Electricity

(A) Objective Type Questions — 1 Mark Each

Stand Alone MCQs (1 Mark Each)

AI 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 '2*l*' is

(A) $\frac{A}{2}$ (B) $\frac{3A}{2}$

(C) 2 A (D) 3 A

AE [CBSE OD, 2020]

Ans. Option (C) is correct.

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

Resistivity of the conductor in second case,

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

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 :

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

$$\Rightarrow A' = 2A$$

2. The maximum resistance which can be made using four resistor each of resistance $\frac{1}{2}\ \Omega$ is

(A) 2 Ω (B) 1 Ω

(C) 2.5 Ω (D) 8 Ω

[CBSE OD, 2020]

Ans. Option (A) is correct.

Explanation: Maximum resistance in series = 4 × ½ = 2 Ohm.

3. When a 4 V 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 AE

[CBSE SQP, 2020]

Ans. Option (B) is correct.

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

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

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

(A) Volt-ampere (B) Kilowatt-hour

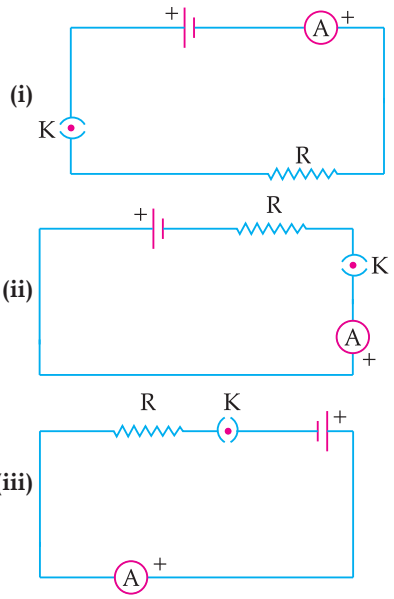
(C) Watt-second (D) Joule-second R

[CBSE SQP, 2020]

Ans. Option (A) is correct.

Explanation: Unit of electric power is volt-ampere.

5. A cell, a resistor, a key, and ammeter are arranged as shown in the circuit diagrams given below. 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. U

Ans. Option (D) is correct.

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

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

(A) its length. **(B)** its thickness.

(C) its shape. **(D)** nature of the material.

Ans. Option (D) is correct.

> ***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.

7. 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 AE

Ans. Option (D) is correct.

> ***Explanation:*** In a series connection, the current through each device remains the same. Therefore, the current through the 40 W bulb will also be 1 A.

8. 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 U

Ans. Option (D) is correct.

> ***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.

9. The resistivity does not change if :

(A) the material is changed.

(B) the temperature is changed.

(C) the shape of the resistor is changed.

(D) both material and temperature are changed. R

Ans. Option (C) is correct.

> ***Explanation:*** Resistivity always varies with change in temperature, nature of material. But resistivity cannot change due to change in any shape of conductor.

AI **10. 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 U

Ans. Option (B) is correct.

> ***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 parallel to each other such that
>
> $$\frac{1}{R} = \frac{1}{1/5} + \frac{1}{1/5} + \frac{1}{1/5} + \frac{1}{1/5} + \frac{1}{1/5} \Rightarrow \frac{1}{R} = \frac{5}{1/5}$$
>
> $$\Rightarrow \frac{1}{R} = \frac{25}{1}$$
>
> $$\Rightarrow R = \frac{1}{25}\ \Omega$$

11. 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% AE

Ans. Option (C) is correct.

> ***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 = $\frac{3P_1}{P_1} \times 100$
$= 300\%$

AI **12. 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.

AE

Ans. Option (C) is correct.

Explanation: Brightness of a bulb is given by $P = I^2R$. Thus, the power rating of bulb is directly proportional to the brightness produced by bulb. Therefore, brightness of bulb C will be highest, and brightness of bulb B with power rating 60 W will be more than the brightness of bulb A having power rating as 40 W.

13. 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 AE

Ans. Option (D) is correct.

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.

Assertion and Reason Based MCQs
(1 Mark Each)

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 A and R are true and R is the correct explanation of A.

(B) Both A and R are true but R is NOT the correct explanation of A.

(C) A is true but R is false.

(D) A is false and R is true.

1. Assertion (A): The resistivity of conductor increases with the increasing of temperature.
Reason (R): The resistivity is the reciprocal of the conductivity.

Ans. Option (B) is correct.

Explanation: The resistivity of the conductors varies with temperature. Thus, resistivity dependent on temperature and nature of material used and independent of length, cross-section area. Resistivity is the measure of inhibit the flow of electricity and conductivity is the measure of how easily flow of electricity happen.

2. Assertion (A): Bending a wire does not affect electrical resistance.
Reason (R): Resistance of wire is proportional to resistivity of material.

Ans. Option (A) is correct.

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.

3. Assertion (A): Two resistance having value R each. Their equivalent resistance is $\frac{R}{2}$.
Reason (R): Resistances are connected in parallel.

Ans. Option (A) is correct.

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

Thus, $R_{eq} = \frac{R \times R}{R \times R}$

$\Rightarrow$ $R_{eq} = \frac{R}{2}$

4. 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 than their constituent metals.

Ans. Option (C) is correct.

Explanation: Alloys have high resistivity and high melting point as compared to pure metals. So, alloys cannot easily burn or oxidise at higher temperature. Thus, due to higher temperature in heating devices these are used for domestic purposes.

5. 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. Option (C) is correct.

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 to avoid eventual electric shock.

By Earthing 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.

6. **Assertion (A):** Copper is used to make electric wires.
Reason (R): Copper has very low electrical resistance.

Ans. Option (A) is correct.

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

7. **Assertion (A):** Silver is not used to make electric wires.
Reason (R): Silver is a bad conductor of electricity.

Ans. Option (C) is correct.

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

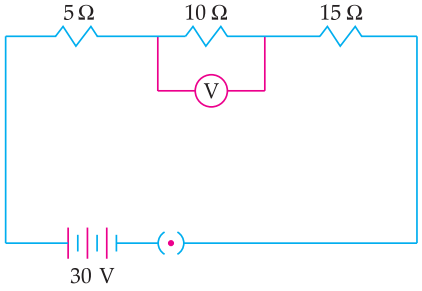
Case-based MCQs (1 Mark Each)

AI **I. Read the passage and answer the questions given below :**

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.

1. **Which of the following is the correct circuit diagram to connect all the devices in proper correct order.** U

(A)



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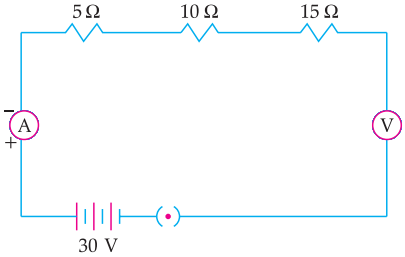

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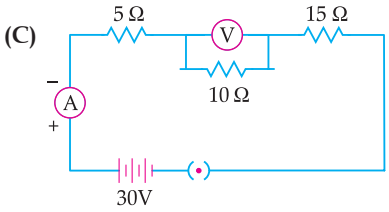
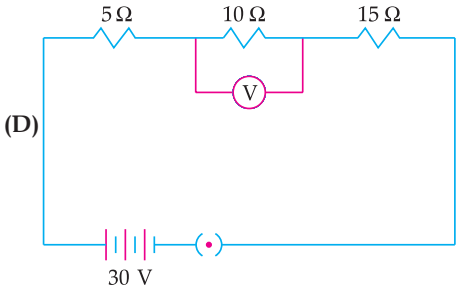
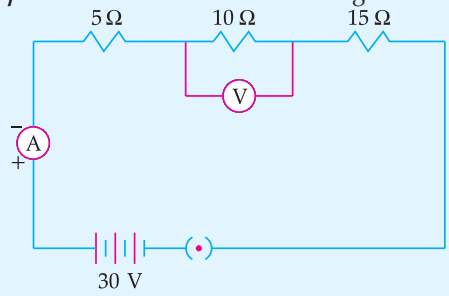


(D)



Ans. Option (D) is correct.

Explanation: The correct circuit diagram is :



2. **How much is the total resistance in the above circuit diagram?**

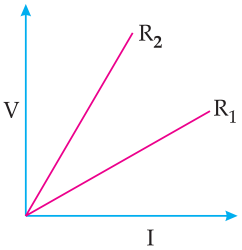
(A) 30 Ω (B) 20 Ω
(C) $\frac{11}{30}\Omega$ (D) $\frac{30}{11}\Omega$ R

Ans. Option (A) is correct.

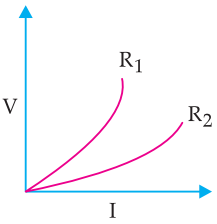
Explanation: In series combination, $R = R_1 + R_2 + R_3 = 30\ \Omega$

3. **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

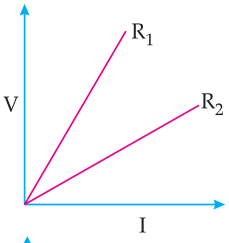
(A)



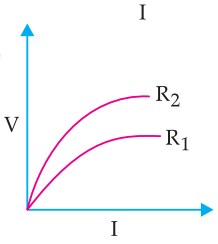
(B)



(C)



(D)



Ans. Option (C) is correct.

> ***Explanation:*** Diagram in option (A) is correct as R_1 is large so the slope of V–I graph (V/I) is greater in diagram and is correctly represented as R_1.
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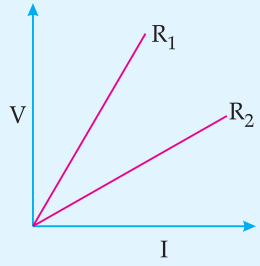
> 
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4. Which of the following is connected in series in circuit?

(A) Ammeter **(B)** Voltmeter
(C) Both of these **(D)** None of these R

Ans. Option (A) is correct.

> ***Explanation:*** Ammeter is used to measure the current. It is connected in series in the circuit. Whereas voltmeter is connected in parallel to measure voltage around resister.

AI III. Study the given table and answer the questions given below :

	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}

1. Which is a better conductor ?

(A) Chromium **(B)** Nickel
(C) Mercury **(D)** Iron R

Ans. Option (B) is correct.

> ***Explanation:*** Nickel is better conductor because its resistivity value is lower than others.

2. Element used to make heating element of electric geyser is :

(A) Iron **(B)** Silver
(C) Nichrome **(D)** Tungsten U

Ans. Option (C) is correct.

> ***Explanation:*** Nichrome is used to make the heating element of an electric geyser due to its high melting point and high resistivity. It controls the melting of wire easily and allow to produce large amount of energy.

3. Element used to make filament of incandescent bulb is:

(A) Copper **(B)** Silver
(C) Nichrome **(D)** Tungsten U

Ans. Option (D) is correct.

> ***Explanation:*** Tungsten is used to make filament of incandescent bulb because of its high melting point.

4. What happens to resistance of a conductor when its area of cross section is increased?

(A) Resistance increases **(B)** Resistance decreases
(C) No change **(C)** Resistance doubles A

Ans. Option (B) is correct.

> ***Explanation:*** Electrical resistance is directly proportional to the length (L) of the conductor and inversely proportional to the cross-sectional area (A).

IV. Electrical resistivities of some substances, at 20°C are given below in the table. Study the table and answer the given questions.

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

1. Which is a better conductor of electric current ?

(A) Silver **(B)** Copper
(C) Tungsten **(D)** Mercury U

Ans. Option (A) is correct.

> ***Explanation:*** Silver is a better conductor because it has lower resistivity.

2. Which element will be used for electrical transmission lines ?

(A) Iron **(B)** Copper

(C) Tungsten **(D)** mercury U

Ans. Option (B) is correct.

> ***Explanation:*** Copper, because it is economical, less oxidative than other metals and has low resistivity.

3. Nichrome is used in the heating elements of electric heating device because:

(A) It has high resistivity

(B) It does not oxidise readily at high temperature

(C) Both of the above

(D) None of the above U

Ans. Option (C) is correct.

> ***Explanation:*** Nichrome as it has very high resistivity / as it is an alloy, it does not oxidize readily at high temperature.

4. Series arrangement is not used for domestic circuits because:

(A) Current drawn is less

(B) Current drawn is more

(C) Neither of the above

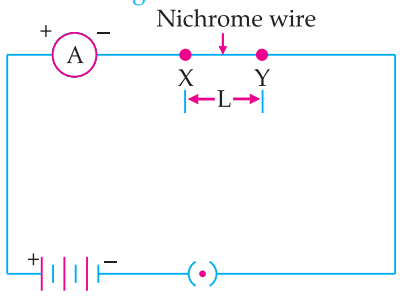
(D) Both of the above U

Ans. Option (A) is correct.

> ***Explanation:*** In series arrangement, same current will flow through all the appliances which is not required and the equivalent resistance becomes higher, hence the current drawn becomes less.

V. Based on the given diagram, answer the questions given below :

In the given circuit, connect a nichrome wire of length '*L*' between points X and Y and note the ammeter reading.



1. 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) Ammeter reading will increase.

(B) Ammeter reading will decrease.

(C) Will show double the increase.

(D) No change in ammeter reading. AE

Ans. Option (B) is correct.

> ***Explanation:*** The ammeter reading will decrease (becomes half). As resistance is directly proportional to the length of the wire and inversely proportional to cross-section area. Thus, with the increase in length, resistance of the circuit increases, hence current decreases.

2. 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.

(A) Ammeter reading will increase

(B) Ammeter reading will decrease

(C) Will decrease to half

(D) No change in ammeter reading AE

Ans. Option (A) is correct.

> ***Explanation:*** The ammeter reading will increase (becomes two times). Resistance R $= P\frac{l}{A}$, thus as area increases, resistance decreases and hence current increases.

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

(A) 1 : 2 **(B)** 1 : 3

(C) 2 : 1 **(D)** 1 : 1 AE

Ans. Option (D) is correct.

> ***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.

4. 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) Nichrome wire

(B) Copper wire

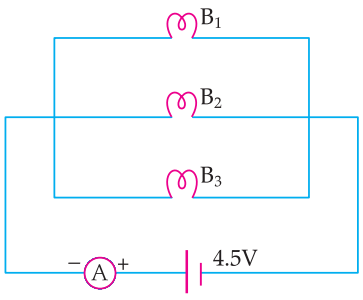
(C) Both will heat up at the same temperature

(D) None of the wire will get heated up. A

Ans. Option (A) is correct.

> ***Explanation:*** In series combination, current I is same in nichrome and copper wires. But resistance in nichrome wire is more than copper, thus nichrome wire will produce more heat.

VI. In the given circuit, three identical bulbs B_1, B_2 and B_3 are connected in parallel with a battery of 4.5 V. Study the diagram and answer the questions given below :



1. What will happen to the other two bulbs if the bulb B_3 gets fused ?

(A) They will also stop glowing.
(B) Other bulbs will glow with same brightness.
(C) They will glow with low brightness.
(D) They glow with more brightness. A

Ans. Option (B) is correct.

Explanation: Other bulbs will glow with same brightness because glowing of bulbs depend upon power and potential difference, and resistance remain same for other bulbs.

2. 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?

(A) 1.0 A **(B)** 2 A
(C) 1.5 A **(D)** None of the above AE

Ans. Option (A) is correct.

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

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

3. Find the total resistance of the circuit.

(A) 1.0 Ω **(B)** 4.5 Ω
(C) 1.5 Ω **(D)** 2.0 Ω AE

Ans. Option (B) is correct.

Explanation: Ammeter reading = 1.0 A

$V = 4.5$ V

$R = V/I$

$= 4.5 = 4.5\ \Omega$

4. How many resistors of 88 W are connected in parallel to carry 10 A current on a 220 V line ?

(A) 2 resistors **(B)** 1 resistors
(C) 3 resistors **(D)** 4 resistors AE

Ans. Option (D) is correct.

Explanation: Equivalent resistance,

$= \quad =$

$R_p =$

Ohm's law, $V = IR$

$R =$

$=$

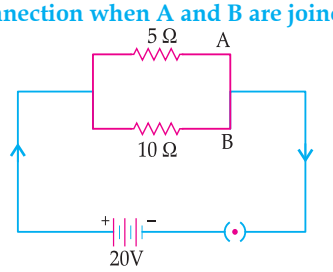
$n = 4$ resistors

AI VII. Study the given passage and answer the questions given below:

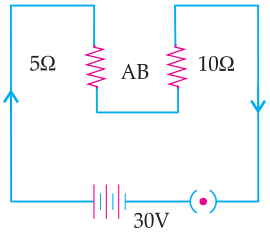
Two conductors A and B of resistances 5 Ω and 10 Ω respectively are first joined in parallel and then in series. In each case the voltage applied is 20 V.

1. Which of these circuit diagram shows the correct connection when A and B are joined in parallel?

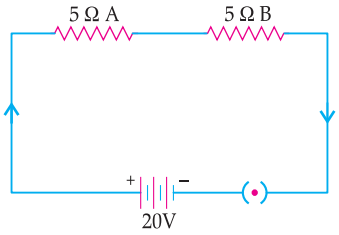
(A)



(B)



(C)



(D) None of these U

Ans. Option (A) is correct.

Explanation: The diagram (A) correctly shows the combination of these conductors in each case. In parallel connection, resistors are connected at the same points of the main wire such that both have same potential difference.

2. In which combination will the voltage across the conductors A and B be the same ?

(A) Series arrangement
(B) Parallel arrangement
(C) Both of the above
(D) None of the above U

Ans. Option (B) is correct.

Explanation: Voltage across A and B will be same in parallel arrangement.

3. In which arrangement will the current through A and B be the same ?

(A) Series arrangement
(B) Parallel arrangement
(C) Both of the above
(D) None of the above U

Ans. Option (A) is correct.

Explanation: In series connection, resistors are connected such that end of first resistor connect to the start of second resistor. Thus, Current through A and B will be same in series arrangement.

4. Equivalent resistance in parallel combination is:

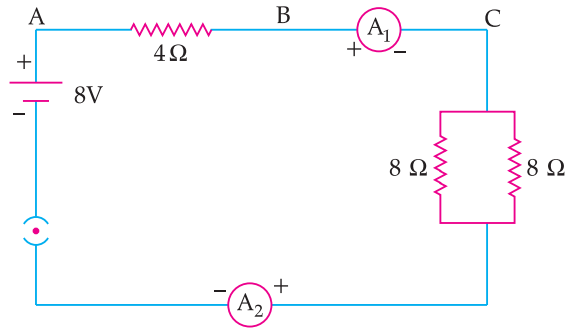
(A) 15 Ω **(B)** 3.33 Ω
(C) 0.3 Ω **(D)** None of the above AE

Ans. Option (B) is correct.

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

$= 3.33\ \Omega$

AI VIII. Study the given circuit diagram and answer the questions given below :



1. Effective resistance of two 8 Ω resistors in the combination.

(A) 4 Ω **(B)** 16 Ω

(C) 8 Ω **(D)** 1 Ω AE

Ans. Option (A) is correct.

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

$R = 4\ \Omega$

2. Current flowing through 4 Ω resistor is :

(A) 1 A **(B)** 2 A

(C) 8 A **(D)** 4 A AE

Ans. Option (A) is correct.

Explanation: Current flowing through the circuit = Current flowing through 4 Ω

Equivalent resistance of the circuit = 4 Ω + 4 Ω = 8 Ω

Current flowing in the circuit = $\frac{V}{R} = \frac{8V}{8\Omega} = 1$ A

3. Potential difference across 4 Ω resistor is :

(A) 1V **(B)** 2 V

(C) 4 V **(D)** 8 V AE

Ans. Option (C) is correct.

Explanation:

Potential difference across 4Ω = V_1

$V_1 = IR_1$

$V_1 = 1A \times 4\Omega = 4V$

4. Power dissipated in 4 Ω resistor is :

(A) 4 W **(B)** 2 W

(C) 1 W **(D)** 8 W AE

Ans. Option (A) is correct.

Explanation: Power dissipated in 4Ω = P

$P = VI = 4V \times 1A = 4$ watt

(B) Subjective Questions

Very Short Answer Type Questions
(1 Mark Each)

1. Why are the heating elements of electric toasters and electric irons made of an alloy rather than a pure metal ? A [CBSE O.D., 2019]

Ans. Due to high resistivity of alloys rather than its constituting metals. **1**

[CBSE Marking Scheme, 2019]

AI 2. Should the resistance of a voltmeter be low or high? Give reason.

A [CBSE O.D., Set- II, 2019]

Ans. High. In parallel connection, less current passes through high resistance. ½ + ½

[CBSE Marking Scheme, 2019]

3. Write SI unit of resistivity.

R [CBSE Term I, Set-2, 2015] [DDE 2017]

Ans. Ohm metre (ohm m).

4. 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? [O.E.B.]

Ans. Voltage-drop is same across both.

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

U [CBSE O.D., Set-III, 2020]

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.

6. 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

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

A [CBSE O.D. Set-III, 2019]

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

[CBSE Marking Scheme, 2019] 1

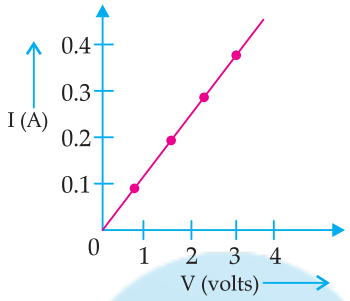
Detailed Answer:

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.

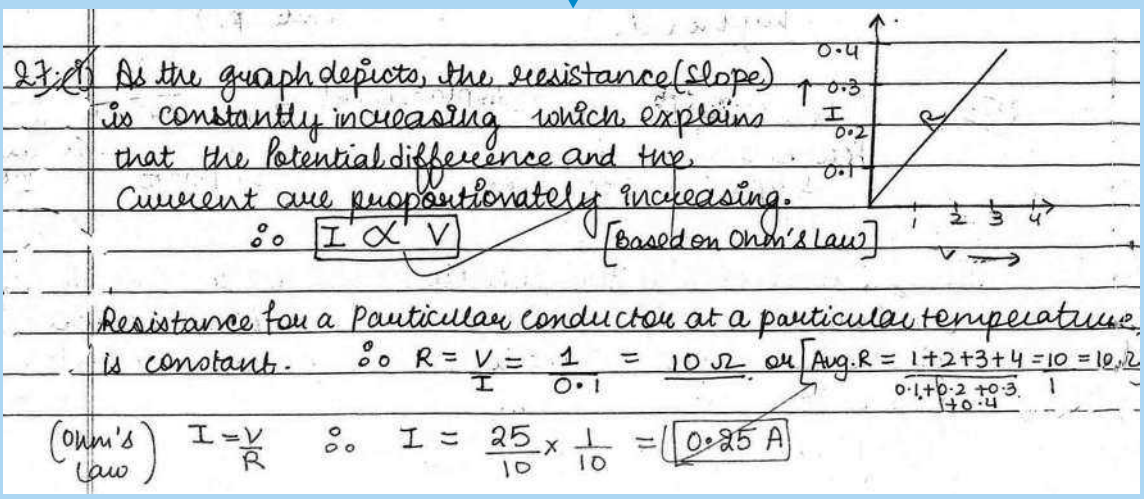
Short Answer Type Questions-I
(2 Marks Each)

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.
(i) What does the graph depict about the dependence of current on the potential difference?
(ii) Find the current that flows through the resistor when the potential difference across it is 2.5V.

A [CBSE, Delhi, 2019]



Topper Answer, 2019

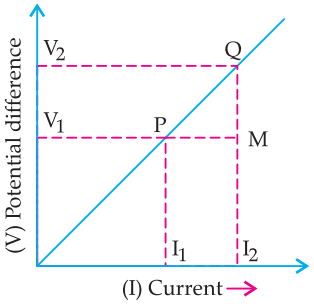


2. While studying the dependence of potential difference (V) across a resistor on the current (I) passing through it, in order to determine the resistance of the resistor, a student took 5 readings for different values of current and plotted a graph between V and I. He got a straight line graph passing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

A [CBSE Delhi 2019]

Detailed Answer:

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



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

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

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

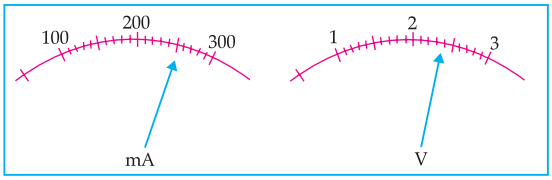
1+1=2

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 ?

U **[CBSE O.D. Set-II, 2019]**



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 milliammeter = 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= $\frac{V}{I} = \frac{24}{250 \times 10^{-3}}$ = 9.6 Ω ½+½

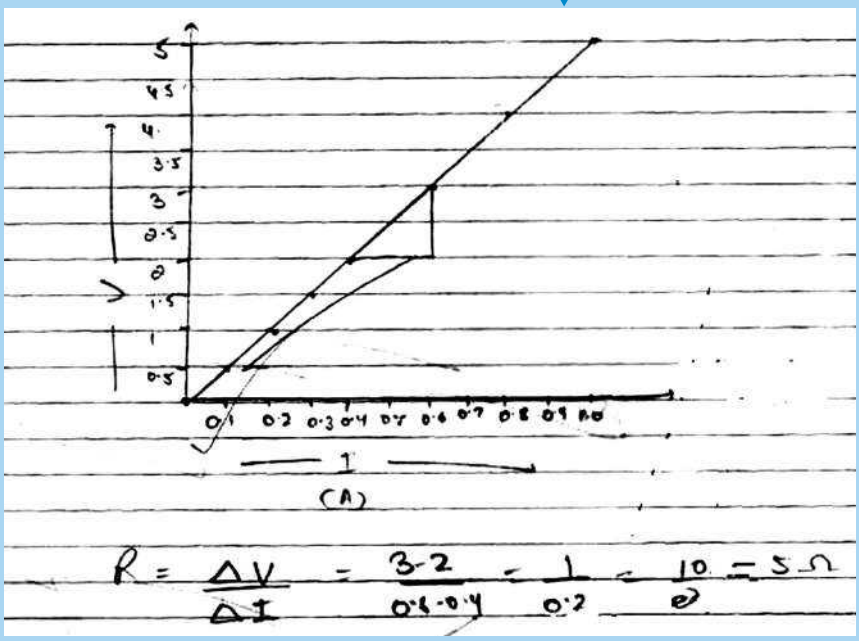
4. The values of current (I) flowing through a given resistor of resistance (R), for the corresponding values of potential difference (V) across the resistor are as given below:

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

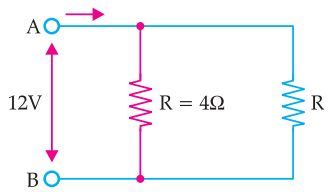
Plot a graph between current (I) and potential difference (V) and determine the resistance (R) of the resistor.

A **[CBSE Delhi Set-I, 2018]**

Topper Answer, 2018



5. 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



U **[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, $4R_2/(4+R_2) = 4/3$
$\therefore \quad R_2 = 2\Omega$ **2**

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

Ans. 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 **2**

7. Define electric power. Write an expression relating electric power, potential difference and resistance. R **[CBSE O.D. 2020]**

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

Expression : $P = \frac{V^2}{R}$ **1 + 1**

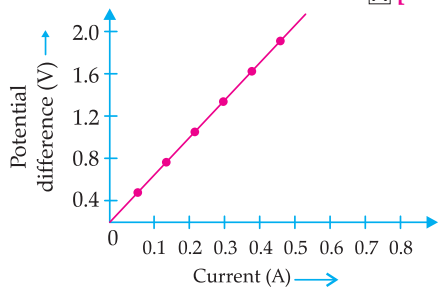
Where, P = Electric Power, V = Potential difference, R = Resistance

8. How many 132 Ω resistors in parallel are required to carry 5 A on a 220 V line ?
A **[CBSE O.D. Set-III, 2020]**

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 **2**

Short Answer Type Questions-II
(3 Marks Each)

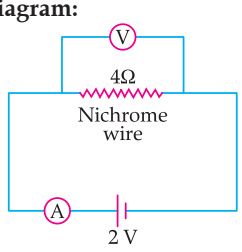
1. A V-I graph for a nichrome wire is given below. What do you infer from this graph? Draw a labelled circuit diagram to obtain such a graph.
A **[CBSE 2020]**



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 difference (V) established across it. This is ohm's law.
Resistance of the wire can be calculated as :

$$R = \frac{V}{I} \quad \frac{0.8}{0.2} = 4 \text{ ohm}$$

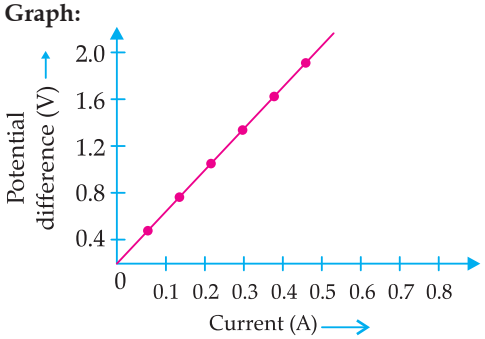
This means nichrome wire has a constant value of the resistance 4 ohm. **2**
Circuit diagram:



1

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.
A **[CBSE 2020]**

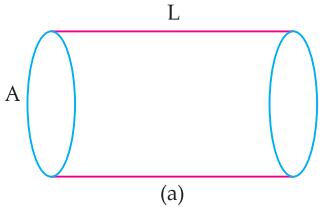
Ans. (a) The flow of current (I) in the conductor is directly proportional to the potential difference (V) established across it provided the physical conditions remain same.
Or V = IR
Graph:

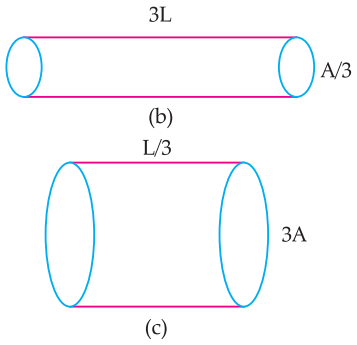


2

(b) Given :
Potential Difference (V)= 1.4 V
Current (I) = 0.35 A
As per formula, V = IR
So, $\frac{V}{I} = \frac{1.4}{0.35} = 4$ ohm **1**

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 [CBSE 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**

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 [CBSE Delhi Comptt. Set-I, II, III, 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**

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

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

Resistance of wire is doubled if its length is doubled.

Hence current is reduced to half.

$$\therefore \text{ Ammeter reading} = \frac{100 \text{ mA}}{2} = 50 \text{ mA} \quad \mathbf{1}$$

[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. Learn the concept of resistance and resistivity carefully.

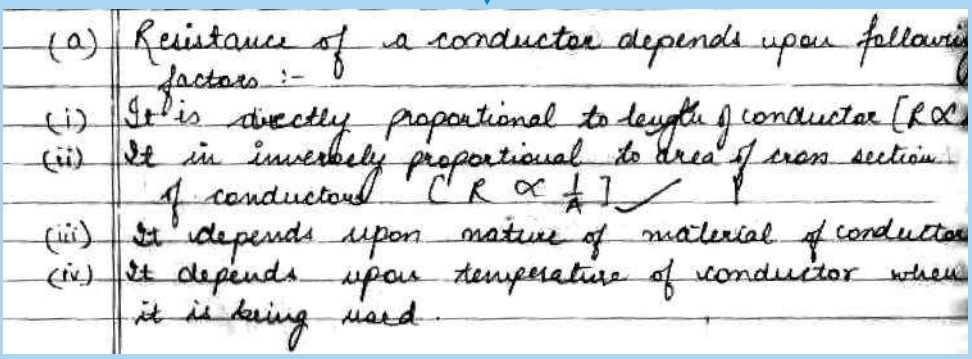
5. (a) List the factors on which the resistance of a conductor in the shape of a wire depends.
(b) Why are metals good conductors of electricity whereas glass is a bad conductor of electricity ? Give reason.
(c) Why are alloys commonly used in electrical heating devices ? Give reason. U [CBSE Delhi /O.D. 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. [CBSE Marking Scheme, 2018] **(Any one) 1**

Topper Answer, 2018



(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^{11} 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 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 [CBSE 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:

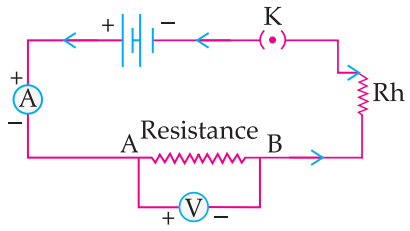
Ohm's Law: It states that "Physical conditions remaining same, the current flowing through a conductor is directly proportional to the potential difference across its two ends".

i.e., $I \propto V$

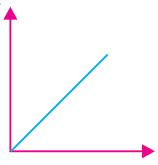
$V = IR$

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.

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 [CBSE Term I, 2016]

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

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

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

[CBSE Marking Scheme, 2016]

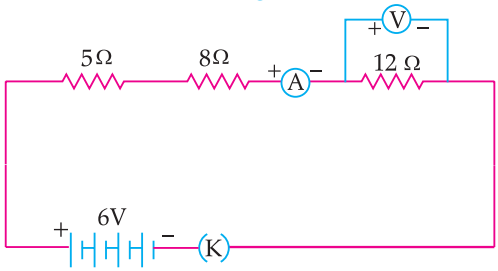
COMMONLY MADE ERROR

- 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.

AI **8. 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. Set-I, II, III, 2018]

Ans. $R = R_1 + R_2 + R_3$

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

$V = 6\ V$

$V = IR$

$\therefore \quad I = \frac{V}{R} = \frac{6\ V}{25\,\Omega} = 0.24\ A$ **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 **9. 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. Set-I, II, III, 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

$\therefore$ Total energy $= (150 + 120)\ kWh = 270\ kWh$ ½

$\therefore$ Total cost $= 270 \times 6 = ₹\ 1620$ **1**

COMMONLY MADE ERROR

- Calculation error is commonly seen in numerical questions.

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.

10. (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 [CBSE Delhi /O.D., 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

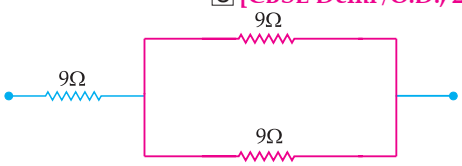
Current in 2nd bulb,

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

AI **11. 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 [CBSE Delhi /O.D., 2018]

Ans. (i)



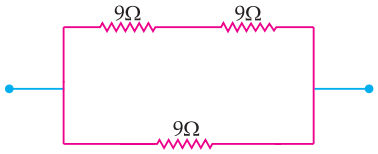
Two 9 ohm resistors in parallel connected to one 9 ohm resistor in series.

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

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

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

(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**

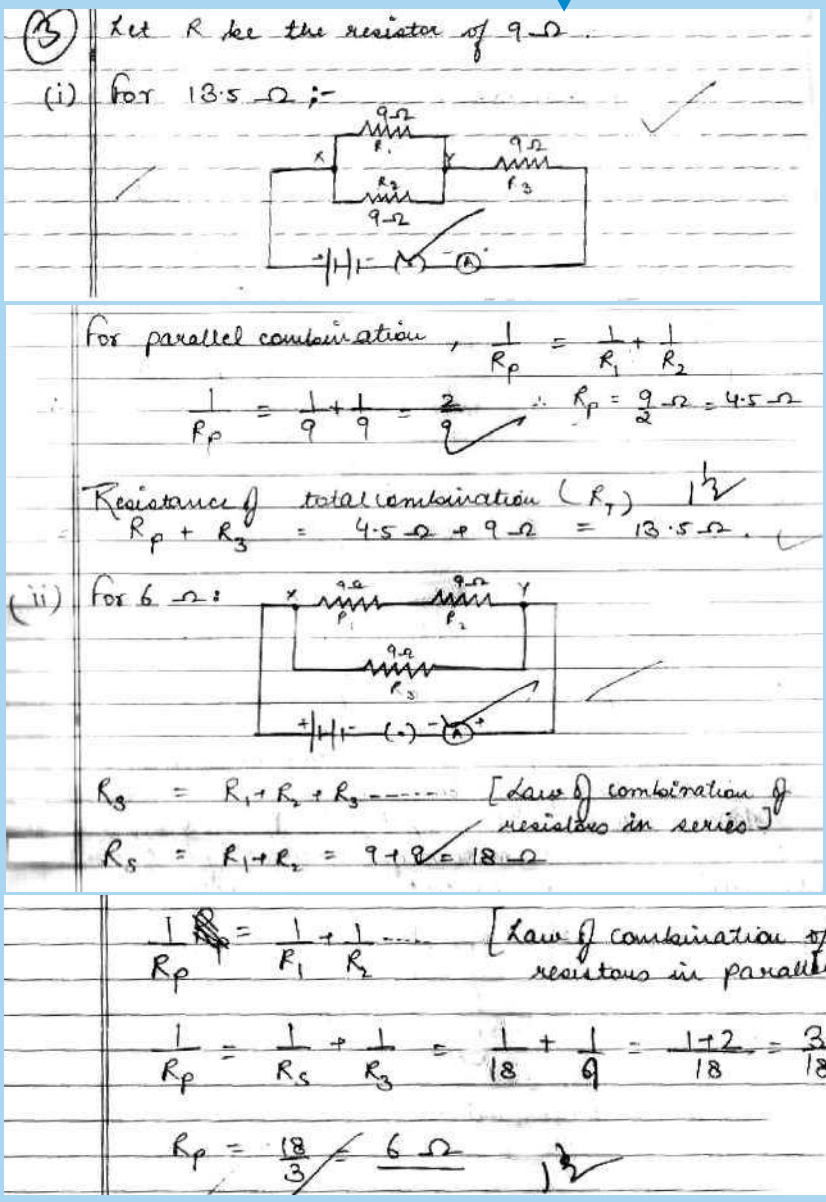
COMMONLY MADE ERROR

- 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.

Topper Answer, 2018



12. 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 [CBSE Term I, 2016]

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

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

$$= 0.2\ A$$

$\therefore$ Current in the circuit = 0.2 A

$\therefore$ Potential drop across 10 Ω resistor is

$V = IR$

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

$= 2\ V$ **1½ + 1½**

[CBSE Marking Scheme, 2016]

13. 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 [CBSE Term-I, 2016]

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

$$nP = VI$$

$$n = \frac{VI}{P} = \frac{200 \times 5}{40}$$

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

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

AI **14. 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 [CBSE 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 $= 40\ W \times 5 = 200\ W$

Time $= 5$ hrs

Electrical energy $= 200\ W \times 5$ hrs.

$= 1000$ Wh

$= 1$ kWh.

Cost of 1 kWh $= ₹\ 5.10$ **3**

$\therefore$ Total cost $= ₹\ 1 \times 5.10 = ₹\ 5.10$

[CBSE Marking Scheme, 2016]

15. 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 [CBSE 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]

16. 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]

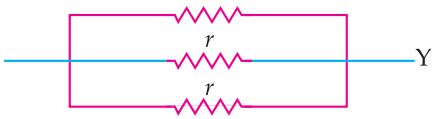
(i) Maximum

(ii) Minimum [CBSE Term-I, 2014]

Ans. (a)

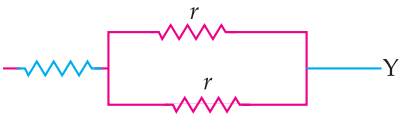
½

(b)



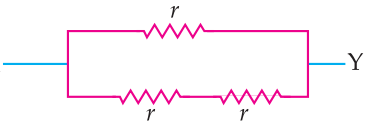
½

(c)



½

(d)



½

(i) Circuit (a) has maximum resistance ½

(ii) Circuit (b) has minimum resistance ½

Long Answer Type Questions

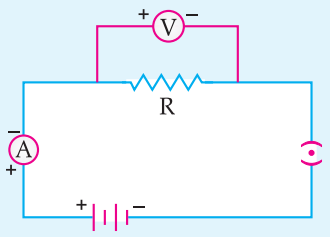
(5 Marks Each)

1. (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 [CBSE Term-I, 2016]

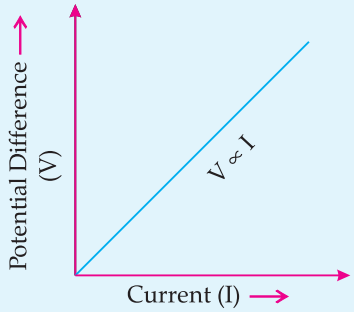
Ans. (i)



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) $V = 1.0\ V$

$I = 0.25\ A$

$V = IR$

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

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

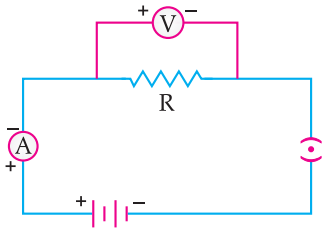
[CBSE Marking Scheme, 2016]

2. 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 **[CBSE Term I, 2015]**

Ans.



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

$V = IR.$

Given, $V = 1.05\ V$

$I = 0.15\ A$

Putting in equation

$V = IR$

or, $1.05 = 0.15 \times R$

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

3. (a) Define Power and state its SI 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 O.D. 2020]**

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) $P = V \times I = 5 \times 0.5 = 2.5\ W$

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

(iii) Energy consumed $= P \times t$

$= 2.5 \times 2.5$

$= 6.25\ Wh$ **3**

4. (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 OD 2020]**

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

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

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

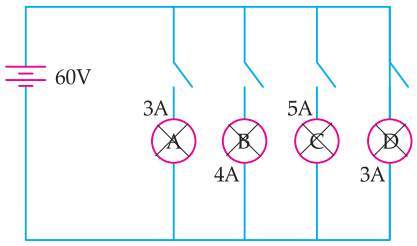
So, $E = 3 \times 100\ W \times 10\ h \times 30 = 90{,}000\ Wh$

$= 90\ kWh$ **2**

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

$= 90\ kWh \times 6.50 = ₹\ 585$ **1**

5. In the given circuit, A, B, C and D are four lamps connected with a battery of 60 V. **[CBSE 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**

6. 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 **[CBSE Delhi, 2019]**

Ans. P = 40 W, V = 220V

$$P = VI$$

$$\therefore \quad I = \frac{P}{V} = \frac{40}{220} = \frac{2}{11}A = 0.18\ A$$

From Ohm's law,

$$V = IR$$

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

When replaced by 25 W, 220 V lamp:

$$I = \frac{P}{V} = \frac{25}{220} = \frac{5}{44}A = 0.113\ A$$

$$R = \frac{V^2}{P} = \frac{220^2}{25} = 1936\ \Omega$$

Yes there is change in current and resistance.

Change in current = 0.18 – 0.1136 = 0.0664 A

Change in resistance = 1936 – 1210 = 726 ohm.

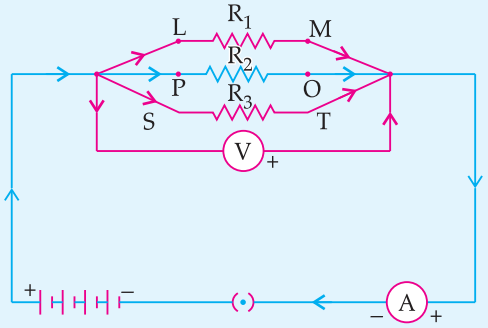
Hence, from the above justification, we can see that current decreases and resistance increases when we use a 25 W bulb in place of a 40 W.

7. (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 Delhi, Set-I, 2019]**

Ans.



1

From figure:

$$I = I_1 + I_2 + I_3$$

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

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

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

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

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

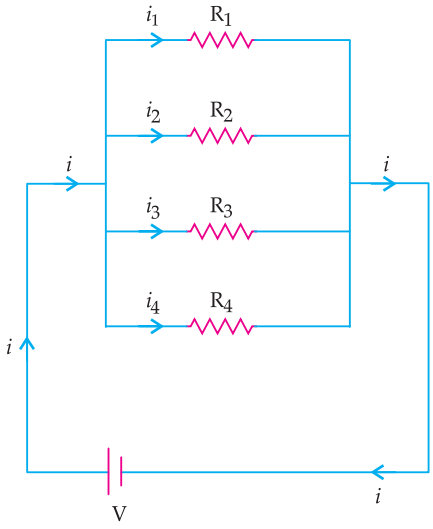
$$\therefore \quad R_p = 6\ \Omega \qquad ½$$

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

[CBSE Marking Scheme, 2013]

Detailed Answer:

(a)



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 **1 + 2 + 2**

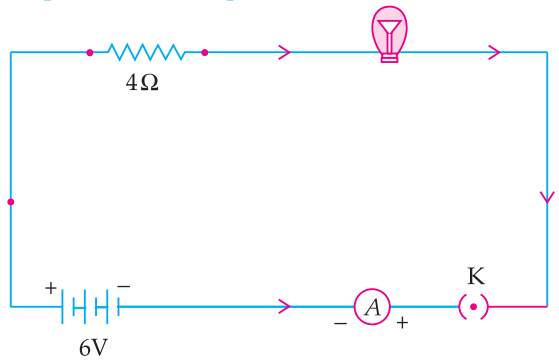
8. An electric lamp of resistance 20 Ω and a conductor of resistance 4 Ω are connected to a 6 V battery as shown in the circuit. Calculate:

(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 Delhi, Set-I, 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, $V_1 = IR_1$

$= 0.25\ \text{A} \times 20\ \Omega$

$= 5$V

(ii) Conductor, $V_2 = IR_2$

$= 0.25\ \text{A} \times 4\ \Omega$

$= 1$V

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

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

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

COMMONLY MADE ERROR

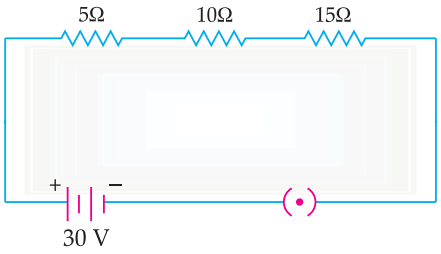
- Many students commit errors in substituting the correct values in formulas.

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.

9. (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 **[CBSE O.D. 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

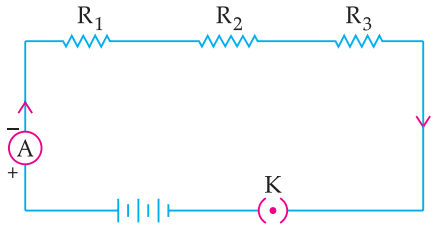
$$V = IR \text{ or } I = \frac{V}{R} = \frac{30\text{V}}{30\ \Omega} = 1\text{A}$$ **1**

Potential difference across 15 ohm Resistor = $1\text{A} \times 15\ \Omega = 15\ \text{V}$ ½

[CBSE Marking Scheme, 2019]

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) $= \frac{V}{R_{eq}}$

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

Potential difference across 15Ω resistor = IR

$= 1 \times 15 = 15\ \text{V}$ **3+2**

10. (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? **[CBSE O.D. 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

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

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

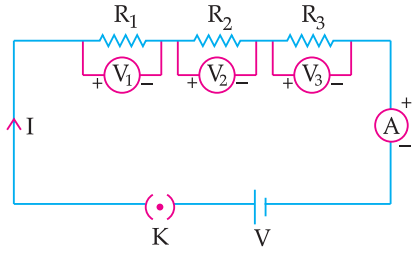
If R_{eqv} is less, power consumed will be more.

In the given case, R_{eqv} is lesser in the parallel and thus power consumed will be more. **1 + 2 + 2**

[CBSE Marking Scheme, 2019]

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 **[CBSE 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,

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

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

$$R_P = 1\ \Omega \qquad \textbf{4 + 1}$$