

**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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Page 2	Mark Scheme	Syllabus	Paper
	GCE A/AS LEVEL – May/June 2007	9702	31

## 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.

<b>Page 3</b>	<b>Mark Scheme</b>	<b>Syllabus</b>	<b>Paper</b>
	<b>GCE A/AS LEVEL – May/June 2007</b>	<b>9702</b>	<b>31</b>

**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]**

Page 4	Mark Scheme	Syllabus	Paper
	GCE A/AS LEVEL – May/June 2007	9702	31

## 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.

<b>Page 5</b>	<b>Mark Scheme</b>	<b>Syllabus</b>	<b>Paper</b>
	<b>GCE A/AS LEVEL – May/June 2007</b>	<b>9702</b>	<b>31</b>

**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]**