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Cambridge International Advanced Subsidiary and Advanced Level

MARK SCHEME for the May/June 2015 series

9702 PHYSICS

9702/51 Paper 5 (Planning, Analysis and Evaluation), maximum raw mark 30

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1 Planning (15 marks)

Defining the problem (3 marks)

P *V* is the independent variable, or vary *V* **and** *f* is the dependent variable, or measure *f*.
O*r f* is the independent variable, or vary *f* **and** *V* is the dependent variable, or measure *V*. [1]

P Change *f* (allow *V*) until the mass leaves/gap between plate. [1]

P Keep the position of the mass constant. (Do not allow keep mass constant.) [1]

Methods of data collection (5 marks)

M Labelled diagram showing signal generator/a.c. supply connected to vibrator with two wires with mass on plate. At least two labels needed. [1]

M Voltmeter/c.r.o. connected in parallel with vibrator in a workable circuit. [1]

M Measure *f* or *T* from signal generator/c.r.o. (Allow detailed use of motion sensor/stroboscope.) [1]

M Detail regarding mass leaving the plate: listen to noise, look for gap. [1]

M Repeat each experiment for the same value of *V* (allow *f* if consistent with above) and average. [1]

Method of analysis (2 marks)

Plot a graph of:

A f^2 against $1/V$ | $1/V$ against f^2 | f against $1/\sqrt{V}$ | $1/\sqrt{V}$ against f | lg V against lg f | lg f against lg V

or

V against $1/f^2$ | $1/f^2$ against V | $\sqrt{V}$ against $1/f$ | $1/f$ against $\sqrt{V}$ [1]

A $k =$ gradient $\times \pi^2$ | $k = \dfrac{\pi^2}{\text{gradient}}$ | $k =$ gradient$^2 \times \pi^2$ | $k = \dfrac{\pi^2}{\text{gradient}^2}$ | $k = \pi^2 \times 10^c$ | $k = \pi^2 \times 10^{2c}$ [1]

Safety considerations (1 mark)

S Precaution linked to mass leaving vibrating plate, e.g. use safety screen/goggles/sand tray. [1]

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Additional detail (4 marks)

D Relevant points might include [4]
1 Wait for vibrator to oscillate evenly
2 Method to determine period of oscillation from c.r.o., i.e. one time period × time-base
3 Method to determine *f* from c.r.o. having determined *T*, i.e. $f = 1 / T$
4 Method to determine *V* from c.r.o, i.e. amplitude (height) × *y*-gain
5 Relationship is valid if the graph is a straight line passing through the origin
[For lg – lg graph the gradient must be correct (–2 or –0.5)]
6 Determine *f* (allow *V* if consistent with above) by increasing and decreasing *V* or *f*
7 Clean surfaces of metal plate/small mass
8 Spirit level to keep plate horizontal/eye level to look for gap

Do not allow vague computer methods.

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2 Analysis, conclusions and evaluation (15 marks)

<table>
<tr><th></th><th>Mark</th><th>Expected Answer</th><th>Additional Guidance</th></tr>
<tr><td>(a)</td><td>A1</td><td>gradient = m
y-intercept = lg k</td><td></td></tr>
<tr><td>(b)</td><td>T1
T2</td><td><table><tr><td>1.70 or 1.699</td><td>1.312 or 1.3118</td></tr><tr><td>1.79 or 1.785</td><td>1.204 or 1.2041</td></tr><tr><td>1.85 or 1.851</td><td>1.114 or 1.1139</td></tr><tr><td>1.90 or 1.903</td><td>1.041 or 1.0414</td></tr><tr><td>1.95 or 1.954</td><td>0.98 or 0.978</td></tr><tr><td>2.00 or 1.996</td><td>0.90 or 0.903</td></tr></table></td><td>Allow a mixture of significant figures.
T1 (first column) and T2 (second column) must be values in table.</td></tr>
<tr><td></td><td>U1</td><td>From ±0.01 to ±0.03</td><td>Allow more than one significant figure.</td></tr>
<tr><td>(c) (i)</td><td>G1</td><td>Six points plotted correctly</td><td>Must be within half a small square.
Do not allow “blobs”.
Ecf allowed from table.</td></tr>
<tr><td></td><td>U2</td><td>Error bars in lg P plotted correctly</td><td>All error bars to be plotted. Must be accurate to less than half a small square.</td></tr>
<tr><td>(ii)</td><td>G2</td><td>Line of best fit</td><td>Upper end of line must pass between (1.75, 1.24) and (1.75, 1.255) and lower end of line must pass between (2.00, 0.900) and (2.00, 0.915).</td></tr>
<tr><td></td><td>G3</td><td>Worst acceptable straight line.
Steepest or shallowest possible line that passes through <u>all</u> the error bars.</td><td>Line should be clearly labelled or dashed.
Examiner judgement on worst acceptable line. Lines must cross. Mark scored only if error bars are plotted.</td></tr>
<tr><td>(iii)</td><td>C1</td><td>Gradient of line of best fit</td><td>Must be negative. The triangle used should be at least half the length of the drawn line. Check the read-offs. Work to half a small square. Do not penalise POT. (Should be about –1.35.)</td></tr>
<tr><td></td><td>U3</td><td>Uncertainty in gradient</td><td>Method of determining absolute uncertainty: difference in worst gradient and gradient.</td></tr>
<tr><td>(iv)</td><td>C2</td><td>y-intercept</td><td>Check substitution into y = mx + c.
Allow ecf from (c)(iii).
(Should be about 4.)
Do not allow read-off of false origin.</td></tr>
</table>

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	U4	Uncertainty in *y*-intercept	Uses worst gradient and point on worst acceptable line. Do not check calculation. Do not allow if false origin used.
(d) (i)	C3	$k = 10^{y\text{-intercept}}$	
	C4	*m* = gradient and given to 2 or 3 s.f. and in the range –1.30 to –1.44	Must be negative. Allow –1.3 or –1.4 (2 s.f.)
(ii)	U5	Percentage uncertainty in *k*	

Uncertainties in Question 2

(c) (iii) Gradient [U3]

uncertainty = gradient of line of best fit – gradient of worst acceptable line

uncertainty = ½ (steepest worst line gradient – shallowest worst line gradient)

(iv) [U4]

uncertainty = *y*-intercept of line of best fit – *y*-intercept of worst acceptable line

uncertainty = ½ (steepest worst line *y*-intercept – shallowest worst line *y*-intercept)

(d) (ii) [U5]

max $k = 10^{\text{max } y\text{-intercept}}$ and min $k = 10^{\text{min } y\text{-intercept}}$

$$\text{percentage uncertainty} = \frac{\max k - k}{k} \times 100 = \frac{k - \min k}{k} \times 100 = \frac{\frac{1}{2}(\max k - \min k)}{k} \times 100$$

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