UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the October/November 2010 question paper for the guidance of teachers

9702 PHYSICS

9702/36 Paper 32 (Advanced Practical Skills 2), maximum raw mark 40

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

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1 **(c)** Measurements for all raw l in range 19.5 to 20.5 cm. [1]

(e) **(i)** Measurements for all raw h_1 and h_2 to nearest mm. [1]

(iii) Measurement for raw d to nearest mm, with unit, in range 1.5 to 2.5 cm. [1]

(f) **Five** sets of readings of h_1, h_2 and d scores 4 marks, four sets scores 3 marks etc. [4]
Incorrect trend then –1.
Help from supervisor then –1.

Range – [1]
d values used must include $d_{min} \leq 3$ cm and $d_{max} \geq 8$ cm

Column headings – [1]
Each column heading must contain a quantity and a unit where appropriate.
There must be some distinguishing mark between the quantity and the unit.
e.g. θ /°, 1/tan θ, sin θ, sin (θ /°) not sin θ /°, not (1/tan θ)/°

Consistency of presentation of raw readings – [1]
All h values in the table must be given to the same precision.

Significant figures – [1]
S.f. for 1/tan θ must be the same as, or one more than, the minimum s.f. given for ($h_1 - h_2$) and l.

Calculation – [1]
1/tan θ calculated correctly.

(Graph) Axes – [1]
Sensible scales must be used, no awkward scales (e.g. 3:10).
Scales must be chosen so that the plotted points must occupy at least half the graph grid in both x and y directions.
Scales must be correctly labelled with the quantity that is being plotted. Ignore units.
Scale markings must be no more than three large squares apart.

Plots – [1]
All observations must be plotted.
Ring and check a suspect plot. Tick if correct.
Re-plot if incorrect. Work to an accuracy of half a small square.
Diameter of plots must be ≤ half a small square (no blobs).

Line of best fit – [1]
Judge by balance of all plots, at least 4 trend points, about the candidate's line.
There must be an even distribution of points either side of the line along the full length.
Line must not be kinked.

Quality – [1]
Scatter of points must be less than ± 0.25 cm in the d direction about the examiner's line.
All points in table must be plotted (at least 4) for this mark to be scored.

(g) (iii) Gradient [1]
The hypotenuse of the triangle must be at least half the length of the drawn line.
Both read-offs must be accurate to half a small square.

Intercept [1]
Check that the read-off from graph or the method of calculation (substitution of correct read offs into $y = mx + c$) is correct.

(h) Value of *a* = gradient and value of *b* = intercept. [1]
Unit for *a* (m^{-1} cm^{-1} or mm^{-1}) consistent with value and *b* (no unit). [1]

[Total: 20]

2 (b) (i) Raw length and width to nearest mm with unit. Help from supervisor –1 [1]
Values of length and width in range 1 cm to 10 cm. [1]
Correct calculation of *A*, with consistent unit. [1]

(ii) S.f. in *A* same as/one more than the (smallest) s.f. in length <u>and</u> width (not just "raw readings"). [1]

(d) (i) Measurement of *F*, with unit, *F* < 10 N. [1]
Evidence of repeated measurements of *F*. [1]

(ii) Uncertainty in measurements of *F* stated, in range 0.1 to 0.5 N. [1]

(e) Values of second length and second width. [1]
Correct calculation of *A*. [1]
Measurement of *F.* [1]
Second *F* = first *F* (within 1 N). [1]

(f) Justification of a valid conclusion based on two values of *F* being within (or outside) the uncertainty in **(d)(ii)**. [1]

(g)

	(i) Limitations **4 max**	**(ii)** Improvements **4 max**	No credit/not enough
A	Two readings not enough (to draw a conclusion)/too few readings/only two readings.	Take many readings for different areas and plot a graph/compare more *F* values	Repeat readings Few readings One reading NOT average *F*
B	Maximum force reached without warning(suddenly)/ reading over quickly, link to short time	Method of recording maximum reading e.g. force sensor + data logger/video recording to find force/meter which retains max reading/ use masses and pulley system	Position sensors /parallax/computer methods/bald human reaction time error/ increase force slowly/fast paper/high speed camera/ slow camera
C	Reason for the problem of detecting paper movement/ difficult to look at meter and paper at same time.	Method to indicate movement e.g. contrasting colours of paper/drawing a reference mark	Difficult to know when paper moves. Fast movement
D	Position of eraser (and weights) not fixed/ Mass(weight) of eraser changes/irregularity of rubber shape (not rectangular)	Method to ensure same position e.g. mark position on top paper/method to ensure constant mass e.g. use malleable strip which can be bent to change *A*/ change total masses to account for change in mass of rubber/pile up unused rubber pieces on top/improved method to measure rubber e.g. vernier caliper	Keep mass constant
E	Variation in direction of force/misalignment of paper strips (which affects *F*).	Method to ensure direction is constant e.g. align strips along straight edge/draw a line to follow/method to equalise levels	
F	Uneven bench surface (leading to contact area being less than *A*).	Method to ensure smoother surface e.g. use named surface e.g. glass or melamine/sand the surface	Use smoother surface

X: Increase mass so increase the force (reducing % uncertainty in force).

Do not credit references to zero error/accuracy/digital meter friction between papers/re-zeroing after each experiment/2 people/paper tearing/clip deforming.

[Total: 20]