MAGNETISM

Molecular theory of magnet and magnetic effect of electric current

What is magnetism?

- Force of attraction or repulsion due to electron arrangement
- Magnetic forces are the strongest at the poles
- Magnets have two poles: North and South
- When free to rotate, to come to rest pointing in a north-south direction
- Like magnetic poles repel
- Unlike magnetic poles attract

Types of magnet

- **Natural magnet**: known as *lodestones* which is a type of iron ore with magnetic properties
- **Artificial magnet :** materials in which magnetic properties are produced artificially such as iron, cobalt, nickel, steel etc
- **Temporary magnet :** that loses their magnetic properties easily and quickly e.g. soft iron
- **Permanent magnet :** which retain their properties more longer and difficult to magnetise e.g. steel
- **Electromagnet :** an electric current produces magnetic effects and a coil of wire carrying a current act as an electromagnet

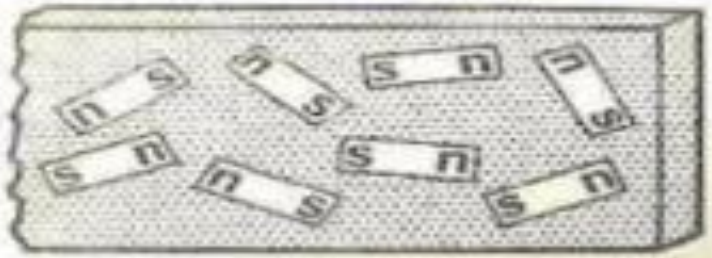
Molecular theory of magnetism

- If we break a magnet into two parts, each part become a complete magnet
- Individual molecule of the magnet act as a tiny molecular magnet
- Their magnetic properties may be due to electrons rotation in their orbits, which constitute minute electric current and thus produce magnetic properties
- When material is unmagnetized, molecular magnets lie in haphazard manner and their magnetic properties neutralize each other

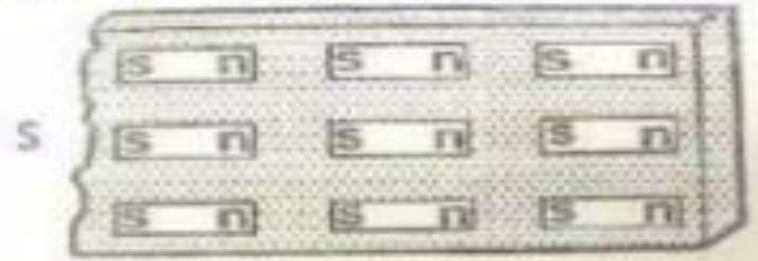
- When material is magnetized, the molecular magnets are arranged in an order so that their properties augmented and become apparent
- Heating or hammering a magnet accelerate loss of magnetic properties why?
- **Point of saturation:** is a point where further magnetizing a magnet cannot increase the strength of a magnet and all molecular magnets are fully alligned

Theory of Magnetism

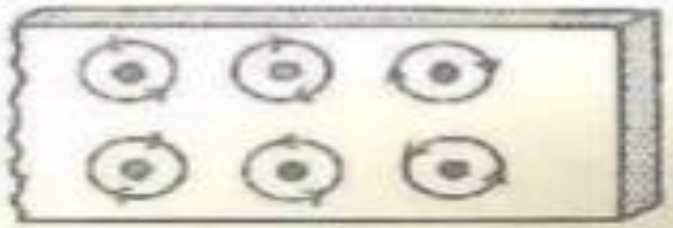
Molecular and Electron Theories



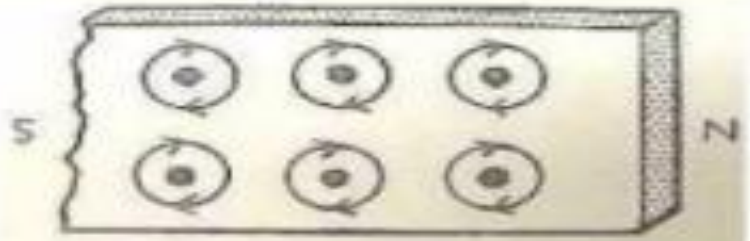
UNMAGNETIZED:
Molecules unarranged



MAGNETIZED:
Molecules orderly arranged



UNMAGNETIZED:
Electrons spinning in different directions



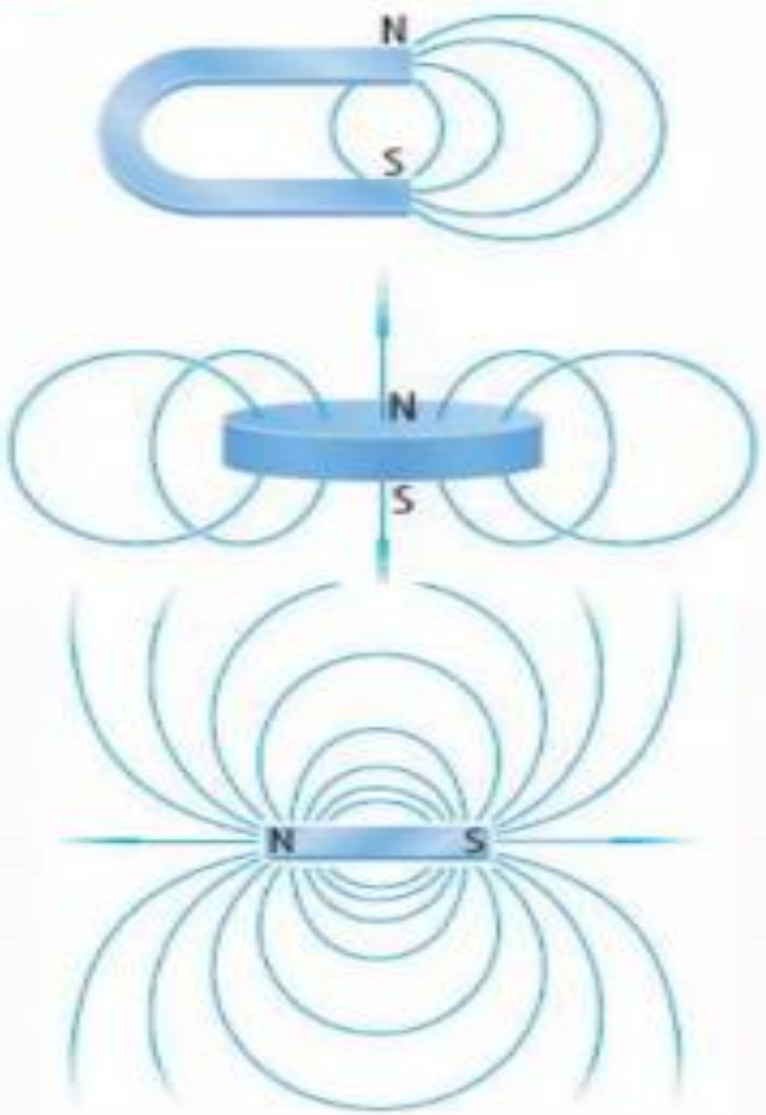
MAGNETIZED:
Electrons all spinning in same direction

Properties of magnet

- Setting in north-south direction: utilized in compass
- Behavior of like and unlike poles
- Magnetic field
- Attraction for objects of magnetisable material
- Transmission of properties
  - Magnetization by contact
  - Magnetic induction

Magnetic field

- A magnetic field is the area around magnet in which magnetic forces are apparent
  - Travel away from north and towards south pole
  - Magnetic field lines are close continuous curves
  - No two lines intersect each other
  - Tend to repel each other helps distribution of magnetic field
  - Travel more easily through magnetisable material than others



Magnets have two ends or poles, called north and south poles. At the poles of a magnet, the magnetic field lines are closer together.

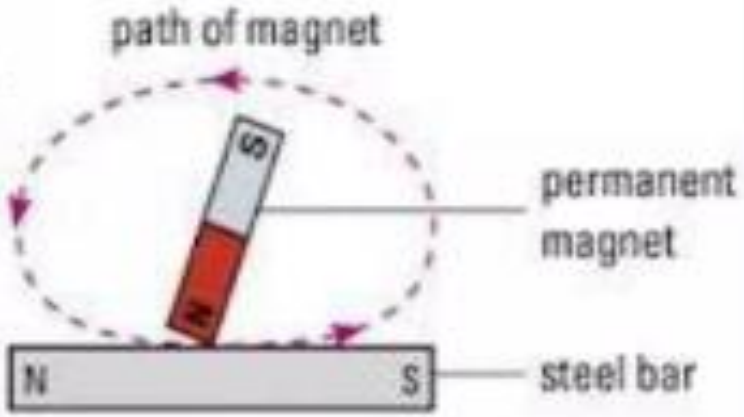
The magnetic field lines around horse-shoe and disk magnets are closest together at the magnets' poles.

Unlike poles of magnets attract each other and like poles of magnets repel.

Transmission of properties

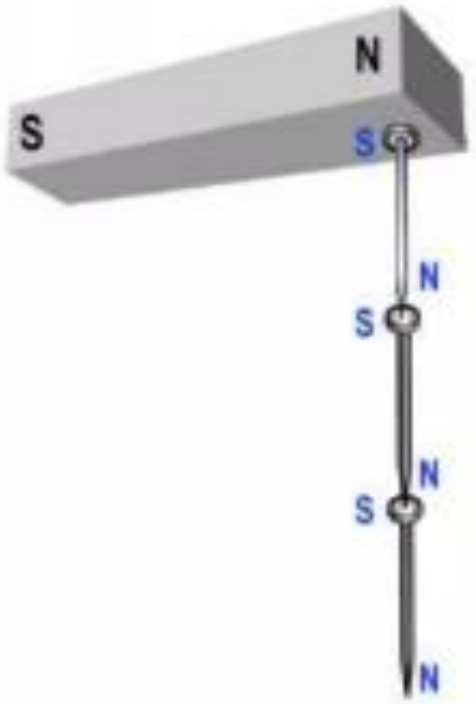
Magnetization By contact

- Stroke a piece of iron or steel with one pole of bar magnet
- Same pole is used throughout and stroke is carried out in same direction
- same polarity where stroke commence and opposite polarity where stroke finishes
- If north pole of magnet is used it will attract the south poles of molecular magnets of steel or iron and draws them towards the point where it leaves the bar



Magnetic induction

- Production of magnetic properties in an object by magnet without contact
- demonstrated by using a magnet to pick up some paperclips or iron tacks.
- The paperclip in contact with the magnet attracts another paperclip due to the fact that it has become magnetised.
- This second paperclip is also magnetised and so on
- Opposite polarity develop at adjacent end and same polarity at far end
- As unlike pole attract each other and repel like pole



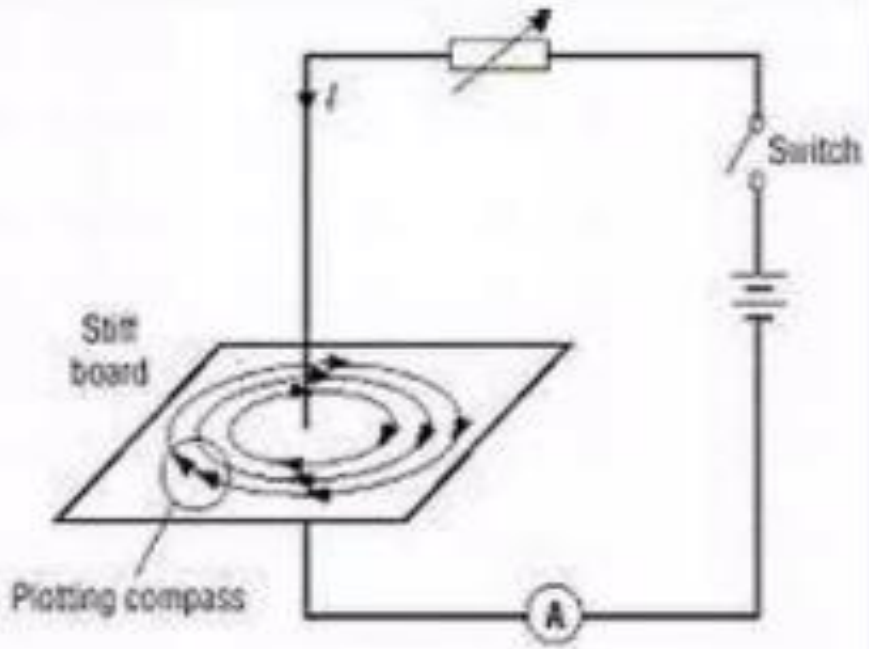
Magnetic effect of electric current

Magnetic field around a straight wire

- An electric current sets up magnetic field around a conductor through which it pass
- The shape of the magnetic field lines for a straight conductor is concentric circles.
- These concentric circles become larger as we move away from the wire.

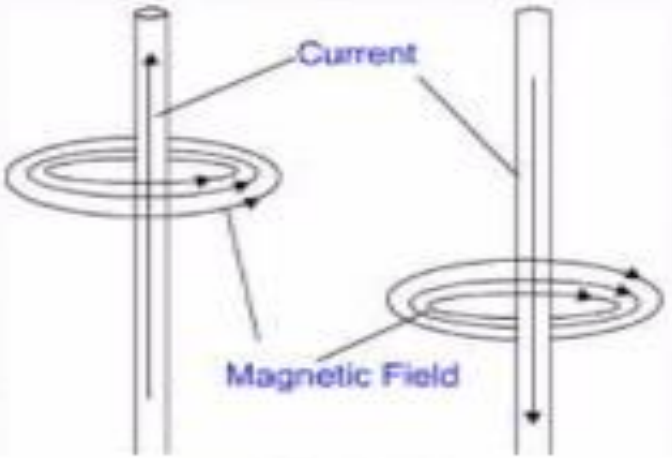
Demonstration

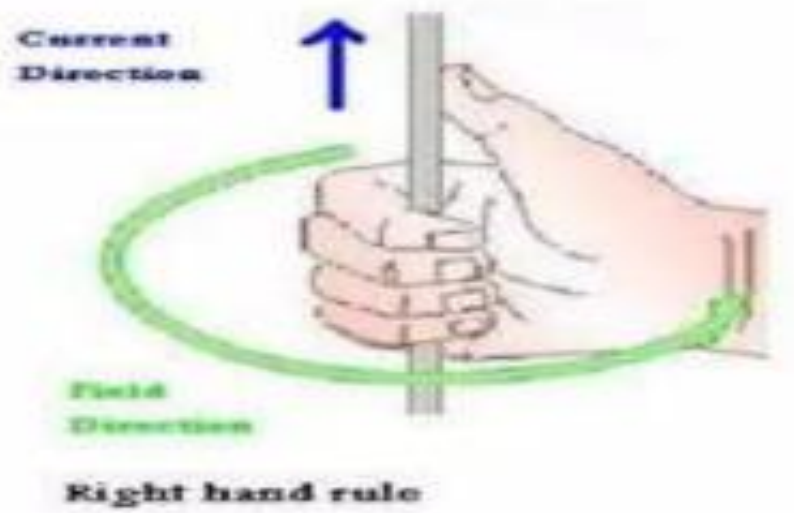
- Take a thick copper wire and pass it through a horizontal cardboard as shown.
- Pass a strong current through the wire.
- Sprinkle iron filings on the cardboard around the wire.
- Tap the cardboard gently. You would see a pattern as shown here.
- You may plot the field lines with a compass needle also.



Right-hand Thumb Rule

- When you wrap your right hand around the straight conductor such that the thumb points in the direction of the current, the fingers will wrap around the conductor in the direction of the field lines of the magnetic field.
- Anticlockwise if current flow from negative to positive
- Clockwise if flow from positive to negative

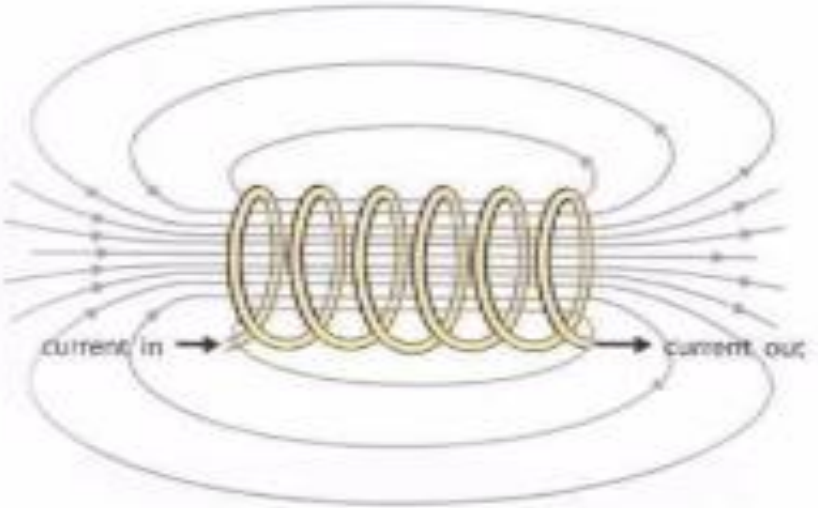


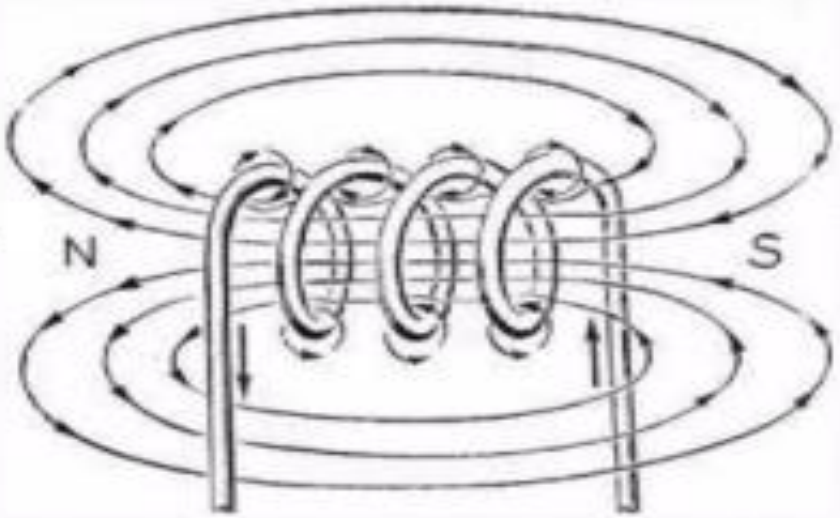


Right hand rule

Magnetic field around coil of wire

- The magnetic field lines are circular at the points where the current enters or leaves the wire
- Within the space enclosed by the coil, the field lines are in same direction and parallel to each other and uniform
- Mag. lines are clockwise in upper turns, positive to negative
- Mag. lines are anticlockwise in lower turns, so direction is towards positive
- Emerging from north pole and returning to south pole





Magnetic polarity

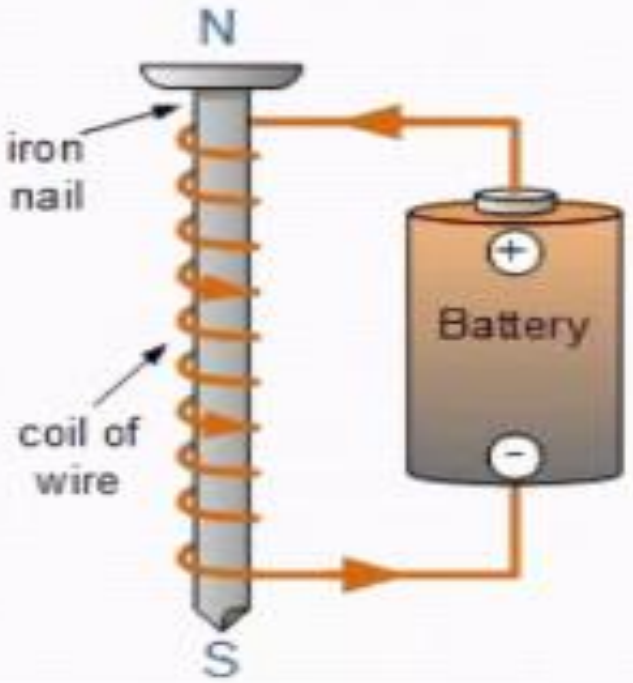
Magnetic poles lie at end of coil and polarity of each pole depends upon:

1. **Direction of current flow:** reversal of current reverses direction of mag. lines of forces
2. **Direction in which coil wound**

Many rules for determining magnetic polarity assume the current flow to be from positive to negative

Electromagnet

- Consist of coil of wire wound on a soft iron bar
- When current pass through the coil, magnetic field set up and soft iron core is magnetised by induction, so that its field is added to that produced by current
- A strong magnetic field is produced, which can turn on and off as required by starting or stopping current
- Soft iron is chosen for core because it can be easily magnetised and demagnetized




Thank you