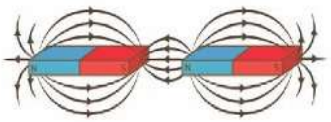
8 CHAPTER

MAGNETISM



8.1 MAGNETIC MATERIALS

Q.1 What are Magnetic materials?

Ans: **DEFINITION:**

Magnetism is a force that acts at a distance upon magnetic materials. These materials are attracted to magnets. These materials are called **magnetic materials**.

Activities:

Activity1

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.

8.2 PROPERTIES OF MAGNETISM

Q.1 Write Properties of Magnet.

Ans: 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 the end that points south is the south magnetic pole (S).

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. So will the two south poles. However, if the north pole of one is placed near the south pole of the other, the poles will attract. We can say that Like poles repel and unlike poles attract.

3. Identification of a Magnet:

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

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.

Q.2 Define induced magnetism. Also explain some of the method for induced magnetism.

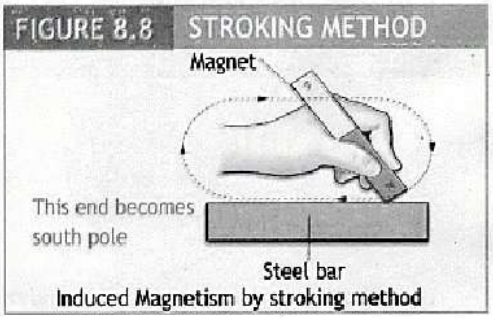
Ans: **INDUCED MAGNETISM**

Definition:

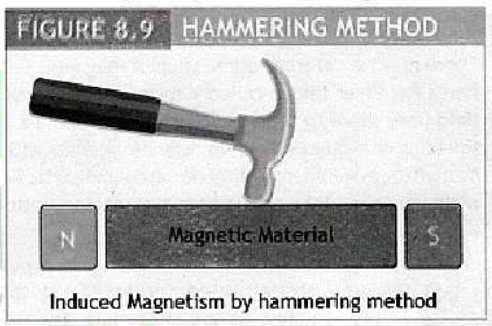
"A material that becomes a magnet when it is placed in a magnetic field is called induced magnet." OR

"A material which is not a magnet in normal condition can be made a magnet with the help of some techniques and is called induced magnet and this phenomenon is called induced magnetism. Similarly a magnetic material can lose its magnetization."

There are many ways to make an object an induced magnet or a magnet to lose its magnetization like, by stroking the material with a magnet, by hammering the material in a magnetic field, by heating or by putting the material inside a coil from which direct current is flowing.



STROKING METHOD: This is the way of aligning the poles of a material by a process called stroking for induced magnetism. A permanent magnet is stroked in this process from one end of a bar of some metal to the other end to magnetize it. After rubbing one pole of the magnet on the bar of material from one end to the other then lift the magnet, as shown in figure 8.8



HAMMERING METHOD:

In this method abar of metal is placed inside a strong magnetic field and hammered gently. The domains will begin to line up in the direction of applied magnetic field and hence metal bar becomes magnetized. This method is mainly used for magnetization of steel. The magnetization can be increased by heating the metal bar slightly before hammering. This method is shown in figure 8.9.

Q.3 What is the difference between temporary and permanent magnetics?

ELECTROMAGNET

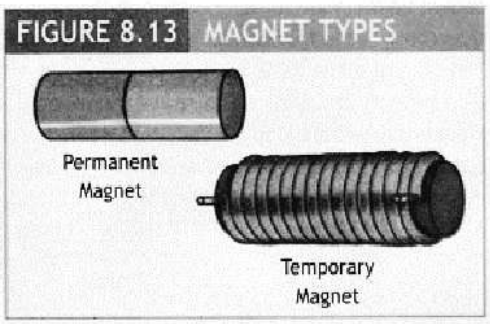
Definition:

"Magnetic materials which do not retain their magnetization after removal of external magnetic field or applied current (as in case of solenoid) are called temporary magnets."

OR

The solenoid as stated earlier behaves like a magnet as long as a current flows through it, just after removal of current it loses its magnetic field, hence it is a temporary magnet. It is also called as electromagnet.

Electromagnet is type of magnet in which the magnetic field is produced due to an electric current.



Example:

Examples of temporary magnetics include iron nails, screws, metal bolts, kitchen utensils etc.

Examples of permanent magnetic materials include iron ore, cobalt, nickel and Alnico. Temporary and permanent magnets are shown in figure 8.13. Some of the differences are listed below.

8.3.2 USES OF PERMANENT MAGNETS AND ELECTROMAGNETS:

Q.3 What is the use of permanent magnets and electromagnets?

PERMANENT MAGNETS AND ELECTROMAGNETS

Introduction:

Magnets are used in many fields, depending upon the need we can use permanent or electromagnets. A permanent magnet is made from a material which is magnetized once and does not lose its magnetization by itself and has its own magnetic field. As we know that permanent magnet does not require a continuous supply of electric energy for maintaining its magnetic field. Hence it is used in those applications where continuous supply of electricity is not available or cannot be maintain for long. Although magnetic field strength of permanent magnets are lower than those of electromagnets but they can have magnetic field even in the absence of electricity.

Permanent magnets:

Permanent magnets are used in induction cooker, MRI machines, particle accelerators, transformers etc. and in automotive, aerospace, medical, semiconductor and energy industries. Electromagnets are kind of magnets in which the magnetic field is created by an electric current. Electromagnets can be considered as temporary magnets that function only with the flow of electric current, when the current is turned off it loses its magnetization at once.

Define magnetic field.

Ans: **MAGNETIC FIELD**

Definition:

"The region or space around a magnet where it exerts a force on other magnetic poles is called magnetic field".

Mono-pole never exist in magnets, magnets are always bipolar i.e. they have two poles N-pole and S-pole. Every magnet has a space around it where it has its influence on other magnets in the form of attraction or repulsion.

Q.2 Define Tesla.

Ans: **TESLA**

Definition:

"The intensity of magnetic field (B) at any point in the field can be measured in the unit called tesla (T)."

Graphically the magnetic

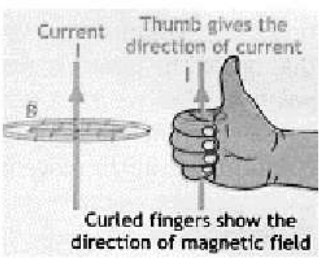
Graphically the magnetic field is represented by the field lines. The direction of the magnetic field of a material at any point can be found by the direction of force acting on the N- pole placed at that point. Magnetic field lines are curved in general, hence the direction of magnetic field on a point at such a curved line can be found by drawing a tangent at that point."

Q.3 What is right hand grip rule?

Ans: **MAGNETIC FIELD**

Definition:

Magnetic field (B) of a wire carrying a current (1) can be found by placing iron filling around the wire. We get the magnetic field of current carrying wire as the concentric circles having centers in the wire. The direction of such field can be found by using right hand rule. Hold the current carrying wire in your right hand, the fingers will curve in the direction of magnetic field.

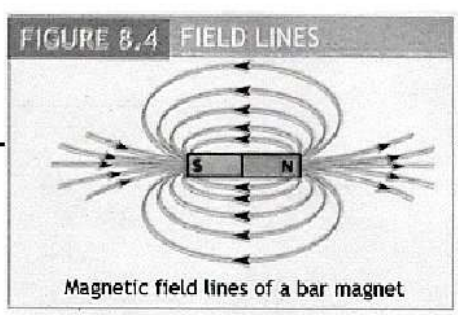


Magnetic Field of a Bar Magnets:

Q.4 What is magnetic field lines of a bar magnets:

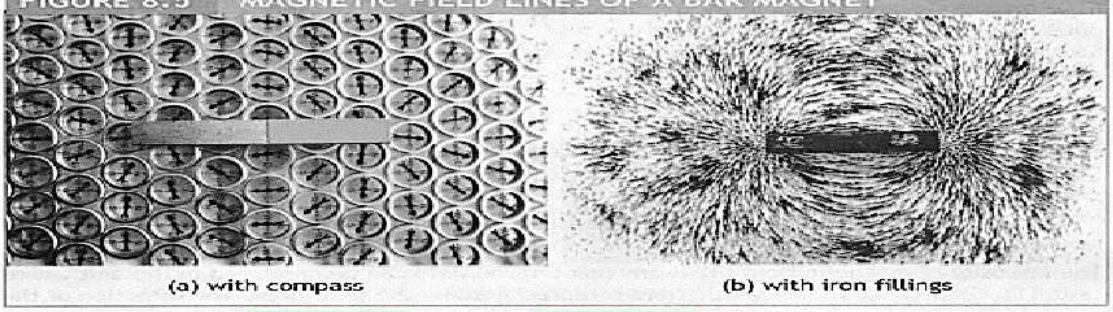
Ans: **BAR MAGNETS**

Definition:



A bar magnet is a rectangular part of a material which shows permanent magnetic properties. The magnetic field of a bar magnet can be found by placing the magnet on a plane sheet such that it has compass needles around it. You will notice that all the compass needles point in a particular manner, which shows the magnetic field pattern of the bar magnet, as shown in figure 8.4.
The field lines originate from N-pole and terminate at S-pole, while within the body of magnet these lines travel from S-pole to N-pole. This pattern of magnetic field of a bar magnet can also be found by putting the iron fillings around a bar magnet instead of compass needles. The iron filling arrange them in the same pattern as that of compass needle as shown in figure 8.5 (a) and 8.5 (b).

FIGURE 8.5 MAGNETIC FIELD LINES OF A BAR MAGNET



8.2.2 Direction of magnetic Field at a point:

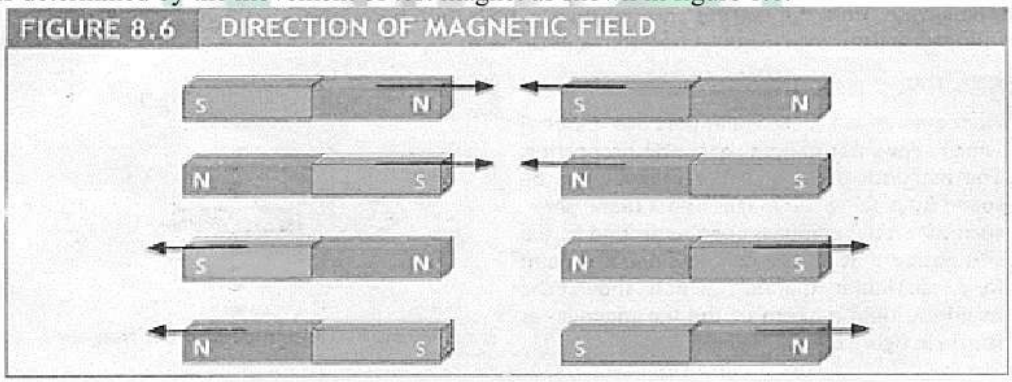
Q.5 What is direction of magnetic field at a point?

Ans:

DIRECTION OF MAGNETIC FIELD

The magnetic field is the map that we use to describe how the magnetic force is distributed in the space around a magnetic material or magnet and even within a magnetic material or magnet. To find the magnetic field at a point due to some magnet, is determined by placing a north-pole at that point, the force experienced by the north-pole will be the strength of magnetic field at that point. As when we put a test north-pole near the north-pole of material, it repels the test north-pole away from it showing the direction of north-pole of material as outward. The magnetic force is determined by the movement of test magnet as shown in figure 8.6.

FIGURE 8.6 DIRECTION OF MAGNETIC FIELD



8.2.3 Relative Strength of Magnetic Field:

Q.6 What is relative strength of magnetic field?

Ans:

RELATIVE STRENGTH OF MAGNETIC FIELD

Definition:

"The relative strength of a magnetic field is the degree of closeness of the field lines."
The strength of magnetic field at any point due to a magnetic pole can be found by the field lines. The field is stronger where the field lines are closer, while the field is weaker where the field lines are farther apart.

Hence magnetic field lines give the direction and the strength of magnetic field. The relative strength of magnetic field due to like poles and unlike poles is shown in figure 8.7. By placing two N-poles close to each other we can decrease the field similarly by placing N-pole near an S-pole we can make magnetic field strengthen.

Q.7 Write uses of Permanent Magnet.

Ans: There are many uses of permanent magnets such as:

- *They are the essential parts of D.C motors, A.C and D.C electric generators.*
- *Permanent magnets are used in the moving coil loud-speakers.*
- *These are very commonly used in door catchers.*
- *Magnetic strips are fitted to the doors of refrigerators and freezers to keep the door closed tightly.*
- *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.*
- *In the medical field, they are used to remove iron splinters from the eyes.*
- *A piece of permanent magnet is used to reset the iron pointer in a maximum and minimum thermometer.*

APPLICATIONS OF PERMANENT MAGNETS

Q.1 Discuss Applications of Permanent Magnet.

Ans: 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. 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.

Moving Coil Loudspeaker:

A voice coil attached to the cone of the speaker is slipped over one pole (N) of the radial permanent magnet. From a micro phone 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.

ELECTTROMAGNET

Q.1 What is Electromagnet? How can we create an electromagnet?

Ans: **Definition:**

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.

Explanation:

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.

Q.2 Write a note on uses of Electromagnets.

Ans: 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.

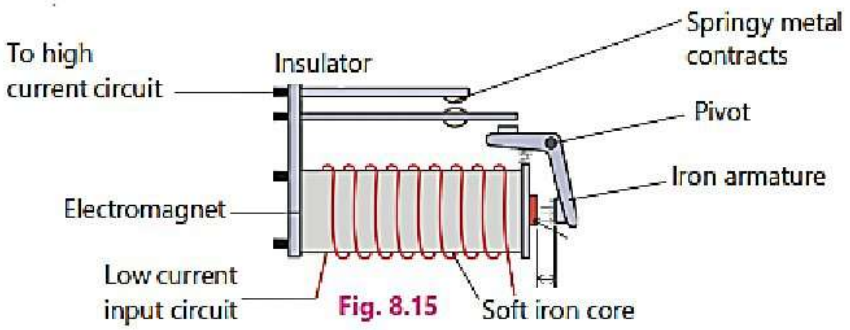
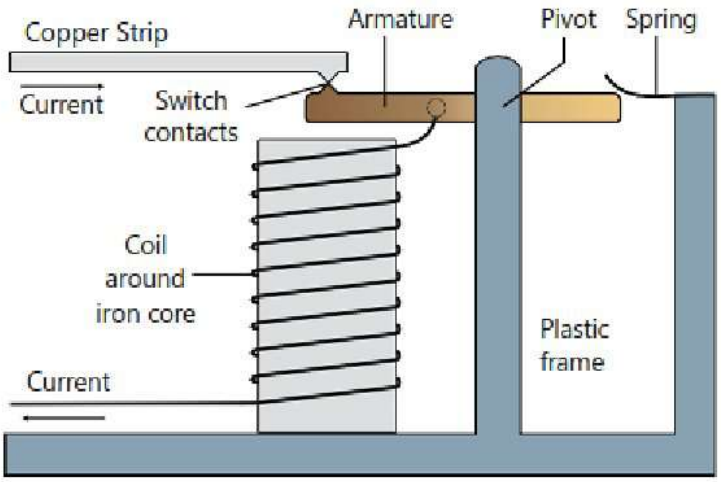


Fig. 8.15

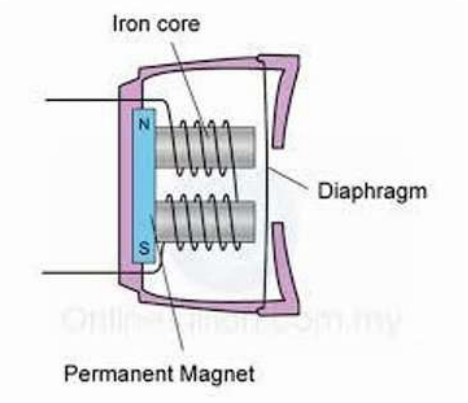
Circuit Breaker:

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. 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.



Telephone Receiver:

There is an iron diaphragm in the receiver under which an electromagnet is placed. 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.



Electromagnetic Cranes:

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

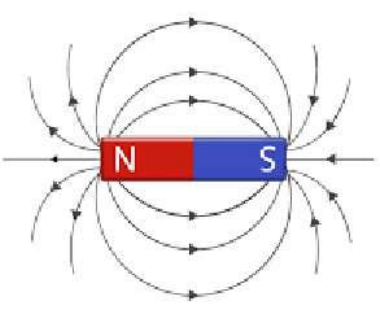
DOMAIN THEORY OF MAGNETISM

LONG QUESTION

Q.1 What is the domain theory magnetism?

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. 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. 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 neighboring 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 0.1mm 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.

Q.2 What is meant by alignment of domain?

Ans: Explanation:

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

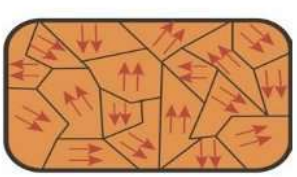
The external magnetic field penetrates the un magnetized iron and induces magnetism in it by causing two effects on the domains. Those domains whose magnetism is parallel or nearly parallel to the external magnetic field grow in size at the expense of other domains that are not oriented. In addition,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

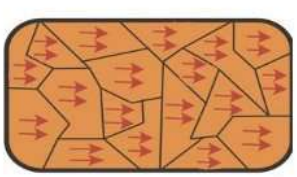
For Your Information!

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.

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.





DIFFERENCE BETWEEN MAGNETIC AND NON-MAGNETIC MATERIALS:

As we studied above that materials are classified as magnetic and non-magnetic on the basis of their response to an applied magnetic field. These differences are summarized in table below.

DIFFERENCE BETWEEN MAGNETIC AND NON-MAGNETIC MATERIALS	
Magnetic Materials	**Non-magnetic materials**
Materials which are attracted to a magnet are known as magnetic materials	Materials which are not attracted to a magnet are known as non-magnetic materials
The atomic states of a magnetic material are aligned	The atomic states of a non- magnetic material are in random
They respond to a magnetic field	They do not respond to a magnetic field
Magnetic materials have field (magnetic field) around them	Non-magnetic materials do not have field (magnetic field) around them
Magnetic materials can attract and repel other magnetic materials	Non-magnetic cannot attract or repel any magnetic material
Examples of magnetic materials are: Nickel, Cobalt, Steel and Iron.	Examples of magnetic materials are: Rubber, Plastic, Wood and Copper.

MAGNETIZATION AND DEMAGNETIZATION

Q.1 Write a note on methods of Magnetization.

Ans: There are two methods used for magnetizing a steel bar:

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.

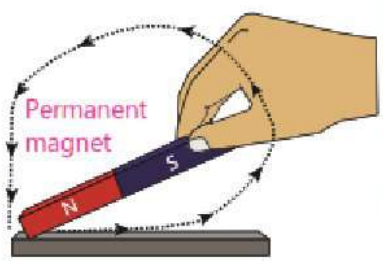


Fig. 8.21

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. This method is more efficient than the first one.

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.

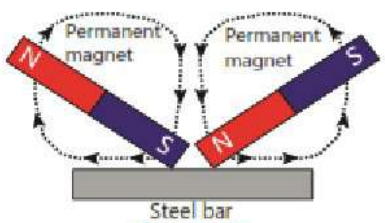


Fig. 8.22

Making a Magnet using Solenoid:

Right Hand Grip Rule:

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.

Explanation:

In this method, a steel bar to be magnetized is placed inside a solenoid (long coil of wire). 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.

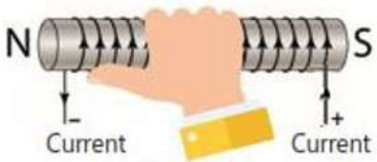
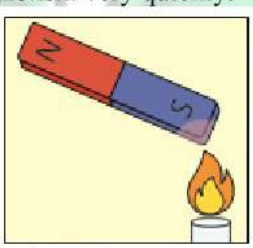


Fig. 8.23

Q.2 Write a note on methods of Demagnetization.

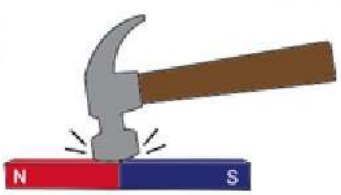
Ans: **Heating:**

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



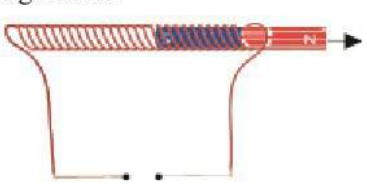
Hammering:

If we beat a magnet, the domains lose their alignment and the magnet is demagnetized. It is also called hammering.



Alternating Current:

When an alternating current (A.C) is flowing through along solenoid, a magnet moved out slowly from inside of the solenoid is demagnetized.



8.10 APPLICATIONS OF MAGNETS:

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 signalsbutalsotostorecomputerdata.Thesematerialsareusuallycoatedwith 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.

A. MAGNETIC TAPE RECORDING:

Magnetic recording is a method of saving sounds, pictures and data in the form of electrical signals by the process of selective magnetization of some portion of a magnetic material. For writing the data a magnetic tape head is moved onto the tape which is in motion the magnetic field of the tape head aligns the pattern of magnetic domains according to the applied current flowing through the tape head, as shown in figure

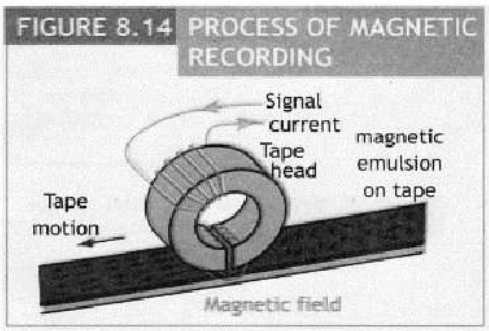


FIGURE 8.14 PROCESS OF MAGNETIC RECORDING

Similarly the reverse process is done for reading the data from the aligned pattern of tape. For magnetic recording the materials commonly used are iron-oxide, cobalt, chromium oxide and pure iron. The main recording media may be a magnetic tape or disk recorders which are used to store and reproduce audio, video signals and computer data. Some other magnetic recording devices are magnetic drum, core and bubble units used for computer storage units.

B. HARD DISC 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 magnetizing tiny spots on the spinning disk in different directions and reads digit by detecting the magnetization direction of spots. The term hard disk is also used to refer to the whole of a computer's internal data storage. 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.

Fig. 8.28

Q.7 What is shielding of magnetic field?

Ans: **SHIELDING OF MAGNETIC FIELD**

There may be different orientation of magnetic field by suitably adjusting the magnets. We can find a field free region called 'neutral zone' by placing two N-poles side by side, such that their field lines seem to repel each other by making a field free region, this phenomenon is called shielding of magnetic field.

Example:

In daily life we deal with a lot of devices which have to work in strong magnetic environment but this external magnetic field can alter the functioning of the device. So we have to shield the device from external magnetic field.

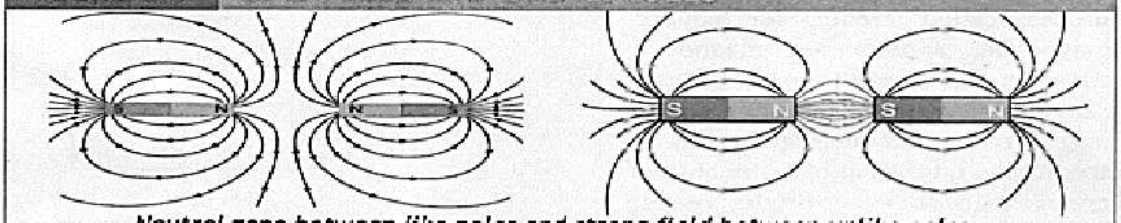
Q.8 Define Shields.

Ans:

SHIELDS

Materials used for magnetic shielding are called shields. These materials are used for protecting sensitive circuits form unwanted parasitic magnetic fields including power inverters, magnetic immunity, magnetic sensors and EMI. The commonly used materials as shield are iron, Nickel and Cobalt. Shields are usually made rounded corners because it is difficult for magnetic field lines to turn an angle of 90^{o}.

FIGURE 8.7 LIKE POLES AND UNLIKE POLES



Neutral zone between like poles and strong field between unlike poles

SUMMARY

Magnetic domain	Magnetic domain is the group of atoms whose N-poles are aligned in the same direction.
Magnets	Magnets are always found in dipole, i.e. they have a N-pole and a S-pole
Like poles of magnets	Like poles of magnets always repel each other, while unlike poles attract each other.
Magnetic materials	Magnetic materials are always attracted by magnets and other magnetic materials.
Magnetic	Magnetic field is the region of space around a magnet in which it is attracted by the magnetic pole of opposite polarity
Bar magnet and solenoid	Bar magnet and solenoid have same pattern of magnetic fields
Magnetic field lines	Magnetic field lines originate form the north-pole and end at south-pole
Magnetic shielding	Magnetic shielding is the phenomenon in which some region of space is made free from magnetic field.
Induced magnetism	Induced magnetism is the phenomenon in which a material is magnetized by placing it inside an external magnetic field.
Temporary magnets	Temporary magnets are those magnets which behave like a magnet only in the presence of current.
Permanent magnets	Permanent magnets are those magnets which have like a magnet even in the absence of current.
Diamagnetic materials	Diamagnetic materials have zero net magnetic fields per atom.
Paramagnetic materials	Paramagnetic materials have small net magnetic field per atom.
Ferromagnetic materials	Ferromagnetic materials have large net magnetic field per atom.
Earth	Earth has a magnetic field which resembles with the field of a bar magnet and shield all the life on it from cosmic rays and radiation form the sun and outer space.
Earth's geographical and magnetic poles	Earth's geographical and magnetic poles are not same but inclined at an angle of 11.3 degrees.
Migrating birds	Migrating birds and animals use earth's magnetic field to navigate.

TEXT BOOK EXERCISE

MULTIPLE CHOICE QUESTIONS

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) enterin to the north pole
(d) enterin to the south pole

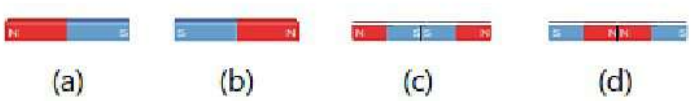
8.3 **Permanent magnets cannot be made by:**
(a) soft iron (b)steel (c)neodymium (d)alnico

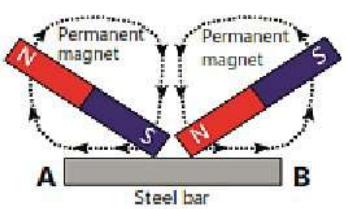
8.4 **Permanent magnets are used in:**
(a) circuit breaker (b)loudspeaker
(c) electric crane (d)magnetic recording

8.5 **A common method used to magnetize a material is:**
(a) stroking
(b) hitting
(c) heating
(d) placing inside a solenoid having A.C current

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?**

8.7 **A steel rod is magnetized 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

SHORT ANSWER QUESTIONS

8.1 **What are temporary and permanent magnets?**

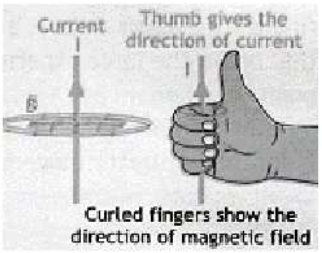
Ans: **Definition:**
"Magnetic materials which do not retain their magnetization after removal of external magnetic field or applied current (as in case of solenoid) are called temporary magnets."

Permanent magnets:
Permanent magnets are used in induction cooker, MRI machines, particle accelerators, transformers etc. and in automotive, aerospace, medical, semiconductor and energy industries. Electromagnets are kind of magnets in which the magnetic field is created by an electric current.

8.2 **Define magnetic field of a magnet.**

Ans: **Definition:**

Magnetic field (B) of a wire carrying a current (1) can be found by placing iron filling around the wire. We get the magnetic field of current carrying wire as the concentric circles having centers in the wire. The direction of such field can be found by using right hand rule. Hold the current carrying wire in your right hand, the fingers will curve in the direction of magnetic field.



8.3 What are magnetic lines of force?

Ans: Magnetic lines of force are a way to visualize the invisible magnetic field and help us understand how magnetic fields interact with objects in the field.

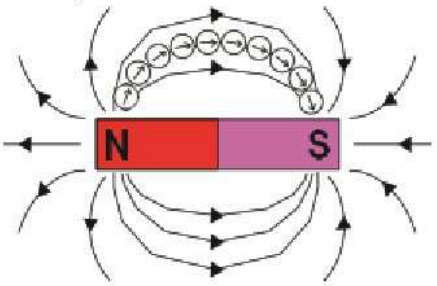


Fig. 8.8

8.4 Name some uses of permanent magnets and electromagnets.

Ans: **Electromagnet:**

Electromagnets have a wide range of daily life applications like in electromechanical and electronics devices. Most of the home appliances use electromagnetism as the basic working principle, like electric fan, electric motors and door bells. In medical fields electromagnets are used in MRI scan. Electromagnets are also used in communication devices and power circuits.

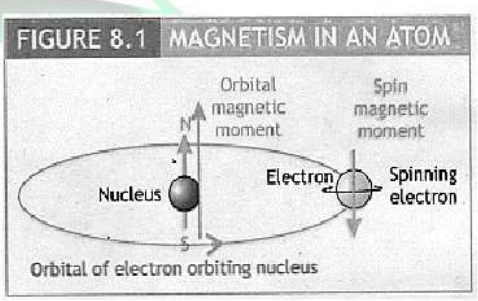
Permanent Magnet:

Magnetic Tape recording
Speakers

8.5 What are magnetic domains?

Ans: **DOMAIN THEORY OF MAGNETISM**

As we know everything around us is made up of atoms, having massive central body with positive charge known as nucleus and light particles with negative charge called electrons orbit around the nucleus. In late twentieth century we found that the basis of magnetism is the motion of charge particles. Electrons (charged particles) move around the nucleus in all atoms producing magnetism. So for a single atom each electron produces a small amount of magnetism as shown in figure 8.1.



For a single electron loop a tiny magnet is produced which has two poles called the north-pole (N pole) and the south-pole (S pole). Spinning nucleus also produces some amount of magnetic field but that is negligibly small and the spin motion of electron also produces a tiny magnetism, hence we take the magnetic field of atoms only due to orbital motion of electrons. In some atoms electrons are so oriented that they may add up their magnetic field to make the atom with net non-zero magnetic field, which makes the whole material as magnetic material.

In a sizeable piece of a material a group of atoms having parallel magnetic field make a 'domain' (of roughly 10^{12} atoms and a size of few mm). In unmagnetized material the domains are

randomly oriented while in a magnetized material (a material can be magnetized by placing it in external magnetic field) the domains are aligned.

8.6 Which type of magnetic field is formed by a current-carrying long coil?

Ans: Electromagnet (a temporary magnet) is formed by a current-carrying long coil.

8.7 Differentiate between paramagnetic and diamagnetic materials.

Ans:

Paramagnetic Materials:

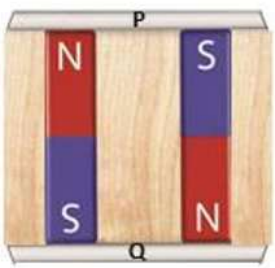
If the orbital and spin axes of the electrons in an atom are so oriented that their fields support one another and the atom behaves like a tiny magnet, the materials with such atoms are called paramagnetic materials such as aluminium and lithium.

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.

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.



Ans: **P**: If it's a ferromagnetic material like iron, it will be attracted to the poles of the magnets.
Q: If it's a wooden object, it will not be influenced by the magnetic field, as wood is not magnetic.

8.2 A steel bar has to be magnetized 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.

Ans:

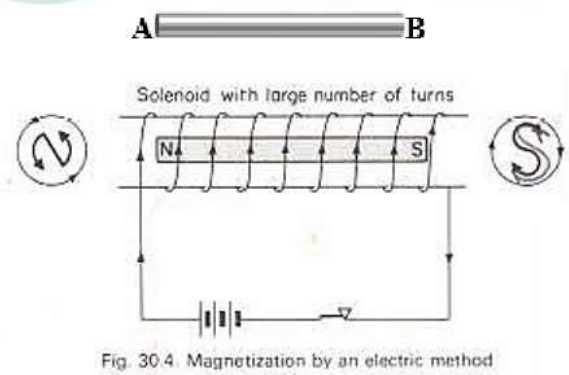
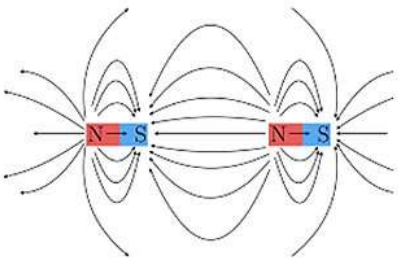


Fig. 30.4. Magnetization by an electric method

Q.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.

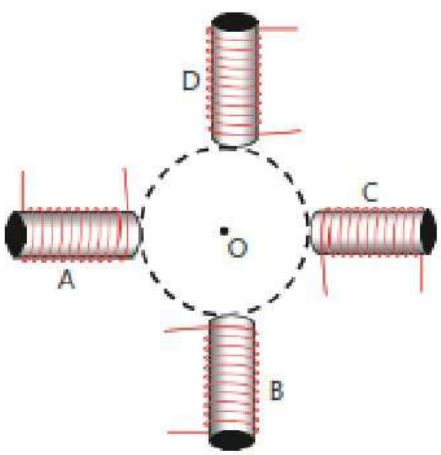
Ans:



Q.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.

Ans: Yes, the reverse process is true! A changing magnetic field can induce an electric current. This phenomenon is known as **electromagnetic induction**, and it was first discovered by Michael Faraday in the 1830s.

Q.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.



Ans: The direction of the currents in the solenoids has been set in such a way that if the current in any solenoid is switched off, the net magnetic field at the center O will point toward that solenoid. This is achieved by carefully arranging the solenoids' magnetic fields in opposing directions and ensuring their vector sum points toward the solenoid that's turned off.

COMPREHENSIVE QUESTIONS

Q.1 How can you identify whether an object is a magnet or a magnetic material?

Ans:

Magnet: Attracts and repels other magnets, has fixed north and south poles, and affects a compass needle in a consistent manner.

Magnetic Material: Only attracted to magnets, does not repel, and becomes magnetized temporarily when exposed to a magnetic field.

By performing these tests, we can identify whether an object is a magnet or just a magnetic material.

Q.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.

Ans:

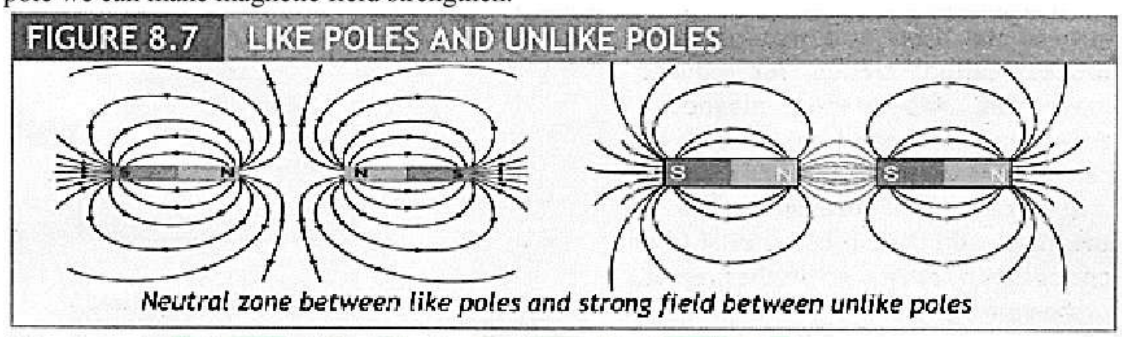
RELATIVE STRENGTH OF MAGNETIC FIELD

Definition:

"The relative strength of a magnetic field is the degree of closeness of the field lines."

The strength of magnetic field at any point due to a magnetic pole can be found by the field lines. The field is stronger where the field lines are closer, while the field is weaker where the field lines are farther apart.

Hence magnetic field lines give the direction and the strength of magnetic field. The relative strength of magnetic field due to like poles and unlike poles is shown in figure 8.7. By placing two N-poles close to each other we can decrease the field similarly by placing N-pole near an S-pole we can make magnetic field strengthen.

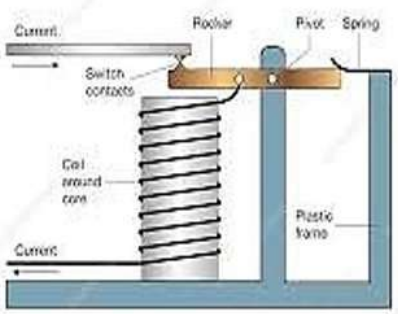


Q.3 What is a circuit breaker? Describe its working with the help of a diagram.

Ans:

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. 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.



Q.4 A magnet attracts only a magnet. Explain the statement.

Ans:

Thus, a magnet attracts magnetic materials (not just other magnets), but its most noticeable interactions are typically with ferromagnetic materials and other magnets. The statement could be a simplified or context-specific way of explaining that magnets are attracted to other magnetic objects (whether they are other magnets or materials that can be magnetized).

Q.5 Differentiate between paramagnetic, diamagnetic and ferromagnetic materials with reference to the domain theory.

Ans:

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 neighboring 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 0.1mm 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.

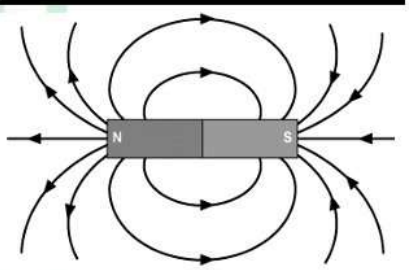
Q.6 Why ferromagnetic materials are suitable for making magnets?

Ans:

Ferromagnetic materials are suitable for making magnets because they can be easily magnetized, retain their magnetization, and generate strong magnetic fields. These characteristics make them ideal for creating permanent magnets, which are used in a variety of applications from electric motors to magnetic storage devices.

LONG RESPONSE QUESTIONS

Q.III Give a detailed response to the questions given below.



1. Define and explain the magnetism.
2. What is the domain theory of magnetism? Explain.
3. Explain magnetic field strength and magnetic shielding.
4. Explain the magnetic field of a bar magnet and that of a solenoid, also compare them.
5. Define induced magnetism. Also explain some of the methods for induced magnetism.
6. Differentiate between permanent and temporary magnets.
7. Explain some uses of electromagnets and temporary magnets.
8. Explain the three types of magnetic materials.
8. Explain the three types of magnetic materials.
9. Explain the Earth's magnetic field. Also relate Earth's geographical and magnetic poles.
10. Explain how birds and other migrating animal use Earth's magnetic field to navigate.

TEXT BOOK EXERCISE

MULTIPLE CHOICE QUESTIONS

ANSWER KEY

1	2	3	4	5	6	7	8
C	D	C	B	A	C	A	A