Practical Circuits & Kirchoff's Law

Mark Scheme 4

Level	International A Level
Subject	Physics
Exam Board	CIE
Topic	D.C. Circuits
Sub Topic	Practical Circuits & Kirchoff's Law
Paper Type	Theory
Booklet	Mark Scheme 4

Time Allowed: **87 minutes**

Score: **/72**

Percentage: **/100**

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

1 **(a**	(work =) force × distance or force × displacement or (W =) $F \times d$	M1	
	units of work: $\text{kg m s}^{-2} \times \text{m} = \text{kg m}^2\text{s}^{-2}$	A1	[2]
(b)	$(\text{p.d.} =) \dfrac{\text{work (done) or energy (transformed) (from electrical to other forms)}}{\text{charge}}$	B1	[1]
(c)	$R = V / I$	B1	
	units of V: $\text{kg m}^2\text{s}^{-2}/\text{A s}$ **and** units of I: A	C1	
	or		
	$R = P / I^2$ [or $P = VI$ **and** $V = IR$]	(B1)	
	units of P: $\text{kg m}^2\text{s}^{-3}$ **and** units of I: A	(C1)	
	or		
	$R = V^2 / P$	(B1)	
	units of V: $\text{kg m}^2\text{s}^{-2}/\text{A s}$ **and** units of P: $\text{kg m}^2\text{s}^{-3}$	(C1)	
	units of R: $(\text{kg m}^2\text{s}^{-2}/\text{A}^2\text{s} =)\ \text{kg m}^2\text{s}^{-3}\text{A}^{-2}$	A1	[3]

2 (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		
	$R_{tot} = 12/0.53 \times 10^{-3}$ (= 22.5×10^3 Ω)	(C1)	
	$R_X = (22.5 - 15.0 - 3.0) \times 10^3$	(C1)	
	$4.5(2) \times 10^3$ Ω	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]

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

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

4 **(a** e.m.f.: energy converted from chemical / other forms to electrical
per unit charge B1
p.d.: energy converted from electrical to other forms per unit char B1 [2]

(b) **(i)** the p.d. across the lamp is less than 12 V
or there are lost volts / power / energy in the battery / internal resistance B1 [1]

(ii) $R = V^2/P$ (or $V = RI$ and $P = VI$) C
$= 144/48$
$= 3.0\,\Omega$ A1 [2]

(iii) $I = E/(R_T + r)$ C
$= 12/2.0$
$= 6.0\,A$ A1 [2]

(iv) power of each lamp = I^2R
$= (3.0)^2 \times 3.0$ C1
$= 27\,W$ A [2]

(c) less resistance (in circuit) / more current M1
more lost volts / less p.d. across battery A1 [2]

5	**(a**	**(i)**	$I_1 + I_3 = I_2$	A1	[1
		(ii)	$E_1 = I_2\frac{R_2}{2} + I_1\frac{R_2}{2} + I_1R_1 + I_1r_1$	A1	[1
		(iii)	$E_1 - E_2$ $= -I_3r_2 + I_1(R_1 + r_1 + R_2 / 2)$	B1 B1	 [2]
	(b)		p.d. across BJ of wire changes / resistance of BJ changes there is a difference in p.d across wire and p.d. across cell E_2	B1 B1	 [2]

6	**(a**	**(i)**	movement/flow of charged particles	B1	[1]
		(ii)	work done per unit charge (transferred)	B1	[1]
	(b)		straight line through origin resistance = V/I , with values for V and I shown = 20 Ω (using the gradient loses the last mark)	B1 M1 A0	 [2]
	(c)	**(**	0.5 A	A	[1]
		(ii)	*either* resistance of each resistor is 20 Ω *or* total current = 0.8 A *either* combined resistance = 10 Ω *or* $R = E/I$ = 10 Ω	C A1	 [2]
	(d)	**(i)**	10 V	A	[1]
		(ii)	power = EI = 10 × 0.2 = 2.0 W	C1 A	 [2]

7 **(a) (i)** resistance is ratio V/I (at a point) **B1**

either gradient increases or *I* increases more rapidly than V **B1** **[2]**

(If states R = reciprocal of gradient, then 0/2 marks here)

(ii) current = 2.00 mA **C1**

resistance = 2 000 Ω **A1** **[2]**

(b) (straight line from origin **M1**

passing through (6.0 V, 4.0 mA) (allow ½ square tolerance) **A1** **[2]**

(ii) individual currents are 0.75 mA and 1/33 mA **C1**

current in battery = 2.1 mA **A1** **[2]**

(allow argument in terms of $P = I^2R$ or IV)

(c) same current in R and in C **M1**

p.d. across C is larger than that across **M1**

so since power = *VI*, greater in C **A1** **[3]**

(allow argument in terms of $P = I^2R$ or IV)

8 **(a)** **(i)** resistance = V/I C1
= $6.0/(40 \times 10^{-3})$
= 150 Ω A1
(no marks for use of gradient)

(ii) at 8.0 V, resistance = $8.0/(50 \times 10^{-3})$ = 160 Ω.............................. C1
change = 10 Ω .... A1 [4]

(b) **(i)** straight line through origin..M1
passes through I = 40 mA, V = 8.0V A1

(ii) current in both must be 40 mA C1
e.m.f. = 8.0 + 6.0 = 14.0 V .... A1 [4]