Cambridge Assessment International Education

Cambridge International AS & A Level

PHYSICS **9702/31**

Paper 3 Advanced Practical Skills 1 **October/November 2023**

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.

Cambridge International will not enter into discussions about these mark schemes.

Cambridge International is publishing the mark schemes for the October/November 2023 series for most Cambridge IGCSE, Cambridge International A and AS Level components, and some Cambridge O Level components.

Question	Answer	Marks
1(a)	Value of final L in the range 38.0–42.0 cm with unit.	**1**
	Values of I_1 and I_2 each less than 1 A **and** each with unit.	**1**
	$I_1 > I_2$.	**1**
1(b)	Six (or more) sets of readings of L (different values), I_1 and I_2 with correct trend (as L increases, I_1 increases and I_2 decreases) and without help from the Supervisor scores 4 marks, five sets scores, 3 marks etc.	**4**
	Range: $L_{min} \leqslant 10.0$ cm **and** $L_{max} \geqslant 70.0$ 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. L / cm, I_1 / mA. $I_2 / (I_1 - I_2)$ must have no unit.	**1**
	Consistency: <u>All</u> values of L must be given to the nearest 0.1 cm.	**1**
	Significant figures: All values of $I_2 / (I_1 - I_2)$ must be given to the same number of s.f. (or one more than) the least number of s.f. in I_1, I_2 and $(I_1 - I_2)$ values.	**1**
	Calculation: Values of $I_2 / (I_1 - I_2)$ are correct.	**1**

Question	Answer	Marks
1(c)(i)	Axes: Axes must be labelled with the correct quantities. Scales must be chosen so that the plotted points occupy at least half the graph grid in both the *x* and *y* directions. Scale markings are no more than 2 cm (one large square) apart. Sensible scales must be used. Scales must not be awkward (e.g. 3:10 or fractions).	**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: Trend of points on graph must be negative. All points in the table must be plotted (at least 5). It must be possible to draw a straight line that is within $\pm$ 5 cm ($\pm$ 0.05 m) to scale on the *L* axis of <u>all</u> plotted points.	**1**
1(c)(ii)	Line of best fit: 'Best fit' is judged by the balance of all points on the grid (at least 5 points) about the candidate's line. There must be an even distribution of points either side of the line along the full length. Lines must not be kinked or thicker than half a square. Some candidates may choose to identify an anomalous point. If they identify **one** point as anomalous (e.g. by circling or labelling) then this point is to be disregarded when judging the line of best fit. There must be at least 5 points left after the anomalous point is disregarded.	**1**
1(c)(iii)	Gradient: The hypotenuse of the triangle used should 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. The method of calculation must be correct, not $\Delta x / \Delta y$. The gradient sign on the answer line must be consistent with the graph drawn.	**1**
	y-intercept: Intercept read directly from the graph where $L = 0$ and accurate to half a small square in *y* direction. **or** Correct read-off from a point on the line substituted correctly into $y = mx + c$ or an equivalent expression. Read–off accurate to half a small square in both *x* and *y* directions.	**1**

Question	Answer	Marks
1(d)	Value of P = candidate's gradient **and** value of Q = candidate's y-intercept. Values must not be written as fractions or given to only one significant figure.	**1**
1(d)	Unit for P correct e.g. cm^{-1} or m^{-1} or mm^{-1} **and** no unit for Q.	**1**

Question	Answer	Marks
2(a)(i)	Value(s) of θ to the nearest degree.	**1**
	Final value of θ in the range 10–15°.	**1**
2(a)(ii)	Correct calculation of cos θ.	**1**
2(b)(i)	Value(s) of V to the nearest cm^3.	**1**
	Evidence of repeat values of V.	**1**
2(b)(ii)	Percentage uncertainty based on an absolute uncertainty in V in range 2–5 cm^3. Correct method of calculation to find percentage uncertainty e.g. absolute uncertainty × 100 / final V value from **(b)(i)**. If repeated readings have been taken, then the uncertainty can be half the range (but not zero) if the working is shown clearly.	**1**
2(c)	Second value of θ.	**1**
	Second value of V.	**1**
	Second value of V is greater than first value of V.	**1**
2(d)(i)	Two values of k calculated correctly. The final k values must not be written as fractions or given to only one significant figure.	**1**
2(d)(ii)	Justification for significant figures in k linked to significant figures in V and θ (not cos θ).	**1**
2(e)	Calculation of percentage difference between candidate's two k values. Comparison of percentage difference with 15% leading to a consistent conclusion.	**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 Difficulty filling container with a reason e.g. overflows as filling **or** restricted access **or** small container not level **or** if put a little too much water in it overflows. C Difficulty measuring accurate value of V with a reason e.g. some water stays in large container **or** water sticks to outside of small container **or** water splashes out. D Difficulty with setup e.g. holding trolley and positioning masses at the same time. E Difficulty with alignment with reason e.g. container moves as being filled **or** container may be replaced in a different position after measuring V **or** masses hit container. F Difficult to ensure the trolley is held at same position each time. *1 mark for each point up to a maximum of 4.*	**4**
2(f)(ii)	A Take more readings (for different values of θ) and plot a graph **or** take more readings and compare k values (**not** "repeat readings" on its own). B Improved method of filling e.g. pipette/syringe/burette. C Improved method to measure V e.g. measure volume needed to top up smaller container. D Improved method for holding trolley e.g. clamp trolley/stop for trolley. E Detailed method to improve alignment e.g. marked sheet taped on floor. F Improved method of to ensure the same position of release e.g. use of gate/mark ramp/use marker. *1 mark for each point up to a maximum of 4.*	**4**