CAMBRIDGE
International Education

Cambridge International AS & A Level

PHYSICS **9702/32**

Paper 3 Advanced Practical Skills 2 **May/June 2024**

MARK SCHEME

Maximum Mark: 40

Published

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge International will not enter into discussions about these mark schemes.

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Generic Marking Principles

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptions for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:

Marks awarded are always **whole marks** (not half marks, or other fractions).

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

GENERIC MARKING PRINCIPLE 4:

Rules must be applied consistently, e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

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GENERIC MARKING PRINCIPLE 5: Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).
GENERIC MARKING PRINCIPLE 6: Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

Science-Specific Marking Principles

1	Examiners should consider the context and scientific use of any keywords when awarding marks. Although keywords may be present, marks should not be awarded if the keywords are used incorrectly.
2	The examiner should not choose between contradictory statements given in the same question part, and credit should not be awarded for any correct statement that is contradicted within the same question part. Wrong science that is irrelevant to the question should be ignored.
3	Although spellings do not have to be correct, spellings of syllabus terms must allow for clear and unambiguous separation from other syllabus terms with which they may be confused (e.g. ethane / ethene, glucagon / glycogen, refraction / reflection).
4	The error carried forward (ecf) principle should be applied, where appropriate. If an incorrect answer is subsequently used in a scientifically correct way, the candidate should be awarded these subsequent marking points. Further guidance will be included in the mark scheme where necessary and any exceptions to this general principle will be noted.
5	‘List rule’ guidance For questions that require ***n*** responses (e.g. State **two** reasons …): • The response should be read as continuous prose, even when numbered answer spaces are provided. • Any response marked *ignore* in the mark scheme should not count towards ***n***. • Incorrect responses should not be awarded credit but will still count towards ***n***. • Read the entire response to check for any responses that contradict those that would otherwise be credited. Credit should **not** be awarded for any responses that are contradicted within the rest of the response. Where two responses contradict one another, this should be treated as a single incorrect response. • Non-contradictory responses after the first ***n*** responses may be ignored even if they include incorrect science.

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6 Calculation specific guidance

Correct answers to calculations should be given full credit even if there is no working or incorrect working, **unless** the question states 'show your working'.

For questions in which the number of significant figures required is not stated, credit should be awarded for correct answers when rounded by the examiner to the number of significant figures given in the mark scheme. This may not apply to measured values.

For answers given in standard form (e.g. $a \times 10^n$) in which the convention of restricting the value of the coefficient (a) to a value between 1 and 10 is not followed, credit may still be awarded if the answer can be converted to the answer given in the mark scheme.

Unless a separate mark is given for a unit, a missing or incorrect unit will normally mean that the final calculation mark is not awarded. Exceptions to this general principle will be noted in the mark scheme.

7 Guidance for chemical equations

Multiples / fractions of coefficients used in chemical equations are acceptable unless stated otherwise in the mark scheme.

State symbols given in an equation should be ignored unless asked for in the question or stated otherwise in the mark scheme.

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Question	Answer	Marks
1(a)	Value of T in range 5.00–8.00 s with unit.	**1**
	Evidence of repeat measurements of T.	**1**
1(b)	Six sets of readings of V_S (different values) and T with correct trend (average T increases as V_S decreases) and without help from the Supervisor scores 5 marks, five sets scores 4 marks etc.	**5**
	Range: V_S (min) $\leqslant$ 4.00 V **and** V_S (max) $\geqslant$ 10.00 V.	**1**
	Column headings: Each column heading must contain a quantity and a unit where appropriate. The presentation of quantity and unit must conform to accepted scientific convention e.g. $1 / T / s^{-1}$.	**1**
	Consistency: <u>All</u> values of T must be given to the nearest 0.01 s (or <u>all</u> to the nearest 0.1 s).	**1**
	Significant figures: Values of $1 / T$ given to same number of s.f. as (or one more than) the number of s.f. in T.	**1**
	Calculation: Values of $1 / T$ calculated correctly	**1**
1(c)(i)	Axes: Axes must be labelled with the required quantities. Scales must be chosen so that the plotted points occupy at least half the graph grid in both the x and y directions. Scale markings are no more than 2 cm (one large square) apart. Sensible scales must be used. Scales must not be awkward (e.g. 3:10 or fractions).	**1**
	Plotting of points: All observations in the table must be plotted on the grid. Diameter of plotted points must be $\leqslant$ half a small square. Points must be plotted to an accuracy of half a small square in both the x and y directions.	**1**
	Quality: All points in the table (at least 5) must be plotted on the grid. Trend must be correct. It must be possible to draw a straight line that is within $\pm$ 0.40 V on the V_s axis of all plotted points.	**1**

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Question	Answer	Marks
1(c)(ii)	Line of best fit: 'Best fit' is judged by balance of all points on the grid (at least 5 points) about the candidate's line. There must be an even distribution of points either side of the line along the full length. Lines must not be kinked or thicker than half a small square. Some candidates may choose to identify an anomalous point. If they identify **one** point as anomalous (e.g. by circling or labelling) then this point is to be disregarded when judging the line of best fit. There must be at least 5 points left after the anomalous point is disregarded.	**1**
1(c)(iii)	Gradient: The hypotenuse of the triangle used should be greater than half the length of the drawn line. Both read-offs must be accurate to half a small square in both the *x* and *y* directions. The method of calculation must be correct, not $\Delta x / \Delta y$. The gradient sign on the answer line must be consistent with the graph drawn.	**1**
	y-intercept: Correct read-off from a point on the line and substituted correctly into $y = mx + c$ or an equivalent expression. Read-off accurate to half a small square in both the *x* and *y* directions. **or** Intercept read directly from the graph, with read-off at $V_s = 0$, accurate to half a small square in *y* direction.	**1**
1(d)	Value *a* = candidate's gradient **and** value of *b* = candidate's intercept. Values must not be written as fractions or given to only one significant figure.	**1**
	Units for *a* and *b* correct and consistent with the readings taken (e.g. $V^{-1}\ s^{-1}$ for *a* and s^{-1} for *b*).	**1**

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Question	Answer	Marks
2(a)(i)	Value for L_0 to nearest mm and in range 0.050–0.200 m.	**1**
2(a)(ii)	Value for T with unit.	**1**
	Evidence of repeat readings: at least two measurements each of at least 5T.	**1**
2(a)(iii)	Justification linked to significant figures in time / T (and α).	**1**
2(b)(i)	Value for L greater than L_0.	**1**
	Value for θ to nearest degree and in range 15°–25°.	**1**
2(b)(ii)	Absolute uncertainty in θ in range 2°–5°. Correct method of calculation to obtain percentage uncertainty e.g. (absolute uncertainty / value from **(b)(i)**) × 100. If several readings have been taken, then the absolute uncertainty can be half the range (but not zero) provided the working is shown clearly.	**1**
2(b)(iii)	Second value of L.	**1**
	Second value of θ.	**1**
	Second value of L > first value of L.	**1**
2(c)	Two values of D calculated correctly. The final D values must not be written as fractions or given to only one significant figure.	**1**
2(d)	Calculation of percentage difference between candidate's two D values. Comparison of percentage difference with 10% leading to a consistent conclusion.	**1**

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Question	Answer	Marks
2(e)(i)	A Two readings are not enough to draw a (valid) conclusion (**not** "not enough for accurate results", "few readings"). B Difficult to measure T with reason, e.g. difficult to judge/determine/decide end or start of a complete oscillation. C Difficult to measure L or L_0 with reason, e.g. parallax error / difficult to hold ruler steady next to spring / spring moves when touched by ruler / ruler not parallel to spring. D Difficulty with setting up apparatus e.g. difficult to ensure wooden rod is parallel to bench / difficult to ensure that spring is vertical / stands slide on bench or fall over when setting larger angle. E Difficult to measure θ with reason e.g. parallax / difficult to hold protractor steady / strings (or plumb line) move when touched by protractor / thick strings. *1 mark for each point up to a maximum of 4.*	**4**
2(e)(ii)	A Take more readings and plot a graph **or** take more readings and compare D values (**not** "repeat readings" on its own). B Method to improve measurement of T with detail e.g. use marker placed at midpoint/equilibrium point of oscillation **or** record/film/video with timer **or** record/film/video and view frame by frame **or** use a position/distance sensor placed below mass with data logger. C Improved method of measuring L or L_0 e.g. calipers/clamp ruler (next to spring). D Measure from rod to bench at both ends / use spirit level beside wooden rod / spirit level beside spring (for L_0) / plumb line beside spring (for L_0) **or** method to stop stand sliding e.g. G-clamp (to bench) **or** add mass to base **or** use heavier stand(s). E Method to improve measurement of θ e.g. hold protractor in clamp / measure using photograph / use thinner string / use of trigonometry with length measurements described. *1 mark for each point up to a maximum of 4.*	**4**

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