4 ELECTRIC CURRENT AND ITS EFFECTS

ELECTRICITY :

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

(i) Static Electricity (ii) Current Electricity

(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.

Use of Electricity : We use electricity for many purposes to make our tasks easier. For example, we use electricity to operate pumps that lift water from wells or from ground level to the roof top tank. Electricity makes it possible to light our homes, roads, offices, markets and factories even after sunset. This helps us to continue working at night.

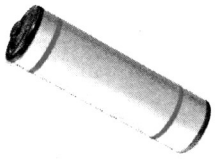
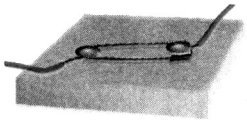
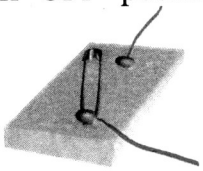
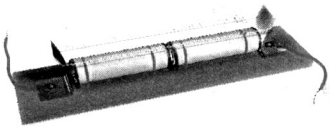
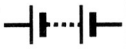
Source of Electricity: Mainly two types of Sources of Electricity

1. **Power Station :** It is a Main Source of Electricity. It produces and supply huge amount of Electricity. All the high voltage equipment get the supply from power station.

2. **Electric Cells (Batteries) :** It gives little amount of Electricity. It is portable and safe.

SYMBOLS OF ELECTRIC COMPONENTS :

The following are the symbols for some electric circuit components.

S.No.	Electric component	Symbol
1.	Electric cell 	
2.	Electric bulb 	
3.	Switch in 'ON' position 	
4.	Switch in 'OFF' position 	
5.	Battery 	
6.	Wire 	

ELECTRIC CHARGE :

From the study of atomic structure we know that an atom consists of a central part called nucleus and around the nucleus (called extra-nucleus) there are a number of electrons revolving in different paths or orbits. The nucleus consist of protons and neutrons. A proton is a positively charged particle while a neutron has no charge. Therefore, the nucleus of an atom bears a positive charge. An electron is a negatively charged particle having magnitude of negative charge equal to the magnitude of positive charge on a proton. Normally, the number of electrons is equal to the number of protons in an atom. Therefore, an atom is neutral as a whole, the negative charge on electrons cancelling the positive charge on protons. This leads to the conclusion that under ordinary conditions, a body is neutral, i.e. it exhibits no charge. When a body has deficiency or excess of electrons from the normal, it is said to be charged or electrified.

Types of Charge :

There are two types of charges known as positive and negative charges. All objects normally contain equal amount of positive and negative charges and are therefore, electrically neutral. When we comb dry hair, the comb gets charged and can pick small pieces of paper brought near it. When we rub a glass rod with silk cloth or a piece of ebonite rod with woolen material, the charge acquired by a glass rod rubbed with silk is called a positive charge. and that on ebonite rod, is called a negative charge. Glass rod and ebonite rod will attract each other while two glass rods as well as two ebonite rods will repel each other.

Unit of charge S. I. unit : Coulomb (C)

Properties of charge

(i) Charge is conserved during any process.
Example : Chemical reaction, nuclear reaction,etc.

(ii) Charge is quantized: Electric charge always occurs as some integral multiple of fundamental unit of charge (e).
Example : The amount of charge present on a body depends on the number of electrons given out or taken by the body, then $Q = \pm ne$. Where $n = 1, 2, 3 ..... \infty$ $n \neq 2/3, 1/2$ or any fraction

(iii) Charge is always associated with mass.

(iv) **Charge is transferable:** If a charged body is put in contact with an uncharged conducting body, then it becomes charged due to transfer of electrons from one body to another, this process is called conduction.

(v) Charge resides on the outer surface of a conductor.

(vi) Similar charges repel each other while opposite charges attract.

(vii) Repulsion is sure test for electrification of bodies.

(viii) Electroscope is a device used to confirm the presence of charge and its nature on a body.

CONDUCTORS, INSULATORS AND SEMICONDUCTORS :

(i) Conductors :

Those substances through which electric charges can flow, are called conductors. All the metals like silver, copper and aluminium etc., are conductors. Carbon, in the form of graphite, is a conductor and the aqueous solutions (water solutions) of salts are also conductors. The human body is a fairly good conductor.

(ii) Insulators :

The material in which there is no flow of current are called insulators. The number of free electron is negligible in them.

(iii) Semiconductors :

The materials whose electrical conductivity lies between conductors and insulators are called semiconductors.

ELECTRIC CURRENT :

The electric current is a 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** flows through it is given by :

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

Where Q = ne, Here, n = number of electrons, e = charge of electron = 1.6×10^{-19}c

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

(a) Unit of Electric Current :

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.

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

Smallest currents are measured in milliamperes (mA) and microampere (μA)
$1mA = 10^{-3}$ A
$1\mu A = 10^{-6}$A

Ex.1 If 10 Coulomb of charge is passed from a point in 2 sec, then find the current at that point.

Sol. Q = 10 C

T = 2 sec

I = ?

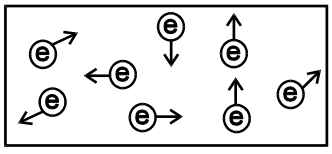
$$I = \frac{Q}{T} = \frac{10}{2} = 5 \ Ampere$$

(b) Direction of Electric Current :

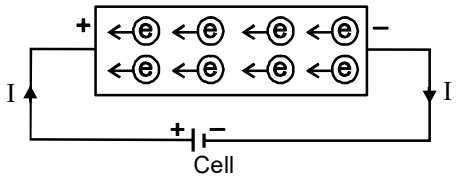
We know that there are two types of charges positive charge and negative charge, but electrons were not discovered at that time. So, electric current was considered to be the flow of positive charges and the direction of flow of the positive charges was taken to be the direction of electric current. The direction of electric current is from positive terminal of 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 present in the wire. Since the electrons are negatively charged, they start moving from negative end to the positive end of the wire. These electrons constitutes the electric current in the wire. The direction of flow of electrons remains opposite to the flow of conventional current.



Direction of conventional current

ELECTRIC POTENTIAL :

Electric potential is equivalent to level of charge. It determines the direction of flow of charge like that of water.

- Water flow : higher level → lower level
- Charge flow : higher potential → lower potential

Electric potential at a point is defined as the work done in bringing a unit positive charge from infinity to that point against the electric field. It is denoted by **V**.

Let **W** be the work done to bring a charge **q** from infinity to a given point, then the electric potential at that point is given by :

$$\mathbf{V = \frac{W}{q}}$$

- Therefore potential difference is necessary condition for the flow of current.

(a) Unit of electric potential :

In S.I., the unit of electric potential is Volt.

Since, $\mathbf{V = \frac{W}{q}}$ $\therefore$ 1 Volt $= \frac{1\text{joule}}{1\text{coulomb}} = 1\ \mathbf{JC^{-1}}$

- Smaller units of electric potential :
  1 Milli volt (mV) = 10^{-3} V
  1 Micro volt (μ V) = 10^{-6} V
- Larger units of electric potential :
  1 Kilovolt (kV) = 10^{3} V
  1 Megavolt (MV) = 10^{6} V

(b) Potential Difference :

Potential difference ($V_A - V_B$) between two points A and B in an electric field is defined as the work done in moving a unit positive charge from point B to point A.

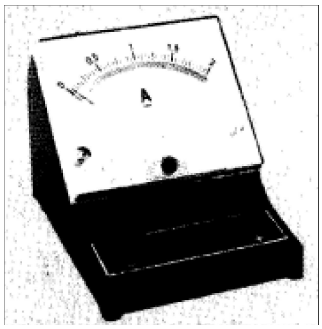
Let W be the work done in moving a charge q from point B to point A, then the potential difference ($V_A - V_B$) between these two points is given by :

$$\mathbf{V_A - V_B = \frac{W}{q}}$$

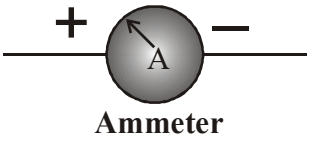
MEASUREMENT OF CURRENT AND POTENTIAL DIFFERENCE :

(a) Ammeter :

It is a device used to determine the amount of current flowing in the circuit. The resistance of ammeter is small and it is used in series in the circuit.



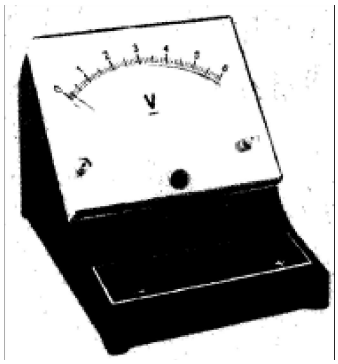
(a) Ammeter



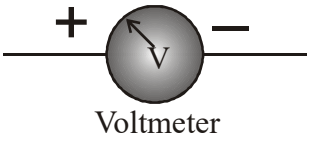
(b) symbol

(b) Voltmeter :

It is a device used to determine the potential difference between two points in the circuit. Its resistance is high and it is used in parallel in the circuit.



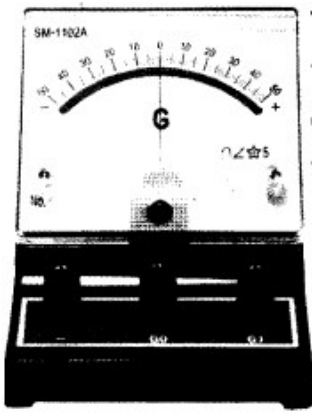
(a) Volt meter



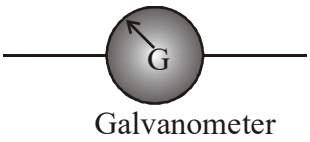
(b) symbol

(c) Galvanometer

The instrument used to detect the flow of current in a circuit is galvanometer.



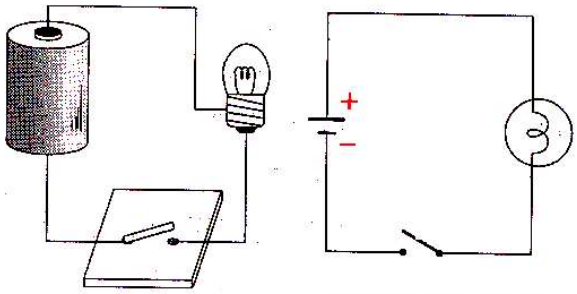
(a) Galvanometer



(b) symbol

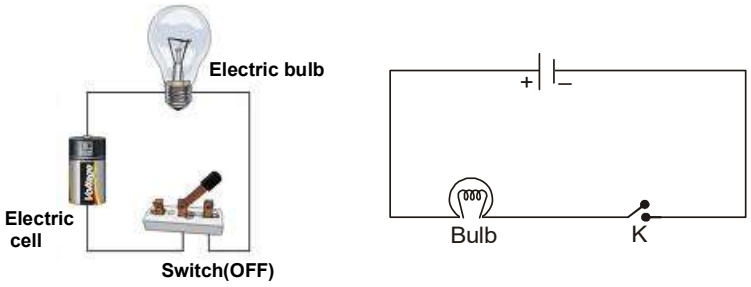
ELECTRIC CIRCUIT :

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



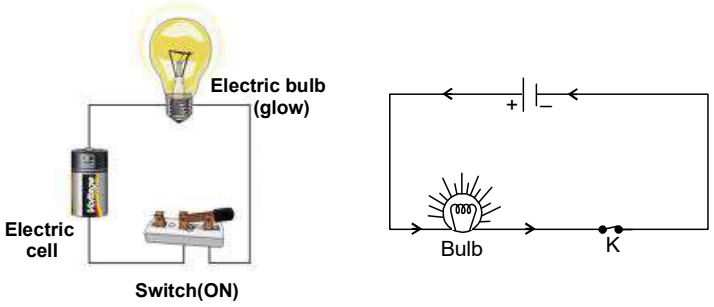
(a) Electrical circuit (b) Circuit diagram

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



(a) Electrical circuit (b) Circuit diagram

(b) Closed Circuit : An electric circuit through which electric current flows continuously is known as closed circuit. The electric circuit will be closed circuit if the plug of the key is at on position.



(a) Electrical circuit (b) Circuit diagrams

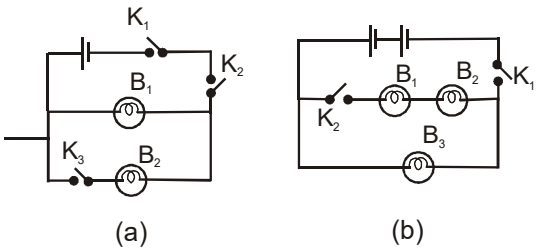
* For flow of electricity, the circuit must be made of conductors. Insulators in the path of electrical circuits makes the circuit incomplete.

Ex.2 Look at the circuit given in figure (a) and figure (b). Read the instructions in each case and answer the questions given.

(i) Which bulb B_1/B_2 in figure (a) will glow when

(a) only K_1 is closed ?

(b) K_1 and K_2 are closed ?



(a) (b)

(c) K_1, K_2 and K_3 are closed ?

(d) only K_2 and K_3 are closed ?

Sol. (a) No bulb will glow, (b) Bulb B_1 will glow, (c) B_1 and B_2 both will glow and (d) No bulb will glow.

(ii) Which bulb $B_1/B_2/B_3$ in figure (b) will glow when

(a) only K_1 is closed ?

(b) only K_2 is closed ?

(c) both K_1 and K_2 both are closed ?

Sol. (a) Bulb B_3 will glow, (b) No bulb will glow and (c) All will glow.

ELECTRICAL RESISTANCE :

The opposition offered by the conductor in the path of the current is called resistance.

S.I. Unit of Resistance :

Resistance is measured in a unit called **ohm (Ω)**. A conductor has a resistance of **1 ohm**, if a current of **1 ampere** flows through it when a potential difference of **1 volt** is applied across its ends.

So, **1 ohm = 1 volt/1 ampere**

- Larger units of electrical resistance :
  1 Kilo ohm (kΩ) = 10^3 Ω
  1 Mega ohm (MΩ) = 10^6 Ω

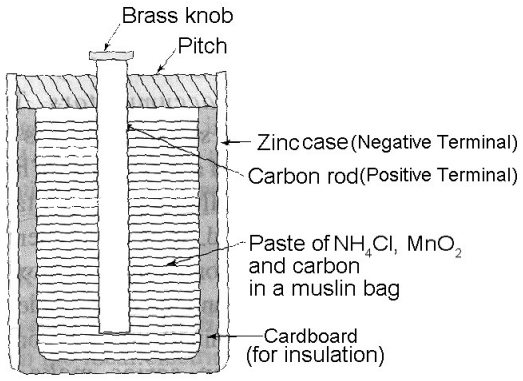
ELECTRICAL CELLS :

Electrical cells are the sources of electric current. Electrical cells are of two types primary and secondary. Voltaic, Daniel and dry cells are examples of primary cells, while Edison cell, lead-acid accumulator are example of secondary cells.

(a) Primary Cells :

The cells which cannot be charged again and again are known as primary cells.

- **Dry Cell :** The outer case of the cell is made of zinc. The cylindrical sides are covered with thick Cardboard or paper, while the bottom which is the negative terminal is bare. Inside the zinc container, is a moist paste of ammonium chloride. A carbon rod is placed at the centre of the zinc container with a brass knob protruding out at the top. This is the positive terminal of the cell. It is surrounded by a closely packed mixture of graphite and manganese dioxide in a muslin bag. The top is sealed to avoid evaporation of moisture, but leaving a small hole for the escape of ammonia gas.



A dry cell

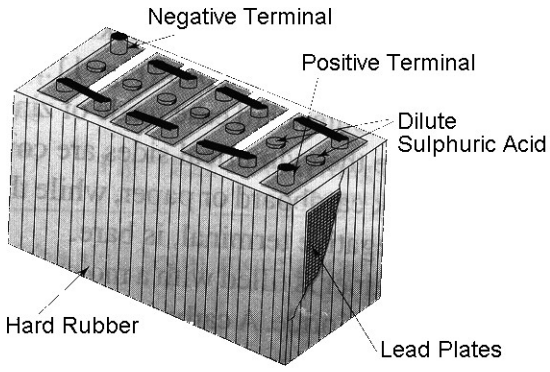
The strength of a fresh dry cell is 1.5 V. Cells of this kind which become useless once the chemicals inside them are used up are known as primary cells.

(b) Secondary Cell :

Cells which are reusable and rechargable.

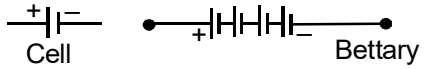
- **Lead accumulator (Reusable and rechargeable cells) :**

Some cells can be reused by recharging them from an external electrical source. Such cells are called secondary cells, storage cells or accumulators. The secondary cell is one which consists of a vessel made of a hard rubber, glass or celluloid, containing dilute sulphuric acid. It are immersed two lead grids, one containing lead dioxide (positive terminal) and the other made up of lead (negative terminal). Six such storage cells connected in series makes up your motor car battery. Each cell has a strength of about 2V, together they make up 12V. After the cell is used up, it can be recharged and reused.



DIFFERENCE BETWEEN CELL AND BATTERY :

The positive terminal of one cell is connected to the negative terminal of the next cell. Such a combination of two or more cells is called a **battery.**



Cells connected in series i.e. battery

If two cells are connected in series as in the above case, their combined strength is the sum of their respective strengths. In this case, the combined strength is **1.5 V + 1.5 V = 3 V**. Similarly, if three identical cells, each of strength **1.5 V**, are connected in series, their combined strength will be

1.5 V + 1.5 V + 1.5 V = 4.5 V

EFFECT OF ELECTRIC CURRENT :

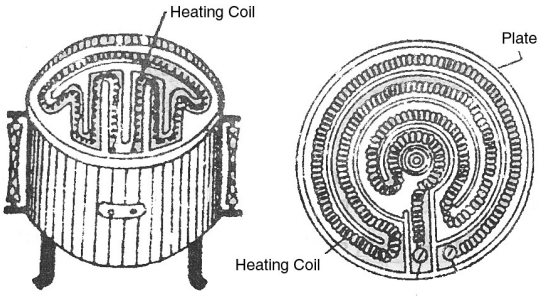
(a) Heating Effect of Electric current :

As you know, electric currents flow through a conductor. This flow experiences some resistance from the conductor. As a result some electricity changes into heat energy. Copper and aluminium offer very small amount of resistance. So, when electric currents flow through them, they produce very small amount of heat. Tungsten and nichrome offer a large resistance.

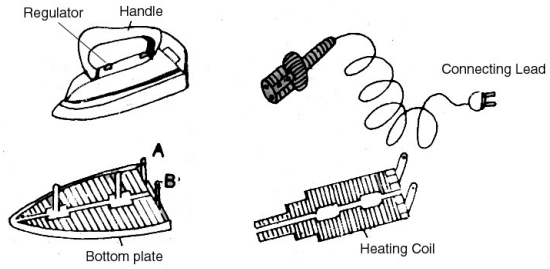
When electric current pass through them, they produce a large amount of heat. Heating effect is used in electric iron, electric heater, electric toaster, electric kettle, electric oven, geyser, etc. When electric current is passed through the heating element of these devices, heat is produced.

Example :

(i) Electric Heater :



(ii) Electric Iron :



The amount of heat produced in a wire depends on its material, length and thickness, Strength of the electric current. Thus, for different requirements, the wires of different requirements, the wires of different materials and different lengths and thicknesses are used.

The filament of an electric bulb gets heated to such a high temperature that it starts glowing.

ELECTRIC FUSE :

Fuse

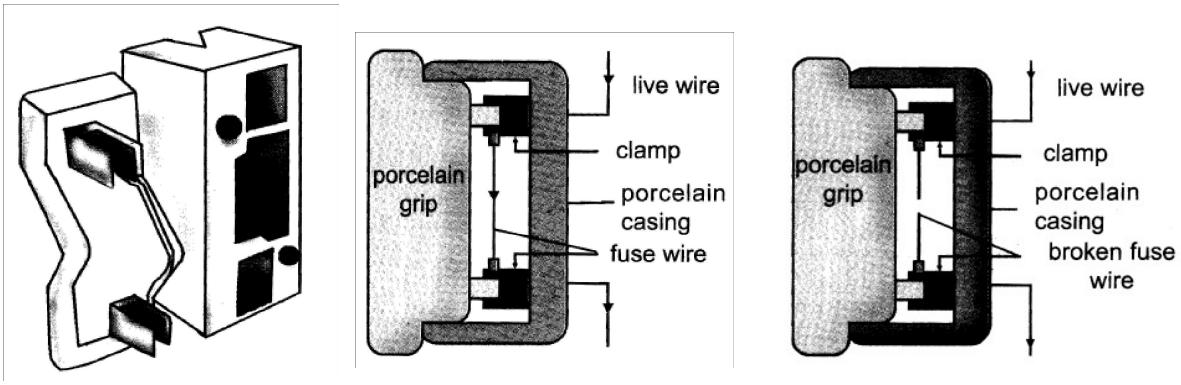
A fuse is a small piece of wire made of lead and tin It is a safety device which limits the current in an electric circuit and prevent short circuits. It is placed in the live wire at the entry point of the current. If the current in **a** circuit exceeds a specified value, the fuse wire melts and breaks the electric circuit.

The common type of fuse consists of a porcelain holder fitted with metallic terminals. The fuse wire is screwed between these terminals. The holder fits into a porcelain socket provided with a live wire. When the holder is in position, current will flow in the circuit.

Characteristics of a Fuse

• It has a short length wire with a low melting point. The fuse wire is made of an alloy containing equal amounts of lead and tin. It melts at about 200°C.

• Fuse wire has higher resistance and its temperature rises much faster than the connecting copper wire in case of overload.

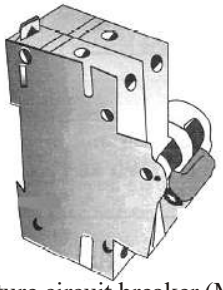


(a) Fuse (b) Fuse wire when connected (c) Broken fuse wire

Fuse wire in an electric circuit

Miniature circuit breaker (MCB)

A miniature circuit breaker (or MCB) is an alternative arrangement for fuse. The main problem with fuses is that whenever a fuse wire blows up, it needs immediate replacement. But in an MCB, we need not to face such a problem. It is placed in series in a given electric circuit. If the current exceeds the specified value, the MCB trips, i.e., puts off the switch and thus, the electric supply is cut off. It can be reset after correcting the fault.



Miniature circuit breaker (MCB)

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

SHORT AND OVERLOAD CIRCUIT :

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 due to **short circuit**.

Overload in an electric circuit, therefore, is a condition when it draws more current than it is designed for. **Short circuit** occurs when a naked live wire and a neutral wire come in contact, by passing the electric device in the circuit which in turn, occurs due to overload or the connection of the live wire with the earth wire.

Short circuiting causes a greater loss of property 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.

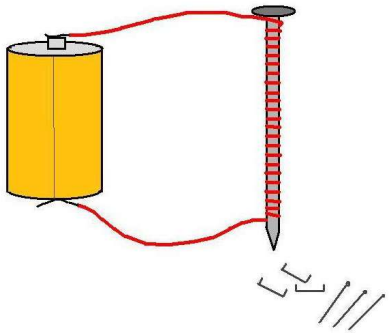
So it may be prevented by proper uses of fuse.

(b) Chemical Effect of Current (Electroplating)

When an electric current is passed through water containing sulphuric acid, the water breaks up into its components hydrogen and oxygen. Therefore an electric current can cause a chemical change. This effect of electric current is used in electroplating . **Electroplating** :The method of plating one metal object with another metal by means of electricity is called electroplating. The metal which is to be electroplated is made cathode and the metal to be deposited is made anode while the soluble salt of the same metal serves as the electrolyte. When a current is passed, a thin film of metal is deposited on the metal, which becomes electroplated.

Eg. : Let we are having a steel razor blade is to be electroplated with copper.

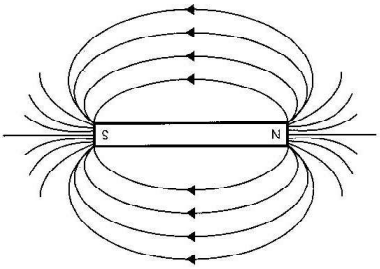
(c) Magnetic effect of electric current



According to Hans Christian Orested, magnetic effects are associated with current. It means, when electric current passes through a wire, it behaves like a magnet. This is the magnetic effect of the electric current.

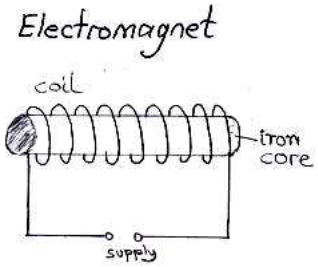
(i) Magnetic field

Let us take a card board tray through which a straight wire is passed in which current is passed. If some iron fillings are kept on to the card-board, it will arrange itself in concentric circles around the wire. Which shows that **magnetic field** is developed, when current is flowing in the wire.



In the same way, when a compass needle is placed below a current carrying conductor it deflects in a specific direction and if the direction of current changes, the direction of deflection in the compass needle also changes. That means a moving magnet can generate an electric current. Also we can say that electric current can produce a magnetic effect.

(ii) 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 otherside of the coil attract the north pole of the magnet. Thus, a current carrying coil has both north and a south pole like a magnet. Such a magnet is called electromagnet.

The electromagnet can be made very strong and can lift very heavy loads. The electromagnets are also used to separate magnetic material from the junk. Doctors use tiny electromagnets to take out small pieces of magnetic material that have fallen in the eye. The most common use of electromagnet is electrical bell.

Factors which effect the strength of electromagnet :

(A) magnetic effect of current depends on number of turns.

(B) magnetic effect of current depends on the value of current.

(C) magnetic effect of current depends on the nature of core inside the coil.

ELECTRIC BELL :

An electric bell is the most common application of electromagnets. It consists of an electromagnet, a springy iron strip, a hammer, a gong, twoswitches and connecting wires.

Construction :

(i) **Electromagnet**: A coil of wire wound on an iron core acts as an electromagnet, when current is applied.

(ii) **Armature**: An armature with a hammer at one end is kept close to the electromagnetic facing its poles.

(iii) **Interupter:** To make the bell ring continuously, a device is needed to keep the hammer moving back and forth. This devide is called an interrupter.

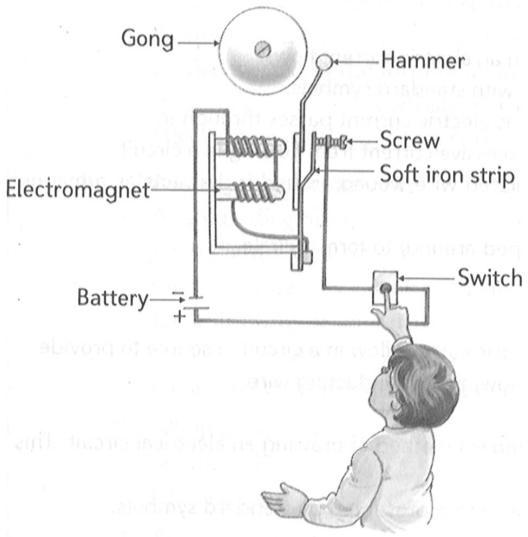


Fig. : 1

Working of Electric bell :

Step 1: When you push the switch of the bell, the electric current flows to the electromagnet.

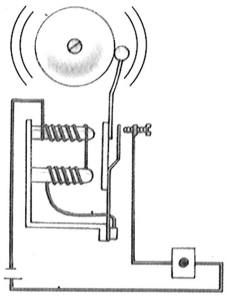


Fig. : 2

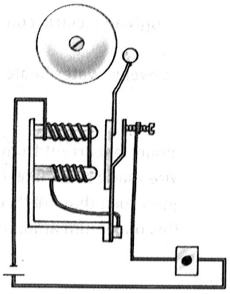


Fig. : 3

Step 2: The electromagnet attracts the soft iron strip. The hammer attached to the strip then hits the gong, causing a ring.

Step 3: When the soft iron strip gets attracted to the electromagnet, it no longer touches the screw (interrupter) and hence the circuit is broken, (much like a switch being turned off). This turns off the electromagnet and it can no longer attract the soft iron strip. The soft iron strip returns to its initial position, touching the screw (interrupter). This results in the circuit being complete, and current flows again.

Steps 1 to 3 repeat in quick succession as long as the switch is on. This is how we hear a continuous ring of the bell.

CALCULATE THE COST OF ELECTRICITY :

- **Commercial unit of electric energy : Kilowatt - hour (kWh) :**

Electric energy is required to run the electric lamps, heaters, refrigerators, televisions and other electric appliances. The department of electricity sells the electric energy to the consumers in units called kilowatt-hours (kWh). If our electricity bill shows that we have paid for 10 units, then it means the electric appliances of our house have consumed 10 kilowatt-hours. So, 1 unit = 1 kWh.
A kilowatt-hour is the amount of electric energy used by 1000 Watt electric appliance (say a heater) when it operates for one hour.

kWh is also known as "**Board of Trade Unit**" (B.O.T.)

(e) Relation between kWh and Joule :

1 kWh = 1000 Wh ($\because$ 1 kW = 1000 W)

Now1 W = 1 Js^{-1} and 1h = 60 × 60 s = 3600 s.

$\therefore$ $1\,kWh = 1000\,Js^{-1} \times 3600\,s = 3600000\,J = 3.6 \times 10^6\,J$

$\therefore$ **$1\ kWh = 3.6 \times 10^6\ J$**

Ex.3 Calculate the cost of electricity for a house in which 7 bulbs of 100 Watt each and 3 fans of 60 Watt each are used for 5 hours a day, for a period of 30 days, if the cost of one unit is Rs. 5.

Sol. Each bulb of 100W consumes 100 Watt hour of energy, when used for 1 hour.

7 bulbs of 100W each when used for 1 hour consume, $7 \times 100 = 700$ Watt hour or 700 Wh of energy.
Thus, 7 bulbs of 100W each when used for 5 hours each day consume, $700 \times 5 = 3500$ Wh or 3.5 KWh.
In this way, we can calculate the total electricity used in 30 days i.e. Total electricity consume, $[(7 \times 100) + (3 \times 60)] \times (5 \times 30) = (700 + 180) \times 5 \times 30 = 132000$ Wh = 132 KWh.
If the cost of each unit is Rs. 5.0, then the total cost = 132×5 = Rs. 660.

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, overloading (i.e. passing excess current above the rated capacity), improper earthing.

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 sole shoes should be worn while repairing electric circuit. This protect the body from electric shocks.

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

(xi) A proper earthing should be done at homes.

EXTENDED LEARNING – ACTIVITIES AND PROJECTS

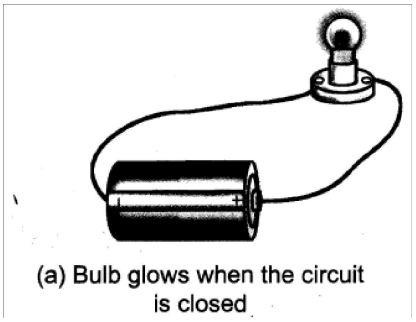
1. To make an electric circuit.

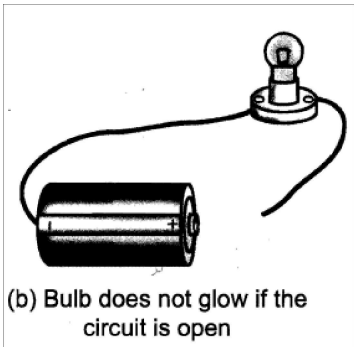
• You need a bulb, a dry cell and insulated copper wires.

• Connect the two ends of the two copper wires to the bulb and dry cell with the help of cellophane tape as shown in figure (a). What do you observe?

• You will observe that the bulb glows brightly.

• Now remove the cellophane tape from one end of the dry cell as shown in figure (b). What do you observe now? Is the bulb still glowing ?


(a) Bulb glows when the circuit is closed


(b) Bulb does not glow if the circuit is open

An electric circuit

The bulb glows only when the circuit is closed.

2. To show that copper wire gets heated when current passes through it.

• Take an insulated copper wire.

• Remove the insulation at the ends of the wire with the help of a knife or a pair of scissors.

• Now connect the two ends of the cell with the two ends of the copper wire as shown in figure.

• Disconnect the two wires from the cell after a few minutes and touch them at the two ends. Note your observations.

You will observe that the two ends of the wire become hot.

The ends of the copper wire get heated when the current passes through them for a few minutes. This shows the heating effect of electric current.

Copper wire becomes warm when connected to a cell

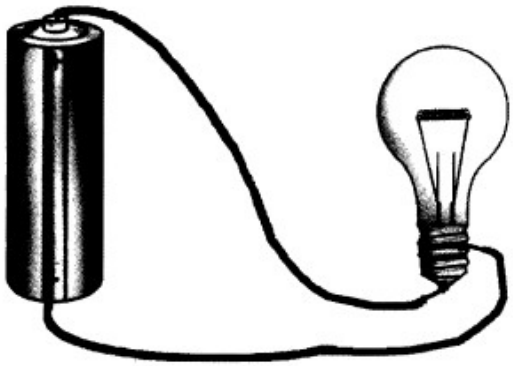
3. To show the heating effect of current on a bulb :

• Insert a bulb between the cell and the conducting copper wire as shown in figure.

• What do you observe after a few minutes? Does the end of the copper wire become warm again? No, why has the temperature not gone up? Now touch the bu'lb. Do you observe any heating effect?

You will observe that the temperature at the ends of the copper wire remains unchanged but the glass of the bulb gets heated.

The heating of the bulb in this activity shows the heating effect of current on the bulb.

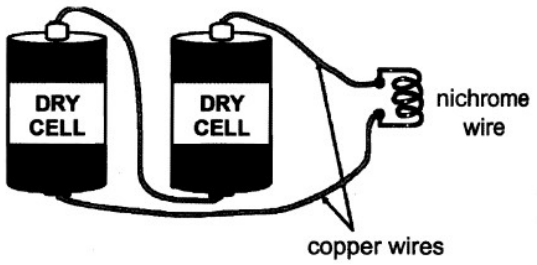


Introduction of bulb reduces the current in flow in the circuit

4. To show heating effect of current on nichrome :

Take a 5 cm long nichrome wire, make a loop of it and connect it to a battery of two cells with the help of copper wires as shown in figure. Note your observations.

You will observe that the loop of nichrome wire gets red hot.The electrical energy changes to heat energy and therefore the wire gets red hot.



Loop of nichrome becomes hot when current passes through it

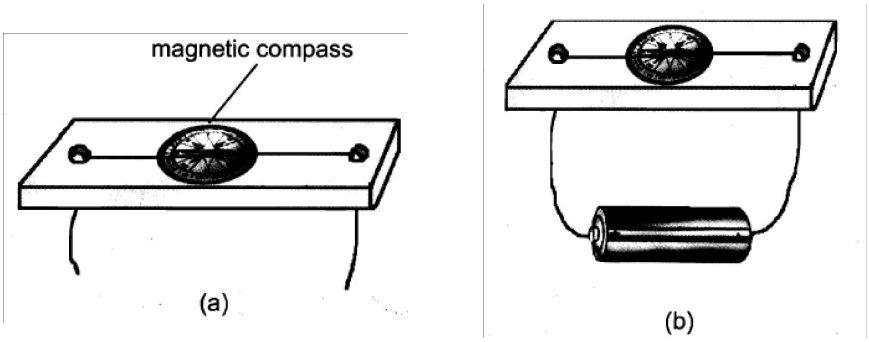
5. To show magnetic effect of electric current :

• Take a small piece of cardboard, make two holes and pass a wire through them.

• Now put a magnetic compass under the wire and rotate the cardboard till the needle of the compass comes parallel to the wire as shown in figure (a).

• Now connect the two free ends of the wire to the two terminals of a cell as shown in figure (b).
• Note your observation. Is there any deflection in the compass needle?
• Now change the connections of the wire with the cell by reversing the terminals and observe the direction of deflection. What happens when you disconnect or break the circuit?

The compass needle shows deflection when connected to the cell. This deflection gets reversed when the connection is reversed. There is no deflection upon disconnection.
The experiment shows that when electric current is passed through a conducting wire, it behaves like a magnet.

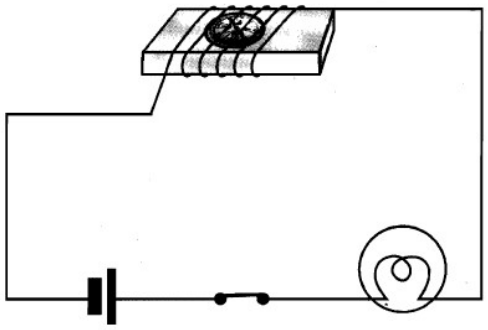


Current carrying conductor deflects the compass needle

6. To show that a magnetic field is Introduced via electric current :

You have already seen in Activity , that the compass needle deflects on passing electric current through the wire. Now loop a long wire around the compass several times as shown in figure and pass the electric current.

You will see stronger deflection in the compass needle.
The needle of the compass shows higher deflection because of the increase in number of rounds of wire around the compass.

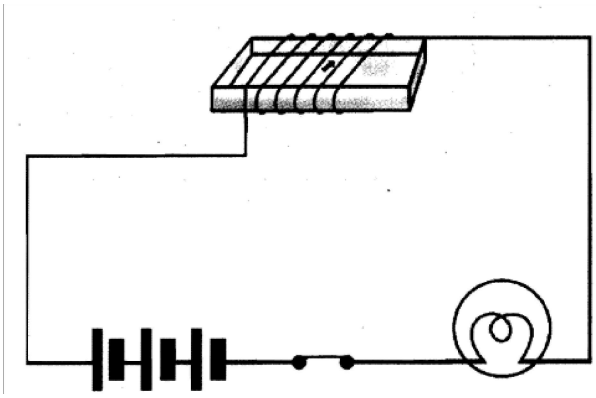


Increase in number of coils increases the magnitude of magnetic field

7. To show that the intensity/magnitude of the magnetic field increases with the increase in current intensity.

Use the arrangement of the earlier activity and connect the conducting wires to a battery of three cells of 1.5 Veach as shown in figure. Do you observe any change in the deflection of compass needle? Why?

The enhanced deflection in the compass needle is due to increase in the current density available through a battery of these cells of 1.5 Veach.

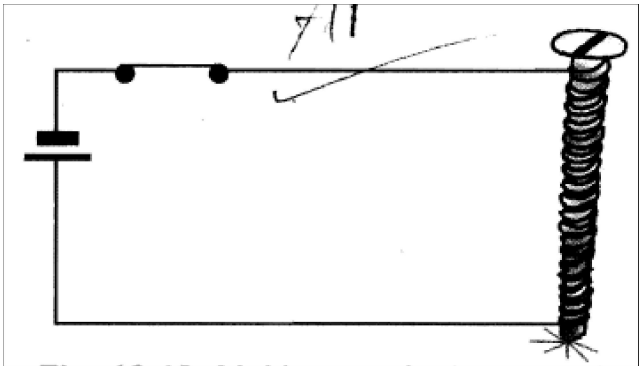


Increase in current intensity (via battery) increases the magnitude of magnetic field

8. To make an electromagnet.

- Take an iron nail of about 6-10 cm in length and wind an insulated copper wire on it
- Now connect the ends of the copper wire to the two terminals of a dry cell via a switch.
- Switch on the current through the circuit and bring a few iron pins near the wounded nail.
- Now switch off the current and see what happens.

The iron nail behaves like a magnet as long as current flows through the circuit. The pins cling to the nail when the switch is 'on' while they drop as soon as the switch disconnects the electric circuit. You can see an enhanced magnetic field (more pins cling to the nail) if you use a battery in place of a cell.

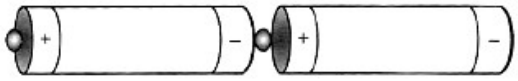


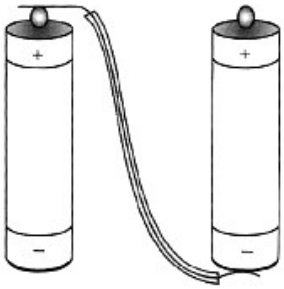
Making an electromagnet

❑❑❑❑❑

LET US RECAPITULATE

1. When two or more cells are joined together, it is called battery. Whether cells are put in the cell holder in a line or in parallel, we must join the (+ve) terminal of one cell to the (–ve) terminal of the other cell.





2. Heating effect of electric current :

(i) When an electric current flows through a wire, the wire gets heated. It is the heating effect of electric current. This effect has many applications e.g., an electric room heater or an electric heater used for cooking, an electric iron.

(ii) The appliances mentioned above contain a coil of wire. This coil of wire is called an element. When these appliances are switched on, after connecting to the electric supply, their elements become red hot and give out heat.

(iii) The amount of heat produced in a wire depends on its material (metal), length and thickness. Thus for different requirements, the wires of different materials and different lengths and thickness are used.

(iv) **MCBs (Miniature Circuit Breakers) :** These are switches which automatically turn off (tripping) when the current in a circuit exceeds the safe limit. It is the perfect replacement of fuse. MCB is easy to use and safe.

3. Magnetic effect of current :

(i) When an electric current flows through a wire, it behaves like a magnet. This is the magnetic effect of electric current.

(ii) **Electromagnets :** A current carrying coil of an insulated wire wrapped around a piece of iron behaves like a magnet and is called an electromagnet. Electromagnets are used in many devices such as cranes, electric bell, etc.

KEYWORDS :

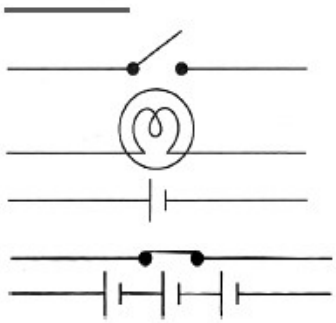
1. **Battery:** When two or more cells are joined together, it is called battery.
2. **Electric components:** Various components of an electric circuit, like cell, wires, switch, bulb, etc., are called electric components.
3. **Circuit diagram :** It is symbolic representation of an electric circuit.
4. **Electric bell :** An electric bell has an iron piece around which a coil of wire is bound. The iron piece has a hammer at one end. On passing current and by pressing button, the iron piece turns into a temporary electromagnet. The hammer i.e., attached with the rion piece, is attracted towards the gong of the bell and bang on it, to produce a sound.
5. **Electromagnetism :** A current carrying coil of an insulated wire wrapped around a piece of iron is called an electromagnet. Electromagnets are used in many devices such as cranes, electric bell, etc.
6. **Electric fuses :** Wire made from som special materials melt quickly and break when large electric currents are passed through them. These materials are used for making electric fuses which prevent fires and damage to electric appliances.
7. **Heating effect of current :** When an electric current passes through a wire, the wire gets heated. This is called the heating effect of current.

CONCEPT APPLICATION LEVEL - I [NCERT Questions]

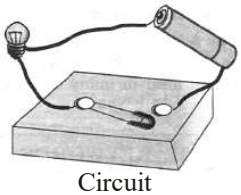
Q.1 Draw in your notebook the symbols to represent the following components of electrical circuits connecting wires, switch in the OFF position, bulb, cell, switch in the ON position and battery.

Ans.

	Name of electric component	**Symbol**
1.	Connecting wire	
2.	Switch the OFF position	
3.	Bulb	
4.	Cell	
5.	Switch in the ON position	
6.	Battery	

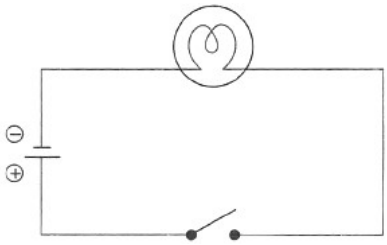


Q.2 Draw the circuit diagram to represent the circuit shown in Fig.

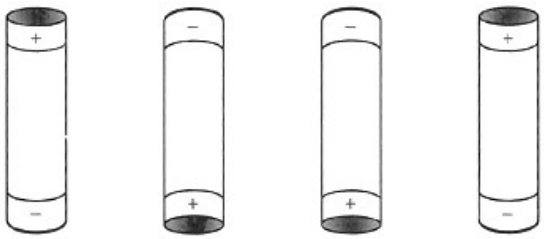


Circuit

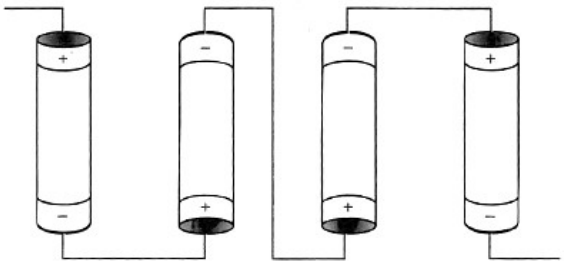
Ans.



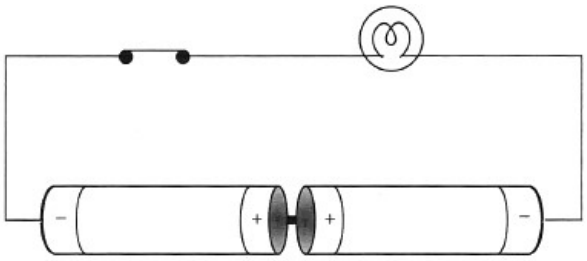
Q.3 Figure shows four cell fixed on a board. Draw lines to indicate how you will connect their terminals with wires to make a battery of four cells.



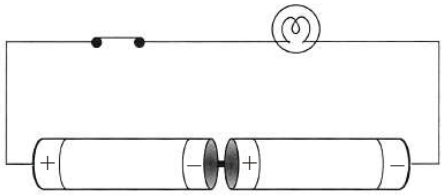
Ans.



Q.4 The bulb in the circuit shown in Fig. does not glow. Can you identify the problem? Make necessary changes in the circuit to make the bulb glow.



Ans. The problem in this circuit is the connection of two cells. Here both the positive terminals of the cells are connected to each other. This must be reversed for any one cell to make the bulb glow i.e., positive terminal of one cell should be connected with the negative terminal of the other.



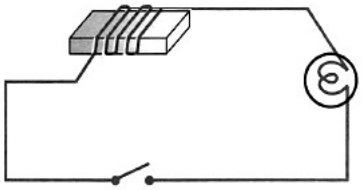
Q.5 **Name any** two **effects of electric current**.

Ans. (i) Heating effect. (ii) Magnetic effect.

Q.6 When the current is switched on through a wire, a compass needle kept nearby gets deflected from its north-south position. Explain.

Ans. We know that the needle of a compass is itself a tiny magnet, which points in north-south direction. When we bring a magnet close to it, the needle gets deflected. When electric current passes through a wire it also behaves like a magnet. And hence the needle of the compass will also be deflected.

Q.7 Will the compass needle show deflection when the switch in the circuit shown by Fig. is closed?



Ans. No. Because there is no cell/battery in the circuit and hence no current will flow through the wires.

Q.8 Fill in the blanks:

(a) Longer line in the symbol for a cell represents its ..... terminal.

(b) The combination of two or more cells is called a .....

(c) When current is switched 'on' in a room heater, it .....

(d) The safety device, based on the heating effect of electric current is called a.....

Ans. (a) positive (b) battery (c) becomes red hot (d) fuse

Q.9 Mark "T" if the statement is true and 'F' if it is false:

(a) To make a battery of two cells, the negative terminal of om cell is connected to the negative terminal of the other cell.

(b) When the electric current, through the fuse exceeds a certain limit, the fuse wire melts and breaks.

(c) An electromagnet does not attract a piece of iron.

(d) An electric bell has an electromagnet.

Ans. (a) False (b) True (c) False (d) True

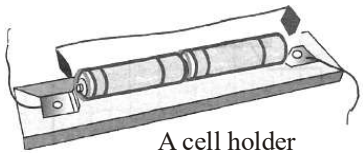
Q.10 Do you think an electromagnet can be used for separating plastic bags from a garbage heap? Explain.

Ans. No. An electromagnet develops magnetic property and it will attract only the magnetic substances. Since the plastic bags are non-magnetic so they cannot be separated from a garbage heap by an electromagnet.

Q.11 An electrician is carrying out some repairs in your house. He wants to replace a fuse by a piece of wire. Would you agree? Give reasons for your response.

Ans. No, I will not agree. Electric fuse is made from some special material which blows off when the current exceeds the safe limit, while an ordinary wire may not perform this function and will cause damages to electrical circuits and appliances and also can cause fires. Hence I will insist to use proper fuse wire carrying ISI mark.

Q.12 Zubeda made an electric circuit using a cell holder shown in the following Fig., a switch and a bulb. When she put the switch in the 'ON position, the bulb did not glow, Help Zubeda in identifying the possible defects in the circuit.



A cell holder

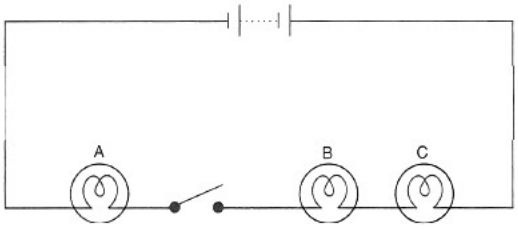
Ans. Defects may arise at following paints:

(i) The cell may be connected in improper way. Check out that the positive terminal of one cell is connected to the negative terminal of the other or pot.

(ii) The junctions of the wire may be loose. Check them again.

(iii) Check the condition of the bulb. Replace it, if it is fused.

Q.13 In the circuit shown in the following Fig.:



(i) Would any of the bulb glow when the switch is in the 'OFF" position?

(ii) What will be the order in which the Bulbs A, B and C will glow when the switch is moved to the 'ON' pssition?

Ans. (i) No. None of the bulbs will glow unless the switch is in the 'ON' position.

(ii) All the three bulb will glow at the same time as far the capacity of the battery is concerned.

CONCEPT APPLICATION LEVEL - II

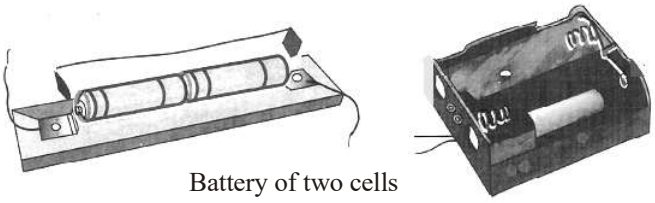
Symbols of Electric Components :

Q.1 What is meant by a. battery?

Ans. When two or more cells are joined together, it is called, a battery.

Q.2 How will you construct a battery?

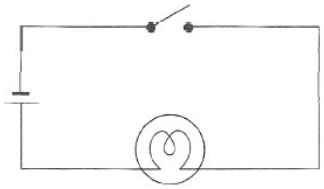
Ans. Battery is a combination of two or mere cells. This can be prepared by placing two or more electric cells properly in a cell holder, such that the positive terminal of one cell is connected to the negative terminal of the other. A piece of wire is connected to each of the two metal clips on the cell holder as shown in the figure.



Battery of two cells

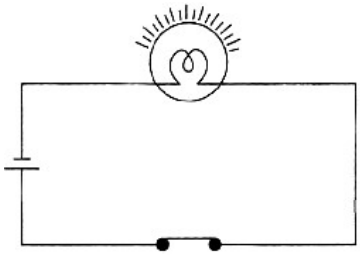
Q.3 What is an open circuit with respect to on-off switch ?

Ans. When the switch is in the OFF position, the circuit is incomplete. It is said to be open. No current flows through any part of the circuit. The bulb will not glow in this situation.



Q.4 What is a closed circuit with respect to the on-off switch ?

Ans. When the switch is in the 'ON' position, the circuit from the positive terminal of the battery to the negative terminal is complete. The circuit is then said to be closed and the current flows throughout the circuit instantly and the bulb starts glowing.



Q.5 What is filament ?

Ans. In the bulb, there is a thin wire, called the filament, which glows when an electric current passes through it. When the bulb gets fused, its filament is broken.

Q.6 At which position in a circuit the key or switch is placed ?

Ans. The key or switch can be placed anywhere in the circuit.

Q.7 What would be the states of an electric circuit if the filament of the bulb is broken?

Ans. If the filament of a bulb is broken, the circuit will not be completed and the bulb will not glow.

Heating Effect of Electric Current :

Q.1 On which effect of electric current does electric iron works ?

Ans. Heating effect of electric current.

Q.2 How does the electric room heater or an electric iron work?

Ans. The wires get hot when an electric current passes through them. An electric room heater or immersion heater, geysers, electric kettles, hair dryers, contain a coil of wire. This coil of wire is called an element. When these appliances are switched 'ON' after connecting to the electrical supply, their elements become red hot and give out heat.

Q.3 Name the device used in our hourses which protects damages to electrical circuits when current exceeds the safe limit accidentally.

Ans. Fuse or MCB (Miniature Circuit Breakers).

Q.4 On what factors does the heat produced in a wire depend ?

Ans. The amount of heat produced in a wire depends on its material, length and thickness.

Q.5 Define CFL.

Ans. An electric bulb is used for light but it also gives heat. This is not desirable. This results in the wastage of electricity. Fluorescent tube lights and **Compact Fluorescent lamps (CFLs)** reduce wastage.

Q.6 Why fluorescent tube lights and compact fluorescent lamps (CFLs) are preferred than ordinary electric bulbs ?

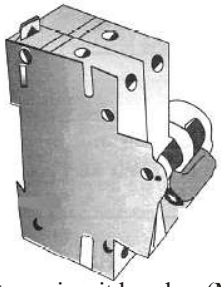
Ans. An electric bulb is used for light but it also gives heat. This is not desirable. This results in wastage of electricity. This wastage can be reduced by using fluorescent tube lights in place of the bulbs. Compact fluorescent lamps (CFLs) also reduce wastage and can be fixed in the ordinary bulb holders.

Q.7 What is an electric fuse? What is its importance ?

Ans. A fuse is a safety device, which prevents damages to electrical circuits and possible fires.
In all buildings, fuses are inserted in all electrical circuits. These is a maximum limit of the current which can safely flow through a circuit. If by accident the current exceeds this safe-limit, the wires may become overheated and may cause fire. If a proper fuse is there in the circuit, it will blow off and break the circuit as safety measure.

Q.8 What are 'MCBs'?

Ans. Instead of fuses, these days miniature circuit breakers or MCBs are used in our homes and offices. These are switches which automatically turn off when current in a circuit exceeds the safe limit. We turn them 'ON' and the circuit is once again complete.



Miniature circuit breaker (MCB)

Q.9 What is the use of MCBs?
Ans. MCBs are the switches which automatically turn off, when current in a circuit exceeds the safe limit.

Q.10 Give the source for electric current in our houses.
Ans. In our homes, we draw electric current from main switch, which in turn receives the electric current from power stations. Power station ultimately receives it from power plants.

Q.11 What precautions must be taken when using fuses?
Ans. One should take the following precautions when using fuses:
(i) Always use proper fuses which have been specified for particular applications, carrying ISI mark.
(ii) Never use just any wire or strip of metal in place of a fuse.

Magnetic Effect of Electric Current :

Q.1 Who discovered the magnetic effects of electric current?
Ans. Hans Christian Oersted.

Q.2 What do you mean by magnetic effect of current?
Ans. When electric current passes through a wire, it behaves like a magnet. This is called magnetic effect of current.

Q.3 Name some devices based on the magnetic effect of electric current.
Ans. Crane, electric bell, loudspeaker, telephone, etc.

Electromagnet :

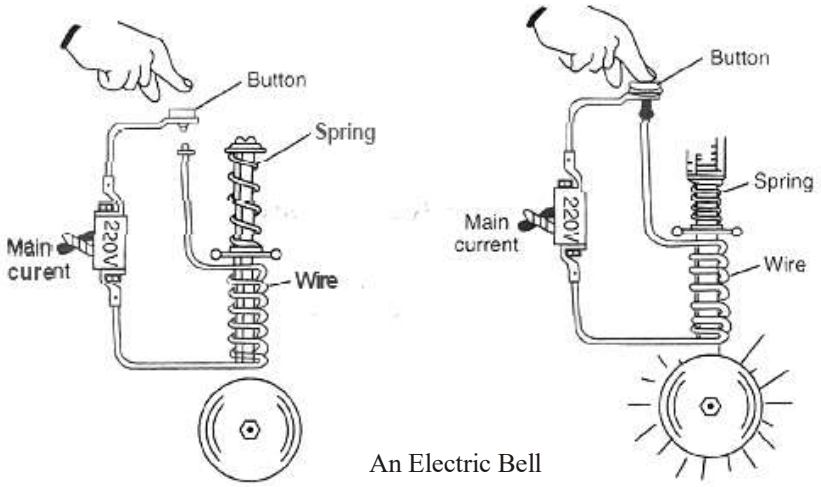
Q.1 What is an electromagnet ? Give applications of electromagnets.
Ans. When an electric current is passed through a coil of wire, it behaves like a permanent magnet. One end of the coil acts as a north pole and the other end acts as a south pole. When the current is stopped, the magnetic properties of the coil vanishes. Such a magnet is called electromagnet.
Electromagnets find wide applications. The important -applications are:
(i) They are used in cranes to lift heavy loads of swap iron or iron sheets.
(ii) They are used in electric bells, telegraphs, telephones, speakers, etc.
(iii) They are used to separate magnetic material from the junk.
(iv) They are used by doctors to take out small pieces of magnetic material that have accidently fallen in the eye.

Q.2 How will you show that a wire carrying current produces magnetism?
Ans. (i) To show that a wire carrying current produces magnetism, we fix a wire on a table with its two ends attached to a battery. Bring a compass needle near it. We will find that the needle deflects differently at varying distances.
(ii) Take a horse shoe magnet suspend a thick metallic wire between its poles with leads of wire attached to a battery. You will find that magnet exerts force on wire and makes it move.
These two experiments show that a wire carrying current, produces magnetism.

Electric Bell :

Q.1 How does an electric bell work?

Ans. An electric bell has an iron hammer around which a wire is wound. On passing by pressing button, the iron hammer turns into temporary magnet. The hammer is attracted towards the bell and bang on it to produce sound. When this strikes, the current is disconnected automatically. It happens due to shift arrangement in it. The magnetic property of wire is lost and it comes back to its original position through a spring. This way, we get hammering in quick succession resulting in ringing of an electric bell.



An Electric Bell

Q.2 You are provided four electromagnets with 20, 40, 60, 80 turns. Which electromagnet will have maximum strength ? Give reason.

Ans. Electromagnet with 80 turns will have maximum strength because strength depends on number of turns.

CONCEPT APPLICATION LEVEL - III

Section–A

Match the items in Column-I with Column-II :

Q.1

	Column-I		Column-II
(i)	Switch	(a)	Coil of wire which heats up when electric current is supplied.
(ii)	Battery	(b)	Blow off, if the current exceeds safe limit.
(iii)	Element	(c)	Consumes less energy than a bulb.
(iv)	Filament	(d)	Mark that ensures that the electric appliance is safe to handle.
(v)	Fuse	(e)	Supplies current to the circuit
(vi)	MCBs	(f)	Turns the circuit ON and OFF
(vii)	CFL	(g)	Turns OFF if current exceeds safe limit
(viii)	ISI	(h)	Wire in the bulb which glows

Section–B

Fill in the blank space in the following statements:

Q.1 Battery is the combination of .....

Q.2 In a battery positive terminal of one cell is connected to the ..... terminal of the next cell.

Q.3 In an electric circuit, the bulb glows only when the switch is in the ..... position.

Q.4 In the electric bulb, there is a thin wire, called ..... which glows when an electric current is passed.

Q.5 The coil of wire in an electric heater is called an .....

Q.6 A ..... is a safety device which prevents damages to ebctrical circuits and possible fires.

Q.7 The wire gets ..... when an electric current passes through it.

Q.8 We must look for ..... mark on electrical applianees.

Q.9 When electric current passes through a wire, it behaves like a magnet. It is the ..... effect of current.

Q.10 Crane has a strong ..... attached to it.

Section–C

Choose the true and false statements from the following :

Q.1 It is convenient to represent electric components by symbols.

Q.2 A connecting wire is symbolized by a zig-zag line in the circuit diagram.

Q.3 When an electric current flows through a wire, the wire gets heated.

Q.4 The key or switch can be placed anywhere in the circuit. . .

Q.5 The amount of heat produced in a wire depends on its material, length and thickness.

Q.6 CFLs consume more electricity than ordinary bulbs.

Q.7 For different requirements, the wires of different materials, different lengths and thicknesses are used.

Q.8 A fuse is used to save energy in electrical circuits.

Q.9 MCBs are the switches which automatically turn off when current in a circuit exceeds the safe limit.

Q.10 When an electric current flows through a wire, it behaves like a magnet.

Section–D

Choose the correct option in the following :

Q.1 In making a battery
(A) positive terminal of one cell is connected to the negative terminal of the next cell
(B) positive terminal of one cell is connected to the positive terminal of the next cell
(C) negative terminal of one cell is connected to the negative terminal of the next cell
(D) none of the above

Q.2 Where can the key or switch be placed in the circuit?
(A) Left side of the battery (B) Right side of the battery
(C) Can be placed anywhere in the circuit (D) Near the positive &rminal of the bulb

Q.3 Which one of the following is based on the heating effect of current ?
(A) Geyser (B) Hair dryer
(C) Immersion rod (D) All of these

Q.4 The coil of wire contained in an electric heater is known as
(A) component (B) element (C) circuit (D) spring

Q.5 The amount of heat produced in a wire depends on
(A) material (B) length (C) thickness (D) all of these

Q.6 Which mark is necessary on electric appliances?
(A) AGMARKS (B) ISI (C) FICCI (D) KSK

Q.7 What is the full form of MCBs?
(A) Maximum Current Breakers (B) Minimum Current Breakers
(C) Miniature Current Breakem (D) Miniature Circuit Breakers

Q.8 Which device is used to prevent damages to plectrical circuits and possible fires?
(A) Fuse (B) MCBs (C) Both (A) and (B) (D) None of these

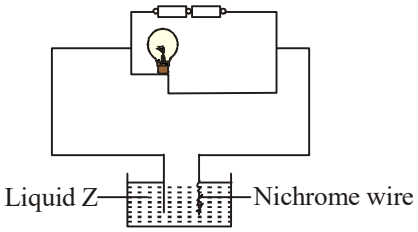
Q.9 Who discovered magnetic effect of current?
(A) H.C.Oersted (B) Michael Faraday (C) Flemming (D) Ohm

Q.10 Which effect of current is used in an electric bell?
(A) Heating effect (B) Magnetic effect (C) Chemical effect (D) None of these

Section–E

Objective Type Questions

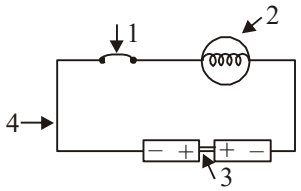
zQ.1 Radha set up a circuit as shown. At the end of the experiment, she concluded that liquid Z is a conductor of electricity. Which of the following led her to such a conclusion ?



(i) The nichrome wire turns red hot
(ii) The bulb lights up
(A) (i) only (B) (ii) only (C) (i) and (ii) (D) None of these

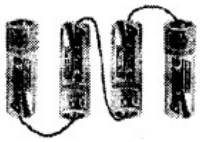
Q.2 When the switch of an electric bell is pushed :
(A) Flow of current stops through the electromagnet in the bell
(B) A current starts to flow through the electromagnet
(C) Electromagnet becomes inactive
(D) None of these

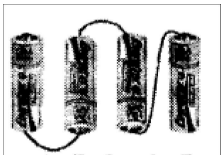
Q.3 The bulb in the circuit given here does not glow. Which labelled part is responsible for this ?

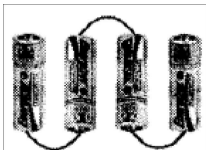


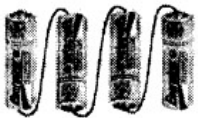
(A) 1 (B) 2 (C) 3 (D) 4

Q.4 The given figure shows four cells fixed on a board. The correct connection of their terminals to make a battery of four cells is _____

(A) 

(B) 

(C) 

(D) 

Q.5 A current carrying coil of an insulated wire wrapped around a piece of iron is called _____ .
(A) An electric cell (B) An electromagnet (C) An electric wire (D) None of these

Q.6 When an electron moves from negative electrode to positive electrode,
(A) Negative charge moves from negative electrode to positive electrode
(B) Positive charge moves from positive electrode to negative electrode
(C) No charge flows from either electrode to other electrode
(D) Both (A) and (B)

Q.7 A switch is used to turn an appliance on and off. Which is the safest position for the switch ?

(A) On the live wire (B) On the neutral wire

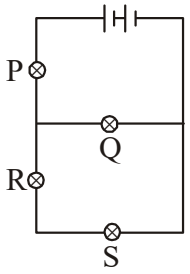
(C) On the heating element (D) On the earth wire

Q.8 Bulb does not glow when the probs are hanged in air. The reason is _____ .

(A) Air absorbs the electricity (B) Air is a bad conductor of electricity

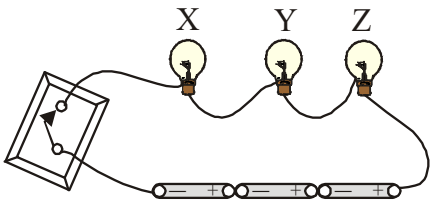
(C) Electricity is discharged into air (D) Air disperses the electricity

Q.9 A battery lights up all the four lamps as shown in figure. When one of the lamp filament melts, the other three lamps stay on. Which of the following lamp filaments melt ?



(A) P (B) Q (C) R (D) S

Q.10 Three bulbs X, Y and Z are connected in a circuit as shown in figure. When the switch is put on, then



(A) All the bulbs will glow at the same time

(B) Bulbs will glow in the order of X, Y and Z

(C) Bulb X will glow first whereas bulbs Y and Z will glow simultaneously after some time

(D) Bulb Z will glow first

Q.11 Marking on a bulb is 60 W, 220 V. What does it signify ?

(A) The bulb is connected across the 220 volts, 60 joules of energy is consumed for every second.

(B) The bulb is connected across 60 joules, 220 volts of energy is consumed

(C) 60 unit of current will flow in the bulb

(D) 220 unit of current will flow in the bulb

Q.12 An electric kettle is plugged in and switched on. The fuse in the plug blows immediately. Which single fault could cause this ?

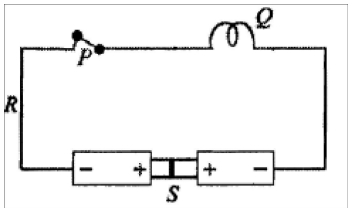
(A) The earth wire is not connected to the kettle

(B) The line wire and neutral wire connections in the plug are swapped around

(C) The line wire touches the metal case of the kettle

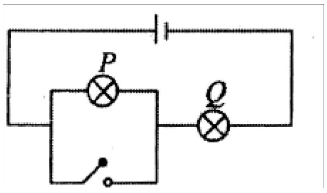
(D) The wires connected to the plug are too thin.

Q.13 The bulb in the circuit given here does not glow. Which labelled part is responsible for this ?



(A) P and S
(B) P only
(C) R only
(D) S only

Q.14 The given figure shows a circuit which contains two identical lamps. When the switch is closed, which of the following statements best describes, what happened to lamp P and Q ?



(A) P is brighter than before, but Q does not light up.
(B) P does not light up, but Q is brighter than before
(C) Both P and Q are brighter than before
(D) P and Q both will not light up

Q.15 bulb 1 and bulb 2 are connected in series as shown in the given figure (i). What will happen to the brightness of these two bulbs when a third identical bulb is connected across bulb 1 as shown in the given figure (ii) ?

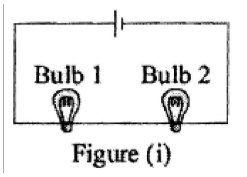


Figure (i)

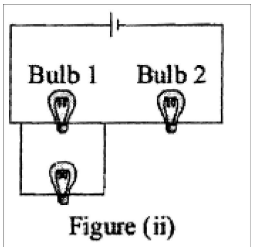


Figure (ii)

	Bulb-1	**Bulb-2**
(A)	Brighter	Brighter
(B)	Brighter	Dimmer
(C)	Dimmer	Dimmer
(D)	Dimmer	Brighter

ANSWER KEY

CONCEPT APPLICATION LEVEL - III

Section–A

Q.1 (i) f (ii) e (iii) a (iv) h (v) b (vi) g (vii) c (viii) d

Section–B

Q.1	Cells	Q.2	Negative	Q.3	ON	Q.4	Filament
Q.5	Element	Q.6	Fuse	Q.7	Hot	Q.8	ISI
Q.9	Magnetic	Q.10	Electromagnet				

Section–C

Q.1	True	Q.2	False	Q.3	True	Q.4	True
Q.5	True	Q.6	False	Q.7	True	Q.8	False
Q.9	True	Q.10	True				

Section–D

Q.1	A	Q.2	C	Q.3	D	Q.4	B	Q.5	D
Q.6	B	Q.7	D	Q.8	C	Q.9	A	Q.10	B

Section–E

Q.1	C	Q.2	B	Q.3	C	Q.4	A	Q.5	B
Q.6	D	Q.7	A	Q.8	B	Q.9	B	Q.10	A
Q.11	A	Q.12	C	Q.13	D	Q.14	B	Q.15	D

Notes