Cambridge Assessment International Education

Cambridge International AS & A Level

PHYSICS **9702/34**

Paper 3 Advanced Practical Skills 2 **May/June 2023**

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.

Cambridge International is publishing the mark schemes for the May/June 2023 series for most Cambridge IGCSE, Cambridge International A and AS Level and Cambridge Pre-U components, and some Cambridge O Level components.

This document consists of **10** printed pages.

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 descriptors 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.

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	<u>‘List rule’ guidance</u> 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.

6	<u>Calculation specific guidance</u> 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	<u>Guidance for chemical equations</u> 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.

Question	Answer	Marks
1(a)	Value of *M* with unit and in range 10–100 g.	**1**
	Value of *T* with unit and in range 0.950–2.00 s.	**1**
	Repeats: At least two measurements of at least 5*T*.	**1**
1(b)	Six sets of readings of *M* (different values, may include 0 g) and *T* (or time) with correct trend (as *M* increases *T* increases) and without help from the Supervisor scores 4 marks, five sets scores 3 marks etc.	**4**
	Range: $M_{min} \leqslant 10$ g **and** $M_{max} \geqslant 70$ g.	**1**
	Column headings: Each column heading must contain a quantity and a unit where appropriate. The presentation of quantity and unit conforms to accepted scientific convention e.g. M^2 / g^2.	**1**
	Consistency: All values of raw time must be given to the nearest 0.01s or all to the nearest 0.1 s.	**1**
	Significant figures: Values of T^2 must be given to the same number of s.f. as (or one more than) the number of s.f. in the corresponding *T*.	**1**
	Calculation: Values of T^2 calculated correctly.	**1**

Question	Answer	Marks
1(c)(i)	Axes: Axes must be labelled with the correct quantities. Scales must be chosen so that the plotted points occupy at least half the graph grid in both *x* and *y* directions. Scale markings are no more than 2 cm apart (one large square). Sensible scales must be used. Scale 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 less than half a small square. Points must be plotted to an accuracy of half a small square in both *x* and *y* directions.	**1**
	Quality: Trend of points must be positive. All points in the table must be plotted on the grid. It must be possible to draw a straight line that is within ± 500 g^2 (to scale) on the M^2 axis of all plotted points.	**1**
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 *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: Intercept read directly from the graph, with read-off at $M^2 = 0$, accurate to half a small square in *y* direction. **or** Correct read-off from a point on the line and substituted correctly into $y = mx + c$ or an equivalent expression. Read-off is accurate to half a small square in both *x* and *y* directions.	**1**

Question	Answer	Marks
1(d)	Value of *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**
	Correct units for *a* and *b* (e.g. $s^2 g^{-2}$ for *a* and s^2 for *b*).	**1**

Question	Answer	Marks
2(a)	Value for L with unit, to nearest mm and in range 11.7–12.7 cm.	**1**
	Value for T_0 with unit and to nearest degree.	**1**
2(b)(i)	Value for x_1 with unit and to nearest mm.	**1**
2(b)(ii)	Value for T greater than T_0.	**1**
	Value of x_2 different from x_1.	**1**
2(b)(iii)	Correct calculation of ($x_1 – x_2$).	**1**
2(b)(iv)	Percentage uncertainty in ($x_1 – x_2$) based on absolute uncertainty in the range 0.2–0.5 cm. Correct method of calculation to obtain percentage uncertainty e.g. (absolute uncertainty / value from **(b)(iii)**) × 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(c)	Second values of L, x_1, T and x_2.	**1**
	Second L less than first L.	**1**
2(d)(i)	Two values of k calculated correctly. The final k values must not be written as fractions.	**1**
2(d)(ii)	Justification for significant figures in k linked to significant figures in ($x_1 – x_2$), L and ($T – T_0$).	**1**
2(e)	Calculation of percentage difference between candidate's two k values. Comparison of percentage difference with 20% leading to a consistent conclusion.	**1**

Question	Answer	Marks
2(f)(i)	A Two readings are not enough to draw a (valid) conclusion (**not** "not enough for accurate results", "few readings"). B Difficult to measure <u>*x*</u> or <u>height</u> with a reason e.g. rod moves/rule not vertical/ruler moves. C ($x_1 - x_2$) is small so large uncertainty **or** large % uncertainty in ($x_1 - x_2$). D Difficult to measure <u>*T*</u> or <u>water temperature</u> with a reason e.g. *T* varies with position in measuring cylinder/thermometer touches sides of cylinder/cannot measure *x* and *T* at the same time/*T* decreases rapidly. E <u>T_0</u> or <u>room temperature</u> may change during the experiment. F Difficulty with pipe e.g. difficult to measure *L* because pipe is curved/pipe does not expand as expected/*L* is not the distance between the holes. G Difficulty with string e.g. string changes length when wet. *1 mark for each point up to a maximum of 4.*	**4**
2(f)(ii)	A Take more readings (for different values of *x*) <u>and</u> plot a graph **or** take more readings <u>and</u> compare *k* values (**not** "repeat readings" on its own). B Clamp rule/use a plumb line. C Increase length of rod/pipe. D Use a stirrer for the water/clamp thermometer/<u>thermostatically controlled</u> water bath. E Measure T_0 just before water is added. F Use tape measure/string and ruler **or** make *L* the distance between the holes. G Use named waterproof material e.g. nylon string/plastic/metal wire. *1 mark for each point up to a maximum of 4.*	**4**