Chapter 3: Current Electricity

Q. 1. Fill in the blanks:

(1) **ρ** is the constant of proportionality and is called the resistivity of the material.
(2) The unit of resistance is called **Ohm**
(3) An **electric current** is the flow of electrons through a conductor.
(4) The unit of current is called **ampere**.
(5) 1mA (mili ampere) = $\mathbf{10^{-3}}$ A
(6) In India, the voltage difference between the live and neutral wires is about **220V**.
(7) **Fuse** is made of a mixture of substances and has a specific melting point.
(8) Some conductors do not obey Ohm's law. Such conductors are called **non-ohmic** conductors.
(9) If three bulbs are connected in **series**, their light output will decrease further.
(10) 1kV (kilovolt) = $\mathbf{10^{3}}$ V

Q. 2. State weather True or False:

(1) A voltmeter is always connected in series with the device. **False**
(2) An ammeter is always connected in parallel in the circuit. **False**
(3) Silver and copper are good conductors. **True**
(4) Resistivity of a metal depends on temperature. **True**
(5) Resistivity of pure metals is more than that of alloys. **False**
(6) The electric bulb consists of the filament made of the material whose melting point is low. **False**
(7) The material used for fuse has low melting point. **True**

Q. 3. Find odd man out:

(1) Copper, Silver, Aluminium, Wood. **Wood**
(2) Aluminium, Silver, Gold, Nichrome. **Nichrome**
(3) Rubber, Glass, Aluminium, Wood. **Aluminium**
(4) The joule, The erg, The calorie, The newton. **The newton**

Q. 4. Match the following:

Column A	**Answers**	**Column B**
(1) 10^{-6} V	1mV (millivolt)	(a) 1MV (megavolt)
(2) 10^{-3} V	1uV (microvolt)	(b) 1kV (kilovolt)
(3) 10^{3} V	1kV (kilovolt)	(c) 1uV (microvolt)
(4) 10^{6} V	1MV (megavolt)	(d) 1mV (millivolt)

Q. 5. Write units of:

Quantities	**Units**
Charge	C
Current	A
Potential Difference	V
Resistance	Ω

Q. 6. Answer in one sentence:

(1) What is resistance of one ohm?

Answer: If one Ampere current flows through a conductor when one Volt potential difference is applied between its ends, then the resistance of the conductor is one Ohm.

(2) What is electric circuit?

Answer: A continuous path of an electric current through conducting wires connected to the two ends of a cell and other resistances is called an electric circuit.

(3) What is conductors?

Answer: Those substances which have very low resistance and through which current can flow easily are called conductors.

(4) What is insulators?

Answer: Those substances which have extremely high resistance and through which current cannot flow are called insulators.

(5) What is non-ohmic conductors?

Answer: Some conductors do not obey Ohm's law. Such conductors are called non-ohmic conductors.

(6) What is ampere?

Answer: One ampere current is said to flow in a conductor if one Coulomb charge flows through it every second.

Q. 7. Answer the following questions:

(1) Explain resistance of the conductor.

Answer: When a potential difference is applied between the two ends of the conductor, these electrons start moving from the end at lower potential to the end at higher potential. This directional motion of the electrons causes the flow of current. Moving electrons strike the atoms and ions which lie along their path. Such collisions cause hindrance to the flow of electrons and oppose the current. This hindrance is called the resistance of the conductor.

(2) What is free electrons.

Answer: Every atom of a metallic conductor has one or more outermost electrons which are very weakly bound to the nucleus. These are called free electrons. These electrons can easily move from one part of a conductor to its other parts. The negative charge of the electrons also gets transferred as a result of this motion. The free electrons in a conductor are the carriers of negative charge.

(3) Write uses of (a) Electric cell (b) Battery (collection of a number of cells) (c) Connecting (conducting) wires (d) Crossing wires

Answer:

(a) Electric Cell: To apply a potential difference between two ends of a conductor

(b) Battery (collection of a number of cells): To apply a larger potential difference between two ends of a conductor

(c) Connecting (conducting) wires: To connect various components in the circuit.

(d) Crossing wires: To show wires which cross but are not connected

(4) Write uses of (a) Light bulb (b) Resistance (c) Ammeter (d) Voltmeter

Answer:

(a) Light bulb: To test the flow of electricity : Lighted : current is flowing; unlighted : current is not flowing

(b) Resistance: To control the flow of current in the circuit

(c) Ammeter: To measure the current flowing in the circuit

(d) Voltmeter: To measure the potential difference between two points in the circuit

(5) Write the formula for resistors in series and resistors in parallel.

Answer:

For series connection

$R_s = R_1 + R_2 + R_n$

For parallel connection $R_P\, R_1\, R_2\, R_n$

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

Q.8. Solve:

(1) The resistance of a 1m long nichrome wire is 6 W. If we reduce the length of the wire to 70 cm. what will its resistance be?

Given:

- Resistance of 1 m nichrome wire (R_1) = 6 Ω
- Initial length of the wire (L_1) = 1 m
- New length of the wire (L_2) = 70 cm = 0.7 m

To Find:

New resistance (R_2) when the wire length is reduced to 70 cm

Concept:

Resistance (R) is directly proportional to the length (L) of the wire:

$R \propto L$

$\frac{R_2}{R_1} = \frac{L_2}{L_1}$

Calculation:

$R_2 = R_1 \cdot \frac{L_2}{L_1}$

$R_2 = 6\ \Omega \cdot \frac{0.7\ m}{1\ m}$

$R_2 = 6 \cdot 0.7$

$R_2 = 4.2\ \Omega$

Answer:

New resistance = 4.2 Ω

(2) When two resistors are connected in series, their effective resistance is 80 W. When they are connected in parallel, their effective resistance is 20 W. What are the values of the two resistances?

Given:

- Series resistance (R_s) = 80 Ω
- Parallel resistance (R_p) = 20 Ω

To Find:

Individual resistances R1 and R2

Formulas:

1. In series:

   $$R_s = R_1 + R_2$$

2. In parallel:

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

   $$R_p = \frac{R_1 \cdot R_2}{R_1 + R_2}$$

Step 1: Series resistance formula

In series:

$R_1 + R_2 = 80\,\Omega$

So,

$R_2 = 80 - R_1$

Step 2: Parallel resistance formula

In parallel:

$R_p = \frac{R_1 \cdot R_2}{R_1 + R_2}$

Substitute $R_2 = 80 - R_1$ into the equation:

$20 = \frac{R_1 \cdot (80 - R_1)}{80}$

Multiply both sides by 80:

$1600 = R_1 \cdot (80 - R_1)$

Step 3: Form a quadratic equation

Expand the equation:

$1600 = 80R_1 - R_1^2$

Rearranging:

$R_1^2 - 80R_1 + 1600 = 0$

Step 4: Solve using the splitting method

We need to split the middle term, $-80R_1$, into two terms whose product is $(R_1^2 \cdot 1600 = 1600)$ and whose sum is $-80R_1$.

The factors of 1600 that add to -80 are -40 and -40.

So, the equation becomes:

$R_1^2 - 40R_1 - 40R_1 + 1600 = 0$

Step 5: Factorize

Group the terms:

$R_1(R_1 - 40) - 40(R_1 - 40) = 0$

Factor out the common terms:

$(R_1 - 40)(R_1 - 40) = 0$

Step 6: Solve for R_1

So, $R_1 = 40\,\Omega$

Step 7: Find R_2

Since $R_2 = 80 - R_1$:

$R_2 = 80 - 40 = 40\,\Omega$

Answer:

The two resistances are $R_1 = 40\,\Omega$ and $R_2 = 40\,\Omega$.

(3) If a charge of 420 C flows through a conducting wire in 5 minutes what is the value of the current?

Given:

- Charge (Q) = 420 C
- Time (t) = 5 minutes = 5 × 60 = 300 seconds (converted to seconds)

To Find:

Current (I)

Formula:

Current (I) = $\frac{Q}{t}$

Calculation:

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

I = $\frac{420\,C}{300\,s}$=

I = 1.4 A

Answer:

The current flowing through the wire = 1.4 A

(4) A current of 0.4 A flows through a conductor for 5 minutes. How much charge would have passed through the conductor?

Given:

- Current (I) = 0.4 A
- Time (t) = 5 minutes = 5 × 60 = 300 seconds (converted to seconds)

To Find:

Charge (Q)

Formula:

Charge (Q) = Current (I) × Time (t)

Calculation:

Q=I x t

Q = 0.4 A×300 s

Q = 120 C

Answer:

The charge that passed through the conductor = 120 C

(5) The resistance of the filament in a light bulb is 1000 W. If the bulb is fed by a current from a source of potential difference 230 V, how much current will flow through it?

Given:

- Resistance of the filament (R) = 1000 Ω
- Potential difference (V) = 230 V

To Find:

Current (I)

Formula:

Ohm's Law:

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

Calculation:

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

I = $\frac{230\,V}{1000\,\Omega}$=

I = 0.23 A

Answer:

The current flowing through the light bulb = 0.23 A

(6) A current of 0.24 A flows through a conductor when a potential difference of 24 V is applied between its two ends. What is its resistance?

Given:

- Current (I) = 0.24 A
- Potential difference (V) = 24 V

To Find:

Resistance (R)

Formula:

Ohm's Law:

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

Calculation:

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

$R=\frac{24\,V}{0.24\,A}=$

$R=100\,\Omega$

Answer:

The resistance of the conductor = 100 Ω

(7) Determine the current that will flow when a potential difference of 33 V is applied between two ends of an appliance having a resistance of 110 W. If the same current is to flow through an appliance having a resistance of 500 W, how much potential difference should be applied across its two ends?

Given:

- Potential difference (V_1) = 33 V
- Resistance of the first appliance (R_1) = 110 Ω
- Resistance of the second appliance (R_2) = 500 Ω

To Find:

1. Current (I) when 33 V is applied to a 110 Ω appliance
2. Potential difference (V_2) to get the same current through a 500 Ω appliance

Step 1: Finding current (I) for the first appliance

Formula:

Ohm's Law:

$I=\frac{V_1}{R_1}$

Calculation:

$I = \frac{V_1}{R_1}$

$I=\frac{33\,V}{110\,\Omega}=$

$I = 0.3$ A

Step 2: Finding potential difference (V_2) for the second appliance

Formula:

Ohm's Law:

$V_2 = I \times R_2$

Calculation:

$V_2 = 0.3\,A \times 500\,\Omega$

$V_2 = 150$ V

Answer:

1. Current through the first appliance = 0.3 A
2. To get the same current (0.3 A) through a 500 Ω appliance, the potential difference required = 150 V

(8) Three resistors having resistances of 15 W, 3 W and 4 W are connected in series. What is the effective resistance in the circuit?

Given:

Resistors:

- R_1=15 Ω
- R_2=3 Ω
- R_3=4 Ω

To Find:

Effective resistance (R_S) in series connection

Formula:

For resistors in series:

$R_S = R_1 + R_2 + R_3$

Calculation:

$R_S = R_1 + R_2 + R_3$

R_S = 15 Ω + 3 Ω + 4 Ω=22 Ω

Answer:

The effective resistance in the circuit = 22 Ω

(9) Resistors having resistances of 15 W, 20 W and 10 W are connected in parallel. What is the effective resistance in the circuit?

Given:

Resistors connected in parallel:

- R_1=15 Ω
- R_2=20 Ω
- R_3=10 Ω

To Find:

Effective resistance (R_P) in parallel connection

Formula:

For resistors in parallel:

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

Calculation:

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

$$\frac{1}{Rp} = \frac{1}{15} + \frac{1}{20} + \frac{1}{10}$$

Taking the LCM of 15, 20, and 10:

$$\frac{1}{Rp} = \frac{4}{60} + \frac{3}{60} + \frac{6}{60}$$

$$\frac{1}{Rp} = \frac{4+3+6}{60}$$

$$\frac{1}{Rp} = \frac{13}{60}$$

$$\frac{Rp}{1} = \frac{60}{13} \approx 4.62\Omega$$

Answer:

The effective resistance in the circuit is approximately 4.62 Ω.