GCE AS MARKING SCHEME

SUMMER 2019

AS
PHYSICS - UNIT 2
2420U20-1

INTRODUCTION

This marking scheme was used by WJEC for the 2019 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.

AS UNIT 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)*	(i)	The current [through a metal conductor at constant temperature] is proportional to the pd [across it] Accept $I \propto V$ with well-defined symbols.	1			1		
		(ii)	Constant [or independent of current [or pd]] (1)	1			1		
	(b)	(i)	pd across X = 0.70 [V] (1) or by impl so R_X = 58 [Ω] (1) **or** total resistance = 183 [Ω] (1) or by impl so R_X = 58 [Ω] (1)		2		2	2	
		(ii)	R_X = 16 [Ω] or equivalent (1) So Ohm's law not obeyed (1) [not freestanding] **no ecf** **or** If R_X stayed at 58 [Ω] (or 58.3 Ω), then I = 27 (or 26) mA (1) Not so, therefore Ohm's law not obeyed (1) **no ecf**			2	2	1	
		(iii)	No. Filament resistance increases with increasing pd [or current] **or** equivalent **ecf** on calculated value of R_X in (b)(ii)			1	1		
	(c)	(i)	Temperature at which a material [that is classed as a superconductor] loses all its resistivity [accept resistance] [when cooled]. Accept "... below which a material [...] has no resistivity [accept resistance]"	1			1		
		(ii)	Coil for MRI machine, power cables, magnets / electromagnets or anything reasonable (1) Can be kept below transition temp [cheaply] by liquid nitrogen [accept: superconducts in liquid nitrogen] (1)	2			2		
			Question 1 total	**5**	**2**	**3**	**10**	**3**	**0**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
2.	*(a)*			Gives charge [electrical potential] energy *Accept* pumps charge around circuit / does work on charge. Accept electrons instead of charge	1			1		
	(b)	(i)		Total emf = 3 × 1.60 **or** 4.80 [V] (1) Total resistance = (1.20 + (3 × 0.10)) **or** 1.50 [Ω] (1) Current [$= \frac{V}{R}$]= 3.2 [A] (1) N.B. If workings in reverse award a maximum of 2 marks		3		3	1	
		(ii)	I	12.3 [W] **ecf** (10.8 W if 3 A used) e.g. using $P = I^2R$ = $3.2^2 \times 1.2$ = 12.3 [W]		1		1	1	
			II	15.4 [W] **ecf** (14.4 W if 3 A used) e.g. using $P = IE$ = 3.2 × 4.8 = 15.4 [W]		1		1	1	
		(iii)		Thermal or internal. *Accept* 'heat', 'dissipated' (1) in internal resistance (1)	2			2		
	(c)			3.15 A or 3.2 A [*Accept*: even on short-circuit, extra cell gives only 3.0 A] (1) No. Current less than [*accept* same as] before **ecf** on (b)(i) (1)			2	2	1	
				Question 2 total	**3**	**5**	**2**	**10**	**4**	**0**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
3.	*(a)*			In a <u>water</u> bath **or** in a beaker of <u>water</u> must imply heading (1) Using ice cubes / taking water from fridge / in an ice bath or equivalent (1)	1		1	2		2
	(b)	(i)		Straight line of best fit drawn (from 18 – 100 °C) with points either side **or** reference to very little scatter in the readings (1) Reference to or comparison with $y = mx + c$ (1) Positive intercept **or** positive gradient (1)		1	1 1	3		3
		(ii)	I	5.5 Ω, 5.6 Ω or 5.7 Ω **unit mark** [Accept attempts at 3 sf]		1		1	1	1
			II	**Either** Readings from graph line inserted in $\frac{\Delta R}{\Delta \theta}$. Tolerate slips (1) Gradient = 0.023 [± 0.002] [$\Omega\,°C^{-1}$] **or** by implication (1) α = 3.9 [± 0.4] $\times 10^{-3}$ °C^{-1} **unit mark ecf** on R_0 and gradient (1) **Or** Value of R_0 and (R, θ) values from another point on graph line inserted in equation. Tolerate slips (1) Correct algebra (1) α = 3.9 [± 0.4] $\times 10^{-3}$ °C^{-1} **unit mark ecf** on R_0			1 1 1	3	3	3
				Question 3 total	**1**	**2**	**6**	**9**	**4**	**9**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
4.	*(a)*		**Requirements** • Direction of polarisation in common • Comparable amplitude • Same frequency / wavelength • Coherent • Diffraction **Possible explanation material** • Coherent sources means constant [**or** constant or zero] phase difference between sources • Sketch-graphs showing meaning of constant phase difference • Rapidly shifting interference pattern if phase difference varies • No cancellation if polarisation directions or amplitudes different • Diffraction needed for overlap **Possible examples of compliance and non-compliance** • Two *slits* illuminated by single laser would fulfil requirements • Slits illuminated by ordinary lamp or separate lamps wouldn't • Contrived cases e.g. sources polarised at 90^{o} to each other; polaroids crossed or one source (e.g. slit) covered by dark glass acceptable	6			6		

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
			5-6 marks Comprehensive account of all areas i.e. requirements, explanations and examples given. *There is a sustained line of reasoning which is coherent, relevant, substantiated and logically structured.* **3-4 marks** Comprehensive account of 2 out of the 3 areas i.e. requirements, explanations and examples given **or** limited attempt of all 3 areas. *There is a line of reasoning which is partially coherent, largely relevant, supported by some evidence and with some structure.* **1-2 marks** Comprehensive account of 1 out of the 3 areas i.e. requirements, conditions and examples given **or** limited attempt of 2 areas. *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.						

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
	(b)	(i)	Mean of measurements i.e. x (= 5Δy) = 6.6[2] [mm] **or** by impl (1) Mean of Δy = 1.3[2] [mm] (1) Absolute uncertainty in x = 0.3 [mm] **or** in Δy = 0.06 [mm] or by implication (1) % uncertainty = 5 % Accept 4.5 % **ecf** on Δy and unc in Δy and on x and unc in x (1)		4		4	3	4
		(ii)	Correct substitutions into $\lambda = \frac{a\,\Delta y}{D}$, with **ecf** on Δy and allowing slips in powers of 10 (1) λ = 520 n[m] or 528 n[m] with **ecf** on Δy (1) % uncertainty = 10 % Accept 9.5 % **ecf** on uncertainty in Δy (1)		3		3	3	3
	(c)	(i)	$\lambda = \frac{1500\text{ nm} \sin 45°}{2}$ substitution in re-arranged eq. allow slips of powers of 10 (1) λ = 530 n[m] Accept 530.3 n[m] (1)		2		2	2	
		(ii)	Bright areas further apart in case of grating (1) Because slits closer together in grating [than double slits] (1) not freestanding Bright areas sharper **or** smaller **or** brighter for grating or equivalent (1) Because more slits in grating **or** more destructive interference **or** (for brighter fringes) more constructive interference (1) not freestanding	4			4		
			Question 4 total	**10**	**9**	**0**	**19**	**8**	**7**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
5.	*(a)*		[Minimum] energy needed to remove an electron [from the surface or from the metal] Don't accept reference to atoms or ionisation	1			1		
	(b)		Photon energy needed = 3.2×10^{-19} J + 1.5×10^{-19} J [= 4.7×10^{-19} J] **or** substitution of data into $E_{k\,max} = hf - \phi$ **or** by implication (1) $f = 7.1 \times 10^{14}$ [Hz] (1)		2		2	2	
	(c)	(i)	Photons per second = $\frac{0.3\,[W]}{4.7 \times 10^{-19}\,[J]ecf}$ (1) = 6.4×10^{17} [s^{-1}] Accept 6.5×10^{17} [s^{-1}] (1)		2		2	2	
		(ii)	Number of electrons per second = $\frac{0.8 \times 10^{-6}\,[A]}{1.6 \times 10^{-19}\,[C]}$ or by implication Accept slips of powers of 10 (1) = 5.0×10^{12} [s^{-1}] (1) Assumes all emitted electrons captured [or equivalent] (1)		3		3	2	
		(iii)	7.8×10^{-6} [or 7.8×10^{-4} %] **ecf** on *(c)*(i) and *(c)*(ii) **or** 8.3×10^{-6} [or 8.3×10^{-4} %] if 6×10^{17} used, **ecf** on *(c)*(ii)		1		1	1	
			Question 5 total	**1**	**8**	**0**	**9**	**7**	**0**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
6.	*(a)*			Dark lines [or equivalent] (1) Bright background [accept rainbow background or equivalent] (1) Dark lines in same positions [or for same wavelengths] as [some of the] bright lines in emission spectrum (1)	3			3		
	(b)	(i)	I	Electron given energy **or** pumped' (1) [Electron having fallen from P to U] increases population of U or brings about population inversion (1)	2			2		
			II	Electron falls quickly **or** spontaneously [from L to level G] (1) So depopulating level L **or** making pop inversion easier to establish (1)	2			2		
		(ii)		Photon energy = (1.43 – 0.26) [eV] [= 1.17 eV] or by impl (1) Conversion to J even if incorrect energy gap [= 1.87×10^{-19} J or by implication] (1) Correct use of $\lambda = \frac{hc}{E}$ **or** $\lambda = \frac{c}{f}$ and $f = \frac{E}{h}$ **ecf** on E (1) 1 060 n[m] **no ecf and** infra-red (1)		4		4	3	
	(c)			A maximum of (3) marks by addition from... • Laser pointer (arguably) too low-powered to be dangerous • Lecturer should be trusted not to shine lasers at students (or strongly reflecting surfaces) or lasers not viewed directly • Might stop sight of bright spot even when pointer used correctly • Any good physics involving polarisation • Will make field of view dimmer so note-taking difficult **or** opening pupils of eyes, making laser beam *more* dangerous • Any other valid point • Conclusion argued using more than one of the above			3	3		
				Question 6 total	**7**	**4**	**3**	**14**	**3**	**0**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
7.	*(a)*	(i)	$v_{\text{plastic}} = \frac{\text{AC}}{\text{BD}} \times c$ **or** equivalent **or** by implication (1) BD = 44 **or** 45 **or** 46 [mm]; AC = 31 **or** 32 **or** 33 [mm] (1) $v_{\text{plastic}} = (2.1 \pm 0.1) \times 10^8$ [m s^{-1}] (1)		3		3	3	
		(ii)	n = 1.4 [± 0.1] **ecf**		1		1	1	
	(b)	(i)	A correct relevant time calculation e.g. for 120 m, 608 ns **or** for 120.9 m, 613 ns **or** by implication (1) Extra time by zig-zag route = 5 ns [4.6 n[s]] (1) **Therefore** overlap will occur, [as 4.6 ns > 4.0 ns] **no ecf** (1) [Allow 1 mark if n (refractive index) omitted leading to 3.0 ns delay and hence no overlap] **Alternative:** Extra distance for 4.0 ns extra time $\frac{3.00 \times 10^8 \times 4.0 \times 10^{-9}}{1.52}$ (1) = 0.79 [m] (1) **Therefore** overlap will occur [as 0.79 < 0.90 m] (1) [Allow 1 mark if n (refractive index) omitted leading to 1.2 m delay and hence no overlap]			3	3	2	
		(ii)	n_{clad} [sin 90°] = 1.520 sin 83° or equivalent (1) n_{clad} [sin 90°] = 1.51 (1)		2		2	2	
			Question 7 total	**0**	**6**	**3**	**9**	**8**	**0**

AS UNIT 2: ELECTRICITY AND LIGHT

SUMMARY OF MARKS ALLOCATED TO ASSESSMENT OBJECTIVES

Question	AO1	AO2	AO3	TOTAL MARK	MATHS	PRAC
1	5	2	3	10	3	0
2	3	5	2	10	4	0
3	1	2	6	9	4	9
4	10	9	0	19	8	7
5	1	8	0	9	7	0
6	7	4	3	14	3	0
7	0	6	3	9	8	0
TOTAL	**27**	**36**	**17**	**80**	**37**	**16**