Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2023

Centre Number

Candidate Number

Physics

Assessment Unit AS 3B

assessing

Practical Techniques and Data Analysis

[SPH32]

SPH32

FRIDAY 2 JUNE, MORNING

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.

13549

1 An experiment was carried out to measure the volume V of a fixed mass of gas at a constant pressure as the temperature T of the gas was changed.

The results are shown in **Table 1.1**.

Table 1.1

T / °C	V / m^3
–258	1.6
–228	3.2
–215	4.8
–196	6.4
–168	8.7
–149	10.4
–122	12.8

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

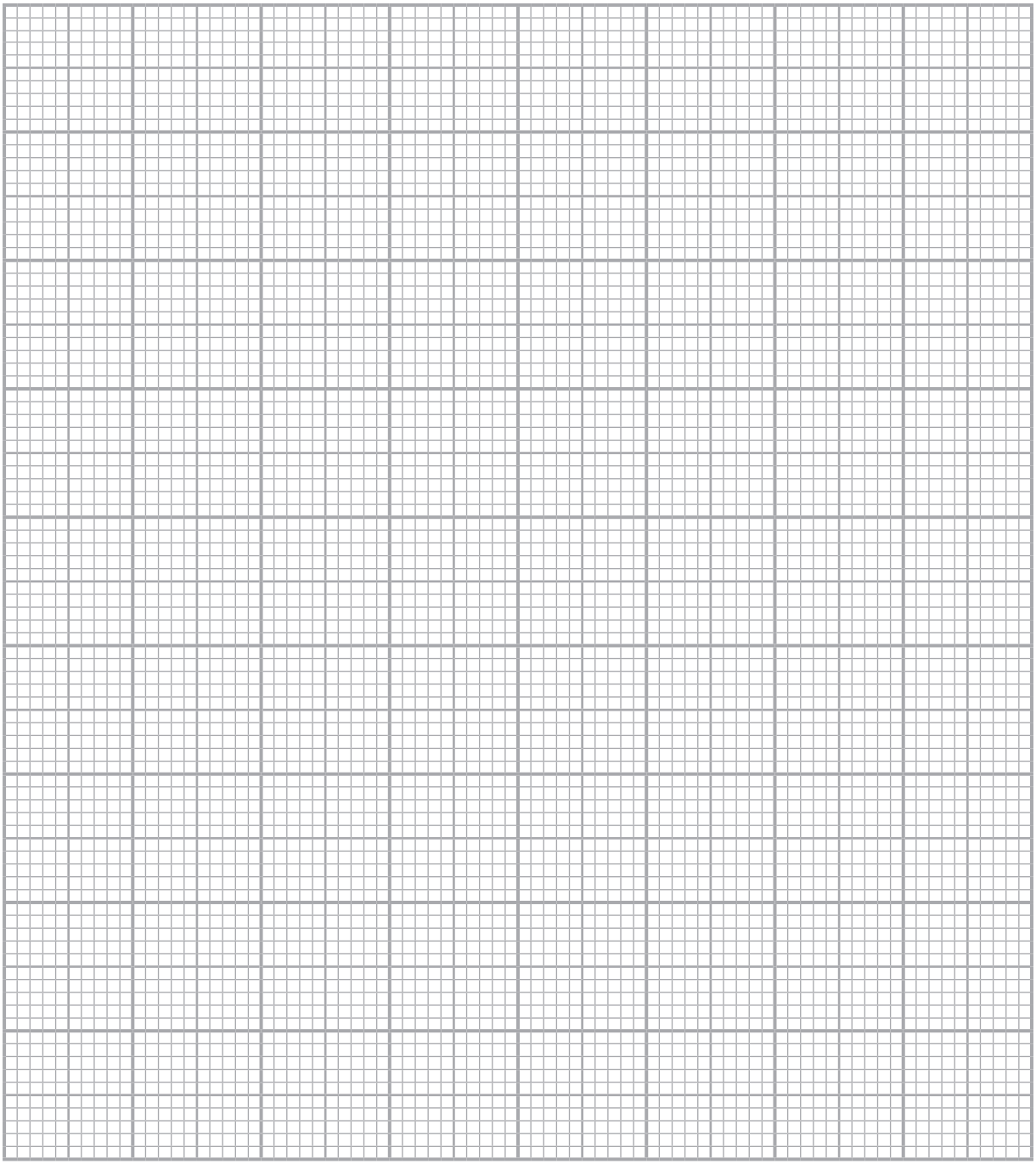

Fig. 1.1

[8]

[Turn over

2 Two different methods are available to measure the period of an oscillating pendulum.

In method 1, a timer is started and stopped electronically as the pendulum passes through a light beam. The error in starting and stopping the timer is negligible. The timer reads to 0.001 s but is running 3% fast.

In method 2, a digital stopwatch which reads to 0.01 s is used. The stopwatch times correctly but a human error of +0.2 s occurs as the stopwatch is used.

The period of oscillation of the pendulum is exactly 2 s.

(a) Calculate the reading on the timer in method 1.

Reading = _____ s [3]

(b) If a single oscillation is timed, how much closer to the true value of the period of oscillation is method 1 than the period obtained from method 2?

Difference in values = _____ s [1]

(c) Calculate the minimum number of complete oscillations of the pendulum that would have to be timed to give the period of oscillation obtained from method 2 a lower percentage uncertainty than the period obtained from method 1.

Number of oscillations = _____ [4]

3 An approximate value for the Planck constant h can be determined experimentally by measuring the voltage at which a light emitting diode (LED) just lights up. This is known as the activation voltage V_a.

Three different colours of LED were used in the experiment and the values of V_a were obtained for each LED.

Fig. 3.1 shows a graph of V_a against $\frac{1}{\lambda}$ where λ is the wavelength of the light emitted by the LED.

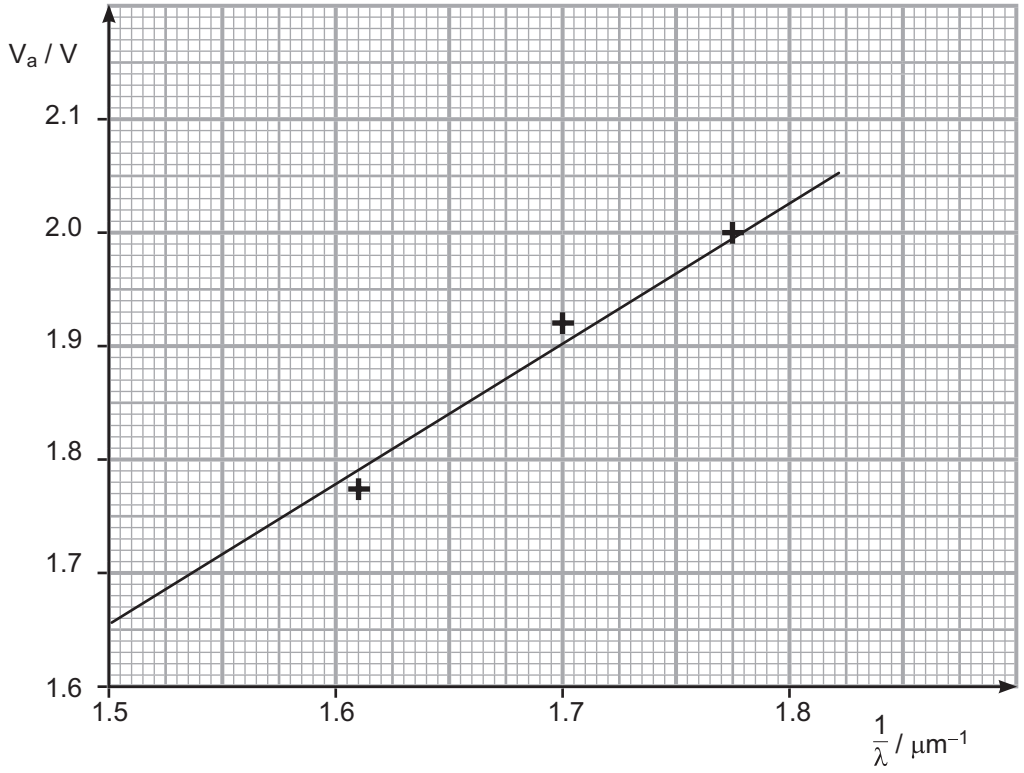

Fig. 3.1

(a) (i) State the name of an experiment that could be used to determine the wavelength of the light emitted by each LED.

_____ [1]

(ii) Suggest how the experiment could be improved to give a better choice of where to draw a best fit line on the graph.

_____ [1]

[Turn over

(b) (i) Calculate the gradient of the graph in V m.

Gradient = _____ V m [4]

The relationship between V_a, λ and h is given by **Equation 3.1** where c is the speed of light in a vacuum, 3.00×10^8 m s^{-1} and e is the elementary charge, 1.60×10^{-19} C.

B is a constant.

$$V_a = \frac{hc}{e\lambda} + B \qquad \textbf{Equation 3.1}$$

(ii) Use your answer to **(b) (i)** to calculate a value for h.

h = _____ J s [2]

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4 An experiment was carried out to investigate how the angle θ to the vertical at which a glass toppled was affected by the vertical height H of the water in the glass as shown in **Fig. 4.1**.

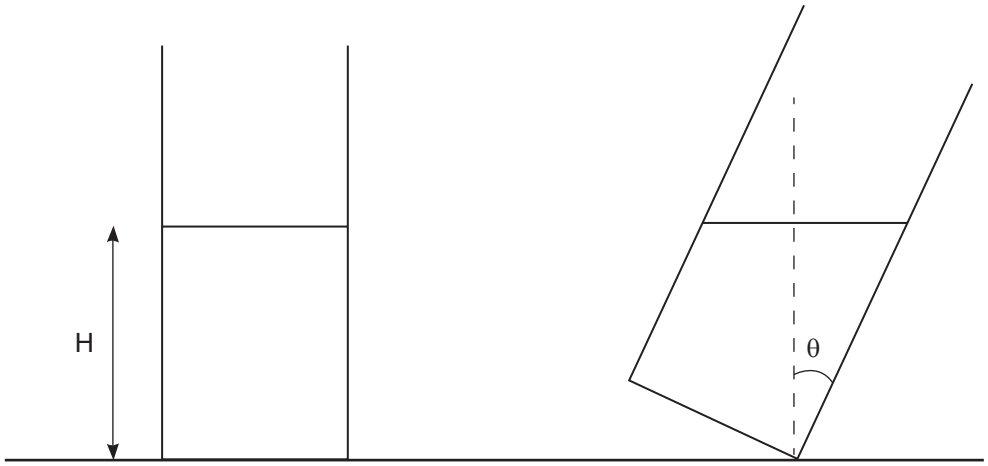

Fig. 4.1

The initial results are shown in **Table 4.1**.

Table 4.1

H / cm	θ / °		
	Trial 1	Trial 2	Ave
0.0	19	21	20
3.0	29	28	29
5.4	34	34	34
9.1	33	32	33
12.0	24	26	25

(a) In the shaded row of **Table 4.1**, where H = 3.0 cm, is the average value of θ correct? Explain your answer.

_____ [1]

(b) The results were plotted on the grid of **Fig. 4.2** as shown.

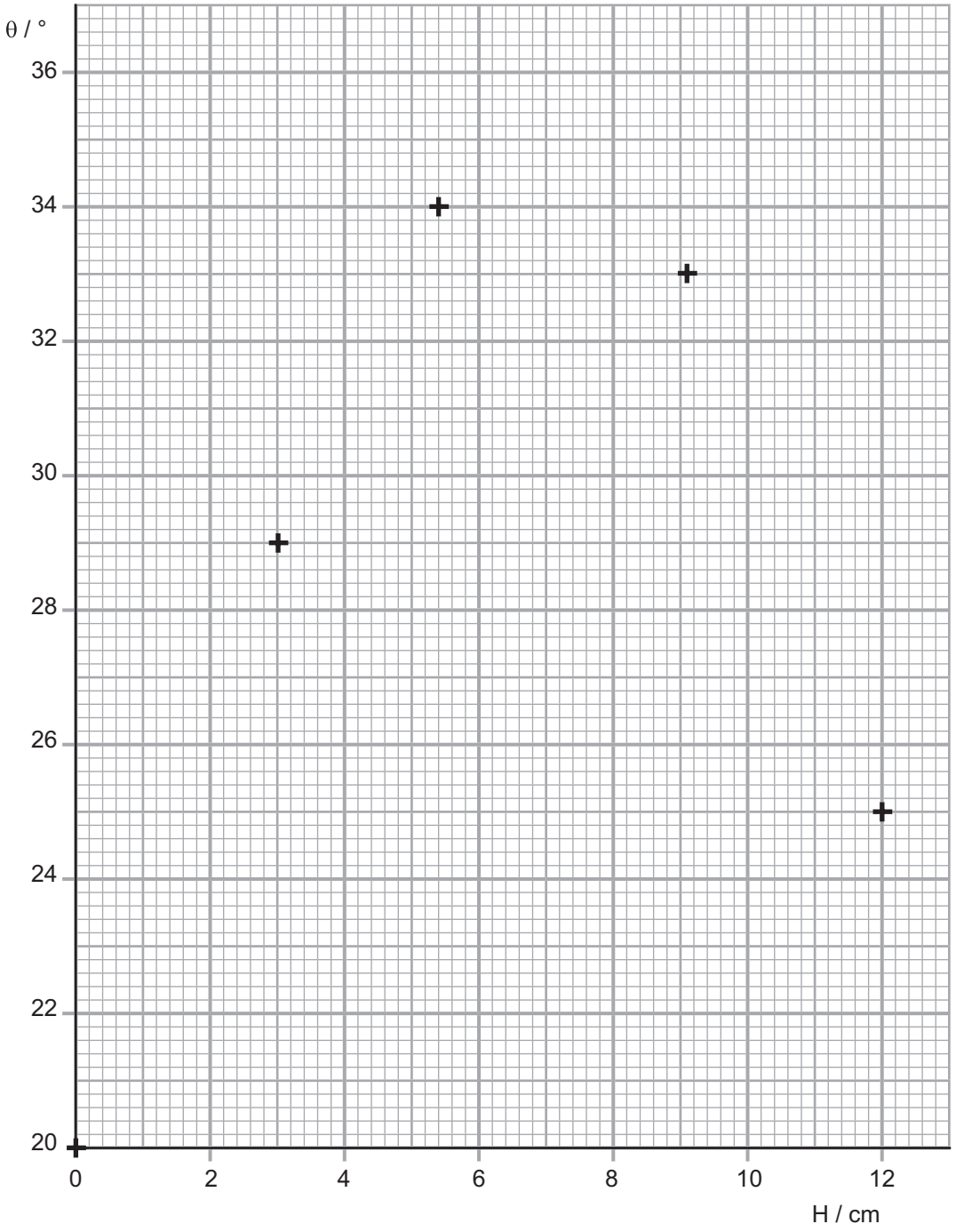

Fig. 4.2

[Turn over

(i) The value of H when the glass was most stable is to be determined. Explain how this value of H is determined from **Fig. 4.2**.

_____

_____ [1]

(ii) It was decided to take some more readings for H values between 5.4 and 9.1 cm.

Explain why additional values in this range should be taken.

_____

_____ [1]

Two additional values are shown in **Table 4.2**.

Table 4.2

H / cm	θ / °
6.0	35
8.1	35

(iii) **Fig. 4.3 (a)** shows a third additional height of water before the glass is tilted and **Fig. 4.3 (b)** shows the glass when it is just about to topple. Take measurements from **Fig. 4.3** to complete the final row of **Table 4.2**. [2]

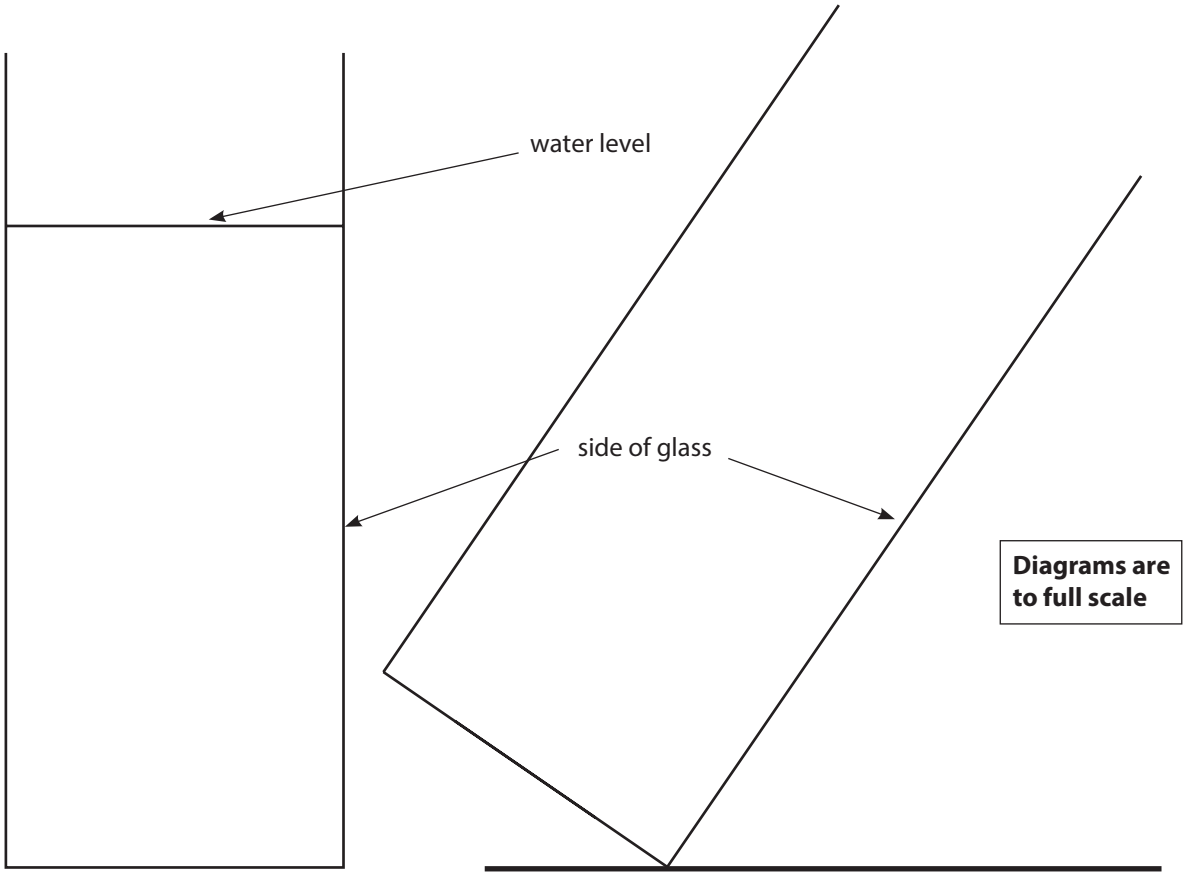

Fig. 4.3 (a) **Fig. 4.3 (b)**

(iv) State the uncertainty in each of your measurements.

Uncertainty in H = _____ cm

Uncertainty in θ = _____ ° [2]

(c) **(i)** On the graph grid of **Fig. 4.2**, plot the points from **Table 4.2** and draw the best fit curve for the plotted points. [2]

(ii) Determine the height of water in the glass when the glass is most stable.

H = _____ cm [1]

[Turn over

5 The power P of the heat radiated from a flat square of surface area A is given by **Equation 5.1** where T is the absolute temperature of the object and X is a constant.

$$P = AXT^4 \qquad \textbf{Equation 5.1}$$

(a) Determine the base units of the quantity X.

Base units of X = _____ [4]

(b) The value for the length L of one side of the square and T were recorded.

The value of the quantity X can be assumed to have no percentage uncertainty.

If the percentage uncertainty in T is 1.2% and the percentage uncertainty in L is 0.7%, calculate the percentage uncertainty in the value of P that would be obtained from the recorded results.

Percentage uncertainty in P = _____ % [3]

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6 In an experiment to measure the efficiency of the electric motor of a toy train, the power output and power input are required.

The train is powered by a 9 V supply that is connected across the rails of the track.

The power input to the train can be found by measuring the current I and voltage V.

(a) When the train moves at a constant velocity u along a straight horizontal section of the track, the power output can be calculated using **Equation 6.1**.

$$P = F\,u \qquad \textbf{Equation 6.1}$$

The force F is the driving force from the motor and is equal to the friction force between the train and the track.

(i) Explain why the driving force and friction force can be said to be equal.

_____

_____ [1]

(ii) Describe how an accurate value for the constant velocity of the train can be determined.

_____

_____

_____ [3]

(iii) The power supply to the train is turned off at a point on the track and the train comes to rest a distance d along the track. Explain how the friction force can be determined from this d value.

_____

_____

_____

_____ [3]

(b) Write down an equation for the efficiency of the electric motor in terms of V, I, u and F.

Efficiency = _____ [2]

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For Examiner's use only	
Question Number	**Marks**
1	
2	
3	
4	
5	
6	
Total Marks	

Examiner Number