



*Rewarding Learning*  
ADVANCED SUBSIDIARY (AS)  
General Certificate of Education  
2017

Centre Number

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Candidate Number

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## Physics

Assessment Unit AS 3  
*assessing*  
Practical Techniques

**MV18**

[AY131]

**TUESDAY 2 MAY, MORNING**

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### **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** the 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 Teacher/Supervisor will tell you the order in which you are to answer the questions.

One hour is to be spent on Section A and 30 minutes on Section B.

Section A consists of four short experimental tests. **You will have access to the apparatus for 13 minutes for each of the tests.** At the end of this 13-minute experimental period there is a 2-minute changeover to the area set aside for the next test. Any spare time before the start of the next test may be used to write up anything you have not yet completed.

At the end of your Section A work you will be told to move to the area set aside for Section B.

Section B consists of one question in which you will analyse a set of experimental results.

## Information for Candidates

The total mark for this paper is 40.

Section A and Section B carry 20 marks each.

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

You may use an electronic calculator.

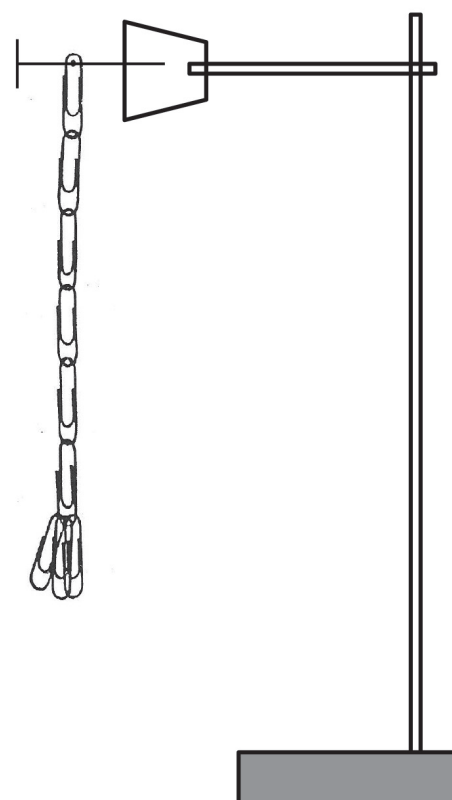
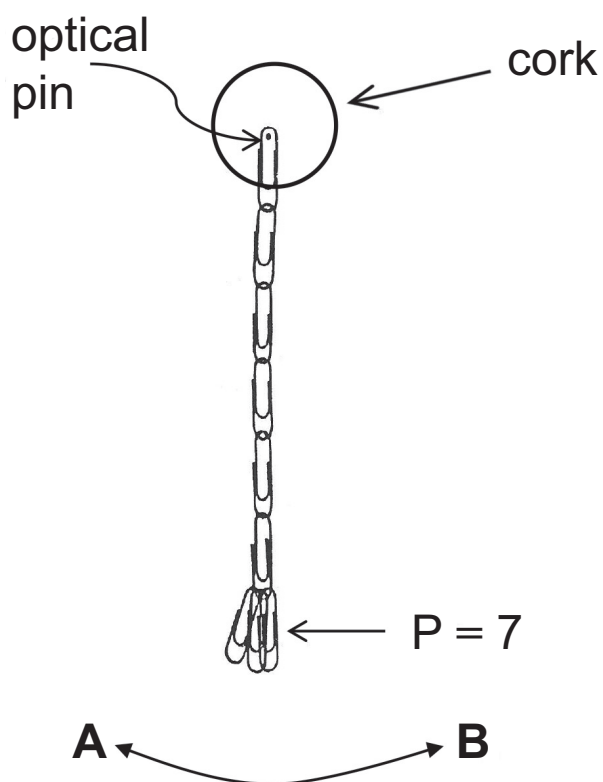
## Section A

- 1 In this experiment you are to determine an accurate value for the period of oscillation of a pendulum and to determine the value of a constant.

**Fig. 1.1** shows the arrangement of the apparatus that has already been set up for you. The pendulum is made of 7 paperclips linked together, 2 extra paperclips are placed in parallel with the bottom clip. This is referred to as position 7,  $P = 7$ .

**Front View**

**Side View**



**Fig. 1.1**

(a) Head the blank column in **Table 1.1** to allow appropriate results to be recorded enabling an accurate period for this pendulum to be determined.

Displace the pendulum a **small** distance in a horizontal plane and release it so it oscillates from **A** to **B**. Record your results in **Table 1.1**. [3 marks]

**Table 1.1**

Position, P		T/s
7		

(b) **Equation 1.1** is the theoretical relationship between the period of oscillation **T** and position **P** of the extra two paperclips, where **b** is a constant.

$$\mathbf{T^2P = 2.30 + bP^2} \quad \mathbf{Equation\ 1.1}$$

Determine a value for **b** using data from **Table 1.1** and **Equation 1.1**. [2 marks]

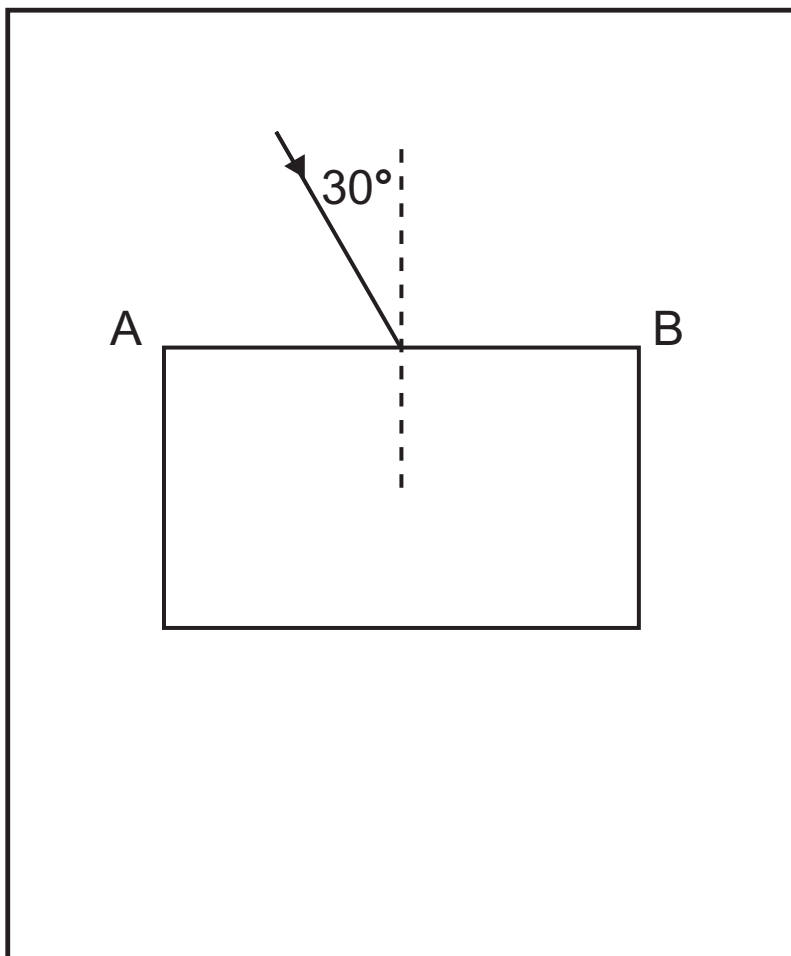
**b** = \_\_\_\_\_

unit = \_\_\_\_\_

- 2 In this experiment you are to investigate the refraction of light as it travels from air into a transparent block; and to determine the time taken for the refracted light to travel through the block.

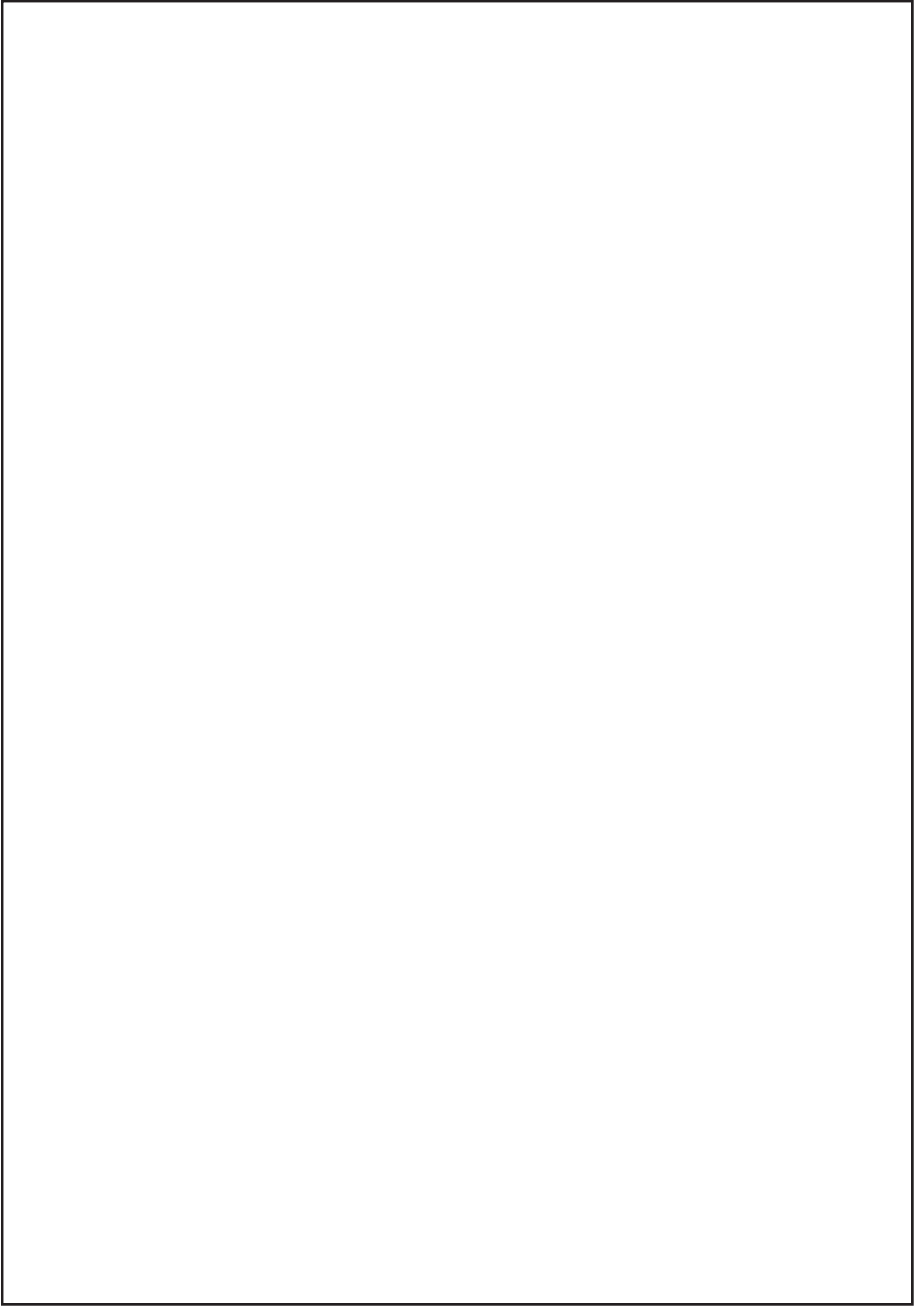
You are provided with a transparent rectangular block, a ray box, a protractor and a ruler.

- (a) Place the transparent block in the space in **Fig. 2.2** on **page 7** in the orientation shown in **Fig. 2.1**. Draw around the block. Remove the block and draw a normal near the middle of side AB of the block. Draw a line to represent an incident ray at an angle of incidence  $30^\circ$  as shown in **Fig. 2.1**.



**Fig. 2.1**

**Question continues on page 8**



**Fig. 2.2**

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Replace the block and direct a ray of light along the incident ray drawn. Mark the path of the emergent ray. Remove the block and construct the path of the refracted ray through the block. Measure the angle of refraction **R** using the protractor and record your result in **Table 2.1**. [2 marks]

**Table 2.1**

Angle of incidence $i/^\circ$	Angle of refraction $R/^\circ$
30	

**(b) (i)** Use your result for **R** to calculate the refractive index **n** of the transparent block. [1 mark]

Refractive index **n** = \_\_\_\_\_



- (ii) Determine the speed of light in the transparent block using the relationship given in **Equation 2.1**. The speed of light in air is  $3.0 \times 10^8 \text{ m s}^{-1}$ . [2 marks]

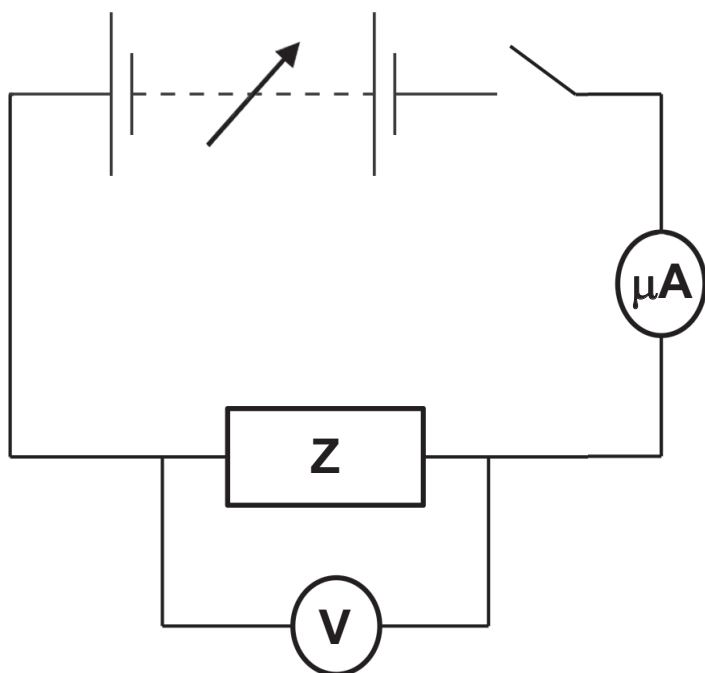
$$\text{refractive index} = \frac{\text{speed of light in air}}{\text{speed of light in block}} \quad \text{Equation 2.1}$$

Speed of light in the block = \_\_\_\_\_  $\text{m s}^{-1}$

Make an appropriate measurement, and use your answer for the speed of light in the block, to determine how long it took for the light to travel through the transparent block.

Time = \_\_\_\_\_ s

- 3 In this experiment you are to identify the component within a sealed box, labelled **Z**. The circuit shown in **Fig. 3.1** has been set up for you.



**Fig. 3.1**

- (a) Close the switch and record readings of voltage and current from the voltmeter and the micro-ammeter. Increase the power supply voltage and repeat this process. You should take readings for five well-spaced voltages between 0V and 12V. Record all your readings in the first two columns of **Table 3.1**. [1 mark]

**Table 3.1**

V/V	I/ $\mu$ A	R/ $\Omega$

- (b) Calculate the resistance **R** of the component for each set of readings. Record your answers in the third column of **Table 3.1**. [2 marks]

- (c) Identify component **Z** and justify your choice with reference to your data. [2 marks]

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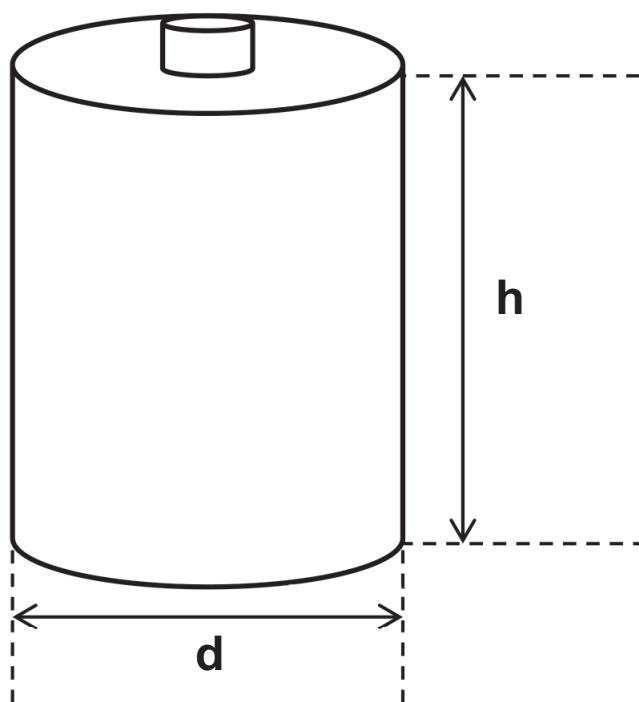
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- 4 In this question you are to determine the density of a cylinder in the form of a 1.5V battery. You will also consider the uncertainty in your measurements.

The density of a cylinder is given by **Equation 4.1**.

$$\rho = \frac{4m}{\pi d^2 h} \quad \text{Equation 4.1}$$

Where  $\rho$  is the density,  $m$  is the mass,  $d$  is the diameter and  $h$  is the height of the cylinder as shown in **Fig. 4.1**.



**Fig. 4.1**

(a) You are provided with a cylindrical 1.5 V battery. Take measurements to determine the density of the battery. Record all your measurements in **Table 4.1** using the equipment stated. State the absolute uncertainty in the measurement of mass and height. The absolute uncertainty of the diameter has already been entered. [2 marks]

**Table 4.1**

Measurement	Equipment	Value	Unit	Uncertainty
Mass	Electronic Scales		g	± g
Diameter	Calliper		cm	± 0.01 cm
Height	Ruler		cm	± cm

(b) Using your values in **Table 4.1** calculate the density of the battery to 2 significant figures. [1 mark]

Density  $\rho =$  \_\_\_\_\_ g cm<sup>-3</sup>

(c) Determine the percentage uncertainty in your result for the density. [2 marks]

Percentage uncertainty =  $\pm$  \_\_\_\_\_ %

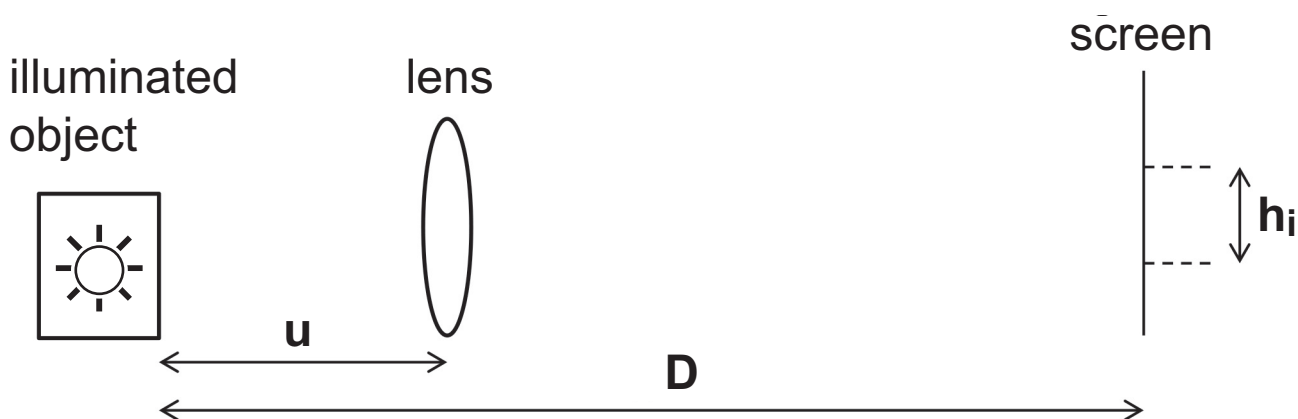
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**(Questions continue overleaf)**

## Section B

### 5 The focal length of a converging lens

An experiment using an illuminated object, optical bench and screen was carried out to determine the focal length of a converging lens. The screen was set at a distance  $D$  from the illuminated object and then the lens was moved until a focused, magnified image of the object was observed on the screen. The distance,  $u$ , between the object and the lens was recorded. The height of the image  $h_i$  was measured and recorded. This was repeated for various values of  $D$ . A simplified diagram of the experimental set-up is shown in **Fig. 5.1**.



**Fig. 5.1**



The results obtained for  $D$ ,  $u$ , and  $h_i$  are shown in **Table 5.1**. The height  $h_o$  of the illuminated object was kept constant at 2.5 cm.

**Table 5.1**

$D/cm$	$u/cm$	$h_i/cm$	$(D - u)$	$h_i/h_o$
90.0	18.4	10.0		
80.0	19.5	7.8		
70.0	21.0	5.8		
65.0	23.2	4.5		
60.0	28.7	2.7		

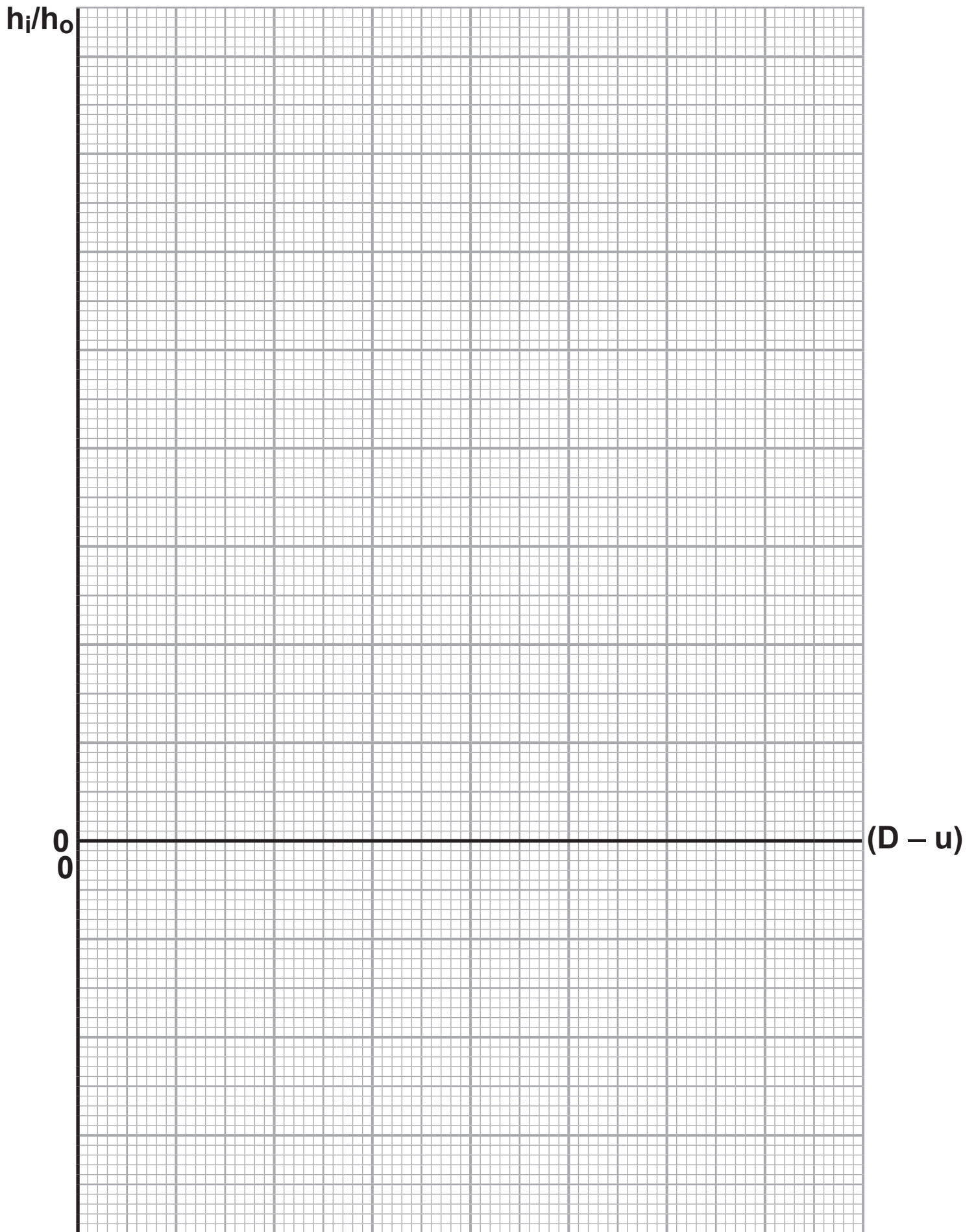
The focal length  $f$  of a converging lens can be determined by **Equation 5.1**.

$$\frac{h_i}{h_o} + 1 = \frac{(D - u)}{f} \quad \text{Equation 5.1}$$

where  $h_o$  is the height of the object.

**(a) Data Processing**

- (i)** Show why a graph of  $(h_i/h_o)$  against  $(D - u)$  is a suitable graph to plot, from which a value of the focal length of the lens can be determined. [2 marks]
- (ii)** Calculate the numerical values required to complete the blank columns in **Table 5.1**. [2 marks]
- (iii)** Complete the headings in **Table 5.1** where necessary. [2 marks]
- (iv)** On the grid of **Fig. 5.2** (page 19), draw the graph indicated in **(a)(i)**. Choose suitable scales, plot the points and draw the best-fit straight line. [4 marks]



**Fig. 5.2**

**(b) Analysis**

- (i) Determine the gradient of the graph. Include an appropriate unit. [3 marks]

Gradient = \_\_\_\_\_ Unit = \_\_\_\_\_

- (ii) Hence determine the value of the focal length  $f$  of the lens. [1 mark]

Focal length = \_\_\_\_\_

**(iii)** Determine the intercept on the vertical axis.  
[1 mark]

Intercept = \_\_\_\_\_

### (c) Evaluation

- (i) Determine the magnitude of the percentage uncertainty in the value of your intercept.  
[2 marks]

Percentage uncertainty = \_\_\_\_\_ %

- (ii) Describe the nature of the image for the result when  $D = 70 \text{ cm}$ . [1 mark]

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- (iii) State what the value of the intercept on the ( $D - u$ ) axis represents. Explain your answer with reference to **Equation 5.1**. [2 marks]

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**THIS IS THE END OF THE QUESTION PAPER**

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<b>Question Number</b>	<b>Marks</b>	<b>Remark</b>
1		
2		
3		
4		
5		
<b>Total Marks</b>		

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