



Cambridge International AS & A Level

PHYSICS**9702/33**

Paper 3 Advanced Practical Skills 1

May/June 2020

MARK SCHEME

Maximum Mark: 40

Published

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

Question	Answer	Marks
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 $m \leq 100$ g and $m \geq 140$ 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 $\leq$ 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
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
	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 $l < \text{first value of } l$.	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

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. <i>1 mark for each point up to a maximum of 4.</i>	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. <i>1 mark for each point up to a maximum of 4.</i>	4



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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: $d_{\min} \leq 10.0$ cm and $d_{\max} \geq 20.0$ 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 $\leq$ 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 $\pm 20 \text{ s}^2$ 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 $H < \text{first } H$.	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

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. <i>1 mark for each point up to a maximum of 4.</i>	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. <i>1 mark for each point up to a maximum of 4.</i>	4



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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. $T^2 / m / \text{s}^2 \text{kg}^{-1}$.	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 $\leq$ 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

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 ($s^2 \text{ kg}^{-1}$).	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 $V < \text{first value of } V$.	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

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. <i>1 mark for each point up to a maximum of 4.</i>	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. <i>1 mark for each point up to a maximum of 4.</i>	4