13. MAGNETISM

13.1

Magnet has been an object of mystery to man from ages. For years scientists have been trying to find how a magnet could attract objects of iron from a distance. You must also have played many games with a magnet and tried to know about its qualities. There is an interesting story about the discovery of the magnet.

Some two thousand years ago, in a small village called Mangnesia in Asia minor (Turkey), there lived a shepherd named Magnus. He used to take his goats and sheep to the hills for grazing. He had a stick with iron attached to the ends. Once he was sitting near a waterfall, where his sheep were grazing. When he lifted his stick to call back his sheep, he found some black stones attached to the iron ends. To know more about these stones, he dug the earth and found some mysterious stones (iron ore), which had the quality to attract iron towards them. This ore got to be called magnetite. It was found that when this stone was taken in form of a rock and suspended by a string it came to rest in the north –south direction. So this came to be known as 'leading stone' or 'lode stone'(directing). About 2500 years ago people in Greece used to show some miracles with this stone. We also have proof that in the 12th century, in China, the Chinese used to rub needles with this stone and suspend it on a string to find the north-south direction(fig.-13.1). This proves that the Chinese had knowledge of making iron ,magnetic with the help of lode-stone.

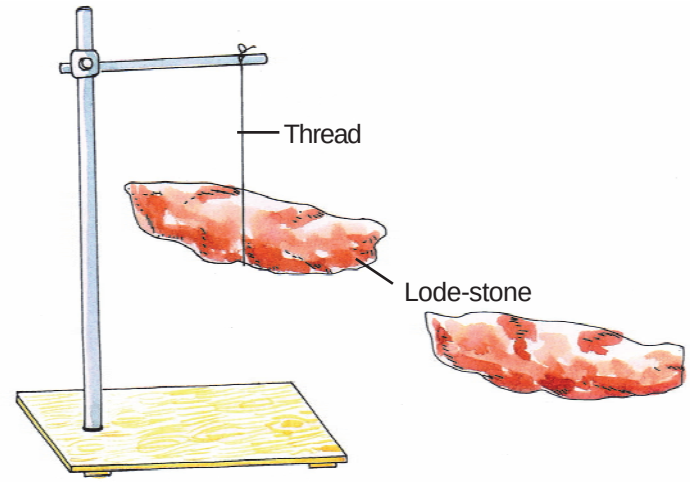


Fig 13.1 Freely suspended lodestone

You know that magnet is that which can attract iron towards it. This property of magnet is called Magnetism.

13.2 Natural and Artificial Magnets

In the earth the natural ore of iron 'Magnetite' is the only form of natural magnet, which is an oxide of iron (Fe_3O_4). Some other rocks, ores and meteorites also have magnetic properties.

1. In natural magnets the measure of magnetism is very less. They are not powerful .
2. Their shapes are irregular.
3. They are less stable and are very fragile.

So these are less used in practical purposes.

Artificial Magnets

Some metals and alloys are such that they can be made into powerful magnets by artificial methods. These are called artificial magnets. Powerful magnets are made from steel or cobalt-steel or nickel-steel or aluminum- nickel- cobalt alloy (Alnico). Their magnetism remains for longer time. Now a days magnets of different shapes and sizes, which are powerful and permanent are made and used widely.

Artificial magnets are named as per their shapes.

1. Bar Magnet or Rod Magnet :- These are in shape of cuboids or cylinders.(fig 13.2a)

2. Horse-shoe shaped Magnet:- These are bar magnets bend in shape of a horse shoe.(fig 13.2b)

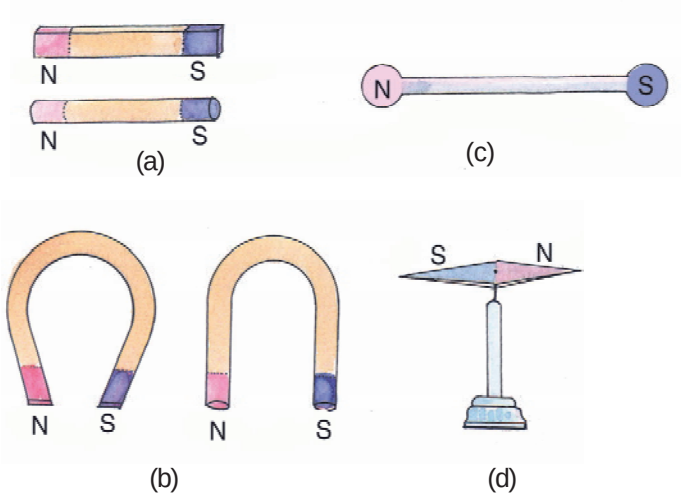


Fig 13.2 Different types of artificial magnet

3. U-shaped Magnet :-When rod magnets are bend in U form, they are called U-Magnets.(fig 13.2b)

4. Spherical Magnet:- These are in form of a long rod with spheres at its ends.(fig 13.2c)

5. Magnetic Needle :- These are flat and thin pieces made of steel which is broad at the centre and tapering towards the ends. At the mid centre they are attached to a pointed nail on a stand, so that they can move freely horizontally.(fig 13.2d)

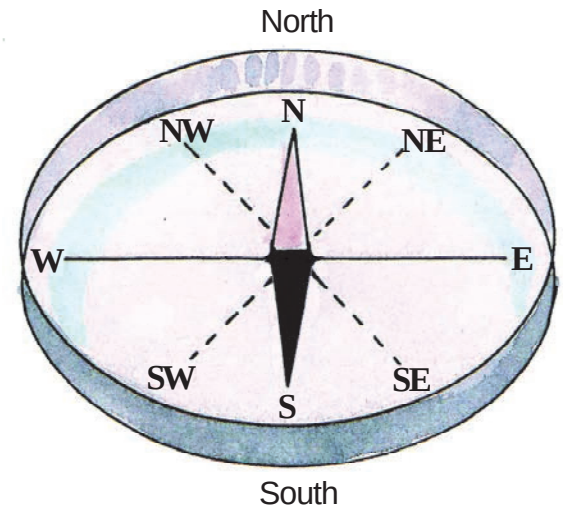


Fig 13.3 Magnetic compass

6. Magnetic Compass:- These are magnetic needles packed in boxes which have transparent plates on the upper side. Both ends of the magnetic needle are marked N and S.(fig 13.3). these are mainly used in aircrafts and ships to know the direction.

13.3 Magnetic and Non-magnetic Substances

Magnetic Substances

Those substances which can be attracted by a magnet or which can be converted to a magnet is known as a magnetic substance. Iron ,cobalt ,nickel and their alloys are examples of magnetic substances.

Non-magnetic Substances

Those substances which are not attracted by a magnet or which cannot be made into a magnet even by artificial methods is known as non-magnetic substances. Copper, Aluminium, Sulphur, Carbon, Cotton, wood, paper, rubber, glass etc are the examples of non-magnetic substances.

Let us identify magnetic and non-magnetic substances by activity :-

ACTIVITY 1

Materials required :- materials collected as pieces of wood, rubber, plastic, glass, nickel, cobalt, iron, steel materials, salt, sugar and a powerful magnet.

Place all these objects on a wooden table covered with a paper. Place all the articles on this table some distance away from each other. Now bring a powerful magnet near all the articles one by one. Observe the effect of magnet on each of the articles. Draw the table 13.1 in your copy and fill in the details.

TABLE NO 13.1

S.No.	Name of the object	Attracted by the magnet or not	Magnetic/ Non magnetic
1 .	plastic straw	no	non magnetic
2 .	blade (Iron)	yes	magnetic
3 .	_____	_____	_____
4.	_____	_____	_____

Answer These

1. What are magnets?
2. Why are artificial magnets more useful than natural magnets?
3. What are magnetic and non-magnetic substances?
4. Why is magnetite called a lode stone?

13.4 Properties of a Magnet

From the above experiment we have seen that magnet attracts some objects made of magnetic materials towards itself. Let us know about the properties of magnet through some experiments.

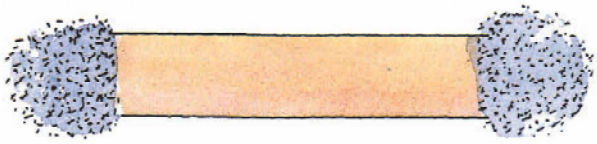
Property No. 1 Magnetic poles / Attraction Property

ACTIVITY 2

Materials required :- bar magnet, white paper, and iron powder.

Scatter the iron powder all over the white paper. Now bring a powerful magnet and turn it over the iron powder. What do you find? The iron powder is mostly attached to the ends of the bar magnet.

And towards the middle there is no piece attached.(fig13.4). This proves that the magnetic power is concentrated towards the ends. These are called the 'poles'. Attraction of the magnetic substances by a magnet is known as attraction property of the magnet.



(a)

(b)

Fig 13.4 Poles of a magnet

Property No 2 Directional Property of Magnet :

ACTIVITY 3

Materials required :- wooden stand , bar magnet and a string.

From the wooden stand, suspend a bar magnet with a string tied at its middle(centre of gravity) freely. On which direction does the magnet come to rest? The direction is north- south (fig 13.5).

Now rotate this magnet with your hand and leave it. At which direction does it settle now? After some time it again comes to rest in north- south direction. So we can say that a freely suspended magnet always comes to rest in the north- south direction. This is known as directional property of the magnet. The end of the magnet pointing towards the north is called its North Pole and which points south is the South Pole of the magnet.

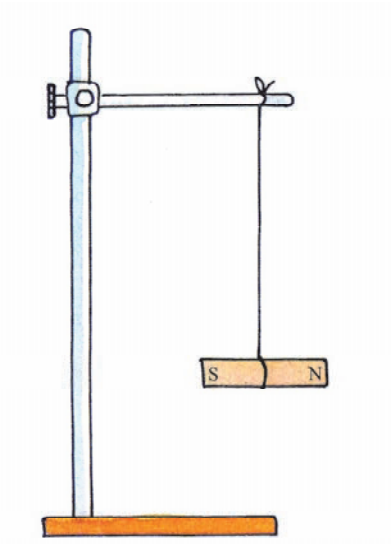


Fig 13.5

Property No 3 Attraction and Repulsion

ACTIVITY 4

Materials required :- wooden stand, two magnetic needles.

Two magnetic needles to be placed such that there is no movement. Find their north and south poles and mark them. Now place one magnet in your hand and bring its poles near the magnetic needles, one after the other (fig 13.6) and write your finding in the given table copied in your notebook.

Table 13.2

S.No.	Poles Brought Near		Observation	
	Magnetic Needle	Other magnet	Attraction	Repulsion
1	north	north	———	yes
2.	south	north	———	———
3.	north	south	———	———
4.	south	south	———	———

From the above observations we can say that

1. There is repulsion between similar poles.(north-north ; south-south)

2. There is attraction between dissimilar poles that is north – south.

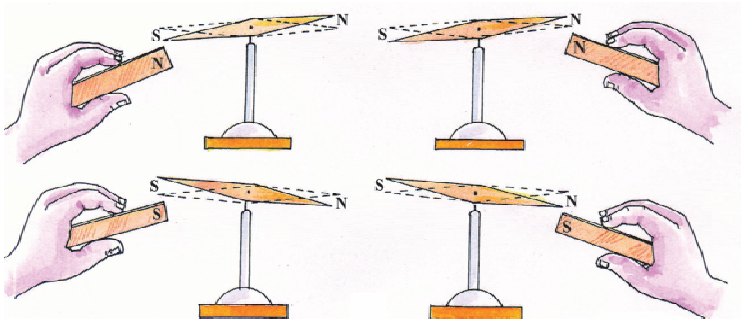


Fig 13.6 Magnetic attraction & repulsion

ACTIVITY 5

Materials required :- two magnets and an iron rod.

To differentiate between a magnet and an iron rod. Take another magnet and bring it near both the ends of both the magnet and the rod. If there is attraction to both the ends then it is an iron rod, and if is attracted to one end and is repelled by the other end then it is a magnet. So we can say that repulsion identifies a magnet.

ANSWER THESE

1. What do you mean by poles of a magnet?

2. What do you mean by the directional property of a magnet ?

3. Write the laws of attraction and repulsion between the poles of a magnet ?

4. How will you identify a magnet and a magnetic substance?

Property No. 4 Opposite poles are present in pairs

When we cut a bar magnet into two pieces, we cannot obtain the two poles separately. That is, if we cut any bar magnet into two halves, then the two halves will have north pole and south pole. And if you

again cut the two halves you will get the four pieces each having a north pole and south pole.(fig 13.7). In this way if we cut a magnet into any number of pieces each will have the two poles. This proves that the smallest particle of any magnet, which is the atom, itself is a complete magnet, with one end as north pole and the other end as south pole.

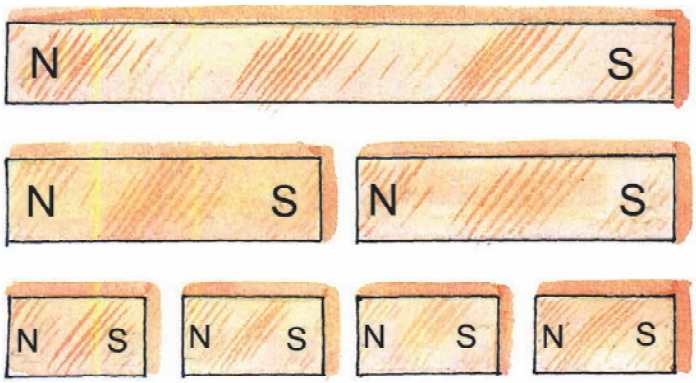


Fig 13.7 Divided pieces of a magnet each having the two poles

Property no. 5 Magnetic Induction

ACTIVITY 6

Materials required :- a powerful magnet, iron nails.

Bring a nail to one end of the magnet. It gets attached to that end. Now bring another nail near the first nail, at its free end. Does it get attached? In this way, the nails are attached to the free end and form a chain. (fig 13.8) If the magnet is powerful this chain will be longer and each nail acts as a magnet.

Now pull the first nail away from the magnet. If it is not in contact but near the magnet, then also the chain remains. But when the first nail is removed far away then all the nails fall off.(fig 13.8b). Why does it happen?

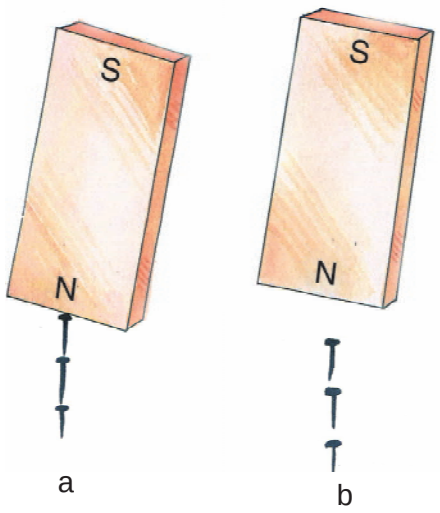


Fig 13.8 Magnetic induction

When a magnetic substance is kept near a magnet, it acquires the property of a temporary magnet and on removing the magnet its property of magnetism is lost. This process is called magnetic induction .That magnet which caused induction is called inducting magnet. From the above experiment we can say that

1. When an inducing magnet is brought near a magnetic substance, that end of the substance acquires the opposite pole and its other end has the same pole.

2. The power of magnetism depends on the power of the inducing magnet.

3. The quality or power of the induced magnetism is more at the poles and becomes less as we move towards the centre.

It is also seen that the magnetic effect is felt only upto some area around the magnet. This area is known as **magnetic field**.

Property No 6 Transforming a Magnetic Substance to a Magnet

ACTIVITY 7

Materials required: - A long bar of soft iron and a powerful magnet.

Place the iron bar on a wooden table. Now take the magnet and rub it over the bar with its north pole from one end to other as shown in the figure. Now pull away the magnet and again repeat it from the starting end of the iron bar. (fig13.9) Repeat this a number of times. Note that during all this repetitions , neither the pole of the bar magnet nor the direction of the magnet change.

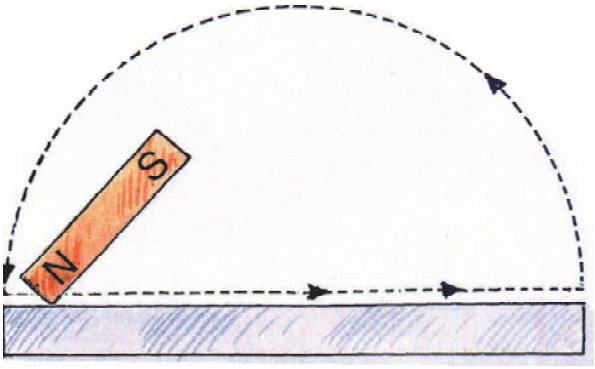


Fig.13.9Transforming a magnetic substance to a Maganet

Now test the iron bar for its magnetism by bringing another magnet near its ends. You will find that the starting end of the iron bar is the north pole and the other end is the south pole.

Property No. 7 Effect of Magnet through a Non-magnetic Substance.

ACTIVITY 8

Materials required :- one powerful magnet , drawing paper and some iron powder.

Place the sheet of drawing paper and spread the iron powder over it. At first, move the magnet. Repeat, by keeping wood or other non-magnetic materials between the iron powder and the magnet. What does the movement of iron powder with the magnet prove?

Can you prove from this experiment that the magnetic effect passes through non-magnetic substances?

Property No 8 Loss of Magnetic Effect due to Careless Handling and Storage

ACTIVITY 9

Materials required:- a powerful magnet, iron rod, hammer, and iron powder.

Insert the iron rod in the iron powder. You will find that the powder does not stick to the rod. Now place the rod on a wooden table and rub it with a magnet,(as shown in activity 7) to make it a magnet. Now insert the rod in the iron powder, you will find that some pieces of the powder has stuck to the rod.

This means that the iron rod has gained some magnetic property. Now beat the rod with a hammer many times to flatten it. Again insert this into the iron powder. The iron powder does not stick. What does this prove?

It is also seen that when weak magnets are carelessly left for a long period of time, or when it is heated,or beaten ,then its magnetic power is lost.

So it is proved that if proper care is not taken in storing or handling, then the magnetic power may be lost.

13.4 Magnetic Protector

From the above activities it can be noted that for a loss of magnetic power, the causes are:-

1. Beating or hitting a magnet
2. Heating a magnet.
3. Keeping the two similar poles of two magnet near to each other.
4. Improper storage.

So we must take property care that the magnetic power of a magnet is not lost.

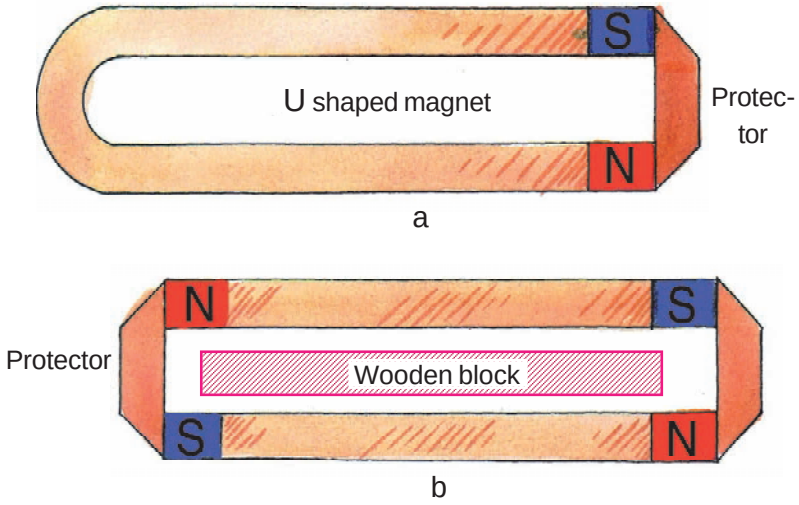


Fig 13.10 Magnetic protetor

To protect a magnet from losing its magnetic property , a rod of soft iron is placed on the poles of a horse-shoe magnet.(fig 13.10a)

In the same way to store bar magnets, two bar magnets are placed with their dissimilar poles near and a wooden piece is kept in between them. At their ends pieces of soft iron is kept (fig 13.10b). The soft iron bands or pieces are called magnetic protectors, because when they are placed on the magnet, the magnet does not lose its power.

Soft iron is used as a magnetic protector because its magnetic domains gets aligned quite easily on coming in contact with any magnet. This alignment is formed in such a way that a circle is formed and the alignment of the magnetic domain of the magnet is not disturbed.

13.5 Earth as a Magnet

Have you ever imagined why a freely suspended magnet comes to stay in the north-south direction?

The earth itself behaves as a magnet. The magnetic north lies near the geographical south of the earth and its magnetic south lies near the geographical north. The line joining the geographical north and south makes an angle of 17^0 to the line joining the magnetic north and south.(fig 13.11). We know that the opposite poles attract each other. That is why any freely suspended magnet's north pole always points to the geographical north(where the earth's magnetic south is situated). It is seen that if an iron is buried in the earth for some days, it becomes a magnet and its end which has pointed towards the geographical north becomes its north pole.

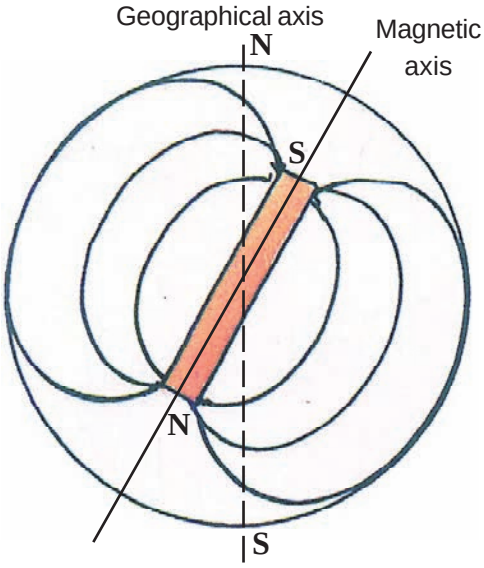


Fig 13.11 Earth as a magnet

Human beings do not feel the earth's magnetic effect but birds and animals can feel it. It is said that the migratory birds find their way by using the magnetic field of the earth.

13.6 Uses of a Magnet

There are many uses of magnet in our day to day life. Some of which are given below.

1. Magnets are used in bulletin boards, magnetic toys, stickers(placed on iron almirahs), electric bell, electric generator or dynamo, television, loudspeaker etc.
2. Usually the doctor uses a magnet to extract minute iron pieces from the patient's eye.
3. Iron ore is extracted from mixed ores by using a magnet.
4. The main use of magnet is to make magnetic compass which is used in aeroplanes and ships to know direction.
5. To lift very heavy iron blocks, cranes are fitted with magnet.

ANSWER THESE

1. For which purpose ship navigators use the magnetic compass?
2. From which material is magnet protector made of ?
3. How can the magnetic properties of a magnet be lost?
4. Write any two uses of magnet.

WE HAVE LEARNT

- Magnet attract iron and materials made of iron towards it.
- Substances which can be attracted towards a magnet or which can be made a magnet are known as magnetic substances. Those which are not attracted towards a magnet or which can not be made into a magnet are known as non-magnetic substances.
- Magnets found in nature in free state are called natural magnets and those which are artificially made are called artificial magnets.
- In a magnet the maximum power is towards its ends which are called poles.
- A magnet freely suspended from its centre of gravity always comes to rest in the north-south direction. The end which points the north is its north pole and that which points south is its south pole.
- Similar poles of the magnet repel each other and dissimilar poles are attracted.
- Poles of a magnet are always present in pairs of opposite poles. Never can a pole be separately obtained.
- When a iron bar is kept near a magnet it obtains the property of a magnet. This is known as magnetic induction.
- The effect of magnet is also felt through non-magnetic materials.
- If a magnet is beaten or hit with a hammer, its magnetism is lost.
- To protect a magnet, pieces of soft iron is used. It is called a magnetic protector.
- Magnetic compass is used by navigators and aircraft pilots to know the direction.
- Earth acts as a magnet itself. Its magnetic north pole points the geographical south and its south pole points geographical north.
- Magnets are used in generators, telephone, television, loud speaker, magnetic toys, and for magnetic therapy etc.

EXERCISE

1. Name these :-

1. The place from where the word ‘magnet’ has come .
2. When a nonmagnetic substance is brought near a magnet it obtains the property of a magnet.
3. Magnets which are found free in nature.
4. The alloy from which powerful magnets are made.
5. The portion of the magnet where maximum magnetic power is felt.
6. The piece of soft iron which protect a magnet.

2. Choose the correct answer :-

1. This is a natural magnet;
   (a) magnetic needle (b) bar magnet
   (c) lode stone (d) soft iron
2. This is a magnetic substance :-
   (a) glass (b) cotton
   (c) rubber (d) iron
3. Permanent magnet are made from :-
   (a) iron (b) nickel
   (c) cobalt (d) alnico
4. Magnetic north of a magnet :-
   (a) attracts other north pole. (b) repels other north pole.
   (c) repels other south pole (d) sometimes attract and sometimes repels south pole
5. Magnetic power of a magnet is :-
   (a) maximum at the poles (b) minimum at the mid point
   (c) both the above statement are correct (d) its same allover

3. Answer the following questions :-

1. Give two examples each of magnetic and non-magnetic materials.
2. Why are artificial magnets used more than natural magnets?
3. Explain in brief, the method how a needle can be made into magnet.
4. What is done to preserve the magnetic power of a magnet ?
5. Write two important properties of a magnet.
6. Write the uses of a magnet.
7. "Repulsion is the proper identification of a magnet". Prove it.
8. "Earth is a magnet". Justity.
9. Two bar magnets are usually kept in pairs. In the given figure 13.12 E and F are pieces of two metals;
   (1) Name the metal E and F
   (2) Explain the use of E and F
   (3) Mark the poles of the other magnet.
   (4) Name the black part in the middle.

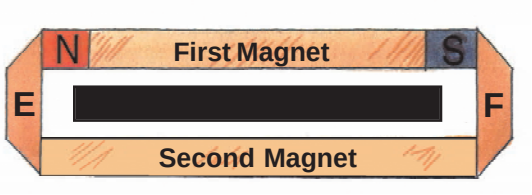


Fig 13.12

10. Suppose you have two iron rods, and one of them is a magnet. How will you identify it ?