Cambridge Assessment International Education

Cambridge International AS & A Level

PHYSICS **9702/32**

Paper 3 Advanced Practical Skills 2 **May/June 2021**

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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[Turn over

Question	Answer	Marks
1(a)	Final value of s_A to at least two significant figures and in the range 1.05–1.10 mm.	**1**
	Evidence that s_A has been correctly calculated from a measurement of at least $10s_A$.	**1**
1(b)	Value of G in range 0°–45°.	**1**
1(c)	Six (or more) sets of readings of G and F (different values) with correct trend (F increases as G increases) and without help from the Supervisor scores 3 marks, five sets scores 2 marks, four or fewer sets scores 1 mark.	**3**
	Range: $G_{min} \leqslant 3°$ and $G_{max} \geqslant 17°$.	**1**
	Column headings: Each column heading must contain a quantity and a unit where appropriate. Headings for sin F and sin (F–G) must have no unit. The presentation of quantity and unit must conform to accepted scientific convention e.g. F / °.	**1**
	Consistency: All values of raw G and raw F must be given to the nearest degree.	**1**
	Significant figures: Values of sin F should be to the same number of significant figures as, or one greater than, the number of significant figures in the corresponding value(s) of raw F.	**1**
	Calculation: Values of sin (F–G) calculated correctly.	**1**

Question	Answer	Marks
1(d)(i)	Axes: Sensible scales must be used, no awkward scales (e.g. 3:10 or fractions). Scales are 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 are $\leqslant$ half a small square. Points must be plotted to an accuracy of half a small square.	**1**
	Quality: All points in the table must be plotted (at least 5) on the grid. Trend of points on graph must be correct. It must be possible to draw a straight line that is within ± 0.02 on the sin *F* 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 equal to candidate's gradient **and** value of q equal to candidate's intercept. Values must not be written as fractions.	**1**
	Values for p and q both given without a unit.	**1**
1(f)	Correct calculation of s_B using $s_B = ps_A$.	**1**

Question	Answer	Marks
2(a)(i)	Value of T_V with unit and in range 0.20–0.40 s.	**1**
	At least two measurements of nT_V where $n \geqslant 5$.	**1**
2(a)(ii)	Value for T_S larger than T_V.	**1**
2(b)	Second values of T_V and T_S.	**1**
	Second T_S > first T_S.	**1**
2(c)(i)	Two values of $T_S^2 - T_V^2$ calculated correctly.	**1**
2(c)(ii)	Justification based on significant figures in T_S and T_V.	**1**
2(c)(iii)	Valid comment consistent with the calculated values of $T_S^2 - T_V^2$, testing against a criterion stated by the candidate.	**1**
2(d)(i)	Value for x_1 in range 4.0–6.0 cm.	**1**
2(d)(ii)	Percentage uncertainty based on an absolute uncertainty in the range 2–3 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(d)(iii)	Raw value(s) for x_2 to nearest 0.1 cm.	**1**
2(d)(iv)	Correct calculation of g with consistent unit.	**1**

Question	Answer	Marks
2(e)(i)	A Two $T_S^2 - T_V^2$ values are not enough to draw a (valid) conclusion (**not** "not enough for accurate results", "few readings"). B Difficult to maintain single mode of oscillation e.g. spring swings when measuring vertical oscillations/spring bounces when measuring swinging oscillations/spring swings in more than one plane. C Spring slides along rod during the oscillation. D Difficult to judge/determine/decide when an oscillation starts/ends/is complete. E Large % uncertainty in *T*v **or** *T*v is small so large uncertainty. F Difficult to measure x_1 or x_2 with reason e.g. parallax error **or** difficult to measure x_2 due to space at end of ruler. *1 mark for each point up to a maximum of 4.*	**4**
2(e)(ii)	A Take more readings and plot a graph or take more readings and compare (**not** "repeat readings" on its own). B Method to help maintain single mode of oscillation e.g. restrict sideways motion with tube/use parallel guides. C Method to attach spring to rod/stop spring sliding on rod e.g. adhesive putty/glue spring to rod/cut notch in rod/use rod with diameter same as diameter of spring loop/rougher rod. D Video/record/film with timer in view/frame by frame **or** use fiducial marker at centre of oscillation. E Use larger masses/use spring with lower spring constant/stiffness. F Use calipers/travelling microscope/use ruler starting at zero/use blocks with detail. *1 mark for each point up to a maximum of 4.*	**4**