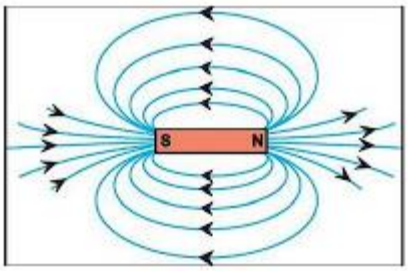
POONAM LATA YADAV

MAGNETIC EFFECTS OF CURRENT

The region surrounding the magnet, in which the force of the magnet can be detected, is said to have a **magnetic field**.

Why does a compass needle get deflected?

Compass needle get deflected when brought near magnet due to the force of the magnet.
The lines along which the iron fillings align themselves represent **magnetic lines of force.**



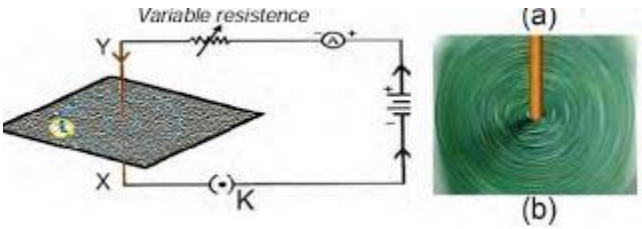
Magnetic field is a quantity that has both magnitude and direction.

The **direction of the magnetic field** is taken to be the direction in which a north pole of the compass needle moves inside it.

The field lines emerge from the **North Pole** and merge at **the South Pole outside** magnet. **Inside** the magnet, the direction of field lines is **from its south pole to its north pole**. Thus the magnetic field lines are closed curves. This is why no two field-lines are found to cross each other.

Magnetic field due to current carrying conductor

The direction of magnetic field produced by the electric current depends upon the direction of flow of current. If we reverse the direction of current then the direction of magnetic field produced by the electric current get changed.



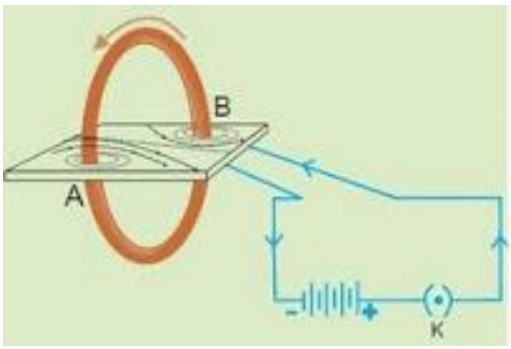
The magnitude of the magnetic field produced at a given point increases as the current through the wire increases.

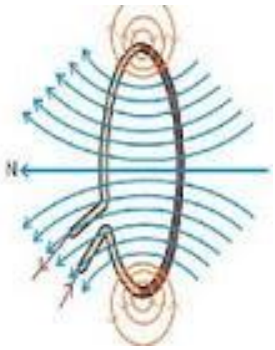
The concentric circles representing the magnetic field around a current-carrying straight wire become larger and larger as we move away from it.

Magnetic field due to current carrying circular loop:

We know that the magnetic field produced by a current- carrying straight wire depends inversely on the distance.

We know that the magnetic field produced by a current- carrying conductor 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 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.

Magnet

A substance which has the property of attracting other substances like iron filings and points in the north south direction when suspended freely is called a magnet.

Magnetic field

The space around a magnet in which the force of attraction and repulsion due to it can be detected is called the magnetic field.

Magnetic field lines

The curved paths along which the north pole of the compass needle moves in a magnetic field are called magnetic field lines. Magnetic field lines are used to represent a magnetic field.

POONAM LATA YADAV

Properties of magnetic field lines

The magnetic field lines never intersect each other because if they do so it means that at that point the compass needle would point towards two directions which is not possible.
They emerge at North Pole and merge at South Pole.
They are crowded near the poles and are far apart near the middle.
These are directed from North Pole to South Pole outside the magnet and from south to North Pole inside the magnet.

Compass needle

A compass needle is a small bar magnet whose ends always point towards north south direction. The end pointing towards north is called North Pole and the end pointing towards south is called South Pole.

Magnetic field due to a current carrying straight wire

The straight current carrying conductor produces a magnetic field around it in the form of concentric circular field lines with the conductor at the center.

Factors affecting strength of magnetic field around a current carrying straight conductor.

Strength of magnetic field is directly proportional to the current passing through the conductor and inversely proportional to the distance from the conductor.

$B \alpha I$

$B \alpha 1/r$

Right hand thumb rule or Maxwell's clockwise rule

If we hold a straight wire in our right hand, and if the thumb represents the direction of current then the fingers represent the direction of magnetic field lines.

Magnetic field due to current carrying circular loop or coil

When the current is passed through circular loop or coil, the lines of force are circular near the wire but straight and parallel near the center of loop or coil. Factors affecting magnetic field due to current carrying circular loop or coil.

Magnetic field due to current carrying circular loop at its center is–

Directly proportional to the current passing through it.
Inversely proportional to the radius of loop.

Magnetic field due to current in a solenoid

The Magnetic field due to current carrying solenoid is similar to the magnetic field produced by a bar magnet. The ends of the solenoid act as North Pole and South Pole. The field lines inside the solenoid are in the form of straight parallel lines.

Factors affecting Magnetic field due to current in a solenoid

1. Magnetic field is directly proportional to the number of turns in the coil.

2. It is directly proportional to the current passing through it.

3. It is inversely proportional to the length of air gaps between the poles.

4. It depends on the nature of the core material used in the solenoid. Electromagnet.

An electromagnet consists of a long coil of insulated copper wire wrapped around a soft iron core. It is a temporary magnet as it works as long as current is passed through it. Factors affecting the strength of magnetic field of an electromagnet

Strength of magnetic field of an electromagnet

1. Directly proportional to the number of turns.

2. Directly proportional to the current flowing through it.

3. Inversely proportional to the length of air gaps between the poles.

Uses of electromagnet

1. They are used in electrical devices such as electric bell, electric fan, motor, and generator.

2. They are used for lifting and transporting large mass of iron.

3. They are used in medical practices for removing pieces of iron from wound and used in MRI.

Permanent magnets

A permanent magnet is made from steel alloys like carbon steel, chromium steel, cobalt steel, etc. They are weaker than electromagnets and their strength and polarity cannot be changed. Force on a current carrying conductor in a magnetic field.

A current carrying conductor placed in a magnetic field experiences a force due to the interaction between

a. Magnetic field due to current carrying conductor and

b. External magnetic field in which conductor is placed.

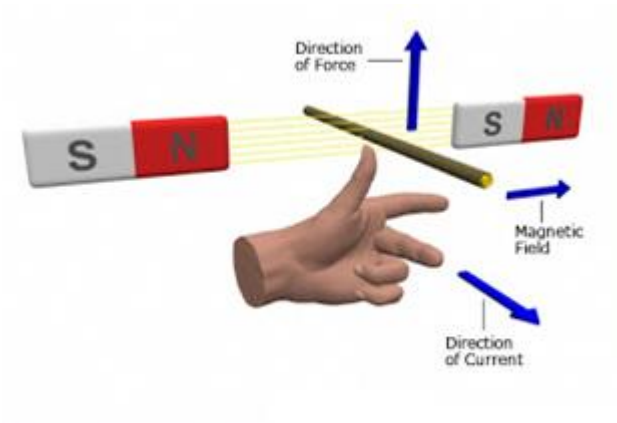
Force on a current carrying conductor in a magnetic field

A current carrying conductor placed in a magnetic field experiences a force due to the interaction between

a. Magnetic field due to current carrying conductor and

b. External magnetic field in which conductor is placed.

Flemming's Left Hand Rule



If we stretch our thumb, fore finger and the middle finger of our left hand mutually perpendicular and if the fore finger represents the direction of magnetic field and the middle finger represents the direction of current then the thumb represents the direction of motion in conductor.

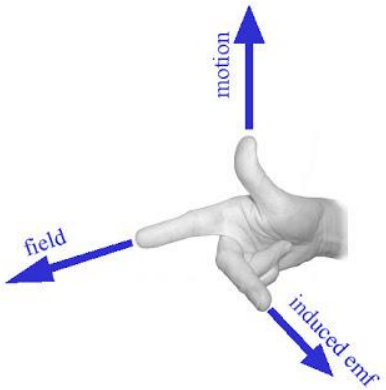
Electric motor

A motor is the device which converts electrical energy into mechanical energy. It has a shaft which rotates continuously when current is passed through it. It is used in electric fans, mixer grinder, etc.

Principle of electric motor

When a rectangular coil of copper wire is placed in a magnetic field and current is passed through it, a force acts on the coil which rotates it continuously. Electromagnetic induction. The production of electric current by moving a straight conductor in a magnetic field is called electromagnetic induction. It is the production of electricity from magnetism.

Flemming's Right Hand Rule.



If we stretch our thumb, fore finger and the middle finger of our right hand mutually perpendicular and if the fore finger represents the direction of magnetic field and the thumb represents the direction of motion in conductor then the middle finger represents the direction of induced current in the conductor.

Electric generator

A generator is a machine which is used to generate electric current by converting mechanical energy into electrical energy. There are two types of generators – alternating current (AC) generator and direct current (DC) generator.

Principle of electric generator

When a coil of copper wire is moved in a strong magnetic field, a current is induced in the coil.

Earthing

The appliances that have metallic body (like electric iron, toaster, refrigerator, etc.) are connected with green wire which provides a low resistance conducting path for the current and keeps the body of appliance at the potential of the earth. This is called earthing.

Earthing is done to save ourselves from electric shocks.

Electric fuse

The device having a short length of thin wire which is made of alloy lead and tin is called fuse wire or electric fuse. It has a very low melting point. It melts and breaks the circuit if the current exceeds the safe value.

Fuse wire is connected in series in the circuit.

Overloading

When too many electrical appliances of high power rating (electric oven, air conditioner, etc.) are switched on at the same time, a large current from the circuit is drawn. This is called overloading of the circuit. It may also occur when the live wire and the neutral wire come into direct contact.

Short circuiting

When the live wire and neutral wire come into direct contact, a large amount of current flows through the circuit due to very small resistance, this is called short circuiting. The heat produced during short circuiting is so high that it may cause fire.