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# **GCE AS MARKING SCHEME**

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**SUMMER 2017**

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

## **INTRODUCTION**

This marking scheme was used by WJEC for the 2017 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.

## 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				Maths	Prac
			AO1	AO2	AO3	Total		
1	(a)	$v = \frac{I}{nAe}$ correct transposition at any stage or by implication(1) $A = 12.00 \times 10^{-3} \text{ m} \times 2.00 \times 10^{-3} \text{ m} [= 2.4 \times 10^{-5} \text{ m}^2]$ (1) $v = 2.45 \times 10^{-5} \text{ [m s}^{-1}]$ (1) Accept $2.5 \times 10^{-5} \text{ [m s}^{-1}]$		3		3	3	
	(b)	Energy = $I^2Rt$ or equivalent used (1) 192 J [or 190 J] <b>UNIT</b> (1) Collisions between [free] <u>electrons and ions</u> [or atoms or lattice] (1)	1	1 1		3	2	
		<b>Question 1 total</b>	<b>1</b>	<b>5</b>	<b>0</b>	<b>6</b>	<b>5</b>	<b>0</b>

Question			Marking details	Marks available				Maths	Prac
				AO1	AO2	AO3	Total		
2	(a)	(i)	$\rho = \frac{RA}{L}$ correct transposition at any stage or by implication (1) $A = \pi \left(\frac{d}{2}\right)^2$ or equivalent correctly used to give value in $m^2$ or by implication (1) $\rho = 4.9 \times 10^{-7} \Omega m$ [accept $4.90 \times 10^{-7} \Omega m$ ] <b>UNIT</b> (1) Only one mark lost for $20 \times 10^{-7} \Omega m$ or $19.6 \times 10^{-7} \Omega m$ No sig fig penalty	1	1		3	3	3
		(ii)	One mark penalty for working with uncertainties of half the resolutions without comment. No penalty if reasonable justification given. This applies to both methods below. <b>Fractional or percentage uncertainties method</b> In $r$ : 0.02[1] or 2[.1]%. In $R$ : 0.04 5 or 4.5% In $L$ : 0 or 0.1% (1) Correct composition of individual fractional or percentage uncertainties (0.087 (8.7%) and 0.09 (9%)) (1) So $0.4$ or $0.5 \times 10^{-7} [\Omega m]$ if $4.9 \times 10^{-7} [\Omega m]$ given in (i) <b>or</b> $0.39$ to $0.44 \times 10^{-7} [\Omega m]$ if $4.90 \times 10^{-7} [\Omega m]$ given in (i) <b>ecf</b> (1) <i>Only one mark penalty for omitting <math>10^{-7}</math> in this part.</i> <b>Maximum value method</b> $\frac{2.3 \times \pi \times (0.245 \times 10^{-3})^2}{0.811}$ or by implication (1) $5.34$ <b>or</b> $5.35 \times 10^{-7} [\Omega m]$ , <b>or</b> $5.3$ <b>or</b> $5.4 \times 10^{-7} [\Omega m]$ (1) So $\pm 0.4$ or $0.5 \times 10^{-7} [\Omega m]$ if $4.9 \times 10^{-7} [\Omega m]$ given in (i) or $0.43$ , $0.44$ or $0.45 \times 10^{-7} [\Omega m]$ if $4.90 \times 10^{-7} [\Omega m]$ in (i) (1) Answer to 1 or 2 sig figs only		3		3	3	3

Question		Marking details	Marks available				Maths	Prac
			AO1	AO2	AO3	Total		
	(b)	<p>Longer wire (1) Don't accept more repeat readings Less percentage or fractional uncertainty in resistance (1) <b>Don't accept</b> less percentage or fractional uncertainty in length</p> <p><b>Or</b> winding wire or equivalent to measure across several diameters at once (1) Less percentage error in diameter (1)</p>			2	2		2
		<b>Question 2 total</b>	<b>1</b>	<b>5</b>	<b>2</b>	<b>8</b>	<b>6</b>	<b>8</b>

Question		Marking details	Marks available				Maths	Prac
			AO1	AO2	AO3	Total		
3	(a)	$I = \frac{12.0 \text{ V}}{450 \Omega + 150 \Omega} [= 0.020 \text{ A}] \text{ or equivalent or } \frac{V_{\text{out}}}{V_{\text{in}}} = \frac{150 \Omega}{450 \Omega + 150 \Omega} \text{ or equivalent (1)}$ Give mark if included in single equation (as below) $V_{\text{out}} = 0.020 \text{ A} \times 150 \Omega \text{ or } \frac{150 \Omega}{450 \Omega + 150 \Omega} \times 12.0 \text{ V}$ <b>and</b> = 3[.0 V] [as required] (1)		1		2	2	
	(b)	Any valid power calculation i.e. $\frac{3^2}{150}$ or $\frac{9^2}{450}$ or $\frac{12^2}{600}$ (1) <b>For 2<sup>nd</sup> mark:</b> - If used $\frac{9^2}{450}$ power in $R_1$ is 0.18 W which is < 0.5 W <b>or</b> which meets requirement - If used $\frac{12^2}{600}$ total power is 0.24 W and therefore power in $R_1$ is < 0.5 W (1) If $\frac{3^2}{150}$ don't award 2 <sup>nd</sup> mark <b>ecf</b> on current and $V_{\text{out}}$ from part (a)		1		2	2	
	(c)	$\frac{1}{R} = \frac{1}{150} + \frac{1}{600}$ or equivalent or by implication (1) $R = 120 [\Omega]$ (the modified $R_2$ ) (1) $V_{\text{out}} = 2.5 [\text{V}]$ <b>or</b> 2.53 [V] (1) So drop of > 0.4 V [therefore requirement not met] (give mark only if whole argument valid) (1) <b>ecf</b> on $V_{\text{out}}$ from part (a)		1 1 1		4	2	
		<b>Question 3 total</b>	<b>0</b>	<b>5</b>	<b>3</b>	<b>8</b>	<b>6</b>	<b>0</b>

Question			Marking details	Marks available				Maths	Prac
				AO1	AO2	AO3	Total		
4	(a)	(i)	$\lambda = 0.20 \text{ [m]}$ (or by implication) (1) $v = \frac{0.20 \text{ [m]}}{0.040 \text{ [s]}}$ <b>or</b> $0.20 \text{ [m]} \times 25 \text{ [Hz]}$ <b>or</b> $5.0 \text{ [m s}^{-1}\text{]}$ <b>or</b> $d = 0.20 \text{ [m]} \times \frac{0.34 \text{ [s]}}{0.04 \text{ [s]}}$ (1) $d = 1.7 \text{ [m]}$ (1) Award 1 mark only if $\lambda$ wrong but all else right		3		3	2	
		(ii)	Upside down, roughly same amplitude at least one complete cycle shown		1		1		
	(b)	(i)	[Point] that doesn't move <b>or</b> of no oscillation <b>or</b> of zero (minimum) amplitude <b>or</b> of destructive interference <b>or</b> equiv (1) $0.10 \text{ [m]}$ <b>ecf</b> (1) Don't accept $\frac{\lambda}{2}$	2			2		
		(ii)	Points between [successive] nodes in phase <b>or</b> points a wavelength apart are in phase (1) Phase reversals at each node or equivalent (1)	2			2		
		(iii)	[Progressive] waves reflect [at clamp] (1) [Progressive] waves travelling in opposite directions [reflected covers this] <b>and</b> interfere or superpose (1) Accept specific case, e.g. waves travelling in opposite directions <b>and</b> interfere destructively at nodes	2			2		
		(iv)	Nodes closer together <b>or</b> shorter wavelength Accept more nodes or more antinodes		1		1		
			<b>Question 4 total</b>	<b>6</b>	<b>5</b>	<b>0</b>	<b>11</b>	<b>2</b>	<b>0</b>



Question		Marking details	Marks available				Maths	Prac
			AO1	AO2	AO3	Total		
5	(a)	<ul style="list-style-type: none"> <li>Placing of laser slits, screen <b>or</b> travelling microscope <b>or</b> transverse ruler in words or diagram even if no suggested distances.</li> <li>Distance between slits and screen measured: stated with metre ruler or tape measure .</li> <li>Fringe separation/spacing measured with ruler [or travelling microscope] with details included e.g. between centres of fringes or across several fringes or repeat readings taken or use of magnifying glass or large slit-screen distance</li> <li>Slit-screen distance, slit separation, fringe separation 'put into formula' stated: <math>\lambda = \frac{\text{slit separation} \times \text{fringe separation}}{\text{slit-screen distance}}</math> symbols, if used, must be identified with measured quantities. No penalty for swapping <math>a</math> and <math>y</math>.</li> </ul> <p><b>5-6 marks</b> Comprehensive description of how to set up the apparatus, the measurements to be taken (including details of instruments / techniques) and how to determine the wavelength with the equation clearly stated. <i>There is a sustained line of reasoning which is coherent, relevant, substantiated and logically structured.</i></p> <p><b>3-4 marks</b> Description of how to set up the apparatus, the measurements to be taken either both measurements specified or one measurement / technique and how to determine the wavelength with the equation stated. <i>There is a line of reasoning which is partially coherent, largely relevant, supported by some evidence and with some structure.</i></p>	6			6		6

Question			Marking details	Marks available				Maths	Prac
				AO1	AO2	AO3	Total		
			<p><b>1-2 marks</b> Some correct attempt at either how to set up the apparatus, which measurements are taken and <math>l</math> or how the wavelength is determined. <i>There is a basic line of reasoning which is not coherent, largely irrelevant, supported by limited evidence and with very little structure.</i></p> <p><b>0 marks</b> <i>No attempt made or no response worthy of credit.</i></p>						
	(b)	(i)	Right angled triangle drawn and labelled with 0.6[00] on the correct side (1) adj side $\approx$ hypot <b>or</b> $\sin \theta_1 \approx \tan \theta_1$ (accept calculations) <b>or</b> equivalent (1)		2		2	2	
		(ii)	Correct insertion of values of $d$ , $\sin \theta_1$ and $n = 1$ in equation <b>or</b> correct use of Youngs slits equation (1) $\lambda = 510 \text{ n[m]}$ (1)		2		2	2	
		(iii)	39 orders (1) <b>ecf</b> accept 39.2 orders Slit separation is very large [compared with $\lambda$ ] (1) Accept $\lambda$ <u>much</u> less than slit separation		1	1	2	1	
			<b>Question 5 total</b>	<b>6</b>	<b>5</b>	<b>1</b>	<b>12</b>	<b>5</b>	<b>6</b>

Question			Marking details	Marks available				Maths	Prac
				AO1	AO2	AO3	Total		
6	(a)	(i)	Total internal reflection Don't accept TIR	1			1		
		(ii)	$1.52 \sin \theta_c = 1.33 [\sin 90^\circ]$ (1) $\theta_c = 61^\circ$ (1) $45^\circ$ (or angle of inc) $< 61^\circ$ (or $\theta_c$ ) so won't work properly <b>or</b> no TIR <b>ecf</b> (1) <b>Alternative:</b> $1.52 \sin 45^\circ = 1.33 \sin \theta_w$ (1) $\theta_w = 54^\circ$ or $\sin \theta_w < 1$ (1) Light escapes or not TIR so won't work properly <b>ecf</b> (1)			3	3	3	
	(b)	(i)	$t = \frac{d}{v}$ in this transposed form, or by implication – ignore units and accept omission of $n$ (1) $v = \frac{c}{n}$ or equivalents used or by implication (1) $7.6 \mu[s]$ (1)		3		3	3	
		(ii)	Monomode fibre allow only one route/path for light [whereas multimode fibres allow many] (1) [Therefore] any one pulse arrives without spreading [over time] (smearing) in a monomode fibre. Accept all light takes the same time to travel through fibre. Accept converse point for thicker (1) Hence likelihood of pulses overlapping [muddling] (1)	3			3		
			<b>Question 6 total</b>	<b>4</b>	<b>3</b>	<b>3</b>	<b>10</b>	<b>6</b>	<b>0</b>

Question			Marking details	Marks available				Maths	Prac
				AO1	AO2	AO3	Total		
7	(a)	(i)	Increase pd until microammeter reads zero. <b>Or</b> decrease pd until microammeter just starts to read a current (1) Reading of voltmeter <u>gives the energy value needed</u> or equivalent statement (1) Accept $E_k = eV_{\text{stop}}$	2			2		2
		(ii)	$\phi = \frac{6.63 \times 10^{-34} \times 3.00 \times 10^8}{405 \times 10^{-9}} \text{ [J] (1) } - 0.480 \times 1.60 \times 10^{-19} \text{ [J] (1)}$ $\text{[} 4.91 \times 10^{-19} \text{] } \quad \text{[} -7.68 \times 10^{-20} \text{]}$ <b>or</b> $\phi = \frac{6.63 \times 10^{-34} \times 3.00 \times 10^8}{405 \times 10^{-9} \times 1.60 \times 10^{-19}} \text{ [eV] (1) } - 0.480 \text{ [eV] (1)}$ $\text{[} 3.07 \text{]}$ even if not transposed $4.1 \times 10^{-19} \text{ [J] or } 2.6 \text{ [eV] (1)}$		3		3	3	3
		(iii)	For 650 nm, photon energy = $3.1 \times 10^{-19} \text{ J or } 1.9 \text{ eV (1)}$ Photon energy not enough to knock out electron <b>or</b> photon energy $< \phi$ (1) More photons [per second] won't help or increasing intensity doesn't increase photon energy (1) Accept only gives more photons at the same energy or doesn't change frequency <b>Alternative</b> Calculation of $f_0 = 6.2 \times 10^{14} \text{ [Hz] ecf}$ or calculation of $\lambda_0 = 4.8 \times 10^{-7} \text{ [m] ecf (1)}$ $4.6 \times 10^{14} \text{ [Hz]} < 6.2 \times 10^{14} \text{ [Hz] or } 650 \text{ nm is } > 480 \text{ nm}$ so no emission occurs (1) More photons [per second] won't help or increasing intensity doesn't increase photon energy (1) Accept only gives more photons at the same energy or doesn't change frequency - Subtract 1 mark if no useful reference made to photons			3	3		3

Question			Marking details	Marks available				Maths	Prac
				AO1	AO2	AO3	Total		
	(b)	(i)	$v = \frac{h}{m\lambda}$ transposed and used (1) $v = 1.5 \times 10^7 \text{ [m s}^{-1}\text{]} (1)$		2		2	2	
		(ii)	Electrons are wavelike <b>or</b> diffract <b>or</b> interfere (1) Accept reference to wave-particle duality Graphite crystals act as diffraction gratings <b>or</b> electrons diffract <u>between (around) atom[s]</u> (through lattice) <b>or</b> $\lambda$ comparable with gaps between atoms (1)	2			2		
			<b>Question 7 total</b>	<b>4</b>	<b>5</b>	<b>3</b>	<b>12</b>	<b>5</b>	<b>8</b>

Question			Marking details	Marks available				Maths	Prac
				AO1	AO2	AO3	Total		
8	(a)	(i)	Use of $\lambda = \frac{hc}{\Delta E}$ including wrong transition <b>or</b> equivalent (1) 1.55 $\mu$ [m] (1)		2		2	2	
		(ii)	<b>Absorption:</b> photon disappears <b>or</b> is absorbed <b>or</b> has its energy transferred (1) Electron promoted <u>from L</u> (or ground state) [to U] (1) Don't accept if state going to P <b>Stimulated em:</b> [passing] photon demotes electron <u>from U</u> [to L] (1) [another] photon emitted; 2 photons must be implied (1)	4			4		
		(iii)	Stimulated emission because more electrons <u>in U</u> [than L] Accept population inversion		1		1		
		(iv)	So P stays relatively empty to receive [pumped] electrons <b>or</b> so as not to impede pumping <b>or</b> equivalent <b>or</b> so as to keep the population of U high (1) To maintain high population in U <b>or</b> to maintain population inversion <b>or</b> equivalent (1)	2			2		

Question		Marking details	Marks available				Maths	Prac
			AO1	AO2	AO3	Total		
	(b)	<p><b>At least 1 from:</b></p> <ul style="list-style-type: none"> <li>- no power loss in wires</li> <li>- high power lasers very inefficient</li> <li>- laser beam only travels in straight lines / wires are flexible</li> <li>- less use of raw materials (e.g. copper) for laser beams</li> <li>- no danger of electrocution with laser beams</li> <li>- light isn't versatile needs to be transferred into other more useful forms</li> <li>- reference to beam spreading and absorption</li> </ul> <p><b>Maximum of 3 from the following:</b></p> <ul style="list-style-type: none"> <li>- no visual pollution</li> <li>- cheaper because less raw materials used</li> <li>- replacement cost very large</li> <li>- danger to birds / aeroplanes, possibly to humans accept to anything getting in the way</li> <li>- if intercepted cuts power</li> </ul>			4	4		
		<b>Question 8 total</b>	<b>6</b>	<b>3</b>	<b>4</b>	<b>13</b>	<b>2</b>	<b>0</b>

## AS UNIT 2: ELECTRICITY AND LIGHT

### SUMMARY OF MARKS ALLOCATED TO ASSESSMENT OBJECTIVES

Question	AO1	AO2	AO3	TOTAL MARK	MATHS	PRAC
1	1	5	0	6	5	0
2	1	5	2	8	6	8
3	0	5	3	8	6	0
4	6	5	0	11	2	0
5	6	5	1	12	5	6
6	4	3	3	10	6	0
7	4	5	3	12	5	8
8	6	3	4	13	2	0
<b>TOTAL</b>	<b>28</b>	<b>36</b>	<b>16</b>	<b>80</b>	<b>37</b>	<b>22</b>