



Rewarding Learning

**ADVANCED SUBSIDIARY (AS)**  
**General Certificate of Education**  
**2025**

Centre Number

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Candidate Number

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# Physics

Assessment Unit AS 3B

*assessing*

Practical Techniques  
and Data Analysis



**[SPH32]**

\*SPH32\*

**FRIDAY 30 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 and use a dark HB pencil for drawings and graphs.

**Do not write with a gel pen.**

Answer **all four** 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 a scientific calculator.

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\*16SPH3201\*

- 1 An experiment was carried out to investigate the power transferred from an electrical source to a load resistor in a circuit. The load resistance  $R$  was varied, and the power  $P$  transferred to this load was determined. The results are shown in **Table 1.1**.

**Table 1.1**

$R / \Omega$	$P / \text{mW}$
7.5	215
10	244
15	274
18	281
33	273
39	262
47	247

- (a) On **Fig. 1.1**, plot a graph of  $P$  against  $R$  and draw a curved line of best fit for the data.

Mark your points clearly with a  $\odot$  or a  $+$ .

[8]

- (b) (i) The internal resistance of the electrical source is equal to the value of the load resistance when maximum power is transferred from the source. Use your graph to obtain a value for the maximum power transferred from the source and the internal resistance of the electrical source.

Maximum power = \_\_\_\_\_ mW

Internal resistance = \_\_\_\_\_  $\Omega$

[2]

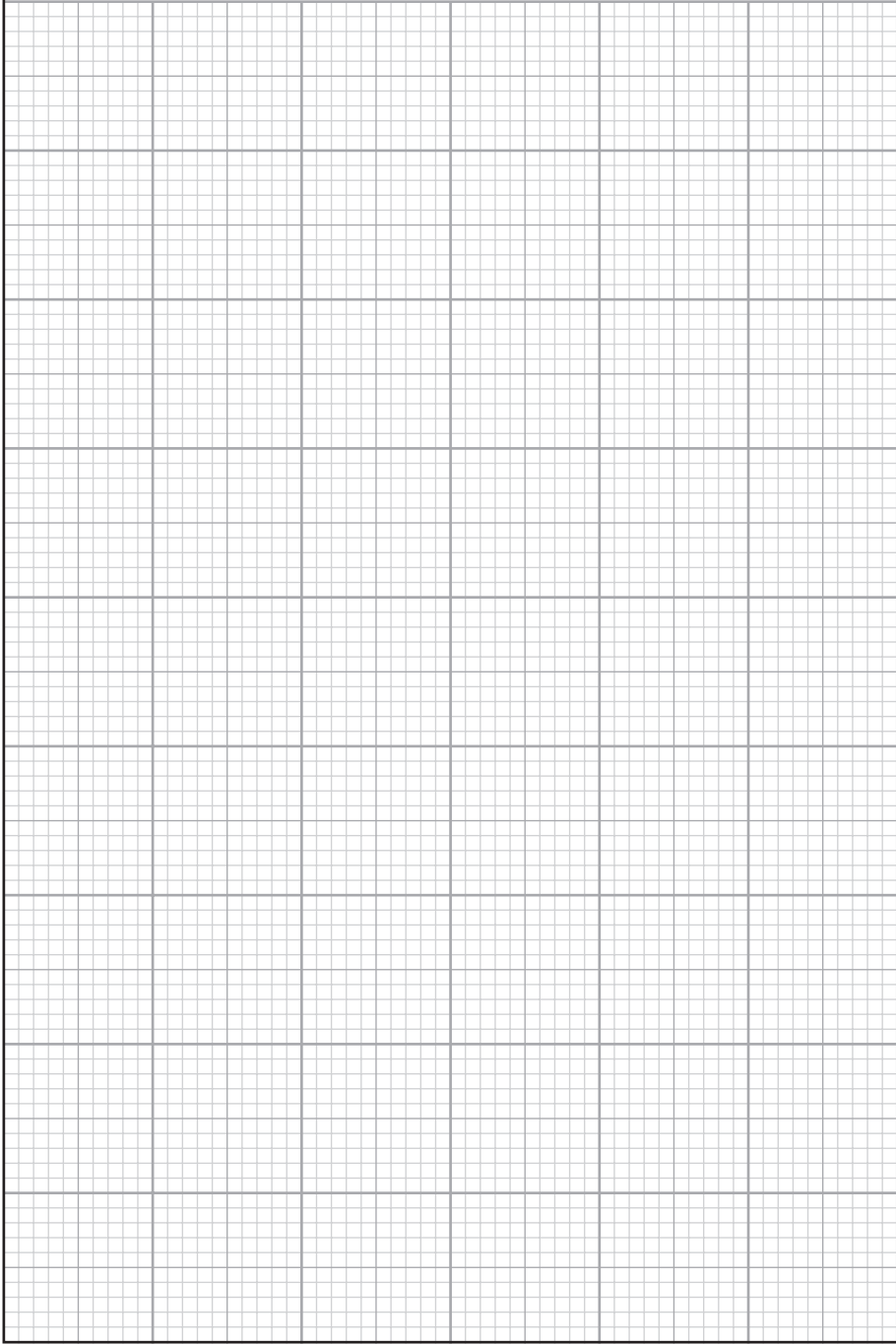
- (ii) State how the experiment could be improved so that the values of maximum power and internal resistance obtained from the graph are more accurate.

\_\_\_\_\_

\_\_\_\_\_ [1]



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**Fig. 1.1**

**[Turn over**

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\*16SPH3203\*

- 2 A phenomenon known as the Doppler effect can be used to determine the speed of blood through different blood vessels in the body. An ultrasound probe is placed at the same angle  $\theta$  to each blood vessel being tested as shown in Fig. 2.1.

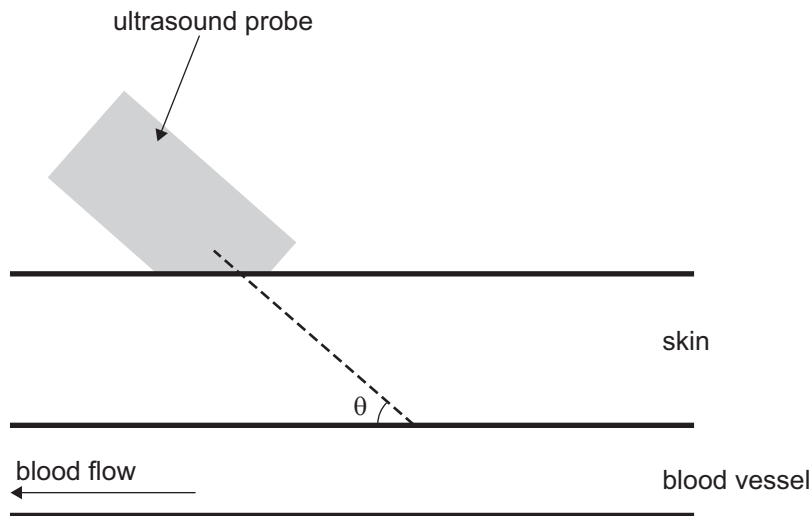


Fig. 2.1

The difference in the emitted and reflected ultrasound frequencies  $\Delta f$  was measured for four different types of blood vessel. The speed  $v$  of the blood through the blood vessel being tested was also determined.

The relationship between  $\Delta f$  and  $v$  is given by **Equation 2.1**

$$\Delta f = \frac{2 f v \cos \theta}{c} \quad \text{Equation 2.1}$$

where:-

- $f$  is the emitted frequency of the ultrasound
- $\theta$  is the angle of the probe to the blood vessel
- $v$  is the speed of blood in the blood vessel
- $c$  is the speed of ultrasound in the blood



Fig. 2.2 shows a graph of  $\Delta f$  against  $v$  for the four different types of blood vessel.

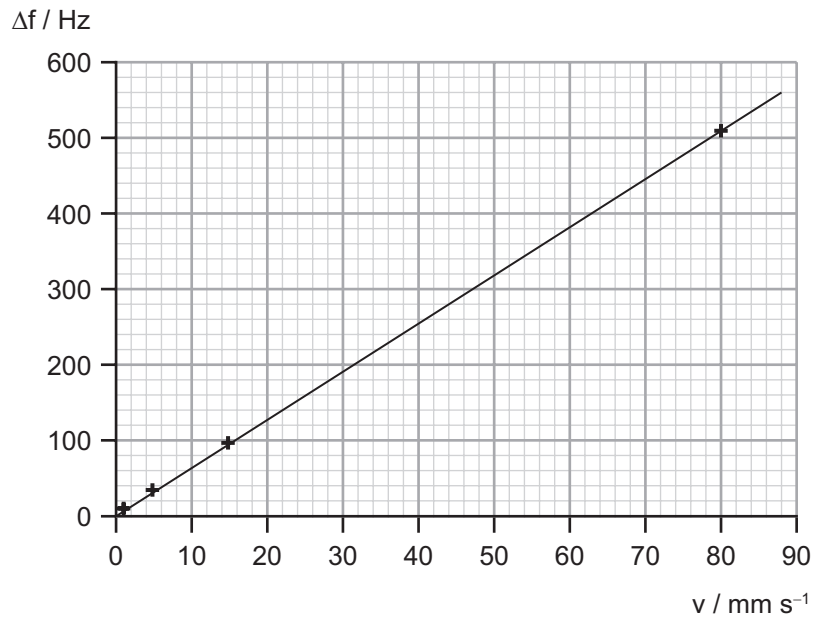


Fig. 2.2

(a) (i) Calculate the gradient of the graph and state the unit in its simplest form.

Gradient = \_\_\_\_\_ Unit = \_\_\_\_\_ [4]



(ii) Use the value of the gradient to determine the angle  $\theta$  of the probe to the blood vessels.

The original frequency of the ultrasound is  $1.04 \times 10^7$  Hz and the speed of ultrasound in the blood is  $1570 \text{ m s}^{-1}$ .

$$\theta = \text{_____}^\circ \quad [5]$$

(b) Explain why the probe should not be held at right angles to the flow of blood.

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[1]





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**(Questions continue overleaf)**

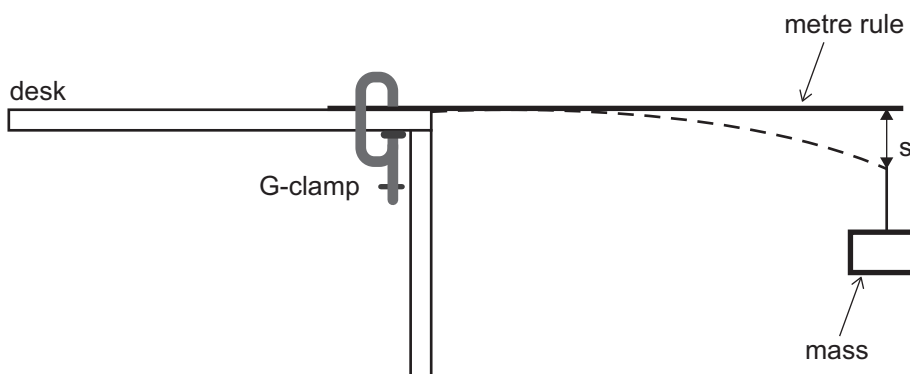
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**[Turn over**



\*16SPH3207\*

- 3 When a mass is added to the free end of a clamped metre rule, it sags as shown in **Fig. 3.1**.



**Fig. 3.1**

The sag  $s$  is given by **Equation 3.1**

$$s = \frac{m}{k b t^3}$$

**Equation 3.1**

where:-

$m$  is the mass added

$b$  is the breadth of the metre rule

$t$  is the thickness of the metre rule

$k$  is a constant.

The mass added to the free end of the metre rule was initially placed on an electronic balance to determine its value. The reading on the balance is shown in **Fig. 3.2**.



**Fig. 3.2**



Values of the measurements obtained when this mass was added to the free end of the clamped metre rule are shown in **Table 3.1**.

**Table 3.1**

Quantity	Value			Average value	Uncertainty
m / g	99				$\pm$
s / mm	16				$\pm$ 1
b / mm	26.1	26.7	26.4	26.4	$\pm$ 0.3
t / mm	6.83	6.82	6.83		$\pm$

**(a) (i)** Complete **Table 3.2** below by stating the name of the instrument used to measure b and t.

**Table 3.2**

Quantity	Measuring Instrument
b	
t	

[2]

**(ii)** Explain why b and t were measured at different points along the length of the metre rule.

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[2]

**[Turn over**



(b) (i) Calculate the average value for  $t$  and insert the value in the appropriate column of **Table 3.1**.

[1]

(ii) Complete the final column of **Table 3.1** by inserting the uncertainty for the measurements of  $m$  and  $t$ .

[2]

(iii) Explain how an uncertainty of  $\pm 0.3 \text{ mm}$  has been deduced for the  $b$  value.

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[1]

(c) (i) Use the values in **Table 3.1** and **Equation 3.1** to calculate a value for the constant  $k$ .  
Give the unit of  $k$ .

Value of constant  $k$  = \_\_\_\_\_ Unit = \_\_\_\_\_

[5]



(ii) The percentage uncertainty in the sag  $s$  is 6.25%. State and explain how you could change the experiment to reduce this value.

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[2]

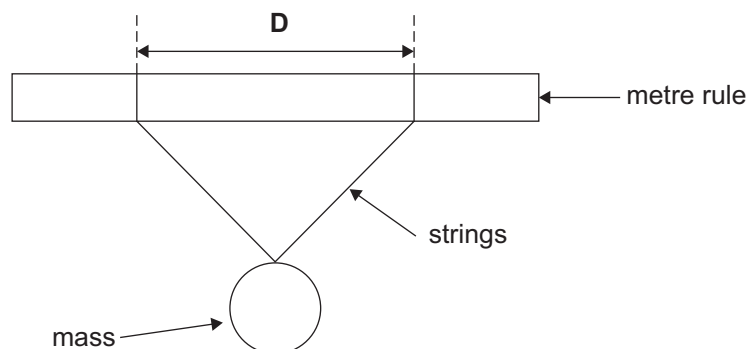
(iii) Determine the absolute uncertainty in the value of  $k$ .

Absolute uncertainty = \_\_\_\_\_ [7]

[Turn over



- 4 The acceleration of free fall  $g$  can be determined using the apparatus shown in **Fig. 4.1**. A mass is suspended from a metre rule by two strings separated by a distance  $D$ . The mass is set oscillating in a plane perpendicular to the plane of this page. The period of oscillation  $T$  is determined. The distance  $D$  is varied, and the experiment is repeated.



**Fig. 4.1**

The relationship between  $T$  and  $D$  is given by **Equation 4.1**

$$T^4 = -pD^2 + \frac{4\pi^4}{g^2} \quad \text{Equation 4.1}$$

where:-

$p$  is a constant

$g$  is the acceleration of free fall.



Fig. 4.2 shows a graph of  $T^4$  against  $D^2$  for the results obtained.

(a) Draw the best fit line for the plotted points.

[1]

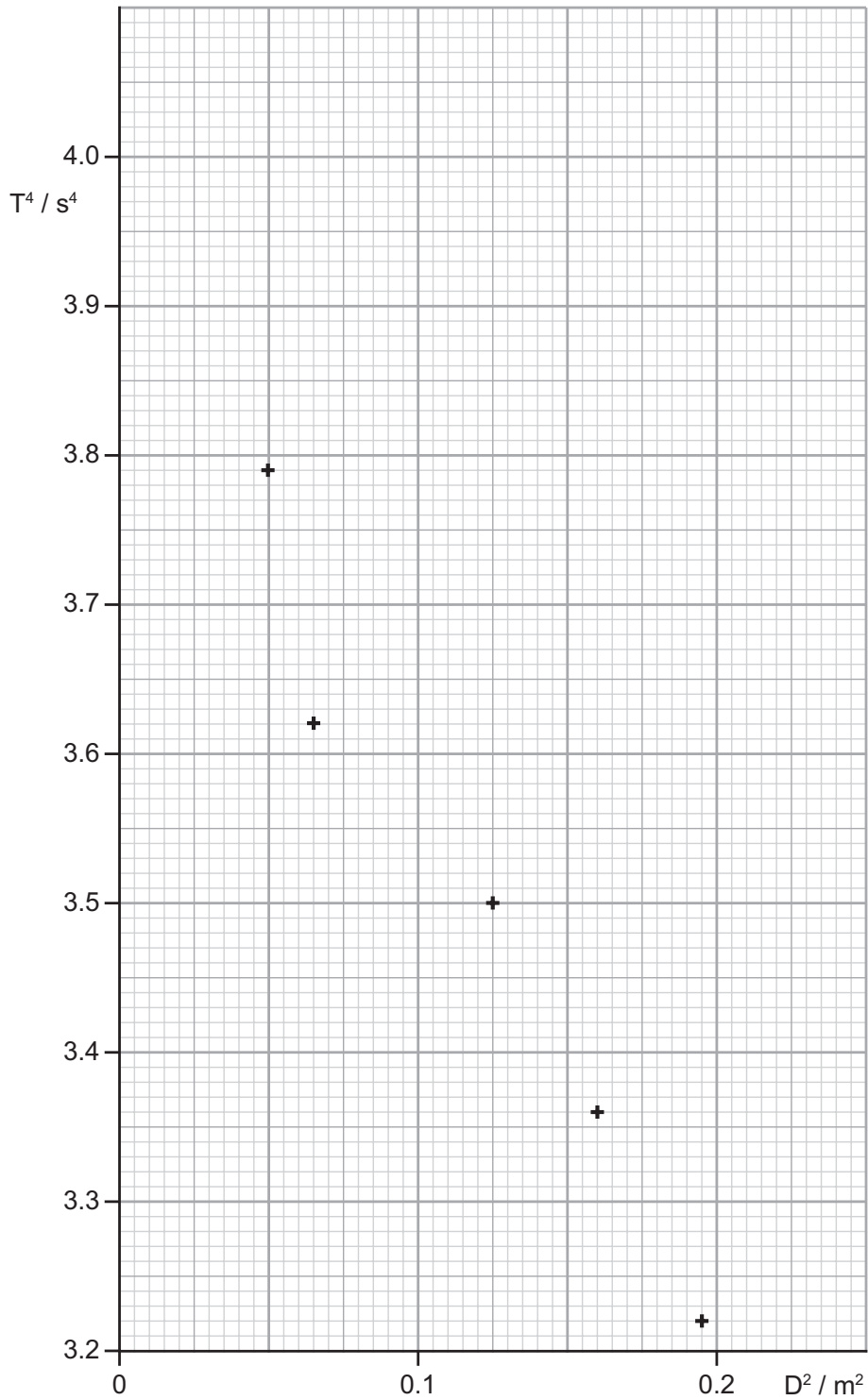


Fig. 4.2

[Turn over



**(b) (i)** Use Equation 4.1 to show how the intercept of the graph could be used to determine a value for  $g$ .

[2]

**(ii)** Use your graph to determine a value for  $g$ .

$g =$  \_\_\_\_\_  $\text{m s}^{-2}$  [2]



(c) The acceleration of free fall is  $9.81 \text{ m s}^{-2}$ . Calculate the percentage difference in this value and your answer to part (b)(ii).

Percentage difference = \_\_\_\_\_ % [2]

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**THIS IS THE END OF THE QUESTION PAPER**

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For Examiner's use only	
Question Number	Marks
1	
2	
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4	
<b>Total Marks</b>	

Examiner Number

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# **Physics**

Assessment Units AS 1 and AS 2

**[SPH11/SPH21]**

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## **DATA AND FORMULAE SHEET**

# Data and Formulae Sheet for AS 1 and AS 2

## Values of constants

speed of light in a vacuum	$c = 3.00 \times 10^8 \text{ m s}^{-1}$
elementary charge	$e = 1.60 \times 10^{-19} \text{ C}$
the Planck constant	$h = 6.63 \times 10^{-34} \text{ J s}$
mass of electron	$m_e = 9.11 \times 10^{-31} \text{ kg}$
mass of proton	$m_p = 1.67 \times 10^{-27} \text{ kg}$
acceleration of free fall on the Earth's surface	$g = 9.81 \text{ m s}^{-2}$
electron volt	$1 \text{ eV} = 1.60 \times 10^{-19} \text{ J}$
the Hubble constant	$H_0 \approx 2.4 \times 10^{-18} \text{ s}^{-1}$

## Useful formulae

The following equations may be useful in answering some of the questions in the examination:

### Mechanics

conservation of energy	$\frac{1}{2} mv^2 - \frac{1}{2} mu^2 = Fs$ for a constant force
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### Waves

two-source interference	$\lambda = \frac{ay}{d}$
diffraction grating	$d \sin\theta = n\lambda$

## Light

lens equation

$$\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$$

## Electricity

terminal potential difference

$$V = E - Ir \text{ (e.m.f., } E; \text{ Internal Resistance, } r)$$

potential divider

$$V_{\text{out}} = \frac{R_1 V_{\text{in}}}{R_1 + R_2}$$

## Particles and photons

Einstein's equation

$$\frac{1}{2} m v_{\text{max}}^2 = hf - hf_0$$

de Broglie equation

$$\lambda = \frac{h}{p}$$

## Astronomy

red shift

$$z = \frac{\Delta\lambda}{\lambda}$$

recession speed

$$z = \frac{v}{c}$$

Hubble's law

$$v = H_0 d$$

