CAMBRIDGE
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Cambridge International AS & A Level

PHYSICS **9702/31**

Paper 3 Advanced Practical Skills 1 **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.

This document consists of **17** printed pages.

[Turn over

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.

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 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.

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

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

Question	Answer	Marks	Guidance
1(a)	Final value of V_1 to at least the nearest 0.001 V and in the range 0.380–0.470 V with correct unit **and** any raw values of V_1 all to at least the nearest 0.001 V.	**1**	If OOR check SV ± 0.050 V. Allow negative values of V.
1(b)(i)	$V_2 > V_1$	**1**	Ignore precision and units. Ignore negative signs.
1(b)(ii)	Correct calculation of $\frac{V_1}{V_2 - V_1}$.	**1**	Answer must be correct to the number of significant figures used by the candidate. Ignore unit if given.
1(c)	Without help from Supervisor: six sets of readings (different values of R) scores 3 marks, five sets scores 2 marks, four sets scores 1 mark, three or fewer 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 of readings. If minor help given (correcting/connecting one component): six sets of readings scores 2 marks, five sets of readings scores 1 mark, four or fewer sets of readings scores 0 marks. If unspecified help, or major help, given e.g. building circuit: six sets of readings scores 1 mark, five sets of readings scores 0 marks. Indicate help with SR on script front with details near table.
	Values recorded in a table for R, V_1, and V_2.	**1**	All data must be in a table for this mark.
	Trend correct [V_1 and V_2 increase as R increases].	**1**	Judge trend from table not from graph. Judge trend from mean V_1 (and mean V_2) if available. If no V_1 values, judge trend on V_2 and $V_1/(V_2 - V_1)$. If no V_2 values, judge trend on V_1 and $V_1/(V_2 - V_1)$. Do not award if two (or more) values of V_1 **or** V_2 are equal. Do not award if one or more values in the table is 'out of trend'. This may not affect the quality mark on the graph.

Question	Answer	Marks	Guidance
1(c)	Range of R: must include 12 Ω **and** 39 Ω.	**1**	Ring minimum and maximum values in the table. If SR indicates a different range of resistors used (e.g. 10 Ω rather than 12 Ω) then the range must include the smallest and the largest values of resistors available.
	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.	**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. Do not credit V / V for unit of $\frac{V_1}{V_2 - V_1}$.
	Significant figures: All values of $\frac{V_1}{V_2 - V_1}$ must be given to the same number as, or one more than, the least number of s.f. in V_1 and V_2.	**1**	Check consistency in every row.
1(d)(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 the x and y directions. Scale markings on both axes 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 $\frac{V_1}{V_2 - V_1}$ and R. Actual numbers on the axes need not correspond to labels. Ignore any units given on axes labels. Do not allow reversed numerical scales e.g., 10, 9, 8, 7… left to right. Allow 8:10 scales. Do not allow awkward markings (e.g. 2.57, 3.57, 4.57 an awkward offset of a sensible linear scale). 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. Do not award if non-linear scale (ignore false zeros at the origin). Indicate x-axis false origin with FO.

Question	Answer	Marks	Guidance
1(d)(i)	Plotting of points: All observations <u>in the table</u> 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. Allow correct plotting of points on a wrong graph e.g. V_1 vs R. Indicate reason if mark not awarded. Do not award if: • any table value is not plotted; • the numbers on the scales do not correspond to the axes labels. • any point has diameter larger than half a small square (blob); • the point **furthest** from the line is plotted more than half a small square out. • a point is (or should be) off the grid (check any point on the edge) Ring and check point furthest from the line. Tick if correct, re-plot if incorrect. If a point on the edge is checked and found correct, still check point furthest from the line.
	Quality: Trend of points must be positive. All points in the table (at least 5) must be plotted on the grid for this mark to be awarded. It must be possible to draw a straight line that is within ± 0.10 on the $\frac{V_1}{V_2 - V_1}$ axis (normally *y*-axis) of <u>all</u> plotted points.	**1**	Ignore the 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 point on edge) • non-linear scale in region of the points; • wrong <u>quantity</u> plotted or calculated • any data point in the table is not plotted • there are 4 or fewer plotted points.

Question	Answer	Marks	Guidance
1(d)(ii)	Line of best fit: 'Best fit' is judged by the 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 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. Indicate reason 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 plotted. Assess line on all points if more than one point is identified as anomalous or only 5 points are plotted on the grid. Line must span ALL plotted points considered in assessing the line in the *x* or the *y* direction (or both).
1(d)(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 straight 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 units. Ignore POT error if it is the same for both *x* values or both *y* values. Allow use of points from the table ONLY if they are less than or equal to half a small square from the line. Check the plotting of these points. Other valid methods: 1 Using simultaneous equations; 2 Counting squares x 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 must be shown). Do not award if points on a CURVED line are used in $\Delta y / \Delta x$.

Question	Answer	Marks	Guidance
1(d)(iii)	*y*-intercept: Intercept read directly from the graph, with read-off at $R = 0$, 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. Read-off accurate to half a small square in both *x* and *y* directions.	**1**	Check for *x*-axis false origin (FO) i.e. $x \neq 0$. Check correct substitution in $y = mx + c$. Allow ecf of gradient value, *m*, in a correct substitution Do not check beyond the substitution. Ignore POT error. 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. Allow *y*-intercept read off with a drawn CURVE but do not allow substitution method for a curved line.
1(e)	*P* = candidate's gradient value **and** *Q* = candidate's intercept value. Values must not be written as fractions or given to only one significant figure.	**1**	Allow a correctly rounded value (to 2 or more sf). Allow unrounded values if seen in working in **1(d)(iii)**. 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* consistent with readings: Ω^{-1} **and** *Q* has no unit.	**1**	
1(f)	Line Z: steeper line above the original line and not crossing on the grid (except at $R = 0$).	**1**	Allow line with no label. Allow if trend negative. Indicate × or ✓ in **1(f)**.

Question	Answer	Marks	Guidance
2(a)	Final value of l_0 to the nearest mm with unit. Any raw values of l_0 must all be to the nearest mm.	**1**	Allow answer line value to 0.1 mm only if all repeats to the nearest mm are seen.
2(b)	Final value of T_0 in the range 0.50 s to 0.90 s with unit (seen somewhere).	**1**	Ignore precision. Do not allow if frequency on answer line for T_0.
	At least two values of nT where $n \geqslant 5$.	**1**	
2(c)(i)	Value of l **and** correct calculation of e.	**1**	
2(c)(ii)	Absolute uncertainty in e in range 2–6 mm. Correct method of calculation to find percentage uncertainty e.g. absolute uncertainty/value from **2(c)(i)** × 100. If repeated readings have been taken, then the uncertainty can be half the range if the 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(c)(i)**. Allow new mean e if repeated here rather than **2(c)(i)**.
2(d)(i)	$T < T_0$.	**1**	
2(d)(ii)	Correct calculation of $(T_0 - T)$.	**1**	Check value of $(T_0 - T)$ when rounded to 2 sf is the same as the examiner's when also rounded to 2 sf. Check to 1 sf if candidate's value is to 1 sf.
2(e)	Second values of m and l.	**1**	Different value of m, different value of l. Ignore units, ignore precision.
	Second values of T_0 and T.	**1**	If unit missing for T, T_0, m or l then assume same units as on page 8 and 9.
	Second value of $(T_0 - T)$ > first value of $(T_0 - T)$.	**1**	If either value of $(T_0 - T)$ is negative then do not award the mark here.

Question	Answer	Marks	Guidance
2(f)	Two values of C calculated correctly. The final C values must not be written as fractions.	**1**	Allow C to 1 sf only if $(T_0 - T)$ is to 1 sf. Check second C value using values from **2(e)** on page 10. C value on answer line when rounded to 2 sf must be the same as the examiner's value when also rounded to 2 sf. If small difference in rounding, check calculation from candidate's raw values if necessary. Ignore POT errors if the same for both C values. Allow the second C value to be written on either answer line. If no working shown still award mark if C value correct. If candidate C value is incorrect, write the correct value near the answer line.
2(g)	Calculation of percentage difference between candidate's two C 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. $(C_1 - C_2) / (C_1 + C_2)$. Allow ECF of C values. 2. Comparison to 15(%) or 'the (suggested/ percentage) uncertainty'. Do not allow any other uncertainty e.g. their own or the uncertainty in **2(c)(ii)**. Accept 'within 15%' as equivalent to '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 C values to determine whether there is an overlap or not, with a valid conclusion stated. Special case: Allow the statement $C_1 = C_2$ only if the values are the same to 3 s.f. with a valid conclusion stated.

Question	Answer	Marks	Guidance
2(h)(i)	A Two (sets of) readings are not enough to draw a valid conclusion **or** two *C* values are not enough to draw a conclusion.	**4**	Allow reference to '*k*' to mean '*C*'. Allow 'too few readings to draw a conclusion'. Allow reference to 'relationship' to mean the 'conclusion'. Allow 'values of *C* are insufficient to make a conclusion'. Allow 'one or two readings are not enough to draw a conclusion'. Allow '…to conclude (experiment)'. Do not allow 'repeat readings' on its own. Do not allow 'two readings are not enough for (accurate) results'/ 'to find *C*'. Do not allow '…to conclude the results'. Do not allow 'too few readings' on its own. Do not allow '(only) one reading' or '(only) three readings' etc.
	B Difficulty with measuring $\underline{l}$ with a reason e.g. parallax error / spring moves if touched / unclear where coiled section of spring begins and ends.		Accept 'extended spring length' for l (reference to extended length must be clear). Do not credit 'spring moves' on its own. Ignore 'ruler is not precise / accurate enough'. Ignore 'ruler has zero error'. Ignore 'metre ruler is clumsy / awkward to use'. Ignore reference to moving / unsteady hands.
	C Difficulty with the setup with a reason e.g. stands unstable / slide on table (at longer spring extensions), difficult to judge when spring (A) is horizontal / other springs are vertical / difficult to keep spring (A) horizontal (when stretched) / difficult to set springs vertical and spring (A) horizontal at the same time.		Accept 'parallel to the bench' for 'horizontal'. Do not credit 'spring (A) is / may not be level'. Ignore references to the accuracy of the mass value. Do not allow 'tell' (when spring is horizontal / vertical).
	D Springs slide along rod / fall off rod.		Allow if related to either the setup of the apparatus **or** to the oscillations but only credit once.

Question	Answer	Marks	Guidance
2(h)(i)	E Difficulty with measuring the time period or *T* of oscillations with a reason e.g. other modes of oscillation present / small amplitude / high damping **or** difficulty with measuring the time period or *T* e.g. difficult to judge / determine / decide / find / identify / know the start or end of an oscillation or a complete oscillation		Do not allow wind, ideas of air conditioning/fans. Do not allow 'mass is not pulled to exactly the same distance each time' or words to that effect. Do not allow 'see' or 'observe' oscillations. Ignore 'force applied to mass is not constant'. Do not credit references to human reaction (time). Do not credit 'oscillations are too quick' or words to that effect.

Question	Answer	Marks	Guidance
2(h)(ii)	A Take more readings (for different values of *m* and l) and plot a graph **or** take more readings and compare *C* values.	**4**	Allow reference to '*k*' to mean '*C*'. Allow 'repeat readings and plot a graph'. Do not allow 'repeat readings and draw line / plot a diagram' (need to mention graph). Do not allow 'repeat readings' on its own. Do not allow 'take more readings and (calculate) average *C*.
	B Method of improving length measurement e.g. measure the entire length of spring rather than coiled section / clamp a ruler (to measure l) / use a caliper (to measure l) / use markers or pointers placed at ends of spring.		Ignore references to micrometer / travelling microscope. Use of markers or pointers must be qualified with positioning at the ends of the spring.
	C Method of improving the setup e.g. add weights to base of stands / (G) clamp stands to bench / use plumb line to get springs vertical / use a set square between the vertical springs and spring A / use a spirit level to set spring A horizontal.		Allow 'use a plumb line and set square to ensure spring A is horizontal'. Do not allow 'set square' on its own. Do not allow 'use a spirit level' on its own.
	D Method of preventing the spring sliding on the rod e.g. make notches or grooves in the rods / use clip / clamp / stopper on end of rod / use adhesive putty / tape / string to fix the springs to the rod / turn rod by 90° to prevent spring sliding.		Must be clear that the method of fixing is to the rods (i.e. not just 'use adhesive putty / tape' etc.

Question	Answer	Marks	Guidance
2(h)(ii)	E Video / record / film oscillations with a timer in view (or playback frame by frame) **or** use a fiducial marker at the centre / middle / equilibrium of the oscillation		Allow in-built timer / timestamp for timer. Allow use of motion sensor (with data logger) placed beneath the oscillating mass (must indicate position of the sensor). Do not allow light gates. Ignore references to 'slow motion camera' or 'camera'. Do not allow 'slow motion camera' in place of video / record / film. Do not allow use of 'guides' (to keep oscillations vertical). Ignore references to release mechanisms (for starting the mass oscillating).