CHAPTER 4 ELECTRICITY

I. Choose the best answer

1. Which of the following is correct?

a) Rate of change of charge is electrical power.

b) Rate of change of charge is current.

c) Rate of change of energy is current.

d) Rate of change of current is charge.

Ans : b) Rate of change of charge is current.

2. SI unit of resistance is

a) mho b) joule c) ohm d) ohm meter

Ans: c) ohm

3. In a simple circuit, why does the bulb glow when you close the switch?

a) The switch produces electricity.

b) Closing the switch completes the circuit.

c) Closing the switch breaks the circuit.

d) The bulb is getting charged.

Ans: d) The bulb is getting charged.

4. Kilowatt hour is the unit of

a) resistivity b) conductivity c) electrical energy d) electrical power

Ans: c) electrical energy

II. Fill in the blanks

1. When a circuit is open, _____ cannot pass through it.

Ans: Current

2. The ratio of the potential difference to the current is known as _____.

Ans: Ohm's law

3. The wiring in a house consists of _____ circuits.

Ans: domestic electric

4. The power of an electric device is a product of _____ and _____.

Ans: electric current, potential difference

5. LED stands for _____.

Ans: Light Emitting Diode.

III. State whether the following statements are true or false: If false correct the statement.

1. Ohm's law states the relationship between power and voltage.

Ans: False

Correct Statement: Ohm's law states the relationship between potential difference and current.

2. MCB is used to protect house hold electrical appliances.

Ans: True

3. The SI unit for electric current is the coulomb.

Ans: False

Correct statement: The SI unit for electric current is the Ampere.

4. One unit of electrical energy consumed is equal to 1000 kilowatt hour.

Ans: True

5. The effective resistance of three resistors connected in series is lesser than the lowest of the individual resistances.

Ans: False

Correct Statement: The effective resistance of three resistors connected in series is greater than the highest value of the individual resistances.

IV. Match the items in column-I to the items in column-II:

Column - I	**Column - II**
(i) electric current	(a) volt
(ii) potential difference	(b) ohm meter
(iii) specific resistance	(c) watt
(iv) electrical power	(d) joule

(v) electrical energy (e) ampere

Ans:

(i) electric current(e) ampere

(ii) potential difference (a) volt

(iii) specific resistance (b) ohm meter

(iv) electrical power (c) watt

(v) electrical energy (d) joule

V. Assertion and reason type questions:

Mark the correct choice as

a) if both the assertion and the reason are true and the reason is the correct explanation of the assertion.

b) if both the assertion and the reason are true, but the reason is not the correct explanation of the assertion.

c) if the assertion is true, but the reason is false.

d) if the assertion is false, but the reason is true.

1. Assertion: Electric appliances with a metallic body have three wire connections.

Reason: Three pin connections reduce heating of the connecting wires.

Ans: c) if the assertion is true, but the reason is false.

2. Assertion: In a simple battery circuit the point of highest potential is the positive terminal of the battery.

Reason: The current flows towards the point of the highest potential.

Ans: c) if the assertion is true, but the reason is false.

3. Assertion: LED bulbs are far better than incandescent bulbs.

Reason: LED bulbs consume less power than incandescent bulbs.

Ans: a) if both the assertion and the reason are true and the reason is the correct explanation of the assertion.

VI. Very short answer questions.

1) Define the unit of current.

Ans : The unit of current is ampere (A). The current flowing through the conductor is said to be one ampere when a charge of one coulomb flows across any cross-section of conductor in one second. Hence,

$$1 \text{ ampere} = \frac{1\ coulomb}{1\ Second}$$

2) What happens to the resistance, as the conductor is made thicker?

Ans: Resistance of conductor is inversely proportional to the area of cross-section of conductors. Hence, resistance is inversely proportional to square of the radius of the conductor.

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

$$\mathrm{R} \propto \frac{1}{r^2}$$

From the equation, when a conductor is made thicker, radius will be increased and so resistance will be decreased.

3. Why is tungsten metal used in bulbs, but not in fuse wires?

Ans : Because tungsten has high melting point so it is use in bulbs. It cannot be used in fused wires because in fuse wires the material must have low melting point.

4. Name any two devices, which are working on the heating effect of the electric current.

Ans: 1) Electric heater

2) Fuse wire

VII. Short answer questions

1. Define electric potential and potential difference.

Ans: **Electric potential:** Electric potential at a point is defined as the amount of work done in moving a unit positive charge from infinity to that point against the electric force.

Potential difference: The electric potential difference between two points is defined as the amount of work done in moving a unit positive charge from one point to another point against the electric force.

2. What is the role of the earth wire in domestic circuits?

Ans: The role of the earth wire in domestic circuits is this wire provides the low resistance path to the electric current. The earth wire sends current from the body of appliance to the earth, whenever

a wire touches the body of metallic electric appliance, thus the earth wire used as protective conductor and protect us from the electric shocks.

3. State Ohm's law.

Ans : According to ohm's law, at a constant temperature , the steady current 'I' flowing through a conductor is directly proportional to potential difference 'V' between the two ends of the conductor.

$I \propto V$

$V = IR$

Where,

I = current through conductor,

V= voltage

R= Resistance

4. Distinguish between the resistivity and conductivity of a conductor.

Ans:

Resistivity	Conductivity
1. It is the resistance of a conductor of a unit length and unit area of cross-section. $\rho = RA/L$ 1. The unit of electrical resistivity is Ohm meter. 2. It is the measure of the resisting power of specified material.	1. It is the reciprocal of electrical resistivity of a material. $\sigma = 1/\rho$ 2. The unit of conductivity is ohm $^{-1}$ meter $^{-1}$ or mho meter $^{-1}$ 3. It is the measure of its ability to pass the current through it.

5. What connection is used in domestic appliance and why?

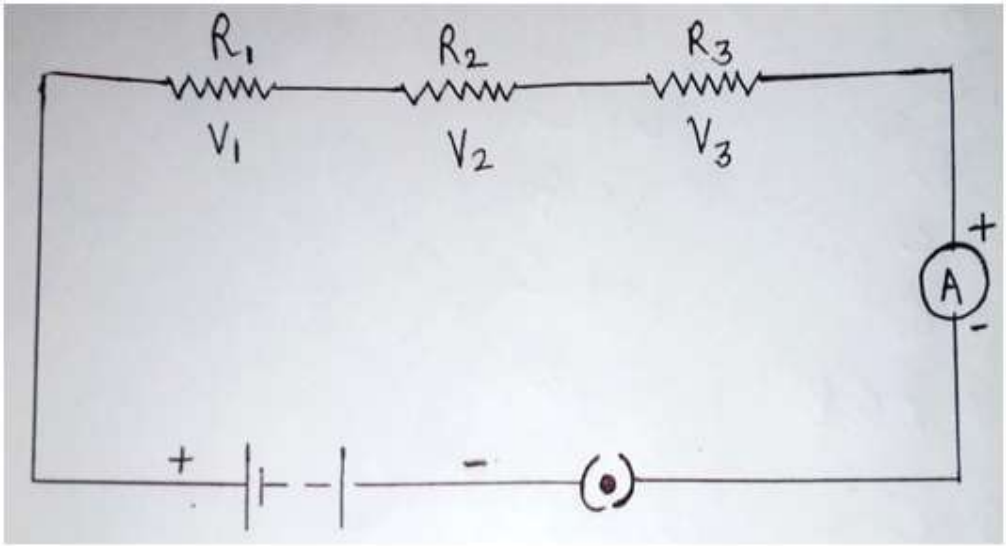
Ans: Parallel connection is used in domestic appliances because If there is any connection in one circuit is disconnect in our house, then due to parallel connection it does not affect the other connection in circuit.

VIII. Long answer questions.

1. With the help of a circuit diagram derive the formula for the resultant resistance of three resistances connected: a) in series and b) in parallel

Ans: (a) Resistor in series :

Resistor is an important of an electric circuit and in series circuit the components are connects one after other to form a 'single-loop'. A series circuit has a single loop through which the current can pass. If circuit is damaged at any point in the loop then current cannot pass through it and hence electric appliance connected in circuit will not work. Series circuits commonly used in flashlights.



Series combination of resistor

Resistor are connected end to end so that the same current can pass through it, then they are said to be connected in series.

There are three resistors R1, R2 and R3 connected in series.

Current flowing through these resistors I.

According to the Ohm's law, the potential differences V1, V2 and V3 across the resistors R1, R2 and R3 respectively,are given by,

$V_1 = IR_1$ .....(i)
$V_2 = I R_2$ .....(ii)
$V_3 = I R_3$ .....(iii)

The sum of potential difference is given by,
$V = V_1 + V_2 + V_3$

Using equation (i),(ii) and (iii), we get
$V = IR_1 + IR_2 + IR_3$ .....(iv)

If we want to use the effective resistor then we can replace the resistor effectively, the effective resistor is single resistor and it allow the same current through the circuit.

In series combination resistors the effective resistance is Rs. Then,

$V = IR_s$ .....(v)

Combine the equation (iv) and (v)

$IR_s = IR_1 + IR_2 + IR_3$

$R_s = R_1 + R_2 + R_3$

From this we can say that,

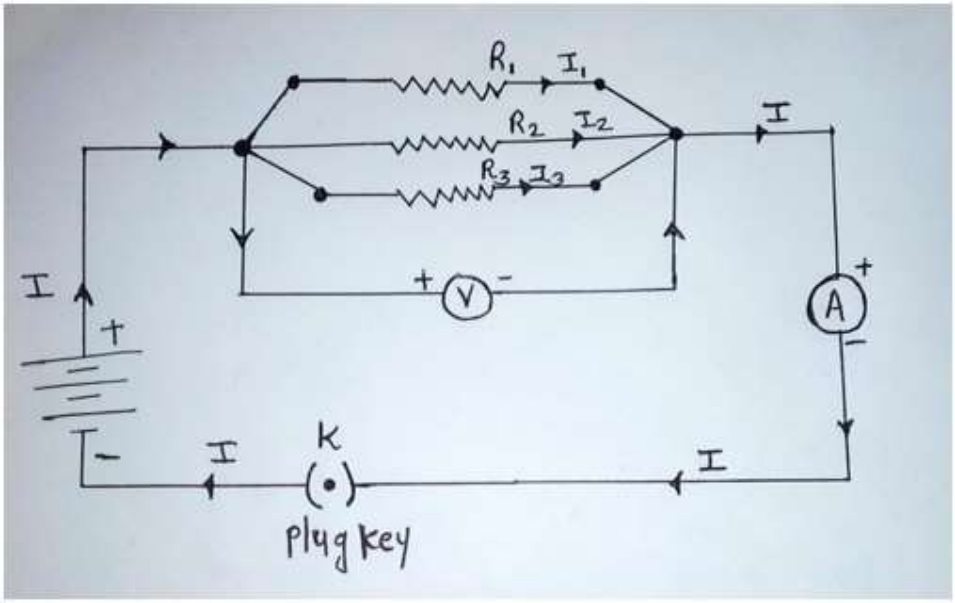
When number of resistor are connected in series, their effective resistance or equivalent resistance is equal to the sum of individual resistance.

When 'n' resistors of equal resistances R connected in series, the equivalent resistances is 'nR'. i.e., $Rs = nR$

The equivalent resistance in a series combination is greater than the highest of individual resistance.

b) Resistor in parallel:

In parallel circuit there are two or more loops through which current can pass. If one loop is disconnected the can still passing through the other loops. The wiring in house consists of parallel circuits.



Parallel combination of resistors

Consider the resistors R1, R2 and R3 are connected in parallel at common point on both side.

The potential difference across each resistance is same and measured using the voltmeter.

The current I divides into three branches I1, I2 and I3 passing through respectively

According to Ohm's law, we have,

$I_1 = V/ R_1$ .....(i)
$I_2 = V/ R_2$ .....(ii)
$I_3 = V/ R_3$ .....(iii)

The total current through the circuit is given by,

$I = I_1 + I_2 + I_3$

Using equation (i) ,(ii) and (iii), we get,

$I = \frac{V}{R1} + \frac{V}{R2} + \frac{V}{R3}$ .....(iv)

The effective resistance of the parallel combination of resistors be Rp then,

$I = \frac{V}{Rp}$ .....(v)

Combining equation (iv) and (v), we have,

$$\frac{V}{Rp} = \frac{V}{R1} + \frac{V}{R2} + \frac{V}{R3}$$

$$\frac{1}{Rp} = \frac{1}{R1} + \frac{1}{R2} + \frac{1}{R3}$$

When the number of resistors are connected in parallel, the sum of reciprocals of the individual resistances is equal to reciprocal of the effective or equivalent resistance.

When 'n' resistors of equal resistances R are connected in parallel, the equivalent resistance is R/n

1/Rp=1/R+1/R+1/R+⋯1/R= n/R

Hence, RP = R/n

The equivalent resistance in a parallel combination is le then the lowest of the individual resistances.

2. a) What is meant by electric current?

b) Name and define its unit.

c) Which instrument is used to measure the electric current? How should it be connected in a circuit?

Ans: (a) Electric current is the rate of flow of charge in conductor.

(b) The unit of current is Ampere (A). The current flowing through the conductor is said to be one ampere when a charge of one coulomb flows across any cross-section of conductor in one second. Hence,

$$1 \text{ ampere} = \frac{1\ coulomb}{1\ Second}$$

(c) Ammeter is used to measure the current and ammeter is always connected in series.

3. a) State Joule's law of heating.

b) An alloy of nickel and chromium is used as the heating element. Why?

c) How does a fuse wire protect electrical appliances?

Ans: (a) The charge flowing through the circuit for a time interval 't' is 'Q'.

The work done in moving the charge Q across the ends of the resistor with a potential difference of V is VQ. Thus, the heat produced in the resistor is:

H = W = VQ

You know that the relation between the charge and current is

Q = I t.

Using this, we get

H = V I t .....(i)

From Ohm's Law, V = IR. Hence, we have

H = I2Rt ..... (ii)

This is known as Joule's law of heating. Joule's law of heating states that the heat

produced in any resistor is:

- directly proportional to the square of the current passing through the resistor.
- directly proportional to the resistance of the resistor.
- directly proportional to the time for which the current is passing through the

(b) An alloy of nickel and chromium is used as the heating element. because it has high resistivity, high melting point and it is not easily oxidized. The fuse wire is connected in series, in an electric circuit. When a large current passing through the circuit, the fuse wire is melts due to Joule's heating effect and hence the circuit gets disconnected. The fuse wire is made up of material whose melting point is low and therefore the fuse wire is protect the electrical appliances.

4. Explain about domestic electric circuits. (circuit diagram not required)

Ans:

5. a) What are the advantages of LED TV over the normal TV?

b) List the merits of LED bulb.

Ans : (a) Advantages of LED TV over the normal TV

It has brighter picture quality.

Its life spam is more.

It is more reliable.

It is thinner in size.

It uses less power and consumes very less energy.

b) Merits of LED bulb.

As there is no filament, there is no loss of energy in the form of heat. It is cooler than the incandescent bulb.

It is not harmful to environment.

The more colours are possible in LED.

It is cost-efficient and energy efficient.

Mercury and other toxic materials are not required.

IX. Numerical problems:

1. An electric iron consumes energy at the rate of 420 W when heating is at the maximum rate and 180 W when heating is at the minimum rate. The applied voltage is 220 V. What is the current in each case?

Ans: Case I:

Power (P) = 420Watt

Applied voltage (V) = 220 V

Current (I) = P/V = 420/220 = **1.9 A**

Case II :

Power (P) = 180 Watt

Applied Voltage (V) = 220 V

Current(I) = P/V =180/220 = **0.8 A**

2. A 100 watt electric bulb is used for 5 hours daily and four 60 watt bulbs are used for 5 hours daily. Calculate the energy consumed (in kWh) in the month of January.

Ans: The energy used by the 100 W bulb in 5 hours is (E) = P× t = 100 × 5 =500Wh

The energy used by the four 60 W bulb in 5 hours is (E) = P × t = 4× 60 × 5 =1200Wh

Total energy = 500 + 1200 = 1700 Wh = 1.7 KWh

Total no of days in January is 31

So Energy consumed in the month of January = 1.7 × 31

= 52.7 kWh.

3. A torch bulb is rated at 3 V and 600 mA. Calculate it's

a) power

b) resistance

c) energy consumed if it is used for 4 hour.

Ans: Given : voltage = 3V

Current = 600 mA = 6 × 10-3 A

Power (P) = VI = 3 × 600 × 10-3

P = 1800 × 10-3 W

P = 1.8 W.

Resistance (R) = V/I= 3/(600 × 〖10〗 ^(-3))

R = 5 Ω

Power =1.8 W and time = 4 hours = 4 × 60 × 60 = 14400 second

Energy consumed E = P × t = 1.8 × 14400 = 25920 joules

E = 25.9 KJ.

4 A piece of wire having a resistance R is cut into five equal parts.

a) How will the resistance of each part

of the wire change compared with the original resistance?

b) If the five parts of the wire are placed in parallel, how will the resistance of the

combination change?

c) What will be ratio of the effective resistance in series connection to that of the parallel connection?

Ans : (a) A piece of wire having resistance R and It cut into five equal parts.

The equivalent resistance of R is 'RS'

$$R = R_S$$

$$\Rightarrow R_S = 5R$$

⇨ **$R = R_S/5$**

(b) Effective Resistance of 5 resistors are R_p

$$R_p = \frac{1}{R1} + \frac{1}{R2} + \frac{1}{R3} + \frac{1}{R4} + \frac{1}{R5}$$

$$R_p = \frac{1}{\frac{R}{5}} + \frac{1}{\frac{R}{5}} + \frac{1}{\frac{R}{5}} + \frac{1}{\frac{R}{5}} + \frac{1}{\frac{R}{5}}$$

$$\frac{1}{Rp} = \frac{5}{R} + \frac{5}{R} + \frac{5}{R} + \frac{5}{R} + \frac{5}{R}$$

$$\frac{1}{Rp} = \frac{25}{R}$$

$$\therefore \boldsymbol{Rp = \frac{R}{25}}$$

c) $R_S = \frac{R}{5} + \frac{R}{5} + \frac{R}{5} + \frac{R}{5} + \frac{R}{5}$

$R_S = \frac{5R}{5} \Rightarrow R_S = R$

The ratio of the effective resistance in series connection to that of the parallel connection

$$\frac{Rs}{Rp} = \frac{R}{\frac{R}{25}} \Rightarrow \frac{25R}{1R} = \boldsymbol{\frac{Rs}{Rp}} = \mathbf{25:1}$$

X. HOTS:

1. Two resistors when connected in parallel give the resultant resistance of 2 ohm; but when connected in series the effective resistance becomes 9 ohm. Calculate the value of each resistance.

Ans: Resultant resistance of parallel combination Rp = 2 Ω,

Resultant resistance of series combination Rs = 9Ω

$$\frac{1}{Rp} = \frac{1}{R1} + \frac{1}{R2}$$

$$\frac{1}{2} = \frac{1}{R1} + \frac{1}{R2}$$

$$\frac{1}{2} = \frac{R1 + R2}{R1R2}$$

$$2(R_1 + R_2) = R_1R_2 \text{.....(i)}$$

$$R_s = R_1 + R_2$$

$$9 = R_1 + R_2$$

$$R_1 = 9 - R_2 \text{ .....(ii)}$$

Put the value of equation (i) in equation (ii)

$$2(9 - R_2 + R_2) = (9 - R_2)R_2$$

$$\Rightarrow 18 = 9R_2 - R_2^2$$

$$\Rightarrow R_2^2 - 9R_2 + 10 = 0$$

$$\Rightarrow (R_2 - 3)(R_2 - 6) = 0$$

$$\Rightarrow R_2 = 3, 6$$

1) $R_2 = 3$; $R_1 = 9 - R_2$; $R_1 = 9 - 3 = 6\Omega$

2) $R_2 = 6$; $R_1 = 9 - R_2$; $R_1 = 9 - 6 = 3\Omega$

2. How many electrons are passing per second in a circuit in which there is a current of 5 A?

Ans: Given

I = 5A

Number of electron passing per second for 5A current = ?

I = Q/t

Charge of an electron

C = 1.6 × 10-19 C

1 coulomb = 1/〖1.6 ×10〗^(-19) electrons

1 coulomb = 6.25 ×1018 electrons

For 1 A current, no of electrons are 6.25 ×1018 electrons. Therefore for 5A current,

= 5 × 6.25 ×1018

= 3.125 ×1019 electrons

3. A piece of wire of resistance 10 ohm is drawn out so that its length is increased to three times its original length. Calculate the new resistance.

Ans: Specific resistance = (ρ) = $\frac{RA}{l}$

$$R = \frac{\rho l}{A}$$

When the length is increased by three time then area of cross-section is also reduced by three,

Resistance of wire (R) = 10Ω

$$\text{New resistance (R')} = \frac{\rho(3l)}{(\frac{A}{3})}$$

$$= \rho(3l) \times 3/A$$

$$= 9\ \rho\ l/A$$

$$= 9 \times R$$

$$= 9 \times 10$$

R' = 90 Ω