MAGNETIC FIELD DUE TO A CURRENT CARRYING CONDUCTOR

Magnetic Field due to a Current through a Straight Conductor

1. A current carrying straight conductor behaves as a **magnet**. The direction of the magnetic field is given by the **Right-Hand Thumb Rule**. The following will be observed for a current carrying straight conductor:

   (i) The strength of the **magnetic field increases** as we move towards the straight conductor carrying current. If you bring a compass from the outside towards the conductors, the deflection in the compass increases indicating increase in magnetic field.

   (ii) If the **current is increased** in the conductor, then the **magnetic field also increases**. This is seen in the compass where the deflection increases when current is increased.

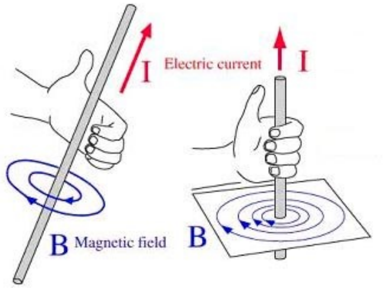
   (iii) The magnetic field produced by a given current in the conductor **decreases as the distance from the conductor increases**.

   (iv) When the **direction of the current is reversed**, the **magnetic field produced** in the conductor is **also reversed**.

Right–Hand Thumb Rule

2. A convenient way of finding the direction of magnetic field associated with a current-carrying conductor is by Right Hand Thumb Rule. The Rule States–

"If you are holding a current–carrying straight conductor in your right hand such that the thumb points towards the direction of current. Then your fingers will wrap around the conductor in the direction of the field lines of the magnetic field. This is known as the right–hand thumb rule*."



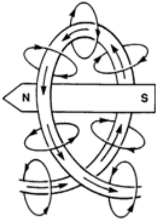
MAGNETIC FIELD DUE TO A CURRENT CARRYING CONDUCTOR

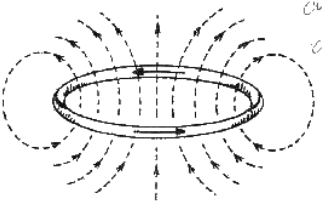
Magnetic Field due to a Current through a Circular Loop

3. A straight wire is **bent in the form of a circular loop** and a current is passed through it.

   (i) At every point of a current-carrying circular loop, **the concentric circles representing the magnetic field** around it would **become larger and larger as we move away from** the wire. By the time we reach at the centre of the circular loop, the arcs of these big circles would appear as straight lines.

   (ii) **Every point** on the wire carrying current would **give rise to the magnetic field** appearing as straight lines at the centre of the loop.

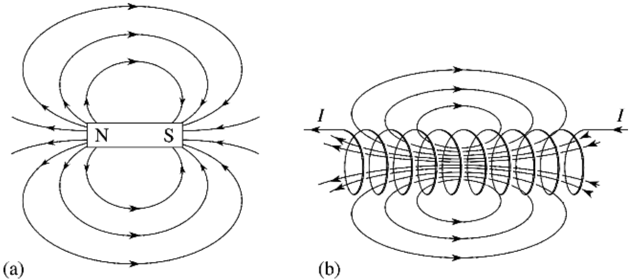




(iii) By applying the right-hand thumb rule, it is easy to check that **every section of the wire contributes to the magnetic field** lines in the same direction within the loop.

(iv) Magnetic field produced by a current-carrying wire loop at a given point depends directly on the current passing through it. Therefore, **if there is a circular coil having n turns, the field produced is 'n' times as large as that produced by a single turn**. This is because the current in each circular turn has the same direction, and the **field due to each turn then just adds up**.

(i) A coil of many circular turns of insulated copper wire wrapped closely in the shape of a cylinder is called a **solenoid**. One **end of the solenoid behaves as a magnetic north pole**, while the **other behaves as the south pole**. The field lines inside the solenoid are in the form of parallel straight lines. This indicates that the magnetic field is the same at all points inside the solenoid. The magnetic field is uniform inside the solenoid.



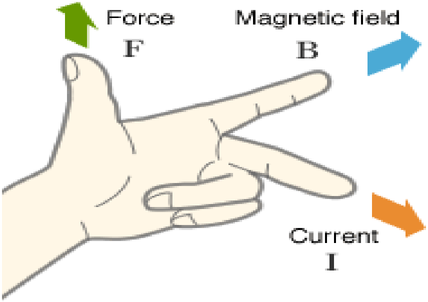
(ii) How to know which side is north pole and which is south pole see figure (b)(↑)

4. A strong magnetic field produced inside a solenoid can be used to magnetise a piece of magnetic material, like soft iron, when placed inside the coil. The magnet so formed is called an **electromagnet**.

Force on A Current-Carrying Conductor in A Magnetic Field

5. French scientist Andre Marie Ampere (1775–1836) suggested that the **magnet** must also exert an equal and opposite force when brought **near the current-carrying conductor**. A current carrying conductor has **three components**- (i) direction of current; (ii) direction of magnetic field; and (iii) direction of force due to magnetic field.

6. The three components can be illustrated through a simple rule, called **Fleming's left-hand rule**.



Fleming's left-hand rule: Stretch the thumb, forefinger and middle finger of your left hand such that they are mutually perpendicular. If the first finger points in the direction of magnetic field and the second finger in the direction of current, then the thumb will point in the direction of motion or the force acting on the conductor.

7. Devices that use current-carrying conductors and magnetic fields include electric motor, electric generator, loudspeakers, microphones and measuring instruments.