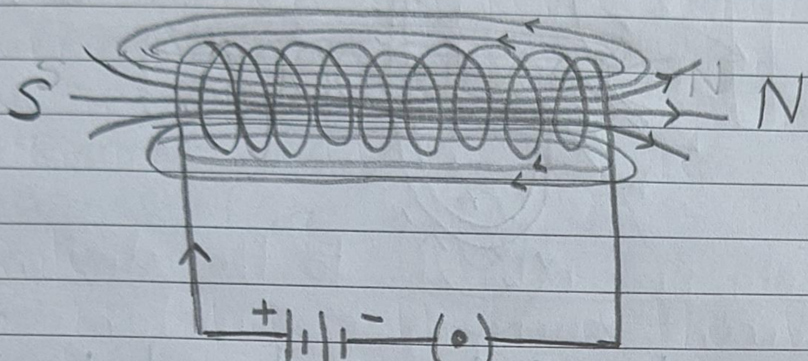
- This is because the current in each turn is in the same direction and therefore, the field due to these turns get added up.

Thus, the strength of magnetic field produced by a current carrying circular coil can be increased by :

(a) increasing the number of turns of the coil

(b) increasing the current flowing through the coil

MAGNETIC FIELD DUE TO A CURRENT IN A SOLENOID



>>> A Solenoid is defined as a coil consisting of a large number of circular turns of insulated copper wire. These turns are wrapped closely to form a cylinder.

>>> The field around a current carrying solenoid are similar to that produced by a bar magnet.

>>> This means that a current carrying solenoid behaves as if it has North pole and South pole.

>>> The field lines inside the solenoid are parallel to each other.

>>> Thus, the strength of magnetic field is the same, i.e. uniform at all

inside a solenoid.

FORCE ON A CURRENT CARRYING CONDUCTOR

>>> When a current carrying conductor is placed in a magnetic field, it experiences a force except when it is placed parallel to the magnetic field.
[$\parallel$ - no force, $\perp 90^\circ$ - most force, $0 \leq \theta < 90$ - force accordin

>>> The force acting on a current carrying in a magnetic field is due to interaction between magnetic field produced by the current carrying conductor and external magnetic field in which the conductor is placed.

>>> The direction of force on the conductor depends on :

(i) <u>Direction of current</u> : The direction of force on the conductor can be reserved by reversing the direction of current.

(ii) <u>Direction of magnetic field</u> : The direction of force on the conductor can be reversed by reversing the direction of magnetic field by interchanging the position of poles.

Force on the conductor is maximum when

the direction of current is at right angles to the direction of magnetic field.

FLEMING'S LEFT HAND RULE

››› The direction of force which acts on a current carrying conductor placed in a magnetic field is given by Fleming's left-hand rule.

››› Rule:

- It states that, if the forefinger, thumb and middle-finger of left hand are stretched mutually perpendicular to each other, such that the forefinger points along the direction of external magnetic field, middle finger indicates the direction of current, then the thumb points towards the direction of force acting on the conductor.