

**CAMBRIDGE INTERNATIONAL EXAMINATIONS**

Cambridge International Advanced Subsidiary and Advanced Level

**MARK SCHEME for the March 2016 series****9702 PHYSICS****9702/52**Paper 5 (Planning, Analysis and Evaluation),  
maximum raw mark 30

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## 1 Planning (15 marks)

### Defining the problem (2 marks)

P  $k$  is the independent variable and  $h$  is the dependent variable, or vary  $k$ , measure  $h$ . [1]

P Keep mass of object constant. [1]

### Methods of data collection (4 marks)

M Labelled diagram (minimum two labels) showing object (mass) attached to cord and other end of cord fixed (e.g. stand and clamp or hook) and rule(r) drawn vertically next to cord. [1]

M Method of measuring mass e.g. balance / scales. [1]

M  $k = (\text{weight or force}) / \text{extension}$  or  $mg / \text{extension}$ ; allow graphical methods. Allow any subject e.g.  $mg = k \times \text{extension}$ . [1]

M Use of rule to measure  $h$  or maximum distance / length (fallen by the object). Allow clear indication on diagram (i.e. dotted lines) linking distance  $h$  to rule. Do not credit length of cord. [1]

### Method of analysis (3 marks)

✓ Plot a graph of  $\frac{(h-L)^2}{h}$  against  $1/k$  [Allow  $2/k$  or  $2m/k$  or  $m/k$ ] [1]

✓  $g = \text{gradient} / 2m$  [gradient /  $m$  or gradient or gradient / 2] [1]

✓ Relationship is valid if the graph is a straight line passing through the origin. [1]

### Additional detail (6 marks)

D Relevant points [6]

1 Keep starting point constant / drop object from same position / use of electromagnet to drop object / ensure mass is dropped from fixed point / check object falls vertically

2 Rule(r) fixed e.g. retort stand

3 Method to determine extension, e.g. measure length of stretched cord and subtract original length / 50.0 cm. [Accept from a diagram]

4 Safety precaution linked to prevention of mass / cord hitting a person – use safety screen / goggles; sand tray to catch falling object if cord breaks

5 Trial experiment to locate approximate point of  $h$  / to prevent object hitting surface

6 Detailed use of video camera with slow motion or frame by frame playback / motion sensor clearly explained

7 Cord obeys Hooke's law or must not exceed elastic limit

8 Use set square to ensure ruler is vertical

9 For each cord, repeat experiment determine average  $h$

Do not allow vague computer methods.

**[Total: 15 marks]**

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## 2 Analysis, conclusions and evaluation (15 marks)

| Part   | Mark | Expected Answer  |
|--------|------|--|
| (a)    | A1   | $\text{Gradient} = \frac{c_m \Delta \theta}{P}$ $y\text{-intercept} = \frac{m_w c_w \Delta \theta + k}{P}$             |
| (b)    | T1   | Column heading $m_m / g$<br>100<br>200<br>300<br>400<br>500<br>600   |
|        | U1   | From $\pm 10$ to $\pm 60$  |
| (c)(i) | G1   | Six points plotted correctly   |
|        | U2   | Error bars in $m_m$ plotted correctly  |
| (ii)   | G2   | Line of best fit   |
|        | G3   | Worst acceptable straight line.<br>Steepest or shallowest possible line that passes through <u>all</u> the error bars. |
| (iii)  | C1   | Gradient of best fit line  |
|        | U3   | Difference in worst gradient and gradient.   |
| (iv)   | C2   | y-intercept  |
|        | U4   | Uncertainty in y-intercept   |
| (d)(i) | C3   | $c_m$ in the range 470 to 530 <u>and</u> given to 2 or 3sf   |
|        | C4   | $k = y\text{-intercept} \times P - m_w c_w \Delta \theta$<br>$k = y\text{-intercept} \times 50 - 21000$                |
|        | C5   | Units for $c_m$ and $k$  |
| (ii)   | U5   | Percentage uncertainty in $C_m$  |

[Total: 15 marks]

|        |   |          |       |
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### Uncertainties in Question 2

#### (c) (iii) Gradient [U3]

- 1 Uncertainty = gradient of line of best fit – gradient of worst acceptable line
- 2 Uncertainty =  $\frac{1}{2}$  (steepest worst line gradient – shallowest worst line gradient)

#### (iv) [U4]

- 1 Uncertainty = y-intercept of line of best fit – y-intercept of worst acceptable line
- 2 Uncertainty =  $\frac{1}{2}$  (steepest worst line y-intercept – shallowest worst line y-intercept)

#### (d) (ii) [U5]

$$1 \quad \% \text{uncertainty} = \left( \frac{\Delta \text{gradient}}{\text{gradient}} + \frac{5}{50} + \frac{0.5}{20} \right) \times 100 = \left( \frac{\Delta \text{gradient}}{\text{gradient}} \right) \times 100 + 12.5\%$$

$$2 \quad \max c_m = \frac{\max \text{gradient} \times \max \text{power}}{\min \text{temperature change}} = \frac{\max \text{gradient} \times 55}{19.5}$$

$$3 \quad \min c_m = \frac{\min \text{gradient} \times \min \text{power}}{\max \text{temperature change}} = \frac{\min \text{gradient} \times 45}{20.5}$$