Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2019

Centre Number

Candidate Number

Physics

Assessment Unit AS 3B
(Theory)

assessing

Practical Techniques
and Data Analysis

[SPH32]

SPH32

TUESDAY 7 MAY, AFTERNOON

TIME

1 hour.

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.
You must answer the questions in the spaces provided.
Do not write outside the boxed area on each page or on blank pages.
Complete in black ink only. **Do not write with a gel pen.**
Answer **all six** questions.

INFORMATION FOR CANDIDATES

The total mark for this paper is 50.
Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question or part question.
You may use an electronic calculator.

1 A potential difference V was applied to an electron that was initially moving with constant velocity. It caused the electron to accelerate, reaching a final kinetic energy E. **Table 1.1** gives corresponding values of V and E.

Table 1.1

V / MV	0.08	0.24	0.50	0.86	1.12
E / pJ	2.74×10^{-3}	2.84×10^{-2}	7.20×10^{-2}	1.28×10^{-1}	1.79×10^{-1}

On **Fig. 1.1**, plot a graph of E against V and draw the best fit line.
Mark your points clearly using a ⊙ or a **+**.

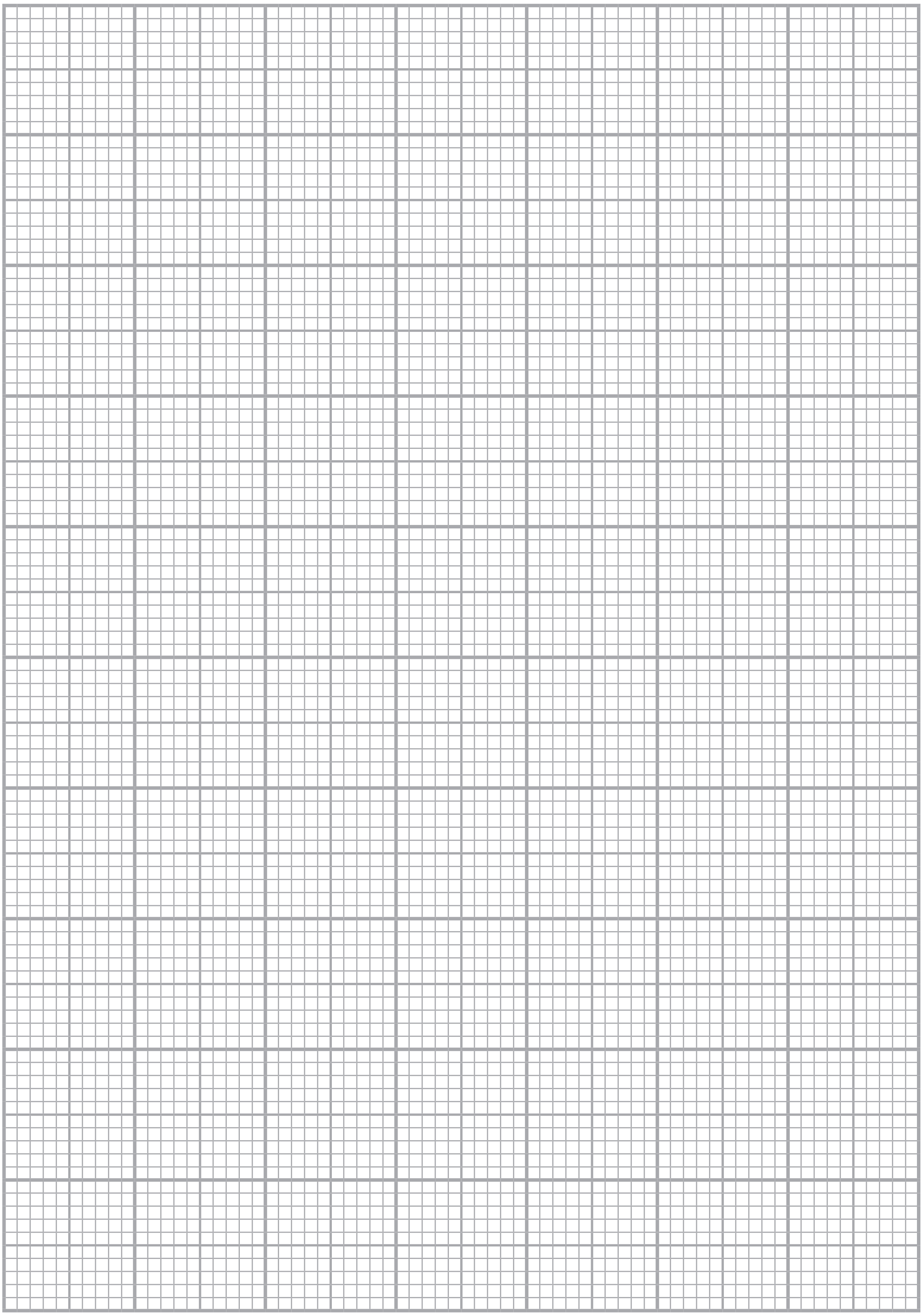

Fig. 1.1

[8]

2 The graph drawn in **Fig. 2.1** shows the relationship between the number of antinodes n along a standing wave on a stretched string and the frequency f of oscillation of the string.

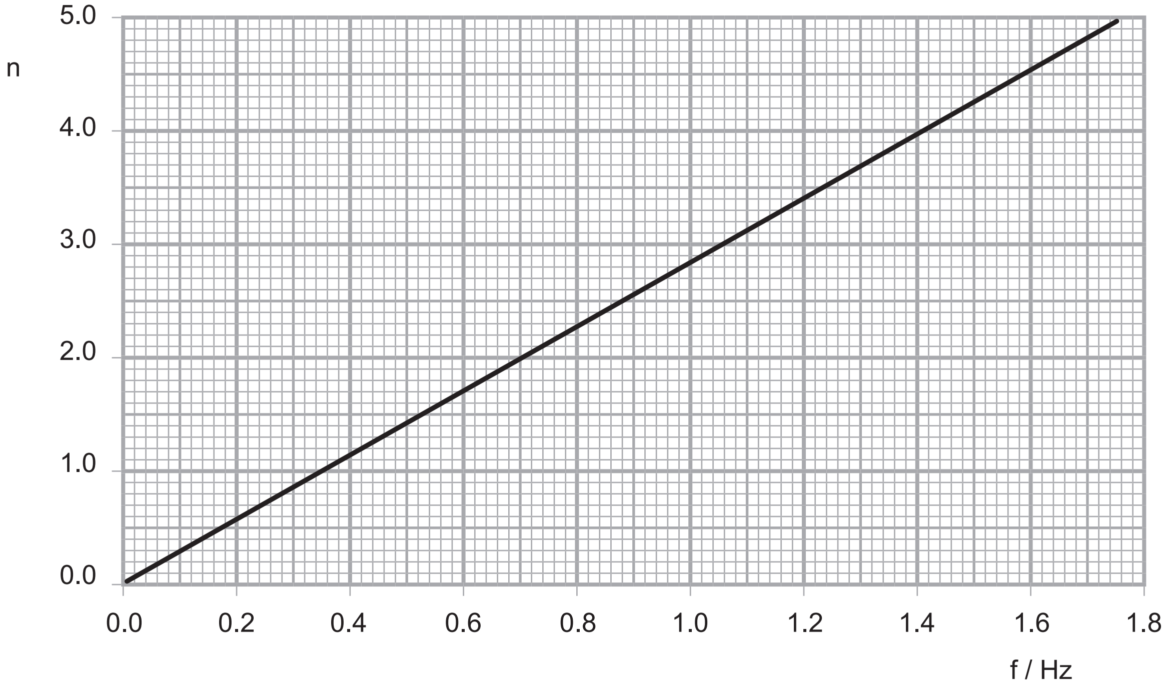

Fig. 2.1

(a) The equation of the straight line in **Fig. 2.1** is given by **Equation 2.1**.

$$n = 2.9 f$$ **Equation 2.1**

State the unit of the constant 2.9 in **Equation 2.1**.

Unit = ______________ [1]

(b) The relationship between n and f is given by **Equation 2.2**.

$$n = \frac{2Lf}{v}$$ **Equation 2.2**

where L is the length of the string and v the speed of the wave that created the standing wave on the string.

(i) Explain how the speed of the wave can be calculated from the gradient of the graph in **Fig. 2.1**.

____

____ [2]

(ii) The length of the string was 1.71 m. Use the gradient value to calculate the speed of the wave that created the standing wave along the string. Give your answer to one decimal place.

Speed = ______________ $m\ s^{-1}$ [1]

3 The graph in **Fig. 3.1** shows how the square of the velocity v^2 of an object moving with constant acceleration varies with the distance s it has travelled past a point.

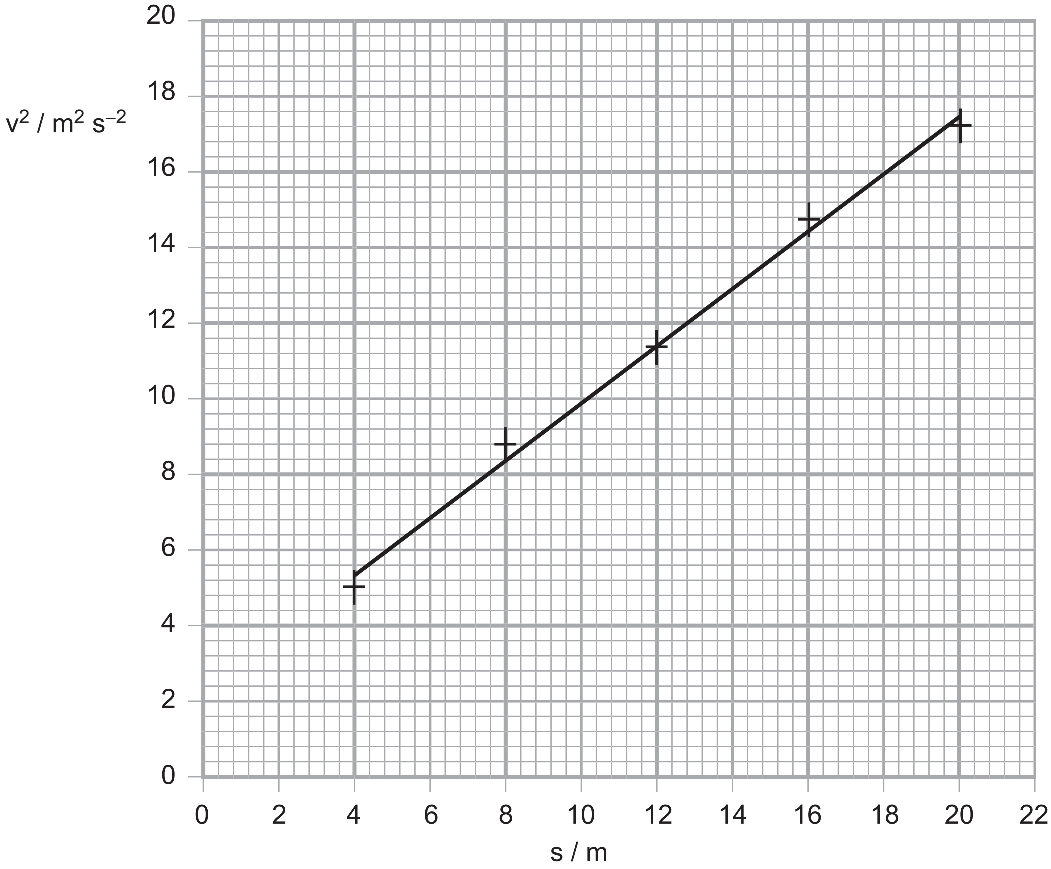

Fig. 3.1

(a) Use the graph to determine the velocity of the object when s = 0.

Velocity = _______________ $m\ s^{-1}$ [3]

(b) **(i)** Use an appropriate equation of motion to show that the gradient of the graph is equal to 2a where a is the acceleration of the object.

[2]

(ii) Calculate the gradient of the graph.

Gradient = ______________ $m\ s^{-2}$ [3]

(iii) Use your value of gradient to calculate the acceleration of the object.

Acceleration = ______________ $m\ s^{-2}$ [1]

(iv) **Describe** how the absolute uncertainty in the value of the acceleration could be calculated.

____

____

____

____ [3]

4 **(a)** A micrometer screw gauge was used to measure the diameter of a wire. A single value of 3.66 mm was obtained.

(i) State the uncertainty in this measurement.

Uncertainty = ______________ mm [1]

(ii) 1. Explain why the measurement should have been repeated over the length of the wire.

____

____

____

2. What steps should then be taken to obtain a reliable and accurate value for the diameter?

____

____

____ [3]

(b) The length of the wire was measured as 5.63 ± 0.01 cm.

What instrument was used to measure the length?

____ [1]

Use the data given in parts **(a)** and **(b)**.

(c) Determine the volume of the wire and its absolute uncertainty in cm^3.

Volume = _______________ cm^3

Absolute uncertainty = _______________ cm^3 [6]

5 **Equation 5.1** is the lens equation.

$$\frac{1}{f} = \frac{1}{u} + \frac{1}{v} \qquad \textbf{Equation 5.1}$$

An experimental arrangement to verify the lens equation is shown in **Fig. 5.1**.

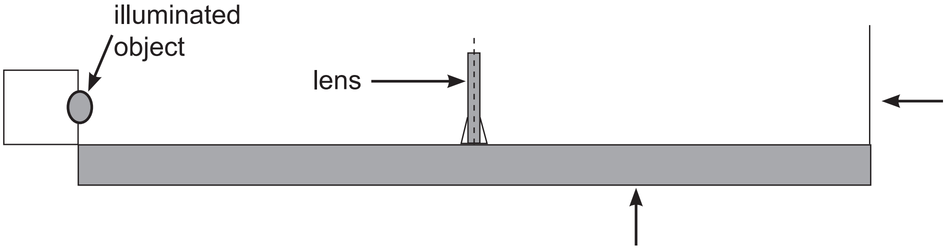

Fig. 5.1

In this experiment the lens was kept in a fixed position at the 50.0 cm mark on the metre rule. The object position P_o was initially at the 100.0 cm mark on the metre rule. The screen was moved until a focused image was produced. The position P_I of the screen on the metre rule was recorded in **Table 5.1**. To get a series of results to verify **Equation 5.1**, P_o was changed.

(a) What type of lens must be used in this experiment?

______________________________ [1]

(b) The results were recorded in **Table 5.1**.

The raw data in **Table 5.1** cannot be used directly to verify the lens equation. Add any additional necessary columns and appropriate headings to **Table 5.1** that would allow graphical verification of the lens equation. Now complete the row for $P_o = 100.0$ cm.

You do not need to complete the table for any of the other P_o values

[4]

Table 5.1

P_o / cm	P_I / cm				
	1	2	3	Mean	
100.0	28.6	28.8	29.4		
95.0	27.5	27.2	27.7		
90.0	26.0	25.6	25.8		
85.0	23.8	24.2	23.5		
80.0	20.0	20.5	20.3		

(c) Compare the uncertainty in the values of P_o and P_I. Explain any difference in the uncertainties of the values.

____

____

____

____ [3]

6 A linear air track is a device used to study motion in a low friction environment. Air is pumped through small holes in a long hollow track. This allows gliders, that are lifted just above the surface of the track by the air, to move friction-free along the track.

In an experiment to verify the principle of conservation of momentum, two identical gliders were used, one at rest and the other moving towards it at a constant velocity. After the collision both moved together along the remainder of the air track.

(a) Suggest how it is ensured that the gliders do not separate after the collision.

____

____ [1]

(b) The air track and two gliders, labelled A and B, are shown in **Fig. 6.1**. Glider A is moving to the right, glider B is stationary.

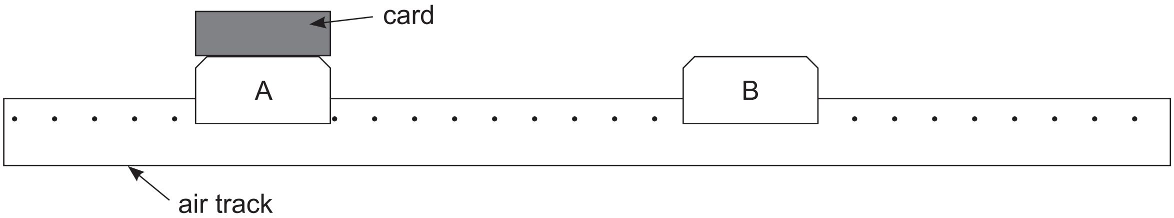

Fig. 6.1

(i) Two light gates, connected to appropriate software, are used to determine the velocity of the card on top of glider A before and after the collision.

On **Fig. 6.1** mark suitable positions for the light gates. Label the positions 1 for the first light gate and 2 for the second light gate. [2]

(ii) What information must be input to the software to allow the velocity to be determined?

____ [1]

(c) Show how the principle of conservation of momentum is verified from the results.

[3]

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