

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

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.

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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  $\Delta$  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]**