OCR
Oxford Cambridge and RSA

GCE

Physics B

H157/01: Foundations of physics

AS Level

Mark Scheme for June 2023

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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
	Blank Page – this annotation must be used on all blank pages within an answer booklet (structured or unstructured) and on each page of an additional object where there is no candidate response.
	Tick
	Cross
	Confused (replaces the question mark)
	Benefit of doubt
	AO1 – Knowledge and understanding
	AO2 – Apply knowledge and understanding
	AO3 - Analyse
	AO4 - Evaluation
	Omission
	Not answered question
	Noted but no credit given
	Too vague
	Own figure rule

Annotation	Meaning
REP	Repetition

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

SECTION B

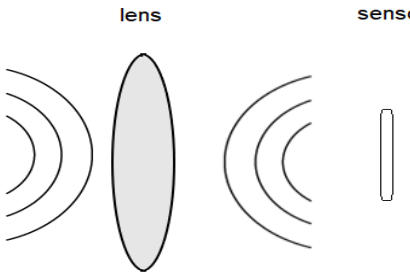
Question			Grid	Answer	Mark	Rationale/Additional Guidance
21	(a)			28 kN In direction of thrust	1 1	 **Allow** forwards (not upwards)
21	(b)			F = 28 × sin25 = 12 (kN)	1 1	**ecf** from 21(a) Evaluation to at least 2sf (11.8)
21	(c)			Weight acts vertically / downwards Vertical and horizontal forces (or accelerations) are independent / there is no component of the vertical force (or acceleration) in the horizontal direction	1 1	 **NOT** just the vertical and horizontal forces don't act in the same direction / at 90°
				Total	6	

Question			Grid	Answer	Mark	Rationale/Additional Guidance
22	(a)			($\lambda = h/p$) = 6.63 ×10^{-34} / (9.11 × 10^{-31} × 8.5 × 10^{6}) = 8.6 × 10^{-11} (m)	1 1	Mark for full substitution Evaluation to at least 2sf (8.56 × 10^{-11})
22	(b)			Light regions occur due to constructive interference / Dark regions occur due to destructive interference Constructive interference (or light regions) occurs when waves arrive in phase / Destructive interference (or dark regions) occur when wave arrive in antiphase	1 1	**Allow** superposition in place of interference Not maxima/minima in place of light/dark **Allow** correct explanation in terms of path difference **Allow** diagrams of waves in phase / in antiphase for the second mark if clear which region they refer to
				Total	4	

Question			Grid	Answer	Mark	Rationale/Additional Guidance
23	(a)			(Glass) Breaks / snaps / fractures (Copper) Bends (without breaking)	1 1	**Allow** shatters **Allow** any description of deformation but **NOT** extends / stretches as a wire **NOT** just "does not break" **Ignore** references to plastic / elastic
23	(b)			Dislocations are mobile in copper (metals) and dislocations are not mobile in glass In metals, slip / slide (of planes/atoms) occurs / stress reduces / force is spread out over larger area OR In glass, crack propagation occurs / force is concentrated / stress increases	1 1	Both descriptions needed **Allow** spreads / moves through for propagation **Allow** from suitably labelled diagrams for either mark
				Total	4	

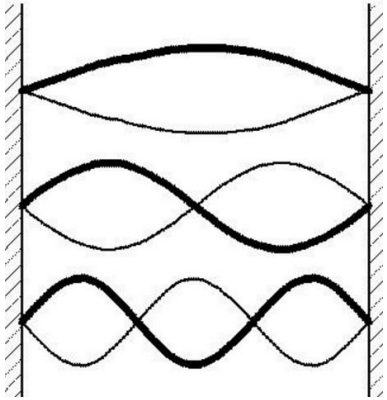
Question			Grid	Answer	Mark	Rationale/Additional Guidance
24	(a)			A Number of mobile/free charge carriers increases	1 1	 **Allow** electrons for charge carriers
24	(b)	(i)		Any one of: Resistance of metals increases with temperature / conductivity of metals decreases with temperature Resistance / behaviour of circuit would not change as temperature increased Circuit can make smaller for same power Less power dissipation / less energy wasted as heat / doesn't get as hot	1	**Ignore** explanations in terms of cost
24	(b)	(ii)		(Rearrangement of G = σA/L and G = 1/R to give) $\sigma = L/AR$ = 100 x 10^{-9} / (2 x 10^{-9} x 40 x 10^{-9}) × 200 = 6.3 × 10^{6} (Sm^{-1})	1 1 1	Or σ = GL/A and G = 1/R This mark may be given by clear part substitutions into equations Allow working or correct calculation of area (2 x 10^{-9} x 40 x 10^{-9} OR 8 x 10^{-17}) only if it is CLEAR the area is being calculated Evaluation to at least 1sf Only apply one POT penalty from nm conversions
				Total	6	

SECTION C

Question			Answer	Mark	Guidance
25	**(a)**		Use of $1/v = 1/u + 1/f$ with correct substitutions and units conversion 1/f = 1/v – 1/u = 1/4 - (-1/500) leading to f = 3.97cm	**1** **1**	Ignore signs of u and v. Allow u and v in cm or m, but units for each must be consistent Need to see calculated value (not simply 4) Condone small rounding errors in evaluation if rounds to 4. **Allow** v and u to be substituted interchangeably. Alternative method $u >> v$ (1st mark) so $f \approx v$ (second mark – dependent on 1st)
25	**(b)**		Curvature (on all wavefronts drawn) in the direction shown Approximately same spacing (wavelength)  	**1** **1**	Expect at least one wavefront and similar curvature to incoming on all wavefronts At least three wavefronts, all equally spaced by eye IGNORE wavefronts after the sensor
25	**(c)**		$n = \log_2 16000000$ OR n = log 16000000 / log 2 (= 23.9) so 24 bits required	**1** **1**	**Allow** $2^{24} = 16777216$ leading to 24 on answer line for both marks Integer value required

Question			Answer	Mark	Guidance
25	(d)		64 × 1024 × 1024 × 1024 = 6.87 x 10^{10} byte Or 64 × 1024 × 1024 × 1024 x 8 = 5.50 x 10^{11} bit	1	Calculation of memory card capacity in bytes or bits **Allow** 64 × 1000^3 = 6.4 x 10^{10} Or 64 × 1000^3 x 8 = 5.12 x 10^{11}
			24 x 4096 x 2048 x 1/10 x 22 = 4.4 x 10^8 bit s^{-1} Or (24 x 4096 x 2048 x 1/10 x 22) / 8 = 5.5 x 10^7 byte s^{-1}	1	Calculation of bit s^{-1} or byte s^{-1} following compression
			6.87 x 10^{10} bytes / 5.5 x 10^7 byte s^{-1} = 1249 s = 20.8 min OR 5.50 x 10^{11} bits / 4.4 x 10^8 bit s^{-1} = 1249 s = 20.8 min	1	Calculation of storage time in seconds converted to minutes **Allow** 1000 throughout for 1024 and mixture of 1024 and 1000 Final answer for use of 1000 only is 19.3 mins. **Allow** small intermediate rounding errors, as long as correct conclusion can be drawn. All suitable alternative methods allowed. **In general**: 1st mark for suitable starting calculation, such as bits in one frame 2nd mark for calculation including 10% compression and number of frames per second, which will allow time to be calculated in one final step 3rd mark for single calculation leading to time, which needs to be converted to minutes (or 21 minutes to seconds) for comparison. 2 marks may be awarded for one error of: using 24 (bit) instead of 3 (byte); not using bits for 64 GB card; ignoring the 10% compression: as long as followed through
			Total	9	

Question			Answer	Mark	Guidance
26	(a)		Any **three** of: (Outward travelling waves are) reflected (at ends) Superposition / interference occurs (Always) constructive interference at antinodes (Always) destructive interference at nodes	3	**Allow** bounces for reflection
26	(b)		10 (mV)	1	
26	(c)		(Distance between equivalent points) = 3 cm (Time period = $1x10^{-3}$ x 3) = 3 ms f = 1/(3 x 10^{-3}) = 330 (Hz)	1 1 1	**Allow** "wavelength = 3 cm" **Allow** value of 2.9 cm. Only other values between 3.1 cm and 2.75 cm can score subsequent 2 marks if followed though correctly. 3 ms (or 2.9 ms) implies first mark. Evaluation to at least 2sf. Apply POT error at this point **Special case**: if smallest divisions on time base are used as 1ms, then award max 2 marks if followed through correctly. E.g. one cycle = 15 ms leading to f = / 15 x 10^{-3} = 67 Hz (or 71Hz from 14 x 10^{-3})

Question			Answer	Mark	Guidance
26	(d)			1 1 1	Only either line (bold or fainter line) required but if both given, both must be correct. **Ignore** amplitude variations in each individual wave. **Ignore** labelling on each wave. Judge node position by eye. **Allow** in any order
			Total	**10**	

Question			Answer	Mark	Guidance
27	(a)		Weight downwards and air resistance upwards (Weight and air resistance are) equal (in magnitude)	1 1	**Allow** drag for air resistance **Not** gravity for weight, but allow gravitational force Must have correct directions for named forces **Allow** resultant force = 0 for 1 mark **Condone** balanced / forces are in equilibrium
27	(b)		1.9 / 1.62 = (1.17) = <u>1.2</u>	1 1	Calculation and substitution of correct average time Correct 2sf answer only
27	(c)		This equation required the acceleration to be constant (in this case as) the air resistance changes	1 1	**Allow** The acceleration is not constant in this situation **Allow** the resultant force varies The link between varying force and varying acceleration required for 2nd marking point
27	(d)	(i)	Inverse proportionality would show as one doubles the other halves OR product is constant Mathematically shown not to be true using any chosen pair (or more) of measurements using mean values e.g. using 30° and 60° time 1.72 ≠ half of 1.60 OR 30 x 1.72 = 51.6 ≠ 60 x 1.60 = 96	1 1	 Second mark implies first **Allow** use of calculation of constant (θ = k/t) and showing k is not the same for any pair of values **Ignore** comments relating to individual times rather than means (e.g. trial 1 at 105° is smaller than trial 1 at 120°)

Question			Answer	Mark	Guidance
27	(d)	(ii)	Student A	1	
			Largest source of error is reaction time	1	**Ignore** use of term “human error”
			Increasing reaction time gives a smaller percentage uncertainty / It has less impact with a larger true value	1	**Allow** Increasing height gives a smaller percentage uncertainty in height **Special case** Allow 1 mark for selection of student C if stated that additional data can be used to <u>remove</u> anomalies / outliers
			Total	**11**	
			Total Section C	**30**	
			Total Sections B & C	**50**	

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