Practical Circuits & Kirchoff's Law

Mark Scheme 1

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 1

Time Allowed: **75 minutes**

Score: **/62**

Percentage: **/100**

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

1	**(a** very high/infinite resistance for negative voltages up to about 0.4 V	B1	
	resistance decreases from 0.4 V	B	[2]
	(b) initial straight line from (0,0) into curve with decreasing gradient but not to horizontal	M1	
	repeated in negative quadrant	A1	[2]
	(c) **(i)** $R = 12^2 / 36 = 4.0\,\Omega$	A1	
	or $I = P / V = 36 / 12 = 3.0$ A and $R = 12 / 3.0 = 4.0\,\Omega$	(A1)	[1]
	(ii) lost volts = $0.5 \times 2.8 = 1.4$ (V) $E = 12 = 2.8 \times (R + r)$	C1	
	$R = V / I = (12 - 1.4) / 2.8$ or $(R + r) = 4.29\,\Omega$	C1	
	$= 3.8\ (3.79)\,\Omega$ or $R = 3.8\,\Omega$	A1	[3]
	(d) resistance of the lamp increases with increase of V or I	B1	[1]

2 **(a** due to the lost volts in internal resistance / cell or energy losses in the internal resistance / cell [1]

(b) **(i)** $V = IR$ C1

$= 1.2 \times 6 = 7.2\,V$ A [2]

(ii) p.d. across Y and internal resistance $r = 4.8$ (V) [12 – 7.2] C1

resistance of Y + r = 4.8 / 1.2 = 4 (Ω) C

resistance of Y = 4 – 0.5 = 3.5 Ω A1 [3]

or

R_{total} = 12 / 1.2 = 10 (Ω) (C1

X + r = 6.5 (Ω) (C1

resistance of Y = 3.5 Ω (A1)

(iii) $P = I^2 r$ C1

$= (1.2)^2 \times 0.5 = 0.72\,W$ A1 [2]

(c) terminal p.d. increases as R is increased
current decreases so there are less lost volts B1 [1]

3 (a (i)	in series $2X$ <u>or</u> in parallel $X/2$	M1	
	other relationship given <u>and</u> 4× greater in series (than in parallel)	A1	[2]
(ii)	due to the internal resistance	B1	
	total resistance for series circuit is not four times greater than resistance for parallel circuit	B1	[2]
(iii)	**1.** $E = I_1(2X + r)$ or $12 = 1.2(2X + r)$	A1	
	2. $E = I_2(X/2 + r)$ or $12 = 3.0(X/2 + r)$	A1	[2]
(iv)	$2X + r = 10$ and $X/2 + r = 4$		
	$X = 4.0\,\Omega$	A1	[
(b)	$P = I^2R$ or V^2/R or VI	C1	
	ratio $= [(1.2)^2 \times 4] / [(1.5)^2 \times 4]$ $= 0.64$	A1	[2]
(c)	the resistance (of a lamp) changes with V or I	B1	
	V or I is greater in parallel circuit or circuit 2 *or* V or I is less in series circuit or circuit 1	B1	[2]

4 **(a)** lost volts / energy used within the cell / internal resistance	B1	
when cell supplies a current	B1	[2]
(b) **(i)** $E = I(R + r)$	C	
$4.5 = 0.65\ (6.0 + r)$		
$r = 0.92\,\Omega$	A1	[2]
(ii) $I = 0.65$ (A) and $V = IR$	C1	
$V = 0.65 \times 6 = 3.9\,\text{V}$	A	[2]
(iii) $P = V^2/R$ or $P = I^2R$ and $P = IV$	C1	
$= (3.9)^2/6 = 2.5\,\text{W}$	A	[2]
(iv) efficiency = power out / power in	C1	
$= I^2R/I^2(R + r) = R/(R + r) = 6.0/(6.0 + 0.92) = 0.87$	A1	[2]
(c) (circuit) resistance decreases	B1	
current increases	M1	
more heating effect	A1	[3]
5 **(a** e.m.f. = total energy available (per unit charge)	B1	
some (of the available energy) is used/lost/wasted/given out in the internal resistance of the battery (hence p.d. available less than e.m.f.)	B1	[2]
(b) **(i)** $V = IR$	C1	
$I = 6.9 / 5.0 = 1.4\ (1.38)$ A	A1	[2]
(ii) r = lost volts / current	C1	
$= (9 - 6.9) / 1.38 = 1.5(2)\ \Omega$	A1	[2]
(c) **(i)** $P = EI$ (**not** $P = VI$ if only this line given or 9 V not used in second line)	C1	
$= 9 \times 1.38 = 12\ (12.4)$ W	A1	[2]
(ii) efficiency = output power / total power	C1	
$= VI / EI = 6.9 / 9$ or $(9.52) / (12.4) = 0.767 / 76.7\%$	A1	[2]

6 **(a** **(i)** $I_1 = I_2 + I_3$ B1 [1]

(ii) $I = V / R$ or $I_2 = 12 / 10$ (= 1.2 A)
$R = [1/6 + 1/10]^{-1}$ [total $R = 3.75\ \Omega$] or $I_3 = 12 / 6$ (= 2.0 A)
$I_1 = 12 / 3.75 = 3.2$ A or $I_1 = 1.2 + 2.0 = 3.2$ A A1 [3]

(iii) power = VI or I^2R or V^2 / R C1

$$x = \frac{\text{power in wire}}{\text{power in series resistors}} = \frac{I_2^2 R_w}{I_3^2 R_s} \text{ or } \frac{VI_2}{VI_3} \text{ or } \frac{V^2/R_w}{V^2/R_s}$$ C1

$x = 12 \times 1.2 / 12 \times 2.0 = 0.6(0)$ allow 3 / 5 or 3:5 A1 [3

(b) p.d. BC: 12 – 12 × 0.4 = 7.2 (V) / p.d. AC = 4.8 (V)
p.d. BD: 12 – 12 × 4 / 6 = 4.0 (V) / p.d. AD = 8.0 (V)
p.d. = 3.2 V A1 [3]