CAMBRIDGE INTERNATIONAL EXAMINATIONS

Cambridge International Advanced Subsidiary and Advanced Level

MARK SCHEME for the October/November 2014 series

9702 PHYSICS

9702/51 Paper 5 (Planning, Analysis and Evaluation), maximum raw mark 30

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1 Planning (15 marks)

Defining the problem (3 marks)

P (cos) θ is the independent variable, or vary (cos) θ. [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 θ. [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) θ – 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]

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2 Analysis, conclusions and evaluation (15 marks)

<table>
<tr><th></th><th>Mark</th><th>Expected Answer</th><th>Additional Guidance</th></tr>
<tr><td>(a)</td><td>A1</td><td>gradient = $\frac{1}{4\pi^2 L}$</td><td></td></tr>
<tr><td>(b)</td><td>T1
T2</td><td><table><tr><td>4.0 or 4.00</td><td>22.2 or 22.20</td></tr><tr><td>3.3 or 3.33</td><td>18.0 or 17.96</td></tr><tr><td>2.9 or 2.86</td><td>15.1 or 15.13</td></tr><tr><td>2.3 or 2.27</td><td>11.4 or 11.45</td></tr><tr><td>1.5 or 1.52</td><td>6.7 or 6.72</td></tr><tr><td>1.1 or 1.14</td><td>4.2 or 4.23</td></tr></table></td><td>T1 (first column) and T2 (second column) must be table values.
Allow a mixture of significant figures.</td></tr>
<tr><td></td><td>U1</td><td>From $\pm$ 0.4 (or $\pm$ 0.5) to $\pm$ 0.1 (or $\pm$ 0.2)</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.
Penalise “blobs”.
Ecf allowed from table.</td></tr>
<tr><td></td><td>U2</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>(c) (ii)</td><td>G2</td><td>Line of best fit</td><td>If points are plotted correctly then lower end of line should pass between (1.65, 8.0) and (1.75, 8.0) and upper end of line should pass between (3.95, 22) and (4.05, 22). Allow ecf from points plotted incorrectly – examiner judgement.</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 all error bars are plotted.</td></tr>
<tr><td>(c) (iii)</td><td>C1</td><td>Gradient of best fit line</td><td>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 6.)</td></tr>
<tr><td></td><td>U3</td><td>Uncertainty in gradient correctly determined</td><td>Method of determining absolute uncertainty:
difference in worst gradient and gradient.</td></tr>
<tr><td>(d)</td><td>C2</td><td>$L = \frac{1}{4\pi^2 \times \text{gradient}}$</td><td>Allow ecf from (c)(iii).
(Should be about 4×10^{-3}.)</td></tr>
</table>

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	C3	$F^{-1}\,Hz^{-2}$ or $s^2\,F^{-1}$	Allow H or $kg\,m^2\,A^{-2}\,s^{-2}$ or $\Omega\,Hz^{-1}$ or $\Omega\,s$. Conventional notation required.
	U4	Absolute uncertainty in L.	
(e) (i)	C4	f in the range 760 to 800 and given to 2 or 3 s.f.	$f = \frac{1}{2\pi\sqrt{LC}} = \sqrt{\frac{\text{gradient}}{C}}$
(ii)	U5	Percentage uncertainty in f. Must be greater than 5%.	½(Percentage uncertainty in L + percentage uncertainty in C)

[Total: 15]

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) [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]

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

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

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

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