Resistance & Resistivity

Mark Scheme 1

Level	International A Level
Subject	Physics
Exam Board	CIE
Topic	Current of Electricity
Sub Topic	Resistance & Resistivity
Paper Type	Theory
Booklet	Mark Scheme 1

Time Allowed: **82 minutes**

Score: **/68**

Percentage: **/100**

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

1 **(a** curved line showing decreasing gradient with temperature rise M1

smooth line not touching temperature axis, not horizontal or vertical anywhere A1 [2]

(b) **(i)** (no energy lost in battery because) no/negligible internal resistance B1 [1]

(ii) $I = V / R$

$= 8 / 15 \times 10^3$ or $1.6 / 3.0 \times 10^3$ or $2.4 / 4.5 \times 10^3$ or $12 / 22.5 \times 10^3$ C1

$= 0.53 \times 10^{-3}$ A A [2]

(iii) p.d. across X = $12 - 8.0 - 3.0 \times 10^3 \times 0.53 \times 10^{-3}$ (= 2.4 V)

$R_X = 2.4 / (0.53 \times 10^{-3})$ C

or
$R_{tot} = 12 / 0.53 \times 10^{-3}$ (= $22.5 \times 10^3\ \Omega$) (C1)
$R_X = (22.5 - 15.0 - 3.0) \times 10^3$ (C1)

$4.5(2) \times 10^3\ \Omega$ A1 [3]

(iv) resistance decreases hence current (in circuit) is greater M1

p.d. across X and Y is greater hence p.d across Z decreas A1

or explanation in terms of potential divider:
R_Z decreases so $R_Z / (R_X + R_Y + R_Z)$ is less (M1)
therefore p.d. across Z decreases (A1) [2]

2	(a	$R = \rho l / A$	C1	
		$= (5.1 \times 10^{-7} \times 0.50) / \pi(0.18 \times 10^{-3})^2 = 2.5\ (2.51)\,\Omega$	M1	[2]
	(b) (i)	resistance of CD = 8 × resistance of AB = 20 (Ω)	C1	
		circuit resistance = $[1/5.0 + 1/20]^{-1} = 4.0\ (\Omega)$	C1	
		current = V/R = 6.0 / 4.0	C1	
		= 1.5 A	A1	[4]
	(ii)	power in AB = I^2R or power = V^2/R	C1	
		$= (1.2)^2 \times 2.5 = 3.6\,W$ $= (3.0)^2/2.5 = 3.6\,W$	A1	[2]
	(iii)	potential drop A to M = 1.25 × 1.2 = 1.5 V	M1	
		potential drop C to N = 3.0 V p.d. MN = 1.5 V	A1	[2]

3	(a	random error (in the measurements) of the length OR resistance	B1	[1]
	(b)	gradient = (3.6 – 1.9) / (0.8 – 0.4)	C1	
		= 4.25	A1	[2]
	(c)	$R = \rho l / A$	C1	
		ρ = gradient × area = $4.25 \times 0.12 \times 10^{-6}$	C1	
		$= 5.1(0) \times 10^{-7}\,\Omega\,m$	A	[3]
	(d)	resistance decreasing with increasing area	B1	
		correct shape with curve being asymptote to both axes	B1	[2]

4 **(a** $R = \rho l / A$ C1

$A = [\pi \times (0.38 \times 10^{-3})^2] / 4 \quad (= 0.113 \times 10^{-6}\ m^2)$ C

$R = (4.5 \times 10^{-7} \times 1.00) / ([\pi \times (0.38 \times 10^{-3})^2] / 4) = 4.0\ (3.97)\,\Omega$ M1 [3]

(b) **(i)** $I = V / R$ C1
$= 2.0 / 5.0 = 0.4(0)\,A$ A [2]

(ii) p.d. across BD = $4 \times 0.4 = 1.6\,V$ A [1]

(iii) p.d. across BC (l) = 1.5 (V)

BC (l) = $(1.5 / 1.6) \times 100 = 94\ (93.75)\,cm$ [2]

(c) p.d. across wire not balancing e.m.f. of cell OR cell Y has current B1
energy lost or lost volts due to internal resistance B1 [2]

5 **(a)** ohm = volt / ampere B1 [1]

(b) $\rho = RA / l$ or unit is $\Omega\,m$ C
units: $V A^{-1} m^2 m^{-1} = N m C^{-1} A^{-1} m^2 m^{-1}$ C1
$= kg\,m^2 s^{-2} A^{-1} s^{-1} A^{-1} m^2 m^{-1}$
$= kg\,m^3 s^{-3} A^{-2}$ A1 [3]

(c) **(i)** $\rho = [3.4 \times 1.3 \times 10^{-7}] / 0.9$ C1
$= 4.9 \times 10^{-7}\ (\Omega\,m)$ [2]

(ii) max = 2.(0) V A1
min = $2 \times (3.4 / 1503.4) = 4.5 \times 10^{-3}$ V A1 [2]

(iii) $P = V^2 / R$ or $P = VI$ <u>and</u> $V = IR$ C1
$= (2)^2 / 3.4$
$= 1.18$ (allow 1.2) W A1 [2]

(d) **(i)** power in Q is zero when $R = 0$ B1 [1]

(ii) power in Q = 0 / tends to zero as R = infinity B1 [1]

6	**(a**	**(i)**	Start from (0,0) and smooth curve in correct direction	B1	
			Curve correct for end section never horizontal	B1	[2]
		(ii)	$R = V / I$ hence take co-ords of V and I from graph and calculate V / I	B1	[1]
	(b)		each lamp in parallel has a greater p.d. / greater current	M1	
			lamp hotter	M1	
			resistance of lamps in parallel greater	A1	[3]
		(ii)	$P = V^2 / R$ or $P = VI$ and $V = IR$	C1	
			R = 144 / 50 = 2.88 for each lamp	C1	
			total R = 1.44 Ω	A1	[3]
7	**(a**	**(i)**	*either* $P = V^2 / R$ *or* $P = VI$ <u>and</u> $V = IR$	C1	
			R = 4.0 Ω	A1	[2]
		(ii)	sketch vertical axis labelled appropriately	B1	
			(straight) line from origin then curved in correct direction	B1	
			line passes through 12 V, 3.0 A	B1	[3]
	(b)	**(i)**	2.0 kW	A1	[1
		(ii)	0.5 kW	A1	[1
		(iii)	total resistance = 3R / 2	C1	
			power = 0.67 kW	A1	[2]