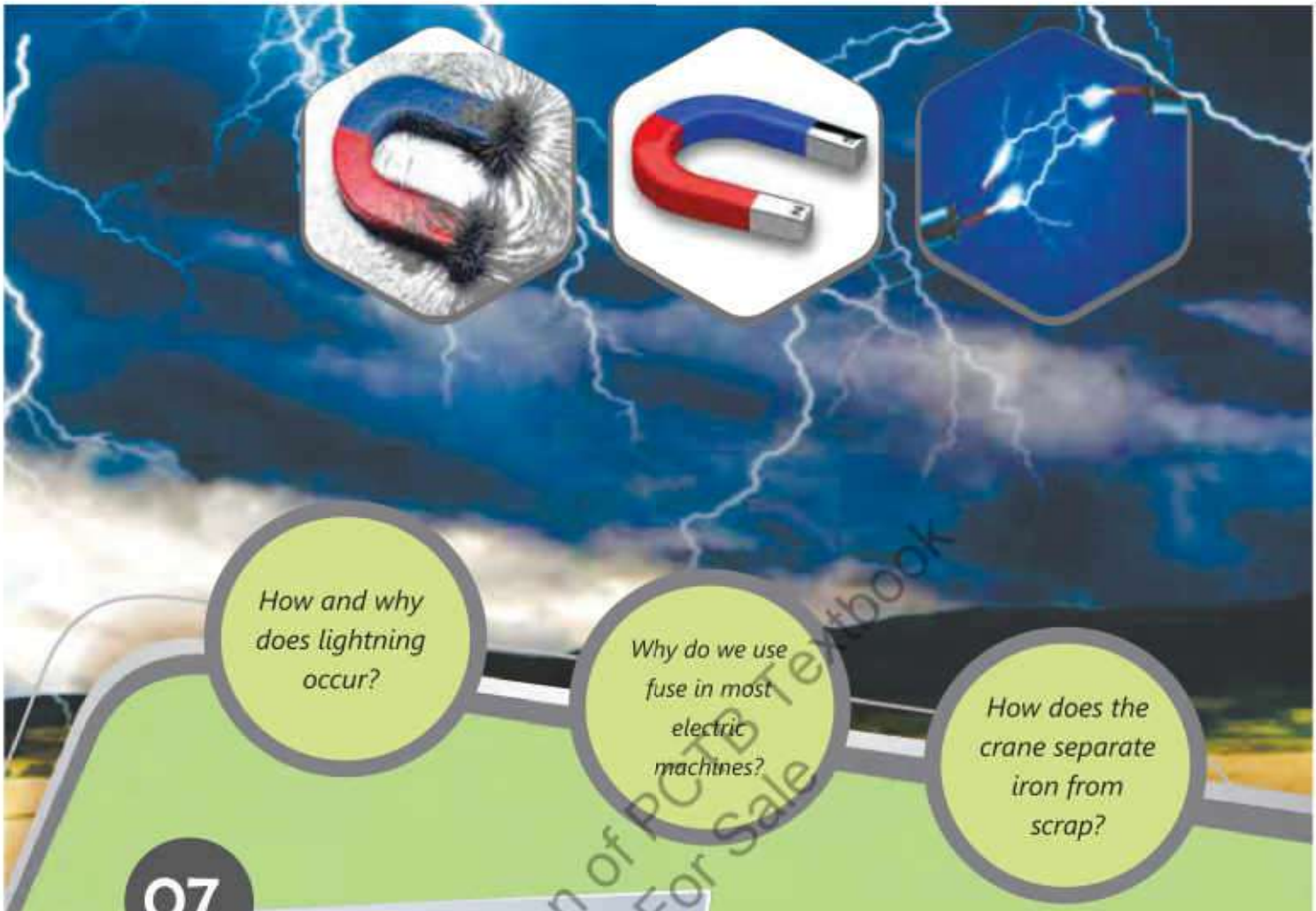


How and why does lightning occur?

Why do we use fuse in most electric machines?

How does the crane separate iron from scrap?

07 Electricity and Magnetism

Students' Learning Outcomes

After studying this chapter, the students will be able to:

1. Explain the phenomenon of static electricity in everyday life.
2. Describe charges and their properties.
3. Differentiate between conductors and insulators in daily life.
4. Describe flow of electric current in an electric circuit.
5. Describe and design an electric circuit and explain its components.
6. Recognize that magnets can be used to attract some metallic objects.
7. Describe and demonstrate that magnets have two poles and like poles repel and opposite poles attract.
8. Identify Earth as huge bar magnet and demonstrate it with experiment.
9. Describe the working of a magnetic compass.
10. Explain different types of magnets (permanent, temporary and electromagnet).

Every one of us is familiar with the use of electricity. We use electricity to light up a bulb or run an electric fan for air. In addition to that, television, Refrigerator, washing machine, electric iron and many other devices also work with electricity. You have already studied that electricity is a form of energy.

Static Electricity

Electricity is commonly known as electric current. Current flows through metal cables but there is a kind of electricity which does not flow. Have you ever thought, why your hair are pushed apart and also raised on combing your dry hair? This happens because of static electricity. Let us perform an experiment to understand it.

Charge

Activity 7.1

1. Place a few paper bits on the table.
2. Pull a plastic comb through your dry hair twice or thrice in the same direction.
3. Bring the comb near the paper bits. Do the bits stick to it? Why does the comb attract these paper bits?

   The reason for this phenomenon is that the comb has acquired charge.

Charge is a basic property of matter.

Types of Charge

Let us observe the types of charge by an experiment.

Activity 7.2

1. Suspend an inflated balloon with the stand using a thread.
2. Bring a piece of woolen cloth near. Does the cloth attract the balloon towards it?

3. Rub the balloon vigorously with the woolen cloth and then remove it.
4. Bring the cloth nearer the balloon slowly, once again.
5. Does the cloth attract the balloon this time? You will observe that the cloth attracts balloon this time.

The reason is that there was no charge on both of them before rubbing. After rubbing they have acquired opposite charges due to which they attract each other. The balloon has acquired negative charge and the cloth positive charge.

There are two types of charge: Positive charge and negative charge.

Do You Know?

The clouds are charged due to rubbing with air. One end of the cloud becomes positive and the other negative. A spark is produced when clouds having opposite charges come near each other. We call it lightning. This is a kind of static electricity.

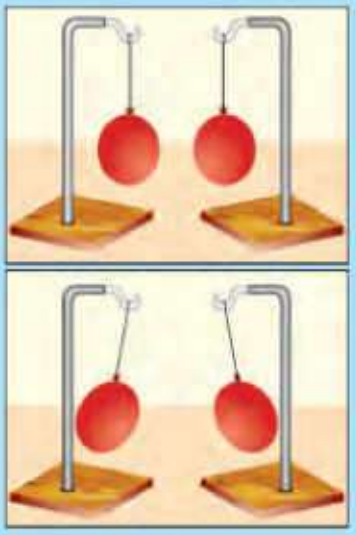
Point to Ponder!

When a plastic comb is pulled through dry hair, it is negatively charged. What is the charge on the hair? What causes the hair to push apart?

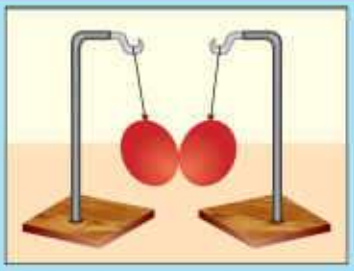
Properties of Charge

Activity 7.3

1. Suspend two inflated balloons with the stand using thread.
2. Place them at a small distance from each other as shown in the figure.
3. Bring the balloons closer by moving the stands. Do the balloons attract or repel each other?
4. Rub each balloon with a woolen cloth. Bring them close, again. Do they attract or repel each other?
5. Now rub one balloon with woolen cloth and the other with a plastic comb or ruler. Bring the balloons closer.



Do they attract or repel each other? What inference do you draw from your observations?



When balloons were rubbed with woolen cloth, both of them acquired negative charge. Due to which they repelled each other. When one balloon was rubbed with woolen cloth and the other with plastic object they acquired opposite charges. Hence, they attracted each other.

Similar charges repel each other and opposite charges attract each other.

Do you know?

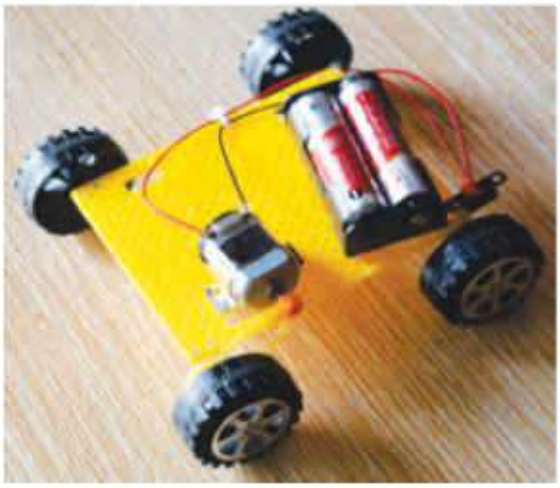
The smallest particle of a material is called atom. The atom contains further smallest particles electron and protons. Proton has a positive charge and electron has the same amount of negative charge. Protons and electrons are equal in number in an atom. As a whole, atom is neutral. It has no charge.

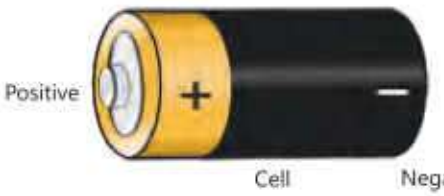
How and Why?

When two different materials are rubbed together, the electrons from one material are transferred to the other. The material which loses electron becomes positively charged and the other which has now excess of electrons becomes negatively charged.

Electric Current

Do you know that many toys have switches? When you turn ON the switches they start moving and stop when you turn them OFF. Why does it happen? You know that electric cell or a battery is used in these toys. The cell supplies energy for their working. An electric cell is shown in the figure. Its one end is positive and the other negative. The negative end has excess of electrons whereas there is a deficiency of electrons at its positive end. When both ends are joined through a metal wire and a switch, the electrons start moving from the end with excessive electrons to the end with deficiency of electrons. This flow of electrons or charge is called electric current.





Flow of charge is known as an electric current.

A switch is used to control the flow of charge.

Electric Circuit and its Components

In our homes, we turn ON the switch to light a bulb or to run a fan. The same switch is also used to turn them OFF. Various electric circuits are made for this purpose.

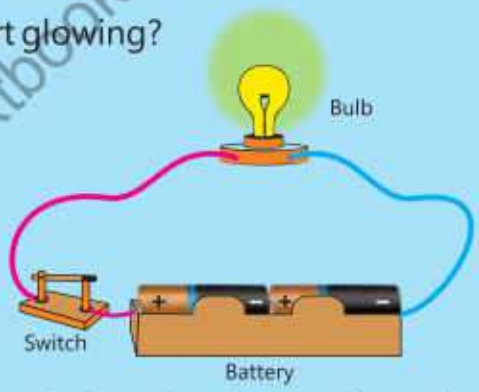
Simple Electric Circuit

Let us make a simple electric circuit.

Activity 7.4

1. Insert a torch bulb in a holder.
2. Connect the bulb to a cell or battery through a switch with the help of metal wires as shown in the figure.
3. Turn the switch ON and observe the bulb. Does it start glowing?
4. Now, turn the switch OFF and observe the bulb. Why did it stop glowing? When the switch is turned ON then why does the bulb start glowing?

   Bulb starts glowing because an electric current flows through it.



Electric current passes through the cell or battery, bulb, switch and wires as shown in figure. They together provide a path for current to flow through.

Electric circuit is a path of flow of current.

As you see in the figure that battery, bulb and switch are connected through wires in an electric circuit.

Bulb, battery or cell and switch are called the components of electric circuit.

Battery is a source of electric current. The switch is used to control the flow of current and glowing bulb indicates that current is passing through it.

Do you know?

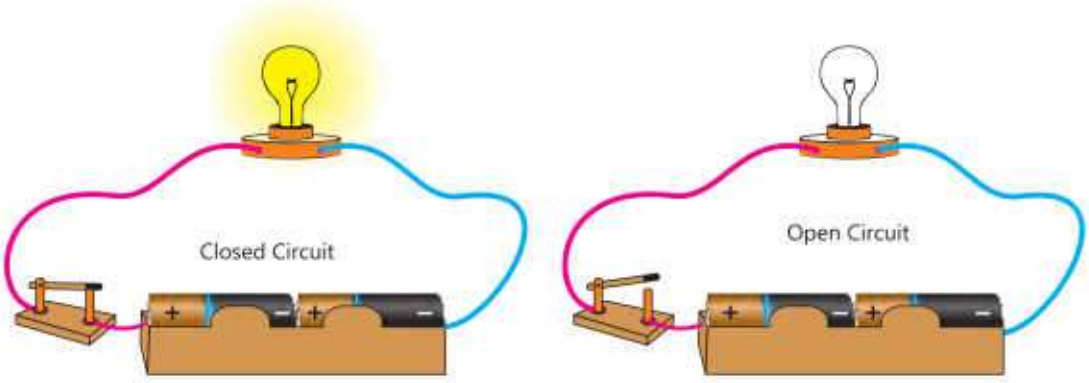
A battery consists of more than one cell.

Point to Ponder!

If battery connections are reversed in a closed circuit, will the bulb glow?

Open and Closed Circuits

You have learnt that on turning the switch ON, the circuit becomes complete or CLOSED due to which the current starts flowing through it. On turning the switch OFF, the circuit becomes incomplete or OPEN, so the current stops flowing through the circuit. It is called open circuit.

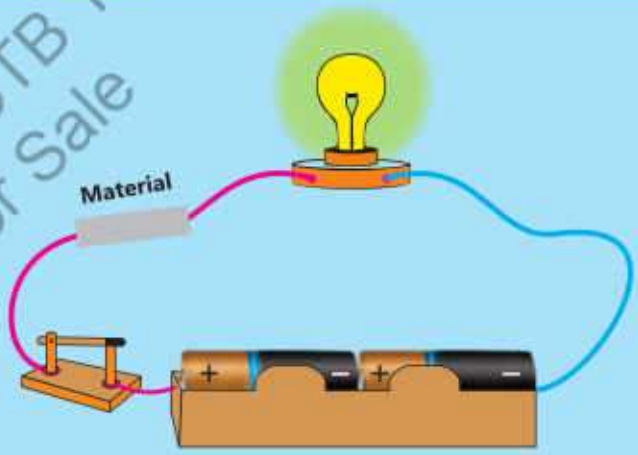


Conductors and Insulators

We have observed in the above activity that in case of closed circuit, electric current passes through its components. Does current pass through all kinds of materials in case of closed circuit? To know this, let us perform another experiment.

Activity 7.5

1. Collect some objects made of different materials such as aluminium foil, a pencil, iron wires, copper wires, an eraser, glass strip, plastic ruler, etc.
2. Can you predict, which material will allow the current to pass through it?
   Let us confirm it.
3. Make a circuit by connecting a bulb, a battery and a switch through wires.



4. Turn the switch ON. The bulb will glow, which indicates that the current is flowing through the circuit.
5. Now connect collected objects turn by turn in the circuit according to the figure. Observe the bulb. Which materials allow the bulb to glow and which ones do not?

The material which does not let the bulb glow, cannot conduct current. This shows that current can pass through some materials and cannot pass through some other materials.

The materials through which the current can pass are called conductors. On the other hand, the materials through which the current cannot pass are called insulators.

The iron or copper wires and other metallic objects are conductors. The materials like wood, rubber and plastic, etc. are insulators.

We have observed in our homes that those parts of electrical appliances are made up of insulators which are to be touched or held with our hands. This is done to avoid the danger of electric shock. For example, electric iron is made of metal but its handle is of plastic. The handles of electric heaters and electric kettle are also made of insulators. Now-a-days, the bodies of the entire electric fans, washing machines and refrigerators are made up of plastic instead of metal.

Quick Quiz

Name any three conductors and insulators other than those mentioned here.

Interesting Information

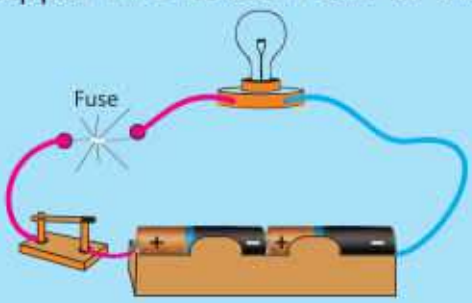
Usually the conductors of electricity are also the conductors of heat. However, diamond is insulator for electricity but conductor for heat. Hence, the jewelers can verify the real or fake diamond by touching it with their lips.

Fuse and its Use

Electricity is commonly used in our homes to operate fans, television, refrigerator, iron and washing machine, etc. A fuse is used in a circuit for the safe use of electricity. What is a fuse? Let us perform an experiment to understand it.

Activity 7.6

1. Make a battery joining two cells. Connect thick copper wire to each end of the battery with the help of sellotape.
2. Take a piece of very thin metallic wire.
3. Touch the ends of the thin wire with the thick copper wires as shown in the figure.
4. Does the thin wire melt and break? What is its reason?



When excessive current passes through the piece of thin wire, it becomes too hot and melts instantly. As a result, the circuit breaks and current stops flowing. Such a piece of thin wire is called a fuse.

Caution!

Do not touch switch, wire and electric devices with wet hands or bare foot.

Fuse is a piece of thin wire that is used in an electric circuit to protect electrical appliances.

A fuse is used in an electric iron, washing machine, heater, oven, water pumps and other electric appliances. If due to some fault current starts flowing in any appliance, one may get an electric shock on touching it. If a fuse is used, it will blow immediately and current will stop flowing. In this way the electrical appliances and the person touching it both will be protected.

Point to Ponder!

You must have heard building set on fire by short circuit. How can it be avoided?

Interesting Information

There is a limit of electric current to pass through any electric appliance. The fuse is inserted accordingly. If the amount of current in the circuit exceeds this limit due to some fault, the fuse blows immediately. The flow of current in the circuit stops and the appliance is not damaged.

Do you know?

Circuit breakers are used these days instead of fuse. They also work like a fuse. The instant tripping of a circuit breaker stops the current flow.

Magnet

Have you ever seen a piece of metal which has the ability to attract some materials? We call it a magnet. Which materials are attracted by a magnet, let us explore by an experiment.

Magnetic and Non-Magnetic Materials

Activity 7.7

1. Place some objects of different materials such as pencil, rubber, steel pins, copper wire, iron nails, steel clips, stone, etc. on the table.
2. Bring a strong magnet near these things turn by turn and observe if the magnet attracts them.

3. Write down the names of things which are attracted by the magnet. Write separately those which are not attracted by the magnet.

Materials which are attracted by the magnet are called magnetic materials.

These materials include things made up of iron, nickel and cobalt. For example, steel pins, iron nails, coins made up of nickel and cobalt, etc.

Materials which are not attracted by the magnet are called non-magnetic materials.

The examples of non-magnetic materials are copper, wood, plastic, rubber, glass, etc.

Do you know?

Only magnetic materials can be magnetized to make magnets.

Interesting Information

Over 2,000 years ago, Greeks discovered a rock (lodestone) which could attract things containing iron. It is a natural magnet.

Magnets of Different Shapes

U Magnet

Bar Magnet

Ring Magnet

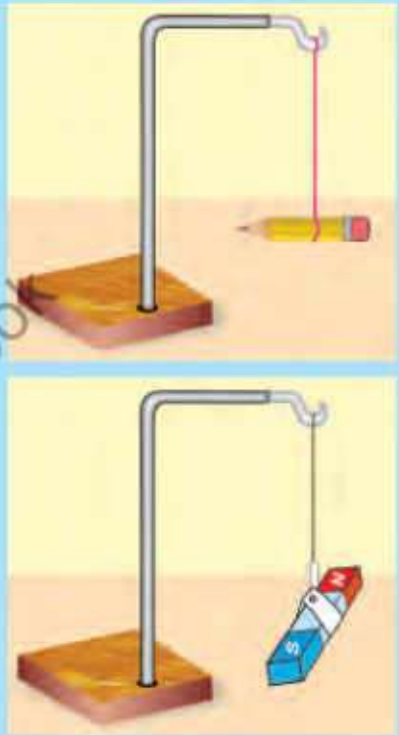
Disc Magnet

Properties of a Magnet

Magnets have very interesting and useful properties. Let us perform the following activities to explore some of the properties of magnets.

Activity 7.8

1. Suspend a pencil with the help of a thread as shown in the figure. Observe the direction along which it comes to rest.
2. Disturb its position and again observe its position after it comes to rest. Has its position changed? You will see that the pencil does not come to rest in any specific direction.
3. Now suspend a bar magnet. Observe its direction when it comes to rest. Disturb it and again observe in which direction it comes to rest. Repeat the process two or three times. Does it always come to rest in a specific direction? What is that direction?



A freely suspended magnet always points in the north-south direction.

The end of bar magnet that points towards north is called its north pole and the end pointing towards south is called its south pole. Thus a magnet has two poles.

The ends of a magnet are called its magnetic poles.

Usually, red colour is coated to show north pole that is labelled as (N). Blue colour is coated to show south pole (S).

Point to Ponder!

Can you make two magnets having one pole each by breaking a bar magnet?

Investigate: Find out which part of the magnet attracts strongly using a magnet and iron filing.

Do you know?

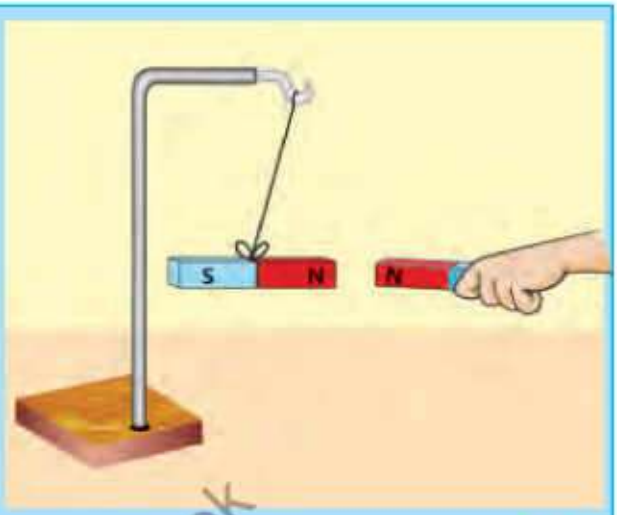
The magnetic force of the magnet is the strongest at the magnetic poles.

Activity 7.9

1. Suspend a bar magnet with the help of a thread such that it can rotate freely as shown in figure.
2. Take another bar magnet. Bring its north pole near the north pole of the

suspended magnet. What do you observe?

3. Now bring the south pole of second magnet near the south pole of the suspended magnet. Observe what happens?
4. Repeat the process by bringing opposite poles near each other and observe them.
5. What do you conclude from these observations?



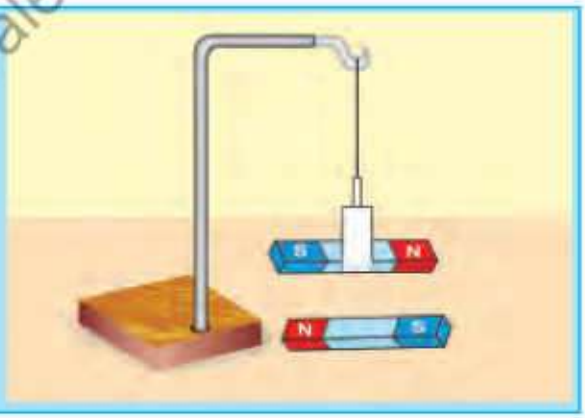
Two like magnetic poles repel each other while opposite poles attract each other.

Earth - A Huge Magnet

Earth behaves like a huge bar magnet. Let us explore it by doing an experiment.

Activity 7.10

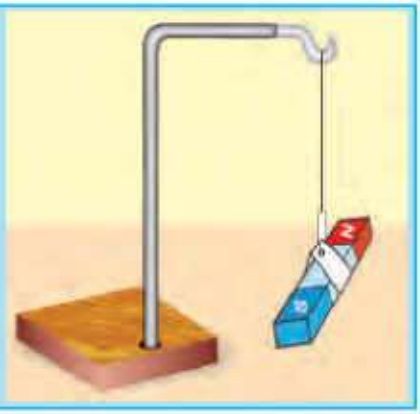
1. Place a bar magnet along east-west direction on a table.
2. Suspend another bar magnet from a stand using a thread over it so that it can rotate freely as shown in the figure.
3. Observe the direction of suspended magnet when it comes to rest.



You will observe that the suspended magnet also comes to rest along the same direction as that of magnet below it but with opposite poles near each other.

Activity 7.11

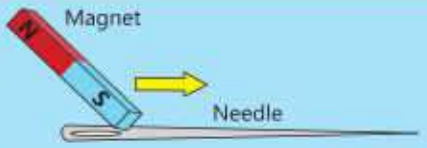
1. Remove the magnet placed on the table in the above experiment. In which direction does the suspended magnet come to rest now? Why does it happen?
2. The Earth compels the suspended magnet to do so. This happens as if a very large magnet is present in north-south direction inside the Earth.



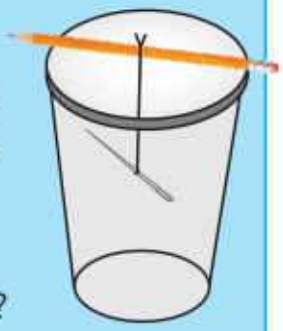
The Earth behaves like a huge bar magnet.

Magnetic Compass

Activity 7.12



1. Place a sewing needle on the table. Make it a magnet by rubbing it a few times in the same direction with north or south pole of a strong bar magnet.
2. Tie one end of a thread with the needle and other with the pencil. Suspend it in an empty glass as shown in the figure so that it can move freely.
3. Observe in which direction the needle comes to rest?
4. Disturb the needle. Does it come to rest again in the same direction?
5. Does it stay always in north-south direction?



Magnetic compass is also made on this principle. It is used to find the directions at any place.

Working of Magnetic Compass

Let us perform an experiment to know the use of a magnetic compass.

Activity 7.13

1. To know directions at any place put a magnetic compass on a table or ground. Its needle will stay along north-south direction.
2. Ensure there is no other magnet or an object made of iron near it.
3. Rotate the compass slowly until the north pole of the needle is aligned with the north direction (N) of the compass.

Do you know?

A magnetic chip is built in a credit card of a bank. The ATM is programmed to read the data of the user present in the chip.

In this condition, the magnetic compass will indicate correctly the four directions marked on it.

Types of Magnet

There are three types of magnet:

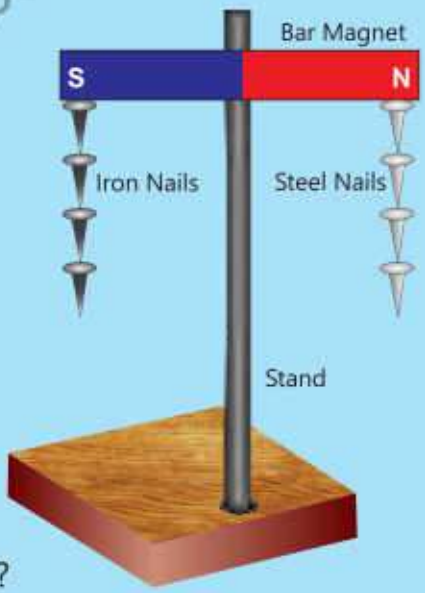
1. Temporary magnet 2. Permanent magnet 3. Electromagnet

Temporary and Permanent Magnets

Let us perform an experiment to identify temporary and permanent magnets.

Activity 7.14

1. Clamp a strong bar magnet in a horizontal position with a stand.
2. Bring a tiny iron nail near its one pole (say S). Does it stick to the magnet?
3. Take another iron nail and try to hang it with the first nail. Why does it stick to the first nail? The reason is that the first nail has become a magnet under the effect of strong magnetic force of the bar magnet.
4. Continue hanging as many as nails one by one as could be held by the magnet. It forms a chain of nails.
5. Now hang some steel nails to the other pole of the magnet in the same manner. What do you observe?
6. Now remove the iron chain by pulling the top nail away from the magnet. What happened and why? The iron nails will no longer support each other and fall down. Now remove the steel chain from the top. What do you observe?



You will see that iron chain collapses whereas the steel chain did not. It means that iron nails temporarily become magnets. On the other hand, steel nails retain their magnetism and become permanent magnets.

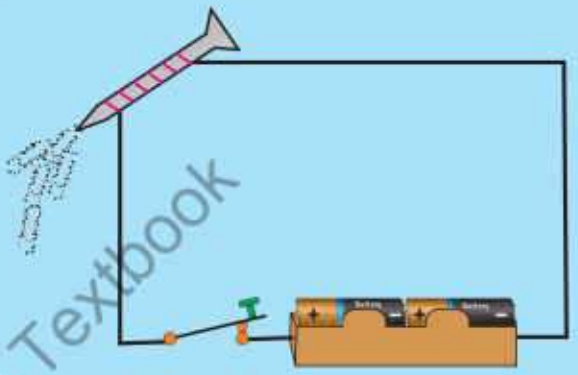
Magnets made by iron are temporary magnets while the magnets made by steel are permanent magnets.

Electromagnet

Can a magnet be made with the help of an electric current. Let us perform an experiment.

Activity 7.15

1. Wind an insulated copper wire very closely over an iron nail or a rod so that it becomes a long coil.
2. Attach the connecting wires to the two ends of the coil and connect them to battery through a switch as shown in the figure.
3. Keep the switch OFF and bring some steel pins near one end of the nail. Does the nail attract them?
4. Turn the switch ON and see if the nail attracts the pins now.
5. What inference do you draw from it?
   Predict what will happen if the current is switched OFF.
6. Turn the switch OFF to verify your prediction.
7. What do you conclude from this experiment?



When an iron nail or a rod is placed in a current carrying coil, it becomes a magnet. This is known as electromagnet.

Electromagnet is a temporary magnet. It does not remain a magnet when the current is stopped in the coil.

Point to Ponder!

How will you identify the north and south poles of an electromagnet? If battery terminals are reversed do the poles also change?

Quick Quiz

Electric crane can lift iron objects from the scrap easily. How are they dropped in a truck to be carried to a factory?

Key Points

1. Charge is a basic property of matter.
2. There are two kinds of charge: Positive charge and negative charge. Similar charges repel each other and opposite charges attract each other.
3. The flow of charge is called electric current.
4. The path of current flow is known as an electric circuit.
5. The bulb, cell and switch connected in an electric circuit are known as components of circuit.
6. Turning ON a switch allows current to flow in the circuit. It is called complete or closed circuit. Turning OFF the switch stops current flow in the circuit. It is called open or incomplete circuit.
7. The materials which allow the flow of electric current through them are called conductors.
8. The materials which do not allow the flow of current through them are called insulators.
9. A fuse is inserted in an electric circuit for safety purpose.
10. Magnet is a piece of metal which attracts objects made of iron, nickel and cobalt.
11. The materials which are attracted by a magnet are called magnetic materials.
12. A freely suspended magnet always stays in north-south direction.
13. The ends of a magnet are called magnetic poles.
14. Similar magnetic poles repel each other and opposite poles attract each other.
15. The Earth behaves as a huge bar magnet.
16. The magnetic compass is used to find directions accurately.
17. If current is passed through a coil wound around an iron nail or a rod, it behaves as a magnet. It is known as an electromagnet. This is a temporary magnet.

Weblinks: Use the following weblinks to enhance your knowledge about the topics in this chapter.

Static Electricity	https://kids.nationalgeographic.com/explore/science/all-charged-up-wiggly-water/
Magnetism	https://www.nationalgeographic.org/encyclopedia/magnetism/

Exercise

1. Tick (✓) the correct answer.

i. The flow of current in an electric circuit is controlled by:

(a) bulb (b) copper wire

(c) switch (d) rubber

ii. Current can easily pass through:

(a) steel paper clip (b) glass strip

(c) plastic comb (d) wooden spoon

iii. How many poles are there on a ring shaped magnet?

(a) 1 (b) 2 (c) 3 (d) 4

iv. A freely suspended bar magnet always stays along:

(a) east-west direction (b) north-south direction

(c) any direction (d) keeps oscillating

v. Which one is a true statement?

(a) North pole attracts north pole (b) North pole repels north pole

(c) South pole repels north pole (d) South pole attracts south pole

2. Write short answers.

i. Why does a bulb light up in a closed circuit?

ii. You are given a bulb. What other components are required to light it up?

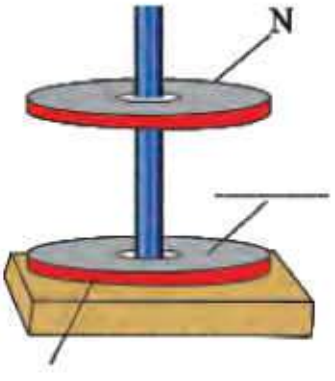
iii. Why does an iron nail stuck to a magnet attract another nail?

iv. How are directions known using a magnetic compass?

v. A balloon is charged by rubbing it with a woolen cloth. Why does it stick to a wall when brought near it?

3. Constructed Response Questions:

i. Two ring magnets are shown on a wooden stand. The upper magnet rises up and is suspended in air as shown in the figure.



a. Why does the upper magnet float in the air?

b. Label the N and S-poles of the magnets.

ii. There is a bar magnet without any indication. How will you identify its south pole?

iii. There are three similar metal bars. One is a magnet, the second one is that of iron and third bar is of aluminium. How would you identify each bar?

iv. A plastic comb charged with a woolen cloth is touched with an iron key. What do you observe? Give an example of similar phenomenon in daily life.

4. Investigate:

You are provided a bar magnet, paper pins, glass, plastic, aluminium and steel plates and a wooden board. Investigate which material allows magnetic attraction to pass through it?

5. Project:

i. You are provided with a water tub, cardboard, magnet and sellotape. Make a boat using the materials provided to you whose forward or backward motion can be controlled by another magnet.

ii. You are given a cardboard, torch bulb, electric cell, screws and connecting wires. Design and make a test board for 4 science quizzes so that the bulb lights up on the correct answer only.