GCE AS MARKING SCHEME

SUMMER 2025

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 2025 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)	(i)		Number of {free / delocalised} electrons per {metre cubed / m^3 / unit volume} Accept free electron {concentration / density}	1			1		
		(ii)		Rate of flow of charge **OR** charge passing [through a cross section] per unit time (1) Don't accept current is flow of charge **ACCEPT** $I = \frac{[\Delta]Q}{[\Delta]t}$ with terms named $\therefore \frac{nAvte}{t}$ **or** $It = nAvte$ (1)	1	1		2		
	(b)	(i)		Rearrange and sub into $\rho = \frac{RA}{l}$ (1) condone power slips and factor of 2 errors $\rho = 4.9 \times 10^{-7}$ [Ω m] (1) can be implied Rearrange and sub into $l = \frac{RA}{\rho}$ (1) condone power slips and factor of 2 errors $l = 3.722$ **OR** 3.72 [m] (1) **allow ecf on ρ** **Alternative** Realising the resistivities are equal (1) Substituting into Griff's equation (1) Substituting into Gwen's equation (1) $l = 3.722$ **OR** 3.72 [m] (1) **Alternative** Halving the resistance means half the length (1) Doubling the diameter means 4 × the csa (1) so needs 4 × the length (1) [Combining both gives twice the length], i.e. 3.722 [m] (1)		4		4	4	

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
		(ii)	I	Clockwise	1			1		
			II	Current will be the same in both resistors as they are in <u>series</u> **OR** due to conservation of charge (1) Gwen's wire has larger [cross-sectional] area, so will have smaller drift velocity (1) $A \propto \frac{1}{v}$ [for constant current] (1)		3		3		
				Question 1 total	**3**	**8**	**0**	**11**	**4**	**0**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
2	(a)		Use of Ohm's law e.g. $V \propto I$ [temperature is constant] **or** $\frac{V}{I}$ = a constant **or** I-V graph is a straight line graph through the origin **or** $R = \frac{V}{I}$ (1) Use of values from 0 V to 2.0 V to prove proportionality **or** from 3.0 V to 10.0 V to prove not proportional (1) Conclusion that ohm's law is obeyed for lower voltages **or** not obeyed for higher voltages (1)			3	3	2	3
	(b)		**Indicative content** • pd causes force on [free] electrons • Force causes electrons to accelerate **or** to move to the positive terminal • This movement of electrons is an electric current • Electrons collide with {positive ions / atoms} • This gives rise to resistance • Electrons transfer kinetic energy to ions • Ions vibrate more / have greater vibrational / thermal energy • Temperature increases • Electrons move faster • Collisions {are more frequent / impart more force} • Electrons have less time to accelerate • Current increases at decreasing rate [hence higher resistance] **5-6 marks** A comprehensive description is provided. *There is a sustained line of reasoning which is coherent, relevant, substantiated and logically structured.*	6			6		

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
			3-4 marks A reasonable description is provided. *There is a line of reasoning that is partially coherent, largely relevant, supported by some evidence and with some structure.* **1-2 marks** A limited description is provided. *A basic line of reasoning that 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)		[When metal is cooled,] the temperature at which it loses all its electrical resistance (1) Transition temperature of a few Kelvin (1) Accept >0-50 K	2			2		
	(d)		**Any 2 ×(1) from:** • Repeat their own work • Ask scientific community to repeat the work / reproducibility comment • Produce report for small number within the science community to view / check **OR** publish findings to press to be passed by a referee • Check for errors in the equipment measuring resistance **OR** temperature			2	2		
			Question 2 total	**8**	**0**	**5**	**13**	**2**	**3**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
3	(a)		The energy converted from some other form (e.g. chemical / solar / light) to <u>electrical</u> [potential] energy (1) per {unit charge / coulomb} [flowing through the cell] (1)	2			2		
	(b)	(i)	$V = E - Ir$ used (1) Point chosen from line and r calculated e.g. $r = \frac{E-IR}{I} = \frac{6-(1\times4)}{1}$ (1) **Alternative 1** $r = \frac{E}{I}$ at $R = 0$ (1) $\frac{6}{3}$ (1) **Alternative 2** When $R = r$ there is twice the total resistance compared to when $R = 0$ (1) From graph the value of resistance that gives half the maximum current is $2\,\Omega$ (1)	1	1		2	2	
		(ii)	$P = I^2R$ used at $2\,\Omega$ i.e. $1.5^2 \times 2 = 4.5$ [W] (1) Power calculated for a resistance that is $< 2\,\Omega$ (1) Power calculated for a resistance that is $> 2\,\Omega$ (1) **and** suitable comment made e.g. Bryn is correct **or** 4.5 W is the highest power			3	3	3	
			Question 3 total	**3**	**1**	**3**	**7**	**5**	**0**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
4	(a)		Sound waves from loudspeaker reflect off surface of water **OR** two waves travelling in opposite directions (1) With same {frequency / wavelength} (accept coherent) **AND** [similar] amplitude (1) Don't accept identical superpose **OR** interfere (1)	3			3		3
	(b)	(i)	$\frac{0.348-0.332}{2}$ = 0.008 [m] or equivalent (1) $\frac{0.008}{0.340} \times 100$ = 2.35[%] or 2[%] or 2.4[%] (1) no sig fig penalty			2	2	2	2
		(ii)	$c = f\lambda$ seen **AND** node to node distance is $\frac{\lambda}{2}$ (1) $2x = \lambda$ (1)			2	2		2
		(iii)	$2 \times 495 \times 0.340$ = 337 **OR** 336.6 [m s^{-1}] (1) % unc in c = % unc in f + % unc in x **ecf from (b)(i)** = 4% **OR** 4.4% (1) Abs unc in c = 13 **OR** 15 **OR** even 10 [m s^{-1}] (1) **ecf** no sig fig penalty here Absolute uncertainty to 1 or 2 sig figs and c written to corresponding place value e.g. (337 ± 13) **OR** (337 ± 15) **OR** (340 ± 10) **OR** (340 ± 14) [m s^{-1}] (1) **Allow ecf on c**			4	4	4	4
			Question 4 total	**3**	**0**	**8**	**11**	**6**	**11**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
5	(a)		Spreading [out] of waves due to {gap / obstacle / slit}	1			1		
	(b)	(i)	4 wavefronts drawn with [increasingly longer] straight portions and curved edges (1) Accept at least 3 wavefronts Wavelength consistent with incoming waves (1)	1	1		2		
		(ii)	[Roughly] semicircular **or** spread around 180^{o} Don't accept more curved or more circular	1			1	1	
	(c)	(i)	Coherent	1			1		
		(ii)	A – {Equidistant from dippers / zero path difference} (1) [arrive in phase hence] constructive interference (1) B – Path difference of 1½ wavelengths (1) Arrive in antiphase hence destructive interference (1) Accept λ ≈0.6-0.8 cm and path difference ≈0.7 cm measured from diagram. So not in phase with partial interference.		4		4		
		(iii)	Red laser suitable as slits act as in phase sources **OR** light from slits will have a constant phase difference ∴ suitable (1) accept red laser light is coherent Slits would not act as coherent sources **OR** would not have a constant phase difference **OR** non-point source so overlapping interference patterns ∴ not suitable with only a double slit (1) Different {wavelengths / frequencies} **OR** not monochromatic ∴ not suitable (1)		3		3		
			Question 5 total	**4**	**8**	**0**	**12**	**1**	**0**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
6	(a)	(i)	Use of $n = \frac{c}{v}$ **or** $n_1v_1 = n_2v_2$ (1) can be implied Air → plastic: [Slows down from] 3×10^8 [m s^{-1}] to 1.9×10^8 [m s^{-1}] (1) **ACCEPT** decreases speed by a factor of 1.57 **OR** decreases by 1.1×10^8 [m s^{-1}] Plastic → water: [Increases speed] to 2.3×10^8 [m s^{-1}] (1) **ACCEPT** increases speed by a factor of {1.18 / 1.2 / 1.21} **OR** increases by 0.4×10^8 [m s^{-1}] [m s^{-1}] If no calculations given award 1 mark for air to plastic decreases speed and plastic to water increases speed	1	1 1		3	1	
		(ii)	Substitution into $\sin C = \frac{n_1}{n_2} = \frac{1}{1.33}$ (1) or equivalent C = 49°(1) First angle $i > 49°$ stated **OR** $74° > 49°$ (1) so TIR occurs (1)	1	1 1 1		4	4	
	(b)	(i)	{Passing / incoming} photon causes (1) emission of a [second] photon [from an excited atom] (1) of energy equal to energy difference (accept jump / gap) between excited state and state into which the electron drops (1)**ACCEPT** reference to incoming and stimulated photons having equal {energy / frequency / wavelength} accept in phase or coherent	3			3		
		(ii)	$E = \frac{hc}{\lambda} = \frac{6.63\times10^{-34}\times3\times10^8}{550\times10^{-9}}$ **or** use of $c = f\lambda$ **and** $E = hf$ (1) 3.62×10^{-19}[J] (1) $\frac{1\times10^{-3}}{3.62\times10^{-19}} = 2.8 \times 10^{15}$ [s^{-1}] (1) **ecf** on photon energy		3		3	3	
			Question 6 total	**5**	**8**	**0**	**13**	**8**	**0**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
7	(a)		$\Delta E = [-]3.04 - [-]5.14 = 2.10$ [eV] (1) $\times e$ [= 3.36 $\times$ 10^{-19}] [J] (1) $\lambda =$ 592 nm (1) **UNIT MARK AND ecf on ΔE**		3		3	3	
	(b)		{Bright / colourful / yellow} lines (1) on a black background (1)		2		2		
	(c)		Photons (accept light) of particular {frequency / wavelength / energy} **OR** photons of energy 2.10 eV **ecf** (1) {absorbed by sodium atoms / cause electrons to move up energy levels} (1) Atoms [spontaneously] re-emit photons in random directions **OR** only a very small fraction of photons will arrive in the position of the dark line (1)		3		3		
			Question 7 total	**0**	**8**	**0**	**8**	**3**	**0**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
8	(a)		[Concentric] circles (1) accept ring-like pattern Electrons behave like waves (1) accept reference to wave particle duality of matter	2			2		
	(b)		$9.11 \times 10^{-31} \times 1.8 \times 10^{7} = 1.6 \times 10^{-23}$ [kg m s^{-1}] (1) can be implied $p = \frac{h}{\lambda}$ rearranged to give $\lambda = \frac{h}{p}$ (1) $= 40.4$ p[m] (1)		3		3	3	
			Question 8 total	**2**	**3**	**0**	**5**	**3**	**0**

AS UNIT 2 – ELECTRICITY AND LIGHT

SUMMARY OF MARKS ALLOCATED TO ASSESSMENT OBJECTIVES

QUESTION	AO1	AO2	AO3	TOTAL MARK	MATHS	PRAC
1	3	8	0	11	4	0
2	8	0	5	13	2	3
3	3	1	3	7	5	0
4	3	0	8	11	6	11
5	4	8	0	12	1	0
6	5	8	0	13	8	0
7	0	8	0	8	3	0
8	2	3	0	5	3	0
TOTAL	**28**	**36**	**16**	**80**	**32**	**14**