CAMBRIDGE INTERNATIONAL EXAMINATIONS

Cambridge International Advanced Subsidiary and Advanced Level

MARK SCHEME for the May/June 2015 series

9702 PHYSICS

9702/52 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 t is the independent variable and I (or amplitude of reflected signal) is the dependent variable, or vary t and measure I (or amplitude of reflected signal). [1]

P Keep distance from the wall/foam to the speaker/microphone constant. [1]

P Keep the amplitude or intensity I_0 of the sound before reflection constant. [1]

Methods of data collection (5 marks)

M Labelled diagram of workable experiment including speaker, microphone/sound detector, foam and wall. [1]

M Signal generator/a.c. power supply connected to speaker. [1]

M Microphone connected to oscilloscope or sound (intensity) meter. [1]

M Measure the thickness with a rule/micrometer/vernier calipers. [1]

M Method to determine the density; $\rho = m / V$. [1]

Method of analysis (2 marks)

A Plot a graph of ln I against t.
(Allow log I against t and lg I against t graphs.) [1]

A $\alpha = -\text{gradient} / \rho$ (must be consistent with graph plotted) [1]

Safety considerations (1 mark)

S Precaution linked to loud sounds, e.g. use ear plugs/muffs/defenders.
Allow switch off sound source to prevent damage to ears. [1]

Additional detail (4 marks)

D Relevant points might include [4]

1 Keep the frequency constant
2 Carry out experiment in a quiet room/no other sources of sound
3 Method to keep angles constant/positions of speaker and microphone constant.
4 Method and explanation to detect reflected sound from foam only, e.g. barrier, tube or method to avoid reflections
5 Method to determine mass, e.g. use scales/balance and method to determine volume
6 Relationship is valid if the graph is a straight line (ignore reference to y-intercept)
7 Method to check that emitted sound I_0 is constant or method to check y-intercept is ln I_0.
8 Intensity is proportional to the amplitude^2.

Do not allow vague computer methods.

2 Analysis, conclusions and evaluation (15 marks)

		Expected Answer	Additional Guidance
(a)	A1	gradient = $\frac{\varepsilon Ef}{d}$	
(b)	T1	X / 10^{-2} m^2	
	T2	4.80 or 4.800 5.40 or 5.400 6.30 or 6.300 7.20 or 7.200 8.10 or 8.100 9.00 or 9.000	Allow a mixture of significant figures. Must be table values.
	U1	From ±0.2 to ±0.3	Allow more than one significant figure.
(c) (i)	G1	Six points plotted correctly	Must be within half a small square. Do not allow "blobs". Ecf allowed from table.
	U2	Error bars in X plotted correctly	All error bars to be plotted. Must be accurate to less than half a small square.
(ii)	G2	Line of best fit	Lower end of line must pass between (5.1, 5.0) and (5.3, 5.0) **and** upper end of line must pass between (8.5, 8.5) and (8.8, 8.5).
	G3	Worst acceptable straight line. Steepest or shallowest possible line that passes through <u>all</u> the error bars.	Line should be clearly labelled or dashed. Examiner judgement on worst acceptable line. Lines must cross. Mark scored only if error bars are plotted.
(iii)	C1	Gradient of best fit line	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 1×10^{-4}.)
	U3	Uncertainty in gradient	Method of determining absolute uncertainty: difference in worst gradient and gradient.
(d) (i)	C2	$\varepsilon = 6.25 \times 10^{-7} \times$ gradient	Do not penalise POT. (Should be about 6 or 7×10^{-11}.)
	C3	$F\,m^{-1}$ or $C\,V^{-1}\,m^{-1}$	Allow $A\,m^{-1}\,V^{-1}\,Hz^{-1}$ or $A\,s\,m^{-1}\,V^{-1}$ or $A^2\,s^4\,kg^{-1}\,m^{-3}$. Power of 10 must be correct.
(ii)	U4	Percentage uncertainty in ε	10.83% + percentage uncertainty in gradient

(e)	C4	*f* in the range 73.0 to 84.4 and given to 2 or 3 s.f.	Allow 73 to 84 for 2 s.f. $f = \dfrac{5.0 \times 10^{-9}}{\varepsilon}$
	U5	Absolute uncertainty in *f*	Clear working needed. Allow ecf from **(d)(ii)**.

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)

(d) (ii) [U4]

$$\text{max } \varepsilon = \frac{\text{max gradient} \times \text{max } d}{\text{min } E \times \text{min } f}$$

$$\text{min } \varepsilon = \frac{\text{min gradient} \times \text{min } d}{\text{max } E \times \text{max } f}$$

$$\%\text{ uncertainty } = \left(\frac{\Delta\text{gradient}}{\text{gradient}} + \frac{\Delta d}{d} + \frac{\Delta f}{f} + \frac{\Delta E}{E}\right) \times 100$$
$$= \left(\frac{\Delta\text{gradient}}{\text{gradient}} + \frac{0.0002}{0.0030} + \frac{10}{400} + \frac{0.2}{12.0}\right) \times 100$$

(e) [U5]

$$\text{max } f = \frac{\text{max } I \times \text{max } d}{\text{min } X \times \text{min } \varepsilon \times \text{min } E}$$

$$\text{min } f = \frac{\text{min } I \times \text{min } d}{\text{max } X \times \text{max } \varepsilon \times \text{max } E}$$

$$\Delta f = \left(\frac{\Delta I}{I} + \frac{\Delta d}{d} + 2\frac{\Delta l}{l} + \frac{\Delta E}{E} + \frac{\Delta\varepsilon}{\varepsilon}\right) f = \left(\frac{0.1}{5.0} + \frac{0.0002}{0.0030} + 2\frac{0.001}{0.500} + \frac{0.2}{12.0} + \frac{\Delta\varepsilon}{\varepsilon}\right) f = \left(0.107 + \frac{\Delta\varepsilon}{\varepsilon}\right) f$$

$$\Delta f = \left(\frac{10.7 + \textbf{(d)(ii)}}{100}\right) f \quad \left[= \left(\frac{21.5 + \%\text{ uncertainty in gradient}}{100}\right) f \text{ if } \textbf{(d)(ii)} \text{ is correct}\right]$$