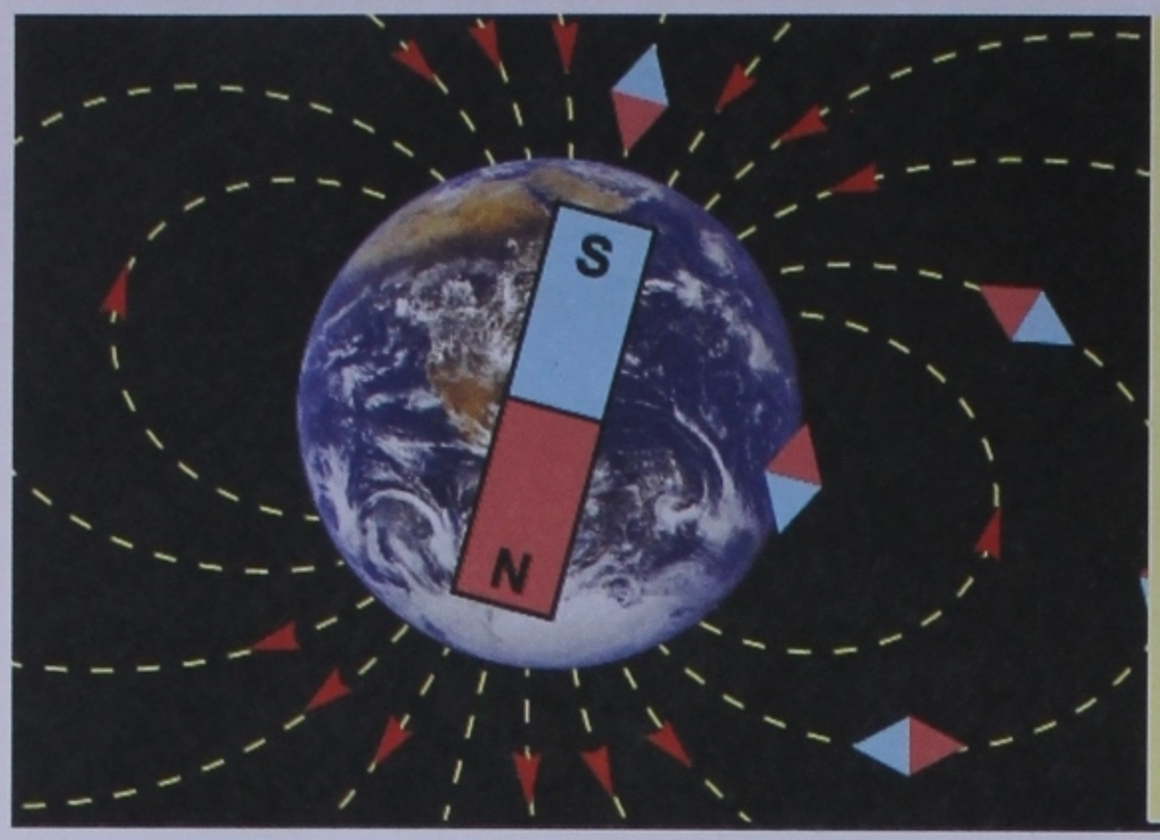


7 Magnetism

SYLLABUS

This chapter contains :

- Discovery of magnets, artificial and natural magnets, poles of a magnet, properties of magnetic poles.
- Types of magnet : *Temporary magnet, permanent magnet, discovery of an electromagnet.*
- Making magnets : *Magnetic induction method, single touch method, double touch method, electrical method.*
- Advantage and uses of electromagnets, demagnetising a magnet, properties of a bar magnet, uses of magnets.

DISCOVERY OF MAGNETS

The first magnets were found from a naturally occurring mineral called **magnetite** around 800 B.C. There is a story about a shepherd named **Magnes** whose shoe nails and iron hook of his stick were stuck to a rock containing magnetite. The rock was later found to attract iron pieces. This rock was also called lodestone. The lodestone means stone which can indicate a correct direction. The word magnet originated from the name of town **Magnesia**, a district in Asia Minor where large deposits of magnetite were found.

What is a magnet ?

A magnet is an object made of certain materials like iron which can create a magnetic field. The property of attracting iron by the magnet is called **magnetic attraction**. The force that a magnet exerts on iron is called **magnetic force**.

Substances that get attracted by a magnet are called magnetic substances. Iron, steel, cobalt and nickel are magnetic substances. Substances that do not get attracted by a magnet are called non-magnetic substances, *e.g.*, wood, plastic, copper, paper, aluminium, rubber, stone, sand, ceramics, glass, aluminium, gold, silver, brass, *etc*. Magnetic substances are also known as FERRO MAGNETIC substances.

ARTIFICIAL AND NATURAL MAGNETS

Since magnetite is already magnetised when found in nature, it is called a **natural**

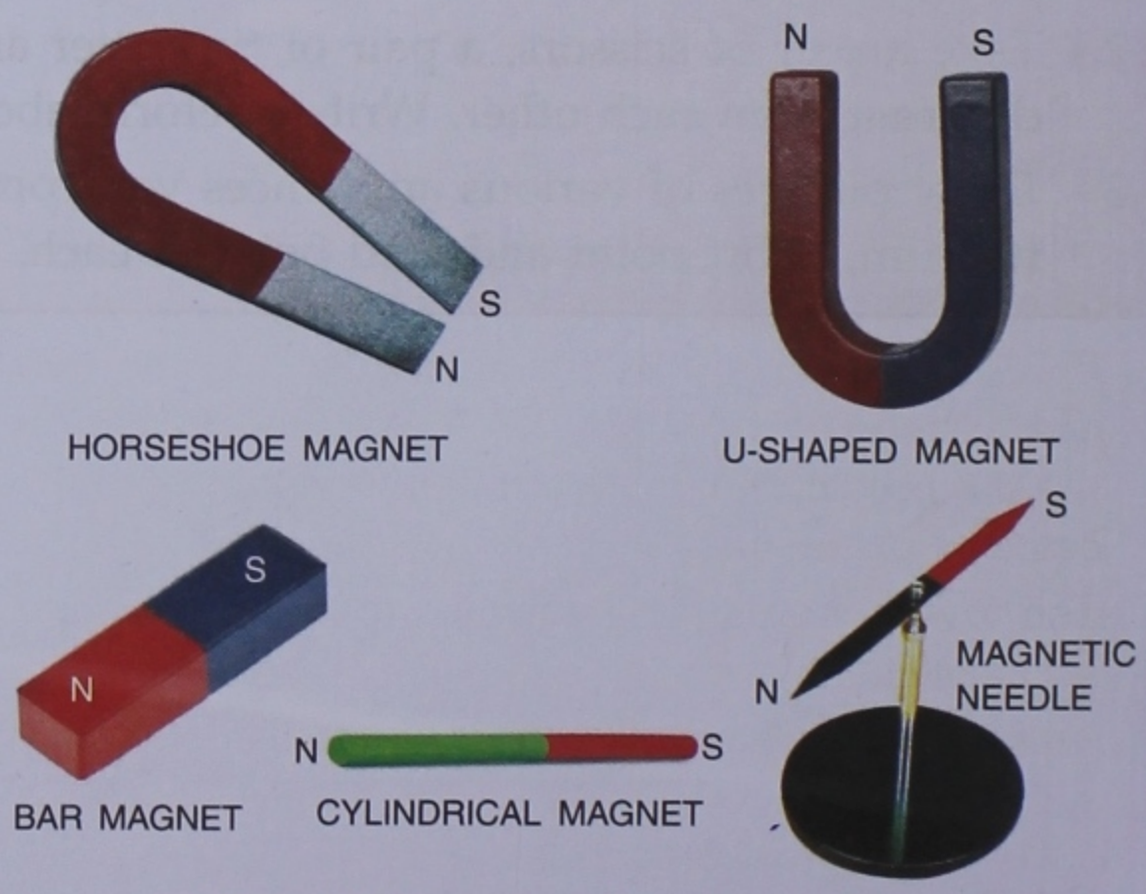


Fig. 7.1 Magnets of various shapes

magnet. Magnets that are made by man are called **artificial magnets**. These are generally made of steel in various shapes and sizes according to their uses. We have bar magnets, horseshoe magnets, U-shaped magnets, cylindrical magnets, magnetic needle, magnetic compass, *etc*.

ACTIVITY 1

To identify magnetic and non-magnetic substances.

Material required : Substances – coal, metals, wood, plastics, etc.

Procedure : Get some specimens of different substances, *e.g.*: iron, steel, nickel, plastic, wood, copper, stainless-steel spoon, etc.

Use a magnet to test which ones are attracted by the magnet and which ones are not. Record your observations in the table given below:

Magnetic substance	Non-magnetic substance
Iron	.....
.....	.....
.....	.....
.....	.....

Conclusion : The substances that are attracted by a magnet are called magnetic substances, whereas those that are not attracted by a magnet are called non-magnetic substances.

ACTIVITY 2

Searching a sewing needle in a box containing buttons, thread etc.

Material required : A bar magnet, a box containing buttons, thread etc. and a sewing needle.

Procedure : Drop the sewing needle into the box and reshuffle the contents. You may not be able to see the needle. Now move the bar magnet over the contents of the box.

The sewing needle gets attracted to the magnet and sticks to it.

You have found the sewing needle easily.

POLES OF A MAGNET

If a bar magnet is suspended with a string tied at its mid-point such that it rests horizontally and can turn freely, it will come to rest pointing in a north-south direction. If it is disturbed and again allowed to come to rest, the same end of the bar will point to the north. The end of the magnet pointing geographical north is called the *north pole* of a magnet This is an abbreviation for "a north-seeking pole'. Similarly, the other end of the bar magnet is "a south-seeking pole", called the *south pole*.

Every magnet, no matter what is its shape, has both north and south poles. If you break a bar magnet into two pieces, each piece will again have a north pole and a south pole. The strength of the magnet is concentrated at these poles. This can be shown by dipping a bar magnet into a box of iron filings. It is seen that a large number of filings stick to the ends or poles of the magnet and only a very few are attracted towards its centre portion.

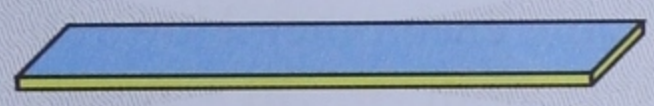


Fig. 7.2 The strength of magnetism is maximum on both poles

ACTIVITY 3

Take a bar magnet and suspend it by a string tied at its centre so that it may hang horizontally and freely as shown in Fig. 7.3. You will notice that the magnet points in the north-south direction when it comes to rest. You disturb the magnet any number of times, but when at rest, it will again point in the north-south direction.

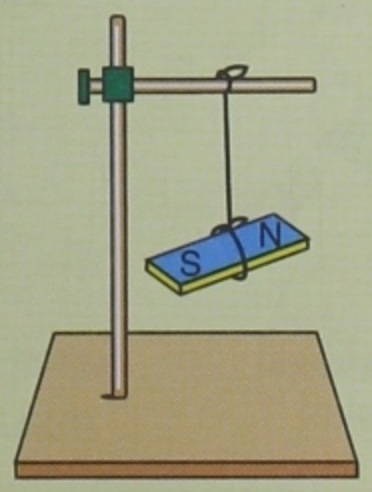


Fig. 7.3 A freely suspended magnet rests always in the north-south direction

PROPERTIES OF MAGNETIC POLES

Like poles repel, unlike poles attract :

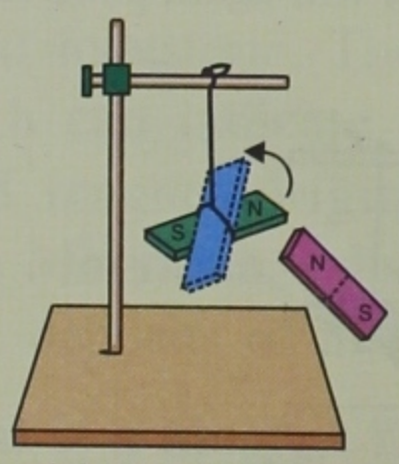
Bring the north pole of a bar magnet near the north pole of a freely suspended bar magnet. The pole of the suspended magnet will be repelled. If the south pole of the first magnet is brought near the south pole of the suspended magnet, the same repulsion will take place. However, if the south pole of the first magnet is brought near the north pole of the suspended magnet, we observe an attraction between the opposite poles. This proves that '*Like poles repel and unlike poles attract*'.

Repulsion is the only true test for a magnet:

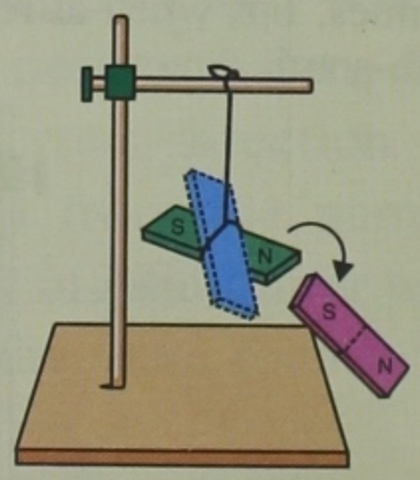
Two north poles or two south poles are called like poles. A north pole and a south pole are unlike poles. It should be noted that *repulsion is the only true test for a magnet.* A magnet will attract a magnetic substance and will also attract another magnet if two unlike poles are facing each other. However, repulsion indicates that both are like poles. When an object is repelled by a magnet, the object is definitely a magnet.

ACTIVITY 4

Take a bar magnet and suspend it from a stand with a thread. It would come to rest in the north-south direction. Take another magnet and bring its north pole close to the north pole of the suspended magnet. The north pole of the suspended magnet is **repelled**. Similarly, the repulsion of south pole of the suspended magnet will be observed when the south pole of another magnet is brought close to it. Now bring the north pole of another magnet near the south pole of the suspended magnet. The south pole of the suspended magnet will be **attracted** towards the north pole of the second magnet. Similarly, the south pole of the second magnet will be attracted towards the north pole of the suspended magnet and vis-a-vis.



(a) Like poles



(b) Unlike poles

Fig. 7.4 Like poles of two magnets repel each other while unlike poles attract each other

Magnetic poles always occur in pairs :

Take a bar magnet and cut it into two pieces. You will have two new magnets each with its own north and south poles. No matter how many pieces you make out of these, each piece will behave as a magnet, *i.e.*, having a north pole and a south pole (see Fig. 7.5). It is not possible to isolate one pole from a magnet, *i.e.*, north and south poles cannot exist separately.

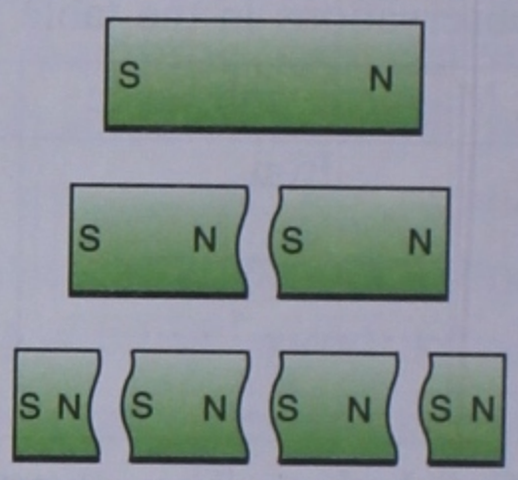


Fig. 7.5 Each broken part of a magnet has its own north and south poles

Hence, we conclude that a **single magnetic pole can never exist; rather they always occur in pairs.**

TYPES OF MAGNETS

Some magnets can retain the magnetic properties for a longer period of time while some other magnets show magnetism as long as they are being magnetised. Accordingly, magnets can be classified as **permanent** and **temporary** magnets. The third type of magnets are called **electromagnets**.

ACTIVITY 5

You are given with two steel pieces one of them is a magnet and other is not. They are exactly alike in appearance. Identifiy which one is a magnet. You are not allowed to use anything else apart from those specimens provided to you.

Consider them to be specimens A & B. Place A on the table. Touch one side of specimen B to A, first at one end, then on the other end and finally at the centre. B will get stuck to A at both the ends and if it sticks at the centre also then A is an ordinary steel piece. Repeat by keeping B on the table and touching A at the three places. At the centre it will not stick which means B is the magnet as magnet is neutral at the centre.

Temporary Magnets : These magnets are usually made of soft (pure) iron. They can act as magnets only for a short duration. They lose their magnetism as soon as the magnetising force is removed. *For example*, paper clips, iron nails and other soft iron items.

Permanent Magnets : These magnets are made of steel, cobalt and nickel and are capable of retaining magnetism for a longer period of time even when the magnetising force is removed.

Differences between temporary and permanent magnets

Temporary magnet	Permanent magnet
1. The magnet which loses its magnetic properties as soon as the magnetising force is removed away from it, is called temporary magnet.	1. The magnet, which does not lose its magnetic properties easily is called permanent magnet.
2. It cannot convert an ordinary piece of iron into a magnet because of its weak power.	2. It can convert an ordinary piece of iron into a temporary magnet.
3. These magnets are made up of soft (pure) iron.	3. These magnets are made up of steel, cobalt and nickel.

KNOWLEDGE BANK

Iron is called a 'soft' magnetic material because it loses its magnetism easily. Iron is used in making electromagnets. It acts as a magnet as long as you are magnetising it. The moment you stop the process of magnetising, it loses the magnetic property.

Steel is called a 'permanent' magnetic material because it does not lose its magnetism easily. It remains a magnet even after you stop the process of magnetising it. This is the reason why it is used to make a permanent magnet.

Discovery of an Electromagnet : A Danish Physicist, Hans Christian Oersted, in 1819, discovered that there is a magnetic field around every wire carrying an electric current. This discovery has been one of the most fruitful achievements in the history of physical sciences. This was the discovery of electromagnets which are widely used. Whenever we ring an electric bell, run a motor, talk over a telephone or listen to a transistor, we make use of the magnetic field that surrounds current-carrying wires. Electromagnets are also used in fans, motors, mixers, airconditioners, *etc*. They are used for lifting heavy iron loads. You will learn more about them later in this lesson.

VARIOUS PARTS OF A BAR MAGNET

- **Magnetic poles :** The end points of a magnet where most of its magnetic power is concentrated are called the **poles of a magnet**.

- **Magnetic north pole :** The point N at the end of the freely suspended bar magnet which points towards the geographic north pole is called **magnetic north pole**.
- **Magnetic south pole :** The point S at the end of the freely suspended bar magnet which points towards the geographic south pole is called **magnetic south pole**.
- **Magnetic axis :** An imaginary line (XY) passing from the magnetic north pole and the magnetic south pole of a bar magnet is called **magnetic axis**.
- **Length of a magnet :** The total distance between the north pole to the centre (NO) and the centre to the south pole (SO) of a magnet is called the **length of a magnet.**
- **Effective length :** The distance (NS) between the magnetic north pole and the magnetic south pole is called the **effective length** of the magnet.

  It is the distance between the north pole and the south of the bar magnet along its axis.
- **Magnetic equator :** An imaginary line (PQ) bisecting the effective length is called the **magnetic equator**.

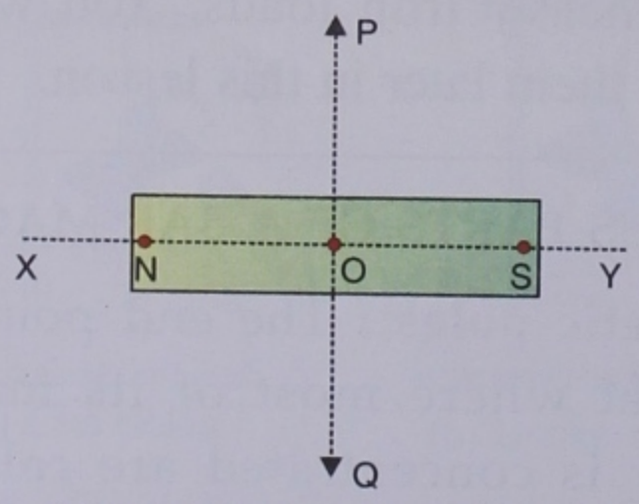


Fig. 7.6 Parts of a magnet

ACTIVITY 6

To show that magnetic force is maximum at the ends of magnet.

Materials required : Bar magnet, ordinary iron alpins.

Procedure : Suspend a bar magnet and try to stick iron alpins across its length. You can observe that the number of alpins which stick to the magnet decreases as we go towards its centre.

Conclusion : This activity shows that the magnetic force is maximum at the ends (poles) of the magnet.

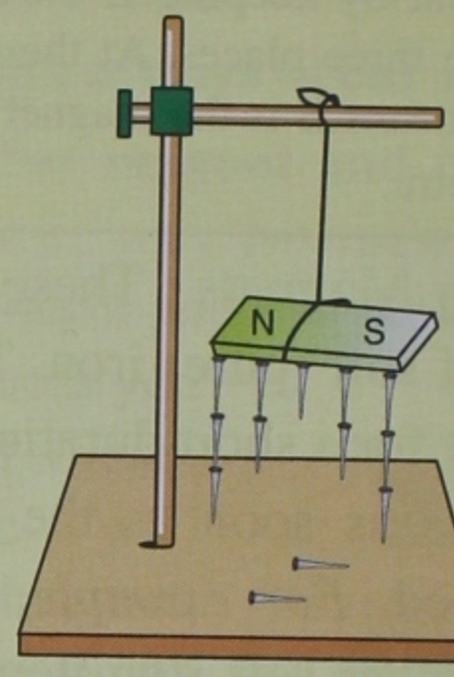


Fig. 7.7 Magnetic force of attraction is maximum at the ends of a magnet.

ACTIVITY 7

Take a long piece of insulated copper wire. Wrap it around a large screw as shown in Fig. 7.8. Attach the free ends of the wire to the poles of a dry cell. Now you have an electromagnet with which you can pick up small pieces of iron such as paper clips or small bits of iron. However, if the number of cells are increased or if more amount of electric current is passed, the electromagnet will show strong magnetic attraction.

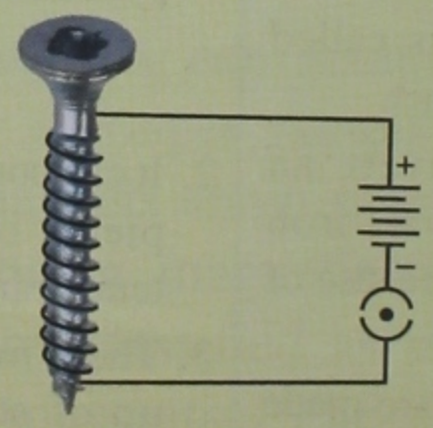


Fig. 7.8 Making of an electromagnet

Intext Questions

1. Write the names of different shapes of magnets.
2. What is the name of iron ore showing magnetic properties ?
3. Give examples of temporary magnets.
4. Who discovered an electromagnet ?

Do You Know ?

Magnetic force can act through certain things like water, air, cloth, glass, paper depending on the strength of magnetism. It is a non-contact force.

MAKING MAGNETS

Magnets can be prepared with the help of a magnetic substance using the following methods.

1. Magnetic induction method : Take a long nail. Put it on the arm of a stand as shown in Fig. 7.9. Spread some iron pins on the base of the stand. You will find that the pins do not get attracted towards the nail. Now touch a magnet at the head of the nail. As soon as you bring one of the poles of a magnet close to the head of the nail, some pins at the base of the stand will cling to the nail. Why does this happen ? It happens because the nail turns into a magnet and hence acquires the properties of magnetism. The moment you remove the magnet from the head of the nail, the pins will fall down showing that the nail is demagnetised.

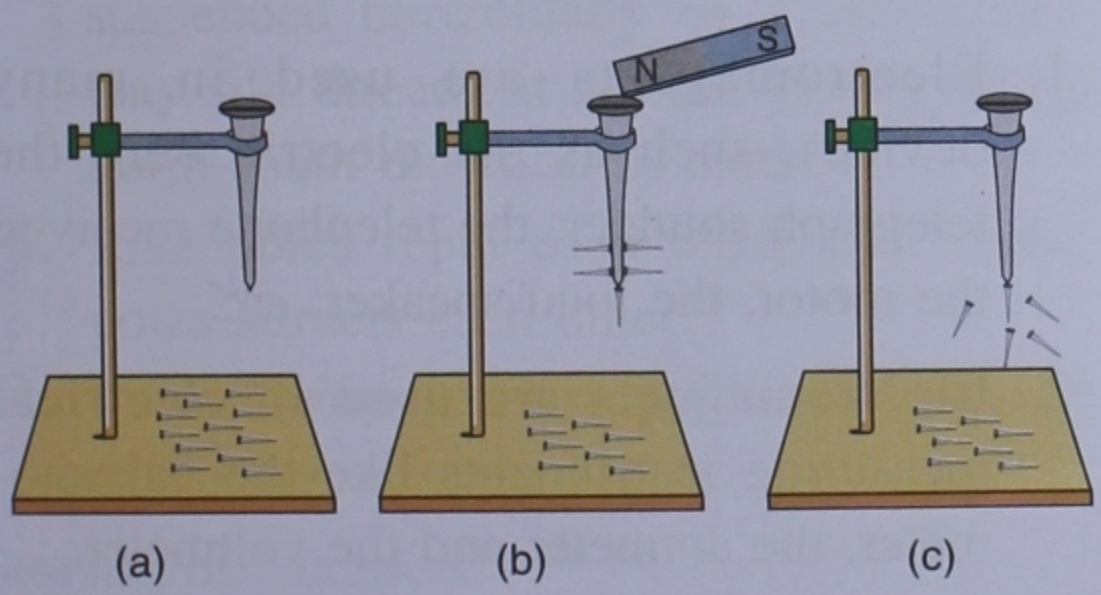


Fig. 7.9 (a) Nail does attract the pins
(b) Magnetised nail attracts the pins
(c) Pins fall down when the magnet is removed

This property by which an ordinary piece of iron (or any magnetic substance) acquires magnetic properties, temporarily due to the presence of another magnet close to it, is known as **magnetic induction**.

2. Single touch method : Take an of iron bar. Place it on a table top. Take a magnet and select its one pole (either north or south pole). Use the same pole of the magnet every time and rub it on the iron bar **only in one direction** for several times. You will notice that after sometime, the iron bar turns into a magnet (Fig. 7.10).

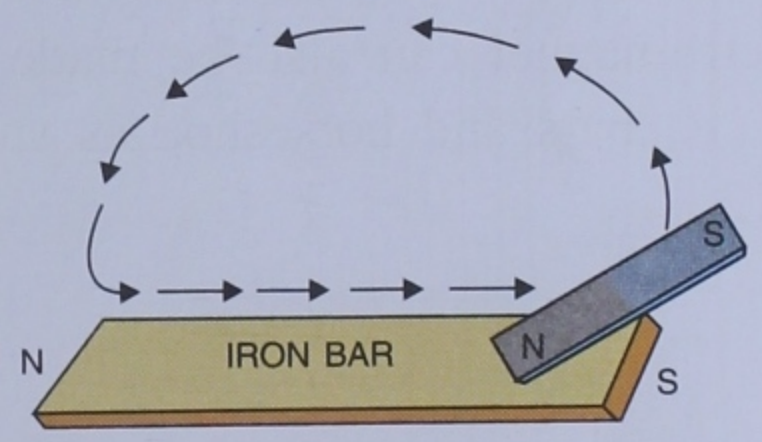


Fig. 7.10 Single touch method

3. Double touch method : Take two magnets of the same size and same strength. Place north pole of one magnet and south pole of the other magnet at the middle of the iron

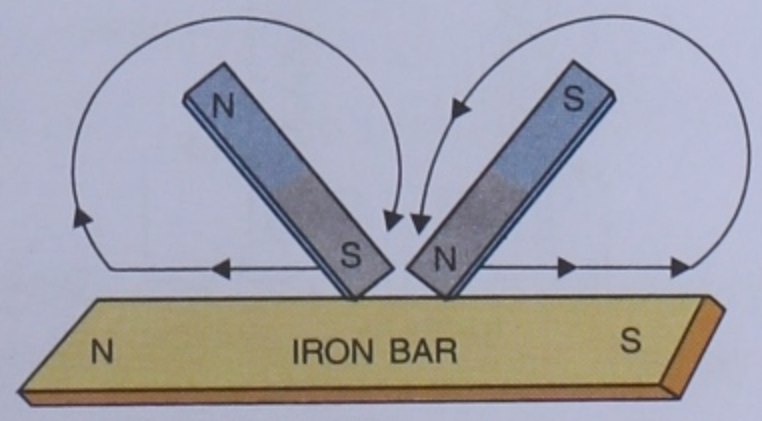


Fig. 7.11 Double touch method

bar. Rub both the magnets against iron rod several times taking one magnet to the one end of the iron bar and other magnet to the other end of the iron bar. Each time, start from the middle of the iron bar and rub upto its ends.

4. Electrical Method : If a bar of soft iron is placed inside a coil of insulated wire with several turns and current is then passed through the coil, the soft iron will become strongly magnetised. One end of it will become a north pole and the other end, a south pole. When the current in the coil is turned off, the soft iron bar loses nearly all its magnetism. This type of combination of a current-carrying coil and a soft iron bar or core is called an **electromagnet**. Thus, an electromagnet is a temporary magnet because its magnetism can be switched *on* or *off* as and when required. An electromagnet can also be made in two shapes *i.e.*, bars and horseshoe as shown in Fig. 7.12.

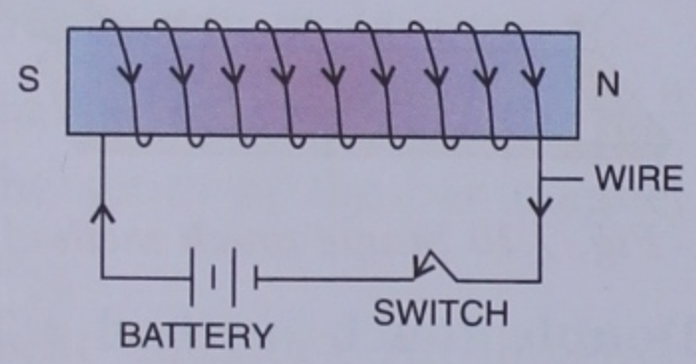


Fig. 7.12 Types of electromagnets

Advantages of an Electromagnet

Electromagnets have *three* advantages over permanent magnets.

1. They can easily be magnetised and demagnetised by turning the current *on* or *off* in the coil.
2. They can be made stronger than any other permanent magnet, as per the need.
3. Poles of an electromagnet can be interchanged by reversing the direction of current, this is not possible in the case of permanent magnet.

Strength of an electromagnet : The strength of an electromagnet depends upon the following factors :

1. The amount of current flowing through the coil.

By increasing the amount of current, the strength of the electro-magnet is increased and *vice-versa*.

2. The number of turns used in the coil.

By increasing the number of turns, the strength of the magnet will increase and *vice-versa*.

Uses of Electromagnets

1. Electromagnets are used in many devices, such as the electric bell, the telegraph sounder, the telephone receiver, the motor, the loud speaker, *etc*.
2. Electromagnets are used in electrical measuring instruments like the galvanometer, the ammeter and the voltmeter.
3. Huge electromagnets are also used for loading and unloading heavy loads

at shipyards, scrap iron and other iron objects.

4. Eye specialists use them to remove small bits of iron or steel lodged in the eyes.

Demagnetising a Magnet

A magnet can be demagnetised, *i.e.* the magnetising properties can be destroyed by the following ways :

1. By hammering the magnet repeatedly.
2. By rough handling.
3. By heating the magnet to a very high temperature and keeping it in the east-west direction.
4. By passing alternating current through a coil around the magnet.
5. Dropping it repeatedly on a hard surface.
6. By self-demagnetisation - when the two poles of a magnet are left free, the magnet loses its magnetism slowly. This is called self-damagnetisation.

Properties of a Bar Magnet

1. **Attractive property :** A magnet can attract small pieces of iron filing.
2. **Directive property :** If a magnet is suspended horizontally by a thin thread (say silk thread), it rests always pointing north-south direction of earth.
3. Like poles repel each other and unlike poles attracts each other.
4. **Poles always exist in pairs :** Single pole can never exist.

Storing of Magnets

When magnets are not in use, they should be kept and stored in **magnetic keepers**. A magnetic keeper has a card board box with one or two soft iron pieces. Two magnets are placed in such a way that their opposite poles are close to each other and then a soft iron keeper is attached to them. Two magnets are separated by keeping a piece of wood between them (Fig. 7.13). This way the magnets do not lose their magnetism. A U-shaped magnet requires only one magnetic keeper.

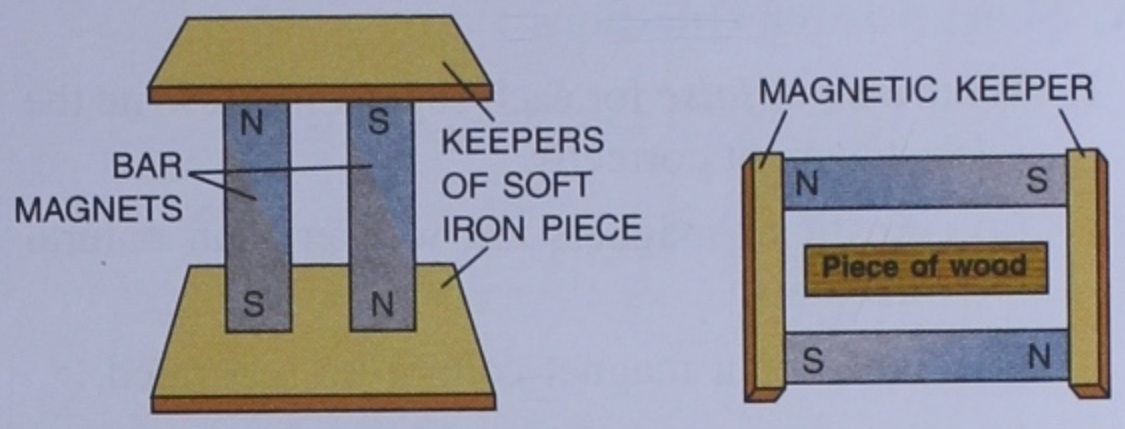


Fig. 7.13 Magnets with magnetic keepers

KNOWLEDGE BANK :

- Ceramic magnets are made from the oxides of iron, nickel and beryllium.
- The magnetic compass is a device that is used by travellers, sailors and navigators to find the direction.
- The earth behaves as a huge magnet. But actually there is no magnet inside the earth.

Uses of Magnets

Some common uses of magnets are listed below:

1. Magnets are used in magnetic compass, door bells, refrigerators, cupboard doors, *etc*.
2. Magnets are used in dynamos, motors, loudspeakers, microphones, floppy disks, stereo speakers, televisions, *etc*.

3. Ceramic magnets are used in computers.
4. Magnetic tapes are used in tape recorders and radio recorders.
5. Magnets are used in toys to give magic effect.

Intext Questions

1. List the methods for making magnets.
2. Write *two* uses of an electromagnet.
3. What is demagnetisation ?
4. What is the use of magnetic keepers ?

TEST YOURSELF

A. Short Answer Questions :

1. Write ***true*** or ***false*** for each statement. Rewrite the *false* statement correctly.
   (a) Artificial magnets are weaker than natural magnets.
   (b) Poles of a magnet cannot be separated.
   (c) A magnet can attract only a magnetic substance.
   (d) A magnet has no effect when it is heated to a very high temperature.
   (e) Permanent magnets lose their magnetic properties as soon as the magnetising force is withdrawn.
   (f) Magnetic poles occur in pairs.
   (g) Single touch method is better than electrical method for magnetising a specimen.
   (h) Repulsion is a sure test of magnetism.
   (i) Copper cannot be magnetised.
2. Fill in the blanks :
   (a) Temporary magnets are usually made up of .....
   (b) Rough handling destroys the ..... properties of a magnet.
   (c) ..... like effect is given by magnets in certain toys.
   (d) A freely suspended magnet points in the ..... direction.
   (e) In a magnet, ... have the maximum magnetic effect.
   (f) A magnet is ..... at its centre.
3. Match the following columns :

Column A	*Column B*
(a) Steel	(i) Magnet
(b) Soft iron	(ii) Temporary magnet
(c) Used in computers	(iii) Permanent magnet
(d) Earth behaves like a	(iv) Ceramic magnets

4. Tick the correct answer :
   (a) If we suspend a magnet freely, it will settle in
      (i) east-west direction
      (ii) north-south direction
      (iii) north-east direction
      (iv) east-south direction
   (b) Making a magnetic substance like a magnet by bringing it closer to another magnet but not touching it is
      (i) magnetic induction method
      (ii) single touch method
      (iii) double touch method
      (iv) electrical method
   (c) An example of natural magnet is
      (i) iron
      (ii) steel
      (iv) lodestone
      (iv) none of these
   (d) The artificial magnet used to detect direction in the laboratory is
      (i) U-shaped magnet
      (ii) horseshoe magnet
      (iii) electromagnet
      (iv) magnetic needle

B. Long Answer Questions :

1. (a) What are natural and artificial magnets ?
   (b) How is an artificial magnet prepared from a natural magnet ?
   (c) State the ways of magnetising an iron piece ?
   (d) How can magnetic properties be destroyed ?
   (e) Why the magnetic poles always occur in pairs ?
   (f) Draw a diagram of four different shapes of artificial magnets.
2. Why are artificial magnets preferred over natural magnets ?
3. Describe an experiment to prove that maximum magnetic force acts at the poles of a magnet.
4. State four important properties of a magnet.
5. Explain with the help of an experiment, the attractive property of a magnet.
6. What are the two methods by which a demagnetised iron bar can be magnetised ?
7. How are magnets kept safely ? What is the role of keepers in storing magnets ?
8. You are given two identical iron bars A and B. Which one is a magnet ? Without using any other substance, how will you identify the magnetised bar out of the two ?
9. "Repulsion is the surest test of polarity". Explain.
10. Define : Magnetic poles, magnetic axis, magnetic equator, effective length of a magnet.
11. Suppose you are given a long bar magnet and you are asked to break it into 10 small magnets. Calculate how many north poles will be there in these small magnets.
12. What are the important uses of a magnet ?
13. State and explain the properties of a bar magnet.
14. What is magnetic induction ? Explain with the help of a diagram.
15. In which direction does a suspended bar magnet come to rest?
16. Differentiate between temporary and permanent magnets.
17. A magnet was brought from different directions towards a toy boat that has been floating in water in a tub. Effects observed in each case is stated in Column I. Possible reasons for the observed affects are mentioned in column II. Match the statements given in column I with those in column II.

Column I	Column II
1. Boat gets attracted towards the magnet.	1. Boat is made up of non-magnetic material.
2. Boat is not affected by the magnet.	2. Boat is fitted with a magnet with south pole towards its head.
3. Boat moves towards the magnet if north pole of the magnet is brought near its head.	3. Boat has a magnet fixed along its length.
4. Boat moves away from the magnet when north pole is brought near its head.	4. Boat is made of a non-magnetic material.
5. Boat gets attracted by one end of the magnet and gets repelled by its other end.	5. Boat is fitted with a magnet with north pole towards its head.

RECAPITULATION

- Natural magnet is an ore of iron.
- Some materials behave in a particular manner showing magnetic properties.
- Iron, cobalt, nickel and steel are magnetic substances.
- If a piece of iron is rubbed with lodestone, it acquires the properties of lodestone (magnet).
- A magnet attracts iron pieces and settles along north-south direction when suspended horizontally.
- The end which settles towards the earth's north pole (geographic) is called the north pole.
- Temporary magnets retain their magnetism only for a short duration and lose their magnetic properties when the magnetic field is removed.
- Permanent magnets are made of nickel, cobalt or steel and retain their magnetism for a long time even when the magnetic field is removed.
- Like poles repel each other while unlike poles attract each other.
- Poles always exist in pairs and cannot be isolated.
- A bar magnet is neutral (no magnetism) at its centre.
- Direct electric current can be used for making magnets. Such magnets are called electromagnets. An electromagnet is a temporary magnet.
- An iron piece can be magnetised by induction, single touch, double touch and by electrical method using a direct electric current (D.C.).
- Lodestone was the first natural magnet discovered by the man.
- The two ends of a magnet, where the magnetic force is maximum, are called its magnetic poles.
- The force with which a magnet attracts a magnetic substance is called magnetic force.