OCR
Oxford Cambridge and RSA

GCE

Physics A

H156/01: Breadth in 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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PREPARATION FOR MARKING ON-SCREEN

1. Make sure that you have accessed and completed the relevant training packages for on-screen marking: *RM assessor Online Training* and the *OCR Essential Guide to Marking*.

2. Make sure that you have read and understood the Instructions for On-Screen Marking and 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 and the **required number** of standardisation responses.

MARKING INSTRUCTIONS – FOR MARKING ON-SCREEN AND FOR PAPER BASED 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% deadlines. If you experience problems, you must contact your Team Leader 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. **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.

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**.

10. Here are the subject specific instructions for this question paper.

CATEGORISATION OF MARKS

The marking schemes categorise marks on the MACB scheme.

B marks These are awarded as independent marks, which do not depend on other marks. For a **B**-mark to be scored, the point to which it refers must be seen specifically in the candidate's answers.

M marks These are method marks upon which **A**-marks (accuracy marks) later depend. For an **M**-mark to be scored, the point to which it refers must be seen in the candidate's answers. If a candidate fails to score a particular **M**-mark, then none of the dependent **A**-marks can be scored.

C marks These are compensatory method marks which can be scored even if the points to which they refer are not written down by the candidate, providing subsequent working gives evidence that they must have known it. For example, if an equation carries a **C**-mark and the candidate does not write down the actual equation but does correct working which shows the candidate knew the equation, then the **C**-mark is given.

A marks These are accuracy or answer marks, which either depend on an **M**-mark, or allow a **C**-mark to be scored.

SIGNIFICANT FIGURES

If the data given in a question is to 2 sf, then allow to 2 or more significant figures.
If an answer is given to fewer than 2 sf, then penalise once only in the entire paper.
Any exception to this rule will be mentioned in the Additional Guidance.

11. Annotations available in RM Assessor

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.**
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

SECTION A

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

SECTION B

General rule: For substitution into an equation, allow any subject - unless stated otherwise in the guidance

Question			Answer	Marks	Guidance
21	(a)		distance = area under the graph/suvat equations ½ (4.0 + 10.0) × 3.0 / 10.0 × 5.0 horizontal distance = 71 (m)	C1 C1 A1	**Allow** any attempt to calculate part of the area under the graph or suvat equations **Allow** any correct calculation of part of the area under the graph/suvat eqn e.g. 9, 12, 20, 21, 30, 32, 50 (m)
	(b)	(i)	$a = \frac{6.0}{3.0}$ 2.0	C1 A0	**Allow** any correct gradient calculation
		(ii)	680cos55 / 150 × 2.0 680cos55 – R = 150 × 2.0 R = 90 (N)	C1 C1 A1	If both components given (vertical and horizontal) it must be clear that the 390N is the horizontal component.
			Total	7	

Question			Answer	Marks	Guidance
22	(a)		Add (a range of) loads/force/weights to the spring **and** determine the compression (for each load) Plot a graph for force against compression **and** gradient is the force constant	B1 B1	**Allow** extension for compression throughout **Allow** W = mg **Not** length for compression **Allow** force constant = $\frac{\text{force}}{\text{compression}}$ and k = F/x (k must be subject)
	(b)		KE/kinetic to gravitational PE/potential	B1	**Allow** KE transferred to GPE **Ignore** increase of thermal store of the surroundings **Not** elastic potential energy
	(c)		$E = ½ \times 1.7 \times 10^4 \times (0.45 – 0.25)^2$ E = 340 (J)	C1 A1	**Allow** gain in GPE = 68g(0.76 – 0.25) **Ignore** E = ½ Fx
	(d)		The gravitational potential energy store of the person has been omitted/(elastic) potential store of the spring has been transferred to gravitational potential energy store (of the person)	B1	**Ignore** references to energy losses
			Total	6	

Question			Answer	Marks	Guidance
23	(a)		Gradients/rate of change of momentum are opposite/ positive & negative Gradients/rate of change of momentum of the graphs have the same magnitude/Force on A and B = 24000N	B1 B1	**Ignore** change in momentum is the same for **A** and **B** **Allow** calculations of the gradient for 2 marks **A** F = (20 – (-4))/1ms = 24000N and **B** F = (-30 – 6)/1ms = -24000N **Ignore POT** **Allow** 1 mark if no reference to the graph - The forces acting on each object are opposite and the (magnitude) of the forces are the same
	(b)		momentum before = 20 – 30 (= -10 kg m s^{-1}) momentum after = -4 -6 (= -10 kg m s^{-1}) (Therefore, the momentum is conserved)	B1 B1	**Allow** alternative answer of: loss of momentum of A = 24 (kg/m/s) gain of momentum by B = 24 (kg/m/s) (Therefore, the momentum is conserved)
	(c)		(2.0 + 3.0) v = 10 v = 2.0 (m s^{-1})	C1 A1	 **Allow** answer of 2 **1sf**, without any **SF** penalty **Ignore** sign
	(d)		$s = ½ gt^2$ $120 = ½ \times 9.81 \times t^2$ t = 4.9 (s)	C1 C1 A1	 **Allow** 4.95, **not** 5.0
			Total	9	

Question			Answer	Marks	Guidance
24	(a)		Appearance of nodes / antinodes	B1	**Ignore** the waves don't move
	(b)	(i)	**Any acceptable methods e.g.** Note matched to a note produced by a speaker connected to a variable (calibrated) signal generator/ Reduce background sound level **OR** Count the number of oscillations and divide by time taken (from a stopwatch/oscilloscope/slow motion camera) Take many oscillations e.g. 5 or 10/ longer time **OR** Microphone connected to oscilloscope to measure T / period <u>and</u> $f = 1/T$/period Reduce background sound level **OR** Use a (calibrated) strobe to determine the frequency Dim down the lights (AW) to get the best results	 B1 B1	 **Allow** vibration generator connected to a variable (calibrated) signal generator **Allow** Adjust signal generator to the fundamental frequency (when a stationary wave is achieved)
		(ii)1	1.24 (m)	B1	**Allow** 1.2(m)

Question			Answer	Marks	Guidance
		(ii)2	($v = f\lambda$) $v = 58 \times 1.24$ $v = 72$ (m s^{-1})	 C1 A1	 **ECF** from **(b)(ii)1**
		(ii)3	% uncertainty = $[2 \times 2.5] + 1.0 + 0.5$ (= 6.5) $0.065 \times [4 \times 58^2 \times 9.7 \times 10^{-4} \times 0.62]$ absolute uncertainty = 0.53 (N)	C1 A1	 Answer to **2sf** only **Allow ECF** 1 mark for %uncertainty of 4% and absolute uncertainty 0.32N **2sf**
			Total	**8**	

Question			Answer	Marks	Guidance
25	(a)		Both measured in Volts / same units	B1	**Allow** V for volt **Allow** they are both voltages/they are both measured with a voltmeter
	(b)	(i)	Graph from 1.5 V at **0/A** to 0 V at **L/B** Curve of decreasing gradient	M1 A1	**Allow** curve of increasing gradient/straight line
		(ii)	At **A** / x = 0, V = 1.5 V and at **B** / x = L, V = 0.75 V/p.d is shared/halved Total resistance increases so current decreases (as length of wire **L** and resistor of **R** are in series)	B1 B1	**Allow** V (across **R**) decreases as x increases (as **S** moves from **A** to **B**) **Allow** Explanation of potential divider e.g. At **B** resistance of length of wire = resistance of **R**
	(c)	(i)	p.d across wire = 14.4 – 12.0 = (2.4 V) resistance of wire = $\frac{2.4}{3.0}$ (= 0.80 Ω) $0.80 = \frac{\rho \times 25.0}{0.54 \times 10^{-6}}$ ρ = 1.7 × 10^{-8} (Ω m)	C1 C1 C1 A1	 **ECF** R = 2.8 Ω (V = 8.4 V) to give ρ = 6.0 × 10^{-8} (Ω m) for 3 marks
		(ii)	(I = $Anev$) 3.0 = 0.54 × 10^{-6} × 1.60 × 10^{-19} × 8.5 × 10^{28} × v v = 4.1 × 10^{-4} (m s^{-1})	 C1 A1	 Do not penalise the same **POT** error in 0.54 mm^2 from **(c)(i)** again
			Total	11	

Question			Answer	Marks	Guidance
26	(a)	(i)	Energy (of photon) is less than work function/ϕ (of **C**) 3.3 (eV)	**B1**	**Allow** energy of photon / 3.2 (eV) < 3.3 (eV)/work function (of **C**) (so no photoelectrons)
		(ii)	190 (nm)	**B1**	**Allow** 194 (nm) from calculation E=hf
		(iii)	($hf = \phi + KE_{max}$) 5.3 = 4.1 + $KE_{(max)}$ **or** (KE_{max} =) 1.2 (eV) ½ × 9.11 × 10^{-31} × v^2 = 1.2 × 1.6 × 10^{-19} $\lambda = \frac{6.63 \times 10^{-34}}{9.11 \times 10^{-31} \times 6.4924 \times 10^{5}}$ λ = 1.1 × 10^{-9} (m)	 **C1** **C1** **A1**	 **Allow** KE = 1.92 x 10^{-19} (J) **Allow** v = 6.5 × 10^5 (m s^{-1}) or p = 5.9 × 10^{-25} (kg m s^{-1})
	(b)	(i)	Line of best fit drawn	**B1**	**Not** drawn through 0.5/5.0
		(ii)	gradient <u>calculated</u> **and** gradient = 6.2 × 10^{-34} (J s) Correct use equation of straight line, **and** <u>gradient</u> to determine the y-intercept / ϕ ϕ = 2.7 × 10^{-19} (J)	**C1** **M1** **A1**	**Allow** value in the range 5.8 to 6.6 × 10^{-34} (J s) **ECF** from incorrect value of h **Allow** value in the range 2.4 to 3.0 × 10^{-19} (J)
			Total	**9**	

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