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Cambridge International Advanced Subsidiary and Advanced Level

MARK SCHEME for the October/November 2014 series

9702 PHYSICS

9702/33 Paper 3 (Advanced Practical Skills 1), maximum raw mark 40

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1 (c) Value of T in range 1.0 s – 2.0 s with unit. [1]
Evidence of repeated timings. [1]

(d) Six sets of readings of L and time (different values) scores 5 marks, five sets scores 4 marks etc. [5]
Help from Supervisor –1.

Range: [1]
$L_{max} - L_{min} \geq 30.0$ cm.

Column headings: [1]
Each column heading must contain a quantity and a unit.
The unit must conform to accepted scientific convention e.g. T^2L / s^2 m, L^2 / m^2.
Accept separating mark as a solidus, brackets or 'in' but not commas.

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

Significant figures: [1]
All values of L^2 must be given to the same s.f. as (or one more than) the s.f. in L.

Calculation: [1]
Values of T^2L 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 must be no more than three large squares apart.

Plotting: [1]
All observations in the table must be plotted on the graph grid.
Diameter of plotted points must be ≤ half a small square (no "blobs").
Plotted points must be accurate to within half a small square.

Quality: [1]
All points in the table must be plotted on the grid for this mark to be awarded.
Judge by scatter of all points about a straight line.
All points must be within ± 0.025 m^2 (250 cm^2) in the L^2 direction from a straight line.

(ii) Line of best fit: [1]
Judge by balance of all points on the grid (at least 5) about the candidate's line.
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 candidate (i.e. circled or labelled).
Lines must not be kinked or thicker than half a small square.

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(iii) Gradient: [1]
Sign of gradient must match the graph.
The hypotenuse of the triangle must be greater than 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:
Correct read-offs from a point on the line and substituted into $y = mx + c$.
Read-offs must be accurate to half a small square in both x and y directions.
Or:
Correct read-off of the intercept directly from the graph.

(f) Value of A = candidate's gradient. Value of B = candidate's intercept. [1]
Allow correct rounding unless to 1 s.f.

Unit for A ($s^2\,m^{-1}$ or $s^2\,cm^{-1}$ or $s^2\,mm^{-1}$) and B ($s^2\,m$ or $s^2\,cm$ or $s^2\,mm$). [1]

[Total: 20]

2 (a) (ii) Value of h_2 with unit, in the range $20.0\,cm \leq h_2 \leq 35.0\,cm$. [1]
Evidence of repeat readings. [1]

(b) (ii) Value of $\theta = 10°$, $11°$ or $12°$ with unit. [1]

(iii) Correct calculation of $\cos^2(2\theta)$. [1]

(iv) Correct justification of s.f. in $\cos^2(2\theta)$ linked to s.f. in value of θ. [1]

(c) (iii) Value of h with consistent unit. [1]

(iv) Absolute uncertainty in h in range 5 mm – 20 mm.
If repeated readings have been taken, then the uncertainty can be half the range (but not zero) if the working is clearly shown.
Correct method of calculation to get percentage uncertainty. [1]

(d) (i) Second value of θ. [1]

(ii) Second value of h. [1]
Second value of $h <$ first value of h. [1]

(e) (i) Correct calculation of two values of k. [1]

(ii) Valid comment consistent with the calculated values of k, testing against a stated criterion. [1]

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(f)	(i) Limitations (4 max.)	(ii) Improvements (4 max.)	Do not credit
A	Two readings not enough to draw a conclusion	Take many readings (for different angles) and plot a graph. Take more readings and compare values of *k*	repeat readings / few readings / "too few readings" / "two readings" / "not enough readings"
B	Large uncertainty in θ	Make θ larger / use trigonometry with detail	Parallax error in angle measurement Use larger protractor More accurate protractor "Angle too small" Zero line not on edge
C	Difficult to release the ball without applying a force / difficult to drop at 40 cm with reason e.g. hands shaking.	Clamp ball prior to release / use a card gate or stop gate / use marker at 40 cm / valid method of release	Electromagnet Robotic arm
D	Difficult to measure / judge position of *h* with timing reason e.g. ball stops at maximum height for a short time	Use a video with a scale / trial and improvement with marker	Use camera Ignore high speed/slow motion camera
E	Difficult to measure / judge position of *h* with positioning reason e.g. because of parallax error / ruler not vertical / no lower horizontal reference line.	Use a set square on bench / plumb-line / (graduated) grid behind / clamp a ruler horizontally / use a second rule with detail of position.	Judging centre of ball / marking line on ball / vertical lines / lines
F	Rebound height is variable / ball veers off course / ball moves sideways.	Detailed method to ensure ball does not veer off course.	Ball falls off the board.

[Total: 20]

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