17

MAGNETIC EFFECT OF ELECTRIC CURRENT

In the earlier lesson you have learnt that, electricity is an important part in today's world of industrialization. Our life is incomplete without it. Whether we work in an office or at home, every thing depends upon the availability of electricity. Appliances like the electric bulb, fan, television, refrigerator, washing machine, motor, radio, everything works due to electricity.

When electric current passes through current carrying conductor or coil then a magnetic field is produced around it. The working of appliances like electric bell is based on this principle. As opposite to this if a continuous change in magnetic field is produced then electric current can be produced. This is how electricity and magnetism have become synonymous today. Transmission of electric current takes place from the distant electricity generation stations through high tension wires, through transformers to homes. This chapter deals with the meaning of safe use of electricity. Along with this the same concepts related to magnetism are explained through simple activities that one can perform on their own.

OBJECTIVES

After studying this lesson you will be able to:

- *identify magnets and explain their properties;*
- *explain the concept of magnetic field and state the properties of lines of magnetic force;*
- *infer that when electricity flows through a conductor, magnetic field is produced around it;*
- *describe electro-magnets and explain the working of electric bells;*
- *explain the force experienced by a current carrying conductor placed in a magnetic field;*

- *describe electromagnetic induction and its importance in different aspects of daily life;*
- *describe alternate current (AC) and direct current (DC) currents and list the appliances that work on these currents;*
- *state the hazards involved in using electrical energy in industries and at home and describe safety measures necessary to minimize them.*

17.1 MAGNET AND ITS PROPERTIES

Magnet has always been a thing of awe use and attraction for humans. According to history, the use of magnets were discovered by the ancient Greeks during the period of Greek Civilization.

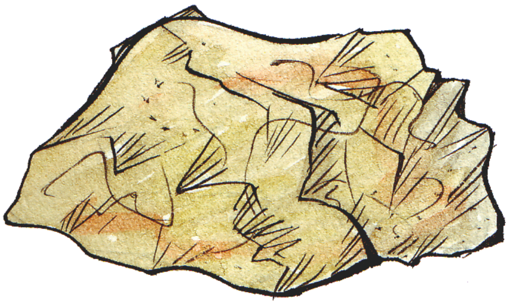


Fig. 17.1 *Natural magnet*

They found stones which were able to attract iron and nickel like other substances. This naturally occurring stones (see Fig. 17.1) which was discovered then is called as 'lodestone'. This is an oxide of iron (Fe_3O_4). The property of attraction of small particles of iron towards lodestone is called as 'magnetism'. It has been often seen that the magnetic force of attraction of these natural magnets is much less and thus, these magnets cannot be use for practical purposes. Strong magnets made of iron, nickel and lead are made artificially and used for practical purposes. Those magnets are also called as permannent magnet. So, a magnet is a material or object that produces a magnetic field which is responsible for a force that pulls or attacts on other materials.

These strong magnets can be made in various shapes and creats its own persistent magnetic field. The magnets that are commonly available in different shapes are:

(a) Bar magnet
(b) Horseshoe magnet
(c) Cylindrical magnet
(d) Circular magnet
(e) Rectangular magnet

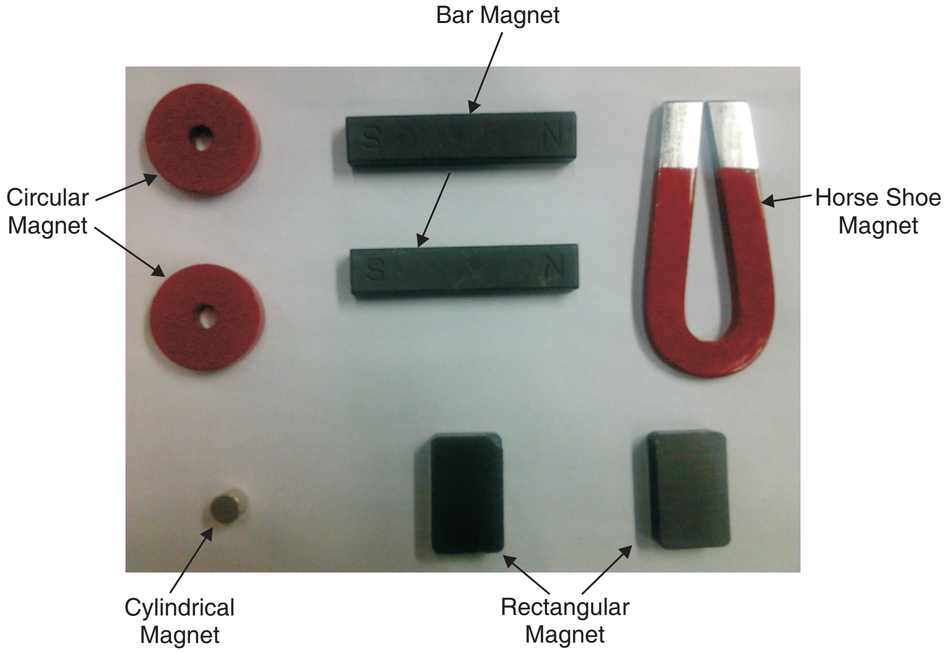


Fig. 17.2 *Magnets of different shapes*

Have you ever observe magnets of any of above shapes arround you? These magnets of different shapes are used in various appliances used at home like tape recorder, radio, motor, door-bell, head phones etc. These magnets are used in various appliances to either hold or separate, control, elevate (lift) substances, changing electrical energy to mechanical energy (motors, loudspeakers) or mechanical to electrical energy (generators and microphones).

If a natural magnet is suspended freely with the help of a string, it always rests in the 'north-south' direction. If the magnet is slightly turned from this direction, it still returns to the same. The end that rests towards the 'north' is named as 'North Pole' while the one which ends at 'south' is named as South Pole. They are represented as 'N' and 'S'.

ACTIVITY 17.1

Take one magnetic needle, two bar magnets, some iron filling, an alpin and do the experimental study of properties of magnet.

Following step may followed:

1. Tie a string at the middle of a bar magnet and hang it with the help of a hook. This bar always rests at the same direction. With the help of the magnetic needle,

find out the direction. By this you will be able to prove that a bar magnet always rests in the north-south direction.

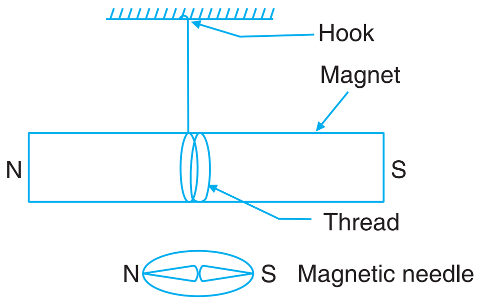


Fig. 17.3 (i)

2. Take iron fillings near the bar magnet. They stick to the magnet. Thus, magnet attracts iron. You would observe that the amount of iron fillings near the poles is maximum while at the middle is negligible.

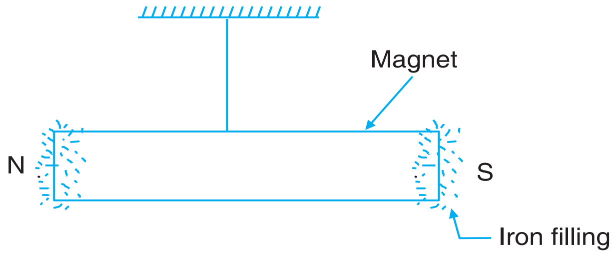


Fig. 17.3 (ii)

3. If you bring any pole of a bar magnet near the pole of a freely suspended bar magnet, then either it will attract or repel the same. Opposite poles of a magnet attract each other while like poles (north-north or south-south) repel each other.

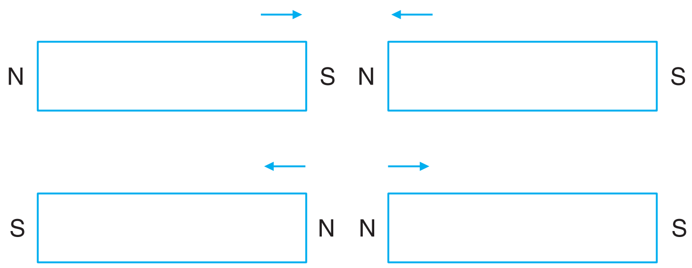


Fig. 17.3 (iii)

4. Take an iron alpin near a bar magnet leave it there for sometime. You will find that the alpin has acquired magnetic properties and iron fillings start sticking to the ends of the alpin as well.

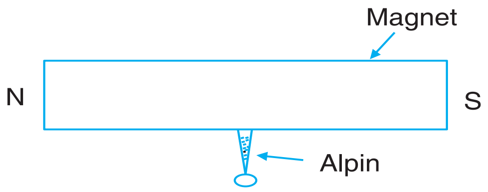


Fig. 17.3 (iv)

5. Break the bar magnet into smaller pieces. Now observe that magnetic properties are retained in the pieces as well. Thus, the two poles of a magnet cannot be separated.

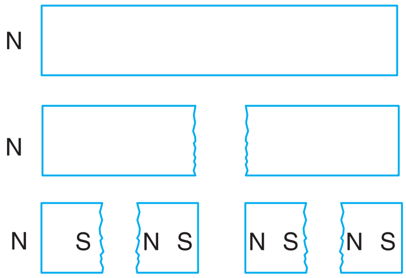


Fig. 17.3 (v)

17.1.1 Properties of Magnets

Through the activity 17.1 we can list the properties of magnetic as follows:

1. Attracts iron towards itself.
2. Freely suspended magnet always rests at the north-south direction.
3. Like poles repel while unlike poles attract.
4. If iron pieces are brought near a strong magnet they also start behaving as magnets.
5. The poles of a magnet cannot be separated.

17.2 MAGNETIC FIELD

Keep a small magnetic needle near a bar magnet. The magnetic needle rotates and stops in a particular direction only. This shows that a force acts on the magnetic needle that makes it rotate and rest in a particular direction only. This force is called torque.

The region around the magnet where the force on the magnetic needle occurs and the needle stops at a specific direction, is called a **magnetic field**. The direction of magnetic field is represented by magnetic line of forces. As shown in Fig. 17.4(i), the direction of magnetic needle changes continuously and it takes the curved path while moving from north to south. This curved path is known as magnetic line of forces. Tangent line draw at any point on magnetic line of force, represent the direction of magnetic field at that point. These magnetic line of forces have following properties:

1. Magnetic line of forces always start from north pole and end at south pole of the magnet.
2. These line of forces never intersect each other.
3. Near the poles magnetic lines are very near to each other which shows that magnetic field at the poles is stronger as compare to other parts.

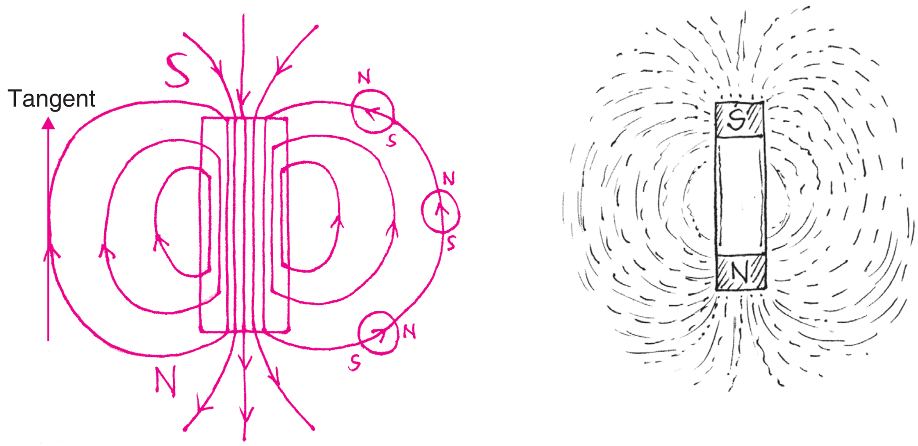


Fig. 17.4 (i)

Our Earth itslef acts as a giant magnet with south magnetic pole somewhere in the Arctic and north magnetic pole in Antaractic. The Earth also behaves like a bar magnet. It's hot liquid centre core contains iron and as it moves, it creates an electric current that cause a magnetic field around the Earth. The Earth has a north and south magnetic pole. These poles are not same with the geographic north and south poles on a map and tilted at an angle of 11.3 degree with repect to it. Due to this, if a magnetic needle is suspended freely, it rests in the north-south direction and is useful for navigation.

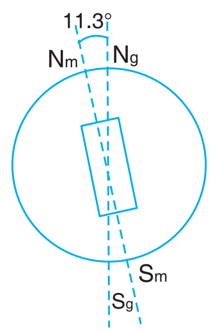


Fig. 17.4 (ii)

ACTIVITY 17.2

You can also detect the presence of magnetic field. For doing this take two bar magnets, one scale and follow the given steps:

1. Keep two bar magnets in such a way that they are laid on the same line and in same plane at a distance of 10 cm.
2. Bring the like poles slowly towards each other. Could you feel something?
3. You will feel two poles are repelling each other.
4. Change the orientation of one of the bar magnets so that opposite poles face each other. You would observe that the two magnets quickly come close together due to force of attraction between them.

With this we can conclude that force acts between the magnets and the region around the magnets in which this force may be experienced is called the 'magnetic field'.

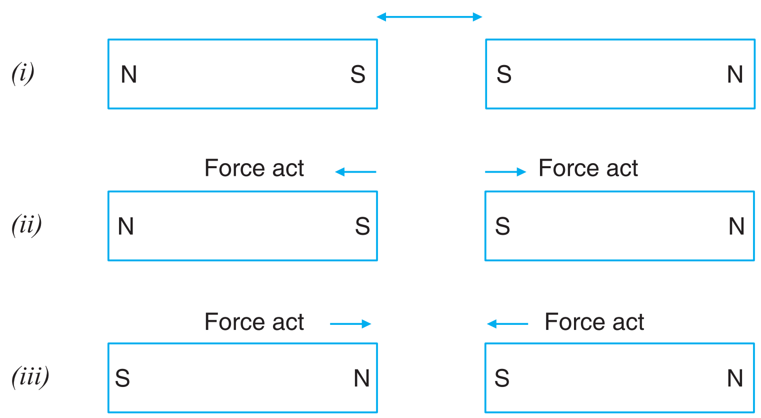


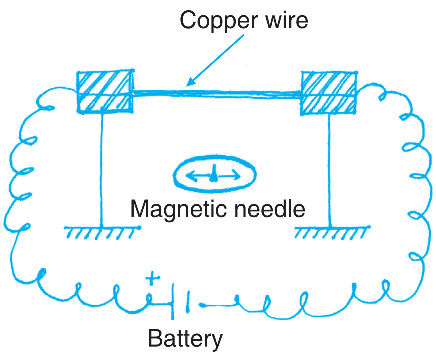
Fig. 17.5

INTEXT QUESITONS 17.1

1. Define magnet and list its properties?
2. What happen, with the properties of magnet when it is broken into two pieces?
3. Name the part of telephone where magnet is used?
4. Hang the bar magnet with the string, it will always rest in which directions
   - (i) East-west
   - (ii) West-south
   - (iii) North-south
   - (iv) North-east
5. Do magnetic field exist throughout space?
6. The north pole, magnetic needle points towards earth's
   - (i) North pole
   - (ii) South pole
   - (iii) Centre
   - (iv) None of the above
7. What are magnetic poles?

17.3 MAGNETIC FIELD AROUND THE CURRENT CARRYING WIRE

If an electric current is made to flow in a wire, magnetic field produce arround it. For seeing this take a conducting wire (like copper). Now with the help of connecting wires attach this to the two ends of a battery. Keep a magnetic needle parallel to the conducting copper wire as shown in Fig. 17.6(a). When the circuit is complete the magnetic needle shows deflection. This shows that when electric current flows through a conductor, magnetic field is produced around the conductor. If the current is increased, there is greater amount of deflection. If the direction of flow of electric current is changed (by reversing the end of the battery) the direction of deflection in the magnetic needle is also reversed. If the current flow is stopped the deflection in the magnetic needle also ceases. Thus magnetic field is an effect of flow of electric current through conducting wire. In the year 1820 a scientist from Denmark named H.C. Oersted observed this effect for the first time.



(*a*)

H.C. Oersted (1770-1851)

(*b*)

Fig. 17.6

The principle of the magnetic effect of electric current used in many appliances like motor etc.

17.4 ELECTROMAGNET

An electromagnet is a type of magnet in which magnetic field is produced by the flow of elctric current. For making electromagnet take a piece of paper and give a cylindrical shape.

Make several turns of a copper wire over this from one end to the other. This is called solenoid a long thin loop of wire. When the ends of the copper wires are attached to the ends of a battery (+ and –) current starts flowing through the coil which starts functioning as a bar magnet.

When the flow of current is stopped from the battery, then, its magnetic property ceases. If the +ve and –ve terminals of the battery are reversed, then the poles of the magnet are also reversed.

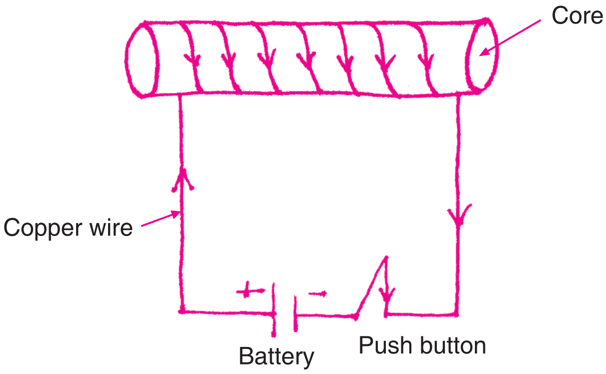


Fig. 17.7 *Solenoid*

For increasing the magnetic field, put soft iron like iron nails inside the core. So Current carry solenoid with soft iron core inside it forms an electromagnet. Electromagnet may be made as strong as one may desire. Electromagnet are widely used as a components in electrical devices such as motor, generator, electrical bells MRI machine etc. Beside that strong electromagnet are also being used in break system of the superfast train in the world, in the cyclotrons and in mega experiments like experiment at CERN laboratory at Geneva. The comparison of a bar magnet and an electromagnet has been illustrated in the table given below.

17.4.1 Difference between a Bar Magnet and an Electromagnet

Bar magnet	Electromagnet
This is a permanent magnet. Its magnetic field remains constant.	This is a temporary magnet. Its magnetism remains till current flows through it.
Its magnetic strength cannot be reduced or increased.	Its magnetic strength may be changed at will by changing the amount of current flow.
This is a weak magnet.	This is a strong magnet. Strength of magnetic field can be controlled.
The poles do not change.	By mere change in the direction of flow of electric current the poles may be altered.

ACTIVITY 17.3

Let us try to make an electromagnet with our hands. For this take thick paper like drawing sheet, copper wire, 9V battery or eliminator through which mill ampere current may flow, switch and iron scale and follow the given steps.

1. Make a cylindrical tube of 15 cm. long with a diameter of 1 cm. by rolling the thick paper sheet.
2. Make around 100 to 150 coils of copper wire around this tube. Please note that core is empty here.

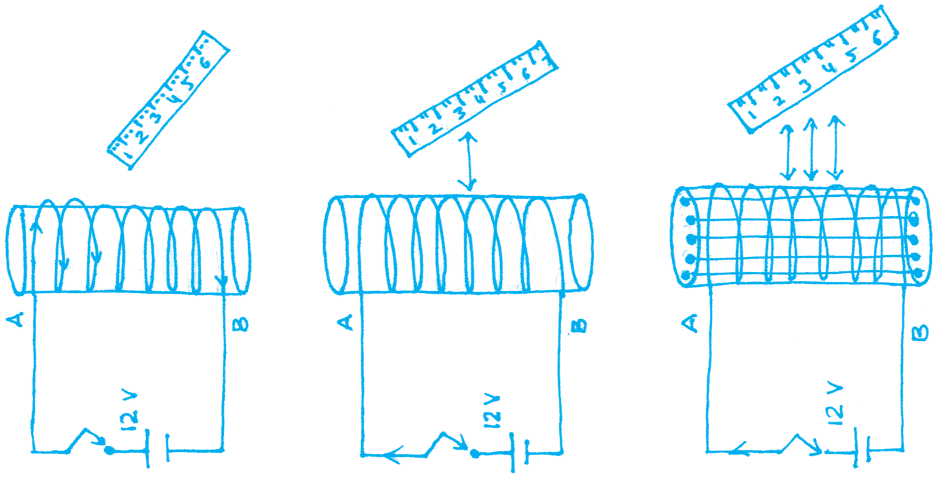
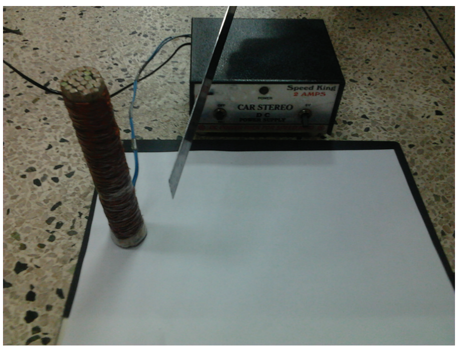
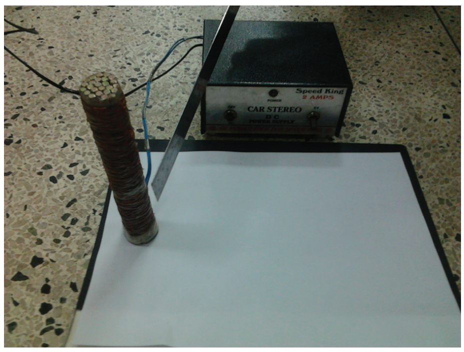


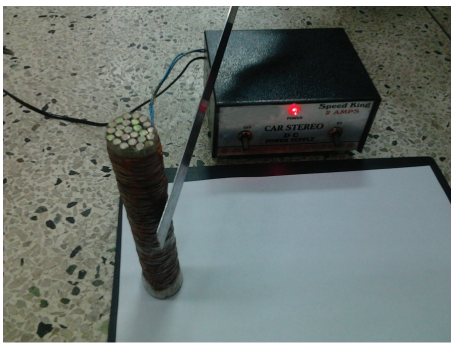
Fig. 17.8 (a)



(i)



(ii)



(iii)

Fig. 17.8 (b)

3. Connect the end of the wires with the help of a switch to the ends of the battery.
4. Take an iron scale near the tube before the switch is on.
5. You will see that no force may be felt over the iron scale.
6. Now the switch it on and allow the current to flow.
7. As current flows the iron scale is pulled towards the tube. This shows that the cylindrical tube works as a magnet. This magnetic property occurs due to solenoid.
8. Now fill iron nails inside the tube (core). You will observe that there is a greater force pulling at the scale. This shows that the electromagnet has become stronger. This happened because from atoms inside the core line up and increase magnetic field.
9. As the current flow is stopped, the magnetic effect of the tube is also lost.

17.4.2 Electric Bell

How does electrical bell work? This electrical device where electromagnetic is used as components. In electric bell 'U' shaped electromagnet is used. This is also called horse shoe electromagnet. Soft iron is placed between the arms of this electromagnet. This is called as 'core'.

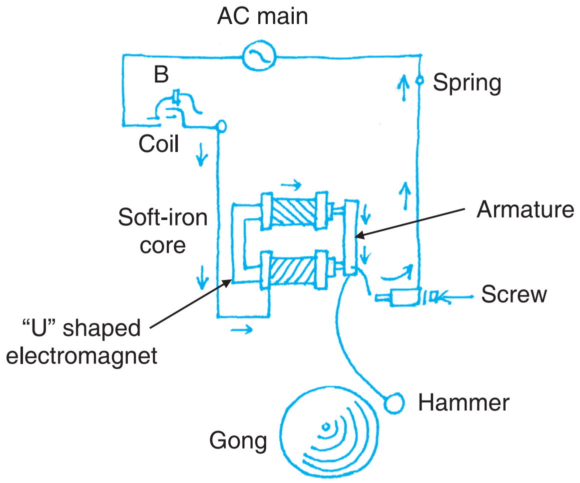


Fig. 17.9 *Electric bell*

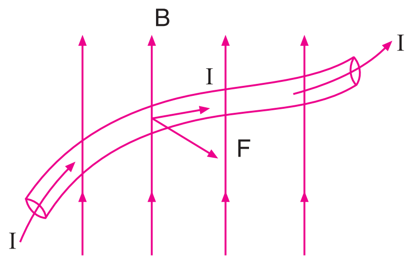
The poles of the electromagnet are connected to a power supply (battery or main). Between this a push button (B) is attached as shown in Fig. 17.9. When the push button is pressed, current starts flowing in the coil of the electromagnet and its soft iron 'core' gets magnetized. This magnetized core pulls the armature attached to the electromagnet towards itself. As a result of this, the hammer attached to the armature strikes the gong and a loud sound is produced. As soon as the armature is attracted by electromagnet the circuit is brought at the contact screw. The electromagnet no more remains magnetic. The armature returns to its original position due to armature spring action.

This process occurs repeatedly. Till the push button remains pressed, the hammer keeps striking the gong of the bell and as a result of this, sound is produced.

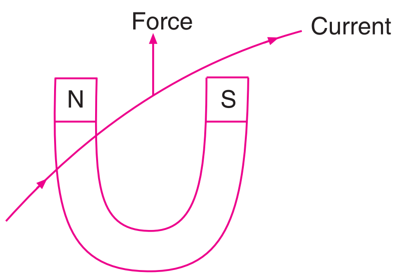
17.5 FORCE ON A CURRENT CARRYING CONDUCTOR PLACED IN A MAGNETIC FIELD

You have seen earlier that, when current flows through a conductor, magnetic field is produced around it. The direction of this field (B) depends upon the direction of flow of electric current (I). Similarly when an electrical conductor is placed in a magnetic field a force acts upon it. The following experiment may be done to observe this.

Let us suspend a piece of copper wire between the poles of a horse shoe magnet in such a manner that the length of the wire is aligned perpendicular to the direction of magnetic field between the poles. As soon as current is allowed to flow through this wire it becomes taut upwards. With this becomes clear that a force acts on the current flowing conductor. The direction of this force always perpendicular to both direction of current and direction of magnetic field and the direction of the flow of current are both perpendicular to the direction of the magnetic field. If the magnet is flipped i.e. the poles are reversed, the conducting wire becomes taut downwards. This force acts on the wire downwards. If the current flowing through the conductor is increased then the force also increases. This force acting on a current conducting wire was discovered by the great scientist Michael Faraday. This principle is used in electric motors.



(a)



(b) Force on a current carrying conductor

Fig. 17.10

The direction of force acting on a current carrying conductor placed in a magnetic field can be found according to the following rule:

Flemings left hand rule

According to Fleming left hand rule the direction of force applied to a current carrying wire is perpendicular to both the direction of the current as well as the magnetic field. It means that, stretch the thumb, the first finger and the middle finger in such a manner that they are perpendicular to each other i.e. the angle between the pairs of fingers is 90°. Then if the first finger shows the direction of the magnetic field and the middle one the direction of current flow, then the thumb shows the direction of force 'F' acting on the current carrying conductor. This rule was originated by John Ambrose Fleming in the late 19th century as a simple way of workout the direction in an electric motor or the direction of electric current in an electric generator.

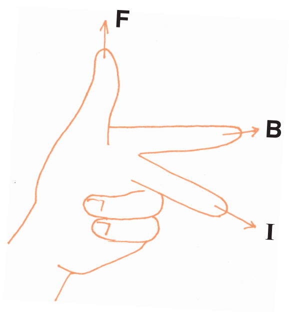


Fig. 17.11 Flemings left hand rule

INTEXT QUESITONS 17.2

1. Presence of magnetic field around an electric wire can be proved by which an behaviour of iron filings
   (i) They form a circular patterns as soon as the electricity is turned on.
   (ii) Try filing fly off the card when the current is on
   (iii) They do not prove anything, because it is magic trick.
   (iv) None of the above
2. Among these which property is not belong to electromagnet?
   (i) It is permanent magnet
   (ii) Its magnetic strength can not be decreased or increased at as well
   (iii) Its polarity can be remove by reversing flow of electric current.
   (iv) It produce strong magnetic field.
3. To findout the direction of force in the electric motor which rules is used?
   (i) Flemings right hand rule
   (ii) Flemings left hand rule

(iii) Right plam rule of right hand

(iv) Left palm rule of left hand

4. Why does an iron core increase the magnetic field of a coil of wire

   (i) The iron atom line up to add the magnetic field

   (ii) Iron attract things includes magnetic fields

   (iii) The iron core actually decrease the field, allowing it to be turned off

5. List the factors affecting the strength of an electromagnet?

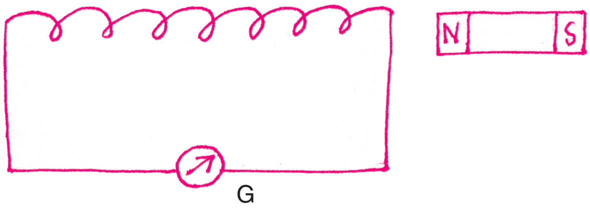
6. What is the role of solenoids in making electromagnet?

17.6 ELECTROMAGNETIC INDUCTION

Previously in this lesson, we have seen that magnetic field is created when current flows through a solenoid (a cylindrical core of insulated copper wires). Do you think that the reverse should also be possible? That means conversion of electricity from magnetism. Michael Faraday, a great scientist also think over it and gave a discovery of induction in 1831. After several years of continuous experimentation he discovered that if changes are brought about in the magnetic field then electric current can be produced. If we rotate a coil of a good conducting wire between the poles of a magnet, then the number of magnetic lines of force associated with it are altered. Similarly if a magnet moves within the coil there is change in the same manner. When this occurs, current starts flowing in the coil. So electromagnetic induction is the production of an electric current across a conductor moving through a magnetic field. Generators, transformers some devices which works on this principle.etc working on this principle.

ACTIVITY 17.4

With this activity, we would able to see, how electricity generated through a magnetic field. You will required a strong magnet, copper wire, pipe (a non conductor), a current measuring instrument like galvanometer, a non conductor pipe (for example made up of cardboard, bamboo etc.) on which copper wire is wound to form a coils. First connect both ends of copper wire to the galvanometer, (Fig. 17.12a) keep the magnet parallel to the coil, bring it close to it and take it away. Repeat the process several times. You will see that each time there is a deflection in the galvanometer. With this you will be also observe that the see that the rate of flow of electric current through the coil increases with the rate of change of magnetic field, the faster the change the greater is the amount of a current flow.



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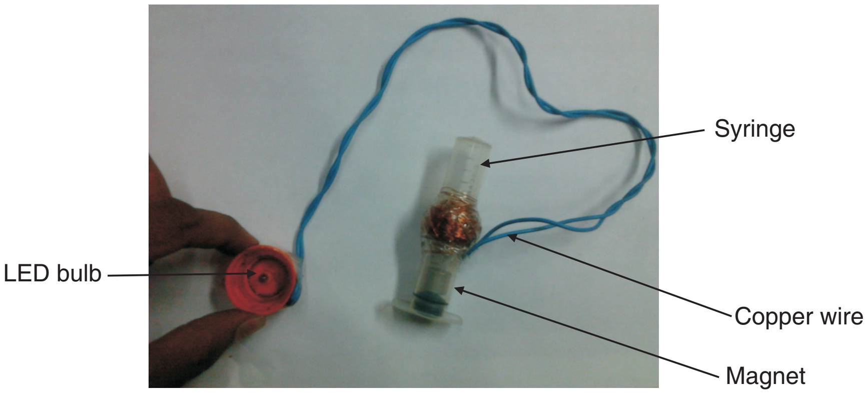

(*b*)

Fig. 17.12

To understand the above principle better, we will try to make a simple experiment, Take a disposable syringe (the one with which a doctor administers injections). Make a 150 turns thin copper insulating wire at the middle of the syringe. Join the two ends of copper wire to Light Emitting Diode (LED) through connecting wire. LED may be fixed inside the plastic bottle capas in Fig. 17.12(b). Placed one cylindrical magnet inside the syringes. When you move magnet, holding the syringe in your hand, continues change in magnetic field take place and LED start glowing.

17.7 ELECTRIC GENERATOR

Electric Generator is such a device that converts mechanical energy to electrical energy. Generators are of two types:

1. **A.C. Generator (Alternating Current Generator):** This produces current that flows in such a manner that its direction and amplitude changes constantly with time.
2. **D.C. Generator (Direct Current Generator):** This generator produces current that flows in the same direction in a continuous manner.

17.7.1 Structure and Function of an A.C. Generator

A.C. generators operate on the principle of electromagnetic induction. Alternating voltage or current may be generated by rotating a coil in the magnetic field or by rotating a magnetic field with a stationary coil. The value of the voltage or current generated depends on

- the number of turns in the coil
- strength of the field
- the speed at which the coil or magnetic field roates

The structure of an A.C. Generator has been shown in Fig. 17.13. Here N-S is a strong permanent magnet. ABCD is a nonconductor frame on which copper wire has been coiled several times to form a rectangular coil. The coil is coated with a nonconductor substance like varnish so that they do not touch each other. This coil can freely move between the N-S poles. This rectangular coil is made to rotate between two rings E and F. There are two contact brushes G and H attached to the rings respectively.

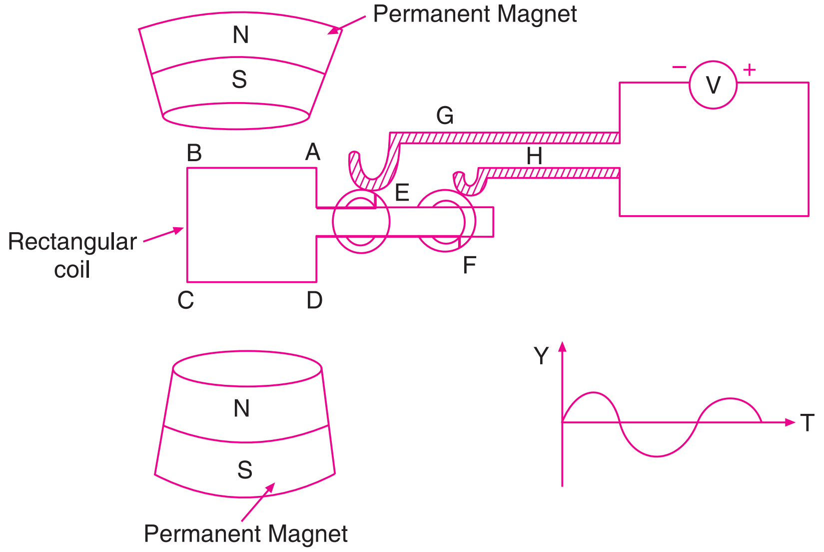

Fig. 17.13 *A.C. Generator*

The rectangular frame ABCD moves between the N-S poles due to mechanical energy. Assume that the plane of the coil in that of the magnet lines of force and the coil starts moving in an anti-clockwise direction. The magnetic field entering into the face ABCD of coil increase from zero to some infinite value and continues to increase till the coil becomes normal to the field. The rate, at which the magnetic field liked with coil charges, is the maximum in the begining and then it decrease continuously. Thus the induced current in the coil is maximum at time, $t = 0$ and decrease passing time. When the coil become normal to the field the rate at which magnetic flux of force charges become zero and hence current in the coil is zero.

When the coil further rotates the face of the coil through which magnetic field enters start changing the directing of current reversed. It keeps increasing till the plane of the coil does not become parallel to the magnetic field lines. Thus maximum current flows through the coil at this juncture. If the coil is rotated further, the area in contact with DCBA increase and the rate of change of magnetic field area becomes less. Thus the amount of current flowing through the coil decreases. When the coil is perpendicular to the magnetic lines of force then, current becomes zero. Now the north pole of the magnet is reversed. Current starts flowing from its original direction. The direction of current produced and its resultant keeps changing with time. Figure 17.14 shows the positions of the coils at different stages and the current in the coil at these instants.

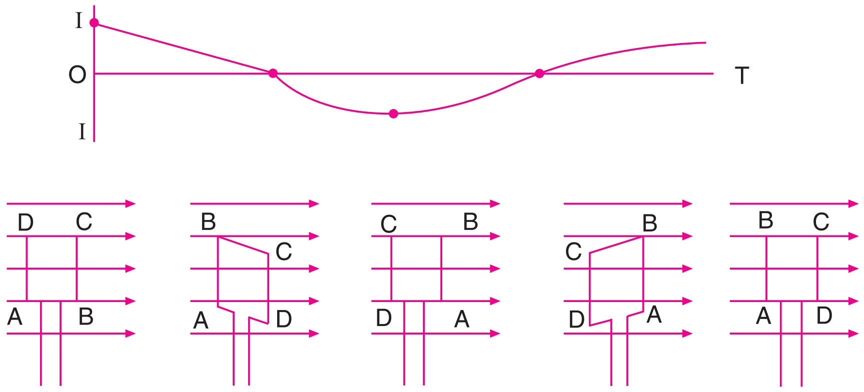

Fig. 17.14

17.7.2 D.C. Generator

This also works like the AC generator. There is just one difference in its structure. There is a half rectangular rings rather than E and F rings as seen in AC generators. The rectangular frame rotates and moves from a position parallel to the magnetic field to an upper one. The brush present creates a connection as electric current starts flowing. We can see thus that current flows in the same direction.

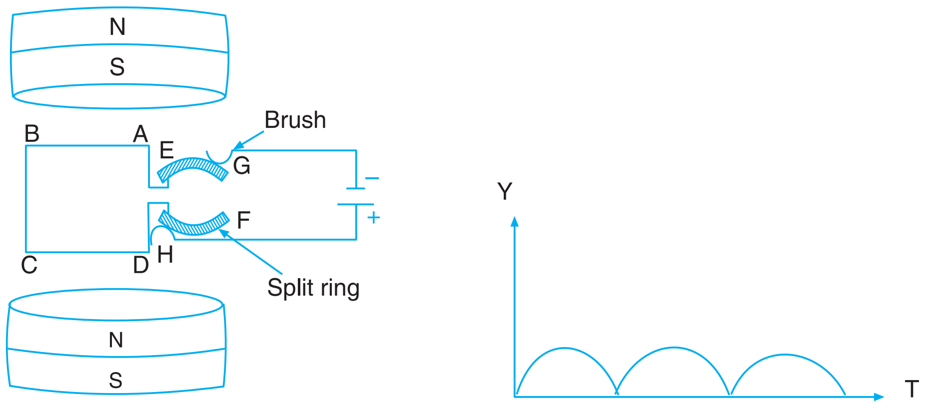

Fig. 17.15 *D.C. Generator*

17.7.3 Alternative Current AC and Direct Current (DC)

In household as well as industrial purposes AC is widely used. The current that flows out from the switch points at homes is AC. The current produced by a battery is

DC. AC can be changed to DC and vice versa. To change AC to DC a rectifier is used.

1. AC is transmitted from electricity generation centers to houses and industries through high voltage transformer (step up transformers) at very high voltage. At the site of delivery like houses and industries the voltage is reduced with the help of step down transformers. In this way transmission cost is reduced as well as wastage of energy is minimized. Transmission of DC causes the loss of a large amount of energy. Transformers cannot be used for DC.
2. Devices like electric motor that work on AC are stronger than those that use DC. They are also more convenient to use. DC generally used in electrolysis, changing the cells, making electromagnet etc.
3. DC of same voltage as AC is more dangerous because in DC direction of flow of current doesn't change. Thus people coming in contact with DC accidentally get stuck to it while when the come in contact with AC, due to change in direction of flow of current they are flung afar.
4. Major portion of AC flows through the upper portion of a wire. Thus where a thick wire has to be installed, several thin wires are coiled together to form a thick wire which will not the case with DC.

17.8 DISTRIBUTION OF ELECTRICAL ENERGY FOR HOUSEHOLD PURPOSES

You may have seen huge electricity poles, transformers, wires etc. around your houses. The production of electricity is done far away from cities at electricity generation centers. These power plants depend upon water, thermal energy, wind or geothermal power. Here electricity is produced usually at 11 KV (voltage), 50 Hertz (frequency). The system by which electricity is transmitted from such centers to the consumer can be divided into two parts.

A) Transmission system.

B) Distribution system.

By using step up transformer voltage is converted transmissions of electricity at the production centre. At the electricity generation centre, by using step up transformer voltage is converted from 11 kV to 132 kV. Then the electricity reaches at low power station through high tension wire. At lower power station it again converted up to 3.3 kV by using step down transformer. In this way by using step down transformer electricity reaches at home at the village of 220 V and 50 Hz. Hertz (Hz) is unit of frequency. The number of cycles completed by AC in one second is called as its frequency. A frequency of 50 Hertz means, AC completes 50 cycles per second. That means AC flows in one direction 50 times while in the other again 50 times in electrical wires, bulbs and other electrical appliances. This means that a bulb lights up 100 times and goes out 100 times in a second. But due to the lack of perception of such small intervals of time, a bulb appears to glow constantly.

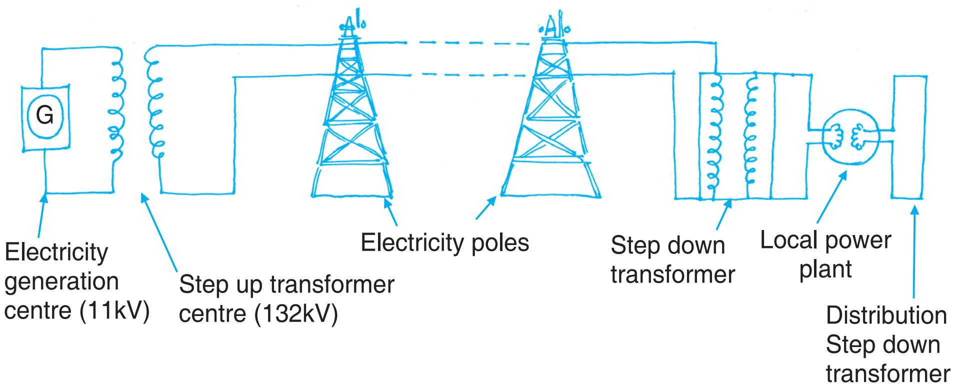

Fig. 17.16 *Distribution of electrical energy*

If the voltage of a transformer is increased then current flow reduces in the same proportion. Thus by using step up transformers we change electricity to higher voltage and reduce the current flow. By transmitting this low current we reduced the losses occured during the transmission.

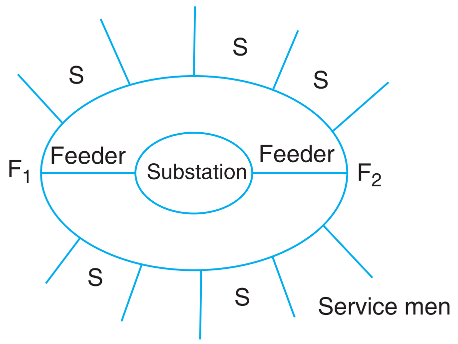

Fig. 17.17 *Ring System*

The distribution system is the arrangement which provides power from substation to the consumer. It involved feeder distrinbutors, sub distributors and service men.Normally there are two types of distribution systems.

1. Tree system   2. Ring system

These days mostly, ring system is used. The arrangement of various component of rings system made distribution is shown in Fig. 17.17.

17.8.1 Household Circuits

Till the poles near our houses, electricity reaches through the distribution system. Two wires from the poles come to our houses. Among these one wire is called as 'phase' while the other is called as neutral. In the phase wire the voltage is 220V while in the neutral the voltage is zero same as that of earth. It is represented as N. Usually the phase wire has a red coloured insulation over it while neutral wire has insulation of any colour other than red or green. Inside the houses wiring is done in parallel mode such that when one lights an appliance in a room it doesn't affect the strength of current in another room.

Household circuits are shown in Fig. 17.18. We use another wire that has green coloured insulation over it which is called as earth wire or earth-connecting wire. All the appliances are connected to this to the earth.

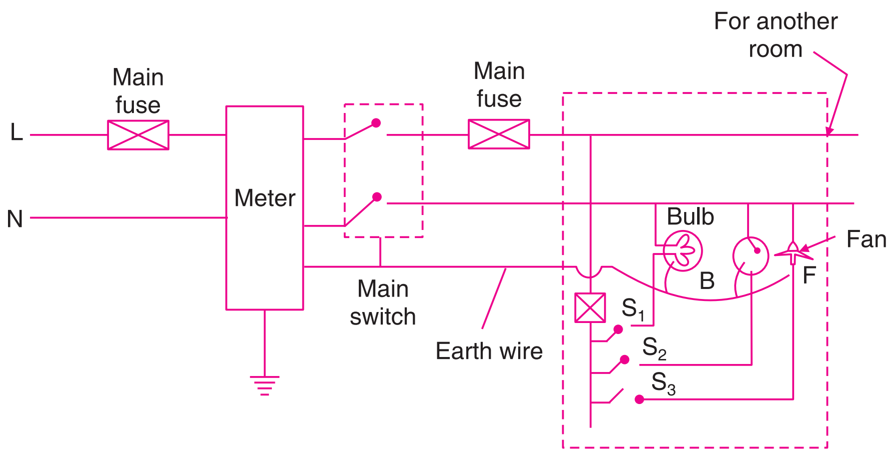

Fig. 17.18 *Household circuit (one bulb, one fan and one plug point)*

This electrical energy is produced by using our natural resources. Population growth growing urbanization is increasing the demand of electricity day by day. This is creating a pressure on our natural resources. Thus it is important today that we use electricity judiciously and not waste it in any way.

17.8.2 Precautions to be taken while using Electrical Energy

If electricity is used in a careful and safe manner it is the largest and most convenient form of energy. If one uses it carelessly it will become lethal.

1. Before working with electricity one must ensure whether it is AC or DC current. DC of the same voltage of AC is more dangerous.
2. Do not touch electricity supply wires with your bare hands. One may even die due to shock from current. AC flungs a person away while one gets stuck to a DC source. The main switch should be switched off in case of any accident. One must separate a person who has received a current shock with the help of a safe nonconductor eg. (rubber, stick, shoes, gloves). Never touch such a person directly.
3. Never use water to extinguish fire caused due to electrical spark.
4. Always ensure that a main supply is switched off before working on electric circuits. Use rubber gloves, shoes and separator device when it is necessary to work on live circuit.
5. In household wiring always use good quality wires, proper thickness and insulation. All the materials should be ISI marked. Connector should be tight and joined should be covered with insulating tapes. Ensure that the safety measures of earthing and fuse are properly done in your household electrical circuit.
6. Ensure that a miniature circuit board (MCB) is there or at least a fuse wire of appropriate load capacity is present.
7. All switches can be switched off by simply closing the single large main switch so that current flow to all appliances is cut off in the emergency.

17.8.3 Accidents Caused by Electricity

You may have often heard that several dangerous accidents have occurred due to electricity at homes or industries. Such accidents by electricity occur due to the following reasons;

- leakage of current
- short circuit
- over load.

1. Leakage of Current

Often due to continuous flow of electric current the insulation over wires gets affected and is scraped off and the wires are left bare. Current leakage occur through such bare wires. Often these bare wires in contact with a metallic surface increase its voltage to that of the main source. The surface of the metal if comes in contact with earth, allows current flow into the earth. When a person touches such appliances gets a severe shock.

2. Short Circuit

If somehow the main and neutral wire come in contact with each other there is a sudden huge spark that takes the form of fire.

3. Overload

If several appliances are connected to the same circuit there is an overload in the circuit. The value of current flow goes above the required value of the circuit. At this juncture the wire fails to bear the load of electric current. This is called overloading. Household appliances are connected parallel to each other in the circuit. The greater the amount of resistance the source would take more of current. You may have seen that during summer when the demand on electricity increases, transformers often burn due to extra load.

17.8.4 Safety Devices used in Electrical Circuits

1. Electrical Fuse

A piece of wire made of lead and tin alloy is used in making fuse. It have its melting point lower and high resistance then that of electrical wire. Due to this, if current in a circuit increase above a particular point the fuse wire gets heated and burns out. Due to this the whole circuit is saved from burning. The fuse wire is connected to the main source in series. Usually 5 A (ampere) fuse is used for household appliances, while 15 A (ampere) fuse is use for power circuits. 15A fuse wires are thicker than 5A (ampere) fuse wires.

2. Miniature Circuit Breaker (MCB)

These days MCB is attached to the household circuit wirings. MCB is a self regulatory switch which saves the circuit from overloading as well as from short circuits. If there is any barrier in the flow of electrical current it immediately stops the flow of current. Fuse is also used for this purpose but MCB is prepared in different shapes varying in use from small to large appliances saving them from high voltage.

3. Earthing of Electrical Appliances

Leakage of electric current in electrical appliances can harm us and may get electrical shock by touching them. Thus as a precaution there is another wire other than phase and neutral which is called as earth wire. The metallic end of all appliances is connected to one end of this wire and the other end is attached to a copper plate and burried deep in the ground. Thus, the body of all electrical appliances is of the same potential difference as that of the earth.

If ever we come in contact with electrical current, the path of earthing would be shorter than that through our bodies and thus we would be saved as current would flow through the alternative (earth) pathway rather than through our bodies.

INTEXT QUESTIONS 17.3

1. The work of an electric generator is to:
   (i) Change chemical energy to electrical energy.
   (ii) Change mechanical energy to electrical energy.
   (iii) Change electrical energy to mechanical.
   (iv) Change electrical energy to chemical energy.
2. Appliance that works on the principle of electromagnetic induction.
   (i) Electric kettle (ii) Electric bell
   (iii) Electric lamp (iv) Electric generator
3. Electric fuse should have the following combination of melting point and resistance:
   (i) high resistance and low melting point
   (ii) low resistance and high melting point

(iii) high resistance and high melting point

(iv) Low resistance and low melting point

4. Which principle states that by changing magnetic field, current produced:

   (i) Coulombs law (ii) Magnetic behaviour of a solenoid

   (iii) Electromagnetic induction (iv) Ohms law

5. Appliance that converts high voltage to low voltage is:

   (i) Step up transformer (ii) Step down transformer

   (iii) Rectifier (iv) Amplifier

6. Fuse wire is made up of

   (i) Silicon and Tin alloy (ii) Tin coated with zinc

   (iii) tin coated with nickel (iv) Tin coated with aluminium

7. According to Flemmings left hand rule the force acting on the current carrying conductor is:

   (i) Parallel to magnetic field and current flow.

   (ii) Perpendicular to magnetic field and current flow.

   (iii) Parallel to magnetic field but perpendicular to the direction of current flow.

   (iv) Perpendicular to magnetic field but parallel to direction of current flow.

8. Which wire saves appliances from damage among those that come into our homes?

   (i) Phase (ii) Neutral

   (iii) Earth (iv) None of the above.

9. Give the three reason of accident caused by electricity.

10. Name one of the tool used to check the current in wire and commonly used in home and industry.

11. Sometimes while touching the electrical appliance we have a shocked. What will the commonly answer for this?

12. Two coils A and B are placed close to each other. If the current in the coil A is changed, will some current be induced in the coil B? Give reason.

WHAT YOU HAVE LEARNT

- Magnetic field is that region around a magnet that deflects a magnetic needle kept in the region due to application of force.
- The electrical appliances like fan, mixer, juicer-grinder, crane etc. that use motors are based on magnetic effects of electric current.

- A change in magnetic lines of force present in conjunction with a current carrying coil produce electric current. This is called as electromagnetic induction.
- The strength of an electromagnet depends upon:- (i) the current that flows through it; (ii) No. of magnetic lines of force in unit length of coil; (iii) Nature of core etc.
- Flemings left hand rule gives the direction of force that acts upon a current carrying conductor placed in a magnetic field.
- Electrical generators are such devices in which mechanical energy is converted to electrical energy.
- Electric current is transmitted at high voltage and low current from one place to another.
- Rectifiers are used to convert AC to DC. Current produced by a battery is DC.
- Household appliances are always connected in parallel so that if the appliance is used, it does not affect electric current taken by other appliances.
- Transformers convert high voltage to lower (step down transformers) or low voltage to higher voltage (step-up transformers).
- Fuse wire has a low melting point and high resistance.
- One must wear rubber shoes and gloves while working with electrical circuits. It is because rubber is a bad conductor of electricity. Thus current does not flow through it.
- During an accident due to electricity switch off the main switch. The person who is a victim of electric shock should be separated from the appliance or lifted from the ground with the help of a non-conductor. The person should not be touched in any case.
- During disaster like fire or earthquake try to switch off the main switch.

TERMINAL EXERCISE

1. Why does a compass needle get deflected when brought near a bar magnet?
2. Explain magntic field using the concept for magnetic line of forces.
3. Write down the properties of magnetic lines of force.
4. Explain the force acting on current carrying conductor in a magnetic field.

5. How is an electromagnet made from a solenoid? Explain. Write down the differences between bar magnet and electromagnet.

6. What is electromagnetic induction. Explain in detail the functioning of any one appliance based on this principle.

7. Describe the advantages of AC over DC.

8. What is the function of an earth wire? Why is it necessary to earth electrical appliances.

9. Make such a household circuit that shows current coming from a pole to the room and at least a fan and a bulb can be lit. Explain the use of socket, switch and fuse as well.

10. Name some devices in which elctric motors are used.

11. How does current reach from electricity production centre to the houses?

12. Explain the structure and functions of AC generator.

13. Explain the magnetic effects of electric current and on the basis of this explain the functioning of the electric bell.

14. What is Flemings left hand rule?

15. When does an electric short circuit occur?

ANSWER TO INTEXT QUESTIONS

17.1

2. it properties does not changed
3. speaker in handset
4. North-South
5. yes, but their strength depends on where you are
6. (ii) South pole, which corresponds to the geographic north
7. Magnetic poles are the surfaces from which the invisible line of magnetic field emanate and connect on return to the magnet

17.2

1. (i)
2. (ii)
3. (ii)
4. (i)

5. (i) Number of turns
   (ii) Current flowing in the coil
   (iii) Length between the poles
6. A solenoid is used for making electromagnets. The use of soft iron rod as core in a solenoid produces strong magnetism.

17.3

1. (ii)	2. (iv)	3. (i)	4. (iii)
5. (ii)	6. (i)	7. (ii)	8. (iii)

9. Leak of current, short circuit, overloading
10. Electrical tester
11. Proper earthing is not there
12. When the current in coil A is changed the magnetic field associated will also changes. As a result magnetic field around coil B also changes. This changes in magnetic field lines around coil B induced an electric current. This is called electromagnetic induction.