GCE AS MARKING SCHEME

SUMMER 2016

PHYSICS AS Component 2
B420U20/01

INTRODUCTION

This marking scheme was used by WJEC for the 2016 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.

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)		(For a metal wire) current is proportional to pd (1) accept $I \propto V$ if terms defined. Don't accept $V = IR$ Provided temperature (or physical conditions) remains constant (1)	2			2		
	(b)	(i)	Using $R = \frac{V}{I}$ (1) Using $\rho = \frac{RA}{l}$ (1) Resistivity = $1.1 \times 10^{-6}\ \Omega$ m (1) **unit mark**	1 1	 1		 3	 3	
		(ii)	Area will reduce by factor of 4 [3.14×10^{-8} m^2](1) Attempt at substitution in $I = \frac{VA}{\rho l}$ (1) Correct conclusion "0.60 A is close to 0.55 A" or correct comparison made (1) **Alternative** based on calculating resistivity: Resistivity = $\frac{VA}{Il}$ (1) Resistivity = $1.21 \times 10^{-6}\ \Omega$ m (1) **ecf** on unit Correct conclusion based on comparison with value of resistivity in question (1) **Alternative** based on ratios: Area will reduce by factor of 4 (1) Resistance doubles, so current halves (1) Correct conclusion or correct comparison made (1)			3	3	2	
			Question 1 total	**4**	**1**	**3**	**8**	**5**	**0**

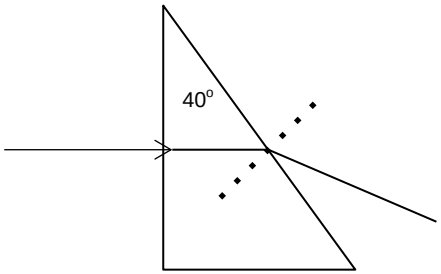
Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
2	(a)		Wavelength = 0.40 [m] (1) Phase difference = 180^{o} or π or antiphase (1)		2		2		
	(b)	(i)	A stationary wave is produced (1) Minimum – nodes and Maximum – Antinodes / waves travel in opposite directions (1) Nodes destructive interference; waves in antiphase **/** Antinodes – constructive interference; waves arrive in phase / by Principle of Superposition or superpose to create minima and maxima (1)	1	1 1		3		3
		(ii)	Determining 4 node to node lengths (1) Node to node length = $\frac{\lambda}{2}$ (1) Using $c = f\lambda$ (1) Speed of sound = 330 [m s^{-1}] (1)	1 1	1 1		4	3	
			Question 2 total	**3**	**6**	**0**	**9**	**3**	**3**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
3	(a)		Resistance decreases with temperature [accept graph non-linear] / metal's resistance increases [linearly] with temperature	1			1		
	(b)	(i)	R across thermistor decreases (1) pd across thermistor decreases / current will increase (1) Reading on voltmeter increases (1) correct reasoning needs to be present			3	3		
		(ii)	Resistance of thermistor = 1.43 ± 0.3 kΩ (from graph)(1) Current through R = 2.10 mA (1) **ecf** on R Value of R = 2.86 [kΩ] (1) **Alternatives:** **Method 1** $\frac{R}{R_{\text{thermistor}}}$ (1) = $\frac{6}{3}$ (1) Value of R = 2.86 [kΩ] (1) **Method 2** Solution based on potential divider equation $\frac{R}{R+R_{total}} = \frac{6}{9}$ (1) Correct algebraic manipulation (1) Value of R = 2.86 [kΩ](1) Penalise power of 10 error once only.		3		3	3	
		(iii)	Bulb connected reduces resistance / current through thermistor increases / pd across thermistor increased (1) So pd is less than 6.0 V (1)		2		2		
			Question 3 total	**1**	**5**	**3**	**9**	**3**	**0**

Question			Marking details		Marks available				
				AO1	AO2	AO3	Total	Maths	Prac
4	(a)		Diffraction at each slit **or** overlap of beams [allows interference to occur] (1) Waves arrive in phase / constructive interference (1) Path difference is whole number of wavelengths (1)	3			3		
	(b)	(i)	Axes labelled with units and suitable scale with data points occupying half the grid (1) All points plotted correctly to within ± ½ small square division (1) Good line of best fit consistent with the data (1)		3		3	3	3
		(ii)	Triangle or data points used and clearly shown using at least half of the line or data point on line clearly indicated (1) Correct gradient value or substitution in $\lambda = \frac{\Delta y a}{D}$ for data points selected (1) Final answer = 6.23 (Range ± 0.50) $\times 10^{-7}$ [m] (1) expressed to 2 or 3 sig figs Penalise omission of 10^{-3} factor once only in part (b)		3		3	3	3
			Question 4 total	**3**	**6**	**0**	**9**	**6**	**6**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
5	(a)		Using $n\lambda = d\sin\vartheta$ (1) Calculating d = 1.11 × 10^{-6} m (1) can be implied Calculating $\vartheta = \tan^{-1}(\frac{55}{80})$ or 34^{o} (1) can be implied Wavelength = 6.23 $(\pm 0.10) \times 10^{-7}$ [m] (1)	1	 1 1 1		 4	 4	
	(b)		Conversion of kW or mW (1) Conversion of mm^2 or m^2 (1) Correct comparison e.g. intensity of sun is [36%] bigger (1) Valid conclusion – e.g. no less dangerous than looking briefly at sun or almost as dangerous as looking at sun so goggles are necessary (1) must be reasoning present			4	4	2	
	(c)	(i)	An incoming photon (1) [Causes] an electron/atom to drop from level U to L (stimulated emission) (1) Energy loss of electron/atom is emitted in the form of a photon identical to the incident one (1)	3			3		
		(ii)	Recalling $\Delta E = \frac{hc}{\lambda}$ (1) $\Delta E = 3.37 \text{ x } 10^{-19}$J (1) (3.35 × 10^{-19} J if h = 6.6 × 10^{-34} J s used) Energy of level U = 4.63 × 10^{-19} [J] (1) (or 4.61 × 10^{-19} J)	1	 1 1		 3	 3	
			Question 5 total	**5**	**5**	**4**	**14**	**9**	**0**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
6	(a)		**Diagram and Method** M0 – Labelled diagram of set-up M1 – Angle of incidence and refraction indicated on diagram M2 – Method to measure angle of incidence and angle of refraction (e.g. method of tracing refracted rays) M3 – Range of angles of incidence indicated **Results** R0 – Determine sine of angles R1 – Noting that n = 1 for air R2 – n for glass determined for a variety of angles / graph of sine incident angle plotted against sine refracted angle R3 - Mean determined or possible alternative / gradient = n **5-6 marks** 6+ of M0 to M3 and R0 to R3 present *There is a sustained line of reasoning which is coherent, relevant, substantiated and logically structured.* **3-4 marks** 4-5 of M0 to M3 and R0 to R3 present *There is a line of reasoning which is partially coherent, largely relevant, supported by some evidence and with some structure.* **1-2 marks** 2-3 of M0 to M3 and R0 to R3 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.*	6			6		6

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
	(b)	(i)	Ray drawn through prism with no bending (1) Ray emerging from prism with angle of refraction greater than the angle of incidence (1) Don't accept TIR  		2		2		
		(ii)	Using $n_1 \sin\vartheta = n_2 \sin\vartheta$ (1) Angle of refraction = 78° (1) Light is deviated by 78° – 40° = 38° **ecf** (1)	1	 1 1		 3	 3	
		(iii)	Calculating critical angle = 41° (1) Angle of incidence is greater than critical angle (1) Ray is [refracted] on bottom side (1) **Alternative:** Calculation to show TIR (1) TIR occurs (1) Ray is [refracted] on bottom side (1)			3	3	1	
			Question 6 total	**7**	**4**	**3**	**14**	**4**	**6**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
7	(a)	(i)	The emission of electrons from a surface (1) By light or em radiation or photons (1)	2			2		
		(ii)	Longest wavelength when $E_{k\,max}$ = 0 or attempt at using photoelectric equation or $\phi = \frac{hc}{\lambda}$ or $\varphi = hf_0$ (1) Therefore $\frac{hc}{\lambda}$ = 5.24 × 10^{-19} (1) Wavelength = 3.79 × 10^{-7} [m] (1)	1	1 1		3	3	
	(b)	(i)	Energy of photon = 3.62 ×10^{-19} [J] (1) Number of photons falling on 1 m^2 = $\frac{1.39 \times 10^3}{3.6 \times 10^{-19}}$ or total energy on the whole panel = 2.28 × 10^4 [J] (1) Number of photons = 6.3 × 10^{22} (1)		3		3	3	
		(ii)	Total momentum of photons = 7.6 × 10^{-5} [N s] (1) Pressure = 4.53 × 10^{-6} [Pa](1) **Alternative:** Pressure = $\frac{(\frac{\text{power}}{\text{area}})}{c}$ (1) Pressure = 4.53 × 10^{-6} [Pa](1)		2		2	2	

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
	(c)		Either one of the following points [P – comment made and C – Concluding remark] P1 - Increase in space expenditure results in more space debris (1) C1 – Meaning more pollution in space for future generations (1) P2 – Countries like the USA spend a huge budget on space (1) C1 – But should tackle home issues such as ensuring health care for all (1) [Any comment contrasting issues from a country] P2 – Increase in space budget means more jobs and careers (1) C2 – This should help economy in long term (1) P3 – Technology developed from space exploration (1) C3 – Improves conditions for mankind on Earth (1) P4 – Impossible to draw conclusion on ethical issue from one graph (1) C4 – Need more information to form balanced view (1)			2	2		
			Question 7 total	**3**	**7**	**2**	**12**	**8**	**0**

COMPONENT 2: ELECTRICITY AND LIGHT

SUMMARY OF MARKS ALLOCATED TO ASSESSMENT OBJECTIVES

Question	AO1	AO2	AO3	TOTAL MARK	MATHS	PRAC
1	4	1	3	8	5	0
2	3	6	0	9	3	3
3	1	5	3	9	3	0
4	3	6	0	9	6	6
5	5	5	4	14	9	0
6	7	4	3	14	4	6
7	3	7	2	12	8	0
TOTAL	**26**	**34**	**15**	**75**	**38**	**15**