ICSE CLASS 10 · PHYSICS

Chapter 8 : CURRENT ELECTRICITY

STEP-BY-STEP SOLUTIONS & MARKING SCHEME (40 MARKS)

Maximum Marks: 40 · Section A (20) compulsory · Section B: any two of three questions (2 × 10 = 20) · $V = IR$ · $R = \rho l \div a$ · $\varepsilon = I(R + r)$ · $P = VI = I^2R = V^2 \div R$ · $W = Pt$ · 1 kWh = 3.6×10^6 J

Marks for each step are shown in square brackets on the right. Values added in the solution figures are shown in red.

SECTION A (20 Marks)

Question 1 — Multiple choice [8 marks, 1 mark each]

No.	Answer	Reason
(i)	**(c)** junction diode	A junction diode does not obey Ohm's law (its V–I graph is not a straight line); metallic wires and alloys such as nichrome and constantan are ohmic.
(ii)	**(b)** R ÷ 4	$R = \rho l \div (\pi r^2)$. Doubling r makes the area 4 times, so R becomes R ÷ 4.
(iii)	**(a)** 3.6×10^6 J	1 kWh = 1000 W × 3600 s = 3.6×10^6 J.
(iv)	**(d)** $\varepsilon - Ir$	Terminal voltage $V = \varepsilon - Ir$ (the voltage drop inside the cell is Ir).
(v)	**(c)** Both (A) and (R) are true, and (R) is the correct explanation for (A).	Both are true: the low melting point lets the wire melt when the current is excessive, and the high specific resistance makes it heat quickly; (R) explains (A).
(vi)	**(c)** 2 Ω	$R_p = R \div n = 6 \div 3 = 2\ \Omega$.
(vii)	**(b)** 0.45 A	I = P ÷ V = 100 ÷ 220 = 0.45 A (approximately).
(viii)	**(b)** increases	In a metal, more collisions at a higher temperature obstruct the electrons more, so the resistance rises.

Question 2 [6 marks]

(a) **Ohm's law**: the current flowing through a conductor is directly proportional to the potential difference across its ends (V = IR). [1] **[2]**

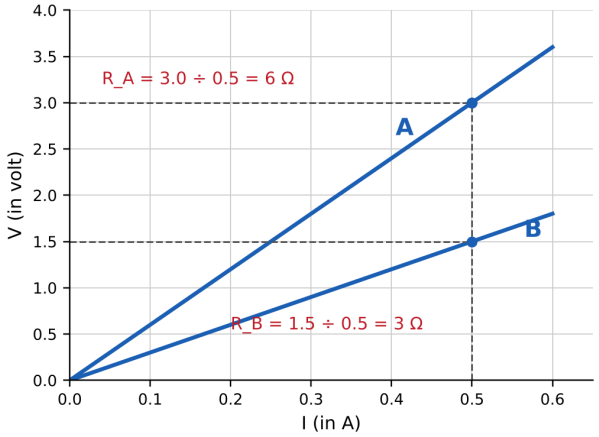
Condition: the temperature (and other physical conditions) of the conductor must remain constant. [1]

(b) Take the point at I = 0.5 A on each line (the dotted guide lines in the figure). **[3]**

(i) For A: V = 3.0 V at I = 0.5 A, so $R_A = V \div I = 3.0 \div 0.5 =$ **6 Ω**. [1]

(ii) For B: V = 1.5 V at I = 0.5 A, so $R_B = 1.5 \div 0.5 =$ **3 Ω**. [1]

(iii) In parallel: $R_p = (R_A \times R_B) \div (R_A + R_B) = (6 \times 3) \div (6 + 3) = 18 \div 9 =$ **2 Ω**. [1]



Solution to Q2(b)

(c) (i) **Tungsten** (high melting point); (ii) **nichrome** (high specific resistance, and it does not oxidise easily when hot). [½ + ½] **[1]**

Question 3 [6 marks]

(a) Given: I = 0.5 A, R = 10 Ω, t = 2 min = 120 s. **[3]**

(i) Q = I × t = 0.5 × 120 = **60 C**. [1]

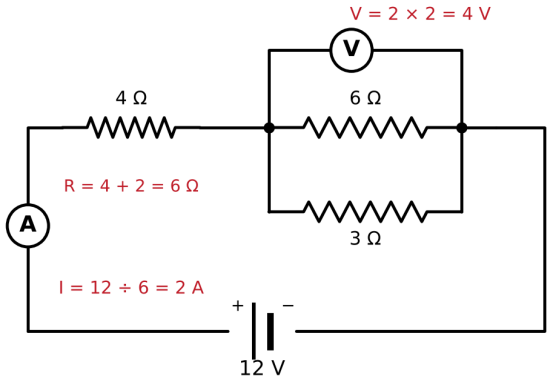
(ii) n = Q ÷ e = 60 ÷ (1.6 × 10^{-19}) = **3.75 × 10^{20} electrons**. [1]

(iii) V = IR = 0.5 × 10 = **5 V**. [1]

(b) (i) The 6 Ω and 3 Ω resistors are in parallel: 1 ÷ R_p = 1 ÷ 6 + 1 ÷ 3 = 3 ÷ 6, so R_p = 2 Ω. This is in series with 4 Ω, so total R = 4 + 2 = **6 Ω**. [1] **[3]**

(ii) The ammeter reads the total current: I = V ÷ R = 12 ÷ 6 = **2 A**. [1]

(iii) The voltmeter is across the parallel pair: V = I × R_p = 2 × 2 = **4 V**. [1]



Solution to Q3(b)

SECTION B (20 Marks) — any two questions

Question 4 [10 marks]

(a) (i) On stretching to double the length, the area becomes half, so R becomes 2 × 2 = 4 times: R′ = 4 × 12 = **48 Ω**. [1] **[3]**

(ii) Each of the three equal parts has resistance 12 ÷ 3 = 4 Ω. In parallel, R_p = R ÷ n = 4 ÷ 3 = **1.33 Ω**. [1]

(iii) The specific resistance **does not change**; it depends only on the material and the temperature. [1]

(b) (i) Copper has a very low specific resistance, and a thick wire has a small resistance, so little energy is lost as heat. [1] **[3]**

(ii) The alloy has a low melting point and a higher specific resistance; so it heats up and melts when the current exceeds the safe limit, breaking the circuit. [1]

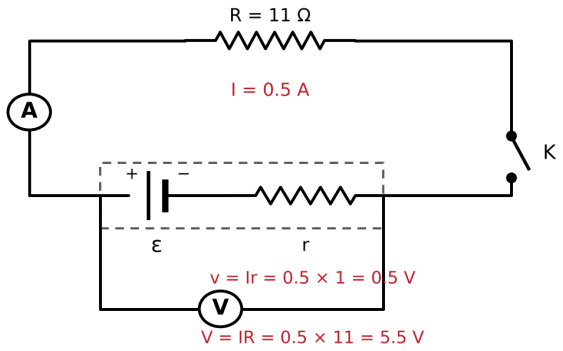
(iii) The resistance of a metal increases with temperature; the glowing filament is at a high temperature. [1]

(c) (i) With the key open no current flows, so the voltmeter reads the e.m.f.: **ε = 6 V**. [1] **[4]**

(ii) With K closed, V = IR = 0.5 × 11 = **5.5 V**. [1]

(iii) Voltage drop inside the cell v = ε − V = 6 − 5.5 = **0.5 V**. [1]

(iv) r = v ÷ I = 0.5 ÷ 0.5 = **1 Ω**. (Check: ε = I(R + r) = 0.5 × 12 = 6 V.) [1]



Solution to Q4(c)

Question 5 [10 marks]

(a) Any three (1 mark each): **[3]**

• E.m.f. is the p.d. between the terminals when no current is drawn; terminal voltage is the p.d. between the terminals when current is drawn.

• E.m.f. does not depend on the current drawn; terminal voltage decreases as more current is drawn.

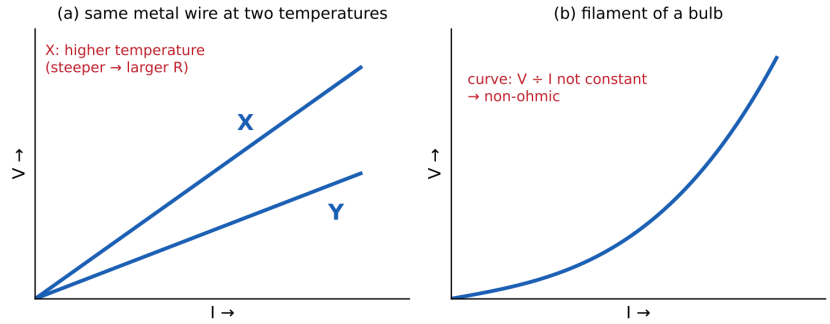
• E.m.f. is the work done per unit charge in the whole circuit (inside and outside the cell); terminal voltage is the work per unit charge in the external circuit only.

• E.m.f. is greater than the terminal voltage in a closed circuit and equal to it in an open circuit.

(b) (i) **X**: the line is steeper, i.e. its slope V ÷ I = R is larger, and the resistance of a metal increases with temperature. [1] **[3]**

(ii) **Non-ohmic**: the V–I graph is a curve, so V ÷ I is not constant (the resistance changes as the filament heats up). [1]

(iii) A junction diode (or LED, transistor). [1]



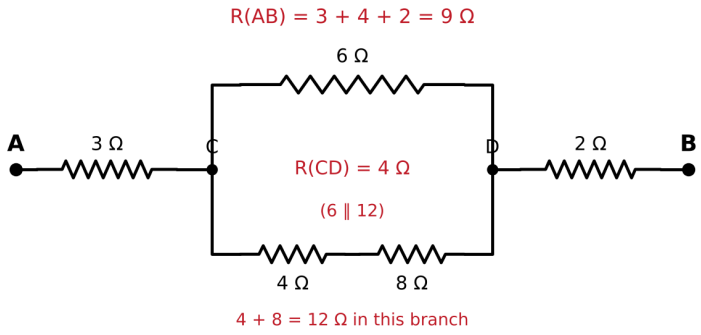
Solution to Q5(b)

(c) (i) 4 Ω and 8 Ω are in series: R = 4 + 8 = **12 Ω**. [1] **[4]**

(ii) The 6 Ω branch is in parallel with the 12 Ω branch: $1 \div R_p = 1 \div 6 + 1 \div 12 = 3 \div 12$, so R_{CD} = **4 Ω**. [1]

(iii) 3 Ω, R_{CD} and 2 Ω are in series: R_{AB} = 3 + 4 + 2 = **9 Ω**. [1]

(iv) I = V ÷ R = 9 ÷ 9 = **1 A**. [1]



Solution to Q5(c)

Question 6 [10 marks]

(a) Given: P = 750 W = 0.75 kW, t = 2 h per day. **[3]**

(i) Energy per day = 0.75 × 2 = **1.5 kWh**. [1]

(ii) Energy in 30 days = 1.5 × 30 = **45 kWh**. [1]

(iii) Cost = 45 × ₹ 7 = **₹ 315**. [1]

(b) Given: P = 2000 W, V = 250 V. **[3]**

(i) $R = V^2 \div P = (250)^2 \div 2000 = 62\,500 \div 2000$ = **31.25 Ω**. [1]

(ii) I = P ÷ V = 2000 ÷ 250 = **8 A**. [1]

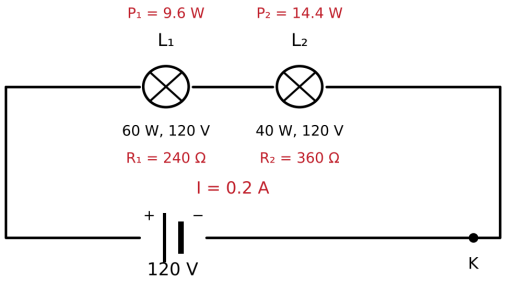
(iii) W = P × t = 2000 × (10 × 60) = **1.2×10^6 J**. [1]

(c) (i) $R_1 = V^2 \div P = (120)^2 \div 60$ = **240 Ω**; $R_2 = (120)^2 \div 40$ = **360 Ω**. [1] **[4]**

(ii) The bulbs are in series: R = 240 + 360 = 600 Ω, so I = 120 ÷ 600 = **0.2 A**. [1]

(iii) $P_1 = I^2R_1 = (0.2)^2 \times 240$ = **9.6 W**; $P_2 = (0.2)^2 \times 360$ = **14.4 W**. [1]

(iv) **L_2** (the 40 W bulb) glows brighter: the same current flows through both, so $P = I^2R$ is larger for the bulb of greater resistance. [1]



Solution to Q6(c)

Marks summary	
Section A: Q1 (8) + Q2 (2 + 3 + 1 = 6) + Q3 (3 + 3 = 6)	**20**
Section B: any two of Q4 – Q6 (10 marks each)	**20**
Total	**40**