UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the May/June 2007 question paper

9702 PHYSICS

9702/31 Paper 31 (Advanced Practical Skills), maximum raw mark 40

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UNIVERSITY of CAMBRIDGE
International Examinations

1 Manipulation, measurement and observation

Successful collection of data

(b) Measurements [6]
One mark for each set of readings for *V* and *n.*

(b) Apparatus set up without help from supervisor. [1]

Range and distribution of values

(c) *n* = 1 or 2 and *n* = 10 or 11 must be included and no more than a gap of three. [1]

Quality of data

(Graph) Judge by scatter of points about the best fit line. [1]
At least 5 plots are needed on the trend line for this mark to be scored.

Presentation of data and observations

Table: layout

(b) Column headings (*V*/V, 1/*V* / V^{-1} only). Ignore *n* column. [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.

Table: raw data

(b) Consistency of presentation of raw readings. [1]
All values of *V* must be given to the same number of decimal places.

Table: calculated quantities

(b) Significant figures [1]
Apply to 1/*V*.
If *V* is given to 2 s.f., then accept 1/*V* to 2 or 3 s.f.
If *V* is given to 3 s.f., then accept 1/*V* to 3 or 4 s.f.
If *V* is given to 4 s.f., then accept 1/*V* to 4 or 5 s.f.

(b) Values of 1/*V* correct. [1]
Check a value. If incorrect, write in the correct value. Allow small rounding errors.

Graph: layout

(Graph) 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 must occupy at least half the graph grid in both *x* and *y* directions. Indicate false origin with FO.
Scales must be labelled with the quantity which is being plotted. Ignore units.

Graph: plotting of points

(Graph) All observations must be plotted. [1]
Ring and check a suspect plot. Tick if correct. Re-plot if incorrect.
Work to an accuracy of half a small square.

Graph: trend line

(Graph) Line of best fit (of 5 or 6) [1]
Judge by scatter of 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.

Analysis, conclusions and evaluation

Interpretation of graph

(c) Gradient [1]
The hypotenuse of the Δ must be greater than half the length of the drawn line.
Read-offs must be accurate to half a small square.
Check for $\Delta y/\Delta x$ (i.e. do not allow $\Delta x/\Delta y$).

(c) y-intercept from graph or substitute correct read-offs into y = mx + c. [1]
If a false origin has been used then label FO.

Drawing conclusions

(d) Value for *E.* [1]
Expect between **4–5V**. Should be 1/y-intercept.
Check the value. Unit required. 2/3 s.f.

(d) Value for R_1/R_2. [1]
Expect **0.19–0.23** unless supervisor has used different resistors.
Method of working must be correct.
If **a unit** is given then this mark **cannot** be scored. 2/3 s.f.

[Total: 20]

2 Manipulation, measurement and observation

Successful collection of data

(a) (iii) Position of centre of mass of ball at equilibrium [1]
(Value < 1m and appropriate unit. No more than 1 d.p. in cm.)

(b) (i) Position of centre of mass of ball when displaced [1]
(ii) Position of centre of mass of ball at maximum height [1]

(d) Second position of centre of mass of ball when displaced [1]

(d) Second position of centre of mass of ball at maximum height [1]

(b)/(d) Repeated measurements for maximum height [1]

Quality of data

(d) Bigger x gives bigger h [1]

Presentation of data and observations

Display of calculation and reasoning

(b), (d) Values of x calculated correctly. (Displaced – equilibrium position) [1]
Both values required. Unit need not be stated but must be consistent.
Calculations must be checked.

(b), (d) Values of h calculated correctly. (Max height – equilibrium position) [1]
Both values required. Unit need not be stated but must be consistent.
Calculations must be checked.

(e) Correct calculation to check proportionality [1]
Possibilities include: Two calculations of x^2/h or ratio of x^2 values and ratio of h values both calculated.

Analysis, conclusions and evaluation

Drawing conclusions

(e) Conclusion [1]
Sensible comments supported by calculations and suggested relation.
Incorrect ideas score zero.

Estimating uncertainties

(c) (ii) Percentage uncertainty in h. [1]
Uncertainty in h is 2–10 mm. Whole numbers only.
If repeated readings have been done then the uncertainty could be half the range.
Correct ratio idea required, ×100 stated/implied.

Identifying limitations

(f) (i) Relevant points must be underlined and ticked. [4]
Some of these might be:

A Ruler not vertical.

B Locating the **centre** of the ball (when reading ruler).

C Parallax error.

D Establishing **when** the ball is at its maximum displacement.

E Only two displacements (are not enough to validate the conclusion).

F Difficulty in the **release** of the mass (reference to force/vertical plane).

Suggesting improvements

(f) (ii) Relevant points must be underlined and ticked. [4]
Some of these might be:

A Sensible method to ensure ruler vertical.

B Place the rule as close as possible to the mass/mark the **centre** of the ball with mark or pointer/use the bottom/top of the ball.

C Measure at eye level/repeat to get eye in the right place/place the rule as close as possible to the mass.

D Use video camera (play back) frame by frame/slow motion/position sensor **above** or **below**.

E Need a wider range of displacements **and** plot a graph/find mean *k.*

F Use a clamp/electromagnet to release the mass.

Do not allow 'repeated readings', 'human error'.
Do not allow 'use a computer to improve the experiment'.

[Total: 20]