A-Level Physics

Paper 5

Unsolved Topical

Past Papers with Marking Schemes

All Variants

2014-2021

Title	A-LEVEL UNSOLVED TOPICAL PHYSICS PAPER 5
Published by	MS Books (042-35774780)
Legal Advisor	Ashir Najeeb Khan (Advocate) **AKBAR LAW CHAMBERS** 39-40, 1st Floor, Sadiq Plaza, The Mall, Lahore. 0307-4299886, 042-36314839
For Complaints/Order	**MS Books** 83-B Ghalib Market, Gulberg III Lahore (042-35774780),(03334504507),(03334548651)
Price	**Rs.**

PREFACE

Excellence in learning cannot be claimed without application of concepts in a dexterous way. In this regard one of the logical approach is to start in chunks; like chapter wise learning and applying the concept on exam based questions.

This booklet provides an opportunity to candidates to practice topic wise questions from previous years to the latest. Extensive working of Team MS Books has tried to take this booklet to perfection by collaborating with top of the line teachers.

We have added answer key / marks scheme at the end of each topic for the candidate to compare the hfis/her answer to the best.

MS Books strives to maintain actual spacing between consecutive questions and within options as per CAIE format which gives students a more realistic feel of attempting question.

Review, feedback and contribution in this booklet by various competent teachers of a subject belonging to renowned school chains make it most valuable resource and tool for both teachers and students.
With all belief in strength of this resource material I can confidently claim that it is worth in achieving brilliance.

Our sincere thanks and gratification to Mr. Syed Jabran Ali Kamran who took out special time to help compile and manage this booklet. We would also like to appreciate physics faculty for reviewing and indorsing it.

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PHYSICS PAPER 5

CONTENT TABLE

Kinematics

Q1/52/O/N/14

1 A student investigates the power dissipated by a lamp connected to a model wind turbine as shown in Fig. 1.1.

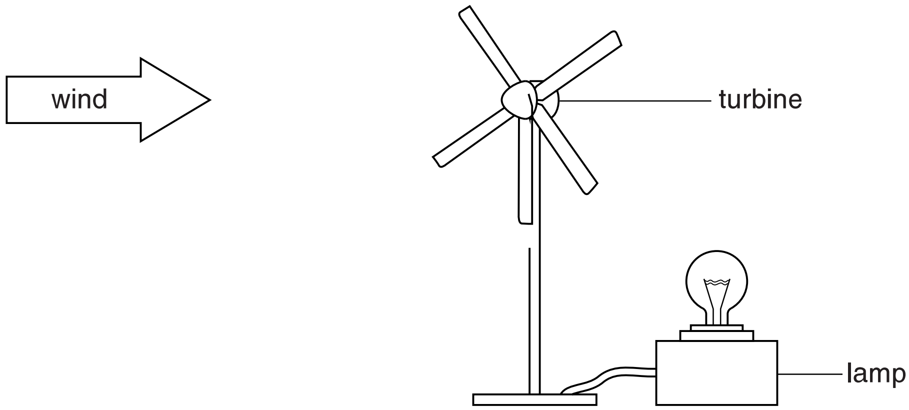

Fig. 1.1

The power P dissipated in the lamp depends on the angle θ between the axis of the turbine and the direction of the wind, as shown by the top view in Fig. 1.2.

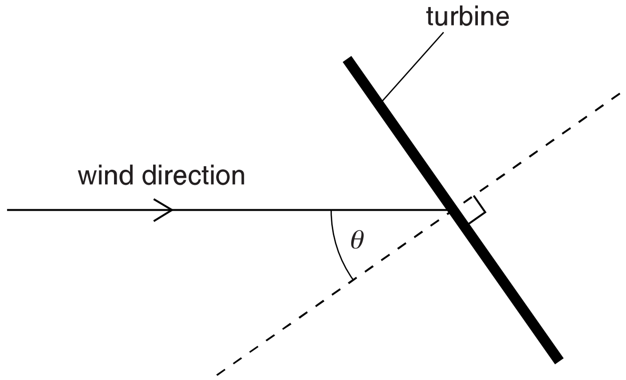

Fig. 1.2

It is suggested that

$$P = k\cos\theta$$

where k is a constant.

Design a laboratory experiment to test the relationship between P and θ and determine a value for k. You should draw a diagram, on page 3, showing the arrangement of your equipment. In your account you should pay particular attention to

(a) the procedure to be followed,

(b) the measurements to be taken,

(c) the control of variables,

(d) the analysis of the data,

(e) the safety precautions to be taken.

[15]

Diagram

....

....

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....

....

....

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....

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....

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Q2/53/O/N/14

2 A student investigates how the final velocity v of a cylinder rolling down a board varies with the height h of the board as shown in Fig. 2.1.

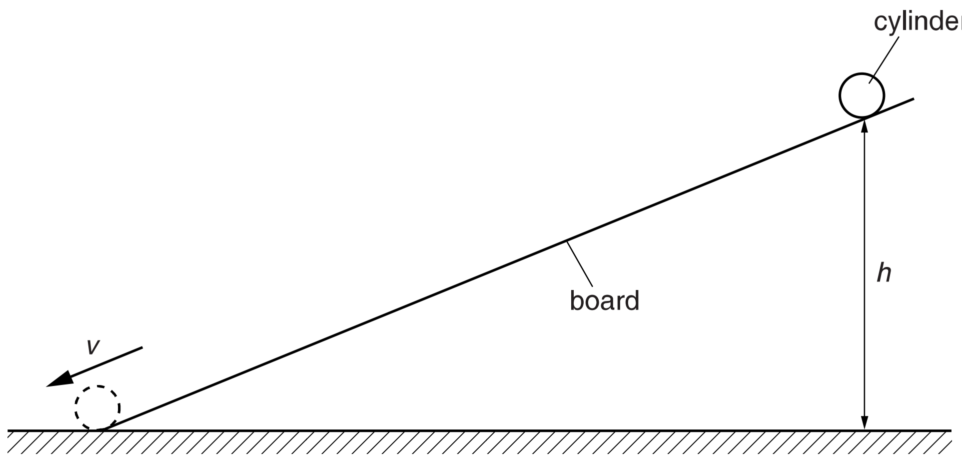


Fig. 2.1

For different values of h, the velocity v is determined using a light sensor connected to a data logger.

It is suggested that v and h are related by the equation

$$2gh = v^2Z$$

where g is the acceleration of free fall and Z is a constant.

(a) A graph is plotted of v^2 on the y-axis against h on the x-axis. Determine an expression for the gradient in terms of g and Z.

gradient = ... [1]

(b) Values of *h* and *v* are given in Fig. 2.2.

h / m	v / m s^{-1}	
0.230	1.40 ± 0.05	
0.280	1.55 ± 0.05	
0.320	1.65 ± 0.05	
0.360	1.75 ± 0.05	
0.400	1.85 ± 0.05	
0.450	1.95 ± 0.05	

Fig. 2.2

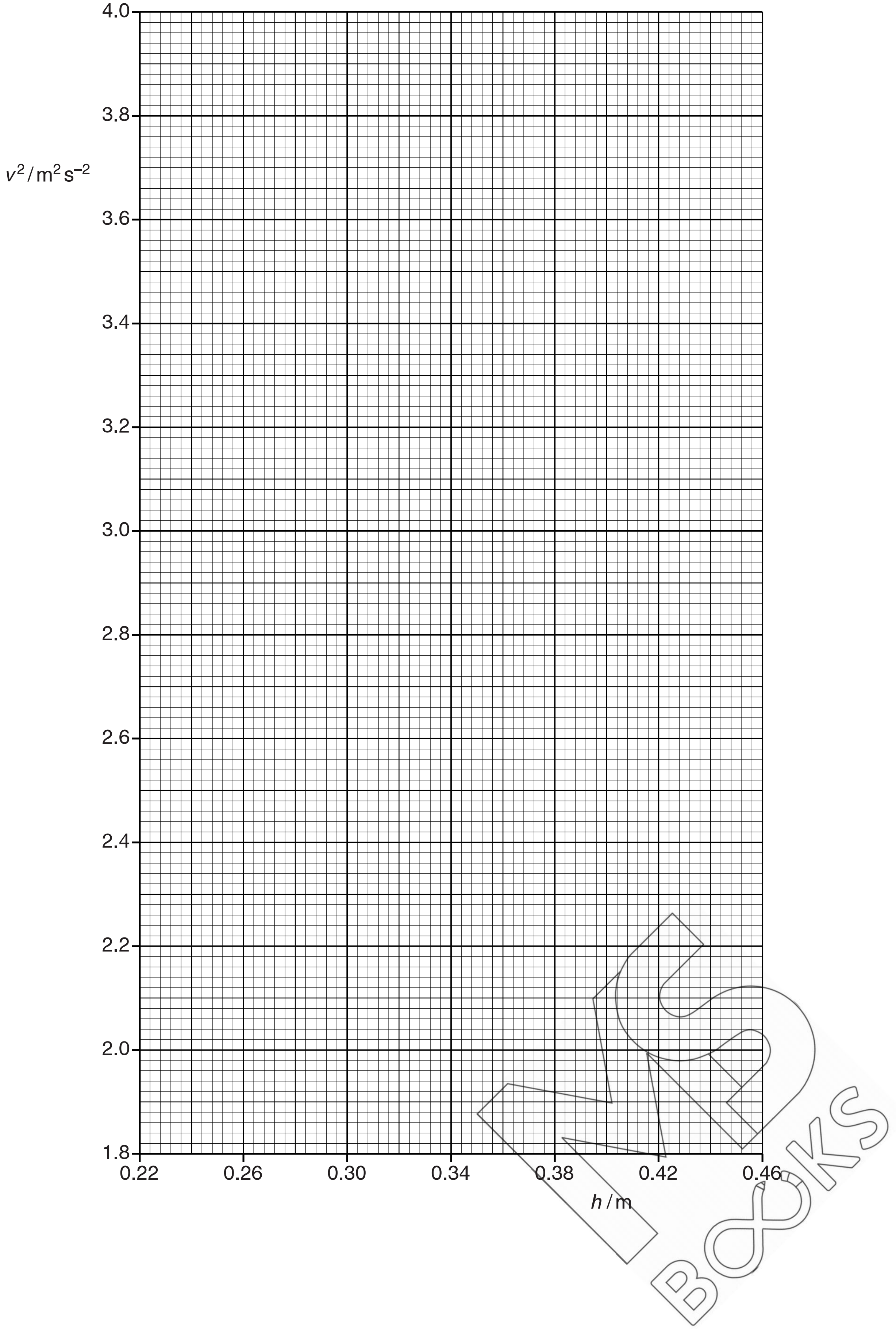
Calculate and record values of v^2 / m^2 s^{-2} in Fig. 2.2. Include the absolute uncertainties in v^2. [3]

(c) **(i)** Plot a graph of v^2 / m^2 s^{-2} against h / m. Include error bars for v^2. [2]

(ii) Draw the straight line of best fit and a worst acceptable straight line on your graph. Both lines should be clearly labelled. [2]

(iii) Determine the gradient of the line of best fit. Include the uncertainty in your answer.

gradient = ... [2]


4.0
3.8
v^2 / $m^2 s^{-2}$
3.6
3.4
3.2
3.0
2.8
2.6
2.4
2.2
2.0
1.8
0.22
0.26
0.30
0.34
0.38
0.42
0.46
h / m

(d) The experiment is repeated with $h = 0.700\,\text{m}$.

(i) Using your answer to **(c)(iii)**, determine the value of v using the relationship given.

v = ... $\text{m}\,\text{s}^{-1}$ [1]

(ii) Determine the percentage uncertainty in the value of v.

percentage uncertainty = ... % [1]

(e) The constant Z is given by

$$Z = \left(1 + \frac{K}{mr^2}\right)$$

where m is the mass of the cylinder and r is the radius of the cylinder.

Using your answers to **(a)** and **(c)(iii)**, determine the value of K. Include the absolute uncertainty in your value and an appropriate unit.

Data: $g = 9.81\,\text{m}\,\text{s}^{-2}$, $m = 2.5\,\text{kg}$ and $r = 0.015\,\text{m}$.

K = ... [3]

Q2/53/M/J/15

3 A student is investigating the performance of a motor vehicle.

The vehicle is driven at a constant speed v on a test track, as shown in Fig. 2.1.

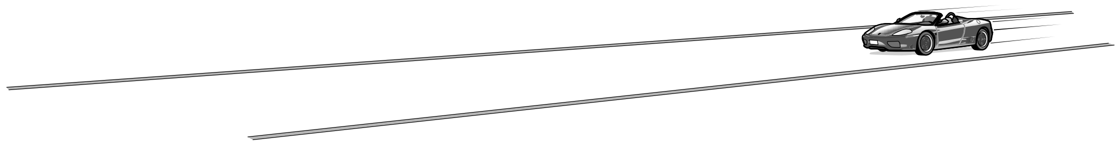


Fig. 2.1

The performance P of the vehicle is the distance travelled per unit volume of fuel, measured in kilometres per litre (km l^{-1}). This is obtained from the vehicle's computer system.

The experiment is repeated for different speeds.

It is suggested that P and v are related by the equation

$$P = kv^m$$

where k and m are constants.

(a) A graph is plotted of lg P on the y-axis against lg v on the x-axis.

Determine expressions for the gradient and y-intercept.

gradient = ...

y-intercept = ...
[1]

(b) Values of v and P are given in Fig. 2.2.

v/km h^{-1}	P/km l^{-1}	lg (v/km h^{-1})	lg (P/km l^{-1})
50	20.5 ± 0.5		
61	16.0 ± 0.5		
71	13.0 ± 0.5		
80	11.0 ± 0.5		
90	9.5 ± 0.5		
99	8.0 ± 0.5		

Fig. 2.2

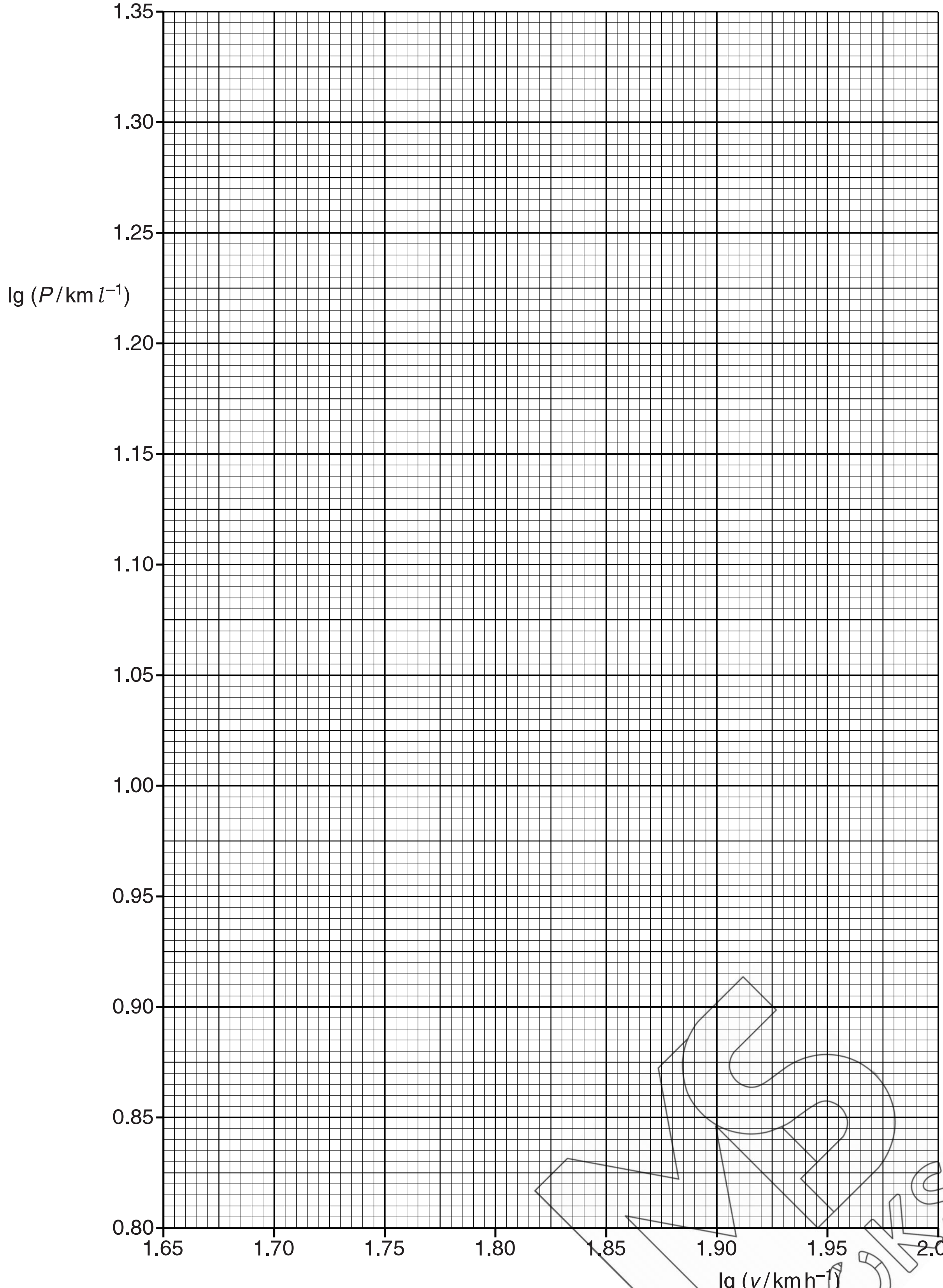
Calculate and record values of lg (v/km h^{-1}) and lg (P/km l^{-1}) in Fig. 2.2.
Include the absolute uncertainties in lg (P/km l^{-1}). [3]

(c) (i) Plot a graph of lg (P/km l^{-1}) against lg (v/km h^{-1}).
Include error bars for lg (P/km l^{-1}). [2]

(ii) Draw the straight line of best fit and a worst acceptable straight line on your graph.
Both lines should be clearly labelled. [2]

(iii) Determine the gradient of the line of best fit. Include the uncertainty in your answer.

gradient = ... [2]


1.35
1.30
1.25
lg (P / km l⁻¹)
1.20
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
1.65
1.70
1.75
1.80
1.85
1.90
1.95
2.00
lg (v / km h⁻¹)

(iv) Determine the y-intercept of the line of best fit. Include the uncertainty in your answer.

y-intercept = ... [2]

(d) **(i)** Using your answers to **(a)**, **(c)(iii)** and **(c)(iv)**, determine the values of k and m. You need not be concerned with the units of k and m.

k = ...

m = ...
[2]

(ii) Determine the percentage uncertainty in k.

percentage uncertainty in k = ... %
[1]

Q1/52/O/N/14

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]

Q2/53/O/N/14

2 Analysis, conclusions and evaluation (15 marks)

	Mark	Expected Answer	Additional Guidance
(a)	A1	gradient = $\frac{2g}{Z}$	
(b)	T1	v^2 / m^2 s^{-2}	Allow v^2 (m^2 s^{-2})
	T2	1.96 or 1.960 2.40 or 2.403 2.72 or 2.723 3.06 or 3.063 3.42 or 3.423 3.80 or 3.803	Must be table values. Allow a mixture of significant figures.
	U1	From $\pm$ 0.1 to $\pm$ 0.2 with uncertainties increasing	Allow more than one significant figure.
(c) (i)	G1	Six points plotted correctly	Must be within half a small square. Penalise "blobs". Ecf allowed from table.
	U2	Error bars in v^2 plotted correctly	All error bars to be plotted. Must be accurate to less than half a small square.
(c) (ii)	G2	Line of best fit	If points are plotted correctly then lower end of line should pass between (0.24, 2.04) and (0.24, 2.10) **and** upper end of line should pass between (0.42, 3.54) and (0.42, 3.60). Line should not be from top point to bottom point.
	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 all error bars are plotted.
(c) (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 8.4.)
	U3	Uncertainty in gradient	Method of determining absolute uncertainty: difference in worst gradient and gradient.
(d) (i)	C2	$v = \sqrt{\text{gradient} \times h}$	Gradient must be used (no substitution methods). Should be between 2.39 and 2.46.
(ii)	U4	$\frac{1}{2}\frac{\Delta\text{gradient}}{\text{gradient}} \times 100 = \frac{\Delta v}{v} \times 100$	Allow ecf from **(d)(i)**.

(e)	C3	K in the range 7.20×10^{-4} to 7.80×10^{-4} and given to 2 or 3 s.f.	$K = mr^2\left(\dfrac{2g}{\text{gradient}} - 1\right)$
	C4	kg m^2	
	U5	Absolute uncertainty in K	Uses worst gradient. Allow ecf.

[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) (ii) [U4]

max $v = \sqrt{\text{max gradient} \times h}$

min $v = \sqrt{\text{min gradient} \times h}$

(e) [U5]

max $K = mr^2\left(\dfrac{2g}{\text{min gradient}} - 1\right)$

min $K = mr^2\left(\dfrac{2g}{\text{max gradient}} - 1\right)$