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**Cambridge International Advanced Subsidiary and Advanced Level**

# MARK SCHEME for the October/November 2015 series

## 9702 PHYSICS

**9702/35** Paper 3 (Advanced Practical Skills 1), maximum raw mark 40

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**1 (b) (i)** Value of $a$ with consistent unit and in the range 0 to 50.0 cm. [1]

**(v)** Value of $V$ with unit to nearest 0.001 V and in range 0 to 2 V. [1]

**(c)** Six sets of readings of $a$, $b$ and $V$ scores 5 marks, five sets scores 4 marks etc. [5]
Incorrect trend –1. Minor help from Supervisor –1. Major help from Supervisor –2.

Range: [1]
$a_{max} - a_{min} \geqslant 30.0$ cm.

Column headings: [1]
Each column heading must contain a quantity and a unit. The presentation of quantity and unit must conform to accepted scientific convention. e.g. $a$ / m or $a$ (m), $1/V$ / $V^{-1}$.

Consistency: [1]
All values of $a$ and $b$ must be given to the nearest mm.

Significant figures: [1]
Every value of $1/V$ must be given to the same number of significant figures as (or one more than) the number of significant figures in the corresponding value of $V$.

Calculation: [1]
Values of $1/V$ calculated correctly to the number of significant figures given by the candidate.

**(d) (i)** Axes: [1]
Sensible scales must be used. Awkward scales (e.g. 3:10) are not allowed.
Scales must be chosen so that the plotted points occupy at least half the graph grid in both $x$ and $y$ directions.
Scales must be labelled with the quantity that is being plotted.
Scale markings should be no more than three large squares apart.

Plotting: [1]
All observations in the table must be plotted on the grid.
Diameter of plotted points must be $\leqslant$ half a small square (no "blobs").
Points must be plotted to an accuracy of half a small square.

Quality: [1]
All points in the table must be plotted (at least 5) for this mark to be awarded.
Scatter of points must be no more than $\pm$ 0.050 m (5.0 cm) to scale in the $b$ direction from a straight line.

**(ii)** Line of best fit: [1]
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 (i.e. circled or labelled) by the candidate.
Lines must not be kinked or thicker than half a square.

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**(iii)** Gradient: [1]
The hypotenuse of the triangle must be greater than half the length of the drawn line. Do not allow $\Delta x / \Delta y$. Sign of gradient must match graph drawn. Both read-offs must be accurate to half a small square in both the $x$ and $y$ directions.

$y$-intercept: [1]
Either:
Correct read-off from a point on the line substituted into $y = mx + c$ or an equivalent expression.
Read-offs must be accurate to half a small square in both $x$ and $y$ directions.
Or:
Intercept read directly from the graph, with read-off accurate to half a small square.

**(e)** Value of $P$ = candidate's gradient and value of $Q$ = candidate's intercept. [1]

Unit for $P$ is correct (e.g. $m^{-1}V^{-1}$) and unit for $Q$ is correct (e.g. $V^{-1}$). [1]

**2 (b) (iv)** All values of $x$ with unit to nearest mm. Average $x \leqslant 20.0$ cm. [1]

**(c) (i)** Value of $\theta$ to the nearest degree in the range 25° to 35°. [1]

**(ii)** Absolute uncertainty in $\theta$ in range 2° to 5° and correct method of calculation to obtain percentage uncertainty. If repeated readings have been taken, then the absolute uncertainty can be half the range (but not zero) if working is clearly shown. [1]

**(iii)** Correct calculation of $\cos^2(\theta/2)$. No unit. [1]

**(iv)** Justification for significant figures in $\cos^2(\theta/2)$ linked to significant figures in $\theta$. [1]

**(d) (ii)** $T$ in range 0.5 s to 2.5 s, with unit. [1]

Evidence of repeat readings of $T$. [1]

**(f)** Second value of $\theta$. [1]

Second values of $T_1$ and $T_2$. [1]

Second value of $T_1 / T_2$ < first value of $T_1 / T_2$ when rounded to 2 s.f. [1]

**(g) (i)** Two values of $k$ calculated correctly. [1]

**(ii)** Valid comment consistent with the calculated values of $k$, testing against a criterion specified by the candidate. [1]

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| (h) | (i) Limitations (4 max.) | (ii) Improvements (4 max.) | Do not credit |
|---|---|---|---|
| A | Not enough readings to draw a conclusion | Take more readings and plot a graph/<br>obtain more *k* values and compare | Few readings/<br>only one reading/<br>not enough readings for an accurate result/<br>"repeat readings" on its own/<br>take more readings and (calculate) average *k* |
| B | Difficult to measure $\theta$ or read protractor with reason e.g. rod is above protractor/rod obscures view | Improved method of measuring $\theta$ e.g. shadow projection with light above/thinner rod/rod with smaller diameter/plumb-lines hung from rod/larger protractor/360° protractor | Just "difficult to measure $\theta$"/<br>smaller rod/<br>"protractor reads to 1°" |
| C | Oscillations or *T* affected by...<br>e.g. air movement<br>force on release<br>different forces<br>angle of release<br>unwanted modes of oscillation | Improved method of release e.g. card gate<br>**or**<br>switch off air conditioning/close windows/closed room | Release by electromagnet/<br>cutting string/<br>damping/<br>air resistance/<br>friction |
| D | Large percentage uncertainty in time/period *T* is short | Valid method to improve timing e.g. use video with timer/frame by frame/motion sensor and position at side of cradle<br>**or**<br>Increase T by... e.g. heavier nail/longer nail/string | Oscillations too fast/<br>high/low speed camera/<br>video on its own/<br>human reaction time/<br>just "difficult to determine time"/<br>fiducial marker |
| E | Valid problem linked to magnetism e.g. nail weakly magnetised/metal stand attracts nail/interference by Earth's magnetic field. | Valid method to overcome problem linked with magnetism e.g. stroke nail more times/use of coil | Nail loses magnetism |
| F | | Method of fixing paper/protractor/magnets e.g. tape/Blu-tack/draw protractor on paper | Just "stick paper" without method |

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