GCE

Physics B

H157/01: Foundations of physics

AS Level

Mark Scheme for June 2024

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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.

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 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. These are posted on the RM Cambridge Assessment Support Portal http://www.rm.com/support/ca

3. Log-in to RM Assessor and mark the **required number** of practice responses ("scripts") and the **number of required** standardisation responses.

   YOU MUST MARK 10 PRACTICE AND 10 STANDARDISATION RESPONSES BEFORE YOU CAN BE APPROVED TO MARK LIVE SCRIPTS.

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 by telephone or the RM Assessor messaging system, or by email.

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.

   Rubric Error Responses – Optional Questions
   Where candidates have a choice of question across a whole paper or a whole section and have provided more answers than required, then all responses are marked and the highest mark allowable within the rubric is given. Enter a mark for each question answered into RM assessor, which will select the highest mark from those awarded. *(The underlying assumption is that the candidate has penalised themselves by attempting more questions than necessary in the time allowed.)*

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. Always check the pages (and additional objects if present) at the end of the response in case any answers have been continued there. If the candidate has continued an answer there, then add a tick to confirm that the work has been seen.

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 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 phone, the RM Assessor messaging system, or e-mail.

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. For answers marked by levels of response:
    a. **To determine the level** – start at the highest level and work down until you reach the level that matches the answer
    b. **To determine the mark within the level**, consider the following:

Descriptor	**Award mark**
On the borderline of this level and the one below	At bottom of level
Just enough achievement on balance for this level	Above bottom and either below middle or at middle of level (depending on number of marks available)
Meets the criteria but with some slight inconsistency	Above middle and either below top of level or at middle of level (depending on number of marks available)
Consistently meets the criteria for this level	At top of level

11. **Annotations**

Annotation		**Meaning**
	Correct response	Used to indicate the point at which a mark has been awarded (**one tick per mark awarded**).
	Incorrect response	Used to indicate an incorrect answer or a point where a mark is lost.
AE	Arithmetic error	Do not allow the mark where the error occurs. Then follow through the working/calculation giving full subsequent ECF if there are no further errors.
BOD	Benefit of doubt given	Used to indicate a mark awarded where the candidate provides an answer that is not totally satisfactory, but the examiner feels that sufficient work has been done.
BP	Blank page	Use BP on additional page(s) to show that there is no additional work provided by the candidates.
CON	Contradiction	No mark can be awarded if the candidate contradicts himself or herself in the same response.
ECF	Error carried forward	Used in numerical answers only, unless specified otherwise in the mark scheme. Answers to later sections of numerical questions may be awarded up to full credit provided they are consistent with earlier incorrect answers. Within a question, ECF can be given for AE, TE and POT errors but not for XP.
L1	Level 1	L1 is used to show 2 marks awarded and L1^ is used to show 1 mark awarded.
L2	Level 2	L2 is used to show 4 marks awarded and L2^ is used to show 3 marks awarded.
L3	Level 3	L3 is used to show 6 marks awarded and L3^ is used to show 5 marks awarded.
POT	Power of 10 error	This is usually linked to conversion of SI prefixes. Do not allow the mark where the error occurs. Then follow through the working/calculation giving ECF for subsequent marks if there are no further errors.
SEEN	Seen	To indicate working/text has been seen by the examiner.
SF	Error in number of significant figures	Where more SFs are given than is justified by the question, do not penalise. Fewer significant figures than necessary will be considered within the mark scheme. **Penalised only once in the paper.**

Annotation		Meaning
TE	Transcription error	This error is when there is incorrect transcription of the correct data from the question, graphical read-off, formulae booklet or a previous answer. Do not allow the relevant mark and then follow through the working giving ECF for subsequent marks.
XP	Wrong physics or equation	Used in numerical answers only, unless otherwise specified in the mark scheme. Use of an incorrect equation is wrong physics even if it happens to lead to the correct answer.
^	Omission	Used to indicate where more is needed for a mark to be awarded (what is written is not wrong but not enough).

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

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

12. **Subject Specific Marking Instructions**

LEVELS OF RESPONSE TARGETING AO1 AND AO2

Where a mark scheme targets marks at AO1 and AO2, there is no requirement for a response to be awarded in the same level for AO1 as for AO2, so for example a response could be awarded Level 3 for AO1 and Level 2 for AO2.

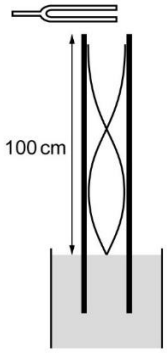
SECTION A

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

SECTION B

Question			Grid	Answer	Mark	Rationale/Additional Guidance
21	**(a)**	**(i)**	3.1.2 a i L	Charged particles	**1**	
21	**(a)**	**(ii)**	3.1.2 b i L	Series	**1**	
21	**(b)**		3.1.2 a ii L	4 (J)	**1**	
21	**(c)**		3.1.2 a vii M	I = 4 / 20 = 0.2 (A) R = ((6-4) ÷ 0.2) = 10 (Ω)	**1** **1**	**Allow** voltage ratio method R / 2 = 20 / 4 (ratio needs to be seen for first mark) Bare answer is awarded both marks
				Total	**5**	

Question			Grid	Answer	Mark	Rationale/Additional Guidance
22	**(a)**	**(i)**	3.1.1 c ix L	8	**1**	
22	**(a)**	**(ii)**	3.1.1 c ix L	$(\log_2 8) = 3$	**1**	Ecf on $\log_2$ (a)(i)
22	**(a)**	**(iii)**	3.1.1 c ix L	40 (μs)	**1**	
22	**(b)**		 311cvii M M2.1	Rate of sampling = 1 / 40 x 10^{-6} = 25 000 (Hz) 25 000 > (2 x 12 000 =) 24 000, so <u>YES</u>	**1** **1**	Ecf from (a)(iii) **Allow** 1 / 40 = 0.025 for first mark Second mark for correct comparison and correct conclusion drawn. No ecf from incorrectly calculated sample rate, except POT error **Allow** all done in kHz
				Total	**5**	

	Question		Grid	Answer	Mark	Rationale/Additional Guidance
23	**(a)**		4.1 a i M	(Incident wave) reflects (at the bottom) / waves travelling in opposite directions Superposition / interference occurs	**1** **1**	
23	**(b)**		4.1 a i M		**1**	Expect the following: Node at water surface Antinode at/near tube opening 3 x ½ wavelengths Each ½ wavelength approx. equal length (judge by eye) Both sides of standing wave required **Allow** dotted or solid line
23	**(c)**		4.1 d v H	1: Change stated independent variable e.g Use more harmonics, use different frequency forks They can plot a graph / take an average 2: Use an electronic sound sensor / microphone To allow a more accurate measurement of length / reduce error of judgement 3: Make repeats To get an average to reduce random error	**1** **1** **(1)** **(1)** **(1)** **(1)**	Explanation dependent on suggestion **Allow** other suitable suggestions and explanations
				Total	**5**	

Question			Grid	Answer	Mark	Rationale/Additional Guidance
24	**(a)**		4.2 c vi M	Momentum has to be conserved / total momentum has to remain zero / Newton's third law applies Change in Xe ion momentum is negative so change in rocket momentum has to be positive / Xe ion and rocket momentum equal and opposite (after emission)	**1** **1**	Alternative: force is rate of change of momentum Force on ions = force on rocket in opposite direction
24	**(b)**		4.2 c iv LHH M2.3	m (of xenon ion) = (0.131 / 6.0 x10^{23}) = 2.18 x 10^{-25} kg $p = mv$ = (40000 x 2.18 x 10^{-25}) = 8.7 x 10^{-21} kg ms^{-1}	**1** **1** **1**	Penalise POT error in m and v once only No attempt tp convert mass (use of 131 or 0.131) scores zero on calculation **Allow** kg m/s or Ns. Standalone mark
				Total	**5**	

SECTION C

Question			Grid	Answer	Mark	Guidance
25	**(a)**		1.1.1a L	Hazard: Wire may snap Precaution: Wear goggles / eye protection Hazard : Weights may fall Precaution: Bucket/tray of sand under weights (to catch)	**1** **1** **1** **1**	 **Allow** other suitable precaution
25	**(b)**		3.2 a iv M M4.3	$A = \pi d^2/4 = \pi \times (0.22 \times 10^{-3})^2 / 4$ $= 3.8 \times 10^{-8}$ (m^2)	**1** **1**	**Ignore** POT error in *d* in for first mark Use of diameter in place of radius scores zero
25	**(c)**	**(i)**	3.2 d ii M M3.4 AO3	Gradient = $(5 \times 10^{-3}) / 8 = 6.3 \times 10^{-4}$ (mN^{-1}) Young modulus = ($7.37 \times 10^{7} / 6.3 \times 10^{-4}$ =) 120 (GPa)	**1** **1**	**Allow** any two points which give gradient in range 6.2 – 6.3 x 10^{-4} to 2sf **Allow** 117 or 118 (GPa) Apply POT error from gradient in second mark
25	**(c)**	**(ii)**	3.2 b ii H M3.8	Strain / elastic energy Stored in the wire	**1** **1**	Work done in stretching the wire
				Total	**10**	

<table>
<tr><th colspan="3">Question</th><th>Grid</th><th>Answer</th><th>Mark</th><th>Guidance</th></tr>
<tr><td>26</td><td>(a)</td><td></td><td>1.1.1b L</td><td>
<table>
<tr><th></th><th>Independent</th><th>Dependent</th><th>Control</th></tr>
<tr><td>Temperature of wire</td><td></td><td></td><td>✓</td></tr>
<tr><td>Fixed resistor value</td><td></td><td></td><td></td></tr>
<tr><td>Length of wire in circuit</td><td>✓</td><td></td><td></td></tr>
<tr><td>Emf of cell</td><td></td><td></td><td></td></tr>
<tr><td>Terminal pd of cell</td><td></td><td>✓</td><td></td></tr>
</table>
</td><td>3</td><td>One mark for each correct column

Only allow one tick per column

Allow fixed resistor or emf for control</td></tr>
<tr><td>26</td><td>(b)</td><td></td><td>3.1.2 d v L
M1.2</td><td>$R = (V - \varepsilon) / I = (9.0 - 8.68) / 266 \times 10^{-3} = 1.203$</td><td>1</td><td>Allow Answer in table or in answer space – answer space taken as final answer if different

Answer must be to 3dp (in either table or answer space)</td></tr>
<tr><td>26</td><td>(c)</td><td></td><td>1.1.4 d M</td><td>Precision is the closeness of agreement between (independent) measurements (obtained under the same conditions.)

Accuracy is a measure of the closeness of agreement between an individual test result and the true value.</td><td>2</td><td>Allow idea of advantage gained from taking repeated measurements (e.g, removal of outliers, reducing random error)

Allow systematic error leads to difference between result and true value

Allow correct discussion of students comments relating to precision and accuracy</td></tr>
</table>

Question			Grid	Answer	Mark	Guidance
26	**(d)**		3.1.2 d ii H	$R_{(total)} = V / I$ = 8.79 / 175 X 10^{-3} = 50.2 (Ω)	**1**	Substitution from values at 120cm
				$R_{wire} = R_{total} - R_{wire}$ = 50.2 – 22 = 28.2 (Ω)	**1**	Calculation of R_{wire} by subtraction of *22* Ω from their total resistance
				$\rho = RA / l$ = 28.2 x 2.84 x 10^{-8} / 1.2	**1**	ecf on R_{wire}
				= 6.7 x 10^{-7} (Ωm)	**1**	**Allow** ecf for any resistance for final two marks
26	**(e)**		3.1.2 b iii L	Filament lamp / bulb	**1**	
				Total	**11**	

Question			Grid	Answer	Mark	Guidance
27	**(a)**		41bi AO1 M	Path difference	**1**	
27	**(b)**		41d iv L)	(1 / 1385000) (m^{-1}) = 7.22 x 10^{-7} (m)	**1**	
27	**(c)**		2b iv M	Mis-positioned the zero mark on ruler / not measured between centre of spots	**1**	**Allow** zero error and other reasonable specific answer Reject bare "human error" / misread
27	**(d)**		AO1 4.1 d iv M M4.6	θ not small (enough) / $D >> s$ is not true	**1**	**Allow** only applies for small angle approximation / tan θ not equal to θ
27	**(e)**		2b iii M M4.5	$\theta = \tan^{-1}(43.2 / 21.5) = 63.5°$	**1**	Working and at least 1dp answer needed **Allow** use of 43.0 cm (=63.4°) or 43.3 cm (=63.5°) **Do not allow** use of s = 44.1 cm (giving 64°)
27	**(f)**		41c iii H M0.6	$n\lambda = d\sin\theta$ giving λ = 7.22 x 10^{-7} x sin 64 λ = 649 (nm)	**1** **1**	**Allow** ecf from (b). **No** ecf from (e) unless leading to θ = 63 or 64° **Allow** value between 645 and 650 nm
27	**(g)**		1.1.2c	Percentage uncertainty in s is determined by the range of readings More measurements cannot reduce the existing range (and decrease the percentage uncertainty)	**1** **1**	**Allow** D is the largest contributor to wavelength uncertainty they should take some repeats of D first Ignore responses in terms of d

Question			Grid	Answer	Mark	Guidance
				Percentage uncertainty in wavelength determined by adding together percentage uncertainties in *s* and *D* Need to address the largest source of uncertainty / D first	**(1)** **(1)**	
				Total **Total Section C** **Total Sections B & C**	**9** **30** **50**	

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