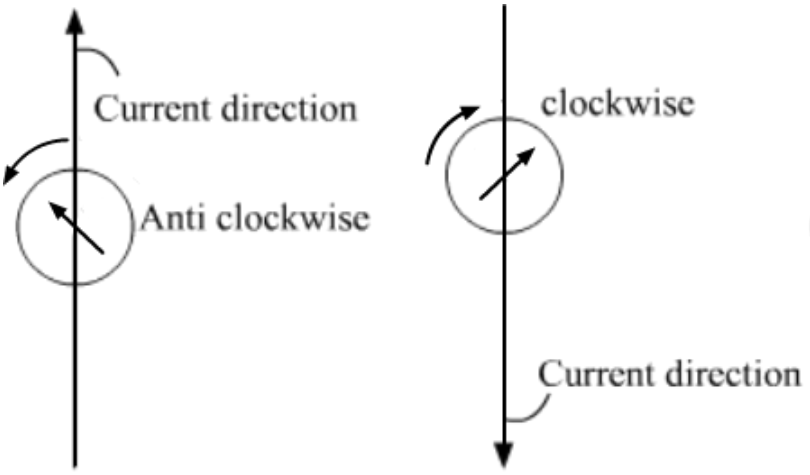
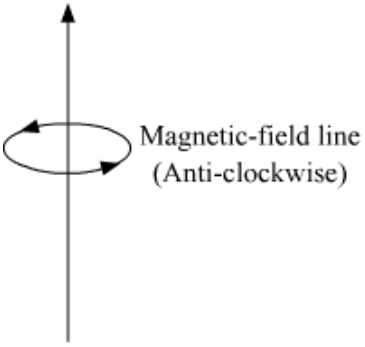
Magnetism

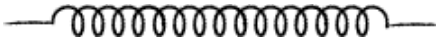
- **Deflection of compass**



- **Right-hand thumb rule**



- **Solenoid**
  - A cylindrical coil having many turns of insulated wires wrapped closely



- **Right-hand thumb rule/ Maxwell's corkscrew rule**
  - If one holds a current-currying wire in the right hand such that the thumb is pointing in the direction of the current, then the direction in which the other finger encircles the wire will give the direction of the produced magnetic field lines around the wire.
- **Corkscrew rule**
  - **If one drives a corkscrew in the direction of the current, then the direction in which the handle is turned is the direction of the magnetic field on the magnetic field lines.**

- **The magnitude of the field lines produced by a circular loop at its centre is**

  - directly proportional to the amount of current
    inversely proportional to the radius of the loop

- The strength of the magnetic field produced by a current carrying a solenoid

  1. is directly proportional to the number of turns in the solenoid
  2. is directly proportional to the strength of the current in the solenoid
  3. depends upon the nature of the core material

1. When an electric current flows through a wire, it behaves as a magnet. This is called the magnetic effect of electric current.
2. **Electric bell** works on the principle of magnetic effect of electric current.
3. A **compass needle** shows deflection when brought near a current carrying wire.
4. An iron nail behaves as a electromagnet when a current is allowed to flow through a wire, which is wrapped around the nail.
5. Magnet is used to separate iron objects from a heap of garbage.
6. **Types of electromagnet :** Bar-shaped or I-shaped electromagnet and Horse-shoe or U-shaped electromagnet
7. An electric bell works on the principle of electromagnetism.

- A current carrying the rod experiences a force when placed between two poles of strong magnets. The direction of force exerted on the rod is related with the direction of current.
- Magnitude of magnetic force depends upon three factors:

  (1) $F \propto I$ (current I flowing in the rod)(2) $F \propto B$ (Strength of magnetic field B)(3) $F \propto l$ (length of the rod l)

  where *K* is a constant and its value in SI unit is 1.
  So, $F = IBl$
  Fleming's left-hand rule
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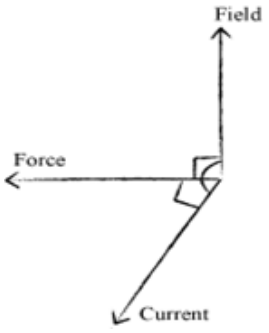
  - If the thumb, forefinger, and middle finger of the left hand are stretched in such a way that they are mutually perpendicular to each other and the forefinger points in the direction of the magnetic field and the middle finger in the direction of the current, then the thumb will point in the direction of the force acting on the conductor.

Fore finger = Magnetic field

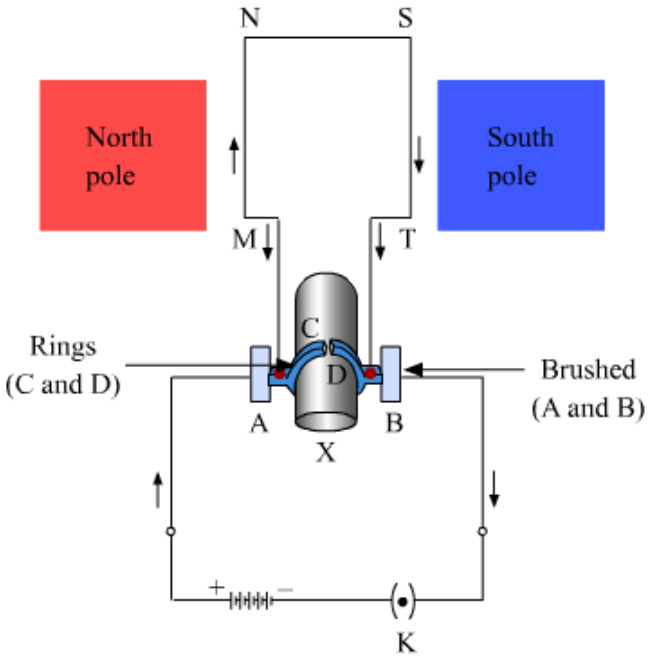
Middle finger = Current

Thumb = Force on conductor



- **<u>Application</u>** – Electric motor

- An electric motor is a rotating device that converts electrical energy into mechanical energy.
- **Motor principle:** The basic principle on which the electric motor works is the magnetic effect of current. A current carrying rectangular coil starts rotating when placed in a magnetic field.
- **Simple electric motor**



- An electric device that reverses the direction of current in a circuit is called a **commutator**. The split ring acts as a commutator of the electric motor.
- The phenomenon of the generation of induced current in a conductor by changing the magnetic field or by moving a conductor in the magnetic field is known as **electromagnetic induction.**

e(induced e.m.f.)=change in magnetic flux in each turn×number of turn in the coiltime in which the magnetic flux chang

The direction of induced e.m.f is given by Lenz's law according to which the direction of induced e.m.f. (or induced current) is such that it opposes the cause which produces it.

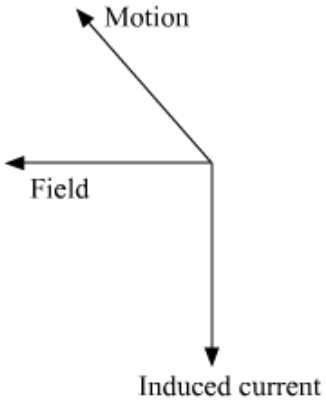
Difference between A.C. and D.C.

Direct Current (D.C.)	Alternating Current (A.C.)
Current of constant magnitude	Magnitude of current varies periodically with time
Always flow in one direction	Direction of current reverses periodically
Can be obtained from cell or battery	Can be obtained from A.C. generator

The working of a transformer is based on the phenomenon of mutual induction.

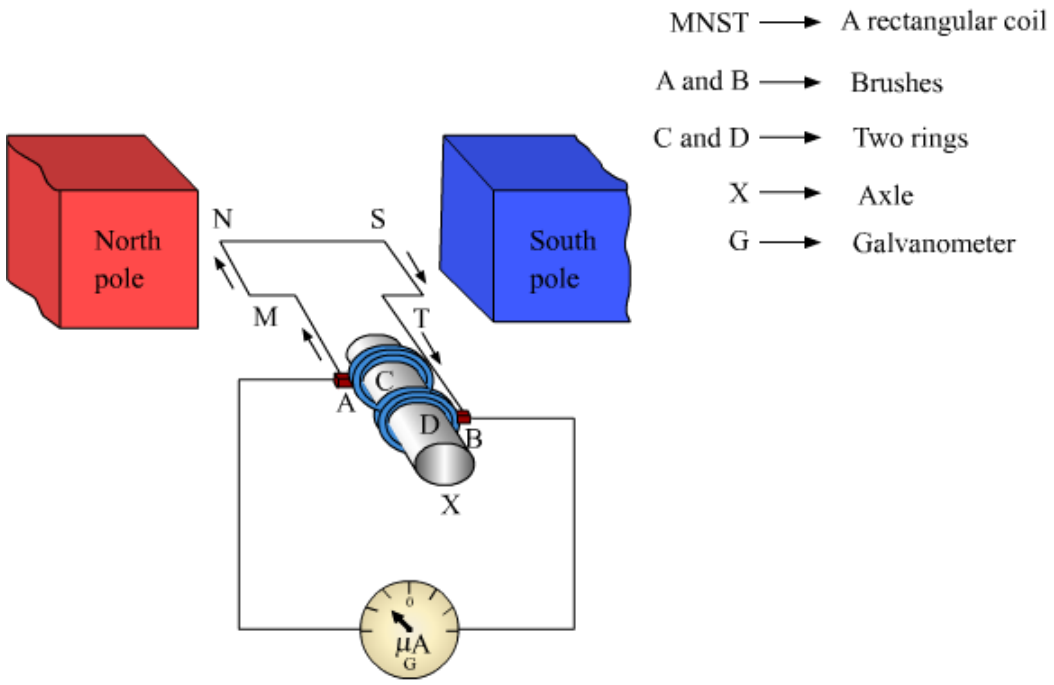
- The direction of the current induced with respect to the directions of the magnetic field and motion of the coil is given by **Fleming's right hand rule**.
    - If the thumb, forefinger, and middle finger of the right hand are stretched in such a way that they are mutually perpendicular to each other and the forefinger points in the direction of the magnetic field and the thumb points towards the motion of the conductor, then the middle finger will point in the direction of the current through the conductor.

      Fore finger = magnetic field
      Thumb = movement of conductor
      Middle finger = direction of current



- **Application** – Generator

- **Electric Generator** converts mechanical energy into electrical energy.
- The direction of the induced current in the generator is given by **Fleming's right hand rule**.
- **Simple electric generator:**



- To get a current that flows in one direction only, a split ring is used.
- Most power stations in the world generate AC than DC. This is because AC can be transmitted over very long distances without much loss of energy.

1. Transformers work on the principle of electromagnetic induction. When current in one circuit changes, an induced current is set up in the neighbouring circuit.

2. Step-up transformers

(i) Step-up transformers are used to step up (increase) ac voltage. In this, the number of turns in the secondary coils is greater than that in the primary coil.

3. Step-down transformers

(ii) Step-down transformers are used to step down (decrease) ac voltage. In this, the number of turns in the secondary coils is less than that in the primary coil.

4. $\frac{V_s}{V_p} = \frac{N_s}{N_p} = k$

For step-up transformer, $K > 1$

$\therefore V_s > V_p$

5. For step-down transformer, $K < 1$

$\therefore V_s < V_p$

6. Input electrical power = Output electrical power for the transformer

$V_p I_p = V_s I_s$