Board – ICSE	Class – 10^{TH}	Topic – Current electricity

1. (a) Define Ampere.

(b) Calculate the current flowing in ampere, if a charge of 5000 C flows through a circuit in 20 minutes.

Answer:

(a) When one coulomb of charge flows through a conductor in one second, then the current flowing through the circuit is said to be one ampere

(b) $\text{Current (I)} = \frac{Q}{t}$

$= \frac{5000\ C}{1200\ s}$

$= 4.16\ A$

2. (a) Define Volt.

(b) 4000 J of work is done in bringing 1600 C of charge from infinity to a given point A in an electric field. Calculate the potential at point A.

Answer:

(a) When one coulomb electric charge is brought from infinity to a given point in an electric field, such that work done is 1 joule, then the electric potential at that point is one volt.

(b) $\text{Electric potential} = \frac{\text{Work done}}{\text{Charge}}$

$= \frac{4000J}{1600C} = 2.5\ V$

3. (a) Define the term electric resistance and state its practical unit.

(b) Define the unit of resistance named in (a).

(c) How does the resistance of following conductors change with the rise in temperature?

(1) Tungsten wire,

(2) German silver,

(3) Carbon rod.

Answer:

(a) The opposition offered by a conductor, to the passage of drifting electrons is called electric resistance. Its practical unit is ohm.

(b) When a current of 1A flows through a conductor, whose ends are maintained at a p.d. of 1 volt, then the resistance of conductor is one ohm.

(c) (1) The resistance of tungsten increases with the rise in temperature.

(2) The resistance of German silver does not increase appreciably with the rise in temperature.

(3) The resistance of carbon rod decreases with the rise in temperature.

4. (a) What do you understand by terms :

(i) Electric circuit,

(ii) Series circuit?

(b) State three characteristics of series circuit.

Answer:

(a) (i) A continuous conducting path, between the terminals of source of electricity (such as cell or battery) is called electric circuit.

(ii) When a number of resistors are connected end to end, such that tail of one resistor is connected to initial end of other resistor, so as to form closed electrical circuit, then such a circuit is called series circuit.

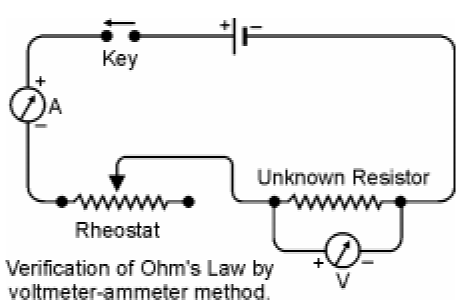
(b) (i) The current in series circuit is a constant quantity.

(ii) There is a continuous drop in potential all along in series circuit, but potential difference goes on increasing.

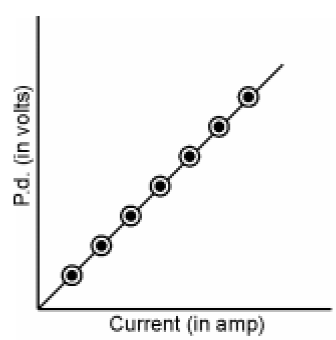
(iii) Total p.d in series circuit is equal to the sum total of p.d across the terminals of individual resistors : $V = V_1 + V_2 + V_3$

5. Draw a neat circuit diagram for the verification of Ohm's law by voltmeter ammeter method. By another diagram show the relation between p.d. and current.

Answer:



Verification of Ohm's Law by voltmeter-ammeter method.



Graph between p.d. and current.

6. Write an expression connecting the resistance and resistivity. State the meaning of symbols

used.

Answer:

$$R = \rho.\frac{l}{a}$$

'R' is resistance in ohm, 'ρ ' is the resistivity (sp. resistance) of conductor, 'l' is the length of the conductor and 'a' the area of cross-section of the conductor.

7. State the order of resistivity of :
   (i) metals,
   (ii) semi-conductors and
   (iii) insulators.

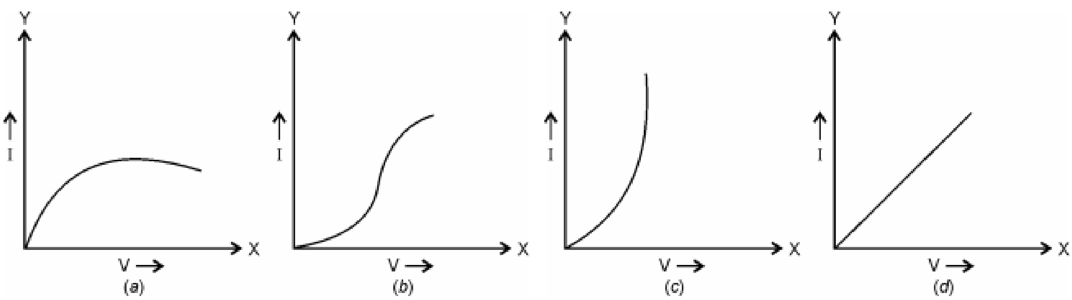
   Answer:

   The order of resistivity of metals is of the order of 10^{-8} ohm-metre.

   The order of resistivity of semiconductors is of the order of 10^{-5} ohm-metre.

   The order of resistivity of insulators is of the order of 10^{8} to 10^{16} ohm-metre.

8. Figures (a), (b), (c) and (d) below shows I–V characteristic curves for same resistors. Identify the ohmic and non-ohmic resistors and give a reason for your answer.



   Answer:

   (a), (b) an (c) are non-ohmic resistors. It is because the V ∝ I as the curves

   are not a straight line. (d) is an ohmic resistance as V ∝ I and the curve is a straight line.

NUMERICALS:

1. A wire of resistance 4.5 Ω and length 1.5 m has area of cross-section of 0.04 cm². Calculate the specific resistance of wire.

   Answer:

   R = 4.5 Ω; l = 1.5 m = 150 cm; a = 0.04 cm^2; ρ = ?

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

$= \frac{4.5 \times 0.04}{150}$

$= 0.0012\ \Omega\ \text{cm}$

2. A conductor of length 85 cm has a resistance of 3.75 Ω. Calculate the resistance of a similar conductor of length 540 cm.

Answer:

l_1 = 85 cm; R_1 = 3.75 Ω; l_2 = 540 cm; R_2 =?

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

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

$\therefore R_2 = \frac{3.75 \times 540}{85}$

$= 23.82\ \Omega$

3. (a) A metallic wire has a resistance of 2 ohms per metre. Find the total resistance of two lengths of this wire, each 1.5 m long and connected in parallel.

(b) What will be the resistance of 4 m of a wire of same material, but twice the area of cross-section?

Answer:

(a) Resistance of 1.5 m of wire = 2 × 1.5 = 3 Ω

∴ Resistance of two 1.5 m wires in parallel,

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

$R = \frac{3}{2} = 1.5\ \Omega$

(b) Resistance of 4 m wire = 4 × 2 = 8 Ω

$\therefore 8\ \Omega = \rho \frac{4}{a}$ ... (i)

When the area of cross-section of wire doubles,

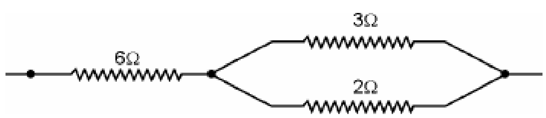
$R_1 = \rho \frac{4}{2a}$ ... (ii)

Dividing (ii) by (i) $\frac{R_1}{8\Omega} = \rho \frac{4}{2a} \times \frac{a}{\rho_4}$

$\therefore R_1 = \frac{8}{2} = 4\ \Omega$

4. Three resistors of 6 Ω, 3 Ω. and 2 Ω are connected together, such that their total resistance is greater than 6 Ω, but less than 8 Ω. Draw a diagram to show this arrangement and calculate total resistance.

Answer:



Equivalent resistance of 3 Ω and 2 Ω in parallel

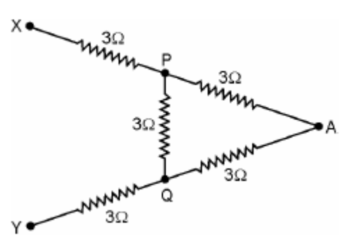
$$\frac{1}{R} = \frac{1}{3} + \frac{1}{2} = \frac{5}{6}$$

$$\therefore R = \frac{6}{3}$$

$$= 1.2\ \Omega$$

∴ Resistance of circuit = 6 Ω + 1.2 Ω = 7.2 Ω.

5. The diagram below shows resistors of 3Ω, in a network. Calculate the equivalent resistance :



(i) Between points P and Q.

(ii) Between points X and Y.

Answer:

(i) Equivalent resistance of PA and QA in series;

R_1 = 3 Ω + 3 Ω = 6 Ω.

∴ Equivalent resistance of R_1 in parallel with PQ;

$$R_2 = \frac{1}{6} + \frac{1}{3} = \frac{3}{6} = \frac{1}{2}$$

∴ R_2 = 2 Ω

∴ Resistance between points P and Q = 2 Ω

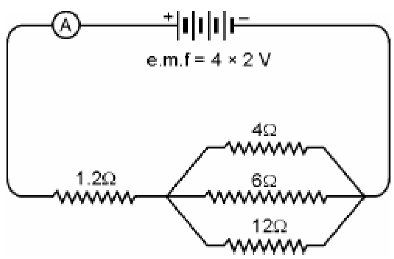
(ii) Equivalent resistance of XP; R_2 and YQ in series

= 3 Ω + 2 Ω + 3 Ω = 8 Ω.

6. Four cells, each of e.m.f. 2V and internal resistance 0.2 Ω are connected in series to form a battery. The battery is connected to an ammeter, a resistance of 1.2 Ω and a set of three resistances of 4 Ω; 6 Ω and 12 Ω in parallel, so as to complete an overall circuit in series.
   (i) Draw the circuit diagram of the arrangement.
   (ii) Calculate current recorded by ammeter.
   (iii) Calculate current flowing in 6 Ω wire
   (iv) Calculate p.d. across 1.2 Ω wire
   (v) Calculate drop in potential across the terminals of battery.

Answer:

(i) The figure is shown below.



(ii) e.m.f. of four cells in series, E = 4 × 2 = 8 V.

Internal resistance of four cells in series, r = 4 × 0.2 = 0.8 Ω

Equivalent external resistance of parallel circuit

$$\frac{1}{R_1} = \frac{1}{4} + \frac{1}{6} + \frac{1}{12} + \frac{6}{12} = \frac{1}{2}$$

$\therefore R_1 = 2\ \Omega$

∴ Total external resistance = (2 × 1.2) = 3.2 Ω.

Current recorded by ammeter,

$$I = \frac{E}{R + r} = \frac{8}{3.2 + 0.8} = \frac{8}{4} = 2\text{ A}$$

(iii) p.d. across parallel circuit,

$V = IR_1 = 2 \times 2 = 4$ V.

$\therefore$ Current in 6 Ω wire, $I_1 = \frac{V}{R} = \frac{4}{6} = 0.67$ A

(iv) p.d. across 1.2 Ω wire V= IR = 2 × 1.2 = 2.4 V.

(v) Drop in potential across terminals of battery, (E – V) = Ir = 2 × 0.8 = 1.6 V.