Potential Dividers

Mark Scheme

Level	International A Level
Subject	Physics
Exam Board	CIE
Topic	D.C. Circuits
Sub Topic	Potential Dividers
Paper Type	Theory
Booklet	Mark Scheme

Time Allowed: **54 minutes**

Score: **/45**

Percentage: **/100**

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

1	**(a**	there are no lost volts / energy lost in the battery *or* there are no lost volts / energy lost in the internal resistance	B1	[1
	(b)	the current / I decreases (as R increases)	M1	
		p.d. decreases (as R increases)	A1	
		or		
		the parallel resistance (of X and R) increases	M1	
		p.d. across parallel resistors increases, so p.d. (across Y) decreases	A1	[2]
	(c) (i)	current = 2.4 (A)	C1	
		p.d. across AB = 24 – 2.4 × 6 = 9.6 V	M	
		or		
		total resistance = 10 Ω (= 24 V / 2.4 A) (parallel resistance = 4 Ω), p.d. = 24 × (4 / 10) = 9.6 V	M1	[2]
	(ii)	R (AB) = 9.6 / 2.4 = 4.0 Ω	C1	
		1 / 6 + 1 / X = 1 / 4 [must correctly substitute for R]	C1	
		X = 12 Ω	A1	
		or		
		I_R = 9.6 / 6.0 = 1.6 (A)	(C1)	
		I_X = 2.4 – 1.6 = 0.8 (A)	(C1)	
		X (= 9.6 / 0.8) = 12 Ω	(A1)	[3]
	(iii)	power = VI *or* EI *or* V^2/R *or* E^2/R *or* I^2R	C1	
		= 24 × 2.4 *or* $(24)^2/10$ *or* $(2.4)^2 \times 10$		
		= 57.6 W (allow 2 or more s.f.)	A1	[2]
	(d)	power decreases	M0	
		e.m.f. constant or power = 24 × current, and current decreases *or* e.m.f. constant or power = 24^2 / resistance, and resistance increases	A1	[1]

2	**(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)	$E_1 - E_2$	B1
			$= -I_3r_2 + I_1 (R_1 + r_1 + R_2 / 2)$	B1 [2]
	(b)		p.d. across BJ of wire changes / resistance of BJ changes	B1
			there is a difference in p.d across wire and p.d. across cell E_2	B1 [2]
3	**(a**	**(i)**	$I = 12 / (6 + 12)$	C1
			minimum current = 0.67 A	A1 [2]
		(ii)	correct start and finish points	M1
			correct shape for curve with decreasing gradient	A1 [2]
	(b)		maximum current = 2.0 A	A1
			minimum current = 0	A1 [2]
	(c)	**(i)**	smooth curve starting at (0,0) with decreasing gradient	M1
			end section not horizontal	A1 [2]
		(ii)	full range of current / p.d. possible *or* currents / p.d. down to zero *or* brightness ranging from off to full brightness	B1 [1]

4 **(a)** *either* $P \propto V^2$ *or* $P = V^2/R$ ……
reduction = $(230^2 - 220^2)/230^2$
= 8.5 % …….. A1 [2]

(b) **(i)** zero ……. A1 [1]

(ii) 0.3(0) A …….. A1 [1]

(c) **(i)** correct plots to within ± 1 mm ……. B1 [1]

(ii) <u>reasonable line/curve</u> through points giving current as 0.12 A
allow ± 0.005A) ……. B1 [1]

(iii) $V = IR$ …….
$V = 0.12 \times 5.0$
= 0.6(0) V ……... A1 [2]

(d) circuit acts as a potential divider/current divides/current in AC not the same as current in BC ……. B1
resistance between A and C not equal to resistance between C and B ……. B1
or current in wire AC × R is not equal to current in wire BC × R B1 [2]
any 2 statements

5 **(a** *either* $V = IP$ B1
current in circuit = $E / (P + Q)$ B1
hence $V = EP / (P + Q)$ A0 [2]
or current is the same throughout the circuit (M1)
$V / P = E / (P + Q)$ (A1)
hence $V = EP / (P + Q)$ (A0

(b) **(i)** (as temperature rises), resistance of (thermistor) decreases M1
either resistance of parallel combination decreases
or p.d. across 5 kΩ resistor / thermistor decreases M1
p.d. across 2000 Ω resistor / voltmeter reading increases A1 [3]

(ii) if R is the resistance of the parallel combination,
either $3.6 = (2 \times 6) / (2 + R)$ *or* current in 2 kΩ resistor = 1.8 mA C1
R = 1.33 kΩ current in 5 kΩ resistor = 0.48 mA C1
$\frac{1}{1.33} = \frac{1}{5} + \frac{1}{T}$ current in thermistor = 1.32 mA C1
T = 1.82 kΩ T = 2.4 / 1.32 = 1.82 kΩ A1 [4]