UNIT 8

ELECTRICITY AND MAGNETISM

Unit outcomes: **After completing this unit you should be able to:**

- ✓ **understand concepts related to electricity and magnetism.**
- ✓ **develop skill of manipulating numerical problems related to electricity and magnetism.**
- ✓ **appreciate the interrelatedness of all things.**
- ✓ **use a wide range of possibilities for developing knowledge of the major concepts with in physics.**

Introduction

This unit is made up of two main topics called electricity and magnetism. It treats magnetism first and then electricity. Magnetism deals with the properties of a magnet while electricity deals with the properties of electrons at rest and in motion. The relationship between magnetism and electricity will be treated in grade 8.

PART-1 MAGNETISM

8.1. Magnets

Activity 8.1

Do the following activity with your friends and answer the given questions

i. Visit a radio repair shop or shoes shops or a science kit in your school. Ask the responsible person to show you magnets.
ii. What is a magnet?
iii. In what shapes do you find a magnet?
iv. What materials does it attract?

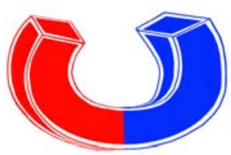
A Magnet is a piece of iron that attracts substances like iron, steel, and nickel at a distance.

The word "**magnet**" comes from the name "**magnesia**". Magnesia was an ancient city in Middle East, where the first magnet was discovered. This magnet was in a form of stone and it was called **lode stone** meaning leading stone. Lode stone is a naturally found magnet.

Magnet can be natural or artificial. A lodestone is naturally occurring magnet. Artificial magnets are magnets that are produced by people. They are usually made of iron and alloys of iron such as steel. Artificial magnets have different shapes such as bar, horse–shoe, U-shaped and cylindrical. See Fig 8.1 to identify the shapes of magnets.

a. Rectangular bar magnet

b. Cylindrical magnet



c. Horse-shoe magnet

d. U-shaped magnet

Fig. 8.1 Different shapes of magnets

Magnetic and non-magnetic substances

From Activity 8.2, it is very simple to observe that all materials are not attracted by magnets. Hence materials are classified into two: as magnetic and non-magnetic materials (substances).

Activity 8.2 *To identify whether a material is magnetic or non magnetic*

i. Collect some materials like iron nail, coins, pins, pen, wood stick, rubber, etc.

ii. Bring a magnet near to these materials and try to attract them one by one.

iii. Fill the table shown bellow using ✕ or ✓symbols for the result of your activity. ✕ for not attracted and ✓ for attracted .

Material	Attracted	Not attracted
___ ___ ___ ___ ___ ___		

Does the magnet attract all the materials?

- Substances that can be attracted by a magnet are called magnetic substance. Iron, steel, nickel, and cobalt, are examples of magnetic substances.
- Non-magnetic substances are substances which cannot be attracted by magnets. Rubber, paper, wood, plastic, copper, Aluminum, gold, and glass are examples of non-magnetic substance. All metals are not attracted by a magnet.

Activity 8.3- *Making a magnet*

I. *Materials required:* a large nail (steel bar), small pins, and a bar magnet.

ii. Procedure-*1.* Move the end point of the nail around in a small pile of pins (number of pins lying on one another).Dose the nail pick up any pin?

iii. *Procedure-2.* Using one end of a magnet, stroke the nail repeatedly in one direction only. Lift away the magnet each time when you reach the end of the nail. Return to the point of the nail where you started the stroking and stroke again. As shown in Fig 8.2

- Now bring the stroked nail near to the pins again. What happens this time? Will the pins be attracted or not? Repeat this process.

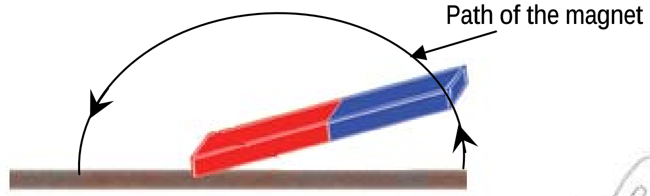


Fig 8.2 magnetizing an iron bar by stroking

The process of making a magnet by stroking or other methods is called **magnetization**.

From the process of magnetization in activity 8.3, the end of the nail or steel bar, where the stroking ends will be magnetized opposite in polarity with the polarity of the permanent magnet. i.e. if the stroking is with North pole of the permanent magnet, the last end of the steel bar will be magnetized as a South pole and vice versa.

This method has a disadvantage that the magnet produced by this process will not have both the poles at the two exact ends. Then it will be better to use other methods like a double stroking method or electricity to avoid this problem.

Properties of magnets

You have learnt in unit 3 of this book, that magnets exert a force at a distance. It attracts iron materials or repels other magnets at a distance. In this section you will learn more properties of a magnet.

a) Magnetic poles

If a magnet is dipped into iron filings and then shaken lightly, the iron filings stick to the ends of the magnet. From this activity we observe that the force of a magnet is concentrated at the two ends. These ends of a magnet are called **magnetic poles**.

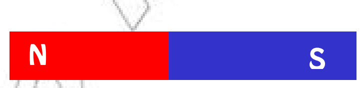


Fig 8.3 N and S poles of a magnet

Magnetic poles are the two ends of a magnet where the attractive forces are strong.

If a magnet is suspended from a thin thread, it always points in the same direction toward the geographic north - south direction.

The end of the magnet that points north is called the North Pole (in short N. pole). The other end that points south is called the South Pole (in short S-pole).

The following are some basic properties of any magnet:

i. A magnet attracts pieces of iron and steel.
ii. If a magnet is suspended freely, it always comes to rest with its ends pointing in a north-south direction.
iii. A magnet has two poles.
iv. No matter what its shape or its size may be the two poles always exist in pairs.

b) The laws of magnetism

Activity 8.4 *Observing the laws of magnetism*

Materials required: Two bar magnets and a thread

i. Suspend one magnet with a thread and hold the other magnet with your hand.
ii. Bring close the north pole of one magnet to the south pole of another magnet. What do you observe? Record your observation.
iii. Bring close to each other the north poles or the south poles of two magnets. What do you observe? Record your observation.
iv. What do you conclude from these observations?

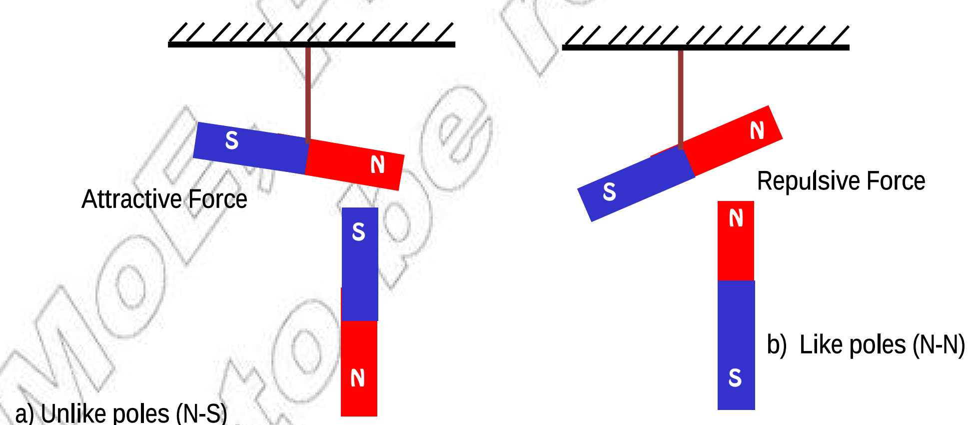


Fig 8.4 Forces between poles of magnets

Activity 8.4 leads you to the following conclusion. Magnetic poles exert forces on other magnetic poles.

The law of magnetism states that: unlike poles attract each other and like poles repel each other.

If you break a bar-magnet into two pieces, then, the north and south poles will not be separated. But, each piece will become a full magnet having both North and South poles. Thus, an isolated magnetic pole does not exist.

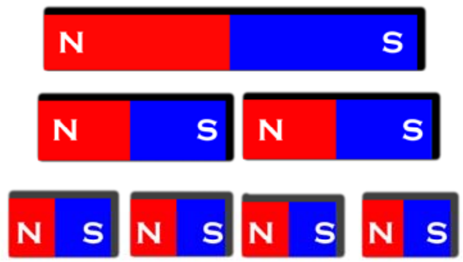


Fig 8.5 Breaking a magnet

Challenging Question

Suppose a certain magnet is broken into two parts, what will happen to the two magnetic poles (N and S)?

A compass

What is a compass?

A compass is a small suspended magnet used to show the geographic northern direction.

a) Pocket Compass b) Compass Needle

Fig 8.6 Different shapes of a compass

A compass consists of a bar magnet that is mounted on a sharp point so that it can turn freely in the horizontal plane see fig 8.6 and 8.7. When the mounted magnet comes to rest, its North Pole points towards the geographic north. A compass helps people in traveling on sea, land and air; because it always points in the northern direction.

Navigators and pilots make use of a compass to find their directions in their journey.

Activity 8.5 *How to make a compass*

Tie a string around a cylindrical magnet. Suspend the magnet away from other magnets and magnetic materials. When the magnet comes to rest, notice in which direction it is pointing. Does the magnet line up in a north-south direction?

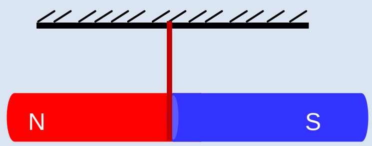


Fig 8.7 Freely suspended magnet points N-S direction

From Activity 8.5 you learn that magnets that are free to moe can be used as a compass. You can easily make a compass of your own as illustrated in Activity 8.5.

Earth's magnetism

Activity 8.6. *Group Discussion*

Discuss with your friends or parents.

Why does a compass or a suspended magnet always point to the geographic north pole?

In olden days, it was believed that some objects in the sky such as the North Star, made a compass turn to the north-south position.

But now the answer for the above question is the magnetic nature of the earth.

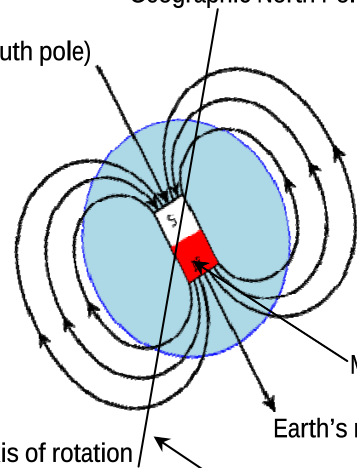


Fig 8.8 The earth's magnetism

Scientists explain the earth as a big magnet. They assume that a big magnet exists inside the earth. Its north pole is found in the geographic south-pole and its south pole is at the geographic north-pole. A suspended magnet or a compass always points in the geographic North, because of the magnetic property of the earth.

The earth's magnetic south pole attracts the North-pole of a compass or a suspended bar magnet.

The earth's magnetic field resembles that of a huge bar magnet with the magnetic poles near to the geographical north and south poles. (Refer to section 8.2)

Six things to know about magnets

You need to remember the following six basic facts about how magnets behave:

1. A magnet has two ends called poles. One of which is called a North Pole or north-seeking pole, while the other is called a South Pole or south-seeking pole.
2. The north pole of one magnet attracts the south pole of another magnet, while the north pole of one magnet repels the other magnet's North Pole. The law of magnet states that: like poles repel and unlike poles attract each other.

3. A magnet creates an invisible area of magnetism all around it called a magnetic field.
4. The north pole of a magnet points roughly toward Earth's North Pole and vice-versa. That's because the earth itself contains magnetic materials and behaves like a huge magnet.
5. If you cut a bar magnet in half, it's a bit like cutting an earthworm in half! You get two brand new, smaller magnets, each with its own North and South Pole.
6. If you rub a magnet a few times over an unmagnetized piece of a magnetic material (such as an iron nail), you can convert it into a magnet as well. This is called **magnetization**.

Check point 8.1

1. What is a magnet?
2. What are the properties of a magnet?
3. Distinguish between magnetic and non-magnetic substances. (Give some examples for each.)
4. What is a magnetic pole?
5. State the law of magnetism.
6. What is a compass? Describe its uses.
7. Explain why a suspended magnet always points to the geographic north and south poles.

8.2. Mapping Magnetic Lines of Force

Activity 8.7

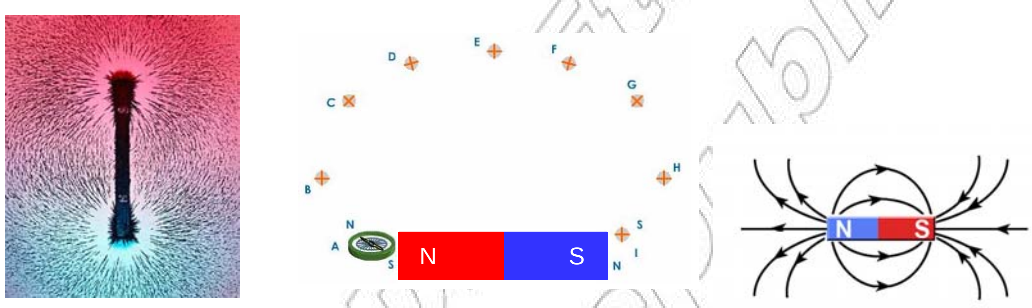
Discuss with your friends.

i. What is a non-contact force? How do you explain magnetic force as a non-contact force?
ii. Describe the magnetic field and magnetic lines of force for a magnet.

Activity 8. 8 *Mapping a magnetic field*

a) Observing magnetic lines of force.
Materials required: iron filings, a bar magnet, paper sheet.
Procedure:- put a paper on a bar magnet lying on a table top.
- Sprinkle the iron filings on the paper covering the magnet.
- What do you observe? What do you call the space around the magnet?

b) Mapping a magnetic field using compass
Materials required: pocket compass, bar magnet and a sheet of paper.
Procedures: place a magnet on a sheet of paper.
- Place a compass near the North Pole and mark its direction.
- Repeat this activity for different places around the magnet.
- Draw the directions of the compass at different pointers.
- The compass shows the directions of the magnetic field represented by the magnetic lines of force.



a) Iron filing around a bar magnet.
b) Compass around a bar magnet.
c) Magnetic lines of force around a bar magnet.

Fig 8.9 Mapping lines of force

You have already learnt that a magnet exerts a force at a distance. The space around a magnet is called **magnetic field**.

Magnetic field is a region where a magnetic pole would experience a force or exerts a force. Magnetic field is represented by imaginary lines of force called **magnetic lines of force**.

Magnetic lines of force are imaginary lines which continuously represent the direction of the magnetic field.

Properties of magnetic lines of Force

1. The magnetic lines of force of a bar magnet always emanate from the North Pole and following a curved path enter to the south pole. Then they reach back the North pole moving inside the magnet from south pole to the North pole of the magnet. Thus they are closed lines.
2. Magnetic lines of force never cross each other.
3. Near the magnetic poles, where the magnetic force is stronger, the lines of force are closer. Going away from the magnetic poles, the strength of the magnetic force decreases and the lines become sparse.

- A magnet exerts a force at a distance.
- The direction of the magnetic filed shows the direction of magnetic force.
- The closeness of the magnetic field lines shows the strength of the magnetic force.

Check point 8.2

1. What are magnetic lines of force?
2. Describe the common properties of magnetic lines of force.
3. Sketch the magnetic lines of force
   a) For a bar magnet b) between two unlike magnetic poles.

8.3. Uses of Magnets

In Activity 8.1 you visited different shops where magnets are used for different purposes.

Activity 8.9
Mentions some common uses of magnets.

Magnets have different applications (uses). Some of these uses are:-

- Magnets in compasses are used to indicate directions on seas, oceans, air and ground.
- They are used for lifting up iron or steel to higher places.

- They are used in the construction of electric bells, motors, radio, generators, etc.
- They are used to separate magnetic substances like iron from mixtures of different non-magnetic materials.

Check point 8.3

1. List and describe some uses of a magnet.

PART-2 ELECTRICITY

8.4. Electrostatics

Activity 8.10

Discuss the following observations with your friends or family.

i. What causes sparks and crackling sound when you take off your nylon clothes? Why does a comb made of plastic pick up scraps of light paper or dust particles when dropped after combing hair?
ii. What do you understand by the term "electrostatics"?
iii. What are electric charges?

In this section you will begin to study important phenomena about electric charges at rest. All the sparks you see and the crackling sound you hear when you take of nylon clothes are the effects of electric charges at rest. The study of electric charges at rest is called **electrostatics**.

When two materials rub together, there is friction. This friction causes rubbed materials to attract unrubbed materials. For example, if a rod of glass is rubbed with fur, it gains the power to attract light bodies such as pieces of paper or aluminum-foil or a pith ball. A body made attractive by rubbing is said to be **'electrified' or 'charged'**.

The branch of electricity that studies electric charges at rest is called electrostatics.

What are charges?

Activity 8.11

Revise your chemistry knowledge to answer the following questions with your friends.

i. What is an atom?
ii. What are the two types of charges?
iii. What type of charge is carried by protons?
iv. What type of charge is carried by electrons?
v. When do we say an atom is electrically charged?

The results of numerous experiments indicated that under certain circumstances, matter exhibited a 'new' property. This property was eventually traced to the atom and is called **electric charge**.

Electric charge is an inherent physical property of certain sub-atomic particles that is responsible for electrical and magnetic phenomena. Charge is represented by 'Q' and the unit of charge is the Coulomb (C).

The smallest particle of an element is called an **atom**. The three important particles of an atom: **protons**, **electrons** and **neutrons** are known as the basic building blocks of all atoms. Fig 8.10 shows a model of how these particles are thought to form an atom. The protons and the neutrons are held together at the centre of the atom called the **nucleus**. The electrons exist around the nucleus. They revolve in orbits around the nucleus at high speed.

Electric charge is a characteristic property of many subatomic particles. Electric charge is the property of a matter that exhibits attraction or repulsion over other matter.

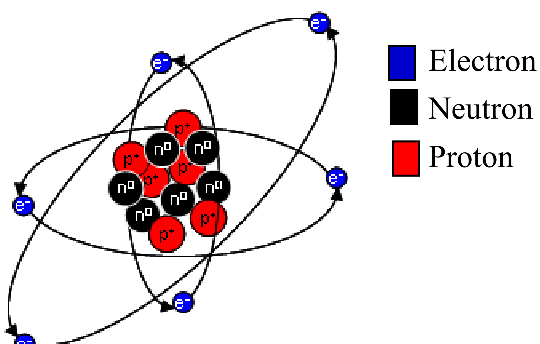


Fig 8.10 Structure of an atom

Types of charges

The idea of electricity is based on the theory that all matter are built up of atoms. Each atom has a tiny core called the **nucleus** and around this nucleus spins a number of electrons. The nucleus consists of neutron and proton.

Negative and positive charges

As it is mentioned above an atom consists of neutron, proton and electron particles.

i. Neutron is a neutral particle; it does not have a charge.
ii. Proton is positively charged particle.
iii. Electron is a negatively charged particle.

Hence there are two types of electric charges called positive and negative charges. A negative charge is carried by electrons and a positive charge is carried by protons.

The allocation of signs to charges was made randomly many years ago. We use this assignment today.

Note the following points carefully

i. Every matter is electrical in nature.
ii. We have two types of charges.
iii. In the normal state, the number of electrons is equal to the number of proton in an atom. Therefore, an atom is neutral as a whole. This explains why a body does not exhibit any charge under ordinary conditions.
iv. If some electrons are removed from a neutral body, there occurs a deficit of electrons in the body and consequently the body has surplus positive charge.
v. If a neutral body is supplied with electrons, there occurs an excess of electron and consequently the body is said to have a negative charge.

Check point 8.4

1. What does the term electrostatics stand for?
2. Describe the two types of electric charges.
3. What charges are carried by
   a) Protons
   b) Electrons

8.5. Methods of Charging a Body

Charging is the process of electrifying bodies i.e. removing from or adding electrons to a body.

There are different methods of charging a body:-
i. Charging by rubbing ii. Charging by conduction

i.Charging by rubbing

Activity 8.12 *Charging a body by rubbing*

Apparatus:- a piece of paper, a polythene rod (plastic comb, plastic ruler, ball point, pen.) woolen cloth or you can use your hair.

Procedure:

i. Tear pieces of paper into bits and put them on the table.
ii. Touch the bits of paper with a polythene rod without rubbing, observe what happens.
iii. Now rub the polythene rod with woolen cloths (your hair) and bring it close to the bits of paper. Observe what happens. Do you explain why it happens this way?

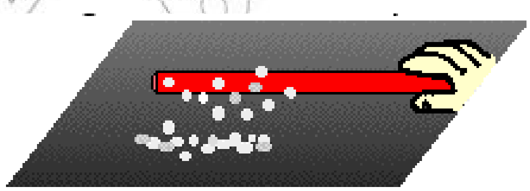


Fig 8.11 Charged plastic rod attracts pieces of paper

From the structure of an atom we could understand that the rubbing of two bodies cause a transfer of electrons from one body to another. One of the bodies gains electrons, while the other loses electrons.

For example in Activity 8.12, when a plastic rod is rubbed with woolen clothes (your hair) electrons will be transferred from the plastic rod to the woolen cloth (you hair). Hence, the plastic rod is negatively charged while the woolen clothes is charged positively.

Similarly when a glass rod is rubbed with silk, electrons will be transferred from the glass to the silk. Hence the glass is positively charged while the silk is negatively charged.

ii. Charging by conduction (sharing)

When a neutral body is made to contact or touch a charged body, it shares the charges and becomes charged. Charging by conduction involves sharing of electrons between the charged and uncharged bodies.

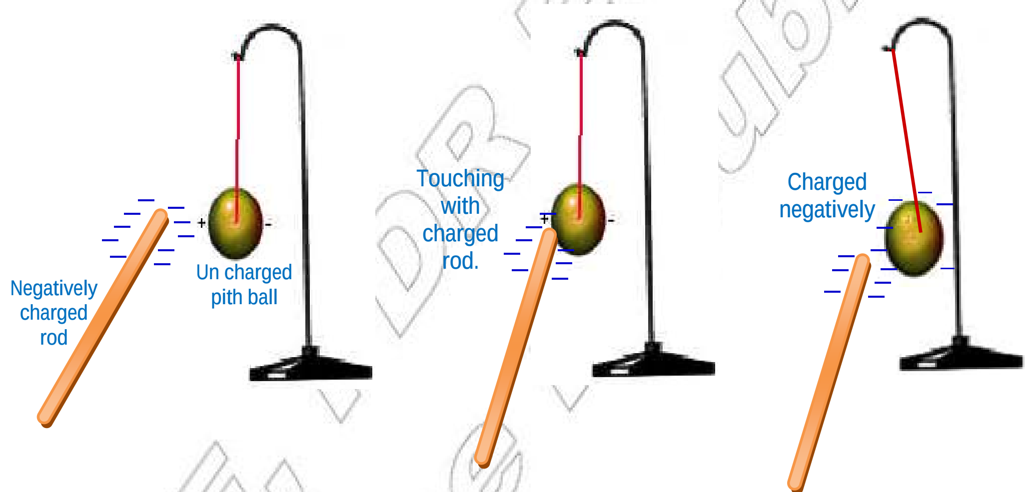


Fig 8.12 Charging pith ball by conduction

For example, consider a charged body that has surplus of electrons. If you bring this charged rod near the uncharged body it attracts the uncharged body. When the charged body touches the uncharged body, same negative charges transfer to the uncharged body and make it negatively charged. Then the two bodies repel each other, because they have the same charges. The process of charging a body by touching it with a charged body is called "**charging by conduction or sharing**".

Discharging a body is the process of removing electric charges from a charged body**.** A charged body can be made to lose its charges by touching it with a conductor. When a body is discharged, it becomes neutral.

Check point 8.5

1. Explain the term charging.
2. State two methods of charging a body.
3. Compare charging by rubbing and charging by sharing.
4. When do we say a body is charged positively?
5. When do we say a body is charged negatively?

8.6. Law of Electrostatics

Activity 8.13 ***Illustrating the law of electrostatics***

Material required: pith balls, glass, rubber rods, woolen cloth, silk cloth

Procedure:

i. A pith ball is charged positively by conduction or touching with a charged glass rod. (Fig 8.13(a)
ii. Observe what happens.
iii. Repeat this activity with rubber rod rubbed with silk. Charge another pith ball by touching. (Fig 8.13 b)
iv. Bring two balls one touched with charged glass rod and another ball touched with charged rubber rod.
v. Bring these charged balls, closer to each other. Fig 8.13 (c)
vi. Observe what happens.
vii. These two balls attract each other because they carry different charges.

Conventionally negative charge is represented by (-) and positive charge is represented by (+).

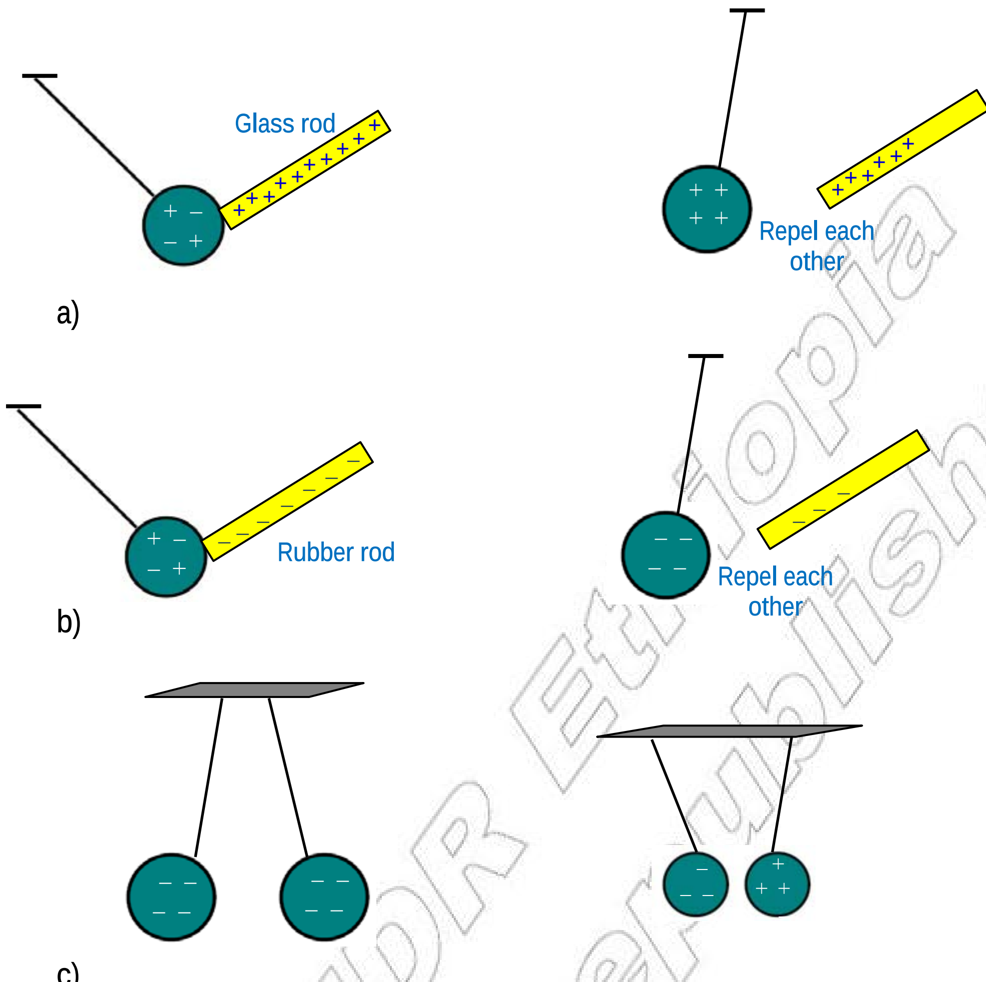


Fig 8.13 Law of electrostatics

You have learnt in unit 3 of this book that electric charges exert a force at a distance. It either attracts or repels other charged bodies without direct contact. Electric charges have similar properties as magnetic forces. They are non-contact forces.

All charged bodies exert forces on each other;

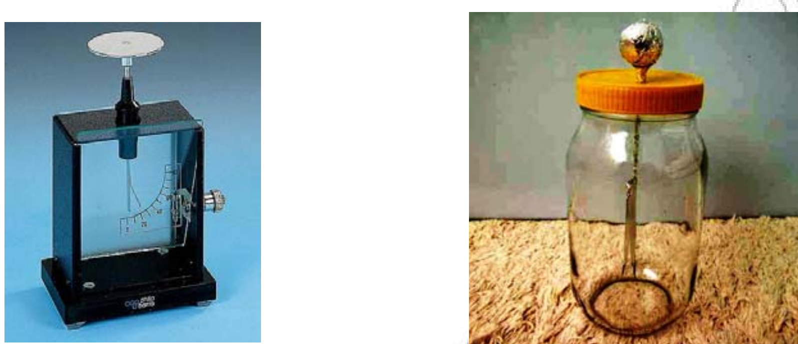
i) Like charges repel each other
ii) Unlike charges attract each other.

This is the law of electrostatics.

Electroscope and its use

From different activities in the previous sections, you studied how charged bodies are detected and the existence of two kinds of electric charges.

An electroscope is a simple device used to study the properties of charges. It enables us to determine both the sign of the charge and the magnitude of the charge on a body.



a) Aluminum leaf electroscope

b) Locally made electroscope

Fig 8.14 Electroscope

Fig.8.14 (a) shows an aluminum foil electroscope. It consists of a brass rod, on which is mounted a brass cap, at the top, and a brass plate at the bottom, with thin leaves of aluminum foil attached to the brass plate. The brass rod is mounted on a metal case, and supported by a plug of insulating material. The metal case has glass windows to allow the aluminum leaves to be seen.

Uses of electroscope

An electroscope is used:

i. To illustrate that charges move through metals.
ii. To test whether a body is charged or not.
iii. To detect the sign of a charge on a body. i.e. to check whether a body is negatively or positively charged.

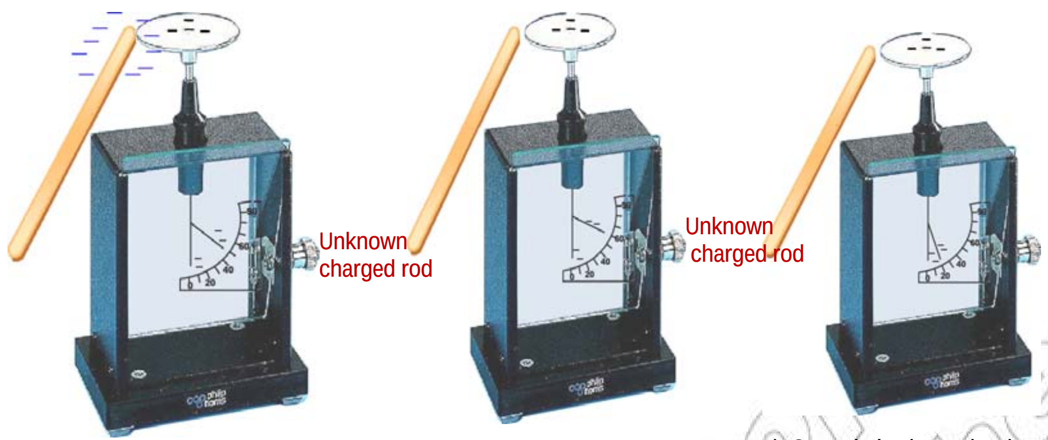
Activity 8.14 *Detecting whether a body is charged or not*

Charge a glass rod by rubbing with silk clothes. Bring the charged rod near to the cap of a neutral electroscope without touching. The leaves of the neutral electroscope will diverge to show that the nearby rod is charged. The leaves will not show any deflection when uncharged rod is brought near to the cap of the neutral electroscope.

Fig 8.15 Deflected leaves of an electroscope

Activity 8.15 *Detecting the sign of charges on a charged body*

i. An electroscope must be charged first to use it to detect the sign of charges on a charged body. A neutral electroscope does not help us to detect the sign of charge on a charged body.
ii. Charge the electroscope negatively by touching its cap with a negatively charged rod. Then bring another charged rod whose sign is not known near the cap of the charged electroscope without touching it.
iii. If the divergence of the leaves increases, we can conclude that the near by charged rod have similar (--) charges as the charges of the electroscope. But if the original divergence of the leaves decreases when the unknown charged rod is brought near to the cap of the electroscope, then the sign of the unknown charged body is opposite (+) to the charge of the electroscope.



a) Charged Electroscope.

b) Similarly charged rod causes electroscope to increase in deflection.

c) Oppositely charged rod causes electroscope to decrease in deflection.

Fig 8.16 Detecting the sign of unknown charged body

Project work: Making your own electroscope

Materials required:

- Small medicine bottle with plastic lid or cork.
- Aluminum foil obtained from the inside of a chewing gum or cigarette packet.
- Copper wire (from electric wire) or paper clip.

Procedure:

1. Bend the copper wire at one end.
2. Pierce the bottle lid with the copper wire and push the wire through it.
3. Tie the aluminum foil with silk thread or fasten it with a sellotape
4. Close the bottle with the bend of the wire at the top. This is a locally made electroscope.
5. Use this electroscope to demonstrate the uses of electroscope.

For example, you can bring an uncharged body near the cap of a positively or negatively charged electroscope. What do you think will happen to the leaves? Will the leaves decrease or increase its divergence?

Activity 8.16 ***Complete the following table considering testing charged and uncharged bodies***

Charge on electroscope	Charge on unknown body	Leaf divergence
-	-	Increase
-	+	Decrease
neutral	-	Decrease
+	+	
+	neutral	
-	neutral	

An increase in leaf divergence occurs when the charge on the electroscope and the charged body are having the same sign of charge. A decrease in the leaf divergence does not only mean the body and the electroscope are oppositely charged. The body can also be uncharged. Hence the best test for the sign of charge on a body is the increase in divergence of the leaf.

Activity 8.17 ***Identifying a material as a conductor or an insulator using an electroscope.***

Apparatus: an electroscope and different materials like plastic rod, glass rod, wood, metallic materials like copper, tin, aluminum, etc.

Procedure: charge an electroscope (either positively or negatively)

Hold the different materials to be tested in your hand and place it on the cap of the electroscope. (Note: the materials are not charged.)

If the leaf collapses very rapidly (immediately), the material is a good conductor. Because the charge from the electroscope moves through the conductor to your hand. If the leaf remains diverged as it was previously, the material is an insulator. Because the charges from the electroscope do not move through the insulator to your hand.

Can a conductor be charged?

As you have observed in previous pages, insulators like glass rod and plastic rods can be easily charged.

Charging a conductor is possible, but not as easy as in an insulator. In a conductor, charges spread through its body. If it is touched or held with hands, the charges move to your hands. To avoid the flow of charges to other bodies you can use a conductor with insulating handle, or support the conductor with insulating stand for example, the metal rod in an electroscope is charged using insulating materials like rubber.

8.7. Electric Current and Potential Difference

In Section 8.6 you learnt the properties of charges at rest. This section introduces you to the properties of moving charges.

Activity 8.18

i. What is an electric current?
ii. Discuss what makes electric charges flow in a wire.

Electric current

When two oppositely charged bodies are connected by a metallic conductor a movement of charges occurs. The electrons flow from the negatively charged body to the positively charged body. This motion of electric charges is called **electric current**.

The strength of an electric current in a conductor is determined by the number of electrons which pass through the conductor at a point in a given time interval.

Electric current is the rate of flow of electric charge. It is the amount of charge that flows per second.

$$\text{Electric current} = \frac{\text{Charge moved}}{\text{Time taken}} \Rightarrow I = \frac{Q}{t}$$

Where I is the current
Q is the amount of charge flow
t is time taken.

The SI unit of electric current is **Ampere**, symbolized by A. One ampere is equal to one coulomb moved in one second. Here, electric charges are measured in coulomb (C) and time in second(s).

$$1A = 1\frac{c}{s}$$

1 milliampere (1mA)= 0.001A

1 microampere(1μA)= 0.000001A. μ is a Greek letter, read as '*miu*'.

Electric current is measured with a device called an **ammeter**.

The electric current in a conductor is not visible. We can only notice its effects. The effects of electric current are heating, lighting, magnetic, etc.

Worked examples

1. A charge of 120 C passes through a conductor every 1 minute. What is the charge that flows every second?

Given	Required	Solution
Q = 120 C	I = ?	By definition $I = \frac{Q}{t}$
t = 1 minute = 60 s		$I = \frac{120\,C}{60s} = 2A$

Therefore, the charge flow per second = 2A.

2. How much charge flows through a conductor if a current of 1.5A flows for 2 minutes?

Given	Required	Solution
I = 1.5 A	Q = ?	Q = It
t = 2 minutes		Q = (1.5A) (120s)
= 120 Seconds		Q = 180 C

Sources of potential difference

Activity 8.19 *Group discussion*

i. Explain what causes water to flow from high level to low level in a pipe.

ii. Explain the importance of gravitational potential energy in water flow.

The potential difference between two positions causes water to flow. Similarly charges flow because of the potential difference between two points.

We have seen that current is a flow of charge through a conductor. For charges to flow through a conductor a source that supply energy to move charges to the end points are necessary. The common sources of potential difference are **electric cells** and **generators**. **Battery** is a combination of two or more electric cells. It is a common source of potential difference.

- A source of potential difference provides electric current. Potential difference is also called **voltage.**
- The unit of potential difference (voltage) is Volt (V)
- The instrument used for measuring potential difference is a **voltmeter**.

Primary and secondary cells

Activity 8.20
Collect different dry cells from your locality. Study the types and value of potential difference of each cell.

Of all the sources of potential differences, the most widely available is the chemical cells. Chemical cells change chemical energy into electrical energy. Electric cells are of two types: **primary** and **secondary** cells.

1. **Primary cells** are cells which can produce current as a result of chemical changes taking place between their various components. Once they are used exhaustively they cannot be used again. Example of this type is a dry cell. A dry cell has two terminals labeled as '+' and '–'. The potential difference between these terminals is 1.5 volt (1.5V). Two or more dry cells are connected in series to obtain greater potential difference. 3 dry cells connected in series give 4.5V.
2. **Secondary cells** can be recharged and used again and again. A typical example of this type is car battery. They are also known as storage cells or accumulators.

Check point 8.7

1. What is an electric current?
2. List some sources of potential difference.
3. What is the difference between primary and secondary cells?
4. A current of 90 milliAmpere (mA) flows for 150 s. What amount of charge are transferred during this time?

8.8. Electric Circuit

Electric current needs a complete path to flow from one point to another. A complete path through which electric current flows is called an **electric circuit**. A simple electric circuit is constructed from a source of potential difference, a device, and a switch. These elements are connected to each other by connecting wires. See Fig 8.17.

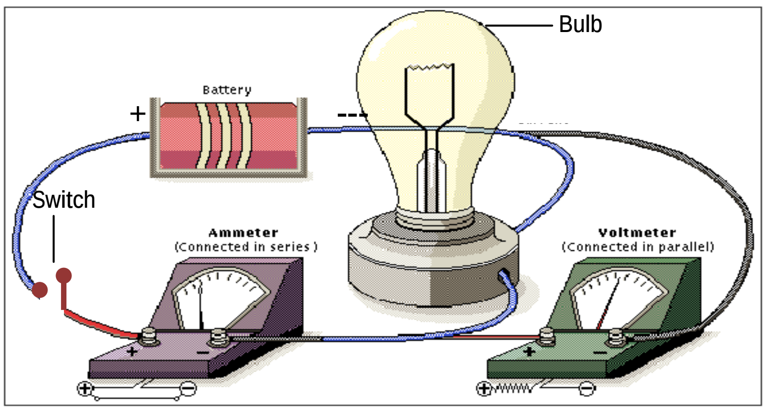


Fig 8.17 Simple electric circuit

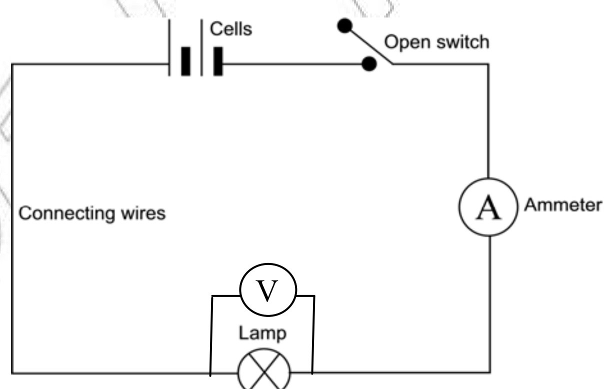


Fig 8.18 Electric current drawn with symbols

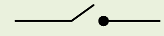
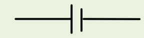
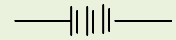
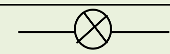
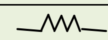
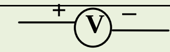
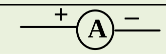
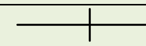
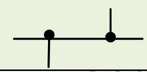
Items	Symbols
Switch	
Cell	
Battery	
Lamp	
Resistor	
Voltmeter	
Ammeter	
Crossing wires	
Joined wires	

Fig 8.19. Symbols of elements of an electric circuit

Direction of electric current

Electric current has a certain direction of flow in an electric circuit. This direction is determined by the type of charged particles flowing through the circuit. Suppose the end points of a metallic conductor are connected to the two terminals of a source of potential difference, the free electrons of the conductor move from the negative to the positive terminal of the source across the conductor.

Electron current is the flow of electrons from the negative terminal to a positive terminal of the source. The direction of electric current is the direction in which electrons are actually moving.

However, before the discovery of electrons as moving particles, it was assumed that current is the flow of positively charged particles from positive terminal to negative terminal.

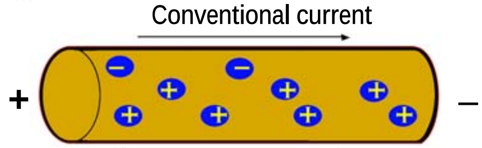


Fig 8.20 Direction of electric current

This kind of current is called **conventional current.** It is in opposite direction to that of electron current. Thus, conventional current is the agreed direction of electric current in a circuit, and this current direction is consistently used in this and other physics books.

Conductors and Insulators

Conductors are materials made up of atoms with a large number of free electrons. Free electrons are in the outer most orbit of an atom. They are free to move because they are far from the nucleus. Consequently the flow of charges (electrons) is possible through conductors. Conductors are materials that allow an electric current to flow through them. Opposite to conductor we have insulators. Insulators have few free electrons or no free electron. Thus, the flow of charges through them is highly restricted. Insulators are materials that do not allow an electric current to pass through them.

A simple electric circuit is used as a tester to check whether a material is a conductor or insulator.

Activity 8.21

To test whether materials are conductors or insulators.

Materials required:- a simple circuit with a bulb, connecting wires, dry cells, different materials to be tested

- Example, metallic materials, wood, plastic, cloth, , etc.

Procedure:

1) Arrange the circuit as shown in Fig 8.21
2) Put the different materials between points A and B and observe what happens to the bulb. Check whether the bulb gives light or not. Complete the following table by writing “gives light, do not give light”

materials	Gives light	No light
Rubber rod		
metallic materials		
wood		
plastic		
Cloth		
Water		

3) classify materials that give light as conductors and those which don’t give light as insulators

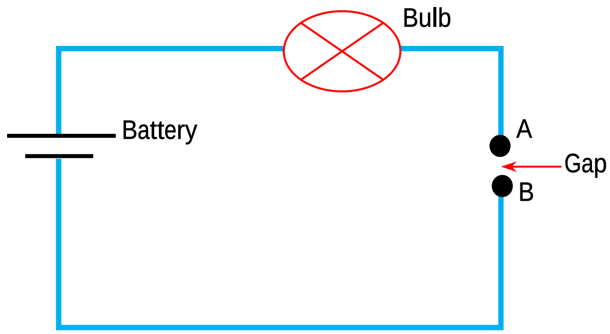


Fig 8.21 Simple circuit as a tester

Check point 8.8

1. What is an electric circuit?
2. List the elements of simple electric circuit. (Draw a simple electric circuit using symbols).
3. Define conductors and insulators. (Give examples of each.)
4. Explain the way to identify a material as a conductor or an insulator using a simple circuit.

Summary

In this unit you learnt that

- a magnet attracts irons and nickels. Magnets can be categorized in to two main types. Natural and artificial magnets. A magnet has two poles. The North Pole and the South Pole. Magnetic Poles can never be separated by breaking a magnet into pieces. The law of magnetism is stated as: Like poles of a magnet repel each other and un-like poles attract each other.
- we can produce a magnet, but the period of permanency depends up on the type of the stroked metal.
- a suspended magnet called a compass always rests in north – south direction, due to the magnetic effect of the earth. Materials which are attracted by a magnet are called magnetic materials. And the materials which are not attracted by a magnet are called non- magnetic materials.
- electrostatics is the study of electric charges at rest. It is the basis of the study of electricity. Friction causes charges to transfer from one body to another body. The process of charging materials by friction is called charging by rubbing. The law of electrostatic is stated as: like charges repel and un-like charges attract each other.
- discharging is the process of removing charges from a charged body.
- electrons carry negative charges, protons carry positive charges and neutrons carry no charge and it is called a neutral particle.
- a device which detects the presence of charges on an object is called an electroscope. The study of electric charges is best illustrated by an electroscope.
- electric current is the time rate of flow of charge. The SI unit of current is Ampere (A). Conventional current flows from the positive (+) terminal to the negative (-) terminal of the source while electron current flows from the (-) terminal to the (+) terminal of the source.
- current and voltage are measured with an instrument called Ammeter and Voltmeter respectively. The unit of voltage or potential difference (P.D) is Volt. (V)

Review Questions and Problems

I. Write true if the statement is correct and false if the statement is wrong.

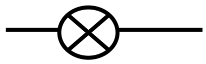
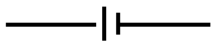
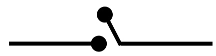
1. Magnetic poles always appear in pair.
2. Iron and nickel are examples of magnetic materials.
3. The two ends of a magnet are called magnetic poles.
4. Two similar magnetic poles attract each other
5. If one end of an iron bar attracts one pole of a compass needle, then the iron bar must be a magnet.

II. Match the terms in column A with the phrases in column B.

A	B
1. Electron current	a) device used to identify whether a body is charged or not
2. Law of electrostatic	b) flow of electrons from – terminal to + terminal.
3. Electroscope	c) unlike charges attract each other and like charges, repel each other
4. Coulomb/ second	d) unit of electric potential difference
5. Volt	e) Ampere.

III. Multiple choice question- chose the best answer among the given alternative answers.

1. Which of the following devices consists of a magnet
   a) Telephone c) electric motor
   b) radio d) all of the above
2. Which one of the followings can be picked up by a magnet.
   a) Iron and Steel c) wood
   b) plastic d) all non metals
3. Which of the following substances cannot be magnetized?
   a) Iron b) nickel c) Aluminum
4. The Magnetic attraction is greater
   a) At the middle c) a and b
   b) at the poles d) none

5. Magnets are made of ________
   a) Iron
   b) steel
   c) a and b
   d) copper
6. Which one of the follow diagrams represents a battery?
   a) 
   b) 
   c) 
   d) 
7. Which one of the following instruments measure electric current?
   a) Voltmeter
   b) Ammeter
   c) electroscope
   d) electric cur
8. A pith ball is positively charged. What happens when a negatively charged body is brought near to it?
   a) They repel each other.
   b) They attract each other.
   c) Share their charges and remain neutral
   d) Nothing happens.

IV. Fill in the blanks with a correct word or words.

1. Like poles ______ each other and unlike poles _______ each other.
2. ________ is a natural magnet.
3. Artificial magnets are made of _______ or ______.
4. We call the ends of the magnets _______.
5. Magnets are made in the shape of _________, ________ , ____ etc.
6. _______ are materials that allow electric current to pass through them.
7. ________ is the rate of flow of electric charges through a point.
8. Charging by sharing is called ________.
9. A body is said to be ________ charged if it gains electrons.
10. A neutral sub atomic particle is called ________.

V. Questions

1. How do you know which end of a magnet is North Pole?
2. State the law of magnetism.
3. What are the essential parts of an electroscope?
4. What is meant by a non magnetic material?

5. Name three common magnetic materials.
6. Mention some applications of a magnet in our daily life.
7. What is measured in a) coulomb and b) ampere?
8. What is the electric current when 10 coulombs of charges pass a point in 2 second?
9. What are the amounts of charges that pass a point if 4 Amperes flows for 3 seconds?
10. Explain the difference between a conductor and an insulator of electric current.
11. Take a hand torch and study parts of its electric circuit. Draw the circuit diagram of a torch.
12. What are essential parts of an electroscope? Draw an electroscope and label it.
13. What is the difference between conventional current and electron current?
14. How do charges transfer from one body to another?
15. You know that when you comb your hair, charges will be transferred from the hair to the comb. What is the charge on the comb and your hair after combing?
16. If you rub a balloon with wool or duster you can charge it negatively. Where do these extra charges come from?
17. State what happens when.
    a) A glass rod is rubbed with fur.
    b) This glass rod is touched with your finger