



Cambridge International AS & A Level

PHYSICS

9702/33

Paper 3 Advanced Practical Skills 1

May/June 2021

MARK SCHEME

Maximum Mark: 40

Published

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

Question	Answer	Marks
1(a)	Final value of L with unit and in the range 60.0–70.0 cm.	1
1(b)	Raw values of I with unit and to the nearest 0.1 mA and final value of $I < 1$ A.	1
1(c)	Six sets of readings of x and I (different values) without help from the Supervisor and showing the correct trend (I decreases as x increases) scores 4 marks, five sets scores 3 marks, etc.	4
	Range: $x_{\min} \leq 10.0$ cm and $x_{\max} \geq 60.0$ cm.	1
	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. $1/I$ / A^{-1} or $1/I$ (A^{-1}) and x/m .	1
	Consistency: All values of x must be given to the nearest mm.	1
	Significant figures: All values of $1/I$ must be given to the same number of significant figures as, or one greater than, the number of significant figures in raw I .	1
	Calculation: Values of $1/I$ are correct.	1

Question	Answer	Marks
1(d)(i)	Axes: Sensible scales must be used, no awkward scales (e.g. 3:10 or fractions). Scales must be chosen so that the plotted points occupy at least half the graph grid in both x and y directions. Axes 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 in both x and y directions.	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 2.0 cm (to scale) on the x-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. Allow one anomalous point only if clearly indicated by the candidate. There must be at least five points left after the anomalous point is disregarded. Lines 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. Method of calculation must be correct, i.e. $\Delta y / \Delta x$. Gradient sign on answer line matches graph drawn. 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 at $x = 0$, accurate to half a small square.	1

Question	Answer	Marks
1(e)	Value of P = candidate's gradient and value of Q = candidate's intercept. Values must not be written as fractions.	1
	Unit for P is correct (e.g. $A^{-1} m^{-1}$ or $mA^{-1} cm^{-1}$) and unit for Q is correct (e.g. A^{-1} or mA^{-1}).	1
1(f)	Correct calculation of ρ_A/ρ_B using $PL/Q + 1$.	1

Question	Answer	Marks
2(a)	Final value for d with unit and in the range 28.0–40.0 cm.	1
2(b)	Percentage uncertainty based on absolute uncertainty in the range 2–6 mm. If repeat readings have been taken, then the absolute 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)(i)	Measurement of raw b to the nearest mm. Final value with unit and in the range 9.0–11.0 cm.	1
2(c)(ii)	Correct calculation of α .	1
2(c)(iii)	Justification for the number of significant figures in α linked to s.f. in b and d .	1
2(d)	Final value for T with unit and in the range 1.50–2.50 s.	1
	At least two measurements of nT where $n \geq 5$.	1
2(e)	Second values of b and T .	1
	Second value of $T < \text{first value of } T$.	1
2(f)(i)	Two values of C calculated correctly. The final values must not be written as fractions.	1
2(f)(ii)	Valid comment consistent with calculated values of C , testing against a criterion <u>stated</u> by the candidate.	1
2(g)	Value of k correctly calculated from the <u>second</u> value of C and with consistent unit, i.e. N m^{-1} or kg s^{-2} .	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 <u>Masses</u> falling off/<u>masses</u> stick to a small surface area/not enough adhesive putty for the <u>masses</u>/adhesive putty not strong enough to hold <u>masses</u>. C Difficult to judge when the wooden strip is horizontal/difficult to set wooden strip horizontal or difficult to judge or set the spring or string vertical. D Difficulty measuring <u>g</u> with a reason, e.g. finding/determining the centre of the mass/hole or difficulty measuring <u>b</u> with a reason, e.g. finding/determining the centre of the nail/holding the ruler parallel to the strip/set-up wobbly/holding ruler in mid-air. E Difficult to <u>judge/determine/decide</u> when an oscillation starts/finishes/is complete. F Different modes of oscillation/string moves during oscillation or strip bends/twists/flexes (during oscillation). <i>1 mark for each point up to a maximum of 4.</i>	4

Question	Answer	Marks
2(h)(ii)	A Take more readings <u>and</u> plot a graph or take more readings <u>and</u> compare C values (not “repeat readings” on its own). B Wider strip/named method for improving the adhesion of the <u>masses</u>, e.g. glue/tape with reference to masses. C Method of ensuring strip is horizontal, e.g. use a spirit level or method to ensure spring/string is vertical, e.g. use a plumb-line. D Improved method to measure b or d, e.g. add a scale to the strip/mark on the strip/clamp ruler. E Fiducial marker at the <u>centre</u> of the oscillation or video/record/film with timer in view/play back frame by frame. F Use a thicker/stiffer/laminated strip or sand to make rougher/add notch to wooden strip or rod/stick sandpaper to wooden strip or rod. <i>1 mark for each point up to a maximum of 4.</i>	4



Cambridge International AS & A Level

PHYSICS**9702/34**

Paper 3 Advanced Practical Skills 2

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Question	Answer	Marks
1(a)(i)	Value of C to the nearest mm.	1
1(a)(ii)	Value of T with unit and in the range 0.50–1.50 s.	1
	At least two measurements of nT where $n \geq 5$.	1
1(b)	Six sets of readings of C and T (different values) with correct trend (T increases as C increases) and without help from the Supervisor scores 4 marks, five sets scores 3 marks etc.	4
	Range: $C_{\min} \leq 18.0$ cm and $C_{\max} \geq 35.0$ cm.	1
	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. $1/\sqrt{C}$ / cm ^{-½} , $1/T$ (s ⁻¹).	1
	Consistency: All values of <u>raw times</u> must be given to the nearest 0.1 s or <u>all</u> to the nearest 0.01 s.	1
	Significant figures: Values of $1/\sqrt{C}$ must be given to the same number of significant figures as, or one greater than, the number of significant figures in C .	1
	Calculation: Values of $1/\sqrt{C}$ calculated correctly.	1

Question	Answer	Marks
1(c)(i)	Axes: Sensible scales must be used, no awkward scales (e.g. 3:10 or fractions). Scales must be chosen so that the plotted points occupy at least half the graph grid in both x and y directions. Axes 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 in both x and y directions.	1
	Quality: All points in the table must be plotted (at least 5) on the grid. Trend of points must be correct. It must be possible to draw a straight line that is within $\pm 5.0 \times 10^{-3} \text{ cm}^{-1/2}$ ($\pm 5.0 \times 10^{-2} \text{ m}^{-1/2}$) on the $1/\sqrt{C}$ axis (normally x-axis) of all plotted points.	1
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. Allow one anomalous point only if clearly indicated by the candidate. There must be at least five points left after the anomalous point is disregarded. Lines 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. Method of calculation must be correct, i.e. $\Delta y / \Delta x$. Gradient sign on answer line matches graph drawn. 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 at $x = 0$, accurate to half a small square.	1

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

Question	Answer	Marks
2(a)(i)	Values of D_1 and D_2 both to nearest mm.	1
	Evidence of repeat readings for D_1 and D_2 .	1
2(a)(ii)	Percentage uncertainty based on an absolute uncertainty of 2–5 mm. If repeat readings have been taken, then the absolute 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)	<u>All</u> values of h_1 and h_2 to nearest 0.1 mm or <u>all</u> to nearest 0.01 mm.	1
	Correct calculation of y .	1
2(c)(i)	Values of A and B recorded and $A < B$.	1
2(c)(ii)	Correct calculation of F .	1
2(c)(iii)	Justification for significant figures in F linked to s.f. in B <u>and</u> A .	1
2(d)	Second values of D_1 , D_2 , h_1 and h_2 .	1
	y smaller for smaller D_2 .	1
2(e)(i)	Two values of k calculated correctly.	1
2(e)(ii)	Valid comment relating to the calculated values of k , testing against a criterion specified by the candidate.	1

Question	Answer	Marks
2(f)(i)	A Two readings are not enough to draw a (valid) conclusion (not “not enough for accurate results”, “few readings”). B Difficult to judge/determine whether rod is horizontal. C Difficult to measure h with reason e.g. parallax error/wooden block or ring getting in way. D Large percentage uncertainty in y. E Difficult to measure A or B with reason e.g. judging centre of slotted mass when measuring B/judging centre of nail for A or B/parallax error in A or B/difficult to hold ruler steady when measuring A or B. (Allow parallax error linked to h or A or B only once.) <i>1 mark for each point up to a maximum of 4.</i>	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 Improved method to determine if rod horizontal e.g. use a spirit level/use set square(s) with description of method. C Method to reduce error in measuring h e.g. use wider rod/move ring to edge of block/use travelling microscope. D Method to reduce percentage uncertainty in y e.g. measure change in height at end of rod/use larger mass/increase B. E Improved method of measuring A or B e.g. clamp ruler/method to locate and mark centre of slotted mass e.g. measure diameter and halve to find radius. <i>1 mark for each point up to a maximum of 4.</i>	4



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Paper 3 Advanced Practical Skills 1

May/June 2021**MARK SCHEME**Maximum Mark: 40

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Question	Answer	Marks
1(a)	Final value of L with unit and in the range 9.5–10.5 cm.	1
1(b)	Final value of T in the range 0.80–1.20 s.	1
1(c)	Five sets of readings of d and time (different values) without help from the Supervisor and with the correct trend (d increases, T increases) scores 5 marks, four sets scores 4 marks etc.	5
	Range: Includes $d \leq 25.0$ cm and $d \geq 40.0$ cm.	1
	Column headings: Each column heading must contain a quantity and a unit where appropriate. The presentation of the quantity and the unit must conform to accepted scientific convention e.g. $T/\sqrt{d}/\text{s m}^{-1/2}$.	1
	Consistency: Raw values of d must all be given to the nearest mm.	1
	Significant figures: All values of $\sqrt{\frac{d-L}{d}}$ must be given to the same number of significant figures as, or one greater than, the least number of number of significant figures in either $(d-L)$ or d .	1
	Calculation: Correct calculation of $T/\sqrt{d}$ and $\sqrt{\frac{d-L}{d}}$.	1

Question	Answer	Marks
1(d)(i)	Axes: Sensible scales must be used, no awkward scales (e.g. 3:10 or fractions). Scales must be chosen so that the plotted points occupy at least half the graph grid in both x and y directions. Axes must be labelled with the quantity which 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 in both the x and y directions.	1
	Quality: All points in the table (at least 4) must be plotted on the grid. Trend of points must be correct. It must be possible to draw a straight line that is within 0.01 on the $\sqrt{\frac{d-L}{d}}$ 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 4 points). There must be an even distribution of points either side of the line along the full length. Allow one anomalous point only if clearly indicated by the candidate. There must be at least four points left after the anomalous point is disregarded. Lines 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. Method of calculation must be correct, i.e. $\Delta y / \Delta x$. Gradient sign on answer line matches graph drawn. Both read-offs must be accurate to half a small square in both the x and y directions.	1
	y-intercept: Check 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 at $x = 0$, accurate to half a small square.	1

Question	Answer	Marks
1(e)	Value of P = candidate's gradient and value of Q = candidate's intercept. Values must not be written as fractions.	1
	Unit for P is correct (e.g. $\text{s m}^{-\frac{1}{2}}$) and unit for Q is correct ($\text{s m}^{-\frac{1}{2}}$).	1

Question	Answer	Marks
2(a)	Final value of H in the range 38.0–42.0 cm.	1
2(b)(i)	Value of raw x to the nearest mm.	1
	Value of raw θ to the nearest degree and in the range 60° – 80° .	1
2(b)(ii)	Percentage uncertainty in θ based on absolute uncertainty of 2° – 5° . If repeat readings have been taken, then the absolute 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 $x \tan \theta$	1
2(b)(iv)	Justification for significant figures in $x \tan \theta$ linked to s.f. in x and θ .	1
2(c)	Second value of x .	1
	Second value of θ .	1
	Second value of $\theta < \text{first value of } \theta$.	1
2(d)(i)	Two values of k calculated correctly. Final values must not be written as fractions.	1
2(d)(ii)	Valid comment consistent with calculated values of k , testing against a criterion stated by the candidate.	1
2(e)	Correct calculation of M with consistent unit.	1

Question	Answer	Marks
2(f)(i)	A Two readings are not enough to draw a (valid) conclusion (not “not enough for accurate results”, “few readings”). B Difficult to measure H with a reason e.g. locating centre of modelling clay/parallax error/locating centre of the hole. C Difficult to measure H because the ruler is not long enough. D Difficult to determine if the string is horizontal or difficult to set up the string horizontally. E Difficulty measuring θ with reason e.g. parallax error/holding protractor in air/wooden strip moves when knocked by protractor. (Allow parallax error linked to H or θ only once.) F The modelling clay falls off. <i>1 mark for each point up to a maximum of 4.</i>	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 Method of locating and marking the centre. C Use a half-metre rule or a metre rule. D Use a spirit level/metre rule and set square with detail. E Clamp protractor or take a photo and measure angle or attach protractor to wooden rod. F Use glue to stick a sphere of clay to end/use a regular shape of mass (instead of the modelling clay). <i>1 mark for each point up to a maximum of 4.</i>	4