Rewarding Learning

Centre Number	
71	

Candidate Number

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2009

Physics

Assessment Unit AS 3B

assessing

Module 3B: Experimental and Investigative Skills
Session No. 2

[ASY33]

ASY33

THURSDAY 14 MAY, MORNING

TIME

1 hour 15 minutes.

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.
Turn to page 3 for further Instructions and Information.

For Supervisor's use only

Question 1(a)

	YES	NO
Was the previously-connected circuit provided?	☐	☐

For Examiner's use only	
Question Number	Marks
1	
2	
Total Marks	

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Instructions to Candidates

Answer **both** 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 Supervisor will tell you the order in which you are to answer the questions. Not more than 35 minutes are to be spent in answering each question. In Question **1**, you must stop using the apparatus after 33 minutes so that it can be re-arranged for the next candidate. At the end of the 35-minute period you will be instructed to move to the area set aside for the next question. At the end of the Test a 5-minute period will be provided for you to complete the calculations, etc., in either of the questions of the Test, but you will not have access to the apparatus during this time.

Information for Candidates

The total mark for this paper is 45.

Quality of written communication will be assessed in Question **2**.

Question **1** carries 25 marks, and Question **2** carries 20 marks.

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

1 In this experiment you will use a potential divider circuit to determine the resistance of an unknown resistor.

Aims

The aims of this experiment are

(a) to connect a potential divider circuit,

(b) to take a series of readings of input and output voltages,

(c) to plot and interpret a graph from the experimental results,

(d) to assess the uncertainty in the experiment.

Apparatus

You are provided with a variable d.c. supply, two digital voltmeters, two resistors labelled $\mathbf{R_1}$ and $\mathbf{R_2}$ and a number of connecting leads. The resistance of resistor $\mathbf{R_1}$ is 330 Ω. The resistance of resistor $\mathbf{R_2}$ is unknown.

Procedure

(a) Connect the components as shown in the circuit of **Fig. 1.1**.

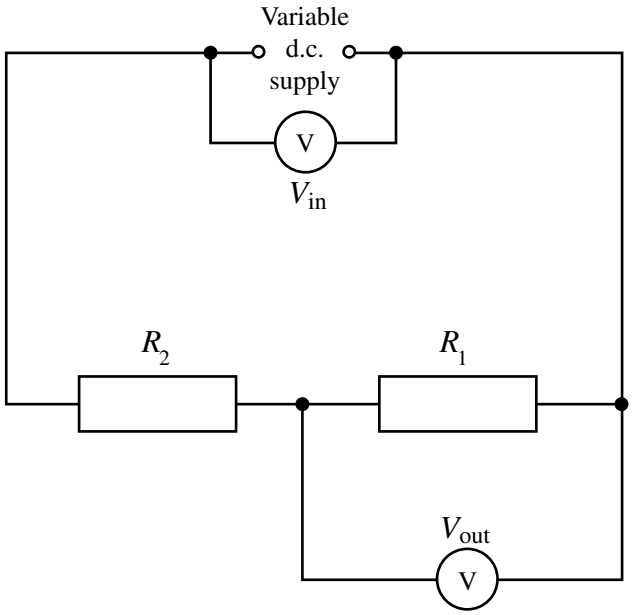


Fig. 1.1

If you are unable to set up this circuit, ask the Supervisor for assistance. A deduction of 3 marks will be made. [3]

Examiner Only	
Marks	Remark

(b) You are to obtain a series of readings of output voltage V_{out} for a range of input voltages V_{in} from 0 to 10V. Record your results in **Table 1.1**.

Examiner Only

Marks	Remark

Results

Table 1.1

Input voltage V_{in}/V	
Output voltage V_{out}/V	

[4]

Theory

(c) The relation between the input voltage V_{in} and the output voltage V_{out} is given by **Equation 1.1**.

$$V_{out} = \frac{R_1 V_{in}}{(R_1 + R_2)} \qquad \textbf{Equation 1.1}$$

where R_1 and R_2 are the resistances of resistors $\mathbf{R_1}$ and $\mathbf{R_2}$.

Compare **Equation 1.1** with the equation of a straight line

$$y = mx + c$$

(i) State the quantities which should be plotted to obtain a straight line graph from your results.

x-axis: _____ *y*-axis: _____ [1]

(ii) Write down an expression for the gradient of this graph.

gradient: _____ [1]

(iii) What should be the intercept of this graph?

intercept: _____ [1]

Graph

Examiner Only	
Marks	Remark

(d) On the grid of **Fig. 1.2**, draw a graph of the quantities identified in **(c)(i)**. Label the axis, choose suitable scales, plot the points and draw the best straight line through them. [5]

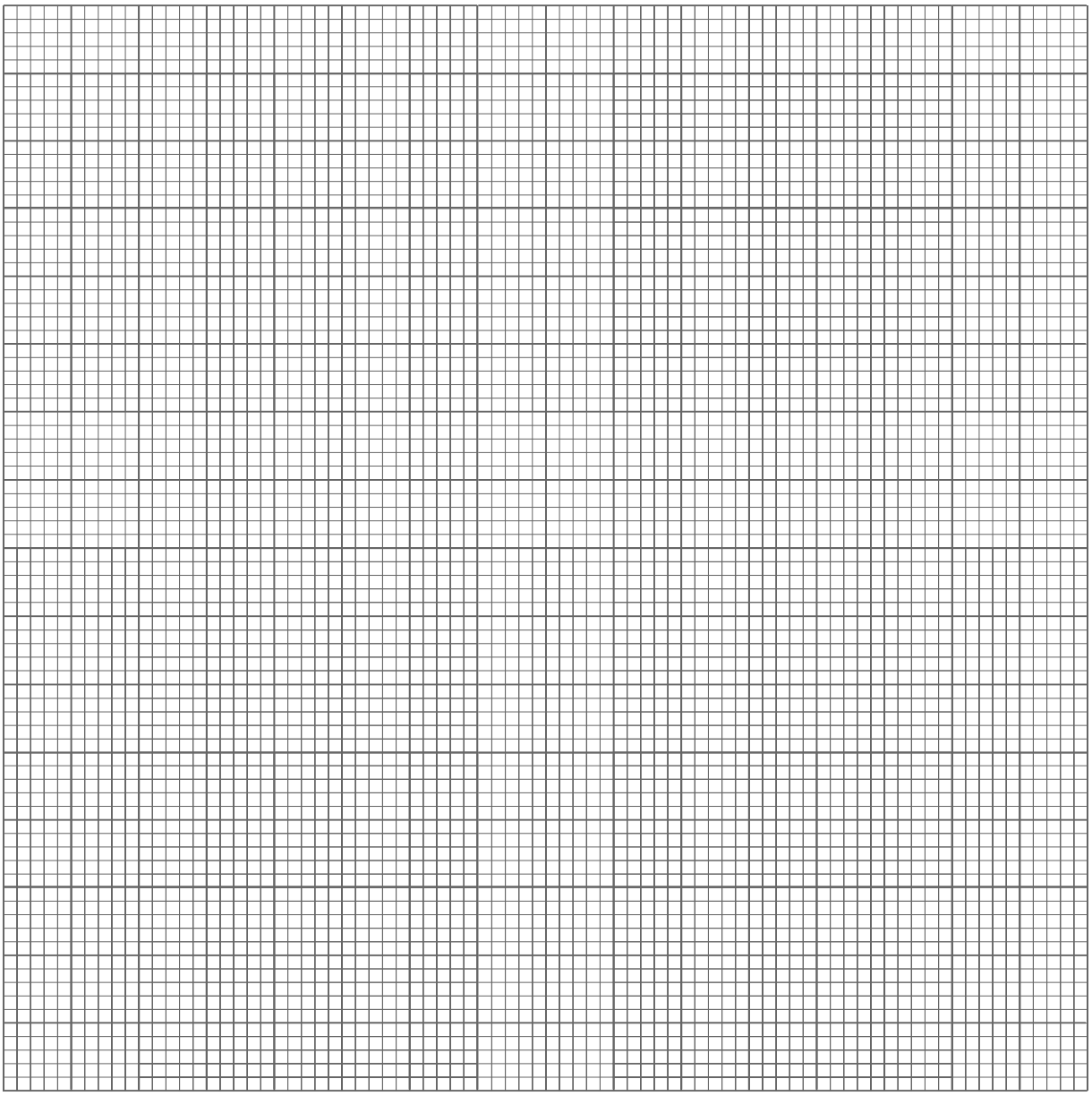


Fig. 1.2

Analysis

Examiner Only	
Marks	Remark

(e) (i) Determine the gradient of your line and state its units. If the gradient does not have a unit, write "NO UNIT".

Gradient = _____ [3]

Unit = _____ [1]

(ii) The resistance of resistor $\mathbf{R_1}$ is 330 Ω. Use this information and your value of the gradient from **(e)(i)** to calculate the resistance of resistor $\mathbf{R_2}$.

Resistance of $\mathbf{R_2}$ = _____ Ω [2]

Uncertainty

Examiner Only	
Marks	Remark

A student performing a similar experiment on a different potential divider measures V_{in} to be 9.61 V ± 0.02 V and V_{out} to be 1.49 V ± 0.01 V.

(f) (i) Calculate the percentage uncertainty in this student's value for $\frac{V_{out}}{V_{in}}$.

Uncertainty in $\frac{V_{out}}{V_{in}}$ = ± _____ % [3]

(ii) The student considers repeating the investigation, but this time measuring V_{in} with a voltmeter that is accurate to ±0.01 V. The known resistor $\mathbf{R_1}$ in the potential divider is accurate to ±10 %. Would you advise the student to repeat the investigation with the object of obtaining a more accurate value of R_2? Explain your answer.

_____

_____ [1]

Your answer to part (b)(ii) of this question should be in continuous prose. You will be assessed on the quality of your written communication.

2 Planning and design question

Introduction

In this question you will plan an experiment to investigate how stationary waves may be used to determine the speed of sound in air.

A loudspeaker emits sound waves that travel towards a fixed reflecting surface. The speaker is powered by a signal generator of variable frequency. A microphone detects the displacement of air particles at the position at which it is placed. The displacement is displayed on a cathode ray oscilloscope (c.r.o.). The arrangement is sketched in **Fig. 2.1**.

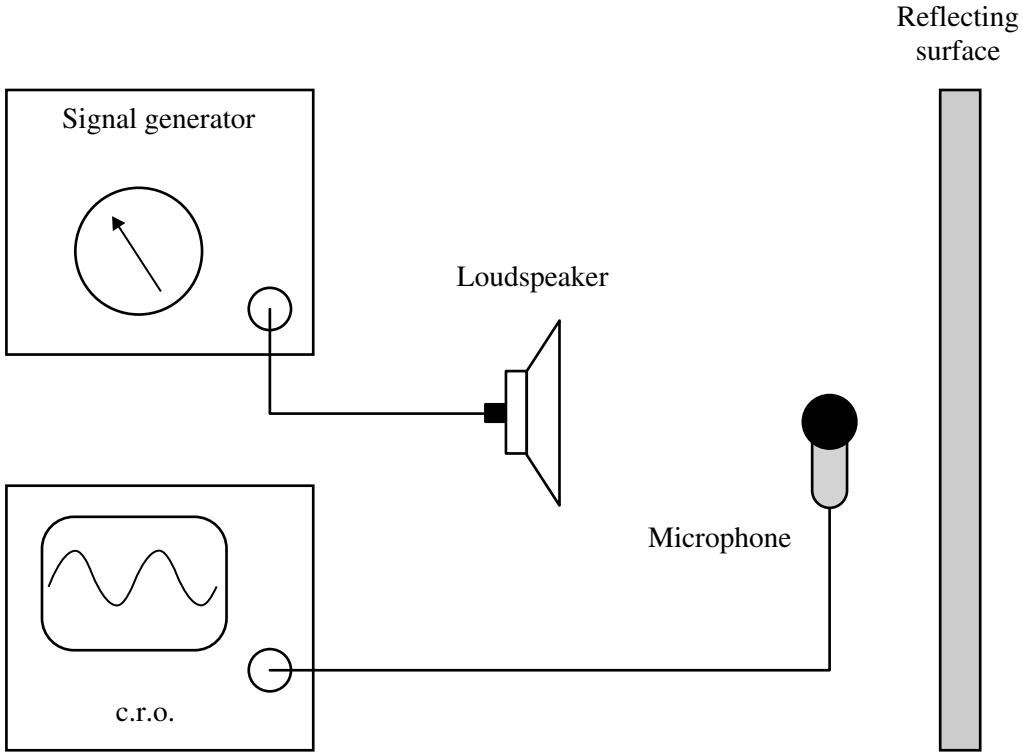


Fig. 2.1

A stationary wave is established between the loudspeaker and the reflecting surface. There will be a series of loud and quiet positions in this region. The amplitude of the c.r.o. trace is proportional to the loudness.

Questions

(a) Observation of the c.r.o. trace allows the positions of the nodes and the antinodes in the stationary wave to be identified. **Fig. 2.2** shows four possible c.r.o. traces.

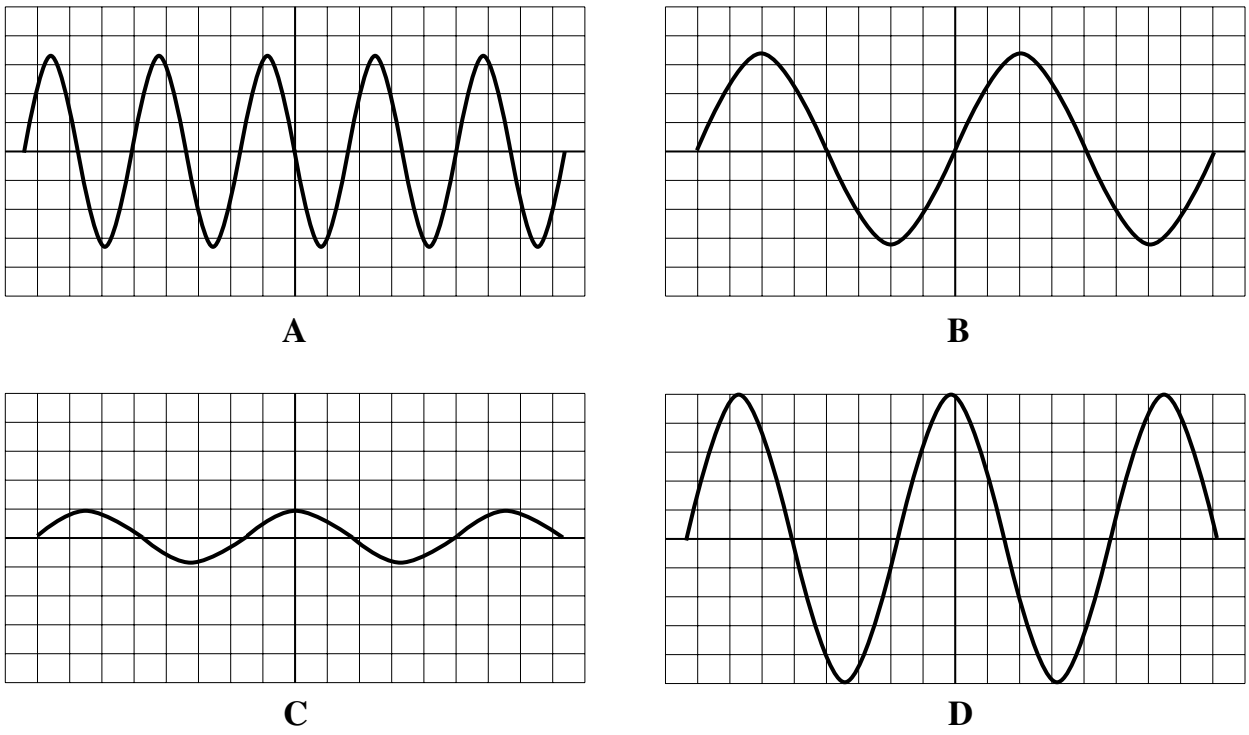


Fig. 2.2

Examiner Only	
Marks	Remark

Identify the trace most likely to represent the position of an **antinode**.

Trace _____

Explain why you have selected this trace.

_____

_____ [2]

(b) (i) State how the wavelength λ of a stationary wave is related to the separation x of adjacent antinodes.

_____ [1]

(ii) Describe how the apparatus could be used to obtain a **reliable** value for the wavelength of a stationary wave of a particular frequency.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____ [6]

Quality of written communication [1]

Examiner Only	
Marks	Remark

Examiner Only	
Marks	Remark

(c) The speed of the sound wave can be determined using the relationship

$$v = f\lambda \qquad \textbf{Equation 2.1}$$

The arrangement shown in **Fig. 2.1** enables both wavelength λ and frequency f to be determined.

(i) It is considered good practice to analyse results graphically. Explain how this experiment should be conducted in order to obtain results that will enable a graph to be plotted from which can be obtained a value for the speed v of sound in air.

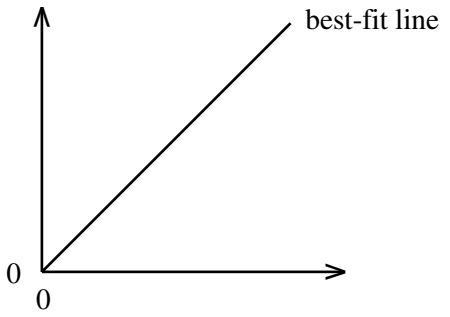
_____

_____

_____

_____ [2]

(ii) On **Fig. 2.3**, label the axes to show how a linear graph through the origin could be obtained, making use of the results from the experiment in **(c)(i)** and **Equation 2.1**.



[2]

Fig. 2.3

(iii) Explain how the speed of sound v could be obtained from your graph in **(c)(ii)**.

_____

_____

_____ [1]

Examiner Only	
Marks	Remark

(d) **Fig. 2.4** shows the same graph as in **Fig. 2.3**, but with the addition of an extreme-fit line (the dashed line).

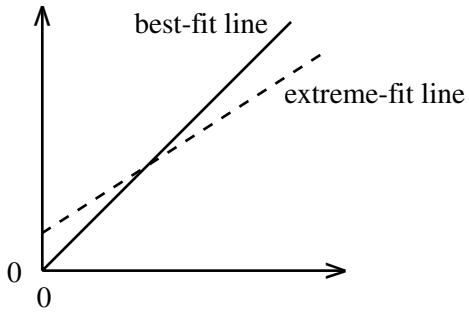


Fig. 2.4

Explain how the extreme-fit line and the best-fit line can be used to estimate the percentage uncertainty in the value for the speed of sound from **(c)(iii)**.

_____

_____

_____

_____

_____ [3]

(e) Discuss how the uncertainty in the wavelength measurement changes when the frequency of the signal generator is increased.

_____

_____

_____

_____ [2]

THIS IS THE END OF THE QUESTION PAPER