

**GCE**

**Physics B**

**H157/01: Foundations of physics**

AS Level

**Mark Scheme for June 2022**

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This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

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## MARKING INSTRUCTIONS

### PREPARATION FOR MARKING

#### RM ASSESSOR

1. Make sure that you have accessed and completed the relevant training packages for on-screen marking: *RM Assessor Online Training; OCR Essential Guide to Marking*.
2. Make sure that you have read and understood the mark scheme and the question paper for this unit.
3. Log-in to RM Assessor and mark the **required number** of practice responses (“scripts”) and the **required number** of standardisation responses.

#### MARKING

1. Mark strictly to the mark scheme.
2. Marks awarded must relate directly to the marking criteria.
3. The schedule of dates is very important. It is essential that you meet the RM Assessor 50% and 100% (traditional 40% Batch 1 and 100% Batch 2) deadlines. If you experience problems, you must contact your Team Leader (Supervisor) without delay.
4. If you are in any doubt about applying the mark scheme, consult your Team Leader via the RM Assessor messaging system in the first instance.

5. **Crossed Out Responses**

Where a candidate has crossed out a response and provided a clear alternative then the crossed out response is not marked. Where no alternative response has been provided, examiners may give candidates the benefit of the doubt and mark the crossed out response where legible.

**Multiple Choice Question Responses**

When a multiple choice question has only a single, correct response and a candidate provides two responses (even if one of these responses is correct), then no mark should be awarded (as it is not possible to determine which was the first response selected by the candidate).

*When a question requires candidates to select more than one option/multiple options, then local marking arrangements need to ensure consistency of approach.*

**Contradictory Responses**

When a candidate provides contradictory responses, then no mark should be awarded, even if one of the answers is correct.

**Short Answer Questions** (requiring only a list by way of a response, usually worth only **one mark per response**)

Where candidates are required to provide a set number of short answer responses then only the set number of responses should be marked. The response space should be marked from left to right on each line and then line by line until the required number of responses have been considered. The remaining responses should not then be marked. Examiners will have to apply judgement as to whether a 'second response' on a line is a development of the 'first response', rather than a separate, discrete response. *(The underlying assumption is that the candidate is attempting to hedge their bets and therefore getting undue benefit rather than engaging with the question and giving the most relevant/correct responses.)*

**Short Answer Questions** (requiring a more developed response, worth **two or more marks**)

If the candidates are required to provide a description of, say, three items or factors and four items or factors are provided, then mark on a similar basis – that is downwards (as it is unlikely in this situation that a candidate will provide more than one response in each section of the response space.)

**Longer Answer Questions** (requiring a developed response)

Where candidates have provided two (or more) responses to a medium or high tariff question which only required a single (developed) response and not crossed out the first response, then only the first response should be marked. Examiners will need to apply professional judgement as to whether the second (or a subsequent) response is a 'new start' or simply a poorly expressed continuation of the first response.

6. On each blank page a "seen" annotation must be inserted to confirm that the page has been checked. For additional objects (if present), a "seen" annotation must be inserted on each page to confirm that it has been checked.  
Always check the pages (and additional objects if present) at the end of the response in case any answers have been continued there.
7. Award No Response (NR) if:
  - there is nothing written in the answer space

Award Zero '0' if:

- anything is written in the answer space and is not worthy of credit (this includes text and symbols).

Team Leaders must confirm the correct use of the NR button with their markers before live marking commences and should check this when reviewing scripts.

8. The RM Assessor **comments box** is used by the Principal Examiner or your Team Leader to explain the marking of the practice responses. Please refer to these comments when checking your practice responses. **Do not use the comments box for any other reason.**

If you have any questions or comments for your team leader, use the RM Assessor messaging system.

9. Assistant Examiners will send a brief report on the performance of candidates to their Team Leader (Supervisor) via email by the end of the marking period. The report should contain notes on particular strengths displayed as well as common errors or weaknesses. Constructive criticism of the question paper/mark scheme is also appreciated.

10. **Level of response (LoR)**

Read through the whole answer from start to finish, concentrating on features that make it a stronger or weaker answer using the indicative scientific content as guidance. The indicative scientific content indicates the expected parameters for candidates' answers, but be prepared to recognise and credit unexpected approaches where they show relevance.

Using a 'best-fit' approach based on the science content of the answer, first decide which set of level descriptors, Level 1 (L1), Level 2 (L2) or Level 3 (L3), **best** describes the overall quality of the answer using the guidelines described in the level descriptors in the mark scheme.

Once the level is located, award the higher or lower mark. For the higher mark use just the level annotation, e.g. for 6 marks use **L3**. For the lower mark use the level annotation with one mark omitted, e.g. for 5 marks use **L3** **^**.















**The higher mark** should be awarded where the level descriptor has been evidenced and all aspects of the communication statement (in italics) have been met. **The lower mark** should be awarded where the level descriptor has been evidenced but aspects of the communication statement (in italics) are missing.

In summary:

- the **science** content determines the **level**
- the **communication statement** determines the **mark within a level**.

Level of response questions on this paper are **X** and **Y**

## 11. Annotations available in RM Assessor

Annotation	Meaning
	Benefit of doubt given
	Contradiction
	Incorrect response
	Error carried forward
	Level 1
	Level 2
	Level 3
	Transcription error
	Benefit of doubt not given
	Power of 10 error
	Omission mark
	Error in number of significant figures
	Correct response
	Wrong physics or equation

12. Abbreviations, annotations and conventions used in the detailed Mark Scheme (to include abbreviations and subject-specific conventions).

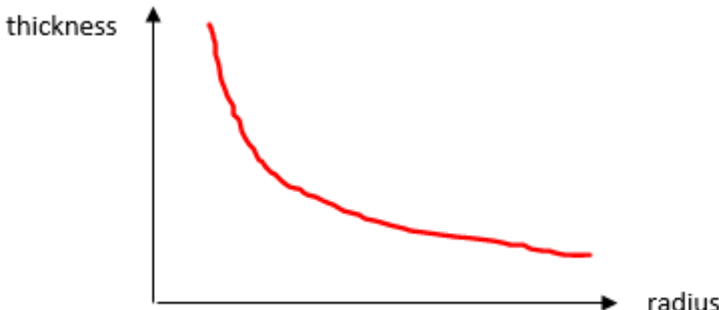
<b>Annotation</b>	<b>Meaning</b>
/	alternative and acceptable answers for the same marking point
<b>reject</b>	Answers which are not worthy of credit
<b>not</b>	Answers which are not worthy of credit
<b>Ignore</b>	Statements which are irrelevant
<b>Allow</b>	Answers that can be accepted
( )	Words which are not essential to gain credit
—	Underlined words must be present in answer to score a mark
<b>ECF</b>	Error carried forward
<b>AW</b>	Alternative wording
<b>ORA</b>	Or reverse argument

Question		Answer	Mark	Guidance
1		D	1	
2		A	1	
3		A	1	
4		A	1	
5		C	1	
6		D	1	
7		D	1	
8		B/C	1	
9		D	1	
10		B	1	
11		D	1	
12		A	1	
13		A	1	
14		D	1	
15		C	1	
16		B	1	
17		C	1	
18		B	1	
19		B	1	
20		B	1	
<b>Total</b>			<b>20</b>	



Question		Answer	Mark	Guidance
21	(a)	amp(ere)	1	Not just A. Condone spelling errors if clear.
21	(b)	Resistance (= 24 + 36) = 60 (kΩ)  $I = V/R$ = 12 / 60 = 0.2 (mA)	1  1	Addition of resistances inferred from 60  0.2 scores 2 marks
21	(c)	(Because when temperature increases) resistance (of thermistor) decreases  so current increases (and reading increases)	1  1	<b>Allow</b> circuit resistance decreases  Second mark needs to refer to current not just ammeter reading. <b>Allow</b> current reading increases.
<b>TOTAL</b>			<b>5</b>	

Question		Answer	Mark	Guidance
22	(a)	$(5 + 1.5 = ) 6.5 \text{ (N)}$	1	<b>Not</b> 1sf answer of 7.
22	(b)	substitution $\sqrt{[1.5^2 + 5.8^2]} (= \sqrt{35.89})$ $= 6.0 \text{ (N)}$	1 1	<b>Allow</b> 1sf answer of 6.
22	(c)	increase in magnitude  closer to vertical / angle to vertical decreases / closer to W / more straight down	1 1	<b>Allow</b> increase in vertical component if clear that it is the vertical component of tension. Penalise incorrect changes in other forces. Ignore any references to horizontal component of tension  Ignore references to clockwise/anticlockwise rotation
<b>TOTAL</b>			<b>5</b>	

Question		Answer	Mark	Guidance
23	(a)	negative gradient of decreasing magnitude	1	Must not be horizontal or vertical or straight for more than final 1/3 <sup>rd</sup> of either axis. Expect curve approximating 1/r <sup>2</sup> relationship.
		Curve of negative gradient of decreasing magnitude which doesn't touch either axis	1	Do not penalise horizontal, vertical or straight sections in the second mark  
23	(b)	$t = V / \pi r^2$ (in any form) Unit conversion of $r = 20\text{cm}$ and $V = 0.05 \text{ mm}^3$ $= 4 \times 10^{-10} \text{ (m)}$	1 1 1	Can be implied from a calculation. To give $r = 0.2 \text{ m}$ and $V = 0.05 \times 10^{-9} \text{ mm}^3$ ( $3.98 \times 10^{-10}$ ) <b>allow</b> one or both missing or incorrect unit conversions for final mark
<b>TOTAL</b>			<b>5</b>	

Question			Answer	Mark	Guidance
24	(a)		Number of complete waves / cycles (emitted) / oscillations in 1s / per second	1	<b>Allow</b> number of waves passing a point per second
24	(b)		250 (mV)	1	
24	(c)	i	Identification of correct time period e.g $T = 0.44$ (s)  Calculation leading to 2.3 Hz e.g. $f = 1/T = 2.3$ (Hz)	1  1	<b>Allow</b> 0.43  <b>Allow</b> one mark for use of 0.45 leading to 2.2 Hz or 0.42 leading to 2.4 Hz. No marks for values outside of these.
24	(c)	ii	increases	1	Ignore comments about rate of change of frequency
			<b>TOTAL</b>	<b>5</b>	

Question		Answer	Mark	Guidance
25	(a)	$(2^8 =) 256$	1	
25	(b)	$1798 \times 2117 \times 8 = 30.5 \times 10^6$ bits $30.5 / 54 = 0.56$ (s)	1 1	Accept 0.54s obtained by using $1024^2$ for M <b>Allow</b> 1 mark for 0.070s (for missing x8) <b>Allow</b> 1 mark for 18s (for multiplying x256)
25	(c)	Estimate of virus size on paper = 1.3 cm  Using width of image as 4.5 cm gives $4.5 / 1798 = 0.0025$ cm pixel <sup>-1</sup> OR Using height of image = 5.3 cm gives $5.3 / 2117 = 0.0025$ cm pixel <sup>-1</sup>  Size of virus = $100 \times 10^{-9} / 1.3$ m = $7.69 \times 10^{-8}$ m  Resolution = $0.0025 \times 7.69 \times 10^{-8}$ m = $1.9 \times 10^{-10}$ m pixel <sup>-1</sup>  Alternative method: Width of image (approximately) 3.5 virus widths OR height of image (approximately) 4.1 viruses  Width of image = $3.5 \times 100$ nm = 350 nm OR height of image = $4.1 \times 100$ nm = 410 nm  = $350$ (nm) / 1798 (pixels) OR $410$ (nm) / 2117 (pixels)  = $1.9 \times 10^{-10}$ m per pixel	1  1  1  1  (1)  (1)  (1)  (1)	<b>Allow</b> range 1.1 to 1.5 cm  <b>Allow</b> range 4.4 to 4.6cm OR $1798 / 4.5 = 400$ pixel cm <sup>-1</sup> <b>Allow</b> range 5.2 to 5.4cm OR $2117 / 5.3 = 400$ pixel cm <sup>-1</sup>  Final mark only awarded if quoted to 2sf.  <b>Allow</b> 3.2- 3.8 <b>Allow</b> 3.8 - 4.4  320 nm – 380 nm 380 nm – 440 nm  Final mark only awarded if quoted to 2sf.

Question		Answer	Mark	Guidance
25	(d)	Any TWO of: Adjust brightness Adjust contrast Reduce noise False colour Edge detection	2	Apply the following: if more than two statements given, mark first two statements only. Ignore any irrelevant statements. <b>Allow</b> correct descriptions of how these methods would enhance the image even if the term is loose. Do not allow smoothing unless linked to reduction of noise
<b>TOTAL</b>			<b>9</b>	

Question		Answer	Mark	Guidance
26	(a)	<p>LED (striking voltage, single frequency) No photons until a certain (striking) voltage Single frequency / photons all have same energy</p> <p>OR</p> <p>Line spectra Only certain frequencies observed Correspond to transitions between (discrete/quantised) energy levels</p> <p>OR</p> <p>Fluorescence Photons of a particular frequency/energy Emitted when electrons move down energy levels</p> <p>OR</p> <p>Photographic film exposure Due to arrival of photons Brightness of image due to probability of arrival of photons</p> <p>Allow other correct alternatives</p>	<p>1 1 1</p> <p>(1) (1) (1)</p> <p>(1) (1) (1)</p> <p>(1) (1) (1)</p>	<p><b>Allow</b> same colour</p> <p><b>Not</b> quanta/energy packets for photons</p> <p><b>Not</b> quanta/energy packets for photons</p>
26	(b)	<p><math>f = 3.0 \times 10^8 / 270 \times 10^{-9} \text{ Hz}</math></p> <p><math>= 1.1 \times 10^{15} \text{ Hz}</math></p> <p><math>h = E/f</math></p> <p><math>= 6.9 \times 10^{-19} / 1.11 \times 10^{15}</math></p> <p><math>= 6.2 \times 10^{-34} \text{ Js}</math></p>	<p>1</p> <p>1</p> <p>1</p>	<p>Evaluation of frequency or implied in later calculation</p> <p>Substitution</p> <p><b>Allow</b> 6.3 for use of rounded <math>1.1 \times 10^{15}</math></p>

Question		Answer	Mark	Guidance
26	(c)	(It has) light and dark regions /constructive and destructive interference	1	Interference alone not sufficient
		showing there is a different probability of arrival of quanta / quanta from different paths have (add with) different phases	1	<b>Allow</b> electrons behave as waves for second mark, but only if correctly linked to 1 <sup>st</sup> mark
<b>TOTAL</b>			<b>8</b>	



Question		Answer	Mark	Guidance
27	(a)	<p>Line of best fit added to graph</p> <p>Gradient triangle covering &gt; half the range</p> <p><math>k = (0.0129 - 0.008)/5 = 98 \pm 6 \text{ Nm}^{-1}</math></p>	<p>1</p> <p>1</p> <p>1</p>	<p>Judge by eye</p> <p>Or implied by calculation (eg from two data points)</p> <p><b>Allow</b> k between 92 and 104 <math>\text{Nm}^{-1}</math> Bare answer within range only scores 1 only</p> <p><b>Allow</b> k in <math>\text{N cm}^{-1}</math> only if unit changed on paper</p> <p><b>Allow</b> use of g as 9.81 or 10 <math>\text{N kg}^{-1}</math></p>
27	(b)	<p>Any one of:</p> <p>Don't start the graph at <math>y=0</math></p> <p>Measure extension not spring length</p> <p>plot with error bars</p>	1	<p><b>Not</b> "draw line of best fit"</p> <p><b>Not</b> explanations which alter the results e.g. more readings</p>
27	(c)	i	<p>1</p> <p>1</p> <p>1</p>	<p><b>Allow</b> calculation with any maximum height value</p> <p>0.65m gives 0.33J (2/3)</p> <p>Apply a maximum of 1 POT error throughout.</p>
27	(c)	ii	<p>1</p> <p>1</p>	<p><b>Allow</b> there will be some energy losses / named specific energy loss.</p> <p>Do not allow responses in terms of efficiency or resistive forces unless linked to loss of energy.</p> <p>Condone use of <math>g = 10 \text{ N kg}^{-1}</math></p> <p><b>Allow</b> compression is greater initially than at the point of launch</p>

Question			Answer	Mark	Guidance
27	(c)	iii	Height measurements have largest uncertainty / mass uncertainty would be very small with a more precise balance	1	<b>Allow</b> discussion of decimal places of measurements for first mark
			Final uncertainty limited by this / not reduced appreciably by very precise measurement of mass	1	
27	(c)	iv	Too few measurements Not a clear pattern	2	<b>Allow</b> argument based on longer time does not change energy stored (so does not change height) <b>Allow</b> use of 2 or more data sets to show the pattern is not consistent.
			<b>TOTAL</b>	<b>13</b>	

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