

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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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.

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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]

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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, $\times 100$ stated/implied.

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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]