(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

2

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

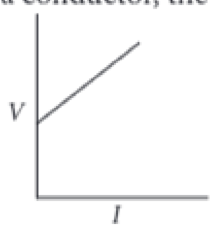
(a) current remains same

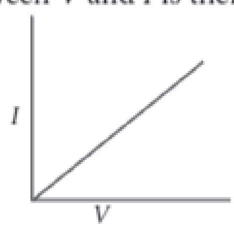
(b) current is doubled

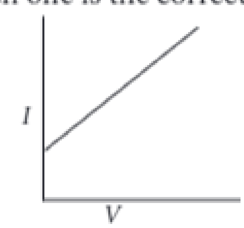
(c) current is halved

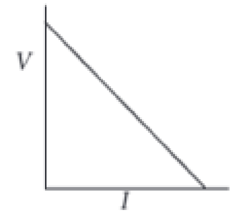
(d) current is quadrupled

(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.

3

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?

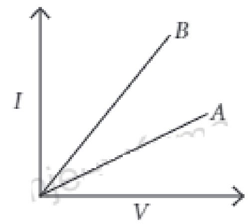
(a) High melting point

(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

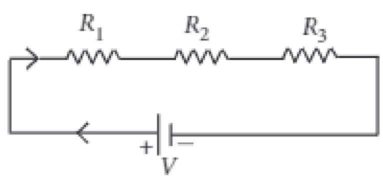
(v) A wire of resistance 20 Ω is cut into 5 equal pieces. The resistance of each part is

(a) 4 Ω
(b) 10 Ω
(c) 100 Ω
(d) 80 Ω

4

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) $V > V_1 + V_2 + V_3$

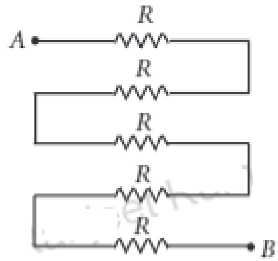
(ii) When the three resistors each of resistance R ohm, connected in series, the equivalent resistance is

(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

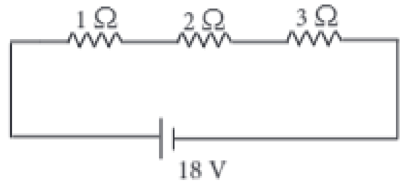
(a) 20 Ω
(b) 4 Ω
(c) 5 Ω
(d) 10 Ω

(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) $4\ \Omega$

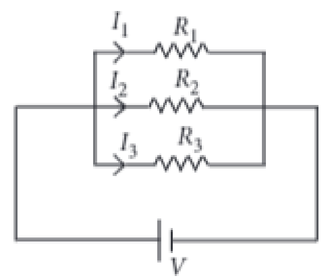
(v) In the given circuit, the current in each resistor is



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

5

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

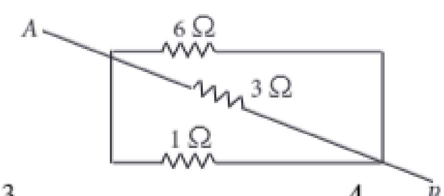
(i) Three resistances, $2\ \Omega$, $6\ \Omega$ and $8\ \Omega$ are connected in parallel, then the equivalent resistance is

(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

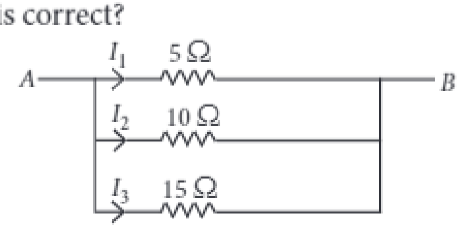
(a) $\frac{3}{8}\ \Omega$ (b) $\frac{4}{3}\ \Omega$ (c) $\frac{3}{4}\ \Omega$ (d) $\frac{5}{6}\ \Omega$

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



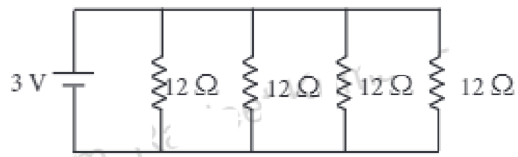
(a) $\frac{2}{3}\ \Omega$ (b) $\frac{3}{2}\ \Omega$ (c) $\frac{4}{3}\ \Omega$ (d) $\frac{3}{4}\ \Omega$

(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

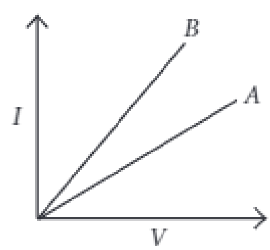
6

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?

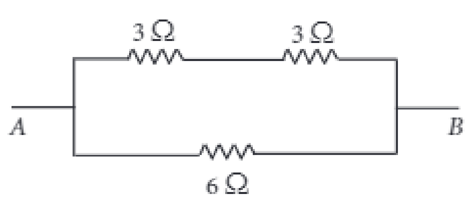


(a) A denotes parallel combination.
(b) B denotes series combination.
(c) A denotes series combination and B denotes parallel combination.
(d) None of these.

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

(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

7

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

8

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

ASSERTION & REASON

For question numbers 9-25, two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below :

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

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

(c) A is true, but R is false.

(d) A is false, but R is true.

9. **Assertion :** Fuse wire must have high resistance and low melting point.
Reason : Fuse is used for small current flow only.

10. **Assertion :** The connecting wires are made of copper.
Reason : The electrical conductivity of copper is high.

11. **Assertion :** Electron has a negative charge.
Reason : Electrons move always from a region of higher potential to a region of lower potential.

12. **Assertion :** Heater wire must have high resistance and high melting point.
Reason : If resistance is high, the electric conductivity will be less.

13. **Assertion :** In a chain of bulbs, 50 bulbs are joined in series. One bulb is removed now and circuit is completed again. If the remaining 49 bulbs are again connected in series across the same supply, then light gets decreased in the room.
Reason : Net resistance of 49 bulbs will be less than 50 bulbs.

14. **Assertion :** Current is the rate of flow of charge.
Reason : Electric current will not flow between two charged bodies when connected, if they are at same potential.

15. **Assertion :** A bird perches on a high power line and nothing happens to the bird.
Reason : The circuit is incomplete for the bird sitting on high power line.

16. **Assertion :** When a wire is stretched to three times of its length, its resistance becomes 9 times.
Reason : Resistance is directly proportional to length of wire.

17. **Assertion :** It is advantageous to transmit electric power at high voltage.
Reason : High voltage implies high current.

18. **Assertion :** Bending a wire does not affect electrical resistance.
Reason : Resistance of a wire is proportional to resistivity of material.

19. **Assertion :** The coil of a heater is cut into two equal halves and only one of them is used into heater. The heater will now require half the time to produce the same amount of heat.
Reason : The heat produced is directly proportional to square of current.

20. **Assertion :** A voltmeter and ammeter can be used together to measure resistance but not power.
Reason : Power is proportional to voltage and current.

21. **Assertion :** The 200 W bulbs glows with more brightness than 100 W bulbs.
Reason : A 100 watt bulb has more resistance than a 200 W bulb.

22. **Assertion :** If 10 bulbs are connected in series and one bulb fused, then the remaining 9 bulbs will not work.
Reason : Bulb of higher wattage will give less bright light.

23. **Assertion :** Good conductors of heat are also good conductors of electricity and vice versa.
Reason : Mainly electrons are responsible for conduction.

24. **Assertion :** The wires supplying current to an electric heater are not heated appreciably.
Reason : Resistance of connecting wires is very small and $H \propto R$.

25. **Assertion :** A current carrying wire should be charged.
Reason : The current in a wire is due to flow of free electrons in a definite direction.

HINTS & EXPLANATIONS

1. **(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): $V = \dfrac{W}{q} = \dfrac{W}{It}$

2. **(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 $= \dfrac{I}{V} = \dfrac{1}{R}$.

(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.

3. **(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): $R_1 = \rho\dfrac{L}{A}$, $R_2 = \rho\dfrac{2L}{A/2}$

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

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

4. **(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): $R_s = 1 + 2 + 3 = 6\ \Omega$

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

5. (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

6. (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.

7. (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

8. (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 × 5 = ₹ 16

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

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

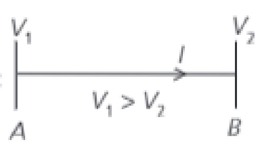
$E = 90000$ J = 90 kJ

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

9. (c) : Fuse wire must have high resistance because according to Joule's law $H = I^2Rt$, heat produced is high if R is high. The melting point must be low so that wire may melt with increase in temperature. As a current larger than the specified value flows through the circuit the temperature of the fuse wire increases. This melts the fuse wire and breaks the circuit.

10. (a) : Due to high electrical conductivity of copper, it conducts the current without offering much resistance.

11. (c) :



Suppose A and B are two regions having potentials V_1 and V_2 such that $V_1 > V_2$. So the electric current will flow from A to B (*i.e.*, from higher potential to lower potential). Since electrons move opposite to the direction of current, hence, the electrons move from a region of lower potential to a region of higher potential.

12. (b) : Heater wire must have high resistance and high melting point, because in series current remains same, therefore according to Joule's law $H = i^2Rt / 4.2$, heat produced is high if R is high. Melting point must

be high, so that wire may not melt with increase in temperature.

13. **(d)**: Since the bulbs are joined in series, so when one bulb is removed from chain then the resistance of the chain is decreased, hence current flowing through each bulb is increased. As heat produced $\propto i^2$, hence light gets increased in the room.

14. **(b)**: Current will not flow when two bodies are at the same potential. When their charges are same, their potential may be different. Hence current may flow in this case.

15. **(a)**: Electric shock is due to the electric current flowing through a living body. When the bird perches on a single high power line, no current passes through its body because its body is at equipotential surface, *i.e.*, there is no potential difference. While when man touches the same line, standing bare foot on ground, the electrical circuit is completed through the ground. The hands of man are at high potential and his feets are at low potential. Hence large amount of current flows through the body of the man and therefore, gets a fatal shock.

16. **(b)**: Volume of material on stretching remains same. *i.e.*, Al = constant. When l becomes three times, its area of cross section (A) becomes 1/3rd. From $R = \rho\frac{l}{A}$, R would becomes 9 times.

17. **(c)** : As $P = Vi$, hence for the transmission of same power, high voltage implies less current. Therefore heat energy losses ($H = i^2 Rt / 4.2$) are minimized if power is transmitted at high voltage.

18. **(b)**: Resistance of wire, $R = \rho\frac{l}{A}$.

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

19. **(b)**: Since in the given case the voltage is same, therefore, $H = \frac{V^2}{R}t$ = constant. Hence, if R is halved, t must be halved.

20. **(d)**: As $R = V / I$ and $P = VI$, by measuring V and I simultaneously in circuit we can measure both resistance and power, using the given relation.

21. **(b)**: The resistance , $R = \frac{V^2}{P}$, *i.e.*, $R \propto 1/P$

i.e., higher is the wattage of a bulb, lesser is the resistance and so it will glow bright.

22. **(b)**: When bulbs are connected in series and out of that one get fused then due to this there will be no continuity in the circuit (or resistance offered by fused bulb is infinite) and no current will flow through the remaining bulbs.

23. **(a)**: Metals are good conductors of electricity. It is because of the presence of a large number of free electrons in metals. And for metals electrons are the main cause for thermal conduction. That's why all good conductors of heat are also good conductors of electricity.

24. **(a)**: Resistance of the connecting wires is much smaller than the electric appliances to which current is supplied by the wires.

25. **(d)**: The current in a wire is due to flow of free electrons in a definite direction. But the number of protons in the wire at any instant is equal to number of electrons and charge on electrons is equal and opposite to that of proton. Hence, net charge on the wire is zero.