CBSE Test Paper-05

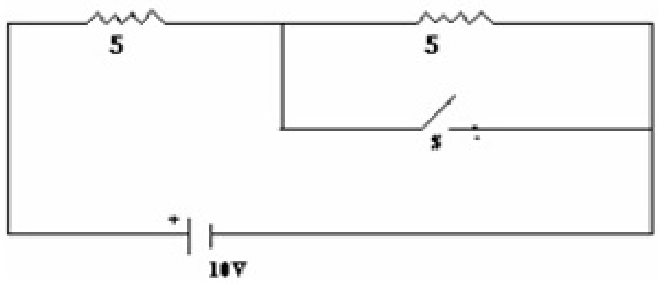
Class - 12 Physics (Current Electricity)

1. Amount of charge in coulomb required to deposit one gram equivalent of substance by electrolysis is:
   a. 4.8×10^{-4}
   b. 96500
   c. 6500
   d. 9.6×10^{4}

2. Ammeter is always used
   a. in series with the element through which current is to be determined
   b. in parallel with the element through which current is to be determined
   c. to simulate the element across which voltage is to be determined
   d. to simulate the element through which current is to be determined

3. A potentiometer has a uniform wire of length 10m and resistance 5 ohms. The potentiometer is connected to an external battery of emf of 10V and negligible internal resistance and a resistance of 995 ohms in series. The potential gradient along the wire is:
   a. 1 mV/cm
   b. 5 mV/cm
   c. 1 mV/m
   d. 5 mV/m

4. The ratio of the currents I_1 when switch S is off and I_2 when switch S is on is



a. 2: 1
b. 1: 2
c. 0: 2
d. 1: 1

5. In a Wheatstone's bridge, P = 9 ohms, Q = 11 ohms, R = 4 ohms and S = 6 ohms. How much resistance must be put in parallel to the resistance S to balance the wheatstone bridge?

a. 24 ohms
b. 18.7 ohms
c. 26.4 ohms
d. $\left(\frac{44}{9}\right)$ ohms

6. Would the galvanometer show any current if the galvanometer and cell are interchanged at the balance point of the bridge?

7. The resistivity of the alloy manganin is (nearly independent of / increases) rapidly with increase of temperature.

8. Plot a graph showing the variation of resistance of a conducting wire as a function of its radius. Keeping the length of the wire and its temperature as constant.

9. Estimate the average drift speed of conduction electrons in a copper wire of cross-sectional area 1.0×10^{-7} m^2 carrying a current of 1.5 A. Assume the density of conduction electrons to be 9×10^{28} m^{-3}.

10. The storage battery of a car has an emf of 12 V. If the internal resistance of the battery is 0.4Ω what is the maximum current that can be drawn from the battery?

11. A cell of emf E and internal resistance r is connected to two external resistances R_1 and R_2 and a perfect ammeter. The current in the circuit is measured in four different situations:

i. Without any external resistance in the circuit
ii. With resistance R_1 only

iii. With R_1 and R_2 in series combination

iv. With R_1 and R_2 in parallel combination

The currents measured in the four cases are 0.42 A, 1.05 A, 1.4 A and 4.2 A, but not necessarily in that order. Identify the currents corresponding to the four cases mentioned above.

12. We have 30 watt, 6 volt bulb which we want to glow by a supply of 120 V. What will have to be done for it?

13. Explain how electron mobility changes for a good conductor when (i) the temperature of the conductor is decreased at constant potential difference and (ii) applied potential difference is double at constant temperature.

14. Prove that when a current is divided between two resistors in accordance with Kirchhoff's laws, the heat produced is minimum.

15. A battery if 24 cells each of emf 1.5 V and internal resistance, 2Ω is to be connected in order to send the maximum current through a 12Ω resistor. How are they to be connected? Find the current in each cell and the potential difference across the external resistance.

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Answers

1. b. 96500

   Explanation: Let X be the element in electrolytic solution to be deposited.

   $X^{+} + e^{-} \rightarrow X(s)$

   $\Rightarrow$ 1mole e^- is required to produce 1 mole of X

   Now 1 mole electrons $= N_A \times e^-$

   $= 6.022 \times 10^{23} \times 1.6 \times 10^{-19}$

   = 96500C

2. a. in series with the element through which current is to be determined

   Explanation: Ammeter is a device used to measure current. Since it has to allow the complete current flowing in the circuit through it, it has to be connected in series. For this reason, ammeters have very low values of resistances so that they do not add to the value of resistance connected in the circuit.

3. d. 5 mV/m

   Explanation: The total resistance is the sum of the resistance of the potentiometer and the external resistance.

   R = R_{pot} + R_{ext} = 5 + 995 = 1000 ohms .

   The current through the potentiometer wire $I = \frac{E}{R} = \frac{10}{1000} = 0.01A$

   The potential drop across the potentiometer wire is

   $V = I \times R_{pot}$

   $\Rightarrow V = 0.01 \times 5$

   V = 0.05V

   The potential gradient = (potential drop across the potentiometer wire)/ length of the potentiometer wire)

   $= \frac{0.05}{10}$

   $= 5 \times 10^{-3} V/m$

   = 5 mV/m

4. b. 1: 2

Explanation: When swithch S is off, both resistances are included in the circuit.

Total Resistance, R1 = 5 + 5 = 10Ω

$\therefore I_1 = \frac{V}{R_1} = \frac{10}{10}$

I_1 = 1A

When the switch S is closed, the 5Ω resistor in parallel to the switch is shorted out. Total resistance R_2 = 5Ω.

Total Resistance, R_1 = 5 + 5 = 10Ω

$\therefore I_2 = \frac{V}{R_2} = \frac{10}{5}$

I_2 = 2A

$\frac{I_1}{I_2} = \frac{1}{2}$

$I_1 : I_2$ = 1 : 2

5. c. 26.4 ohms

Explanation: Let a resistance M be put in parallel to S and the equivalent resistance of the parallel combination be X. In the bridge balance condition

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

$\Rightarrow X = R \times \left(\frac{Q}{P}\right)$

$X = 4 \times \frac{11}{9} = \frac{44}{9}$

In the parallel combination of S and M,

$\frac{1}{X} = \frac{1}{S} + \frac{1}{M}$

$\frac{1}{M} = \frac{1}{X} - \frac{1}{S}$

$\Rightarrow \frac{1}{M} = \frac{9}{44} - \frac{1}{6} = \frac{10}{264}$

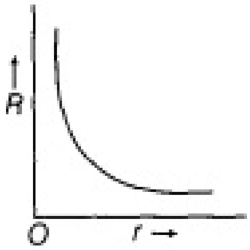
$\therefore M = 26.4\Omega$

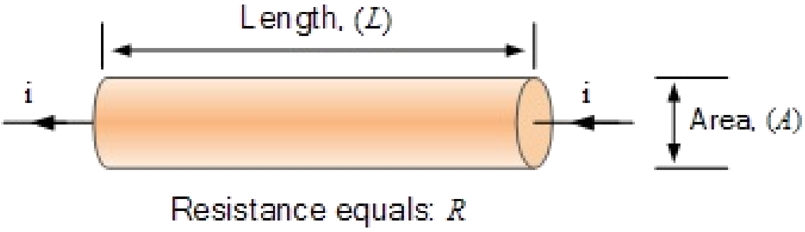
6. No. The galvanometer will not show any current.

7. The resistivity of the alloy manganin is nearly independent of temperature.
In alloys, the atoms are arranged in a disorderly fashion and hence, they have higher resistivity.

8. Resistance of a conductor of length l and radius r is given by
$R = \rho \frac{I}{\pi r^2}$, i.e. $R \propto \frac{1}{r^2}$
$\therefore$ The variation of resistance of a conducting wire as a function of its radius is given

in the figure which states that area of cross section of the wire increases and its resistance decreases in hyperbolic manner.





9. The **drift velocity** is the average velocity that a particle, such as an electron, attains in a material due to an electric field. It can also be referred to as axial drift velocity.

   Given, A = 1.0×10^{-7} m^2

   Current, I = 1.5 A

   Electron density, n = 9×10^{28} m^{-3}

   Drift velocity, v_d = ?

   We know that, I = $neAv_d$

   $\Rightarrow v_d = \frac{I}{neA} = \frac{1.5}{9\times10^{28}\times1.6\times10^{-19}\times1.0\times10^{-7}}$

   = 1.042×10^{-3} m/s

10. When the external resistance in the circuit is zero i.e. R = 0 then the maximum current is drawn from a battery.
    Given, $\varepsilon = 12V,\ r = 0.4$
    $I_{\max} = \frac{\varepsilon}{r} = \frac{12}{0.4} = 30A$

11. Internal resistance usually means the electrical resistance inside batteries and power supplies that can limit the potential difference that can be supplied to an external load. Internal resistances within power supplies are normally constant and independent of use unless the power supply gets hot as a result of short circuits or low resistance loads.

    The current relating to corresponding situations are as follows

i. Without any external resistance, I_1 = E/R

In this case, effective resistance of circuit is minimum, so current is maximum. Hence, I_1 = 4.2A.

ii. With resistance R_1 only $I_2 = \frac{E}{r+R_1}$

In this case, effective resistance of circuit is more than situations (i) and (iv) but less than

So, I_2 = l .05A.

iii. With R_1 and R_2 in series combination,

I_3 = E/r + R_1 + R_2

In this case, effective resistance of circuit is maximum, so current is minimum. Hence, I_3 = 0.42A.

iv. $I_4 = \frac{E}{r+R_1R_2/R_1+R_2}$

In this case, the effective resistance is more than (i) but less than (ii) and (iii). So, I_4 = 1.4A.

12. Given, P = 30 W, V = 6 V

∴ Resistance of the bulb,

$R = \frac{V^2}{P} = \frac{(6)^2}{30} = 1.2\Omega$

Current capacity of the bulb,

$I = \frac{P}{V} = \frac{30}{6}$ = 5 A

Supply voltage, V' = 120V

Let R' be the resistance used in series with the bulb to have a current of 5 A in the circuit.

Total resistance = R' + R = (R' + 1.2)

∴ Current $I = V'(R' + 1.2)$

or $5 = \frac{120}{R'+1.2}$

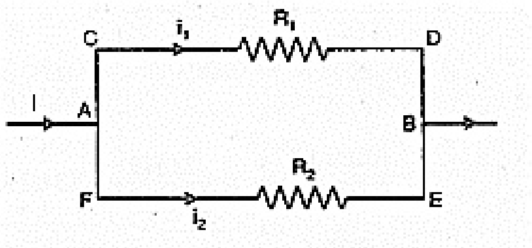
$R' = \frac{120}{5} - 1.2 = 22.8\Omega$or in series

13. Electron mobility of a conductor, $\mu = \frac{e\tau}{m}$ and $\tau \propto T$

i. When the temperature of the conductor increases, the relaxation time τ of free electrons increases. So mobility μ increases.

ii. Mobility μ is independent of applied potential difference.

14. Consider two resistors R_1 and R_2 connected in parallel and the current through the various arms of the circuit be as shown in the figure below.



According to Kirchhoff's first law, at junction A,

$i = i_1 + i_2$ or $i_2 = i - i_1$ ...(i)

Let H be the heat produced in the circuit in t seconds, then

$H = i_1^2 R_1 t + i_2^2 R_2 t$

$= i_1^2 R_1 t + (i - i_1)^2 R_2 t$ [from (i)]

In case the heat produced in the circuit is minimum, then $\frac{dH}{di_1} = 0$ therefore

$2i_1R_1t + 2(i - i_1)(-1)R_2t = 0$

or $2i_1R_1t - 2i_2R_2t = 0$

or $i_1R_1 - i_1R_2 = 0$

which is according to Kirchhoff's second law in a closed circuit ACDEFA.

15. Let x be the number of cells in series in each row and let there be y such rows in parallel.

Total number of cells = xy = 24

Resistance of each row in series = 2 x ohms

Total internal resistance due to all xy batteries = R

$\frac{1}{R} = \frac{1}{2x} + \frac{1}{2x} + \ldots y$ times $\frac{1}{R} = \frac{y}{2x}$

Total internal resistance $= \frac{2x}{y}$ ohms (because there are y rows in parallel)

The maximum current passes through the circuit when the internal resistance of the battery of cells equal the external resistance.

Thus, $\frac{2x}{y} = 12$

Or $\frac{x}{y} = 6$

But xy = 24

Hence x = 12 and y = 2

i.e. there should be two rows of 12 cell in series

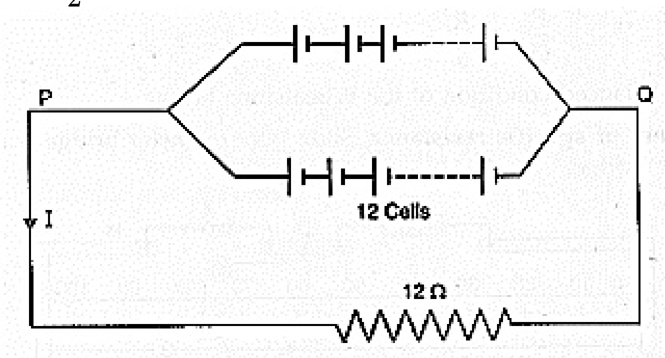
The current in the circuit is

$$I = \frac{\text{Total emf}}{\text{Total resistance}}$$

$= \frac{1.5 \times 12}{12+12} = \frac{18}{24}$ = 0.75 A

Because of two rows have the same resistance, the current in each arm must be

$= \frac{0.75}{2}$ = 0.375 A



Therefore, current through each cell = 0.375 A

The potential difference across the external resistance is

$= 12 \times 0.75$ = 9 V