5 CHEMICAL EFFECT OF ELECTRIC CURRENT AND MAGNETISM

5.1 INTRODUCTION

Ever imagined that your house is lit up with kerosene lanterns and summers without ACs and water coolers? What if the refrigerator door did not close by itself and you have to lock it every time you opened it? Just the thought makes you sweat, right?

Two marvels of science-electricity and magnetism without which life is hard to imagine. Let us study the "How" and "What" of these two wonders.

In this chapter we will learn about some sources of electric current and electric circuits. Later on we will discuss the term resistance and its different combinations.

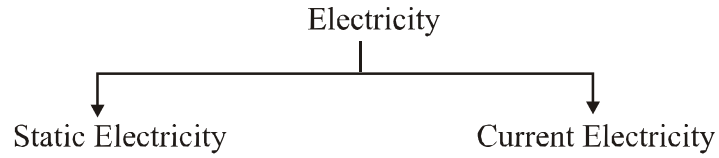
In the second half of the chapter we will learn about magnets and their basic properties.

5.2 ELECTRICITY

Let us start with a few very basic points about electricity

- Electricity is an invisible form of energy.

It is the branch of physics which deals with the study of interaction of one charge to another charge. It can be divided into two parts :



(a) **Static Electricity :** The branch of physics which deals with the study of the electric charges at rest and their effects is known as electrostatic or static electricity.

(b) **Current Electricity :** The branch of physics which deals with the study of the electric charges in motion and their effects is known as current electricity.

- There are 2 forms of electricity-static and current.
- Static electricity is stationary electricity where as current electricity is electricity in motion.
- It is the current electricity which light up our houses and streets and our televisions.

During early studies on the properties of electric charges. It was discovered that there are 2 kinds of charge-positive and negative. It was also found that "like" charges repel each other, whereas "unlike" charges attract each other.

To understand current electricity better lets have a look at the structure of an atom. An atom is made up of a nucleus and electrons. Nucleus has positive charge while the electrons have negative charge.

In some materials the electrons in the outermost shell are loosely held. A current flows when electrons jump between the atoms that make up the metal in wire. Thus, a flow of electrons is called an electric current.

5.2.1 Electric Charge

A property of matter, called **charge**, gives rise to electricity charge produces different effects depending on whether it is static (at rest) or moving. Amber rubbed with silk attracts feather because of the accumulation, or gathering, of charge on it. This is an example of the effect of static electricity, which we study under **electrostatics**. When charges flow, we get an electric current. The glowing of a bulb when a current passes through it is an effect of an electric current.

5.2.2 Type of Charge

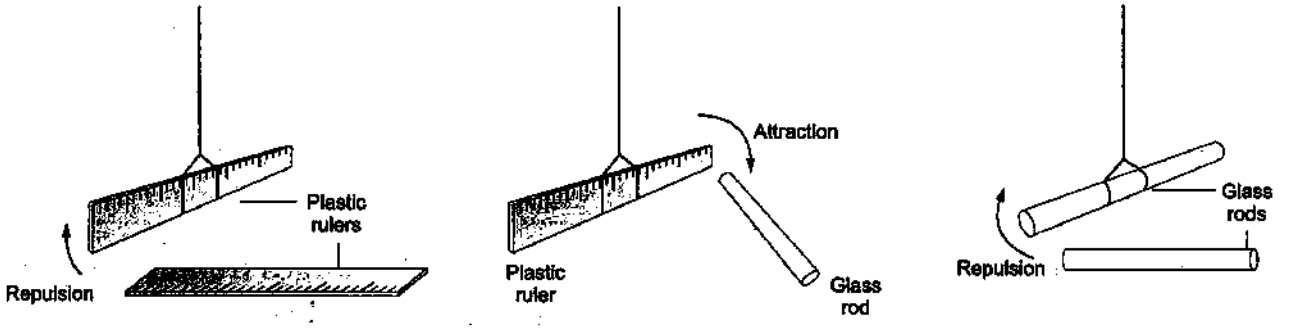
There are two kinds of charge, called positive charge and negative charge. Note that these names are used by convention, and have no special meaning. In an atom, particles that carry negative charge are called **electrons**. And those that carry positive charge are called **protons**. Electrons can move from one place to another within a substance, but protons cannot.

Normally, in a substance, the electrons and protons are equal in number. This means that the negative and positive charges are equal. So, they 'balance' each other, i.e., neither charge produces any effect. This makes the substance electrically 'neutral'. But when you rub something against another, the way you rubbed the comb against your hair, the balance can get upset. Some of the negative charges (electron) travel from one object to the other. The object losing the negative charges then has a greater number of positive charges, or becomes positively charged. And the object receiving the negative charges becomes negatively charged.

A charged object can either repel or attract another charged object. The force acting between them is called **electrostatic force**. A charged object can also attract an electrically neutral object, like your comb attracted the pieces of paper.

DEMO- 1

Rub a plastic ruler with a woollen cloth or a piece of flannel and suspend it from a support, with the help of a string. Now rub another ruler similarly and bring it near the first one. The suspended ruler will move away from the ruler in your hand, or it will be repelled.



Charged bodies attract or repel each other.

Rub a glass rod with a piece of silk and bring it near the suspended ruler. The ruler will be attracted to the glass rod. If you bring the glass rod close to another glass rod which you have rubbed with a piece of silk, the two will repel each other.

5.2.3 Properties of Charge

(i) Like charges repel each other and unlike charges attract each other.

(ii) The charge is quantized i.e. charge on an object is equal to $\pm$ **ne** where **n** is an integer and $e = 1.61 \times 10^{-19}$ C.

(iii) Electric charge is a scalar quantity.

(iv) The electric charge on a system is always conserved.

5.2.4 Unit of Charge

The charge on an electron is so small that it is not convenient to select it as the unit of charge. In practice, coulomb is used as the unit of charge, i.e. 81 unit of charge is coulomb abbreviated as **C**. One coulomb of charge is equal to the charge on 625×10^{16} electrons.

1 coulomb = charge on 625×10^{16} electrons

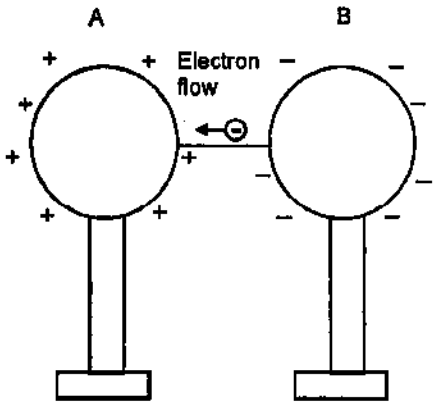
Thus, when we say that a body has a positive charge of one coulomb (i.e. + 1 C) it means that the body has a deficit of 625×10^{16} electrons from the normal due share.

The charge on one electron in coulomb is given by :

$$-e = -\frac{1}{625 \times 10^{16}} = -1.6 \times 10^{-19}\ C$$

5.2.5 Flow of Charge

Consider two metallic spheres A and B which are placed on the insulated stands as shown in the figure. Let sphere A is positively charged and sphere B is negatively charged. Let these spheres are connected by a metallic wire. The electrons flow from sphere B (at lower potential) to the sphere A (at higher potential). The flow of electrons continues till the potential of both the spheres becomes equal. This shows that the flow of charge (i.e. electrons) between two spheres continues as long as they are at different potentials or as long as there is potential difference between these two spheres.



5.3 ELECTRIC CURRENT

It is defined as the rate of flow of charge in a conductor or amount of charge flowing through a conductor in a unit time.

The electric current is flow of electric charges (called electrons) in a conductor (metal wire). It is the amount of electric charge passing through a given point of conductor in one second if a charge of Q coulombs flows through a conductor in time t second, then the magnitude of the electric current I flow through it is given by :

$$I = \frac{Q}{t}$$

The S.I. unit of charge is coulomb (C)

1C = charge of 6.25×10^{18} electrons.

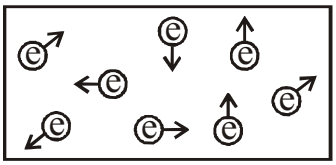
(a) **The S.I. unit of current is Ampere :** When one coulomb of charge flows through any cross-section of a conductor in 1 second, the electric current flowing through it is said to be 1 ampere.

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

Instrument used to measure current is called ammeter. It should have a very low resistance. It is connected in series in the circuit.

(b) **Direction of Electric current :** We know that there are two types of charges positive charges and negative charges, but electrons were not discovered at that time. So, electric current was considered to be the flow of positive charges were taken to be the direction of electric current. The direction of electric current is from positive terminal of the cell to the negative terminal through the circuit.

(c) Flow of Electric current in a wire : An electric current is the flow of electrons in a metal wire (or conductor) when a cell or battery is applied across its ends. A metal wire has plenty of free electrons in it. When the metal wire has not been connected to a source of electricity like a cell or a battery, then the electrons present in it move randomly in all the directions between the atoms of the metal wire as shown in figure. When a source of electricity like a cell or a battery is connected between the ends of the metal wire, then an electric force acts on the electrons from negative end to the positive end of the wire. These electrons constitute the electric current in the wire.



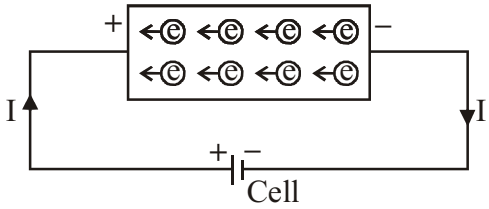


Fig: Direction of conventional current

Remember

Characteristics of the electric current

(i) The flow of charge is due to transfer of negatively charged particles called electrons.

(ii) Conventionally, the direction of current is taken as opposite to the direction of motion of electrons.

(iii) SI unit of electric current is Ampere (A)

(iv) If Q coulombs of charge flow through a conductor in t seconds, the current through the conductor is I ampere where

$$I = \frac{Q}{t} = \frac{ne}{t}$$

where, n = number of electrons flowing through the conductor in time 't' and
e = charge on electron = -1.6×10^{-19} C

(v) It is a scalar quantity.

Illustrations

Illustration 1

A charge of 500 C flows through an electric circuit in 50 sec. Calculate the magnetic of the current flowing through the circuit.

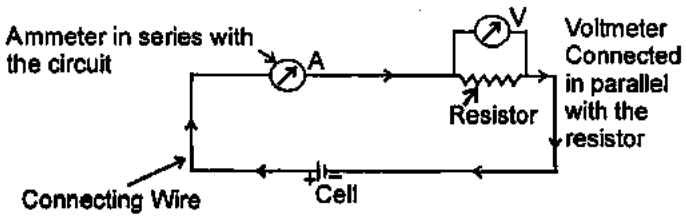
Solution

Here, charge = Q = 500 C, t = 50 sec, I = ?

$$I = \frac{Q}{t} = \frac{500}{50} = 10\,A$$

5.4 ELECTRIC CIRCUIT

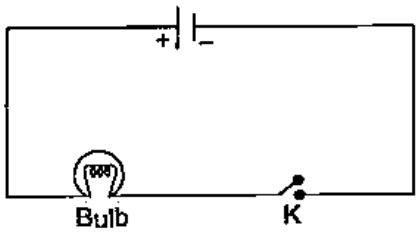
The path of flow of electricity starting from one terminal of cell and returning to the other is called an electric circuit. It consists of conducting wires and other resistances (like lamps etc.) between the terminals of a battery, along which an electric current flows.



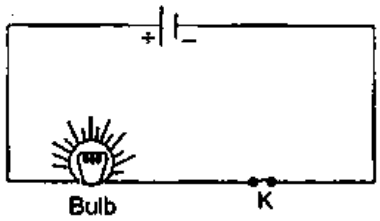
For the flow of electricity, the entire circuit must be made up of conductors. The symbols of commonly used components in the electric circuit are shown in the figure below.

S. No.	Circuit Component	Symbols
1.	Lamp	OR
2.	Connecting wire	or
3.	Cell	
4.	Battery	
5.	Switch or Open key	or
6.	Closed key	
7.	Fixed Resistance	
8.	Variable Resistance	
9.	Ammeter	
10.	Voltmeter	

(a) **Open Electric Circuit :** An electric circuit through which no electric current flow is known as open electric circuit. The electric circuit will be open circuit If the plug of the key is taken out of if the connecting wires break from any point.

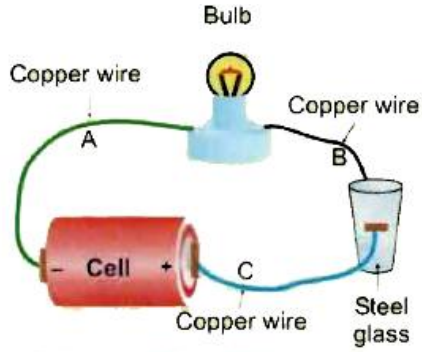


(b) **Closed Circuit:** An electric circuit through which electric current flows continuously is known as closed circuit.



5.5 ELECTRIC TESTER

In Class VI, we made an electric tester [figure] to test a particular material which allows the electric current to pass through it or not. Recall how tester helped us in checking it.



An electric tester to find conductors and insulators

5.5.1 Checking an Electric Tester

Join the free ends of the electric tester for a moment. This will complete the circuit of the tester and hence the bulb will glow.

However, if the bulb does not glow, it implies that tester is not working. What are the possible reasons ?

(i) It is possible that the electrical connections are loose.

(ii) It is possible that the cell/cells is/are used up.

So, first check the electrical connections. If they are tight, replace the bulb. Now, if tester does not work, it implies the cell/cells is/are used up. Replace the cell/cells with fresh ones.

This tester can also be used to find the flow of electric current through liquids. However, in case of liquids, the resistance is sufficiently large. So, instead of a single cell we can use a battery of two or more cells. If the bulb glow, then we can say that liquid is a conductor. However, if the bulb does not glow, then the liquid is a poor conductor.

In the above sentence, we have used the word "poor conductor" for liquids, rather than insulator. It is because the liquid may be conducting electric current, whose magnitude is very small due to the large resistance offered by it. Now, the bulb works on the principle of heating effect of current. It will glow only if a current of appropriate magnitude passes through its filament and in doing so heats it to a high temperature, so that it starts emitting light. Had we used the term "insulator" then it would have meant that there is no scope for the flow of weak current.

5.5.2 Modifications in Electric Tester

The electric tester can be modified for weak electric currents by the following methods.

(a) Use of LED [Light emitting diode] instead of standard bulb

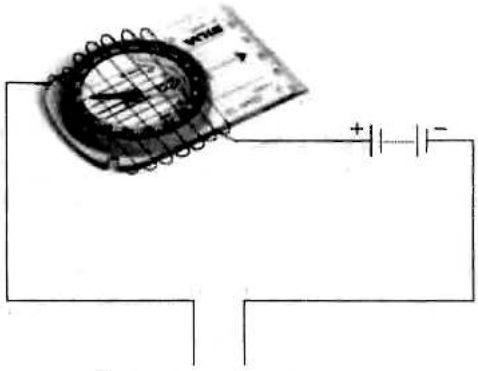
Light emitting diode [LED] glows even when a weak current flows through it.

There are two wires at the base of LED, such that one wire is longer than the other. These wires are commonly called lead wires. The longer wire to the positive terminal.

When the standard bulb in the electric tester is replaced by LED, it can easily detect a weak electric current in a circuit.

(b) **By using a coil wound over small magnetic compass :** You have already known that when a wire carrying current is held near a magnetic needle or magnetic compass, the needle shows deflection, even when the current is very weak. We generally use this effect of electric current to make an electromagnetic tester.

Take out the tray from a discarded matter place a small magnetic compass on the tray and secure it by using some adhesive, such as fevicol, etc. Wrap an insulated electric wire around the tray as shown in Fig.



Electromagnetic tester

Now connect one free end of the above arrangement with the positive terminal of the cell/ battery. Join another copper wire to the negative terminal of the cell/battery. Your electromagnetic tester is ready. Join the free ends of the copper wires momentarily. You will notice the compass needle shows deflection.

5.6 CLASSIFICATION OF LIQUIDS AS CONDUCTORS AND POOR CONDUCTORS / INSULATORS

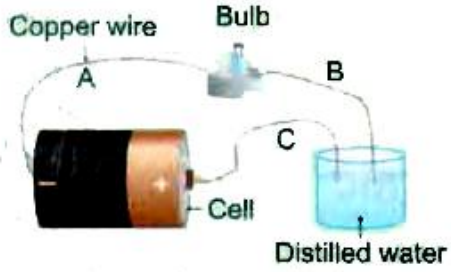
Having learnt about electric tester, let us perform the following activities to find conductors/poor conductors/ insulators amongst the liquids.

DEMO-1

To find out whether distilled water conducts electricity or not.

Materials required :

- A dry cell
- A 1 volt bulb fixed in a bulb holder
- Distilled water
- Copper wires A, B and C with bare ends
- A beaker
- Cellotape.



To show that distilled water does not conduct electric current.

Method : Half fill the beaker with distilled water. Connect the bare ends of the copper wires A, B and C through a bulb with the help of cellotape. Touch the bare ends of the wires Band C with one another. You will observe that bulb glows, thereby showing that all the parts of circuit are conducting electricity.

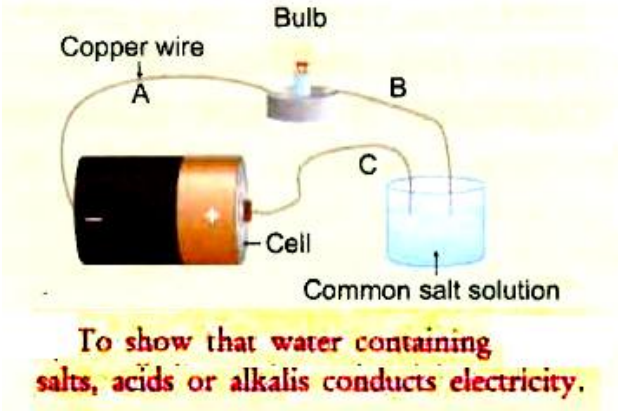
Dip the bare ends of the wires Band C in the distilled water. You will observe that the bulb does not glow. Thus, the activity clearly proves that distilled water does not conduct electricity.

DEMO-2

To show that the addition of salts, acids or alkalis, make the distilled water a conductor of electricity.

Materials required : All the materials as in Demo-1

- Common salt
- Sodium hydroxide
- Sulphuric acid
- A glass rod and a dropper.



Method : Proceed as in Demo 1 and confirm that distilled water does not conduct electricity. Now take a spoonful of common salt and add it into the distilled water. Dissolve the common salt by stirring it with a glass rod.

Dip the bare ends of the wires B and C in the above solution. You will observe that the bulb lights up. Thus, the activity proves that addition of common salt in water makes it a conductor of electricity. Pour off the common salt solution and rinse the beaker with distilled water. Half fill the beaker with distilled water and add to it about 10 drops of sulphuric acid, On dipping the bare ends of wire B and C in the above solution you will observe that bulb lights up. This proves that acids on dissolving in distilled water make it a conductor of electricity.

Similarly, if you repeat the activity by adding 10 drops of sodium hydroxide solution in distilled water; the bulb will light up, thereby proving that alkalis on dissolving in distilled water make it conductor of electricity.

DEMO-3

To find electrically conducting and electrically non-conducting liquids from given liquids.

Materials required:

- A dry cell, three insulated copper wire A. Band C with bare ends
- cello tape
- 1 volt bulb fixed in a bulb holder
- 100 cc beaker containing distilled water
- tap water
- common salt solution
- vinegar solution
- lemon juice solution
- alcohol petrol
- kerosene oil
- mustard oil and dilute hydrochloric acid solution.

Method : Set up the apparatus as in Demo-1 or 2, Dip the bare ends of the wires Band C in the above mentioned solutions one by one, and record in which solutions the bulb lights up and in which solutions the bulb does not light up. You will observe that the bulb lights up in case of tap water; common salt solution, vinegar solution, lemon juice solution and dilute hydrochloric acid solution. Thus, these liquids conduct electricity.

You will also observe that bulb does not light up in case of distilled water; alcohol, petrol, kerosene, oil and mustard oil. Thus, these liquids do not conduct electricity.

5.7 CHEMICAL EFFECTS OF ELECTRIC CURRENT

When a liquid which conducts electric current and at the same time undergoes a chemical change is call1ed chemical effect of the electric current.

Let us perform the following activity.

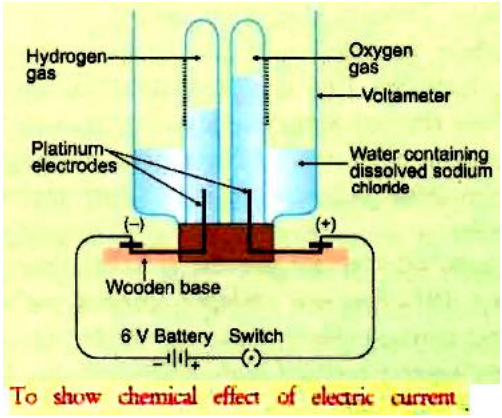
DEMO-4

To show chemical reaction takes place when electric current is passed through common salt solution in water.

Materials required :

- A cup-shaped voltameter with platinum electrodes
- common salt solution in distilled water
- a matchbox
- 6 volt battery
- a switch.

Method : Take the given voltameter. It consists of a cup-shaped glass vessel from the bottom of which arise two platinum electrodes. These electrodes are connected to the brass terminals fixed on the wooden base.



To show chemical effect of electric current

Fill 3/4th of the voltameter with water containing dissolved common salt. The dissolved common salt makes the water electrically conducting.

Fill each of the test tubes of the voltameter with common salt solution and. then invert them over the platinum electrodes as shown in Fig 14.6, taking care that no water flows out of them. This can be achieved by placing the thumb on the mouth of test tubes and then removing the thumb under the common salt solution in the voltameter.

Put the switch in off position and then connect the terminals of 6 volt battery to the voltameter as shown in Fig. Now put the switch in the on position.

You will observe that tiny bubbles of colourless gases arise from both the electrodes and collect in the test tubes. Furthermore, the gas collected at the negative terminal of the battery is twice in volume as compared to the gas collected at the positive terminal of the battery.

The gas collected on the negative terminal of the battery is hydrogen gas. This gas can be easily tested by bringing a burning matchstick near the mouth of the test tube. The gas catches fire with a loud pop sound and the matchstick goes off.

The gas collected on the positive terminal of the battery is oxygen gas. This gas can be easily tested by introducing the glowing end of the matchstick in the test tube, when the matchstick bursts into flame.

$$\text{Water} \xrightarrow{\text{electric current}} \text{Hydrogen gas} + \text{oxygen gas}$$

➢ **How does the electric current bring about chemical change in water ?**

A very, very small amount of water decomposes on its own to form positively charged hydrogen [H^+] ions and negatively charged hydroxyl [OH^-] ions.

However, their number remains same, and hence, the water remains electrically neutral. When electric current is passed through water, hydrogen [H^+] ions are attracted towards negatively charged terminal. Here, they gain electric charges to form neutral hydrogen atoms. The hydrogen atoms subsequently join to form hydrogen molecules.

Conversely, on the passage of electric current, hydroxyl [OH^-] ions are attracted towards positively charged terminal. Here, they lose electric charges to form neutral hydroxyl ions, which unite to form oxygen gas.

Example : $H_2O \rightleftharpoons H^+ \ OH^-$

At cathode – $2H^+ + 2e^- \longrightarrow H_2(g)$

At anode – $4OH^- \longrightarrow 4\ OH + 4e^-$

$4OH \longrightarrow 2\ H_2O + O_2(g)$

5.8 GENERAL TERMS ASSOCIATED WITH THE PASSAGE OF CURRENT THROUGH SOLUTIONS

1. **Electrolyte :** An aqueous solution of a chemical compound, which conducts electric current and at the same time undergoes a chemical change is called electrolyte.
   Examples :
   (i) Aqueous solutions of all acids, such as HCl, HNO_3, H_2SO_4, etc.
   (ii) Aqueous solutions of all alkalis, such as NaOH, KOH, etc.
   (iii) Aqueous solution of soluble salts, such as common salt, copper sulphate, sodium nitrate, zinc chloride, etc.
2. **Non-electrolyte :** A solution of a chemical compound which does not conduct electric current and hence does not undergo any chemical change is called non-electrolyte.
   Examples : Petrol, kerosene oil, diesel oil, vegetable oils, chloroform, carbon tetrachloride, alcohol, ether, benzene, distilled water, etc.
3. **Electrolysis :** The process due to which a solution of a chemical compound conducts electric current and at the same time undergoes a chemical change is called electrolysis.
4. **Electrodes :** The metal wires/plates/rods through which the current enters or leaves an electrolyte are called electrodes.
5. **Cathode :** The electrode connected to the negative terminal of a cell/battery is called cathode.
6. **Anode :** The electrode connected to the positive terminal of a cell/battery is called anode.
7. **Ions :** The electrically charged atoms/group of atoms formed when a chemical compound is dissolved in water are called ions.
8. **Cations :** The positively charged ions formed when a chemical compound dissolves in water are called cations. During electrolysis, the cations are discharged at cathode by taking electric charges from it.
9. **Anions :** The negatively charged ions formed, when a chemical compound dissolves in water are called anions. During electrolysis, the anions are discharged at anode by losing electric charges to it.
10. **Voltameter :** An apparatus in which electrolysis is carried out, such that is consists of a vessel, two electrodes and electrolyte is called voltameter.

5.9 ELECTROPLATING

One of the uses of chemical effect of an electric current is electroplating. During electroplating the metal surface of a given article is coated with a thin layer of superior metal with the help of electric current. Let us perform the following activity in order to show electroplating of an iron object.

DEMO-5

To electroplate an article of iron with copper.

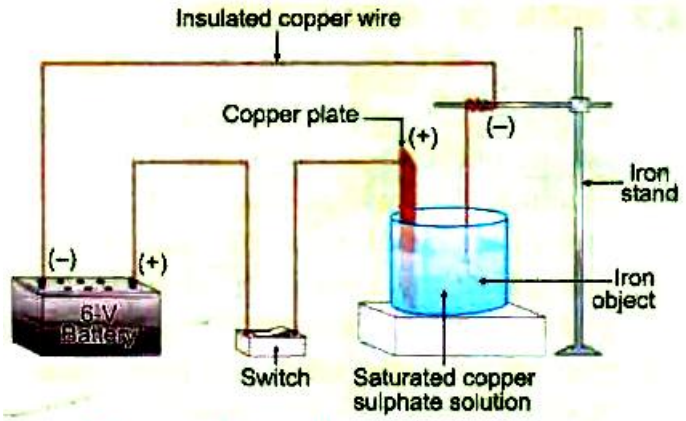
Materials required :

- A glass container or 500 cc beaker
- distilled water
- a copper plate
- a switch
- three insulated copper wires with bare ends
- a glass rod
- copper sulphate crystals
- concentrated sulphuric acid
- a 6 volt battery
- an iron object.

Method :

(i) Half fill the given glass vessel with distilled water. To the distilled water add copper sulphate crystals and stir with a glass rod, till the crystals stop dissolving. The solution so obtained is saturated copper sulphate solution.

(ii) In the above solution place a copper plate connected to an insulated copper wire through a switch. Tie the bare end of another copper wire to an iron object and then immerse it in copper sulphate solution. Complete the electrical circuit as shown in Fig.



Copper plating of an iron object.

(iii) Switch on the current and wait for 10 minutes.

(iv) Switch off the current and take the iron object out of the copper sulphate solution. You will notice that its surface is coated with a thin layer of copper which is reddish in colour.

➢ **How is a thin layer of copper metal deposited on the given object?**

The saturated copper sulphate solution contains the following cations and anions.

Cations : The positively charged cations are copper ions [Cu^{2+}] from copper sulphate and hydrogen ions [H^+] from water.

Anions : The negatively charged anions are hydroxyl ions [OH^-] from water and sulphate ions (SO_4^{2-}) from copper sulphate.

When the electrical current is switched on, the cations start migrating towards the cathode and the anions towards the anode.

At the cathode the positively charged copper ions gain electrical charges to form copper atoms which deposit themselves on the surface of an iron object. Thus, a thin layer of copper is deposited on the iron object.

The hydrogen ions do not discharge. Why? You will learn more about it in the higher classes.

At anode, none of the negatively charged anions [hydroxyl and sulphate ions] discharge. Instead, the copper atoms on the copper plate lose their charges to form copper ions [Cu^{2+}] which enter in the copper sulphate solution.

The reason for non-discharge of hydroxyl and sulphate ions is beyond the scope of this book. You will learn about it in the higher classes.

Thus, on the whole, the anode loses copper atoms to form copper ions and the cathode gains an equal number of copper ions to form copper atoms.

5.9.1 Uses of Electrolysis

1. Electroplating is one of the uses of electrolysis. It is not only used for depositing copper, but a number of superior metals. For example, the wheel covers of cars, the handles of bicycles and motorcycles are coated with nickel and chromium, so as to give a bright shining appearance. Similarly, silver and gold can be electroplated on copper and brass objects. Cheap imitation jewellery is made by electroplating silver or gold on the brass or aluminium jewellery.
2. The process of electrolysis is also used to obtain pure metals from the impure metals.
3. The process of electrolysis is also used in the extraction of aluminium metal from its ore.

Some electroplated objects

Difference between primary cell and secondary cell

Primary cell	Secondary cell
1. This is the cell that can't be used once its chemicals get used up	1. This is the cell in which it is possible to restore the chemical present in the cell once it has been used for sometime.
2. Example: Daniel cell, voltaic cell and dry cell	2. Example: Lead accumulator

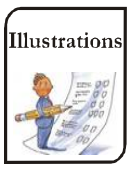


Illustration 2

What is charging?

Solution

When the current in the cell is passed in opposite direction, that is from its negative terminal to positive terminal, then it starts a chemical reaction which again produces the chemicals initially present in the cell. This process is known as charging.

5.9.2 Conductors and Insulators

Difference between Conductors and Insulators

Conductors	Insulators
1. The materials that allow the current to pass through them are called conductors.	1. The materials that do not allow current to pass through them are called insulators
2. Most of the metals are conductors with gold, silver and copper being the best of them.	2. Mica, rubber, plastics, glass, wood, bakelite, ebonite, dry air and pure distilled water are all insulators.

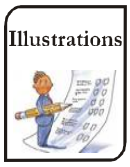
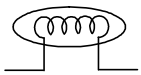


Illustration 3

Give the symbol of (i) a bulb (ii) a resistance (iii) a battery

Solution

(i)  (ii)  (iii) 

5.10 FUSE

Sometimes you must have heard that fuse is blown-off. What does it mean? If fact a fuse is a safely device, which is used to control the excess flow of current, whenever a current in the circuit exceed the desired limit, due to heating effect wire melts and circuit breaks.

The wires made from some special material melt quickly and break, when large electric currents are passed through them.

Fuses of different rating are used for different purposes. It can be of 1 ampere, 2 ampere, 3 ampere or 5 ampere.

Now imagine in a circuit, if a 2000 W room heater is used. It will draw a large amount of current. This in turn will heat the connecting copper wires to such an extent that plastic insulation on them will melt. Now the bare wires will come in contact with one another. This will cause electric sparking and hence an electric fire. Such a circuit is called overloaded circuit and the sparking which causes fire is called short circuit.

Short circuiting causes a greater loss of properly and life every year in the homes and factories.

Hence a fuse is the weakest part in an electric circuit, which melts and breaks the electric circuit when the circuit gets overloaded.

(i) Due to a large current

(ii) Due to short circuiting

(iii) Due to fluctuations of current in power supply system.

Note: These days Miniature circuit breakers (MCBs) are increasingly being used in place of fuses. These are switches which automatically turnoff, when current in a circuit exceeds the safe limit.

5.11 MAGNETISM

Magnetism is the study of the behaviour and properties of magnets. A magnet in its ordinary form, is a bar of iron possessing the following two properties:

(i) It attract small pieces of iron towards it

(ii) It always points in the north-south direction when swinging freely.

5.11.1 Basic Properties of Magnet

(i) It attracts small pieces of iron towards it.

(ii) It always points in the north-south direction when swinging freely

(iii) It has its maximum power at its two ends which are known as its poles.

(iv) One pole of the magnet always points north and is known as its North or N-pole. The other end always points south and is known as its south or S-pole.

(v) Like poles of two magnets repel each other while their unlike poles attract each other.

(vi) We can't have an isolated north or an isolated south pole.

We know that a moving magnet can generate an electric current. Also we can say that electric current can produce a magnetic effect. A coil, through which when an electric current flows behave like a magnet with its two poles.

Eg. : Electric bell shows magnetic effect of current.

5.11.2 Danger of Electricity

(i) If the current happens to pass through the heart, it cause the heart muscles to contract and generally death occurs .

(ii) A strong electric shock can give the body a big shock that can damage the body cells. Such a shock occurs on touching a live electric wire suddenly.

(iii) Handling electrical appliances in wet places is very dangerous.

(iv) Electricity could turn dangerous due to loose connections in switches, improper wiring, over-loading (i.e. passing excess current above the rated capacity), improper earthing.

5.11.3 Safety Measures in using Electricity

(i) The wires used in the circuit should be of good quality and with good insulation.

(ii) Defective and damaged plugs, sockets and switches must be immediately replaced.

(iii) All connections in plugs, switches and sockets must be made of a proper insulating material.

(iv) Extension cords must not be overloaded and must be regularly tested.

(v) Switches and plugs should not be touched with wet hands.

(vi) The main switch should be immediately switched off in case of fire or short circuit.

(vii) Always use a safety fuse of proper rating and material in an electric circuit.

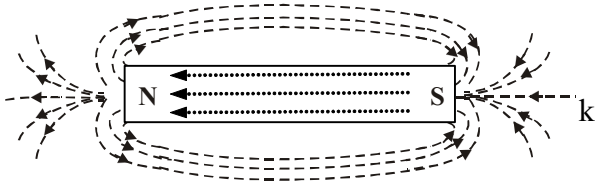
(viii) All appliances must be properly earthed.

(ix) Rubber soled shoes should be worn while repairing electric circuit. This protect the body from electric shocks.

(x) The inside of socket are made of inducting material and therefore must not be touched.

5.11.4 Magnetic Field and Magnetic Field Lines

Magnetic field: It is the space surrounding a magnet where its influence i.e. (force of attraction) can be felt.

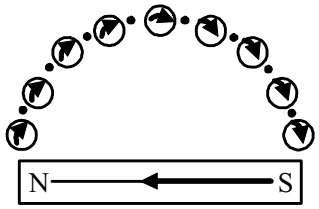


(Magnetic field of bar magnet)

5.11.5 Magnetic field lines of force

These are defined as the lines straight or curved, along which a free unit N-pole moves or these are lines straight or curved, tangent to which at any point gives the direction of magnetic field at that point
Properties of magnetic lines of force are listed below:

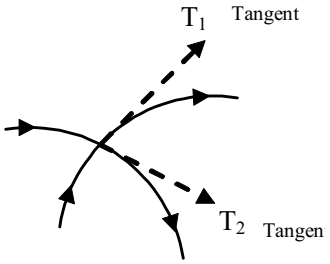
(i) Outside a magnet, the magnetic field lines are directed from N-pole of magnet towards S-pole. However, inside a magnet, the field lines are directed from S-pole to N-pole. Thus, magnetic field lines are closed curves.



(Plotting of magnetic lines of bar magnet with compass)

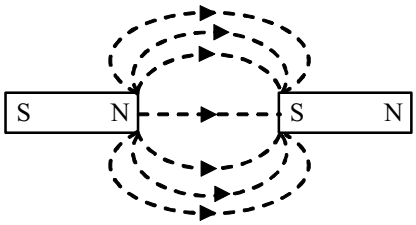
(ii) The relative strength of magnetic field lines is given by degree of closeness of the field lines. More crowded field lines means a stronger magnetic field.

(iii) Two lines of force can never intersect each other because it they do so, then at the point of intersection there will be two directions of magnetic field at the same point 'P' along PT_1 and PT_2 which is not possible.



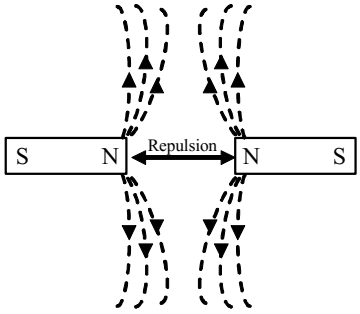
(Two magnetic lines can't intersect)

(iv) These behave like a stretched bow and have a tendency to contract lengthwise, which shows attraction between two opposite pole as shown in figure.



(Attraction between unlike poles)

(v) Lines of force exert a lateral force of repulsion on each other which explains repulsion between the similar poles as shown in figure. (No line of force exists in the region between two similar poles)



(Repulsion between like poles)

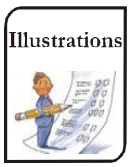


Illustration 4

In a bar magnet, identify the position where the magnetic properties are strongest?

Solution

Poles

Illustration 5

How does the magnetic field due to a current carrying wire vary at a point, when the point is moved away from the wire?

Solution

The magnetic field produce by a given current in a straight wire at a point decreases as the distance of point from the wire is increased. Thus, magnetic field is inversely proportional to the distance.

5.12 ELECTROMAGNET

When the current carrying coil is brought near a suspended bar magnet, one side of the coil repels the north pole of the magnet. The other side of the coil attract the north pole of the magnet. Thus, a current carrying coil has both a north and a south pole like a magnet. Such a magnet is called electromagnet. The strength of an electromagnet can be increased by placing an iron rod or core inside the coil.

5.12.1 Properties of Electromagnets

(i) Electromagnets are very strong temporary magnets when the current is passed through them and get demagnetized as soon as the current is switched off.

(ii) The strength of electromagnet depends upon the current in the coil and type of bar used (i.e. the material on which the wire is coil around)

(iii) Electromagnets can be made in different sizes and shapes depending on their use.

5.12.2 Practical applications of electromagnets

(i) It find use in many appliances of everyday use such as electric bells, electric motors, dynamos, lifting weights, loudspeakers telegraphs and telephones.

(ii) Electromagnets are also used by the surgeons for removing iron bits and pieces from the wounds.

5.13 ELECTROMAGNET INDUCTION

Oersted experiments revealed that magnetism is associated with electric current flowing through a conductor i.e. production of magnetism from electricity. Faraday, after a series of experiments to find its reverse i.e. "Production of current from magnetism", found that electric current can be produced in a coil momentarily when a bar magnet is made to move quickly near or away from the coil without the use of cells.

This current produced is called 'Induced current'.

Electromagnetic Induction: It is the phenomenon of production of induced current in a coil by changing magnetic field crossing the coil, which lasts as long as the magnetic field actually changes.

Investigations made by Faraday and Henry shows that

(i) A current flows when the coil is moved relative to the magnet.
(ii) A current flows when the magnet is moved relative to the coil.
(iii) No current flows when both coil and magnet are stationary relative to one another.
(iv) Reversing the direction of movement of the coil or the magnet reverses the direction of the current.
(v) The magnitude of the current increases with the number of loops of wire in the field, the strength of the magnet and the speed of the movement.

Illustrations

Illustration 6

Which material is used to prepare an electromagnet-soft iron or hard steel?

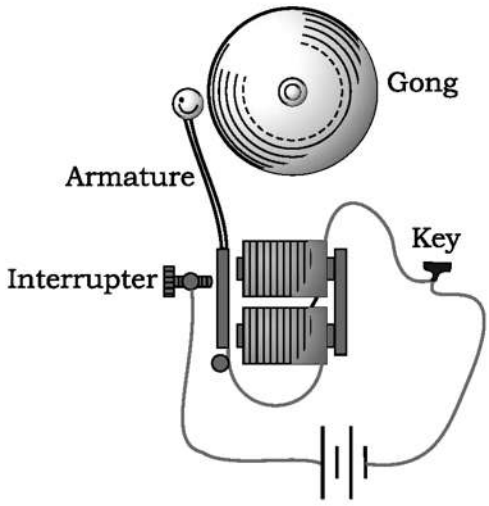
Solution

Soft iron

5.14 ELECTRIC BELL

Construction:

(i) Electromagnet: A coil of wire wound on an iron core acts as an electromagnet.
(ii) Armature: An armature with a hammer at one end is kept close to the electromagnetic facing its poles.
(iii) Interrupter: To make the bell ring continuously, a device is needed to keep the hammer moving back and forth. This device is called an interrupter.



Electric Bell

Working:

When a current flows through the coil, it becomes an electromagnet and attracts the armature made of iron. As a result, the armature gets pulled towards the magnet.
In the process, the hammer at the end of the armature strikes the gong of the bell to produce a sound.
When the electromagnet pulls the armature, a break occurs in the circuit and the current through the coil ceases to flow.
Armature is then pulled back by a spring attached to it, which brings back the contact to its position to complete the circuit again. Current then again flows in the coil and the cycle is repeated automatically.

LET US RECAPITULATE

- On touching an electric switch with wet hands a person can receive an electric shock, because natural water contains dissolved salts and is a good conductor of electricity.
- Substances like distilled water, alcohol, ether, petrol, kerosene oil, diesel oil, vegetable oil, etc. are non-electrolytes.
- Water, containing acid or alkalis or salts forms an electrolyte.
- During electrolysis, the electrolyte undergoes a chemical change.
- Water containing acids or alkalis or salt on the passage of electric current decomposes into hydrogen and oxygen.
- During electroplating, the cations discharge at cathode by gaining electric charges, whereas anions discharge at anode by losing electric charges.
- The process of electrolysis is used in (i) electroplating, (ii) refining of metals, (iii) extraction of metals

CONCEPT APPLICATION LEVEL - I [NCERT Questions]

Q.1 Fill in the blanks

(a) Most liquids that conduct electricity are solutions of _____, _____ and _____.

(b) The passage of an electric current through a solution causes _____ effect.

(c) If you pass current through copper sulphate solution, copper gets deposited on the plate connected to the _____ terminal of the battery.

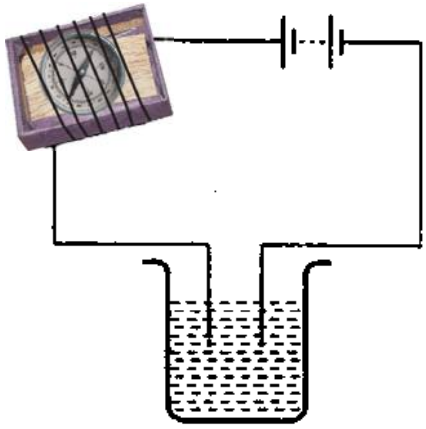
(d) The process of depositing a layer of any desired metal on another metallic object, by means of electricity, is called _____.

Ans. (a) acids, bases, salts ; (b) chemical ; (c) negative ; (d) electroplating

Q.2 When the free ends of a tester are dipped into a solution the magnetic needle shows deflection. Can you explain the reason?

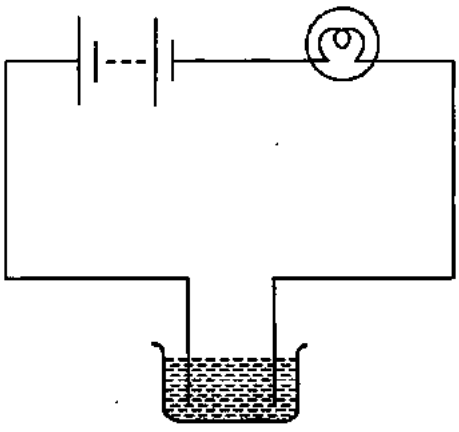
Ans. Yes, we can explain the reason. The magnetic needle will show deflection when circuit is complete. The deflection of magnetic needle shows that the solution is a good conductor.

Q.3 Name three liquids, which when tested in the manner shown in figure may cause the magnetic needle to deflect?



Ans. Tap water, hydrochloric acid, sodium hydroxide.

Q.4 The bulb does not glow in the set up shown in figure. List the possible reasons. Explain your answer.



Ans. The possible reasons may be:
(i) The connections of the circuit may be loose.
(ii) Bulb may be fused.
(iii) Cells may be used up.
(iv) The liquid may be poor conductor.

Q.5 A tester is used to check the conduction of electricity through two liquids, labelled A and B. It is found that the bulb of the tester glows brightly for liquid A while it glows very dimly for liquid B. You would conclude that:
(i) liquid A is a better conductor than liquid B.
(ii) liquid B is a better conductor than liquid A.
(iii) both liquids are equally conducting.
(iv) conducting properties of liquid cannot be compared in this manner.

Ans. We conclude that option (i) 'liquid A is a better conductor than liquid B'.

Q.6 Does pure water conduct electricity? If not what can we do to make it conducting?

Ans. No, the pure water does not conduct electricity. Pure water can be made conducting by dissolving salt in it.

Q.7 In case of a fire before the firemen use the water hoses, they shut off the main electrical supply for the area. Explain why they do this.

Ans. The water used in water hoses is good conductor of electricity. Firemen shut off the main electrical supply, because if the supply of electricity continues this may be high risk of electrocution due to water.

Q.8 A child staying in the coastal region tests the drinking water and also the sea water with his tester. He finds that the compass needle deflects more in the case of sea water. Can you explain the reason?

Ans. Sea water contains more amount of salt than drinking water. So the sea water is a better conductor of electricity. This is the reason that the compass needle deflects more in case of sea water.

Q.9 Is it safe for the electrician to carry out electrical repairs outdoors during heavy downpour? Explain.

Ans. No, It is not safe for the electrician to carry out electrical repairs during heavy downpour. It is because during heavy downpour there is a higher risk of electrocution.

Q.10 Paheli had heard that rain water is as good as distilled water. So she collected some rain water in a clean glass tumbler and tested it using a tester. To her surprise she found that the compass needle showed deflection. What could be the reasons?

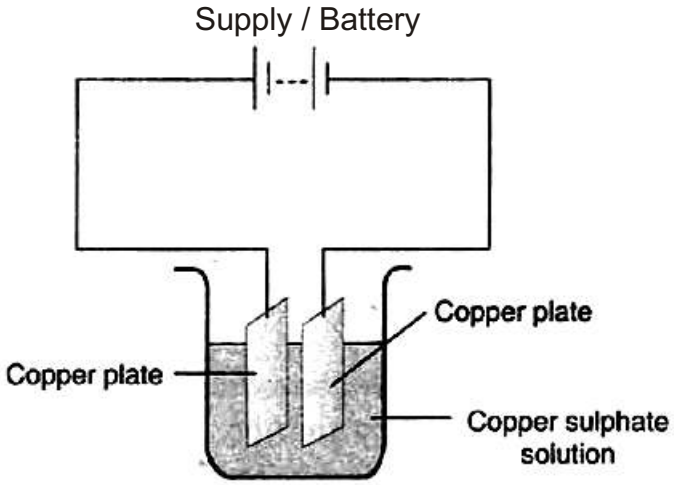
Ans. Rain water is like a distilled water but some impurities are mixed in from the atmosphere. These impurities make the rain water conducting. This could be the reason for the deflection of compass needle.

Q.11 Prepare a list of objects around you that are electroplated.

Ans. Pots of metals, bath taps, ornaments, rims of vehicles, handle bar of cycles and motor cycles, kitchen gas burner, bottom of cooking utensils, handles of doors, tin cans are the some objects around us that are electroplated.

Q.12 The process that you saw in Activity 14.7 is used for purification of copper. A thin plate of pure copper and a thick rod of impure copper are used as electrodes. Copper from impure rod is sought to be transferred to the thin copper plate. Which electrode should be attached to the positive terminal of the battery and why?

Ans. The rod of copper plate should be connected to the positive terminal of the battery. Because when electric current is passed through the copper sulphate solution, it dissociates into copper and sulphate. The free copper drawn to the negative terminal of the battery gets deposited on it. On the other hand the loss of copper from the solution would be regained from the impure copper rod which is connected to the positive terminal of the battery.



A Simple circuit showing electroplating.

CONCEPT APPLICATION LEVEL - II

SECTION - A

MULTIPLE CHOICE QUESTIONS

Q.1 Plastic wire is
(A) an insulator (B) a conductor
(C) both of these (D) none of these.

Q.2 Electroplating is based on
(A) magnetic effect of electricity (B) chemical effect of electricity
(C) heating effect of electricity (D) physical effect of electricity.

Q.3 Adding common salt to distilled water makes it
(A) good conductor (B) insulator
(C) neither (A) nor (B) (D) both (A) and (B)

Q.4 An electrolyte is
(A) a metal (B) a solution
(C) a liquid that conducts current (D) all of above.

Q.5 Copper wire is a
(A) good conductor (B) poor conductor
(C) both (A) and (B) (D) none of these.

Q.6 Poor conductors are
(A) Plastics (B) Clothes
(C) Wood (D) All of these.

Q.7 Distilled water is
(A) Poor conductor (B) Good conductor (C) Both (A) and (B) (D) None.

Q.8 Flow of electron is called
(A) Electroplating (B) Electric current (C) Electrodes (D) Electrolyte.

Q.9 Electroplating prevents
(A) Current (B) Chemical effect (C) Rusting (D) All

Q.10 An electric lamp glows due to
(A) Chemical effect (B) Magnetic effect (C) Heating effect (D) None

SECTION - B

VERY SHORT ANSWER TYPE QUESTIONS

Q.1 What are the benefits of electroplating?
Ans. Electroplating prevent corrosion of metals, metals look shiny for a long time and foods do not get spoilt.

Q.2 How will you make distilled water as super conductor?
Ans. We will make it conductor into it by putting a pitch of salt.

Q.3 What is electric current?
Ans. The flowing of charge from positive to negative terminal.

Q.4 What happens to a compass needle kept nearby when current flows in a wire? What does it prove?
Ans. The deflection of the magnetic needle can be seen. It proves that electric current produces a magnetic effect.

Q.5 Do liquids conduct electricity?
Ans. Yes, mostly liquids conduct electricity.

Q.6 What are electrodes and electrolyte?
Ans. A metal rod used in a battery is called an electrode and liquids are called electrolytes.

Q.7 Expand the term LED.
Ans. Light Emitting Diode.

Q.8 When connecting LED to a circuit which wire should be connected to positive terminal of the battery and wire to negative terminal?
Ans. The longer lead should be connected to the positive terminal of the battery and the shorter lead to the negative terminal of the battery.

Q.9 Our body is a conductor or insulator of electricity.
Ans. Conductor of electricity.

Q.10 What are good conductors?
Ans. The materials which allow electric current to pass through them are called good conductors of the electricity.

Q.11 Give two examples of good conductors of electricity.
Ans. Copper, iron.

Q.12 Why is it dangerous to touch an electrical appliance with wet hands?
Ans. Wet hands act as good conductors. So we feel electric shocks when we touch electric appliance with wet hands.

Q.13 What are insulators (poor conductors) of electricity?
Ans. The materials which do not allow electric current to pass through them are called poor conductors.

Q.14 Give two examples of poor conductors of electricity.
Ans. Dry wood, rubber.

Q.15 Do liquids conduct electricity?
Ans. Yes, liquids also conduct electricity.

Q.16 How can you check current?
Ans. We check current by using tester.

Q.17 Give an example of any liquid conductor.
Ans. Tap water.

Q.18 Can distilled water conduct electricity?
Ans. No, distilled water cannot conduct electricity.

Q.19 Name some substances which make the liquids good conductor of electricity.
Ans. Acids, Bases and Salts.

Q.20 Name two liquid substances other than water which conduct electricity.
Ans. (i) Lemon Juice (ii) Vinegar.

Q.21 Sometimes even though the liquid is conducting, the bulb may not glow. Give reason.
Ans. Sometimes the bulb does not glow because the current through it is too weak to make the bulb glow.

Q.22 Which effect of current causes the bulb to glow?
Ans. Heating effect.

Q.23 Name the part of bulb which glows.
Ans. Filament.

Q.24 What are the three effects of electric current?
Ans. There are three effects of electric current-heating, magnetic and the chemical effect.

Q.25 What is magnetic effect of electric current?
Ans. The electric current also produces the magnetic effect in which a current carrying wire behaves like a magnet.

Q.26 What happens when a compass needle is brought near a wire in which current is flowing?
Ans. The needle deflects.

Q.27 How can we check magnetic effects of current?
Ans. By using magnetic compass.

Q.28 What is distilled water?
Ans. The water which is free of salts is called distilled water.

Q.29 Name a salt which makes distilled water a good conductor of electricity.
Ans. Common salt. (NaCl)

Q.30 What are electrodes?

Ans. The metal rods dipped in liquids to which cells are attached are called electrodes.

Q.31 Name the gases which release when current is passed through water.

Ans. Hydrogen and oxygen.

Q.32 Name the gas deposited on negative electrode.

Ans. Hydrogen.

Q.33 Name the gas deposited on a positively charged electrode.

Ans. Oxygen.

SHORT ANSWER TYPE QUESTIONS

Q.1 What do you mean by electric current?

Ans. The continuous and directional flow of charges (electrons) is called electric current. It is denoted by I and its unit is ampere.

Q.2 What is a tester?

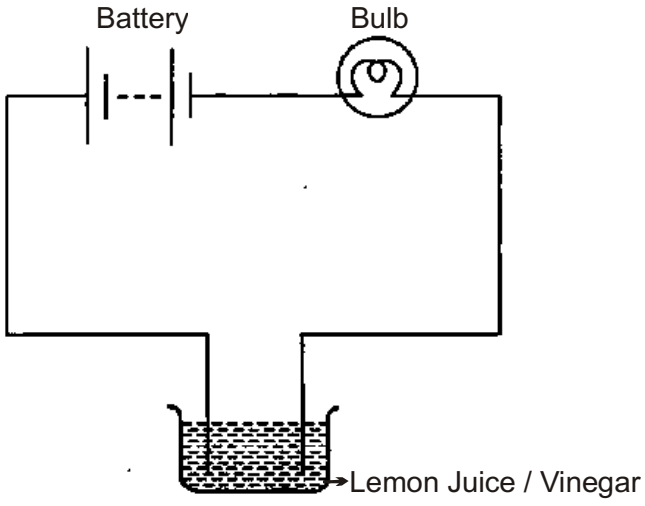
Ans. The instrument which is used to check the flow of electric current is called tester. It is attached to the terminals of the electric circuit. If the bulb of tester glows, it confirms that current is flowing through the circuit.

Q.3 How can you test whether liquids conduct or do not conduct the electricity?

Ans. Some liquids are the good conductor of electricity while some are poor conductors. The liquids can be tested for the conduction of electricity. The free ends of a tester are dipped in liquid to be' tested and then observe the bulb, if it glows, it confirms that the liquid is good conductor otherwise liquid is a poor conductor.

Q.4 Show that lemon juice and vinegar are good conductor of electricity.

Ans. Collect a few plastic or rubber caps of bottles. Pour one tea spoon of lemon juice or vinegar in one cap. Bring the tester over the cap and let the ends of the tester dip into lemon juice or vinegar. We see that bulb starts to glow. It indicates that lemon juice and vinegar are good conductors of electricity.



Q.5 Explain the mechanism of glowing of bulb in liquid.

Ans. When the liquid between the two ends of a tester allows the electric current to pass, the circuit of the tester becomes complete. The current flows in the liquid circuit and the bulb glows. When the liquid does not allow the electric current to pass, the circuit of the tester is not complete and the bulb does not glow.

Q.6 There are some situations in which even though liquid is conducting, bulb may not glow. Give reasons.

Ans. The possible reasons may be (i) The current may be weak. (ii) Bulb may be fused. (iii) Incomplete circuit.

Q.7 Explain why a bulb glows on passing current.

Ans. When the current passes through a bulb, the filament of the bulb gets heated to a high temperature due to the heating effect of current. The bulb starts to glow. Sometimes the current is too weak and filament does not get heated sufficiently and bulb does not glow.

Q.8 What is LED? Why is it most important source of light?

Ans. The device which is used in the tester in place of bulb is called LED. It is used even when a weak electric current flows through it and it starts to glow in weak current. There are two wires called leads attached to the LED. One lead is longer than the other. A long wire is connected with the positive terminal and shorter lead is connected to the negative terminal of battery.

Q.9 What do you mean by magnetic effect of electricity?

Ans. When electric current is passed through a coil or wire, then it behaves like a magnet. This is called magnetic effect of current. The strength of magnetic field depends on the amount of current passing through a coil or wire. The coil or wire shows magnetism till current is passed.

Q.10 The ordinary water can conduct electricity while distilled water does not. Explain why?

Ans. The water that we get from various sources like taps, hand pumps, wells and ponds is not pure. It may contain several salts dissolved in it. This water is thus good conductor of electricity. Distilled water is free of salts due to which it is a poor conductor.

Q.11 Why do we need magnetic compass to test the conduction of electric current?

Ans. Sometimes the bulb does not glow on passing electric current. This is because the electric current flowing through a conductor is so small, that the filament of the bulb does not get heated up to the temperature where it starts glowing. So, in case of small current we need magnetic compass to test the conduction.

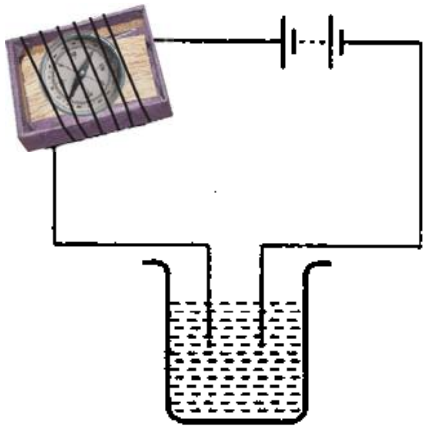
Q.12 What is chemical effect of electricity? Give some examples of chemical effects.

Ans. The process in which a chemical reaction or change takes place in a solution on passing electricity. The passage of an electric current through a conducting solution causes chemical reactions. For example change in colour of solutions and electroplating.

LONG ANSWER TYPE QUESTIONS

Q.1 Prepare a tester to test conduction based on magnetic effect of the electricity.

Ans. Take the tray of a discarded matchbox. Wrap an electric wire a few times around the tray. Place a small compass needle inside it. Now connect one free end of the wire to the terminal of a battery. Leave the other end free. Take another piece of wire and connect it to the terminal of battery. Join the free ends of two wires momentarily. The compass needle should show deflection. The tester with two free ends of wire is ready.



Q.2 Complete the following table and classify the liquids by using tester.

S. No.	Material	Compass needleshows deflection (Yes/No)	Conductor / Insulator
1	Lemon Juice	Yes	Conductor
2	Vinegar		
3	Tap water		
4	Vegetable Oil		
5	Milk		
6	Honey		

Ans.

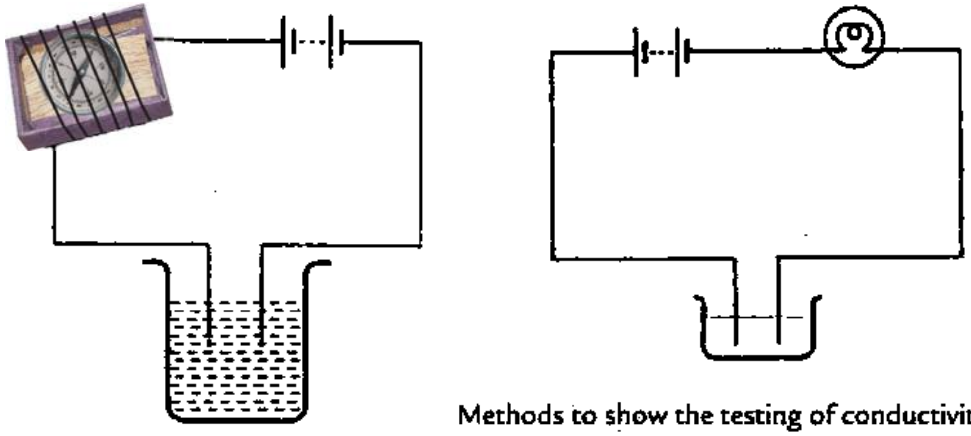
S. No.	Material	Compass needleshows deflection (Yes/No)	Conductor / Insulator
1	Lemon Juice	Yes	Conductor
2	Vinegar	Yes	Conductor
3	Tap water	Yes	Conductor
4	Vegetable Oil	No	Insulator
5	Milk	No	Insulator
6	Honey	No	Insulator

Q.3 What are the two methods of testing all insulator or a conductor?

Ans. These two methods are used to test the conduction.

(i) We use an electric lamp to test conductivity. An electric lamp is attached in the electric circuit. If the substance allows the current to pass through it, the bulb will start glowing. Otherwise the bulb will not glow. This method does not work when current is very small. In such cases magnetic compass is used.

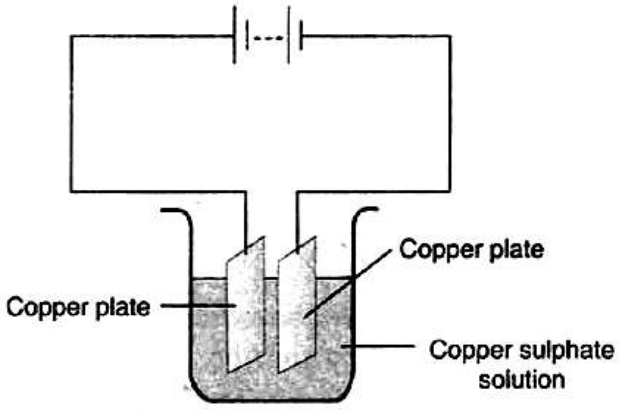
(ii) A magnetic tester is used to test conductivity when current is allowed to pass through it, it creates a magnetic field and the compass shows deflection. The deflection of compass shows that the current is passing through circuit (See Fig. 14.6).



Methods to show the testing of conductivity of lemon juice.

Q.4. What do you mean by electroplating? How does it take place?

Ans. The process of coating a desired metal on other metal surface by using electric current is called electroplating. A metal plate and the substance to be coated are dipped in a current conducting solution with conducting wires. The object to be coated is attached to the negative terminal. When electric current is passed through the solution, the compounds of the conducting solution start breaking. The free metallic particles get deposited on the object at negative terminal of the battery. In this way we can get a coating of desired metal on any object by preparing suitable conducting solution and by using suitable electrodes.



A Simple circuit showing electroplating.

Q.5 Explain the advantages of electroplating.

Ans. The advantages of electroplating:

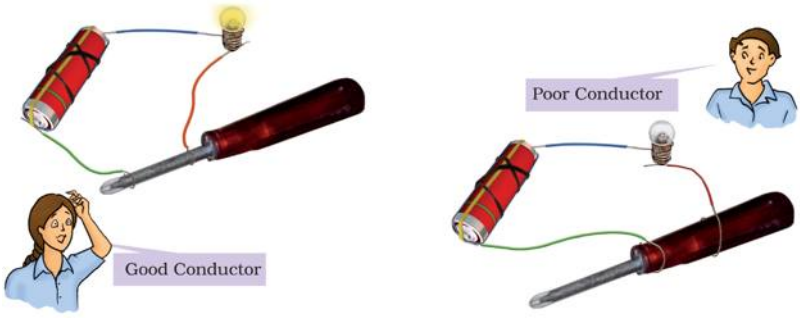
(i) It is used to coat a desired metal on other objects.
(ii) It protects the metals from the corrosion.
(iii) It also prevents the metallic surfaces from rusting.
(iv) Some cheap and dull metals are coated with costly and shiny metals.
(v) It can make more reactive metals like iron, less reactive.
(vi) Coating of chromium on metals give lustre to objects.

SECTION - C

SKILL-BASED QUESTIONS

Q.1 (a) Draw a diagram of a tester to show (i) Good conductor (ii) Poor conductor.
(b) What is the difference between a circuit of good conductor and poor conductor?

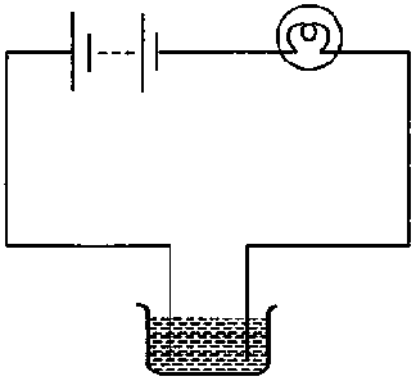
Ans. (a)



(b) If the bulb is glowing in the circuit then it means the wire is a good conductor. If the bulb does not glow it indicates is a poor conductor.

Q.2 Draw a circuit diagram to show the conduction of electricity in lemon juice or vinegar.

Ans.



Q.3 (a) Identify the following figure and differentiate between LED and electric bulb.
(b) Expand the LED.

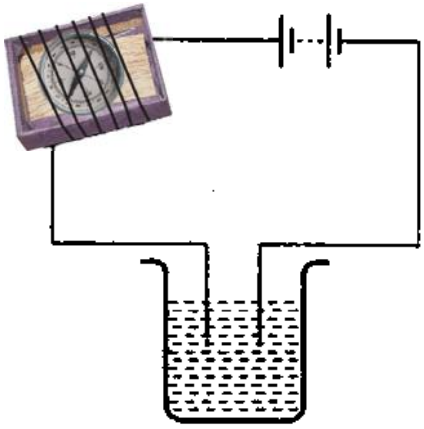
Ans. (a)

Difference between LED and electric bulb:
LED: It can be used to test even when a weak electric current flows through it.
Electric bulb: It can be used to test only a strong current which is sufficient to heat the filament of bulb.

(b) The full form of LED is Light Emitting Diode.

Q.4 Draw a circuit diagram to show preparation of tester based on magnetic effect of current.

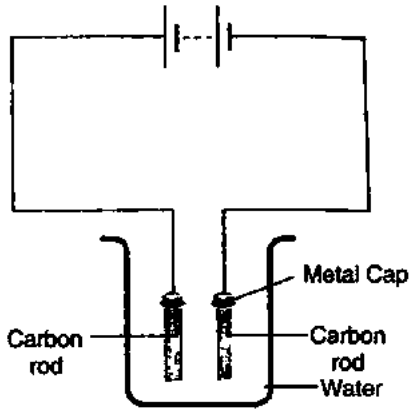
Ans.



Q.5 Draw a well labelled diagram of passing current through water and answer the following questions

(i) Name the electrodes?
(ii) Name the material use to make caps of electrodes?
(iii) Which metal wire is wrapped around the electrodes?
(iv) What do you observe on passing electricity?
(v) Name the gases formed?
(vi) Can we call the change in water as chemical change?

Ans.



Passing current through water.

(i) Carbon rods are used as electrodes.
(ii) Brass caps or any other metal.
(iii) Copper wire.
(iv) We observe the bubbles of a gas near electrodes.
(v) Oxygen and hydrogen gases.
(vi) Yes, it is a chemical change.

Q.6 Draw a simple circuit diagram to show electroplating and answer the following questions.

(i) Write the name of electrodes?

(ii) Name the solutions used as electrolyte?

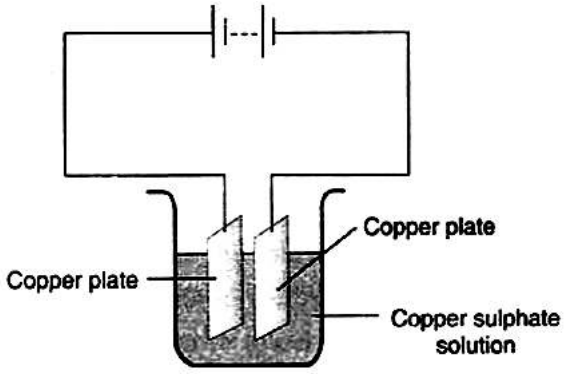
(iii) What is the colour of solution before passing electricity?

(iv) What is the colour of solution after passing electricity?

(v) Do you observe any coating on anyone of electrode?

(vi) Name the process of coating?

Ans.



A simple circuit showing electroplating.

(i) Copper plates are used as electrodes.

(ii) Copper sulphate solution.

(iii) Blue colour

(iv) Colour is fed up (light or colourless).

(v) We observe coating on one electrode.

(vi) This process is called electroplating.

Q.7 Draw a diagram to show the testing of potato as good conductor .

Ans.