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CAMBRIDGE
International Education

Cambridge International AS & A Level

PHYSICS **9702/38**

Paper 3 Advanced Practical Skills 2 **May/June 2026**

MARK SCHEME

Maximum Mark: 40

Published

This mark scheme contains the instructions and marking guidance that our examiners used to mark candidate responses for this component.

Before they start marking, examiners complete a standardisation process. They review a range of candidate responses and discuss the mark scheme in detail to agree which answers can and cannot be accepted. Examiners award marks where it is clear that candidate responses have met the requirements of the mark scheme. These requirements may vary between different components or different versions of the same component, depending on the exact requirements of the question and the candidate responses seen during the standardisation process.

Sometimes, our mark schemes may allow marks to be awarded to responses which contain elements that are factually incorrect or for content not covered by the syllabus. We do this in response to the demands of a specific question to support candidates and make sure that our assessments are fair. However, these allowances should not be used as a guide for teaching and learning.

We cannot discuss the mark scheme with schools, and we recommend that schools read the mark scheme together with the assessment material and the Principal Examiner Report for Teachers.

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General marking principles

All examiners must apply these marking principles when marking candidate responses.

1	Examiners must award marks for each response in line with: • the specific **content** defined in the mark scheme • the specific **skills** defined in the mark scheme or in the level descriptions • the **standard of response** required as exemplified by the standardisation scripts.
2	Examiners must award **whole marks** (not half marks, or other fractions).
3	Examiners must award marks **positively**. This means that: • marks are not deducted for errors or omissions • marks are awarded for correct/valid answers as defined in the mark scheme and also for **other valid answers** which go beyond the scope of the syllabus and mark scheme referring to your team leader as appropriate • the quality of spelling, punctuation and grammar are judged **only** when the mark scheme indicates that these features are **specifically assessed** in the question. However, the meaning of all responses must be unambiguous.
4	Examiners must **consistently** apply the requirements of the mark scheme and any rules for what to do when candidates have not followed instructions correctly.
5	Examiners must use the **full range of marks** defined in the mark scheme, unless limited by the quality of the candidate responses seen.
6	Examiners must award marks according to the mark scheme and **must not** award marks with grade thresholds or grade descriptions in mind.

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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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Annotations guidance for centres

Examiners use a system of annotations as a shorthand for communicating their marking decisions to one another. Examiners are trained during the standardisation process on how and when to use annotations. The purpose of annotations is to inform the standardisation and monitoring processes and guide the supervising examiners when they are checking the work of examiners within their team. The meaning of annotations and how they are used is specific to each component and is understood by all examiners who mark the component.

We publish annotations in our mark schemes to help centres understand the annotations they may see on copies of scripts. Note that there may not be a direct correlation between the number of annotations on a script and the mark awarded. Similarly, the use of an annotation may not be an indication of the quality of the response.

The annotations listed below were available to examiners marking this component in this series.

Annotations

Annotation	Meaning
AE	arithmetic error
AWK	awkward scale used on graph
BOD	benefit of the doubt given
CON	contradiction in response, mark not awarded
	correct point or mark awarded
ECF	error carried forward applied
FO	false origin used on graph
	incorrect point or mark not awarded
^	information missing or insufficient for credit
POT	power of ten error

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Annotation	Meaning
RO	read-off from graph
SH	supervisor's help given
SR	supervisor's report taken into account
SV	supervisor's value/sample results taken into account
TE	transcription error
IR	value in range
OOR	value out of range

Abbreviations

/	Alternative and acceptable answers for the same marking point.
( )	Bracketed content indicates words which do not need to be explicitly seen to gain credit but which indicate the **context** for an answer. The context does not need to be seen but if a context is given that is incorrect then the mark should not be awarded.
SF	Significant figures

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GradeMax

Question	Answer	Marks	Guidance
1(a)(i)	Final values for d and A with consistent unit **and** $A > d$.	**1**	Ignore precision. Unit must be seen on at least one answer line. Assume same unit for d and A if one unit is missing. Expect approx. 100 mm for d and approx. 250 mm for A.
1(a)(ii)	Final value of B in the range of 2.0 cm–8.0 cm with unit and to nearest mm. Any raw values present must be to the nearest mm.	**1**	If out of range, allow SV $\pm$ 1.0 cm. Allow answer line value to the nearest tenth of a mm only if repeats are seen to the nearest mm.
1(b)	Without help from Supervisor: six sets of data (different values of d) scores 3 marks, five sets scores 2 marks, four sets scores 1 mark, three or fewer sets scores 0 marks.	**3**	Record the total number of sets of readings in a ring to left of the table. Allow more than six sets. If help provided: six sets of reading scores 2 marks, five sets of readings scores 1 mark; four or fewer sets of readings scores 0 marks. Indicate with SR on script front, with details near table.
	Values recorded in table for d, A and B.	**1**	
	Trend correct (B decreases as d increases).	**1**	Judge trend from table not from graph. Judge trend on mean d and / or B, if available. If table includes values of t and $1 / d$ only, judge trend on these values (t increases as $1 / d$ increases) **Not** equal values. If one or more values in the table is 'out of trend' then this mark not awarded BUT this may not affect quality on the graph yet.
	Range: Table contains at least one value of $d \geqslant 13.0$ cm.	**1**	Circle maximum value of d in table. If only $1 / d$ values in table, allow $1 / d \leqslant 0.0769\ \text{cm}^{-1}$.

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9702/38 Mark Scheme June 2026

GradeMax

Question	Answer	Marks	Guidance
1(b)	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. $1 / d / \text{cm}^{-1}$. t must have no unit.	**1**	Ignore units in the body of the table. Ignore POT errors. Accept separating mark as a solidus, brackets around units or 'in', but not a comma. Allow e.g., 1 / d / 1 / cm Allow 'no unit' for t. Do not accept 'cm / cm' etc. for t.
	Consistency: All raw values of d must be given to the nearest mm.	**1**	Do not allow all zeros in the mm position.
	Significant figures: All values of t given to the same number of s.f. as (or one more than) the least number of s.f. in the corresponding raw values of A and B.	**1**	Check every row.
	Values of t calculated correctly.	**1**	Check value in last line of table. If incorrect from mean values of A and/or B (if present) go back to raw values and recalculate. If still incorrect write in correct value. Answer should be correct to the number of sf given by the candidate.

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Question	Answer	Marks	Guidance
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, no awkward scales (e.g. 3:10 or fractions).	**1**	Accept labels on axes ONLY as *t* and 1 / *d*. Allow inverted axes 1 / *d* against *t*. Actual numbers need not correspond to label. Ignore units. Do not allow reversed scales e.g., 10, 9, 8, 7…left to right. Minimum 6 large squares on long axis and 4 large squares on short axis. Ignore point(s) plotted off the grid and assess on remaining points. Allow 8:10. Do not allow non-linear scales (ignore false zeros at origin) Do not allow awkward markings (e.g. 2.57, 3.57. 4.57 i.e., an awkward offset of a sensible linear scale) Indicate *x*-axis false origin with FO.
	Plotting of points: All observations in the table must be plotted on the grid. Diameter of plotted points must be ⩽ half a small square. Points must be plotted to an accuracy of half a small square in both *x* and *y* directions.	**1**	Ignoring any point off the grid, write a ringed total of points. Indicate reason if mark not awarded. Do not award if: • any table value is not plotted; • numbers do not correspond to the axes labels; • any point has diameter larger than half a small square (blob); • a point is (or should be) off grid (check point on edge); • the point **furthest** from the line is plotted more than half a small square out. Ring and check point furthest from the line. Tick if correct, re-plot if incorrect. If point on edge is checked and should be on grid, still check point furthest from line.

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Question	Answer	Marks	Guidance
1(c)(i)	Quality: General trend of points must be positive. All points in the table must be plotted (at least 5) for this mark to be awarded. It must be possible to draw a straight line that is within $\pm$ 0.02 on the *t* axis of <u>all</u> plotted points.	**1**	Ignore line drawn by the candidate. If examiner has replotted a point judge quality on position of replot. Indicate the tolerance on the graph. <u>Indicate reason</u> if mark not awarded. Do not award if: • wrong trend on the graph (i.e. negative gradient); • a point is (or should be) off the grid (check pt on edge); • non-linear scale in region of the points; • wrong <u>quantity</u> plotted or calculated; • 4 or fewer plotted points.
1(c)(ii)	Line of best fit: 'Best fit' is judged by the balance of all points (at least 5 points) on the grid 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 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**	Allow a straight line through a curved trend. <u>Indicate reason</u> if not awarded. Do not award if: • rotation or translation achieves a better fit; • line is kinked; • a curve has been drawn; • line is thicker than 1 mm or 'hairy'; • points are too scattered to judge; • there are 4 or fewer points. • line does not span all plotted points considered in assessing the line (line must span in either the *x* or *y* direction) Assess line on <u>all</u> points if more than one point is identified as anomalous or only 5 points are plotted on the grid.

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Question	Answer	Marks	Guidance
1(c)(iii)	Gradient: gradient sign on answer line consistent with graph drawn. 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. Method of calculation must be correct, not $\Delta x / \Delta y$.	**1**	Allow hypotenuse to be exactly half the length of the drawn line. Correct substitution must be shown. Do not check beyond the substitution regardless of the method used. If a read-off is incorrect, write in correct value(s). Ignore POT error if it is the same for both values. Ignore units. Allow use of points from the table ONLY if they are less than or equal to 1 / 2 a small square from the line. Check the plotting of these points. Other valid methods: 1. Using simultaneous equations (with two correct coords, sufficiently far apart on the line); 2. Counting squares × scale factor (must see a triangle); 3. Using only Δy and Δx (without read-offs) – check these values to one small square using their triangle (triangle or coords must be shown).
	y-intercept: Intercept read directly from the graph, with read-off at $1 / d = 0$, accurate to half a small square in y direction. **or** Correct read-off from a point on the line is substituted into $y = mx + c$ or an equivalent expression, with read-off accurate to half a small square in both x and y directions.	**1**	Check for x-axis false origin (FO) i.e. $1 / d \neq 0$. Allow correct read-off from a curved line (for intercept read directly method only). Allow ecf of gradient value, m. Check correct substitution in $y = mx + c$. Do not check beyond the substitution. If read-off used is incorrect and gradient mark not awarded because of this incorrect read-off, then check 2nd read-off in the gradient substitution. If this 2nd read-off is also incorrect, do not allow the intercept mark. If correct, allow ecf and award the mark. Ignore POT.

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Question	Answer	Marks	Guidance
1(d)	p = candidate's gradient value **and** q = candidate's intercept value. Values must not be written as fractions or to only one significant figure.	**1**	If $q = 0$ ignore sf in q. Special case when q is read off the axis: allow 1 sf for q if it is close to the origin and can only be read to 1 sf. Allow a correctly rounded value with > 1 sf. Allow POT adjustment if consistent with unit. Ignore any working. If axes are inverted, this mark cannot be awarded unless the candidate makes a correction at this point (true gradient = 1 / candidate's gradient and true intercept = – candidate's intercept / candidate's gradient).
	Units for p and q correct and consistent with readings (e.g. cm for p and no unit for q).	**1**	

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9702/38 Mark Scheme June 2026

GradeMax

Question	Answer	Marks	Guidance
2(a)(i)	Final value of L with unit and to the nearest mm. Any raw values present must be to the nearest mm.	**1**	Do not allow value of $L < 30.0$ cm. Allow answer line value to the nearest tenth of a mm only if repeats are seen to the nearest mm.
2(a)(ii)	Final value of D in the range of 2.70 to 3.30 mm. Raw measurements of D must be <u>all</u> to the nearest 0.1 mm **or** <u>all</u> to the nearest 0.01 mm.	**1**	If out of range allow SV $\pm$ 0.30 mm. Answer line value must be to the same sf as raw data unless repeats seen where we then allow same or one more sf.
2(b)(i)	Final value of $H \leqslant 45.0$ cm with a compatible unit.	**1**	Ignore precision. Expect $H \approx 40$ cm.
2(b)(ii)	Absolute uncertainty in H of 2–5 mm. Correct method of calculation to obtain percentage uncertainty e.g. absolute uncertainty / value from **2(b)(i)** $\times$ 100. If repeated readings have been taken, then the absolute uncertainty can be half the range, but only if working is clearly shown, but NOT zero if values are equal.	**1**	 With × 100 seen or implied. If repeated readings used, need to see repeats either here or in **2(b)(i)**. Allow new mean H if repeated here rather than in **2(b)(i)**.
2(b)(iii)	Final value of T in range 1.0 s to 60.0 s with unit. Raw measurements of T must be <u>all</u> to the nearest 0.1 s **or** <u>all</u> to the nearest 0.01 s.	**1**	If raw values are to the nearest 0.1 s, allow final value to the nearest 0.1 s or 0.01 s. If raw values are to the nearest 0.01 s, allow final value to the nearest 0.1 s or 0.01 s or 0.001 s. Allow ‘sec’ or ‘seconds’ for s. Do not allow ‘secs’ for s.
	Evidence of repeated measurements of T.	**1**	
2(c)(i)	Second value of L.	**1**	Any different value of L, ignore units, ignore precision.

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9702/38 Mark Scheme June 2026

GradeMax

Question	Answer	Marks	Guidance
2(c)(ii)	Second value of *T*.	**1**	Any value of *T*, ignore units, ignore precision.
	Value for second *T* greater than first *T*.	**1**	If units missing, assume same units for both.
2(d)(i)	Two values of *k* calculated correctly. The final *k* values must not be written as fractions or given to only one significant figure.	**1**	Check *k* value for values of *T*, *H* and *L* on page 10 and the value of *D* on page 8 when rounded to 2 sf is the same as the examiner's value when also rounded to 2 sf. Check calculation from raw values if necessary. If incorrect, record correct value. Ignore POTs if same for both *k* values. Allow your calculated value to be written on either line. If no working shown still award mark if *k* value correct.
2(d)(ii)	Justification based on the significant figures in *T*, *D*, *H* and *L*.	**1**	Ignore D^4. Allow lower case lettering throughout. Ignore the actual sf used in the calculation. Do not credit 'raw readings' unspecified. Any additional numerical justification must be valid (i.e., *k* value given to same sf (or one more) as least sf in *T, D*, *H* or *L*)

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Question	Answer	Marks	Guidance
2(e)	Calculation of percentage difference between candidate's two *k* values. Comparison of percentage difference with 15% leading to a consistent conclusion.	**1**	1. Look for a % difference calculation. Allow the use of half the % difference calculation e.g. $(k_1 – k_2) / (k_1 + k_2)$. Allow ecf of *k* values. 2. Comparison to 15(%) or 'the (suggested / percentage) uncertainty'. Do not allow any other uncertainty e.g. their own or the uncertainty in *H* from **2(b)(ii)**. Accept 'within' 15% as 'less than 15%'. 3. Valid comment linking points 1 and 2. The candidate's conclusion must be consistent with the criterion 15%. Allow use of 15% criterion with one or both *k* values to determine whether there is an overlap or not with a valid conclusion stated. Special Case: Allow the statement $k_1 = k_2$ only if the values are the same to 3 sf with a valid conclusion stated.

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Question	Answer	Marks	Guidance
2(f)(i)	A Two (sets of) readings are <u>not enough to draw a valid conclusion.</u> **or** Two *k* values are not enough to draw a conclusion.	**4**	Do not allow 'two readings not enough for (accurate) results'. Allow 'not enough *k* values to draw a conclusion'. Allow '(one or) two readings are not enough to draw a conclusion'. Allow 'too few readings for a conclusion'. Allow '… to conclude (the experiment)'. Do not allow '… to conclude the results'. Allow reference to 'relationship' to mean 'conclusion'.
	B Difficult to measure *D* / diameter with reason e.g. not circular, changes shape when held / measured / caliper jaws too large / *D* not consistent.		Ignore '*D* too small to measure' unqualified. Ignore reference to zero error.
	C Difficult to measure *H* with reason e.g. parallax / difficult to hold rule steady.		Ignore 'hand moves' etc. unqualified. Ignore 'rule not vertical'. Allow difficult to **keep** rule vertical (i.e. not steady).
	D Difficult with *T* / time with reason e.g. difficult to judge when water level passes graduation(s) / difficult to judge when to start / stop the timer / difficult to judge the start / end point.		Allow 'determine', 'tell', 'know', 'identify', 'decide' or 'find' for 'judge'. Ignore 'see', 'observe', 'measure', or 'estimate' for 'judge'. Ignore references to short / small time or reaction times.
	E Difficulties with tube e.g., end of tube is not vertical / end of tube moves / end of tube not straight / air bubbles in tube / rubber band deforms tube.		Ignore references to the rubber band or 30 cm ruler without mention of the tube. 'At rubber band', 'at beaker' or 'on 30 cm ruler' implies 'end' of tube.

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Question	Answer	Marks	Guidance
2(f)(ii)	A Take more readings (for different values of *H* and *T*) <u>and</u> plot a graph **or** take more readings <u>and</u> compare *k* values.	**4**	Ignore 'repeat readings' on its own. Do not allow 'take more readings and (calculate) average *k.* Allow 'repeat readings and plot a graph'. Do not allow 'repeat readings and draw a line / plot a diagram' without reference to a graph.
	B Take photo of tube end with ruler in view / use a travelling microscope / measure external diameter and subtract 2× wall thickness.		Ignore 'repeat measurements of *D* and calculate a mean' Ignore 'scale' on its own.
	C Measure to top and bottom from bench and subtract **or** clamp ruler.		
	D Video (syringe) with timer in view **or** use smaller *H* / a longer tube / narrower tube / measure *T* between graduations with a greater separation e.g. between the 50 cm^3 and 20 cm^3 lines (to increase *T*).		Allow 'film' or 'record' for 'video' Allow 'frame-by-frame', 'time stamp' or 'time code' for timer Allow video with 'inbuilt timer' Ignore 'video with timer' unqualified.
	E Use a second rubber band **or** use adhesive tape / glue / adhesive putty to secure the end of the tube (to the 30 cm ruler) **or** insert end of tube through a rigid tube (to act as a guide), **or** method of removing air bubbles e.g., flushing water through tube before topping up syringe (to measure *T*).		Ignore references to checking if the end of the tube is vertical (e.g. spirit levels). Ignore ideas of changing the flexible tube for a rigid one or splicing flexible and rigid tube. Ignore 'tapping tube to remove air bubbles'.

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