Cambridge Assessment International Education

Cambridge International AS & A Level

PHYSICS **9702/31**

Paper 3 Advanced Practical Skills 1 **October/November 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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Question	Answer	Marks
1(a)	Value of x with unit and in the range 21.0–23.0 cm.	**1**
1(b)	Value(s) of p to nearest mm and final value with unit and in the range 17.0–19.0 cm.	**1**
1(c)	Value of n with evidence of repeats.	**1**
1(d)	Six sets of readings of p (different values) and n with correct trend and without help from Supervisor scores 4 marks, five sets scores 3 marks etc.	**4**
	Range: $p_{min} \leqslant 15.0$ cm **and** $p_{max} \geqslant 19.0$ 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. p / cm, (1 / p) / (1 / m) or p^{-1} / mm^{-1}. There must be no unit for n or 1 / n.	**1**
	Consistency: All values of p must be given to the nearest mm.	**1**
	Significant figures: All values of 1 / p must be given to the same number of s.f. as, or one greater than, the number of s.f. of the p values as recorded in the table.	**1**
	Calculation: Values of 1 / p are correct.	**1**

Question	Answer	Marks
1(e)(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 the *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 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 must be correct. It must be possible to draw a straight line that is within $\pm$ 0.002 cm^{-1} on the $1 / p$ axis of <u>all</u> plotted points.	**1**
1(e)(ii)	Line of best fit: Judge by the 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 (i.e. circled or labelled) by the candidate. There must be at least five points left after the anomalous point is disregarded. Line must not be kinked or thicker than half a small square.	**1**
1(e)(iii)	Gradient: The hypotenuse of the triangle used must be greater than half the length of the drawn line. Both read-offs must be accurate to half a small square in both the *x* and *y* directions. Method of calculation must be correct, e.g. $\Delta y / \Delta x$. Gradient sign on answer line matches graph drawn.	**1**
	y-intercept: Correct read-off from a point on the line and 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 $1 / p = 0$, accurate to half a small square.	**1**

Question	Answer	Marks
1(f)	Value of *A* = candidate's gradient **and** value of *B* = candidate's intercept. Values must not be written as fractions.	**1**
	Unit for *A* correct e.g. cm, m or mm **and** no unit given for *B*.	**1**

Question	Answer	Marks
2(a)(i)	Final value of l with unit and in the range 3.0–3.4 cm.	1
2(a)(ii)	Value(s) of raw D all to nearest 0.01 cm or all to nearest 0.001 cm **and** final value of D with unit and less than 1.0 cm.	1
2(a)(iii)	Correct calculation of V.	1
2(a)(iv)	Justification for significant figures in V linked to number of s.f. in D and l.	1
2(b)(i)	Value of time t > 1.0 s with unit.	1
	Evidence of repeated values of t.	1
2(b)(ii)	Percentage uncertainty based on an absolute uncertainty in t in the range 0.2–5 s. 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 find percentage uncertainty.	1
2(c)	Second value of l.	1
	Second value of t.	1
	Second value of t is less than first value of t.	1
2(d)(i)	Two values of k calculated correctly. The final k values must not be written as fractions.	1
2(d)(ii)	Valid comment consistent with the 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 Difficulty in measuring time *t* with a reason (at the start or at the finish) e.g. lifting straw and starting stopwatch simultaneously/judging or predicting when to stop timing. C Difficulty linked to oil with detail e.g. difficult to see as colourless/clear/transparent or some oil left in straw drips out later/oil leaks from straw/paper straw absorbs oil. D Difficulty linked to raising or positioning the straw e.g. not always in centre/hand moves when lifted/straw tilted/putty obscures the centre. E Problem with volume *V* with reason e.g. *D* is the external diameter/no account of thickness of straw/squashing straw/putty goes up straw/oil left in straw. *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 *k* values (**not** "repeat readings" on its own). B Improved method to measure *t* e.g. video/film/ record with timer/view frame by frame. C Improved method to see oil e.g. add dye **or** improved method to contain the oil e.g. flap/cap/plastic straw. D Improved method to release or positioning of straw e.g. clamp a laser with beam above the centre point/clamp a guide at the centre/draw a cross on the paper. E Valid method to measure internal straw diameter e.g. travelling microscope or method to measure thickness directly e.g. cut open and use micrometer to measure wall thickness. *1 mark for each point up to a maximum of 4.*	**4**

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