Centre Number

71

Candidate Number

Rewarding Learning

cea

ADVANCED
General Certificate of Education
2014

Physics

Assessment Unit A2 3
Practical Techniques

Session 2

[AY232]

MONDAY 12 MAY, MORNING

MV18

TIME

1 hour 30 minutes, plus your additional time allowance.

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.
Turn to page 2 for further Instructions and Information.

INSTRUCTIONS TO CANDIDATES

Answer **all** questions in this paper. Rough work and calculations must also be done in this paper. Except where instructed, do not describe the apparatus or experimental procedures.

The supervisor will tell you the order in which you are to answer the questions. Not more than 30 minutes are to be spent in answering each question. You may be told to start with the experimental tests in Section A, or with the single question in Section B.

Section A consists of two experimental tests. A 28-minute period is allocated for you to use the apparatus. Two minutes is allocated to the supervisor to prepare the station for the next candidate. At the end of the 30-minute period you will be instructed to move to the area set aside for your next question.

Section B consists of one question in which you will be tested on aspects of planning and design.

All timings may vary if you have an additional time allowance.

INFORMATION FOR CANDIDATES

The total mark for this paper is 60.

All questions carry 20 marks each.

Figures in brackets printed at the end of each question indicate the marks awarded to each part question.

You may use an electronic calculator.

Section A

1 In this experiment you will investigate the oscillation of a pendulum in the form of a metre rule. The period of oscillation of the pendulum depends on the distance of the point of suspension to the centre of mass of the rule.

The aims of the experiment are:
- to obtain the period of oscillation of the metre rule when it swings from each point of suspension
- to analyse the results and determine the values of two constants.

Apparatus

You are provided with a metre rule which has holes drilled in it at distance D of 20 cm, 25 cm, 30 cm, 35 cm, 40 cm from the end of the rule.

Procedure

Suspend the rule from the pin clamped on the stand, using the hole drilled in the rule at the 40 cm mark, as shown in **Fig. 1.1**.
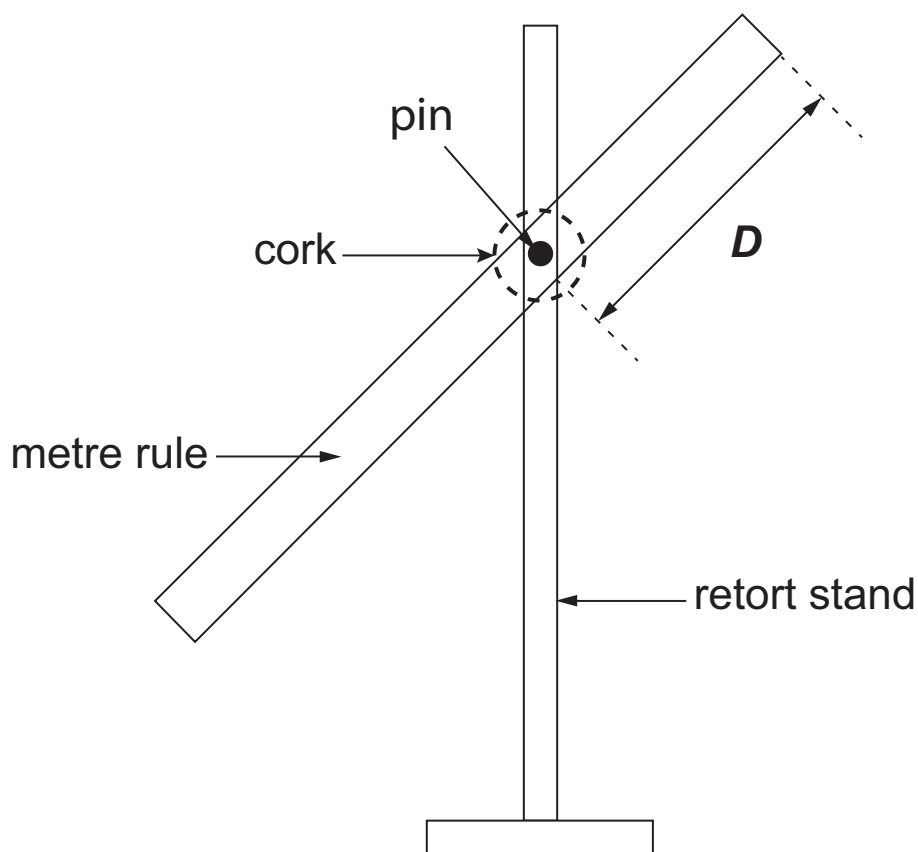

Fig. 1.1

(a) (i) Set the rule into oscillations of small amplitude and take readings to allow you to determine an accurate value of the period **T** of one oscillation. Record your readings in **Table 1.1**.

Repeat the procedure, suspending the rule in turn from the holes at 35 cm, 30 cm, 25 cm and 20 cm. Record your readings in **Table 1.1**. The other columns in the table are for use later. [6 marks]

Table 1.1

D/cm		Period T/s	d/m	$\frac{T^2}{d}$/s^2 m^{-1}	$\frac{1}{d^2}$/m^{-2}
40					
35					
30					
25					
20					

(ii) **d** is the distance from the centre of mass (assumed to be at the 50 cm mark) to the point of suspension, hence

d = 50 – **D**

Insert values for **d in metres** in **Table 1.1**. [1 mark]
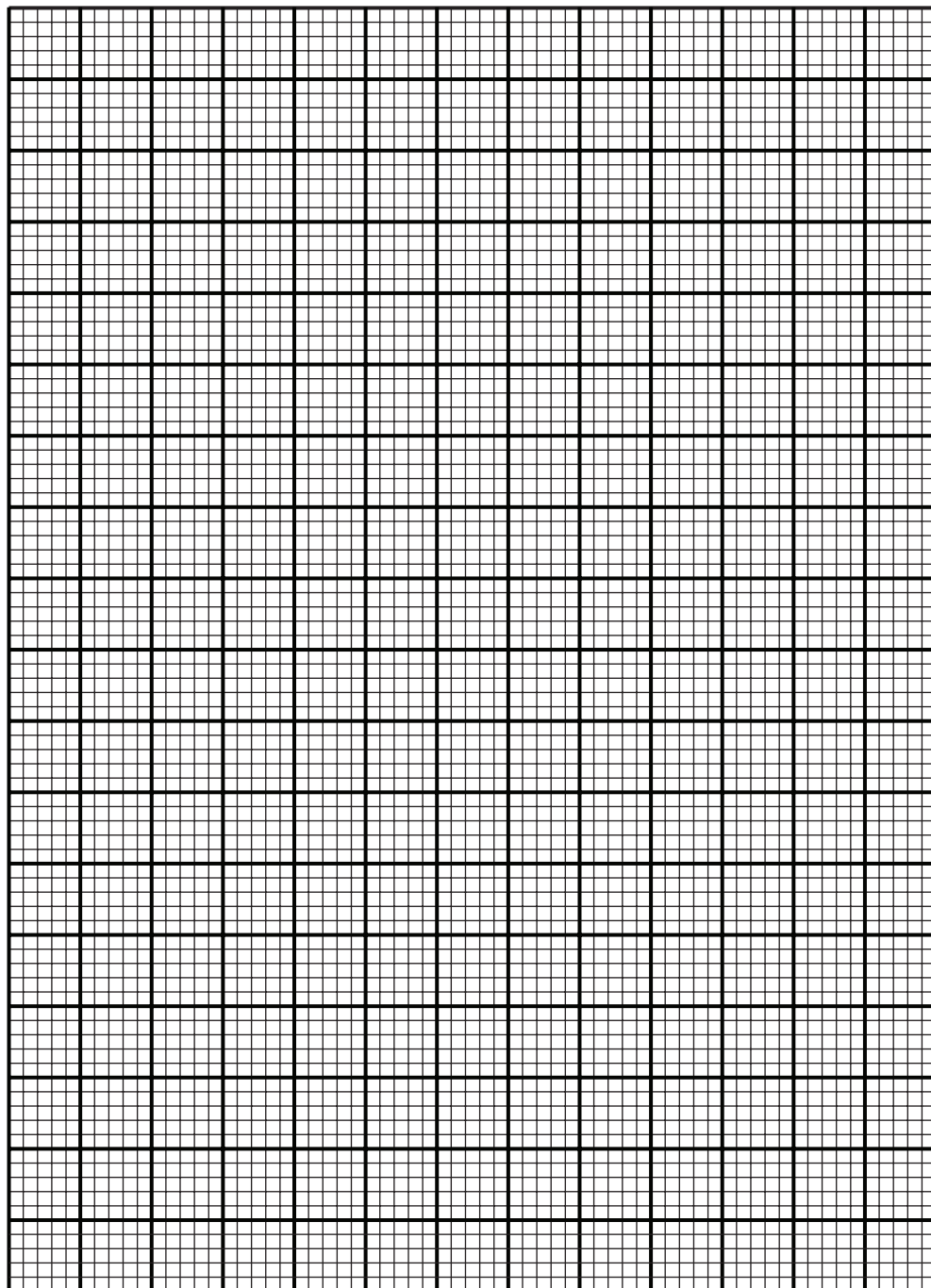
(b) A relationship between **T** and **d** is given by **Equation 1.1**

$$T^2 - \frac{A}{d} - Bd = 0 \qquad \textbf{Equation 1.1}$$

where A and B are constants.

(i) Use **Equation 1.1** to show that a graph of T^2/d (*y*-axis) against $1/d^2$ will be linear. [2 marks]

(ii) To draw this graph, it is necessary to calculate T^2/d and $1/d^2$.
In the two blank columns on the right of **Table 1.1** insert values calculated from your results. [1 mark]

(iii) You are to draw the graph T^2/d against $1/d^2$.
Choose suitable scales for the graph grid in **Fig. 1.2**.
Plot the points and draw the best fit straight line.
[4 marks]

$\dfrac{T^2}{d}$/s² m⁻¹

$\dfrac{1}{d^2}$/m⁻²

Fig. 1.2

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(iv) From your graph, find the numerical values of the constants A and B. Show clearly how the values are obtained. Enter the values, with appropriate units, below. [6 marks]

A **=** _____ Unit _____

B **=** _____ Unit _____

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(Questions continue overleaf)

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[Turn over

2 In this experiment you will investigate how the power dissipated by a small bulb varies with the voltage applied.

The aims of the experiment are:
- to measure current and voltage
- to plot a graph to find the relationship between the power dissipated by the bulb and the applied voltage.
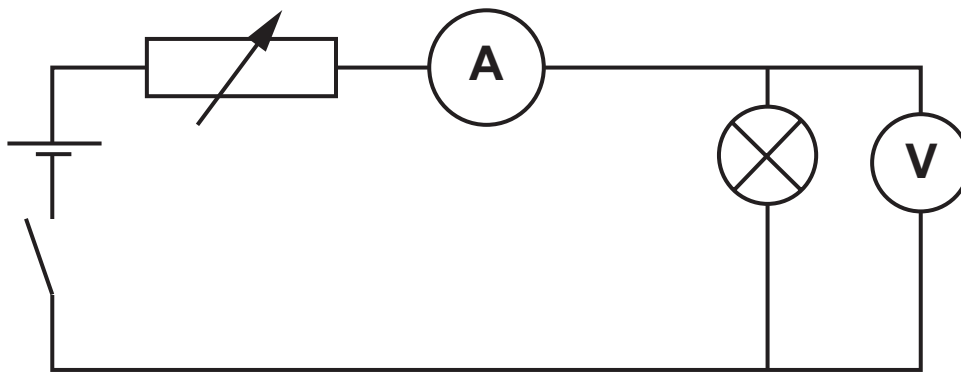
(a) The circuit shown in **Fig. 2.1** has been set up.

Fig. 2.1

(i) You are to take a series of five readings of the voltage, *V* across the bulb, and the current, *I* flowing through it. Using the variable resistor, vary the voltage from about 0.7 V to about 1.4 V.

Record these readings in **Table 2.1**. [5 marks]

Table 2.1

V/V	*I*/A	*P*/___	$\lg_{10}(P/\text{unit})$	$\lg_{10}(V/\text{V})$

(ii) For each pair of the readings of *V* and *I* calculate the corresponding value of the power, *P* dissipated by the bulb.
(Reminder: **power = voltage × current**)
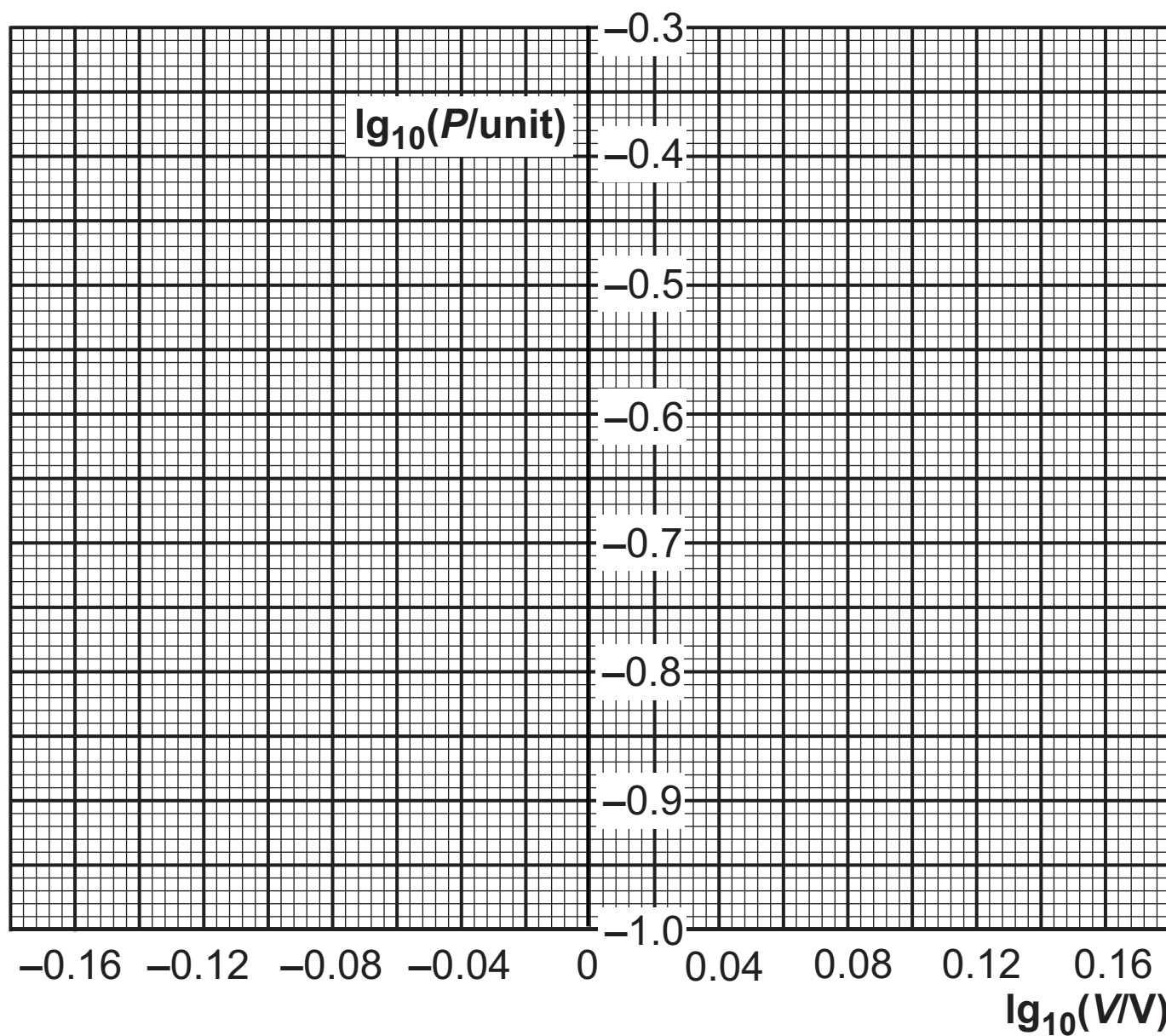Enter the values in the column headed *P* in **Table 2.1**.
Include a unit for *P*. [2 marks]

(b) The power dissipated by the bulb is related to the voltage across the bulb by the relationship given by **Equation 2.1**

$$P = BV^n \qquad \textbf{Equation 2.1}$$

where B and n are constants.

(i) Use **Equation 2.1** to show that a graph of $\lg_{10}P$ (*y*-axis) against $\lg_{10}V$ will be linear. [2 marks]

(ii) To draw this graph, it is necessary to calculate additional quantities from your results. Complete the two blank columns of **Table 2.1** with quantities calculated from your results. [2 marks]

(iii) Plot the points on **Fig. 2.2** and draw the best fit straight line. [3 marks]

Fig. 2.2

(iv) From your graph, find the value of B. Show clearly how the value is obtained. [3 marks]

B **= _____**

(v) Determine the percentage uncertainty in the value for B obtained in **(iv)** using your graph in **Fig. 2.2**. [3 marks]

Uncertainty in B **= _____ %**

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(Questions continue overleaf)

Section B

3 In this question you will plan an experiment to investigate the behaviour of solid brass cylinders, of various diameters, as they roll down a slope as shown in **Fig. 3.1**.

The cylinder diameters are in the range 30 mm–100 mm but they all have a length **L** of 38.0 mm. You have access to any equipment normally found in a physics laboratory except that used to measure mass. However, a value for the density of brass is provided, and density **=** mass/volume.
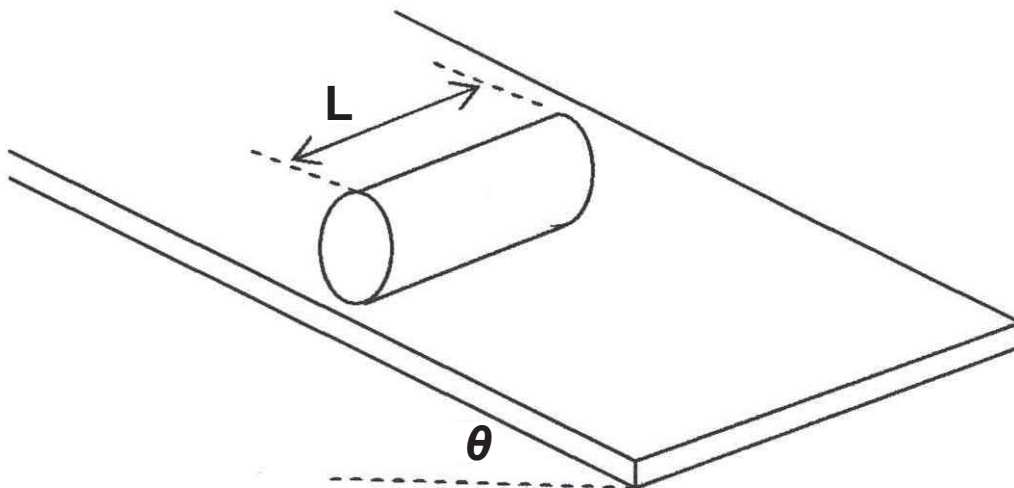

Fig. 3.1

The plan

(a) (i) Describe a suitable method, based on the arrangement of **Fig. 3.1**, that will allow you to investigate the relationship, if any, that exists between the mass of the cylinders and their average velocity, **v**, as they travel down the slope [8 marks].

Your method should also include:

- the measurements you will take
- the instruments used, include the uncertainty in any measurement taken with each instrument
- an explanation as to how the average velocity and mass of the cylinder are determined from your measurements
- how you will maximise the reliability of your results

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(ii) One cylinder has a diameter of 54.0 mm. The density of the brass used to make the cylinders is 8650 kg m^{-3}. Find the mass of this cylinder and estimate the uncertainty in this value. Assume the uncertainty in the value for the density is negligible. (Cylinder volume $= \pi r^2 L$) [5 marks]

Mass = _____ kg

Uncertainty = ± _____ kg

(b) (i) A student suggests that another factor which changes the average velocity is the angle θ of the slope to the horizontal. Suggest an accurate method for measuring this angle. [2 marks]

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(ii) State another factor which will affect the average velocity. [1 mark]

_____

(c) Explain how the results taken can be used to determine the acceleration experienced by the cylinder as it rolls down the slope. [2 marks]

(d) (i) In one experiment a cylinder of mass 1.80 kg loses 2.05 J of potential energy and acquires a velocity of 1.36 m s^{-1} at the bottom of the slope. Calculate the kinetic energy gained. [1 mark]

Kinetic energy **=** _____ J

(ii) From what vertical height was the cylinder released in this experiment? (The acceleration of free fall is 9.81 m s^{-2}) [1 mark]

Height **=** _____ m

_____

THIS IS THE END OF THE QUESTION PAPER

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