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 must be read in conjunction with the question papers and the report on the examination.

- CIE will not enter into discussions or correspondence in connection with these mark schemes.

CIE is publishing the mark schemes for the October/November 2009 question papers for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level syllabuses and some Ordinary Level syllabuses.
Question 1

Planning (15 marks)

Defining the problem (3 marks)

P1 Vary $V$ or $f$  

P2 Measure $f$ for different $V$ or measure $V$ for different $f$  

P3 Keep temperature constant

Methods of data collection (5 marks)

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

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

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

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

M5 Perform experiment in quiet room or avoid other noise

Method of analysis (2 marks)

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

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

Safety considerations (1 mark)

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

Additional detail (4 marks)

D Relevant points might include

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.
Question 2 Analysis, conclusions and evaluation (15 marks)

<table>
<thead>
<tr>
<th>Part</th>
<th>Mark</th>
<th>Expected Answer</th>
<th>Additional Guidance</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a)</td>
<td>A1</td>
<td>Gradient = $h$</td>
<td>Allow log and/or ln</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$y$-intercept = $\frac{1}{g}$ or $-\lg g$</td>
<td></td>
</tr>
<tr>
<td>(b)</td>
<td>T1</td>
<td>2.467 or 2.4669</td>
<td>T1 for $\lg T$</td>
</tr>
<tr>
<td></td>
<td>T2</td>
<td>2.481 or 2.4814</td>
<td>T2 for $\lg R$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.496 or 2.4955</td>
<td>Allow mixture of dp.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.509 or 2.5092</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.522 or 2.5224</td>
<td></td>
</tr>
<tr>
<td>(c) (i)</td>
<td>G1</td>
<td>Five points plotted correctly</td>
<td>Must be within half a small square. Use transparency. Ecf allowed from table.</td>
</tr>
<tr>
<td>U1</td>
<td>± 0.004 to ± 0.007</td>
<td>Allow more than one significant figure.</td>
<td></td>
</tr>
<tr>
<td>(c) (ii)</td>
<td>G2</td>
<td>Line of best fit</td>
<td>There must at least four trend plots with a reasonable balance of points about the line. Allow ecf from points plotted incorrectly. Examiner judgement.</td>
</tr>
<tr>
<td>G3</td>
<td>Worst acceptable straight line. Steepest or shallowest possible line.</td>
<td>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).</td>
<td></td>
</tr>
<tr>
<td>(c) (iii)</td>
<td>C1</td>
<td>Gradient of best fit line</td>
<td>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.</td>
</tr>
<tr>
<td>U3</td>
<td>Uncertainty in gradient</td>
<td>Method of determining absolute uncertainty Difference in worst gradient and gradient.</td>
<td></td>
</tr>
<tr>
<td>(c) (iv)</td>
<td>C2</td>
<td>$y$-intercept</td>
<td>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.</td>
</tr>
<tr>
<td>U4</td>
<td>Uncertainty in $y$-intercept</td>
<td>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).</td>
<td></td>
</tr>
</tbody>
</table>
### 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)

#### (c) (iv) \(y\)-intercept [U4]

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

#### (d) [U5]

1. Uncertainty = \(10 - \text{best } y\)-intercept - \(10 - \text{worst } y\)-intercept