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ADVANCED
General Certificate of Education
January 2010

Physics

Assessment Unit A2 3B

assessing

Module 6: Experimental and Investigative Skills
Session No. 1

[A2Y32]

FRIDAY 8 JANUARY, MORNING

A2Y32TQP

TIME

1 hour 30 minutes.

TEACHER'S COPY
Not to be used by candidates

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Instructions to Candidates

Answer **all** the questions in this paper, using 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 28 minutes are to be spent in answering each question, and after 26 minutes you must stop using the apparatus in Questions **1** and **2** so that it can be re-arranged for the next candidate. At the end of the 28-minute period you will be instructed to move to the area set aside for the next question. At the end of the Test a 6-minute period will be provided for you to complete the answer to any question, but you will not have access to the apparatus during this time.

Information for Candidates

The total mark for this paper is 70.

Quality of written communication will be assessed in Question **3(d)**.

Questions **1** and **2** carry 25 marks each, and Question **3** carries 20 marks.

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

Question **3** contributes to the synoptic assessment of the Specification. In this question, you will need to make and use connections between different areas of physics and to use your knowledge and understanding of more than one area.

1 Introduction

In this experiment, you will determine the value of the resistance of an unknown resistor and the resistivity of resistance wire by taking current readings.

Aims

The aims of this experiment are:

(a) to construct a circuit from information given in a circuit diagram,
(b) to take current readings in this circuit,
(c) to analyse the results and plot a linear graph,
(d) to use this graph to determine a value for the resistance of an unknown resistor and the resistivity of the resistance wire.

Apparatus

You are provided with a battery of fixed voltage, a switch, an ammeter labelled A, an unknown resistance labelled X, a length of resistance wire, two crocodile clips, a metre rule and a number of connecting leads.

Procedure

Fig. 1.1 shows the circuit to be used:

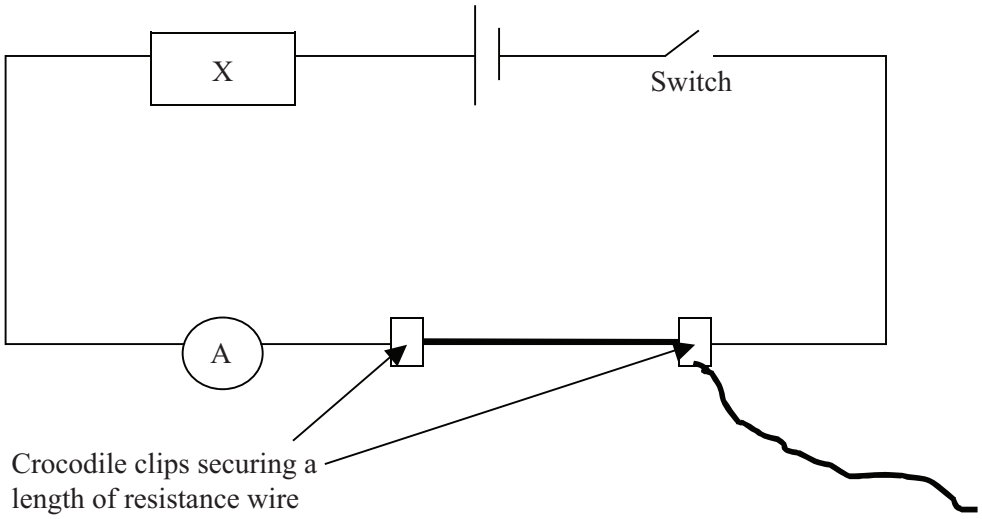

Fig. 1.1

(a) Connect the circuit shown in **Fig. 1.1** with a 40 cm length of resistance wire between the crocodile clips. [2]

Before closing the switch, ask the Supervisor to check your circuit. You will be told whether the circuit is correct or incorrect. There will be no deduction of marks for this check.

However, if you have difficulty in connecting a working circuit, you may ask the Supervisor for assistance. A deduction of 2 marks will be made.

Close the switch. Take the current reading I from the ammeter. Record your readings in **Table 1.1**.

(b) (i) Repeat this procedure for **four more** different lengths L of resistance wire up to a maximum value of approximately 100 cm.

Results

Table 1.1

L/m	I/A	(V/I)/ _____
0.40		

[3]

(ii) Taking the battery voltage to be 1.5 V, calculate V/I for each length. Insert a suitable unit for V/I in the column heading. [2]

Examiner Only

Marks	Remark

Analysis

Examiner Only	
Marks	Remark

The relationship between V/I and L is represented by the equation below

$$\frac{V}{I} = X + KL \qquad \textbf{Equation 1.1}$$

In this equation, K and X are constants.

(c) From the trend of your results in **Table 1.1**, explain why **Equation 1.1** is of a suitable form.

_____

_____

_____ [2]

(d) You are to plot a linear graph of the equation which will allow you to find the value of X.

(i) State the quantities to be plotted on each axis of the graph.

Vertical axis _____

Horizontal axis _____ [1]

(ii) On the grid in **Fig. 1.2**, label the axes and choose suitable scales (starting from the 0 value on both axes). Plot the points and draw the best straight line through them. [5]

(iii) Use your graph to find the value of X.

X = _____ Unit _____ [1]

(iv) Use your graph to obtain a value for K.

K = _____ Unit _____ [3]

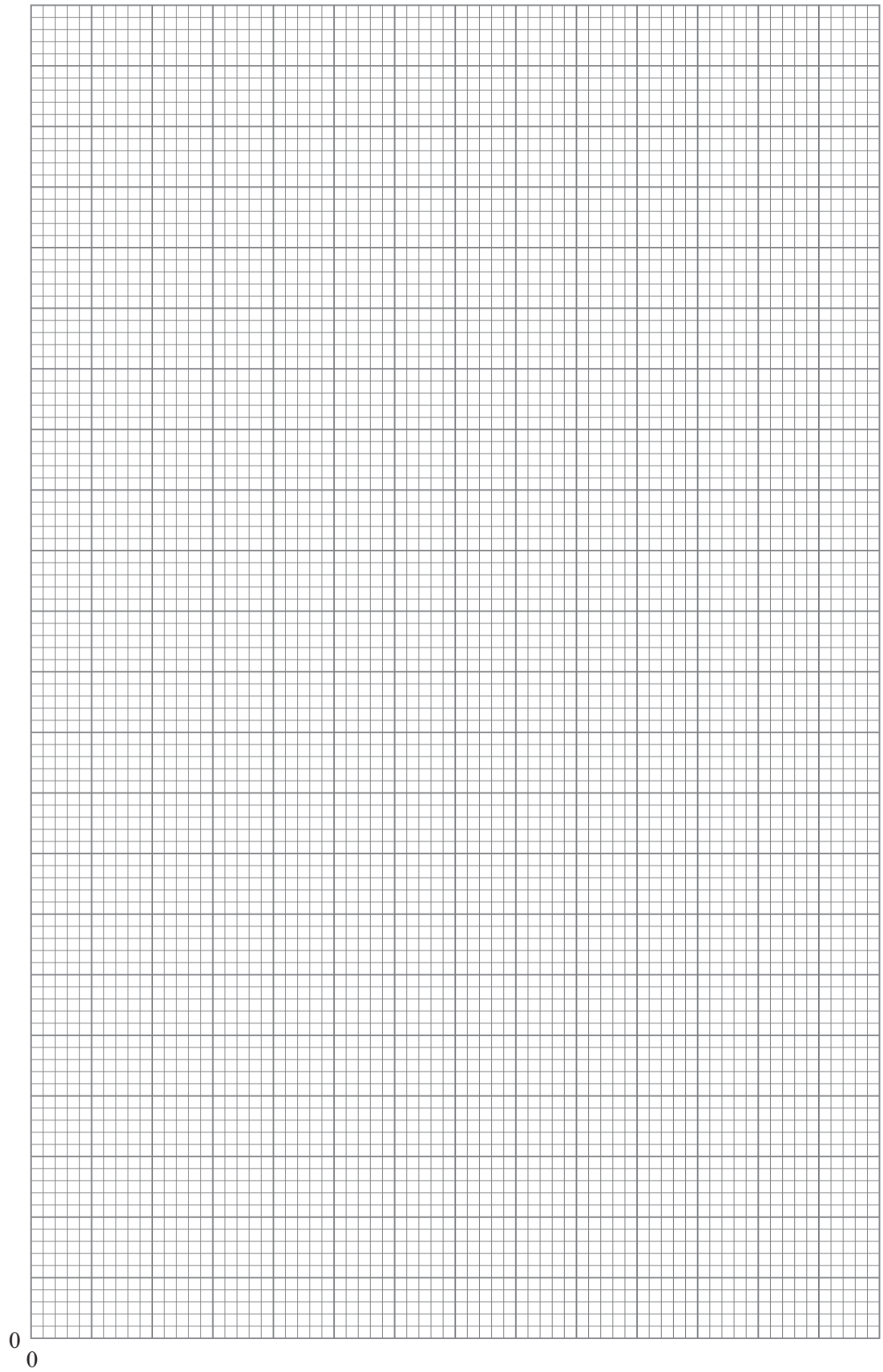

Fig. 1.2

Uncertainty

Examiner Only	
Marks	Remark

(e) (i) On the graph of **Fig. 1.2**, draw a line of "extreme fit". [1]

(ii) Hence calculate a value for the percentage uncertainty in your value for K.

Uncertainty = _____ % [3]

The value for K depends on the cross-sectional area (A) and the resistivity (r) of the resistance wire according to the relationship

$$K = r/A \qquad \textbf{Equation 1.2}$$

(f) Given that the diameter of the resistance wire is 0.023 cm, calculate the resistivity of the resistance wire.

Resistivity = _____ Ω cm [2]

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(Questions continue overleaf)

2 Introduction

In this experiment, you will investigate the oscillations of a metre rule suspended horizontally by two vertical cords of fixed separation, but variable length. This arrangement is called a **bifilar pendulum**.

Aims

The aims of the experiment are:

(a) to show that the rule can be made to oscillate about a vertical axis through the centre of the rule,

(b) to determine the period T of the oscillations for a number of lengths L of the suspending cords,

(c) to analyse the results to determine the relationship between T and L.

Apparatus

The apparatus in **Fig. 2.1** has already been set up for you.

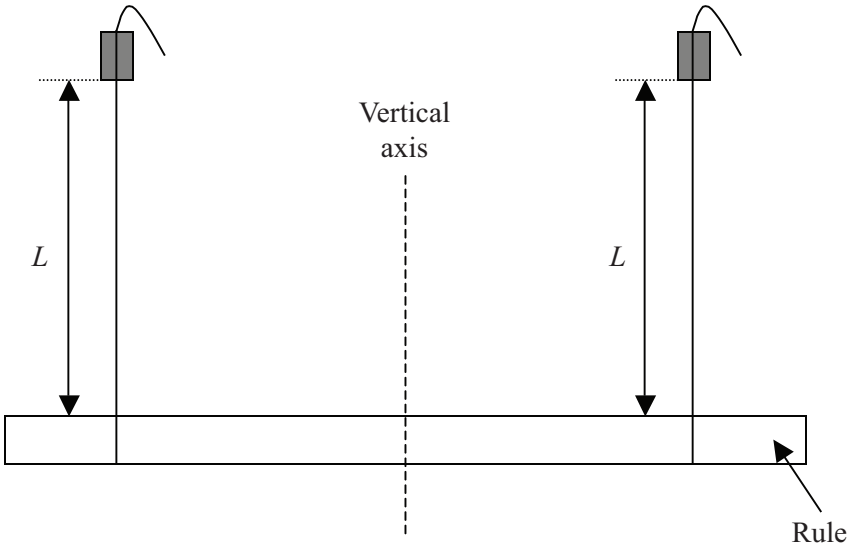

Fig. 2.1

It consists of a metre rule suspended horizontally and symmetrically by two vertical cords of equal length L. The distance between the cords is fixed.

In addition to the apparatus in **Fig. 2.1**, you are provided with a stopwatch (or stopclock) and a half-metre rule.

Procedure

The initial value of L has been set at 400 mm.

Cause the rule to oscillate about the vertical axis through the centre of the rule **(Fig. 2.1)**.

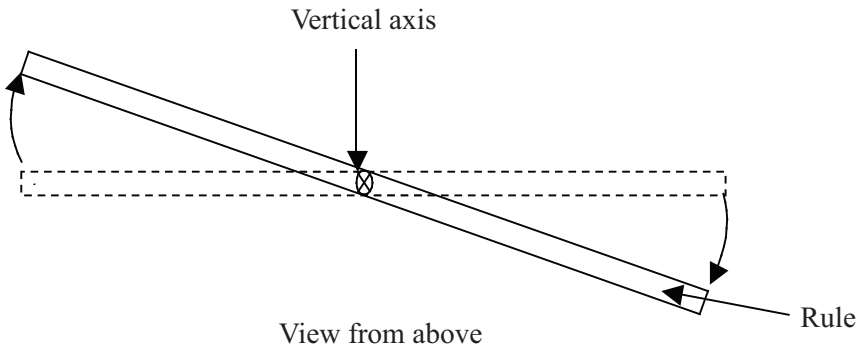

Fig. 2.2

This is best achieved by holding the rule lightly at its centre between finger and thumb, and twisting gently. When you release the rule, it will execute horizontal oscillations of small angular amplitude about the central vertical axis.

Decrease the length L of the suspending cords to about 350 mm, ensuring that the rule remains horizontal. Measure L and record the value in **Table 2.1**. Set the rule into oscillation as before, and take readings to determine the period. Record all your observations in **Table 2.1**.

Repeat this procedure until you have 5 sets of readings. The range of values of L should be from 400 mm to about 200 mm.

Results

Table 2.1

L/mm		T/s		
400				

[7]

The blank column in the centre of **Table 2.1** is for you to record your timing readings. The other two blank columns will be used later.

Examiner Only

Marks	Remark

Analysis

Examiner Only	
Marks	Remark

(a) For each value of length L of the supporting cords, calculate the corresponding period of oscillation T. Enter the values in **Table 2.1**.

[2]

(b) The relationship between T and L is given by

$$T = AL^B \qquad \textbf{Equation 2.1}$$

where A and B are constants.

You are to draw a suitable straight line graph from which you will determine values of constants A and B. In order to do this, **Equation 2.1** must be adapted by taking logarithms of each side.

(i) Complete **Equation 2.2** by taking logarithms to base 10 of the right hand side of **Equation 2.1**.

$$\log_{10} T = \_\_\_\_\_ \qquad \textbf{Equation 2.2}$$ [1]

(ii) State the values to be plotted on the axes of the graph.

Vertical axis _____

Horizontal axis _____ [1]

(iii) To plot this graph, it is necessary to calculate other values. Enter the calculated values in the blank columns in **Table 2.1**. Remember to quote these values to an appropriate number of decimal places. Remember also to label the headings of the columns you use. [3]

(iv) On the grid of **Fig. 2.3**, label the axes and choose suitable scales. Plot the points and draw the best fit line. [5]

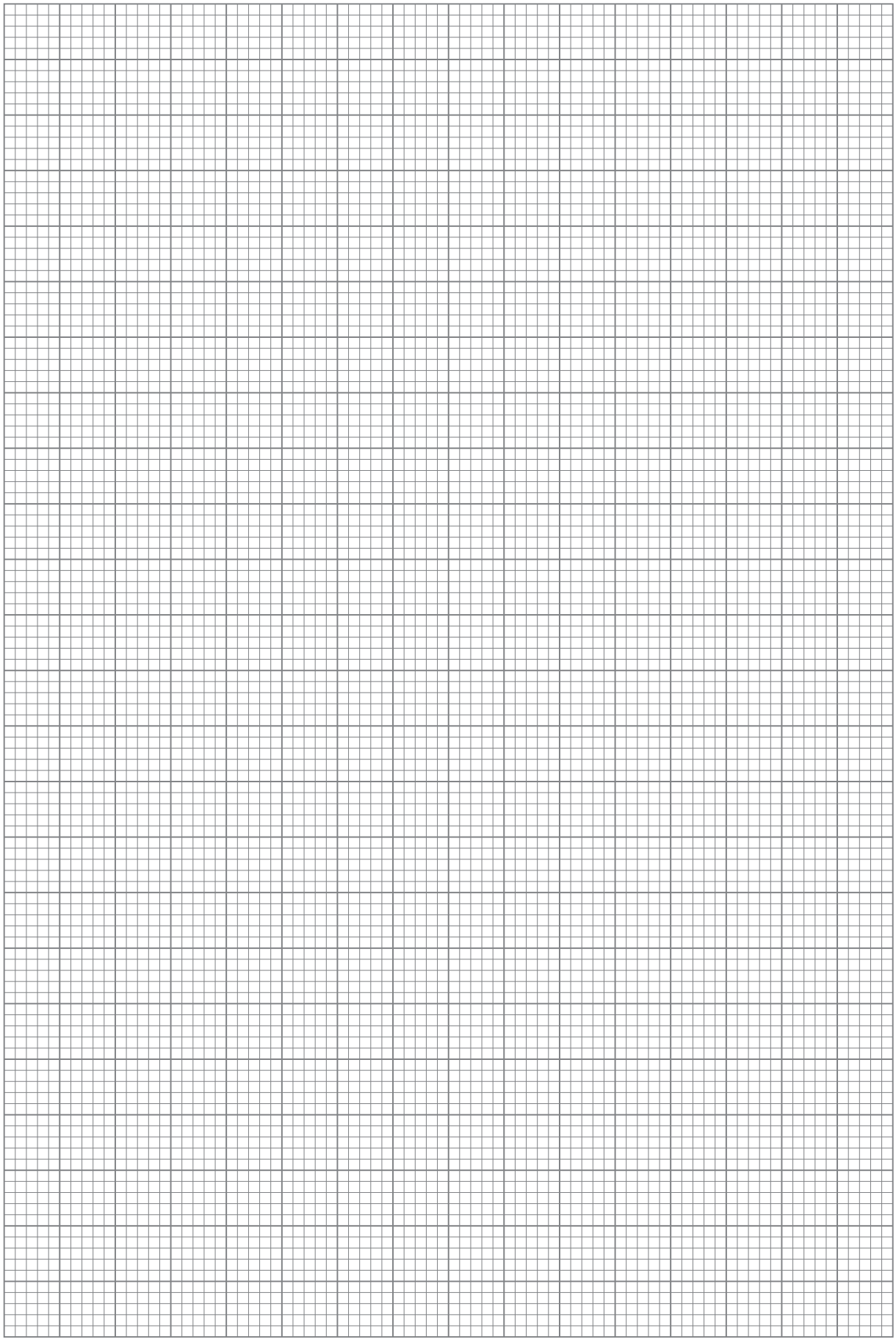

Fig. 2.3

(v) Use your graph to find the numerical value of B.
Show clearly how you obtained your value (units may be ignored in this part).

B = _____ [3]

(vi) Using your results and your value for B, calculate a value for A.

A = _____ [3]

Examiner Only	
Marks	Remark

Where appropriate, your answer to this question should be in continuous prose. You will be assessed on the quality of your written communication in part (d).

Examiner Only

Marks	Remark

3 Introduction

Polarised light may be produced by passing light through a sheet of polaroid. If two sheets of polaroid, with their faces in contact, are arranged so that there is an angle θ between their polarising planes, the intensity I of the light transmitted by the sheets is given by **Equation 3.1**.

$$I = I_o (\cos \theta)^2 \qquad \textbf{Equation 3.1}$$

where I_o is a constant.

Problem

You are to design an experiment to verify the relationship given in **Equation 3.1**.

The polaroid sheets are square. The polarising plane of each sheet is parallel to an edge, but there is no indication as to which edge.

Assume that the normal equipment of a school or college Physics laboratory is available. Assume also that a light-detecting device is available. The output voltage from this device is proportional to the intensity of the light falling on it.

Planning and design procedure

(a) Explain how you can identify when the polarising planes of the polaroid sheets are at right angles and when they are parallel.

_____

_____

_____ [2]

(b) Explain why a filament light bulb would be a better light source to use than a laser.

_____

_____ [1]

(c) In the space below, draw a labelled sketch of a possible arrangement of apparatus to carry out an experiment to verify **Equation 3.1**.

[4]

(d) Outline the method you propose to use to obtain the necessary readings. In your answer, you should describe how the equipment is manipulated and name any measuring instruments needed.

_____

_____

_____

_____

_____

_____

_____

_____

_____ [4]

Quality of written communication [2]

Examiner Only	
Marks	Remark

(e) Describe how you would test graphically whether **Equation 3.1** is an adequate description of the behaviour of the polaroid system. Remember, the output from the light detector is a voltage.

_____

_____

_____

_____ [3]

(f) In carrying out such an experiment, a pupil obtained results where the variation in I with angle θ was minimal. Give a reason why the experimental set-up gave rise to this and suggest a solution.

_____

_____

_____ [2]

Examiner Only	
Marks	Remark

Fig. 3.1 indicates a more accurate technique to determine θ.

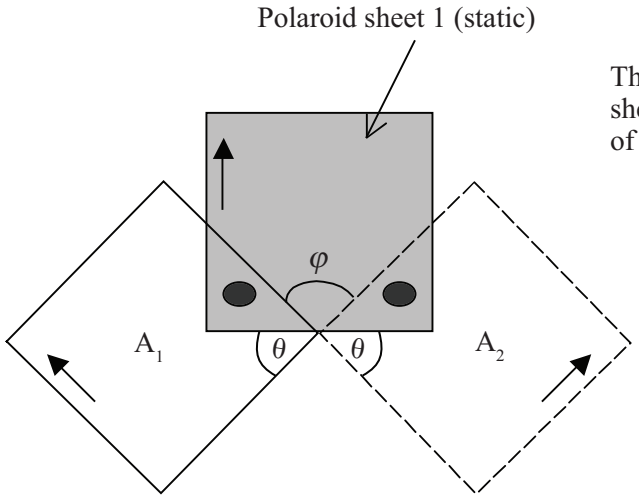

Fig 3.1

The second polaroid sheet is moved from position A_1 to position A_2. The light detector is lined up at the two positions indicated by the dots. At each of these positions, the light intensity detected is exactly the same. The angle between these two positions φ is measured.

Simple geometry shows that $\varphi = 2\theta$.

(g) Explain why this technique is better.

_____

_____ [2]

Examiner Only

Marks	Remark

THIS IS THE END OF THE QUESTION PAPER