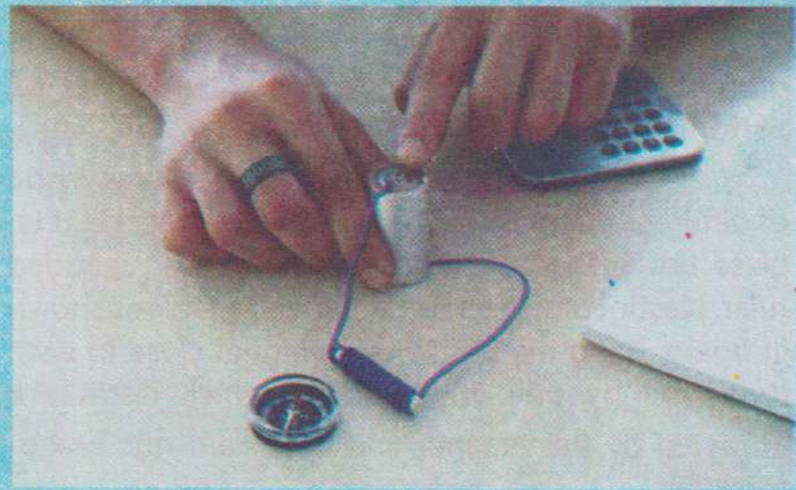
Chapter 8 Magnetism

Student Learning Outcomes

After completing this chapter, students will be able to:



- Describe the forces between magnetic poles and between magnets and magnetic materials [Including the use of the terms north pole (N pole), south pole (S pole), attraction and repulsion, magnetised and unmagnetised]
- Describe induced magnetism
- Differentiate between temporary and permanent magnets
- Describe magnetic fields [as a region in which a magnetic pole experiences a force]
- State that the direction of the magnetic field at a point is the direction of the force on the N pole of a magnet at that point
- State that the relative strength of a magnetic field is represented by the spacing of the magnetic field lines
- Describe uses of permanent magnets and electromagnets
- Explain qualitatively in terms of the domain theory of magnetism how materials can be magnetised and demagnetise [stroking method, heating, orienting in north-south direction and striking, use of a solenoid]
- Differentiate between ferromagnetic, paramagnetic and diamagnetic materials [by making reference to the domain theory of magnetism and the effects of external magnetic fields on these materials]
- Analyse applications of magnets in recording technology [and illustrate how electronic devices need to be kept safe from strong magnetic fields]
- State that soft magnetic materials (such as soft iron) can be used to provide shielding from magnetic fields

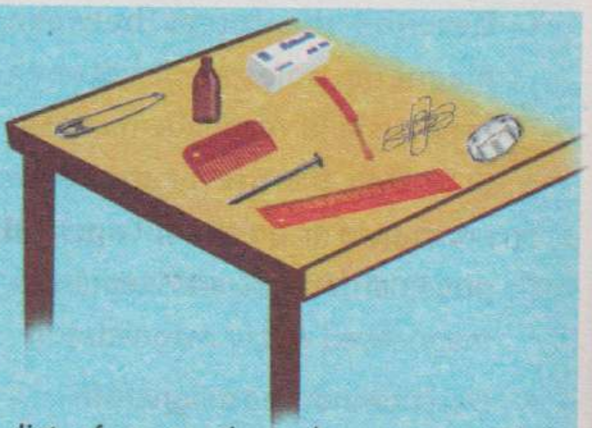
Almost all of us are familiar with a magnet because of its interesting properties. In lower classes, we have studied some of the properties. You might have also enjoyed a magnet attracting small pieces of iron.

8.1 Magnetic Materials

Magnetism is a force that acts at a distance upon magnetic materials. These materials are attracted to magnets. These materials are called **magnetic materials**. Let us perform an activity to test such materials.

Activity 1

The teacher should divide the students into groups and provide them permanent magnets to perform this activity.



Each group should collect some items made of different materials such as copper wire, nickel ring, glass bottle, paper clips, iron nail, eraser, wooden ruler, plastic comb, etc. Place them on a table as shown in figure. Bring the permanent magnet close to each item one by one and observe which items are attracted by the magnet and which are not. Make a list of magnetic and non magnetic materials.

Materials such as iron, nickel and cobalt will be attracted by the magnet. They are magnetic materials. The materials such as brass, copper, wood, glass and plastic are not attracted by the magnet. They are called non-magnetic materials.

We will discuss different types of materials in detail later in this chapter.

For Your Information!

Over 1000 years ago, the Greeks discovered a rock called lodestone or magnetite that could attract materials that contained iron. Also, if suspended from a string to rotate freely, it would always settle in north-south direction. This unique property led to form the basis of compass which was later on used for navigation on land and at sea.

Activity 2

The teacher should facilitate each group to perform this activity as per instructions.

1. Place some iron filings scattered on the top of a card paper or a sheet of glass.
2. Move a magnet beneath the card paper, glass or a plastic sheet as shown in the figure.
3. What do you observe? Describe briefly.

(a) Scattered Iron filings on a glass sheet

(b) Iron filings attracted by magnet

You must have seen the iron filings following the movement of the magnet. Magnetic force accounts for these movements. This activity also shows that magnets can attract objects containing iron, etc. even if they are not in direct contact with them.

8.2 Properties of Magnets

The property of attracting magnetic materials by the magnets has been discussed above. The magnets also exhibit the following properties.

1. Magnetic Poles

If a bar magnet is suspended horizontally through a string and allowed to come to rest, it will point in north-south direction. The end of the magnet that points north is called the **north magnetic pole** (N) and rhe end that points south is the **south magnetic pole** (S) as shown in Fig. 8.1.

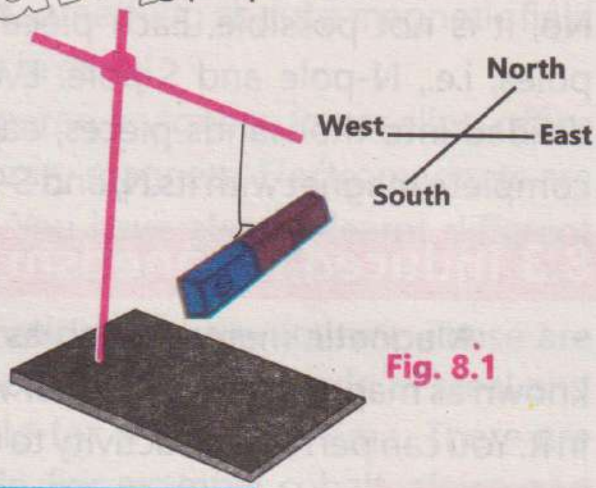


Fig. 8.1

2. Attraction and Repulsion of Magnetic Poles

When two freely suspended bar magnets are placed close to each other, the two north poles will repel each other (Fig. 8.2). So will the two south poles (Fig. 8.3).

However, if the north pole of one is placed near the south pole of the other, the poles will attract (Fig. 8.4 & Fig. 8.5). We can say that **Like poles repel and unlike poles attract**.


Fig. 8.2


Fig. 8.3


Fig. 8.4

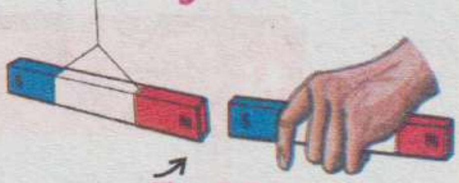


Fig. 8.5

3 . Identification of a Magnet

To identify whether an object is a magnet or simply a magnetic material, we can bring its one end close to any pole of a suspended bar magnet. If it is attracted, then we can conclude that the end of the object is either of opposite pole to that of the suspended magnet or it is simply a magnetic material. Then we should bring the same end of the object close to the other end of the suspended magnet. If the object is again attracted, it is not a magnet but it is a magnetic material.

If it is repelled by the other end of the suspended magnet, then the object is a magnet.

The repulsion between the like poles is a real test to identify a magnet.

4. Is Isolated Magnetic Pole Possible?

If we break a bar magnet into two equal pieces, can we get N-pole and S-pole separately? No, it is not possible. Each piece will have its two poles, i.e., N-pole and S-pole. Even if a magnet is divided into thousands pieces, each piece will be a complete magnet with its N, and S-poles (Fig.8.6).

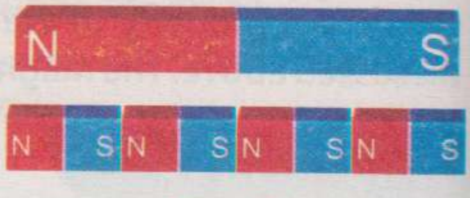


Fig. 8.6

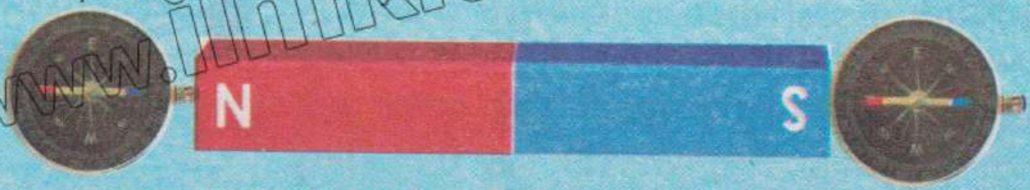
8.3 Induced Magnetism

Magnetic material such as iron or steel can be made a magnet. This is known as magnetization. In other words, we can say that magnetism has induced in it. You can perform an activity to observe this fact.

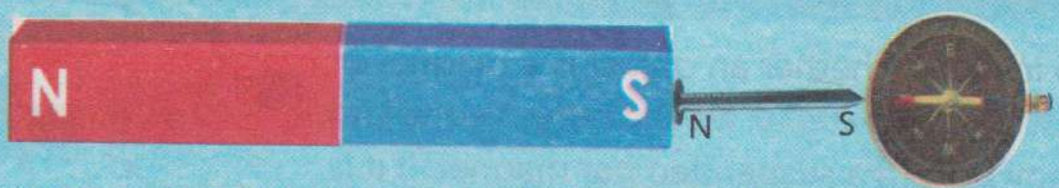
Activity 3

The teacher should facilitate each group to perform this activity as per instructions.

1. Take a magnetic compass. Put it on a table and see which end of its needle points north. The N-pole of the needle is usually coloured red.
2. Place a bar magnet on the table. Bring the compass near to its N-pole. In which direction does the N-pole of the needle stay?



3. Put the compass near to the S-pole of the bar magnet. In which direction does the N-pole of the needle stay this time?
4. Now place an iron nail having its head in contact with any pole of the bar magnet.



5. Put the compass near to the pointed end of an iron nail. Observe the direction in which N-pole of the needle settles. Has the nail become a magnet? Has magnetism been induced in it?
6. Take the bar magnet away from the nail. Again check the behaviour of the nail by bringing compass near to its ends. Does the magnetism vanish?

From the above activity, we conclude that the S-pole of the true magnet induces N-pole in the near end of the piece of iron (nail) while the far end of the iron piece becomes S-pole as shown in the figure.

It should be noted that the induced magnetism vanishes as the true magnet is removed.

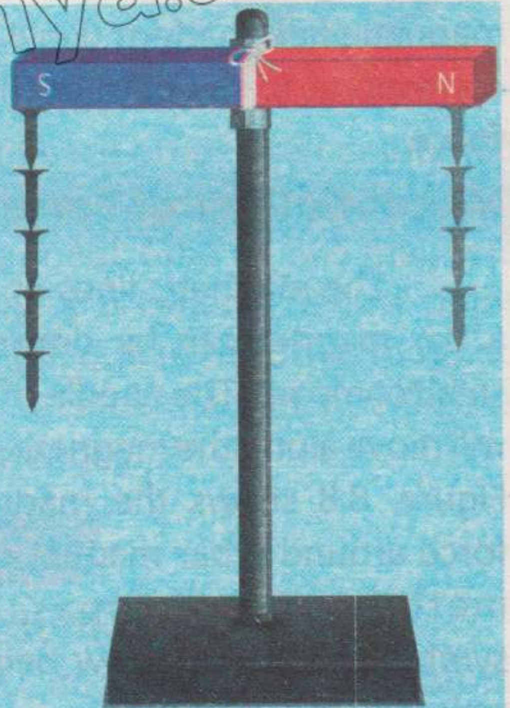
8.4 Temporary and Permanent Magnets

Temporary magnets are the magnets that work in the presence of a magnetic field of permanent magnets. Once the magnetic field vanishes, they lose their magnetic properties. You have learnt something about a magnetic field in lower classes. In this chapter, we will study it in detail.

Usually, soft iron is used to make temporary magnets. Paper clips, office pins and iron nails can easily be made temporary magnets. Electromagnets are also good examples of temporary magnets. You have already learnt different uses of electromagnets.

Permanent magnets retain their magnetic properties forever. These are either found in nature or artificially made by placing objects made of steel and some special alloys in a strong magnetic field for a sufficient time. There are many types of permanent magnetic materials. For example cobalt, alnico and ferrite.

Activity 4



The teacher should facilitate the groups to provide each a bar magnet, a stand with clamp, some small nails made of iron and also some nails of steel. He should further supervise them to perform the activity as per instructions.

1. Clamp the bar magnet horizontally on the stand.
2. Touch the head of an iron nail to anyone end of the magnet. It will be attracted and stick to the magnet. Touch another iron nail to the lower end of the first one, does it stick to it?
   Yes, it will, because the upper nail has become a magnet itself. Go on hanging iron nail one by one to make a chain until no more nails stay attached to the chain.
3. Try to hang steel nails at the other end of the bar magnet to form a similar chain.
4. Remove the chain of iron nails by pulling the topmost nail. Does the chain collapse?
5. Remove the chain of steel nails in the same way. Does this collapse?
   You will observe that the chain of iron nails immediately collapses but the steel nails remain attached to each other for some time. This shows that the magnetism induced in the iron nails is temporary while that in the steel nails is permanent.

8.5 Magnetic Fields

When a magnet attracts a certain magnetic material, it exerts some force to do so. Similarly, when it attracts or repels a magnetic pole of another magnet, it exerts a force on it. This force can be observed up to a certain distance from the magnet that can be explained by the concept of magnetic field around the magnet.

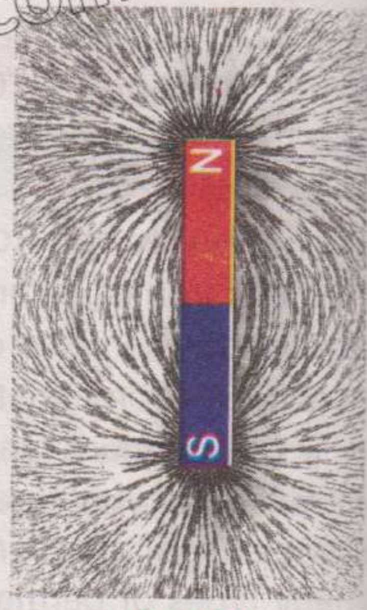


Fig. 8.7

A magnetic field is the region around a magnet where an other magnetic object experiences a force on it.

The pattern of a magnetic field around a bar magnet can be seen very easily by a simple experiment.

If iron filings are sprinkled on a thin glass plate placed over a bar magnet, the filings become tiny magnets through magnetic induction. Now if the glass surface is gently tapped, the filings form a pattern. This pattern is known as the magnetic field pattern (Fig.8.7). This pattern can be better shown by lines that correspond to the path of the filings. These lines are called **magnetic lines of force**.

Magnetic lines of Force

The magnetic lines of force around a bar magnet can be drawn by using a small compass. The needle of the compass will move along the magnetic lines of force. Figure. 8.8 shows the magnetic lines of force around a bar magnet drawn by this method. The compass needle is symbolized by an arrow being the north pole (Fig. 8.9).

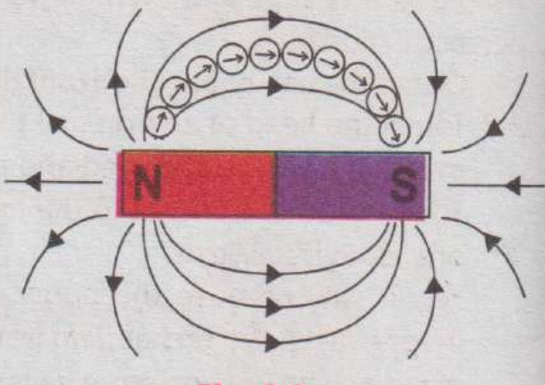


Fig. 8.8


Fig. 8.9

The magnetic field at a point has both a magnitude and a direction.

The direction of the magnetic field at any point in space is the direction indicated by the N-pole of a magnetic compass needle placed at that point.

Figure. 8.8 also shows that the field lines appear to originate from the north pole and end on the south pole. Actually, the magnetic field extends in space all around the magnet but the figure shows the field in one plane only.

Strength of the Magnetic Field

The strength of the magnetic field is proportional to the number of magnetic lines of force passing through unit area placed perpendicular to the lines. Thus, the magnetic field is stronger in regions where the field lines are relatively close together and weaker where these are far apart. For example in Fig. 8.10, the lines are closest together near north and south poles indicating that the strength of the magnetic field is stronger in these regions. Away from the poles, the magnetic field becomes weaker.

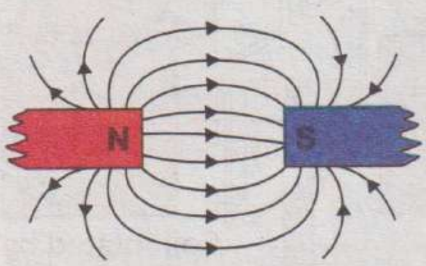


Fig. 8.10

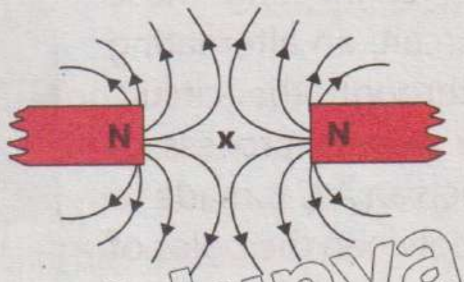


Fig. 8.11

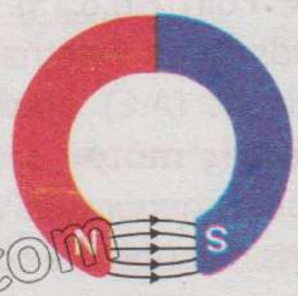


Fig. 8.12

In case the two magnets are placed close to each other, their combined magnetic field can also be drawn by using the compass needle. Figure. 8.10 and Fig. 8.11 show the patterns of the combined magnetic field of two magnets lying with different orientations. In Fig. 8.11, point '**x**' is called a neutral point because the field due to one magnet cancels out that due to the other magnet. Figure. 8.12 represents the field pattern of a horse-shoe magnet. The field is almost uniform between the poles except near the edges.

8.6 Uses of Permanent Magnets

There are many uses of permanent magnets such as:

1. They are the essential parts of D.C motors, A.C and D.C electric generators.
2. Permanent magnets are used in the moving coil loud-speakers.
3. These are very commonly used in door catchers.
4. Magnetic strips are fitted to the doors of refrigerators and freezers to keep the door closed tightly.
5. They are commonly used to separate iron objects from different mixtures. Flourmills use permanent magnets to remove iron nails, etc. from the grains before grinding.

6. In the medical field, they are used to remove iron splinters from the eyes.
7. A piece of permanent magnet is used to reset the iron pointer in a maximum and minimum thermometer.

Applications of Permanent Magnets

Let us see, how some of the following devices use permanent magnets.

A.C Generator

When a coil is rotated between the poles of a permanent magnet, the magnetic field through the coil changes and an emf is induced between the ends of the coil (Fig.8.13). On connecting these ends to an external circuit, an alternating current (A.C) flows through the circuit. **Electric motor** is the reverse process of electric generator. When an A.C is made to pass through the coil between the poles of a permanent magnet, it starts rotating.

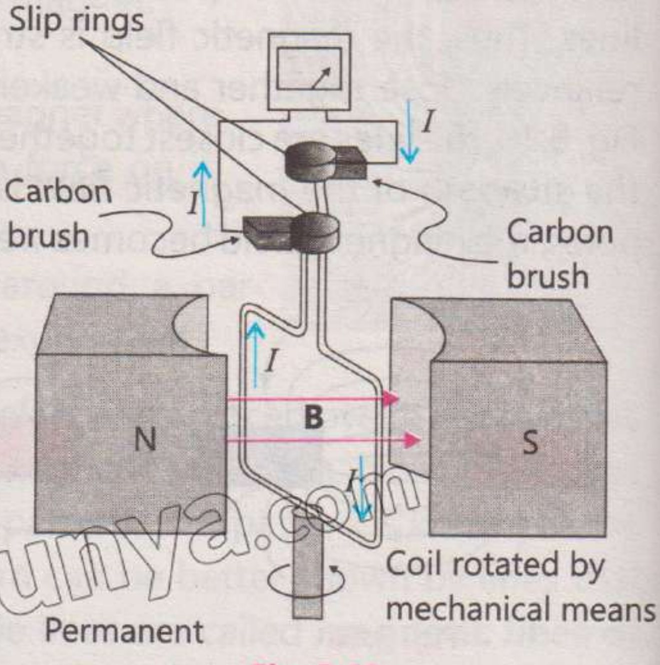


Fig. 8.13

Moving Coil Loudspeaker

A voice coil attached to the cone of the speaker is slipped over one pole (N) of the radial permanent magnet as shown in Fig. 8.14. From a microphone or some other sound signals in the form of varying (A.C) current passes through the voice coil that is inserted in the gap of permanent magnet. This A.C interacts with the magnetic field to generate a varying force that pushes and pulls on the voice coil and the attached cone. The cone vibrates back and forth to produce sound in the air.

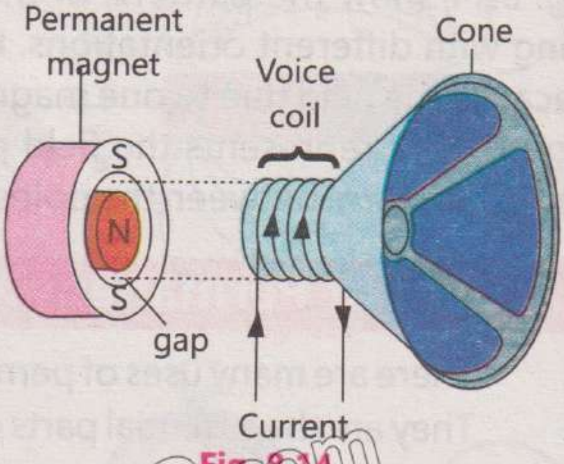


Fig. 8.14

8.7 Electromagnets

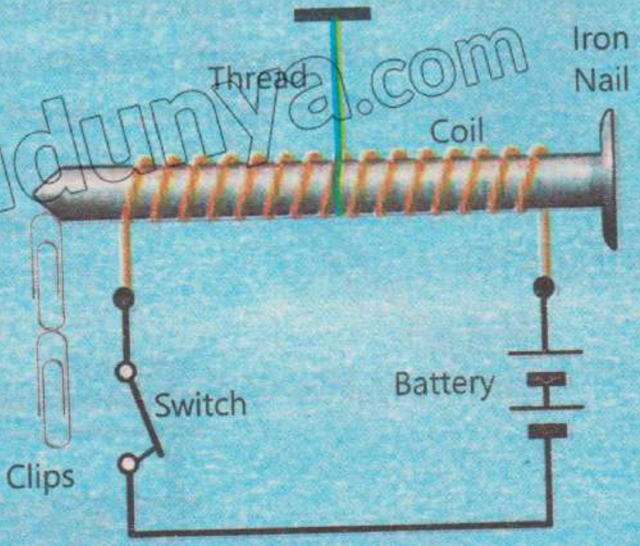
Electromagnets are also a kind of temporary magnets. The following activity will show how electromagnets can be made and tested.

Activity 5

The teacher should divide the students into groups and facilitate them to perform this activity.

Take a battery of two cells, a switch, an iron nail, cotton (or plastic) covered copper wire, thread and a few paper clips.

Wind the wire over the iron nail to form a coil. Suspend the coil by means of thread tied to its centre. Connect ends of the wire to the battery through the switch as shown in the figure.



Keeping the switch OFF, bring some paper clips near to one end of the nail. Do they stick to the nail? Now turn the switch ON and again bring the paper clips near to the end of the nail. Do they stick this time? Does the nail behave like a magnet? Yes, the nail has become a magnet. Turn the switch OFF and see what happens to the clips. Do they fall down? What do you conclude from this activity?

An iron nail or a rod becomes a magnet when an electric current passes through a coil of wire around it. It is called an electromagnet.

When an electric current passes through the coil of wire, magnetic field is produced inside the coil that magnetizes the iron nail. As we have observed that the magnetic properties of an electromagnet are temporary, therefore, iron object remains a magnet as long as the electric current passes through the coil. When the current is stopped, it no longer remains a magnet.

If we increase the number of cells in the battery or increase the number of turns of the coil, we will observe that the strength of the magnetic field in each case increases. This will be indicated by the more number of clips held by the nail in these cases.

Uses of Electromagnets

Electromagnets are used in electric bell, telephone receiver, simple magnetic relay, circuit breaker, reed switches, cranes, tape recorder, maglev trains and many other devices. Functions of some of them are described below:

Magnetic Relay

This is a type of switch which works with an electromagnet. It is an input circuit which works with a low current for safety purpose. When it is turned ON it activates another circuit which works with a high current.

The input circuit supplies a small current to electromagnet. It attracts the iron armature which is pivoted. The other end of the armature moves up and pushes the metal contacts to join together which turn the high current-circuit ON (Fig.8.15).

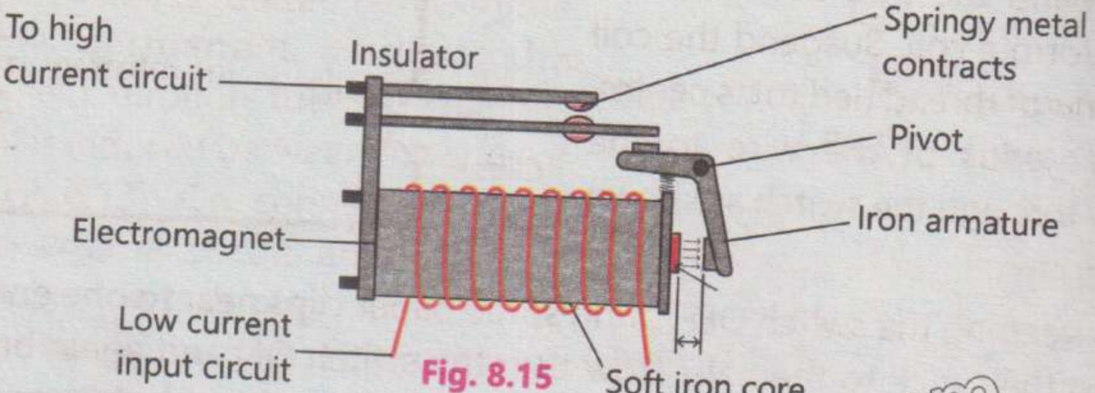


Fig. 8.15

Circuit Breaker

A circuit breaker is designed to pass a certain maximum current through it safely. If the current becomes excessive, it switches OFF the circuit. Thus, electric appliances are protected from burning. As shown in Fig.8.16, inside a circuit breaker, the current flows along a copper strip, through the iron armature and coil of the electromagnet. The electromagnet attracts the armature. If the current is large enough, the armature is detached from the copper strip and the circuit breaks.

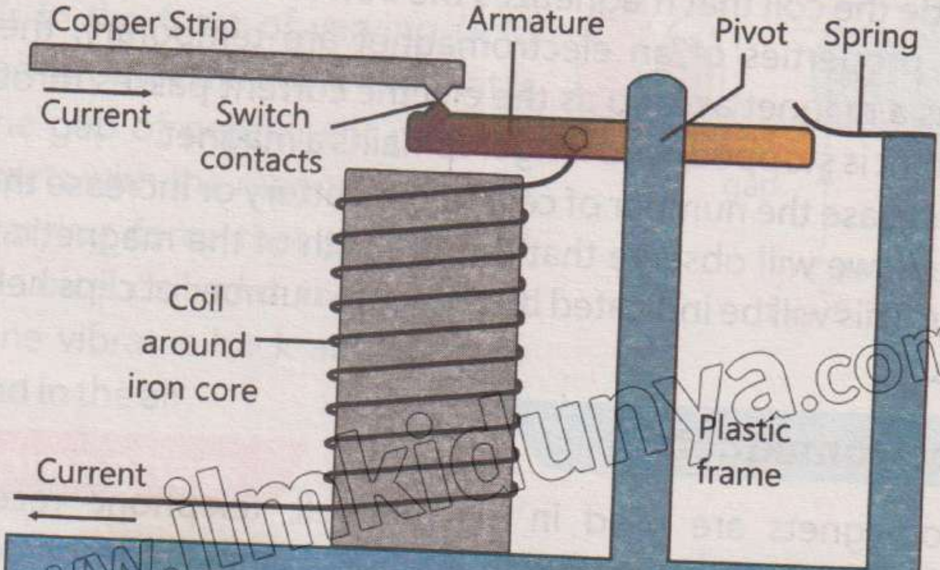


Fig. 8.16

Telephone Receiver

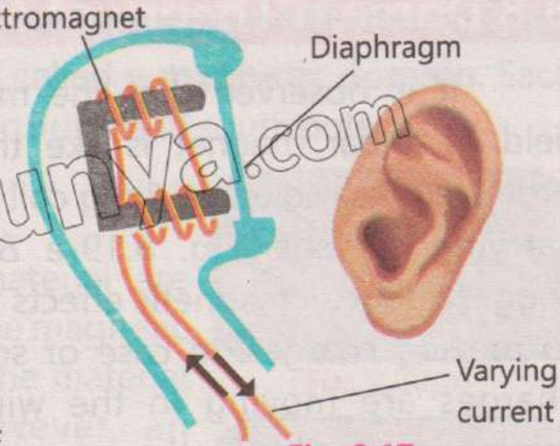
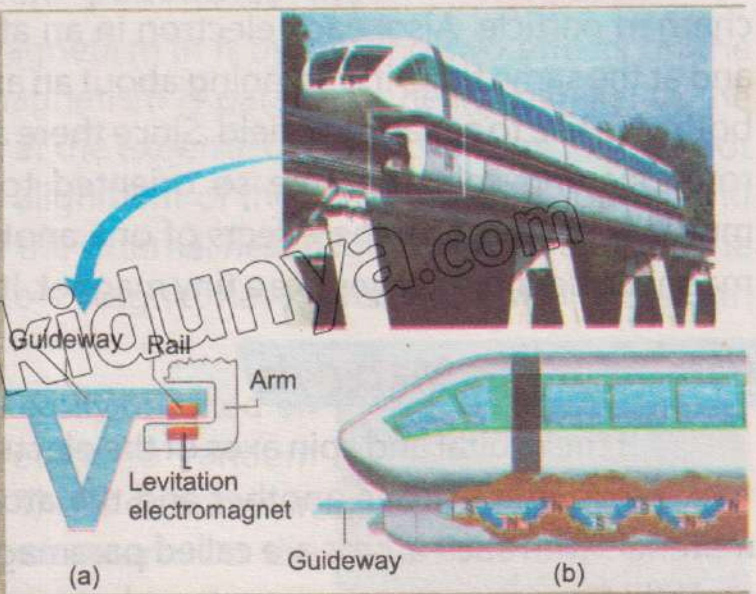


Fig. 8.17

There is an iron diaphragm in the receiver under which an electromagnet is placed (Fig.8.17). The microphone of the telephone handset on the other side sends varying electric current in accordance with the sound signals. When the varying current passes through the coil of receiver on this side, it causes variation in the force of electromagnet. As a result, the diaphragm over it moves back and forth to produce sound.

For Your Information!

A wonderful use of electromagnets can be seen in the **Maglev trains**. The maglev stands for a magnetically levitated train. A maglev uses forces that arise from induced magnetism to levitate or float a few centimetres above the guideway. That is why, it does not need wheels and faces no friction. In Japan, it is known as a bullet train that can run up to a speed of 400 km per hour.



As described above, magnetic levitative only lifts the train and does not move it forward. To push the train forward, propulsion electromagnets are installed along the guideway and train. The push and pull of these magnets moves the train forward.

Electromagnetic Cranes

Huge electromagnets are used in cranes at scrapyards, steel works and on ships. These are so powerful that they can lift iron and steel objects such as cars as shown in Fig.8.18. After moving the heavy objects to the required position, the objects are released by just switching OFF the current of the electromagnet.


Fig. 8.18

8.8 Domain Theory of Magnetism

It is observed that the magnetic field of a bar magnet is like the field produced by a solenoid (long coil of wire) carrying current (Fig. 8.19-a & b). It suggests that all magnetic effects are due to moving charges. In case of solenoid, charges are moving in the wire. The motion responsible for the magnetism in a magnet is due to electrons within the atoms of the material.

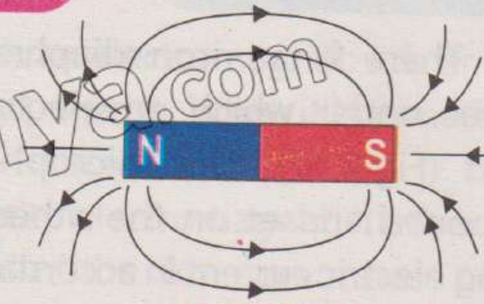


Fig. 8.19(a)

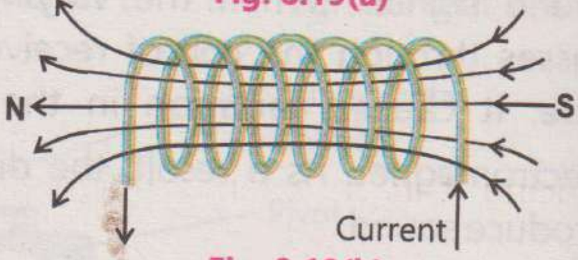


Fig. 8.19(b)

We know that an electron is a charged particle. Also, each electron in an atom is revolving about the nucleus and at the same time, it is spinning about an axis through it. The rotation and spin both give rise to a magnetic field. Since there are many electrons in an atom, their rotations and spins may be so oriented to strengthen the magnetic effects mutually or to cancel the effects of one another. If an atom has some resultant magnetic field, it behaves like a tiny magnet. It is called a **magnetic dipole**.

Paramagnetic Materials

If the orbital and spin axes of the electrons in an atom are so oriented that their fields support one another and the atom behaves like a tiny magnet, the materials with such atoms are called paramagnetic materials, such as aluminium and lithium.

Diamagnetic Materials

Magnetic fields produced by both orbital and spin motions of the electrons in an atom may add up to zero. In this case, the atom has no resultant field. The materials with such atoms are called diamagnetic materials. Some of their examples are copper, bismuth, water, etc.

Ferromagnetic Materials

There are some solid substances such as iron, steel, nickel, cobalt, etc. in which cancellation of any type does not occur for large groups of neighbouring atoms of the order of 10^{16} because they have electron spins that are naturally aligned parallel to each other. These are known as ferromagnetic materials.

The group of atoms in this type of material form a region of about 0.1 mm size that is highly magnetized. This region is called a **magnetic domain**. Each domain behaves as a small magnet with its own north and south poles.

Alignment of Domains

Fig. 8.20(a)

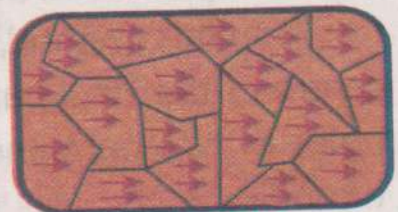


Fig. 8.20(b)

The domains in a ferromagnetic material are randomly oriented as shown in Fig.8.20 (a). The magnetic fields of the domains cancel each other so the material does not display any magnetism. However, an unmagnetized piece of iron can be magnetized by placing it in an external magnetic field provided by a permanent magnet or an electromagnet.

The external magnetic field penetrates the unmagnetized iron and induces magnetism in it by causing two effects on the domains. Those domains whose magnetism is parallel or nearly parallel to the external magnetic field grow in size at the expense of other domains that are not oriented. In addition, the magnetic alignment of the other domains rotates and become oriented in the direction of the external field (Fig.8.20-b). As a result, the iron is magnetized and behaves like a magnet having its own north and south poles.

In soft iron, the domains are easily oriented on applying an external field and return to random position when the field is removed. This is desirable in an electromagnet and also in transformers. On the other hand, steel is not so easily oriented to change order. It requires very strong external field, but once oriented, retains the alignment. That is why, steel is used to make permanent magnets.

In non-ferromagnetic materials, such as aluminium and copper, the formation of magnetic domains does not occur, so magnetism cannot be induced into these substances.

For Your Information!

The magnetism induced in a ferromagnetic material can be surprisingly large in the presence of weak external field. In some cases, induced field is a thousand times stronger than the external field. That is why, high field electromagnets are made by using cores of soft iron of some other ferromagnetic material.

8.9 Magnetisation and Demagnetisation

There are two methods used for magnetising a steel bar:

1. **Stroking**

In this method, magnetism is induced in a steel bar by using the magnetic field of a permanent magnet. The steel bar can be stroked in two ways:

(a) Single-Touch Method

A steel bar is placed on a horizontal surface. It is stroked from one end to the other several times in the same direction using the same pole (say N) of the permanent magnet. Every time the magnet is lifted up sufficiently high on reaching the other end of the bar (Fig. 8.21).

Fig. 8.21

(b) Double-Touch Method

In this method, stroking is done from the centre of the steel bar onwards with the unlike poles of two permanent magnets at the same time (Fig. 8.22). This method is more efficient than the first one.

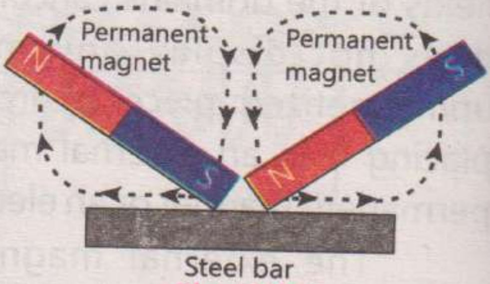


Fig. 8.22

In both the cases, the poles produced at the ends of magnetized steel bar after stroking are of the opposite polarity to that of the stroking pole.

2. Making a Magnet using Solenoid

In this method, a steel bar to be magnetised is placed inside a solenoid (long coil of wire) as shown in Fig. 8.23. The solenoid should have several hundred turns of insulated copper wire. When direct current is passed through the solenoid, the steel bar becomes a magnet. The polarity of the magnetised steel bar is found by applying **Right hand Grip rule** which is stated as:

Fig. 8.23

> Grip the solenoid with the right hand such that fingers are curled along the direction of current (positive to the negative terminal of the battery) in the solenoid, then the thumb points to the N-pole of the bar end.

Demagnetisation of Magnets

1. Heating

Thermal vibrations tend to disturb the order of the domain. Therefore, if we heat a magnet strongly, the magnet loses its magnetism very quickly (Fig. 8.24).

Fig. 8.24

2. **Hammering**

If we beat a magnet, the domains lose their alignment and the magnet is demagnetised. It is also called hammering (Fig. 8.25).

Fig. 8.25

3. **Alternating Current**

When an alternating current (A.C) is flowing through a long solenoid, a magnet moved out slowly from inside of the solenoid is demagnetised (Fig. 8.26).

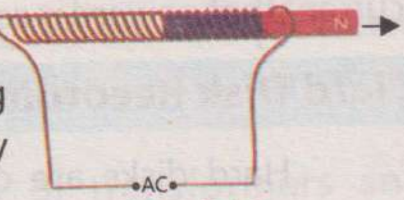


Fig. 8.26

8.10 Applications of Magnets in Recording Technology

Electromagnets have widely used in recording technology of sound, video and data in the form of electrical signals through magnetization of a magnetic material. Most common magnetic recording mediums are **magnetic tapes** and **disk recorders** which are used not only to reproduce audio and video signals but also to store computer data. These materials are usually coated with iron oxide. Some other recordings mediums are magnetic drums, ferrite cores and magnetic bubble memory. We will discuss the process of magnetic recording on tapes and disks in some detail.

Magnetic Tape Recording

Induced magnetism is used in the process of magnetic tape recording. Recording and playing head is a coil of wire wrapped around an iron core. The iron core has a horse-shoe shape with a narrow gap in between its two ends. Audio and video tapes are synthetic tapes coated with a layer of ferromagnetic material.

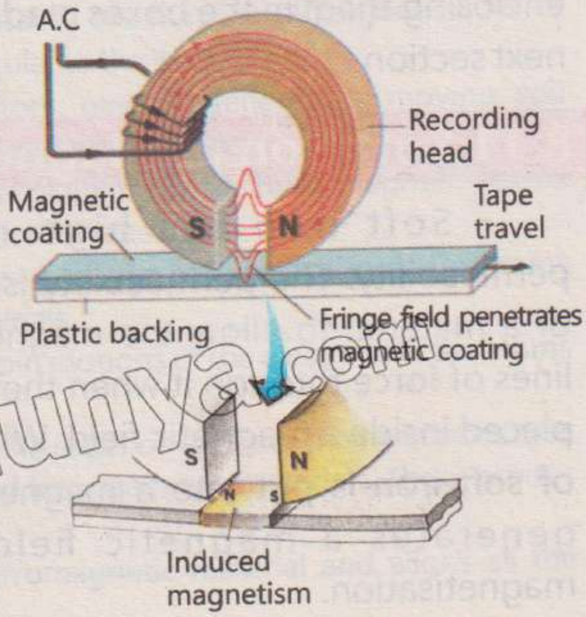


Fig. 8.27

Sound or picture is converted into electrical forms as varying currents. These currents are sent to the head that becomes an electromagnet with a N-pole at one end and a S-pole at the other end. The magnetic field lines pass through the iron core and cross the gap. Some of the field lines in the gap curved outward as shown in Fig. 8.27. The curved part of the magnetic field called as **fringe field** penetrates magnetic coating on the moving tape and induces magnetism in the coating. This induced magnetism is retained when the tape leaves the vicinity of the recording head. The reverse process changes the varying induced magnetism into varying current that onward is converted into sound or picture.

Hard Disk Recording

Hard disks are circular flat plates made of aluminium, glass or plastic and coated on both sides with iron oxide. Hard disks can store terabyte of information.

A magnetic head is a small electromagnet which writes a binary digit (1 or 0) by magnetising tiny spots on the spinning disk in different directions and reads digit by detecting the magnetisation direction of spots (Fig. 8.28). The term hard disk is also used to refer to the whole of a computer's internal data storage.

Fig. 8.28

Magnetic disk devices have an advantage over tapes recorders. A disk unit has the ability to read or write a recording instantly while locating a desired information on tape may take many minutes.

Electronic devices can be protected from strong magnetic effects by enclosing them in the boxes made of soft iron. We will describe it in detail in the next section.

8.11 Soft Iron as Magnetic Shield

Soft iron has high magnetic permeability. The permeability is the ability of a material to allow the magnetic flux or lines of force through it when the material is placed inside a magnetic field. When a piece of soft iron is put into a magnetic field, it generates a magnetic field due to magnetisation.

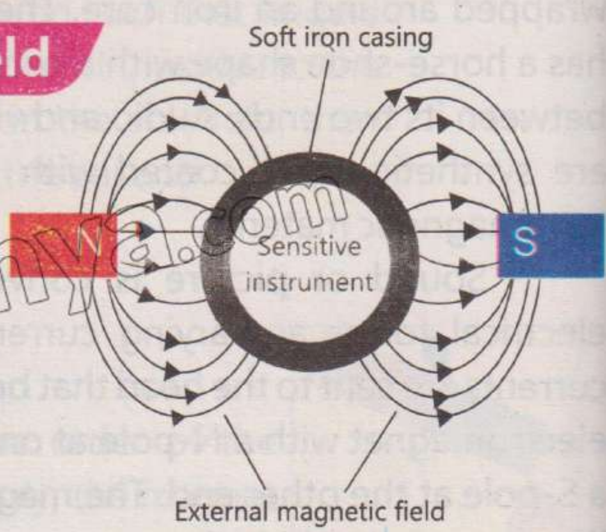


Fig. 8.29

If a sensitive magnetic device is enclosed in a casing of soft iron, the magnetic flux gets established in the soft iron rather than the device. Thus, the device is shielded from external magnetic field.

Figure 8.29 can explain this phenomenon well. A soft iron casing (shell) is placed inside a magnetic field produced by opposite poles of two bar magnets. Since the magnetic permeability of the iron shell is higher than that of air, so the magnetic flux is established in the soft iron. As a result, the device is protected from the magnetic field. Usually, the casing is made with rounded corners to facilitate the magnetic field line up easily.

Soft iron is generally used in the cores of transformers and electromagnets because of its high permeability. In case of an electromagnet, the core of soft iron can be easily magnetised when current is passed around it and quickly lost when current is stopped. That is why, electromagnets are widely used in electric bells, loud speakers, picking and releasing iron scraps by the cranes and in many more appliances. The sensitivity of a moving coil galvanometer is also increased by placing a soft iron core inside the coil.

KEY POINTS

- Magnets can attract magnetic materials even if they are not in direct contact with them.
- A magnet has two poles; north pole and south pole. Like poles repel and unlike poles attract each other.
- To get an isolated magnetic pole is not possible.
- Temporary magnets work only in the presence of a magnetic field, whereas permanent magnets retain their magnetic properties forever.
- A magnetic field is the region around a magnet where a magnetic object experiences a force on it.
- A magnetic field at a point has both a magnitude and a direction.
- The strength of the magnetic field is proportional to the number of magnetic lines of force passing through unit area placed perpendicular to the lines.
- Permanent magnets are used in electric motors, electric generators, moving coil loudspeakers, separating iron objects from different mixtures etc.
- Electromagnets are temporary magnets. They are used in electric bells, magnetic relays, circuit breakers, telephone receivers, electromagnetic cranes, etc.
- The materials in which fields due to orbital and spins motion of the electrons in the atoms support each other are called paramagnetic materials.
- The materials in which fields due to orbital and spin motions of the electrons in the atoms add up to zero are called diamagnetic materials.
- The materials in which large groups of atoms of the order of 10^{16} have their electrons spin naturally aligned parallel to each other are called ferromagnetic materials. These groups are called magnetic domains.
- The external magnetic field penetrates the ferromagnetic material and aligns all the domains to make it a magnet.

- Steel bars are magnetised by stroking, single and double touch sliding with permanent magnets or keeping them in a very strong magnetic field inside a solenoid through which large current is passed.
- Magnets can be demagnetised by heating, hitting or drawing through a solenoid in which A.C current is passed.
- Electromagnets are widely used in recording technology. Such recording mediums are audio/video magnetic tapes, hard disks of computers and other data storing devices.
- Soft iron is also used to protect sensitive magnetic device from external magnetic fields.

EXERCISE

A Multiple Choice Questions

Tick (✓) the correct answer.

8.1 Which one of the following is not a magnetic material?

(a) Cobalt (b) Iron
(c) Aluminium (d) Nickel

8.2 Magnetic lines of force:

a) are always directed in a straight line
(b) cross one another
(c) enter into the north pole
(d) enter into the south pole

8.3 Permanent magnets cannot be made by:

(a) soft iron (b) steel (c) neodymium (d) alnico

8.4 Permanent magnets are used in:

(a) circuit breaker (b) loudspeaker
(c) electric crane (d) magnetic recording

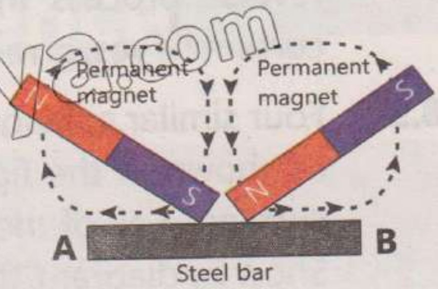
8.5 A common method used to magnetise a material is:

(a) stroking
(b) hitting
(c) heating
(d) placing inside a solenoid having A.C

8.6 A magnetic compass is placed around a bar magnet at four points as shown in figure below. Which diagram would indicate the correct directions of the field?

(a) (b) (c) (d)

8.7 A steel rod is magnetised by double touch stroking method. Which one would be the correct polarity of the AB magnet?



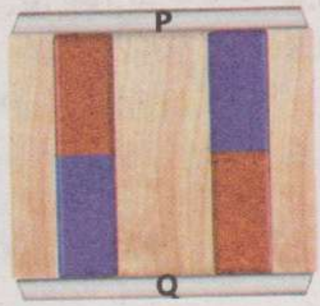
8.8 The best material to protect a device from external magnetic field is:
(a) wood (b) plastic (c) steel (d) soft iron

B Short Answer Questions

8.1 What are temporary and permanent magnets?
8.2 Define magnetic field of a magnet.
8.3 What are magnetic lines of force?
8.4 Name some uses of permanent magnets and electromagnets.
8.5 What are magnetic domains?
8.6 Which type of magnetic field is formed by a current-carrying long coil?
8.7 Differentiate between paramagnetic and diamagnetic materials.

C Constructed Response Questions

8.1 Two bar magnets are stored in a wooden box. Label the poles of the magnets and identify P and Q objects.



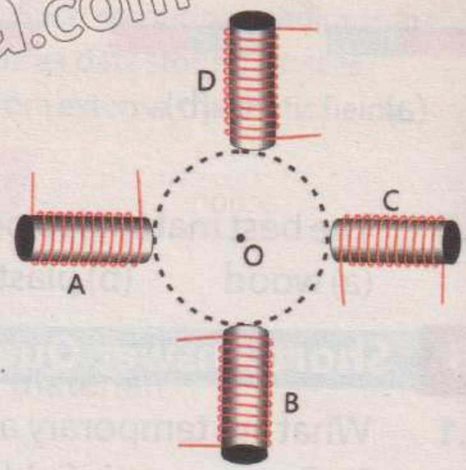
8.2 A steel bar has to be magnetised by placing it inside a solenoid such that end A of a bar becomes N-pole and end B becomes S-pole. Draw circuit diagram of solenoid showing steel bar inside it.

Steel bar

8.3 Two bar magnets are lying as shown in the figure. A compass is placed at the middle of the gap. Its needle settles in the north-south direction. Label N and S poles of the magnets. Justify your answer by drawing fields lines.

8.4 Electric current or motion of electrons produce magnetic field. Is the reverse process true, that is the magnetic field gives rise to electric current? If yes, give an example and describe it briefly.

8.5 Four similar solenoids are placed in a circle as shown in the figure. The magnitude of current in all of them should be the same. Show by diagram, the direction of current in each solenoid such that when current in anyone solenoid is switched OFF, the net magnetic field at the centre O is directed towards that solenoid. Explain your answer.



D Comprehensive Questions

8.1 How can you identify whether an object is a magnet or a magnetic material?

8.2 Describe the strength of a magnetic field in terms of magnetic lines of force. Explain it by drawing a few diagrams for the fields as examples.

8.3 What is a circuit breaker? Describe its working with the help of a diagram.

8.4 A magnet attracts only a magnet. Explain the statement.

8.5 Differentiate between paramagnetic, diamagnetic and ferromagnetic materials with reference to the domain theory.

8.6 Why ferromagnetic materials are suitable for making magnets?