Cambridge International AS & A Level

Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

PHYSICS **9702/32**

Paper 3 Advanced Practical Skills 2 **May/June 2016**

MARK SCHEME

Maximum Mark: 40

Published

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1 (b) (i) Value for θ in range 20° to 30° to nearest degree, with unit. [1]

(iv) Value for T in range 0.50 s to 1.50 s. [1]

Evidence of repeat readings. At least two measurements of nT, with $n \geq 3$. [1]

(d) Six sets of values for θ and T with correct trend scores 4 marks, five sets scores 3 marks etc. No θ values over 90°. [4]
Help from Supervisor –1.

Range: [1]
θ values must include 30° or less and 70° or more.

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. θ/°, θ(°) or θ(deg) etc. $1/\sqrt{\tan\theta}$ must have no unit.

Consistency: [1]
All raw values of time must be given to the nearest 0.1 s, or all to the nearest 0.01 s.

Significant figures: [1]
Every value of $1/\sqrt{\tan\theta}$ must be given to 2 or 3 s.f.

Calculation: [1]
Values of $1/\sqrt{\tan\theta}$ 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 must be no more than three large squares apart.

Plotting of points: [1]
All observations must be plotted.
Diameter of plotted points must be ≤ half a small square (no "blobs").
Plotted points must be accurate to half a small square.

Quality: [1]
All points in the table (at least 5) must be plotted for this mark to be awarded.
All points must be no more than ±0.02 s (in the y (T) direction) of 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 plot only if clearly indicated by the candidate.
Line must not be kinked or thicker than half a small square.

(iii) Gradient: [1]
Sign of gradient must match graph drawn.
The hypotenuse of the triangle used 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 x and y directions.

y-intercept: [1]
Either:
Correct read-off 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:
Intercept read off 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.

Correct units for p and q (both should have the unit s). [1]

2 **(a)** **(i)** h to nearest mm and in range 2.5 cm to 3.5 cm. [1]

(ii) Raw values for d to nearest mm. [1]

(b) Absolute uncertainty in d in range 2 mm to 5 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 obtain percentage uncertainty. [1]

(c) **(i)** Value for t in range 20.0 s to 90.0 s, with unit. [1]

Evidence of repeat measurements of t. [1]

(ii) Correct calculation of R to the s.f. used by the candidate (must be 2 or more s.f.). [1]

(d) **(ii)** Value for x_1 to nearest mm, with unit. [1]

(e) Second values of h and d and t. [1]

Second values of x_1 and x_2. [1]

Quality: $(x_2 – x_1)$ greater for shorter t. [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 are not enough to draw a conclusion	Take more readings and plot graph/ obtain more *k* values and compare	"Repeat readings" on its own/few readings/only one reading/take more readings and find average *k*
B	Parallax error when measuring *d*	Measure on bench between two set squares/ use (vernier) calipers/ use string to find circumference then calculate *d*	
C	Bottle distorts when measuring *d*/ *d* varies along bottle/ base of bottle not flat	Collect water lost between marks and measure volume	
D	Difficult to judge/see/operate stopwatch when water level reaches mark	Use video with timer in view/ use frame counting/ use coloured water	Reaction time Light gates
E	Wooden strip moves continuously when water is falling on it	Use video with scale in view	
F	Difficult to measure height because rule not vertical/rule touches strip	Use set square on bench/ clamp rule	Only short time to measure *x*
G	Water soaks into wooden strip/ water stays on wooden strip	Use waterproof strip	Use new strip/ dry the strip
H	*R* not constant between lines	Move lines closer to top/ have lines closer together	