



Cambridge International AS & A Level

PHYSICS

9702/36

Paper 3 Advanced Practical Skills 2

October/November 2023

MARK SCHEME

Maximum Mark: 40

<p>Published</p>

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.

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Question	Answer	Marks
1(a)	Value for R in range 0.68–4.7 k Ω with unit.	1
	Value for V in range 2.30–3.50 V with unit.	1
1(b)	Six sets of readings of R and V with correct trend (as V increases as R increases) and without help from the Supervisor scores 5 marks, five sets scores 4 marks, etc.	5
	Range: $R_{\min} = 0.68 \text{ k}\Omega$ and $R_{\max} = 4.7 \text{ k}\Omega$.	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. $1/R(\text{k}\Omega^{-1})$.	1
	Consistency: Values of V must all be given to the nearest 0.01 V.	1
	Significant figures: Values of $1/R$ should be given to the same number of s.f. as, or one more than, the number of s.f. in the corresponding value of R .	1
	Calculation: Values of $1/R$ calculated correctly.	1

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Question	Answer	Marks
1(c)(i)	<p>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).</p>	1
	<p>Plotting of points: All observations in the table must be plotted on the grid. Diameter of plotted points must be \leq half a small square. Points must be plotted to an accuracy of half a small square in both x and y directions.</p>	1
	<p>Quality: Trend of points must be negative. All points in the table (at least 5) must be plotted. It must be possible to draw a straight line that is within ± 0.01 V on the V axis of all plotted points.</p>	1
1(c)(ii)	<p>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.</p> <p>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.</p>	1
1(c)(iii)	<p>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.</p>	1
	<p>y-intercept: Intercept read directly from the graph, with read-off at $1 / R = 0$, accurate to half a small square in y direction. or Correct read-off from a point on the line and substituted correctly into $y = mx + c$ or an equivalent expression. Read-off accurate to half a small square in both x and y directions.</p>	1

Question	Answer	Marks
1(d)	Value of a = candidate's gradient and value of b = candidate's y -intercept. The values must not be written as fractions or given to only one significant figure.	1
	Units for a (e.g. $\text{k}\Omega\text{V}$) and b (e.g. V) are correct.	1

Question	Answer	Marks
2(a)	Value for l_0 in range 30.0–50.0 cm.	1
2(b)	Value(s) for d to nearest mm.	1
	Final d in range 1.0–3.0 cm.	1
2(c)(i)	Value for h .	1
2(c)(ii)	Percentage uncertainty in h based on an absolute uncertainty in the range 0.3–0.5 cm. Correct method of calculation to obtain percentage uncertainty, e.g. (absolute uncertainty \times 100 / final value from (c)(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)(iii)	Value for l_{max} to nearest mm and greater than l_0 .	1
2(d)	Second values of d_0 and d .	1
	Second values of l_0 , h and l_{max} .	1
	Second value of h less than first value of h .	1
2(e)(i)	Two values of C calculated correctly. The final C values must not be written as fractions or given to only one significant figure.	1
2(e)(ii)	Justification for significant figures in C based on the significant figures in $(l_{\text{max}} - l_0)$, h and $(d_0 - d)$.	1
2(f)	Calculation of percentage difference between candidate's two C values. Comparison of percentage difference with 15% leading to a consistent conclusion.	1

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Question	Answer	Marks
2(g)(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 l_0 with a reason e.g. hard to get the string straight / hard not to stretch the string.</p> <p>C Difficult to measure d with a reason e.g. parallax or 100 g mass falls off or rule moves string.</p> <p>D Hard to judge if the mass just touches the pad or difficult to align mass with clip before release.</p> <p>E Parallax error when measuring h.</p> <p>F Difficult to measure l_{\max} with a reason e.g. rule unsteady or string may not be vertical.</p> <p><i>1 mark for each point up to a maximum of 4.</i></p>	4
2(g)(ii)	<p>A Take more readings <u>and</u> plot a graph or take more readings <u>and</u> compare C values (not “repeat readings” on its own).</p> <p>B Improved method to find l_0 e.g. method to fix one end (e.g. tape to the bench).</p> <p>C Use smaller 100 g mass or mirror scale behind 50 g mass.</p> <p>D Improved method for judging contact e.g. video and replay frame by frame or use pressure pad or use sand tray or place microphone near paper and display trace on CRO.</p> <p>E Clamp rule and use pointer (for h or d).</p> <p>F Measure to bottom of mass (or to paper pad) and subtract diameter of mass (for l_{\max}).</p> <p><i>1 mark for each point up to a maximum of 4.</i></p>	4