



Rewarding Learning

ADVANCED
General Certificate of Education
2011

Centre Number

71	
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Candidate Number

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Physics

Assessment Unit A2 3

Practical Techniques
(Internal Assessment)

Session 1

[AY231]



MONDAY 9 MAY, MORNING

TIME

1 hour 30 minutes.

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.

Question Number	Marks	
	Teacher Mark	Examiner Check
1		
2		
3		
Total Marks		



INSTRUCTIONS TO CANDIDATES

Answer **all** questions in this booklet. Rough work and calculations must also be done in this booklet. 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.

INFORMATION FOR CANDIDATES

The total mark for this paper is 60.

All questions carry 20 marks each.

Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each part question.

You may use an electronic calculator.

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(Questions start overleaf)

Section A

- 1 In this experiment you will use a converging lens to focus images of an object on to a screen. You will measure the object and image distances, and the size of the image.

The aims of this experiment are:

- to obtain focused images of the object and take measurements of object and image distances, and of image size;
- to use the results to plot a linear graph;
- to use the graph to determine the focal length of the lens.

Apparatus

The apparatus consisting of an illuminated object, a converging lens, a screen, and a metre rule has been set up as shown in **Fig. 1.1**. The object consists of two crossed lines with a flat circular ring as shown in **Fig. 1.2**. The lines are to assist focusing. The screen is a graph grid of **2 mm** squares.

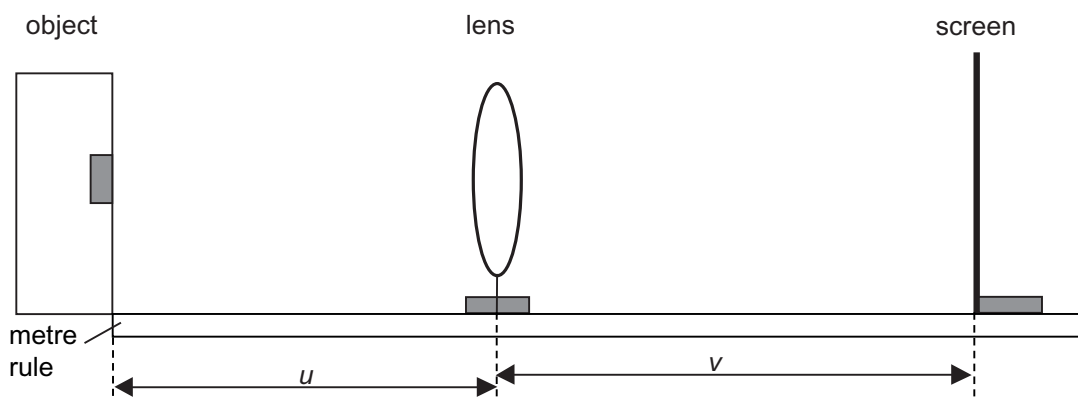


Fig. 1.1

In **Fig. 1.1**, u is the distance between the illuminated object and the lens (the object distance), and v is the distance between the lens and the corresponding sharply-focused image on the screen (the image distance).

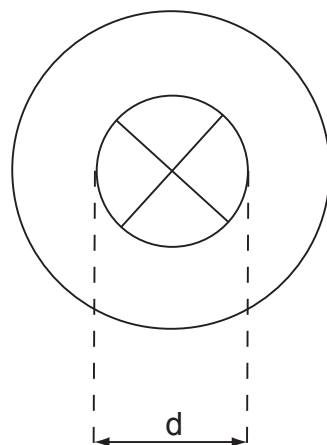


Fig. 1.2

Teacher Mark	Examiner Check	Remark

- (a) Set the object distance u to 120 mm and adjust the position of the screen until a clearly-focused image of the object is obtained. Measure the image distance v and the internal diameter d of the image (see **Fig. 1.2**). Record these values in **Table 1.1**.

Repeat this procedure to obtain five sets of results for the values of u given in **Table 1.1** and record these results.

Table 1.1

u/mm	v/mm	d/mm
120		
140		
160		
180		
200		

[5]

- (b) Plot a graph of v on the y-axis against d on the x-axis on the grid of **Fig. 1.3**. Choose a suitable scale, label the axes, plot the points and draw the best fit line. [4]

The relationship between v and d is given by the **Equation 1.1**

$$v = Ad + F \quad \text{Equation 1.1}$$

where A and F are constants for this experimental arrangement.

- (c) Use your graph to find a value of the constants A and F . Show clearly how the values are obtained and give the values, with units where appropriate, below.

$A =$ _____

$F =$ _____

[5]

Teacher Mark	Examiner Check	Remark

(d) For each **image** distance there is experimental uncertainty in the value.

(i) State **two** experimental factors which contribute to this uncertainty.

1. _____

2. _____ [2]

(ii) Estimate the experimental uncertainty in the value for the distance between the lens and the image.

Uncertainty = \pm _____ [1]

(iii) Using your graph find the uncertainty in the value of F .

Uncertainty in F = \pm _____ [2]

(iv) F is the focal length of the lens. The manufacturer's value of F is given as 100 mm. Calculate the percentage difference between the value you have calculated in part (c) and the manufacturer's value.

Percentage difference in values of F = _____ % [1]

Teacher Mark	Examiner Check	Remark

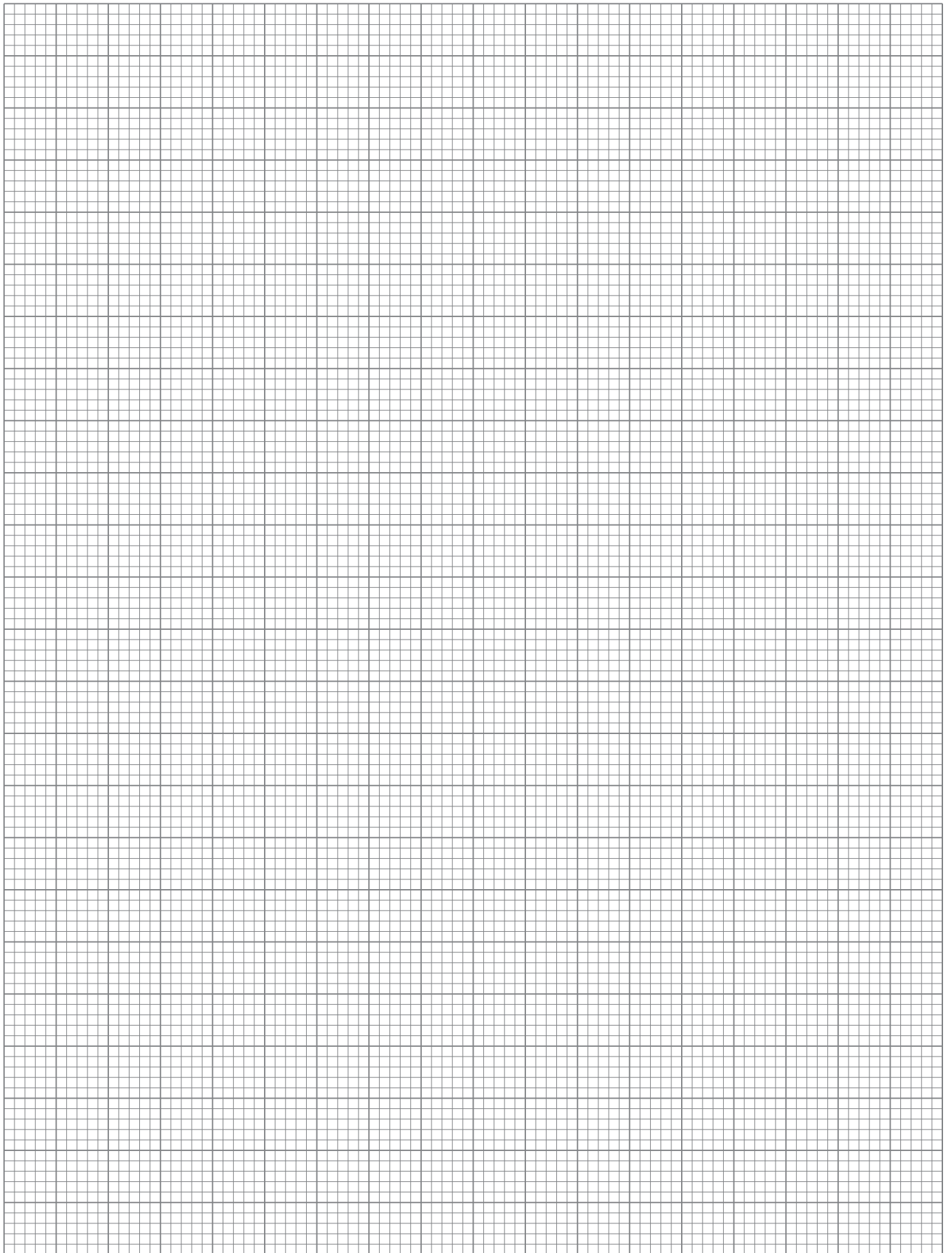


Fig. 1.3

2 In this experiment you will investigate the discharge of a capacitor network through a resistor.

The aims of this experiment are:

- to take measurements of the discharging current as a function of time;
- to use the results to plot a natural log straight line graph;
- to use the graph to determine the capacitance from a measurement of the time constant of the circuit;
- to deduce the arrangement of the capacitors in the network.

Apparatus

You are provided with a box containing a resistor and a two capacitor network. A switch is provided to allow the capacitor network to charge and discharge. A d.c. supply is connected to one pair of terminals on the box. A digital microammeter is connected to the other pair of terminals. You are also provided with a stop clock.

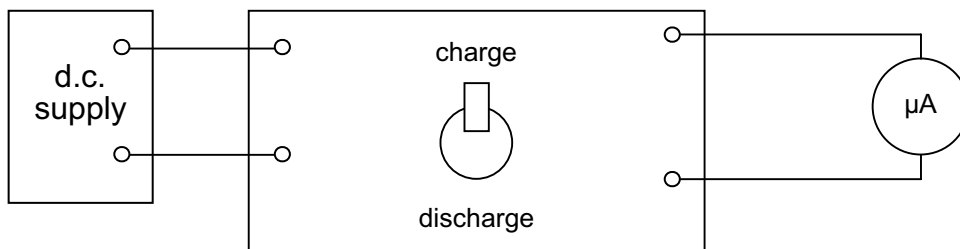


Fig. 2.1

- (a) Set the switch to the charge position for a few seconds. Then set the switch to the discharge position and at the same time start the stop clock. You are to take a series of current I readings at ten second intervals for 90 seconds. Record your results in **Table 2.1**.

Teacher Mark	Examiner Check	Remark

Table 2.1

t/s	$I/\mu A$	
0		
10		
20		
30		
40		
50		
60		
70		
80		
90		

[5]

When a charged capacitor network of capacitance C discharges through a resistor of resistance R , the current I through the resistor varies according to the equation

$$I = I_0 e^{-\frac{t}{CR}} \quad \text{Equation 2.1}$$

where I_0 is the initial current and CR is the time constant of the circuit.

- (b) You are to find the value of the time constant CR from the linear graph obtained by plotting the **natural logarithm \ln of the current I against the time t** .
Using **Equation 2.1** as a starting point, show that this plot will produce a linear graph.

[2]

Teacher Mark	Examiner Check	Remark

(c) (i) Make the necessary calculations to enable you to plot the linear graph and enter the values in the blank column in **Table 2.1**. Label the column appropriately. [2]

(ii) Using the graph grid of **Fig. 2.2**, select suitable scales, label the axes, plot the values and draw the best straight line. [5]

(iii) Find the time constant for the discharge circuit and record the value with the appropriate unit.

$CR =$ _____ [4]

(d) The resistance of the resistor in the discharge circuit is $15\text{ k}\Omega$ and the capacitance of each of the two capacitors is $1000\ \mu\text{F}$. Using this information and the value you have obtained for the time constant of the circuit, deduce whether the two capacitors are in series or in parallel. Indicate your choice by placing a tick in the appropriate box and explain your choice.

series

parallel

_____ [2]

Teacher Mark	Examiner Check	Remark

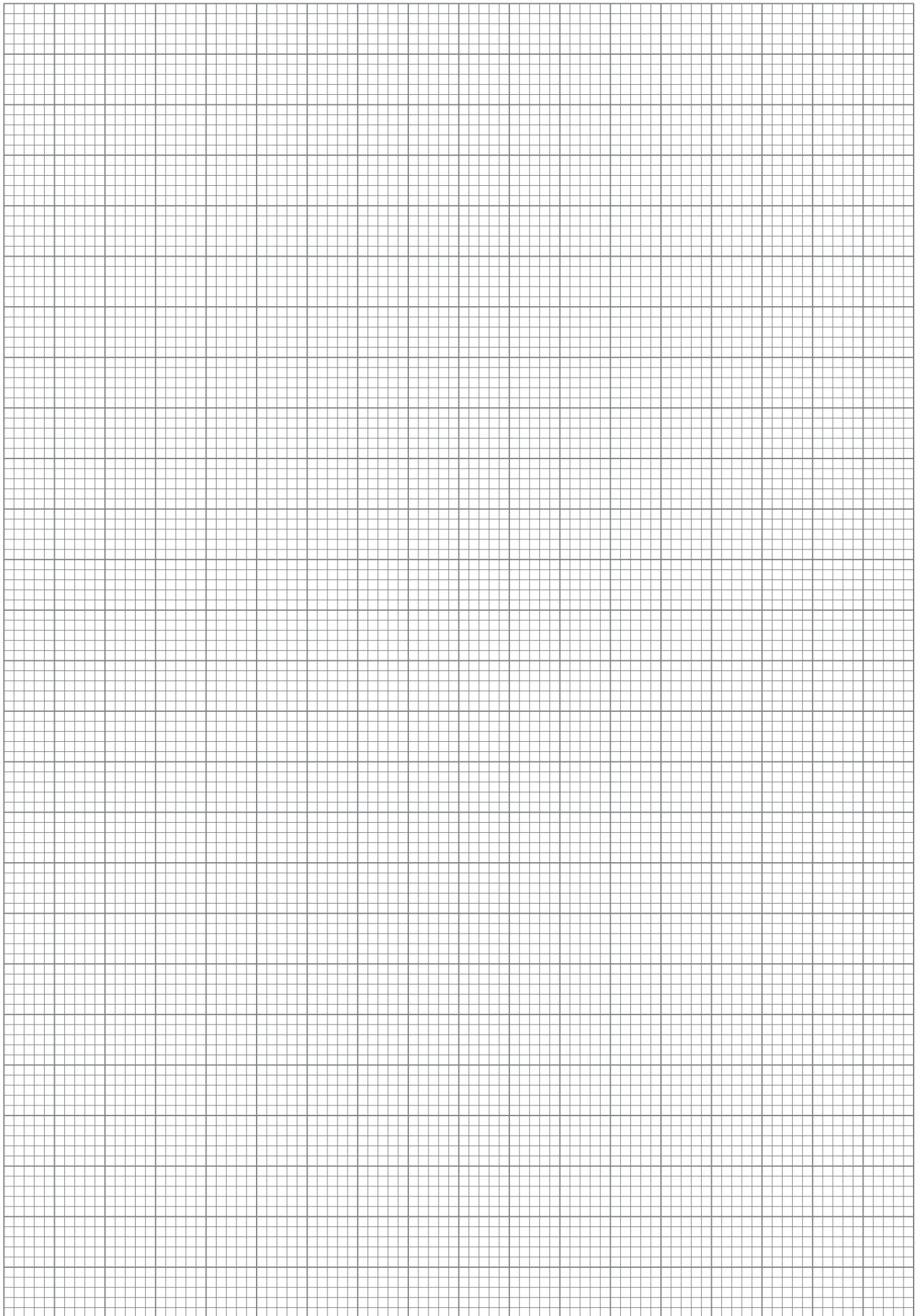


Fig. 2.2

Section B

3 In this question you will plan an experiment to find the period of oscillation of a liquid in a U-tube of uniform cross-sectional area.

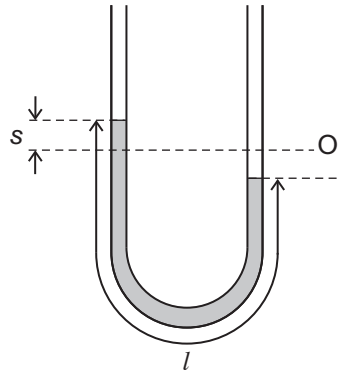


Fig. 3.1

If the liquid on one side of the U-tube is depressed by blowing gently down on one side, the levels of the liquid will oscillate for a short time about the equilibrium position O before finally coming to a rest, see **Fig. 3.1**.

(a) (i) Describe an experiment to find how the period of oscillation T depends on the total length l of the liquid in the tube. In your answer you should include:

- the procedure, including the measurements that are to be taken and how they are taken;
- how the results should be processed to find the values of the period of oscillation T for different lengths l

Teacher Mark	Examiner Check	Remark

- (b) The relationship between the period of oscillation T and the total length l of the liquid in the tube is given by the equation

$$T = 2\pi\sqrt{\frac{l}{2g}} \quad \text{Equation 3.1}$$

- (i) A straight line graph is to be drawn of the results. Label the axes on **Fig. 3.2** to show the quantity you would plot on each axis and sketch the line you would expect to obtain.

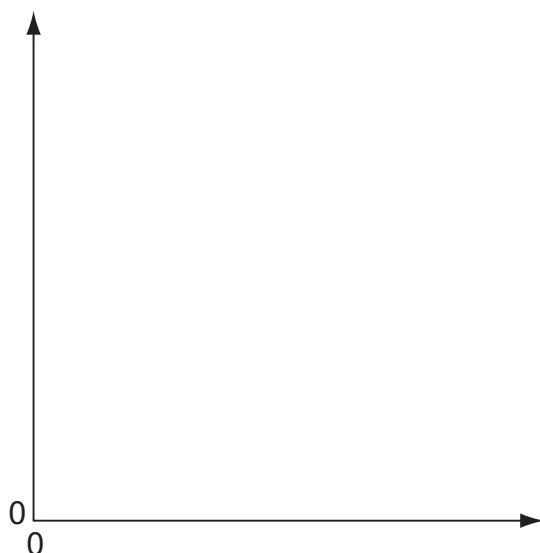


Fig. 3.2

[2]

- (ii) Explain how you could use the graph to find a value for the acceleration of free fall g .

[2]

Teacher Mark	Examiner Check	Remark

- (c) When the liquid of density ρ in the U-tube is displaced a distance s above the equilibrium position there is excess pressure P exerted on the liquid in the tube. This excess pressure is given by **Equation 3.2**.

$$P = 2s\rho g \quad \text{Equation 3.2}$$

To calculate the excess pressure P in the liquid the student must use the equations for pressure and density. She starts this process by finding the density ρ of the liquid. The mass of the liquid was found using a balance reading to 0.01 g and was 543.53 g. The length of the liquid in the tube was found to be 15.3 ± 0.1 cm and the internal diameter of the tube was measured by vernier callipers to be 1.84 cm.

- (i) Find the density of the liquid $\left(\text{density} = \frac{\text{mass}}{\text{volume}} \right)$.

Density = _____ [2]

- (ii) The value of the density is derived from the measurements of several quantities. State which quantity contributes most to the overall percentage uncertainty, explain your choice and evaluate the percentage uncertainty in this quantity.

 _____ [3]

- (iii) **Equation 3.2** was obtained by analysis of experimental results. Check the validity of **Equation 3.2** by comparing the units of the quantities on both sides of the equation in terms of base units.

N.B. pressure = $\frac{\text{force}}{\text{area}}$.

 _____ [2]

Teacher Mark	Examiner Check	Remark

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