GCE AS MARKING SCHEME

SUMMER 2024

AS
PHYSICS – COMPONENT 2
B420U20-1

About this marking scheme

The purpose of this marking scheme is to provide teachers, learners, and other interested parties, with an understanding of the assessment criteria used to assess this specific assessment.

This marking scheme reflects the criteria by which this assessment was marked in a live series and was finalised following detailed discussion at an examiners' conference. A team of qualified examiners were trained specifically in the application of this marking scheme. The aim of the conference was to ensure that the marking scheme was interpreted and applied in the same way by all examiners. It may not be possible, or appropriate, to capture every variation that a candidate may present in their responses within this marking scheme. However, during the training conference, examiners were guided in using their professional judgement to credit alternative valid responses as instructed by the document, and through reviewing exemplar responses.

Without the benefit of participation in the examiners' conference, teachers, learners and other users, may have different views on certain matters of detail or interpretation. Therefore, it is strongly recommended that this marking scheme is used alongside other guidance, such as published exemplar materials or Guidance for Teaching. This marking scheme is final and will not be changed, unless in the event that a clear error is identified, as it reflects the criteria used to assess candidate responses during the live series.

GCE AS PHYSICS COMPONENT 2 – ELECTRICITY AND LIGHT

SUMMER 2024 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)		The <u>oscillations / vibrations</u> of the particles is <u>at right angles</u> (1) to the direction <u>of travel</u> of the wave (1)	2			2		
	(b)	(i)	Maximum displacement of the particles [from their equilibrium position]	1			1		
		(ii)	Number of waves = 2.5 in 0.44 mm (1) Wavelength = 0.176 m[m] (1)		2		2	2	
		(iii)	Using $c = f\lambda$ **ecf** (1) Frequency = 1.9×10^6 [Hz] (1)	1	1		2	1	
	(c)		Phase difference = 90° / (accept $\frac{\pi}{2}$ (radians)) (1) Q leads point P (1) Accept ¼ of wavelength as phase difference		2		2		
			Question 1 total	**4**	**5**	**0**	**9**	**3**	**0**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
2	(a)		Diagram showing right angled triangle with d and θ labelled (1) Light is diffracted through the grating (1) Accept by implication e.g. light spreads out for light diffracted through grating Path difference = $d\sin\theta$ (1) Condition for constructive interference path difference = $n\lambda$ (1)	4			4	1	
	(b)	(i)	Grating separation = $\frac{20 \times 10^{-3}}{8000} = 2.5 \times 10^{-6}$ [m] (1) Determining $\sin\theta = \frac{1 \times 590 \times 10^{-9}}{2.5 \times 10^{-6}}$ (1) Angle θ = 13.7° (1)		3		3	3	
		(ii)	Maximum orders when angle θ = 90° (1) Therefore $n = \frac{d}{\lambda}$ **ecf** ≤ 4.23 (1) Number of spots = 4 + 4 + 1 = 9 (1)		3		3	2	
			Question 2 total	**4**	**6**	**0**	**10**	**6**	**0**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
3	(a)		Minimum energy to remove an electron from a surface	1			1		
	(b)	(i)	Energy of photon = $3.8 \times 10^{-19} + 1.5 \times 10^{-19} = 5.3 \times 10^{-19}$ [J] (1) Frequency = $\frac{5.3 \times 10^{-19}}{h} = 8.0 \times 10^{14}$ [Hz] (accept 7.99×10^{14}) (1)		2		2	2	
		(ii)	Minimum pd = $\frac{E_{k\,max}}{e}$ (1) Minimum pd = 0.94 [V] (1)	1	1		2	1	
		(iii)	Individual photon energy remains unchanged, **or** frequency does not change (1) Photons do not co-operate to release electrons or just more photons [per second] (1) Accept increases number of electrons [per second] emitted Minimum pd will remain the same so Ronald not correct (1)			3	3		
	(c)	(i)	Electrons behave as waves or diffract or interfere	1			1		
		(ii)	The atoms in the crystal act as diffraction grating (1) Interference occurs to form pattern (1)		2		2		
		(iii)	$v = \frac{h}{m\lambda}$ transposed and used (1) $v = 4.3 \times 10^{7}$ [m s^{-1}] (1)		2		2	2	
			Question 3 total	**3**	**7**	**3**	**13**	**5**	**0**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
4	(a)		**Method** Labelled diagram of apparatus given Tuning fork with known frequency, f, or speaker (with variable frequency) used Adjust height, l, of column Distance for loud sound noted Use metre ruler to measure distance Repeat for different values of frequency **Analysis** Reference to end correction to account for distance at the end of tube for speaker or tuning fork The equation for the length, l of column = $\frac{c}{4f}$ Plot graph of l (y-axis) against $\frac{1}{f}$ (x–axis) Gradient of graph = $\frac{c}{4}$ End correction, e, included in the equations i.e. $l = \frac{c}{4f} - e$	6			6		6

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
			5-6 marks Comprehensive explanation of the method and analysis given. *There is a sustained line of reasoning which is coherent, relevant, substantiated and logically structured.* **3-4 marks** Comprehensive description of either method or analysis or limited description of both. *There is a line of reasoning which is partially coherent, largely relevant, supported by some evidence and with some structure.* **1-2 marks** Some attempt at method or analysis. *There is a basic line of reasoning which is not coherent, largely irrelevant, supported by limited evidence and with very little structure. Some attempt at analysis of components.* **0 marks** No attempt or nothing worthy of credit.						
	(b)	(i)	Recall distance = speed $\times$ time (1) Using $6t = 3.5(t + 60)$ **or** $3.5t = 6(t - 60)$ (1) Time t = 84 [s] (1) Distance = 504 [km] (allow **ecf** on t) (1)	1	1 1 1		4	3	
		(ii)	**Any 2 ×(1) from:** • Enables people to take action and save lives • Provides additional employment • Countries may wish to spend on health and education • There is less risk of earthquakes in some countries			2	2		
			Question 4 total	**7**	**3**	**2**	**12**	**3**	**6**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
5	(a)	(i)	Pumping transition stated from ground state to level P **or** correct upward arrow in diagram		1		1		
		(ii)	Increase stimulated emission (1) Compared with absorption or decrease absorption (1) Increase in light intensity or light amplification (1) accept more photons produced as well as light amplification	3			3		
	(b)		Using $E = \frac{hc}{\lambda}$ (1) Conversion from J to eV seen i.e. 3.15×10^{-19} [J] (1) Correct energy level difference used 2.43 – 0.46 = 1.97 eV (1) Correct conclusion. wavelength = 631 nm **ecf** – equivalent to the energy calculated for the photon of light so manufacturer's label is correct (1)			4	4	3	
			Question 5 total	**3**	**1**	**4**	**8**	**3**	**0**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
6	(a)		Circuit correct (1) Symbols correct (1)	2			2		2
	(b)		Both axes labelled with correct units (1) Suitable scales chosen so that data points occupy at least ½ of the axes and not involving awkward factors e.g. 3 for both axes (1) All points plotted correctly to within ± ½ small square division **ecf** (1) Correct line of best fit drawn consistent with data (1)	1	1 1 1		4	3	4
	(c)	(i)	Mean diameter calculated correctly 0.32 mm no sf penalty (1) Determine cross-sectional area using $A = \pi \frac{d^2}{4}$ or equivalent (1) Large triangles used (should be close to the extremities of the lines) or two suitable points clearly shown on each graph or clearly implied by calculation (1) Gradient correctly calculated **ecf** (1) Gradient = $\frac{\rho}{A}$ (1) Resistivity = $100 \times 10^{-8}\ \Omega$m (1) **UNIT MARK ecf** on gradient			6	6	6	6
		(ii)	Calculating 18% of Beatrice's answer (1) Correct conclusion in that Beatrice's answer lies within range (1)		2		2	1	2
			Question 6 total	**3**	**5**	**6**	**14**	**10**	**14**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
7	(a)	(i)	Reading = 1.62 [V]		1		1		
		(ii)	Current $I = \frac{V}{R}$ = 0.92 [A] (1) Recall $V = E - Ir$ or implied by 1.38 = 1.62 – 0.92r (1) Therefore r = 0.26 [Ω] (1) **Alternative:** $1.38 = \frac{1.62 \text{ x } 1.5}{1.5 + r}$ (1) $r = \frac{1.62 \text{ x } 1.5}{1.38} - 1.5$ (1) Therefore r = 0.26 [Ω] (1)	1	1 1		3	3	
		(iii)	$t = \frac{550}{EI}$ transposed and used (1) ecf Time = 370 [s] (1) Accept 369 s **Alternative:** $W = \left(\frac{E^2}{R_{\text{total}}} \right) t$ (1) **ecf** Time = 370 [s] (1) Accept 369 s **Alternative:** 550 = $0.92^2 \times 1.76t$ (1) **ecf** Time = 370 [s] (1) Accept 369 s		2		2	2	

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
	(b)		Substitute values into the equation $0.56I = 1.62 - 0.26I$ **or** total circuit resistance = (0.26 + 0.56) Ω (1) **ecf** Circuit current = 1.98 [A] (1) V = 1.11 [V] (1) **Alternative:** $V = \left(\frac{0.56}{0.56+0.26}\right) \text{x } 1.62\,(2)$ **ecf** V = 1.11 [V] (1)	1	1 1		3	3	
			Question 7 total	**2**	**7**	**0**	**9**	**8**	**0**

SUMMARY OF MARKS ALLOCATED TO ASSESSMENT OBJECTIVES

Question	AO1	AO2	AO3	TOTAL MARK	MATHS	PRAC
1	4	5	0	9	3	0
2	4	6	0	10	6	0
3	3	7	3	13	5	0
4	7	3	2	12	3	6
5	3	1	4	8	3	0
6	3	5	6	14	10	14
7	2	7	0	9	8	0
TOTAL	**26**	**34**	**15**	**75**	**39**	**20**