LONG QUESIONS

14.1 Electric Current

Q.1 Define and explain the term electric current (14.1).

Ans: Definition:

"The rate of flow of electric charges through any cross-sectional area is called current."

Mathematically:

If charges 'Q' is passing through any area in time 't' the current 'I' flowing through it will be given as"

$$\text{current} = \frac{\text{charge}}{\text{time}}$$

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

Unit: SI unit of current is Ampere (A)

Ampere:

One ampere is the amount of electric current due to the flow of electric charge at the rate of one coulomb per second.

$$1A = \frac{1\text{COLOUMB}}{1\text{second}} = \frac{1c}{1s}$$

Flow of current through a conductor

Consider a conductor in form of a copper wire. It has a large number of free electrons which are in random motion just like the molecules of a gas confined in a container. Their movement does not obey any symmetry but they move in all directions.

Motion of free electrons in absence of electric field

In absence of an electric field, rate at which the free electrons cross any section of the wire from right to left is equal to the rate at which they cross from left to right with the result that the net rate is zero.

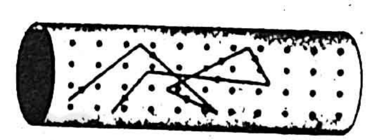


Fig. 16.3

So in-spite of the fact that electrons are in motion, no current flows through any section of the conductor.

Motion of free electrons in presence of electric field

If one end of the copper wire is connected with positive terminal of a battery and other with its negative terminal, an electric field E is established at each point of wire. Now the free electrons, because of their negative charge, experience a force in a direction opposite to the direction of electric field E.

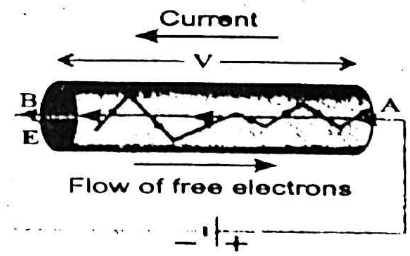


Fig. 16.4

Because of this force a net directed flow of free electrons takes place from the negative terminal of the battery towards its positive terminal and an electric current begins to flow through the wire from the positive terminal towards the negative terminal of the battery.

Direction of flow of current

The current flow due to negative charges has been changed with conventional current. This current flows in the wire from positive to negative terminal of the battery i.e., current flows from a point of higher potential to a point of lower potential

Current in solutions (electrolyte)

In case of electrolyte its molecules in aqueous solution dissociate among positive and negative ions. So current in electrolyte is produced due the flow of both positive and negative charges.

Q.2 Explain battery as source of energy (14.1)

Battery is one of the sources of current. The electrochemical reaction inside a battery separates positive and negative electric charges as shown in fig.

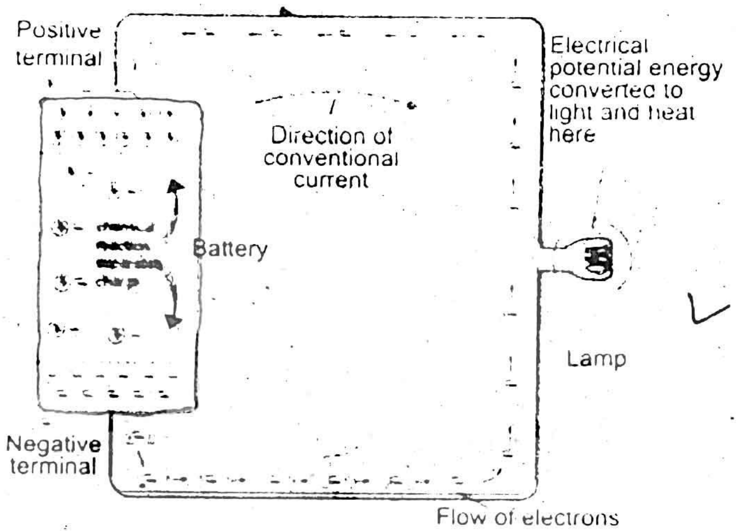


Fig.14.1: Schematic diagram of battery as a current source

This separation of charges set up potential difference between the terminals of the battery. When we connect a conducting wire across the terminals of the battery, the charges can move from one terminal to the other due to the potential difference.

Potential energy per unit charge:

The chemical energy of the battery changes to electrical potential energy. The electrical potential energy decreases as the charges move around the circuit. This electric potential energy can be converted to another useful forms of energy (heat, light, sound etc.) it is only the energy which changes form but the number of charge carriers and the charge on each carrier always remains the same (i.e. charge are not used up.) instead of electrical potential energy we use the term electrical potential which is potential energy per unit charge.

Q.3 Define and explain the term conventional current (14.1).

Ans: Definition

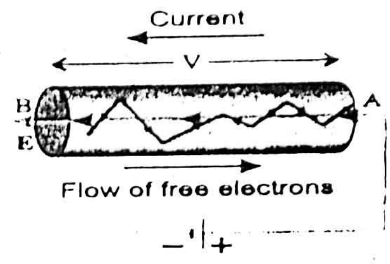
"Current flowing from positive to negative terminal of battery due to flow of positive charges is called conventional current."

Convential mean

Before the idea of free electrons which constitute in metals, it was thought that current in conductors flowed due to motion of positive charges. Therefore, this convention is still in used.

Explanation

When the ends of a copper wire are at different temperatures, heat energy flows from one end of higher temperature to the end of lower temperature. The flow stops when both ends reach the same temperature. Water in pipe also flows in a pipe from high level to low level. Similarly when a conductor is connected to a battery, it pushes positive charges to flow current from high potential to low potential as shown in fig.



The flow of current continues as long as there is a potential difference. Conventional current produces the same effect as the current flowing from negative terminal to the positive terminal due to flow of negative charges.

Q.4 How we can detect and measure the electric current (14.1)?

Ans: We use different electrical instruments which can detect and measure the current in the circuit.

1. **Galvanometer:**

"Galvanometer is a device which is used to detect the presence of electric current in any circuit."

ii. **Ammeter:**

"Ammeter is a device which is used to measure the current in any circuit."

Importance of Galvanometer

Galvanometer is very sensitive instruments and can detect small current. A current of few milli amperes is sufficient in it. Ideal galvanometer should have very small resistance to pass the maximum current in the circuit.

Polarity of galvanometer

While making the connections polarity of the terminals of the galvanometer should be taken into consideration. Generally the terminal of the galvanometer with red colour shows the positive polarity while that of with black colour shows negative polarity.

How Ammeter is formed?

After suitable modification galvanometer can converted into an ammeter. A suitable but small resistance is connected in parallel to the galvanometer, this circuit is called ammeter. A large current of the range such as 1A or 10 A can be measured by means of ammeter, like galvanometer ammeter is also connected in series, so that the current flowing in the circuit also passes through the ammeter.

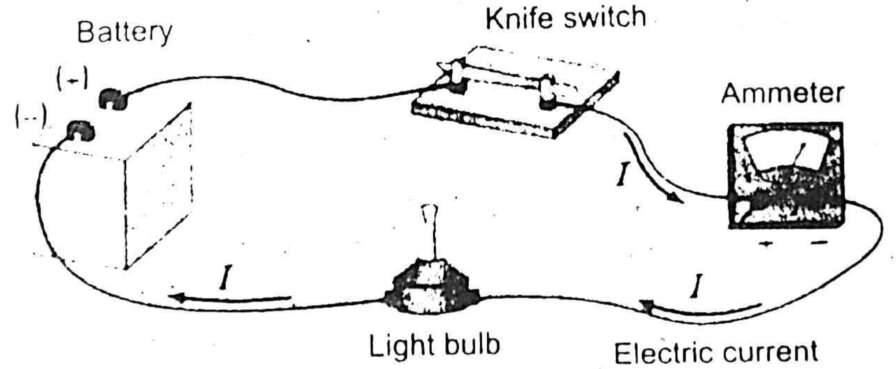


Fig. 14.5: Schematic diagram showing the measurement of current

14.2 and 14.3 Potential Difference and e.m.f

Q.5: Define and explain the potential difference (14.2).

Ans: Definition:

"Potential difference across the two ends of a conductor causes the dissipation of electrical energy into other forms of energy as charges flow through the circuit.

Explanation:

When one end A of conductor is connected to the positive terminal and its other end B is connected to the negative terminal of the battery then the potential of A becomes higher than the potential of as shown in figure.

This cause a potential difference between the two ends of the conductor. The flow of current continues as long as there is a potential difference. The agent which provides the steady flow of current in the copper wire is the battery. As the current flows form higher potential to the lower potential through the conductor, the electrical energy (due to current) is converted into to other form i.e. heat and light etc.

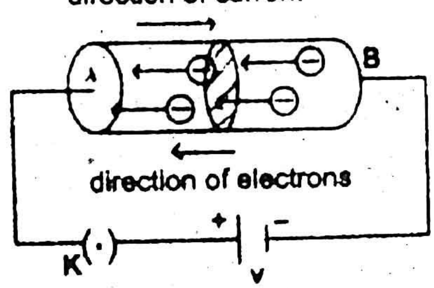


Fig.14.6

When current flows through the conductor, it experiences a resistance in the conductor. The energy supplied by the battery is utilized in overcoming this resistance and is dissipated as heat and other form of energy. The dissipation of this energy is accounted for by the potential difference across the two ends of the conductor (light bulb)

SI unit of potential difference is volt.

A potential difference of I volt across a bulb means that each coulomb of charge or 1 ampere of current that passes through the bulb consumers 1 joule of energy. When a bulb is lit, the energy is taken from the current and is transformed into light and heat energy.

Q.6 What is mean by electromotive force? Write its equation and explain its unit.(14.3)

Ans: **Definition of e.m.f**

"It is the energy converted form non-electrical form when one coulombs of positive charge passes through the battery".

OR

"it is the energy supplied by a battery to a unit charge when it flows through the closed circuit".

Equation:

$$\text{emf} = \frac{\text{energy}}{\text{charge}}$$

$$E = \frac{W}{Q}$$

Where 'W' is energy converted from non-electrical forms to electrical form and 'Q' is a positive charge.

Unit of e.m.f

SI units of energy and charge are Joule and coulomb, then the unit of em.f will be JC^{-1} i.e.

$$\text{emf} = \frac{\text{energy}}{\text{charge}}$$

$$= JC^{-1}$$

$$\text{e.mf} = \text{volt}$$

Hence if the e.m.f of the battery is 2V, the total energy supplied by the battery is 2 Joules when one coulombs of charge flows through the closed circuit.

Explanation

Sources of e.m.f

Batteries, thermocouples and generators are the best examples of the sources of e.m.f When a conductor is connected to battery current flows through it due to potential difference. A source of electromotive (e.m.f) converts non-electrical energy (chemical, thermal, mechanical into electrical energy.

How do charges move a circuit?

Battery supplies energy to the charges for continuous flow of current. The positive charges leave the positive terminal of the battery, pass through the conductor and reach the negative terminal of the battery. As this positive charge enters the battery at its lower potential point (negative terminal), the battery must supply energy, say W to the positive charge derive it to appoint of higher potential (positive terminal).

Q.7 How we measured the potential difference and e.m.f across a circuit?(14.3),

Ans: The Measurement of potential Difference

The potential difference across a circuit component (e.g., light bulb) can be measured by a voltmeter (Fig.) connected directly across the terminal of the component. The positive terminal of the cell is connected to the positive terminal of the voltmeter and the nega ve terminal of the cell is connected to the negative terminal of the voltmeter. An ideai voltmeter should have very large value of resistance so that no current passes through it, voltmeter is always connected in parallel with the device across which the potential difference is to be measured (Fig)

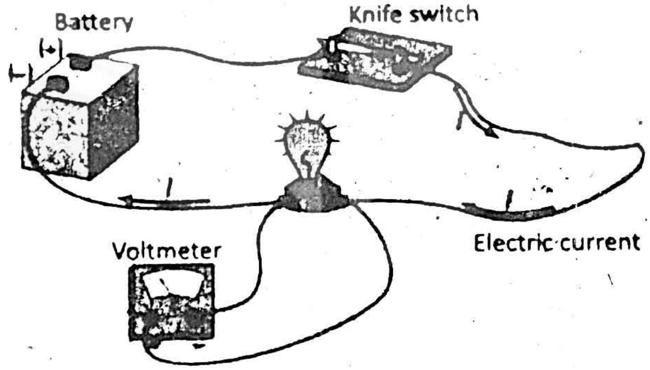


Fig. 14.8: Schematic diagram for measuring potential difference in a circuit.

The measurement of e.m.f

In general e.m.f refers to the potential difference across the terminals of the battery when it is not driving current in the external circuit. So in order to measure e.m.f of the battery we connect voltmeter directly with the terminals of the battery as shown in

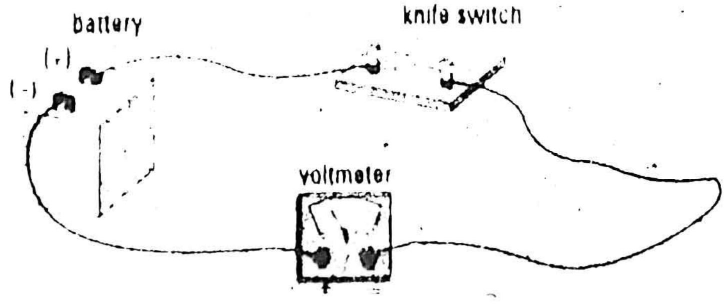


Fig. 14.9: Schematic diagram for measuring e.m.f. of the battery

14.4 Ohms's Law

Q.8 States and explain Ohm's law. What are its limitation?

Ans: Ohm's law:

The amount of current I passing through a conductor is directly proportional to the potential difference V applied across its ends, provided the temperature and the physical state of the conductor does not change.

Explanation:

If 'V' is the potential difference across the two ends of any conductor, then current I will flow through it. The value of the current 'I' changes with the changes in potential difference 'V', hence by the definition of Ohm's law.

$V \propto I$

$V = (\text{Constant}) \quad (I)$

$V = (R)I$

$V = IR$ ....(1)

Where 'R' is the constant of proportionality, and is the resistance of the conductor. Its SI units is Ohm.

Resistance:

"The property of a substance which offers opposition to the flow of current through it is called its resistance".

Unit:

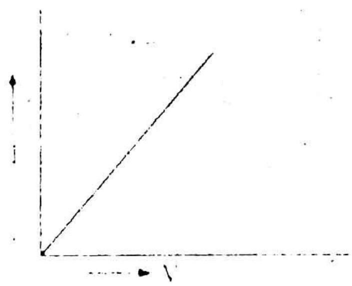
SI unit of the resistance 'R' is Ohm. It is denoted by the symbol, called Omega (Ω).

Definition of Ohm:

"When a potential difference of one volt is applied across the ends of a conductor and 1 ampere of current passes thorough it, then its resistance will be one ohm"

Graphically representation:

If a graph is plotted between the current 'I' and the potential difference 'V' a straight line will be obtained.



Limitations of Ohm's Law:

Ohm's law is applicable when temperature of conductor is kept constant. It has been observed that only good conductors obey ohm's law as long as the electric current through them is not very large and the physical state of the conductor also remains the same.

14.5 Characteristics of Ohmic and Non Ohmic conductors

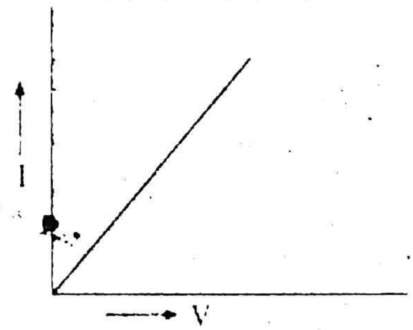
Q.9 Explain the V-I characteristics of Ohmic and non Ohmic conductor.(14.5)

Ans: Materials that obey Ohm's law, and hence have a constant resistance over a wide range of voltages, are said to be Ohmic."

Ohmic Conductor:

Ohmic conductors have a linear current-voltage relationship over a wide range of applied voltages as shown in figure:

The straight line shows a constant ratio between voltage and current, So Ohm's law is obeyed. For example most metals show Ohmic behavior.



(i) Ohmic

None-Ohmic Conductor

Non-Ohmic materials have a non-linear current-voltage relationship.

Example:

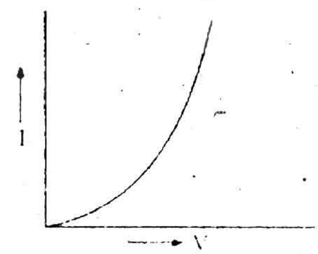
(i) Filament lamp

(ii) Thermister

(iii) Filament lamp

(i) **Filament lamp:**

The filament lamp shows the non-Ohmic materials properties. The resistance of filament rises (current decreases) as it gets hotter, which is shown by the gradient getting steeper as shown in fig.

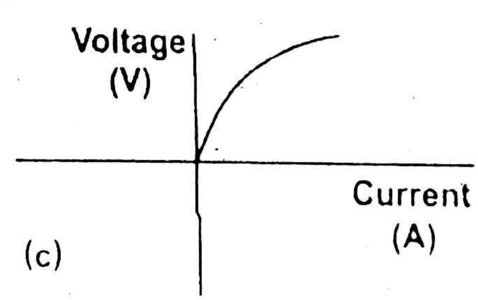


(ii) Non-ohmic

(ii) **Thermister:**

A thermister (a heat sensitive resistor) behaves in the opposite way as that of filament lamp. Its resistance decreases (current increases) as it gets hotter as shown in fig.

This is because on heating, more free electrons become available for conduction of current.



(c)

Q.10: Define resistance and its units.

Ans: **Resistance:**

"The property of a substance which offers opposition to the flow of current through it is called its resistance".

Reason:

Opposition to the flow of current is due to the collisions of the moving electrons with atoms of the substance.

Unit:

SI unit of the resistance 'R' is Ohm. It is denoted by the symbol, called Omega (Ω).

Definition of Ohm:

Since, $V = IR$

If we put $V = 1$ volt and $I = 1$ Ampere the value of 'R' will be 1 ohm, Thus, "When a potential difference of one volt is applied across the ends of a conductor and 1 ampere of current passes thorough it, then its resistance will be one ohm"

14.6 Specific Resistance (Resistively)

Q.11 Define and explain the term specific resistance. Discuss different factors which affect the resistance of conductors.(14.6)

Ans: **Definition:**

"The resistance of one meter cube of a substance is called its specific resistance".

Explanation:

A short pipe offers less resistance to water flow than a long pipe. A pipe with larger cross-sectional area offers less resistance than the pipe having smaller cross-sectional area.

Same is the case for resistance of wire that carry current .the resistance of wire depends both on the cross-sectional area and length of the wire, current flow also depends upon the nature of the material of the wire.

Factors:

At specific temperature resistance depends upon the following factors.

(a) Length of conductor:

Longer wires have more resistance than short wires.

(b) Cross-sectional area of conductor

Thick wires have less resistance than thin wires.

(c) Nature of the conductor:

Copper wire has less resistance than steel wire of the same size.

Note: Electrical resistance also depends on temperature.

MATHEMATICALLY EXPLANATION OF SPECIFIC RESISTANCE

At a certain temperature and for a particular substance;

(1) **Length and Resistance;**

The resistance 'R' of wire is directly proportional to the length of the wire i.e.

$$R \propto L \rightarrow (i)$$

It means if we double the length of wire its resistance will also be double and , if its length is halved its resistance would become one half.

(2) **Cross-sectional area and resistance**

The resistance 'R' of the wire is inversely proportional to the area of cross-section 'A' of the wire .i. c.

$$R \propto \frac{1}{A} \longrightarrow (ii)$$

It means that a thick wire would have smaller resistance than a thin wire.

By combining these above relations.

$$R \propto L\frac{1}{A}$$

$$R \propto \frac{L}{A}$$

$$R = \rho\frac{L}{A} \longrightarrow (iii)$$

Where 'ρ' is the constant of proportionality, known as specific resistance.

Nature of conductor (specific resistance)

Where ρ is the constant of proportionality known as specific resistance. Its value depends upon the nature of conductor i.e., copper, iron, tin and silver would each have a different values of ρ.

Unit of specific resistance

In above equation, if L = 1 m and A = $1m^2$ then R = ρ i.e., the resistance of one meter cube of a substance is equal to its specific resistance. According to above equation the unit of ρ is ohm-meter (Ωm)

14.7 and 14.8 Conductor and Insulators

Q.12: What is the difference between the conductors and insulators?(14.7 and 14.8)

Ans: Conductors:

Why do we always use metal wires for conduction of electricity? Because, they are good conductors of electricity and offer less resistance to the flow of current. But how can they conduct electricity with much ease? Metals like silver and copper have excess of free electrons which are not held strongly with any particular atom of metals. These free electrons move randomly in all direction inside metals. When we apply external electric field these electrons can easily move in a specific direction. This movement of free electrons in particular direction under the influence of external field causes flow of current in metal wires. The resistance of conductors increases with increase in temperature. This is due to increase in the number of collisions of electrons with the themselves and the atoms of metals.

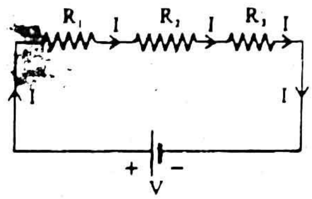
Insulators

All materials contain electrons. The electrons in insulators, like rubber, however, are not free to move they are tightly bound inside atoms. Hence, current cannot flow through an insulator because there are no free electrons for the flow of current. Insulators have very large value of resistance. Insulators can be easily charged by friction and the induced charge remains static on their surface. Other examples of insulators are glass, wood, plastic, fur, silk etc.

14.9 Combination of Resistors

Q.13: How are resistance are connected in series? Describe the characteristics features of this combination. What is meant by equivalent resistance of a series combination? Find its value.(14.9)

Ans: In this method resistance are connected end to end and the circuit thus formed provides only one path for the flow of current.1



Characteristics of series combination

(i) In this arrangement, the magnitude of current that flows through each individual resistor is same.

(ii) In series combination, the sum of voltages across each of the resistor is equal to the voltage of the battery connected across the combination. If the voltage of the battery is V and V_1, V_2, V_3 are the voltages across the resistors R_1, R_2, R_3 respectively, then

$$V = V_1 + V_2 + V_3$$

If the current passing through the resistors R1, R2, and R3 is I, then

$$V = IR_1 + IR_2 + IR_3$$

$$V = I(R_1 + R_2 + R_3) \quad \ldots\ldots\ldots \quad (1)$$

Equivalent resistance of series combination

The equivalent resistance R_e of a series combination is that resistance which is substituted in place of the combination, the same current would flow through the circuit. Figure shows the equivalent resistance Re. Note that the battery is sending the same current, which it was sending when the combination was connected in the circuit. By Ohm's law,

$$V = IR_e$$

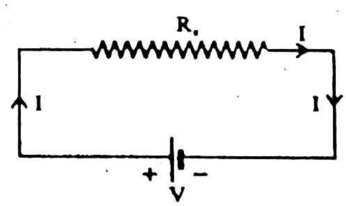
By substituting the value of V in equation (1), we have

$$IR_e = I(R_1 + R_2 + R_3)$$

$$R_e = R_1 + R_2 + R_3$$

Thus the equivalent resistance of a series combination is equal to the sum of the individual resistances of the combination.

If resistances R_1, R_2, R_3, ……, R_n are connected in series then their equivalent resistance can be determined by the following equation.



$$R_e = R_1 + R_2 + R_3 + \ldots\ldots + R_n$$

Q.14: How are resistance are connected in parallel? Describe the characteristics features of this combination. What is meant by equivalent resistance of a parallel combination? Find its value. (14.9)

Ans: In this combination, resistances are connected in such a way that one end of all the resistors is connected to one point, say 'A' and the other ends to another point 'B' as shown in the figure.

In the circuit formed, several paths are available for the flow of current. The total current is divided in these paths. The parallel combination has the following characteristics.

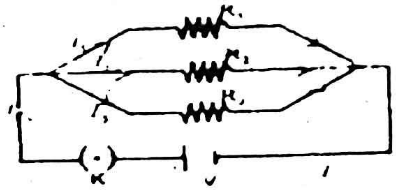


Fig 14.12: three resistors in parallel combination

Features of Parallel combination

(i) In this combination, the potential drop across all the resistances is the same. The potential drop across each of the resistance in the figure will be V.

(ii) The sum of the current flowing through the various resistances of this combination is equal to the total of the circuit.

$$I = I_1 + I_2 + I_3 \quad .... \quad (1)$$

As the potential drop across each resistance is V. So by Ohm's law

$$I_1 = \frac{V}{R_1} \qquad I_2 = \frac{V}{R_2} \qquad I_3 = \frac{V}{R_3}$$

By substituting the values of I_1, I_2, I_3 in equation (1), we have

$$I = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}$$

Or

$$I = V\left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right) \quad .... \quad (2)$$

(iii) The equivalent resistance R_e of the parallel combination is that resistance which when substituted in place of the parallel combination does not alter the total current of the circuit.

By Ohm's law $I = \frac{V}{R_e}$

By putting the value of I in equation (2), we have

$$\frac{V}{R_e} = V\left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right)$$

Or

$$\frac{1}{R_e} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

If resistances R_1, R_2, R_3, ..., R_n are connected in parallel then their equivalent resistance can be determined by the following equation.

$$\frac{1}{R_e} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + ...+ \frac{1}{R_n}$$

Advantages of Parallel

Parallel circuits have two big advantages over series circuits.

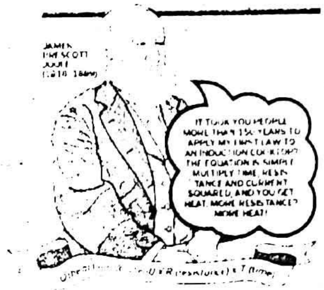
(i) Each device in the circuit receives the full battery voltages.

(ii) Each device in the circuit may be turned off independently without stopping the current flowing to other devices in the circuit. This principle is used in our wiring.

14.10 Electrical energy and Joule's Law

Q. 15: State and explain joule's law. Derive its formula.(14.10)

Ans: Joule's law:



Statement:

"The amount of heat energy generated in a resistance due to flow of charges in equal to the product of square of current 'I' resistance 'R' and the time during 't'."

Explanation:

When water falls on turbine form higher gravitational. Potential to lower gravitational potential. Then electrical energy is produced by the running of generator.

Similarly when charge moves form a higher electrical potential to a lower potential it delivers electric current.

Hence the electric current, during when charges continuously move form a higher potential to a lower potential, becomes a continuous source of electrical energy.

Mathematics formula:

Consider two point with a potential difference 'V' volts. If one coulomb of charge passes between these points, the amount of energy delivers by the charge would be V joule, when 'Q' coulomb of charge flows between these two points, then we get QV joule of energy. It is represented by W.

$$\text{i.e. } W = QV \rightarrow \text{(i)}$$

When charge 'Q' flow in time 't' then by definition of current, we have.

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

$$\Rightarrow Q = It \quad \rightarrow \text{(ii)}$$

Put eq (ii) in eq (i)

$$W = It\,V \rightarrow \text{(iii)}$$

This electrical energy can be converted into heat and other forms in the circuit.

By Ohms law, we have

$$V = IR \rightarrow \text{(iv)}$$

Put eq.(iv) in eq (iii) we get.

$$W = It\,(IR)$$

So energy supplied by 'Q' charge in given as:

$$W = I^2 Rt$$

This equation is called joules law.

Importance:

The heat energy produced can be utilized for different useful purposes. E.g.

(i) Bulb converts this energy into light and heat.

(ii) Heater and Iron convert this heat energy into heat.

(iii) Electric fans convert into mechanical energy.

Note: When current pass through conductor (heater) we get heat

14.11 Electric Power:

Q. 16: What is electric power? How it is calculate and write its unit.(14.11)

Ans: Electric power:

"The amount of energy supplied by current in unit time is known as electric power

How power can be determined?

If the work done by the electric current in time 't' is 'W' then 'P' is determined by the formula.

$$\text{Electric power} = \frac{\text{electrical energy}}{\text{time}}$$

$$P = \frac{W}{t} \longrightarrow (i)$$

Where 'w' is the electrical energy given as:

$$W = QV \rightarrow (ii)$$

$$P = \frac{QV}{t} \rightarrow (iii)$$

By definition of current

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

Hence eq. (iii) becomes

$$P = IV \rightarrow (iv)$$

By Ohm's law

$$V = IR \rightarrow (iv)$$

Hence equation (iv) can be written as:

Electrical power = $P = I\,(IR)$

Electrical power = $P = I^2R$

When current I is passing through resistor R, the electric power that generates heat in the resistance is given by I^2R.

Unit:

The unit of electric power is watt which is equal to one joule per second. It is represent by the symbol W.

Examples:

- Electric bulbs commonly used in houses consume 25w, 40w, 60w, 75w, and 1000 w of electric power.

Q.17 What is kilowatt hour? How the cost of electricity in a house can be a calculated?

Ans: "The amount of energy delivered by a power of one kilowatt in one hour is called kilowatt hour."

Explanation:

Electric energy is commonly consumed in very large quantity for the measurement of which joule is a very small unit hence a very large unit of electric energy is needed which is called kilowatt hour.

$$\begin{aligned} \text{One kilowatt hour} &= \text{Kwh} \\ &= 1000\text{W} \times (3600\text{s}) \\ &= 36 \times 10^5\ \text{Ws} \\ &= 3.6 \times 10^6\ \text{Ws} \end{aligned}$$

$$\therefore 10^6 = \text{Mega} = \text{M},\ \text{Ws} = \text{J}$$

Hence,

One kilowatt hour = 3.6MJ

Formula:

$$\text{The amount of energy in kwh} = \frac{\text{Power(watt)} \times \text{time of use in hours}}{1000}$$

Or

$$\text{No. of units consumed} = \frac{\text{Power(watt)} \times \text{time of use in hours}}{1000}$$

Calculation for cost of Electricity in House:

The electric meter installed in our houses measures the consumption of electric energy in units of kilowatt hour according to which we pay our electricity bills. If the cost of one kilowatt-hour i.e., one unit is known then cost of electricity is calculated as:

Formula:

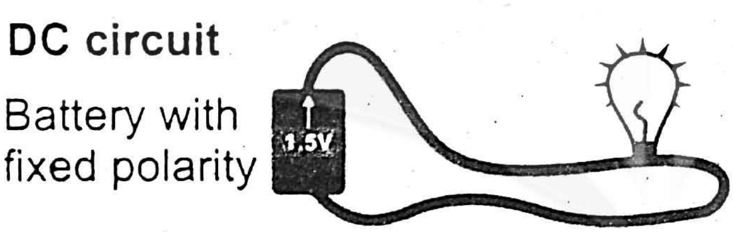
$$\text{Cost of electricity} = \text{number of units consumed} \times \text{cost of one unit}$$

$$\text{Cost of electricity} = \frac{\text{Power(watt)} \times \text{time of use in hours}}{1000} \times \text{cost of one unit}$$

14.12 Direct current and alternating current

Q.18: What is difference between D.C. and A.C.? OR
Compare direct current (D.C) and alternating current (A.C)(14.12)

Ans: "The current which does not change its direction of flow is known as direct current or d.c."
The current derived from a cell or a battery is direct current (D.C.) since it is unidirectional. The positive and negative terminals of d.c. sources have fixed polarity, therefore, level of d.c. remains constant with time as shown in figure.



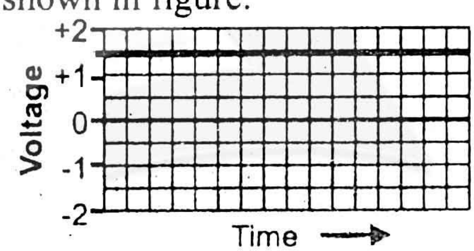
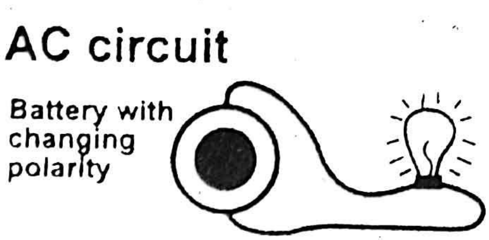
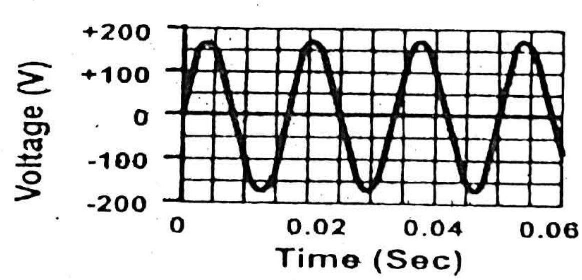


Fig. 14.13: Variation of D.C Current with time.

Alternating Current (A.C)

"The current which changes its direction of flow after regular intervals of time is known as alternating current or A.C." The current produce by A.C generators changes its polarity again and again as shown in fig:





Characteristics of A.C

Time period: The interval after which the A.C. voltage or current repeat its value is known as time period.

Cycle:

The set of all the value of current during one period is known as one cycle"

Frequency: The number of cycles completed by alternating current in one second is called its frequency."

The change in the values of voltage and current corresponds to the frequency of the source. In Pakistan, alternating current oscillates 50 time every second. Thus, its frequency is 50Hz.

Importance of A.C:

Alternating current has advantages that make it more practical for use in transferring electrical energy. The current supplied to our homes by power companions is alternating current.

Q.19. How electricity is distributed in our house? How electrical appliances are connected in houses?(14.12)

Ans: **Supply to Houses:**

The electric power enters our house through three wires. One is called earth wire or ground wire (E). This caries no electricity. The earthy wire is connected to a large metal plate buried deep in the ground near the house the other wire is maintained as zero potential by connecting it to the earth at the power station itself and is called neutral wire (N). This wire provides the return path for the current. The third wire is at a high potential and is called live wire (L).

Potential difference between live wire and neutral wire:

The electric power enters our houses through wires, the potential difference between the live wire and neutral wire is 220V.

Dangers

Our body is a good conductor of electricity through which current can easily pass. Therefore, if a person holds live wire current will start flowing to the ground while passing through his body which may prove fatal for the person.

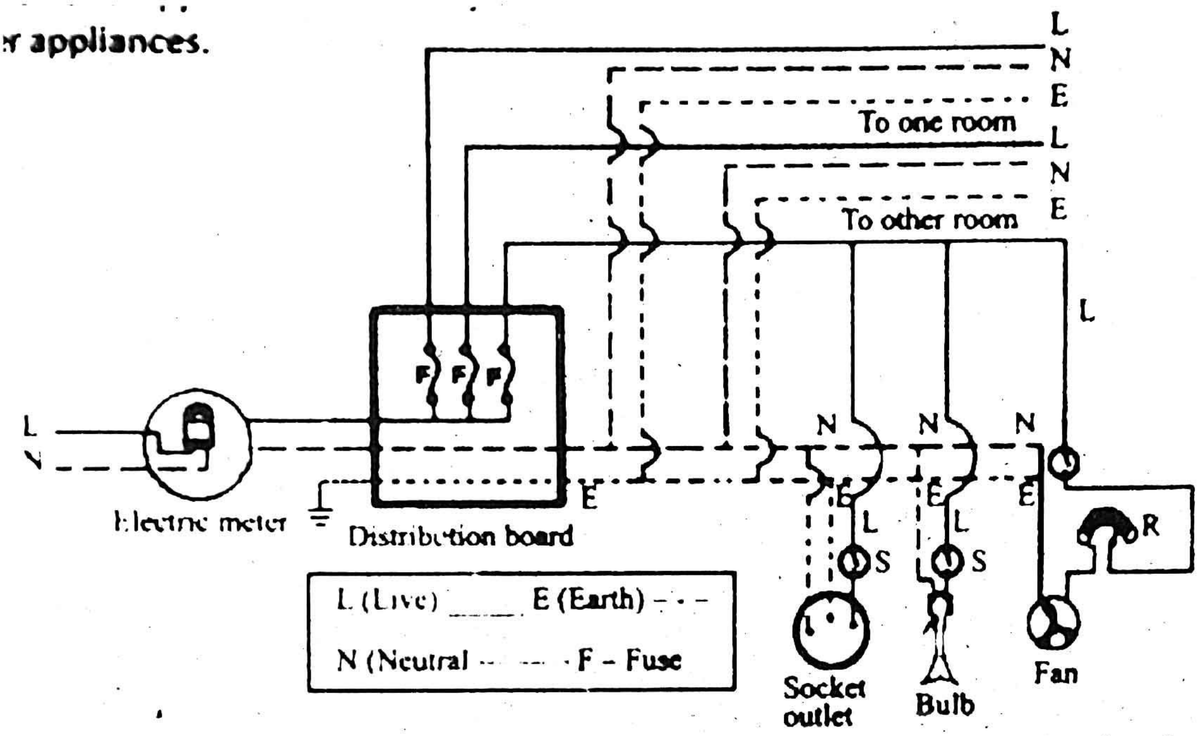
How electric appliances are connected?

All electrical appliances are connected across the neutral and live wires. The same potential difference is therefore applied to all of them and hence these are connected in parallel to the power source.

Q.20 Explain the circuit of house wiring.

Ans: The wires coming from power sub-station are connected to electricity meter installed in house. The output power from the electric meter is taken to the distribution board and then to the domestic electric circuit.

r appliances.



The main box contains fuses of rating about 30A.A separate connection is taken from the live wire for each appliance. Terminal of the appliance is connected to the live wire through a separate fuse and a switch. If the fuse of the one appliance burns out, it does not affect the other appliances.

How all appliances are connected?

In house wiring all appliances are connected in parallel with each other. This means they get the full mains voltage and one can turn on any appliance without having to turn on another.

14.13 Hazards of electricity:

Q. 21: Discuss some faults in electrical circuits that may cause electricity hazards.(14.13)

Ans: Electricity has become part and parcel of our lives, care should be taken to save ourselves form its hazardous effects.

Major dangers:

Major dangers of electricity are:

(i) Electric shock.

(ii) Fire.

Some major faults in electrical Circuit:

These are the major faults in electrical circuits that may cause electrical hazards.

1. **Insulation Damage:**

How insulation damage:

(i) **Excess of current:** Electrical current exceeds the rated current carrying capacity of the conductor it can produce excess current that can damage insulation due to overheating of cables.

(ii) **Friction:** Constant friction may also remove the insulation from the wire.

(iii) **Moisture:** Too much moisture also damages the insulation because moisture decrease resistance and increase the rate of current.

How Circuit become short?

(i) A short circuit occurs when circuit with a very low resistance is formed. The low resistance causes the current to be very large.

(ii) When appliances are connected in parallel, each additional appliances placed in circuit reduces the equivalent resistance (Re) in the circuit increase the current through the wires. This additional current might produce enough thermal energy to melt the wiring's insulation, cause a short circuit, or even start a fire.

(iii) Short circuit can also occur when the live wire and the neutral wire come in direct contact.

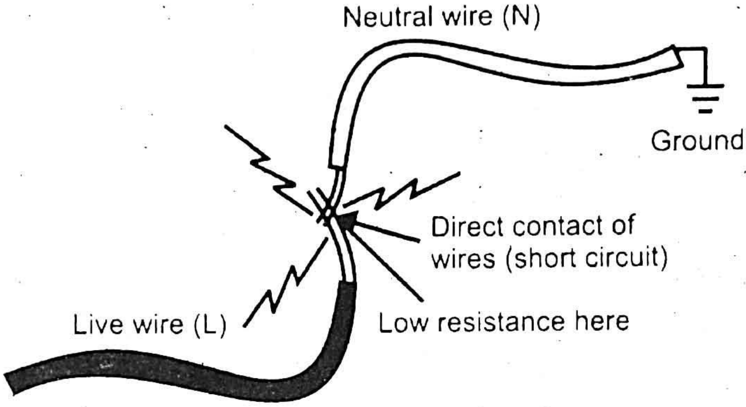


Fig. 14.16: Short circuit

Precautions:

Cable: All electrical wires are well insulated with plastic cover for the purpose of safety. Plastic is a good insulator. Such an insulation covered wire is called cable

i. In order to avoid dangerous situation it is advisable to use a cable with two layers of insulation.

ii. Don't use naked current carrying wires.

iii. Do not fly kites near electricity naked lines. It may cause some fatal accident.

2. Damp Conditions:

We environment is called damp conditions.

Dry human skin has a resistance of 1000,000 ohms or more. But under damp conditions resistance of human skin is reduced drastically to few hundred ohms. Therefore never operate any electrical appliance with wet hands. The switches, plugs, sockets and wires must be dry.

14.14 Safe Use of Electricity in Homes

Q. 22: Briefly describe the importance of safety devices.(14.14)

Ans: "The electrical devices which prevent the damage of electrical circuits appliances and property are called safety devices.

Examples:

(i) Fuse

(ii) Circuit Breaker

(iii) Earth wire

Importance:

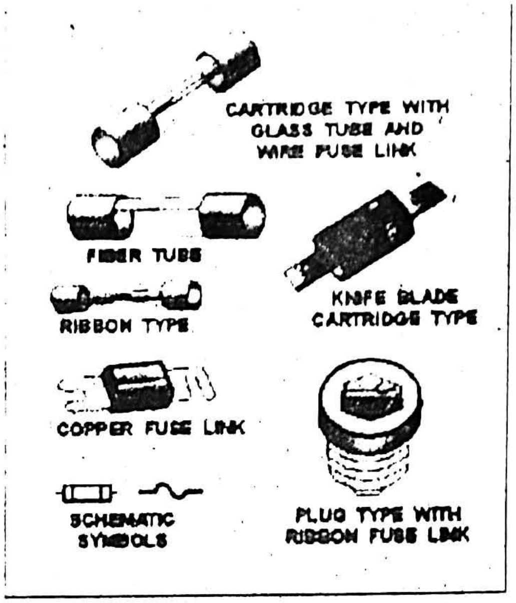
In order to protect persons, devices and property form the hazards of electricity. There is a need of extensive safety measures in household electricity. Safety devices prevent circuit form overloading that can occur when too many appliances are turned on at the same time or when a short circuit occurs in one appliance.

Q.23: Write a note on fuse:

Ans: Definitions: "A fuse is a safety device that is connected in series with the live wire in the circuit to protect the equipments when excess current flows."

Construction: Fuse is made of a short and thin piece of metal wire that melts when large current passes through it.

Working: If a large, unsafe current passes through the circuit, the fuse melts and breaks the circuits before the wires becomes very hot and cause fire.



Fuse rating: Fuse are normally rated as 5A, 10A, 13A and 30 A etc.

We can determine the fuse rating of circuit, let use determine the fuse rating of air conditions of power 3000W.

$P = 3000W.$

$V = 240$ Volt

$I = ?$

$P = VI$

$$\Rightarrow \quad I = \frac{P}{V}$$

$$I = \frac{300}{240} = 12.5A$$

Hence suitable fuse for this circuit would be 13A.

Safety Measures:

Following safety measures should be taken while using fuses in house hold electrical circuits.

(i) fuses to be used should have slightly more rating than the current which the electrical appliance in will draw under conditions. For example, for a lightening choose a 5A fuse as the current drawn by each lamp is very small (about 0.4A) for a 100 W lamp. In such circuit 10 lamps of 100 W can be safely used because the total current drawn is only 9A which can be calculated using the formula $P = VI$

(ii) Fuses should be connect to the live wire so that the appliance will not become live after the fuse has blown.

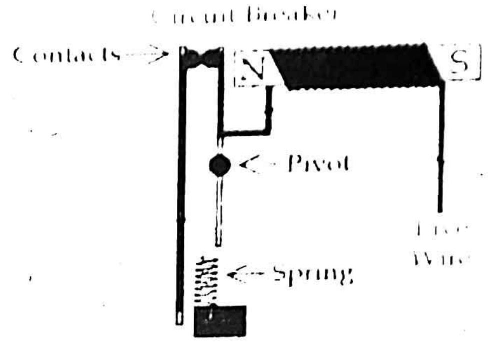
(iii) Switch off the main before changing any fuse.

Q. 24: What is the principle of circuit breaker?(14.14)

Ans: Circuit Breaker:

The circuit breaker acts as a safety device in the same way as a fuse. It disconnects the supply automatically if current exceeds the normal value.

Working principle: When the normal current passes through the live wire the electromagnet is not strong enough to separate the contacts. If something goes wrong with the appliance and large current flows through the live wire, the electromagnet will attract the iron strip to separate the contracts and break the circuit. The spring then keeps the contacts apart as shown in figure.



After the fault is repaired, the contacts can then be pushed back together by pressing a bottom on the outside of the circuit breaker box.

Q. 25: Explain the importance of Earth wire.(14.14)

Ans: Earth Wire:

Sometimes, even the fuse cannot capture the high currents coming from the live wire into the household appliance. Earthing further protects the user form electric shock by connecting the metal casing of the appliance to earth (a wired connection to the bare ground) many electrical appliances have metal cases, including cookers, washing machines and refrigerators, the earth wire provides a safe route for the current to flow through, if the live wire touches the cashing as shown in fig below.

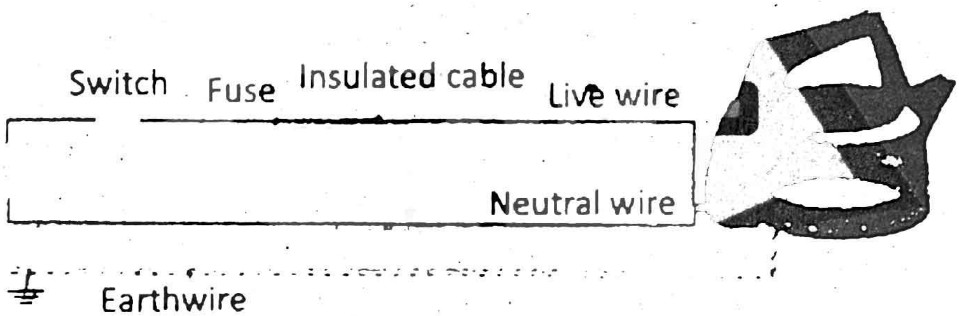


Fig. 14.20

We will get an electric shock if the live wire inside an appliance comes loose and touches the metal casing, However, the earth terminal is connected to the metal cashing, so the current goes though the earth wire instead of passing through our body and causing an electric shock, A strong current passes through the earth wire because it has a very low resistance. This breaks the fuse and disconnects the appliance.

Working principle of Earth wire

Whenever the metal casing of the appliance, due to faulty insulation, gets connected with the live wire, the circuit shorts and a large current would immediately flow to ground through the earth wire and causes the fuse wire to melt or the circuit breaker breaks the circuit. Therefore, the person who is using the appliance is saved.