Cambridge Assessment International Education

Cambridge International AS & A Level

PHYSICS **9702/31**

Paper 3 Advanced Practical Skills 1 **May/June 2020**

MARK SCHEME

Maximum Mark: 40

Published

Students did not sit exam papers in the June 2020 series due to the Covid-19 global pandemic.

This mark scheme is published to support teachers and students and should be read together with the question paper. It shows the requirements of the exam. The answer column of the mark scheme shows the proposed basis on which Examiners would award marks for this exam. Where appropriate, this column also provides the most likely acceptable alternative responses expected from students. Examiners usually review the mark scheme after they have seen student responses and update the mark scheme if appropriate. In the June series, Examiners were unable to consider the acceptability of alternative responses, as there were no student responses to consider.

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Generic Marking Principles

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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
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- 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.

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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	<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.

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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.

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Question	Answer	Marks
1(a)	Value of *V* with unit in the range 0.400–0.500 V.	**1**
1(b)	Six sets of readings of *R* and *V* (different values) showing the correct trend and without help from the Supervisor scores 4 marks, five sets scores 3 marks etc.	**4**
	Range: Values of *R* must include 12 Ω and 18 Ω and 39 Ω.	**1**
	Column headings: Each column heading must contain a quantity, a unit and a separating mark where appropriate. The presentation of quantity and unit must conform to accepted scientific convention e.g. 1 / *V* / V^{-1} and *R* / Ω.	**1**
	Consistency: All values of *V* must be given to the nearest 0.001 V (or 1 mV).	**1**
	Significant figures: All values of 1 / *V* must be given to the same number of s.f. as, or one more than, the number of s.f. in *V*.	**1**
	Calculation: Values of 1 / *V* are correct.	**1**
1(c)(i)	Axes: Sensible scales must be used, no awkward scales (e.g. 3:10). Scales must be chosen so that the plotted points occupy at least half the graph grid in both *x* and *y* directions. Scales must be labelled with the quantity that is being plotted. Scale markings should be no more than three large squares apart.	**1**
	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.	**1**
	Quality: All points in the table (at least 5) must be plotted on the grid. Trend of points on graph must be correct. It must be possible to draw a straight line that is within 0.05 V^{-1} on the 1 / *V* axis of all plotted points.	**1**

Question	Answer	Marks
1(c)(ii)	Line of best fit: Judge by balance of all points on the grid about the candidate's line (at least 5 points). There must be an even distribution of points either side of the line along the full length. If there are 6 or more points, allow one anomalous point only if clearly indicated by the candidate. Line must not be kinked or thicker than half a small square.	**1**
1(c)(iii)	Gradient: The hypotenuse of the triangle used must be greater than half the length of the drawn line. The method of calculation must be correct. Do not allow $\Delta x / \Delta y$. Both read-offs must be accurate to half a small square in both the *x* and *y* directions.	**1**
	y-intercept: Correct read-off from a point on the line and substituted into $y = mx + c$. Read-off must be accurate to half a small square in both *x* and *y* directions. **or** Intercept read directly from the graph with read-off at $x = 0$ accurate to half a small square.	**1**
1(d)	Value of *A* = candidate's gradient and value of *B* = candidate's intercept. The values must not be fractions.	**1**
	Unit for *A* correct (e.g. $\Omega\ V^{-1}$ or $\Omega\ mV^{-1}$) and unit for *B* correct (e.g. V^{-1} or mV^{-1}).	**1**
1(e)(i)	*E* calculated correctly using $E = 2 / y$-intercept **or** $E = 2 / B$.	**1**
1(e)(ii)	*X* correctly determined e.g. calculation of $3 / E$, read-off of the corresponding value of $1 / R$ from the graph, then calculation of X **or** using $X = A / (3 / E - B)$ **or** using $X = EA$.	**1**

Question	Answer	Marks
2(a)(i)	Value of L to the nearest mm in the range 98.5–99.5 cm with unit.	**1**
2(a)(ii)	Correct calculation of L / 3.	**1**
2(b)(i)	Measurement of θ to the nearest degree.	**1**
	Value of θ in the range 0°–20°.	**1**
2(b)(ii)	Percentage uncertainty in θ based on absolute uncertainty in the range 2°–5°. If repeated readings have been taken, then the uncertainty can be half the range (but not zero) if the working is clearly shown. Correct method of calculation to obtain percentage uncertainty.	**1**
2(b)(iii)	Correct calculation of sin θ.	**1**
2(b)(iv)	Justification for s.f. in sin θ linked to s.f. in θ.	**1**
2(c)	Second value of θ.	**1**
	Quality: Second value of θ > first value of θ.	**1**
2(d)(i)	Two values of C calculated correctly.	**1**
2(d)(ii)	Valid comment consistent with calculated values of C, testing against a criterion stated by the candidate.	**1**
2(e)	Value of k correctly calculated **and** in the range 10–20 N m^{-1} **and** with consistent unit.	**1**

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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 θ with reason e.g. holding protractor and hand moves. C Rule slips on clamp. D Difficult to know when rule is horizontal. E Difficulty linked to setting L / n with a reason e.g. stands move suddenly/friction between bench and stands. F Difficult to hold one end of the rule and adjust the other end at the same time. *1 mark for each point up to a maximum of 4.*	**4**
2(f)(ii)	A Take more readings <u>and</u> plot a graph or take more readings <u>and</u> compare k values (**not** "repeat readings" on its own). B Mount protractor on block/use another ruler and use trigonometry to determine angle. C Use adhesive putty/tape on rod. D Use spirit level/another rule to ensure horizontal. E Method to ensure smooth movement of stands e.g. mount stands on wheels/rollers. F Use a third stand and clamp to hold the free end of the rule. *1 mark for each point up to a maximum of 4.*	**4**

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Question	Answer	Marks
1(a)	Value of d in range 5–40 cm.	**1**
1(b)	Value of T in range 0.10–1.50 s.	**1**
	Evidence of repeat readings: at least two values of at least 5T.	**1**
1(c)	Six sets of readings of d and T showing the correct trend and without help from the Supervisor scores 4 marks, five sets scores 3 marks etc.	**4**
	Range: $x_{min} \leqslant 10.0$ cm and $x_{max} \geqslant 30.0$ cm.	**1**
	Column headings: Each column heading must contain a quantity, a unit and a separating mark where appropriate. The presentation of the quantity and unit must conform to accepted scientific convention e.g. $1 / T^2$ (s^{-2}).	**1**
	Consistency: All raw values of d must be given to the nearest mm.	**1**
	Significant figures: Number of significant figures for every value of d^2 the same as, or one more than, the number of s.f. in the corresponding value of d.	**1**
	Calculation: Values of d^2 calculated correctly.	**1**

Question	Answer	Marks
1(d)(i)	Axes: Sensible scales must be used, no awkward scales (e.g. 3:10). Scales must be chosen so that the plotted points occupy at least half the graph grid in both *x* and *y* directions. Scales must be labelled with the quantity that is being plotted. Scale markings should be no more than three large squares apart.	**1**
	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.	**1**
	Quality: All points in the table (at least 5) must be plotted on the grid. Trend of points on the graph must be correct. It must be possible to draw a straight line that is within ± 0.20 s^{-2} on the $1 / T^2$ axis of all plotted points.	**1**
1(d)(ii)	Line of best fit: Judge by balance of all points on the grid about the candidate's line (at least 5 points). There must be an even distribution of points either side of the line along the full length. If there are 6 or more points, allow one anomalous point only if clearly indicated by the candidate. Line must not be kinked or thicker than half a small square.	**1**
1(d)(iii)	Gradient: The hypotenuse of the triangle used must be greater than half the length of the drawn line. The method of calculation must be correct. Do not allow $\Delta x / \Delta y$. Both read-offs must be accurate to half a small square in both the *x* and *y* directions.	**1**
	y-intercept: Correct read-off from a point on the line and substituted into $y = mx + c$. Read-off must be accurate to half a small square in both *x* and *y* directions. **or** Intercept read directly from the graph with read-off at $x = 0$ accurate to half a small square.	**1**

Question	Answer	Marks
1(e)	Value of *a* equal to candidate's gradient and value of *b* equal to candidate's intercept. The values must not be fractions.	**1**
	Units for *a* (e.g. $s^{-2}\,cm^{-2}$) and *b* (s^{-2}) correct.	**1**

Question	Answer	Marks
2(a)	Value of *L* to nearest mm, with unit.	**1**
	Value of *d* to the nearest 0.01 mm and in the range 2.00–5.00 mm, with unit.	**1**
2(b)	Values of *x* and *y*, with $x < y$.	**1**
2(c)	Value for F_m, with unit, to nearest 0.1 N.	**1**
	Evidence of repeated readings of F_m.	**1**
2(d)	Percentage uncertainty in F_m based on an absolute uncertainty of 0.2–0.5 N. If repeated readings have been taken, then the uncertainty can be half the range (but not zero) if the working is clearly shown. Correct method of calculation to obtain percentage uncertainty.	**1**
2(e)	Correct calculation of *F*.	**1**
2(f)	Justification based on s.f. in F_m, *x* and *y*.	**1**
2(g)	Second values of *L*, *d* and F_m.	**1**
	Quality: Second F_m > first F_m.	**1**
2(h)(i)	Two values of *E* calculated correctly.	**1**
2(h)(ii)	Valid comment relating to the calculated values of *E*, testing against a criterion specified by the candidate.	**1**

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Question	Answer	Marks
2(i)(i)	A Two readings are not enough to draw a (valid) conclusion (**not** “not enough for accurate results”, “few readings”). B Difficult to measure 1 cm bend. C Rod bends suddenly (so difficult to stop at 1 cm bend). D (Whole) weight of newton meter not included in F_m. E Large percentage uncertainty in F_m (for longer rod). F Repeat values of F_m differ because rod stays bent. G Difficult to measure deflection and F_m at the same time. *1 mark for each point up to a maximum of 4.*	**4**
2(i)(ii)	A Take more readings <u>and</u> plot a graph or take more readings <u>and</u> compare *k* values (**not** “repeat readings” on its own). B Clamp ruler/use grid behind rod/workable method using stop. C Use motor/other workable method to pull newton meter slowly. D Zero then weigh newton meter and add to reading, or similar. E Increase *x*/decrease *y* (for longer rod). F Provide more identical rods. G Video rod and newton meter and replay. *1 mark for each point up to a maximum of 4.*	**4**

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1(a)	Value of L in the range 0.987–0.993 m.	**1**
	Value of $y_1 > y_2$.	**1**
	Correct calculation of y.	**1**
1(b)	Five sets of readings of m and y (different values) showing the correct trend and without help from the Supervisor scores 5 marks, four sets scores 4 marks etc.	**5**
	Range: Must include values of $m \leqslant 100$ g and $m \geqslant 140$ g.	**1**
	Column headings: Each column heading must contain a quantity, a unit and a separating mark where appropriate. The presentation of the quantity and unit must conform to accepted scientific convention e.g. y / cm.	**1**
	Consistency: All raw values of y_1 and y_2 must be given to the nearest mm only.	**1**
1(c)(i)	Axes: Sensible scales must be used, no awkward scales (e.g. 3:10). Scales must be chosen so that the plotted points occupy at least half the graph grid in both x and y directions. Scales must be labelled with the quantity that is being plotted. Scale markings should be no more than three large squares apart.	**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.	**1**
	Quality: All observations in the table (at least 4) must be plotted on the grid. Trend of points on graph must be correct. It must be possible to draw a straight line that is within ± 2.0 cm (to scale) on the y / cm axis (normally y-axis) of all plotted points.	**1**

Question	Answer	Marks
1(c)(ii)	Line of best fit: Judge by balance of all points on the grid about the candidate's line (at least 4 points). There must be an even distribution of points either side of the line along the full length. If there are 5 or more points, allow one anomalous point only if clearly indicated by the candidate. Line must not be kinked or thicker than half a small square.	**1**
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1(d)	Value of *A* = candidate's gradient and value of *B* = candidate's intercept. The values must not be fractions.	**1**
	Units for *A* (e.g. cm g^{-1}) and *B* (m, cm or mm) correct.	**1**
1(e)	Calculation of *R* correct [$= 2(L - B) / A$] and given to three significant figures.	**1**

Question	Answer	Marks
2(a)	Value of *D* in the range 2.300–2.500 cm with unit and to the nearest 0.01 cm or 0.001 cm.	**1**
	Value of *d* in the range 1.100–1.300 cm with unit and to the nearest 0.01 cm or 0.001 cm.	**1**
2(b)(i)	Value of *L* in the range 29–31 cm with unit and to the nearest 0.1 cm.	**1**
2(b)(ii)	Final value of l in the range 40–80 cm with unit. Raw readings to the nearest mm.	**1**
	Evidence of repeats.	**1**
2(b)(iii)	Percentage uncertainty in l based on an absolute uncertainty of 2–5 mm. If repeated readings have been taken, then the uncertainty can be half the range (but not zero) if the working is clearly shown. Correct method of calculation to obtain percentage uncertainty.	**1**
2(b)(iv)	Correct calculation of $(l - L)^2$.	**1**
2(c)	Second value of *D*.	**1**
	Second values of *L* and l.	**1**
	Quality: Second value of l < first value of l.	**1**
2(d)(i)	Two values of *k* calculated correctly.	**1**
2(d)(ii)	Valid comment consistent with calculated values of *k*, testing against a criterion stated by the candidate.	**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 Problem in placing cylinder A on the line (e.g. because cylinder covers line when placed). C Narrow strip so A (or C) not centrally placed at release. D A (or C) not hitting B ‘full on’. E Large step at bottom of strip causes deviation. F Uneven friction of surface of bench. G Difficult to measure *L* (or *l*) with a reason e.g. parallax/rule not touching edge of ramp. *1 mark for each point up to a maximum of 4.*	**4**
2(e)(ii)	A Take more readings <u>and</u> plot a graph or take more readings <u>and</u> compare *k* values (**not** “repeat readings” on its own). B Improved method of releasing A (or C) from the same height each time e.g. a stop. C Use wider strip. D Improved method of guiding A (or C) after rolling down strip e.g. place apparatus in a channel. E Use a thinner strip/bevelled edge. F Provide smoother/more even surface for A (or C) to roll horizontally. G Improved method to measure *L* (or *l*) e.g. place apparatus on a grid of 1 mm graph paper/use set square. *1 mark for each point up to a maximum of 4.*	**4**

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Cambridge Assessment International Education

Cambridge International AS & A Level

PHYSICS **9702/34**

Paper 3 Advanced Practical Skills 2 **May/June 2020**

MARK SCHEME

Maximum Mark: 40

Published

Students did not sit exam papers in the June 2020 series due to the Covid-19 global pandemic.

This mark scheme is published to support teachers and students and should be read together with the question paper. It shows the requirements of the exam. The answer column of the mark scheme shows the proposed basis on which Examiners would award marks for this exam. Where appropriate, this column also provides the most likely acceptable alternative responses expected from students. Examiners usually review the mark scheme after they have seen student responses and update the mark scheme if appropriate. In the June series, Examiners were unable to consider the acceptability of alternative responses, as there were no student responses to consider.

Mark schemes should usually be read together with the Principal Examiner Report for Teachers. However, because students did not sit exam papers, there is no Principal Examiner Report for Teachers for the June 2020 series.

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

Cambridge International is publishing the mark schemes for the June 2020 series for most Cambridge IGCSE™ and Cambridge International A & AS Level components, and some Cambridge O Level components.

This document consists of **9** printed pages.

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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 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.

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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.

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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	<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.

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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.

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Question	Answer	Marks
1(a)	Value of *d* in range 14.0–16.0 cm.	**1**
1(b)	Value of *t* in range 10.00–20.00 s.	**1**
	Evidence of repeated readings of *t*.	**1**
1(c)	Six sets of readings of *d* and *T* showing the correct trend and without help from the Supervisor scores 4 marks, five sets scores 3 marks etc.	**4**
	Range: $d_{min} \leqslant 10.0$ cm and $d_{max} \geqslant 20.0$ cm.	**1**
	Column headings: Each column heading must contain a quantity, a unit and a separating mark where appropriate. The presentation of quantity and unit must conform to accepted scientific convention. e.g. 1 / *d* / cm^{-1}	**1**
	Consistency: All values of *d* must be given to the nearest 0.1 cm.	**1**
	Significant figures: Number of significant figures for every value of 1 / *d* the same as, or one more than, the number of s.f. of *d* as recorded in table.	**1**
	Calculation: Values of 1 / *d* calculated correctly.	**1**
1(d)(i)	Axes: Sensible scales must be used, no awkward scales (e.g. 3:10). Scales must be chosen so that the plotted points occupy at least half the graph grid in both *x* and *y* directions. Scales must be labelled with the quantity that is being plotted. Scale markings should be no more than three large squares apart.	**1**
	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.	**1**

Question	Answer	Marks
1(d)(i)	Quality: All observations in the table (at least 5) must be plotted on the grid. Trend of points must be correct. It must be possible to draw a straight line that is within ± 20 s^2 in the t^2 direction of all plotted points.	**1**
1(d)(ii)	Line of best fit: Judge by balance of all points on the grid (at least 5) about the candidate's line. There must be an even distribution of points either side of the curve along the full length. If there are 6 or more points, allow one anomalous point only if clearly indicated by the candidate. Line must not be kinked or thicker than half a small square.	**1**
1(d)(iii)	Gradient: The hypotenuse of the triangle used must be greater than half the length of the drawn line. The method of calculation must be correct. Do not allow $\Delta x / \Delta y$. Both read-offs must be accurate to half a small square in both the x and y directions.	**1**
	y-intercept: Correct read-off from a point on the line and substituted into $y = mx + c$. Read-off must be accurate to half a small square in both x and y directions. **or** Intercept read directly from the graph with read-off at $1 / d = 0$ accurate to half a small square.	**1**
1(e)	Value of a equal to candidate's gradient and value of b equal to candidate's intercept. The values must not be fractions.	**1**
	Correct units for a (e.g. cm s^2) and b (s^2).	**1**

Question	Answer	Marks
2(a)(i)	Value of *T* in the range 0.50–1.00 s.	**1**
2(a)(ii)	Correct calculation of *k*.	**1**
2(b)	Value of *y* to nearest 0.001 m and in range 0.050–0.150 m.	**1**
2(c)	Value for *H*.	**1**
	Evidence of repeated readings of *H*.	**1**
2(d)	Percentage uncertainty in *H* based on an absolute uncertainty of 4–8 mm. If repeated readings have been taken, then the uncertainty can be half the range (but not zero) if the working is clearly shown. Correct method of calculation to obtain percentage uncertainty.	**1**
2(e)	Second values of *y* and *H*.	**1**
	Quality: second *H* < first *H*.	**1**
2(f)(i)	Two values of *c* calculated correctly **and** both values given to two or more significant figures.	**1**
2(f)(ii)	Justification based on significant figures in *H* and *y*.	**1**
2(f)(iii)	Valid comment consistent with calculated values of *c*, testing against a criterion stated by the candidate.	**1**
2(g)	Correct calculation of *g*, with unit.	**1**

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Question	Answer	Marks
2(h)(i)	A Two readings are not enough to draw a (valid) conclusion (**not** “not enough for accurate results”, “few readings”). B Mass oscillates horizontally as well as vertically. C *y* varies around the masses/other specific problem with *y*. D Difficult to judge end points of oscillation. E *H* decreases with time/oscillations damped. F Parallax error when taking measurements for *H*. G Difficult to raise masses to same position for repeats. *1 mark for each point up to a maximum of 4.*	**4**
2(h)(ii)	A Take more readings <u>and</u> plot a graph or take more readings <u>and</u> compare *k* values (**not** “repeat readings” on its own). B Valid method of restricting oscillation to vertical direction e.g. a guide. C Take several readings and average/clamp ruler vertically to measure *y*. D Video with rule in view and play back. E Use ‘peak-hold’ indicator to indicate maximum and minimum/use data logger with position sensor under mass hanger. F Hold rule in a clamp/other valid method to reduce parallax. G Use a stop e.g. horizontal piece of wood held by clamp. *1 mark for each point up to a maximum of 4.*	**4**

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Cambridge Assessment International Education

Cambridge International AS & A Level

PHYSICS **9702/35**

Paper 3 Advanced Practical Skills 1 **May/June 2020**

MARK SCHEME

Maximum Mark: 40

Published

Students did not sit exam papers in the June 2020 series due to the Covid-19 global pandemic.

This mark scheme is published to support teachers and students and should be read together with the question paper. It shows the requirements of the exam. The answer column of the mark scheme shows the proposed basis on which Examiners would award marks for this exam. Where appropriate, this column also provides the most likely acceptable alternative responses expected from students. Examiners usually review the mark scheme after they have seen student responses and update the mark scheme if appropriate. In the June series, Examiners were unable to consider the acceptability of alternative responses, as there were no student responses to consider.

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Question	Answer	Marks
1(a)	Value of T in the range 1.0–1.5 s.	**1**
1(b)	Six sets of readings of m and time (different values) showing the correct trend and without help from the Supervisor scores 5 marks, five sets scores 4 marks etc.	**5**
	Range: Must include m = 0.100 kg and m = 0.700 kg.	**1**
	Column headings: Each column heading must contain a quantity, a unit and a separating mark where appropriate. The presentation of the quantity and the unit must conform to accepted scientific convention e.g. T^2 / m / s^2 kg^{-1}.	**1**
	Consistency: Raw values of time must all be given to the nearest 0.1 s or all be given to the nearest 0.01 s.	**1**
	Significant figures: Number of s.f. for every value of 1 / m same as, or one more than, the number of s.f. in the corresponding value of m.	**1**
	Calculation: Values of T^2 / m calculated correctly.	**1**
1(c)(i)	Axes: Sensible scales must be used, no awkward scales (e.g. 3:10). Scales must be chosen so that the plotted points occupy at least half the graph grid in both x and y directions. Scales must be labelled with the quantity that is being plotted. Scale markings should be no more than three large squares apart.	**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.	**1**
	Quality: All observations in the table (at least 5) must be plotted on the grid. Trend of points must be correct. It must be possible to draw a straight line that is within 0.5 kg^{-1} on the 1 / m axis of all plotted points.	**1**

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Question	Answer	Marks
1(c)(ii)	Line of best fit: Judge by balance of all points on the grid about the candidate's line (at least 5 points). There must be an even distribution of points either side of the line along the full length. If there are 6 or more points, allow one anomalous point only if clearly indicated by the candidate. Line must not be kinked or thicker than half a small square.	**1**
1(c)(iii)	Gradient: The hypotenuse of the triangle used must be greater than half the length of the drawn line. The method of calculation must be correct. Do not allow $\Delta x / \Delta y$. Both read-offs must be accurate to half a small square in both the x and y directions.	**1**
	y-intercept: Correct read-off from a point on the line and substituted into $y = mx + c$. Read-off must be accurate to half a small square in both x and y directions. **or** Intercept read directly from the graph with read-off at $x = 0$ accurate to half a small square.	**1**
1(d)	Value of A = candidate's gradient and value of B = candidate's intercept. The values must not be fractions.	**1**
	Unit for A correct (s^2) and unit for B correct ($s^2\ kg^{-1}$).	**1**
1(e)	Line W drawn with larger gradient and larger y-intercept.	**1**

Question	Answer	Marks
2(a)(i)	Value of *d* in the range 0.22–0.25 mm	**1**
2(a)(ii)	Correct calculation of Ed^2.	**1**
2(a)(iii)	Justification for s.f. in Ed^2 linked to s.f. in *E* and *d*.	**1**
2(b)(i)	Value of *L* in the range 48.0–52.0 cm with unit.	**1**
2(b)(ii)	Percentage uncertainty in *L* based on absolute uncertainty of 2–5 mm. If repeated readings have been taken, then the uncertainty can be half the range (but not zero) if the working is clearly shown. Correct method of calculation to obtain percentage uncertainty.	**1**
2(c)	Value of *V* to the nearest 0.001 V with unit in the range 0.5–1.0 V.	**1**
2(d)	Second value of *d*.	**1**
	Second value of *V*.	**1**
	Quality: Second value of *V* < first value of *V*.	**1**
2(e)(i)	Two values of *k* calculated correctly.	**1**
2(e)(ii)	Valid comment consistent with calculated values of *k*, testing against a criterion stated by the candidate.	**1**
2(f)	Correct calculation of *D* with value between candidate's *d* values.	**1**

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Question	Answer	Marks
2(g)(i)	A Two readings are not enough to draw a (valid) conclusion (**not** “not enough for accurate results”, “few readings”). B Clips slide on wire. C Contact poor between clip and (thinnest) wire. D Resistance of wires and internal resistance of cell may distort results. E Difficult to measure *L* with reason related to wire e.g. kinks/not straight. F Difficult to measure length of wire on wooden strip e.g. nails obstruct measurement. *1 mark for each point up to a maximum of 4.*	**4**
2(g)(ii)	A Take more readings <u>and</u> plot a graph or take more readings <u>and</u> compare *k* values (**not** “repeat readings” on its own). B Improved method of gripping e.g. screw clips to wire. C Use thicker wires/improved method to improve contact with (thinnest) wire e.g. solder connections. D Monitor p.d. across cell/use shorter connecting wires. E Solder wires A and B to (different) nails (to ensure wires are straight). F Improved method e.g. use longer wire and attach clips/use nails with smaller heads. *1 mark for each point up to a maximum of 4.*	**4**

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