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UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the October/November 2009 question paper for the guidance of teachers

9702 PHYSICS

9702/51 Paper 51 (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.

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Question 1

Planning (15 marks)

Defining the problem (3 marks)

P1 *V*ary *V* or *f* [1]

P2 Measure *f* for different *V* or measure *V* for different *f* [1]

P3 Keep temperature constant [1]

Methods of data collection (5 marks)

M1 labelled diagram including source of sound adjacent to the opening e.g. loudspeaker/tuning fork [1]

M2 Method of producing sound of different frequencies e.g. several tuning forks or signal generator [1]

M3 Method of measuring volume of air – volume of container - volume of water or find total volume of each different container [1]

M4 Method of determining resonant frequency e.g. largest sound heard or displayed [1]

M5 Perform experiment in quiet room or avoid other noise [1]

Method of analysis (2 marks)

A1 Plot a graph of f^2 against $1/V$ or lg f against lg V or or lg f against lg $1/V$ [1]

A2 Relationship is correct if graph is a straight line through the origin or straight line for log-log graph [1]

Safety considerations (1 mark)

S Switch off power supply when not in use/ ear defenders for loudspeaker method [1]

Additional detail (4 marks)

D Relevant points might include [4]

1. Detail on measuring volume – use of measuring cylinder/burette
2. Determination of frequency using oscilloscope/read off tuning fork or signal generator
3. Detailed timebase calculation
4. Detail determining resonance e.g. adding/subtracting small amounts of water/changing signal generator to create resonance
5. Discussion of container e.g. end correction/shape of mouth of bottle
6. Gradient = k or lg f = -0.5 lg V + 0.5 lg k or lg f = 0.5 lg $1/V$ + 0.5 lg k
7. Constant amplitude/intensity of source of sound
8. Method to check fundamental frequency.

15 marks can be scored in total.

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Question 2 Analysis, conclusions and evaluation (15 marks)

Part	Mark	Expected Answer	Additional Guidance
(a)	A1	Gradient = h y-intercept = $\lg \frac{1}{g}$ or $-\lg g$	Allow log and/or ln
(b)	T1 T2	2.467 or 2.4669 3.00 or 2.996 2.481 or 2.4814 2.93 or 2.934 2.496 or 2.4955 2.88 or 2.881 2.509 or 2.5092 2.83 or 2.833 2.522 or 2.5224 2.79 or 2.785	T1 for lg T T2 for lg R Allow mixture of dp.
	U1	$\pm$ 0.004 to $\pm$ 0.007	Allow more than one significant figure.
(c) (i)	G1	Five points plotted correctly	Must be within half a small square. Use transparency. Ecf allowed from table.
	U2	Error bars in lg R plotted correctly	Check first and last point. Must be accurate within half a small square. Allow ecf from **(b)**
(c) (ii)	G2	Line of best fit	There must at least four trend plots with a reasonable balance of points about the line. Allow ecf from points plotted incorrectly. Examiner judgement.
	G3	Worst acceptable straight line. Steepest or shallowest possible line.	Line should be clearly labelled or dashed. Should pass from top of top error bar to bottom of bottom error bar **or** bottom of top error bar to top of bottom error bar. Mark scored only if error bars are plotted. Allow ecf from **(b)** and **(c) (i)**
(c) (iii)	C1	Gradient of best fit line	The triangle used should be greater than half the length of the drawn line. Check the read offs. Work to half a small square. Do not penalise POT or sign of gradient.
	U3	Uncertainty in gradient	Method of determining absolute uncertainty Difference in worst gradient and gradient.
(c) (iv)	C2	y-intercept	Gradient must be used. Check substitution into $c = y - mx$. Allow ecf from **(c) (iii)**. If gradient negative then y-intercept should be about 11-13. If gradient positive then y-intercept should be about -4 or -5.
	U4	Uncertainty in y-intercept	Method of determining absolute uncertainty Difference in worst y-intercept and y-intercept. Do not allow ecf from false origin read-off. Allow ecf from **(c) (iv)**

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(d)	C3	$g = 1/10^{y\text{-intercept}} = 10^{-y\text{-intercept}}$	*y*-intercept must be used. *g* should be about 10^{-13} Allow ecf from **(c) (iv)**. If FO or positive gradient used then *g* should be about 10^{-4}.
	C4	*h* = candidate's gradient value	Answer must be <u>negative</u> <u>and</u> given to 2 or 3 sf.
	U5	Method for uncertainty in *g* <u>and</u> uncertainty in *h.*	Expect to see difference in values for *g*. Uncertainty in *h* must be the same as the gradient.

[Total: 15]

Uncertainties in Question 2

(c) (iii) Gradient [U3]

1. Uncertainty = gradient of line of best fit – gradient of worst acceptable line
2. Uncertainty = ½ (steepest worst line gradient – shallowest worst line gradient)

(c) (iv) *y*-intercept [U4]

1. Uncertainty = *y*-intercept of line of best fit – *y*-intercept of worst acceptable line
2. Uncertainty = ½ (steepest worst line gradient – shallowest worst line gradient)

(d) [U5]

1. Uncertainty = $10^{-\text{best } y\text{-intercept}} - 10^{-\text{worst } y\text{-intercept}}$

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