



## Cambridge International AS & A Level

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**PHYSICS**

**9702/33**

Paper 3 Advanced Practical Skills 1

**May/June 2021**

**MARK SCHEME**

Maximum Mark: 40

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<b>Published</b>
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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 **10** printed pages.

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Question	Answer	Marks
1(a)	Final value of $L$ with unit and in the range 60.0–70.0 cm.	1
1(b)	Raw values of $I$ with unit and to the nearest 0.1 mA <b>and</b> final value of $I < 1$ A.	1
1(c)	Six sets of readings of $x$ and $I$ (different values) without help from the Supervisor and showing the correct trend ( $I$ decreases as $x$ increases) scores 4 marks, five sets scores 3 marks, etc.	4
	Range: $x_{\min} \leq 10.0$ cm and $x_{\max} \geq 60.0$ 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. $1/I / \text{A}^{-1}$ or $1/I (\text{A}^{-1})$ and $x/\text{m}$ .	1
	Consistency: All values of $x$ must be given to the nearest mm.	1
	Significant figures: All values of $1/I$ must be given to the same number of significant figures as, or one greater than, the number of significant figures in raw $I$ .	1
	Calculation: Values of $1/I$ are correct.	1

Question	Answer	Marks
1(d)(i)	<p><b>Axes:</b> 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.</p>	<b>1</b>
	<p><b>Plotting of points:</b> All observations in the table must be plotted on the grid. Diameter of plotted points must be <math>\leq</math> half a small square. Points must be plotted to an accuracy of half a small square in both x and y directions.</p>	<b>1</b>
	<p><b>Quality:</b> All points in the table (at least 5) must be plotted on the grid. Trend of points on graph must be correct. It must be possible to draw a straight line that is within 2.0 cm (to scale) on the x-axis of all plotted points.</p>	<b>1</b>
1(d)(ii)	<p><b>Line of best fit:</b> 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.</p>	<b>1</b>
1(d)(iii)	<p><b>Gradient:</b> 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. <math>\Delta y / \Delta x</math>. 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.</p>	<b>1</b>
	<p><b>y-intercept:</b> Correct read-off from a point on the line and substituted into <math>y = mx + c</math>. Read-off must be accurate to half a small square in both x and y directions. <b>or</b> Intercept read directly from the graph at <math>x = 0</math>, accurate to half a small square.</p>	<b>1</b>

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Question	Answer	Marks
1(e)	Value of $P$ = candidate's gradient <b>and</b> value of $Q$ = candidate's intercept. Values must not be written as fractions.	<b>1</b>
	Unit for $P$ is correct (e.g. $A^{-1} m^{-1}$ or $mA^{-1} cm^{-1}$ ) <b>and</b> unit for $Q$ is correct (e.g. $A^{-1}$ or $mA^{-1}$ ).	<b>1</b>
1(f)	Correct calculation of $\rho_A / \rho_B$ using $PL / Q + 1$ .	<b>1</b>

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Question	Answer	Marks
2(a)	Final value for $d$ with unit and in the range 28.0–40.0 cm.	1
2(b)	Percentage uncertainty based on absolute uncertainty 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)(i)	Measurement of raw $b$ to the nearest mm. Final value with unit and in the range 9.0–11.0 cm.	1
2(c)(ii)	Correct calculation of $\alpha$ .	1
2(c)(iii)	Justification for the number of significant figures in $\alpha$ linked to s.f. in $b$ and $d$ .	1
2(d)	Final value for $T$ with unit and in the range 1.50–2.50 s.	1
	At least two measurements of $nT$ where $n \geq 5$ .	1
2(e)	Second values of $b$ and $T$ .	1
	Second value of $T < \text{first value of } T$ .	1
2(f)(i)	Two values of $C$ calculated correctly. The final values must not be written as fractions.	1
2(f)(ii)	Valid comment consistent with calculated values of $C$ , testing against a criterion <u>stated</u> by the candidate.	1
2(g)	Value of $k$ correctly calculated from the <u>second</u> value of $C$ and with consistent unit, i.e. $\text{N m}^{-1}$ or $\text{kg s}^{-2}$ .	1

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Question	Answer	Marks
2(h)(i)	<p>A Two readings are not enough to draw a (valid) conclusion (<b>not</b> “not enough for accurate results”, “few readings”).</p> <p>B <u>Masses</u> falling off/<u>masses</u> stick to a small surface area/not enough adhesive putty for the <u>masses</u>/adhesive putty not strong enough to hold <u>masses</u>.</p> <p>C Difficult to judge when the wooden strip is horizontal/difficult to set wooden strip horizontal <b>or</b> difficult to judge or set the spring or string vertical.</p> <p>D Difficulty measuring <u>d</u> with a reason, e.g. finding/determining the centre of the mass/hole <b>or</b> difficulty measuring <u>b</u> with a reason, e.g. finding/determining the centre of the nail/holding the ruler parallel to the strip/set-up wobbly/holding ruler in mid-air.</p> <p>E Difficult to <u>judge/determine/decide</u> when an oscillation starts/finishes/is complete.</p> <p>F Different modes of oscillation/string moves during oscillation <b>or</b> strip bends/twists/flexes (during oscillation).</p> <p><i>1 mark for each point up to a maximum of 4.</i></p>	<b>4</b>

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Question	Answer	Marks
2(h)(ii)	<p>A Take more readings <u>and</u> plot a graph or take more readings <u>and</u> compare <math>C</math> values (<b>not</b> “repeat readings” on its own).</p> <p>B Wider strip/named method for improving the adhesion of the <u>masses</u>, e.g. glue/tape with reference to masses.</p> <p>C Method of ensuring strip is horizontal, e.g. use a spirit level <b>or</b> method to ensure spring/string is vertical, e.g. use a plumb-line.</p> <p>D Improved method to measure <math>b</math> or <math>d</math>, e.g. add a scale to the strip/mark on the strip/clamp ruler.</p> <p>E Fiducial marker at the <u>centre</u> of the oscillation <b>or</b> video/record/film with timer in view/play back frame by frame.</p> <p>F Use a thicker/stiffer/laminated strip <b>or</b> sand to make rougher/add notch to wooden strip or rod/stick sandpaper to wooden strip or rod.</p> <p><i>1 mark for each point up to a maximum of 4.</i></p>	<b>4</b>