Cambridge International Examinations
Cambridge International Advanced Level

CANDIDATE NAME											
CENTRE NUMBER							CANDIDATE NUMBER				

9820037802

PHYSICS **9702/53**

Paper 5 Planning, Analysis and Evaluation **October/November 2015**

1 hour 15 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.

Electronic calculators may be used.
You may lose marks if you do not show your working or if you do not use appropriate units.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

This document consists of **8** printed pages.

DC (LEG/FD) 97183/3

CAMBRIDGE International Examinations

[Turn over

1 A beaker contains water and some metal blocks as shown in Fig. 1.1.

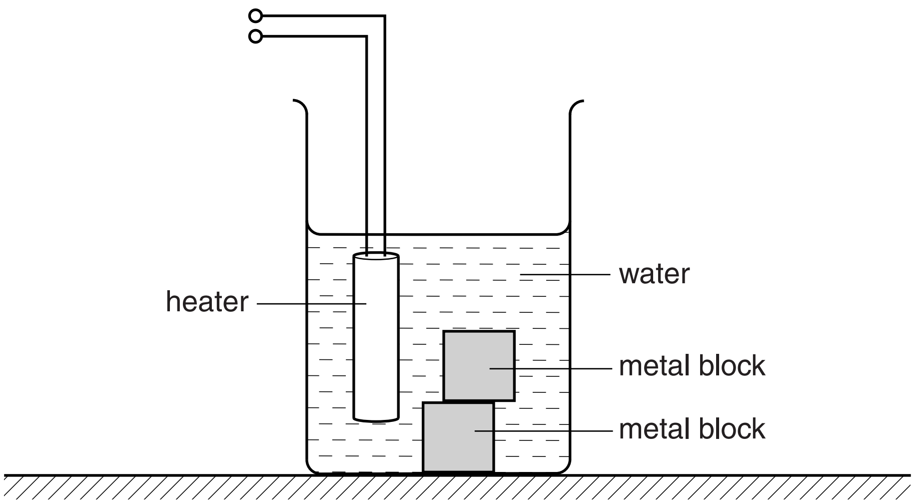

Fig. 1.1

A student uses an electrical heater to produce a particular temperature increase in the water.

It is suggested that the electrical energy E supplied to the heater is related to the mass m of metal blocks by the relationship

$$E = am + b$$

where a and b are constants.

Design a laboratory experiment to test the relationship between E and m. Explain how your results could be used to determine values for a and b. 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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Defining the problem	Methods of data collection	Method of analysis	Safety considerations	Additional detail

2 A student is investigating circular motion.

A small mass m attached to a larger mass P is rotated at constant speed in a horizontal circle, as shown in Fig. 2.1.

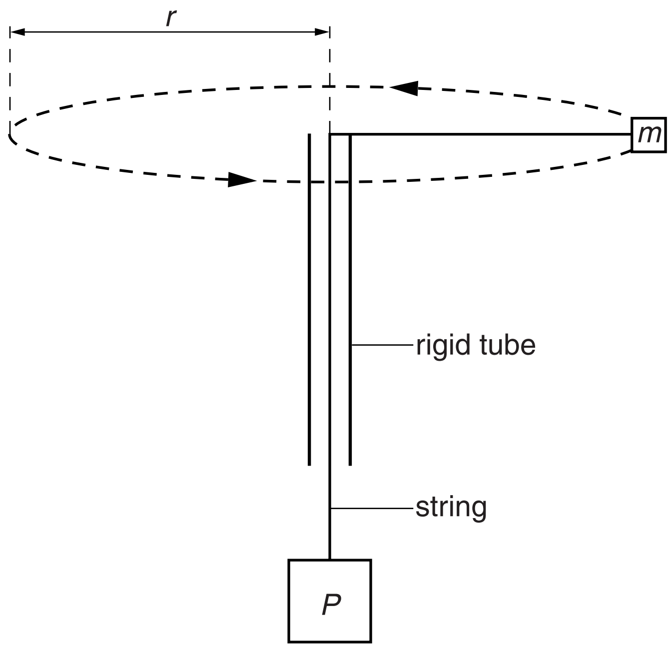


Fig. 2.1

The student changes the radius r of the circle and measures the time t for ten revolutions. The student then determines the period T of a revolution and then the speed v.

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

$$Pg = \frac{mv^2}{r}$$

where g is the acceleration of free fall.

(a) A graph is plotted of v^2 on the y-axis against r on the x-axis.
Determine an expression for the gradient.

gradient = ... [1]

(b) The speed v is given by

$$v = \frac{2\pi r}{T}.$$

Values of r and t are given in Fig. 2.2.

r/m	t/s			
0.160	3.4 ± 0.2			
0.280	4.0 ± 0.2			
0.400	4.8 ± 0.2			
0.520	5.4 ± 0.2			
0.640	6.0 ± 0.2			
0.760	6.6 ± 0.2			

Fig. 2.2

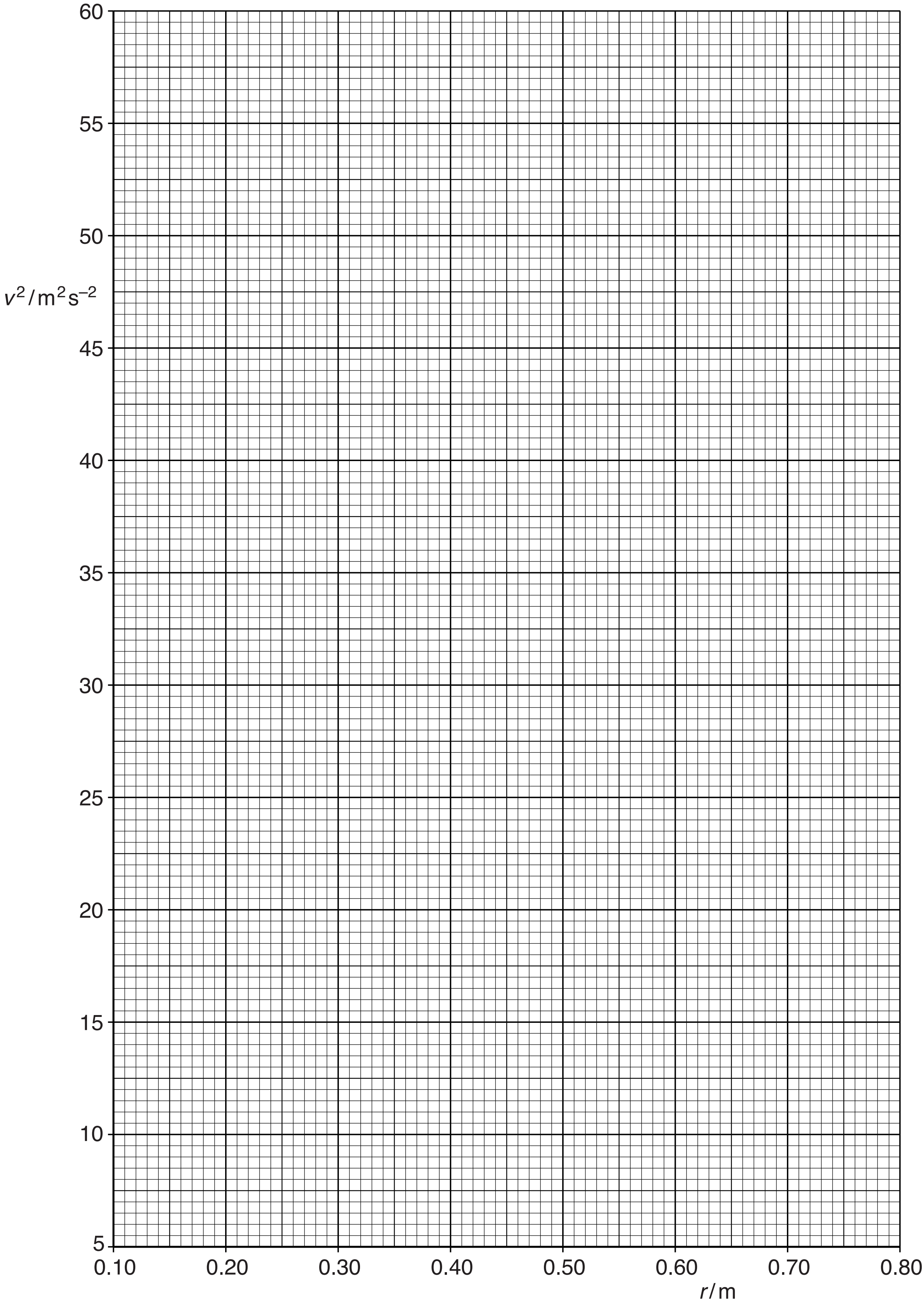
Calculate and record values of T/s, v/m s^{-1} and v^2/m^2 s^{-2} in Fig. 2.2. Include the absolute uncertainties in v^2. [3]

(c) **(i)** Plot a graph of v^2/m^2 s^{-2} against r/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 absolute uncertainty in your answer.

gradient = ... [2]


60
55
50
v^2 / $m^2 s^{-2}$
45
40
35
30
25
20
15
10
5
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
r / m

(d) (i) Using your answers to **(a)** and **(c)(iii)**, determine the value of P. Include an appropriate unit.

Data: $g = 9.81\,\text{m}\,\text{s}^{-2}$ and $m = 0.025 \pm 0.001\,\text{kg}$.

P = ... [2]

(ii) Determine the percentage uncertainty in your value of P.

percentage uncertainty = ... % [1]

(e) (i) The experiment is repeated with a small mass m of 0.040 kg. Determine the speed v when the radius r is $0.500 \pm 0.005\,\text{m}$.

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

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

percentage uncertainty = ... % [1]