MCQ 50 marks

1. **A. 1.33 times**
Explanation: Both batteries have the same voltage, so energy is proportional to charge
Effectively transferable charge = 0.8 × 5000 = 4000 mAh
Therefore, number of charges = $\frac{4000}{3000}$ = 1.33 times

2. **B.** 23 A
Explanation: $I = \frac{dq}{dt} = 10t + 3$
At t = 2 s, I = 10 × 2 + 3
Therefore, I = 23 A

3. **D.** 0.034 Vm^{-1}
Explanation: $J = \sigma E = \frac{E}{\rho} \Rightarrow E = \rho J$
$= 1.7 \times 10^{-8} \times 2 \times 10^{6}$
Therefore, E = 0.034 Vm^{-1}

4. **A.** 10^{29} m^{-3}
Explanation: $I = nAev_d \Rightarrow n = \frac{I}{Aev_d}$
$= \frac{1.6}{10^{-6} \times 1.6 \times 10^{-19} \times 10^{-4}}$
Therefore, n = 10^{29} m^{-3}

5. **D.** 3 Ω
Explanation: Folding twice puts four layers in parallel
Length of each layer is $\frac{l}{4}$, so its resistance = $\frac{48}{4}$ = 12 Ω
Four layers in parallel: $R = \frac{12}{4}$
Therefore, R = 3 Ω

6. **D. 21%**
Explanation: For constant volume, $R \propto l^2$
$R' = R(1.1)^2 = 1.21R$
Therefore, increase in resistance = 21%

7. **C.** 125°C
Explanation: $1 + 50\alpha = 1.2 \Rightarrow \alpha = 0.004\ °C^{-1}$
$1 + 0.004\theta = 1.5$
Therefore, θ = 125°C

8. **B.** 1 : 8
Explanation: $\rho = \frac{R\pi r^2}{l}$; R is equal
$\frac{\rho_A}{\rho_B} = \left(\frac{r_A}{r_B}\right)^2 \times \frac{l_B}{l_A}$
$= \frac{1}{4} \times \frac{1}{2}$
Therefore, $\rho_A : \rho_B = 1 : 8$

9. **D.** 3.6 Ω
Explanation: $\frac{2}{4} = \frac{3}{6}$, so the bridge is balanced and no current flows through the 5 Ω resistor
The two paths are in parallel: $R = \frac{(2+4)(3+6)}{(2+4)+(3+6)}$
$= \frac{54}{15}$
Therefore, R = 3.6 Ω

10. **C.** 4 Ω
Explanation: $r = \frac{E-V}{I} = \frac{9-8}{2} = 0.5\ \Omega$
$R = \frac{V}{I} = \frac{8}{2}$
Therefore, R = 4 Ω

11. **B. 4**
Explanation: Let there be n equal parts; each has resistance $\frac{12}{n}$
In parallel, $R = \frac{1}{n} \times \frac{12}{n} = \frac{12}{n^2} = 0.75$
$n^2 = 16$
Therefore, n = 4

12. **A.** 4 Ω
Explanation: $\frac{V}{E} = \frac{R}{R+r} = 0.8$
R = 0.8R + 0.8
Therefore, R = 4 Ω

13. **C.** 1.6 A
Explanation: With one cell reversed, E_{net} = (9 − 1) × 2 = 16 V
Internal resistance is unchanged: r = 10 × 0.5 = 5 Ω
Therefore, $I = \frac{16}{5+5}$ = 1.6 A

14. **B. 6**
Explanation: The total resistance is unchanged, so $I \propto E_{net}$
$\frac{(n-2)E}{nE} = \frac{2}{3}$
3n − 6 = 2n
Therefore, n = 6

15. **D. 2 rows with 8 cells in each row**
Explanation: Let there be n cells in each row and m rows; nm = 16
Condition for maximum current: $\frac{nr}{m} = R \Rightarrow \frac{0.5n}{m} = 2 \Rightarrow n = 4m$

$4m^2 = 16 \Rightarrow m = 2$
Therefore, n = 8, i.e. 2 rows with 8 cells in each row

16. **D.** $4\,\Omega$
Explanation: $P_{max} = \frac{E^2}{4r}$
$9 = \frac{144}{4r}$
Therefore, $r = 4\,\Omega$

17. **A.** $7\,\Omega$
Explanation: The bridge is not balanced; let $V_A = V$ and $V_B = 0$
By symmetry, $V_C + V_D = V$
Kirchhoff's law at C: $\frac{V-V_C}{5} = \frac{V_C}{10} + \frac{V_C-V_D}{5}$
Substituting $V_D = V - V_C$, $V_C = \frac{4V}{7}$, $V_D = \frac{3V}{7}$
Total current $I = \frac{V-V_C}{5} + \frac{V-V_D}{10} = \frac{3V}{35} + \frac{2V}{35} = \frac{V}{7}$
Therefore, $R_{AB} = \frac{V}{I} = 7\,\Omega$

18. **C.** $20\,\Omega$
Explanation: $\frac{P}{Q} = \frac{40}{60} \Rightarrow P = \frac{2Q}{3}$
With the null point in the middle, $P + 10 = Q$
$\frac{2Q}{3} + 10 = Q \Rightarrow Q = 30\,\Omega$
Therefore, $P = \frac{2\times30}{3} = 20\,\Omega$

19. **C.** $8.33 \times 10^{-7}\,\Omega m$
Explanation: $X = 10 \times \frac{25}{75} = 3.33\,\Omega$
$\rho = \frac{XA}{l} = \frac{3.33\times0.5\times10^{-6}}{2}$
Therefore, $\rho = 8.33 \times 10^{-7}\,\Omega m$

20. **D.** 3.75 m
Explanation: If the potential difference V across the wire is fixed, the potential gradient is $k = \frac{V}{L}$
$E = \frac{V}{4} \times 1.5 = \frac{V}{10} \times l$
Therefore, $l = \frac{10\times1.5}{4} = 3.75$ m

21. **B.** 80 cm
Explanation: $\frac{l_2}{l_1} = \frac{V}{E} = \frac{R}{R+r}$
$l_2 = 100 \times \frac{2}{2+0.5}$
Therefore, $l_2 = 80$ cm

22. **A.** $0.505\,\Omega$
Explanation: $\frac{GS}{G+S} = 0.5$
$50S = 0.5(50 + S) = 25 + 0.5S$
Therefore, $S = \frac{25}{49.5} = 0.505\,\Omega$

23. **B.** 0.2 A
Explanation: $I_g = I \times \frac{S}{G+S}$
$= 5 \times \frac{2}{48+2}$
Therefore, $I_g = 0.2$ A

24. **B.** 7.69 V
Explanation: $4\,\Omega$ and the voltmeter in parallel: $\frac{4\times20}{4+20} = 3.33\,\Omega$
$I = \frac{10}{3.33+1} = 2.308$ A
Therefore, voltmeter reading $V = 2.308 \times 3.33 = 7.69$ V

25. **D. the circuit current will be nearly zero and the voltmeter will show nearly the source voltage**
Explanation: A voltmeter has a very high resistance, so the circuit current becomes nearly zero
Almost the entire potential drop occurs across the voltmeter
Therefore, the circuit current will be nearly zero and the voltmeter will show nearly the source voltage

26. **A.** 17.5 min
Explanation: $H = ms\Delta\theta = 10 \times 4200 \times 40 = 1.68 \times 10^6$ J
Effective power = $0.8 \times 2000 = 1600$ W
$t = \frac{1.68\times10^6}{1600} = 1050$ s
Therefore, t = 17.5 min

27. **B.** $24\,\Omega$ **and** $8\,\Omega$
Explanation: In series, $R_1 + R_2 = \frac{V^2}{P_s} = \frac{144}{4.5} = 32\,\Omega$
In parallel, $\frac{R_1R_2}{R_1+R_2} = \frac{144}{24} = 6\,\Omega \Rightarrow R_1R_2 = 192$
$x^2 - 32x + 192 = 0$
Therefore, $x = 24\,\Omega$ and $8\,\Omega$

28. **A.** 111.1 W
Explanation: $R \propto l \Rightarrow R' = 0.9R$
$P = \frac{V^2}{R} \Rightarrow P \propto \frac{1}{R}$
Therefore, $P' = \frac{100}{0.9} = 111.1$ W

29. **A.** 1 : 6
Explanation: For equal l and A, $R \propto \rho \Rightarrow R_{Fe} = 6R_{Cu}$
In series the current is the same, $H = I^2Rt \Rightarrow H \propto R$
Therefore, $H_{Cu} : H_{Fe} = 1 : 6$

30. **C. 1382.4 taka**

Explanation: Tubelights: $3 \times 40 \times 8 = 960$ Wh
Refrigerator: $200 \times 24 = 4800$ Wh
Daily = 5760 Wh = 5.76 kWh
In 30 days = $5.76 \times 30 = 172.8$ kWh
Therefore, bill = $172.8 \times 8 = 1382.4$ taka

31. **C.** 6 V
Explanation: Current in the closed loop $I = \frac{8-4}{2+2} = 1$ A
The 8 V cell supplies the current
Therefore, terminal voltage $V = 8 - 1 \times 2 = 6$ V

32. **D.** 1 Ω **and** 4 Ω
Explanation: $P = \frac{E^2R}{(R+r)^2} = \frac{36R}{(R+2)^2} = 4$
$9R = R^2 + 4R + 4$
$R^2 - 5R + 4 = 0$
Therefore, R = 1 Ω or 4 Ω

33. **B.** 10 Ω
Explanation: $11.2 = R_0(1 + 30\alpha)$ and $13.2 = R_0(1 + 80\alpha)$
Subtracting, $50\alpha R_0 = 2 \Rightarrow \alpha R_0 = 0.04$
Therefore, $R_0 = 11.2 - 30 \times 0.04 = 10$ Ω

34. **A.** 10 Ω
Explanation: From $V = \frac{ER_V}{R_V + r}$, $1.35(90 + r) = 90E$ and $1.425(190 + r) = 190E$
From the first, $E = 0.015(90 + r)$
Substituting in the second, $1.425(190 + r) = 2.85(90 + r)$
$270.75 + 1.425r = 256.5 + 2.85r$
Therefore, r = 10 Ω (and E = 1.5 V)

35. **C.** $[ML^2T^{-3}A^{-2}]$
Explanation: $R = \frac{V}{I} = \frac{W}{QI} = \frac{W}{I^2t}$
$= \frac{ML^2T^{-2}}{A^2 \times T}$
Therefore, $R = [ML^2T^{-3}A^{-2}]$

36. **B.** 0.67 W
Explanation: $\frac{1}{R_p} = \frac{1}{2} + \frac{1}{3} + \frac{1}{6} = 1 \Rightarrow R_p = 1$ Ω
$I = \frac{10}{1+4} = 2$ A
Potential difference across the parallel part = $2 \times 1 = 2$ V
Therefore, $P_6 = \frac{2^2}{6} = 0.67$ W

37. **C.** 1 : 1
Explanation: $I = \frac{V}{R} = \frac{V\,A}{\rho l}$
$v_d = \frac{I}{nAe} = \frac{V}{ne\rho l}$
Since V , ρ, l and n are equal, v_d does not depend on the diameter
Therefore, $v_1 : v_2 = 1 : 1$

38. **C.** 7 Ω
Explanation: Equivalent resistance between the ends of one edge of a cube = $\frac{7R}{12}$
Here, R = 12 Ω
Therefore, $R_{eq} = \frac{7 \times 12}{12} = 7$ Ω

39. **C.** 266.7 J
Explanation: The current decreases uniformly with time, $I = 10 - 2.5t$
$H = \int_0^4 I^2R\,dt = 2\int_0^4 (10 - 2.5t)^2\,dt$
$\int_0^4 (10 - 2.5t)^2\,dt = \frac{10^3}{3 \times 2.5} = 133.3$
Therefore, $H = 2 \times 133.3 = 266.7$ J

40. **B. 85.7%**
Explanation: Terminal voltage $V = E + Ir = 12 + 4 \times 0.5 = 14$ V
Rate of conversion to chemical energy = EI = 48 W
Power supplied = V I = 56 W
Therefore, $\eta = \frac{48}{56} = 85.7\%$

41. **B.** 4.5 Ω
Explanation: The voltmeter measures the combined potential difference across the resistor and the ammeter (ideal voltmeter)
$\frac{V}{I} = R + R_A = \frac{10}{2} = 5$ Ω
Therefore, $R = 5 - 0.5 = 4.5$ Ω

42. **A.** 3.33 V
Explanation: Lower half 50 Ω and load 50 Ω in parallel: $\frac{50 \times 50}{50+50} = 25$ Ω
This is in series with the upper half of 50 Ω
Therefore, $V = 10 \times \frac{25}{50+25} = 3.33$ V

43. **A.** 1.4 V
Explanation: $r_{eq} = \frac{1.5}{5} = 0.3$ Ω, $E_{eq} = 2$ V
$I = \frac{2}{0.7+0.3} = 2$ A
Therefore, $V = IR = 2 \times 0.7 = 1.4$ V

44. **D. 18**
Explanation: Maximum permitted power = $220 \times 15 = 3300$ W
Power left for the bulbs = 3300 − 1500 =

1800 W
Therefore, number of bulbs = $\frac{1800}{100} = 18$

45. **A.** 333.3 W

Explanation: From $R = \frac{V^2}{P}$, in series $\frac{1}{P} = \frac{1}{P_1} + \frac{1}{P_2}$
$P = \frac{1000 \times 500}{1000+500}$
Therefore, $P = 333.3$ W

46. **B.** 8 : 1

Explanation: $R \propto \frac{1}{r^2} \Rightarrow \frac{R_1}{R_2} = \frac{1}{2} \times \frac{1}{4} = \frac{1}{8}$
In parallel V is the same, $H = \frac{V^2}{R}t \Rightarrow H \propto \frac{1}{R}$
Therefore, $H_1 : H_2 = 8 : 1$

47. **A. The** 40 W **bulb will fuse**

Explanation: $R_{60} = \frac{220^2}{60} = 806.7\,\Omega$, $R_{40} = \frac{220^2}{40} = 1210\,\Omega$
$I = \frac{440}{806.7+1210} = 0.218$ A
Voltage across the 40 W bulb = 0.218 × 1210 = 264 V, which exceeds the rated 220 V
Therefore, the 40 W bulb will fuse

48. **D.** 0.128 A

Explanation: Without the 10 Ω resistor (relative to the negative terminal): potential of the first midpoint = $12 \times \frac{8}{12} = 8$ V and of the second = $12 \times \frac{6}{12} = 6$ V
Thevenin voltage $V_{th} = 8 - 6 = 2$ V
$R_{th} = \frac{4\times8}{4+8} + \frac{6\times6}{6+6} = 2.67 + 3 = 5.67\,\Omega$
Therefore, $I = \frac{2}{5.67+10} = 0.128$ A

49. **D. Zero**

Explanation: Current in the loop $I = \frac{nE}{nr} = \frac{E}{r}$
Terminal voltage of one cell $V = E - Ir = E - \frac{E}{r} \times r$
Therefore, $V = 0$

50. **C.** 4 A

Explanation: Slope of the I–V graph = $\frac{1}{R} \Rightarrow R_1 = 0.5\,\Omega$, $R_2 = 2\,\Omega$
In series, $R = 0.5 + 2 = 2.5\,\Omega$
Therefore, $I = \frac{10}{2.5} = 4$ A