Cambridge Assessment International Education

Cambridge International AS & A Level

PHYSICS **9702/31**

Paper 3 Advanced Practical Skills 1 **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 L with unit and in the range 28.0–32.0 cm.	**1**
1(b)	Raw value(s) of x and b to nearest mm and with units.	**1**
1(c)	Six (or more) sets of readings of x and b (different values) with correct trend (as m decreases, x decreases and b increases) and without help from Supervisor scores 5 marks, five sets scores 4 marks, etc.	**5**
	Range: $(m_{max} - m_{min}) \geqslant 70$ g.	**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. $1/b$ / cm^{-1} or $1/b$ (1/cm).	**1**
	Significant figures: All values of 1 / b must be given to the same number of significant figures as, or one greater than, the number of significant figures in raw b.	**1**
	Calculation: Values of 1 / b are correct.	**1**
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 $\leqslant$ 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 must be correct. It must be possible to draw a straight line that is within ± 0.2 m^{-1} (± 0.002 cm^{-1}) on the 1 / b axis (normally y-axis) of all plotted points.	**1**

Question	Answer	Marks
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**
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**
	Unit for P (e.g. cm^{-2}) **and** unit for Q (e.g. cm^{-1}) correct.	**1**
1(f)	Line W shown with greater gradient.	**1**

Question	Answer	Marks
2(a)	Value of d to the nearest mm with unit.	**1**
2(b)	Correct calculation of temperature change $\Delta\theta$.	**1**
2(c)(i)	Value of h with unit.	**1**
	$D > d$.	**1**
2(c)(ii)	Percentage uncertainty based on absolute uncertainty Δh 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)(iii)	Correct calculation of C.	**1**
2(c)(iv)	Justification for significant figures in C linked to s.f. in D and d **or** linked to s.f. in $(D - d)$.	**1**
2(d)	Second values of θ_0 and θ.	**1**
	Second values of h and D.	**1**
	Temperature decreases in both experiments **and** second value of $\Delta\theta$ < first value of $\Delta\theta$.	**1**
2(e)(i)	Two values of k calculated correctly. The final k values must not be written as fractions.	**1**
2(e)(ii)	Valid comment consistent with the calculated values of k, testing against a criterion stated 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 measure *h* with reason, e.g. scale of ruler does not start at the end/opaque cup/water too hot/rule in water changes water level. C Difficult to measure *D* with reason, e.g. parallax. D Large % uncertainty (error) in $\Delta\theta$ **or** thermometer is not precise enough to measure a small change in temperature. E Difficulty with taking temperature at the <u>end</u> of the two-minute period with reason, e.g. cannot look at stop-watch and thermometer simultaneously. *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 Use a transparent cup/ruler without a space at end/measure (empty depth – depth to water surface) with detailed description e.g. use rod at right angles to a rule across top of cup to reach water surface or cup bottom. C To measure *D* or inside of cup, use calipers/dividers/vertical pointers/travelling microscope. D Improved method to measure $\Delta\theta$ e.g. more precise thermometer/thermometer reading to 0.1 °C/thinner capillary in thermometer/more sensitive thermometer **or** allow experiment to go on for more than two minutes. E Method for simultaneous measurement of temperature and time e.g. sound to mark two-minute period/temperature probe linked to data logger system/video with thermometer <u>and</u> timer in view. *1 mark for each point up to a maximum of 4.*	**4**