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Physics
Standard level
Paper 1B

5 November 2025

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

Candidate session number

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

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

$$F_b = \rho Vg,$$

where V is the volume of the sphere and ρ 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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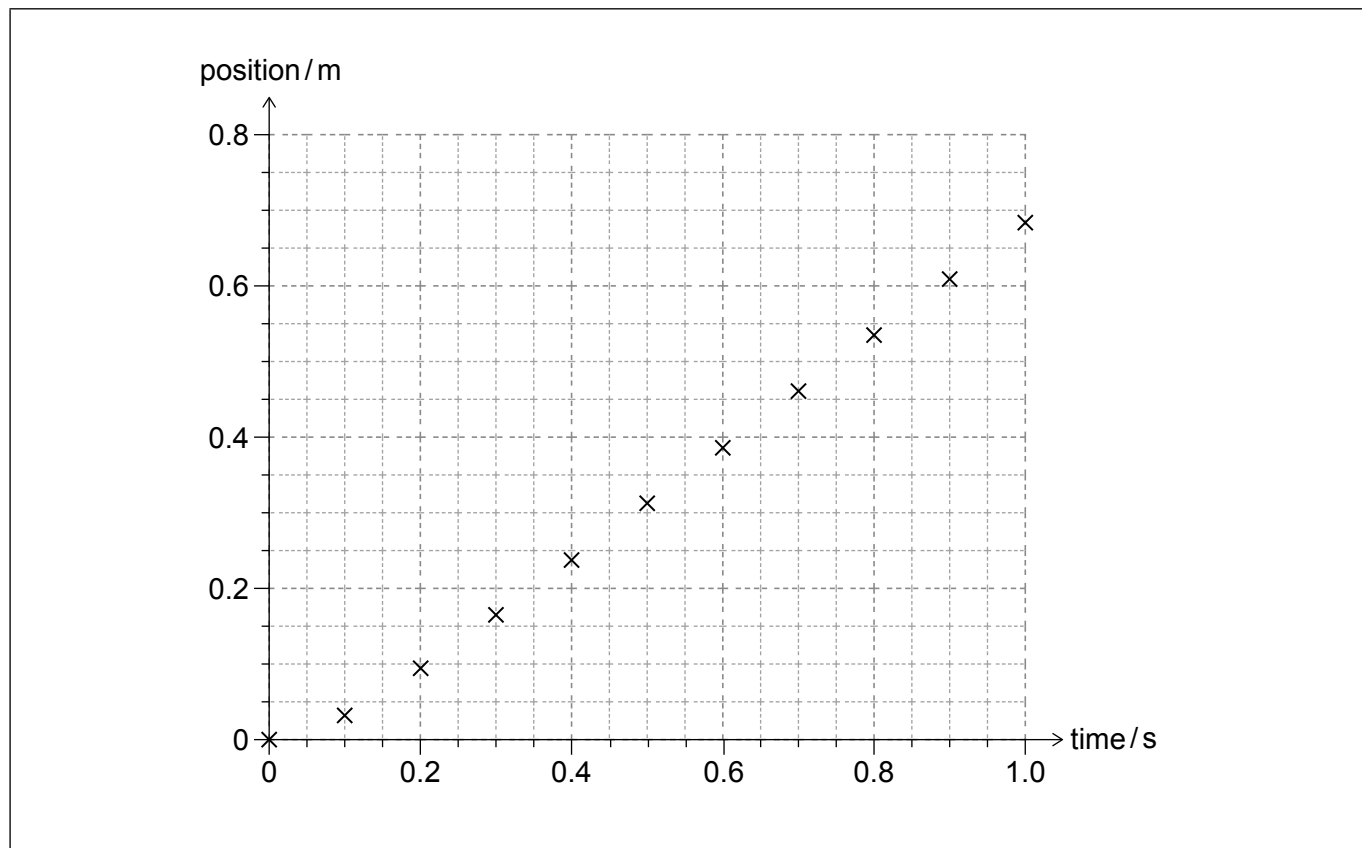
(This question continues on the following page)



(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)



Please **do not** write on this page.

Answers written on this page
will not be marked.



08EP04

(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,

η = 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

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

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

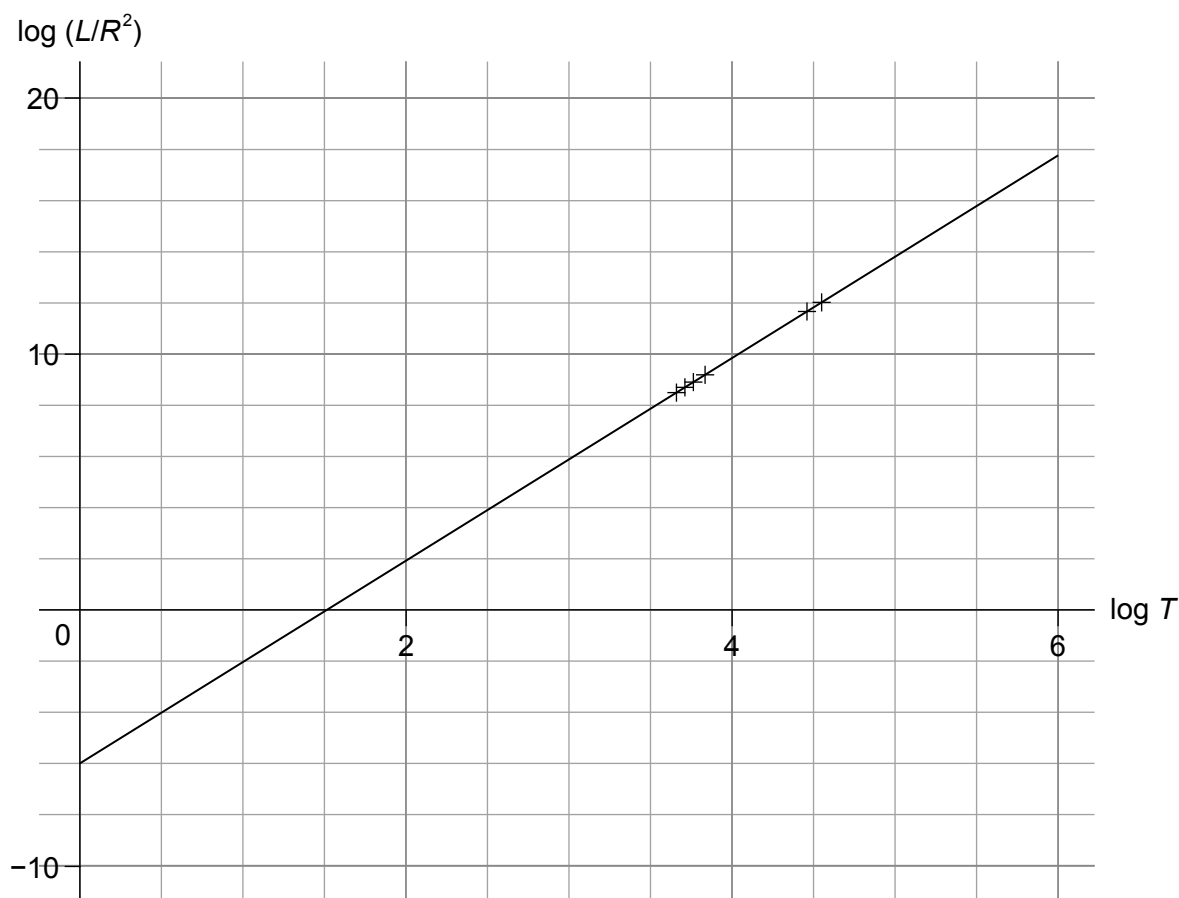
[2]

(This question continues on the following page)



(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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