Mgnetic Effect and Electric

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.

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 centre.

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 a I and B a 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 centre 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 centre 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

- Magnetic field is directly proportional to the number of turns in the coil.
- It is directly proportional to the current passing through it.
- It is inversely proportional to the length of air gaps between the poles.
- 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.

The strength of magnetic field of an electromagnet is -

- Directly proportional to the number of turns.
- Directly proportional to the current flowing through it.
- Inversely proportional to the length of air gaps between the poles.

Uses of electromagnet

- They are used in electrical devices such as electric bell, electric fan, motor, and generator.
- They are used for lifting and transporting large mass of iron.
- 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.

DC	AC
1. The direction of DC remains same. 2. It can't be converted into AC easily. 3. It can't be transmitted over long distances without much loss.	1. The direction of AC changes after regular intervals. 2. It can be easily converted into DC. 3. It can be transmitted over long distances without much loss.

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- Magnetic field due to current carrying conductor and
- External magnetic field in which conductor is placed.

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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.

Steps to avoid overloading

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.

- All the electric appliances should not be used at the same time.
- Fuse wire of suitable value should be used.
- High power rating appliances should be used with 15 A fuses.
- Important Points

Hans Christian Oersted

Hans Christian Oersted showed the relation between electricity and magnetism. He showed that the current carrying conductor produces magnetic field around it.

Points to Members

- Magnetic field is a vector quantity because it has both - the direction and magnitude. The direction of a magnetic field is taken to be the direction in which the north pole of a compass moves.
- The relative strength of a magnetic fields is shown be the degree of closeness of field lines. The field is stronger where the field lines are crowded.
- Straight parallel field lines inside the solenoid represent that the magnetic field is uniform inside the solenoid.

- Current carrying conductors and the magnetic fields are used in electric motors, loud speakers, microscopes, generators, measuring instruments, etc.
- There are two separate circuits in the house – the lighting circuit with 5 ampere fuse and a power circuit with a 15 ampere fuse.
- A long coil containing a large number of close turns of insulated copper wire wrapped closely in shape of a cylinder is called solenoid.
- Soft iron core is used in electromagnets because it loses its magnetism easily after stoppage of current.
- Magnetic field strength increases on increasing number of turns in the solenoid because the current in each circular turn has the same direction and the field due to each turn just adds up.
- A cable has three separate insulated wires - red, black and green. The Red insulated wire is called the live wire or positive wire. The Black insulated wire is called the neutral wire or negative wire. The Green insulated wire is called the earth wire.
- The potential difference between live wire and neutral wire is 220 volt.
- At the centre of the magnet the magnetism is zero.
- The magnetic field produced due to a circular wire at its centre is perpendicular to the plane of the wire.
- A DC generator is based on the principle of electromagnetic induction.
- An electric motor converts electrical energy into mechanical energy.
- The electric generator converts mechanical energy into electrical energy.
- Clock rule is used to find the polarities of a current carrying coil or a solenoid.
- Permanent magnets are made of alloys - steel, ALNICO (Al, Ni, Fe, Co) and Nipermag (Fe, Ni, Al, Ti).
- Soft iron is not used for making permanent magnets because it loses its magnetism easily.
- The direction and magnitude of AC change periodically while in case of DC it remains same
- Fuse wire is made up of an alloy (solder) of lead and tin because it has low melting point.
- The earth wire pin of a plug is thicker and longer than the other so that it gets connected to the earth terminal earlier than live or neutral pins and provides larger surface area. Also, it is thicker so that it may not enter the live or neutral hole of the socket.
- A compass needle placed near a current carrying wire gets deflected showing the magnetic field around it.
- The earth wire is connected to a metallic plate deep inside the earth to provide a low-resistance conducting path for current and keeps the body of

appliance at the same potential as that of the earth. It is used as a safety measure so that any leakage of current to a metallic body does not give any severe shock to the user.

- The instrument that detects the presence of current in the circuit is called galvanometer.
- In India, the frequency of AC is 50 Hz i.e. it changes its direction every 1/100 second.
- The important advantage of AC over DC is that Alternating Current can be transmitted over long distances without much loss of energy.
- When a rectangular coil of copper wire is rotated in a magnetic field, the direction of the induced current changes once in each half revolution.
- A current carrying conductor placed in a magnetic field experiences a force only when the direction of current is perpendicular to the magnetic field.