UNIT 4

# ELECTRICITY

## PART -I TEXTBOOK EVALUATION

### 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: b) Closing the switch completes the circuit**

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. | Answer |
|---|---|
| 1. When a circuit is open, _____ cannot pass through it. | **current.** |
| 2. The ratio of the potential difference to the current is known as _____. | **Resistance** |
| 3. The wiring in a house consists of _____ circuits. | **Parallel.** |
| 4. The power of an electric device is a product of _____and _____. | **Electric current and potential difference** |
| 5. LED stands for _____. | **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**
   - Ohm's law states the relationship between **current** and voltage.
2. MCB is used to protect house hold electrical appliances. **Ans: True.**
3. The SI unit for electric current is the **coulomb**. **Ans: False**
   - The SI unit for electric current is **ampere**.
4. One unit of electrical energy consumed is equal to **1000 kilowatt** hour. **Ans: False**
   - One unit of electrical energy consumed is equal to 1 **kilowatt** hour.

5. The effective resistance of three resistors connected in **series** is lesser than the lowest of the individual resistances.
**Ans: False**
- The effective resistance of three resistors connected in **parallel** is lesser than the lowest of the individual resistances.

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

| Column -I | | | Column - II | Answer |
|---|---|---|---|---|
| i | electric current | a | volt | **ampere** |
| ii | potential difference | b | ohm meter | **volt** |
| iii | specific resistance | c | watt | **ohm meter** |
| iv | electrical power | d | joule | **watt** |
| v | electrical energy | e | ampere | **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.**
- The unit of current - ampere (A)
- One coulomb of charge flows through the conductor in one second.

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

2. **What happens to the resistance, as the conductor is made thicker?**
- Resistance - decreases.
- $R = \frac{\rho l}{A} = \frac{\rho l}{\pi r^2}$

Resistance is inversely proportional to area of cross section A.

3. **Why is tungsten metal used in bulbs, but not in fuse wires?**
   - Tungsten has a very high melting point.
   - If it is used in fuse wire, it will not melt when large current passes through it.
   - The appliances will get damaged.

4. **Name any two devices, which are working on the heating effect of the electric current.**
   - Electric iron box
   - Electric heater
   - Electric toaster

## VII. Short answer questions.

1. **Define electric potential and potential difference.**
   - **Electric potential:**
     The amount of work done in moving a unit positive charge from infinity to that point against the electric force.
   - **Potential difference:**
     The amount of work done in moving a unit positive charge from one point to another point against the electric force
   - SI unit - volt (v)

2. **What is the role of the earth wire in domestic circuits?**
   - It provides a low resistance path to the electric current.
   - It sends the excess current from the appliances to the ground.
   - It saves us from electric shocks.

3. **State Ohm's law.**
   - At constant temperature, the steady current 'I' flowing through a conductor is directly proportional to the potential difference 'v' between two ends of the conductor.

$I \propto v$

$I = \frac{1}{R} V$ $\boxed{V = IR}$

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

| | Resistivity | | Conductivity |
|---|---|---|---|
| 1 | The resistance of a conductor of unit length and unit area of cross section | 1 | The reciprocal of resistivity |
| 2 | It is a measure of resisting power | 2 | It is a measure of conducting power |
| 3 | Less for conductors | 3 | More for conductors than insulators |
| 4 | Unit - ohm. metre ($\Omega$ m) | 4 | unit-ohm$^{-1}$ metre$^{-1}$ ($\Omega^{-1}m^{-1}$) |

5. **What connection is used in domestic appliances and why?**
   - Parallel connection is used in domestic appliances.
   - To provide equal supply voltage to all.
   - If one appliance is removed, it would not affect the condition of others.

## VIII. Long Answer Questions

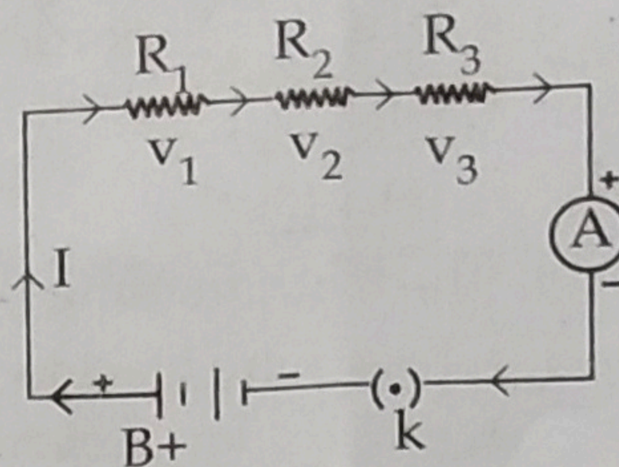
1. **With the help of a circuit diagram derive the formula for the resultant resistance of three resistances connected: a) in series and b) in parallel.**

**a) Resistors in series.**

- $R_1, R_2, R_3$ - Resistances connected in series.
- $V_1, V_2, V_3$ - Potential difference across $R_1, R_2$ and $R_3$

- I - current.
- In series connection, current - same; potential difference - different.
- According to ohm's law

$$\boxed{V_1 = IR_1,\ V_2 = IR_2,\ V_3 = IR_3,\ V = IRs} \quad \text{---------- (1)}$$




- Total potential difference, $V=V_1+V_2+V_3$ ---------- (2)

Substitute (1) in (2)

$$IR_S=IR_1+IR_2+IR_3$$

$$\boxed{R_S=R_1+R_2+R_3}$$

- Equivalent resistance is equal to the sum of the individual resistance.

**b) Resistors in parallel:**

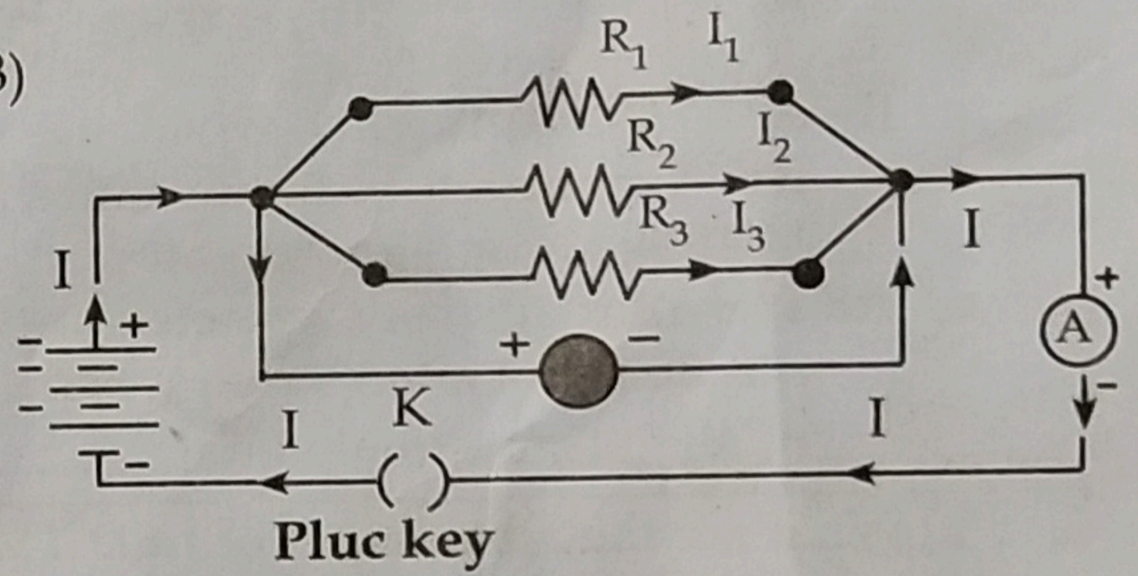
- $R_1, R_2, R_3$ - Resistances connected in parallel.
- $I_1, I_2, I_3$ - Current passing through $R_1, R_2$ and $R_3$
- V- Potential difference.
- In parallel connection, potential difference - same; current - different.
- According to ohm's law,

$$I_1 = \frac{V}{R_1}, I_2 = \frac{V}{R_2}, I_3 = \frac{V}{R_3}, I = \frac{V}{R_p} \quad \text{---------- (3)}$$

- Total current, $I=I_1+I_2+I_3$ ---------- (4)
- Substitute (3 )in (4)

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

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




- Effective resistance is equal to the sum of the reciprocal of the individual resistance.

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**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?**

**(a) Electric current :**

- The rate of flow of charges in a conductor. $I = \frac{Q}{t}$

**(b) Unit :**

- The S.I unit of current - ampere (A)
- One coulomb of charge flows through the conductor in one second.

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

**(c) Ammeter :**

- It should be connected in series in a circuit.

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**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?**

**(a) Joule's law of heating :**

- 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 passing through the resistor.

$$\boxed{H = I^2Rt}$$

**b)** (i) High melting point. (ii) High resistivity (iii) Not easily oxidised.

**c)**
- Fuse wire has low melting point which is connected in series with the circiut.
- When a large current passes through the circuit, the fuse wire melts.
- The circuit gets disconnected and saved from any damage.

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

- The first step is to bring the power supply to the main-box from a transformer.
- Main box has two components.
  - i) Fuse box - To protect the appliances
  - ii) Meter - To record electrical energy.
- Two insulated wires.
  - i) Red insulation - live wire.
  - ii) Black insulation - neutral wire.
- Both wires are connected to electricity meter through main fuse in which live wire is connected.
- It passes to main switch which has two separate circuits.
  - i) 5 A rating - tube lights, bulbs and fans.
  - ii) 15 A rating - refrigerators,air conditioners etc.
- All these circuits are connected in parallel because,
  - i) it does not affect other when any one is disconnected.
  - ii) all gets an equal voltage.

**5. a) What are the advantages of LED TV over the normal TV?**
**b) List the merits of LED bulb.**

**a) Advantages of LED TV over the normal TV**

- Reliable

**It uses**

- Less power and less energy
- Thin size
- Bright quality picture
- More life span

**b) Merits of LED bulb**

- No loss of energy
- Cooler than incandescent bulb
- Low power
- Not harmful
- Possibility of many colours.
- No usage of toxic materials.
- Cost and energy efficient.

## 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?**

**Given :**

Power, $P_1$ = 420 W
Power, $P_2$ = 180 W
Voltage, V = 220 V

**To find:** $I_1$ and $I_2$

**Formula** : Power (P) = Voltage (v)x Current (I)

**Solution:**

$P_1 = VI_1$

$420 = 220 \times I_1$

$I_1 = \frac{420}{220}$

**$I_1$=1.9A**

$P_2 = VI_2$

$180 = 220 x I_2$

$I_2 = \frac{180}{220}$

**$I_2$= 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.**

Given:

i) $P_1 = 100$ W

$t = 5$ hrs

ii) $P_2 = 60$ W

No.of bulbs = 4

$t = 5$ hrs.

**To find : Energy consumed** in the month of January (31 days)

**Formula :**

Energy (E) = No.of bulbs × Power (P) × Time (t)

**Solution :**

(i) Energy consumed by 100 W bulb

$E_1 = P_1 \times t$

$= 100 \times 31 \times 5$

$= 15500$ watt-hr

**$E_1$ = 15.5 kWh**

(ii) Energy consumed by four, 60 watt bulb

$E_2 = n \times P_2 \times t$

$= 4 \times 60 \times 31 \times 5$

**E2 = 37.2 kWh**

Total energy consumed, $E=E_1+E_2$

$E = 15.5 + 37.2$

**E = 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.**

Given: $V = 3V$

$I = 600$ m A $= 600 \times 10^{-3}$ A $= 0.6$ A

**To find:**

a) Power b) resistance c)Energy for 4 hrs

**Formula and Solution:**

**a) Power :**

$P = VI$

$= 3 \times 600 \times 10^{-3}$

$= 1800 \times 10^{-3}$

**P = 1.8 watt**

**b) Resistance:**

$R = \frac{V}{I}$

$= \frac{3}{0.6} = \frac{30}{6}$

**R = 5 ohm**

**c) Energy:**

$E = VIt$

$= 3 \times 0.6 \times 4 \times 60 \times 60$

$= 1.8 \times 14400$

**E = 25920 joules** (or)

$E = 3 \times 0.6 \times 4$

**E = 7.2 watt-hr**

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

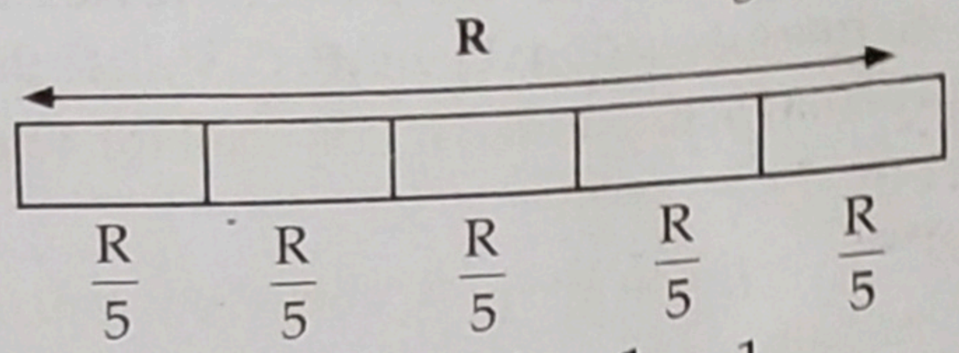
**a) How will the resistance of each part of the wire change compared with the original resistance?**

**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?**

**Solution :**

**a) Resistance of each port = $\frac{R}{5}$**




**b)** $\frac{1}{R_P}=\frac{1}{R_1}+\frac{1}{R_2}+\frac{1}{R_3}+\frac{1}{R_4}+\frac{1}{R_5}$

Here $R_1 = R_2 = R_3 = R_4 = R_5 = \frac{R}{5}$

$$\frac{1}{R_P}=\frac{1}{R/5}+\frac{1}{R/5}+\frac{1}{R/5}+\frac{1}{R/5}+\frac{1}{R/5}$$

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

$$\therefore \boxed{R_P=\frac{R}{25}}$$

**c)** $R_S = R_1+R_2+R_3+R_4+R_5$

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

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

$$\boxed{R_S = R}$$

Ratio of $R_S$ & $R_P$ is $\frac{R_S}{R_P}=\frac{R\times 25}{R}=\frac{25}{1}$

$$\therefore \boxed{\frac{R_S}{R_P}=25:1}$$

## 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.**

**Solution :**

$R_P = 2\Omega$ ---------- (1)

$R_S = 9\Omega$ ---------- (2)

From (1) $\frac{1}{R_P}=\frac{1}{2}$

$$\frac{1}{R_1}+\frac{1}{R_2}=\frac{1}{2}$$

$$\frac{R_1+R_2}{R_1R_2}=\frac{1}{2}$$

$$\frac{R_1R_2}{R_1+R_2}=2$$

$R_1 R_2 = 2 (R_1 + R_2)$ ---------- (3)

From (2)

$R_S = 9$

$R_1 + R_2 = 9$ ---------- (4)

$R_2 = 9 - R_1$ ---------- (5)

Sub (4) in (3)

$R_1 R_2 = 2 \times 9$

$R_1 R_2 = 18$

Substituting (5), $R_1 (9 - R_1) = 18$

$9 R_1 - R_1^2 - 18 = 0$

$R_1^2 - 9 R_1 + 18 = 0$

$(R_1-6)(R_1-3) = 0$

$\boxed{R_1 = 6\Omega}$ $\boxed{R_1 = 3\Omega}$

If $R_1 = 6\Omega$, $R_2 = 9 - 6$, $\boxed{R_1 = 3\Omega}$

If $R_1 = 3\Omega$, $R_2 = 9 - 3$, $\boxed{R_2 = 6\Omega}$

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

**Solution :**

$I = 5A$

$t = 1s$

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

$q = ne$

[Where n - number of electrons

e - charge of an electron]

$e = 1.6 \times 10^{-19} C$

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

$n = \frac{It}{e}$

$$= \frac{5 \times 1}{1.6 \times 10^{-19}}$$

$$= 3.125 \times 10^{19}$$

$n = 31.25 \times 10^{18}$ electrons

**Another method :**

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

1 coulomb contains $6.25 \times 10^{18}$ electrons.

Here, $I = 5A, t = 1s$

$q = It$

$= 5 \times 1$

$\boxed{q = 5\ C}$

$\therefore$ 5 coulomb contains $= 5 \times 6.25 \times 10^{18}$ electrons

$= 31.25 \times 10^{18}$ 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.**

**Give :** $R = 10\Omega$

$l_1 = 3l$

**Solution :** $R = \frac{\rho l}{A}$

$R_1 = \frac{\rho l_1}{A}$

$R_1 = \frac{3(\rho l)}{A}$

$R_1 = 9 \times 10 = 90\Omega$

$R_1 = 90\Omega$

## PART - II. ADDITIONAL QUESTIONS

| I One Mark Questions: | Answer |
|---|---|
| 1. Electric current is represented by the symbol ____. | **I** |
| 2. The rate of flow of charges in a conductor is _____. | **current** |
| 3. The S.I unit of electric current is _____. | **ampere (A)** |
| 4. _____ is a closed conducting path of current. | **Electric circuit** |
| 5. _____ is used to measure the current. | **Ammeter** |
| 6. Galvanometer is used to indicate the ____ of current. | **direction** |
| 7. _____ is used to measure the potential difference. | **voltmeter** |
| 8. The current flowing through the conductor is _____. | **I = Q/t** |
| 9. _____ is used to select the magnitude of the current. | **variable resistor (or) Rheostat** |
| 10. By convention, the direction of current is opposite to the direction of ____ | **flow of electrons** |
| 11. The electric current passes from _____ terminal to the _____ terminal. | **Positive, negative** |
| 12. The components of a circuit are represented by _____. | **symbols** |
| 13. The unit of electric potential (or) potential difference is ____. | **volt** |
| 14. Potential difference (v) = _____ | **$\frac{\text{Work done (W)}}{\text{Charge (Q)}}$** |
| 15. 1 volt = _____. | **$\frac{1\ \text{joule}}{1\ \text{coulomb}}$** |