UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the October/November 2009 question paper for the guidance of teachers

9702 PHYSICS

9702/31 Paper 31 (Advanced Practical Skills 1), 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 (a) First values for *h* and *z,* to the nearest mm. [1]

(b) Measurements – Add up the number of sets of values of *z* and *h* and put a ringed total by the table. [4]
Four marks for six sets of readings of *z* and *h*, three for five sets, etc.
(–1 if help given by supervisor, -1 if wrong trend i.e. $h\uparrow$ $z\downarrow$)

Maximum value for *z* - *h* greater than 6.0 cm [1]

Column headings [1]
Each column heading must contain a quantity and a unit where appropriate.
Ignore units in the body of the table.
There must be some distinguishing mark between the quantity and the unit
(i.e. solidus is expected, but accept, for example, *h* (mm)).

Consistency of presentation of raw readings [1]
All raw values of *h* and *z* must be given to the same number of decimal places.

(c) (i) (Graph) Axes [1]
Sensible scales must be used. Awkward scales (e.g. 3:10) are not allowed.
Scale markings should be no more than 3 large squares apart.
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 being plotted. Ignore units.
Allow reversed axes but do not allow the wrong graph.

(Graph) Plotting
All observations must be plotted. Put a ringed total of plotted points. [1]
Ring and check a suspect plot. Tick if correct. Re-plot if incorrect.
Work to an accuracy of half a small square.
Penalise 'blobs' – dia. of plots must be $\leq$ ½ a small square.

(Graph) Line of best fit [1]
Judge by scatter of at least 5 trend points about the candidate's line.
There must be a fair scatter of points either side of the line.
Indicate best line if candidate's line is not the best line.

(Graph) Quality of results
Judge by scatter of points about the best fit line. [1]
All points in the table (of which there must be at least 5) must be within $\pm$ 0.3 cm (to scale) on the *h* axis.

(ii) Gradient
The hypotenuse must be at least half the length of the drawn line. [1]
Read-offs must be accurate to half a small square. If incorrect write in the correct value. [1]
Check for $\Delta y/\Delta x$ (i.e. do not allow $\Delta x/\Delta y$).

(d) (i) Raw value(s) for d to nearest 0.1 mm or 0.01 mm [1]
18.00 mm $\leq d \leq$ 27.00 mm. Unit required.
Repeated readings for d. [1]

(ii) A calculated correctly. Allow ecf. Check value. If incorrect, write in the correct value. [1]

Significant figures for A must be the same as, or one more than, the sig. figs. of the raw values of d. [1]

(e) Method – value from **(c) (ii)** equated to $k/\rho Ag + 1$ [1]
Substitution methods lose both **(e)** marks
Calculation - value for k in range 4 to 6 Nm^{-1}.(allow $3.50 \leq k \leq 6.49$). [1]
(or refer to supervisor's value). Unit required. Ignore SF.
This mark is conditional on achieving the previous mark.

[Total: 20]

2 (a) (i) First value of l, with unit, to nearest mm. ($40 \leq l \leq 60$ cm) [1]
(-1 if help given by supervisor)

(b) (i) First value of d (18 cm $\leq d \leq$ 22 cm) with consistent unit. [1]

(ii) Method of measuring d accurately – two details of procedure e.g: [2]
- Method of consistent release of marble
- Use of named item(s) as marker(s)
- Refining position of marker
- Place ruler underneath and view vertically from above.

Do not allow 'repeats'

(iii) Percentage uncertainty in d. [1]
Range of absolute uncertainty: 2 mm $\leq \Delta d \leq$ 10 mm.
If repeated readings have been done then the uncertainty can be half the range.
Correct ratio idea required. x 100% implied.

(c) (i) First value of k, substitution correct. Consistent unit. [1]

(ii) Justification for s.f. in value of k. [1]

Either: k must be given to same no. of SF, or one more than, l and d.

Or: k must be given to same no. of SF, or one more than, l or d,
whichever has the least no. of SF.

(d) Second values of l and d. [1]

Evidence of repeat readings for first or second value of d. [1]

Second d less than first d. [1]

(e) Percentage difference (or fractional difference) in k values calculated. [1]

Sensible conclusion consistent with uncertainty of 20% [1]
in values of k, or candidate's stated uncertainty.

(f) Identifying limitations and suggesting improvements:

	(f) (i) Limitations/ sources of error (max 4 marks)	**(f) (ii) Improvements** (max 4 marks))	**Ignore:**
A	Only two readings/two readings are not enough (to draw a valid conclusion)	Take more readings and plot a graph/calculate more k values	repeat readings
B	Hard to measure *d* because ball moves too quickly/ too fast/only stationary for short time …	Use video and play back slowly/ frame by frame Use slow motion camera Use position sensor/motion sensor Allow light gates, adjusting position until beam interrupted	Use a high-speed camera/computer/data logger
C	Difficulty in releasing marble consistently/ from rest/without applying a force	Description of a mechanism to release marble e.g. slot in tube + card	Change angle
D	Parallax error in measurement of *d*	Description of method of reducing parallax error requiring additional equipment e.g. shadow projection	view at eye level view from above use a marker
E	Incorrect alignment/ inconsistent collisions/ different paths down tube	Use narrower tube	
F	Motion of ball affected by air movement/ ball swings around	Turn off fans/air con. Shield from draughts	Use a closed room/vacuum refs to air resistance heavier ball
G	Difficult to measure l because it is hard to judge the position of the centre of the ball	Measure diameter of ball using vernier calipers Measure l to top and bottom of ball and average.	

[Total:20]