New Specification

Rewarding Learning

Centre Number

71	

Candidate Number

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2009

Physics

Assessment Unit AS 3

assessing

Practical Techniques (Internal Assessment)
Session 2

[AY132]

AY132

THURSDAY 14 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.

For Teacher's use only

Question 5(a)(i)

	YES	NO
Was the candidate told which graph to plot?	☐	☐

Question Number	Marks	
	Teacher Mark	Examiner Check
1		
2		
3		
4		
5		
Total Marks		

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 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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Section A

Teacher Mark	Examiner Check	Remark

1 In this experiment you are to investigate the path of light as it travels from air into a plastic block and emerges from the other side.
You are provided with a rectangular plastic block, a raybox, a protractor and a ruler.

(a) Place the plastic block on **Fig. 1.2** on the opposite page and mark its outline. The block should be as indicated in **Fig. 1.1**.

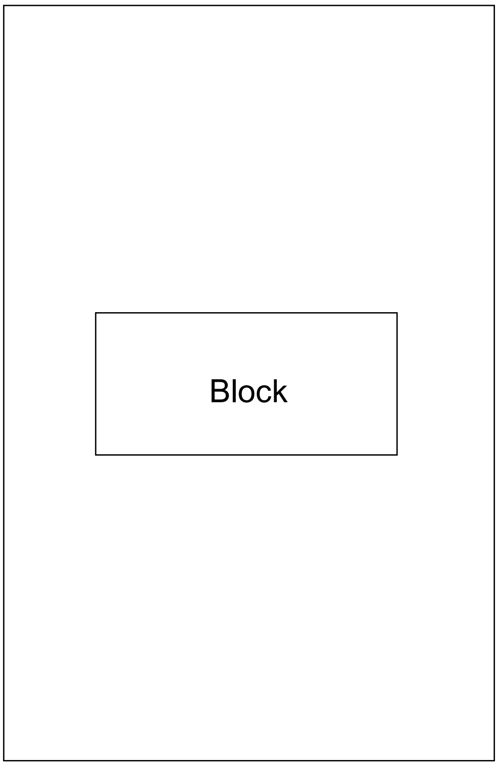

Fig. 1.1

Remove the block and draw a normal near the middle of one of the longer sides of the block. Then draw a line representing an incident ray at an angle of incidence *i* of 30°.
Replace the block on its outline on the paper. Place the raybox to direct a ray of light along the line drawn. Mark the path of the emergent ray.
Remove the block and construct the path of the ray through the block.
Repeat this procedure for an angle of incidence *i* of 40°, using the same normal line. [3]

Fig. 1.2

Teacher Mark	Examiner Check	Remark

(b) Use your diagram to make measurements of the angles of refraction r on entry into the block.

Record the angles of refraction in **Table 1.1**.

Table 1.1

Angle of incidence $i/°$	Angle of refraction $r/°$			
30				
40				

Use your results to obtain an average value of the refractive index of the plastic of which the block is made. Space has been left in **Table 1.1** for you to enter any additional values you may need to calculate.

You are advised to show your working clearly.

Refractive index of plastic = _______________ [2]

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(Questions continue overleaf)

Teacher Mark	Examiner Check	Remark

2 In this experiment you are to obtain an accurate value for the period of oscillation of a pendulum, and to investigate how the period depends on the length of the pendulum.

Fig. 2.1 shows the arrangement of the apparatus, which has already been set up for you.

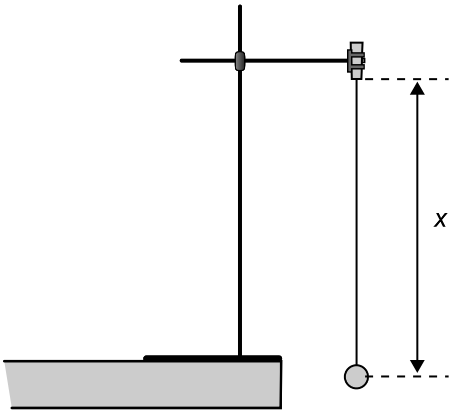

Fig. 2.1 (side view)

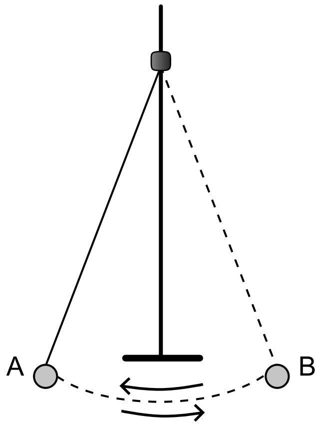

Fig. 2.2 (front view)

The pendulum bob is suspended by a string inserted in a split cork.
The length of the string can be adjusted by pulling it through the cork.
The length is measured between the point of suspension and the centre of the pendulum bob.
The length can be measured with the metre rule.
The period of oscillation is the time taken for the pendulum to swing from A to B and back to A, as shown in **Fig. 2.2**.

(a) Using the rule, check that the length x is 20 cm.
Using small oscillations, determine the period of oscillation T of the pendulum. Record **all** your results in **Table 2.1**. Head the blank column appropriately.

Table 2.1

x/cm		T/s
20		
30		
40		

Repeat the procedure for values of the length x of 30 cm and 40 cm. [3]

(b) It is suggested that the relationship between the length x and the period of oscillation T of the pendulum is given by

$$T = kx^n \qquad \textbf{Equation 2.1}$$

where k and n are constants.

Using your results in **Table 2.1**, choose a possible value for n in **Equation 2.1**. Indicate your choice by placing a tick (✓) in the appropriate box. Explain your answer.

$n = 1$ ☐

$n = \frac{1}{2}$ ☐

$n = -1$ ☐

Explanation: ____

____

____ [2]

Teacher Mark	Examiner Check	Remark

Teacher Mark	Examiner Check	Remark

3 In this experiment you are to measure the wall thickness of a piece of copper pipe.

(a) Use the vernier calipers to measure the external diameter *E* and the internal diameter *I* of the pipe, as shown in **Fig. 3.1**.

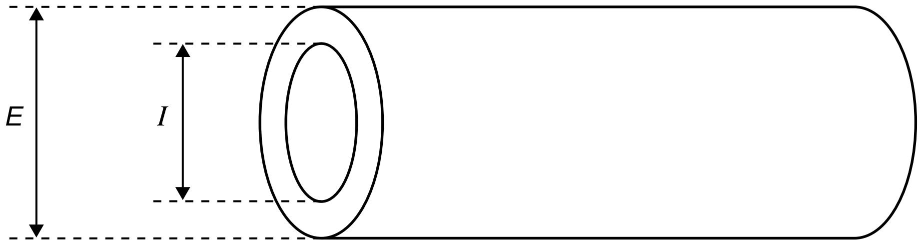

Fig. 3.1

Record **all** your readings in the spaces below.

External diameter *E* = __________ mm

Internal diameter *I* = __________ mm

Use these values to determine the thickness *t* of the copper walls of the tube.

Thickness *t* = __________ mm [4]

(b) Calculate the absolute uncertainty in your value of the thickness *t*. Consider **only** the uncertainty due to reading the calipers.

Absolute uncertainty = ± __________ mm [1]

Teacher Mark	Examiner Check	Remark

4 In this experiment you are provided with a sealed box fitted with four terminals **A**, **B**, **C**, **D**. **Fig. 4.1** shows three possible arrangements of **identical** resistors inside the sealed box.

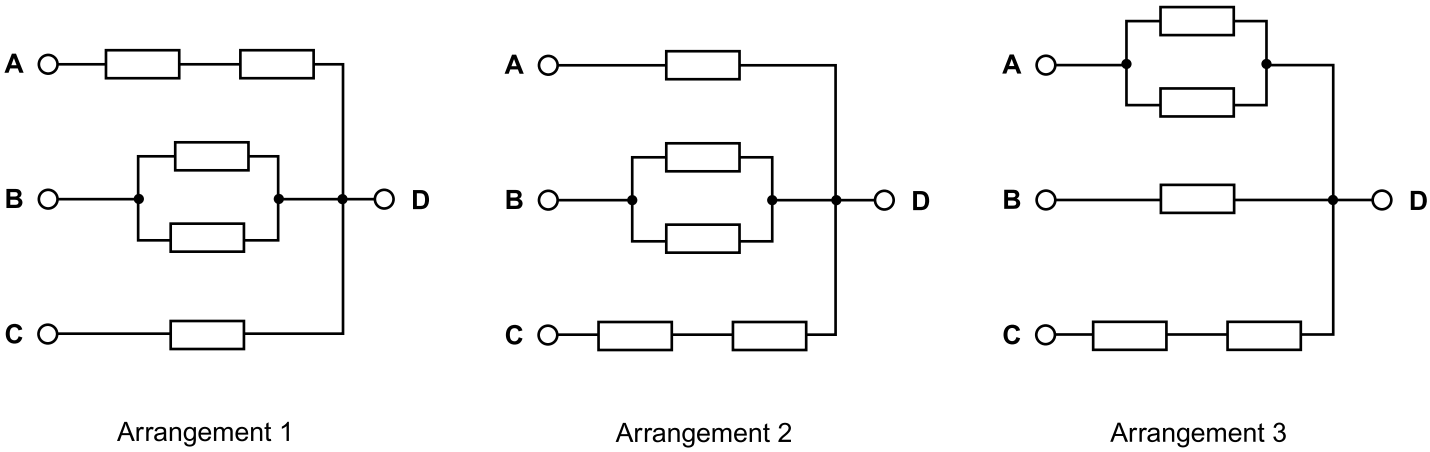

Fig. 4.1

One of these arrangements of resistors is inside the box. You are to find which arrangement it is.

You are also provided with a pre-connected test circuit containing a power supply, an ammeter, a voltmeter and connecting leads, as shown in **Fig. 4.2**.

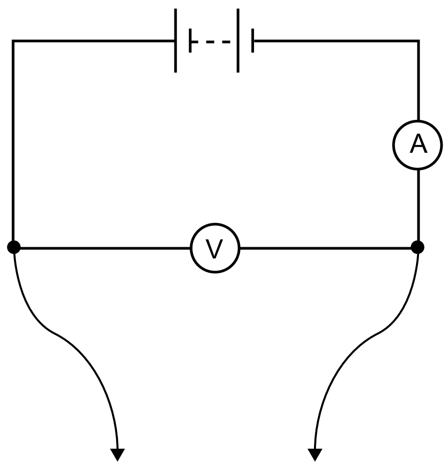

Fig. 4.2

(a) Use the test circuit to take readings of current I and voltage V for each of the connections **AD**, **BD** and **CD**. Record your readings in **Table 4.1**.

Teacher Mark	Examiner Check	Remark

Table 4.1

	AD	BD	CD
I/mA			
V/V			
R/Ω			

Calculate the corresponding resistance R for each connection, and include this in **Table 4.1**. [3]

(b) Deduce which of the arrangements in **Fig. 4.1** is contained in the box.

Indicate your choice by placing a tick (✓) in the appropriate box.
Explain your answer.
You are advised to show your working clearly.

The box contains the arrangement of resistors shown in

Arrangement 1 ☐

Arrangement 2 ☐

Arrangement 3 ☐

Explanation ____

____

____

____ [2]

Section B

Teacher Mark	Examiner Check	Remark

Data Analysis question

5 Acceleration of free fall on the Earth's surface

A student uses laboratory apparatus to determine a value for the acceleration of free fall on the Earth's surface, *g*.

A ball bearing is dropped from rest from a height *h*. The height through which the ball falls is varied by the student. The student measures this height with a metre rule. The time *t* taken for the ball to fall is measured using an electronic timing device.

Results

The student takes a set of values of *t* corresponding to different values of *h*. The student records the results in **Table 5.1**.

Table 5.1

h/cm	*t*/s	..../....
30.0	0.249	
40.0	0.293	
50.0	0.319	
60.0	0.351	
70.0	0.378	
80.0	0.400	

The student plans to apply the standard equation of motion

$$s = ut + \frac{1}{2}at^2 \qquad \textbf{Equation 5.1}$$

where *s* is the distance travelled, *u* is the initial velocity, *a* is the acceleration and *t* is the time taken, to these results.

Teacher Mark	Examiner Check	Remark

(a) **(i)** What graph should be plotted so as to give a straight line from which *g* can be obtained? State the horizontal (*x*) and vertical (*y*) axes.

Horizontal axis: ______________

Vertical axis: ______________ [2]

If you are unable to work out what graph is required, you may ask for assistance. A deduction of 2 marks will be made.

(ii) Explain how the value of *g* may be obtained from the graph in **(a)(i)**.

____

____ [1]

Teacher Mark	Examiner Check	Remark

Data processing

(b) **(i)** Head the blank column of **Table 5.1** with the quantity that should be calculated to draw the graph in **(a)(i)**. Include appropriate units. [2]

(ii) Calculate the numerical values required to complete the blank column in **Table 5.1** to an appropriate number of significant figures. [2]

(iii) On the grid of **Fig. 5.1** opposite, draw the graph of the processed data in **Table 5.1**. Label the axes in the boxes provided and choose suitable scales. Plot the points and draw the best-fit straight line. [5]

Analysis

(c) **(i)** Measure the gradient of your graph in **(b)(iii)**, showing your working clearly. Include an appropriate unit.

Gradient = ______________

Unit: ______________ [3]

(ii) Hence calculate your value of g. Give your answer in $\mathrm{m\,s^{-2}}$.

g = ______________ $\mathrm{m\,s^{-2}}$ [1]

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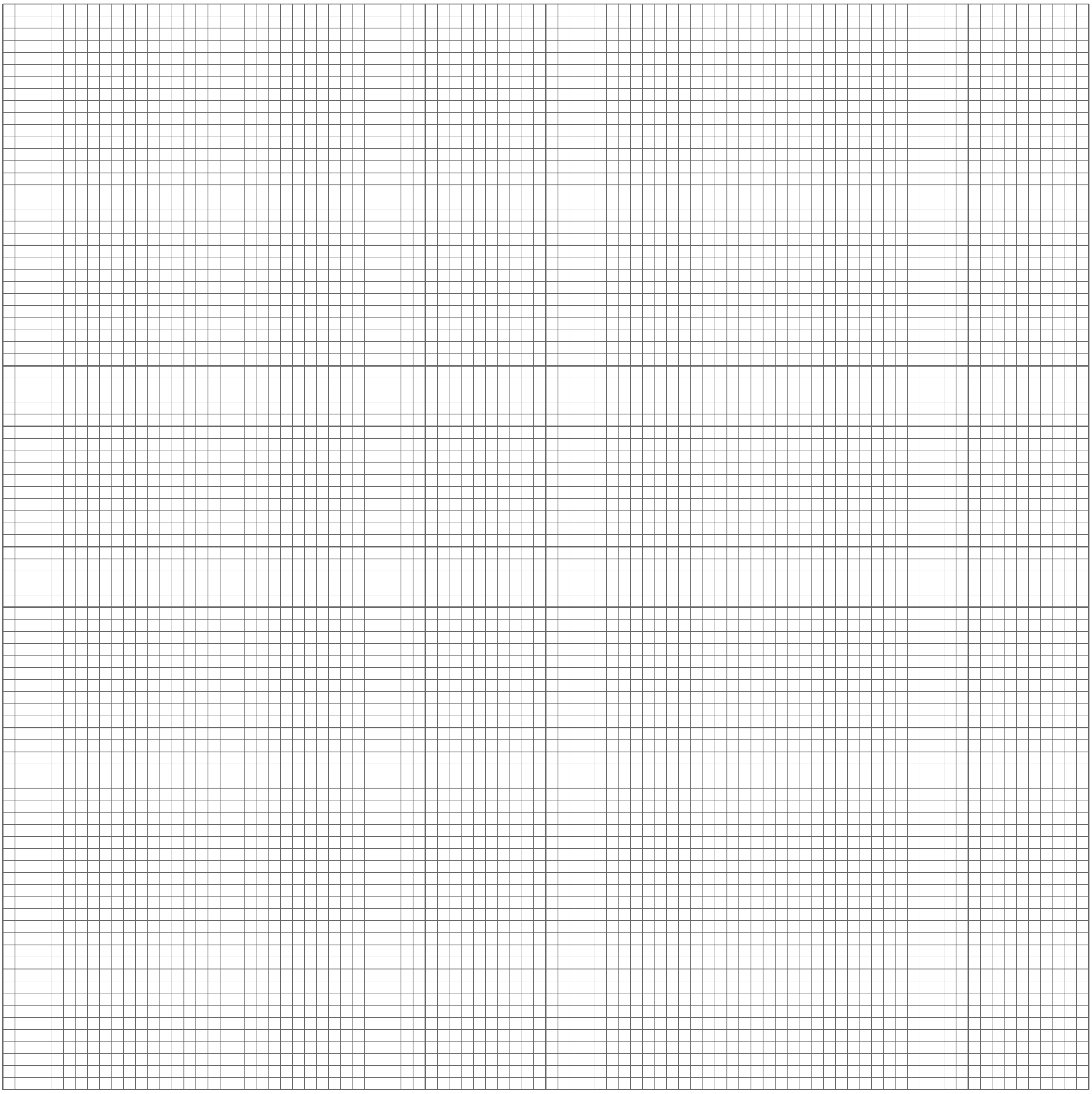

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Fig. 5.1

Teacher Mark	Examiner Check	Remark

Evaluation

(d) (i) The student's data sheet gives the value of g as 9.81 m s^{-2}. Calculate the percentage difference between this value and your value in **(c)(ii)**.

Percentage difference in values of g = ___________ % [2]

(ii) Explain how, using your graph, a lower limit could be placed on the value of g. Find this lower limit.

Explanation:

____

____

Lower limit on value of g = _________ m s^{-2} [2]

THIS IS THE END OF THE QUESTION PAPER