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Physics
Standard level
Paper 1B

29 April 2025

Zone A afternoon | **Zone B** afternoon | **Zone C** afternoon

Candidate session number

1 hour 30 minutes [Paper 1A and Paper 1B]

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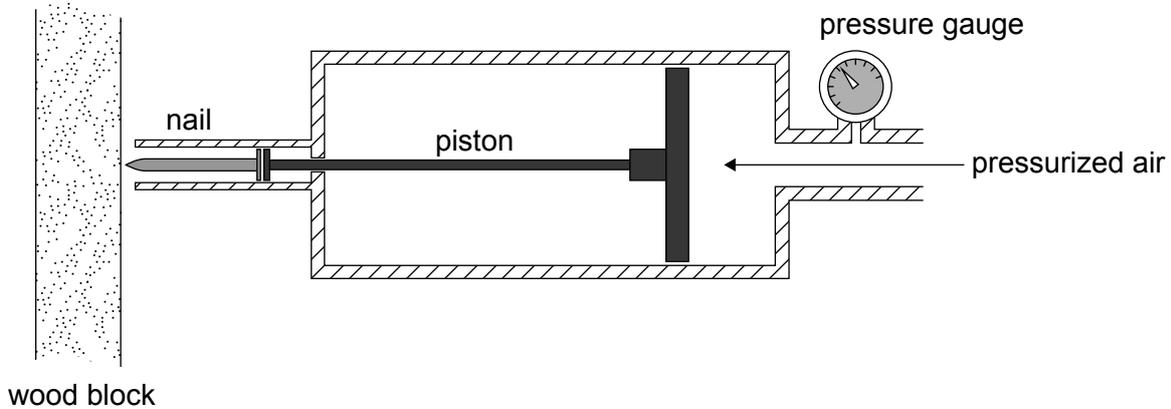
Instructions to candidates

- Write your session number in the boxes above.
- Do not open this examination paper until instructed to do so.
- Answer all questions.
- Answers must be written within the answer boxes provided.
- A calculator is required for this paper.
- A clean copy of the **physics data booklet** is required for this paper.
- The maximum mark for paper 1B is **[20 marks]**.
- The maximum mark for paper 1A and paper 1B is **[45 marks]**.

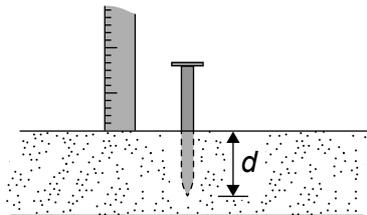


Answer **all** questions. Answers must be written within the answer boxes provided.

1. A group of students uses pressurized air to move a piston that forces a nail into a block of wood. A gauge is used to measure the pressure P of compressed air above atmospheric pressure. The nail enters the wood perpendicular to its surface.



The students use a ruler to measure the length of the nail which remains above the surface of the wood as shown. The depth of the nail inside the wood is d . All necessary length measurements are recorded using a ruler with uncertainty ± 1 mm.



- (a) Describe one consideration that must be made when placing the ruler to ensure that the length of the nail remaining above the surface of the wood is measured accurately. [1]

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(Question 1 continued)

(b) The students systematically increase the pressure and calculate d .

Pressure P/kPa	Nail depth in wood $d/\text{m} \times 10^{-3}$
50	15
100	21
150	26
200	30
250	33
300	37

(i) State one variable that needs to be controlled when collecting the data. [1]

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(ii) Outline how the students determined the value of d . [1]

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(iii) State the absolute uncertainty of d . [1]

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(iv) By using two sets of data in the table, show that the relationship between d and P is not directly proportional. [2]

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(Question 1 continued)

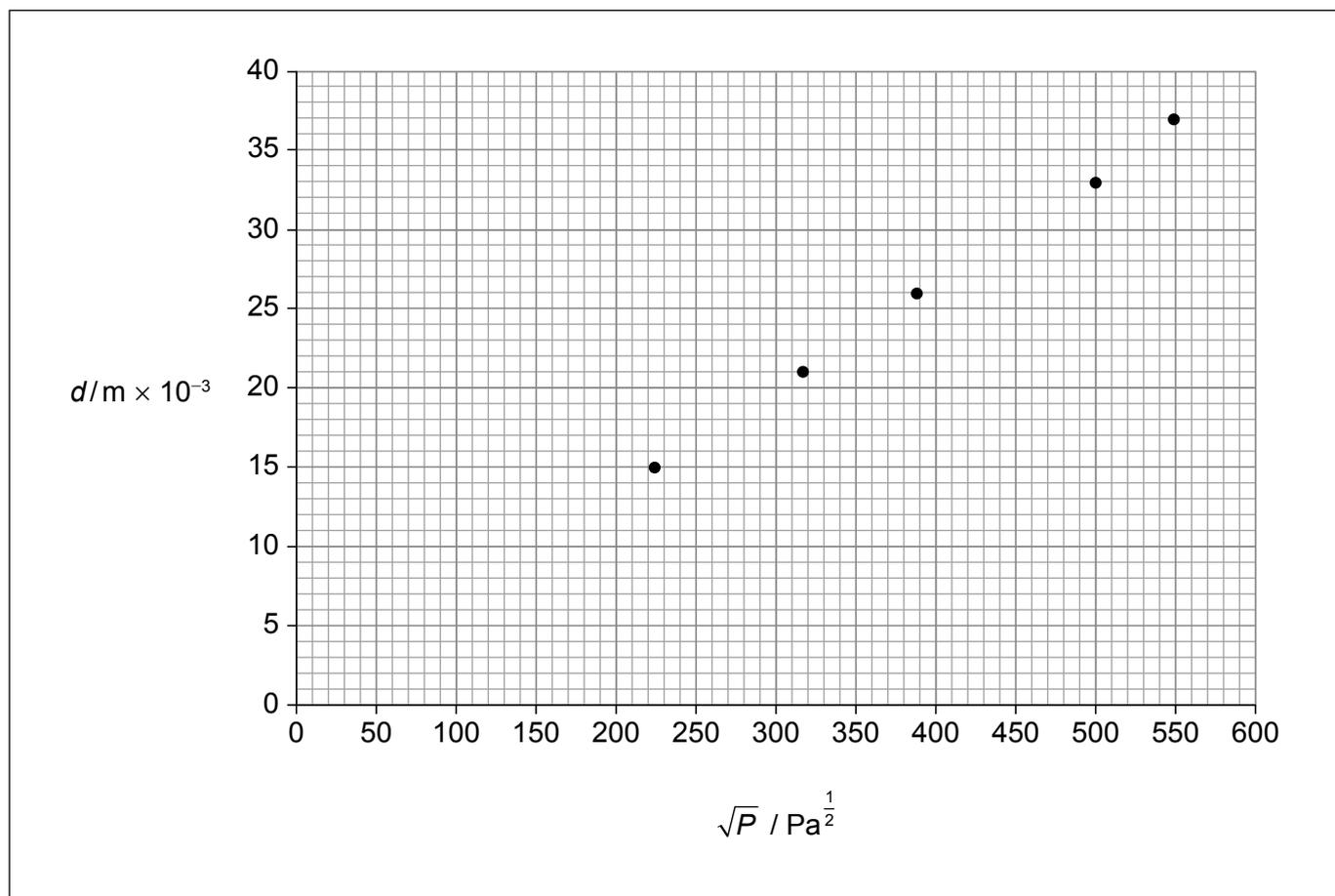
(c) The students suggest the following relationship between d and P :

$$d = k\sqrt{P}$$

where k is a constant.

To verify the relationship, the variation of d with \sqrt{P} is plotted.

One data point is missing.



(This question continues on the following page)



(Question 1 continued)

- (i) Determine the coordinates of the missing point using the original data set and plot it on the graph. [1]

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- (ii) The percentage uncertainty in P is $\pm 8\%$. Determine the uncertainty for \sqrt{P} when $d = 33\text{ mm}$ and draw the uncertainty bar for this data point on the graph. [3]

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- (iii) The SI units of k can be expressed as $\text{kg}^{-\frac{1}{2}} \text{m}^x \text{s}^y$. Determine the values of x and y . [2]

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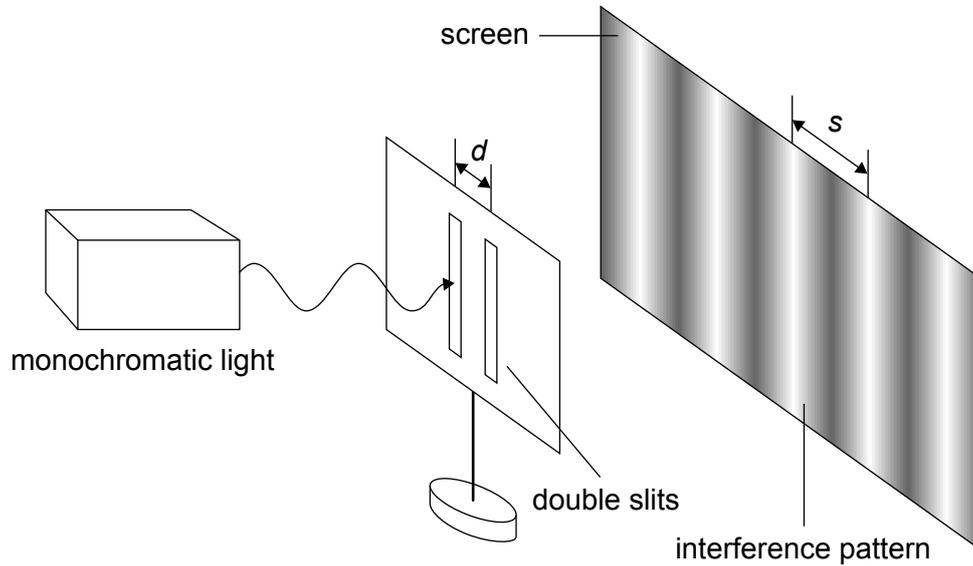
- (d) The students collect only one value of d for each value of P . Suggest why this is a poor method. [1]

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2. Students set up a double slit experiment to determine the wavelength λ of monochromatic light. A light source is directed at a double slit with **variable** separation d . An interference pattern is formed on a screen at a fixed distance from the slits. The separation of the fringes is s .

At close range the pattern is shown as a set of constructive interference fringes.



- (a) Students use a ruler with millimetre intervals to measure s . Describe a method to determine s such that its absolute uncertainty is reduced. [2]

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- (b) Discuss the effect on the fractional uncertainty in s when using a smaller value of d . [2]

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(Question 2 continued)

- (c) (i) To determine λ students plot a graph with s on the vertical axis. State the variable that must be plotted on the horizontal axis to obtain a line of best fit that is straight. [1]

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- (ii) The calculator value obtained from the graph gives $\lambda = 611.089 \text{ nm}$ with a percentage uncertainty of $\pm 5\%$. Deduce how this value should be recorded in a conclusion, including the absolute uncertainty, to the appropriate number of significant digits. [2]

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