

# Practical Circuits & Kirchoff's Law

## Mark Scheme 2

<b>Level</b>	International A Level
<b>Subject</b>	Physics
<b>Exam Board</b>	CIE
<b>Topic</b>	D.C. Circuits
<b>Sub Topic</b>	Practical Circuits & Kirchoff's Law
<b>Paper Type</b>	Theory
<b>Booklet</b>	Mark Scheme 2

**Time Allowed:** 78 minutes

**Score:** /65

**Percentage:** /100

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

1	(a) e.m.f. = chemical energy to electrical energy p.d. = electrical energy to thermal energy idea of per unit charge	M1 M1 A1 [3]
	(b) $E = I(R + r)$ or $I = E / (R + r)$ (any subject)	B1 [1]
	(c) (i) $E = 5.8 \text{ V}$	B1 [1]
	(ii) evidence of gradient calculation or calculation with values from graph e.g. $5.8 = 4 + 1.0 \times r$ $r = 1.8 \Omega$	C1 A1 [2]
	(d) (i) $P = VI$ $P = 2.9 \times 1.6 = 4.6 \text{ (4.64) W}$	C1 A1 [2]
	(ii) power from battery $= 1.6 \times 5.8 = 9.28$ or efficiency $= VI / EI$ efficiency $= (4.64 / 9.28) \times 100 = 50\% \text{ or } (2.9 / 5.8) \times 100 = 50\%$	C1 A1 [2]
2	(a) (i) sum of e.m.f.'s = sum of p.d.'s around a loop/circuit	B1 [1]
	(ii) energy	B1 [1]
	(b) (i) $2.0 = I \times (4.0 + 2.5 + 0.5)$ $I = 0.286 \text{ A}$ (allow 2 s.f.) (If total resistance is not 7.0, 012 marks)	C1 A1 [2]
	(ii) $R = [0.90 / 1.0] \times 4 (= 3.6)$ $V = I R = 0.286 \times 3.6 = 1.03 \text{ V}$ (If factor of 0.9 not used, then 012 marks)	C1 A1 [2]
	(iii) $E = 1.03 \text{ V}$	A1 [1]
	(iv) either no current through cell B or p.d. across $r$ is zero	B1 [1]

3	(a) (i) sum of currents into a junction = sum of currents out of junction	B1 [1]
	(ii) charge	B1 [1]
	(b) (i) $\Sigma E = \Sigma IR$ $20 - 12 = 2.0(0.6 + R)$ <i>not used 3 resistors 0/2</i> $R = 3.4\Omega$	C1 A1 [2]
	(ii) $P = EI$ $= 20 \times 2$ $= 40W$	C1 A1 [2]
	(iii) $P = I^2R$ $P = (2)^2 \times (0.1 + 0.5 + 3.4)$ $= 16W$	C1 A1 [2]
	(iv) efficiency = useful power / output power $24 / 40 = 0.6$ or $12 \times 2 / 20 \times 2$ or 60%	C1 A1 [2]
4	(a) p.d. = <u>energy transformed from electrical to other forms</u> unit charge	B1
	e.m.f. = <u>energy transformed from other forms to electrical</u> unit charge	B1 [2]
	(b) (i) sum of e.m.f.s (in a closed circuit) = sum of potential differences	B1 [1]
	(ii) $4.4 - 2.1 = I \times (1.8 + 5.5 + 2.3)$ $I = 0.24 A$	M1 A1 [2]
	(iii) arrow (labelled) $I$ shown anticlockwise	A1 [1]
	(iv) 1. $V = I \times R = 0.24 \times 5.5 = 1.3(2)V$	A [1]
	2. $V_A = 4.4 - (I \times 2.3) = 3.8(5)V$	A [1]
	3. either $V_B = 2.1 + (I \times 1.8)$ or $V_B = 3.8 - 1.3$ $= 2.5(3)V$	C1 A1 [2]

- 5** (a) (i) energy converted from chemical to electrical when charge flows through cell or round complete circuit B1
- (ii) (resistance of the cell) causing loss of voltage or energy loss in cell B1 [2]
- (b)  $E_B - E_A = I(R + r_B + r_A)$   
 $12 - 3 = I(3.3 + 0.1 + 0.2)$   
 $I = 2.5 \text{ A}$  C1  
A1 [2]
- (ii) Power =  $E \times I$   
 $= 12 \times 2.5$   
 $= 30 \text{ W}$  C1  
A1 [2]
- (iii)  $P = I^2 \times R$   
 $= (2.5)^2 \times 3$   
 $= 22.5 \text{ J s}^{-1}$       or     $P = V^2 / R$   
 $= 9^2 / 3.6$       or     $P = VI$   
 $= 9 \times 2.5$  C1  
A1 [2]
- (c) power supplied from cell B is greater than energy lost per second in circuit B1 [1]
- 6** (a) energy transferred from source / changed from some form to electrical ..... M1  
per unit charge (to drive charge round a complete circuit) ..... A1 [2]
- (b) and power in  $R = I^2 X$  ..... M1  
 $E = I(X + r)$  ..... M1  
power in cell =  $EI$  and algebra clear leading to ratio =  $X / (X + r)$  ..... A1 [3]
- (c) ( i ) 1.4 W ..... A1  
0.40  $\Omega$  ..... (allow  $\pm 0.05 \Omega$ ) ..... A1 [2]
- (ii) current in circuit =  $\sqrt{1.4/0.4} = 1.87 \text{ A}$  ..... C1  
 $1.5 = 1.87(r + 0.40)$  ..... C1  
 $r = 0.40 \Omega$  ..... A1 [3]
- (d) either less power lost / energy wasted / lost  
or greater efficiency (of energy transfer) ..... B1 [1]

[Total: 11]

7	(a) (i)	$R$	B1	[1]
	(ii)	$0.5R$	B1	[1]
	(iii)	$2.5R$ ... (allow e.c.f. from (ii))	B1	[1]
	(b) (i)	$I_1 + I_2 = I_3$	B1	[1]
	(ii)	$E_2 = I_3R + I_2R$	B1	[1]
	(iii)	$E_1 - E_2 = 2I_1R - I_2R$	B1	[1]

