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**Physics**  
**Higher level**  
**Paper 1B**

29 April 2025

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

Candidate session number

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



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

1. A student is analysing a sample of water. To determine its density, the student measures the volume with a measuring cylinder and the mass with an electronic balance.

(a) Identify **one** way to ensure that the volume is read accurately.

[1]

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The following data are collected:

$$\text{Volume} = (10.6 \pm 0.2) \text{cm}^3$$

$$\text{Mass} = (10.82 \pm 0.01) \text{g}$$

(b) (i) Calculate the density of the sample and its absolute uncertainty.

[2]

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(ii) State your answers in  $\text{kg m}^{-3}$  and with correct precision.

[1]

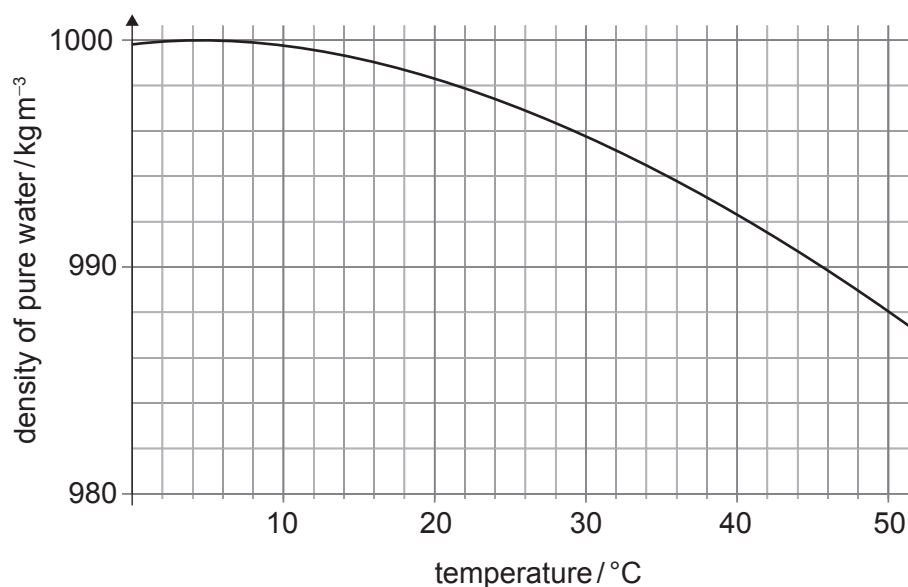
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**(Question 1 continued)**

When the density was measured, the sample was at 35 °C. The student has a graph that shows the variation with temperature of the density of pure water.



(c) Suggest whether the water sample can be considered pure.

[2]

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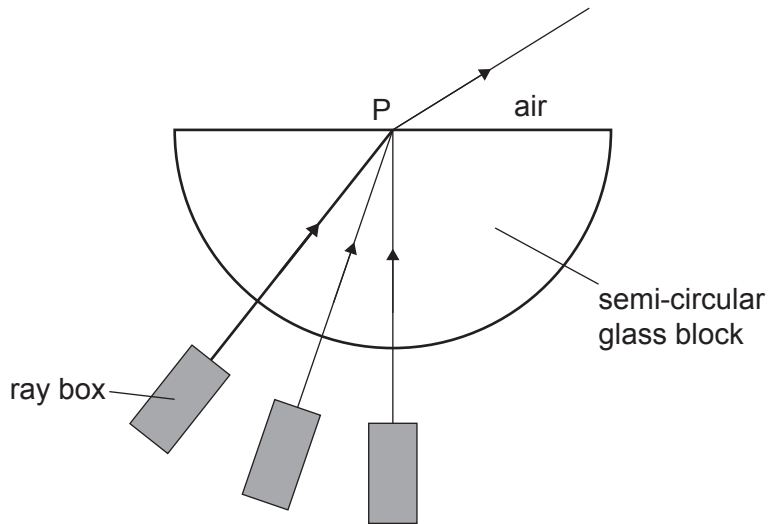
2. A group of students is investigating refraction in a semi-circular glass block.

Light from a ray box enters the curved side of the block. The light passes through the block and leaves, refracted, at P.

- (a) Outline how the students can ensure that the light is not deflected at the curved surface. [1]

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The students vary the position of the ray box to obtain data to determine the refractive index of the glass. They use a protractor to collect values for the angles of incidence  $\theta_i$  and refraction  $\theta_r$  at P and record them on a table.



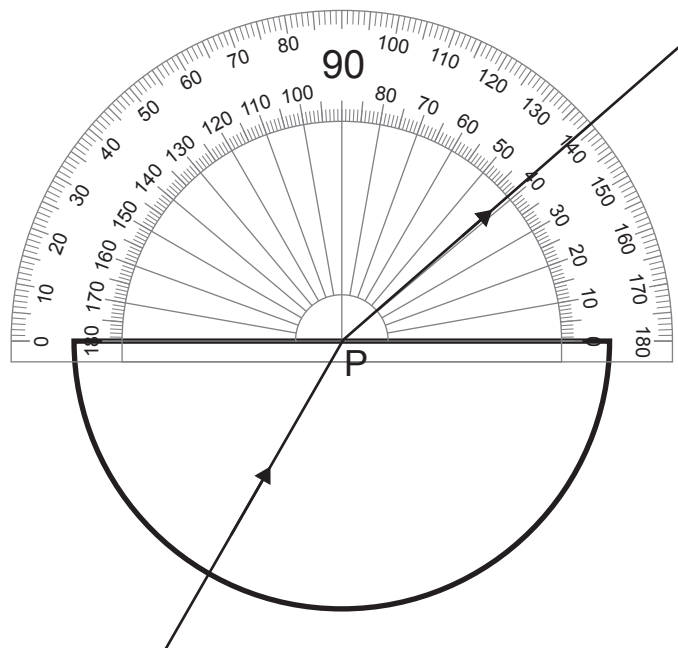
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(Question 2 continued)

- (b) (i) One of their measurements is shown. State  $\theta_r$  for this measurement.

[1]



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- (ii) Complete the table.

[1]

$\theta_i$	$\theta_r$	$\sin \theta_i$	$\sin \theta_r$
10	15	0.174	0.259
20	31	0.342	0.515
25	39	0.423	0.629
30	49	0.500	
35	60	0.574	0.866
40	75	0.643	0.966

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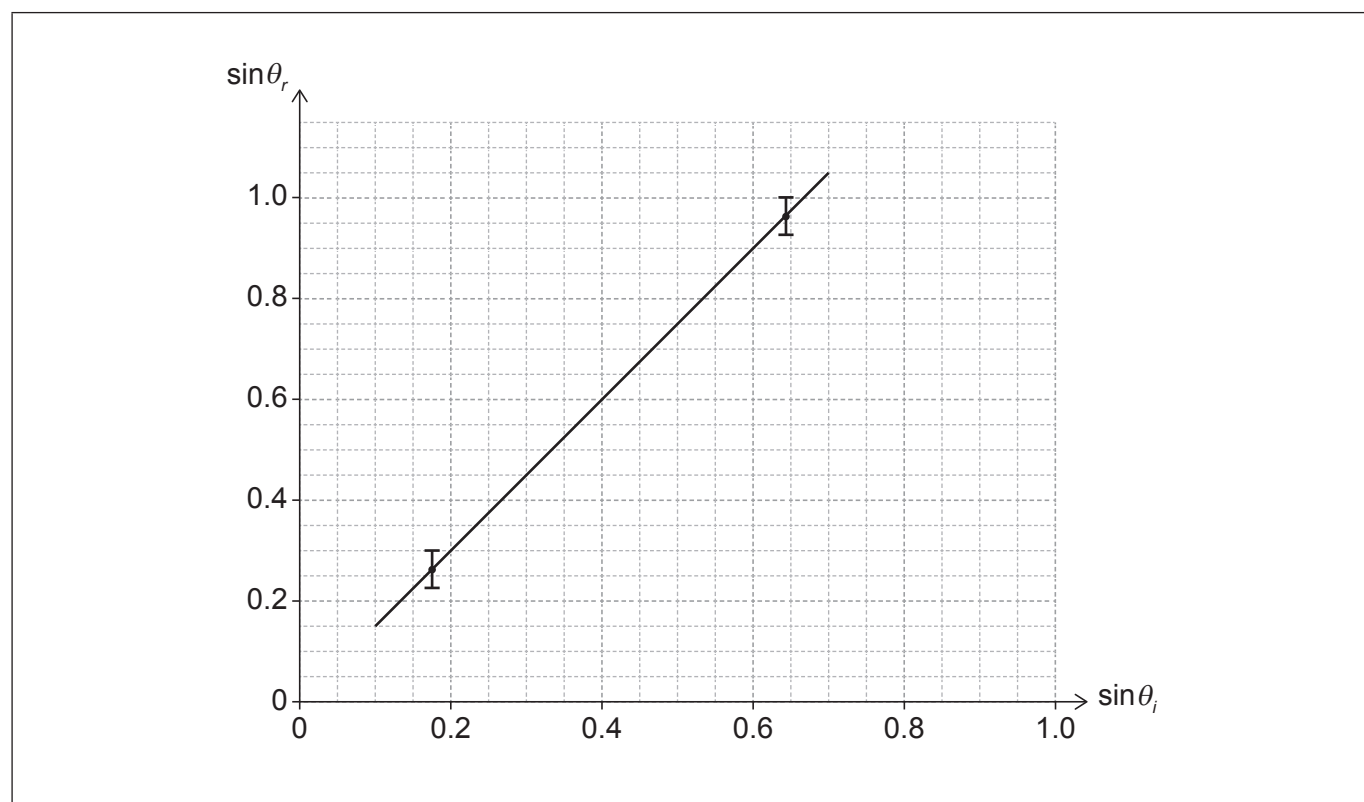
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will not be marked.



**(Question 2 continued)**

They plot a graph of the variation with the sine of  $\theta_i$  of the sine of  $\theta_r$ .

They add uncertainty bars for  $\sin \theta_r$  for the first and last data point and draw the best-fit line.



- (c) (i) Determine the gradient of the students' best-fit line. [2]

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- (ii) Draw on the students' graph the line of maximum gradient. [1]

- (iii) Determine the value of the refractive index of the glass with its absolute uncertainty. [2]

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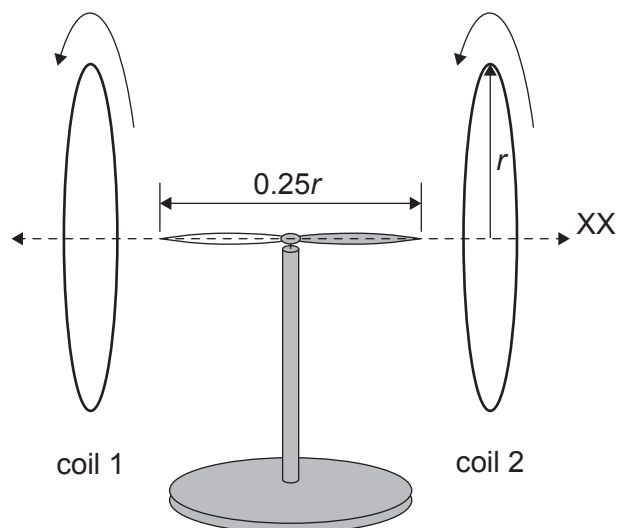


3. A group of students wants to determine the horizontal component  $B_H$  of the Earth's magnetic field.

They place a magnet (in the form of a magnetic needle) midway between two coils.

When there is no current through the coils, the magnet aligns itself in the north-south direction. When there is an identical current established in the coils, the magnetic field produced deflects the magnet.

diagram not to scale



Each coil has a radius  $r$ . The length of the magnet is  $0.25r$ .

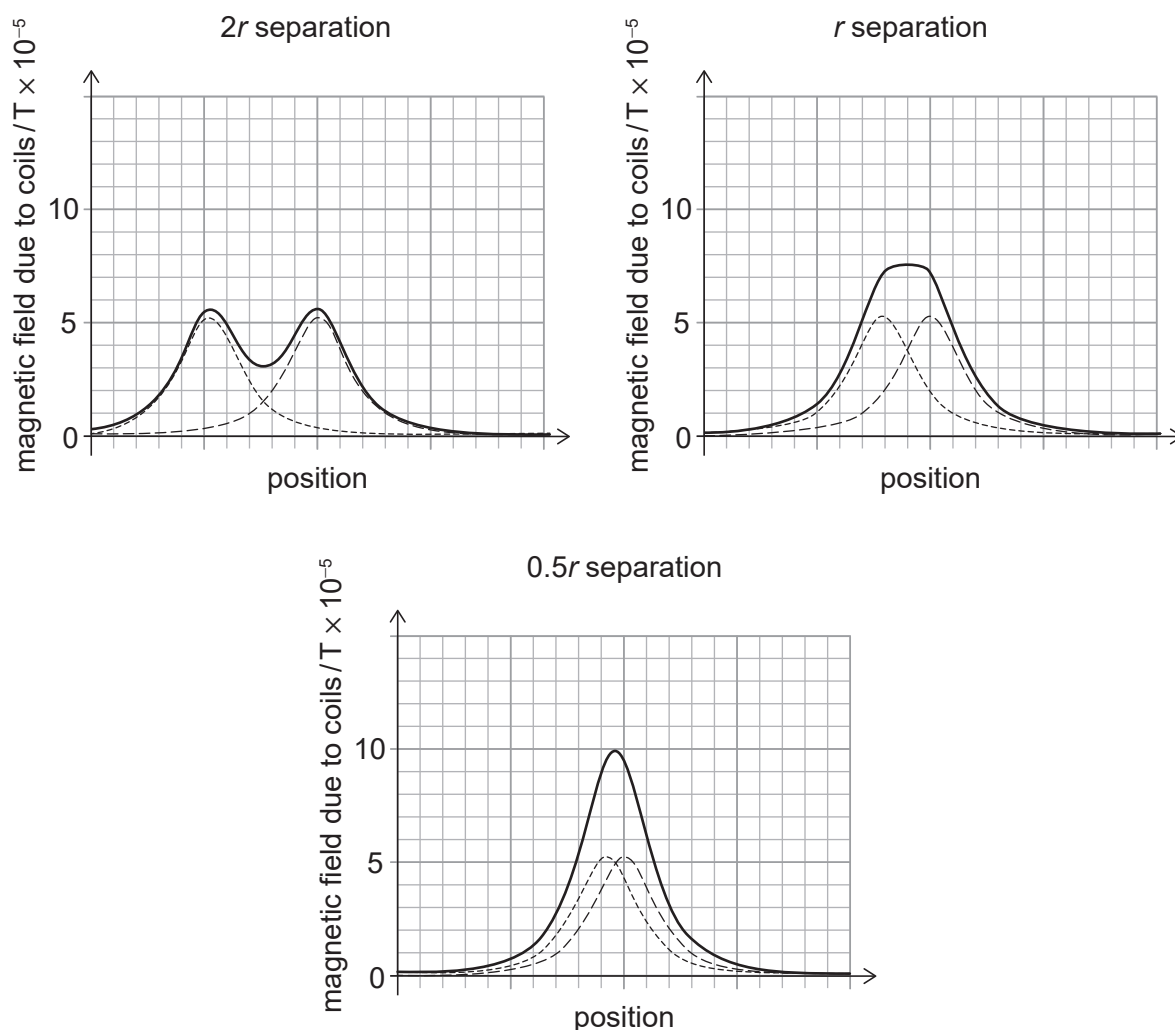
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**(Question 3 continued)**

The students have to decide on the horizontal separation of the two coils. Their choices are separations of  $2r$ ,  $r$  and  $0.5r$ .

The variation with distance of the magnetic field strength due to each coil and the resultant magnetic field strength for both coils are shown for each of these separations. The dotted line represents the magnetic field from each coil, while the solid line shows the resultant magnetic field.



- (a) State and explain which coil separation the students should choose for this experiment. [2]

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**(Question 3 continued)**

- (b) Explain why the students place axis  $XX'$  of the coils in the east-west direction.

[2]

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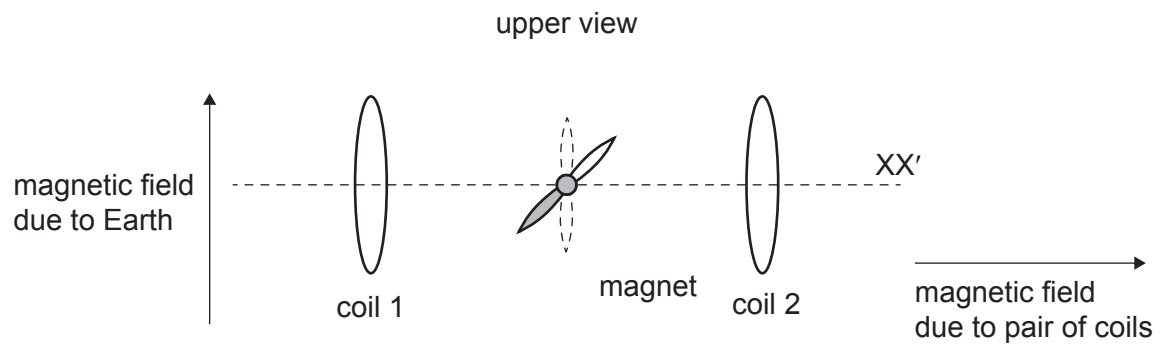
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- (c) The deflection of the magnet is shown.

**diagram not to scale**



The magnet comes to rest when it makes an angle of  $24^\circ$  to  $XX'$ .

Determine, using the graphs,  $B_H$ .

[2]

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