



Cambridge International AS & A Level

PHYSICS

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Paper 3 Advanced Practical Skills 2

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MARK SCHEME

Maximum Mark: 40

Published

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

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This document consists of **8** printed pages.

Question	Answer	Marks
1(a)	Value of raw x to the nearest mm and final value in range 38.0–42.0 cm.	1
1(b)	Value of θ in range 60° – 100° .	1
1(c)	<p>Six (or more) sets of readings of x and θ with correct trend and without help from the Supervisor scores 5 marks, five sets scores 4 marks etc.</p> <p>Values of x should be different and non-zero.</p> <p>Range: $x_{\min} \leq 20.0 \text{ cm}$ and $x_{\max} \geq 45.0 \text{ cm}$.</p> <p>Column headings: Each column heading must contain a quantity, a separating mark and a unit where appropriate. Heading for $\cos\theta$ must have no unit. The presentation of quantity and unit must conform to accepted scientific convention e.g. x / cm.</p> <p>Consistency: All values of raw θ must be given to the nearest degree.</p> <p>Significant figures: Values of $\cos\theta$ should be to the same number of s.f. as (or one more than) the number of s.f. in the corresponding value of θ.</p> <p>Calculation: Values of $\cos\theta$ calculated correctly.</p>	5

Question	Answer	Marks
1(d)(i)	<p>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. Scales must be labelled with the quantity that is being plotted. Scale markings should be no more than three large squares apart.</p>	1
	<p>Plotting of points: All observations must be plotted on the grid. Diameter of plotted points must be \leq half a small square. Plots must be accurate to within half a small square in both x and y directions.</p>	1
	<p>Quality: All points in the table must be plotted (at least 5) for this mark to be awarded. Trend of points should be correct. Scatter of plotted points must be no more than ± 0.05 from a straight line on the $\cos\theta$ axis.</p>	1
1(d)(ii)	<p>Line of best fit: Judged 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 line along the full length. One anomalous point is allowed only if clearly indicated (i.e. circled or labelled) by the candidate. Lines must not be kinked or thicker than half a square.</p>	1
1(d)(iii)	<p>Gradient: The hypotenuse of the triangle used must be greater than half the length of the drawn line. Method of calculation must be correct, e.g. not $\Delta x / \Delta y$. The sign of the gradient must match the graph drawn. Both read-offs must be accurate to half a small square in both the x and y directions.</p>	1
	<p>y-intercept: Correct read-off from a point on the line substituted into $y = mx + c$ or an equivalent expression. Read-off accurate to half a small square in both x and y directions. or Intercept read directly from the graph, with read-off at $x = \text{zero}$ accurate to half a small square in y direction.</p>	1

Question	Answer	Marks
1(e)	a equal to candidate's gradient and b equal to candidate's intercept. Values must not be written as fractions.	1
	Unit for a correct (e.g. cm^{-1}) and consistent with value and no unit given for b .	1

Question	Answer	Marks
2(a)(i)	Value of raw x to nearest mm and final value in range 20–24 mm with unit.	1
2(a)(ii)	Values of raw D and d to nearest mm and final value of D in the range 38–42 mm.	1
2(a)(iii)	Correct calculation of L .	1
2(a)(iv)	Justification based on significant figures in x , D and $(D - d)$.	1
2(b)(i)	Raw values of times all to 0.1 s or all to 0.01 s and value of T in range 0.5–2.5 s.	1
	Evidence of repeats: at least two values of time.	1
2(b)(ii)	Percentage uncertainty based on an absolute uncertainty in time value of 0.2–0.5 s. 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)	Second values of x and T .	1
	Quality: second $T >$ first T .	1
2(d)(i)	Two values of k calculated correctly. The final values of k must not be fractions.	1
2(d)(ii)	Valid comment relating to the calculated values of k , testing against a criterion specified by the candidate.	1
2(e)	Correct calculation of g .	1

Question	Answer	Marks
2(f)(i)	<p>A Two readings are not enough to draw a (valid) conclusion (not “not enough for accurate results”, “few readings”).</p> <p>B Difficult to measure diameters or x with reason e.g. parallax/zero not at end of ruler/x varies around roller/nuts or bolt prevent placement of ruler.</p> <p>C θ small so large uncertainty/large % uncertainty in θ.</p> <p>D Oscillations die away quickly.</p> <p>E Difficult to measure time/T because it is difficult to judge the end/beginning/completion of an oscillation.</p> <p>F Roller slips down board.</p> <p><i>1 mark for each point up to a maximum of 4.</i></p>	4
2(f)(ii)	<p>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).</p> <p>B Use metre rule/calipers/micrometer/blocks either side of washer/use pointers with detail.</p> <p>C Method to reduce uncertainty in θ e.g. use of trigonometry with detail/increase θ.</p> <p>D Method to increase the number of oscillations e.g. smoother board/named smooth material for board/sand board.</p> <p>E Method of improving timing e.g. fiducial marker at centre of oscillation or video/record/film with timer/frame-by-frame.</p> <p>F Method of reducing slipping e.g. rougher/named higher friction surface/smaller θ.</p> <p><i>1 mark for each point up to a maximum of 4.</i></p>	4