12

Electricity

In the Chapter

- A stream of electrons moving through a conductor forms an electric current. Conventionally, the direction of current is considered opposite to the direction of flow of electrons.
- The SI unit of electric current is ampere.
- To set the electrons in motion in an electric circuit, we use a battery or a cell. A cell creates a potential difference across its terminals. It can be measured in volts (V).
- Resistance is a property that resists the flow of electrons in a conductor. It regulates the magnitude of the current. The SI unit of resistance is ohm (Ω).
- Ohm's law: The potential difference across the ends of a resistor is directly proportional to the current through it, provided its temperature remains the same.
- The equivalent resistance of many resistors in series is equal to the sum of their individual resistances.
- The resistance of a conductor depends directly on its length, inversely on its area of cross-section, and also on the material of the conductor.
- A set of resistors connected in parallel has an equivalent resistance Rp given by

$$\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots.$$

- The unit of power is watt (W). One watt of power is consumed when 1 A of current flows at a potential difference of 1 V.
- The electrical energy dissipated in a resistor is given by W = V × I × t
- The commercial unit of electrical energy is kilowatt hour (kWh).
  1 kW h = 3,600,000 J = 3.6 × 106 J.

Intext Exercises

Page No. 200

1. What does an electric circuit mean?

Ans. Combination of electrical devices connected by conducting wires is known as an electric circuit.

2. Define the unit of current.

Ans. The rate of flow of charge is known as electric current and its S.I. unit is ampere. One ampere current is defined as below :

"If one coulomb charge flows through a conductor per second, then the strength of current is called one ampere."

3. Calculate the number of electrons constituting one coulomb of charge.

Ans. We know charge on one election

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

Let the number of electrons consisting 1 coulomb charge = n.

$\therefore n \times 1.6 \times 10^{-19} \text{ C} = 1 \text{ C}$

$$n = \frac{1}{1.5 \text{ x } 10^{-19}} = \frac{10^{19}}{1.6} = \frac{10 \text{ x } 10^{18}}{1.6}$$

$n = 6.25 \times 10^{18}$ electrons

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1. Name a device that helps to maintain a potential difference across a conductor.

Ans. Cell is the device that helps to maintain a potential difference across a conductor.

2. What is meant by saying that the potential difference between two points is 1 V?

Ans. Potential difference of 1 volt means that the rate of doing work during transfer of per coulomb charge is 1 joule.

3. How much energy is given to each coulomb of charge passing through a 6 V battery?

Ans. We know,

$W = V \times Q$

$= W = 6 \times 1$

$W = 6$ joules.

Page No. 209

1. On what factors does the resistance of a conductor depend?

Ans. Resistance of a conductor mainly depends on :

(i) nature of material (resistivity – ρ).

(ii) Length of wire (l),

$\therefore$ $R \propto l$

(iii) The cross sectional area of the wire (a)

$$R = \frac{1}{A} (A = nr^2 \text{ or } l \text{ x } b)$$

2. Will current flow more easily through a thick wire or a thin wire of the same material, when connected to the same source? Why?

Ans. The current will flow easily through the thick wire because the resistance of thick wire is less than thin wire.

$R \propto 1/A$.

3. 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?

Ans. At constant temperature and resistance :

$V \propto I$

4. Why are coils of electric toasters and electric irons made of an alloy rather than

a pure metal?

Ans. Alloys have more resistance than constituent metals. Therefore, they are heated up easily due to the heating effect of electric current.

5. Use the data in Table 12.2 to answer the following –

(a) Which among iron and mercury is a better conductor?

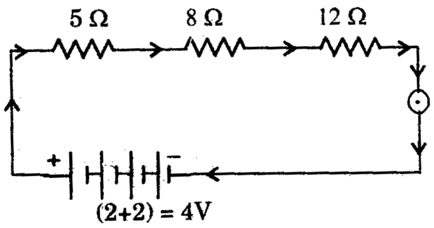
(b) Which material is the best conductor?

Ans. (a) iron (b) silver

Page No. 213

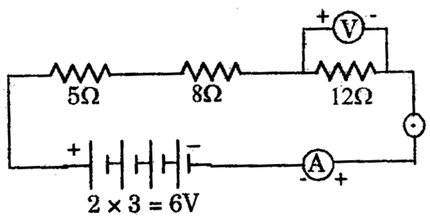
1. Draw a schematic diagram of a circuit consisting of a battery of three cells of 2 V each, a 5 Ω resistor, an 8 Ω resistor, and a 12 Ω resistor, and a plug key, all connected in series.

Ans.



2. Redraw the circuit of Question 1, putting in an ammeter to measure the current through the resistors and a voltmeter to measure the potential difference across the 12 Ω resistor. What would be the readings in the ammeter and the voltmeter?

Ans.



Equivalent resistance = 5 + 8 + 12

$R = 25\,\Omega$

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

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

I = 0.24 ampere

P.D. across 12 Ω resistor = IR

= 0.24 × 12

= 2.88 volts

Ammeter reads 0.24 and voltmeter reads 2.88V.

Page No. 216.

1. Judge the equivalent resistance when the following are connected in parallel – (a) 1 Ω and 10⁶ Ω, (b) 1 Ω and 10³ Ω, and 10⁶ Ω.

Ans. (a) $\frac{1}{R}=\frac{1}{1}+\frac{1}{10^6}=\frac{10^6+1}{10^6}$

$=\frac{1000000+1}{1000000}=\frac{1000001}{1000000}$

$=\frac{1000000}{1000001}=0.9\Omega$ Approx.

(b) $\frac{1}{R}=\frac{1}{1}+\frac{1}{10^3}+\frac{1}{10^6}=\frac{10^6+10^3+1}{10^6}$

$=\frac{1001001}{1000000}$

$R=\frac{1000000}{1000001}=0.9\ \Omega$ Approx.

2. **An electric lamp of 100 Ω, a toaster of resistance 50 Ω, and a water filter of resistance 500 Ω 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?**

Ans. The electric iron will have equivalent resistance to the same as 100Ω, 50Ω and 500Ω resistors are in parallel.

Let it be R Ω

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

$=\frac{5+10+1}{500}=\frac{16}{500}$

$R=\frac{500}{16}\ \Omega=31.25\Omega$

Current $1=\frac{V}{R}=\frac{220}{\frac{500}{16}}$

$=\frac{200 \text{ x } 16 \text{ x } 2}{500 \text{ x } 2}$

$=\frac{22 \text{ x } 32}{100}=\frac{704}{100}$

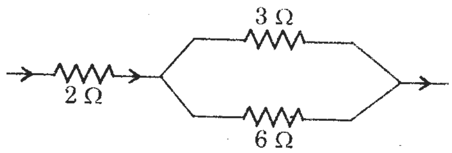
I = 7.04 amperes

3. **What are the advantages of connecting electrical devices in parallel with the battery instead of connecting them in series?**

Ans. The equivalent resistance of resistances connected in parallel is less than even the smallest resistance connected in parallel, so large current is obtained in the circuit for the same potential difference. Since, the equivalent resistance is less, therefore, loss of energy due to resistance of conductor is less. These are the advantages of connecting the resistances in parallel.

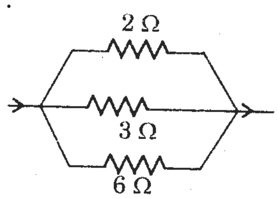
4. How can three resistors of resistances 2 Ω, 3 Ω, and 6 Ω be connected to give a total resistance of (a) 4 Ω, (b) 1 Ω?

Ans. (a) For 4 Ω resistance :



3 Ω and 6Ω resistance are connected in parallel and this combination is connected in series to 2 Ω resistor.

(b) For 1 Ω resistance :



All these three resistances are connected in parallel to get equivalent resistance of 1Ω.

5. What is (a) the highest, (b) the lowest total resistance that can be secured by combinations of four coils of resistance 4 Ω, 8 Ω, 12 Ω, 24 Ω?

Ans. (a) For highest resistance, resistors are connected in series :

$R = R_1 + R_2 + R_3 + R_4$

$= 4+8+12+24$

$R = 48\Omega$

(b) The lowest resistance will be obtained when these are connected in parallel :

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_4}$$

$$\frac{1}{R} = \frac{1}{4} + \frac{1}{8} + \frac{1}{12} + \frac{1}{24}$$

$$\frac{1}{R} = \frac{6+3+2+1}{24} = \frac{12}{24}$$

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

$$R = 2\Omega$$

Page No. 218

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

Ans. We know, $H = I^2Rt$

$H \propto R$

The resistance of heating element is very high, so more electrical energy is converted into heat energy, hence it glows. But the cord has very low resistance, so it does not glow.

2. Compute the heat generated while transferring 96000 coulomb of charge in one hour through a potential difference of 50 V.

Ans. We know, $W = QV$

$H = QV$

$= 96500 \times 50$ Joules

$= 4825000$

$= 4.825 \times 10^6$ Joules

$H = 4.825 \times 10^3$ Kilojoules

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

Ans. We know, $H = I^2Rt$

$H = 5^2 \times 20 \times 30$

$H = 5000$ Joules

$H = 5$ Kilojoules

Page No. 220

1. What determines the rate at which energy is delivered by a current?

Ans. Electrical power determines the rate of which energy is delivered by a current.

2. An electric motor takes 5 A from a 220 V line. Determine the power of the motor and the energy consumed in 2 h.

Ans. Power = VI

$P = 220 \times 5$

$P = 1100$ watts

Energy = Power × Time

$= 1100 \times 2\text{ h} \times 3600$ sec.

$= 3960000$

$= 3.96 \times 10^6$ Joule

$= 3.96 \times 10^3$ Kilojoue

$\therefore \quad \frac{V_1}{V_2} = \frac{I_1}{I_2}$

Given $V_1 = 2V_2$

$$\frac{V_1}{V_2} = \frac{I_1}{I_2}$$

$$= \quad \frac{2V_2}{V_2} = \frac{I_1}{I_2}$$

$$I_1 = 2I_2$$

Hence, current will also become half of its initial value.

Exercise

1. 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) 1/25 (b) 1/5 (c) 5 (d) 25

Ans. (d) 25.

2. 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

3. 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

4. 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

5. How is a voltmeter connected in the circuit to measure the potential difference between two points?

Ans. Voltmeter is connected in parallel to the appliance across which the potential difference is to be measured.

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

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

R = Resistance of the conductor

ρ = resistivity

l = length of the conductor

A = Area of cross-section of conductor

R = 10Ω

and $A = \pi r^2$

$$= \frac{22}{7} \text{ x} \left(\frac{0.5 \text{ x } 10^{-3}}{2}\right)^2$$

$$= \frac{22}{7} \text{ x } (0.25 \text{ x } 10^{-3})^2$$

$$= \frac{22}{7} \text{ x } 0.0625 \text{ x } 10^{-6}$$

$$= \frac{22}{7} \text{ x } 625 \text{ x } 10^{-10} \text{ m}^2$$

$= 13.14 \times 625 \times 10^{-10}$ m^2

$= 1962.50 \times 10^{-10}$ m^2

∴ $A = 9.625 \times 10^{-8}$ m^2

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

$$l = \frac{10 \times 19.625 \times 10^{-8}}{1.6 \times 10^{-8}} \text{ m}$$

$$=\frac{196.25}{1.6}\text{m}=\frac{96.25^{-8}}{1.6}\text{cm}=122.65\text{ m}$$

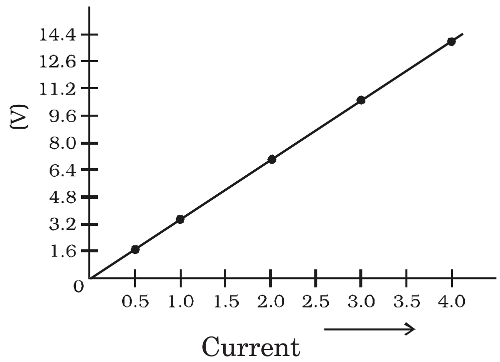
Since $R \propto 1/A$ i.e., $R \propto \frac{1}{r^2}$ hence, if diameter is doubled, resistance will the one fourth.

7. 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 (amperes)	**0.5**	**1.0**	**2.0**	**3.0**	**4.0**
V (volts)	**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. V is kept on y-axis and I on x-axis to plot a graph.



$$\text{Resistance from graph} = \frac{V_2 - V_1}{I_2 - I_1} = R$$

$$R_1 = \frac{3.4 - 1.6}{1.0 - 0.5} = \frac{1.8}{0.5} = 3.6\Omega$$

$$R_2 = \frac{6.7 - 3.4}{2.0 - 1.0} = 3.3\Omega$$

$$R_3 = \frac{10.2 - 6.7}{3.0 - 2.0} = 3.5\Omega$$

$$R_4 = \frac{13.2 - 10.2}{4.0 - 3.0} = 3.0\Omega$$

$$R = \frac{3.6 + 3.3 + 3.5 + 3.0}{4} = \frac{13.4}{4}$$

$$= 3.35\Omega$$

8. 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.

Ans. We know

$$R = \frac{V}{I} \text{ (By Ohm's law)}$$

$V = 12$ volts. $I = 2.5\text{ mA} = 2.5 \times 10^{-3}\text{ A}$

$$R = \frac{12}{2.5 \times 10^{-3}}\Omega = \frac{12 \times 10^{3}}{2.5} \quad \Omega$$

$R = 4.8 \times 10^{3}\,\Omega$

9. A battery of 9 V is connected in series with resistors of 0.2 Ω, 0.3 Ω, 0.4 Ω , 0.5 Ω and 12 Ω, respectively. How much current would flow through the 12 Ω resistor?

Ans. In series combination, same strength of current passes through each and every resistor.

$R_{eq} = R_1 + R_2 + R_3 + R_4 + R_5$

$= 0.2 + 0.3 + 0.4 + 0.5 + 12\,\Omega = 13.4\,\Omega$

$$I = \frac{V}{R_{eq}} = \frac{9V}{13.4} = \frac{90}{134}$$

$I = 0.67$ Ampere

$\therefore$ Value of I through 12 Ω resistor is 0.67 A.

10. How many 176 Ω resistors (in parallel) are required to carry 5 A on a 220 V line?

Ans. Let the number of resistors = n

$$\therefore \quad \frac{1}{R} - \frac{1}{176} + \frac{1}{176} + \text{..........r times}$$

$$R = \frac{176}{n}$$

$$\text{Now,} \quad I = \frac{V}{R}$$

$$5 = \frac{220}{\frac{176}{n}}$$

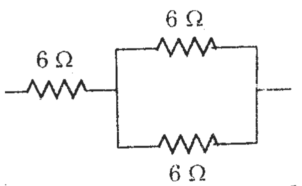
$$n = \frac{5 \times 176}{220} = 4$$

$n = 4$

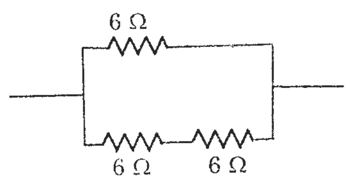
Number of resistors = 4

11. Show how you would connect three resistors, each of resistance 6 Ω, so that the combination has a resistance of (i) 9 Ω, (ii) 4 Ω.

Ans. We can connect resistance for (i) 9 Ω as given below :



This indicates that two resistors are connected in parallel and one is connected in series to these two resistances to get 9Ω resistance.



Here, two resistances are connected in series, and this combination is connected to third resistance in parallel to obtain 4Ω resistance.

12. Several electric bulbs designed to be used on a 220 V electric supply line, are rated 10 W. 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?

Ans. Resistance of each bulb = R

$$R = \frac{V^2}{P} (P = \text{power}) = \frac{220 \text{ x } 220}{10}$$

R = 4840 Ω

Let 'n' such bulbs be connected in parallel to 220 V to get maximum 5A current.

$$\frac{1}{R_{eq}} = \frac{1}{4840} + \frac{1}{4840} + \text{.......n times}$$

$$R_{eq} = \frac{4840}{n}$$

$$\text{Now } R = \frac{V}{1} (\text{Ohm's law})$$

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

$$5A < \frac{V}{R}\left(\frac{A}{9}\right)$$

$$= 5 < \frac{220}{\frac{4840}{n}}$$

$$= 5 < \frac{n\,220}{4840}$$

$$n > 110$$

Number of electric bulb = 110

13. A hot plate of an electric oven connected to a 220 V line has two resistance coils A and B, each of 24 Ω resistance, which may be used separately, in series, or in parallel. What are the currents in the three cases?

Ans. Case (i) : When the plates are connected in series.

R = 24 + 24 = 48Ω

$$I = \frac{V}{R} = \frac{220}{48} \text{ Ampere} = 4.6 \text{ A (approx.)}$$

Case (ii) : When the plates are connected in parallel :

$$R = \frac{24 \text{ x } 24}{24 + 24} = \frac{24 \text{ x } 24}{48} = 12\Omega$$

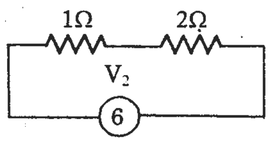
$$I = \frac{V}{R} = \frac{220}{12} = 18.3\,A\ (approx.)$$

Case (iii) : When only one resistance is connected.

$$I = \frac{V}{R} = \frac{220}{24} = 9.2\,A$$

14. Compare the power used in the 2 Ω resistor in each of the following circuits: (i) a 6 V battery in series with 1 Ω and 2 Ω resistors, and (ii) a 4 V battery in parallel with 12 Ω and 2 Ω resistors.

Ans. Case : (i)



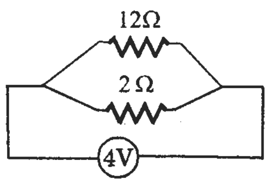
V = 6, R = 1 + 2 = 3 Ω

$$I = \frac{V}{R} = \frac{6}{3}$$

I = 2A

$P_1 = VI = 6 \times 2 = 12W$

Case (ii)



V = 4 V (in parallel V is same for both resistors)

R = 2Ω

$$I = \frac{V}{R} = \frac{4}{2} = 2A$$

$P_2 - VI = 4 \times 2 = 8W$

$$\frac{P_1}{P_2} = \frac{12W}{8W} = P_1 : P_2 :: 3 : 2$$

15. 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?

Ans. Resistance of first lamp = R_1

Resistance of second lamp = R_2

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

$$R_1 = \frac{220 \times 220}{100} = 484$$

$$R_2 = \frac{220 \text{ x } 220}{60} = \frac{2420}{3}$$

When R_1 and R_2 are connected in parallel.

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} \text{ (R is equivalent resistance)}$$

$$R = \frac{R_1 \ R_2}{R_1 + R_2} = \frac{484 \times \frac{2420}{3}}{484 + \frac{2420}{3}}$$

$$= \frac{484 \times \frac{2420}{3}}{484(1 + \frac{5}{3})} = \frac{2420 \times 3}{8 \text{ x } 3} = \frac{605}{2}$$

$$I = \frac{V}{R} = \frac{220}{\frac{605}{2}} = \frac{220 \text{ x } 2}{605}$$

$$I = \frac{8}{11} \text{ A} = 0.727 \text{ A}$$

16. Which uses more energy, a 250 W TV set in 1 hr, or a 1200 W toaster in 10 minutes?

Ans. Energy = Power × Time

For TV set :

$E_1 = 250 \text{ W} \times 1 \times 3600 \text{ sec}$

$= 900000 \text{ J} = 9 \times 10^5 \text{ J}$

For toaster

$E_2 = PT = 1200 \text{ W} \times 10 \times 60 \text{ sec}$

$= 720000 = 7.2 \times 10^5 \text{ J}$

$= E_1 > E_2$

TV set uses more energy.

17. An electric heater of resistance 8 Ω draws 15 A from the service mains 2 hours. Calculate the rate at which heat is developed in the heater.

Ans. Rate of heat = Power

$$P = \frac{E}{t} = \frac{I^2Rt}{t}$$

$P = I^2R$

$= 15^2 \times 8 = 225 \times 8 = 1800 \text{ Watt.}$

Thus, heat is developed at the rate of 1900 j/sec.

18. Explain the following.

(a) Why is the tungsten used almost exclusively for filament of electric lamps?

(b) Why are the conductors of electric heating devices, such as bread-toasters and electric irons, made of an alloy rather than a pure metal?

(c) Why is the series arrangement not used for domestic circuits?

(d) How does the resistance of a wire vary with its area of cross-section?

(e) Why are copper and aluminium wires usually employed for electricity transmission?

Ans. (a) Tungsten has high melting point and high resistance. Therefore, it is used to prepare filament of electric bulbs. Because of high resistance of tungsten, large quantity of heat is produced due to which the bulb glows and due to its high melting point, it does not melt even at higher temperature.

(b) An alloy has the following characteristics– (i) It has a high melting point.
(ii) It has high density.
(iii) It has high resistance.
Because of high resistance, it is used to produce large heat in electric heating devices
$H = I^2Rt$

(c) When appliances are connected in series, then the value of equivalent resistance will be very large as
$R_{eq} = R_1 + R_2 + R_3 + R_4 .....$
Because of high value of equivalent resistance, large quantity of heat will be produced in domestic circuit, which may cause fire in the house. But the equivalent resistance for parallel combination is very low. Thus, series arrangement is not used for domestic circuit.

(d) We know, $R = p\, l/A$
where, R = Resistance of wire,
p = resistivity of wire,
l = length of the wire,
A - area of cross-section.

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

Resistance of conductor increases as radius of cross-sectional area decreases and vice-versa.

(e) Copper and aluminium are the best conductors of electricity. So, copper and aluminium are usually employed for electricity transmission.

Additional Questions

1. What constitutes current ?

Ans. Current is due to flow of electrons.

2. What is the type of force between charges ?

Ans. Like charges repel and unlike charges attract.

3. What is meant by resistance ?

Ans. Resistance is the opposition to the flow of current in the conductor.

4. What is SI unit of resistance ?

Ans. It is ohm.

5. Define 1 ohm of resistance.

Ans. Resistance of a conductor is said to be 1 ohm if 1 A of current flows through it when potential difference of 1 V is maintained across its ends.

6. Define potential at a points.

Ans. Electric potential at a point is the work done in moving a unit positive charge from infinity to that point.

7. What is SI unit of potential ?

Ans. It is volt.

8. What is potential difference between two points ?

Ans. It is the amount of work done to move a unit positive charge from one point to the other against electrostatic force.

9. When is P.D. across two point 1 V ?

Ans. P.D. between two points is 1 V if 1 J of work done to move 1 C of charge from one point to the other.

10. What is other way of writing volt 1.

Ans. JC^{-1} is another way of writing V.

11. Which device measures P.D. ?

Ans. Voltmeter measures P.D.

12. How is voltmeter connected in circuit ?

Ans. Voltmeter is put in parallel to resistance across which P.D. is to be measured.

13. What is used the measure current ?

Ans. Ammeter is used to measure current.

14. What is commercial unit of electric energy ?

Ans. It is kWh (kilowatt hour).

15. How is kWh related to J ?

Ans. 1 kWh = 3.6 × 106 J.

16. Define ampere.

Ans. Current is said to be 1 A if 1C of charge flows per second.

17. How is an ammeter connected in circuit?

Ans. It is connected in series.

18. What will happen if P.D. across a conductor is halved?

Ans. Current will also be halved.

19. On what basis a substance is classified as conductor or an insulator?

Ans. On basis of free electrons present in substance.

20. Which has more resistances a thick or thin wire of same meterial ?

Ans. Thin wire has more resistance than thick wire.

21. Which has more resistance a 100 W bulb or 500 W bulb?

Ans. 100 W bulb has resistance 5 times resistance of 500 W bulb.

22. What is equivalent resistance ?

Ans. It is effective or combined resistance when a number of resistors are connected in a certain manner.

23. Define electric power.

Ans. It is rate of dissipation of electric energy.

24. What is the cause of resistance?

Ans. It is due to collision suffered by free electrons with bound electrons and with ions of the substance.

25. What is direction of current?

Ans. Conventional current flows from positive to negative. However, electric current (electrons) move from negative to positive.

26. Define SI unit of power.

Ans. SI unit of power is watt. Power expanded by a source is said to be 1 W if 1 A of current flow under a P.D. of 1 V. 2nd Def. Power of a device is 1 W if 1 J of energy is dissipated in Is.

27. Why alloys are used in elements of electric heating device?

Ans. Alloys have high resistivity and high melting point. They do not get oxide readily.

28. Name a high resistance meter.

Ans. Voltmeter.

29. Name a low resistance device.

Ans. An ammeter.

30. Two resistors each of 2 ohm are connected in parallel. What is the combined resistance ?

Ans. 1 ohm.

31. What are factors upon which heat dissipated depends ?

Ans. $H \propto 12$; $H \propto R$ and $H \propto t$

$\therefore H \propto 12 Rt$.

32. What is the maximum current drawing house hold electric appliance?

Ans. An AC. draws maximum current among household appliances followed by geyser.

33. What is e.m.f. of a torch cell ?

Ans. Nearly 1.5 V.

34. Three incandescent bulbs of 100 W each are connected in series in an electric circuit. In another circuit another set of three bulbs of the same wattage are connected in parallel to the same source.

(a) Will the bulb in the two circuits glow with the same brightness? Justify your answer.

(b) Now let one bulb in both the circuits get fused. Will the rest of the bulbs continue to glow in each circuit? Give reason.

Ans. (a) They will not glow with the same brightness in the two set ups. They will glow more in parallel set up because they are getting same and full potential difference in this arrangement. In series set up, the voltage is divided and each bulb receives 1/3 rd potential difference and hence the current.

(b) In series combination the other two bulbs will stop glowing when one of the three bulbs get fused. In series, circuit gets broken if either of the bulb is fused.

However in parallel combination however, the other two bulbs will glow with same brightness if any of the bulb get fused.

35. State Ohm's law. How can it be verified experimentally? Does it hold good under all conditions? Comment.

Ans. Ohm's law states that the current passing through a conductor is directly proportional to the potential difference across its ends provided the temperature and other physical conditions remain unchanged.

or $I \propto V$ or $V \propto I$

or $V = RI$

Experimental Verification of Ohm's Law : To verify Ohm's law, take a resistor, R1 connect voltmeter across it. Connect an ammeter, battery, key and rheostat to it. Put in the key K. Read the value of potential difference across resistor R with the help of voltmeter and the current flowing through resistor with the help of ammeter. Note the readings, verify the current in the circuit by sliding rheostat and go on noting reading the voltmeter and ammeter. Plot a graph between V and I on graph paper. It will come out to be straight line indicating a direct proportionality between V and I.

Ohm's law does not hold good under all conditions.

1. Ohm's law is not applicable to vacuum tubes such as diode, triodes.
2. Ohm's law is not applicable to gaseous conductors such as gases in discharge tube.
3. Ohm's law is not applicable when temperature of conductor is changing.
4. Ohm's law is not applicable to semi-conductors.

Multiple Choice Questions

1. Another way of writing volt is :
(a) JC^{-1} (b) Jm^{-2}
(c) JC (d) JC^{-2}
Ans. (a) JC^{-1}

2. Number of electrons in 1 C of charge is :
(a) 1.6×10^{-19} (b) 6.023×10^{23}
(c) 6.23×10^{18} (d) 6×10^{24}
Ans. (c) 6.23×10^{18}

3. For Ohmic resistors, the graph between V and I is
(a) parabolic (b) hyperbolic
(c) circular (d) straight line
Ans. (d) straight line

4. Conductance in measured in :
(a) siemen (b) mHo^{-1}
(c) VA^{-1} (d) $ohm^{-1}\ m^{-1}$
Ans. (a) siemen

5. Safety fuse wire is made of :
(a) copper (b) silver
(c) alloy of tin and lead (d) platinum
Ans. (c) alloy of tin and lead

6. Filament of electric bulb is made of
(a) copper (b) silver
(c) tin (d) tungsten
Ans. (d) tungsten

7. SI unit of electric energy is :
(a) kWh (b) J
(c) Js (d) NC^{-1}
Ans. (b) J

8. SI unit of specific resistance or resistivity is :
(a) ohm (b) ohm–m
(c) Js (d) S
Ans. (b) ohm–m

9. In resistance box, the resistors are connected in :
(a) series (b) parallel
(c) neither of two (d) none.
Ans. (a) series

10. We have 3 resistors of 3 ohm each. To get resistance of 2 ohm, we should connect them :
(a) in parallel (b) in series
(c) two in parallel and third in series with combination
(d) two in series and third in parallel with combination
Ans. (d) two in series and third in parallel with combination

11. Practical unit of electric energy commonly used is :
(a) J (b) kWh
(c) JC^{-1} (d) VA^{-1}
Ans. (b) kWh

12. Household electric appliances are connected in :
(a) series (b) parallel
(c) neither parallel nor series
(d) both.

Ans. (b) parallel

13. Electric heaters are made from wire of :
(a) copper (b) nichrome
(c) constantan (d) manganin

Ans. (b) nichrome

14. According to new convention, the neutral wire is :
(a) red (b) brown
(c) light blue (d) green.

Ans. (c) light blue

15. Electric 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.

16. A current of 1 A is drawn by a filament of an electric bulb. Number of electrons passing through a cross section of the filament in 16 seconds would be roughly :
(a) 10^{20} (b) 10^{16}
(c) 10^{18} (d) 10^{23}

Ans. (a) 10^{20}

17. What is the maximum resistance which can be made using five resistors each of 1.5 Ω ?
(a) 1/5 Ω (b) 10 Ω
(c) 5 Ω (d) 1 Ω

Ans. (d) 1 Ω

18. What is the minimum resistance which can be made using five resistors each of 1/5 Ω ?
(a) 1/5 Ω (b) 1/25 Ω
(c) 1/10 Ω (d) 25 Ω

Ans. (b) 1/25 Ω

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

Ans. (c) 2A

20. If the current I through a resistor is increased by 100% (assume that temperature remains unchanged), the increase in power dissipated will be :
(a) 100% (b) 200%
(c) 300% (d) 400%

Ans. (c) 300%