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**Cambridge International Advanced Subsidiary and Advanced Level**

# MARK SCHEME for the May/June 2015 series

## 9702 PHYSICS

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

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**1 (c) (ii)** Value of $h$ in the range 45.0 to 55.0 cm. [1]

**(iii)** Value of $x$ less than 50.0 cm. [1]

**(d)** Six sets of readings of $x$ and $h$ scores 5 marks, five sets scores 4 marks etc. [5]
Incorrect trend –1. Help from Supervisor –1.

Range: [1]
$x_{max} - x_{min} \geq 60.0$ cm.

Column headings: [1]
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. $1/h/\text{cm}^{-1}$. $x/h$ must have no unit.

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

Significant figures: [1]
Every value of $x/h$ must be given to the same number of s.f. (or one more than) the least number of s.f. in the corresponding values of $x$ and $h$ as recorded in table.

Calculation: [1]
Values of $x/h$ calculated correctly.

**(e) (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 must be plotted on the grid. Diameter of plotted points must be ≤ half a small square (no "blobs").
Plotted points must be accurate to within half a small square in both $x$ and $y$ directions.

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 $\pm$ 0.1 from a straight line in the $x/h$ direction.

**(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.
The method of calculation must be correct.
Both read-offs must be accurate to half a small square in both the *x* and *y* directions.

*y*-intercept: [1]
Either:
Correct read-offs from a point on the line and substituted into $y = mx + c$ or an equivalent expression.
Both read-offs accurate to half a small square in both the *x* and *y* directions.
Or:
Intercept read directly from the graph, with read-off at $x = 0$ accurate to half a small square in *y* direction.

**(f)** Value of *a* = candidate's gradient and value of *b* = candidate's intercept. [1]

Units for *a* and *b* both correct and consistent with values. [1]

**2 (a) (ii)** All values of *D* to nearest 0.1 cm and in range 2.0 cm to 4.0 cm. [1]

Evidence of repeat readings of *D*. [1]

**(iii)** Absolute uncertainty in *D* in range 0.2 to 0.5 cm 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 the working is clearly shown. [1]

**(iv)** Correct calculation of *C* with consistent unit. [1]

**(b)** Justification for significant figures in *C* linked to significant figures in *D* only. [1]

**(d) (ii)** $r_1$ in range 5.0 cm to 25.0 cm, with unit, to nearest mm. [1]

**(v)** $r_2$ in range 5.0 cm to 25.0 cm. [1]

**(e)** Second value of *D*. [1]

Second values of $r_1$ and $r_2$. [1]

Second value of $|r_1 - r_2|$ > first value of $|r_1 - r_2|$. [1]

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

**(ii)** Sensible 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 and plot a graph/<br>obtain more *k* values and compare | "repeat readings"/<br>"few readings"/<br>only one reading/<br>take more readings and (calculate) average *k* |
| B | Difficult to measure *D* (or there is uncertainty in *D* or *C*) because loop is not circular/not flat/deforms | Workable method of making a more circular loop, e.g. wrap loop around tube | Use micrometer<br>Use vernier calipers<br>Material weak<br>Material flexible |
| C | Parallax error with pointer/<br>pointer moves away from scale/<br>pointer (or spring) vibrates | Use shadow method | |
| D | Ruler not vertical | Use set square to ensure ruler vertical/clamp ruler | |
| E | Difficult to judge reading when loop breaks away/<br>loop breaks away suddenly | Video with scale/<br>use maximum marker | Slow motion camera<br>High speed camera<br><br>Difficult to determine point (or moment) loop breaks away |
| F | Difficult to lower beaker steadily | Use adjustable-height stand | |
| G | Reading affected by contact between loop and beaker/<br>impurities in water | Use larger diameter container/ wider container<br>Use distilled water | Larger beaker |

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