**CAMBRIDGE INTERNATIONAL EXAMINATIONS**

**GCE Advanced Level**

# MARK SCHEME for the May/June 2014 series

## 9702 PHYSICS

**9702/32** Paper 3 (Advanced Practical Skills 2), maximum raw mark 40

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 will not enter into discussions about these mark schemes.

Cambridge is publishing the mark schemes for the May/June 2014 series for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level components and some Ordinary Level components.

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**1 (a) (i)** Value of $l_0$ in range 4.0 cm $\leqslant l_0 \leqslant$ 8.0 cm. [1]

**(b) (iii)** Value of $h$ to nearest mm, in the range 40.0 cm $\leqslant h \leqslant$ 50.0 cm. [1]

**(c)** Six sets of values for $h$ and $l$ scores 5 marks, five sets scores 4 marks, etc. [5]
Incorrect trend –1. Help from Supervisor –1.

Range: [1]
$h$ values must include 20 cm or less.

Column headings: [1]
Each column heading must contain a quantity and an appropriate unit.
The presentation of quantity and unit must conform to accepted scientific convention, e.g. $1/h^2/\text{cm}^{-2}$ or $1/h^2$ $(1/\text{cm}^2)$ but not $1/h^2(\text{cm}^2)$.

Consistency: [1]
All values of $h$ and $l$ must be given to the nearest mm only.

Significant figures: [1]
Every value of $1/h^2$ must be given to the same s.f. as (or one greater than) the s.f. in the corresponding $h$.

Calculation: [1]
Values of $(l-l_0)^2$ calculated correctly.

**(d) (i)** Axes: [1]
Sensible scales must be used, no awkward scales (e.g. 3:10).
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 must be no more than 3 large squares apart.

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

Quality: [1]
All points must be plotted (at least 5) for this mark to be scored. Scatter of points must be within ±10 $\text{cm}^2$ of $(l-l_0)^2$ from a straight line.

**(ii)** Line of best fit: [1]
Judge by balance of all points 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 plot only if clearly indicated (i.e. circled or labelled) by the candidate.
Line must not be kinked or thicker than half a small square.

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**(iii)** Gradient: [1]
The hypotenuse must be at least half the length of the drawn line.
Both read-offs must be accurate to half a small square in both $x$ and $y$ directions.
The method of calculation must be correct.

$y$-intercept: [1]
Either:
Read-off from a point on the line is substituted into $y = mx + c$. Read-off must be accurate to half a small square in both $x$ and $y$ directions.
Or:
Check read-off of the intercept directly from the graph.

**(e)** $p$ = value of the gradient, and $q$ = value of the intercept. [1]
Dimensionally correct units for $p$ and $q$. [1]

**[Total: 20]**

**2 (a) (i)** Value for $d$ to nearest mm, in range $1.0\,\text{cm} \leqslant d \leqslant 2.0\,\text{cm}$. [1]

**(ii)** Correct calculation of $l$. [1]

**(b) (ii)** Value for $t$ in range $4.0\,\text{s} \leqslant t \leqslant 10.0\,\text{s}$, with unit. [1]
Evidence of repeat readings of $t$. [1]

**(c) (iii)** Value for $A$ to nearest mm, with unit. [1]

**(d)** Absolute uncertainty in $A$ in range 2 to 5 mm. [1]
If repeated readings have been taken, then absolute uncertainty could be half the range (but not zero) only if working shown.
Correct method of calculation to obtain percentage uncertainty.

**(e)** Second value of $t$. [1]
Second value of $A$. [1]

**(f) (i)** Two values of $k$ calculated correctly. [1]
$kl$ in range $0.20$ to $0.30\,\text{cm}\,\text{s}^{-2}$. [1]

**(ii)** Justification based on the number of s.f. in $d$, $n$, $t$ and $A$ (not just "raw readings"). [1]

**(iii)** Valid comment relating to the calculated values of $k$, testing against a criterion specified by the candidate. [1]

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| (g) | (i) Limitations (4 max) | (ii) Improvements (4 max) | Do not credit |
|---|---|---|---|
| A | Two readings are not enough to draw a valid conclusion | Take more readings (for different masses) and plot a graph, or take more readings and compare *k* values | Not enough repeat readings<br>Few readings<br>Idea of repeats<br>"Too few readings/two readings" on its own |
| B | Difficult to measure *d,* with reason, e.g. parallax error/ measuring outside diameter/loop gets in the way | Use vernier calipers/micrometer<br>Measure inside and outside diameter and find average | "Parallax error" on its own<br>"Calipers" on its own |
| C | Difficult to judge exactly when 10 oscillations completed | Video + timer/video and view frame-by-frame.<br>Use distance sensor in stated and correct position<br>Use a (fiducial) marker at centre of oscillation/equilibrium position<br>Light gate at equilibrium position/centre of oscillation | Human/reaction time error<br><br>High speed cameras/slow motion cameras<br><br>Oscillations too fast |
| D | Mass swings as it oscillates/non-uniform oscillation/spring moves along bolt | Use tube to act as a guide<br>Use deeper groove on bolt<br>Fix top of spring to bolt with, e.g. Blu-tack/Sellotape | |
| E | Difficult to judge when contact is lost/hard to see gap | Use pressure sensor on bolt<br>Use video close-up/zoom lens/ magnifying glass<br>Video + slow-motion, linked to observing gap<br>Better/more sensitive method of adjusting height of bolt, e.g. lab jack | "Video + slow motion" on its own |
| F | *n* is not a whole number | Measure *n* to nearest ¼ turn | |

Do not credit use of an assistant, fans, air conditioning, or use of computers/data loggers on its own.

**[Total: 20]**

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