

**Physics**  
**Standard level**  
**Paper 1B**

5 November 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 is trying to determine the density and the viscosity of a liquid.

To determine the density, they use a balance to read the mass  $m$  of a sphere in air and immersed in the liquid.

They use a sphere of volume  $V = 1.827 \times 10^{-7} \text{ m}^3$ .

The readings are  $m_{\text{air}} = 1.427 \text{ g}$  in air and  $m_{\text{Immersed}} = 1.208 \text{ g}$  in the liquid.

The readings are different due to buoyancy. The buoyancy force  $F_b$  is given by

$$F_b = \rho V g,$$

where  $V$  is the volume of the sphere and  $\rho$  is the density of the liquid.

- (a) State the level of precision in the measurement of  $m$ . [1]

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- (b) Show that  $F_b$  is about 2 mN. [1]

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- (c) Calculate the density of the liquid. [2]

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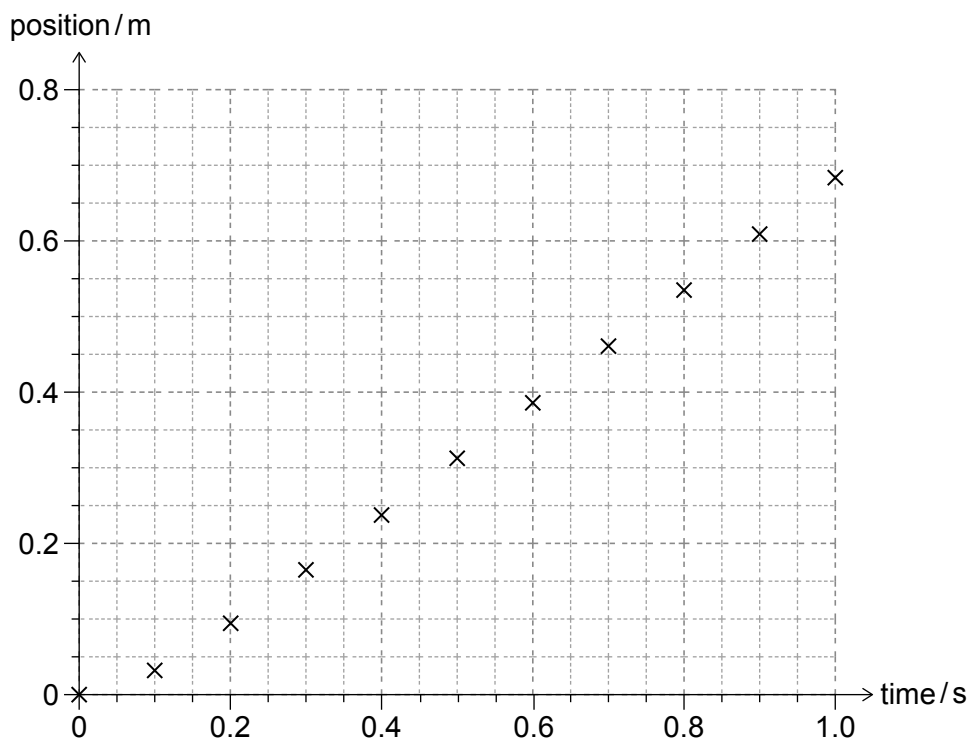
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**(Question 1 continued)**

To determine the viscosity, they immerse the sphere in the liquid and drop it from rest.

They collect values and plot a graph of the position  $d$  of the sphere from the moment they drop it. They verify that the sphere reaches terminal velocity  $v_t$  after 0.5 s.



(d) Draw the line of best fit on the graph. [2]

(e) Outline how the students may verify that the sphere reaches terminal velocity. [1]

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**(This question continues on page 5)**



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Answers written on this page  
will not be marked.



**(Question 1 continued)**

They repeat the experiment several times and estimate an average for

$$v_t = (0.71 \pm 0.05) \text{ m s}^{-1}.$$

They use the equation

$$\eta = \frac{m_{\text{air}}g - \rho Vg}{6\pi r v_t},$$

where

$r$  = radius of the sphere,

$v_t$  = terminal velocity of the sphere,

$\eta$  = viscosity of the liquid.

The radius  $r$  of the sphere is 3.520 mm.

- (f) Calculate the viscosity of the liquid and its absolute uncertainty. Ignore uncertainties in the mass, radius and volume of the sphere. Give your answer in the form  $\eta \pm \Delta\eta$ , to an appropriate number of significant figures, including units. [4]

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The students search literature values and find the viscosity of this liquid to be 0.24, when expressed in SI base units.

- (g) Suggest a conclusion reached by the students. [1]

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2. A student investigates whether the Stefan–Boltzmann law,  $L = 4\pi\sigma R^2T^4$ , applies to stars.

$L$  = luminosity of the star, in W

$\sigma$  = Stefan–Boltzmann constant

$R$  = radius of the star, in m

$T$  = surface temperature of the star, in K

To verify the law, they obtain values from databases and manipulate the data as shown.

| Star                 | $L$                   | $R$                | $T$                | $\frac{L}{R^2}$       | $\log(\frac{L}{R^2})$ | $\log(T)$ |
|----------------------|-----------------------|--------------------|--------------------|-----------------------|-----------------------|-----------|
| 10 Lacertae          | $3.92 \times 10^{31}$ | $5.75 \times 10^9$ | $3.62 \times 10^4$ | $1.19 \times 10^{12}$ | 12.1                  | 4.56      |
| $\sigma$ -Orionis A  | $1.60 \times 10^{31}$ | $3.90 \times 10^9$ | $3.49 \times 10^4$ | $1.05 \times 10^{12}$ | 12.0                  | 4.54      |
| $\sigma$ -Orionis B  | $6.08 \times 10^{30}$ | $3.48 \times 10^9$ | $2.91 \times 10^4$ | $5.02 \times 10^{11}$ | 11.7                  | 4.46      |
| Polaris B            | $1.50 \times 10^{27}$ | $9.60 \times 10^8$ | $6.90 \times 10^3$ |                       | 9.21                  |           |
| $\alpha$ -Centauri A | $5.77 \times 10^{26}$ | $8.49 \times 10^8$ | $5.79 \times 10^3$ | $8.00 \times 10^8$    | 8.90                  | 3.76      |
| $\alpha$ -Centauri B | $1.92 \times 10^{26}$ | $5.97 \times 10^8$ | $5.26 \times 10^3$ | $5.39 \times 10^8$    | 8.73                  | 3.72      |
| $\varepsilon$ -Indi  | $8.08 \times 10^{25}$ | $4.95 \times 10^8$ | $4.65 \times 10^3$ | $3.30 \times 10^8$    | 8.52                  | 3.67      |
| Sun                  | $3.85 \times 10^{26}$ | $6.96 \times 10^8$ | $5.78 \times 10^3$ | $7.95 \times 10^8$    | 8.90                  | 3.76      |

- (a) Complete the table with the missing values for Polaris B.

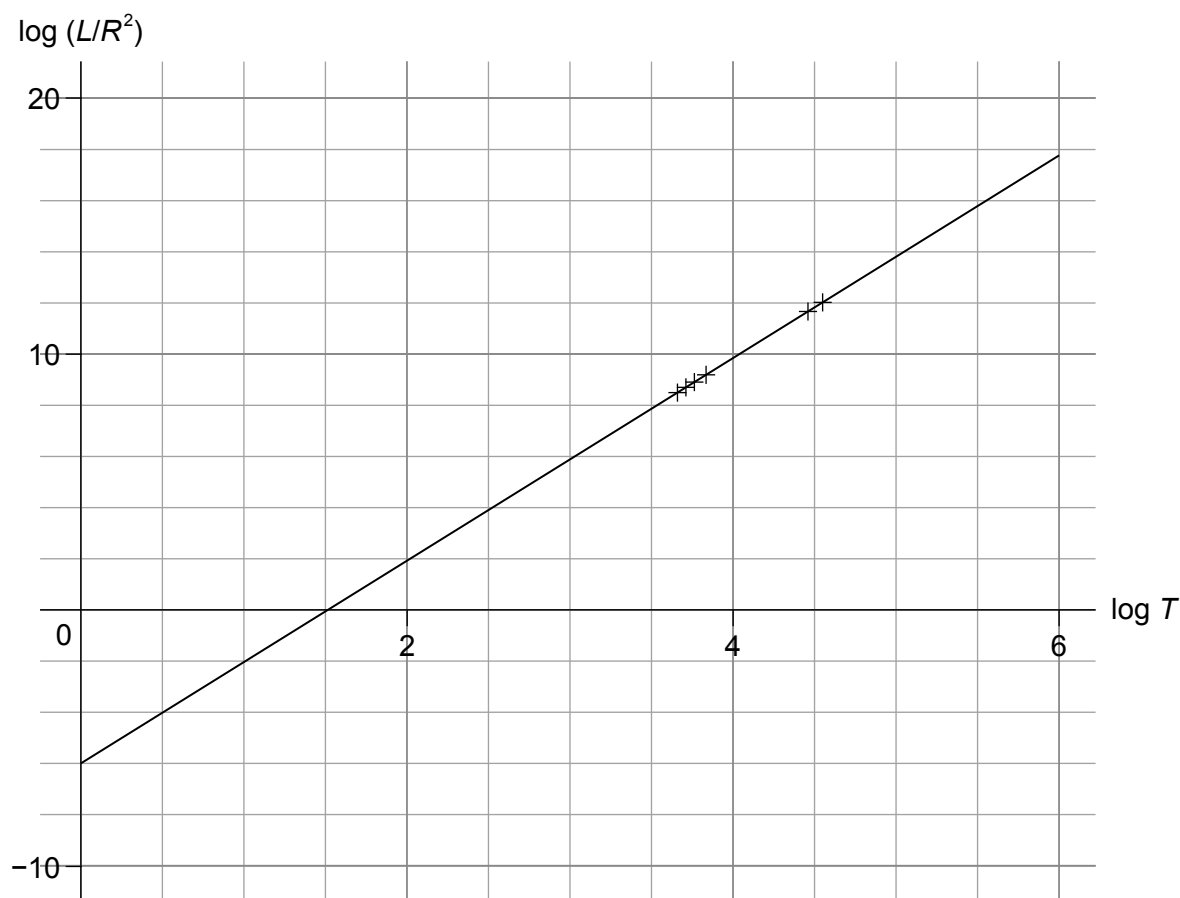
[2]

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**(Question 2 continued)**

The student plots the variation with  $\log T$  of  $\log \left( \frac{L}{R^2} \right)$  and draws the line of best fit.



The student uses a GDC (graphical display calculator) to determine the equation of the line of best fit as  $y = 3.99x - 6.15$ .

- (b) Explain how the gradient of the line of best fit relates to the Stefan–Boltzmann law. [2]

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**(Question 2 continued)**

- (c) Calculate the Stefan–Boltzmann constant obtained in this investigation. [2]

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- (d) Outline a conclusion for the investigation. [1]

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- (e) Suggest a possible improvement of the investigation, related to the range of the surface temperatures of the stars selected. [1]

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