Current Electricity

Standard difficulty · 20 questions · 40 marks · Time: 38 minutes

Name: _____ Date: _____ Score: ____ / 40

Show your working for Sections B and C. Answers are on the last page — try every question first!

Section A — Choose the correct answer — 8 × 1 = 8 marks

1. A current of 4 A flows for 21 s. The charge that passes is:
(a) 84 C **(b)** 25 C **(c)** 5.25 C **(d)** 0.19 C

2. A wire 18 m long with cross-section 8 mm^2 has resistivity 37 × 10^{-8} Ω m. Its resistance is:
(a) 83.25 Ω **(b)** 0.08325 Ω **(c)** 0.8325 Ω **(d)** 0.16 Ω

3. The equivalent resistance of 2 Ω, 5 Ω in parallel is:
(a) 2.86 Ω **(b)** 7 Ω **(c)** 1.43 Ω **(d)** 2.43 Ω

4. A cell of emf 23 V and internal resistance 3 Ω is joined to a 7 Ω resistor. The terminal voltage is:
(a) 16.1 V **(b)** 29.9 V **(c)** 23 V **(d)** 6.9 V

5. Ohm's law states that, at a fixed temperature:
(a) V is proportional to I^2 **(b)** V is proportional to I
(c) R is proportional to I **(d)** V is proportional to 1/I

6. The power used by a 45 Ω resistor across 230 V is:
(a) 2,351.11 W **(b)** 5.11 W **(c)** 10,350 W **(d)** 1,175.56 W

7. In a metre bridge, the balance point is 49 cm from the end where the unknown resistance X is joined; a 10 Ω resistor is in the other gap. X is:
(a) 9.61 Ω **(b)** 19.22 Ω **(c)** 20.41 Ω **(d)** 10.41 Ω

8. Assertion (A): A Wheatstone bridge with P = 10 Ω, Q = 60 Ω and R = 30 Ω balances when S = 5 Ω.
Reason (R): A Wheatstone bridge is balanced when P/Q = R/S.
(a) Both A and R are true, and R is the correct explanation of A.
(b) Both A and R are true, but R is not the correct explanation of A.
(c) A is true, but R is false.
(d) A is false, but R is true.

Section B — Short answer — 8 × 2 = 16 marks

9. A 7 Ω resistor is in series with 2 Ω and 7 Ω in parallel, across an ideal 20 V battery. Find the current through each resistor.

10. 6 identical cells, each of emf 4 V and internal resistance 1 Ω, drive a 7 Ω resistor. Find the current when the cells are joined (a) in series, (b) in parallel.

11. A wire has resistance 85 Ω at 0 °C and temperature coefficient 8×10^{-3} per °C. Find its resistance at 70 °C.

12. Two cells of emf 10 V and 6 V (no internal resistance) are joined through 4 Ω and 5 Ω to a common junction, with their negative terminals joined together, and a 4 Ω resistor runs from the junction to the negative side. Find the current in the 4 Ω resistor.

13. In a metre bridge with X in the left gap and 17 Ω in the right gap, the null point is 63 cm from the left end. Find X. Where would the null point be if the two were swapped?

14. A copper wire of cross-section 5 mm^2 carries 1 A. Find the drift speed of the electrons if there are 8×10^{28} free electrons per m^3. ($e = 1.6 \times 10^{-19}$ C)

15. An 800 W appliance runs 3 hours a day for 16 days. Find the energy used in kWh and the cost at Rs 9 per unit.

16. A wire of resistance 4 Ω is stretched uniformly to 4 times its length. Find its new resistance.

Section C — Word problems — 4 × 4 = 16 marks

17. Cells of 11 V and 8 V (no internal resistance) are joined in parallel through resistors of 4 Ω and 2 Ω respectively, and the pair drives a 4 Ω load. Using Kirchhoff's rules, find the current through each cell and through the load.

18. A cell of emf 9 V and internal resistance 1 Ω drives a load R. Find the power in the load when R = 11 Ω, and the value of R that takes the most power, with that power.

19. A Wheatstone bridge has P from A to B, Q from B to C, R from A to D and S from D to C, with the cell across A and C and a galvanometer across B and D. P = 80 Ω, Q = 80 Ω and S = 90 Ω. Find R for balance. If R is then doubled, in which direction does current flow through the galvanometer?

20. A home uses a 1300 W heater and 6 bulbs of 100 W, all for 8 hours a day on 230 V mains. Find the total current drawn, the energy used in 30 days, and the cost at Rs 7 per kWh.

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Answer key

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Q	Answer	Working
1	**(a) 84 C**	$Q = It$
2	**(c) 0.8325 Ω**	$R = \rho L/A$
3	**(c) 1.43 Ω**	$1/R = \Sigma\ 1/R_i$
4	**(a) 16.1 V**	$V = E - Ir = IR$
5	**(b) V is proportional to I**	—
6	**(d) 1,175.56 W**	$P = V^2/R$
7	**(a) 9.61 Ω**	$X/R = I/(100 - I) = 49/51$
8	**(d) A is false, but R is true.**	A is false: $P/Q = R/S$ gives $S = QR/P = 180\ \Omega$. R is true.
9	**7 Ω: 2.34 A; 2 Ω: 1.82 A; 7 Ω: 0.52 A**	$R = 7 + 1.56 = 8.56\ \Omega$
10	**(a) 1.85 A; (b) 0.56 A**	series: $nE/(R + nr)$; parallel: $E/(R + r/n)$
11	**132.6 Ω**	$R = R_0(1 + \alpha\Delta T)$
12	**1.32 A**	Kirchhoff: $(10 - V)/4 + (6 - V)/5 = V/4$ gives $V = 5.29$ V at the junction
13	**X = 28.95 Ω; 37 cm from the left end**	$X/17 = 63/37$
14	**1.5625×10^{-3} m/s**	$v = I/(neA) = 1 \div (8 \times 10^{28} \times 1.6 \times 10^{-19} \times 5 \times 10^{-6})$
15	**38.4 kWh; Rs 345.6**	$800 \times 3 \times 16 \div 1000$
16	**64 Ω**	volume is unchanged, so A falls 4 times; $R \propto L/A$ grows $4^2 = 16$ times
17	**11 V cell: 1.0625 A; 8 V cell: 0.625 A (a negative value means it is being charged); load: 1.6875 A**	junction potential $V = 6.75$ V from $(11 - V)/4 + (8 - V)/2 = V/4$
18	**6.1875 W; R = 1 Ω; 20.25 W**	$P = E^2R/(R + r)^2$, largest when $R = r$
19	**R = 90 Ω; with R doubled the potential at D falls, so current flows from B to D**	balance: $P/Q = R/S$; $V_D = V \times S/(R + S)$ drops when R grows
20	**8.26 A; 456 kWh; Rs 3,192**	$I = P/V$; energy = $P \times t$

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