CAMBRIDGE INTERNATIONAL EXAMINATIONS

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

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, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

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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.
Or 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	*or*	*or*	*or*			
	V against $1/f^2$	$1/f^2$ against V	$\sqrt{V}$ against $1/f$	$1/f$ against $\sqrt{V}$			[1]

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

Safety considerations (1 mark)

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

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 <u>and</u> 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.

2 Analysis, conclusions and evaluation (15 marks)

<table>
<tr><td></td><td>Mark</td><td>Expected Answer</td><td>Additional Guidance</td></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>

	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 <u>and</u> given to 2 or 3 s.f. <u>and</u> 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 $k = 10^{\text{min } y\text{-intercept}}$

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