COMPONENT 2 – ELECTRICITY AND LIGHT

MARK SCHEME

GENERAL INSTRUCTIONS

Recording of marks

Examiners must mark in red ink.

One tick must equate to one mark (except for the extended response question).

Question totals should be written in the box at the end of the question.

Question totals should be entered onto the grid on the front cover and these should be added to give the script total for each candidate.

Marking rules

All work should be seen to have been marked.

Marking schemes will indicate when explicit working is deemed to be a necessary part of a correct answer.

Crossed out responses not replaced should be marked.

Credit will be given for correct and relevant alternative responses which are not recorded in the mark scheme.

Extended response question

A level of response mark scheme is used. Before applying the mark scheme please read through the whole answer from start to finish. Firstly, decide which level descriptor matches best with the candidate's response: remember that you should be considering the overall quality of the response. Then decide which mark to award within the level. Award the higher mark in the level if there is a good match with both the content statements and the communication statement.

Marking abbreviations

The following may be used in marking schemes or in the marking of scripts to indicate reasons for the marks awarded.

cao = correct answer only
ecf = error carried forward
bod = benefit of doubt

Question		Marking details	Marks available					
			AO1	AO2	AO3	Total	Maths	Prac
1	*(a)*	$v = \frac{I}{nAe}$ or correct substitution (1) v = 1.30 × 10^{-4} [m s^{-1}] (-1 for slips in powers of 10) (1) $t = \frac{5}{1.30 \text{x} 10^{-4}}$ = 3.85 × 10^{4} s (1) **UNIT mark**		1 1 1		3	3	
	(b)	CSA decreased (accept diameter) but n and e constant (1) v increased **and** t decreased (1)			1 1	2	1	
		Question 1 total	**0**	**3**	**2**	**5**	**4**	**0**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
2	*(a)*	(i)	2 [A]		1		1		
		(ii)	Voltmeter reading = 12 [V] (1) pd across R_2 = 6 [V] (1) $R_2 = \frac{6}{4}$ = 1.5 [Ω] (1) pd across R_1= 3 [V] (1) current in R_1= 6 [A] (1) $R_1 = \frac{3}{6}$ = 0.5 [Ω] (1)		1 1 1 1 1 1		6	2	
		(iii)	Currents must stay the same or pds across lamps stay the same (1) pd across R_1 must increase (1) R_1 increases but R_2 stays the same (1)			1 1 1	3		3
	(b)		Use of *mgh* to find the gravitational potential energy (1) $\frac{mgh}{t} = 24$ (1) $\frac{m}{t} = \frac{24}{9.81 \text{x} 1.1}$ = 2.2 [kg s^{-1}] (1)	1	1 1		3	3	
			Question 2 total	**1**	**9**	**3**	**13**	**5**	**3**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
3	*(a)*		$\rho = \frac{RA}{l}$ used (1) $A = \pi r^2$ used **or** $A = \frac{\pi d^2}{4}$ (1) Answer = 4.84×10^{-7} Ω m (1) **UNIT mark**	1 1	 1		 3	 3	
	(b)		More lattice (or ion or atom) vibrations **or** electrons move faster (1) Therefore collisions with electrons occur more often **or** less time between collisions (1) So the drift velocity decreases **or** electrons take longer to travel given distance (1)	1 1 1			3		
	(c)	(i)	(Superconducting) transition temperature **or** critical temperature	1			1		
		(ii)	0 or negligible or infinitesimal or equivalent	1			1		
		(iii)	0 or negligible or infinitesimal or equivalent		1		1		
		(iv)	By using liquid nitrogen	1			1		
			Question 3 total	**8**	**2**	**0**	**10**	**3**	**0**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
4	*(a)*	(i)	Divide a distance by corresponding time **or** implied (1) v = 50 [m s^{-1}] (1)		1 1		2	1	
		(ii)	λ = 0.6 [m] **or** T = 0.012 [s] (1) $\frac{v}{\lambda}$ **or** $\frac{1}{T}$ **computed** (1) f = 83 [Hz] **ecf** on v (1)	1	1 1		3	3	
	(b)	(i)	Amplitude goes up and down regularly (1) Must imply periodic variation. Nodes occur at any 2 from 0.9 [m], 1.2 [m], 1.5 [m], 1.8 [m] **or** antinodes equivalent given (1)	1	1		2		
		(ii)	No, for progressive wave amplitude doesn't vary with distance **or** falls steadily		1		1		
		(iii)	Wall reflects waves (1) Waves from pin interfere with reflected waves **or** waves travelling in opposite directions interfere (1)	1 1			2		2
	(c)	(i)	Use of double slit interference equation (1) Fringe separation = 0.0013 [mm] (1)	1	1		2	1	
		(ii)	Fringes too close together to see (1) Suitable choice of fringe separation e.g. 2 mm backed up by a calculation e.g. $L = \frac{2\text{x}10^{-3}\text{x}0.4\text{x}10^{-3}}{635\text{x}10^{-9}} = 1.25$ [m] (1) Accept 1 m $\leq L \leq$ 5 m			2	2		2
			Question 4 total	**5**	**7**	**2**	**14**	**5**	**4**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
5	*(a)*		Energy (1) of photon (1) **or** Planck constant (1) × frequency (1)	2			2		
	(b)	(i)	Electrons are emitted from barium (1) Barium acquires positive charge (1) Explanation of sign e.g. barium neutral **or** electrons are negative **or** +ive ions no longer balanced by –ive electrons (1)	1	1 1		3		
		(ii)	Photon energy is less than work function of barium (1) **Or** photon frequency is less than threshold frequency (or equivalent statements) So no electrons are emitted from the barium (1)			1 1	2		
	(c)		Use of photoelectric equation to determine $E_{k\,\max} = 6.5 \times 10^{-20}$ [J] (1) Determining $V = 0.41$ [V] from $E_{k\,\max}$ (1) Correct conclusion – NO: electrons will not reach X (1)			1 1 1	3	2	3
			Question 5 total	**3**	**2**	**5**	**10**	**2**	**3**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
6	*(a)*	(i)	Ground state to level P labelled I **or** pumping (1) Level U to Level L labelled II **or** stimulated emission (1)	1 1			2		
		(ii)	$E = \frac{hc}{\lambda}$ = 1.9 × 10^{-19} [J] (1) Energy of level U = 2.2 × 10^{-19} [J] (1)		1 1		2	2	
	(b)		**Energy levels** E0 – More electrons in higher energy levels than lower energy levels. E1 – Population inversion mentioned. E2 – Population inversion between U and L. E3 – L is initially (nearly) empty. E4 – Transition from P to U is instantaneous. E5 – U is a metastable state **or** long lived. E6 – Transition from L to the ground state is instantaneous. **Stimulated emission** S1 – Incident photon causes an electron to drop. S2 – Photon emitted when an electron drops. S3 - -Stimulated emission mentioned. S4 – After stimulated emission there are 2 photons instead of 1 photon. S5 – Incident photon of correct energy **or** frequency **or** wavelength is required. S6 – Intensity or number (can increase exponentially). **5-6 marks** All of E0 – E3 and 1 from E4 – E6 are present. All of S1 - S6 are present. There is a sustained line of reasoning which is coherent, relevant, substantiated and logically structured.	3	3		6		

			3-4 marks 2 or 3 from E0 – E3 are present. 3 from S1 – S6 are present. There is a line of reasoning which is partially coherent, largely relevant, supported by some evidence and with some structure. **1-2 marks** 1 from E0 – E3 is present. 1 or 2 from S1 – S6 are present. There is a basic line of reasoning which is not coherent, largely irrelevant, supported by limited evidence and with very little structure. **0 marks** No attempt made or no response worthy of credit.						
	(c)	(i)	Equation used i.e. $\frac{1.3x10^{15}}{3x10^{8}}$ = [4.3 × 10^{6} N] (1) Recoil explained using Newton's 3rd Law i.e. equal and opposite large force on beam by reflecting surface (1)	1	1		2		
		(ii)	Consideration of the ethical issues involved from the perspective of the scientist (1) Consideration of the lack of ethics of the company (1) Conclusion that is consistent with the argument. (1)		1 1	1	3		
			Question 6 total	**6**	**8**	**1**	**15**	**2**	**0**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
7	*(a)*	(i)	[1.00] $\sin x = 1.52 \sin 25°$ **or** equivalent **or** implied (1) $x = 40°$ (1)		1 1		2	2	
		(ii)	65°		1		1	1	
		(iii)	$1.52 \sin C = 1.00$ **or** equivalent **or** $1.52 \sin 65° > 1$ (1) $C = 41°$ [so $65° > C$] so no refraction **or** no y for which $\sin y = 1.52 \sin 65°$, so no refraction (1)			1 1	2	2	
	(b)	(i)	Light [pulses] at [many] different angles to axis **or** by straighter and more zigzag routes **or** equivalent (1) Leading to a spreading out in time of a pulse. **Accept** overlap of pulses, muddling of pulses (1)	1 1			2		
		(ii)	The core is thinner	1			1		
			Question 7 total	**3**	**3**	**2**	**8**	**5**	**0**

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SUMMARY OF MARKS ALLOCATED TO ASSESSMENT OBJECTIVES

Question	AO1	AO2	AO3	TOTAL MARK	MATHS	PRAC
1	0	3	2	5	4	0
2	1	9	3	13	5	3
3	8	2	0	10	3	0
4	5	7	2	14	5	4
5	3	2	5	10	2	3
6	6	8	1	15	2	0
7	3	3	2	8	5	0
TOTAL	**26**	**34**	**15**	**75**	**26**	**10**

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