GCE AS MARKING SCHEME

SUMMER 2018

AS (NEW)
PHYSICS AS UNIT 2
2420U20-1

INTRODUCTION

This marking scheme was used by WJEC for the 2018 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)		Energy (or work) /charge **or** energy (or work) per coulomb [accept joules per coulomb] (1) The above put correctly into context, e.g. Energy given by battery / energy transfer from chemical [or to electrical]. [Free standing mark] (1)	1 1			2		
		(ii)		**Method 1** $I = \frac{4.33\ \text{V}}{6.60\ \Omega}\left[= 0.656\ \text{A}\right]$ or by implication (1) $r = \frac{4.80\left[\text{V}\right] - 4.33\left[\text{V}\right]}{0.656\left[\text{A}\right]}$ = 0.71 / 0.72 / 0.7 Ω (1) **Method 2** Any correct and relevant pot div equation e.g. $\frac{r}{6.6\ \Omega} = \frac{4.80\ \text{V} - 4.33\ \text{V}}{4.33\ \text{V}}$ or $4.33 = \frac{4.80 \times 6.60}{r + 6.60}$ (1) r = 0.71 / 0.72 / 0.7 Ω (1) See additional guidance for methods assuming 0.7 Ω	1	1		2	2	
		(iii)	I	More current (1) Therefore greater Ir [accept: greater lost volts] (1) NB $V = E - Ir$ on its own doesn't score. **or** Ratio (ext res)/r lower (1) So ratio (ext pd)/(pd aross r) less (1) **or** equivalents	1	1		2		
			II	Current in either resistor = $\frac{3.35}{3.30}$ [= 1.02 / 1.015 A](1) Division by e at any stage (1) [e.g. $\rightarrow$61 C] Electrons in 1 minute = 3.8×10^{20} C, **ecf** on I [NB electrons through parallel combination = $7.6 \times 10^{20} \rightarrow$ (2)]		3		3	2	

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(b)	(i)		$R = \frac{V^2}{P}$ **or** $\left[I = \frac{1000\ \text{W}}{230\ \text{V}} \right.$ **and** $\left. R = \frac{V}{I} \right]$ (1) R = 53 Ω [accept early rounding] (1)	1	1		2	2	
		(ii)		3.6 [MJ]		1		1	1	
	(c)			If electric heating is used rather than gas, for a given heating effect more $\underline{CO_2}$ produced [or more gas, a non-renewable resource [accept: fossil fuel] is used]. (1) Greater contribution to climate change/global warming [so use of electric heaters *should* be discouraged] (1) **Any one of...** • [But] higher cost of electricity [per kW] is discouragement enough • [But] not all power stations *are* gas-fired. [Some eg nuclear, wind, don't produce CO_2] • [But] not all homes have gas available • CO_2 absorbs long-wavelength infrared (or infrared emitted from Earth's surface) in context of climate change • Any other relevant and non-trivial point e.g. safety issue with naked flames / $\underline{CO}$ emission / gas leaks Example of point not worth credit: "it's none of anyone else's business how I heat my home" – the word in the question was "discouraged" / electric heaters more expensive to run			3	3		
				Question 1 total	**5**	**7**	**3**	**15**	**7**	**0**

Additional guidance for 1*(a)*(ii)

Method 3

[Assuming that] $r = 0.7\ \Omega$:

Total resistance = $7.30\ \Omega$

$\therefore$ Current = $\dfrac{4.80[\mathrm{V}]}{7.30[\Omega]} = 0.658$ A (1)

Terminal pd, $V = E - Ir = 4.80 - 0.685 \times 0.7$

= 4.34 V, which is approximately as expected (1)

So the initial assumption is correct

Method 4

[Assuming that] $r = 0.7\ \Omega$:

[Total resistance = $7.30\ \Omega$]

Using the potential divider equation:

$V = E \times \dfrac{R}{R+r} = 4.80[\mathrm{V}] \times \dfrac{6.60[\Omega]}{7.30[\Omega]}$ equation used correctly (1)

= 4.34 V, which is approximately as expected (1)

So the initial assumption is correct

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
2	*(a)*		I = 0.0012 A **and** R_{tot} = 5000 Ω or V_{therm} = 4.80 V **or** $\frac{R_{th}}{1000\,\Omega} = \frac{4.8\text{ V}}{1.2\text{ V}}$ or any other correct and relevant potential divider equation or by implication (1) R_{therm} = 4 000 Ω (1) θ = 15° ecf on R_{therm}(1)		3		3	3	
	(b)		Graph gradient changes [with θ] or graph not straight [**or** voltmeter reading doesn't vary linearly with R_{therm}] or ΔV not proportional to ΔR (1) n not constant [with varying θ] / he is wrong [only award if backed up by reasonable argument] (1)			2	2	1	
	(c)		So <u>thermistor</u> [accept: 'it'] doesn't heat up (1) Reference to electrical heating [even of circuit or resistor] **or** masking response to surroundings (or equiv) (1)		2		2		
			Question 2 total	**0**	**5**	**2**	**7**	**4**	**0**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
3	*(a)*	(i)	1.79 eV = 2.86×10^{-19} J or by implication (1) Use of $hf = E_U - E_L$ and $\lambda = \frac{c}{f}$, **or** $\lambda = \frac{hc}{E_U - E_L}$ **or** equiv (1) λ = 694 [±1] n[m] / 6.9×10^{-7} [m] (1)	1	1 1		3	2	
		(ii)	So a photon is more likely to cause stimulated emission than to be absorbed / more stimulated emission than absorption (**or** so more photons cause SE than are absorbed) (1) So number of photons increases [rather than decreases] / light builds up / 1 photon → 2 photons (1)	2			2		
	(b)	(i)	photons per second = $\frac{6.0\times10^{-3}\,[\mathrm{W}]}{2.86\times10^{-19}\,[\mathrm{J}]}$ **ecf** even if slips (eg by 10^n) (1) 2.09×10^{16} [s^{-1}] (1)	1	1		2	1	
		(ii)	photon momentum = $\frac{6.63\times10^{-34}\,[\mathrm{J\,s}]}{693\times10^{-9}\,[\mathrm{m}]}$ $\left[=9.55\times10^{-28}\,\mathrm{N\,s}\right]$ or by implication **ecf** on λ (1) **or** beam momentum per second = $\frac{0.006\,[\mathrm{W}]}{c}$ **or** by implication beam momentum per second = 2.0×10^{-11} [N] (1) [1.91×10^{-11} N if 2×10^{16} used]	1	1		2	2	
		(iii)	4.0×10^{-11} N ((**unit**)) **ecf** from (ii), i.e. 2 × answer to (ii) But not if answer to (ii) was 0.		1		1	1	
			Question 3 total	**5**	**5**	**0**	**10**	**6**	**0**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
4	*(a)*		T = 0.60 [s] **or** f = 1.67 [Hz] in working or by implication (1) Sinusoid of correct frequency and amplitude drawn from t = 0 to t = 1 s (1) Reasonable graph: Correct phase (–sin ωt) (1)		3		3	2	
	(b)	(i)	1 500 [nm] sin 24.9° = λ or by implication (1) λ = 632 nm (1)	1	1		2	2	
		(ii)	Diagram of right-angled triangle (by eye) with 57.4° (accept θ) marked in a correct position [i.e. wavefront from bottom slit perpendicular to top direction] (1) Either 2λ (or path difference) marked on diagram or statement that path difference [for light from adjacent slits] = 2λ (1) 57.4° (or θ) = $\sin^{-1}\frac{2\lambda}{d}$ or equivalent [e.g. $\sin^{-1}(2\sin 24.9°)$] (1) [Last mark free-standing]	1 1	1		3		
			Question 4 total	**3**	**5**	**0**	**8**	**4**	**0**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
5	*(a)*	(i)	$\lambda \geq 25$ mm / gap / w. [Accept >, not =]	1			1		1
		(ii)	Intensity increased straight in front of gap (or equivalent) [or more total power – accept total intensity – passes through gap] (1) Intensity reduced at large angles to normal / 'at the sides' [accept: waves don't diffract as much] (1)			2	2		2
	(b)		$S_1P = 250$ mm (1) $S_2P = 264$ mm (1) Path difference = 14 mm **or** by implication **ecf** on S_1P and S_2P (1) $\lambda = 28$ mm (1) NB Use of Young slits formula $\rightarrow$ 0 marks	1	1 1 1		4	. 2	
			Question 5 total	**2**	**3**	**2**	**7**	**2**	**3**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
6	*(a)*	(i)	0.327 m (1) ± 1.5% (1) No s.f. penalty		2		2	2	2
		(ii)	335 m s^{-1} (1) **ecf** [allow 334.9] ± 8 m s^{-1} (1) **ecf** [allow 8.4] Allow 1$_{max}$ for incorrect / inconsistent sf		2		2	2	2
	(b)	(i)	$x = \frac{\lambda}{4}$ or $4x = \lambda$(1) Use of $v = f\lambda$ (1)		2		2	1	2
		(ii)	Node, antinode... sequence with antinode at top and node at bottom marked or equiv e.g. string of sausages diagram, with at least one node between top and bottom of air column(1) Correct sequence [A, N, A, N] going downwards or equiv with spacings correct by eye.	1	1		2		2
			Question 6 total	**1**	**7**	**0**	**8**	**5**	**8**

Question			Marking details		Marks available				
				AO1	AO2	AO3	Total	Maths	Prac
7	*(a)*	(i)	1.00 sin θ_{air} = 1.60 sin 30° **or** equivalent **or** by implication (1) θ_{air} = 53° (1) Beam bends sharply to the left at the surface (1)	1	1 1		3	2	
		(ii)	$\theta = \theta_C$ **or** by implication (1) $\sin\theta = \frac{1}{1.60}$ [=0.625] **or** equivalent (eg θ_C= 39°) (1) x =62.5 / 63 mm (1)	1 1	1		3	2	
	(b)		**Marking points** A1. Light [travelling at small angles to axis] hitting core/cladding boundary is totally internally reflected A2. [So] transmitted along fibre without loss B3. Light paths at different angles [to axis] are of different lengths [for given length of fibre] B4. [So] take [slightly] different times and [so] [each] pulse spread out [over time] on arrival at far end C5. Pulses may overlap (if in rapid sequence) C6. Spreading [accept mm dispersion] increases with length of fibre, [so] overlap more likely if fibre longer **5-6 marks** *Expect at least 4 points made from all of sections A, B and C* *There is a sustained line of reasoning which is coherent, relevant, substantiated and logically structured.* **3-4 marks** *Expect at least 3 points made from at least two sections from A, B or C* *There is a line of reasoning which is partially coherent, largely relevant, supported by some evidence and with some structure.*	6			6		

Question			Marking details		Marks available				
				AO1	AO2	AO3	Total	Maths	Prac
			1-2 marks *Any 2 points made* *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 7 total	**9**	**3**	**0**	**12**	**4**	**0**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
8	*(a)*	(i)	No emission if photon energy < ϕ [or emission only if photon energy > ϕ](1) Convincing argument, clearly implying that photon energy = hf and leading to no emission if $f < \frac{\phi}{h}$ (1) Increasing light intensity just gives more photons **or** doesn't change [energy of] individual photons **or** doesn't help because photons don't co-operate (1)	3			3		
		(ii)	Photon energy = 4.37×10^{-19} [J] (1) No emission by Ca or Zn (or equiv) (1) $KE_{max} < 0.56 \times 10^{-19}$ J or $\phi > 3.81 \times 10^{-19}$ J or equivalent, e.g. V_S = 0.78 V (Cs), 0.43 V (K), 0.21 V (Ba) (1) Therefore Ba (1) [award mark only if attempted justification] See below:			4	4	2	
	(b)	(i)	Acceptable straight line through points (going through origin would be unacceptable)		1		1	1	1
		(ii)	Straight line as predicted (1) But not through origin (or non-zero intercept). Equation predicts through origin (or proportionality) (1)			2	2	1	2
		(iii)	Data from graph put into $\frac{\Delta V}{\Delta f}$ irrespective of slips such as incorrect powers of 10 (1) Accept between 3.90×10^{-15} and 4.40×10^{-15} [V Hz^{-1}] and to either 2 or 3 sig figs (1) $h = 6.64 \times 10^{-34}$ J s **ecf** from gradient (1)			3	3	2	3
			Question 8 total	**3**	**1**	**9**	**13**	**6**	**6**

Additional marking guidance for 8*(a)*(ii)

Method 1

$hf = 4.37 \times 10^{-19}$ J (1)

For Barium $hf - \phi = 0.34 \times 10^{-19}$ J (1)

$V_{stop} = 0.21$ V (1)

Therefore barium (1)

Method 2

$hf = 4.37 \times 10^{-19}$ J (1)

$h\phi < 4.37 \times 10^{-19}$ J **or** not Ca or Zn (1)

For potassium, Either $hf - \phi = 0.69 \times 10^{-19}$ J

or $V_{stop} = 0.43$ V (1)

Therefore barium (1)

Method 3

$hf = 4.37 \times 10^{-19}$ J (1)

$h\phi < 4.37 \times 10^{-19}$ J **or** not Ca or Zn (1)

$E_k < 0.56 \times 10^{-19}$ J **or** $\phi > 3.81 \times 10^{-19}$ J (1)

[Don't penalise $E_k = 0.56 \times 10^{-19}$ J or $\phi = 3.81 \times 10^{-19}$ if seen]

Therefore barium (1)

AS UNIT 2: ELECTRICITY AND LIGHT

SUMMARY OF MARKS ALLOCATED TO ASSESSMENT OBJECTIVES

Question	AO1	AO2	AO3	TOTAL MARK	MATHS	PRAC
1	5	7	3	15	7	0
2	0	5	2	7	4	0
3	5	5	0	10	6	0
4	3	5	0	8	4	0
5	2	3	2	7	2	3
6	1	7	0	8	5	8
7	9	3	0	12	4	0
8	3	1	9	13	6	6
TOTAL	**28**	**36**	**16**	**80**	**38**	**17**