# Electricity

## OBJECTIVE TYPE QUESTIONS

### Multiple Choice Questions (MCQs)

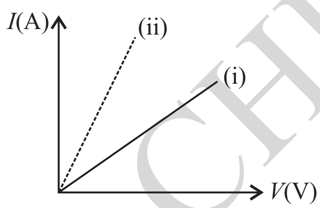
**1.** What is immaterial for an electric fuse wire?

(a) Its specific resistance
(b) Its radius
(c) Its length
(d) Current flowing through it

**2.** The amount of heat produced in a conductor is

(a) directly proportional to the current flowing through it
(b) inversely proportional to the current flowing through it
(c) directly proportional to the square of the current flowing through it
(d) inversely proportional to the square of current flowing through it.

**3.** The given figure shows the $I$-$V$ curve (i) for a nichrome wire of given length and cross-section.



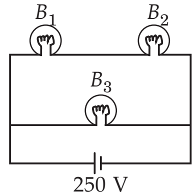

Which of the following will yield the curve (ii)?

(a) Increase the length of nichrome wire.
(b) Decrease the thickness of nichrome wire.
(c) Replace the nichrome wire with a similar copper wire.
(d) Replace the nichrome wire with a similar silicon wire.

**4.** Specific resistance is numerically equal to the resistance offered by

(a) 1 cm length of a conductor
(b) a conductor of unit cross-section
(c) 1 cm length of conductor of 1 cm$^2$ of cross-section
(d) 1 cm$^3$ of a conductor

**5.** A 100 W bulb $B_1$, two 60 W bulbs $B_2$ and $B_3$ are connected to a 250 V source as shown. If $W_1$, $W_2$ and $W_3$ are powers of the bulbs, then

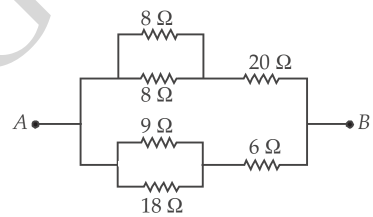



(a) $W_1 > W_2 = W_3$  (b) $W_1 > W_2 > W_3$
(c) $W_1 < W_2 = W_3$  (d) $W_1 < W_2 < W_3$.

**6.** Calculate the length of aluminium wire of area of cross-section 1 mm$^2$ whose resistance is $1.56 \times 10^{-2}\ \Omega$. Given, resistivity of aluminium is $2.6 \times 10^{-8}\ \Omega$ m.

(a) 60 mm  (b) 60 cm
(c) 60 m  (d) 6 m

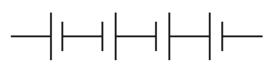
**7.** The equivalent resistance between the points $A$ and $B$ as shown in the figure is



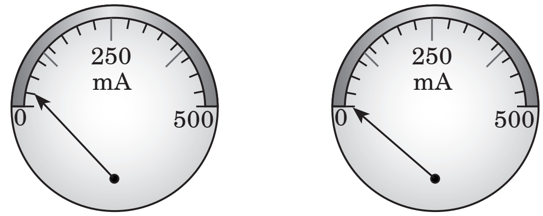

(a) 6 Ω  (b) 8 Ω
(c) 16 Ω  (d) 24 Ω

**8.** The proper representation of series combination of cells obtaining maximum potential is

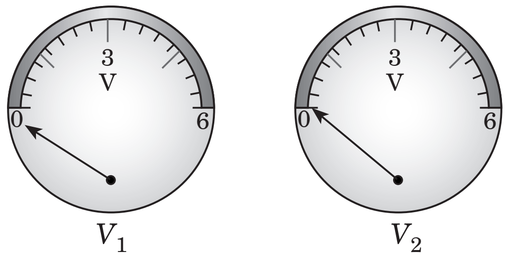
(a)   (b) 

(c)   (d) 

**9.** The normal positions of the pointers of the two ammeters $A_1$ and $A_2$, and two voltmeters $V_1$ and $V_2$ available in the laboratory are shown in figure. For verifying Ohm's law the student should select

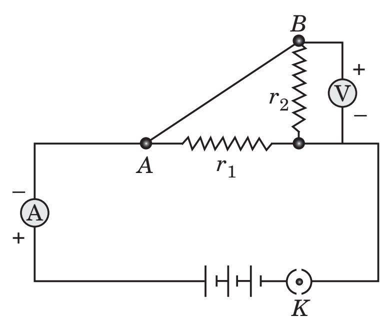



$A_1$  $A_2$




(a) ammeter $A_1$ and voltmeter $V_1$
(b) ammeter $A_1$ and voltmeter $V_2$
(c) ammeter $A_2$ and voltmeter $V_1$
(d) ammeter $A_2$ and voltmeter $V_2$

**10.** The effective resistance between $A$ and $B$ is

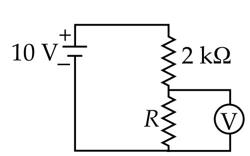



(a) $r_1 + r_2$ (b) $r_1 - r_2$
(c) $\frac{1}{r_1} + \frac{1}{r_2}$ (d) $\frac{r_1 r_2}{r_1 + r_2}$

**11.** If current through a resistance is increased by 100%, simultaneously reducing resistance value to 25%, the new power dissipated will be
(a) same
(b) increased by 100%
(c) decreased by 400%
(d) increased by 400%.

**12.** Suppose five resistances, each of 10 ohm, are provided to you. You are free to get the desired value by combining them. The desired value will lie in between
(a) 2 ohm to 50 ohm
(b) 20 ohm to 40 ohm
(c) 12 ohm to 50 ohm
(d) 10 ohm to 60 ohm

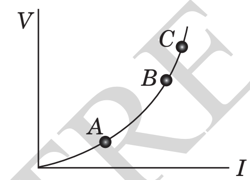
**13.** In the given circuit voltmeter shows a reading of 4 V, then the power developed across $R$ resistance will be




(a) 15 mW
(b) 14 mW
(c) 12 mW
(d) 10 mW

**14.** A current of 4.8 A is flowing in a conductor. The number of electrons passing per second through the conductor will be
(a) $3 \times 10^{20}$ (b) $76.8 \times 10^{20}$
(c) $7.68 \times 10^{-19}$ (d) $3 \times 10^{19}$

**15.** The $V$-$I$ graph of resistor is shown in figure. If the resistance is determined at points $A$, $B$ and $C$, then it is found that

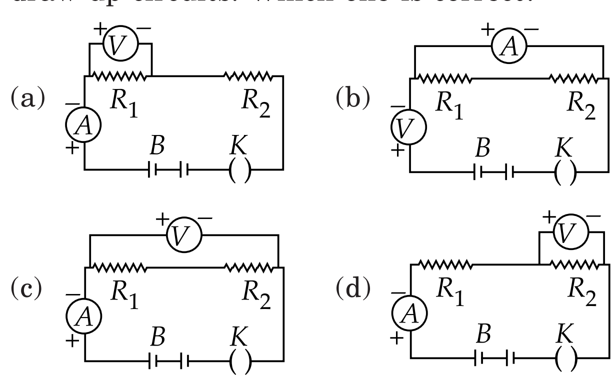



(a) resistances at $A$, $B$ and $C$ a are equal
(b) resistance at $C$ is more than that at $B$
(c) resistance at $B$ is lower than that at $A$.
(d) resistance at $C$ is lower than that at $A$.

**16.** In order to distribute a high potential, we connect a number of resistors
(a) in series
(b) in parallel
(c) some in series and some in parallel
(d) It is not possible to distribute potential.

**17.** 10,000 alpha-particles per minute are passing through a straight tube of radius $r$. The resulting electric current is approximately
(a) $0.5 \times 10^{-16}$ A (b) $2 \times 10^{12}$ A
(c) $0.5 \times 10^{12}$ A (d) $2 \times 10^{-12}$ A

**18.** In an experiment on finding equivalent resistance of two resistors in series, four students draw up circuits. Which one is correct?




**19.** Two metallic wires $A$ and $B$ are connected in series. Wire $A$ has length $l$ and radius $r$, while wire $B$ has length $2l$ and radius $2r$. If both the wires are of same material then find the ratio of the total resistance of series combination to the resistance of the wire $A$.

(a) $\frac{3}{4}$ (b) $\frac{3}{2}$ (c) $\frac{6}{2}$ (d) $\frac{6}{5}$

**20.** The resistivity does not change if
(a) the material is changed
(b) the temperature is changed
(c) the shape of the resistor is changed
(d) both material and temperature are changed.

**21.** A cylindrical conductor of length $l$ and uniform area of cross section $A$ has resistance $R$. Another conductor of length $2l$ and resistance $R$ of the same material has area of cross-section
(a) $A/2$ (b) $3A/2$ (c) $2A$ (d) $3A$

**22.** Consider a simple circuit containing a battery and three identical incandescent bulbs $A$, $B$ and $C$. Bulb $A$ is wired in parallel with bulb $B$ and this combination is wired in series with bulb $C$. What would happen to the brightness of the other two bulbs if bulb $A$ were to burn out?

(a) Only bulb $B$ would get brighter.
(b) Both $A$ and $B$ would get brighter.
(c) Bulb $B$ would get brighter and bulb $C$ would get dimmer.
(d) There would be no change in the brightness of either bulb $B$ or bulb $C$

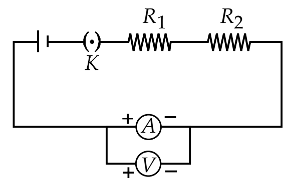
**23.** In a metallic conductor, electric current thought to be due to the movement of
(a) ions (b) amperes
(c) electrons (d) protons

**24.** 1 volt = .............
(a) $1\,\dfrac{\text{joule}}{\text{coulomb}}$ (b) $1\,\dfrac{\text{coulomb}}{\text{joule}}$
(c) $1\,\dfrac{\text{joule}}{\text{coulomb}^2}$ (d) 1 joule coulomb

**25.** If a wire of resistance $R$ is melted and recast to half its length, the new resistance of the wire will be
(a) $\dfrac{R}{4}$ (b) $\dfrac{R}{2}$ (c) $R$ (d) $2R$

**26.** A piece of aluminium of finite length is drawn or stretched such that to reduce its diameter to one fourth its original value, its resistance will become
(a) 256 times (b) four times
(c) eight times (d) sixteen times

**27.** To determine the equivalent resistance of a series combination of two resistors $R_1$ and $R_2$, a student arrange the following set up.




Which one of the following statements will be true for this circuit ? It gives
(a) incorrect reading for current $I$ as well as potential difference $V$
(b) correct reading for current $I$ but incorrect reading for potential difference $V$
(c) correct reading for potential difference $V$ but incorrect reading for current $I$
(d) correct reading for both $I$ and $V$.

**28.** Choices for the correct combination of elements from column-I and column-II are given as options (a), (b), (c) and (d) out of which one is correct?

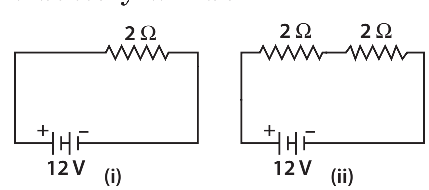
| | **Column-I** | | **Column-II** |
|---|---|---|---|
| (P) | Current | 1. | ohm |
| (Q) | Potential | 2. | ampere |
| (R) | Resistance | 3. | ohm m |
| (S) | Resistivity | 4. | volt |

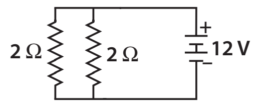
(a) P-2, Q-4, R-1, S-3 (b) P-3, Q-4, R-2, S-1
(c) P-4, Q-3, R-1, S-2 (d) P-2, Q-1, R-4, S-3

**29.** A multimeter is used to measure
(a) current only
(b) resistance only
(c) voltage only
(d) current, resistance and voltage.

**30.** There are three copper wires of lengths and cross-sectional areas $(L, A)$, $(2L, A/2)$, $(L/2, 2A)$. Resistivity is
(a) minimum of wire of cross-sectional area $A/2$
(b) minimum of wire of cross-sectional area $A$
(c) minimum of wire of cross-sectional area $2A$
(d) same in all the three cases.

**31.** In the following circuits, heat produced in the resistor or combination of resistors connected to a 12 V battery will be



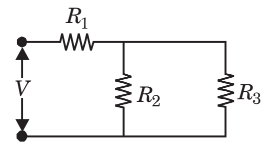



(iii)

(a) same in all the cases
(b) minimum in case (i)
(c) maximum in case (ii)
(d) maximum in case (iii)

**32.** In an electrical circuit, three incandescent bulbs *A*, *B* and *C* of rating 40 W, 60 W and 100 W respectively are connected in parallel to an electric source. Which of the following is likely to happen regarding their brightness?
(a) Brightness of all the bulbs will be the same
(b) Brightness of bulb *A* will be the maximum
(c) Brightness of bulb *B* will be more than that of *A*
(d) Brightness of bulb *C* will be less than that of *B*

**33.** For ensuring dissipation of same energy in all three resistors ($R_1$, $R_2$, $R_3$) connected as shown in figure, their value must be related as




(a) $R_1 = R_2 = R_3$
(b) $R_2 = R_3$ and $R_1 = 4R_2$
(c) $R_2 = R_3$ and $R_1 = \frac{1}{4}R_2$
(d) $R_1 = R_2 + R_3$

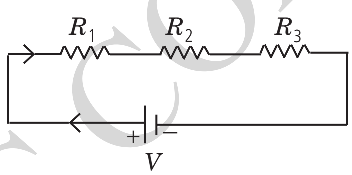
**34.** Masses of three wires of copper are in the ratio 1 : 3 : 5 and their lengths are in the ratio of 5 : 3 : 1. The ratio of their electrical resistances are
(a) 1 : 3 : 5 (b) 5 : 3 : 1
(c) 1 : 15 : 125 (d) 125 : 15 : 1

**35.** The amount of heat energy produced in 5 minutes by an electric heater rated at 1000 W is
(a) $2 \times 10^5$ J (b) $3 \times 10^5$ J
(c) $4 \times 10^5$ J (d) 300 J

## Case Based MCQs

**Case I :** Read the passage given below and answer the following questions from 36 to 40.

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




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

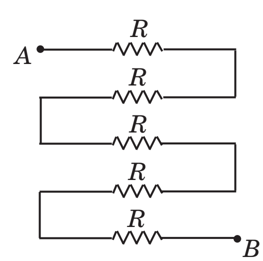
$$R_S = R_1 + R_2 + R_3$$

**36.** When three resistors are connected in series with a battery of voltage *V* and voltage drop across resistors is $V_1$, $V_2$ and $V_3$, which of the relation is correct?
(a) $V = V_1 = V_2 = V_3$ (b) $V = V_1 + V_2 + V_3$
(c) $V_1 + V_2 + V_3 = 3V$ (d) $V > V_1 + V_2 + V_3$

**37.** When the three resistors each of resistance *R* ohm, connected in series, the equivalent resistance is
(a) $R/2$ (b) $> R$
(c) $< R/2$ (d) $< R$

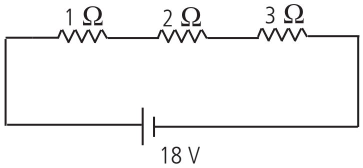
**38.** There is a wire of length 20 cm and having resistance 20 Ω cut into 4 equal pieces and then joined in series. The equivalent resistance is
(a) 20 Ω (b) 4 Ω
(c) 5 Ω (d) 10 Ω

**39.** In the following circuit, find the equivalent resistance between *A* and *B* is ($R$ = 2 Ω)




(a) 10 Ω (b) 5 Ω
(c) 2 Ω (d) 4 Ω

**40.** In the given circuit, the current in each resistor is




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

**Case II :** Read the passage given below and answer the following questions from 41 to 45.

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

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

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

**41.** What are the properties of heating element?

(a) High resistance, high melting point

(b) Low resistance, high melting point

(c) High resistance, low melting point

(d) Low resistance, low melting point.

**42** What are the properties of electric fuse?

(a) Low resistance, low melting point

(b) High resistance, high melting point.

(c) High resistance, low melting point

(d) Low resistance, high melting point

**43** When the current is doubled in a heating device and time is halved, the heat energy produced is

(a) doubled (b) halved

(c) four times (d) one fourth times

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

(a) 4 times (b) 2 times

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

**45.** When a current of 0.5 A passes through a conductor for 5 min and the resistance of conductor is 10 Ω, the amount of heat produced is

(a) 250 J (b) 5000 J

(c) 750 J (d) 1000 J

## Assertion & Reasoning Based MCQs

**For question numbers 46-55,** a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

*(a) Both assertion and reason are true, and reason is correct explanation of the assertion.*

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

*(c) Assertion is true, but reason is false.*

*(d) Assertion is false, but reason is true.*

**46. Assertion :** The connecting wires are made of copper.

**Reason :** The electrical conductivity of copper is high.

**47. Assertion :** A bird perches on a high power line and nothing happens to the bird.

**Reason :** The circuit is incomplete for the bird sitting on high power line.

**48. Assertion :** The coil of a heater is cut into two equal halves and only one of them is used into heater. The heater will now require half the time to produce the same amount of heat.

**Reason :** The heat produced is directly proportional to square of current.

**49. Assertion :** A current carrying wire should be charged.

**Reason :** The current in a wire is due to flow of free electrons in a definite direction.

**50. Assertion :** Electrons always move from a region of lower potential to a region of higher potential.

**Reason :** Electron has a negative charge.

**51. Assertion :** It is advantageous to transmit electric power at high voltage.

**Reason :** High voltage implies high current.

**52. Assertion :** Good conductors of heat are also good conductors of electricity and vice versa.

**Reason :** Mainly electrons are responsible for conduction.

**53. Assertion :** If 10 bulbs are connected in series and one bulb fused, then the remaining 9 bulbs will not work.

**Reason :** Bulb of higher wattage will give less bright light.

**54. Assertion :** The 200 W bulbs glows with more brightness than 100 W bulbs.

**Reason :** A 100 watt bulb has more resistance than a 200 W bulb.

**55. Assertion :** A voltmeter and ammeter can be used together to measure resistance and power.

**Reason :** Power and resistance can be calculated from voltage and current.

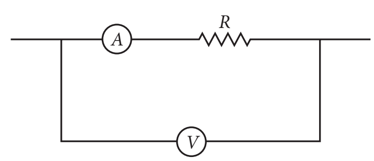
## SUBJECTIVE TYPE QUESTIONS

### Very Short Answer Type Questions (VSA)

1. State Ohm's law.
2. How is the resistivity of alloys compared with those of pure metals from which they may have been formed?
3. Write the relation between resistance ($R$) of filament of a bulb, its power ($P$) and a constant voltage $V$ applied across it.
4. Power of a lamp is 60 W. Find the energy in joules consumed by it in 1 s.
5. Why are filaments of incandescent lamps made of thin tungsten wire ?
6. Why is an ammeter placed in series of a conductor/resistor in a circuit?
7. Three resistors of 3 Ω, 6 Ω and 4 Ω are connected in series. Calculate the total resistance of the combination.
8. Draw a schematic diagram of a circuit consisting of a battery of three cells of 2 V each, a 5 Ω resistor, a 8 Ω resistor, and a 12 Ω resistor, and a plug key, all connected in series.
9. Name a device that helps to maintain a potential difference across a conductor.
10. Name the material with the least resistivity.

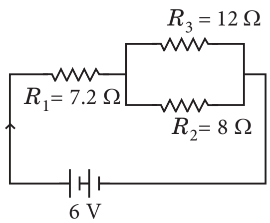
### Short Answer Type Questions (SA-I)

11. Name a device that you can use to maintain a potential difference between the ends of a conductor. Explain the process by which this device does so.
12. (i) List three factors on which the resistance of a conductor depends.
(ii) Write the SI unit of resistivity.
13. Calculate the resistance of a metal wire of length 2 m and area of cross section $1.55 \times 10^{-6}$ m$^2$, if the resistivity of the metal be $2.8 \times 10^{-8}$ Ω m.
14. List the advantages of connecting electrical devices in parallel with an electrical source instead of connecting them is series.
15. A cylinder of a material is 10 cm long and has a cross section of 2 cm$^2$. If its resistance along the length be 20 ohm. What will be its resistivity?
16. In the circuit shown below, the ammeter and the voltmeter readings are 3 A and 6 V respectively. Then find the value of resistance $R$.




17. For a heater rated at 4 kW and 220 V, calculate (a) the current, (b) the resistance of the heater, (c) the energy consumed in 2 hours, (d) the cost, if 1 kW h is priced at 50 paise.

**18.** In the circuit diagram given below, find:

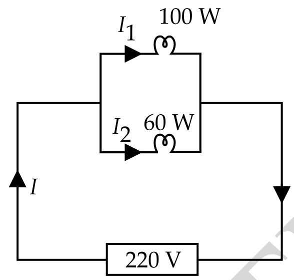



(i) Total resistance of the circuit.

(ii) Total current ($I$) flowing in the circuit.

**19.** Which uses more energy, a 250 W TV set in 1 h or a 1200 W toaster in 10 minutes?

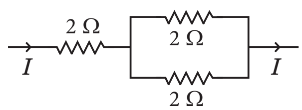
**20.** Two lamps, one rated 100 W at 220 V, and the other 60 W at 220 V, are connected in parallel to electric mains supply.



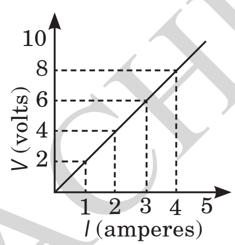

What current is drawn from the line if the supply voltage is 220 V?

## Short Answer Type Questions (SA-II)

**21.** Three 2 Ω resistors; $A$, $B$ and $C$, are connected as shown in figure. Each of them dissipates energy and can withstand a maximum power of 18 W without melting. Find the maximum current that can flow through the three resistors?




**22.** Study the $V$-$I$ graph for a resistor as shown in the figure and prepare a table showing the values of $I$ (in amperes) corresponding to four different values $V$ (in volts). Find the value of current for $V$ = 10 volts. How can we determine the resistance of the resistor from this graph?



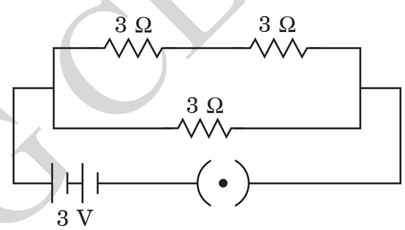

**23.** A wire has a resistance of 16 Ω. It is melted and drawn into a wire of half its original length. Calculate the resistance of the new wire. What is the percentage change in its resistance?

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

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

(c) Why are alloys commonly used in electrical heating devices ? Give reason.

**25.** Three resistors of 3 Ω each are connected to a battery of 3 V as shown. Calculate the current drawn from the battery.



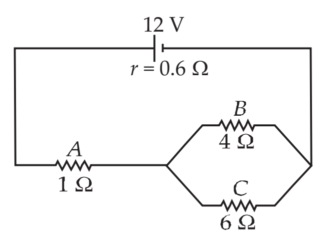

**26.** An electric iron has a rating of 750 W, 200 V. Calculate:

(i) the current required.

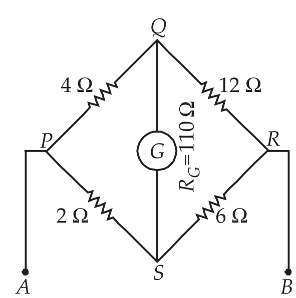
(ii) the resistance of its heating element.

(iii) energy consumed by the iron in 2 hours.

**27.** Figure shows a battery of 12 V and internal resistance 0.6 Ω connected to three resistors $A$, $B$ and $C$. Find the current in each resistor.




**28.** Calculate the total resistance between $A$ and $B$ as shown in the figure. $G$ stands for a galvanometer whose resistance is 110 Ω. It was noticed that the galvanometer did not show any deflection.



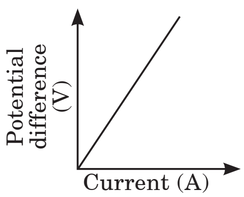

**29.** Two identical resistors are first connected in series and then in parallel. Find the ratio of equivalent resistance in two cases.

**30.** A copper wire has diameter 0.5 mm and resistivity $1.6 \times 10^{-8}\ \Omega$ m. Calculate the length of this wire to make it resistance 100 Ω. How much does the resistance change if the diameter is doubled without changing its length?

**31.** Define resistance of a conductor. State the factors on which resistance of a conductor depends. Name the device which is often used to change the resistance without changing the voltage source in an electric circuit.

Calculate the resistance of 50 cm length of wire of cross sectional area 0.01 square mm and of resistivity $5 \times 10^{-8}\ \Omega$ m.

**32.** *V-I* graph for a conductor is as shown in the figure

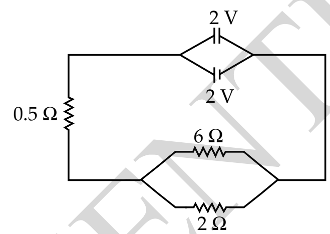



(i) What do you infer from this graph?

(ii) State the law expressed here.

**33. Direction :** Read the passage and answer the following questions given below:

Two cells of 2 V each are connected in parallel. An external resistance of 0.5 Ω is connected in series to the junction of two parallel resistors of 6 Ω and 2 Ω and then to the common terminal of the battery through each resistor, as shown in figure.



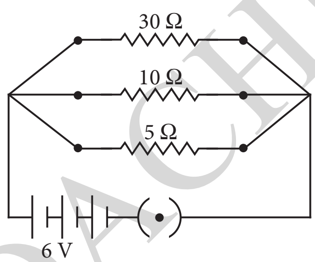

(i) Find the total resistance of the circuit.

(ii) Find the potential difference across the 0.5 Ω resistor.

(iii) Find the current flowing through 6 Ω resistor.

## Long Answer Type Questions (LA)

**34.** Two wires *A* and *B* are of equal length and have equal resistances. If the resistivity of *A* is more than that of *B*, which wire is thicker and why ?




For the electric circuit given below, calculate

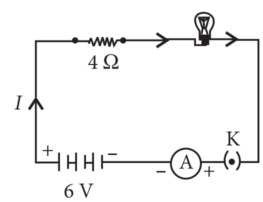
(i) current in each resistor,

(ii) total current drawn from the battery, and

(iii) equivalent resistance of the circuit.

**35.** Define Ohm's law. Draw a labelled circuit diagram to verify this law in the laboratory. If you draw a graph between the potential difference and current flowing through a metallic conductor, what kind of curve will you get? Explain how would you use this graph to determine the resistance of the conductor.

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




(i) the total resistance of the circuit

(ii) the current through the circuit,

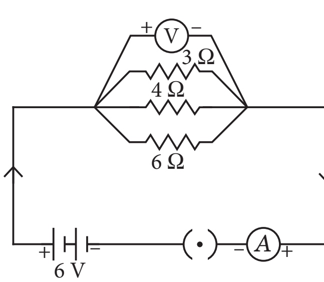
(iii) the potential difference across the (a) electric lamp and (b) conductor, and

(iv) power of the lamp.

**37.** Derive the expression for the heat produced due to a current '*I*' flowing for a time interval '*t*' through a resistor '*R*' having a potential difference '*V*' across its ends. With which name is the relation known? How much heat will an instrument of 12 W produce in one minute if it is connected to a battery of 12 V?

**38.** State ohm's law and represent it graphically.

In the given circuit diagram calculate




(i) the total effective resistance of the circuit.

(ii) the current through each resistor.

# ANSWERS

## OBJECTIVE TYPE QUESTIONS

**1. (c) :** An electric fuse of length $l$, radius $r$ when used in series of the circuit can withstand only if the rate of heat produced due to current in it is equal to the rate of heat lost due to radiation. If $H$ is the rate of the heat lost per unit area of the fuse wire, then

$$H \times 2\pi rl = i^2R = \frac{i^2\rho l}{\pi r^2}$$

$$H = \frac{i^2\rho}{2\pi^2 r^3}$$

Hence length is immaterial.

**2. (c) :** $H = I^2Rt$

**3. (c) :** Slope of the given graph is given by

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

Since the curve (ii) has greater slope than that of (i) *i.e.*, resistance for the curve (ii) should be smaller than that of curve (i).

Also, resistance of a wire is defined as

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

(a) If we increase the length of the nichrome wire then resistance of the wire will increase. Hence, option (a) is wrong.

(b) If we decrease the thickness ($r$), then again $R$ will increase. Hence, option (b) is also wrong.

(c) Copper wire has smaller resistance than that of nichrome wire, therefore the slope of the graph for copper wire will be greater than that of nichrome wire.

Hence, option (c) is correct.

(d) Silicon is a semiconductor. It's $I$-$V$ characteristics would not be straight line.

**4. (c) :** Specific resistance $(\rho) = \frac{RA}{l}$

For $\rho = R$

$A = 1$ m$^2$ or 1 cm$^2$, $l = 1$ m or 1cm

$\therefore$ Specific resistance is numerically equal to resistance offered by 1 cm length of a conductor of 1 cm$^2$ of cross-section.

**5. (d) :** $P = \frac{V^2}{R} \Rightarrow R = \frac{V^2}{P}$

$$R_1 = \frac{V^2}{100},\ R_2 = R_3 = \frac{V^2}{60}$$

Now, $W_1 = \frac{(250)^2}{(R_1+R_2)^2} \cdot R_1$

$$W_2 = \frac{(250)^2}{(R_1+R_2)^2} \cdot R_2$$

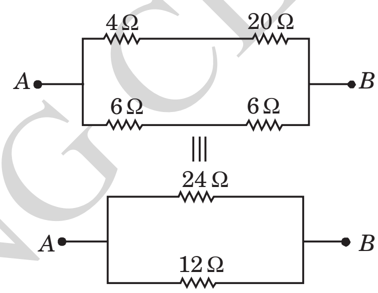
$$W_3 = \frac{(250)^2}{R_3}$$

$\therefore$ $W_1 : W_2 : W_3 :: 15 : 25 : 64$ or $W_1 < W_2 < W_3$

**6. (b) :** $R = \frac{\rho l}{A}$

or $l = \frac{RA}{\rho} = \frac{1.56 \times 10^{-2} \times 1 \times 10^{-6}}{2.6 \times 10^{-8}} = 0.6 \text{ m} = 60 \text{ cm}$

**7. (b) :** The equivalent circuit diagram of the given network is as shown in the figure.




The equivalent resistance between $A$ and $B$ is

$$R_{AB} = \frac{(24\ \Omega)(12\ \Omega)}{(24\ \Omega + 12\ \Omega)} = 8\ \Omega$$

**8. (a) :** Series combination of cells for obtaining maximum potential is correctly represented by figure (a) as the negative terminal of first cell is connected to the positive terminal of the second cell and so on.

**9. (d) :** Ammeter $A_2$ and voltmeter $A_2$ will give the correct reading.

**10. (d) :** $r_1$ and $r_2$ are connected in parallel so effective resistance is $\frac{r_1 r_2}{r_1 + r_2}$

**11. (a) :** Original power = $I^2R$

New power = $(I + I)^2 \left(\frac{R \times 25}{100}\right) = (2I)^2 \times \frac{R}{4} = I^2R$, same as original.

**12. (a) :** Resistance of combination is,

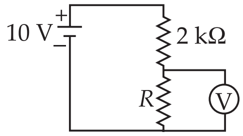
Minimum when resistors are connected in parallel.

$$R_{eq} = \frac{R}{n} = \frac{10}{5} = 2 \text{ ohm}$$

Maximum when resistors are connected in series.

$R_{eq} = nR = 5 \times 10 = 50$ ohm

**13. (c) :** From figure, $6 = I \times 2000$




$$I = \frac{6}{2000} = 3\text{ mA}$$

$\therefore \quad P = VI = 4 \times 3$ mW $= 12$ mW

**14. (d) :** $I = 4.8$ A, $\frac{n}{t} = ?$

$e = 1.6 \times 10^{-19}$ C,

$$\frac{n}{t} = \frac{I}{e} = \frac{4.8}{1.6 \times 10^{-19}} = 3 \times 10^{19}$$

**15. (b) :** The slope ($V/I$) of the curve is increasing, hence resistance is also increasing, *i.e.*, $R_C > R_B > R_A$.

**16. (a) :** Potential is divided in series.

**17. (a) :** $I = \frac{ne}{t} = \frac{10000 \times 2 \times 1.6 \times 10^{-19}\text{ C}}{60\text{ s}}$

$= 0.05 \times 10^{-15}\text{A} = 0.5 \times 10^{-16}$ A

**18. (c) :** From the circuit diagram shown in (c). potential difference and current can be found and the use of Ohm's law will give equivalent resistance.

**19. (b) :** $R = \rho \frac{l}{A}$

$\therefore \quad R_A \propto \frac{l}{\pi r^2}$

Also, $R_B = \frac{2l}{\pi 4 r^2}$

According to the problem, resistances are connected in series, therefore, $R = R_A + R_B$

$$= \frac{l}{\pi r^2} + \frac{l}{2\pi r^2} = \frac{3l}{2\pi r^2}$$

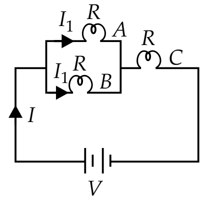
$$\therefore \quad \frac{R_A + R_B}{R_A} = \frac{\frac{3}{2}\frac{l}{\pi r^2}}{\frac{l}{\pi r^2}} = \frac{3}{2}$$

**20. (c) :** Resistivity does not change if the shape of the resistor is changed. It depends on the temperature and nature of material.

**21. (c) :** As $R = \rho \frac{l}{A}$ for first conductor. $\rho$ is same for both the conductors as both are of same material.

Now length of second conductor is doubled and resistance is same as that of first, so area of cross-section of second conductor should be doubled *i.e.* 2 $A$.

**22. (c) :**




$$I = \frac{2V}{3R} \quad \Rightarrow \quad I_1 = \frac{I}{2} = \frac{V}{3R}$$

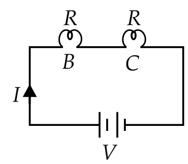
$\therefore$ Power developed in $A$ and $B$

$$= (I_1)^2 R = \frac{V^2}{9R^2} \times R = \frac{V^2}{9R}$$

Power developed in $C$

$$= I^2 R = \frac{4V^2}{9R^2} \times R = \frac{4V^2}{9R}$$

When $A$ is burnt, circuit is




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

$\therefore$ Power developed in $B$ or $C$

$$= I^2 R = \frac{V^2}{4R^2} \times R = \frac{V^2}{4R}$$

$\therefore$ Power of $B$ increases and power of $C$ decreases.

**23. (c) :** Current flow can be due to movement of ions or electrons. But in a metallic conductor, electric current is due to flow of free electrons.

**24. (a) :** $V = \frac{\text{Work}}{\text{Charge}}$

$$1\text{ volt} = \frac{1\text{ joule}}{1\text{ coulomb}} = 1\frac{\text{joule}}{\text{coulomb}}$$

**25. (a) :** Volume of the wire does not change when the wire is melted and recasted. If $l$ and $A$ are the original length and area of cross-section and $l'$ and $A'$ are their corresponding values on recasting,

$Al = A'l'$ or $\frac{l'}{l} = \frac{A}{A'}$

$\because \quad \frac{l'}{l} = \frac{1}{2}$ (Given)

$\therefore \quad \frac{A}{A'} = \frac{1}{2}$

New resistance, $R' = \frac{\rho l'}{A'}$

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

$$\therefore \quad \frac{R'}{R} = \frac{\rho l'/A'}{\rho l/A} = \left(\frac{l'}{l}\right)\left(\frac{A}{A'}\right) = \left(\frac{1}{2}\right)\left(\frac{1}{2}\right) = \frac{1}{4}$$

or $R' = \frac{R}{4}$

**26. (a) :** On drawing a wire,

(i) length of a wire increases

(ii) area of cross section (diameter) decreases.

In the given situation,

$D' = \frac{D}{4}$

As the volume remain constant

$\therefore \quad A'l' = Al$

$\therefore \quad \pi\frac{D'^2}{4}l' = \pi\frac{D^2}{4}l$

$D'^2 l' = D^2 l$

$\left(\frac{D}{4}\right)^2 l' = D^2 l$

$l' = 16l$

$\therefore \quad R' = \frac{\rho l'}{A'} = \frac{\rho 16 l}{\frac{\pi}{4}\left(\frac{D^2}{16}\right)} = 256R \qquad \left[\because \; R = \frac{\rho l}{\pi\frac{D^2}{4}}\right]$

**27. (b) :** Voltmeter should be connected across the combination of $R_1$ and $R_2$ to give correct reading for potential difference.

**28. (a) :** P – 2, Q – 4, R – 1, S – 3

**29. (d) :** Multimeter is used to measure current, voltage and resistance.

**30. (d) :** Resistivity depends on nature of material and temperature. It is independent of length and area of conductor.

**31. (d) :** For a constant potential difference, $V = 12$ V

heat produced, $H \propto \frac{1}{R}$

In case (i), $R = 2\ \Omega$

In case (ii), $R = 2 + 2 = 4\ \Omega$

In case (iii), $R = \frac{2\times 2}{2+2} = 1\Omega$

$\therefore$ Heat produced will be maximum in case (iii) and minimum in case (ii).

**32. (c) :** As the bulbs are connected in parallel to an electric source, so there will be same potential difference across each of them and bulb with minimum resistance or maximum power will glow with maximum brightness. Therefore, brightness of bulb $B$ will be more than that of bulb $A$.

**33. (c) :** For same energy dissipation across $R_2$ and $R_3$,

$\frac{V^2}{R_2} = \frac{V^2}{R_3} \Rightarrow R_2 = R_3 = R$ (say)

Equivalent resistance of $R_2$ and $R_3 = \frac{R}{2}$

For same energy dissipation across $R_1$ and $R_2$

$I^2R_1 = \left(\frac{I}{2}\right)^2 R$ (equal current divided in $R_2$ and $R_3$)

$\Rightarrow \quad 4R_1 = R_2 = R_3$

**34. (d) :** Mass, $M$ = Volume × Density = $Al \times d$

or $\quad A = \frac{M}{ld}$

Resistance of a wire, $R = \frac{\rho l}{A} = \frac{\rho l}{(M/ld)} = \frac{\rho l^2 d}{M}$

As all the three wire are made up of same material (*i.e.* copper) therefore $\rho$ and $d$ are same for all the three wires.

$\therefore \quad R \propto \frac{l^2}{M}$

$\therefore \quad R_1 : R_2 : R_3 = \frac{l_1^2}{M_1} : \frac{l_2^2}{M_2} : \frac{l_3^2}{M}$

$= \frac{5^2}{1} : \frac{3^2}{3} : \frac{1^2}{5} = 25 : 3 : \frac{1}{5} = 125 : 15 : 1$

**35. (b) :** Heat produced = Power × Time

$= 1000 \times 5 \times 60 = 3 \times 10^5$ J

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

**37. (b) :** $R_s = R_1 + R_2 + R_3$

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

**38. (a) :** Resistance of each wire = 20/4 = 5 Ω

Equivalent resistance in series

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

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

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

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

**41. (a) :** Heating element must have high resistance and high melting point.

**42. (c) :** Electric fuse must have high resistance and low melting point.

**43. (a) :** Given: $H = I^2Rt$

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

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

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

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

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

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

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

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

$H = 750$ J

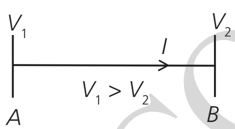
**46. (a) :** Due to high electrical conductivity of copper, it conducts the current without offering much resistance.

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

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

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

**50. (a) :**




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

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

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

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

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

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

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

## SUBJECTIVE TYPE QUESTIONS

**1.** It states that the potential difference $V$, across the ends of a given metallic wire in an electric circuit is directly proportional to the current flowing through it, provided its temperature remains the same. Mathematically,

$V \propto I$

$V = RI$

where $R$ is resistance of the conductor.

**2.** The resistivity of an alloy is generally higher than that of its constituent metals.

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

**4.** Here, power of lamp, $P = 60$ W

time, $t = 1$ s

So, energy consumed = Power × time

= (60× 1)J = 60 J

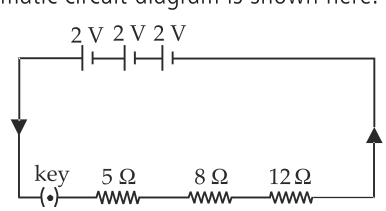
**5.** Tungsten has low resistivity and as such only a thin wire filament will have high resistance necessary to produce large amount of heat to light the bulb brilliantly. Further, tungsten has very high melting point (3300 K) and as such the filament will not burn at the high temperature (2400 K) at which it becomes incandescent.

**6.** Because ammeter is a low resistance instrument. So, the current flowing through the circuit remains virtually unaffected.

**7.** Resistance in a series circuit is given by the expression $R = R_1 + R_2 + R_3$

∴ Total resistance $R = 3\ \Omega + 6\ \Omega + 4\ \Omega = 13\ \Omega$.

**8.** The schematic circuit diagram is shown here:




**9.** A battery consisting of one or more electric cells is used to maintain a potential difference across a conductor.

**10.** Silver metal is best conductor of electricity and has lowest resistivity.

**11.** A cell or a battery can be used to maintain a potential difference between the ends of a conductor. The chemical reaction within a cell generates the potential difference across the terminals of the cell, even when no current is drawn from it. When it is connected to a conductor, it produces electric current and maintain the potential difference across the ends of the conductor.

**12.** (i) Resistance of a conductor depends upon the following factors:

(1) Length of the conductor : Greater the length ($l$) of the conductor more will be the resistance ($R$).

$R \propto l$

(2) Area of cross-section of the conductor: Greater the cross-sectional area of the conductor, less will be the resistance.

$$R \propto \frac{1}{A}$$

(3) Nature of conductor.

(ii) SI unit of resistivity is $\Omega$ m.

**13.** For the given metal wire,

length, $l = 2$ m

area of cross-section, $A = 1.55 \times 10^{-6}$ m$^2$

resistivity of the metal, $\rho = 2.8 \times 10^{-8}$ $\Omega$ m

Since, resistance, $R = \rho \frac{l}{A}$

So, $R = \left( \frac{2.8 \times 10^{-8} \times 2}{1.55 \times 10^{-6}} \right) \Omega$

$$= \frac{5.6}{1.55} \times 10^{-2} \Omega = 3.6 \times 10^{-2} \Omega \text{ or } R = 0.036\ \Omega$$

**14.** (a) When a number of electrical devices are connected in parallel, each device gets the same potential difference as provided by the battery and it keeps on working even if other devices fail. This is not so in case the devices are connected in series because when one device fails, the circuit is broken and all devices stop working.

(b) Parallel circuit is helpful when each device has different resistance and requires different current for its operation as in this case the current divides itself through different devices. This is not so in series circuit where same current flows through all the devices, irrespective of their resistances.

**15.** Here, $l = 10$ cm, $A = 2$ cm$^2$

$R = 20$ ohm

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

$$\rho = \frac{RA}{l} = \frac{20 \times 2}{10} = 4 \text{ ohm cm}$$

$= 0.04$ ohm m

**16.** Case I : If ammeter $A$ and voltmeter $V$ are ideal, then

$$R = \frac{6\text{ V}}{3\text{ A}} = 2\ \Omega$$

Case II : If ammeter $A$ and voltmeter $V$ has some finite resistance, then $R < 2\ \Omega$.

**17.** Power, $P = 4$ kW

Voltage, $V = 220$ V

Time, $t = 2$ h

(a) Current, $I = \frac{P}{V} = \frac{4000\text{ W}}{220\text{ V}} = 18.2\text{ A}$

(b) Resistance, $R = \frac{V}{I} = \frac{220\text{ V}}{18.2\text{ A}} = 12.1\ \Omega$

(c) Energy consumed = $VIt$

$= 220\text{ V} \times 18.2\text{ A} \times 2\text{ h} = 8008\text{ W h} = 8\text{ kW h}$

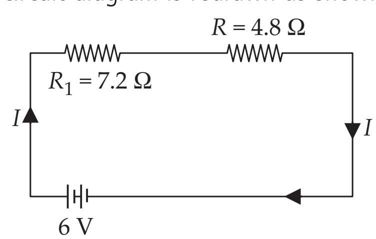
(d) Cost = 8 kW h × ₹ 0.50/kW h = ₹ 4.00

**18.** (i) $R_2$ and $R_3$ are connected in parallel, so their equivalent resistance is

$$\frac{1}{R} = \frac{1}{8} + \frac{1}{12} = \frac{3+2}{24} = \frac{5}{24}$$

$$\therefore\ R = \frac{24}{5} = 4.8\ \Omega$$

The circuit diagram is redrawn as shown in figure




$R_1$ and $R$ are in series, therefore total resistance of the circuit is

$= R_1 + R = (7.2 + 4.8)\ \Omega = 12\ \Omega$

(ii) Total current ($I$) flowing through the circuit is

$$I = \frac{6\text{ V}}{12\ \Omega} = 0.5\text{ A}$$

**19.** Energy consumed by TV set

$= 250\text{ W} \times 1\text{ h} = 250\text{ J s}^{-1} \times 60 \times 60\text{ s}$

$= 900{,}000$ J

Energy consumed by toaster

$= 1200\text{ W} \times 10\text{ min} = 1200\text{ J s}^{-1} \times 10 \times 60\text{ s}$

$= 720{,}000$ J.

Thus, the TV Set will use more energy.

**20.** Since both the bulbs are connected in parallel and to a 220 V supply, the voltage across each bulb is 220 V. Then

Current drawn by 100 W bulb,

$$I_1 = \frac{\text{Power rating}}{\text{Voltage applied}} = \frac{100\,\text{W}}{220\text{V}} = 0.454\,\text{A}$$

Current drawn by 60 W bulb,

$$I_2 = \frac{60\,\text{W}}{220\text{V}} = 0.273\,\text{A}$$

Total current drawn from the supply line, $I = I_1 + I_2$ = 0.454 A + 0.273 A = 0.73 A

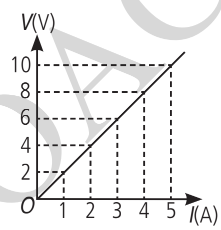
**21.** As $P = I^2R$, $I = \sqrt{\frac{P}{R}}$

Thus, maximum current that can flow through 2 Ω resistor (rating 18 W), $I = \sqrt{\frac{18\,\text{W}}{2\Omega}} = 30\,\text{A}$

Since resistor $B(= 2\ \Omega)$ and resistor $C(= 2\ \Omega)$ are in parallel, and the current through their combination , which is in series with resistor is in series with resistor $A(= 2\ \Omega)$ is also 3 A, current through $B$ and $C$ (having equal resistance and in parallel) $= \frac{3\,\text{A}}{2} = 1.5\,\text{A}.$

**22.** Since, the graph is straight line so we can either extrapolate the data or simply mark the value from graph as shown in figure.

| **Current, *I*(A)** | **Voltage, *V*(V)** |
|---|---|
| 0 | 0 |
| 1 | 2 |
| 2 | 4 |
| 3 | 6 |
| 4 | 8 |




Hence, the value of current for $V$ = 10 volts is 5 amperes (or 5 A).

From Ohm's law, $V = IR$,

We can write, $R = \frac{V}{I}$

At any point on the graph, resistance is the ratio of values of $V$ and $I$. Since, the given graph is straight line (ohmic conductor) so, the slope of graph will also give the resistance of the resistor

$$R = \frac{10\ \text{V}}{5\ \text{A}} = 2\ \Omega$$

Alternately, $R = \frac{(8-2)\ \text{V}}{(4-1)\ \text{A}} = \frac{6\ \text{V}}{3\ \text{A}} = 2\ \Omega$

**23.** When wire is melted, its volume remains same, so,

$V' = V$ or $A'l' = Al$

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

Therefore, $A' = 2A$

Resistance, $R = \rho\frac{l}{A} = 16\ \Omega$

Now , $R' = \rho\frac{l'}{A'} = \rho\frac{(l/2)}{2A} = \frac{1}{4}\rho\frac{l}{A}$

So, $R' = \frac{R}{4} = \frac{16}{4} = 4\ \Omega$ $(\because R = 16\ \Omega)$

Percentage change in resistance,

$$= \left(\frac{R - R'}{R}\right)\times 100 = \left(\frac{16-4}{16}\right)\times 100 = 75\%$$

**24.** (a) Resistance of a conductor depends upon the following factors:

(1) Length of the conductor : Greater the length ($l$) of the conductor more will be the resistance ($R$).

$R \propto l$

(2) Area of cross-section of the conductor: Greater the cross-sectional area of the conductor, less will be the resistance.

$$R \propto \frac{1}{A}$$

(3) Nature of conductor.

(b) Metal have very low resistivity and hence they are good conductors of electricity.

Whereas glass has very high resistivity so glass is a bad conductor of electricity.

(c) Alloys are commonly used in electrical heating devices due to the following reasons

(i) Alloys have high melting point

(ii) Alloys have higher resistivity than metals

(iii) Alloys do not get oxidised or burn readily.

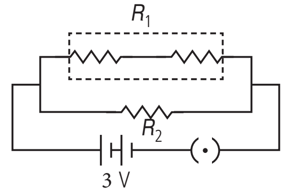
**25.** As given in circuit diagram, two 3 Ω resistors are connected in series to form $R_1$, so

$R_1 = 3\ \Omega + 3\ \Omega = 6\ \Omega$

And, $R_1$ and $R_2$ are in parallel combination,

Hence, equivalent resistance of circuit ($R_{eq}$) is given by

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




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

or $R_{eq} = 2\ \Omega$

Using Ohm's law, $V = IR$

We get,

$3V = I \times 2\ \Omega$

or $\quad I = \frac{3}{2}\text{A} = 1.5\text{ A}$

Current drawn from the battery is 1.5 A.

**26.** Here, $P = 750$ W, $V = 200$ V

(i) As $P = VI$

$I = P/V = (750/200)\text{ A} = 3.75\text{ A}$

(ii) By Ohm's law $V = IR$ or $R = V/I$

$\therefore \quad R = \frac{200}{3.75}\Omega = 53.3\ \Omega$

(iii) Energy consumed by the iron in 2 hours

$= P \times t = 750\text{ W} \times 2\text{ h} = 1.5\text{ kWh}$

or $\quad E = (750 \times 2 \times 3600)\text{ J} = 5.4 \times 10^6\text{J}$

**27.** The equivalent resistance of $B$ and $C$ is given by

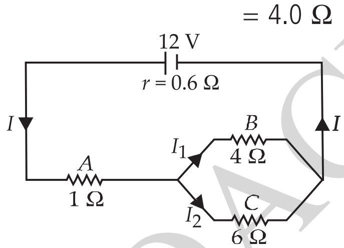
$$\frac{1}{R} = \frac{1}{4\ \Omega} + \frac{1}{6\ \Omega} = \frac{6\ \Omega + 4\ \Omega}{(6\ \Omega)(4\ \Omega)}$$

$$= \frac{10}{24}\ \Omega = \frac{5}{12}\Omega$$

or $\quad R = \frac{12}{5}\Omega = 2.4\ \Omega$

Total resistance in circuit = $1.0\ \Omega + 2.4\ \Omega + 0.6\ \Omega$

$= 4.0\ \Omega$




Current in circuit, $I = \frac{12\text{ V}}{4\ \Omega} = 3\text{ A}$

The potential difference across both $B$ and $C$

$= 3.0\text{ A} \times 2.4\ \Omega = 7.2\text{ V}$

Current through $B, I_1 = \frac{7.2\text{ V}}{4.0\ \Omega} = 1.8\text{ A}$

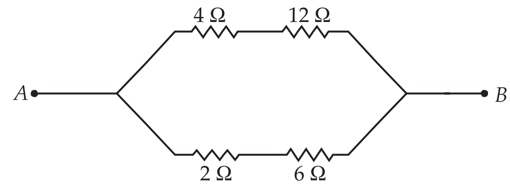
Current through $C, I_2 = \frac{7.2\text{ V}}{6\ \Omega} = 1.2\text{ A}$

Thus, current through resistor $A$ = 3.0 A

Current through resistor $B$ = 1.8 A

Current through resistor $C$ = 1.2 A

**28.** Since the galvanometer did not show any deflection, *i.e.*, no current is passing through the galvanometer. Therefore potential at $Q$ is equal to potential at $S$ and hence galvanometer resistance becomes ineffective. The equivalent circuit diagram as shown in the figure.




The total resistance between $A$ and $B$ is

$$\frac{1}{R} = \frac{1}{(4+12)} + \frac{1}{(2+6)}$$

$$\therefore \quad \frac{1}{R} = \frac{1}{16} + \frac{1}{8} = \frac{1+2}{16} = \frac{3}{16} \quad \text{or} \quad R = \frac{16}{3} = 5.33\ \Omega$$

**29.** Let resistance of each resistor be $R$.

For series combination,

$R_s = R_1 + R_2$

So, $R_s = R + R = 2R \qquad (\because R_1 = R_2 = R)$

For parallel combination,

$$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} \quad \text{or} \quad R_p = \frac{R_1R_2}{R_1 + R_2}$$

So, $\quad R_p = \frac{R \times R}{R + R} = \frac{R}{2}$

Required ratio = $\frac{R_s}{R_p} = \frac{2R}{R/2} = \frac{4}{1} \Rightarrow R_S : R_P = 4:1$

**30.** Given; resistivity of copper = $1.6 \times 10^{-8}\ \Omega$ m, diameter of wire, $d = 0.5$ mm and resistance of wire, $R = 100\ \Omega$

Radius of wire, $r = \frac{d}{2} = \frac{0.5}{2}$mm

$= 0.25\text{ mm} = 2.5 \times 10^{-4}$ m

Area of cross-section of wire, $A = \pi r^2$

$\therefore \quad A = 3.14 \times (2.5 \times 10^{-4})^2$

$\simeq 1.9625 \times 10^{-7}\text{ m}^2$

$\simeq 1.9 \times 10^{-7}\text{ m}^2$

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

$$\therefore \quad 100\ \Omega = \frac{1.6 \times 10^{-8}\ \Omega\text{ m} \times l}{1.9 \times 10^{-7}\text{m}^2}$$

$l \approx 1200$ m

If diameter is doubled ($d' = 2d$), then the area of cross-section of wire will become

$$A' = \pi r^2 = \pi\left(\frac{d'}{2}\right)^2 = \pi\left(\frac{2d}{2}\right)^2 = 4A$$

Now $R \propto \frac{1}{A}$, so the resistance will decrease by four times or new resistance will be

$$R' = \frac{R}{4} = \frac{100}{4} = 25\ \Omega$$

**31.** Resistance is the property of a conductor to resist the flow of charges through it.

Resistance of a conductor depends upon the following factors:

(1) Length of the conductor : Greater the length ($l$) of the conductor more will be the resistance ($R$).

$R \propto l$

(2) Area of cross-section of the conductor: Greater the cross-sectional area of the conductor, less will be the resistance.

$$R \propto \frac{1}{A}$$

(3) Nature of conductor.

Rheostat is the device which is often used to change the resistance without changing the voltage source in an electric circuit.

We are given, length of wire, $l = 50 \text{ cm} = 50 \times 10^{-2}\text{m}$

cross-sectional area, $A = 0.01 \text{ mm}^2$

$= 0.01 \times 10^{-6}\text{m}^2$

and resistivity, $\rho = 5 \times 10^{-8}\ \Omega$ m.

As, resistance, $R = \rho \dfrac{l}{A}$

$$\therefore \quad R = \left(\frac{5\times10^{-8}\times50\times10^{-2}}{0.01\times10^{-6}}\right)\Omega$$

$= 2.5\ \Omega$

**32.** (i) As graph is a straight line, so it is clear from the graph that $V \propto I$

(ii) It states that the potential difference $V$, across the ends of a given metallic wire in an electric circuit is directly proportional to the current flowing through it, provided its temperature remains the same. Mathematically,

$$V \propto I$$
$$V = RI$$

where $R$ is resistance of the conductor.

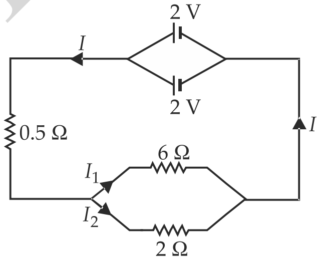
**33.** (i) Resistors 6 Ω and 2 Ω are connected in parallel. So their equivalent resistance is given by

$$\frac{1}{R_p} = \frac{1}{6} + \frac{1}{2} = \frac{1+3}{6} = \frac{4}{6} = \frac{2}{3} \quad \text{or} \quad R_p = \frac{3}{2}\ \Omega = 1.5\ \Omega$$

Total resistance of the circuit,

$R = R_p + 0.5\ \Omega = 1.5\ \Omega + 0.5\ \Omega = 2\ \Omega$

(ii)




Current in the circuit, $I = \dfrac{2\text{ V}}{2\ \Omega} = 1\text{ A}$

The potential difference across 0.5 Ω resistor is

$= (1\text{ A})(0.5\ \Omega) = 0.5\text{ V}$

(iii) The potential difference across 6 Ω resistor is

$= 2\text{ V} - 0.5\text{ V} = 1.5\text{ V}$

The current flowing through 6 Ω resistor is

$I_1 = \dfrac{1.5\text{ V}}{6\ \Omega} = 0.25\text{ A}$

**34.** Let $l_A$, $a_A$ and $R_A$ be the length, area of cross-section and resistance of wire $A$ and $l_B$, $a_B$ and $R_B$ are that of wire $B$.

Here, $l_A = l_B$ and $R_A = R_B$

If $\rho_A$ and $\rho_B$ are the resistivities of wire $A$ and $B$ respectively then

$R_A = \rho_A \dfrac{l_A}{a_A}$ and $R_B = \rho_B \dfrac{l_B}{a_B}$, As $R_A = R_B$

$\therefore \quad \rho_A \dfrac{l_A}{a_A} = \rho_B \dfrac{l_B}{a_B}$

or $\quad \dfrac{\rho_A}{\rho_B} = \dfrac{a_A}{a_B} \qquad (\because l_A = l_B)$

Since $\rho_A > \rho_B$ therefore $a_A > a_B$

Hence, wire $A$ is thicker than wire $B$.

For parallel combination,

$V_1 = V_2 = V_3 = 6\text{ V}$

(i) Using Ohm's law

$I_1 = V_1/R_1 = 6/30 = 0.2\text{ A}$

$I_2 = V_2/R_2 = 6/10 = 0.6\text{ A}$

$I_3 = V_3/R_3 = 6/5 = 1.2\text{ A}$

(ii) Total current drawn from battery,

$I = I_1 + I_2 + I_3 = 0.2 + 0.6 + 1.2 = 2\text{ A}$

(iii) Equivalent resistance of the circuit, $R_{eq}$ can be obtained by Ohm's law

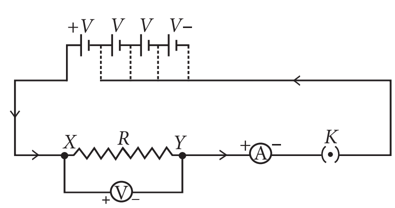
$V = I\,R_{eq}$

So, $6\text{ V} = 2\text{ A} \times R_{eq}$ or, $R_{eq} = \dfrac{6}{2} = 3\ \Omega$

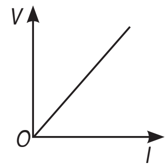
**35.** Ohm's law : It states that the potential difference $V$, across the ends of a given metallic wire in an electric circuit is directly proportional to the current flowing through it, provided its temperature remains the same. Mathematically,

$$V \propto I$$
$$V = RI$$

where $R$ is resistance of the conductor.



The shape of the graph obtained by plotting potential difference applied across conductor against the current flowing through it will be a straight line.




According to Ohm's law,

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

So, the slope of $V$-$I$ graph at any point represents the resistance of the given conductor.

**36.** Resistance of the lamp = 20 Ω

External resistance = 4 Ω

(i) As both the lamp and external resistance are connected in series, therefore the total resistance,

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

(ii) Current, $I = \frac{V}{R} = \frac{6}{24} = 0.25$ A

(iii) (a) Potential difference across the electric lamp

$= \frac{\text{Total voltage}}{\text{Total resistance}} \times \text{Resistance of lamp}$

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

(b) Potential difference across conductor

$= \frac{\text{Total voltage}}{\text{Total resistance}} \times \text{Resistance of conductor}$

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

(iv) Power of the lamp

= $(\text{current})^2 \times$ resistance of lamp

= $(0.25)^2 \times 20 = 1.25$ W

**37.** As we know, from the definition of potential difference ($V$),

$V = \frac{W}{Q}$ ...(i)

here, $W$ is work done in moving charge from one point to another, $Q$ is the amount of charge.

$W = V \times Q$

$W = V \times \frac{Q}{t} \times t$ (On multiplying and dividing by time '$t$')

$\therefore\ W = VIt$

Since this work done is converted into heat energy, so, we can write

$H = VIt$ ...(ii)

Where $H$ is heat energy produced by electrons.

From Ohm's Law,

$V = IR$, here, $R$ is the resistance of the resistor.

Putting this in equation (ii), we get

$H = I^2Rt$

This relation is also known as Joule's law of heating.

Since, heat developed = power × time

$\therefore\ H = P \times t$

Given, $P = 12$ $W$, $t = 1$ min = 60 s

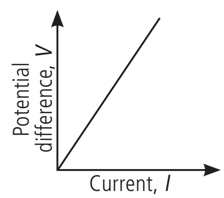
So, heat developed in 1 min = 12 × 60 = 720 J

**38.** Ohm's law: It states that the potential difference $V$, across the ends of a given metallic wire in an electric circuit is directly proportional to the current flowing through it, provided its temperature remains the same. Mathematically,

$$V \propto I$$
$$V = RI$$

where $R$ is resistance of the conductor.

Graphical representation of Ohm's law




For the given circuit

$R_1 = 3\ \Omega$, $R_2 = 4\ \Omega$, $R_3 = 6\ \Omega$ and $V = 6$ V.

(i) Total effective resistance of the circuit, $R_{eq}$ is given by

$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} = \frac{1}{3} + \frac{1}{4} + \frac{1}{6} = \frac{9}{12}$

or, $R_{eq} = \frac{12}{9}\ \Omega = \frac{4}{3}\ \Omega = 1.33\ \Omega$

(ii) Since, potential difference across each resistor connected in parallel is same.

So, $V_1 = V_2 = V_3 = 6$ V

Applying Ohm's law,

$V_1 = I_1R_1$ or $I_1 = \frac{V_1}{R_1}$ or $I_1 = \frac{6}{3}$ A = 2 A

Similarly, $I_2 = \frac{6}{4}$ A = 1.5 A and $I_3 = \frac{6}{6}$ A = 1 A