Electricity

Multiple Choice Questions

1. Two conducting wires of the same material and of equal lengths and equal diameters are first connected in series and then parallel in a circuit across the same potential difference. The ratio of heat produced in series and parallel combinations would be:

(a) 1 : 2

(b) 2 : 1

(c) 1 : 4

(d) 4 : 1

Ans. (c) 1 : 4

Explanation :

As the two conducting wires are of the same material, equal lengths and equal diameters. They will have the same resistance.

Let the resistance of each wire be R and applied potential difference, V.

$$R_{series} = R_1 + R_2$$

$$= R + R = 2R$$

$$P_{series} = \frac{V^2}{R_{series}}$$

$$= \frac{V^2}{(2R)} \quad \ldots(i)$$

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

$$= \frac{1}{R} + \frac{1}{R}$$

$$R_{parallel} = \frac{R}{2}$$

$$P_{parallel} = \frac{V^2}{R_{parallel}}$$

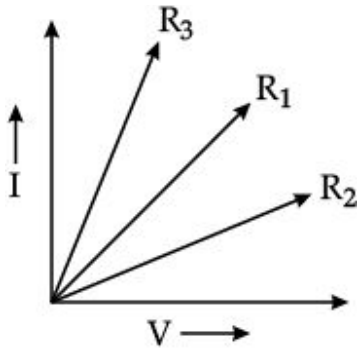
$$= \frac{2V^2}{R} \quad \ldots(ii)$$

Dividing equation (i) by equation (ii)

$$\frac{P_{series}}{P_{parallel}} = \frac{1}{4}$$

Hence, the ratio of heat produced is 1/4 or 1 : 4.

2. A student plots V-I graphs for three samples of nichrome wire with resistances R_1, R_2 and R_3. Choose from the following statement that holds true of this graph.



(a) $R_1 = R_2 = R_3$

(b) $R_1 > R_2 > R_3$

(c) $R_3 > R_2 > R_1<$

(d) $R_2 > R_1 > R_3$

Ans. (d) $R_2 > R_1 > R_3$

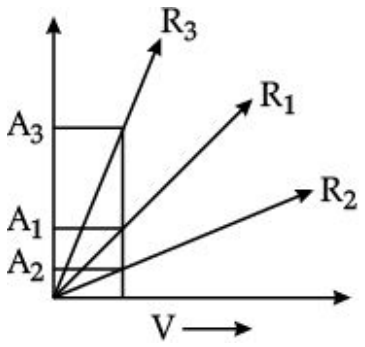
Explanation :

As it is clear from the graph, the current for A_2 conductor is less than A_1 and A_1 is less than A_3 we can say $I_{A2} < I_{A1} < I_{A3}$.

We know

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

$$\text{or } R \propto \frac{1}{I}$$



If I is less, then R will be more.

$I_{A2} < I_{A1} < I_{A3}$

$\therefore R_2 > R_1 > R_3$.

3. The instrument used for measuring electric current is:

(a) galvanometer

(b) ammeter

(c) voltmeter

(d) potentiometer

Ans. (b) ammeter

Explanation :

Ammeter is a device used for measuring electric current in amperes.

4. Which of the following does not apply to silver ?

(a) The resistance provided is directly proportional to its length.

(b) The resistance provided is inversely proportional to the area of cross section.

(b) Their resistivity is in the range 10^{-8} Ω to 10^{-6} Ω.

(d) The movement of electrons on their outer most orbital is tightly held together.

Ans. (d) The movement of electrons on their outer most orbital is tightly held together.

Explanation :

For a given continuous piece of uniform wire, the resistance is directly proportional to its length. Thus, silver which is a good conductor of electricity and the resistance in it is directly proportional to its length.

Silver is a good conductor of electricity, thus, the resistance provided is inversely proportional to the area of cross section.

Silver has resistivity in the range of $10^{-8}\Omega$ to $10^{-6}\Omega$. Therefore, it is considered as very good conductors.

Hence, the statement that does not apply to silver is the movement of electrons on their outer most orbital is tightly held together.

5. R_1 and R_2 are two resistors and r_1 and r_2 are equivalent resistances in series and parallel respectively, then $\frac{R_1}{R_2}$

(a) $\frac{r_1 r_2}{r_1 + r_2}$

(b) $\frac{r_1 + r_2}{r_1 r_2}$

(c) $\frac{r_1+\sqrt{r_1-4r_1r_2}}{r_1+\sqrt{r_1+4r_1r_2}}$

(d) $\frac{r_1+\sqrt{r_1^2-4r_1r_2}}{r_1-\sqrt{r_1^2-4r_1r_2}}$

Ans. (d) $\frac{r_1+\sqrt{r_1^2-4r_1r_2}}{r_1-\sqrt{r_1^2-4r_1r_2}}$

Explanation :

Here, $r_1 = R_1 + R_2$ …(i)

and $r_2 = \frac{R_1R_2}{R_1+R_2}$

$\Rightarrow$ $R_1R_2 = r_2r_1$ …(ii)

Now $(R_1 - R_2)^2 = (R_1 + R_2)^2 - 4\,R_1R_2$

$= r_1^2 - 4\,r_2r_1$

$R_1 - R_2 = \sqrt{r_1^2-4r_2r_1}$

and $R_1 + R_2 = r_1$

$\therefore$ $R_1 = \frac{r_1+\sqrt{r_1^2-4r_1r_2}}{2}$

and $R_2 = \frac{r_1-\sqrt{r_1^2-4r_1r_2}}{2}$

$$\therefore \quad \frac{R_1}{R_2} = \frac{r_1 + \sqrt{r_1^2 - 4r_1r_2}}{r_1 - \sqrt{r_1^2 - 4r_1r_2}}$$

6. There are three resistors connected in parallel, the resistance of each resistor is 3 ohm. What is the total resistance of all the three resistors ?

(a) 1 Ω

(b) 6 Ω

(c) 15 Ω

(d) 3 Ω

Ans. (a) 1 Ω

Explanation :

It is given that the three resistors are connected in parallel and the resistance of each resistor is 3 Ω. Therefore,

$R_1 = R_2 = R_3 = 3\ \Omega$

From the formula given below, we can calculate the total resistance of all the three resistors:

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

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

$$\therefore \quad R_p = 1\ \Omega$$

Hence, the total resistance is 1 Ω.

7. The accumulator which is used for the domestic purpose has the electromotive force of 10 V and with an internal resistance of 0.8 Ω is externally charged by 150 V of the direct current power supply using a series resistor 18 Ω. Calculate the terminal voltage of the accumulator during using.

(a) 16.8 V

(b) 17.1 V

(c) 11.3 V

(d) 15.9 V

Ans. (d) 15.9 V

Explanation :

$$E = V - Ir$$

$$V = E + Ir$$

$$= 10 + \left(\frac{150-10}{18+0.8}\right) \times 0.8$$

$$= 15.9 \text{ V}$$

8. If a person has five resistors each of value $\frac{1}{5}$ W, then the maximum resistance he can obtain by connecting them is:

(a) 1 W

(b) 5 W

(c) 10 W

(d) 25 W

Ans. (a) 1 W

Explanation :

Resistance of one resistor = $\frac{1}{5}$ W

Number of resistors = 5

Maximum resistances can be obtained by combining the resistors in series:

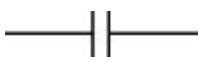
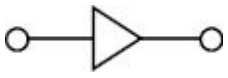
$$R_s = R_1 + R_2 + R_3 + R_4 + R_5$$

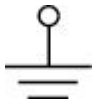
$$= \frac{1}{5} + \frac{1}{5} + \frac{1}{5} + \frac{1}{5} + \frac{1}{5}$$

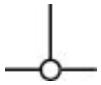
$$= \frac{1+1+1+1+1}{5} = \frac{5}{5} = 1 \text{ W}$$

Hence, a person on combining five resistors in series gets resistance 1 W.

9. Match the components in column A with the symbols in column B.

Column A	Column B
(A) 	(1) Wire joint
(b) 	(2) Capacitor

(c)  (3) Diode

(D)  (4) Earth

(a) A-3; B-4; C-3; D-2

(b) A-1; B-2; C-1; D-4

(c) A-4; B-1; C-2; D-3

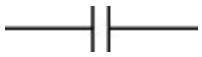
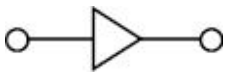
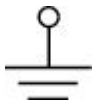
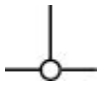
(d) A-2; B-3; C-4; D-1

Ans. (d) A-2; B-3; C-4; D-1

Explanation :

The correct options are:

A-2; B-3; C-4; D-1

Column A	**Column B**
(A) 	(2) Capacitor
(b) 	(3) Diode
(c) 	(4) Earth
(D) 	(1) Wire joint

10. The resistance of the wire when the length of the wire increases two times :

(a) becomes 2 times

(b) becomes 3 times

(c) becomes 6 times

(d) becomes 4 times

Ans. (a) becomes 2 times

Explanation :

The electrical resistance of a wire can be expressed as:

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

Where, A = Area of cross section of the conductor

L = Length of the conductor

ρ = Resistivity

From this relation, it is clear that the resistance is directly proportional to the length and inversely proportional to area of cross-section.

If length becomes 2L, then

$$R' = \frac{\rho(2L)}{A} = 2\frac{\rho L}{A}$$

So, R' = 2 R

Thus, the resistance becomes 2 times if the length of the wire is doubled.

11. Which among the following is the correct way of connecting ammeter and voltmeter in the circuit to determine the equivalent resistance of two resistors in series ?

(a) Both ammeter and voltmeter in series

(b) Both ammeter and voltmeter in parallel

(b) Ammeter in parallel and voltmeter in series

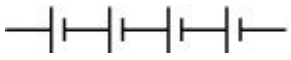
(d) Ammeter in series and voltmeter in parallel

Ans. (d) Ammeter in series and voltmeter in parallel

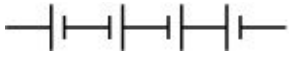
Explanation :

The correct way of connecting ammeter and voltmeter in the circuit to determine the equivalent resistance of two resistors is connecting ammeter in series and voltmeter in parallel. Ammeter is connecting in series, so that whole current passes through it and voltmeter in parallel to it could measure the complete voltage of the circuit.

12. The proper representation of series combination of cells obtaining maximum potential is:

(a) 

(b) 

(c) 

(d) 

Ans. (a) 

Explanation :

The maximum potential is obtained when cells are connected in series such that the negative terminal of the cell is connected to the positive terminal of the second cell and so on.

E.g.,

13. The equivalent resistance of a series combination of two resistances is X ohm. It the resistance are of 10 W and 40 W respectively, the value of X will be:

(a) 10 W

(b) 20 W

(c) 50 W

(d) 40 W

Ans. (c) 50 W

Explanation :

We know that

Total Resistance

$$R = R_1 + R_2$$

$$= 10 + 40$$

$$= 50 \text{ W}$$

Hence, the value of X is 50 W.

14. 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 :

[NCERT Exemplar]

(a) $\frac{A}{2}$

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

(c) 2 A

(d) 3 A

Ans. (c) 2 A

Explanation :

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
2 A. This can be explained as:

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

$$\frac{R_1}{R_2} = \left(\frac{L_1}{L_2}\right) \times \left(\frac{A_2}{A_1}\right)$$

$$A_2 = \left(\frac{R_1}{R_2}\right) \times \left(\frac{L_2}{L_1}\right) \times A_1$$

$$A_2 = \left(\frac{R}{R}\right) \times \left(\frac{2l}{l}\right) \times A$$

$$A_2 = 2\ A$$

15. The maximum resistance which can be made using four resistors

each of resistance $\frac{1}{2}$ W is :

(a) 2 W

(b) 1 W

(c) 2.5 W

(d) 8 W

Ans. (a) 2 Ω

Explanation :

The maximum resistance which can be made using four resistors each of resistance 1/2 Ω is 2 Ω. This can be explained as:

In series combination, the current in each resistance remains constant and the voltage gets added up. As a result, the individual resistances also get added up.

So, Equivalent Resistance = $R_1 + R_2 + R_3 + R_4$

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

$$= \frac{4}{2}$$

$$= 2\ \Omega$$

16. A piece of wire of resistance R is cut into five equal parts. These parts are then connected in parallel. If the equivalent resistance of this combination is R', then the ratio R/R' is :

(a) $\frac{1}{25}$

(b) $\frac{1}{5}$

(c) 5

(d) 25

Ans. (d) 25

Explanation :

Given,

A piece of wire with resistance (R) is cut into 5 equal parts

$$R = \frac{R}{5}+\frac{R}{5}+\frac{R}{5}+\frac{R}{5}+\frac{R}{5}$$

$$R = \frac{5R}{5} = R \qquad \ldots(i)$$

Now, these pieces of wire are connected in parallel then the resistance is (R')

$$\frac{1}{R'} = \frac{5}{R}+\frac{5}{R}+\frac{5}{R}+\frac{5}{R}+\frac{5}{R}$$

So, $$\frac{1}{R'} = \frac{25}{R}$$

$$R' = \frac{R}{25} \quad \ldots(ii)$$

Now,

$$\frac{R}{R'} = \frac{R}{\frac{R}{25}}$$ [Using (i) and (ii)]

$$\frac{R}{R'} = \frac{25R}{R}$$

$$\frac{R}{R'} = 25$$

17. On which of the given factor, resistance does not depend:

(a) length of conductor

(b) area of cross-section

(c) temperature

(d) density

Ans. (d) density

Explanation :

The resistance of wire can be expressed as:

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

Where, A = Area of cross section of the conductor

L = Length of the conductor

ρ = Resistivity

From the above relation, we can see that resistance of a wire is directly proportional to its length and inversely proportional to the area of cross-section. Hence, resistance does not depend on the

density.

18. Which of the following obeys Ohm's law ?

(a) Filament of a bulb

(b) LED

(c) Nichrome

(d) Transistor

Ans. (c) Nichrome

Explanation :

In conductors, resistance remains constant when the current passing through them is increased, they are known as Ohmic conductors. Nichrome which is an alloy is made in such a way that its resistance remains constant for a wide range of temperature. Hence, nichrome obeys Ohm's Law. Whereas, transistor, LED, bulb filament do not obey Ohm's law because with the varied change in temperature their resistance changes.

19. Electrical resistivity of an alloy of copper and nickel is _____ when compared with the electrical resistivity of an alloy of copper, manganese and nickel.

(a) same

(b) double

(c) more

(d) less

Ans. (c) more

Explanation :

Electrical resistivity of an alloy of copper and nickel is more when compared with the electrical resistivity of an alloy of copper, manganese and nickel. The electrical resistivity of Cu-Ni resistance alloys at different temperatures rises steeply. At 200°C, the electrical resistivity of Cu-Ni alloy is
49×10^{-8} W–m whereas of copper, manganese and nickel 44×10^{-8} W–m.

20. There is a dual of 8 ohm resistance on the aerial. Determine the aerial's new resistance.

(a) 2 W

(b) 4 W

(c) 7 W

(d) 10 W

Ans. (a) 2 W

Explanation :

Let L be the length and A be the area of cross section.

$$R = \rho \frac{l}{A} = 8 \text{ W}$$

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

$$A' = 2A$$

$$R' = \rho \frac{l'}{A'}$$

$$= \rho \frac{\frac{l}{2}}{2A}$$

$$= \frac{1}{4}\left(\rho \frac{l}{A}\right)$$

$$= \frac{1}{4} \times 8$$

$$= 2\ \Omega$$

Hence, the aerial's new resistance is 2 Ω.

21. Electrical resistivity of a given metallic wire depends upon:

(a) its length

(b) its thickness

(c) its shape

(d) nature of the material

Ans. (d) nature of the material

Explanation :

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

22. An electric heater is rated at 2 kW. Electrical energy costs ₹4 per kWh. What is the cost of using the heater for 3 hours?

(a) ₹ 12

(b) ₹ 24

(c) ₹ 36

(d) ₹ 48

Ans. (b) ₹ 24

Explanation :

Consumption of electrical energy in 3 hours can be calculated by using the formula:

$$E = P \times t$$

$$= 2\ kW \times 3\ hour = 6\ kWh$$

Unit cost of electrical energy

= ₹ 4 per kWh

Therefore, the cost of energy used for three hours will be: 4 × 6 = ₹ 24

23. Consider the room temperature is 24°C in summer, the electrical resistance of thermocoil which is used in the AC unit is 150 Ω. Then calculate the temperature of the thermocoil if the electrical resistance is 175 Ω. Given the temperature coefficient of the thermocoil is $2.98 \times 10^{-4}\ °C^{-1}$.

(a) 597°C

(b) 583°C

(c) 546°C

(d) 512°C

Ans. (b) 583°C

Explanation :

$$R_t = R_0 (1 + a \Delta T)$$

$$175 = 150 (1 + 2.98 \times 10^{-4} \Delta T)$$

$$\frac{25}{150} = 2.98 \times \Delta T \times 10^{-4}$$

$$\Delta T = 559.28°C$$

$$T - 24 = 559.28°C$$

$$T = 559.28°C + 24$$

$$T = 583.28°C$$

Hence, the temperature of the thermocoil is 583°C.

24. The values of mA and μA are :

(a) 10^{-6} and 10^{-9} A respectively

(b) 10^{-3} and 10^{-6} A respectively

(c) 10^{-3} and 10^{-9} A respectively

(d) 10^{-6} and 10^{-3} A respectively

Ans. (b) 10^{-3} and 10^{-6} A respectively

Explanation :

An ampere is the SI unit of electric current.

1A = 1000 mA or 1 mA = $\frac{1}{1000}$ A = 10^{-3} A

∴ 1mA = $10^{-3} \times 10^{-3}$ A = 10^{-6} A

25. The resistance of a resistor is reduced to half of its initial value. In doing so, if other parameters of the circuit remain unchanged the heating effects on the resistor will become:

(a) two times

(b) half

(c) one - fourth

(d) four times

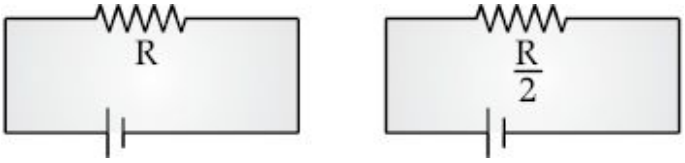
Ans. (a) two times

Explanation :

Resistance of a resistor R W

New resistance of a resistor $\frac{R}{2}$ W.

All other parameters of the circuit remain unchanged



By applying Joule's law of heating $H = I^2 Rt$

As per Ohm's law V = IR

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

$\therefore$ $$H = \frac{V}{R} \times \frac{V}{R} \times R \times t$$

or $= \frac{V^2}{R} \times t$

Case-I Case-II

$H = \frac{V^2}{R} \times t \quad H' = \frac{\frac{V^2}{R}}{2} \times t$

$= \frac{V^2 \times 2}{R} \times t$

$H' = H \times 2$

Hence, the heating effect in the resistor will become two times if all other parameter of the circuit remain same.

26. An electric fuse is connected with :

(a) live wire

(b) earthing

(c) neutral wire

(d) parallel to the line wire

Ans. (a) live wire

Explanation :

An electric fuse is connected with live wire because it gets blown up when an excess current tries to pass through in order to save the electrical appliances by restricting the flow of that current.

27. Which of the following terms does not represent electrical power in a circuit ?

(a) I^2R

(b) IR^2

(c) VI

(d) V^2/R

Ans. (b) IR^2

Explanation :

We know that,

$$P = VI \qquad \ldots(i)$$

Where, P = Power

V = Potential difference

I = Current

$$V = IR \qquad \ldots(ii)$$

On substituting equation (ii) in equation (i), we get

$$P = I^2R \qquad \ldots(iii)$$

Again, from Ohm's law

$$I = \frac{V}{R} \qquad \ldots(iv)$$

On substituting equation (iv) in equation (i), we get

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

Hence, option (b) IR^2 does not represent power.

28. An electric bulb is rated 220 V and 100 W. When it is operated on 110 V, the power consumed will be:

(a) 100 W

(b) 75 W

(c) 50 W

(d) 25 W

Ans. (d) 25 W

Explanation :

We know that,

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

Where, P = Electric power

V = Potential difference in a circuit

R = Resistance

Now, $$R = \frac{V^2}{P}$$

$$R = \frac{220 \times 220}{100} = 484 \text{ W}$$

As the voltage drop across the bulb is 110 V. The power consumed by the bulb is:

$$P_b = \frac{V^2}{R}$$

$$= \frac{110 \times 110}{484}$$

P_b = 25 W

Hence, the power consumed will be 25 W.

29. Let us consider that because of the flow of the current flowing through a metallic wire if the temperature of the entire system increases. What will happen from the following options ?

(a) Potential difference (V) increases

(b) Resistance (R) decreases

(b) Potential difference (V) decreases

(d) V and R remains the same

Ans. (c) Potential difference (V) decreases

Explanation :

If the temperature of the entire system increases when the current is flowing through a metallic wire, the potential difference (V) decreases.

30. Which of the following terms does not represent electrical energy in a circuit?

(a) I^2Rt

(b) IR^2t

(c) VIt (d) V^2t/R

Ans. (b) IR^2t

Explanation :

Electric power, $P = VI = I^2R = \frac{V^2}{R}$

$\therefore$ Electrical Energy = $Pt = VIt = I^2Rt = \frac{V^2t}{R}$

Assertion and Reasoning Based Questions

31. Assertion : In a series circuit, the current is constant throughout the electric circuit.

Reason : All electric devices does not need equal currents to operate properly.

(a) If both assertion and reason are true and reason is the correct explanation of assertion.

(b) If both assertion and reason are true, but reason is not the correct explanation of assertion.

(c) If assertion is true, but reason is false.

(d) If assertion is false, but reason is true.

Ans. (b) If both assertion and reason are true, but reason is not the correct explanation of assertion.

Explanation :

Current is constant in a series circuit as there is only one path for the flow of current. But different devices connected in a circuit have different power ratings and therefore draw different amount of currents. Thus, both assertion and reason are true and reason is not the correct explanation of the assertion.

32. Assertion : When area of the conductor is halved then the

resistance of the material gets doubled when length is kept constant.

Reason : Because resistance is inversely proportional to the area of a cross-section of the material.

(a) If both assertion and reason are true and reason is the correct explanation of assertion.

(b) If both assertion and reason are true, but reason is not the correct explanation of assertion.

(c) If assertion is true, but reason is false.

(d) If assertion is false, but reason is true.

Ans. (a) If both assertion and reason are true and reason is the correct explanation of assertion.

Explanation :

According to the formula: $R = \rho \frac{l}{A}$

Where, R : resistance

ρ : resistivity

l : length of conductor

A : area of cross section of conductor

Here, resistivity of the material never varies. If length is also kept constant and when area is halved then resistance of the material gets doubled as the resistance depends on 3 factors, *i.e.,* length, area and nature of the material.

Thus, both assertion and reason are true and reason is the

correct explanation of assertion.

33. Assertion : In a circuit which is having 3 series resistors of R W each, the total resistance of the circuit will be 3 R.

Reason : As in parallel circuit the resultant resistance will be $\frac{1}{R}=\frac{1}{R_1}+\frac{1}{R_2}+\frac{1}{R_3}.$

(a) If both assertion and reason are true and reason is the correct explanation of assertion.

(b) If both assertion and reason are true, but reason is not the correct explanation of assertion.

(c) If assertion is true, but reason is false.

(d) If assertion is false, but reason is true.

Ans. (b) If both assertion and reason are true, but reason is not the correct explanation of assertion.

Explanation :

Resultant resistance is the addition of individual resistance present in the series circuit. So, according to the above statement,

Resultant resistance (R) = $R_1 + R_2 + R_3$. So total resistance will be 3 R. In parallel combination, resultant resistance will be $\frac{1}{R}=\frac{1}{R_1}+\frac{1}{R_2}+\frac{1}{R_3}.$

Here, both assertion and reason are true, but reason is not the correct explanation of assertion.

34. Assertion: The connecting wires are made of copper.

Reason: The electrical conductivity of copper is high.

(a) If both assertion and reason are true and reason is the correct explanation of assertion.

(b) If both assertion and reason are true, but reason is not the correct explanation of assertion.

(c) If assertion is true, but reason is false.

(d) If assertion is false, but reason is true.

Ans. (a) If both assertion and reason are true and reason is the correct explanation of assertion.

Explanation :

Due to high electrical conductivity of copper, it conducts the current without offering much resistance. The copper being diamagnetic material does not get magnetised due to current through it and hence does not disturb the current in the circuit. Thus, both assertion and reason are correct and reason is the correct explanation of the assertion.

35. Assertion : Voltmeter is always connected in parallel across the circuit while measuring the potential difference.

Reason : As the voltage in parallel circuits is measured to be the same.

(a) If both assertion and reason are true and reason is the correct explanation of assertion.

(b) If both assertion and reason are true, but reason is not the correct explanation of assertion.

(c) If assertion is true, but reason is false.

(d) If assertion is false, but reason is true.

Ans. (a) If both assertion and reason are true and reason is the correct explanation of assertion.

Explanation :

Voltage measured in the parallel circuits is always equal. As all the parallel circuits start from one point and end at another point and the potential difference between the two points will always be the same. So, this is the reason why voltmeter is always connected in parallel across the circuit. Thus, both assertion and reason are true and reason is the correct explanation of assertion.

36. Assertion : Electric current flowing through a metallic wire is directly proportional to the potential difference across its ends.

Reason : Ohms law expression V = IR, where R (resistance) of the wire is always varying.

(a) If both assertion and reason are true and reason is the correct explanation of assertion.

(b) If both assertion and reason are true, but reason is not the correct explanation of assertion.

(c) If assertion is true, but reason is false.

(d) If assertion is false, but reason is true.

Ans. (c) If assertion is true, but reason is false.

Explanation :

Ohm's law states that the electric current flowing through a metallic wire is directly proportional to the potential difference

across its two ends. The expression is written as :

$$V = IR$$

Here, R (resistance of the wire) is constant value then only the statement will be valid.

$$V \propto I \text{ only if } \frac{V}{I} = \text{constant}$$

Thus, assertion is true, but reason is false.

37. Assertion : Alloys are commonly used in electrical heating devices like electric iron and heater.*

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

(a) If both assertion and reason are true and reason is the correct explanation of assertion.

(b) If both assertion and reason are true, but reason is not the correct explanation of assertion.

(c) If assertion is true, but reason is false.

(d) If assertion is false, but reason is true.

Ans. (b) If both assertion and reason are true, but reason is not the correct explanation of assertion.

Explanation :

Alloys are the combination of metals and they are used in the heating devices due to their high resistance which produces more heat energy. And alloys are made up of weak bonds, their melting point is lower than their constituents metals. Thus, both assertion

and reason are true, but reason is not the correct explanation of assertion.

38. Assertion : An ammeter is always connected in parallel with the circuit for which current has to be measured.

Reason : As the current in a series circuit is same.

(a) If both assertion and reason are true and reason is the correct explanation of assertion.

(b) If both assertion and reason are true, but reason is not the correct explanation of assertion.

(c) If assertion is true, but reason is false.

(d) If assertion is false, but reason is true.

Ans. (d) If assertion is false, but reason is true.

Explanation :

In a series circuit the current measured will be same, this is the reason why ammeter is always connected in series with the circuit for which the measurement has to be done. Thus, assertion is false, but reason is true.

39. Assertion : When more current flows to an electrical equipment it shows more heating of the same.

Reason : Heat flow is directly proportional to the square of current only.

(a) If both assertion and reason are true and reason is the correct explanation of assertion.

(b) If both assertion and reason are true, but reason is not the

correct explanation of assertion.

(c) If assertion is true, but reason is false.

(d) If assertion is false, but reason is true.

Ans. (c) If assertion is true, but reason is false.

Explanation :

Heat flow is dependent on three factors :

1. Current flowing through it

2. Time period of flow of current

3. Resistance of the conductor

So, the reason is false that heat flow only depends on square of current. Therefore, assertion is true, but reason is false.

40. Assertion : Bulbs are filled with inactive nitrogen and argon gases.

Reason : As there is a requirement of thermal isolation of the filament.

(a) If both assertion and reason are true and reason is the correct explanation of assertion.

(b) If both assertion and reason are true, but reason is not the correct explanation of assertion.

(c) If assertion is true, but reason is false.

(d) If assertion is false, but reason is true.

Ans. (a) If both assertion and reason are true and reason is the correct explanation of assertion.

Explanation :

Most part of the power consumed by bulb is dissipated as heat but very less part gets converted into light. So, there is a need for thermal isolation in order to reduce heat losses. This is the reason why bulbs are filled with inactive nitrogen and argon. So, both assertion and reason are true and reason is the correct explanation of assertion.

Case Based Questions

41. Read the passage carefully and answer the following questions from Q. 41 (i) to Q. 41 (v).

Ohm's law is the relationship between potential difference and current in a circuit which was first established by George Simon Ohm. The law states that the current passing through a metallic conductor is directly proportional to the potential difference applied between its ends. $V \propto I$ ***i.e.,*** $V = kI$ where k is the resistance offered by the conductor and is constant for a given conductor. Although a large class of materials is known to follow Ohm's law, there do exist materials used in circuits that do not follow the direct relationship between V & I.

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

(a) current is doubled.

(b) current is halved.

(c) current remains same.

(d) current is four times.

(ii) When a battery of 9 V is connected across a conductor and the current flowing is 0.1 A, the resistance is:

(a) 90 W

(b) 0.9 W

(c) 9 W

(d) 900 W

(iii) By increasing voltage across a conductor:

(a) current will increase.

(b) current will decrease.

(c) resistance will decrease.

(d) resistance will increase.

(iv) The slope of the V-I graph shall give:

(a) resistance

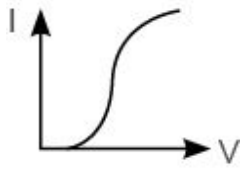
(b) reciprocal of resistance

(c) power

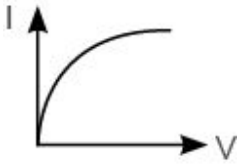
(d) charge

(v) Four students have plotted the graph between V-I for a conductor. Which one is correct?

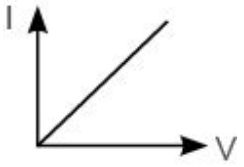
(a)



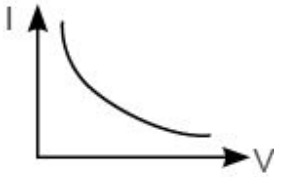
(b)



(c)



(d)



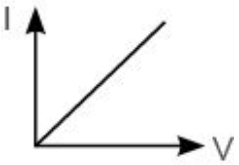
Ans. (i) (c) Current remains same

(ii) (a) 90 Ω

(iii) (d) resistance will increase

(iv) (a) resistance

(v) (c)



42. Read the passage carefully and answer the following questions from Q. 42 (i) to Q. 42 (v).

In a circuit, several resistors may be combined to form a network. The combination must have two endpoints to connect it with a battery or other elements of the circuit. When the resistors are connected in series then the current flowing in each remains the same but potential differences across each resistor will vary. When the resistances are connected in parallel, the potential

difference across each resistor will be the same though a different amount of current will flow in each resistor.

(i) The household circuits are connected in:

(a) series

(b) parallel

(c) both series and parallel

(d) neither series nor parallel

(ii) The equivalent resistance of two resistors x and y is Z when connected in series and M when connected in parallel. Z:M is:

(a) xy

(b) $x + y \times y$

(c) $(x + y)^2/xy$

(d) $xy\,(2x + 2y)$

(iii) 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 resistors, the voltage supplied by the battery is:

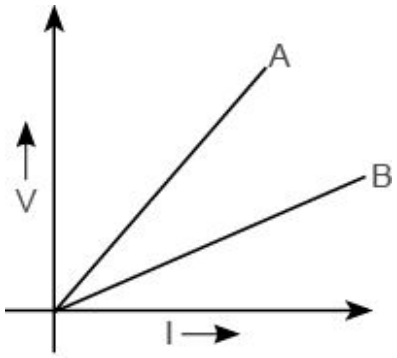
(a) 2 V

(b) 1 V

(c) 4 V

(d) 8 V

(iv) Two wires each having a resistance value equal to R are first connected in series and then connected in parallel. The plot shows the graphical representation of resistances in both cases.



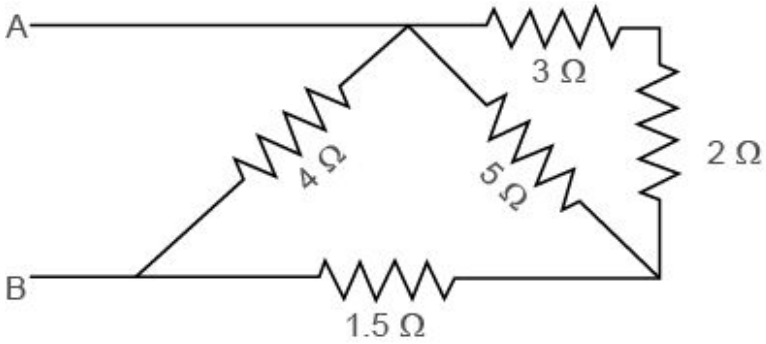
(a) (a) A denotes parallel combination

(a) (b) B denotes series combination

(a) (c) A denotes series combination and B denotes parallel combination

(a) (d) None of the above

(v) The equivalent resistance (in Ω) of the network across A and B is:



(a) 2

(b) 1.5

(c) 2.5

(d) 3

Ans. (i) (b) parallel

(ii) (c) $(x + y)^2/xy$

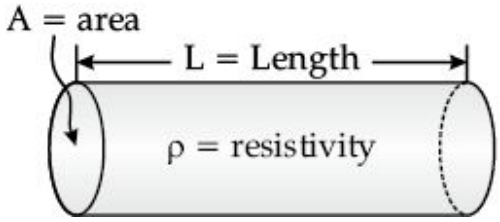
(iii) (a) 2 V

(iv) (c) A denotes series combination and B denotes parallel combination

(v) (a) 2

43. Read the passage carefully and answer the following questions from Q. 43 (i) to Q. 43 (v).

Resistivity or electric resistivity is the inverse of the electrical conductivity. Resistivity is a fundamental property of a material and it demonstrates how strongly the material resists or conducts electric current. A low resistivity is a clear indication of a material which readily allows electric current. The common representation of resistivity is by the Greek letter ρ. Also, the SI unit of electrical resistivity is ohm-meter (Ω-m). Resistivity refers to the electrical resistance of a conductor of a particular unit cross-sectional area and unit length.



Experts can use resistivity for comparing different materials on the basis of their ability to conduct electric currents. High resistivity is the designation of poor conductors.

(i) The value of resistivity depends upon:

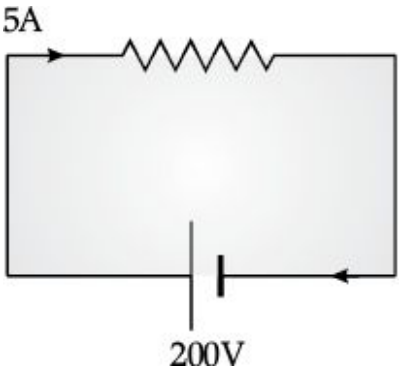
(a) length of wire

(b) area of cross section

(c) nature of conductor

(d) radius of wire

(ii) A wire has the same resistance as the one given in the figure. Calculate its resistivity if the length of the wire is 10 m and its area of cross section is 2 m.



(a) 16 Ω – m

(b) 8 Ω – m

(c) 16 kΩ – m

(d) 8 kΩ – m

(iii) The resistivity of alloys is:

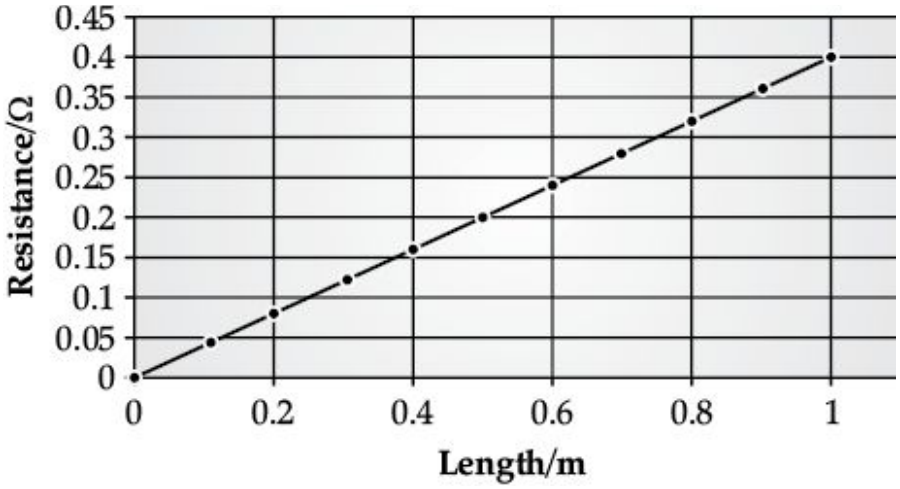
(a) very low

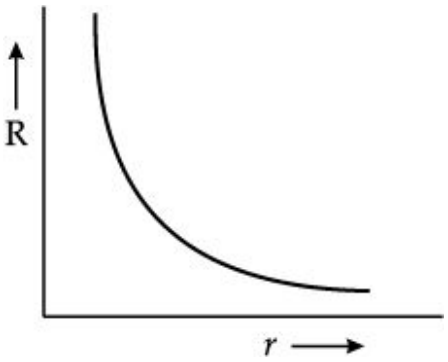
(b) very high

(c) generally lower than its constituent metals

(d) more than resistivity of insulators

(iv) A student plotted the graphs as shown below to study the variation of resistances R of a wire with its length *l* and radius *r*:





(I) The resistance of a wire is inversely related to the length of the wire, *i.e.*, $R \propto \frac{1}{l}$.

(II) The resistance of a wire is directly related to the length of the wire, *i.e.*, $R \propto l$.

(III) The resistance of a wire is inversely related to the radius of the wire, *i.e.*, $R \propto \frac{1}{r}$.

(IV) The resistance of a wire is inversely related to the square of

the radius of the wire, *i.e.*, R $\propto \frac{1}{r^2}$.

(a) Both (I) and (III)

(b) Both (II) and (III)

(c) Both (I) and (IV)

(d) Both (II) and (IV)

(v) A wire of length *l* and of radius of cross-section r has a resistance of R Ω. Another wire of same material and of radius of cross-section 2r will have the same R if the length is:

(a) $\frac{l}{4}$

(b) 2*l*

(c) 4*l*

(d) $\frac{l}{2}$

Ans. (i) (c) nature of conductor

(ii) (b) 8 Ω – m

(iii) (a) very low

(iv) (d) Both (II) and (IV)

(v) (c) 4*I*

44. Read the passage carefully and answer the following questions from Q. 44 (i) to Q. 44(v).

The electrical energy consumed by an electrical appliance is given by the product of its power rating and the duration for which it is used. SI unit of electrical energy is the joule. Where a large quantity of energy is involved, using a joule is not convenient as a unit. So, for commercial purposes, bigger units of electrical energy are involved. 1 kilowatt-hour is equal to 3.6×10^6 joules of electrical energy.

(i) The value of energy dissipated by a certain heater is E. If the duration of operation of the heater is doubled, the energy dissipated will be:

(a) halved

(b) doubled

(c) four-times

(d) remains same

(ii) 60 W is the power of a lamp. The energy dissipated in one minute is:

(a) 360 J

(b) 36 J

(c) 3.6 J

(d) 3600 J

(iii) 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

(iv) Choose the correct statement:

(a) 1 watt-hour = 3600 J

(b) 1 kWh = 36×10^6 J

(c) Energy in kWh = power in W(watt) × time in hour(h)

(d) Energy in kWh = V × I × T1000

(v) Choose the incorrect statement.

(a) Higher the resistance, the lesser the power consumed.

(b) Lower the resistance, more the voltage drawn.

(c) Higher the resistance, the higher the current flown.

(d) Higher the resistance, the lesser the voltage drawn.

Ans. (i) (b) doubled

(ii) (d) 3600 J

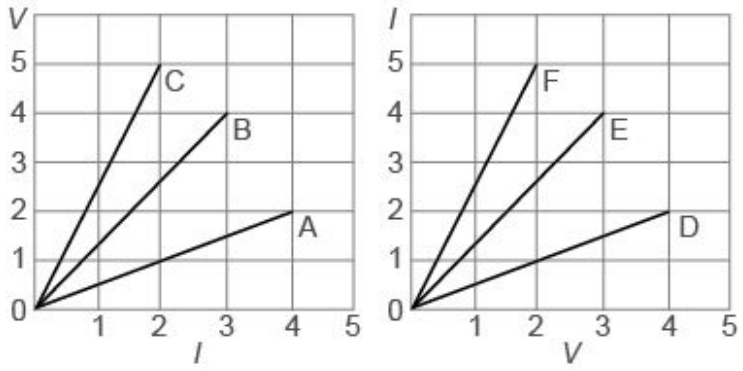
(iii) (a) 90 kJ

(iv) (a) 1 watt-hour = 3600 J

(v) (c) Higher the resistance, the higher the current flown.

45. Observe the figure carefully and answer the following questions from Q. 45 (i) to Q. 45 (v).

The following graphs represent the current versus voltage and voltage versus current for six conductors A, B, C, D, E, and F.



(i) Among conductors A, B, C, D, E, F, the maximum resistance is shown by:

(a) curve C

(b) curve A

(c) curve F

(d) curve D

(ii) Which of the following does not indicate the resistance of curve B?

(a) The slope of curve B

(b) The ratio of V-intercept to I-intercept

(c) The ratio of total grids on the y-axis to total grids on the *x*-axis

(d) $\frac{3}{4}\ \Omega$

(iii) Which indicates the correct sum of least resistances of two graphs?

(a) Curve C + Curve F

(b) Curve A + Curve D

(c) Curve A + Curve F

(d) Curve C + Curve D

(iv) If resistances shown by curve A and curve E are added, the value will be:

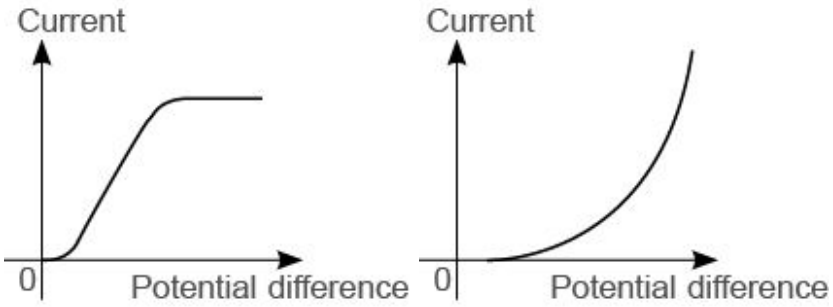
(a) 1.83 W

(b) 1.50 W

(c) 1.64 W

(d) 1.25 W

(v) Which is true for these graphs?



(a) Both are ohmic conductors

(b) Curve A is ohmic and B is non-ohmic conductor

(c) Both are non-ohmic conductors

(d) Curve B is ohmic and A is non-ohmic conductor

Ans. (i) (a) curve C

(ii) (d) $\frac{3}{4}$ Ω

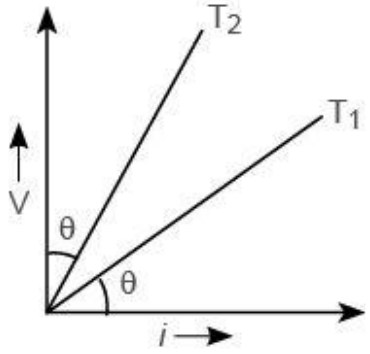
(iii) (c) Curve A + Curve F

(iv) (d) 1.25 W

(v) (c) Both are non-ohmic conductors

46. Read the passage carefully and answer the following questions from Q. 46 (i) to Q. 46 (v).

The graph below is a V-I graph of a metallic circuit drawn at two different temperatures T_1 and T_2.



(i) For the above graph choose the correct option depicting which of the two temperatures is higher with justification.

(a) $T_2 > T_1$; Slope of V-I graph at T_2 is greater than slope at T_1.

(b) $T_1 > T_2$; resistance increases with increase in temperature.

(c) $T_2 > T_1$; resistance increases with decrease in temperature.

(d) $T_1 > T_2$; Slope of V-I graph at T_1 is greater than slope at T_2.

(ii) For the above graph, at which temperature the resistance is

higher?

(a) At T_1

(b) At T_2

(c) Resistance does not depend upon temperature

(d) None of these

(iii) Choose the correct set containing factors on which resistance depends?

(a) Length, Area of cross section, Temperature, Nature of the material.

(b) Area of cross section, Temperature, Nature of the material, Colour.

(c) Length, Area of cross section, Temperature, intermolecular attraction.

(d) Temperature, Nature of the material, Length, physical state of material.

(iv) What is likely to happen if current in a wire is passed for a longer time than required?

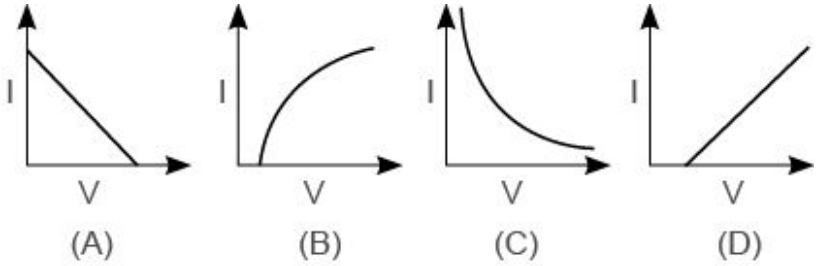
(a) The wire may get burnt and may melt.

(b) Length of the wire may decrease resulting in lower resistance.

(c) Resistance of wire will drop as it will be very difficult to stop the electrons.

(d) Resistance of the wire will get increased due to joule's heating effect.

(v) If the vertical and horizontal axes of a typical V-I straight line graph are reversed, which graph below is likely to represent the I-V graph? (I on vertical, V on horizontal for I-V graph).



(a) (A)

(b) (B)

(c) (C)

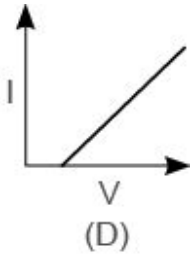
(d) (D)

Ans. (i) (a) $T_2 > T_1$; Slope of V-I graph at T_2 is greater than slope at T_1.

(ii) (b) At T_2

(iii) (a) Length, Area of cross section, Temperature, Nature of the material.

(iv) (d) Resistance of the wire will get increased due to joule's heating effect.



(v) (d) D

Definitions

47. Define resistance of a conductor.

Ans. The obstruction offered to the flow of current by a conductor is called its resistance.

48. State Ohm's law.

Ans. According to Ohm's law, the current flowing in a conductor is directly proportional to the potential difference applied across its ends, provided the temperature and other physical conditions of the conductor remain constant.

49. Define resistivity.

Ans. The resistivity of a substance is numerically equal to the resistance of a rod of that substance which is 1 metre long and 1 square metre in cross-section.

50. What are ohmic conductors ?

Ans. The conductors which obey Ohm's law are called ohmic conductors. The V-I graph for ohmic conductor is a straight line.

51. What are non-ohmic conductors?

Ans. The conductors which does not obey Ohm's law are called non-ohmic conductors. The V-I graph for non-ohmic conductors is not a straight line.

52. State Joule's law of heating.

Ans. Joule's law of heating states that the amount of heat produced in a conductor is directly proportional to:

(a) Square of current (I^2)

(b) Resistance of wire (R)

(b) Time (t), for which current is passed.

53. Define electric power.

Ans. The electrical work done per unit time is called electric power.

54. What does an electric circuit mean?[NCERT]

Ans. A continuous conducting path consisting of wires and other electrical components (like resistance or electric bulb, switch etc.) between the two terminals of a cell or battery, along which an electric current flows, is called an electric circuit.

Formula or S.I. Unit Based Questions

55. Name and define S.I. unit of resistance.**

Ans. The S.I. unit of resistance is ohm (W).

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

$$1 \text{ ohm} = \frac{1 \text{ volt}}{1 \text{ ampere}}$$

56. Write the formula for the equivalent resistance (R) when three resistors R_1, R_2 and R_3 are connected in (a) series, (b) parallel.

Ans. (a) $R = R_1 + R_2 + R_3$

(b) $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$

57. Write the S.I . unit of resistivity.

Ans. Ohm-metre.

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

Ans. Resistance decreases as $R \propto \frac{1}{A}$.

59. How many joules are equals to 1 kWh ?

Ans. 3.6×10^6 J.

60. A given length of a wire is doubled on itself. By what factor does the resistance of the wire change ?*

Ans. When given length of wire is doubled on itself, its new length L′ = $\frac{L}{2}$ and new cross-section area A′ = 2A. Hence, its new resistance

$$R' = \frac{\rho L'}{A'} = \frac{\rho\left(\frac{L}{2}\right)}{(2A)} = \frac{1}{4}\frac{\rho L}{A} = \frac{R}{4}$$

Thus, resistance is reduced to one-fourth of its original value.

61. Derive the relation $R = R_1 + R_2 + R_3$, when resistors are joined in series.*

Ans. In series combination, the same current flows in all the resistances but the potential difference across each of the resistance is different.

According to Ohm's law, we have

$$V_1 = IR_1,\ V_2 = IR_2,\ V_3 = IR_3$$

If the total potential difference between A and B is V, then

$$V = V_1 + V_2 + V_3$$

$$= IR_1 + IR_2 + IR_3$$

$$= I(R_1 + R_2 + R_3)$$

Long Answer Type Questions

Let the equivalent resistance be R, then

$$V = IR$$

and hence $IR = I(R_1 + R_2 + R_3)$

$$\Rightarrow \quad R = R_1 + R_2 + R_3.$$

62. Derive the relation $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$ when resistors are joined in parallel.***

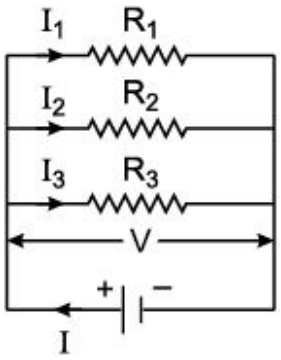
Ans. In parallel combination of three resistance R_1, R_2 and R_3, the current in each of the resistance is different. If I is the current drawn from the cell then it is divided into branches as I_1, I_2 and I_3. Thus,

$$I = I_1 + I_2 + I_3$$

The potential difference across each of these resistances is the same.

Thus, from Ohm's law

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



If R is the equivalent resistance then,

$$\therefore \quad \frac{V}{R} = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}$$

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

63. Out of 60 W and 40 W lamps, which one has a higher electrical resistance when in use.

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

From the above formula, P is inversely proportional to R (resistance) as voltage remaining the same. Hence, 40 We lamp has high resistance.

64. Write the formula for current 'I' flowing through a conductor if '*n*' electrons flow through the cross-section of a conductor in time '*t*'.

Ans. If '*n*' electrons pass through the cross-section of a conductor in time '*t*', the total charge 'Q' passing through the conductor is :

Q = *ne* (*e* is the charge on an electron = 1.6×10^{-19} C)

The current 'I' in the conductor is :

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

65. What is commercial unit of electrical energy ? Convert it into joules.

Ans. The commercial unit of electrical energy is kWh.

1 kWh = 1000 W × 1 hour

$$= 1000 \frac{J}{s} \times 60 \times 60 s$$

$$= 3.6 \times 10^6 \text{ J}$$

66. Name the practical unit of power and state its relation with the S.I. unit.

Ans. The practical unit of power is Horse Power (H.P.)

1 H.P. = 746 watt.

67. Write the formula of electric power (P) in terms of :

(a) Potential difference (V) and current (I).

(b) Current (I) and resistance (R).

(c) Potential difference (V) and resistance (R).

Ans. (a) P = VI

(b) $P = I^2R$

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

68. Write the formula for the heat produced (H) when a current (I) is

passed through a conductor of resistance (R) for **second (*t*).**

Ans. Heat produced, $H = I^2Rt$.

69. What is the formula of (a) Resistance (R) of an electric appliance, (b) Safe current (I) in terms of power rating (P) and voltage rating (V).

Ans. (a) Resistance of appliance

$$= \frac{(\text{Voltage rating of appliance})^2}{(\text{Power rating of appliance})}$$

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

(b) Safe current $= \dfrac{\text{Power rating of appliance}}{\text{Voltage rating of appliance}}$

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

70. Name the physical quantity that represents the ratio of potential difference and current.

Ans. Resistance.

71. What is commercial units of electrical energy ? Convert it into joules.

Ans. The commercial unit of electrical energy is kWh.

$$1 \text{ kWh} = 1000 \text{ W} \times 1 \text{ hour}$$

$$= 1000 \ \frac{\text{J}}{\text{s}} \times 60 \times 60 \ s$$

$= 3.6 \times 10^6$ J

72. Name and define the S.I. unit of electric power.

Ans. The S.I. unit of electric power is watt (W). One watt is the power consumed by an electrical device when it is operated at a potential difference of one volt and carries a current of one ampere.

1 watt = 1 volt × 1 ampere.

73. What is meant by saying that the potential difference between two points is 1 V? [NCERT]

Ans. The potential difference between two points is said to be 1 volt if 1 joule of work is done in moving 1 coulomb of electric charge from one point to the other.

74. Define kWh.

Ans. A kilowatt hour (kWh) is the commercial unit of electrical energy. It is the energy consumed when 1 kW (1000 W) power is used for 1 hour.

Very Short Answer Type Questions

75. The radius of conducting wire is doubled. What will be the ratio of its new specific resistance to the old one?

Ans. 1 : 1, specific resistance does not change as it depends on the nature of material only.

76. How are bulbs connected in a fairy light circuit used for decoration of buildings in festivals ?

Ans. Series combination.

77. What will happen to the resistivity of a wire of length L if it is cut into three parts?

Ans. Resistivity of the wire will not change even when the wire is cut into three parts as resistivity is a characteristic of the material of the conductor and does not depend on the physical dimensions of the conductor.

78. The following table gives the value of electrical resistivity of some materials :****

Material	Copper	Silver	Constantan
Electrical resistivity (in W-**m)**	$1{\cdot}62 \times 10^{-8}$	$1{\cdot}6 \times 10^{-8}$	49×10^{-8}

Which one is the best conductor of

el
e
ct
ri
ci
ty
o
ut
of
th
e
m
?

Ans. Silver, because its electrical resistivity is least out of the given materials.

79. What is the resistance of an (a) ideal ammeter and (b) ideal voltmeter ?

Ans. (a) Zero

(b) Infinite

80. In series combination which remains constant—current or voltage ?

Ans. Current.

81. Name two devices in which electricity is converted into heat.

Ans. Electric heater and electric iron.

82. Name the alloy which is used for making the filament of bulbs.

Ans. Tungsten is used for making the filament of bulbs.

83. Would you connect a fuse in series or in parallel to an electric circuit ?

Ans. In series, of the electric circuit before appliances are present in the circuit.

84. Why do electricians wear rubber hand gloves while working ?*

Ans. Rubber is an electrical insulator. Hence, electrician can work safely while working on an electric circuit without a risk of getting any electric shock.

85. Electric current flows through a metallic conductor from its one end A to other end B. Which end of the conductor is at higher potential ? Why ?

Ans. Since, current flows from a region higher potential to a lower potential. So, it flows from A to B where A is the end with higher potential.

86. Write the function of voltmeter in an electric circuit.*

Ans. Voltmeter measures the potential difference across two points in a circuit. It is always connected in parallel in the circuit.

87. Should the resistance of a voltmeter be low or high ? Give reason.*

Ans. The resistance of a voltmeter should be high, because voltmeter is connected parallel to the component of a circuit and it also takes negligible current from the circuit in order to measure the potential difference accurately.

88. Which material is the best conductor of electricity ?*

Ans. Silver.

89. Which substance is used for making resistance coil of electric heater and why ?

Ans. Nichrome, due to its high resistivity.

90. Why is an ammeter connected in series in an electric circuit ?

Ans. It is connected in series so that whole of electric current, which it has to measure, passes through it.

Reasoning Based Questions

91. Two wires P and Q are made of copper. The wire P is long and thin, while the wire Q is short and thick. Which will have more specific resistance? Give a reason for your answer.

Ans. Both the wires will have same specific resistance, since they are both made of same material (*i.e.,* copper) and there is no change in temperature.

92. Why should a connection wire be thick?

Ans. Resistance of a wire is inversely proportional to its area of cross-section (or thickness). Hence, a connection wire should be thick to reduce its resistance.

93. Why is a series arrangement not used for domestic circuits?

Ans. Series arrangement is not used for domestic circuits for the following reasons :

1. The voltage of the source gets divided in all the appliances connected in series, in the ratio of their resistances, so each appliance does not operate at its rated voltage.

2. The resistance of the circuit increases and it reduces the current in the circuit, so each appliance gets less power.

3. If any one appliance in series arrangement is switched off (or gets spoilt), no other appliance connected with it in series will then operate.

94. Answer the following questions:

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

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

Ans. (a) Resistance of a conductor depends directly on its length and is inversely proportional to the area of cross-section.

(b) Metals have free electrons and they move and conduct electricity, whereas glass does not have free electrons and charges to flow as it is an insulator.

95. Name a material which is used for making standard resistors. Give a reason for your answer.

Ans. Standard resistors are made from alloys such as constantan, manganin etc., because they have high specific resistance and the effect of change in temperature on their resistance is negligible.

96. Which of the cables, one rated 5 A and the other 10 A will be of thicker wire? Give a reason for your answer.

Ans. The cable carrying 10 A current will be of thicker wire because to carry a heavy current, the resistance of wire should be low, hence its area of cross-section should be large.

97. Why are copper and aluminium wires used as connecting wires?*

Ans. Copper and aluminium wires are used as connecting wires because they have low resistivity and are good conductors of electricity.

98. Why is tungsten used for filaments of electric lamps?*

Ans. Tungsten has high melting point and great tensile strength that's why it is used as light bulb filament in electric lamps.

99. Why is lead-tin alloy used for fuse wires?*

Ans. Lead-tin alloy is used for fuse wires because it has low melting point. It will melt when high supply come to prevent the electric circuit from fire.

100. Why are the heating elements of electric toasters and electric irons made of an alloy rather than a pure metal?*

Ans. The resistivity of an alloy is generally higher than that of its constituent metals. Alloys do not oxidise (burn) readily at higher temperatures. Therefore, conductors of electric heating devices, such as toasters and electric irons, are made up of an alloy rather than pure metal.

101. Why are coils of electric heaters and electric irons made of an alloy rather than a pure Metal?

Ans. The resistivity of alloys are generally higher than that of its constituent metals and alloys do not oxidize (burn) readily at high temperatures, hence they are commonly used in electrical heating devices, like electric heaters, electric irons etc.

Short Answer Type Questions

102. Answer the following questions:

(a) Define resistance of a conductor.

(b) State Ohm's law.

(c) State Joule's law of heating.

Ans. (a) The obstruction offered to the flow of current by a conductor is called its resistance.

(b) According to Ohm's law, the current flowing in a conductor is directly proportional to the potential difference applied across its ends, provided the temperature and other physical conditions of the conductor remain constant.

(c) Joule's law of heating states that the amount of heat produced in a conductor is directly proportional to :

1. square of current (I^2),

2. resistance of wire (R), and

3. time (t), for which current is passed.

103. Answer the following questions:

(a) What is an ammeter?

(b) What is a voltmeter?

(c) Define resistivity.

Ans. (a) Ammeter is an instrument which is used to measure electric current in a circuit. It is always connected in series with the circuit.

(b) A voltmeter is an instrument which is used to measure electric potential in the circuit between two points. It is always connected in parallel with the circuit.

(b) The resistivity of a substance is numerically equal to the resistance of a rod of that substance which is one metre long and one square metre in cross-section.

104. Answer the following questions:

(a) Define electric power.

(b) What is a super conductor? Give two examples.

(c) What does an electric circuit mean?

(d) Define conductors and insulators.[NCERT]

Ans. (a) The electrical work done per unit time is called electric power.

(b) A superconductor is a substance of zero resistance at very low temperatures.

Example : Mercury below 4.2 K, Lead below 7.25 K.

(b) A continuous conducting path consisting of wires and other electrical components (like resistance or electric bulb, switch etc.) between the two terminals of a cell or battery, along which an electric current flows, is called an electric circuit.

(d) The substances through which electricity can flow are called conductors and the substances through which electricity cannot flow are called insulators.

Differentiate Between

105

. Write three points of difference between Ohmic resistor and non-Ohmic resistor.

Ans.

S. No.	Ohmic Resistor	Non-Ohmic Resistor
1.	Ohmic resistors obey Ohm's law.	Non-Ohmic resistors do not obey Ohm's law.
2.	The graph for potential difference (V) versus current (I) is a straight line.	The graph for potential difference (V) versus current (I) is not a straight line.
3.	The slope of V-I graph is constant at all values of V or I at a given temperature.	The slope of V-I graph is different at different values of V or I even at a given temperature.

106

. Write two points of difference between resistance and resistivity (or specific resistance).

Ans.

S. No.	Resistance	Resistivity (or Specific Resistance)
1.	The S.I. unit of resistance is Ohm (W).	The S.I. unit of resistivity is ohm-metre (W m).
2.	Resistance of a substance depends on its length and thickness.	Resistivity of a substance is independent of its length and thickness.

107

. Write three points of difference between series combination and parallel combination of resistors.

Ans.

S. No.	Series Combination	Parallel Combination
1.	The current has a single path for its flow, hence, same current flows through each resistor.	The main current from the source divides itself in different arms. The current in each resistors is inversely proportional to its resistance.
2.	The potential difference across the entire circuit is equal to the sum of the potential difference across the individual resistor.	The potential difference across each resistor is same and it is equal to the potential difference across the terminals of the battery (or source).
3.	The equivalent resistance in series combination is greater than the highest resistance in the series combination.	The equivalent resistance in parallel combination is less than the least resistance in the parallel combination.

108

. Distinguish between an open and a closed circuit.

Ans. An electric circuit is said to be an open circuit when the switch is in 'off' mode (or key is unplugged) and no current flows in the circuit.

The circuit is said to be a closed circuit when the switch is in 'on' mode (or key is plugged) and a current flows in the circuit.

109

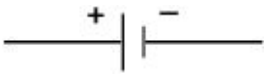
. Write two points of difference between electrical energy and electric power.

Ans.

S. No.	Electrical Energy	Electric Power
1.	Electrical energy consumed by an electrical appliance is given by the product of its power rating and time for which it is used.	It is the rate at which electrical energy is consumed.
2.	It is measured in kWh.	It is measured in watt or kilo-watt.

Diagram Based Questions

110. Identify the components used in circuit diagrams represented by the following symbols :

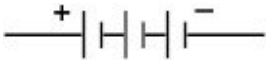
(a) 

(b) 

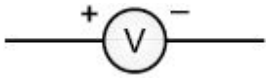
(c) 

(d) 

(e) 

(f) 

(g) 

(h) 

Ans. (a) An electric cell

(b) A fixed resistance

(c) A variable resistance

(d) Plug key (open)

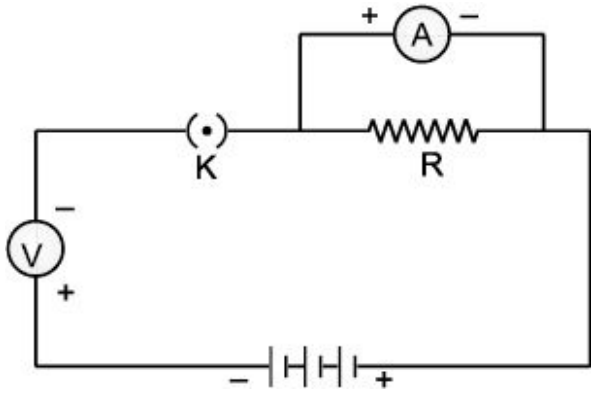
(e) Plug key (closed)

(f) A battery or combination of cells

(g) Ammeter

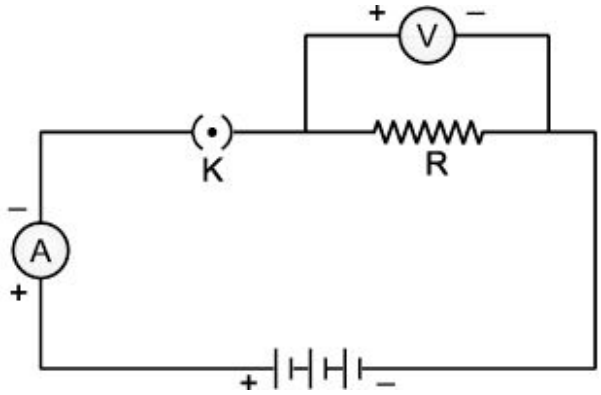
(h) Voltmeter

111. What do you mean by an electric circuit ? Carefully study the circuit diagram given below and make the necessary corrections.

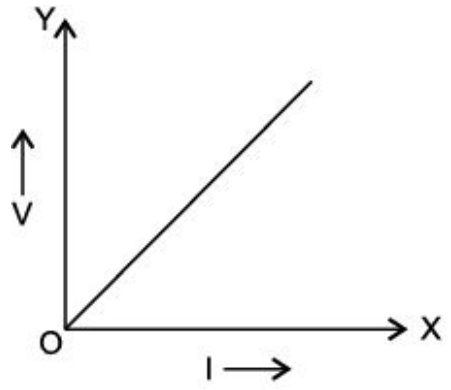


Ans. An electrical circuit is a continuous path comprising conducting wires and other electrical components between the terminals of a battery along which an electric current is set up. It is represented by drawing a circuit diagram.

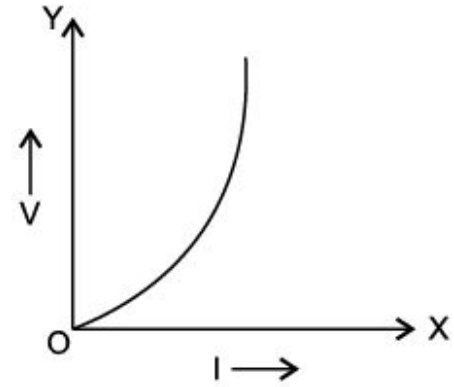
The corrected circuit diagram given in the question is :



112. The given figure shows the V-I graphs for two resistors. Identify the resistor that obeys Ohm's law. Give a reason for your answer



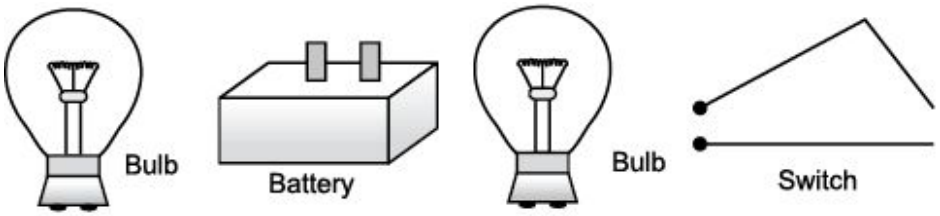
(a)



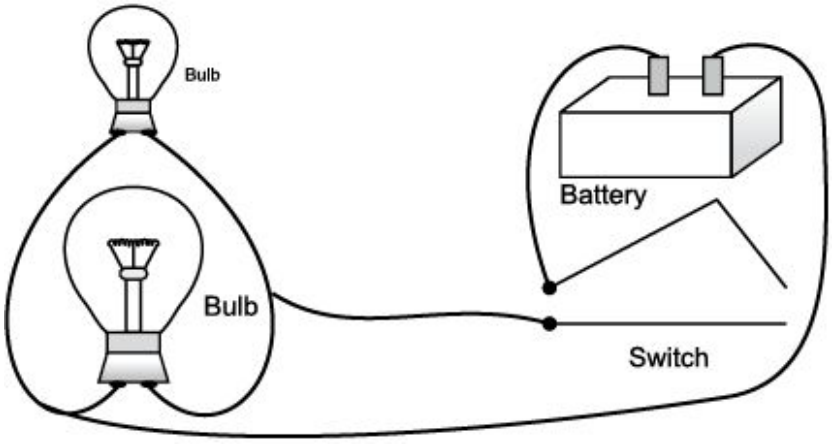
(b)

Ans. The figure (a) obeys Ohm's law because the V-I graph is a straight line and its slope (or resistance) is constant.

113. The given figure shows a battery, a switch and two bulbs. Complete the diagram to show the electric connections of the bulbs to the battery. How have you joined the bulbs ? Give a reason.

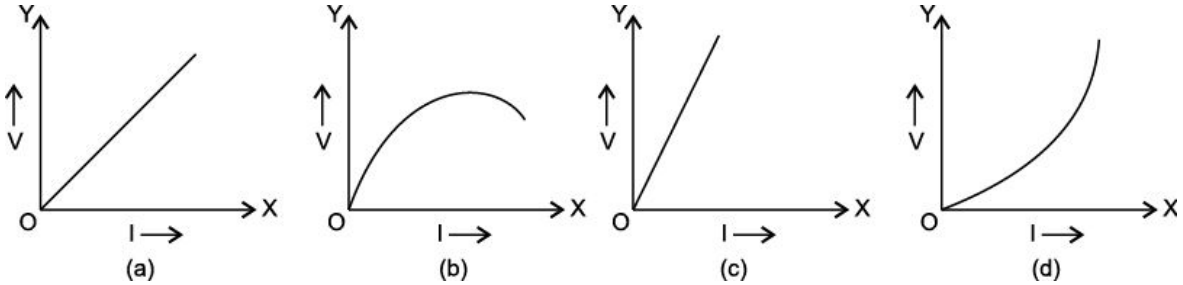


Ans. The two bulbs are connected in parallel and the complete circuit diagram is drawn below :



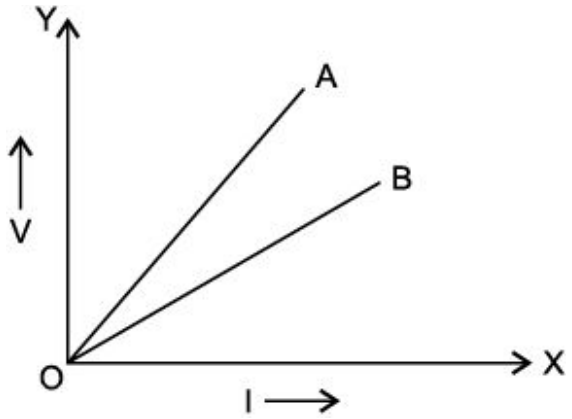
The reason for connecting the two bulbs in parallel is that (i) both the bulbs glow at the same voltage, and (ii) if one bulb stops glowing, the other bulb remains unaffected.

114. The given figures show V-I graphs experimentally obtained for different resistors. Select the graphs for resistors that do not obey Ohm's law.



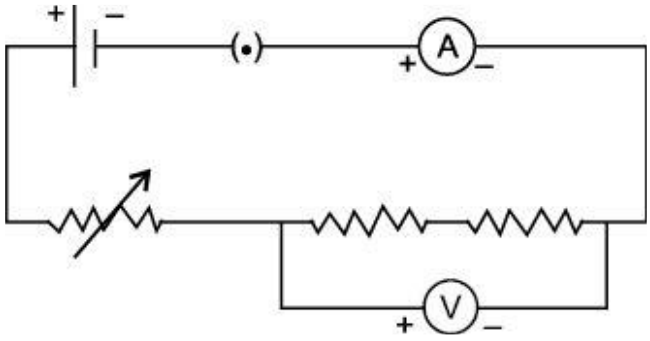
Ans. The figure (b) and (d) do not obey Ohm's law because the V-I graphs are not straight lines.

115. The given figure represents V-I graph for a series combination and for a parallel combination of two resistors. Which of the two, A or B, represents the series combination. Give a reason for your answer.



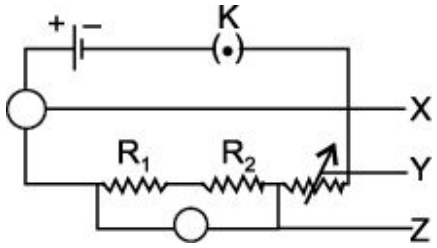
Ans. Since, the straight line A is steeper than B, so the straight line A represents a greater resistance. The equivalent resistance in a series combination is greater than in parallel combination. Hence, A represents series combination.

116. What is the mistake in the circuit given below ?



Ans. The terminals of ammeter are wrongly connected.

117. Identify the X, Y and Z in the circuit given below :



Ans. X = Ammeter, Y = Rheostat, Z = Voltmeter.

Numericals

118. The resistance of a wire of length 150 cm and of uniform area of cross-section 0.015 cm^2, is found to be 3.0 W. Calculate the specific resistance of the wire.

Ans. Here, *l* = 150 cm; A = 0.015 cm^2; R = 3.0 W.

Specific resistance, $r = \frac{RA}{l}$

$$= \frac{3.0 \times 0.015}{150}$$

= 0·0003 W cm.

119. A wire has a resistance of 5 W. Calculate the resistance of a wire of same material, whose length is three times and area of cross-section is four times the first wire.

Ans. Case I : R = 5 W

Let the area of cross-section be 'A' and length be '*l*'.

We know that, $R = r.\frac{l}{A}$

Where r is the specific resistance of the wire.

$\therefore \quad 5 = r\frac{l}{A} \quad \ldots(i)$

Case II : R_1 =?

Here, length = 3*l*, area of cross-section = 4A

$\therefore \quad R_1 = r\frac{3l}{4A} \quad \ldots(ii)$

Dividing equation (ii) by (i), we get

$$\frac{R_1}{5} = \frac{\rho.3l}{4A} \times \frac{A}{\rho.l}$$

$$\therefore \quad R_1 = 5 \times \frac{3}{4} = 3.75 \text{ W}.$$

120

. A torch bulb when cold has a resistance of 2·5 W. It draws a current 450 mA, when connected to a 6 V battery and glows brightly. Calculate the resistance of the bulb when glowing and explain the reason for the difference in resistance.

Ans. While glowing, I = 450 mA = 0.45 A, V = 6 volt

Using Ohm's law, Resistance of bulb, R = $\frac{V}{I} = \frac{6}{0.45}$ = 13.33 W

The reason for the difference in resistance of bulb when cold (R = 2·5 W) and while glowing (R = 13·33 W), is that the resistance of filament of bulb increases with the increase in temperature.

121

. A uniform wire with a resistance of 32 W is divided into four equal parts and they are joined in parallel. Calculate the equivalent resistance of the parallel combination.

Ans. Resistance of each part,

$R_1 = \frac{32}{4}$ W = 8 W

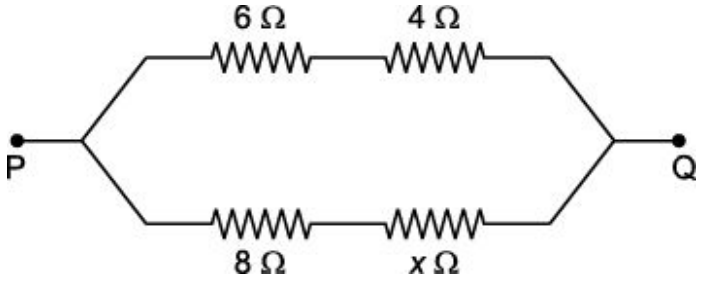
When connected in parallel, the equivalent resistance is

$$\frac{1}{R} = \frac{1}{8}+\frac{1}{8}+\frac{1}{8}+\frac{1}{8}=\frac{4}{8}=\frac{1}{2}$$

or R = 2 W.

122

. Calculate the value of *x* if the equivalent resistance between the points P and Q as shown in figure is 5 W.



Ans. Equivalent resistance of 6 W and 4 W in series,

R_1 = (4 + 6) W = 10 W

Equivalent resistance of 8 W and *x* W in series,

R_2 = (8 + *x*) W.

Now, R_1 and R_2 are in parallel.

Therefore, the equivalent resistance of R_1 and R_2 connected in parallel can be calculated as

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

or $$\frac{1}{5} = \frac{1}{10}+\frac{1}{8+x} \qquad [\because R = 5 W]$$

or $$\frac{1}{5}-\frac{1}{10} = \frac{1}{8+x}$$

or $\frac{2-1}{10} = \frac{1}{8+x}$

or $\frac{1}{10} = \frac{1}{8+x}$

or $8 + x = 10$

$\Rightarrow$ $x = 10 - 8 = 2$ W

$\therefore$ Value of x = 2 W.

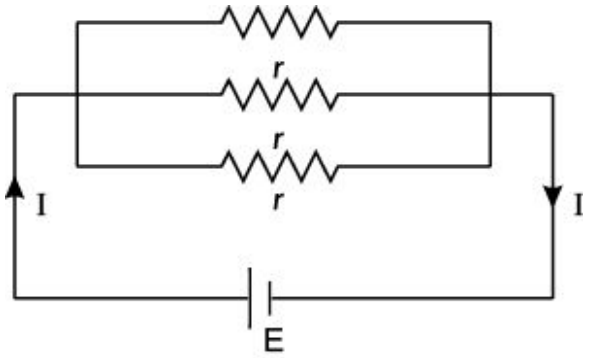
123

. You have three resistors of *r* ohm each and a battery of E volts. How would you connect these resistors with the battery to obtain maximum current? Draw a circuit diagram to illustrate your answer and also calculate the current drawn from the battery.*

Ans. Three resistors are connected in parallel. Let its equivalent resistance be R W.

$\therefore$ $\frac{1}{R} = \frac{1}{r} + \frac{1}{r} + \frac{1}{r}$

$\frac{1}{R} = \frac{1+1+1}{r} = \frac{3}{r}$



$\Rightarrow \quad R = \frac{r}{3}$

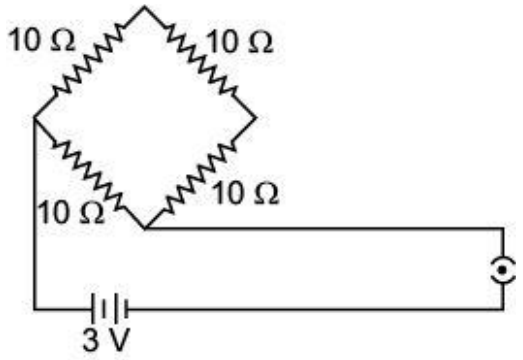
By Ohm's law, E = IR

$\Rightarrow$ Current (I) = $\frac{E \times 3}{r} = \frac{3E}{r}$

These resistances should be connected in parallel with the battery to obtain the maximum current.

124

. Find the current drawn from the battery by the network of four resistors shown in the figure.******

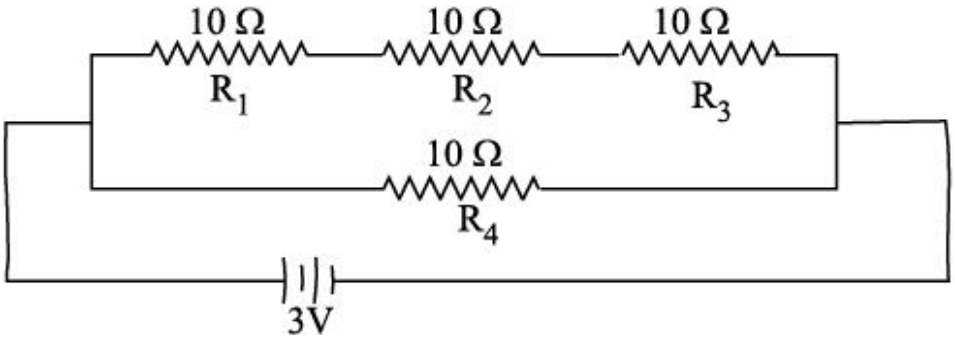


Ans. The given circuit can be redrawn as shown below :

Resultant resistance of R_1, R_2 and R_3 :

$R' = R_1 + R_2 + R_3$

$= 10 + 10 + 10 = 30$ W



Resultant resistance of the circuit :

$$\frac{1}{R} = \frac{1}{R'} + \frac{1}{R_4}$$

$$= \frac{1}{30} + \frac{1}{10} = \frac{1+3}{30} = \frac{4}{30}$$

$$R = \frac{30}{4} = \frac{15}{2} = 7.5 \text{ W}$$

Here, V = 3 volt, I =?

By Ohm's law, V = IR

$$\Rightarrow I = \frac{V}{R} = \frac{3}{7.5} = \frac{30}{75} = 0.4 \text{ A}$$

125

. An electric lamp of 100 W, a toaster of resistance 50 W, and a water filter of resistance 500 W are connected in parallel to a 220 V source. What is the resistance of an electric iron connected to the same source that takes as much current as all three appliances and what is the current through it?

[NCERT]

Ans. The combined resistance R of the three electrical devices R_1,

R_2 and R_3 connected in parallel is :

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

Here, R_1 = 100 W, R_2 = 50 W and R_3 = 500 W

$$\therefore \quad \frac{1}{R} = \frac{1}{100} + \frac{1}{50} + \frac{1}{500}$$

$$= \frac{5+10+1}{500}$$

$$= \frac{16}{500}$$

$$\text{or} \quad R = \frac{500}{16}$$

$$= 31.25 \text{ W}$$

Now, Potential difference, V = 220 V

Current, I =?

Resistance, R = 31.25 W

Using Ohm's law : $\frac{V}{I} = R$

$$\text{or} \quad \frac{220}{I} = 31.25$$

$$\text{or} \quad I = \frac{220}{7.04}$$

= 7.04 A

Hence, the current passing through the electric iron is 7.04 A.

The resistance of electric iron $R_{iron} = \frac{V}{I} = \frac{220}{7.04}$

= 31.25 W.

126

. How can three resistors of resistances 2 W, 3 W and 6 W be connected to give a total resistance of (a) 4 W and (b) 1 W? [NCERT]

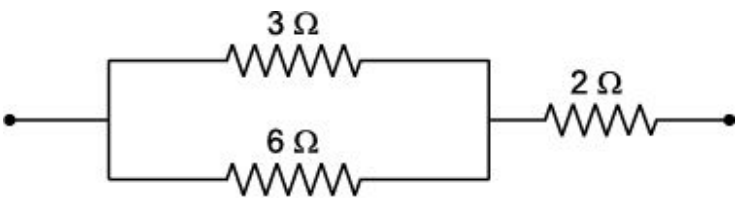
Ans. (a) The three resistors of resistances 2 W, 3 W and 6 W have to be combined as shown in the figure to obtain 4 W resistance.

Equivalent resistance of 3 W and 6 W connected in parallel is,

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

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

or $R_P = \frac{6}{3}$ = 2 W



Now, R_P and 2 W are joined in series and the equivalent resistance is,

$R = R_P + 2$

$= (2 + 2)\ W$

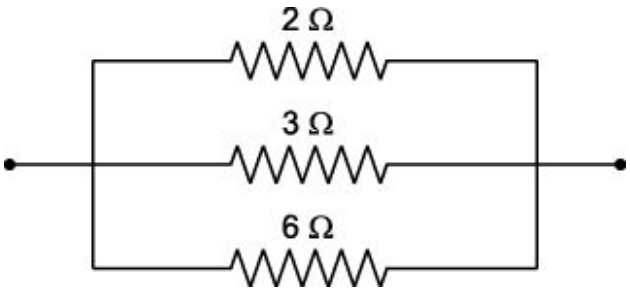
$= 4\ W$

(b) In order to obtain 1 W resistance, the resistors 2 W, 3 W and 6 W have to be combined as shown in figure.

2 W, 3 W and 6 W resistances are connected in parallel,

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

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



$$= \frac{6}{6}$$

or $R = 1\ W$

127

. How many 176 W resistors in parallel are required to carry 5 A on a 220 V line?[NCERT]

Ans. Here, Potential difference, V = 220 V, Current, I = 5 A

$\therefore$ Resistance, $R = \frac{V}{I}$

$$= \frac{220}{5} = 44 \text{ W}$$

Let the number of 176 W resistors to be connected in parallel to give an equivalent resistance of 44 W be *x*.

Equivalent resistance of '*x*' 176 W resistance connected in parallel is $\frac{176}{x}$ W

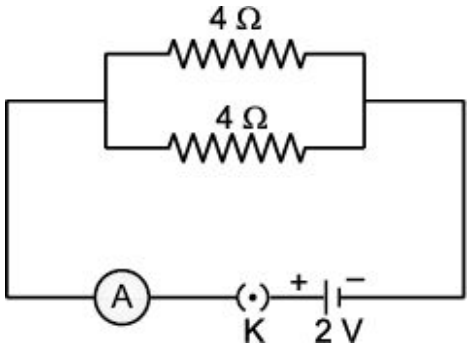
But, $\frac{176}{x} = 44$

$\therefore \quad x = \frac{176}{44} = 4$

Thus, 4 resistors of 176 W each should be connected in parallel.

128

. In the circuit diagram shown below, calculate : (a) total resistance and (b) current shown by the ammeter A.



Ans. (a) The two resistors of resistance 4 W each are connected in parallel.

$\therefore \quad \frac{1}{R} = \frac{1}{4} + \frac{1}{4}$

$$= \frac{1+1}{4}$$

$$= \frac{2}{4} = \frac{1}{2}$$

∴ R = 2 W

Now, Potential difference,

V = 2 V

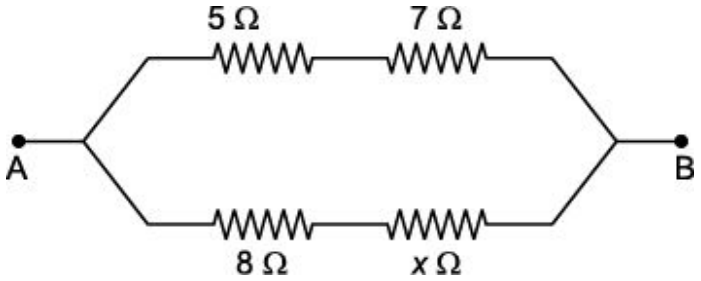
Total resistance, R = 2 W

(b) Using Ohm's law, Current,

$$I = \frac{V}{R} = \frac{2}{2} A = 1 A.$$

129

. In the circuit given below, calculate the value of *x*, if the equivalent resistance between the points A and B is 6 W.



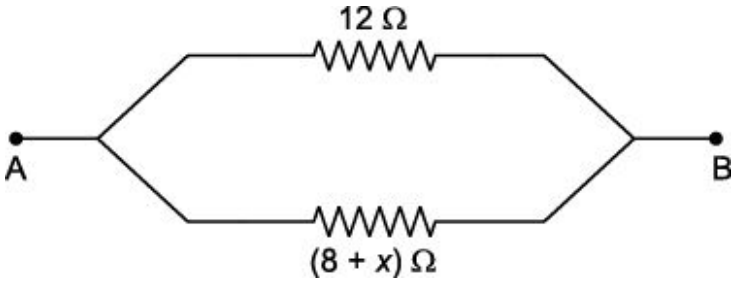
Ans. The network of resistors can be simplified as

(∵ 5 W and 7 W are in series and also 8 W and *x* W are in series).

Here, equivalent resistance (R) = 6 W, R_1 = 12 W, R_2 = (8 + *x*) W

The resistors R_1 and R_2 are connected in parallel.

$$\therefore \quad \frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$$



$$\text{or} \quad \frac{1}{6} = \frac{1}{12} + \frac{1}{8+x}$$

$$\text{or} \quad \frac{1}{6} - \frac{1}{12} = \frac{1}{8+x}$$

$$\text{or} \quad \frac{2-1}{12} = \frac{1}{8+x}$$

$$\text{or} \quad \frac{1}{12} = \frac{1}{8+x}$$

or $\quad 8 + x = 12$

$$\therefore \quad x = 12 - 8 = 4 \text{ W}.$$

130

. Draw a schematic diagram of a circuit consisting of a battery of three cells of 2 V each, a 5 Ω resistor, an 8 Ω resistor, and a 12 Ω resistor and a plug key, all connected in series. Now, connect the ammeter to measure the current through the resistors and a voltmeter to measure the potential difference across the 12 Ω resistors. What would be the readings in the ammeter and the voltmeter?

Ans. The total resistance of the circuit is given by

$$R = 5 + 8 + 12$$

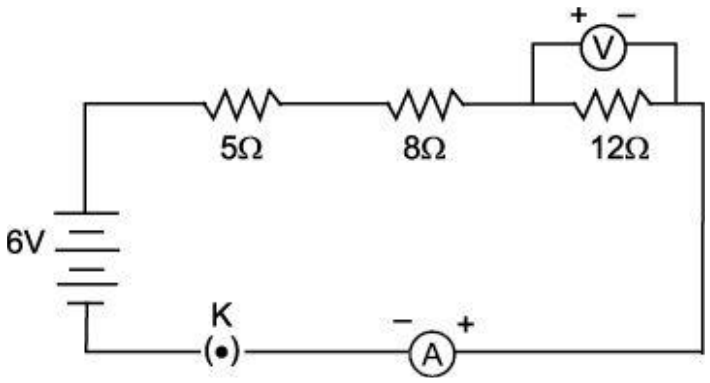
$$= 25 \text{ W}$$

We know, $R = \frac{V}{I}$

Hence, $25 = \frac{6}{I}$

$$I = \frac{6}{25}$$

$$= 0.24 \text{ A}$$



Since, resistances are connected in series, thus electric current remains the same through all resistors.

Here we have,

Electric current, I = 0.24 A

Resistance, R = 12 Ω

Thus, potential difference (V) through the resistor of 12 Ω is given by

$$V = I \times R$$

= 0.24 × 12

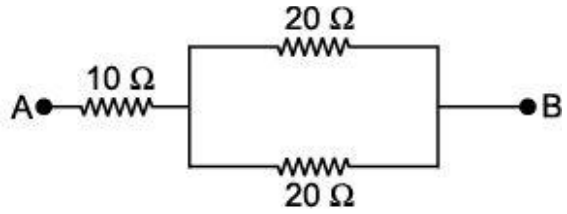
= 2.88 V

∴ Reading of ammeter = 0.24 A

Reading of voltmeter through resistor of 12 Ω = 2.88 V.

131

. Calculate the equivalent resistance of the following network :



Ans. Let R_p is the equivalent resistance of resistors connected in parallel.

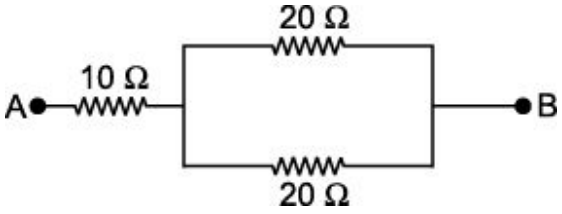
∴ Equivalent resistance of the circuit

$$\frac{1}{R_p} = \frac{1}{20} + \frac{1}{20}$$

$$\frac{1}{R_p} = \frac{1+1}{20}$$

$$= \frac{2}{20} = \frac{1}{10}$$

R_p = 10 W



Now, equivalent circuit becomes.

∵ 10 W and 10 W are connected in series.

∴ Equivalent resistance of the circuit R = 10 W + 10 W

= 20 W

132

. Resistance of a conductor of length 80 cm is 4.0 W. Calculate the resistance of a similar conductor of length 400 cm.

Sol. Here, l_1 = 80 cm, R_1 = 4.0 W, l_2 = 400 cm, R_2 = ?

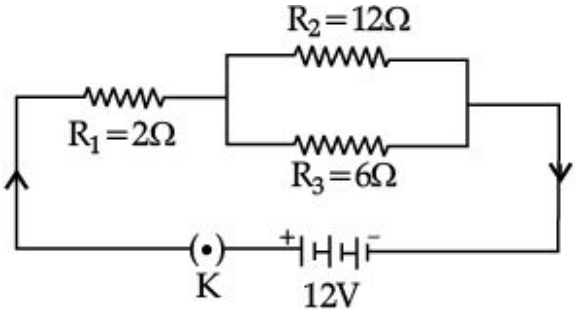
$$\therefore \quad \frac{R_1}{R_2} = \frac{l_1}{l_2}$$

$$\text{or} \quad R_2 = R_1 . \frac{l_2}{l_1}$$

$$= 4.0 \times \frac{400}{80} = 20.0 \text{ W}.$$

133

. The circuit diagram given below shows the combination of three resistors, R_1 = 2 W, R_2 = 12 W and R_3 = 6 W :



Calculate :

(a) Total resistance of the circuit.

(b) Total current flowing in the circuit.

(c) The potential difference across R_1.

(d) The potential difference across R_2 or R_3.

(e) Current flowing through R_2.

Ans. (a) R_2 and R_3 are in parallel.

∴ Equivalent resistance of R_2 and R_3,

$$R_P = \frac{R_2 \times R_3}{R_2 + R_3}$$

$$= \frac{12 \times 6}{12 + 6}\Omega$$

$$= \frac{72}{18}\Omega$$

= 4 W.

∴ Total resistance of the circuit, $R = R_1 + R_P$

Now, R_1 and R_P are connected in series

= (2 + 4) W

= 6 W

(b) Potential difference, V = 12 V

Total resistance, R = 6 W

Using Ohm's law,

Total current flowing in circuit,

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

$$= \frac{12}{6} A = 2A$$

(c) Potential difference across R_1,

$$V_1 = IR_1$$

$$= 2 \times 2 = 4 V$$

(d) Potential difference across R_2 or R_3,

$$V_2 = IR_P$$

$$= 2 \times 4 = 8 V$$

(e) Let the current flowing through R_2 be I'.

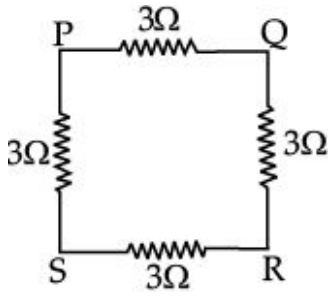
$$\therefore \quad V_2 = I'R_2$$

$$\text{or} \quad I' = \frac{V_2}{R_2} = \frac{8}{12} A$$

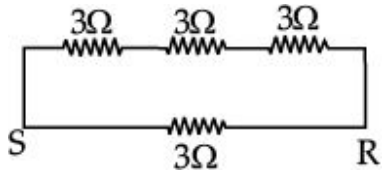
$$= 0.67 A.$$

134

. In a network of resistors as shown in figure, calculate the equivalent resistance between the points (a) S and R and (b) P and R.



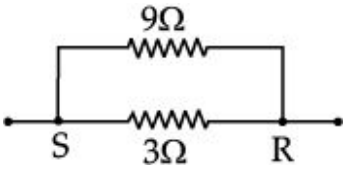
Sol. (a) Between S and R : Between the points S and R the above network of resistors can be represented as :



Equivalent resistance of three 3 Ω resistors connected in series,

$$R_1 = (3 + 3 + 3) = 9\ \Omega$$

Now, R_1 and 3 Ω are connected in parallel.



∴ Equivalent resistance R can be calculated as

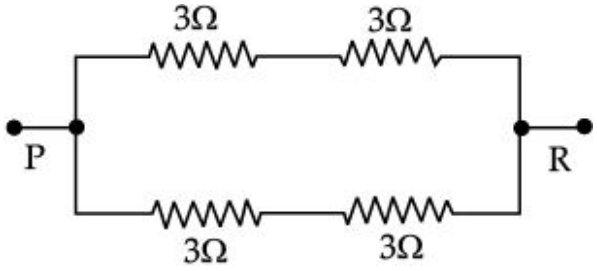
$$\frac{1}{R} = \frac{1}{9} + \frac{1}{3}$$

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

$$= \frac{4}{9}$$

$$\text{or} \qquad R = \frac{4}{9}\ \Omega = 2.25\ \Omega$$

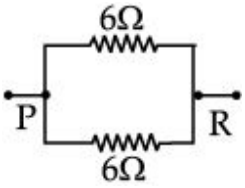
(b) Between P and R : Between the points P and R the network of resistors can be represented as :



Equivalent resistance of two 3 Ω resistors connected in series is (3 + 3) = 6 Ω

Now, two 6 Ω resistors are connected in parallel.

∴ Equivalent resistance is given by



$$\frac{1}{R} = \frac{1}{6} + \frac{1}{6}$$

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

= 3 W.

135

. A copper wire has diameter 0.5 mm and resistivity of 1.6 × 10^{-8} W m. What will be the length of this wire to make its resistance 10 W ? How much does the resistance change if the diameter is doubled ?

Sol. Here, diameter of wire = 0.5 mm, Resistivity (r) = 1.6 × 10–8 W M, Resistance (R) = 1 W. Let the length of wire *l* and the

resistance when diameter is doubled be R_1.

$\therefore$ Radius = $\frac{0.5\,mm}{2}$ = 0.25 mm

= $\frac{0.25}{1000}$ = 0.00025 m

We know that, R = $\rho\frac{1}{A}$

$\therefore$ $l = \frac{RA}{\rho} = \frac{R\pi r^2}{\rho}$

$\Rightarrow$ $l = \frac{10\times 3.14\times(0.00025)^2}{1.6\times10^{-8}}$

$l = \frac{10\times 3.14\times 0.00025\times 0.00025}{1.6\times10^{-8}}$

$\Rightarrow$ $l = \frac{10\times 3.14\times 0.0000000625\times10^{8}}{1.6}$

$l = \frac{10\times10^{8}\times 0.00000196250}{1.6}$

= $\frac{196.26}{1.6}$ = 122.65 m = 122.7 m

When diameter wire is doubled then,

Now diameter = 0.5 × 2 = 1 mm

$\therefore$ Radius = $\frac{1}{2}$mm = 0.5 mm

$$= \frac{0.5}{1000}\text{m} = 0.0005\,\text{m}$$

$\therefore$ $R_1 = \rho\frac{1}{A} = \rho\frac{1}{\pi r^2}$

$$= 1.6 \times 10^{-8} \times \frac{122.7}{3.14 \times 0.0005 \times 0.0005}$$

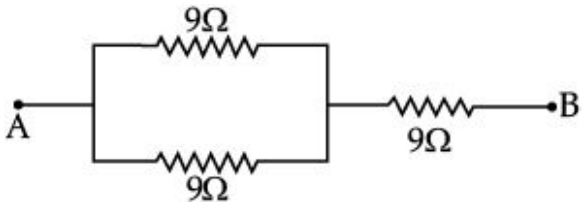
$$= \frac{1.6 \times 10^{-8} \times 122.7}{3.14 \times 0.00000025} = \frac{1.6 \times 122.7}{3.14 \times 0.00000025 \times 10^{8}}$$

$$= \frac{196.32}{78.5} = 2.5\ \text{W}$$

136

. Show how would you join resistors each resistance 9 W so that the equivalent resistance of the combination of combination is (a) 13.5 W (b) W ?

Sol. (a) To get an equivalent resistance of 13.5 W, the resistance should be connected as sown in the figure given below:



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

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

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

$$\frac{1}{R_P} = \frac{2}{9}$$

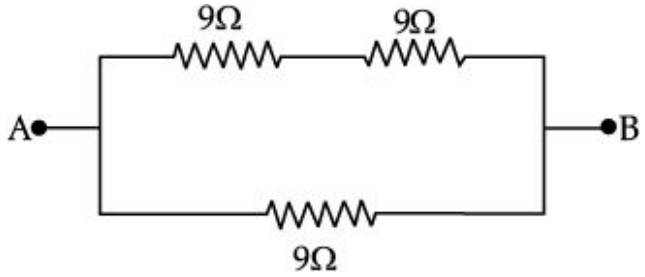
$$R_P = \frac{9}{2} = 4.5\ \Omega$$

Now, $R_S = R_3 + 4.5\ \Omega$

$= 9\ \Omega + 4.5\ \Omega$

$= 13.5\ \Omega$

(b) To get equivalent resistance of 6 W, the resistance should be connected as shown in the given below



$R_S = R_1 + R_2$

$= 9 + 9$

$= 18\ \Omega$

Now both the resistance are in parallel with each other so,

$$R_p = \frac{1}{18} + \frac{1}{9}$$

$$= \frac{1+2}{18} = \frac{3}{18}$$

$$= \frac{1}{6}\Omega$$

So, R_P = 6 W

137

. An electric bulb of resistance 44 W draws a current of 5.0 A. Calculate the line voltage.

Ans. Here, I = 5.0 A, R = 44 W, V =?

Using Ohm's law, V = IR

= 5.0 × 44 = 220 V

138

. An electric iron of resistance 20 W takes a current of 5 A. Calculate the heat developed in 30 s.

[NCERT]

Ans. Here, Current (I) = 5 A, Resistance (R) = 20 W,
Time (*t*) = 30 s

∴ Heat produced (H) = I^2Rt

= $(5)^2 \times 20 \times 30$

= 15000 J

Thus, heat developed is 1.5×10^4 J.

139

. Which uses more energy, a 250 W T.V. set in 1 hour or a 1200 W toaster in 10 minutes?[NCERT]

Ans

. For T.V. Set : Power, P = 250 W

Time, t = 1 h

Electrical energy consumed = P × t

$$= \frac{250 \times 1}{1000} \text{ kWh}$$

$$= 0.25 \text{ kWh}$$

For toaster : Power, P = 1200 W

Time, t = 10 minutes

$$= \frac{10}{60} \text{ h} = \frac{1}{6} \text{ h}$$

Electrical energy consumed = P × t

$$= \frac{1200 \times 1}{1000 \times 6} \text{ kWh}$$

$$= 0.20 \text{ kWh}$$

The T.V. set uses more energy (0.25 kWh) whereas the toaster uses less energy (0.20 kWh).

140

. When a 12 V battery is connected across an unknown resistor, there is a current of 2.5 mA in the circuit. Find the value of the resistance of the resistor.[NCERT]

Ans. Here, Potential difference, V = 12 V

Current, I = 2.5 mA = $\frac{2.5}{1000}$ A = 0.0025 A

Using Ohm's law

Resistance, R = $\frac{V}{I} = \frac{12}{0.0025}$ = 4800 W

141. The values of current I flowing in a given resistor for the corresponding values of potential difference V across the resistor are given below :

I (ampere)	0.5	1.0	2.0	3.0	4.0
V (volt)	1.6	3.4	6.7	10.2	13.2

Plot a graph between V and I and calculate the resistance of that resistor.

Ans. The graph between V and I is given below :

Let us consider two points A and B on the slope.

Draw two lines, one from point B along X-axis and another from point A along Y-axis, which meet at point C.

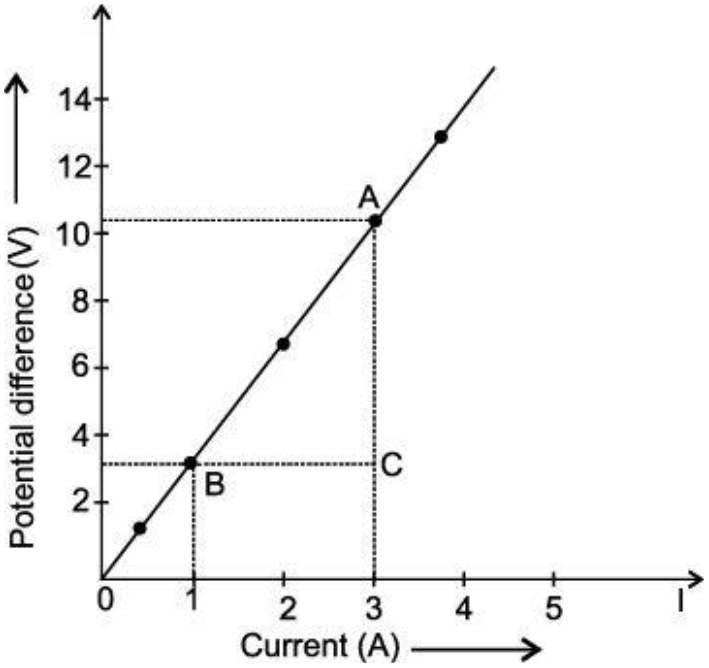
The slope of the graph will give the value of resistance, thus

Slope = R = $\frac{AC}{BC}$

Now, BC = 3 – 1 = 2 A

AC = 10.2 – 3.4 = 6.8 V

Slope = $\frac{6.8}{2}$ = 3.4 W



Thus, resistance (R) = 3.4 Ω.

142

. An electric iron is rated '1 kW – 220 V'. Calculate the following :

(a) The resistance of its heating element.

(b) The amount of current that will flow through the element.

(c) The amount of heat that will be produced in 2 minutes.

(d) The power consumed if the line voltage falls to 200 V.

Ans

. Here, V = 220 volt, P = 1 kW = 1000 W, *t* = 2 minute = 2 × 60 = 120 s

(a) Resistance of the heating element,

$$R = \frac{V^2}{P} = \frac{(220)^2}{1000} = 48.4 \text{ W.}$$

(b) Current through the element,

$$I = \frac{P}{V} = \frac{1000}{220} = 4.54 \text{ A}$$

(c) Heat produced in 2 minutes = P × *t*

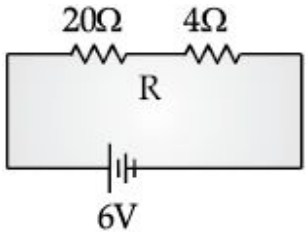
= 1000 × 120 = 1·2 × 10^5 J

(d) If line voltage falls to 200 V, the power consumed is,

$$P = \frac{V^2}{R} = \frac{(200)^2}{48.4} = 826.44 \text{ W.}$$

143

. An electric lamp of resistance 20 W and a conductor of resistance 4 W 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,

(d) power of the lamp.

Ans. (a) Given, R_1 = 20 W, R_2 = 4 W

Since, in Series $R = R_1 + R_2$

$\therefore$ Total resistance of circuit : $R = 20 + 4$

$= 24\ W$

(b) Current through circuit V = 6 V, R = 24 W

According to Ohm's law V = IR

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

$$I = \frac{6}{24}$$

$$= \frac{1}{4} = 0{\cdot}25 \text{ ampere}$$

(c) (i) Potential difference across electric lamp :

$I = \frac{1}{4}$ A, $R_1 = 20$ W

$V_1 = IR_1$

$V_1 = \frac{1}{4} \times 20$

$= 5$ V

(ii) Potential difference across conductor

$V_2 = IR_2$

$= \frac{1}{4} \times 4$

$V_2 = 1$ V

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

$$= \left(\frac{1}{4}\right)^2 \times 20$$

$$= \frac{1}{4} \times \frac{1}{4} \times 20$$

$$= \frac{5}{4} \text{ W}$$

or $P = 1.25$ W.

144

. Two bulbs rated (60 W – 220 V) and (60 W – 110 V) respectively. Calculate the ratio of their resistance.

Sol. First bulb:

Power rating $P_1 = 60$ W

Voltage rating $V_1 = 220$ V

$\therefore$ Resistance, $R_1 = \frac{V_1^2}{P_1}$

$$= \frac{220 \times 220}{60} \Omega$$

Second bulb:

Power rating $P_2 = 60$ W

Voltage rating, $V_2 = 110$ V

∴ Resistance, $R_2 = \frac{V_2^2}{P_2}$

$= \frac{110 \times 110}{60} \Omega$

$\frac{R_1}{R_2} = \frac{\frac{220 \times 220}{60}}{\frac{110 \times 110}{60}}$

$= \frac{220 \times 220}{60} \times \frac{60}{110 \times 110}$

$= \frac{4}{1}$

$R_1 : R_2 = 4 : 1$

145

. An electric kettle is rated at (100 W – 220 V).

(a) What is the resistance of its element when in use?

(b) What is the safe value of current that can pass through its element?

Sol. Here, Power rating, P = 1000 W

Voltage rating, V = 220 V

(a) Using the relation $P = \frac{V^2}{R}$

Resistance of element when in use,

$$R = \frac{V^2}{P} = \frac{220 \times 220}{1000}$$

$$= 48.4 \text{ W}$$

(b) Using the relation P = VI

$$\text{Safe current, } I = \frac{P}{V} = \frac{1000}{20}$$

$$= 4.55 \text{ A}$$

146

. Two lamps, one rated 100 W at 220 V, and the other 60 W at 220 V, are connected in parallel to electric mains supply. What current is drawn from the line if the supply voltage is 220 V?[NCERT]

Sol. **Given:** Power of one lamp, P_1 = 100 W

Power of second lamp, P_2 = 60 W

Since, both the lamps are connected in parallel, thus, potential difference will be equal.

Thus, Potential difference = 220 V

We know, that Power (P) = VI

Thus, the total current through the circuit

$$I = \frac{P_1}{V} + \frac{P_2}{V}$$

$$I = \frac{100}{200} + \frac{60}{200}$$

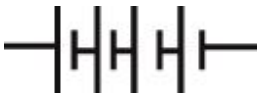
$$= \frac{100 + 60}{220}$$

$$= \frac{160}{220} = 0.727 \text{ A}$$

Analysis and Evaluation Based Questions

147

. If a student wants to connect four cells of 1.5 V each to form a battery of voltage 6 V, then how would he draw the symbol of the battery?

Ans. 

148

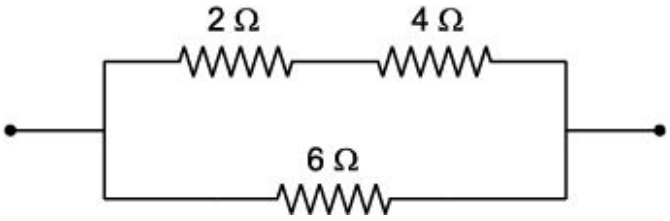
. The atoms of copper contain electrons and the atoms of rubber also contain electrons, then, why does copper conduct electricity but rubber does not conduct electricity?

Ans. Copper contains a large number of free electrons, hence is a good conductor of electric current whereas rubber has negligible number of free electrons and is an insulator.

149

. You are given three resistors of resistance 2 W, 4 W and 6 W. Show by a diagram, how you can get a 3 W resistance with the help of these resistors.

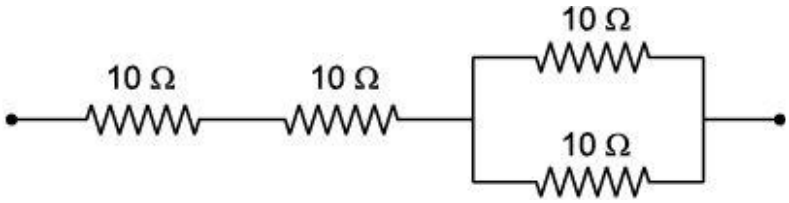
Ans. Connect 2 W and 4 W in series then this combination is connected with the parallel 6 W resistance. By this arrangement we can get resistance 3 W as equivalent resistance.



150

. How many 10 W resistors are required to get a 25 W resistor?

Ans. Four 10 W resistors are required and they are connected as shown.



151

. You are given fifty 5 W resistors. What is (a) smallest and (b) largest resistance can be obtained by using these?

Ans. (a) To get the smallest resistance, all the 5 W resistors must be connected in parallel.

$$\text{Smallest resistance} = \frac{5}{50} = 0.1 \text{ W}$$

(b) To get the largest resistance, the 5 W resistors must be connected in series.

Largest resistance = 5 × 50 = 250 W.

152

. Why are fairy decorative lights always connected in parallel?

Ans. When the fairy lights are connected in series the resistance offered will be greater and brightness of the bulbs will be affected. But in parallel connection all the bulbs will glow with

same intensity and if any bulb gets fused the other bulbs will continue to glow.

153

. What will happen when :

(a) Voltmeter is connected in series?

(b) Ammeter is connected in parallel?

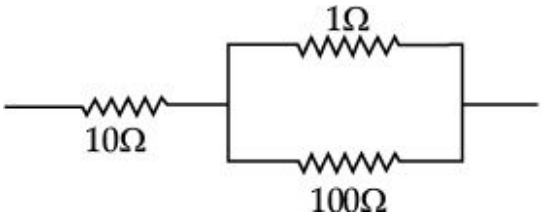
Ans. (a) Negligible current will pass through the circuit because the voltmeter has a very high resistance.

(b) Ammeter will get damaged due to flow of large amount of current through it, because it has low resistance.

154

. Arrange 1 W, 10 W and 100 W such that the equivalent resistance is greater than 10 W but less than 11 W.

Sol. (a) The resistor have to combined as shown in the diagram



The equivalent resistance of 1 W and 100 W connected in parallel is:

$$\frac{1}{R_1} = \frac{1}{1} + \frac{1}{100}$$

$$= \frac{100+1}{100}$$

$$= \frac{101}{100}$$

or $$R_1 = \frac{100}{101}\,\Omega$$

$$= 0.99\ \Omega$$

Now, 10 W and R1 are in series,

Therefore, equivalent resistance R is

$$R = (10 + 0.99)\ \Omega$$

$$= 10.99\ \Omega$$

The above value of resistance is greater than 10 W but less than 11 W.

155

. What is (a) the highest, (b) the lowest resistance that can be secured by combination other resistors of 1 W, 10 W, 100 W and 1000 W?

Sol. (a) To obtain the highest resistance, the resistors must be connected in series.

∴ Highest resistance, $R_S = (1 + 10 + 100 + 1000)\ \Omega$

$$= 1111\ \Omega$$

(b) To obtain the lowest resistance, the resistors must be connected in parallel. the lowest resistance is given by

$$\frac{1}{R_P} = \frac{1}{1} + \frac{1}{10} + \frac{1}{100} + \frac{1}{1000}$$

$$= \frac{1000+100+10+1}{1000}$$

$$= \frac{1111}{1000}$$

∴ Lowest resistance $R_P = \frac{1000}{1111}\Omega$

= 0.9 W.

156

. If two resistors in series have ‘p’ number of common points. What will be the value of ‘p’?

Ans. One.

157

. There are three 2 V cells connected in series. How many joules of energy does 1 C gain on passing through all the three cells?

Ans. Here, the potential difference,

V = 2 + 2 + 2 = 6 V and

charge, Q = 1 C

We know that,

Work done, W = VQ

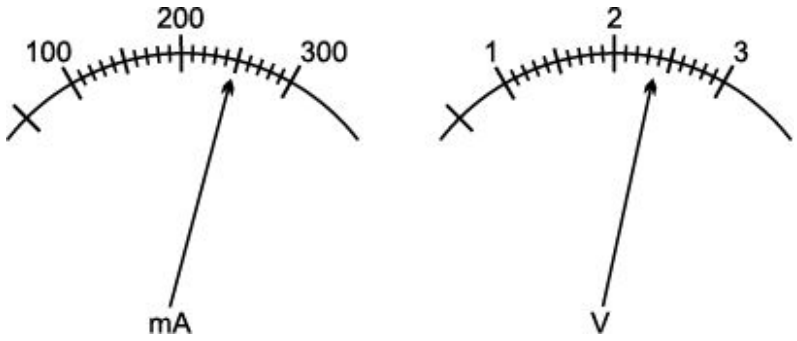
Substituting the values, we get

W = 6 × 1 = 6 J.

158

. 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?

Ans. (a) 10 mA and 0.1 V

(b) V = 2.4 volt, I = 250 mA = 0.25 A

From Ohm's law. R = $\frac{V}{I} = \frac{2.4}{0.25}$ = 9.6 W

159

. Why is the tungsten metal more coiled in the bulb and not installed in straight p arallel wire form?

Ans. The coiled wire of tungsten increases the surface area of the wire in very less space so as to emit more light and helps in glowing with more intensity.

160

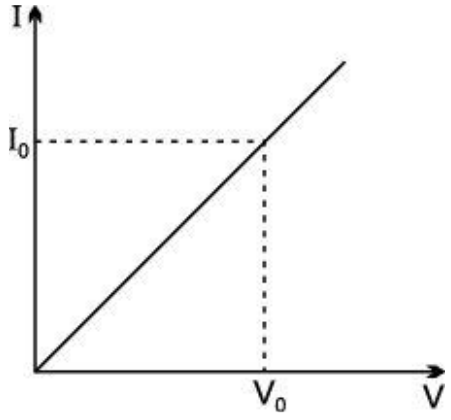
. While studying the dependence of potential difference (V) across a resistor on the current (I) passing through it, in order to determine the resistance of the resistor, a student took 5 readings for different values of current and plotted a graph between V and I. He got a straight line graph passing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

does the straight line signify? Write the method of determining resistance of the resistor using this graph.*

Ans. The straight line in the graph signify that potential difference and current are directly proportional to each other.

The method of determining resistance of resistor using the graph is by Ohm's law,

V = IR and by calculating the slope from the points mentioned on the graph.



$$\therefore R = \frac{1}{\text{Slope of I} - \text{V graph}}$$

161

. What would you suggest to a student if while performing an experiment he finds that the pointer/needle of the ammeter and voltmeter do not coincide with the zero marks on the scales when circuit is open? No extra ammeter/voltmeter is available in the laboratory.

Ans. This is called the zero error of the scale of ammeter or voltmeter. If there is a zero error then this error is subtracted from the value that depicts when the circuit is closed otherwise accurate reading will not be recorded.

162

. Why we must keep the circuit closed for a relatively shorter time and open for a relatively longer time to ensure minimal changes in the values of resistance?

Ans. Due to heating effect of current, we must keep the circuit closed for a relatively shorter time and open for a relatively longer time to ensure minimal changes in the values of resistance.

Creating Based Questions

163

. The following apparatus is available in a laboratory which is summarised in tabular form:

S. No.	Battery	Adjustable from of to 4.5 V
1.	**Resistors**	3 W and 6 W
2.	**Ammeters**	A_1 of range 0 to 3 A least count 0.1 A A_2 of range 0 to 1 A least count 0.05 A.
3.	Voltmeters	V_1 of range 0 to 10 V least count 0.5 V V_2 of range of 0 to 5 V

		least count 0.1 V

(a) For what purpose an ammeter is used ?

(b) If we require the maximum resistance from a number of given resistors we connect :

(i) all in series

(ii) all in parallel

(iii) less resistors in series and more in parallel

(c) The best combination of voltmeter and ammeter for finding the equivalent resistance of the resistors in series would be :

(i) ammeter A_1 and voltmeter V_1

(ii) ammeter A_1 and voltmeter V_2

(iii) ammeter A_2 and voltmeter V_1

(iv) ammeter A_2 and voltmeter V_2

(d) For the experiment to find the equivalent resistance of the parallel combination of the two given resistors, the best choice would be :

(i) ammeter A_1 and voltmeter V_1

(ii) ammeter A_1 and voltmeter V_2

(iii) ammeter A_2 and voltmeter V_1

(iv) ammeter A_2 and voltmeter V_2

Ans. (a) To measure current in the circuit.

(b) (i) All in series

(c) (iv) Ammeter A_2 and voltmeter V_2

(d) (iii) Ammeter A_2 and voltmeter V_1

164

. Shyam designed a burglar alarm circuit in which the resistors are connected in series. The circuit breaks and the current did not flow through the circuit. What is the alternate method he should opt to prevent the circuit break when the resistors are connected in series ?

Ans. There is only a single path which connects from the electric source to the output devices. The electrical appliance damage can be prevented by connecting the **fuse in series** with the mains as well as the electrical appliance. To maintain the current level efficiently series of resistors can be used.

165

. Brisilia designed a prototype in which she used a very sensitive electrical device. But she does not know how to protect the sensitive electrical device from high current. Suggest her with one idea to protect the sensitive device from high current.

Ans. The suggestion to protect the sensitive electrical device from high current is by using a **parallel low resistor known as shunt resistor**. The resistance value of shunt resistor is very low. It is made up of the material having low temperature co-efficient of resistance. It measures the electric current, alternating current or direct current.

166

. Rita designed a circuit in which resistors are connected in series.

Yet she is not satisfied with the series resistors because if there is a fault in some component of the circuit, the whole circuit stops working. What would be your suggestion in alternative to the resistance in series ?

Ans. To overcome the problem faced by Rita, I would suggest to connect the resistors in parallel because if the **resistors are connected parallel**, the whole circuit does not stop working. If the fault is with one component of the circuit, the current continues to flow through the other components of the circuit which makes the device work further.

167

. Electrical resistivities of some substance at 20°C are given below.

S. No.	Metal	Resistivity (in $\Omega \cdot m$)
1.	Silver	1.60×10^{-8}
2.	Copper	1.62×10^{-8}
3.	Tungsten	5.20×10^{-8}
4.	Iron	10.0×10^{-8}
5.	Mercury	94.0×10^{-8}
6.	Nichrome	94.0×10^{-8}

Answer the following relations in relation to them.

(a) Among silver and copper, which one is a better conductor ?

(b) Which material would you advise to be used in electrical heating devices ?

(c) Define resistivity.

(d) What is the effect of temperature on resistivity of a

substance ?

Ans. (a) Silver

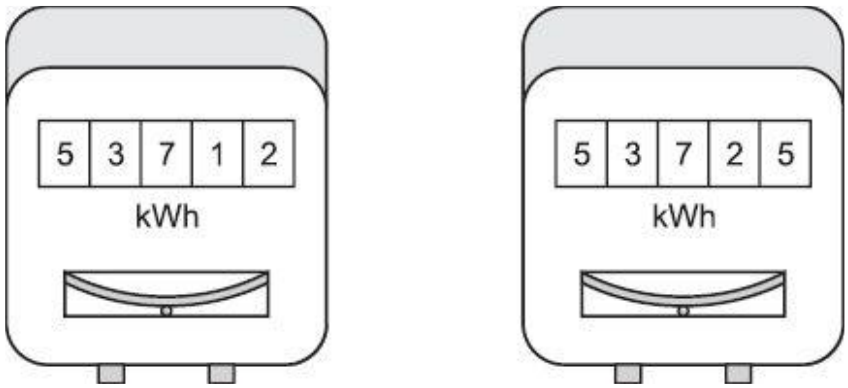
(b) Nichrome

(c) Resistivity of a conductor is defined as the resistance of the conductor of unit length and unit area of cross-section.

(d) Resistivity of a material changes if its temperature changes.

168

. Rhea noted the readings of her home's electricity meter on Monday at 9 a.m. and again on Tuesday at 9 a.m. (as shown in figure given below).



(a) What was the meter reading on Monday ?

(b) What was the meter reading on Tuesday ?

(c) How many units of electrical energy have been used ?

(d) How much time (in hours) have these units been used ?

(e) Calculate the cost of electrical energy used during this time, if the rate is ` 8 per unit.

Ans. (a) Meter reading on Monday = 53712

(b) Meter reading on Tuesday = 53725

(c) Number of units of electrical energy used = 53725–53712

= 13 units

(d) Time = 24 hours

(e) Electrical energy consumed = ₹ 8 × 13

= ₹ 104

Miscellaneous Questions

169

. What is the limitation of Ohm's law ?

Ans. Ohm's law is obeyed only when the temperature of conductor remains constant.

170

. Use the data in table below to answer the following :

	Material	Resistivity (W 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}
		1.84×10^{-8}

	Manganese	
Alloys	**Constantan** (alloy of Cu and Ni)	49×10^{-8}
	Manganin (alloy of Cu, Mn and Ni)	44×10^{-6}
	Nichrome (alloy of Ni, Cr, Mn and Fe)	100×10^{-6}
	Glass	$10^{10} – 10^{14}$

Insulators		
	Hard rubber	$10^{13} – 10^{16}$
	Ebonite	$10^{15} – 10^{17}$
	Diamond	$10^{12} – 10^{13}$
	Paper (dry)	**10^{12}**

(a) Which of these, iron and mercury is a better conductor ?

(b) Which material is the best conductor ?

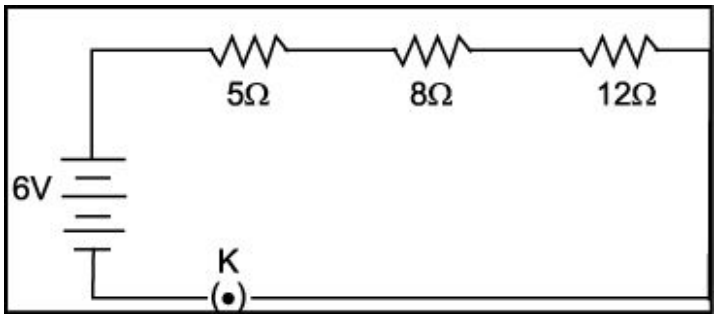
Ans. (a) It can be seen from the above table that the resistivity of mercury is more than that of iron. This implies that iron is a better conductor than mercury.

(b) It can be observed from the above table that the resistivity of silver is the lowest among the listed materials. Hence, it is the best conductor.

171. Draw a schematic diagram of a circuit consisting of a battery of

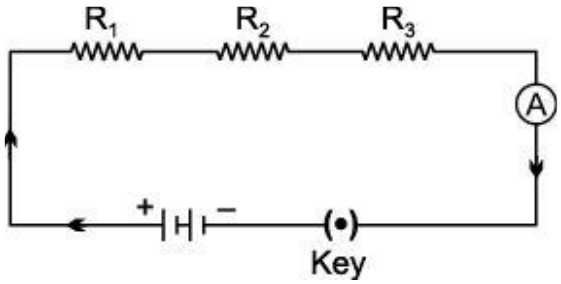
three cells of 2 V each, a 5 Ω resistor, an 8 Ω resistor, and a 12 Ω resistor, and a plug key, all connected in series.

Ans.



172

. 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 ?



Ans. Let three resistors R_1, R_2 and R_3 are connected in series which are also connected with a battery, an ammeter and a key as shown in figure. When key is closed, the current starts flowing through the circuit. Take the reading of ammeter. Now change the position of ammeter to anywhere in between the resistors and take its reading. We will observe that in both the cases reading of ammeter will be same showing same current flows through every part of the circuit above.

173

. Answer the following question:********

(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 current drawn by two bulbs from the line, if the supply voltage is 200 V.

Ans. (a) According to Joule's law of heating, the heat produced in a wire is directly proportional to :

(i) square of current (I^2),

(ii) resistance of wire (R),

(iii) time (*t*) for which current is passed.

Thus, the heat produced in the wire by current in time '*t*' is

$$H \propto I^2Rt$$

or $$H = KI^2 Rt$$

But $K = 1$, $H = I^2Rt$

(b) We know that, $P = VI$

$\Rightarrow$ $I = \frac{P}{V}$ **First lamp :** $P_1 = 100$ W, $V = 220$ volt

$$I_1 = \frac{P_1}{V} = \frac{100}{220} = 0{\cdot}45 \text{ A}$$

Second lamp : $P_2 = 60$ W, $V = 220$ volt

$$I_2 = \frac{P_2}{V} = \frac{60}{220} = 0{\cdot}27 \text{ A}$$

So, Total current = $I_1 + I_2$

$= 0{\cdot}45 + 0{\cdot}27$

$= 0{\cdot}72$ A

174

. Does Ohm's law hold good for electrolytic solutions and semiconductors?

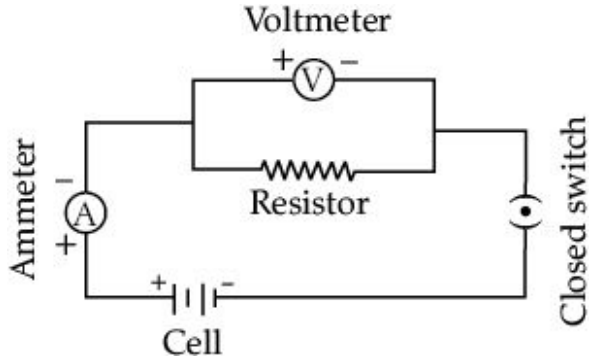
Ans

. No.

175

. Define the electric circuit. Draw a labelled, schematic diagram of an electric circuit comprising of a cell, a resistor, an ammeter, a voltmeter and a closed switch

Sol. A continuous conduction path consisting of wires and other resistance (like bulb, fan, etc) and a switch between the two terminals of a cell or a battery along which an electric current flows, is called a circuit.



176

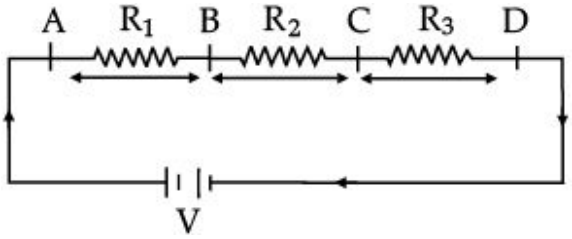
. For the series combination of three resistors establish the relation:

$R = R_1 + R_2 + R_3$

where the symbols have usual meaning. Calculate the

equivalent resistance of the combination of three resistor of 6 W, 9 W and 18 W joined in parallel.

Sol. Same current (I) flows through different resistance, when these are joined in series, as shown in the figure.



Let R be the combined resistance, then

$V = IR$

$V1 = IR_1$, $V_2 = IR_2$, $V_3 = IR_3$

$\square$ $IR = IR_1 + IR_2 + IR_3$

$\therefore IR = IR_1 + IR_2 + IR_3$

$\Rightarrow IR = I(R_1 + R_2 + R_3)$

$\therefore R = R_1 + R_2 + R_3$

Now, $R_1 = 6\ \Omega$, $R_2 = 9\ \Omega$,

$R_3 = 18\ \Omega$

In parallel combination

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

$$\Rightarrow \quad \frac{1}{R} = \frac{1}{6} + \frac{1}{9} + \frac{1}{18} = \frac{3+2+1}{18}$$

$$= \frac{6}{18} = \frac{1}{3}$$

$$\Rightarrow \quad \frac{1}{R} = \frac{1}{3}$$

$$\Rightarrow \quad R = 3\ \Omega.$$

177. Let the resistance of an electrical component remains constant while the potential difference across the two ends of the component decreases to half of its former value. What change will occur in the current through it?

Sol. (a) Since Resistance (R) = $\frac{\text{Potential difference (V)}}{\text{Electric current (I)}}$

Therefore, if potential between to ends of the component will be halved, and resistance remains constant then electric current would also be halved.

178 What are the advantages of connecting electrical devices in parallel with the battery instead of connecting them in series?

Ans. Advantages of connecting electrical appliances in parallel instead of connecting in series:

(a) Voltage remains same in all the appliances.

(b) The total effective resistance is less.

(c) Switching ON/OFF of one device does not affect others.

179. State the energy conversion taking place in the following electric

appliances :

(a) Electric heater, (b) Electric -motor, (c) Loud- speaker, (d) Electrolysis.

Ans. (a) Electrical energy gets converted into heat energy in an electric heater.

(b) Electrical energy changes into mechanical energy in an electric motor.

(c) Electrical energy gets converted into sound energy in a loudspeaker.

(d) Electrical energy changes into chemical energy during electrolysis.

Self-Assessment

180

. When a 12 V battery is connected across an unknown resistor, there is a current of 2.5 mA in the circuit. Find the value of the resistance of the resistor.[NCERT]

Ans. 4800 W

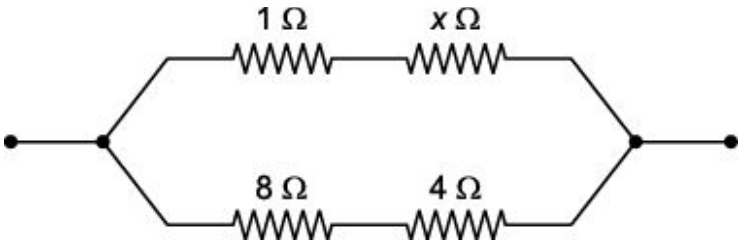
181

. A nichrome wire has a resistance of 10 W. Find the resistance of another nichrome wire, whose length is three times and area of cross-section is four times the first wire.

Ans. 7.5 W

182

. The equivalent resistance of the combination of resistors given in figure is 4 W. Calculate the value of *x*.



Ans

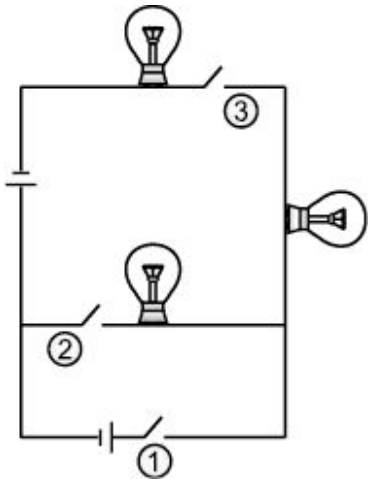
. 5 W

183

. Explain the difference between resistance and resistivity of a conductor.

184

. The given figure shows three lamps and three switches 1, 2 and 3 connected with two cells.



(a) Name the switch/switches to be closed so as to light all the three lamps.

(b) How are the lamps connected : in series or in parallel?

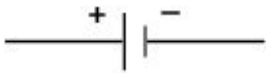
Ans. (a) 2 and 3, (b) in series.

185

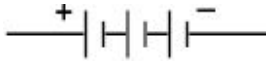
. Identify the components used in circuit diagram represented by

the following symbols :

(a) 

(b) 

(c) 

(d) 

(e) 

(f) 

Ans. (a) resistance or rheostat

(b) Electric cell

(c) A closed plug key

(d) Battery

(e) Fixed resistance

(f) Variable resistance

186

. Why does the resistance of filament of an electric bulb change when it starts to glow ?

187

. Why should a voltmeter never be connected in series ?

188

. Does Ohm’s law always hold good? Give examples.

189

. What is an electric circuit?

190

. What is an electric cell?

191

. Define resistance? What are the factors on which it depends?

192

. Name (a) S.I. unit, (b) Commercial unit of electrical energy and state the relationship between the two.

193

. Define 1 ohm electrical resistance.

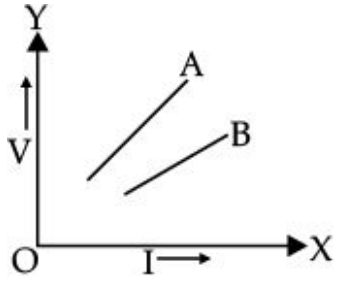
194

. Name the physical quantity associated with the following units:

(a) ampere, (b) ohm, (c) kilowatt-hour, (d) volt.

195

. The given figure shows V-I graph for two conductors A and B.



(a) Which conductor obeys Ohm's law ?

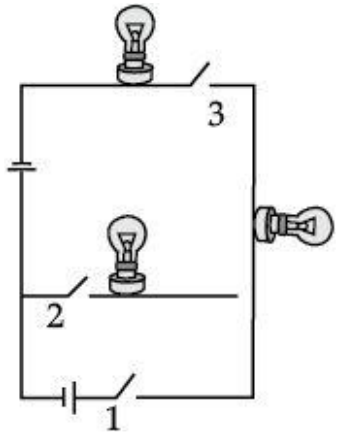
(b) Which conductor (A or B) has more resistance? Explain your answer.

Ans. (a) Both conductors A and B obey ohm's law.

(b) The slope of V-I graph represents resistance of a conductor. The straight line for conductor A is steeper (or has a greater slope). Hence, conductor A has more resistance.

196

. The given figure shows three lamps and three switches 1, 2 and 3 connected with two cells.



(a) Name the switch/switches to be closed so as to light all the three lamps.

(b) How are the lamps connected : in series or in parallel ?

Ans. (a) 2 and 3, (b) in series.

197

. Do all conductors obey Ohm's law ? State two points of difference between conductors obeying Ohm's law and the ones not obeying Ohm's law.

198

. What is the difference between an electric cell and a battery ?

199

. How many 220 Ω resistors (in parallel) are required to carry 5 A on a 220 V line ?

Ans. 5.

200

. Several electric bulbs designed to be used on a 220 V electric supply line, are rated 10W. How many lamps can be connected in parallel with each other across the two wires of 220 V line if the maximum allowable current is 5 A ? [NCERT]

Ans. 110.

201

. Which uses more energy :

(a) a 250 W T.V. set in 1 hour

(b) a 1200 W toaster in 10 minutes ? [NCERT]

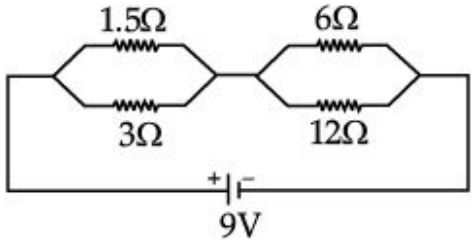
Ans. (a) 9×10^5 J, (b) 7.2×10^5 J (T.V. set uses more energy)

202

. Study the circuit diagram given in figure carefully and calculate :

(a) Current in main circuit.

(b) Current in each of the resistors in the parallel circuit.



Ans. (a) 1.80 A, (b) 1.2 A and 0.6 A, 1.2 A and 0.6 A.

203

. A wire of resistance 1.5 Ω is stretched to double its length. What will be its new resistance ?

Ans. 6 W.

204

. A wire of resistance 36 Ω and length 60 cm is tripled on itself. What is the new resistance ?

Ans. 4 W.

205

. How many electrons are flowing per second past a point in a circuit in which there is a current of 1 A ?

Ans. 6.25×10^{18}.

206

. The graph between V and I for a conductor is a straight line passing through the origin.

(a) Name the law illustrated by such a graph ?

(b) What should remain constant in a statement of this law ?

Ans. (a) Ohm's law, (b) Temperature.

207

. Why are alloys such as constantan and manganin used for making standard resistors ?

208

. Why are connected wires made of thick copper or aluminium wires ?

209

. How is an ammeter connected in an electric circuit and what does it measure ?

210

. Name any six components of an electric circuit and draw their symbols.

211. Calculate the least count of voltmeter in which there are 10 divisions between 1.0 V and 1.5 V marks.

Ans. Least count = $\frac{0.5}{10}$ = 0.05.

212

. Draw a circuit diagram for the experimental verification of Ohm's law and state the function of each component used.

213

. An ammeter has 10 divisions between 0 and 0.5 A marks on its scale. The least count of ammeter is :

(a) 0.01 A

(b) 0.5 A

(b) 0.05 A

(d) 0.1 A

Ans. (c)

214

. For which of the following substances, resistance decreases with increases in temperature?

(a) Mercury

(b) Silver

(b) Copper

(d) Carbon

Ans. (d)

215

. Commercial unit of electrical energy is :

(a) joule

(b) ampere

(b) volt

(d) kilowatt-hour

Ans. (d)

216

. For a parallel combination of three resistors establish the relation :

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

217

. Why are coils of electric toasters and electric irons made of an alloy rather than a pure metal ?

218

. When a current I flows through a resistance R for time *t*, the electrical energy spent is given by :

(a) I^2R/t (b) IRt

(c) I^2Rt

(d) IR^2t

Ans. (c) I^2Rt

219

. The electric meter in a house records :

(a) current

(b) energy

(c) power

(d) voltage

Ans. (b) energy

220

. What is an electric cell ?

221

. An electric heater is rated '1500 W, 250 V'. The heater is connected to 250 V mains. Calculate :

(a) The current drawn.

(b) The energy consumed in 50 hours.

(c) The cost of energy consumed at ₹6 per kWh.

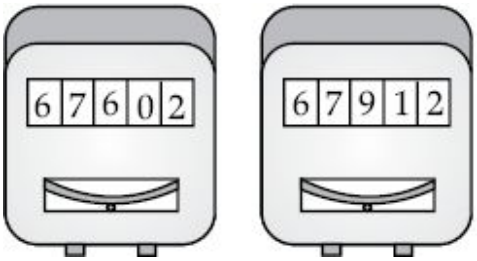
Ans. (a) 6A, (b) 75 kWh, (c) Rs. 450.

222

. Define 1 watt electrical power.

223

. A boy noted the readings of his home's electricity meter on 1st June and again on 1st July (as shown in figure given below) :



(a) What was the meter reading on 1st June ?

(b) What was the meter reading on 1st July ?

(c) How many units of electrical energy have been used ?

(d) Calculate the cost of electrical energy used, if the rate is Rs. 5 per unit.

Ans. (a) 67602

(b) 67912

(c) 310

(d) Rs. 1550.

224

. In an activity performed by a girl to estimate the monthly bill of her house, she reported that 3 bulbs of 100 W each, 2 fans of 50 W each and 1 T.V. set of 60 W are used daily for an average of 8 hours, 10 hours and 5 hours respectively.

(a) Calculate the electrical energy (in kWh) consumed in 1 month.

(b) If the cost of electrical energy is R 6 per unit, what is the monthly bill ?

Ans. (a) 111 kWh

(b) ₹ 666.

225

. Is Joule heating always desirable ?

Ans. No.

226

. Name a material whose resistivity becomes zero at a particular temperature.

Ans. Mercury.

oo