UNIT IV: EFFECTS OF CURRENT

CHAPTER 12

ELECTRICITY

Syllabus

Electric current, potential difference and electric current, Ohm's law; Resistance, Resistivity, Factors on which the resistance of a conductor depends. Series combination of resistors, parallel combination of resistors and its application in daily life, Heating effect of electric current and its applications in daily life, Electric power, Interrelation between P, V, I and R.

Trend Analysis

List of Concepts	2018	2019		2020	
	OD/D	OD	D	OD	D
Electric Current, Potential difference, Galvanometer, ammeter, voltmeter			1 Q (1 M)	2 Q (1 M)	2 Q (3 M)
Ohm's Law, Resistance, Resistivity, Factors on which the resistance of a conductor depends, alloys	1 Q (3 M)				
Series combination of resistors, parallel combination of resistors	1 Q (3 M)	1 Q (5 M) Or 1 Q (5 M)	1 Q (5 M)	1 Q (5 M)	1 Q (1 M)
Heating Effect of Electric Current, Electric Power.	Or 1 Q (3 M)	1 Q (1 M)	Or 1 Q (5 M)	1 Q (5 M)	

TOPIC - 1
Electric Current, Ohm's Law

Revision Notes

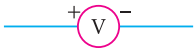
- **Static and Current Electricity:** Static electricity deals with the electric charges at rest while the current electricity deals with the electric charges in motion.
- **Electric Current:** The electric current is defined as the rate of flow of electric charge through any cross section of a conductor.

$$\text{Electric current} = \frac{\text{Charge}}{\text{Time}} \quad \text{or} \quad I = \frac{Q}{t}$$

TOPIC - 1
Electric Current, Ohm's Law

TOPIC - 2
Resistance in Series and Parallel Combination, Electric Power and Heating Effect

- Electric current is a scalar quantity.
- **Ampere:** It is the SI unit of current. If one coulomb of charge flows through any cross-section of a conductor in one second, then current through it is said to be one ampere.
- **Electric circuit:** The closed path along which an electric current flows is called an 'electric circuit'.
- **Conventional direction of current:** Conventionally, the direction of motion of positive charges through the conductor is taken as the direction of current. The direction of conventional current is opposite to that of the negatively charged electrons.
- **Electrochemical or voltaic cell:** It is a device which converts chemical energy into electrical energy.
- **Galvanometer:** It is a device to detect current in an electric circuit.
- **Ammeter:** It is a device to measure current in a circuit. It is a low resistance galvanometer and is always connected in series in a circuit.
- **Voltmeter:** It is a device to measure the potential difference. It is a high resistance galvanometer and is always connected in parallel to the component across which the potential difference is to be measured. Symbol is,



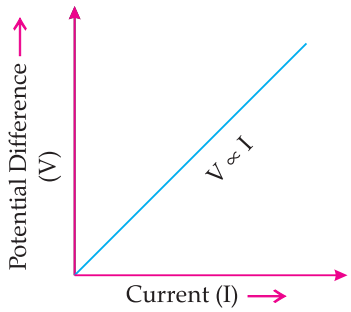
- **Ohm's Law:** The current through a conductor between two points is directly proportional to the voltage across the two points provided external conditions remain constant.

  (i) Mathematical expression for Ohm's law:

  $I \propto V$

  $V = IR$ (Where R = Resistance)

  (ii) *V-I* graph for Ohm's law:



- **Resistance (*R*):** It is the property of a conductor to resist the flow of charges through it.

  (i) S.I. unit of resistance is Ohm (Ω).

  (ii) 1 ohm $= \dfrac{1 \text{ volt}}{1 \text{ ampere}}$

- When potential difference is 1 V and current through the circuit is 1 A, then resistance is 1 ohm.
- **Rheostat:** Rheostat is a variable resistor used to regulate current without changing the source of voltage.
- **Factors on which the Resistance of a Conductor depends:** Resistance of a uniform metallic conductor is,

  (i) Directly proportional to the length of conductor

  (ii) Inversely proportional to the area of cross-section

  (iii) Directly proportional to the temperature

  (iv) Depends on nature of the material.
- **Resistivity (ρ):** It is defined as the resistance offered by a cube of a material of side 1 m when current flows perpendicular to its opposite faces.

  (i) Its S.I. unit is ohm-metre (Ωm).

  (ii) Resistivity does not change with change in length or area of cross-section but it changes with change in temperature.

  (iii) Range of resistivity of metals and alloys is 10^{-8} to 10^{-6} Ωm.

  (iv) Range of resistivity of insulators is 10^{12} to 10^{17} Ωm.

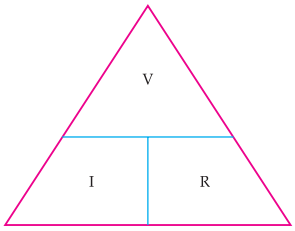
  (v) Resistivity of alloy is generally higher than that of its constituent metals.

  (vi) Alloys do not oxidize (burn) readily at high temperature, so they are commonly used in electrical heating devices.

  (vii) Copper and aluminium are used for electrical transmission lines as they have low resistivity.

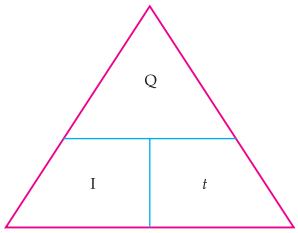
Mnemonics

Concept: Ohm's Law



Interpretation:
To find V=Multiply I and R
To find I=Divide V and R
To find R=Divide V and I

Concept: Current Formula



Interpretation:
I=Q/t
Q=I x t
t=Q /I

Concept: Connection of ammeter and voltmeter

Mnemonics: **m Sleeping Very Patiently**

Interpretation:
Ammeter is connected in **S**eries
Voltmeter is connected in **P**arallel

How is it done on the GREENBOARD?

Q. Calculate the resistance of a 1 km long copper wire of area of corss section 2×10^{-2} cm^2. The restivity of copper is 1.623×10^{-8} ohm-meter.

Solution:

Step I: $R = \rho \frac{L}{A}$

where R = Resistance of the wire
L = Length of the were
A = Area of cm section of the wire

Step II: $\rho = 1.623 \times 10^{-8}$ ohm-meter
$L = 1$ km $= 1000$ m
$A = 2 \times 10^{-2}$ cm^2 $= 2 \times 10^{-2} \times 10^{-4}$ m^2

Step III: $R = \rho \frac{L}{A}$

or $R = 1.623 \times 10^{-8} \times \frac{1000}{2 \times 10^{-2} \times 10^{-4}}$

$\therefore$ $R = 8.1\ \Omega$

Objective Type Questions — 1 mark each

A Multiple Choice Questions

Q. 1. A cylindrical conductor of length 'l' and uniform area of cross section 'A' has resistance 'R'. The area of cross section of another conductor of same material and same resistance but of length '$2l$' is

(a) $\frac{A}{2}$ **(b)** $\frac{3A}{2}$ **(c)** 2 A **(d)** 3 A [OD CBSE, 2020]

Ans. Correct option: (c)

Explanation : Resistivity of the conductor in the first case, $\rho = \frac{RA}{l}$ ...(i)

Resistivity of the conductor in second case,

$\rho = \frac{RA'}{2l}$ ...(ii)

Since, both conductors are of same material and are at same temperature, so the resistivity of both the conductors will be same.

Therefore, from equations, (i) and (ii), we have :

$$\Rightarrow \frac{RA}{l} = \frac{RA'}{2l}$$

$$\Rightarrow A' = 2A$$

Q. 2. The maximum resistance which can be made using four resistor each of resistance ½Ω is

(a) 2 Ω **(b)** 1 Ω

(c) 2.5 Ω **(d)** 8 Ω [OD CBSE, 2020]

Ans. Correct option: (a)

Explanation : Maximum resistance in series = 4 x ½ = 2ohm

Q. 3. When a 4V battery is connected across an unknown resistor there is a current of 100 mA in the circuit. The value of the resistance of the resistor is:

(a) 4 Ω **(b) 40 Ω**

(c) 400 Ω **(d) 0.4 Ω**

[Board SQP, 2020]

Ans. Correct option: (b)

Explanation : $V=IR$, $V = 4$ V, $I = 100$ mA $= 0.1$ A

Hence, $R=\frac{V}{I}=\frac{4}{0.1} = 40\ \Omega$.

Q. 4. Unit of electric power may also be expressed as:

(a) Volt-ampere **(b) Kilowatt-hour**

(c) Watt-second **(d) Joule-second**

[Board SQP, 2020]

Ans. Correct Option: (a)

Explanation : Unit of electric power is volt-ampere.

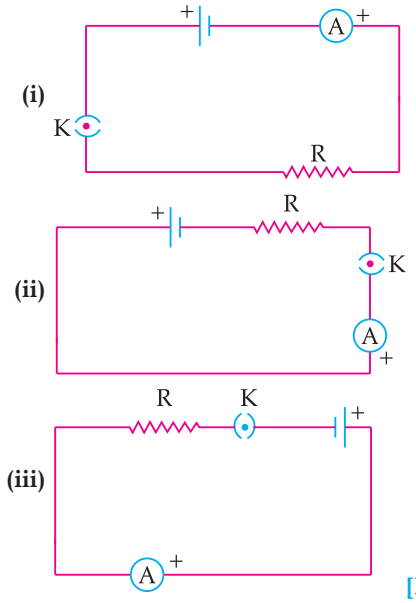
Q. 5. A cell, a resistor, a key, and ammeter are arranged as shown in the circuit diagrams of Figure. The current recorded in the ammeter will be:

(a) maximum in (i).

(b) maximum in (ii).

(c) maximum in (iii).

(d) the same in all the cases.



[NCERT Exemp.]

Ans. Correct option : (d)

Explanation : In series connections, the order of elements in the circuit will not affect the amount of current flowing in the circuit.

Q. 6. Electrical resistivity of a given metallic wire depends upon

(a) its length. **(b) its thickness.**

(c) its shape. **(d) nature of the material.**

[NCERT Exemp.]

Ans. Correct option : (d)

Explanation : The resistivity of a material is constant for a particular material at a constant temperature. It only depends on the temperature. Resistivity of material does not depend on length, thickness, and shape of the material.

Q. 7. A current of 1 A is drawn by a filament of an electric bulb. Number of electrons passing through a cross section of the filament in 16 seconds would be where, $e = 1.6 \times 10^{-19}$ C

(a) 10^{20} **(b)** 10^{16}

(c) 10^{18} **(d)** 10^{23}

[NCERT Exemp.]

Ans. Correct option : (a)

Explanation :

Given, I =1 Amp.

t =16 s

$$\text{As } I = \frac{Q}{t} = \frac{ne}{t}$$

$$n = \frac{(1\times T)}{e} = \frac{1\times 16}{1.6\times 10^{-19}}$$

$$n = 10^{20}$$

B Assertions and Reasons Type Questions

Directions: In the following questions, a statement of assertion (A) is followed by a statement of reason (R). Mark the correct choice as:

(a) Both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A).

(b) Both assertion (A) and reason (R) are true but reason (R) is not the correct explanation of assertion (A).

(c) Assertion (A) is true but reason (R) is false.

(d) Assertion (A) is false but reason (R) is true.

Q. 1. Assertion (A): A conductor has + 3.2 × 10^{-19} C charge.

Reason (R): Conductor has gained 2 electrons.

Ans. Correct option : (c)

Explanation : Conductor has positive charge, so it has lost two electrons.

Q. 2. Assertion (A): The resistivity of conductor increases with the increasing of temperature.

Reason (R): The resistivity is the reciprocal of the conductivity.

Ans. Correct option : (b)

Explanation : The resistivity of the conductors is directly proportional to temperature.

Q. 3. Assertion (A): Bending a wire does not affect electrical resistance.

Reason (R): Resistance of wire is proportional to resistivity of material.

Ans. Correct option : (a)

Explanation : Resistance of wire $R = \rho\left(\frac{l}{A}\right)$

Where ρ is resistivity of material which does not depend on the geometry of wire. Since when wire is bent its, resistivity, length and area of cross-section do not change, therefore resistance of wire also remains same.

Q. 4. Assertion (A): Two resistance having value R each. Their equivalent resistance is $\frac{R}{2}$.

Reason (R): Given Resistances are connected in parallel.

Ans. Correct option : (a)

Explanation : When two resistances R_1 and R_2 connected in parallel than their equivalent resistance will be $R = \frac{R_1R_2}{R_1 + R_2}$.

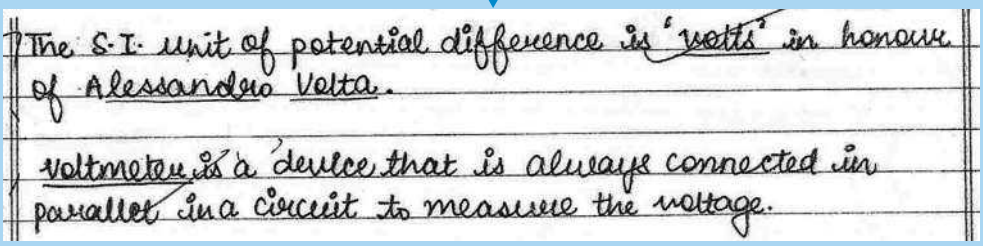
C Very Short Answer Type Questions

Q. 1. Some work is done to move a charge Q from infinity to a point A in space. The potential of the point A is given as V. What is the work done to move this charge from infinity in terms of Q and V? R [SQP-2020]

Ans. W=QV. **1**

Q. 2. State the SI unit of potential difference and name the device used to measure it. A [CBSE Board Delhi, 2019]

Topper Answer, 2019


The S.I. unit of potential difference is 'volts' in honour of Alessandro Volta.

voltmeter is a device that is always connected in parallel in a circuit to measure the voltage.

Q. 3. What is the function of a galvanometer in a circuit ? R [CBSE Board Delhi- Set- I, 2019]

Ans. Detect the presence or direction of current. **1**
[CBSE Marking Scheme, 2019]

Q. 4. Name and define the SI unit of current. R [CBSE Board Delhi, Set- II, 2019]

Ans. Ampere. ½
Flow of 1 coulomb of charge per second.
1 ampere = $\frac{1\text{ coulomb}}{1\text{ second}}$ ½
[CBSE Marking Scheme, 2019]

Q. 5. Write the function of voltmeter in an electric circuit. R [CBSE Board Delhi, Set-II, 2019]

Ans. To measure potential difference across two points.
[CBSE Marking Scheme, 2019] **1**

Q. 6. Why are the heating elements of electric toasters and electric irons made of an alloy rather than a pure metal ? A [CBSE Board Outside Delhi, 2019]

Ans. Due to high resistivity of alloys rather than its constituting metals. **1**
[CBSE Marking Scheme, 2019]

AI **Q. 7. Should the resistance of a voltmeter be low or high? Give reason.** A [Board Outside Delhi, Set- II, 2019]

Ans. High. In parallel connection, less current passes through high resistance. ½ + ½
[CBSE Marking Scheme, 2019]

Q. 8. Name the device that helps to maintain a potential difference across a conductor. R [Board Term I, 2016]

Ans. A battery is used to maintain potential difference across a conductor. **1**

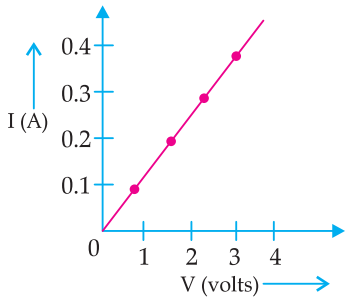
Q. 9. Write SI unit of resistivity. R [Board Term I, Set-2, 2015] [DDE 2017]

Ans. Ohm metre (ohm m).

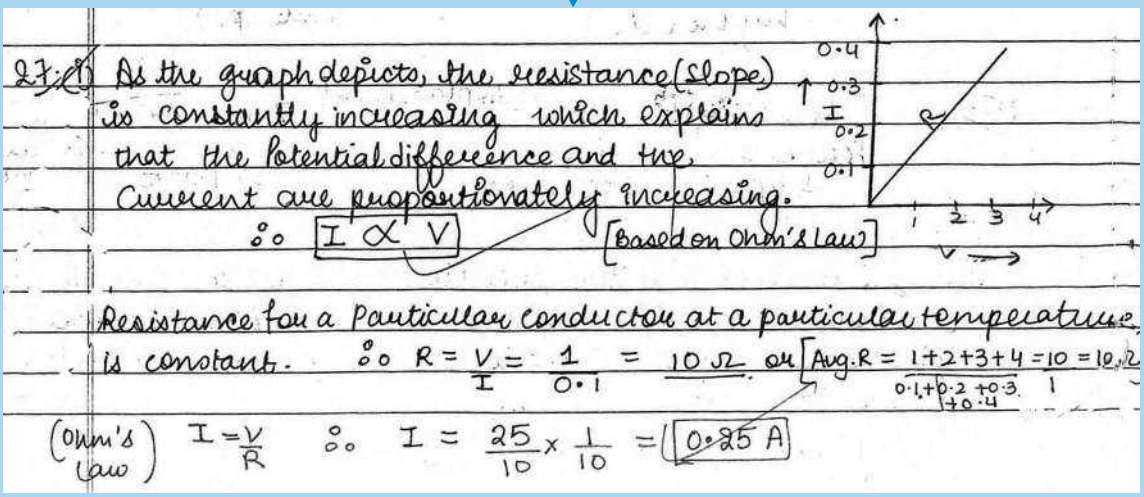
Short Answer Type Questions-I — 2 marks each

Q. 1. In the experiment to study the dependence of current (I) on the potential difference (V) across a resistor, a student obtained a graph as shown,
What does the graph depict about the dependence of current on the potential difference?
Find the current that flows through the resistor when the potential difference across it is 2.5V.

A [CBSE Board Delhi, 2019]



Topper Answer, 2019



Q. 2. While studying the dependence of potential difference (V) across a resistor on the current (I) passing through it, in order to determine the resistance of the resistor, a student took 5 readings for different values of current and plotted a graph between V and I. He got a straight line graph passing through the origin. What does the straight line signify? Write the method of determining resistance of the resistor using this graph.

[CBSE, Delhi 2019]

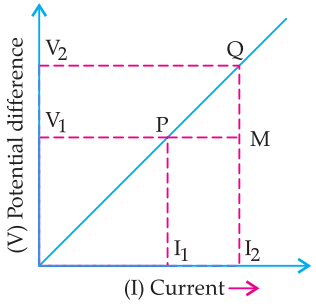
Ans. Potential difference (V) is directly proportional to current (I) or V ∝ I. **1**

- Method : Finding slope of the graph. **1**

[CBSE Marking Scheme 2019]

Detailed Answer:

The graph between V and I is a straight line and passes the origin, this verifies the Ohm's law. **1**



The slope gives the resistance of the resistor used in the circuit. **1**

$$\text{Slope} = \frac{QM}{MP} = \frac{V_2 - V_2}{I_2 - I_2}$$

$$\text{Or } R = \frac{\text{Value of potential differnce at a point}}{\text{Value of current at the same point}}$$

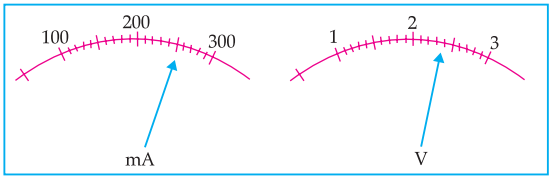
1+1=2

Q. 3. The current flowing through a resistor connected in a circuit and the potential difference developed across its ends are as shown in the diagram by milliammeter and voltmeter readings respectively.

(a) What are the least counts of these meters ?

(b) What is the resistance of the resistor ?

[CBSE 2019, OD SET-2]



Ans. (a) least count of ammeter = 10 mA ½+½

least count of voltmeter = 0.1 V ½+½

(b) $\frac{2.4}{0.25}$ = 9.6 ohm (250 mA = 0.25 A)

[CBSE Marking Scheme 2019]

Detailed Answer:

(a) Least count of millianmeter = 10 mA

Least count of voltmeter = $\frac{1}{10}$ = 0.1 V ½+½

(b) Current, I = 250 mA = 250 × 10^{-3} A

Potential difference, V = 2.4 V

Resistance, R= $\frac{V}{I}$ = $\frac{24}{250\times10^{-3}}$ = 9.6 Ω ½+½

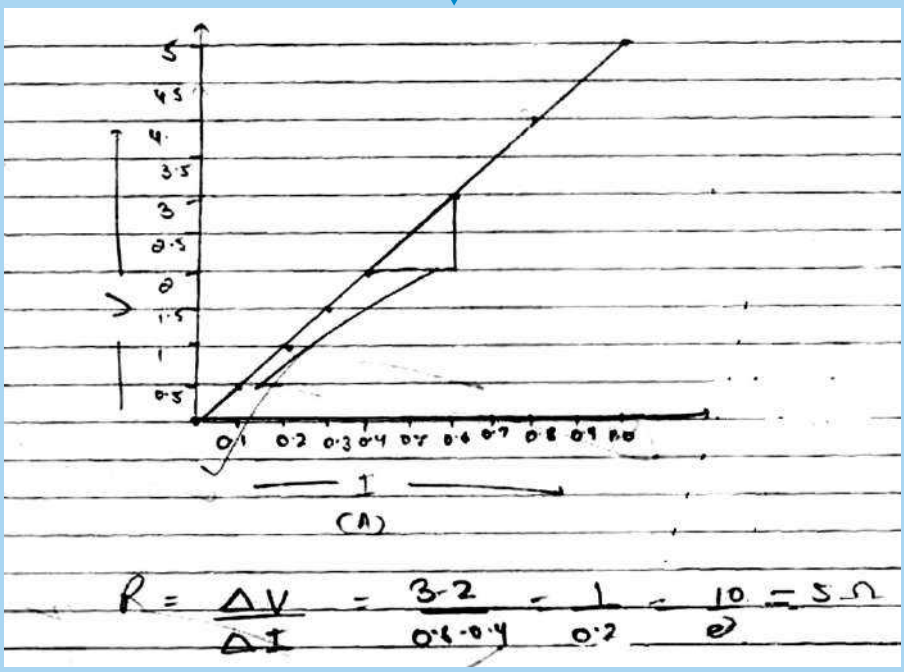
Q. 4. The values of current (I) flowing through a given resistor of resistance (R), for the corresponding values of potential difference (V) across the resistor are as given below:

V (volts)	0.5	1.0	1.5	2.0	2.5	3.0	4.0	5.0
I (amepere)	0.1	0.2	0.3	0.4	0.5	0.6	0.8	1.0

Plot a graph between current (I) and potential difference (V) and determine the resistance (R) of the resistor.

[CBSE 2018 Delhi Set-1]

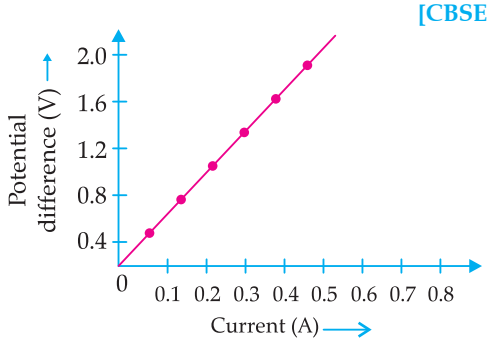
Topper Answer, 2018



Short Answer Type Questions-II — 3 marks each

Q. 1. A V-I graph for a nichrome wire is given below. What do you infer from this graph? Draw a labelled circuit diagram to obtain such a graph.

[CBSE 2020]



Ans. Graph between V and I is a straight line.

So, this infers that the flow of current (I) in the conductor is directly proportional to the potential diffidence (V) established across it. This is ohm's law.

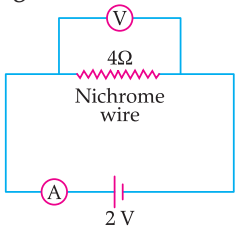
Resistance of the wire can be calculated as :

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

$$\frac{0.8}{0.2} = 4 \text{ ohm}$$

This means nichrome wire has a constant value of the resistance 4 ohm. **2**

Circuit diagram:



1

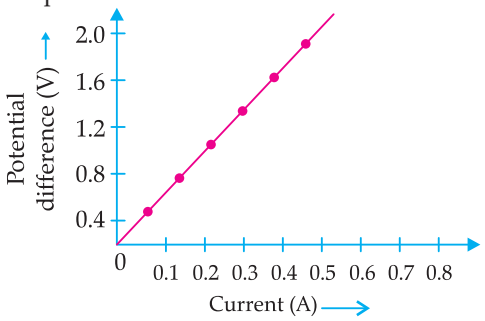
Q. 2. (a) State the relation correlating the electric current flowing in a conductor and the voltage applied across it. Also draw a graph to show this relationship.

(b) Find the resistance of a conductor if the electric current flowing through it is 0.35 A when the potential difference across it is 1.4 V. [CBSE 2020]

Ans. (a) The flow of current (I) in the conductor is directly proportional to the potential difference (V) established across it provided the physical conditions remain same.

Or V = IR

Graph:



2

(a) Given :

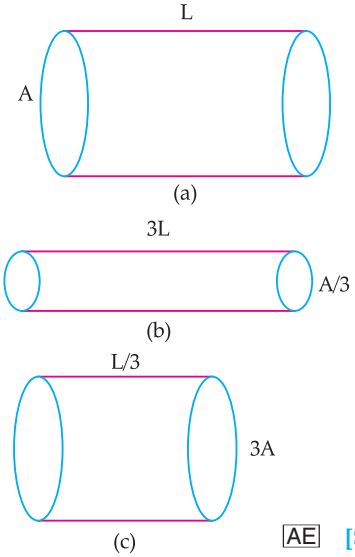
Potential Difference (V)= 1.4 V

Current (I) = 0.35 A

As per formula, V = IR

So, $\frac{V}{I} = \frac{1.4}{0.35}$ = 4ohm **1**

Q. 3. The figure below shows three cylindrical copper conductors along with their face areas and lengths. Compare the resistance and the resistivity of the three conductors. Justify your answer.



AE [SQP - 2018]

Ans. $R_a = \frac{L}{A}$ ½

$R_b = \rho\left(\frac{3L}{A/3}\right) = 9\frac{\rho L}{A} = 9R_a$ ½

$R_c = \rho\frac{L/3}{3A} = \frac{1}{9}\frac{\rho L}{A} = \frac{1}{9}R_a$ ½

Hence $R_b > R_a > R_c$ ½

$\rho_a = \rho_b = \rho_c$ because all the three conductors are of same material. [CBSE Marking Scheme, 2018] **1**

Q. 4. What is electrical resistivity ? Derive its SI unit. In a series electrical circuit comprising a resistor made up of a metallic wire, the ammeter reads 100 mA. If the length of the wire is doubled, how will the current in the circuit change ? Justify your answer. U [Delhi Comptt. 31/1, 31/2, 31/3, 2018]

Ans. Electrical resistivity of the material of a conductor is the resistance offered by the conductor of length 1 m and area of cross-section 1 m^2. **1**

$$\rho = \frac{RA}{l}$$

Unit of $\rho = \frac{\text{ohm meter}^2}{\text{metre}}$ = ohm meter **1**

Resistance of wire is doubled if its length is doubled.

Hence current is reduced to half.

$\therefore$ Ammeter reading = $\frac{100\text{ mA}}{2}$ = 50 mA. **1**

[CBSE Marking Scheme, 2018]

COMMONLY MADE ERROR

- Students often write vague answer. They get confused between the terms resistance and resistivity.

ANSWERING TIP

- Always write the unit in SI system only. Resistance of wire is directly proportional to length of the wire. So, Resistance of wire get doubled if the length is doubled.

Q. 5. (a) List the factors on which the resistance of a conductor in the shape of a wire depends.

(b) Why are metals good conductors of electricity whereas glass is a bad conductor of electricity ? Give reason.

(c) Why are alloys commonly used in electrical heating devices ? Give reason. U [Delhi /Outside Delhi 2018]

Ans. (a) Factors on which resistance of a conductor depends :

(i) Length of conductor [or $R \propto l$]

(ii) Area of cross-section of the conductor

[or $R \propto \frac{1}{A}$] **1**

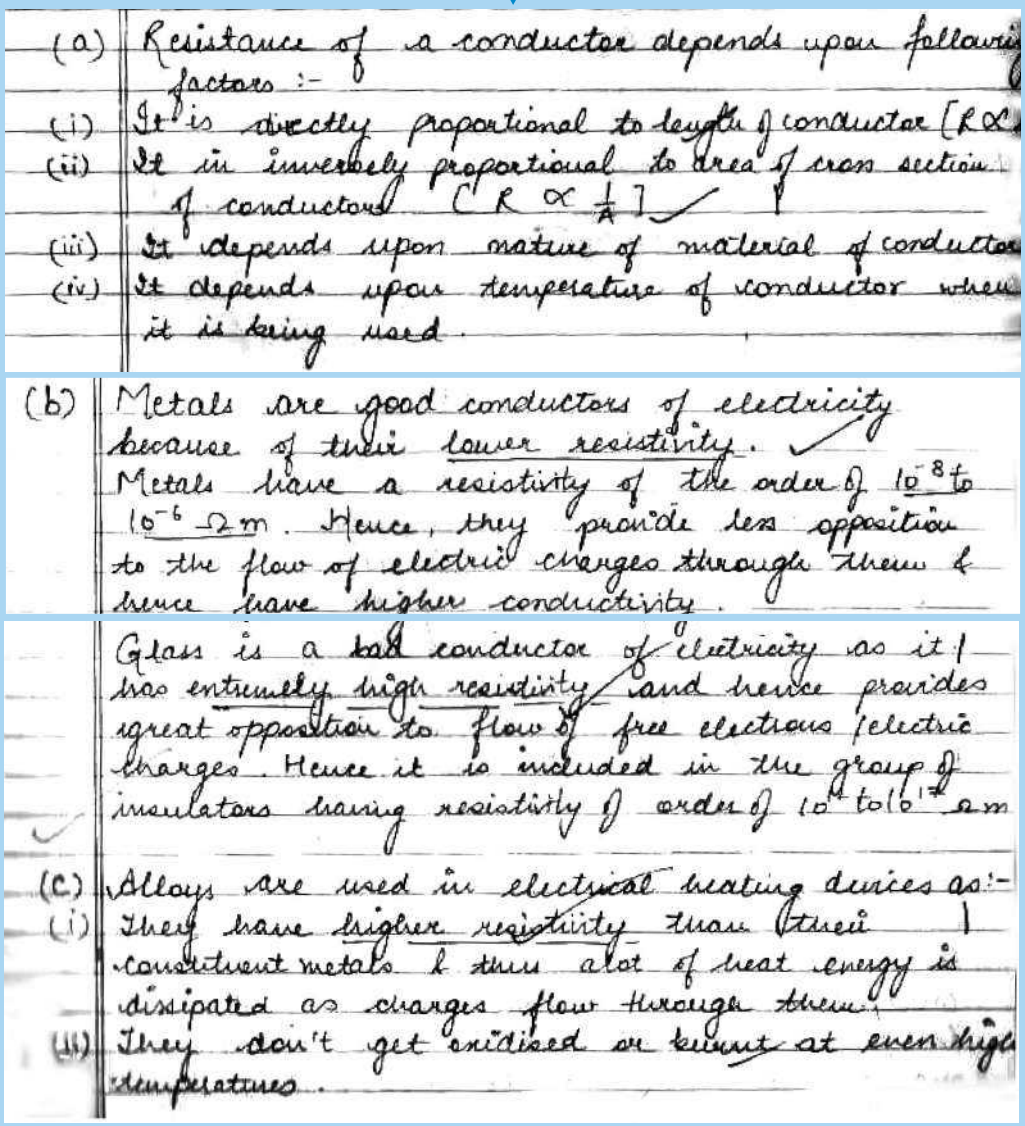
(b) Metals are good conductor of electricity – as they have low resistivity/have free electrons. Glass is a bad conductor of electricity – as it has high resistivity/have no free electrons. **1**

(c) Reason: Alloys have high resistivity/high melting point/alloys do not oxidize (or burn) readily at high temperatures. **(Any one) 1**

[CBSE Marking Scheme, 2018]

Detailed Answer:

Topper Answer, 2018


(a) Resistance of a conductor depends upon following factors :-
(i) It is directly proportional to length of conductor [$R \propto$
(ii) It is inversely proportional to area of cross section of conductor [$R \propto \frac{1}{A}$]
(iii) It depends upon nature of material of conductor
(iv) It depends upon temperature of conductor when it is being used.

(b) Metals are good conductors of electricity because of their lower resistivity.
Metals have a resistivity of the order of 10^{-8} to 10^{-6} Ωm. Hence, they provide less opposition to the flow of electric charges through them & hence have higher conductivity.

Glass is a bad conductor of electricity as it has extremely high resistivity and hence provides great opposition to flow of free electrons (electric charges). Hence it is included in the group of insulators having resistivity of order of 10^{12} to 10^{17} Ωm

(c) Alloys are used in electrical heating devices as:-
(i) They have higher resistivity than their constituent metals & thus alot of heat energy is dissipated as charges flow through them.
(ii) They don't get oxidised or burnt at even high temperatures.

AI **Q. 6. State Ohm's Law. Draw a circuit diagram to verify this law indicating the positive and negative terminals of the battery and the meters. Also show the direction of current in the circuit.**

R [Board Term I, 2016]

Ans. Statement of Ohm's Law,
Circuit diagram with polarity of battery, ammeter and voltmeter
Direction of current by arrow.

[CBSE Marking Scheme, 2016] **3**

Detailed Answer:

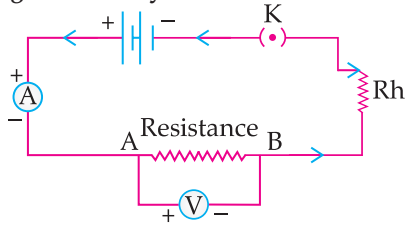
Ohm's Law: It states that "Physical conditions remaining same, the current flowing through a conductor is directly proportional to the potential difference across its two ends".

i.e., $I \propto V$

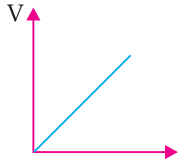
$V = IR$

where the constant of proportionality R is called the electrical resistance.

Diagram to verify Ohm's Law:



Graph :



2 + 1

COMMONLY MADE ERROR

- Students often write incorrect ohm's law. While drawing circuit diagram, many of them fail to mark the direction of current by arrow.

ANSWERING TIP

- Candidates should write Ohm's law correctly and should draw the correct diagram to verify Ohm's law.

Q. 7. Calculate the resistance of a 1 km long copper wire of area of cross section 2×10^{-2} cm^2. The resistivity of copper is 1.623×10^{-8} ohm-meter.

A [Board Term I, 2016]

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

$= \frac{1.623 \times 10^{-8} \times 1000}{2 \times 10^{-2} \times 10^{-4}\ \text{m}^2}$

$= 0.81 \times 10\ \Omega = 8.1\ \Omega.$ **3**

[CBSE Marking Scheme, 2016]

COMMONLY MADE ERROR

- Sometimes, students fail to write the correct formula of resistance.

ANSWERING TIP

- Practice writing formula in the beginning. Make sure you write all essential steps. Final answer need to be expressed along with a proper unit.

Long Answer Type Questions — 5 marks each

Q. 1. What does an electric circuit mean ? Name a device that helps to maintain a potential difference across a conductor in a circuit. When do we say that the potential difference across a conductor is 1 volt ?

R [Board Term I, 2016]

Ans. Electric circuit: The closed path along which an electric current flows is called an 'electric circuit'. The device that helps to maintain a potential difference across a conductor in a circuit are—

Electric cell, electric battery, electric generator **2+1**

1 Volt: The potential difference between two points in an electric field is said to be one volt if one joule of work has to be done in bringing a positive charge of one coulomb from one point to another.

$$1 \text{ volt} = \frac{1 \text{ Joule}}{1 \text{ Coulomb}} \text{ or } 1\ V = \frac{1\ J}{1\ C} \qquad \textbf{2}$$

AI **Q. 2. (i) Name an instrument that measures electric current in a circuit. Define unit of electric current.**

(ii) What are the following symbols mean in an electric circuit.

(a) 

(b) 

(iii) Draw a closed circuit diagram consisting of 0.5 m long nichrome wire XY, an ammeter, a voltmeter, four cells of 1.5 V and a plug key.

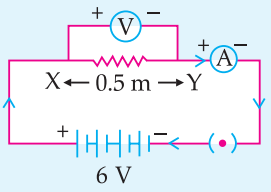
R [Board Term I, 2016]

Ans. (i) Ammeter

The current is said to be one ampere if 1 coulomb of charge flows through a cross section of conductor per second.

(ii) (a) Rheostat **(b)** Plug key (closed)

(iii)



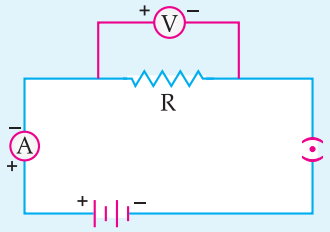
[CBSE Marking Scheme, 2016] **2 + 3**

Q. 3. (i) Draw a labelled circuit diagram to study a relationship between potential difference (V) across the two ends of a conductor and the current (I) flowing through it. State the formula to show how I in a conductor varies when V across it is increased step wise. Show this relationship also on a schematic graph.

(ii) Calculate the resistance of a conductor if the current flowing through it is 0.25 A when the applied potential difference is 1.0 V.

U [Board Term I, 2016]

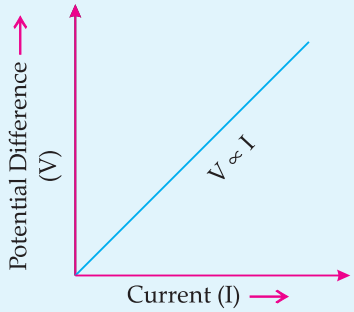
Ans. (i)



The formula states that the current passing through a conductor is directly proportional to the potential difference across its ends, provided the physical conditions like temperature, density, etc. remain unchanged. This is Ohm's law.

$$I \propto V \text{ or } I = \frac{V}{R}$$

$$V = IR.$$



(ii)

$V = 1.0\ V$

$I = 0.25\ A$

$V = IR$

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

$$= \frac{1}{0.25} = 4\ \Omega \quad 1 + 2 + 2$$

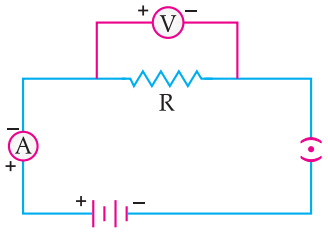
[CBSE Marking Scheme, 2016]

Q. 4. Draw a labelled circuit diagram to study the relationship between the current (*I*) flowing through a conductor and the potential difference (*V*) applied across its two ends. State the formula co-relating the I in a conductor and the *V* across it. Also show their relationship by drawing a diagram.

What would be the resistance of a resistor if the current flowing through it is 0.15 A when the potential difference across it is 1.05 V ?

A [Board Term I, 2015]

Ans.



Try Yourself. See Question No. 3(i) of Long Answer Type Question.

$$I \propto V \text{ or } I = \frac{V}{R}$$

$$V = IR.$$

$V = 1.05\ V$

$I = 0.15\ A$

Putting in equation

$$V = IR$$

or, $1.05 = 0.15 \times R$

$$\therefore \quad R = \frac{1.05}{0.15} = 7\ \Omega \qquad 1 + 2 + 2$$

TOPIC - 2

Resistance in Series and Parallel Combination, Electric Power and Heating Effect

Revision Notes

- **Resistances in series:** When two or more resistances are connected end to end so that same current flows through each one of them in turn, they are said to be connected in series. Here, the total resistance is equal to the sum of the individual resistances.

$$R_s = R_1 + R_2 + R_3 + ...$$

- **Resistances in parallel:** When two or more resistances are connected across two points so that each one of them provides a separate path for current, they are said to be connected in parallel. Here, the reciprocal of their combined resistance is equal to the sum of the reciprocals of the individual resistances.

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

- **Heating effect of current** : When an electric current is passed through a conductor, heat is produced in it. This is known as heating effect of current.
- **Joule's law of heating:** It states that the heat produced in a conductor is directly proportional to **(i)** the square of the current I through it, **(ii)** its resistance R and **(iii)** the time t, for which current is passed. Mathematically, it can be expressed as :

$$H = I^2 Rt \text{ joule} = \frac{I^2 Rt}{4.18} \text{cal}$$

Or

$$H = VIt \text{ joule} = \frac{VIt}{4.18} \text{cal}$$

- **Practical application of the heating effect of electric current:** It is utilised in the electrical heating appliances such as electric iron, room heaters, water heaters etc. The electric heating is also used to produce light as in an electric-bulb.
- **Electric energy:** It is the total work done in maintaining an electric current in an electric circuit for a given time.

Electric energy, $W = VIt = I^2Rt$ joule

- **Electric Fuse:** It is a safety device that protects our electrical appliances in case of short circuit or overloading.
  (i) Fuse is made up of pure tin or alloy of copper and tin.
  (ii) Fuse is always connected in series with live wire.
  (iii) Fuse has low melting point.
  (iv) Current capacity of fuse is slightly higher than that of the appliance.
- **Electric Power:** The rate at which electric energy is consumed or dissipated in an electric circuit :

$$P = VI$$

$$P = I^2R = \frac{V^2}{R}$$

- S.I. unit of power = Watt (W)
  1 Watt = 1 Volt × 1 ampere
- Commercial unit of electric energy = Kilo Watt hour (KWh)
  1 kWh = 3.6×10^6 J
  1 kWh = 1 unit of electric energy
- **Electrical power:** Electrical power is the rate at which electric energy is consumed by an appliance.
- **Watt:** It is the SI unit of power. The power of an appliance is 1 watt if one ampere of current flows through it on applying a potential difference of 1 volt across its ends.

$$1 \text{ watt} = \frac{1 \text{ joule}}{1 \text{ second}} = 1 \text{ volt} \times 1 \text{ ampere}$$

or

$$1 \text{ W} = 1\text{Js}^{-1} = 1\text{VA}$$

$$1 \text{ kilowatt} = 1000 \text{ W.}$$

- **Kilowatt hour:** It is the commercial unit of electrical energy. One kilowatt hour is the electrical energy consumed by an appliance of 1000 watts when used for one hour.

$$1 \text{ kilowatt hour (kWh)} = 3{\cdot}6 \times 10^6 \text{ J}$$

- **Power rating:** The power rating of an appliance is the electric energy consumed per second by the appliance when connected across the marked voltage of the mains.
- **Efficiency of an electrical device:** It is the ratio of the output power to the input power.

$$\text{Efficiency, } \eta = \frac{\text{Output power}}{\text{Input power}}$$

Mnemonics

Concept: Formula of power	
Mnemonics: Twinkle Twinkle Little Star Power equals I squared R	
Interpretation: $P = I^2 R$	

Objective Type Questions — 1 mark each

A Multiple Choice Questions

Q. 1. At the time of short circuit, the electric current in the circuit:

(a) vary continuously **(b) does not change**
(c) reduces substantially **(d) increases heavily**

[CBSE 2020, Delhi]

Ans. Correct option : (d)

Q. 2. Two bulbs of 100 W and 40 W are connected in series. The current through the 100 W bulb is 1 A. The current through the 40 W bulb will be:

(a) 0.4 A **(b) 0.6 A**
(c) 0.8 A **(d) 1 A** [CBSE 2020]

Ans. Correct option : (d)

Q. 3. What is the maximum resistance which can be made using five resistors each of $\frac{1}{5}$ Ω?

(a) $\frac{1}{5}$ Ω **(b) 10 Ω**
(c) 5 Ω **(d) 1 Ω**

[NCERT Exemp.]

Ans. Correct option : (d)

Explanation : The highest resistance is always given by connecting the resistors in series. Here, the highest resistance would be $5 \times \frac{1}{5} = 1$ ohm.

Therefore, the maximum resistance is 1 ohm.

Q. 4. What is the minimum resistance which can be made using five resistors each of $\frac{1}{5}$ Ω?

(a) $\frac{1}{5}$ Ω. **(b) $\frac{1}{25}$ Ω.**
(c) $\frac{1}{10}$ Ω. **(d) 25 Ω.**

[NCERT Exemp.]

Ans. Correct option : (b)

Explanation : Minimum resistance is obtained when resistors are connected in parallel combination. Thus, equivalent resistance obtained by connecting five resistors of resistance $\frac{1}{5}$ Ω each, parallel to each other :

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

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

$$\Rightarrow R = \frac{1}{25}\ \Omega$$

Q. 5. Which of the following represents voltage?

(a) $\frac{\text{Work done}}{\text{Current} \times \text{Time}}$

(b) Work done × Charge

(c) $\frac{\text{Work done} \times \text{Time}}{\text{Current}}$

(d) $\frac{\text{Work done} \times \text{Charge}}{\text{Time}}$ [NCERT Exemp.]

Ans. Correct option : (a)

Explanation : As we know that,

Work done = Charge × Potential difference

⇒Work done = (Current × Time) × Potential Difference

[∵ Charge = Current × time]

$$\Rightarrow \text{Potential difference} = \frac{\text{Workdone}}{\text{Current} \times \text{Time}}$$

Q. 6. If the current *I* through a resistor is increased by 100% (assume that temperature remains unchanged), the increase in power dissipated will be

(a) 100% **(b) 200%**
(c) 300% **(d) 400%**

[NCERT Exemp.]

Ans. Correct option : (c)

Explanation : If I is current and R is resistance then,

Power, $P = I^2R$

Power in first case, $P_1 = I^2R$

100% increase in current means that current becomes 2I

Power in second case, $P_2 = (2I)^2R = 4I^2R$

Now, increase in dissipated power $= P_2 - P_1$

$= 4I^2R - I^2R$

$= 3I^2R$

Percentage increase in dissipated power $= \frac{3P_1}{P_1} \times 100$

$= 300\%$

Q. 7. In an electrical circuit three incandescent bulbs A, B, and C of rating 40 W, 60 W, and 100 W, respectively are connected in parallel to an electric source. Which of the following is likely to happen regarding their brightness?

(a) Brightness of all the bulbs will be the same.
(b) Brightness of bulb A will be the maximum.

(c) Brightness of bulb B will be more than that of A.

(d) Brightness of bulb C will be less than that of B.

[NCERT Exemp.]

Ans. Correct option : (c)

Explanation : We know that power is defined as rate of doing work. A bulb consumes electric energy and produces heat and light. Now, bulb with more power rating will produce more heat and light or we can say that power rating of bulb is directly proportional to the brightness produced by bulb. Therefore, brightness of bulb B with power rating 60 W will be more than the brightness of bulb A having power rating as 40 W.

Q. 8. An electric kettle consumes 1 kW of electric power when operated at 220 V. A fuse wire of what rating must be used for it?

(a) 1 A **(b) 2 A**

(c) 4 A **(d) 5 A**

[NCERT Exemp.]

Ans. Correct option : (d)

Explanation : Given that,

power = P = 1 kW = 1000 W

Voltage = V = 220

Now, $I = \frac{P}{V} = \frac{1000}{220} = 4.5$ A

Now rating of fuse wire must be slightly greater than 4.5 A, that is, 5 A.

B Assertions and Reasons Type Questions

Directions: In the following questions, a statement of assertion (A) is followed by a statement of reason (R). Mark the correct choice as:

(a) Both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A).

(b) Both assertion (A) and reason (R) are true but reason (R) is not the correct explanation of assertion (A).

(c) Assertion (A) is true but reason (R) is false.

(d) Assertion (A) is false but reason (R) is true.

Q. 1. Assertion (A): Alloys are commonly used in electrical heating devices like electric iron and heater.

Reason (R): Resistivity of an alloy is generally higher than that of its constituent metals but the alloys have low melting points then their constituent metals.

Ans. Correct option : (c)

Explanation : Alloy are hold for electrical heating devices due to their light restivity and high melting point compared to constituent metals.

Q. 2. Assertion (A): In a simple battery circuit the point of lowest potential is positive terminal of the battery.

Reason (R): The current flows towards the point of the lower potential as it flows in such a circuit from the positive to the negative terminal.

Ans. Correct option : (d)

Explanation : It is quite clear that in a battery circuit, the point of lowest potential is the negative terminal of the battery and the current flows from higher potential to lower potential.

Q. 3. Assertion (A): Electric appliances with metallic body have three connections, whereas an electric bulb has a two pin connection.

Reason (R): Three pin connections reduce heating of connecting wires.

Ans. Correct option : (c)

Explanation : The metallic body of an electrical appliances is connected to the third pin which is connected to the earth. This is a safety precaution and avoids eventual electric shock. By doing this the extra charge flowing through the metallic body is passed to earth and avoid shocks. There is nothing such as reducing of the heating of connecting wires by three pin connections.

Q. 4. Assertion (A): The electric bulbs glow immediately when switch is ON.

Reason (R): The drift velocity of electrons in a metallic wire is very high.

Ans. Correct option : (a)

Explanation : In a conductor there are large numbers of free electrons. When we close the circuit, the electric field is established instantly with the speed of electromagnetic wave which causes electron drift at every portion of the circuit. Due to which the current is set up in the entire circuit instantly. The current which is set up does not wait for the electrons flow from one end of the conductor to another end. It is due to this, the bulb glows immediately when switch is ON.

Q. 5. Assertion (A): Copper is used to make electric wires.

Reason (R): Copper has very low electrical resistance.

Ans. Correct option : (a)

Explanation : A low electrical resistance of copper makes it a good electric conductor. So, it is used to make electric wires.

Q. 6. Assertion (A): Silver is not used to make electric wires.

Reason (R): Silver is a bad conductor.

Ans. Correct option : (c)

Explanation : Silver is a good conductor of electricity but it is not used to make electric wires because it is expensive.

C Very Short Answer Type Questions

Q. 1. Two unequal resistances are connected in parallel. If you are not provided with any other parameters (eg. numerical values of I and R), what can be said about the voltage drop across the two resistors?

Ans. Voltage-drop is same across both.

Q. 2. What is meant by the statement. "The resistance of a conductor is one ohm" ?

U [CBSE 2020,OD,Set-3]

Ans. The resistance of a conductor is said to be 1 ohm if a current of 1 ampere flows through it when the potential difference across it is 1 volt.

Q. 3. Write the mathematical expression for Joule's law of heating. R [CBSE 2020]

Ans. Mathematical expression of Joule's law of heating is : $H = I^2Rt$

Where, H = Produced Heat

I = Current flowing through the device

t = Time of current flow

R = Resistance of the appliance

Q. 4. What does the cord of an electric oven not glow while its heating element does ?

A [Board Outside Delhi, Set- III, 2019]

Ans. Cord is made up of copper wire whereas heating element is made up of alloy.

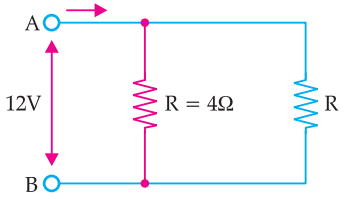
[CBSE Marking Scheme, 2019] **1**

Detailed Answer:

The cord of an electric oven is usually made of copper or aluminium whose resistance is very low so it does not glow. Whereas, its heating element is made up of alloy which has very high resistance. So, when current is passed through the heating element it becomes very hot and glows red.

Short Answer Type Questions-I — 2 marks each

Q. 1. A student has two resistors- 2 Ω and 3 Ω. She has to put one of them in place of R_2 as shown in the circuit. The current that she needs in the entire circuit is exactly 9A. Show by calculation which of the two resistors she should choose



[SQP 2020]

Ans. The overall current needed = 9A.

The voltage is 12V

Hence by Ohm's Law V=IR,

The resistance for the entire circuit = 12/9 = 4/3 Ω. = R

R_1 and R_2 are in parallel. Hence, $R=(R_1 R_2)/(R_1 + R_2)$

or, $\frac{4}{3} = 4R_2/(4+R_2) = 4/3$

$\therefore \quad R_2 = 2\Omega$

Q. 2. Compute the heat generated while transferring 96,000 coulomb of charge in two hours through a potential difference of 40 V.

Ans. (b) Given, Charge (Q)= 96000 C, Time (t) = 2 h, Potential difference (V) = 40 V

Heat generated, H = VIt (where I = Q/t)

H = d

H = V × Q

H = 40 ×96000

H = 384000 J

Q. 3. Define electric power. Write an expression relating electric power, potential difference and resistance.

[CBSE 2020 OD]

Ans. Electric power : It is the amount of electric energy consumed in a circuit per unit time.

Expression : $P = \frac{V^2}{R}$

Q. 4. How many 132 Ω resistors in parallel are required to carry 5 A on a 220 V line ?

[CBSE 2020 OD Set -3]

Ans. Given V = 220 V, I = 5 A

V = IR

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

In parallel combination, let the no. of resistors = x

$$\frac{132}{x} = \frac{220}{5}$$

or, $\frac{132}{x} = 44$

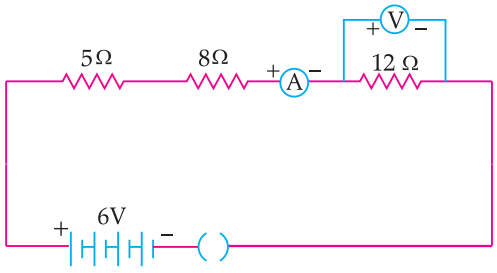
or, $x = \frac{132}{44}$

$\therefore \quad x = 3$

The number of resistors = 3

Short Answer Type Questions-II — 3 marks each

AI **Q. 1. Consider the following circuit:**



What would be the readings of the ammeter and the voltmeter when key is closed ? Give reason to justify your answer.

R [CBSE Delhi Comptt. 31/1, 31/2, 31/3, 2018]

Ans. $R = R_1 + R_2 + R_3$

$R = 5\,\Omega + 8\,\Omega + 12\,\Omega = 25\,\Omega$ **1**

$V = 6$ V

$V = IR$

$\therefore \quad I = \frac{V}{R} = \frac{6\text{ V}}{25\,\Omega} = 0.24$ A **1**

Hence, Current through 12 Ω resistance is $\frac{6}{25}$ A

= 0.24 A

$V = IR = \frac{6A \times 12\Omega}{25} = 2.88\ V$ **1**

AI **Q. 2. Calculate the total cost of running the following electrical devices in the month of September, if the rate of 1 unit of electricity is ₹ 6.00.**

(i) Electric heater of 1000 W for 5 hours daily.

(ii) Electric refrigerator of 400 W for 10 hours daily.

R **[CBSE Comptt. 31/1, 31/2, 31/3, 2018]**

Ans. $P_1 = 1000\ W = \frac{1000}{1000}\ kW, \quad t_1 = 5h$

$P_2 = 400\ W = \frac{400}{1000}\ kW, \quad t_2 = 10h$

No. of days, $n = 30$

$E_1 = P_1 \times t_1 \times n$ ½

$= 1\ kW \times 5h \times 30 = 150\ kWh$ ½

$E_2 = P_2 \times t_2 \times n$

$= \frac{400}{1000}\ kW \times 10\ h \times 30$

$= 120\ kWh$ ½

∴ Total energy = (150 + 120) kWh = 270 kWh ½

∴ Total cost = 270 × 6 = ₹ 1620 **1**

COMMONLY MADE ERROR

- Calculation error should be avoided.

ANSWERING TIP

- While solving numerical, always write formula in the beginning. Keep in mind that the essential steps are properly shown and final answer is expressed along with a proper unit.

Q. 3. (a) Write Joule's law of heating.

(b) Two lamps one rated 100 W 220 V, and the other 60 W 220 V, are connected in parallel to electric mains supply. Find the currents drawn by two bulbs from the line, if the supply voltage is 220 V.

U **[Delhi /Outside Delhi-2018]**

Ans. (a) Joule's law of heating: Heat produced in a resistor is (i) directly proportional to the square of current for a given resistance, (ii) directly proportional to the resistance for a given current and (iii) directly proportional to the time for which the current flows through the resistor. $H = I^2Rt$ where, H = Heat produced, I = current, R = Resistance of the conductor and t = Time for which the current flows through the resistor.

(b) Current in 1st bulb,

$I_1 = \frac{P_1}{V} = \frac{100}{220} = \frac{5}{11}$ A or 0.45 A

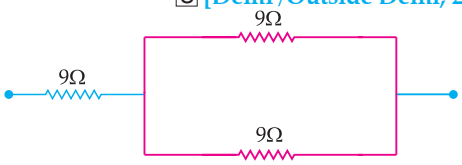
Current in 2nd bulb,

$I_2 = \frac{P_2}{V} = \frac{60}{220} = \frac{3}{11}$ A or 0.27 A **1 + 2**

AI **Q. 4. Show how would you join three resistors, each of resistance 9 Ω so that the equivalent resistance of the combination is (i) 13.5 Ω, (ii) 6 Ω ?**

U **[Delhi /Outside Delhi, 2018]**

Ans. (i)



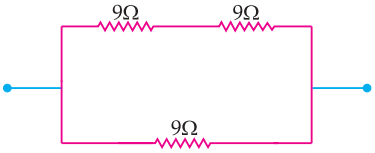
Two 9 ohm resistors in parallel connected to one 9 ohm resistor in series.

$\frac{1}{R_p} = \frac{1}{9} + \frac{1}{9} = \frac{2}{9}$

$\therefore \quad R_p = \frac{9}{2}\ \Omega$

$R = 9\ \Omega + \frac{9}{2}\ \Omega = 13.5\ \Omega$

(ii)



Two 9 ohm resistors in series connected to one 9 ohm resistor is parallel

$R_s = 9\ \Omega + 9\ \Omega = 18\ \Omega$

$\frac{1}{R} = \frac{1}{18} + \frac{1}{9} = \frac{3}{18}$

$\therefore \quad R = 6\ \Omega$ **3**

COMMONLY MADE ERROR

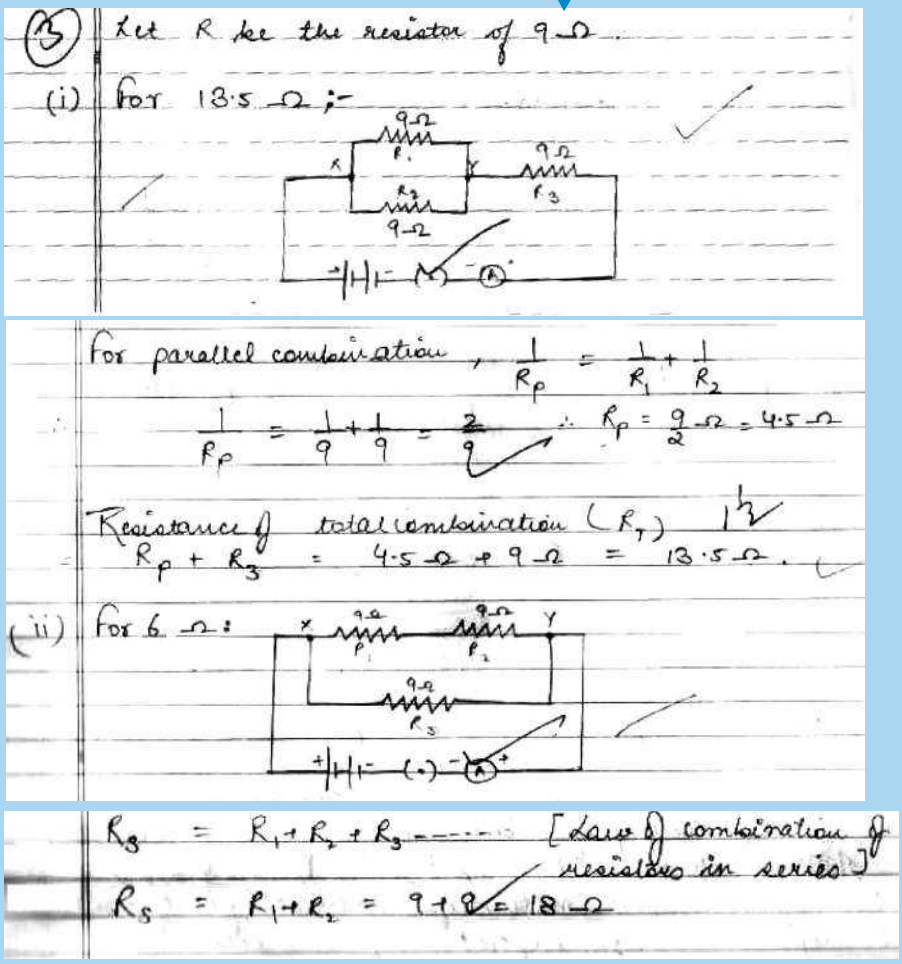
- Students often forget to write formula in the beginning. Keep in mind that the essential steps are properly shown and final answer is expressed along with a proper unit.

ANSWERING TIP

- Candidates should do calculations completely otherwise marks are deducted for incomplete calculations.

Detailed Answer:

Topper Answer, 2018



Q. 5. Three resistors of 10 Ω, 15 Ω and 20 Ω are connected in series in a circuit. If the potential drop across the 15 Ω resistor is 3 V, find the current in the circuit and potential drop across the 10 Ω resistor.

A [Board Term I, 2016]

Ans. In series circuit same current flows through all the resistors. Current through 15 Ω resistor,

$$I = \frac{V}{R} = \frac{3\ V}{15\ \Omega} = \frac{1}{5}$$

$= 0.2$ A

∴ Current in the circuit = 0.2 A

∴ Potential drop across 10 Ω resistor is.

$V = IR$

$= 0.2\ A \times 10\ \Omega$

$= 2$ V

1½ + 1½

[CBSE Marking Scheme, 2016]

Q. 6. A circuit has a line of 5 A. How many lamps of rating 40 W, 200 V can simultaneously run on this line safely ?

A [Board Term I, 2016]

Ans. Given, V = 200 V, P = 40 W, I = 5A, n = ?

$$nP = VI$$

$$n = \frac{VI}{P} = \frac{200\times5}{40}$$

$$= \frac{100}{4} = 25 \text{ lamps}$$

[CBSE Marking Scheme, 2016] **3**

AI **Q. 7. A bulb is rated at 200V – 40W. What is its resistance ? 5 such bulbs are lighted for 5 hours. Calculate the electrical energy consumed ? Find the cost if the rate is 5.10 per KWh.**

A [Board Term I, 2016]

Ans. V = 200 V, P = 40 W

$$P = VI$$

$$I = \frac{P}{V} = \frac{40}{200} = \frac{1}{5} A$$

$$R = \frac{V}{I} = \frac{200}{\frac{1}{5}}$$

$$= 200 \times 5 = 1000\ \Omega$$

Total Power = 40 W × 5 = 200 W

Time = 5 hrs

Electrical energy = 200 W × 5 hrs.

= 1000 Wh

= 1 KWh.

Cost of 1 KWh = ₹ 5.10 **3**

∴ Total cost = ₹ 1 × 5.10 = ₹ 5.10

[CBSE Marking Scheme, 2016]

Q. 8. Give reason for the following:

(i) Why are copper and aluminium wires used as connecting wires ?

(ii) Why is tungsten used for filament of electric lamps?

(iii) Why is lead-tin alloy used for fuse wires ?

AE [Board Term-I- 2015, 2016]

Ans. (i) These are good conductors of electricity/low resistance, low resistivity.

(ii) Very high melting point and high resistivity.

(iii) Low melting point. **1+1+1**

[CBSE Marking Scheme, 2016]

Q. 9. Show four different ways in which three resistors of 'r ' ohm each may be connected in a circuit. In which case is the equivalent resistance of the combination: C [DDE-2015]

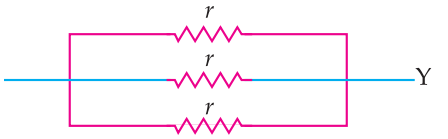
(i) Maximum

(ii) Minimum [Board Term I, 2014]

Ans. (a)

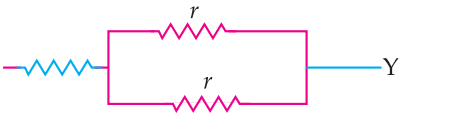
½

(b)



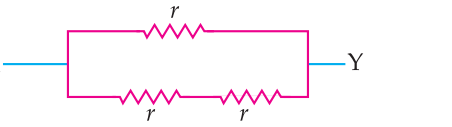
½

(c)



½

(d)



½

(i) Circuit (a) has maximum resistance ½

(ii) Circuit (b) has minimum resistance ½

Long Answer Type Questions — 5 marks each

Q. 1. (a) Define Power and state its S1 unit.

(b) A torch bulb is rated 5 V and 500 mA. Calculate:

(i) Power (ii) Resistances (iii) Energy consumed when it is lighted for 2½ hours. R [CBSE 2020 OD]

Ans. (a) Power: It is the amount of electric energy consumed in a circuit per unit time.

$$P = W/t$$

Its S.I unit is Watt (W).

(b) V = 5V

I = 500 mA = 0.5 A **2**

(i) P = V × I = 5 × 0.5 = 2.5 W

(ii) Resistance $R = \frac{V}{I} = \frac{5}{0.5}$ = 10 ohms

(iii) Energy consumed = P × t

= 2.5 × 2.5

= 6.25 Wh **3**

Q. 2. (a) An electric bulb is rated at 200 V-100 W. What is its resistance ? U

(b) Calculate the energy consumed by 3 such bulbs if they glow continuously for 10 hours for complete month of November. AE

(c) Calculate the total cost if the rate is Rs 6.50 per unit. U [CBSE 2020 OD]

Ans. (a) Given, V = 200 volts and P = 100 watt

$$\text{As } P = \frac{V^2}{R} \text{ or } R = \frac{V^2}{R} = \frac{(200)^2}{100W} = \frac{40000}{100\Omega} = 400 \text{ W}$$

2

(b) Electrical energy consumed, E = number of units × Power of each unit × time × total days

Here, n = 3, P = 100 W, t = 10 hours, Days = 30

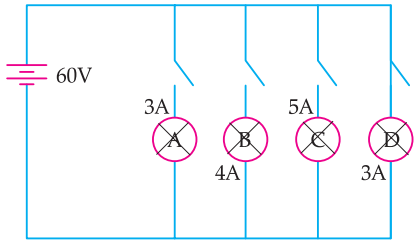
So, E = 3 × 100 W × 10 h × 30 = 90,000 Wh

= 90 kWh **2**

(c) Total cost of electricity = Total unit of energy consumed × Cost per unit

= 90 kWh × 6.50 = ₹ 585 **1**

Q. 3. In the given circuit, A, B, C and D are four lamps connected with a battery of 60 V. [SQP 2020]



Analyse the circuit to answer the following questions.

(i) What kind of combination are the lamps arranged in (series or parallel)? U

(ii) Explain with reference to your above answer, what are the advantages (any two) of this combination of lamps? C

(iii) Explain with proper calculations which lamp glows the brightest? A

(iv) Find out the total resistance of the circuit R

Ans. (i) The lamps are in parallel. **1**

(ii) Advantages: If one lamp is faulty, it will not affect the working of the other lamps. They will also be using the full potential of the battery as they are connected in parallel. **1**

(iii) The lamp with the highest power will glow the brightest.

P=VI In this case, all the bulbs have the same voltage. But lamp C has the highest current. Hence, for Lamp C

P = 5 × 60 Watt = 300 W. (the maximum). **1**

(iv) The total current in the circuit = 3+4+5+3 A = 15A

Voltage = 60V

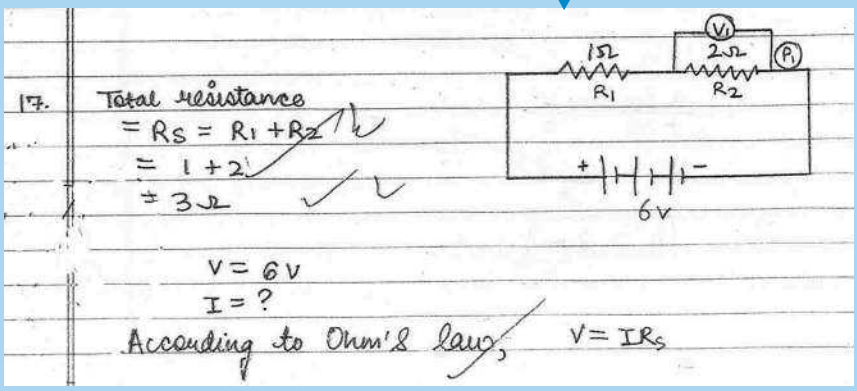
V= IR and hence R = V/I

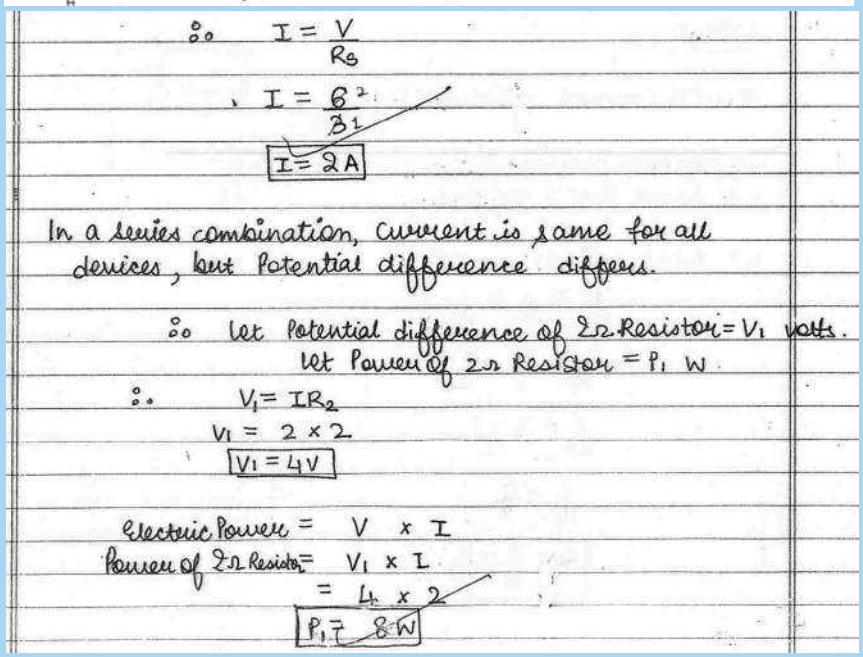
= 60/15 A = 4A **1**

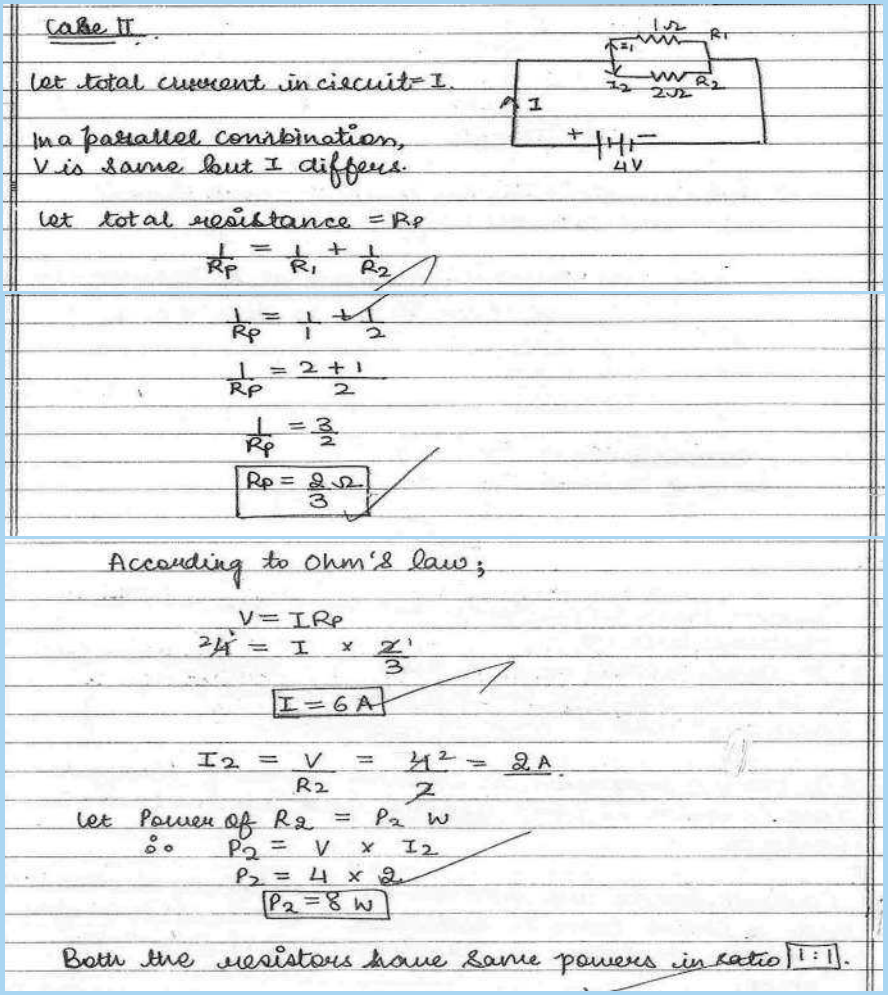
Q. 4. A bulb is rated 40W, 220V. Find the current drawn by it, when it is connected to a 220V supply. Also find its resistance. If the given bulb is replaced by a bulb of rating 25W, 220V,will be there be any change in the value of current and resistance ? Justify your answer and determine the change. U

Ans. [CBSE Delhi, 2019]

Topper Answer, 2019







Ans. P = 40 W, V = 220V

$$P = VI$$

$$\therefore \quad I = \frac{P}{V} = \frac{40}{220} = \frac{2}{11}\text{A}$$

From Ohm's law,

$$V = IR$$

$$R = \frac{V}{I} = \frac{220}{2} = 1210\Omega$$

when replaced by 25w, 220 v lamp

$$I = \frac{P}{V} = \frac{25}{220} = \frac{5}{44}\text{A}$$

$$\mathbf{R} = \frac{V}{I} = \frac{220}{5} = 1936\Omega$$

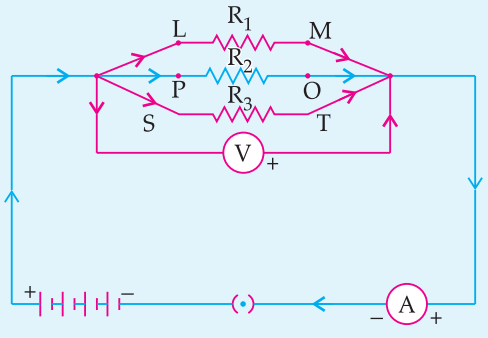
Low power bulb draw less current since its resistance is higher.

Q. 5. (a) With the help of a suitable circuit diagram prove that the reciprocal of the equivalent resistance of a group of resistances joined in parallel is equal to the sum of the reciprocals of the individual resistances.

(b) In an electric circuit two resistors of 12Ω each are joined in parallel to a 6 V battery. Find the current drawn from the battery.

A [CBSE Board Delhi, Set- I, 2019]

Ans.



1

From figure:

$$I = I_1 + I_2 + I_3$$

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

$$\therefore \quad I = V\left(\frac{1}{R_1}+\frac{1}{R_2}+\frac{1}{R_3}\right)=\frac{V}{R_p} \qquad 1$$

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

(b) $R_1 = R_2 = 12\ \Omega$ and $V = 6$ V

$$\therefore \quad \frac{1}{R_p}=\frac{1}{R_1}+\frac{1}{R_2}=\frac{1}{12}+\frac{1}{12} \qquad ½$$

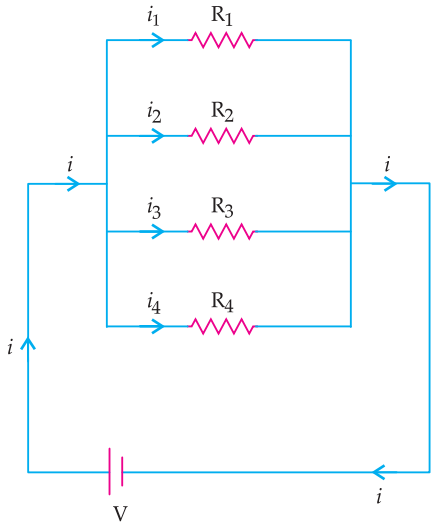
$$\therefore \quad R_p = 6\ \Omega \qquad ½$$

$$I=\frac{V}{R_p}=\frac{6V}{6\Omega}=1\text{A} \qquad 1$$

[CBSE Marking Scheme, 2013]

Detailed Answer:

(a)



1 + 2 + 2

Let there be n resistance, each of value $R_1, R_2 .... R_n$ respectively connected in parallel to a battery of voltage V.
Let current I is sent to the circuit.
If the equivalent resistance is R_{eq}, then current drawn $I = \frac{V}{R_{eq}}$
According to the above circuit,

$$I = I_1 + I_2 + I_3 + ... + I_n$$

$$\frac{V}{R_{eq}} = \frac{V}{R_1}+\frac{V}{R_2}+\frac{V}{R_3}+....+\frac{V}{R_n}$$

So, $$\frac{1}{R_{eq}} = \frac{1}{R_1}+\frac{1}{R_2}+\frac{1}{R_3}+.....+\frac{1}{R_n}$$

Therefore, the reciprocal of the equivalent resistance of a group of resistances joined in parallel is equal to sum of the reciprocals of individual resistances.

(b) In parallel combination, R_{total} is given as

$$\frac{1}{R_{Total}} = \frac{1}{R_1}+\frac{1}{R_2}$$

$$= \frac{1}{12}+\frac{1}{12} = \frac{2}{12} = 1/6 \text{ ohm}$$

$R_{total} = 6$ ohm

Hence, current $I = \frac{V}{R_{Total}} = \frac{6V}{6\Omega} = 1$ A

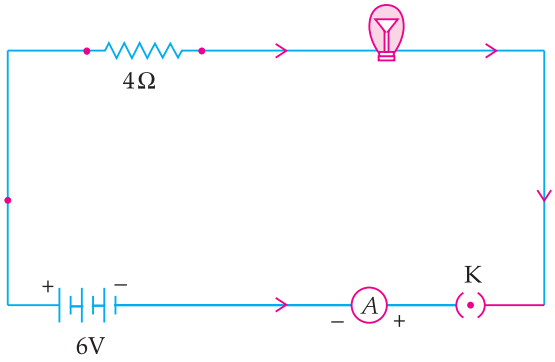
Q. 6. An electric lamp of resistance 20 Ω and a conductor of resistance 4 Ω are connected to a 6 V battery as shown in the circuit. Calculate:

(a) the total resistance of the circuit.

(b) the current through the circuit.

(c) the potential difference across the (i) electric lamp and (ii) conductor, and

(d) power of the lamp.



U [CBSE Board Delhi, Set- 1, 2019]

Ans. (a) $R = R_1 + R_2$ **1**

$= 20\ \Omega + 4\ \Omega = 24\ \Omega$

(b) $I = \frac{V}{R}$

$= \frac{6\ V}{24\ \Omega} = 0.25$ A **1**

(c) (i) For electric lamp:

$V = IR$

$= \frac{6}{24}\times 20 = 5$ V **1**

(ii) For Conductor:

$V = IR$

$= \frac{6}{24}\times 4 = 1$ V **1**

(d) $P = VI$

$= 5\text{V}\times\frac{6}{24}\text{A} = 1.25$ W. **1**

[CBSE Marking Scheme, 2019]

Detailed Answer:

Given, Voltage of battery, $V = 6$ V
Resistance of electric lamp, $R_1 = 20\ \Omega$
Resistance of series conductor, $R_2 = 4\ \Omega$

(a) Total resistance of circuit, $R_{Total} = R_1 + R_2$
$= 20\ \Omega + 4\ \Omega$
$= 24\ \Omega$

(b) Using Ohm's law $I = \frac{V}{R_{Total}}$

$$= \frac{6V}{24\Omega} = 0.25\ A$$

(c) Potential difference across

(i) Electric lamp, $V_1 = IR_1$

$= 0.25\ A \times 20\ \Omega$

$= 5V$

(ii) Conductor, $V_2 = IR_2$

$= 0.25\ A \times 4\ \Omega$

$= 1V$

(d) Power of the lamp $= I^2R$

$= (0.25)^2 \times 20\ \Omega$

$= 1.25\ W$ **1+1+2+1**

COMMONLY MADE ERROR

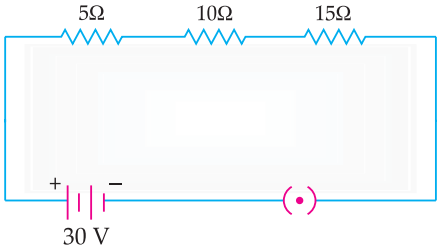
➲ Many students commit errors in substituting the correct values in formulas.

ANSWERING TIP

➲ Cross-check the values after substituting them in the formula. Keep in mind, essential steps need to be shown expressed along with a proper unit.

Q. 7. (a) How will you infer with the help of an experiment that the same current flows through every part of a circuit containing three resistors in series connected to a battery ?

(b) Consider the given circuit and find the current flowing in the circuit and potential difference across the 15 Ω resistor when the circuit is closed.



A [Board Outside Delhi, Set-I, 2019]

Ans. (a) **(i)** Join the three resistors of different values in series.

(ii) Connect them with battery, an ammeter and plug key.

(iii) Plug the key and note the ammeter reading.

(iv) Change the position of ammeter to anywhere in between the resistors and note the ammeter reading each time.

(v) The ammeter reading will remain same every time. Therefore when resistors are connected in series same current flows through all resistors, when it is connected to a battery.

Note: If explained with the help of diagram give full credit. **½ × 5**

(b) Total resistance of the circuit = **1**

$R = R_1 + R_2 + R_3 = 5 + 10 + 15 = 30$ ohm

Potential difference across the circuit / By ohm's law

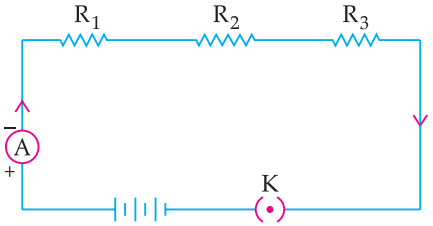
$$V = IR \text{ or } I = \frac{V}{R} = \frac{30V}{30\ \Omega} = 1A$$ **1**

Potential difference across 15 ohm Resistor = $1A \times 15\ \Omega = 15\ V$

[CBSE Marking Scheme, 2019] ½

Detailed Answer:

(a) Suppose the experimental set up comprises of three resistors R_1, R_2 and R_3 of three different values which are connected in series with an ammeter, key and a battery of known voltage is given as below :



The key K is closed and the ammeter reading is recorded. Now, the position of ammeter is changed to anywhere in between the resistors. The ammeter reading is recorded each time. It is found that there is an identical reading each time, which shows that same current flows through every part of the circuit containing three resistances in series connected to a battery.

(b) $R_{eq} = R_1 + R_2 + R_3$

$= 5\ \Omega + 10\ \Omega + 15\ \Omega = 30\ \Omega$

Electric current (I) $= \frac{V}{R_{eq}}$

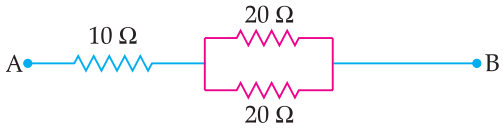
$= \frac{30}{30} = 1A$

Potential difference across 15Ω resistor $= IR$

$= 1 \times 15 = 15\ V$ **3+2**

Q. 8. (a) Three resistors R_1, R_2 and R_3 are connected in parallel and the combination is connected to a battery, ammeter, voltmeter and key. Draw suitable circuit diagram and obtain an expression for the equivalent resistance of the combination of the resistors.

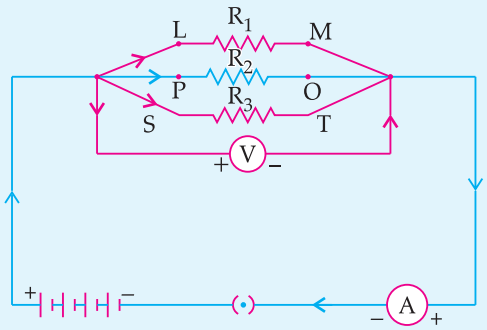
(b) Calculate the equivalent resistance of the following network:



R [Board Outside Delhi, 2019]

Ans. (a) Total current $I = I_1 + I_2 + I_3$

Let R_p be the equivalent resistance of R_1, R_2, R_3. Then the total current $I = \frac{V}{R_p}$ **1**



½

$$I_1 = \frac{V}{R_1}, I_2 = \frac{V}{R_2}, I_3 = \frac{V}{R_3} \quad \text{½}$$

$$\therefore \quad I = V\left(\frac{1}{R_1}+\frac{1}{R_2}+\frac{1}{R_3}\right) = \frac{V}{R_p} \quad \text{½}$$

$$\therefore \quad \frac{1}{R_p} = \frac{1}{R_1}+\frac{1}{R_2}+\frac{1}{R_3} \quad \text{½}$$

(b) On applying ohm's law for each R_1, R_2, R_3

$R_p = 10$ ohm

$$\frac{1}{R_p} = \frac{1}{20}+\frac{1}{20} = \frac{2}{20} = \frac{1}{10} \quad \textbf{1}$$

$R_p = 10$ ohm

Equivalent resistance of the network

$= R_{eq} = R_1 + R_p = 10 + 10 = 20$ ohm. **1**

[CBSE Marking Scheme, 2019]

Q. 9. (i) Consider a conductor of resistance '*R*', length '*L*', thickness '*d*' and resistivity 'ρ'.
Now this conductor is cut into four equal parts. What will be the new resistivity of each of these parts? Why?
(ii) Find the resistance if all of these parts are connected in:
(a) Parallel
(b) Series
(iii) Out of the combinations of resistors mentioned above in the previous part, for a given voltage which combination will consume more power and why? [Board Outside Delhi, 2019]

Ans. (i) Resistivity will not change as it depends on the material of the conductor.

(ii) The length of each part become $\frac{L}{4}$. ρ A constant

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

$$\text{Resistance of each part} = R_{part} = \frac{\frac{\rho L}{4}}{A} = \frac{R}{4}.$$

(a) In parallel the $\frac{1}{R_{eqv}} = \frac{1}{R_{part}}+\frac{1}{R_{part}}+\frac{1}{R_{part}}+\frac{1}{R_{part}}$

$$\therefore \quad = \frac{4}{R_{part}} \Rightarrow R_{eqv} = \frac{R}{16}\Omega$$

(b) In series the $R_{eqv} = \frac{R}{4}+\frac{R}{4}+\frac{R}{4}+\frac{R}{4} = R\,\Omega$

(iii) $P = \frac{V^2}{R}$.

If R_{eqv} is less, power consumed will be more.
In the given case, R_{eqv} is lesser in the parallel and thus power consumed will be more.

[CBSE Marking Scheme, 2019]

AI **Q. 10. What is meant by electric current ? Name and define S.I. unit. In a conductor electrons are flowing from B to A. What is the direction of conventional current ? Give justification for your answer.**
A steady current of 1 Ampere flows through a conductor. Calculate the number of electrons that flow through any section of conductor in 1 second. (Charge on electron = 1.6×10^{-19} C)
R [DDE-2014] [Board Term-I, 2015]

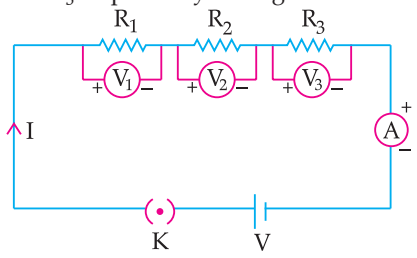
Ans. Definition of Electric current: Refer quick Review
S.I. unit of Current: Ampere
Definition of 1 Ampere: It is the SI unit of current. If one coulomb of charge flows through any cross-section of a conductor in one second, then current through it is said to be one ampere.
Direction of Current from A to B - Justification
Justification: Conventionally, the direction of motion of positive charges through the conductor is taken as the direction of current. The direction of conventional current is opposite to that of the negatively charged electrons.

$$I = \frac{ne}{t} \Rightarrow n = \frac{I \times t}{e} = \frac{1A \times 1s}{1.6 \times 10^{-19} C} = 6.25 \times 10^{18}$$

[CBSE Marking Scheme, 2015] **5**

Q. 11. Establish a relationship to determine the equivalent resistance R of a combination of three resistors having resistances R_1, R_2 and R_3 connected in series. Calculate the equivalent resistance of the combination of three resistors of 2 Ω, 3 Ω and 6 Ω joined in parallel. U [Board Term I, 2016, 2015]

Ans. An applied potential V produces current *I* in the resistors R_1, R_2 and R_3, causing a potential drop V_1, V_2 and V_3 respectively through each resistor.



Total Potential, $V = V_1 + V_2 + V_3$

By Ohm's Law, $V_1 = IR_1$

$V_2 = IR_2$

$V_3 = IR_3$

Thus, $V = IR_1 + IR_2 + IR_3$

$= I(R_1 + R_2 + R_3)$

If R is the equivalent resistance, V = IR

Hence, $IR = I(R_1 + R_2 + R_3)$

$R = R_1 + R_2 + R_3$

This proves that overall resistance increases when resistors are connected in series.

Three resistors 2 Ω, 3 Ω and 6 Ω, are connected in parallel combination.

Equivalent resistance,

$$\frac{1}{R_P} = \frac{1}{2}+\frac{1}{3}+\frac{1}{6}$$

$$= \frac{3+2+1}{6} = \frac{6}{6}$$

$R_P = 1\ \Omega$ **4 + 1**

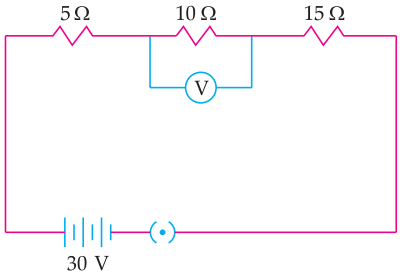
Visual Case-based Questions — 4 marks each

Q. 1. Read the passage and answer any four questions from (a) to (e).

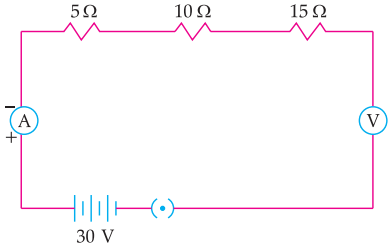
Three resistors of 5 Ω, 10 Ω and 15 Ω are connected in series and the combination is connected to the battery of 30 V. Ammeter and voltmeter are connected in the circuit.

(a) Which of the following is the correct circuit diagram to connect all the devices in proper correct order. A

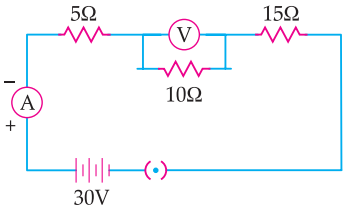
(i)



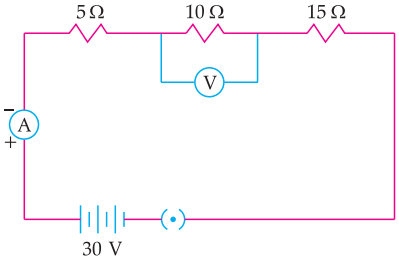
(ii)



(iii)



(iv)



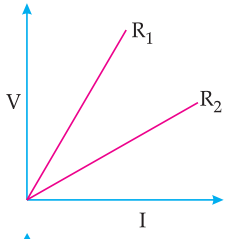
(b) How much is the total resistance? AE

(i) 30Ω **(ii)** 20Ω

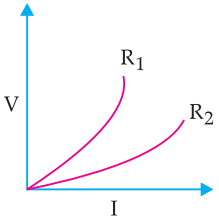
(iii) $\frac{11}{30}\Omega$ **(iv)** $\frac{30}{11}\Omega$

(c) Two students perform experiments on two given resistors R_1 and R_2 and plot the following V-I graphs. If $R_1 > R_2$, which of the diagrams correctly represent the situation on the plotted curves? U

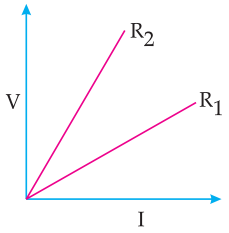
(i)



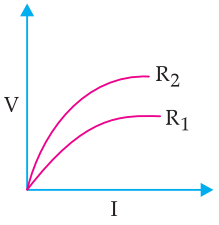
(ii)



(iii)



(iv)



(d) The device used to measure the current:

(i) Ammeter **(ii)** Galvanometer

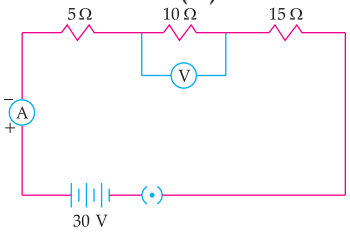
(iii) Voltmeter **(iv)** None of these

(e) Which of the following is connected in series in circuit:

(i) Ammeter **(ii)** Voltmeter

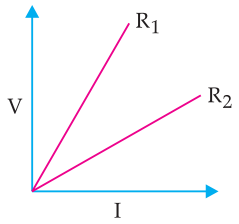
(iii) Both of these **(iv)** None of these

Ans. (a) (iv)



(b) (i) 30Ω

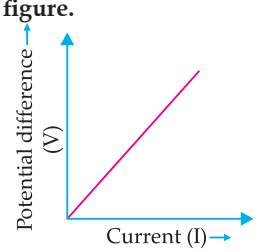
(c) (i)



(d) (i) ammeter

(e) (i) ammeter

Q. 2. Observe the graph and answer any four questions from (a) to (e). V-I graph for a conductor is as shown in figure.



(a) What do you infer from this graph ? AE

(i) $V \propto \frac{1}{I}$ **(ii)** $V \propto I^2$

(iii) $V \propto I$ **(iv)** $V \propto \frac{1}{I^2}$

(b) Name the physical quantity represented by the slope of this graph R

(i) Current
(ii) Resistance
(iii) Potential difference
(iv) None of the above

(c) Ohm is the SI unit of: R

(i) Potential difference
(ii) Resistance
(iii) Current
(iv) Resistivity

(d) Which of the following law justify the above graph: A

(i) Faradays Law **(ii) Ohm's Law**
(iii) Faradays Law **(iv) Joule's Law**

(e) Resistance of a conductor depends on: U

(i) length of conductor
(ii) area of cross-section
(iii) temperature
(iv) all of the above

Ans. (a) (iii) $V \propto I$

(b) (ii) Resistance

(c) (ii) Resistance

(d) (ii) Ohm's Law

(e) (iv) all of the above **1+1+1**

Q. 3. Study the given table and answer any four questions from (a) to (e):

	Material	Resistivity (Ω m)
Conductors	Silver	1.60×10^{-8}
	Copper	1.62×10^{-8}
	Aluminium	2.63×10^{-8}
	Tungsten	5.20×10^{-8}
	Nickel	6.84×10^{-8}
	Iron	10.0×10^{-8}
	Chromium	12.9×10^{-8}
	Mercury	94.0×10^{-8}
	Manganese	1.84×10^{-6}
Alloys	Constantan [alloy of Cu and Ni]	49×10^{-6}
	Manganin [alloy of Cu, Mn and Ni]	44×10^{-6}
	Nichrome [alloy of Ni, Cr, Mn and Fe]	100×10^{-6}

(a) Which is a better conductor: U

(i) Chromium **(ii) Nickel**
(iii) Mercury **(iv) Iron**

(b) Element used to make heating element of electric geyser: AE

(i) Iron **(ii) Silver**
(iii) Nichrome **(iv) tungsten**

(c) Element used to make filament of incandescent bulb: AE

(i) Copper **(ii) Silver**
(iii) Nichrome **(iv) tungsten**

(d) What happens to resistance of a conductor when its area of cross section is increased? A

(i) Resistance increases
(ii) Resistance decreases
(iii) No change
(iii) Resistance doubles

(e) A given length of a wire is doubled and this process is repeated once again. The resistance of wire becomes: U

(i) 1/4th of original resistance
(ii) 16 times of original resistance
(iii) Double the original resistance
(iv) Half of original resistance

Ans. (a) (ii) Nickel

(b) (i) Nichrome

(c) (iv) tungsten

(d) (ii) Resistance decreases as $R \propto 1/A$

(e) (ii) 16 times of original resistance

Q. 4. Observe the following table and answer any four questions from (a) to (e). Electrical resistivities of some substances, at 20°C are given as follows:

Silver	1.60×10^{-8} Ω.m
Copper	1.62×10^{-8} Ω.m
Tungsten	5.2×10^{-8} Ω.m
Mercury	94×10^{-8} Ω.m
Iron	10×10^{-8} Ω.m
Nichrome	10×10^{-6} Ω.m

(a) Which is a better conductor of electric current: U

(i) Silver **(ii) Copper**

(iii) Tungsten **(iv) mercury**

(b) Which element will be used for electrical transmission lines: U

(i) Iron **(ii) Copper**

(iii) Tungsten **(iv) mercury**

(c) Nichrome is used in the heating elements of electric heating device because: AE

(i) It has high resistivity

(ii) It does not oxidise readily at high temperature

(iii) Both of the above

(iv) None of the above

(d) Series arrangement is not used for domestic circuits because: R

(i) Current drawn is less

(ii) Current drawn is more

(iii) Neither of the above

(iv) Both of the above

(e) If the resistance is to be increased, then the resistors are to be increased in: A

(i) Series

(ii) Parallel

(iii) Mixed arrangement

(iv) None of the above

Ans. (a) (i) silver

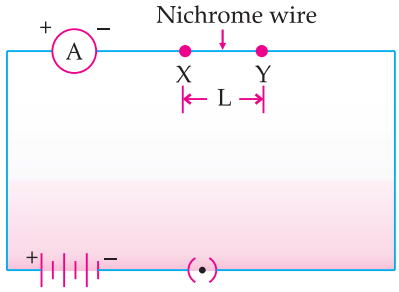
(b) (ii) copper

(c) (iii) Both of the above

(d) (i) Current drawn is less

(e) (i) Series

Q. 5. In the given circuit, connect a nichrome wire of length '*L*' between points X and Y and note the ammeter reading Answer any four questions from (a) to (e).



(a) When this experiment is repeated by inserting another nichrome wire of the same thickness but twice the length (2*L*), what changes are observed in the ammeter reading ? A

(i) Ammeter reading will increase

(ii) Ammeter reading will decrease

(iii) Will show double the increase

(iv) No change in ammeter reading

(b) State the changes that are observed in the ammeter reading if we double the area of cross-section without changing the length in the above experiment. AE

(i) Ammeter reading will increase

(ii) Ammeter reading will decrease

(iii) Will decrease half

(iv) No change in ammeter reading

(c) In a circuit two resistors of 5 Ω and 10 Ω are connected in series. Compare the current passing through the two resistors. U

(i) 1 : 2 **(ii) 1: 3**

(iii) 2: 1 **(iv) 1:1**

(d) The instrument used to measure current is _____. R

(i) Ammeter **(ii) Voltmeter**

(iii) Galvanometer **(iv) manometer**

(e) When nichrome and copper wire of same length and same radius are connected in series and current I is passed through them. Which wire gets heated up more? A

(i) Nichrome wire

(ii) Copper wire

(iii) Both will heat up at the same temperature

(iv) None of the wire will get heated up.

Ans. (a) (i) ammeter reading will decrease (becomes half)

Explanation: The ammeter reading will decrease (becomes half). This is because with the increase in length, resistance of the circuit increases, hence current decreases.

(b) (ii) The ammeter reading will increase (becomes two times).

Explanation: The ammeter reading will increase (becomes two times). This is because as area increases, resistance decreases and hence current increases.

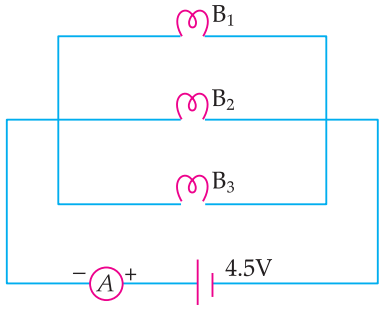
(c) (iv) 1:1

Explanation: In a series connection of resistors, same current passes through all the resistors. Hence, current will be same. Ratio of the currents will be 1 : 1.

(d) (i) Ammeter.

(e) (i) nichrome wire

Q. 6. Study the circuit shown in which three identical bulbs B_1, B_2 and B_3 are connected in parallel with a battery of 4.5 V. Answer any four questions (a) to (e).



(a) What will happen to the other two bulbs if the bulb B_3 gets fused ?

(i) They will also stop glowing

(ii) Other bulbs will glow with same brightness

(iii) They will glow with low brightness

(iv) They glow with more brightness

(b) If the wattage of each bulb is 1.5 W, how much readings will the ammeter A show when all the three bulbs glow simultaneously.

(i) 1.0A **(ii) 2A**

(iii) 1.5W **(iv) None of the above**

(c) Find the total resistance of the circuit:

(i) 1.0Ω **(ii) 4.5Ω**

(iii) 1.5Ω **(iv) 2.0Ω**

(d) How many resistors of 88 W are connected in parallel to carry 10 A current on a 220 V line:

(i) 2 resistors **(ii) 1 resistors**

(iii) 3 resistors **(iv) 4 resistors**

(e) Find the statement which does not justify parallel connection:

(i) The voltage of each component is same

(ii) Overall resistance is lower than the resistance of single component

(iii) Automobile headlight is connected in parallel

(iv) There is a single path for the flow of electrons/ charge

Ans. (a) (ii)

Explanation: Other bulbs will glow with same brightness

(b) (i) 1.0 A

Explanation: When the bulbs are in parallel, wattage will be added (4.5 W) and the ammeter reading would be,

$$I = P/V = \frac{4.5}{4.5} = 1A$$

(c) (ii) 4.5Ω

Explanation: Ammeter reading = 1.0A

$$V = 4.5V$$

$$R = V/I$$

$$= 4.5 = 4.5\ \Omega$$

(d) (iv) 4 resistors

Explanation: Equivalent resistance,$= \frac{1}{R_p} = \frac{n}{88}$

$$R_p = \frac{88}{n}$$

$$\mathbf{V = IR}$$

$$\mathbf{R = \frac{88}{n}}$$

$$\frac{88}{n} = \frac{220}{10}$$

$$n = 4 \text{ resistors}$$

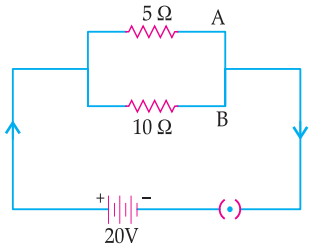
(e) (iv)

Explanation: There is path of flow of electron change through each resistor. So there are several path.

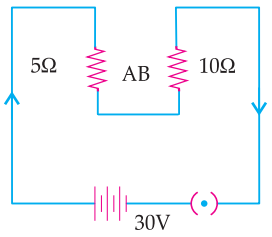
Q. 7. Two conductors A and B of resistances 5 Ω and 10 Ω respectively are first joined in parallel and then in series. In each case the voltage applied is 20 V. Answer any four questions from (a) to (e).

(a) Draw the circuit diagram to show connection when A and B are joined in parallel? U

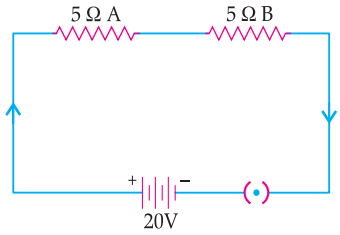
(i)



(ii)



(iii)



(iv) none of these

(b) In which combination will the voltage across the conductors A and B be the same ? C

(i) Series arrangement

(ii) Parallel arrangement

(iii) Both of the above

(iv) None of the above

(c) In which arrangement will the current through A and B be the same ? C

(i) Series arrangement

(ii) Parallel arrangement

(iii) Both of the above

(iv) None of the above

(d) Equivalent resistance in parallel combination is: A

(i) 15 Ω **(ii) 3.33 Ω**

(iii) 0.3 Ω **(iv) None of the above**

(e) Equivalent resistance in series combination is: A

(i) 15 Ω **(ii) 3.33 Ω**

(iii) 0.3 Ω **(iv) None of the above**

Ans. (a) (i) Correct circuit diagram

(b) (ii) Parallel arrangement

(c) (i) Series arrangement

(d) (ii) 3.33 Ω

Explanation :

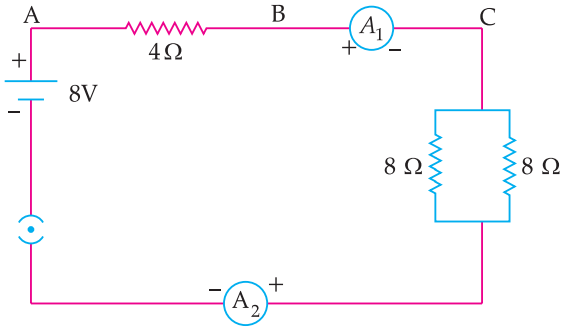
$$\frac{R_1R_2}{R_1+R_2} = \frac{5\times10}{5+10}$$

$$= 3.33\ \Omega$$

(e) (i) 15 Ω

Explanation: 5 + 10 = 15 Ω

Q. 8. Find out the following in the electric circuit given in the figure. Answer any four questions from (a) to (e).



(a) Effective resistance of two 8 Ω resistors in the combination. U

(i) 4Ω **(ii) 16Ω**
(iii) 8Ω **(iv) 1Ω**

(b) Current flowing through 4 Ω resistor. A

(i) 1A **(ii) 2A**
(iii) 8A **(iv) 4A**

(c) Potential difference across 4 Ω resistor R

(i) 1V **(ii) 2V**
(iii) 4V **(iv) 8V**

(d) Power dissipated in 4 Ω resistor A

(i) 4W **(ii) 2W**
(iii) 1W **(iv) 8W**

(e) Difference in reading of ammeter A_1 and A_2 AE

(i) will become double
(ii) will become half
(iii) remains the same
(iv) 8A

Ans. (a) (i) 4 Ω

Explanation: $\frac{1}{R} = \frac{1}{8} + \frac{1}{8} = \frac{2}{8}$

$R = 4\Omega$

(b) (i) 1A

Explanation: Current flowing through the circuit = Current flowing through 4 Ω
Equivalent resistance of the circuit = 4Ω + 4Ω = 8Ω
Current flowing in the circuit = $\frac{V}{R} = \frac{8V}{8\Omega} = 1A$

(c) (iii) 4 V

Explanation: Potential difference across 4Ω = V_1
$V_1 = IR_1$
$V_1 = 1A \times 4\Omega = 4V$

(d) (i) 4W

Explanation: Power dissipated in 4Ω = P
$P = VI = 4V \times 1A = 4$ watt

(e) (iii) Remains the same

Explanation: Since the resistance are in series combination, hence same current will flow through each resistor. Hence ammeter reading will be same.

1 + 1 + 1 + 1

Know the Terms

- **Frictional Electricity:** It is the electricity produced by rubbing two suitable bodies and flow of electrons from one body to other.
- **Electricity:** A fundamental form of energy observable in positive and negative forms that occurs naturally (as in lightning) or is produced (as in a generator) and that is expressed in terms of the movement and interaction of electrons.
- **Ohm:** It is the SI unit of resistance. A conductor has a resistance of one ohm if a current of one ampere flows through it on applying a potential difference of 1 volt across its ends.

$$1 \text{ ohm} = \frac{1 \text{volt}}{1 \text{ ampere}} \quad \text{or} \quad 1\,\Omega = \frac{1V}{1\,A}$$

- **Resistor:** A conductor which has some appreciable resistance is called a 'resistor'.
- **Semiconductors:** Materials having resistivity between that of an insulator and a conductor are called semiconductors. They are used in making integrated circuits.
- **Superconductors:** These are certain materials that lose their resistivity at low temperature. Such materials are called as superconductors. The phenomenon of complete loss of resistivity by substances below a certain temperature is called superconductivity.
- **Fuse Wire:** The wire which melts, breaks the circuit and prevents the damage of various appliances in the household connections. It is connected in series with live line and its thickness determines the maximum current that can be drawn. It is made of an alloy of aluminium, copper, iron and lead.

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