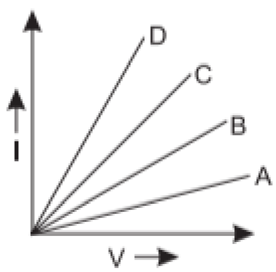
Electricity

Case Study Based Questions

Case Study 1

Ohm's law gives a relationship between current and potential difference. According to this law, at constant temperature, the current flowing through a conductor is directly proportional to the potential difference across its ends. The ratio of potential difference applied between the ends of a conductor and the current flowing through it is a constant quantity called resistance. The following graph is obtained by a researcher while doing an experiment to study Ohm's law. The I-V graph for four conductors A, B, C and D having resistances R_A, R_B, R_C and RD respectively are shown in the graph.



Read the above passage carefully and give the answer of the following questions:

Q1. If all the conductors are of same length and same material, which is the thickest?

a. C b. D

c. A

d. B

Q2. If all the conductors are of same thickness and of same material, which is the longest?

a. B

b. C

c. A

d. D

Q3. Which one of the following relations is true for these conductors?

a. RA > RB >RC> Ro

b. RA=RB < Rc <Ro

C. $R_A < R_B < R_c < R_o$

d. $R_A = R_B = R_C = R_o$

Q4. If conductors A and B are connected in series and I-V graph is plotted for the combination, its slope would be:

a. more than that of A

b. between A and B

c. more than that of D

d. less than that of A

Q5. If conductors C and D are connected in parallel and I-V graph is plotted for the combination, its slope would be:

a. between C and D

b. lesser than that of A

c. more than that of D

d. between B and C

Answers

1. (b) D

2. (c) A

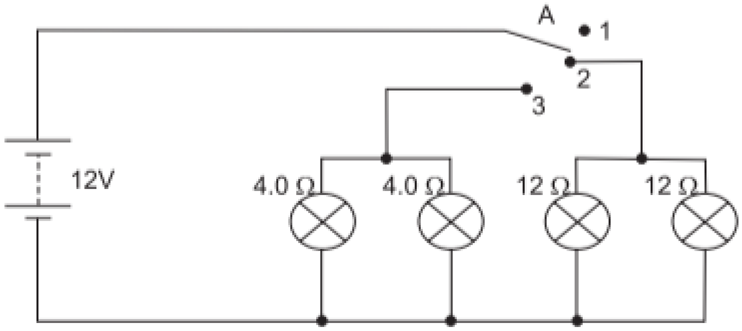
3. (a) RARB>RC>Ro

4. (d) less than that of A

5. (c) more than that of D

Case Study 2

Vinita and Ahmed demonstrated a circuit that operates the two headlights and the two sidelights of a car, in their school exhibition.



Based on their demonstrated circuit, answer the following questions:

Q1. State what happens when switch A is connected to

(i) Position 2

(ii) Position 3

Q2. Find the potential difference across each lamp when lit.

Q3. Calculate the current:

(i) In each 12**Ω** lamp when lit.

(ii) In each 4 **Ω** lamp when lit.

Or

Show, with calculations, which type of lamp, 4.0 **Ω** or 12 **Ω** has the higher power. (CBSE SQP 2023-24)

Answers

1. (1) Only 12 2 lamps will light up.

(ii) Only 4 lamps will light up.

2. 12 V for both sets of lamps as all of them are in parallel.

3. (i) Voltage across both 12 2 lamps = 12 V.

Using Ohm's law, $V = IR$

$$\Rightarrow \quad I = \frac{V}{R} = \frac{12}{12} = 1\,\text{A}.$$

(ii) Voltage across both 4 Ω lamps = 12 V.

Using Ohm's law, $V = IR$

$\Rightarrow \qquad I = \frac{V}{R} = \frac{12}{4} = 3\text{ A.}$

Or

All lamps are in parallel and hence same V for all lamps.

Using, $P = V^2/R$

For 4 Ω lamps, $P = \frac{12 \times 12}{4} = 36\text{ W}$

For 12 Ω lamps, $P = \frac{12 \times 12}{12} = 12\text{ W}$

Hence, 4 Ω lamps will have higher power.

Case Study 3

When an electric current passes through a conductor (like a high resistance wire) the conductor becomes hot after some time and produces heat. This is called heating effect of electric current or joule heating or ohmic heating or resistive heating. The heating effect of electric current is widely used in our day- to-day life. The electric laundry iron, electric toaster, electric bulb, fuse and electric heater are some of the familiar devices based on Joule's heating.

Read the above passage carefully and give the answer of the following questions:

Q1. Write the mathematical expression for Joule's law of heating.

Q2. The following table gives the resistivity of three samples:

Sample	A	B	C
Resistivity	$1.6 \times 10^{-5}\ \Omega\text{ m}$	$5.2 \times 10^{-5}\ \Omega\text{ m}$	$100 \times 10^{-4}\ \Omega\text{ m}$

Which of them is suitable for heating elements of electrical appliances and why?

Q3. Why does the cord of an electric heater not glow while the heating element does?

Q4. State a difference between the wire used in the element of an electric heater and in a fuse wire.

Q5. Tungsten is used almost exclusively for filaments of electric bulb. List two reasons.

Answers

1. The mathematical expression for Joule's law of heating is:
Heat generated, H=12Rt

where is the amount of current flowing through the conductor, R is the resistance of conductor and t is the time for which the current has flown.

2. The resistivity of sample C is maximum so it is suitable for making heating elements of electrical appliances.

3. The cord of an electric heater is made up of copper with very low resistance whereas heating elements are made up of alloys which have very

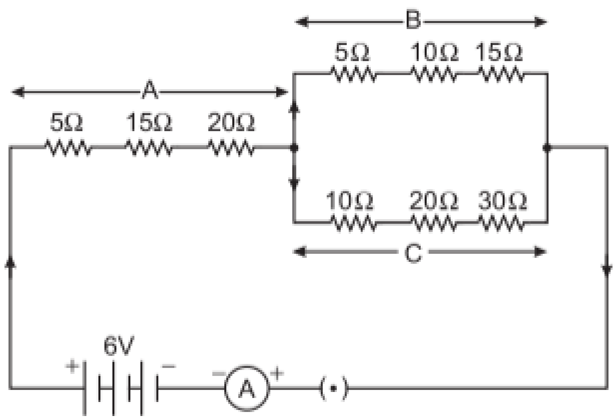
high resistance. So, when current flows through the heating element, it becomes too hot and glows red due to heating effect of current.

4. The wire used in element of electric heater has high resistance and high melting point whereas a fuse wire has low resistance and low melting point.

5. Tungsten is used for making filaments of electric bulb because of the following reasons:
(i) It has very high melting point
(ii) It has high resistivity

Case Study 4

Study the following electric circuit in which the resistors are arranged in three arms A, B and C:



Study the above electric circuit carefully and give the answer of the following questions:

Q1. Find the equivalent resistance of arm C.

Q2. Calculate the equivalent resistance of the parallel combination of the arms B and C.

Q3. (i) Determine the current that flows through the ammeter.

Or

(ii) Determine the current that flows in the ammeter when the arm B is withdrawn from the circuit. (CBSE 2022 Term-2)

Answers

1. In arm C, 10 Ω, 20 Ω and 30 Ω are in series, Thus, the equivalent resistance,
Rc 10+20+30=60 Ω

2. From the given circuit, the equivalent resistance of parallel combination of arm B and C,

$$\frac{1}{R_{BC}} = \frac{1}{(5+10+15)} + \frac{1}{(10+20+30)}$$

$$= \frac{1}{30} + \frac{1}{60}$$

$$\frac{1}{R_{BC}} = \frac{2+1}{60} = \frac{3}{60}$$

$$R_{BC} = \frac{60}{3} = 20\ \Omega$$

3. (i) From the given circuit, the equivalent resistanc of arm A (RA) is combined in series with R_{BC}
.. Total resistance of the circuit $R = R_A + R_{BC}$
= (5+15+20) + 20
=40+20=60Ω
Thus, the current flowing through ammeter,

$$I = \frac{V}{R} = \frac{6}{60}$$

$$= \frac{1}{10} = 0.1\ A$$

Or

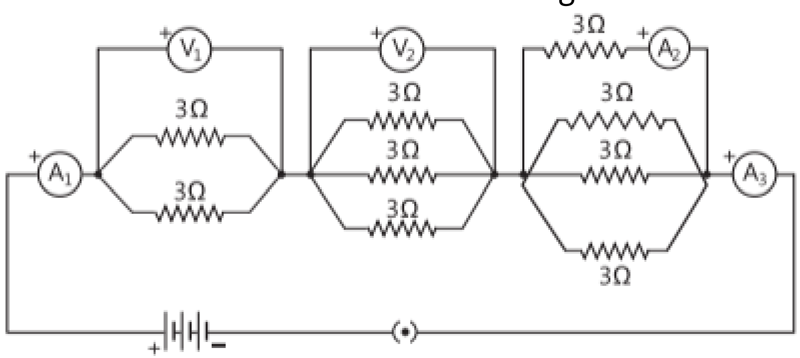
(ii) When the arm B is withdrawn from the circuit, the equivalent resistance,

$$R = (5 + 15 + 20) + (10 + 20 + 30)$$
$$= 40 + 60 = 100$$

$$\therefore \text{Current, } I = \frac{V}{R} = \frac{6}{100} = 0.06 \text{ A}$$

Case Study 5

Consider the following electrical circuit diagram in which nine identical resistors of 3Ω each are connected as shown. The reading of the ammeter A_1 is 1 ampere.



Study the above electrical circuit carefully and give the answer of the following questions:

Q1. What is the relationship between the readings of A_1 and A3? Give reasons for your answer.

Q2. What is the relationship between the readings of A_2 and A3?

Q3. Determine the reading of the voltmeter V1.

Or

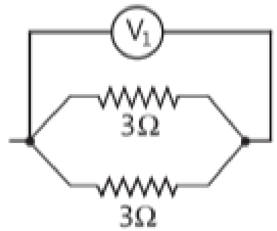
Find the total resistance of the circuit. (CBSE 2023)

Answers

1. Reading of A_1 = Reading of A3 because they are connected in series.

2.

2. Reading of A_2 < Reading of A_3



3. $1/R_{eq} = \frac{1}{3} + \frac{1}{3}$

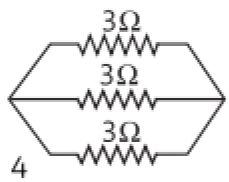
or $R_{eq} = 3/2\ \Omega = 1.5\ \Omega$

$V_1 = IR_{eq} = 1 \times \frac{3}{2} = 1.5\ V$

3.

Or

$1/R'_{eq} = \frac{1}{3} \times \frac{1}{3} \times \frac{1}{3} = \frac{3}{3} = 1$



or $R'_{eq} = 1\ \Omega$

Similarly, $1/R''_{eq} = \frac{1}{3} + \frac{1}{3} + \frac{1}{3} + \frac{1}{3} = \frac{4}{3}$

or $R''_{eq} = \frac{3}{4}\Omega = 0.75\ \Omega$

Total resistance $= R'_{eq} + R'_{eq} + R''_{eq}$

$= 1.5\ \Omega + 1\ \Omega + 0.75\ \Omega$

$= 3.25\ \Omega$

Solutions for Questions 6 to 13 are Given Below

Case Study 6

Read the following and answer any four questions from 1(i) to 1(v).

The rate of flow of charge is called electric current. The SI unit of electric current is Ampere (A). The direction of flow of current is always opposite to the direction of flow of electrons in the current.

The electric potential is defined as the amount of work done in bringing a unit positive test charge from infinity to a point in the electric field. The amount of work done in bringing a unit positive test charge from one point to another point in an electric field is defined as potential difference.

$$V_{AB} = V_B - V_A = \frac{W_{BA}}{q}$$

The SI unit of potential and potential difference is volt.

(i) The 2 C of charge is flowing through a conductor in 100 ms, the current in the circuit is

(a) 20 A (b) 2 A (c) 0.2 A (d) 0.02 A

(ii) Which of the following is true?

(a) Current flows from positive terminal of the cell to the negative terminal of the cell outside the cell.

(b) The negative charge moves from lower potential to higher potential.

(c) The direction of flow of current in same as the direction of flow of positive charge.

(d) All of these

(iii) The potential difference between the two terminals of a battery, if 100 joules of work is required to transfer 20 coulombs of charge from one terminal of the battery to other is

(a) 50 V (b) –5 V (c) 0.5 V (d) 500 V

(iv) The number of electrons flowing per second in a conductor if 1 A current is passing through it

(a) 6.25×10^{20} (b) 6.25×10^{19} (c) 6.25×10^{18} (d) 6.25×10^{-19}

(v) The voltage can be written as

(a) Work done × charge × time

(b) $\frac{\text{Work done}}{\text{Current} \times \text{time}}$

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

(d) Work done × charge

Case Study 7

Read the following and answer any four questions from 2(i) to 2(v).

The relationship between potential difference and current was first established by George Simon Ohm called Ohm's law. According to this law, the current through a metallic conductor is proportional to the potential difference applied between its ends, provided the temperature remain constant *i.e.* $I \propto V$ or $V = IR$; where R is constant for the conductor and it is called resistance of the conductor. Although Ohm's law has been found valid over a large class of materials, there do exist materials and devices used in electric circuits where the proportionality of V and I does not hold.

(i) If both the potential difference and the resistance in a circuit are doubled, then

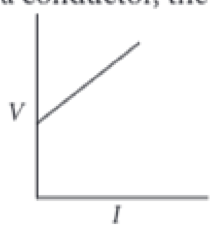
(a) current remains same

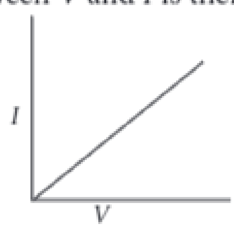
(b) current is doubled

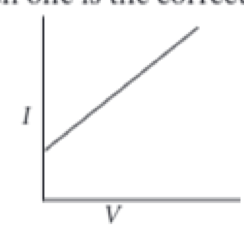
(c) current is halved

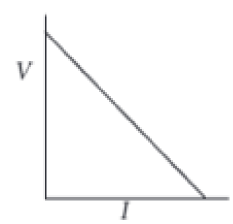
(d) current is quadrupled

(ii) For a conductor, the graph between V and I is there. Which one is the correct?

(a)


(b)


(c)


(d)


(iii) The slope of $V - I$ graph (V on x-axis and I on y-axis) gives

(a) resistance

(b) reciprocal of resistance

(c) charge

(d) reciprocal of charge.

(iv) When battery of 9 V is connected across a conductor and the current flows is 0.1 A, the resistance is

(a) 9 Ω

(b) 0.9 Ω

(c) 90 Ω

(d) 900 Ω

(v) By increasing the voltage across a conductor, the

(a) current will decrease

(b) resistance will increase

(c) current will increase

(d) resistance will decrease.

Case Study 8

Read the following and answer any four questions from 3(i) to 3(v).

The obstruction offered by a conductor in the path of flow of current is called resistance. The SI unit of resistance is ohm (Ω). It has been found that the resistance of a conductor depends on the temperature of the conductor. As the temperature increases the resistance also increases. But the resistance of alloys like mangnin, constantan and nichrome is almost unaffected by temperature. The resistance of a conductor also depends on the length of conductor and the area of cross-section of the conductor. More be the length, more will be the resistance, more be the area of cross-section, lesser will be the resistance.

(i) Which of the following is not will desired in material being used for making electrical wires?

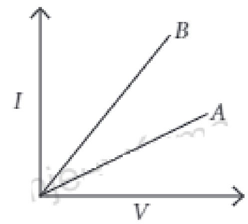
(a) High melting point

(b) High resistance

(c) High conductivity

(d) None of these

(ii) The $V - I$ graph for two metallic wires A and B is given. What is the correct relationship between their temperatures?



(a) $T_A < T_B$ (b) $T_A > T_B$ (c) $T_A = T_B$ (d) none of these

(iii) Two wires of same material one of length L and area of cross-section A, other is of length $2L$ and area $\frac{A}{2}$. Which of the following is correct?

(a) $R_1 = R_2$ (b) $R_1 = 4R_2$ (c) $R_2 = 4R_1$ (d) $R_1 = 2R_2$

(iv) For the same conducting wire

(a) resistance is higher in summer
(b) resistance is higher in winter
(c) resistance is same is summer or in winter
(d) none of these

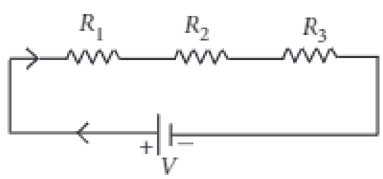
(v) A wire of resistance 20 Ω is cut into 5 equal pieces. The resistance of each part is

(a) 4 Ω
(b) 10 Ω
(c) 100 Ω
(d) 80 Ω

Case Study 9

Read the following and answer any four questions from 4(i) to 4(v).

Two or more resistances are connected in series or in parallel or both, depending upon whether we want to increase or decrease the circuit resistance.



The two or more resistances are said to be connected in series if the current flowing through each resistor is same. The equivalent resistance in the series combination is given by

$$R_S = R_1 + R_2 + R_3$$

(i) When three resistors are connected in series with a battery of voltage V and voltage drop across resistors is V_1, V_2 and V_3, which of the relation is correct?

(a) $V = V_1 = V_2 = V_3$
(b) $V = V_1 + V_2 + V_3$
(c) $V_1 + V_2 + V_3 = 3V$
(d) $V > V_1 + V_2 + V_3$

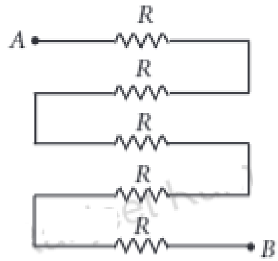
(ii) When the three resistors each of resistance R ohm, connected in series, the equivalent resistance is

(a) $R/2$
(b) $> R$
(c) $< R/2$
(d) $< R$

(iii) There is a wire of length 20 cm and having resistance 20 Ω cut into 4 equal pieces and then joined in series. The equivalent resistance is

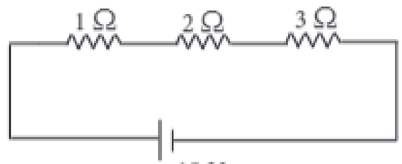
(a) 20 Ω
(b) 4 Ω
(c) 5 Ω
(d) 10 Ω

(iv) In the following circuit, find the equivalent resistance between A and B is ($R = 2\ \Omega$)



(a) $10\ \Omega$ (b) $5\ \Omega$ (c) $2\ \Omega$ (d) $4\ \Omega$

(v) In the given circuit, the current in each resistor is

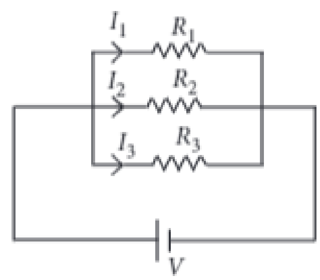


(a) 3 A (b) 6 A (c) 9 A (d) 18 A

Case Study 10

Read the following and answer any four questions from 5(i) to 5(v).

If two or more resistances are connected in such a way that the same potential difference gets applied to each of them, then they are said to be connected in parallel. The current flowing through the two resistances in parallel is, however, not the same. When we have two or more resistances joined in parallel to one another, then the same current gets additional paths to flow and the overall resistance decreases. The equivalent resistance is given by $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$



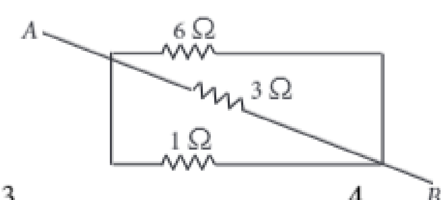
(i) Three resistances, $2\ \Omega$, $6\ \Omega$ and $8\ \Omega$ are connected in parallel, then the equivalent resistance is

(a) less than $6\ \Omega$ but more than $2\ \Omega$ (b) less than $8\ \Omega$ but more than $6\ \Omega$
(c) less than $2\ \Omega$ (d) more than $8\ \Omega$

(ii) A wire of resistance $12\ \Omega$ is cut into three equal pieces and then twisted their ends together, the equivalent resistance is

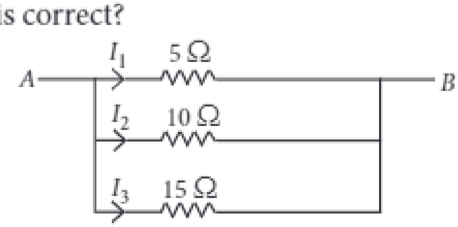
(a) $\frac{3}{8}\ \Omega$ (b) $\frac{4}{3}\ \Omega$ (c) $\frac{3}{4}\ \Omega$ (d) $\frac{5}{6}\ \Omega$

(iii) Three resistances are connected as shown. The equivalent resistance between A and B is



(a) $\frac{2}{3}\ \Omega$ (b) $\frac{3}{2}\ \Omega$ (c) $\frac{4}{3}\ \Omega$ (d) $\frac{3}{4}\ \Omega$

(iv) Which of the following relation is correct?



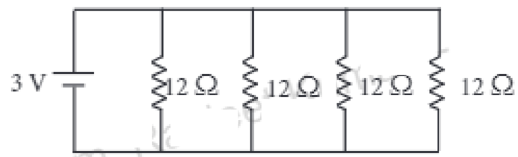
(a) $I_1 = 2I_2 = 3I_3$

(b) $I_1 = 4I_2 = 3I_3$

(c) $2I_1 = I_2 = 3I_3$

(d) $3I_1 = 2I_2 = I_3$

(v) Find the current in each resistance.



(a) 1 A (b) 2 A (c) 3 A (d) 0.25 A

Case Study 11

Read the following and answer any four questions from 6(i) to 6(v).

Several resistors may be combined to form a network. The combination should have two end points to connect it with a battery or other circuit elements. When the resistances are connected in series, the current in each resistance is same but the potential difference is different in each resistor. When the resistances are connected in parallel, the voltage drop across each resistance is same but the current is different in each resistor.

(i) The household circuits are connected in

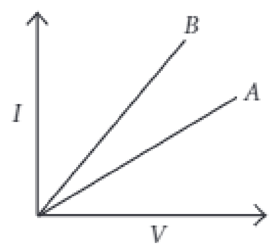
(a) series combination

(b) parallel combination

(c) both (a) and (b)

(d) none of these

(ii) The two wires of each of resistance *R*, initially connected in series and then in parallel. In the graph it shows the resistance in series and in parallel. Which of the following is correct?



(a) *A* denotes parallel combination.

(b) *B* denotes series combination.

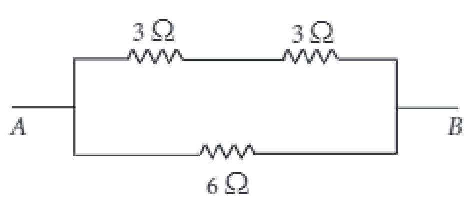
(c) *A* denotes series combination and *B* denotes parallel combination.

(d) None of these.

(iii) The equivalent resistance of r_1 and r_2, when connected in series is R_1 and when they are connected in parallel is R_2. Then the ratio is

(a) $\frac{r_1}{r_2}$ (b) $\frac{r_1+r_2}{r_1r_2}$ (c) $\frac{(r_1+r_2)^2}{r_1r_2}$ (d) $\frac{r_1r_2}{2r_1+2r_2}$

(iv) The equivalent resistance between *A* and *B* is



(a) 6 Ω (b) 9 Ω (c) 3 Ω (d) 12 Ω

(v) Two resistances 10 Ω and 3 Ω are connected in parallel across a battery. If there is a current of 0.2 A in 10 Ω resistor, the voltage supplied by battery is

(a) 2 V (b) 4 V (c) 1 V (d) 8 V

Case Study 12

Read the following and answer any four questions from 7(i) to 7(v).

The heating effect of current is obtained by transformation of electrical energy in heat energy. Just as mechanical energy used to overcome friction is covered into heat, in the same way, electrical energy is converted into heat energy when an electric current flows through a resistance wire. The heat produced in a conductor, when a current flows through it is found to depend directly on (a)strength of current (b) resistance of the conductor (c) time for which the current flows.

The mathematical expression is given by $H = I^2Rt$.

The electrical fuse, electrical heater, electric iron, electric geyser etc. all are based on the heating effect of current.

(i) What are the properties of heating element?

(a) High resistance, high melting point (b) Low resistance, high melting point
(c) Low resistance, high melting point (d) Low resistance, low melting point.

(ii) What are the properties of electric fuse?

(a) Low resistance, low melting point (b) High resistance, high melting point.
(c) High resistance, low melting point (d) Low resistance, high melting point

(iii) When the current is doubled in a heating device and time is halved, the heat energy produced is

(a) doubled (b) halved (c) four times (d) one fourth times

(iv) A fuse wire melts at 5 A. It is is desired that the fuse wire of same material melt at 10 A. The new radius of the wire is

(a) 4 times (b) 2 times (c) $\frac{1}{2}$ times (d) $\frac{1}{4}$ times

(v) When a current of 0.5 A passes through a conductor for 5 min and the resistance of conductor is 10 Ω, the amount of heat produced is

(a) 250 J (b) 5000 J (c) 750 J (d) 1000 J

Case Study 13

Read the following and answer any four questions from 8(i) to 8(v).

The electrical energy consumed by an electrical appliance is given by the product of its power rating and the time for which it is used. The SI unit of electrical energy is Joule. Actually, Joule represents a very small quantity of energy and therefore it is inconvenient to use where a large quantity of energy is involved. So for commercial purposes we use a bigger unit of electrical energy which is called kilowatt hour. 1 kilowatt-hour is equal to 3.6×10^6 joules of electrical energy.

(i) The energy dissipated by the heater is *E*. When the time of operating the heater is doubled, the energy dissipated is

(a) doubled (b) half (c) remains same (d) four times

(ii) The power of a lamp is 60 W. The energy consumed in 1 minute is

(a) 360 J (b) 36 J (c) 3600 J (d) 3.6 J

(iii) The electrical refrigerator rated 400 W operates 8 hours a day. The cost of electrical energy is ₹ 5 per kWh. Find the cost of running the refrigerator for one day?

(a) ₹ 32 (b) ₹ 16 (c) ₹ 8 (d) ₹ 4

(iv) Calculate the energy transformed by a 5 A current flowing through a resistor of 2 Ω for 30 minutes?

(a) 90 kJ (b) 80 kJ (c) 60 kJ (d) 40 kJ

(v) Which of the following is correct?

(a) 1 watt hour = 3600 J

(b) 1 kWh = 36×10^6 J

(c) Energy (in kWh) = power (in W) × time (in hr)

(d) Energy (in kWh) = $\frac{V(\text{volt}) \times I(\text{ampere}) \times t(\text{sec})}{1000}$

HINTS & EXPLANATIONS

6. **(i) (a):** $q = 2$ C, $t = 100$ ms $= 0.1$ s

$$I = \frac{q}{t} = \frac{2}{0.1} = 20 \text{ A.}$$

(ii) (d)

(iii) (b): $W = 100$ J, $q = 20$ C

$$V = \frac{W}{q} = \frac{100}{20} = 5 \text{ V}$$

(iv) (c): $I = 1$ A, $t = 1$ s

$q = It = 1 \times 1 = 1$ C

$$n = \frac{q}{e} = \frac{1}{1.6 \times 10^{-19}} = 6.25 \times 10^{18}$$

(v) (c): $V = \frac{W}{q} = \frac{W}{It}$

7. **(i)(a):** $V = IR$

So, $V' \to 2V$, $R' \to 2R$

$$I' = \frac{2V}{2R} = I$$

(ii) (b): $V \propto I$. So, the graph is a straight line and passing through origin.

(iii) (b): Slope of V-I graph $= \frac{I}{V} = \frac{1}{R}$.

(iv) (c): Given: $V = 9$ V, $I = 0.1$ A

$$R = \frac{V}{I} = \frac{9}{0.1} = 90\ \Omega$$

(v) (c): On increasing the voltage, the resistance remain same, so current will increase.

8. **(i) (b):** The electrical wire should have low resistance.

(ii) (b): More is the temperature, more will be the resistance. The resistance of A is more, so temperature of A is more.

(iii) (c): $R_1 = \rho\frac{L}{A}$, $R_2 = \rho\frac{2L}{A/2}$

(iv) (a): In summers, temperature is more, so resistance is more.

(v) (a): $R' = \frac{R}{5} = \frac{20}{5} = 4\ \Omega$

9. **(i) (b):** In series combination, the total voltage is equal to the sum of voltage drop across each resistance.

(ii) (b): $R_s = R_1 + R_2 + R_3$

So, $R_s = R + R + R = 3R$

(iii) (a): Resistance of each wire $= 20/4 = 5\ \Omega$

Equivalent resistance in series

$$R_s = 5 + 5 + 5 + 5 = 20\ \Omega$$

(iv) (a): All are in series, $R_s = 5R = 5 \times 2 = 10\ \Omega$

(v) (a): $R_s = 1 + 2 + 3 = 6\ \Omega$

$$I = \frac{18}{6} = 3 \text{ A}$$

10. **(i) (c):** The equivalent resistance in the parallel combination is lesser than the least value of the individual resistance.

(ii) (b): Resistance of each piece $= \frac{12}{3} = 4\,\Omega$

$$\frac{1}{R_p} = \frac{1}{4}+\frac{1}{4}+\frac{1}{4} = \frac{3}{4} \Rightarrow R_p = \frac{4}{3}\,\Omega$$

(iii) (a): All the three resistors are in parallel.

$$\therefore \quad \frac{1}{R_p} = \frac{1}{6}+\frac{1}{3}+\frac{1}{1} = \frac{1+2+6}{6} = \frac{9}{6}$$

$$R_p = \frac{6}{9} = \frac{2}{3}\,\Omega$$

(iv) (a): Voltage is same across each resistance.

So, $I_1 \times 5 = I_2 \times 10 = 15 \times I_3$

$I_1 = 2I_2 = 3I_3$

(v) (d): All are in parallel.

$$\frac{1}{R_p} = \frac{1}{12}\times 4 = \frac{1}{3} \Rightarrow R_p = 3\,\Omega$$

$$I = \frac{3}{3} = 1\text{A}$$

So, current in each resistor $I' = \frac{3}{12} = \frac{1}{4}$ A

11. **(i) (b)**

(ii) (c): In series combination, resistance is maximum and in parallel combination, resistance is minimum.

(iii) (c): $R_1 = r_1 + r_2$ ...(i)

$$R_2 = \frac{r_1 r_2}{r_1 + r_2} \quad \text{...(ii)}$$

$$\therefore \quad \frac{R_1}{R_2} = \frac{(r_1+r_2)^2}{r_1 r_2}$$

(iv) (c): In the given circuit, 3 Ω resistors are in series.

$R_s = 3 + 3 = 6\,\Omega$

Now, R_s and 6 Ω are parallel.

$$\frac{1}{R_p} = \frac{1}{6}+\frac{1}{6} = \frac{2}{6} = \frac{1}{3} \Rightarrow R_p = 3\,\Omega$$

(v) (a): $V = 0.2 \times 10 = 2$ V

So, total voltage supplied is same as 2 V.

12. **(i) (b)**

(ii) (c)

(iii) (a): Given: $H = I^2Rt$

So, $H' = (2I)^2 \cdot \frac{R}{2} t = 2H$

(iv) (b): Given: $I = 5$ A, resistance $= R$. Let r be the new radius.

Now, $H = I^2Rt$ ...(i)

Also $H' = I'^2R't$ ...(ii)

From (i) and (ii), $5^2 \times \rho\frac{L}{\pi r^2}t = 10^2 \times \rho\frac{L}{\pi r'^2}\cdot t$

$$\frac{25}{r^2} = \frac{100}{r'^2} \Rightarrow \frac{r'}{r} = 2 \Rightarrow r' = 2r$$

(v) (c): Given: $I = 0.5$ A, $R = 10\,\Omega$, $t = 5$ min

$H = I^2Rt = 0.5 \times 0.5 \times 10 \times 5 \times 60$

$H = 750$ J

13. **(i) (a):** $E \propto t$

(ii) (c): Given: $P = 60$ W, $t = 1$ min

$E = 60 \times 1 \times 60 = 3600$ J

(iii) (b): Given: $P = 400\,\Omega$, $t = 8$ hour

$E = 400 \times 8 = 3200$ Wh $= 3.2$ kWh

Cost $= 3.2 \times 5 =$ ₹ 16

(iv) (a): Given: $I = 5$ A, $R = 2\,\Omega$, $t = 30$ min

$E = I^2Rt = 5 \times 5 \times 2 \times 30 \times 60$

$E = 90000$ J $= 90$ kJ

(v) (a): 1 watt hr = 3600 J