Diploma Programme
Programme du diplôme
Programa del Diploma

Physics
Higher level
Paper 1B

5 November 2025

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

Candidate session number

2 hours [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 **[60 marks]**.

8 pages

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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 $m_{air} = 1.427\,\text{g}$ in air and $m_{Immersed} = 1.208\,\text{g}$ 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 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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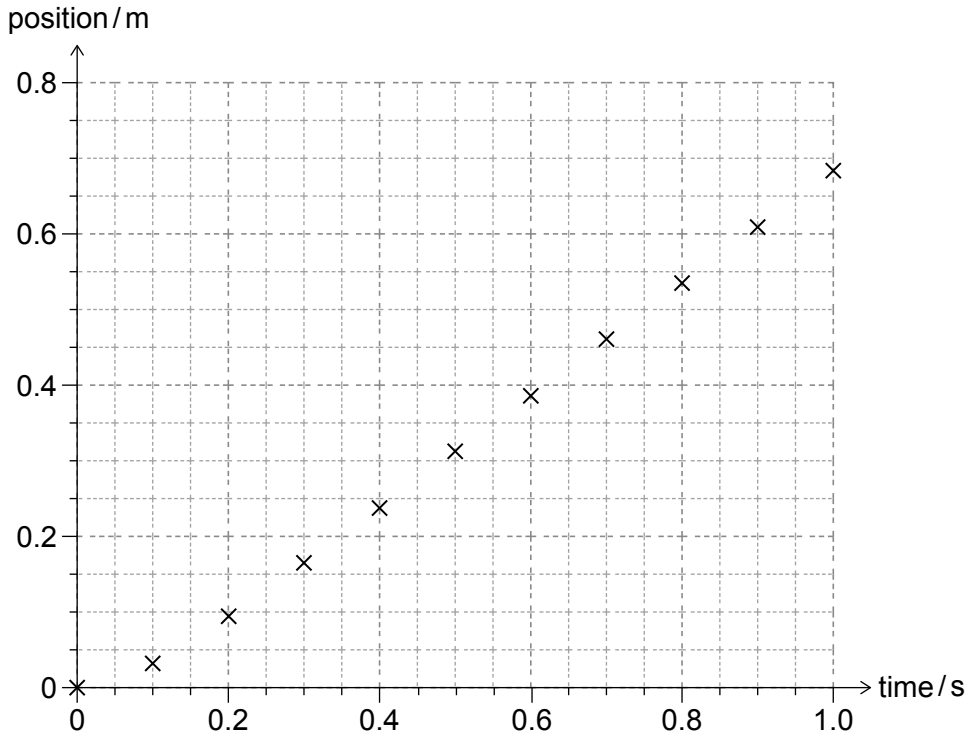
(Question 1 continued)

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

Answers written on this page
will not be marked.

(Question 1 continued)

They repeat the experiment several times and estimate an average for

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

They use the equation

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

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	$\frac{L}{R^2}$	$\log(\frac{L}{R^2})$	$\log(T)$
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]

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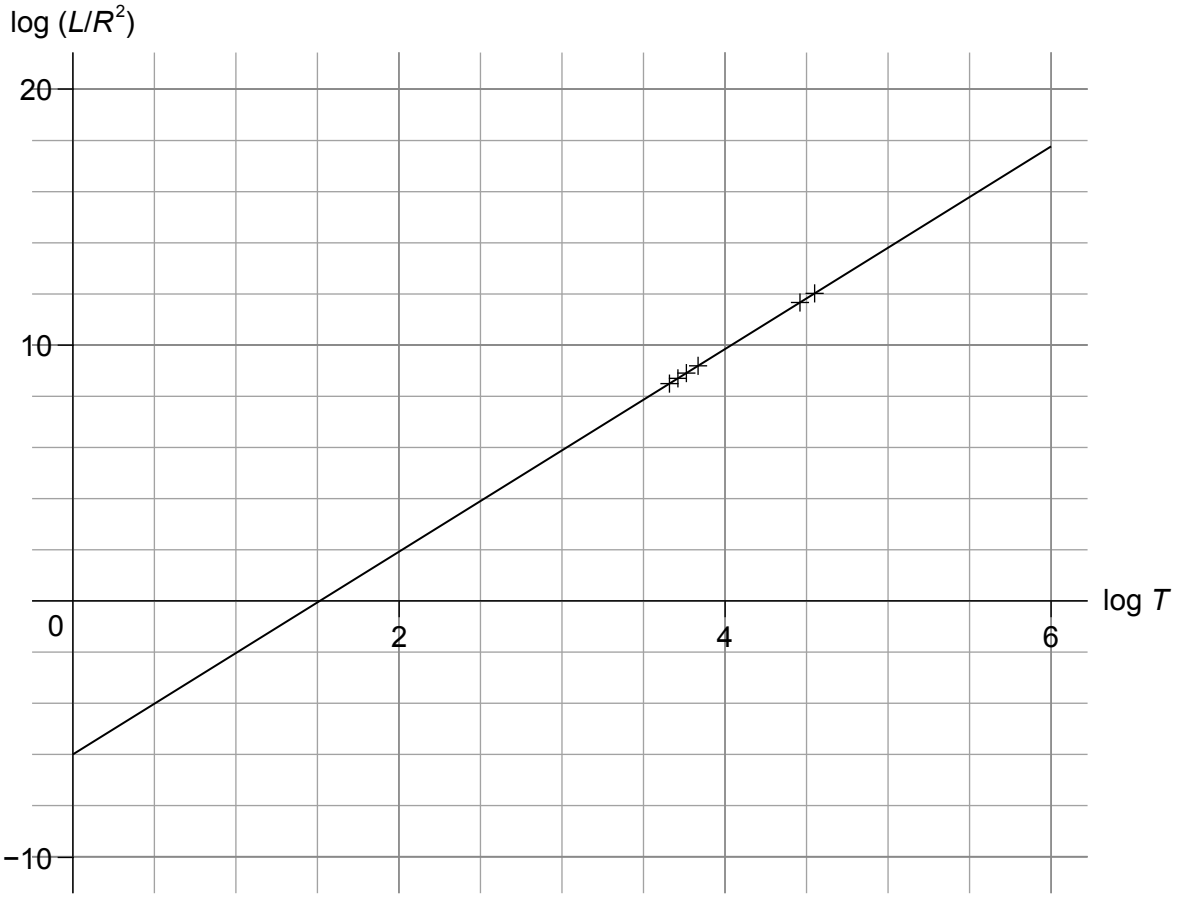
(Question 2 continued)

The student plots the variation with log T of log ($\frac{L}{R^2}$) 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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