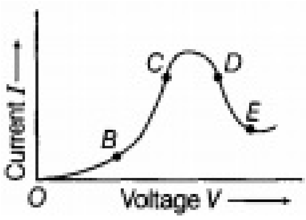
CBSE Test Paper-04

Class - 12 Physics (Current Electricity)

1. The sensitivity of the potentiometer can be increased by:
   a. increasing the e.m.f. of primary cell.
   b. increasing the length of potentiometer wire.
   c. decreasing the length of potentiometer wire.
   d. increasing the potential gradient.
2. A thermoelectric refrigerator works on:
   a. Thermionic effect
   b. Seebeck effect
   c. Peltier effect
   d. Joule effect
3. If the length of the filament of a heater is reduced by 10% the power of the heater will ________
   a. increase by about 19%
   b. Increase by about 11%
   c. Increase by about 9%
   d. decrease by about 29%
4. A Wheatstone bridge ABCD is balanced with a galvanometer between the points B and D. At balance the resistance between the points B and D is:
   a. None of these
   b. Zero
   c. Between zero and infinite
   d. Infinite
5. Which can be the units of Resistivity?
   a. $meter \times \frac{Ampere}{Volt}$
   b. $Volt \times \frac{Ampere}{meter}$
   c. $\frac{Volt\ meter}{Ampere}$
   d. $Volt \times Ampere$

6. Graph showing the variation of current versus voltage for a material GaAs is shown in the figure. Identify the region
    i. of negative resistance.
    ii. where Ohm's law is obeyed



7. Plot a graph showing the variation of resistivity of a conductor with temperature.

8. How does the random motion of free electrons in a conductor get affected when a potential difference is applied across its ends?

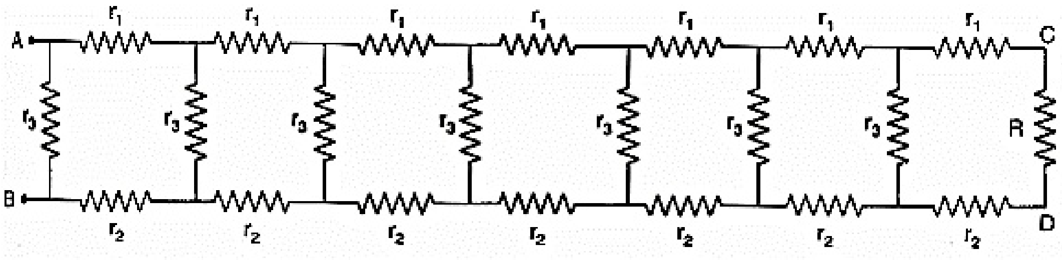
9. A carbon resistor has three strips of red colour on its surface and a gold strip at one end of it. What is the value of this resistance?

10. A high tension (HT) supply of say 6 kV must have a very large internal resistance. Why?

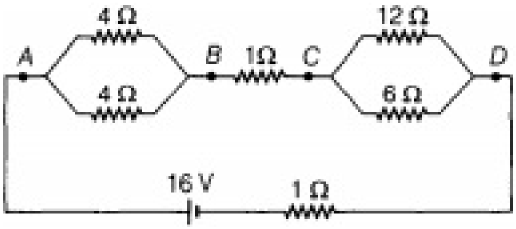
11. A battery of emf 10 V and internal resistance 3Ω is connected to a resistor. If the current in the circuit is 0.5 A, what is the resistance of the resistor? What is the terminal voltage of the battery when the circuit is closed?

12. Twelve cells each having the same emf are connected in series and are kept in a closed box. Some of the cells are wrongly connected. This battery of cells is connected in series with an ammeter and two cells identical with the others of previous cells. The current is 3A when the cells and the battery add each other and is 2 A when the cells and the battery oppose each other. How many cells in the battery are wrongly connected?

13. Study the following circuit, Values of r_1, r_2 and r_3 are 1 ohm, 2 ohm and 3 ohm respectively. A resistor R is connected across the points C and D. What should be the value of R for which the resistance of the network across AB is R?



14. A network of resistors is connected to a 16 V battery of internal resistance of 1Ω as shown in the figure.



   i. Compute the equivalent resistance of the network.
   ii. Obtain the voltage drops V_{AB} and V_{CD}.

15. Deduce the condition for balance in a Wheatstone bridge. Using the principle of Wheatstone bridge, describe the method to determine the specific resistance of a wire in the laboratory. Draw the circuit diagram and write the formula used. Write any two important precautions you would observe while performing the experiment.

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Answers

1. b. increasing the length of potentiometer wire.

   Explanation: A potentiometer is considered to be sensitive if the potential gradient $\frac{dV}{dl}$ is low. Such a potentiometer can measure very small changes in potential difference. Increasing the length of the potentiometer wire decreases the potential gradient. Its sensitivity increases. Increasing potential gradient decreases the sensitivity. increasing the emf of the primary cell and by decreasing the length, potential gradient increases.

2. c. Peltier effect

   Explanation: Thermoelectric cooling uses the Peltier effect to create a heat flux between the junction of two different types of materials. A Peltier cooler is solid-state active heat pump which transfers heat from one side of the device to the other, with consumption of electrical energy, depending on the direction of the current.

3. b. Increase by about 11%

   Explanation: The power is related to resistance as,

   $P \propto \frac{1}{R}$
   $\frac{P_2}{P_1} = \frac{R_1}{R_2}$
   also, $R \propto L$
   $\therefore \frac{P_2}{P_1} = \frac{L_1}{L_2}$
   $\frac{P_2}{P_1} = \frac{L}{0.9L}$
   $\Rightarrow P_2 \approx 0.11P_1$
   So Power increases by 11%.

4. d. Infinite

   Explanation: No current passes through the Galvanometer in the bridge balance condition.
   Therefore, the resistance between B and D is infinite.

5. c. $\frac{Volt\ meter}{Ampere}$

Explanation: $\because$ Resistance $R = \rho \frac{L}{A}$

Where ρ is resistivity, L is length and A is area.

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

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

$\therefore \rho = \frac{V \times A}{I \times L}$

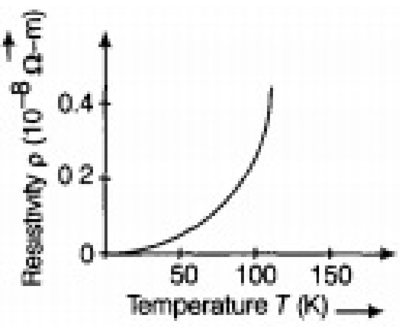
and in units,

$\rho = \frac{(Volts) \times (meter)^2}{(Ampere) \times (meter)}$

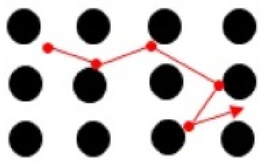
$\Rightarrow \rho = \frac{Volt\ meter}{Ampere}$

6. As Resistance is the voltage divided by current so region having negative slope will have negative resistance so DE is the region of negative resistance because the slope of curve in this part is negative.
   BC is the region where Ohm's law is obeyed because in this part, the current varies linearly with the voltage.

7. Resistivity is a measure of the resistance of a given size of a specific material to electrical conduction. The electrical resistivity is the electrical resistance per unit length and per unit of cross-sectional area at a specified temperature. The resistivity of a metallic conductor is given by
   $\rho = \rho_0 \left[1 + \alpha \left(T - T_0\right)\right]$
   where, ρ_0 = resistivity at reference temperature
   T_0 = reference temperature and
   α = coefficient of resistivity having unit /Kelvin. From the above relation, we can say that the graph between resistivity of a conductor with temperature is straight line. But, at temperatures much lower than 273 K (i.e. 0°C), the graph deviates considerably from a straight line as shown in the figure.



8. Conductors contain free electrons. In the absence of any external electric field, the free electrons are in random motion just like the molecules of gas in a container and the net current through wire is zero. If the ends of the wire are connected to a battery, an electric field (E) will setup at every point within the wire. Due to electric effect of the battery, the electrons will experience a force in the direction opposite to E and move against the direction of applied Electric field along with their zig zag motion as shown in figure.



9. $22 \times 10^2 \pm 5\% \Omega$

10. If accidently the circuit is shorted, the current drawn will exceed safety limit and will cause damage to circuit. Therefore, a high tension supply must have a large internal resistance.

11. Since, $I = \frac{\varepsilon}{R+r}$
or $R = \frac{\varepsilon}{I} - r$
Putting given values $\varepsilon = 10V, r = 3\Omega$ and I = 0.5 A
$R = \frac{10}{0.5} - 3 = 17\Omega$
Terminal voltage $V = IR = 0.5 \times 17 = 8.5V$

12. If m cells are connected correctly and n cells are connected wrongly, we have
m + n = 12
If E is the emf of each cell, the total emf of the battery is (m - n)E.
When the battery and the cells add each other, the net emf
= (m - n)E + 2E
If R is the total resistance of the circuit, the current is given by
$I = \frac{(m-n)E+2E}{R} = 3$ ...(i)
When the battery and the cells oppose each other, the net emf is (m - n)E - 2E.
Therefore the current is
$\frac{(m-n)E-2E}{R} = 2$ ...(ii)
The division of equation (i) by equation (ii) gives

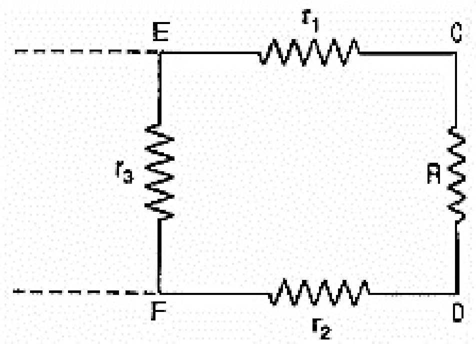
m - n = 10

But m + n = 12

Hence, m = 11 and n = 1. Thus, one cell is wrongly connected.

13. Let us consider the extreme right square of the loop.

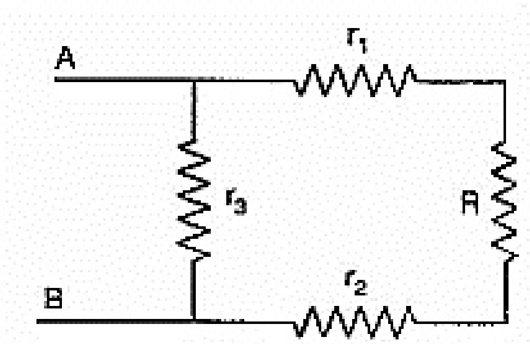
Resistance across EF = (r_1 + R + r_2) and r_3 in parallel



$= \frac{r_3(r_1+r_2+R)}{(r_1+r_2+r_3+R)}$

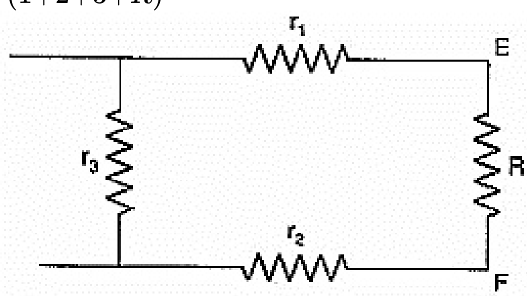
This value should be equal to R, so that by the repeated operation of this type will be left with only one square which will be the left extreme one and it will have a value R.

i.e. $\frac{r_3(r_1+r_2+R)}{(r_1+r_2+R_3+R)} = R$



Substituting the numerical values

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



or $\frac{3(3+R)}{(6+R)} = R$

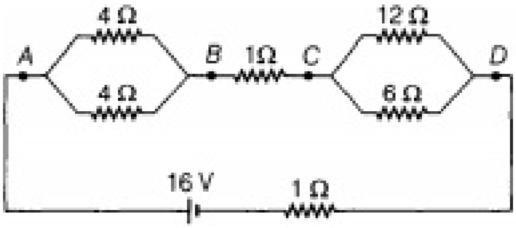
9 + 3R = 6R + R^2

$R^2 + 3R - 9 = 0$

$R = \frac{-3 \pm \sqrt{9+36}}{2}$

$= \frac{-3 \pm 3\sqrt{5}}{2}$

$\therefore R = \frac{3(\sqrt{5}-1)}{2}\Omega$

14. 1. 

In circuit AB, 2 resistors of resistance 4Ω and 4Ω are connected in parallel combination.

Equivalent resistance in parallel combination is given by

$\frac{1}{R_{AB}} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots + \frac{1}{R_n}$

$\therefore$ Equivalent resistance of $4\Omega\ and\ 4\Omega$ in circuit AB is

$\frac{1}{R_{AB}} = \frac{1}{4} + \frac{1}{4} \Rightarrow \frac{1}{R_{AB}} = \frac{2}{4}$

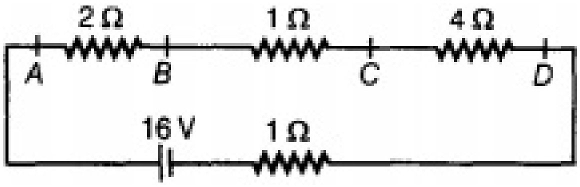
$\Rightarrow R_{AB} = 2\Omega$

In circuit CD, 2 resistors of resistance 12Ω and 6Ω are connected in parallel combination.

Similarly, equivalent resistance of 12Ω and 6Ω in circuit CD is

$\frac{1}{R_{CD}} = \frac{1}{12} + \frac{1}{6} \Rightarrow \frac{1}{R_{BC}} = \frac{1+2}{12} \Rightarrow R_{CD} = 4\Omega$

Now, the circuit can be redrawn as shown in figure below



In circuit AD , 3 resistors of resistance 2Ω , 1Ω and 4Ω are connected in series combination.

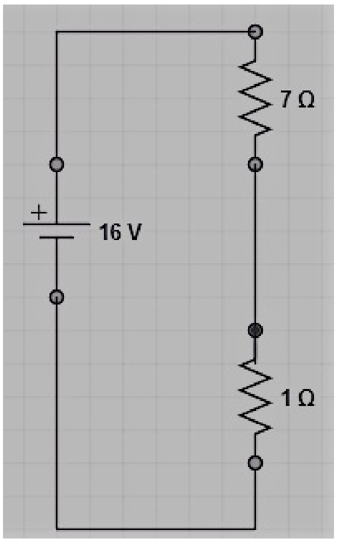
Equivalent resistance in series combination is given by

$R_{eq} = R_1 + R_2 + \ldots\ldots\ R_n$

$\therefore$ Equivalent resistance of $2\Omega,\ 1\Omega\ and\ 4\Omega$ in circuit AD is

$R_{eq} = 2\Omega + 1\Omega + 4\Omega = 7\Omega.$

Now, the circuit can be redrawn as shown in figure below



In the circuit , 2 resistors of resistance 7Ω and 1Ω are connected in series combination.

Equivalent resistance of $7\Omega \ and \ 1\Omega$ in the given circuit is

$R_{eq} = 7\Omega + 1\Omega = 8\Omega.$

Equivalent resistance of the network is 8Ω.

2. $\therefore$ Current drawn from the battery,

$I = \frac{V}{R} = \frac{16}{8} = 2A$

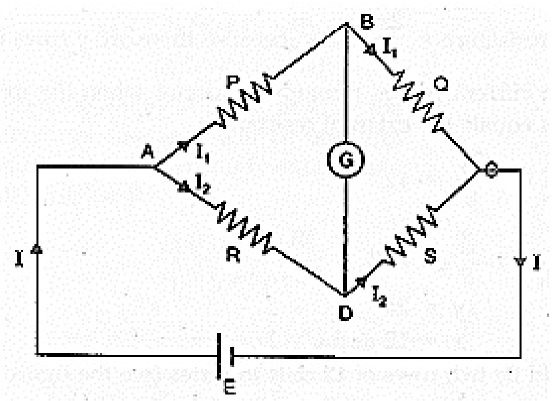
This current will flow from A to B and C to D.

So, the potential difference in between AB and CD can be calculated as

Now, $V_{AB} = IR_{AB} = 2 \times 2 = 4V$

and $V_{CD} = IR_{CD} = 2 \times 4 = 8\text{V}$

15. Four resistances P, Q, R and S are connected to form quadrilateral ABCD. A galvanometer G is connected between B and D. A battery is connected between A and C. The resistances are so adjusted that no current flows in the galvanometer G. The same current I_1 will flow in arms AB and BC. Similarly current I_2 flows in arms AD and DC.



Applying Kirchhoff's second law for mesh ABCD,

$I_1P - I_2R = 0$

or $I_1P = I_2R$ ...(i)

For mesh BCDB,

$I_1Q - I_2S = 0$

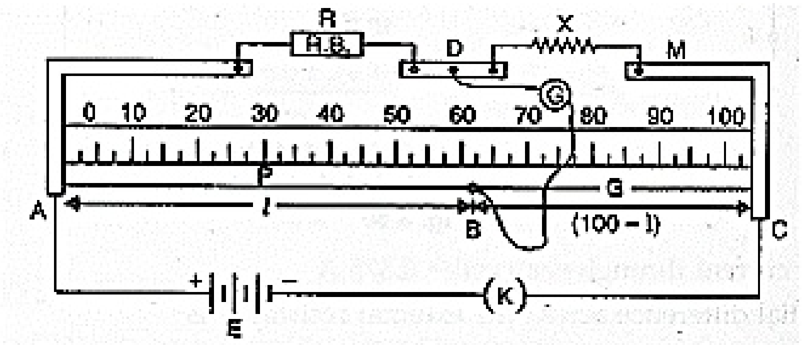
or $I_1Q = I_2S$ ...(ii)

Dividing (i) by (ii) we get

$\frac{P}{Q} = \frac{R}{S}$

This is the balanced condition of the Wheatstone bridge.

Measurement of specific resistance: Slide wire or meter bridge is a practical form of Wheatstone bridge.



In the figure X is unknown resistor and R.B is resistance box. After inserting the key k, jockey is moved on wire AC till galvanometer shows no deflection (point B). If k is the resistance per unit length of wire AC.

P = resistance of AB = kl

Q = resistance of BC = k(100 - l)

$\therefore \frac{R}{X} = \frac{P}{Q} = \frac{kl}{k(100-l)}$

or $X = \frac{(100-l)R}{l}$

If r is the radius of wire and l be its length, then its resistivity will be

$\rho = \frac{XA}{l'} = \frac{\pi r^2 X}{l'}$

Precautions: (i) The null point should lie in the middle of the wire.

(ii) The current should not be allowed to flow in the wire for a long time.