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Cambridge International Advanced Subsidiary and Advanced Level

MARK SCHEME for the October/November 2015 series

9702 PHYSICS

9702/31 Paper 3 (Advanced Practical Skills 1), maximum raw mark 40

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1 (a) (iv) Value of d in range 19.5 cm to 20.5 cm with unit. [1]

(c) (ii) Value of N with evidence of repeat readings. [1]

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

Range: [1]
Smallest value of $d < 9.5$ 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. d^{-1} / m^{-1}.

Consistency: [1]
All values of d must be given to the nearest mm.

Significant figures: [1]
Every value of $1/d$ 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 d.

Calculation: [1]
$\sqrt{N}$ calculated correctly to the number of significant figures given by the candidate.

(f) (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 ± 0.5 in the $\sqrt{N}$ 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-offs 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.

(g) Value of *A* = candidate's gradient and value of *B* = candidate's intercept. [1]

Unit for *A* correct (e.g. m or cm or mm) and consistent with value.
No unit given for *B*. [1]

2 (a) (ii) Value for *x* to the nearest mm. [1]

x in the range 0.155 m to 0.165 m. [1]

(b) (i) Correct calculation of *C* in m (correct to 2 s.f.). [1]

(ii) Justification for significant figures in *C* linked to significant figures in *x* and *h*. [1]

(c) (ii) Value for *R* with unit. [1]

Evidence of repeat readings. [1]

(iii) Absolute uncertainty in *R* in range 5 mm to 20 mm and correct method of calculation to obtain percentage uncertainty. If repeated readings have been taken, then the uncertainty can be half the range (but not zero) if the working is clearly shown. [1]

(d) Second value of *x*. [1]

Second value of *R*. [1]

Second value of *R* < first value of *R*. [1]

(e) (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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(f)	**(i)** Limitations (4 max.)	**(ii)** Improvements (4 max.)	Do not credit
A	Not enough readings to draw a conclusion	Take many readings for different holes and plot a graph/ obtain more *k* values and compare	Few readings/ only one reading/ not enough readings for an accurate result/ "repeat readings" on its own/ take more readings and (calculate) average *k*
B	Ball rolls off block/ball does not move along straight line from the wood/rod does not hit marble square on each time/rod hits marble at an angle	Small groove in the wood to place the marble	
C	Difficult to measure distance rod is pulled back/difficult to hold rod still before release	Use another stand or stop	
D	Difficult to measure *R* with reason e.g. marble skids in sand leaving elongated hole/can't fit ruler in sand tray/parallax error	Improved method for measuring *R* e.g. video with scale/use carbon paper/ink on marble/put scale on the sand	
E	Difficult to flatten sand/know when sand is horizontal	Use a straight edge/ use a spirit level	
F	Difficult to measure *x* with reason e.g. wooden rod moves	Method of measuring *x*/ clamp rule close by/ draw scale on rod	

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