Unit - 2 Current Electricity

Creative One-Mark Questions and Answers

1. The carrier density (number of free electrons per m 3) in metallic conductors is of the order of
   (a) 10^{10} (b) 10^{16}
   (c) 10^{22} (d) 10^{28}
   Ans: (d) 10^{28}; $J = nev_d$
2. The drift velocity of electrons in a metallic conductor carrying a current is usually of the order of
   (a) 1 cm^2/s (b) 10 m/s
   (c) 10^{-4} m/s (d) 10^8 m/s
   Ans: (c) 10^{-4} m/s in book
3. The resistance of a metallic conductor increases with temperature due to
   (a) change in carrier density
   (b) change in the dimensions of the conductor
   (c) increase in the number of collisions among the carriers
   (d) increase in the rate of collisions between the carriers and the vibrating atoms of the conductor
   Ans:(c) increase in the number of collisions among the carriers
4. A piece of copper and another of germanium are cooled from room temperature to 80 K. The resistance of
   (a) each of them increases (b) each of them decreases
   (c) copper increases and that of germanium decreases
   (d) copper decreases and that of germanium increases
   Ans: (d) copper decreases and that of germanium increases
5. A straight conductor of uniform cross-section carries a current *I*. Let *s* = specific charge of an electron. The momentum of all the free electrons per unit length of the conductor, due to their drift velocities only, is
   (a) *Is* (b) *I/s* (c) $\sqrt{I/s}$ (d) $(I/s)^2$
   Ans: (b) *I/s*

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$I = Avne$. No. of free electrons per unit length $= 1 \times A \times n$.

Momentum of each free electron $= mv$.

$$\therefore \quad \text{momentum per unit length} = Anmv = \frac{I}{e} m = \frac{I}{(e/m)} = \frac{I}{s}.$$

6. Current flows through a metallic conductor whose area of cross-section increases in the direction of the current. If we move in this direction,
   (a) the current will change (b) the carrier density will change
   (c) the drift velocity will increase (d) the drift velocity will decrease
   Ans: (d) the drift velocity will decrease
7. A nonconducting ring of radius R has charge Q distributed unevenly over it. If it rotates with an angular velocity ω, the equivalent current will be
   (a) zero (b) $Q\omega$
   (c) $Q\ (\omega/2\pi)$ (d) $Q\ (\omega/2\pi R)$
   Ans: (c) $Q\ (\omega/2\pi)$

   With each rotation, charge Q crosses any fixed point P near the ring. Number of rotations per second $= \omega/2\pi$.

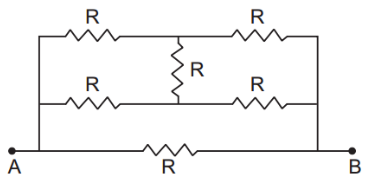
$$\therefore \quad \text{charge crossing P per second} = \text{current} = \frac{Q\omega}{2\pi}.$$

8. All the edges of a block with parallel faces are unequal. Its longest edge is twice its shortest edge. The ratio of the maximum to minimum resistance between parallel faces is
   (a) 2 (b) 4 (c) 8
   (d) indeterminate unless the length of the third edge is specified
   Ans: (b) 4

   Let the edges be $2l$, a and l, in decreasing order.

$$R_{max} = \rho \frac{2l}{al} = \frac{2\rho}{a} \qquad R_{min} = \rho \frac{l}{2la} = \frac{\rho}{2a} \qquad \frac{R_{max}}{R_{min}} = 4.$$

9. In the network shown below, the equivalent resistance between A and B is

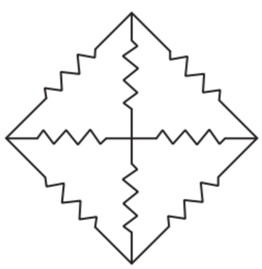


(a) $R/2$ (b) R
(c) $2R$ (d) $4R$

Ans: (a) R/2

By symmetry, points A and B are at the same potential. Thus, removing the resistance R between A and B, the circuit reduces to three resistances of $2R$, $2R$ and R in parallel.

10. In the network shown, each resistance is equal to R. The equivalent resistance between diagonally opposite corners is

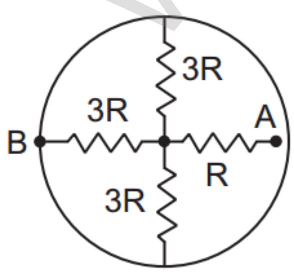


(a) R (b) $R/3$
(c) $2R/3$ (d) $4R/3$

Ans: c) 2R/3

Use symmetry to identify points at the same potential. Remove the resistances connected between such points. The circuit is then rearranged and simplified.

11. In the network shown below, the ring has zero resistance. The equivalent resistance between the point A and B is



(a) 2R (b) 4R (c) 7R (d) 10R

Ans: (a) 2R

As the ring has no resistance, the three resistances of 3R each are in parallel.

12. N identical cells are connected to form a battery. When the terminals of the battery are joined directly (short-circuited), current I flows in the circuit. To obtain the maximum value of I,

(a) all the cells should be joined in series

(b) all the cells should be joined in parallel

(c) two rows of $N/2$ cells each should be joined in parallel

(d) $\sqrt{N}$ rows of $\sqrt{N}$ cells each should be joined in parallel, given that $\sqrt{N}$ is an integer

Ans: (b) all the cells should be joined in parallel

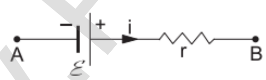
For series connection, $I_{max} = \dfrac{N\mathcal{E}}{Nr} = \dfrac{\mathcal{E}}{r}$.

For parallel connection, $I_{max} = \dfrac{\mathcal{E}}{r/n} = \dfrac{N\mathcal{E}}{r}$.

13. n identical cells, each of emf E and internal resistance r, are joined in series to form a closed circuit. The potential difference across any one cell is

(a) zero (b) ξ (c) $\frac{\xi}{n}$ (d) $\frac{n-1}{n}\xi$

Ans: (a)Zero



Current in the circuit is $i = \dfrac{n\mathcal{E}}{nr} = \dfrac{\mathcal{E}}{r}$.

The equivalent circuit of one cell is shown in the figure above. Potential difference across the cell equals

$$V_A - V_B = -\mathcal{E} + ir = -\mathcal{E} + \frac{\mathcal{E}}{r}\cdot r = 0.$$

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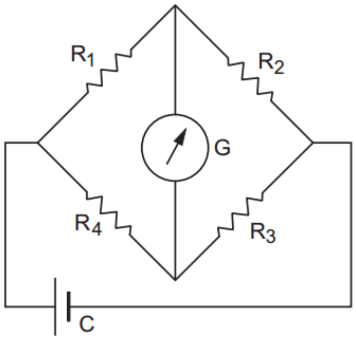
14. The Wheatstone bridge shown in the above figure is balanced. If the positions of the cell C and the galvanometer G are now interchanged, G will show zero deflection

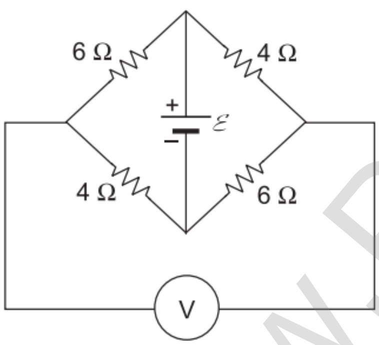


(a) in all cases
(b) only if all the resistances are equal
(c) only if $R_1 = R_3$ and $R_2 = R_4$
(d) only if $R_1/R_3 = R_2/R_4$

Ans: a)in all cases

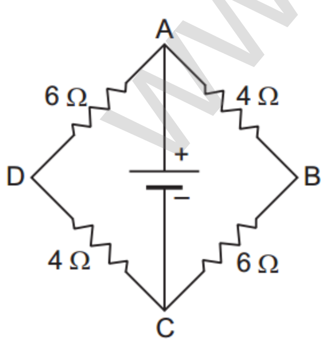
In a Wheatstone bridge, the deflection in the galvanometer does not change if the battery and galvanometer are interchanged.

15. In the circuit shown above, the voltmeter is of large resistance. The emf of the cell is ξ. The reading of the voltmeter is



(a) zero
(b) $\frac{\mathcal{E}}{10}$
(c) $\frac{\mathcal{E}}{5}$
(d) $\frac{\mathcal{E}}{2}$

Ans: ©



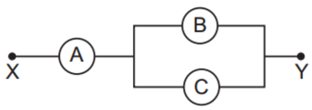
Let $\mathcal{E}$ = emf of the cell.

$$V_A - V_B = \frac{\mathcal{E}}{4\,\Omega + 6\,\Omega} \times 4\,\Omega = \frac{4\mathcal{E}}{10}.$$

$$V_A - V_D = \frac{\mathcal{E}}{6\,\Omega + 4\,\Omega} \times 6\,\Omega = \frac{6\mathcal{E}}{10}.$$

$$V_B - V_D = \frac{\mathcal{E}}{5}.$$

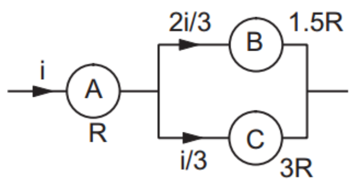
16. A, B and C are voltmeters of resistances R, $1.5R$ and $3R$ respectively. When some potential difference is applied between X and Y, the voltmeter readings are V_A, V_B and V_C respectively.



(a) $V_A = V_B = V_C$ (b) $V_A \neq V_B = V_C$

(c) $V_A = V_B \neq V_C$ (d) $V_B \neq V_A = V_C$

Ans: **(a)**



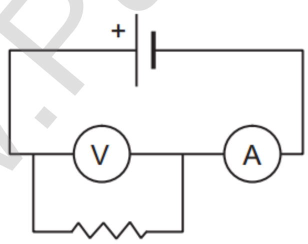
$$V_A = iR \qquad V_B = \frac{2i}{3}(1.5R) = iR \qquad V_C = \left(\frac{i}{3}\right)(3R) = iR.$$

17. An ammeter and a voltmeter are joined in series to a cell. Their readings are A and V respectively. If a resistance is now joined in parallel with the voltmeter,

(a) both A and V will increase (b) both A and V will decrease

(c) A will decrease, V will increase (d) A will increase, V will decrease

Ans:(d) *A* will increase, *V* will decrease



When a resistance is joined in parallel with the voltmeter, the total resistance of the circuit decreases. Current will increase and ammeter reading will increase. The equivalent resistance across the voltmeter decreases and hence its reading will decrease.

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18. A cell of internal resistance r drives a current through an external resistance R. The power delivered by the cell to the external resistance is maximum when

(a) $R = r$ (b) $R >> r$ (c) $R << r$ (d) $R = 2r$

Ans: (a) $R = r$

Let $\mathcal{E}$ = emf of the cell, i = current in the circuit.

$$i = \frac{\mathcal{E}}{R + r}.$$

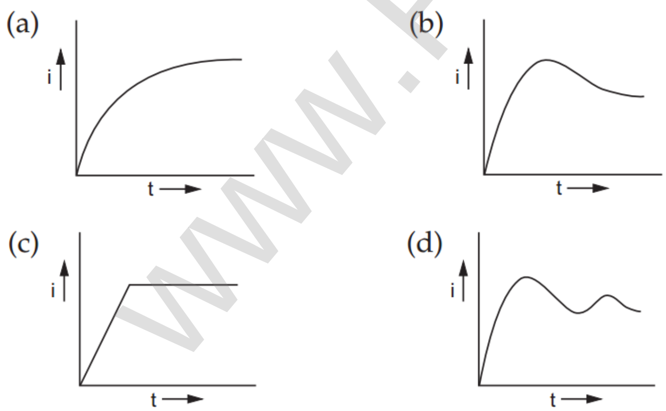
Power delivered to $R = P = i^2 R = \frac{\mathcal{E}^2 R}{(R+r)^2} = f(R)$.

For P to be maximum, $\frac{dP}{dR} = 0 = \mathcal{E}^2 \left[\frac{1}{(R+r)^2} - \frac{2R}{(R+r)^3} \right]$

or $2R = R + r$

or $R = r$.

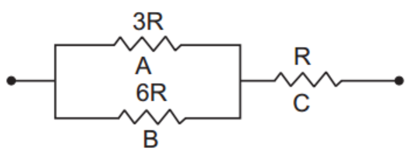
19. When an electric heater is switched on, the current flowing through it (i) is plotted against time (t). Taking into account the variation of resistance with temperature, which of the following best represents the resulting curve?



Ans: (b)

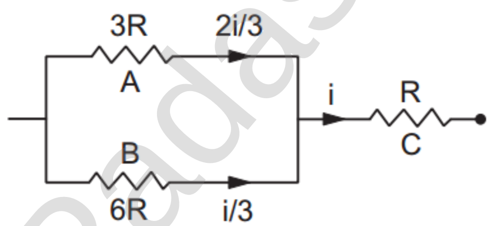
The filament of the heater reaches its steady resistance when the heater reaches its steady temperature, which is much higher than the room temperature. The resistance at room temperature is thus much lower than the resistance at its steady state. When the heater is switched on, it draws a larger current than its steady-state current. As the filament heats up, its resistance increases and the current falls to its steady-state value.

20. The three resistances A, B and C have values 3*R*, 6*R* and *R* respectively. When some potential difference is applied across the network, the thermal powers dissipated by A, B and C are in the ratio



(a) 2 : 3 : 4 (b) 2 : 4 : 3
(c) 4 : 2 : 3 (d) 3 : 2 : 4

Ans: (c) 4 : 2 : 3



$$\text{Thermal power in A} = P_A = \left(\frac{2i}{3}\right)^2 3R = \frac{4}{3} i^2 R.$$

$$\text{Thermal power in B} = P_B = \left(\frac{i}{3}\right)^2 6R = \frac{2}{3} i^2 R.$$

$$\text{Thermal power in C} = P_C = i^2 R.$$

21. An electric bulb is designed to draw P_0 power at V_0 voltage. If the voltage is V, it draws P power. Then,

(a) $P = \frac{V_0}{V} P_0$ (b) $P = \frac{V}{V_0} P_0$

(c) $P = \left(\frac{V}{V_0}\right)^2 P_0$ (d) $P = \left(\frac{V_0}{V}\right)^2 P_0$

Ans: ©

Let R = resistance of the bulb.

$$P_0 = \frac{V_0^2}{R} \quad \text{or} \quad R = \frac{V_0^2}{P_0}.$$

$$P = \frac{V^2}{R} = \frac{V^2}{(V_0^2/P_0)} = \left(\frac{V}{V_0}\right)^2 P_0.$$

22. An electric bulb rated for 500 watts at 100 volts is used in a circuit having a 200-volt supply. The resistance R that must be put in series with the bulb, so that the bulb draws 500 watts is

(a) 10 Ω (b) 20 Ω (c) 50 Ω (d) 100 Ω

Ans: (b) 20 Ω I=P/V = 5A; R = V/I = 20ohm

23. Two electric bulbs A and B are designed for the same voltage. Their power ratings are PA and PB respectively, with PA > PB. If they are joined in series across a V-volt supply,

(a) A will draw more power than B
(b) B will draw more power than A
(c) the ratio of powers drawn by them will depend on V
(d) A and B will draw the same power

Ans:(b) B will draw more power than A

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P = V^2/R. The bulb with higher power rating has lower resistance, and vice versa. When the bulbs are joined in series, they draw the same current. As $P = i^2R$, the bulb with the lower power rating draws more power.

24. n identical light bulbs, each designed to draw P power from a certain voltage supply, are joined in series across that supply. The total power which they will draw is

(a) nP (b) P (c) P/n (d) P/n^2

ans:* (c) *P/n

Let V = voltage of the source, R = resistance of each bulb.

$\therefore \quad R = V^2/P$.

When n bulbs are joined in series across V, current in each bulb

$$= i = \frac{V}{nR}.$$

$$\text{Power drawn by each bulb} = i^2R = \frac{V^2}{n^2R^2} \cdot R = \frac{V^2}{n^2R} = \frac{P}{n^2}.$$

Total power drawn $= n \times P/n^2 = P/n$.

25. When a 500-W electric bulb and a 500-W heater operate at their rated voltages, the filament of the bulb reaches a much higher temperature than the filament of the heater. The most important reason for this is that

(a) their resistances are not equal

(b) they are made of different materials

(c) their dimensions are very different

(d) they radiate different powers at different temperatures

Ans: (c) their dimensions are very different

As the bulb and the heater have the same power rating, they must radiate the same power. The power radiated depends on the surface area and the temperature of the filament. The filament of the heater is much longer and thicker than that of the bulb, and hence has greater surface area. It can therefore radiate the same power as the bulb, at a temperature lower than that of the bulb.

26. If the length of the filament of a heater is reduced by 10%, the power of the heater will

(a) increase by about 9% (b) increase by about 11%

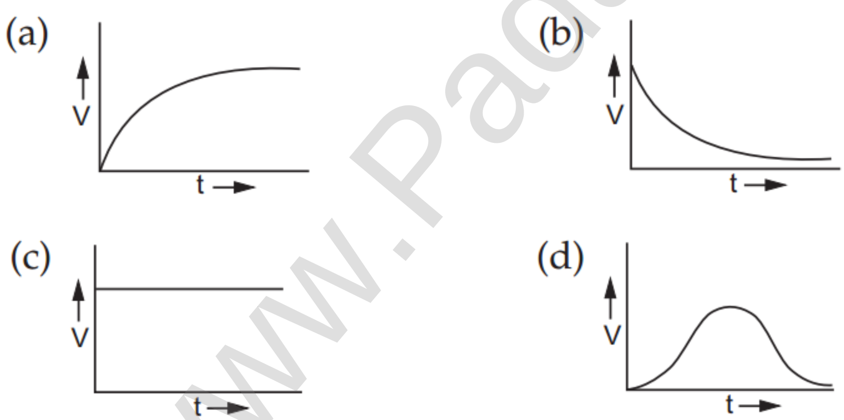
(c) increase by about 19% (d) decrease by about 10%

Ans:(b) increase by about 11%

$P = V^2/R$

R'=R-10%R

27. An ideal cell is connected to a capacitor through a voltmeter. The reading *V* of the voltmeter is plotted against time. Which of the following best represents the resulting curve?



Ans:b)

This is basically an *RC* circuit, charging from a cell. The resistance (*R*) of the voltmeter is the resistance in the circuit. The voltage across R = circuit current $\times R$ = reading of the voltmeter

(*V*). Thus, the nature of the *V–t* curve is the same as the nature of the *I–t* curve.

28.A wire of 9 Ω is bent to form an equilateral triangle. Find the resistance across one of the sides.

(a) 5*Ω* (b) 3 *Ω* (c) 2 *Ω* (d) 3/2 *Ω*

Solution (c) Note that 6 Ω and 3 Ω are in parallel

$$R_{eq} = \frac{6 \times 3}{6+3} = 2\ \Omega$$

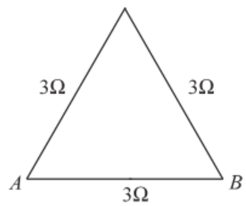
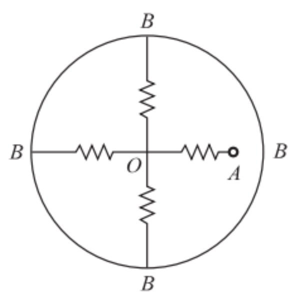


Fig. 4.28

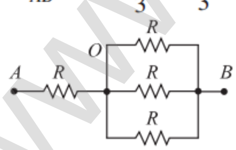
29.Find the equivalent resistance between *AB* in the fig. 4.29(a) below. Each resistance is *R*.



(a) 3*R*/4 (b) *R* (c) 4*R*/3 (d) *R*/4

Solution (c) The equivalent circuit is

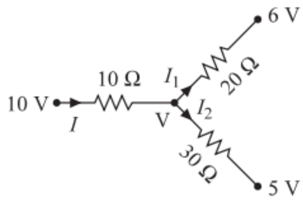
$$R_{AB} = R + \frac{R}{3} = \frac{4R}{3}$$



(b)

Fig. 4.29

30.Find current I in the given circuit.



(a) 0.2A (b) 0 (c) 9.1A (d) none of these

Solution (a) Apply junction law

$I = I_1 + I_2$

$$\frac{10 - V}{10} = \frac{V - 6}{20} + \frac{V - 5}{30}$$

or $$\frac{5.5\,V}{30} = 1 + \frac{3}{10} + \frac{1}{6}$$

$$\frac{5.5\,V}{30} = \frac{30 + 9 + 5}{30} \quad \text{or} \quad V = \frac{44}{5.5} = 8\,V$$

and $I = 0.2$A.

31.In a Wheatstone bridge all the four arms have equal resistance R. If the resistance of the galvanometer arm is also R, then the equivalent resistance of the combination as seen by the battery is

(a) $2R$ (b) $R/4$ (c) $R/2$ (d) R

Solution (d) See shortcut rule 9. Hence $R_{eq} = R$.

32.Two wires of same material having length l and $2l$ and cross-sectional areas $4A$ and A respectively. The ratio of their specific resistances would be

(a) 1 : 2 (b) 8 : 1 (c) 1 : 8 (d) 1 : 1

Solution (d) Specific resistance does not depend upon the length or area of cross-section.

33.Siemen is the unit of

(a) resistance (b) conductance

(c) resistivity (d) conductivity

Solution (b)

---------------All The Best-------------

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