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PHYSICS **9702/31**

Paper 3 Advanced Practical Skills 1 **May/June 2016**

MARK SCHEME

Maximum Mark: 40

Published

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1 (a) (ii) Value of x with consistent unit and in the range 36.0 cm to 39.0 cm. [1]

(c) Value of T with unit in range 0.300 s < T < 1.00 s. [1]

(d) Five sets of readings of x and time with correct trend scores 5 marks, four sets scores 4 marks etc. [5]
Help from Supervisor –1.

Range: [1]
$x_{max} - x_{min} \geq 30$ cm.

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. x / m or x (cm), T^2 / s^2 or T^2 (s^2).

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

Significant figures: [1]
Every value of T^2 must be given to the same number of s.f. as (or one more than) the number of s.f. in the corresponding raw values of time.

Calculation: [1]
T^2 calculated correctly to the number of s.f. given by the candidate.

(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 of points: [1]
All observations in the table must be plotted.
Diameter of plotted points must be ≤ 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 on the grid (at least 5) for this mark to be awarded.
All points must be no more than ±5 cm (to scale) in the x direction from a straight line.

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(ii) Line of best fit: [1]
Judge by balance of all points on the grid about the candidate's line (at least 4 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 by the candidate.
Lines must not be kinked or thicker than half a square.

(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. 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 (accurate to half a small square).

(f) Value of *P* = candidate's gradient and value of *Q* = candidate's intercept. [1]
Do not allow fractions.

Unit for *P* correct (e.g. $s^2 m^{-1}$) and unit for *Q* correct (e.g. s^2). [1]

2 (a) All values of *w* to nearest mm, with final value in range 0.200 m to 0.300 m. [1]

(b) (ii) Value(s) of θ to the nearest degree. Final value < 45° with unit. [1]

(iii) Percentage uncertainty in θ based on an absolute uncertainty in range 1° to 3°.
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 obtain percentage uncertainty. [1]

(c) (iii) Value of *y* in range 0.20 m to 0.50 m. [1]

Evidence of repeat readings. [1]

(d) (i) Correct calculation of *D*. [1]

(ii) Correct justification for s.f. in *D* linked to s.f. in *w* and *y*. [1]

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(e) (ii) Second value of θ. [1]

Second value of y. [1]

Quality: Second value of y > first value of y (if $\theta_2 > \theta_1$). [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]

(g)	**(i)** Limitations [4]	**(ii)** Improvements [4]	Do not credit
A	Two readings not enough to draw a conclusion	Take more readings <u>and</u> plot a graph/ obtain more *k* values and <u>compare</u>	Few readings/ only one reading/ not accurate result/ "repeat readings" on its own
B	Difficulty with starting position e.g. starting position of container not parallel to edge	Improved method for initial placement or release e.g. use of block with detail (aligned with side)	Change shape of container
C	Small range of angles possible/cylinder slips when angle too high/cylinder moves off wrong edge on board	Workable method to increase friction e.g. sheet of paper on board/ sanding board/ use a rougher board/ roughen edge of container	"No friction" on its own/ smoother board/ use longer board
D	Difficult to measure *y* or locate position where container moves off edge with reason e.g. moves off edge too fast/short time to observe moving off edge	Improved method for measuring *y* e.g. use marker or scale on board/use video and playback <u>with scale</u>/ paint on lid/ calibrate board	Effects of moving air/fans/ "frame by frame"
E	Difficulty with set up e.g. board moves/clamp moves/board not an even height across width/board not aligned correctly	Method to improve stability of board e.g. use two clamps/ Blu-Tack to fix board to bench/ spirit level across board/ support board on long blocks	G-clamp to bench
F	Difficult to release without applying force	Improved method of release e.g. card gate/block with detail of removal	Electromagnetic release

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