Engineering Daily 22 [Set 03] EV

Current Electricity

Total Marks: 50 **Negative Marks:** 0.25 **Time:** 1 Hour

MCQ 50 marks

1. A copper wire of diameter 2 mm ($n_{Cu} = 8.5 \times 10^{28}\ m^{-3}$) and an aluminium wire of diameter 1 mm ($n_{Al} = 6 \times 10^{28}\ m^{-3}$) are joined end to end in a circuit. What is the ratio of the drift velocity of electrons in the aluminium wire to that in the copper wire?

(A) 2.83 (B) 4 (C) 1.42 (D) 5.67

2. The instantaneous current in a conductor is $I = (3t^2 + 2t)$ A. What is the charge that flows from $t = 0$ to $t = 2$ s?

(A) 14 C (B) 8 C (C) 16 C (D) 12 C

3. A current of 4 A flows through a copper wire of cross-sectional area 2 mm^2. If the free-electron density of copper is $8.5 \times 10^{28}\ m^{-3}$, what is the drift velocity of the electrons?

(A) $1.47 \times 10^{-4}\ ms^{-1}$ (B) $1.47 \times 10^{-2}\ ms^{-1}$
(C) $7.35 \times 10^{-5}\ ms^{-1}$ (D) $2.94 \times 10^{-4}\ ms^{-1}$

4. A uniform wire of resistance 25 Ω is stretched so that its length increases by 20% (volume unchanged). The wire is then cut into three equal pieces and the pieces are connected in parallel. What is the equivalent resistance of the combination?

(A) 4 Ω (B) 3.33 Ω (C) 2.78 Ω (D) 12 Ω

5. The ratio of the lengths of two wires of the same material is 2 : 3 and the ratio of their diameters is 1 : 2. What is the ratio of their resistances?

(A) 1 : 3 (B) 8 : 3 (C) 3 : 8 (D) 4 : 3

6. Resistors of 10 Ω ($\alpha_1 = 0.004\ °C^{-1}$) and 30 Ω ($\alpha_2 = 0.002\ °C^{-1}$) at 0°C are connected in series. What is the effective temperature coefficient of the combination?

(A) $6 \times 10^{-3}\ °C^{-1}$ (B) $3 \times 10^{-3}\ °C^{-1}$
(C) $3.5 \times 10^{-3}\ °C^{-1}$ (D) $2.5 \times 10^{-3}\ °C^{-1}$

7. A battery has a terminal potential difference of 11 V while supplying a current of 2 A, and 12.5 V while being charged by an external source at 1 A. What is the emf of the battery?

(A) 11.5 V (B) 12.5 V (C) 11.75 V (D) 12 V

8. Several bulbs rated '6 V – 1.5 W' are to be connected in series across a 220 V line for decoration. What is the minimum number of bulbs needed so that no bulb receives more than its rated voltage?

(A) 37 (B) 38 (C) 147 (D) 36

9. Some identical resistors give an equivalent resistance of 50 Ω when connected in series and 2 Ω when connected in parallel. What is the value of each resistor?

(A) 25 Ω (B) 10 Ω (C) 12.5 Ω (D) 5 Ω

10. A carbon resistor ($\alpha = -5 \times 10^{-4}\ °C^{-1}$) and an iron wire ($\alpha = 5 \times 10^{-3}\ °C^{-1}$) are connected in series, giving an equivalent resistance of 22 Ω at 0°C. If the resistance of the combination is independent of temperature, what is the resistance of the carbon resistor?

(A) 18 Ω (B) 11 Ω (C) 20 Ω (D) 2 Ω

11. Each of the 12 edges of a cube has a resistance of 6 Ω. What is the equivalent resistance between the two ends of a body diagonal of the cube?

(A) 4.5 Ω (B) 6 Ω (C) 5 Ω (D) 3.5 Ω

12. By varying the external resistance of a battery, it is found that a maximum power of 25 W is dissipated when the external resistance is 4 Ω. What is the current in the circuit when the external resistance is 6 Ω?

(A) 2.5 A (B) 2 A (C) 1.67 A (D) 3.33 A

13. Resistors of 3 Ω and 6 Ω are connected in parallel and a 4 Ω resistor is connected in series with this combination. The combination is connected to an ideal 12 V battery. What is the current through the 3 Ω resistor?

(A) 1 A (B) 2 A (C) $\frac{4}{3}$ A (D) $\frac{2}{3}$ A

14. A galvanometer of resistance 100 Ω has a full-scale current of 1 mA. It is first converted into an ammeter of range 0–100 mA using a shunt. What resistance must then be connected in series with this ammeter to convert it into a voltmeter of range 0–10 V?

(A) 9900 Ω (B) 99 Ω (C) 100 Ω (D) 9999 Ω

15. A cell gives a current of 1 A when a 4 Ω resistor is connected to it and 0.5 A when a 9 Ω resistor is connected. What is the emf of the cell?

(A) 5 V (B) 6 V (C) 4 V (D) 4.5 V

16. What is the maximum power that a battery of emf 10 V and internal resistance 2 Ω can deliver to a variable external resistance?

(A) 50 W (B) 6.25 W (C) 25 W (D) 12.5 W

17. Twelve cells, each of emf 2 V and internal resistance 1 Ω, are arranged in a mixed grouping to obtain the maximum current through an external resistance of 3 Ω. What is the maximum current?

(A) 1.6 A (B) 2 A (C) 4 A (D) 1.71 A

18. The four arms of a Wheatstone bridge have resistances P = 4 Ω, Q = 6 Ω, R = 8 Ω and S = 20 Ω. What resistance must be connected in parallel with S to balance the bridge?

(A) 12 Ω (B) 8 Ω (C) 20 Ω (D) 30 Ω

19. In a meter bridge, a 6 Ω resistor is placed in the left gap and an unknown resistor X in the right gap, and the null point is found 40 cm from the left end. If an 18 Ω resistor is connected in parallel with X, how far from the left end will the null point be?

Ⓐ 50 cm Ⓑ 57.1 cm Ⓒ 40 cm Ⓓ 60 cm

20. In a series circuit carrying a steady current, the potential difference across R_1 is balanced on a potentiometer at a length of 40 cm, and the combined potential difference across R_1 and R_2 is balanced at 60 cm. If $R_1 = 10\ \Omega$, what is the value of R_2?

Ⓐ 6.67 Ω Ⓑ 5 Ω Ⓒ 15 Ω Ⓓ 20 Ω

21. What length of copper wire of cross-sectional area 1 mm^2 ($\rho = 1.7 \times 10^{-8}\ \Omega m$) is needed to make a shunt of 0.02 Ω?

Ⓐ 1.18 m Ⓑ 11.8 m Ⓒ 0.85 m Ⓓ 0.118 m

22. On a potentiometer, the balancing length for the open-circuit emf of a cell is 80 cm. When a 4 Ω resistor is connected across the cell, the balancing length becomes 64 cm. What is the internal resistance of the cell?

Ⓐ 0.5 Ω Ⓑ 1.25 Ω Ⓒ 0.8 Ω Ⓓ 1 Ω

23. A galvanometer of resistance 50 Ω gives full-scale deflection for a current of 5 mA. What shunt is needed to convert it into an ammeter of range 0–1 A?

Ⓐ 0.0251 Ω Ⓑ 2.51 Ω Ⓒ 0.251 Ω Ⓓ 0.5 Ω

24. A voltmeter is marked '1000 ΩV^{-1}' and has a range of 0–10 V. What resistance must be connected in series with it to measure up to 50 V?

Ⓐ 4 kΩ Ⓑ 10 kΩ Ⓒ 50 kΩ Ⓓ 40 kΩ

25. An ammeter of resistance 0.9 Ω has a range of 0–1 A. What is its new range if a shunt of 0.1 Ω is connected to it?

Ⓐ 0–9 A Ⓑ 0–11 A Ⓒ 0–10 A Ⓓ 0–1.1 A

26. A voltmeter of resistance 1000 Ω is connected in series with a high unknown resistance R across an ideal 120 V source, and the voltmeter reads 20 V. What is the value of R?

Ⓐ 4000 Ω Ⓑ 200 Ω Ⓒ 6000 Ω Ⓓ 5000 Ω

27. How long will a 1000 W heater take to heat 2 kg of water from 25°C to 100°C? (Specific heat of water 4200 $Jkg^{-1}K^{-1}$; neglect heat loss)

Ⓐ 5.25 min Ⓑ 10.5 min
Ⓒ 14 min Ⓓ 8.4 min

28. Of three identical bulbs A, B and C rated '220 V – 60 W', B and C are connected in parallel and A is connected in series with them, and the combination is connected to a 220 V line. What is the power dissipated in bulb A? (Assume the resistance is constant)

Ⓐ 26.7 W Ⓑ 6.67 W Ⓒ 60 W Ⓓ 40 W

29. Two bulbs rated '220 V – 100 W' and '220 V – 60 W' are connected in series across a 220 V source. Which bulb will glow brighter?

Ⓐ Neither will glow Ⓑ Both equally
Ⓒ The 100 W bulb Ⓓ The 60 W bulb

30. In a house, 5 fans of 80 W run 10 h daily and 4 lamps of 40 W run 6 h daily. If the cost per unit is 6 taka, what is the electricity bill for 30 days?

Ⓐ 720 taka Ⓑ 148.8 taka
Ⓒ 892.8 taka Ⓓ 864 taka

31. A battery of emf 6 V with a 2 Ω resistor is in one branch, and another battery of 3 V with a 1 Ω resistor is in another branch. These two branches and a 3 Ω resistor form three parallel branches between two junctions. The positive terminals of both batteries point towards the same junction (internal resistances negligible). What is the current through the 3 Ω resistor?

Ⓐ 0.82 A Ⓑ 1.09 A Ⓒ 3 A Ⓓ 1.5 A

32. Two wires of equal length and equal cross-section, with resistivities $2 \times 10^{-8}\ \Omega m$ and $6 \times 10^{-8}\ \Omega m$, are joined end to end to form a single wire. What is the effective resistivity of the combined wire?

Ⓐ $4 \times 10^{-8}\ \Omega m$ Ⓑ $1.5 \times 10^{-8}\ \Omega m$
Ⓒ $3 \times 10^{-8}\ \Omega m$ Ⓓ $8 \times 10^{-8}\ \Omega m$

33. The resistance of a coil is 10 Ω at 20°C and 12 Ω at 70°C. What is the temperature coefficient of resistance with respect to 0°C?

Ⓐ $4.35 \times 10^{-3}\ °C^{-1}$ Ⓑ $5 \times 10^{-3}\ °C^{-1}$
Ⓒ $4 \times 10^{-3}\ °C^{-1}$ Ⓓ $3.33 \times 10^{-3}\ °C^{-1}$

34. At 0°C, a copper wire has a resistance of 4 Ω ($\alpha = 0.004\ °C^{-1}$) and an iron wire has a resistance of 3.6 Ω ($\alpha = 0.006\ °C^{-1}$). At what temperature will the two wires have equal resistance?

Ⓐ 71.4°C Ⓑ 40°C
Ⓒ 66.7°C Ⓓ 100°C

35. In the V –I graphs of the same wire at two different temperatures T_1 and T_2 (with V on the vertical axis), the graph for T_1 has the greater slope. Then—

Ⓐ $T_1 > T_2$
Ⓑ $T_1 < T_2$
Ⓒ $T_1 = T_2$
Ⓓ Nothing can be said about the temperatures

36. If all the energy stored in a fully charged '12 V – 50 Ah' battery is converted to heat and given to 50 kg of water, by how much will the temperature of the water rise? (Specific heat of water 4200 $Jkg^{-1}K^{-1}$)

Ⓐ 514.3°C Ⓑ 10.29°C
Ⓒ 12.86°C Ⓓ 2.86°C

37. If the current is kept unchanged but a wire of the same material with half the diameter is used, by what factor does the drift velocity of the electrons change?

(A) $\frac{1}{2}$ times (B) 4 times (C) 2 times (D) $\frac{1}{4}$ times

38. Each section of an infinite ladder network has a 2 Ω series resistor and a 2 Ω shunt resistor. What is the equivalent resistance between the input terminals?

(A) 2.83 Ω (B) 1.24 Ω (C) 4 Ω (D) 3.24 Ω

39. A regular hexagon is made from six resistors of 6 Ω each. What is the equivalent resistance between any two adjacent vertices of the hexagon?

(A) 9 Ω (B) 6 Ω (C) 5 Ω (D) 8 Ω

40. A uniform wire of resistance 24 Ω is bent into a circle. What is the equivalent resistance between two points separated by one-quarter of the circumference?

(A) 6 Ω (B) 12 Ω (C) 4.5 Ω (D) 3 Ω

41. Resistors of 2 kΩ and 4 kΩ are connected in series to an ideal 12 V source. If a voltmeter of resistance 4 kΩ is connected across the 4 kΩ resistor, what does it read?

(A) 4 V (B) 8 V (C) 6 V (D) 12 V

42. A voltmeter of resistance 100 Ω is connected in parallel across a resistor, and an ideal ammeter is connected in series with this combination. If the ammeter reads 2 A and the voltmeter reads 10 V, what is the actual value of the resistor?

(A) 5.5 Ω (B) 5.26 Ω (C) 5 Ω (D) 4.76 Ω

43. A battery of emf 10 V and internal resistance 0.5 Ω is being charged at 2 A. What is the terminal voltage of the battery during charging?

(A) 11 V (B) 9 V (C) 12 V (D) 10 V

44. A cell of emf 6 V and internal resistance 1 Ω supplies current to an external resistance of 2 Ω. What is the efficiency of the cell?

(A) 33.3% (B) 50% (C) 66.7% (D) 75%

45. Of the two coils of a kettle, one used alone boils a certain amount of water in 10 min and the other in 15 min. How long will it take to boil the same water if the two coils are connected in parallel across the same source?

(A) 25 min (B) 12.5 min (C) 5 min (D) 6 min

46. Half the length of the coil of a 220 V – 1100 W heater is cut off and the remaining part is used on the same source. What will its power be?

(A) 4400 W (B) 2200 W (C) 550 W (D) 1100 W

47. A '220 V – 100 W' bulb is connected to a 220 V line through a long connecting wire of resistance 16 Ω. What is the actual power in the bulb? (Bulb resistance constant)

(A) 88 W (B) 96.8 W (C) 93.7 W (D) 100 W

48. A 3 Ω resistor and a variable resistor R are connected in parallel across the terminals of a battery of emf 9 V and internal resistance 1 Ω. What is the maximum power that can be dissipated in R?

(A) 20.25 W (B) 6.75 W (C) 15.19 W (D) 13.5 W

49. Resistors of 2 Ω, 4 Ω and 6 Ω are connected in series, in that order, from the positive terminal of an ideal 12 V battery back to its negative terminal. If the junction of the 2 Ω and 4 Ω resistors is grounded (potential zero), what is the potential of the negative terminal of the battery?

(A) −10 V (B) −6 V (C) −2 V (D) 10 V

50. A hollow copper tube 5 m long has an inner diameter of 2 mm and an outer diameter of 3 mm. What is its resistance along its length? ($\rho = 1.7 \times 10^{-8}$ Ωm)

(A) 0.0068 Ω (B) 0.0216 Ω (C) 0.0120 Ω (D) 0.0866 Ω