GCE AS MARKING SCHEME

SUMMER 2023

AS
PHYSICS – COMPONENT 2
B420U20-1

INTRODUCTION

This marking scheme was used by WJEC for the 2023 examination. It was finalised after detailed discussion at examiners' conferences by all the examiners involved in the assessment. The conference was held shortly after the paper was taken so that reference could be made to the full range of candidates' responses, with photocopied scripts forming the basis of discussion. The aim of the conference was to ensure that the marking scheme was interpreted and applied in the same way by all examiners.

It is hoped that this information will be of assistance to centres but it is recognised at the same time that, without the benefit of participation in the examiners' conference, teachers may have different views on certain matters of detail or interpretation.

WJEC regrets that it cannot enter into any discussion or correspondence about this marking scheme.

GCE AS PHYSICS COMPONENT 2 – ELECTRICITY AND LIGHT

SUMMER 2023 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)	2.25 wavelengths = 2.7 [cm] (1) Wavelength = 1.2 [cm] (1)		2		2	2	
		(ii)	2.5 × period = 0.050 [s] (1) Period = 20×10^{-3} [s] (1) Frequency = $\frac{1}{T}$ = 50 [Hz] (1)		3		3	3	
		(iii)	Using $v = f\lambda$ **ecf** from (ii) and (iii) (1) Speed = 0.60 [m s^{-1}] (1)	1	1		2	1	
	(b)		Only transverse waves can be polarised (1) Direction of displacement / oscillations / vibrations is required (1) Cannot determine if transverse or longitudinal from graph (1)			3	3		
			Question 1 total	**1**	**6**	**3**	**10**	**6**	**0**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
2	(a)	(i)	Constant phase difference	1			1		
		(ii)	At this point; the waves at the same point in their cycles at the same time	1			1		
	(b)	(i)	Path difference = 2 × number of wavelengths (1) waves arrive in phase at point A (1)	2			2		2
		(ii)	Use of $\lambda = \frac{ay}{D}$ (1) Determining $y = \frac{0.0243}{6}$ mm (1) Rearrangement: $D = \frac{0.66 \text{ x} 10^{-3} \text{x } 4.05 \text{x} 10^{-3}}{6.42 \text{ x } 10^{-7}}$ (1) Distance to screen = 4.16 [m] (1)	1	1 1 1		4	3	4
	(c)	(i)	Energy of the beam [per second] = 6.0×10^{-3} [J] (1) Energy of photon = $hf = 1.6 \times 10^{-18}$ [J] (1) Number of photons = 3.8 or 3.77×10^{15} (1)	1	1 1		3	3	
		(ii)	Force = rate of change of momentum or change in momentum $= \frac{2p}{c}$ (1) Change in momentum of photons = 1.06×10^{-26} [kg m s^{-1}] **or** = $2 \times \frac{2p}{c}$ (1) Total force = 4.2×10^{-11} [N] **ecf** (accept 4.0×10^{-11} [N]) no sig fig penalty (1)	1	1 1		3	2	
			Question 2 total	**7**	**7**	**0**	**14**	**8**	**6**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
3		(i)	Columns for sin i and sin r correct (1) Consistent sig figs used and maximum 3 sig figs in values (1)		2		2	2	2
		(ii)	Both axes labelled with no units for sin values (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
		(iii)	Large triangle used or suitable points clearly shown on each graph or clearly implied by calculation (1) Gradient correctly calculated **ecf** (1) Gradient = refractive index = 1.35 (± 0.02) (1)			3	3	2	3
		(iv)	Use of $\sin\theta_C = \frac{1}{n}$ (1) Critical angle determined correctly (1) **ecf** on value of n	1	1		2	2	2
		(v)	Using $n_1 c_1 = n_2 c_2$ (1) Speed of light determined correctly (1) **ecf** on value of n (1)	1	1		2	1	2
			Question 3 total	**3**	**7**	**3**	**13**	**10**	**13**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
4	(a)		**Circuit** Vary frequency of light Use of circuit described correctly – vary voltage to stop current and record stopping potential; polarity of power supply. **Analysis** Einstein's photoelectric equation quoted eV_s = Max KE of electrons Plot graph of max KE against f or V_s against f Planck constant = gradient **5-6 marks** Comprehensive description of both circuit and analysis. *There is a sustained line of reasoning which is coherent, relevant, substantiated and logically structured.* **3-4 marks** Comprehensive description of either the circuit 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** Limited description of either the circuit 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** Nothing creditworthy or no attempt made.	6			6		6

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
	(b)		Einstein's photoelectric equation provided evidence for photon model of light or wave particle duality (1) Application described and use e.g. lasers in eye surgery; electron microscope to determine atomic structure (1)			2	2		
			Question 4 total	**6**	**0**	**2**	**8**	**0**	**6**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
5	(a)		Rate of flow of charge	1			1		
	(b)	(i)	Clearly labelled diagram with A and length indicated (1) Number of free electrons = $nAvt$ (or nAl) or Av = volume of free electrons per second (1) Total charge = $nAvte$ **or** nAv = number of free electrons per second (1) Current = $\frac{nAvte}{t}$ = $nAve$ **or** $nAVe$ = charge per second = current (1)	4			4	2	
		(ii)	Cross-sectional area = 2.5×10^{-6} [m^2] (1) Drift velocity = 4.7×10^{-5} [m s^{-1}] (1) **ecf** on incorrect powers of 10 from the conversion of CSA		2		2	2	
	(c)	(i)	Energy of vibration of ions increases (1) Collisions between ions and free electrons more frequent (1) Drift velocity decreases - Alexander is incorrect (1)			3	3		
		(ii)	Current decreases since drift velocity decreases (1) Resistance will increase from $R = \frac{V}{I}$ (1)			2	2		
			Question 5 total	**5**	**2**	**5**	**12**	**4**	**0**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
6	(a)	(i)	1.05 [V]		1		1	1	
		(ii)	Pd across parallel combination = 0.51 [V] **ecf** or total resistance = $\frac{1.56}{0.187}$ = 8.34 [Ω] (1) Use of $I = \frac{V}{R}$ **or** parallel resistance $\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$ (1) Current through parallel combination = $\frac{0.51}{6.8}$ **or** resistance of parallel = 2.74 [Ω] (1) Current through R = 112 [mA] or algebra manipulation (1) R = 4.6 [Ω] (1) Accept 4.55 [Ω]	1	1 1 1 1		5	4	
		(iii)	Use of $P = I^2R$ or equivalent (1) P = 0.057 [W] (1) **ecf** on R – technician correct			2	2	1	
	(b)		Use of $R = \frac{\rho l}{A}$ **ecf** (1) Cross sectional area = 1.4×10^{-7} [m^2] (1) Rearrangement: $\rho = \frac{RA}{l}$ (1) Resistivity = 4.9 (accept 4.8) $\times 10^{-7}$ Ω m (1) **unit mark** **ecf on** R	1	1 1 1		4	3	

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
	(c)		Use of Young modulus = $\frac{\text{stress}}{\text{strain}}$ (1) Strain = $\frac{2.3 \times 10^{-3}}{1.2}$ = 1.9×10^{-3} (1) Stress = $\frac{45}{1.4 \times 10^{-7}}$ (1) **ecf** on area Young modulus = 1.69×10^{11} [Pa] (1)	1	1 1 1		4	3	
	(d)		Shape of graph i.e. R = 0, vertical increase at transition temperature followed by linear increase (1) Transition temperature labelled correctly (1)	1	1		2		
			Question 6 total	**4**	**12**	**2**	**18**	**12**	**0**

AS COMPONENT 2 – ELECTRICITY AND LIGHT

SUMMARY OF MARKS ALLOCATED TO ASSESSMENT OBJECTIVES

Question	AO1	AO2	AO3	TOTAL MARK	MATHS	PRAC
1	1	6	3	10	6	0
2	7	7	0	14	8	6
3	3	7	3	13	10	13
4	6	0	2	8	0	6
5	5	2	5	12	2	0
6	4	12	2	18	12	0
TOTAL	**26**	**34**	**15**	**75**	**38**	**25**