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.

Cambridge will not enter into discussions about these mark schemes.

Cambridge is publishing the mark schemes for the October/November 2014 series for most Cambridge IGCSE®, Cambridge International A and AS Level components and some Cambridge O Level components.
1 Planning (15 marks)

Defining the problem (3 marks)

P (cos) $\theta$ is the independent variable, or vary (cos) $\theta$. [1]

P $P$ is the dependent variable, or measure $P$. [1]

P Keep the speed of the air constant. Allow keep power to the fan/hairdryer constant. [1]

Methods of data collection (5 marks)

M Labelled diagram showing method to produce air flow in line with turbine. Method of producing “wind” must be labelled. [1]

M Circuit connecting turbine to lamp with ammeter and voltmeter connected correctly. No additional power supplies in the lamp circuit. [1]

M $P = IV$. Do not allow $I^2R$ or $V^2/R$ unless it is clear that $R$ is determined from $V/I$. Allow wattmeter or joule meter and stopwatch. [1]

M Measure angle with protractor or use rule to measure appropriate distances. [1]

M Ensure that there are no other draughts or airflows. [1]

Method of analysis (2 marks)

A Plot a graph of $P$ against cos $\theta$. [1]

A $k$ = gradient. [1]

Safety considerations (1 mark)

S Precaution linked to avoiding air flow entering eyes or avoid moving blades. [1]

Additional detail (4 marks)

D Relevant points might include [4]

1 Use of large wind speed to gain measurable readings.

2 Use of low wattage/low resistance lamp or turbine with low friction.

3 Additional detail on measuring (cos) $\theta$ – correct angle must be determined.

4 Wait until airflow/turbine/meter readings constant.

5 Avoid turbulence or reflection of air flow.

6 Ensure distance from fan to turbine is constant.

7 Relationship is valid if the graph is a straight line passing through the origin.

8 Method to check that wind speed is constant.

Do not allow vague computer methods.

[Total: 15]
### Analysis, conclusions and evaluation (15 marks)

<table>
<thead>
<tr>
<th>Mark</th>
<th>Expected Answer</th>
<th>Additional Guidance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>(a)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A1</td>
<td>( \text{gradient} = \frac{1}{4\pi^2L} )</td>
<td></td>
</tr>
<tr>
<td><strong>(b)</strong></td>
<td></td>
<td>T1 (first column) and T2 (second column) must be table values. Allow a mixture of significant figures.</td>
</tr>
<tr>
<td>T1</td>
<td>T2</td>
<td></td>
</tr>
<tr>
<td>4.0 or 4.00</td>
<td>22.2 or 22.20</td>
<td></td>
</tr>
<tr>
<td>3.3 or 3.33</td>
<td>18.0 or 17.96</td>
<td></td>
</tr>
<tr>
<td>2.9 or 2.86</td>
<td>15.1 or 15.13</td>
<td></td>
</tr>
<tr>
<td>2.3 or 2.27</td>
<td>11.4 or 11.45</td>
<td></td>
</tr>
<tr>
<td>1.5 or 1.52</td>
<td>6.7 or 6.72</td>
<td></td>
</tr>
<tr>
<td>1.1 or 1.14</td>
<td>4.2 or 4.23</td>
<td></td>
</tr>
<tr>
<td><strong>U1</strong></td>
<td>From ±0.4 (or ±0.5) to ±0.1 (or ±0.2)</td>
<td>Allow more than one significant figure.</td>
</tr>
<tr>
<td><strong>(c) (i)</strong></td>
<td><strong>G1</strong></td>
<td>Six points plotted correctly</td>
</tr>
<tr>
<td><strong>U2</strong></td>
<td>Error bars in 1/C plotted correctly</td>
<td>All error bars to be plotted. Must be accurate to less than half a small square.</td>
</tr>
<tr>
<td><strong>(c) (ii)</strong></td>
<td><strong>G2</strong></td>
<td>Line of best fit</td>
</tr>
<tr>
<td><strong>G3</strong></td>
<td></td>
<td>Worst acceptable straight line. Steepest or shallowest possible line that passes through all the error bars.</td>
</tr>
<tr>
<td><strong>(c) (iii)</strong></td>
<td><strong>C1</strong></td>
<td>Gradient of best fit line</td>
</tr>
<tr>
<td><strong>U3</strong></td>
<td>Uncertainty in gradient correctly determined</td>
<td>Method of determining absolute uncertainty: difference in worst gradient and gradient.</td>
</tr>
<tr>
<td><strong>(d)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C2</td>
<td>( L = \frac{1}{4\pi^2 \times \text{gradient}} )</td>
<td>Allow ecf from (c)(iii). (Should be about (4 \times 10^{-3}).)</td>
</tr>
</tbody>
</table>
Uncertainties in Question 2

(c) (iii) Gradient [U3]

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

Uncertainty = \( \frac{1}{2} \) (steepest worst line gradient – shallowest worst line gradient)

(d) [U4]

\[
\text{absolute uncertainty in } L = \left( \frac{\Delta \text{gradient}}{\text{gradient}} \times L \right)
\]

\[
\max L = \frac{1}{4\pi^2 \times \min \text{gradient}}
\]

\[
\min L = \frac{1}{4\pi^2 \times \max \text{gradient}}
\]

(e) (ii) [U5]

\[
\% \text{ uncertainty} = \frac{1}{2} \left( \frac{\Delta L}{L} \times 100 + 10 \right) = \frac{1}{2} \left( \frac{\Delta \text{gradient}}{\text{gradient}} \times 100 + 10 \right)
\]

\[
\max f = \frac{1}{2\pi\sqrt{L_{\text{min}}C_{\text{min}}}} = \sqrt{\frac{\max \text{ gradient}}{\min \text{C}}}
\]

\[
\min f = \frac{1}{2\pi\sqrt{L_{\text{max}}C_{\text{max}}}} = \sqrt{\frac{\min \text{ gradient}}{\max \text{C}}}
\]