GCE AS MARKING SCHEME

SUMMER 2024

AS
PHYSICS – UNIT 2
2420U20-1

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

UNIT 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.

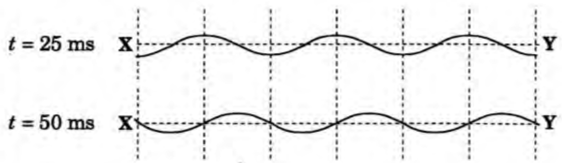
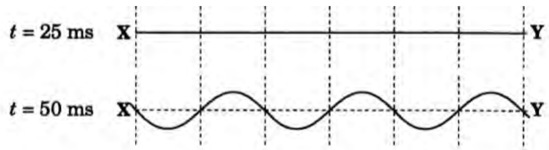
cao	=	correct answer only
ecf	=	error carried forward
bod	=	benefit of doubt

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
1	(a)		$l = \frac{RA}{\rho}$ [rearrangement at any stage] (1) $A = \frac{\pi d^2}{4}$ $[= 1.77 \times 10^{-8}]$ or equivalent or by implication (1) $l = 2.0$ [m] (1)		3		3	3	
	(b)		Taking readings at face value, $R = \left[\frac{1.60}{0.029}\right] = 55$ [Ω]or 55.2 [Ω] **Or** lowest possible resistance $=\left[\frac{1.59}{0.030}\right] = 53.0$ [Ω]or 53 [Ω] (1) But highest possible resistance $=\left[\frac{1.61}{0.028}\right] = 58$ [Ω]or 57.5 [Ω] **or** calculating absolute uncertainty e.g. ± 2 [Ω] (1) accept 4% [56 Ω is between 55.2 Ω (or 53.0 Ω) and 57.5 Ω] so her conclusion is *not* safe (1) [Mark **not** freestanding] Award a max of 2 marks for upper values of V and I used along with lower values of V and I **Alternative:** Calculating V with 3 different possible I values and 56 [Ω] (2) Her conclusion is *not* safe (1) [Mark **not** freestanding]			3	3	2	3
			Question 1 total	**0**	**3**	**3**	**6**	**5**	**3**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
2	(a)	(i)	$I_1 = I_2 = I_3$ **or** two of $I_1 = I_2$, $I_2 = I_3$, $I_1 = I_3$	1			1		
		(ii)	$V_1 + V_2 = V_3$	1			1		
	(b)	(i)	Correct application of any potential divider equation, e.g. $\frac{V_{\text{out}}}{12\text{ V}} = \frac{32\ \Omega}{48\Omega}$ **or** current = $\frac{12\text{ V}}{48\ \Omega}$ [= 0.25 A] (1) $V_{\text{out}} = 8.0$ [V] if it follows clearly from some correct working (1)		2		2	2	
		(ii)	$V_{\text{out}} = \left[12\text{ V} \times \frac{12\ \Omega}{48\Omega}\right] = 3.0$ [V] **or** [0.25 **ecf** × 12] = 3.0 [V]		1		1	1	
	(c)		R_A and R_B each have 2.0 V across them and the 20 Ω resistor has 8.0 V across it (1) $R_A = 5$ [Ω], $R_B = 5$ [Ω] (1) **Alternative 1 ($V = IR$) award 2 marks for:** $I = \frac{2}{R_B} = \frac{10}{20+R_B}$ leads to $R_B = 5$ [Ω] Then $I = \frac{10}{25} = 0.4$ [A] Then $R_A = \frac{2}{0.4} = 5$ [Ω] **Alternative 2 ($\frac{V_{\text{out}}}{V_{\text{in}}} = \frac{R}{R_T}$)** For R_B + 20: $\frac{10}{12} = \frac{R_B+20}{R_A+20+R_B}$ and for R_B: $\frac{2}{12} = \frac{R_B}{R_A+20+R_B}$ (1) Multiplying by 5 gives $\frac{10}{12} = \frac{5R_B}{R_A+20+R_B}$ and so $5R_B = R_B + 20$ $R_B = 5$ [Ω] and with a sub back in $R_A = 5$ [Ω] (1)			2	2		
			Question 2 total	**2**	**3**	**2**	**7**	**3**	**0**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
3	(a)	(i)		<u>12 J</u> transferred [from chemical to electrical or work done] (1) per {unit charge / coulomb} [passing through cell] (1)	2			2		
		(ii)		pd drops below emf **or** energy is wasted inside cell **or** the internal resistance limits the current [that the battery can deliver]		1		1		
	(b)	(i)	I.	7.0 V across parallel combination **or** $R = 20\ \Omega \times \frac{0.35\ \text{A}}{0.25\ \text{A}}$ **or** by implication (1) $R = \left[\frac{7.0\ \text{V}}{0.25\ \text{A}}\right] = 28\ [\Omega]$ (1)		2		2	1	
			II.	5.0 V across r **ecf or** resistance of parallel combi = 11.7 Ω **ecf and** total resistance in circuit = 20.0 Ω **ecf or** by implication (1) $r = \left[\frac{5.0\ \text{V}}{0.60\ \text{A}}\right] = 8.3\ [\Omega]$ (1)		2		2	1	
		(ii)	I.	$0.35^2 \times 20$ (1) $\times 40 \times 60$ [= 5.9 kJ or 5880 J] (1) **Alternative:** 0.35 × 7 **ecf** (1) × 40 × 60 [= 5.9 kJ or 5880 J] (1) **Alternative:** $\frac{7^2\ \textbf{ecf}}{20}$ (1) × 40 × 60 [= 5.9 kJ or 5880 J] (1)	1	1		2	2	
			II.	From electrical (accept KE of electrons) into random **or** vibrational **or** thermal **or** internal (accept heat) (1) [Free] electrons collide with {ions / atoms / lattice} (1)	2			2		

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
3	(b)	(iii)		{Parallel combination / total circuit} resistance increases **or** main current decreases (1) So greater [proportion of 12] V across parallel combination **or** smaller pd across *r* **or** pd across battery terminals increases (1) So for 20 Ω resistor, pd is greater **or** current is greater, so Dafydd is correct (1) No argument that doesn't involve *r* is valid, but give 1 mark for greater [proportion than before of] current goes through the 20 Ω			3	3		
				Question 3 total	**5**	**6**	**3**	**14**	**4**	**0**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
4	(a)	(i)	0.30 [m]	1			1		
		(ii)	$v = \frac{0.30\ [\text{m}]\textbf{ecf}}{0.1\ [\text{s}]}$ **or** $v = 10\ [\text{Hz}] \times 0.3[\text{m}]\textbf{ecf}$ **or** by implication (1) $v = 3.0\ [\text{m s}^{-1}]$ (1)		2		2	2	
		(iii)	 1 mark for each time - graph drawn correctly		2		2	2	
	(b)	(i)	Wave reflected [at fixed point] (1) accept 2 waves travelling in opposite directions Stationary wave arises from superposition **or** interference (1)	1	1		2		
		(ii)	 1 mark for each time - graph drawn correctly	2			2	2	
			Question 4 total	**4**	**5**	**0**	**9**	**6**	**0**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
5	(a)	(i)	Waves spread out [at each slit] (1) Overlap of [diffracted] waves allows <u>interference / superposition</u> (1)	2			2		
		(ii)	$\lambda = \frac{0.45\times10^{-3}\times2.2\times10^{-3}}{1.8}$ [Tolerate wrong powers of 10] (1) λ = 550 n[m] (1)	1	1		2	2	
		(iii)	[For any bright fringe], path difference must be $n\lambda$ $[n = 0, 1, 2 ...]$ (1) can be implied For P, $n = 3$ **or** path difference $= 3\lambda$ or by implication (1) So path difference = 1650 n[m] **ecf** on value of λ from (a)(ii) (1) (Geometrical method that does not use λ gains maximum of 1)	1	1 1		3		
	(b)		Orders / bright fringes much further apart [for grating] (1) Orders / bright fringes much sharper (1) Accept brighter or increased intensity. Don't accept clearer	2			2		2
			Question 5 total	**6**	**3**	**0**	**9**	**0**	**2**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
6			**Indicative content:** In unpolarised light vibrations are in all directions, at right angles to direction of travel and the sequence of directions is random. To distinguish, view light through polaroid and rotate it. Light is unpolarised if intensity / brightness doesn't depend on the angle of the polaroid. Light is polarised if it does depend on the angle of the polaroid. Polaroid decreases the intensity of unpolarised light [equally whatever the angle of the polaroid]. For polarised light there are two angles of extinction per turn of the polaroid (or similar detail). (Not complete extinction if light only partially plane polarised). **5-6 marks** Comprehensive account given of what is unpolarised light **AND** how to determine if light is polarised or not. *There is a sustained line of reasoning which is coherent, relevant, substantiated and logically structured.* **3-4 marks** Limited description given of what is unpolarised light **and** how to determine if light is polarised or not **OR** comprehensive account of how to determine if light is polarised or not. *There is a line of reasoning which is partially coherent, largely relevant, supported by some evidence and with some structure.* **1-2 marks** Limited description given of either what is unpolarised light **OR** how to determine if light is polarised **OR** comprehensive account of what is unpolarised light *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.	6			6		6
			Question 6 total	**6**	**0**	**0**	**6**	**0**	**6**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
7	(a)		Light enters along a normal [to curved face] or equivalent		1		1		1
	(b)		35° **0.574** 66° **0.914** (1) $\sin\theta_P$ plotted between 0.57 and 0.58; $\sin\theta_A$ between 0.91 and 0.92 (1) **ecf**		2		2	2	2
	(c)	(i)	Reasonable best fit line (straight) drawn**.** Accept straight line stated **or** as $\sin\theta_P$ doubles, $\sin\theta_A$ also doubles (1) Don't accept positive gradient Goes through origin (1) Stated to be little scatter of points about straight line (1) [so law confirmed]			3	3	1	3
		(ii)	Figures from a point on line put into $\frac{\sin\theta_A}{\sin\theta_P}$ (i.e. find gradient) (1) Above mark not available if n determined from a single point not on the line of best fit. n between 1.57 and 1.65 (1) (freestanding)			2	2	2	2
	(d)		40° is above critical angle **or** light would not refract out at the plane surface **or** tir would occur (1) Quantitative back-up, e.g. using n value from (c)(ii): $n\sin 40° > 1$ **or** calculation of C: $n = 1.57, C = 39.5°;$ up to $n = 1.65, C = 37.3°$, **or** taking inverse sine of horizontal scale reading where graph line hits top of grid **or** any other valid check **ecf** on n (1)		2		2	1	2
			Question 7 total	**0**	**5**	**5**	**10**	**6**	**10**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
8	(a)	(i)	I.	Energy of photon	1			1		
			II.	[Minimum] energy needed to release an electron from a {surface / material / metal} Don't accept electron**s**	1			1		
		(ii)		**For barium** $E_{\text{k max}} = (6.63 \times 10^{-34} \times 7.9 \times 10^{14} - 4.03 \times 10^{-19})$[J] [$= 1.21 \times 10^{-19}$ J] **or** $E > \phi$ with $E = 5.2 \times 10^{-19}$ [J] (1) $V_{\text{stop}} = 0.76$ V **ecf** (1) **For magnesium** Emission shown not to be possible i.e. $E < \phi$ **or** if $E_{\text{k max}} = -6.2 \times 10^{-20}$ [J] shown, needs a comment (1) If no other mark gained, give one mark for clear statement that photon energy is 5.2×10^{-19} [J] **Alternative for 1st and 3rd mark using threshold frequency.** Using: $hf_0 = \phi$, f_0 for barium = 6.08×10^{14} [Hz] and $7.9 \times 10^{14} > 6.08 \times 10^{14}$ [so possible] (1) f_0 for magnesium = 8.83×10^{14} [Hz] and $7.9 \times 10^{14} < 8.83 \times 10^{14}$ [so not possible] (1)		3		3	2	

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(b)			**Any 3 × (1) from:** • No greenhouse gases emitted [during operation] / decrease use of non-renewables / less demand on National Grid • Cost **or** insurance considerations • May not be pleasing to the eye (especially on old buildings) • Making the panels may damage environment or equiv • Some roofs face North and may not produce much power or may not be strong enough to support the panels • Night-time or heavy cloud makes available energy intermittent • Creation of jobs • Unethical to force people Don't accept photovoltaic panels are renewable or sustainable or eco-friendly			3	3		
				Question 8 total	**2**	**3**	**3**	**8**	**2**	**0**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
9	(a)	(i)	A passing photon with energy equal to 1.79 eV (or equivalent) (1) Causes another photon {of same frequency / same energy / in phase} to be emitted (1) accept similar photon emitted	2			2		
		(ii)	So stimulated emission is more {frequent / probable / likely} than absorption	1			1		
	(b)		$\lambda = \frac{hc}{\Delta E}$ **or** $f = \frac{\Delta E}{h}$ **and** $\lambda = \frac{c}{f}$ transposition at any stage (1) $\Delta E = 2.86 \times 10^{-19}$ J or by implication (1) $\lambda = 694$ n[m] (1) **ecf** on ΔE		3		3	2	
	(c)	(i)	Number per second= $\frac{0.60}{2.86\times10^{-19}\mathbf{ecf}}$ **or** 2.1×10^{18} [s^{-1}]		1		1	1	
		(ii)	$p = \frac{6.63\times10^{-34}}{6.94\times10^{-7}\mathbf{ecf}}$ or by implication **ecf** (1) $p = 9.6 \times 10^{-28}$ N s or kg m s^{-1} **unit mark** (1)		2		2	2	
		(iii)	Momentum per second = Answer to (i) × Answer to (ii) **or** 2.0×10^{-9} [N] (1) Force on reflecting surface = 2 × 2.0 × 10^{-9} = 4.0 × 10^{-9} [N] **ecf** (1) Award 1 mark only for multiplication by 2 anywhere		2		2	2	
			Question 9 total	**3**	**8**	**0**	**11**	**7**	**0**

AS UNIT 2: ELECTRICITY AND LIGHT

SUMMARY OF MARKS ALLOCATED TO ASSESSMENT OBJECTIVES

Question	AO1	AO2	AO3	TOTAL MARK	MATHS	PRAC
1	0	3	3	6	5	3
2	2	3	2	7	3	0
3	5	6	3	14	4	0
4	4	5	0	9	6	0
5	6	3	0	9	2	2
6	6	0	0	6	0	6
7	0	5	5	10	6	10
8	2	3	3	8	2	0
9	3	8	0	11	7	0
TOTAL	**28**	**36**	**16**	**80**	**35**	**21**