Diploma Programme
Programme du diplôme
Programa del Diploma

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]

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.

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]

The following data are collected:

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

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(b) (i) Calculate the density of the sample and its absolute uncertainty. [2]

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(ii) State your answers in kg m^{-3} and with correct precision. [1]

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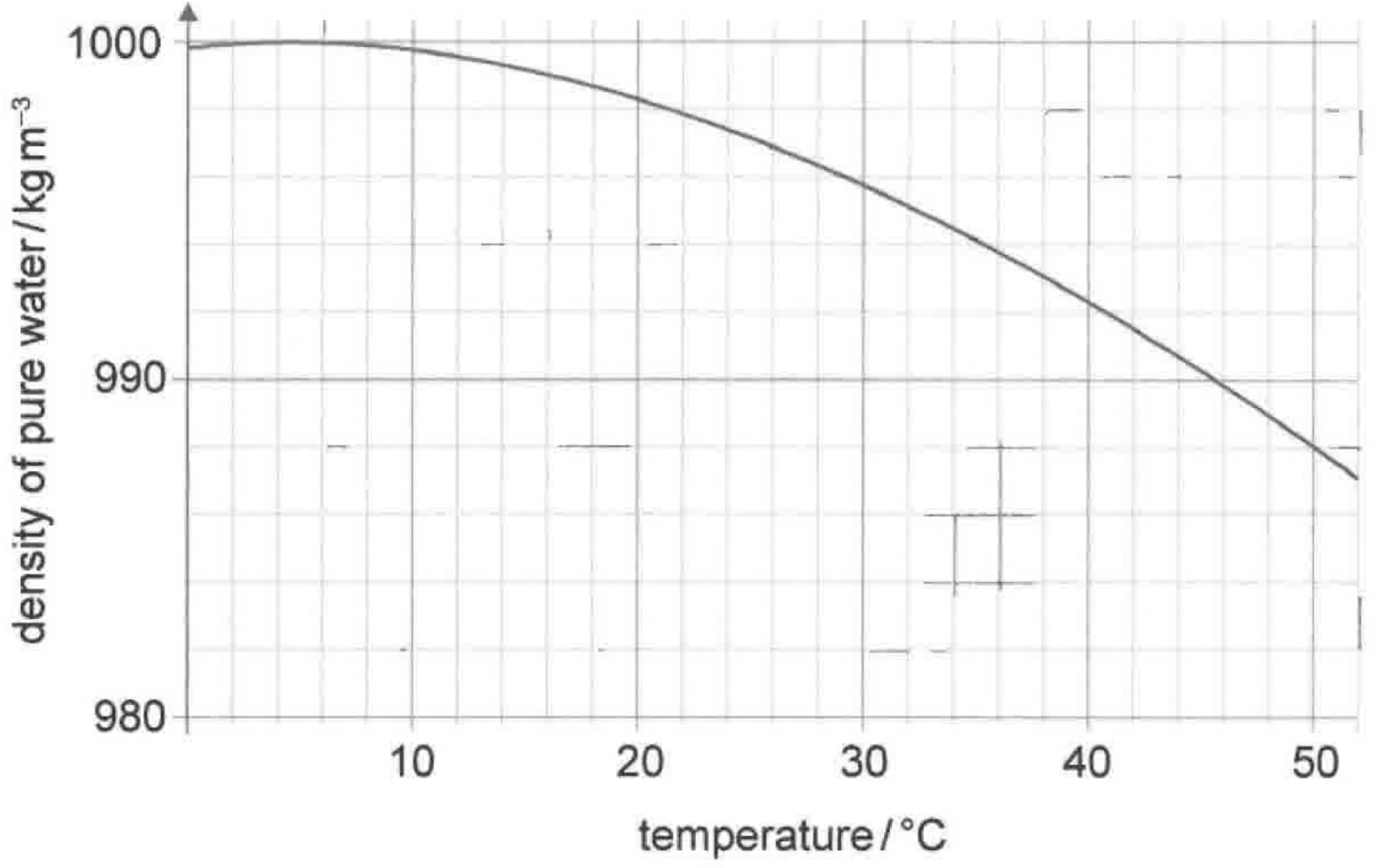
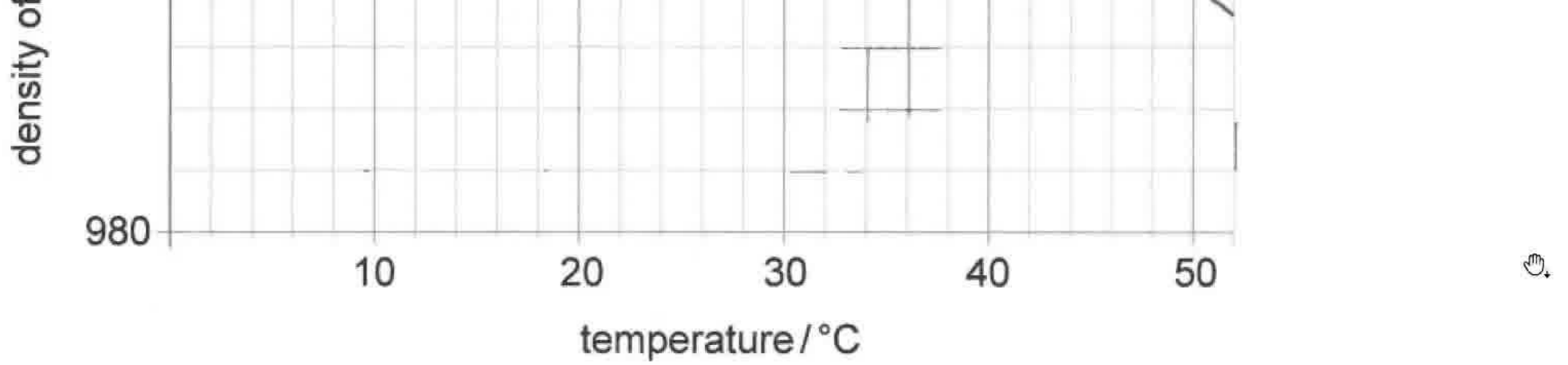
(Question 1 continued)

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 at O. 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 O. [1]

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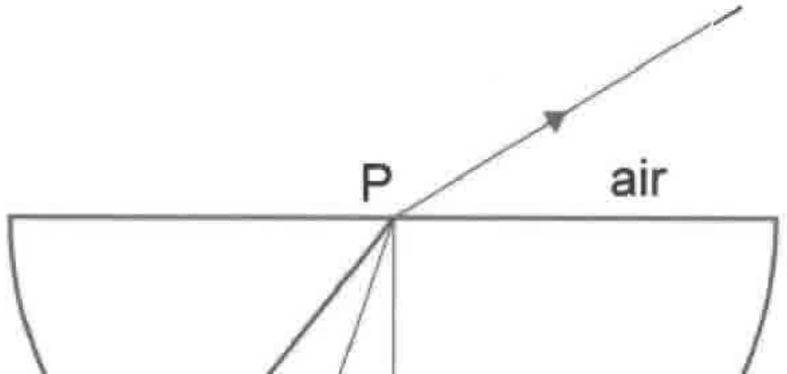
The students vary the position of O to obtain data to determine the refractive index of the glass. They use a protractor to collect values for the angles of incidence θ_i and refraction θ_r at P and record them on a table.



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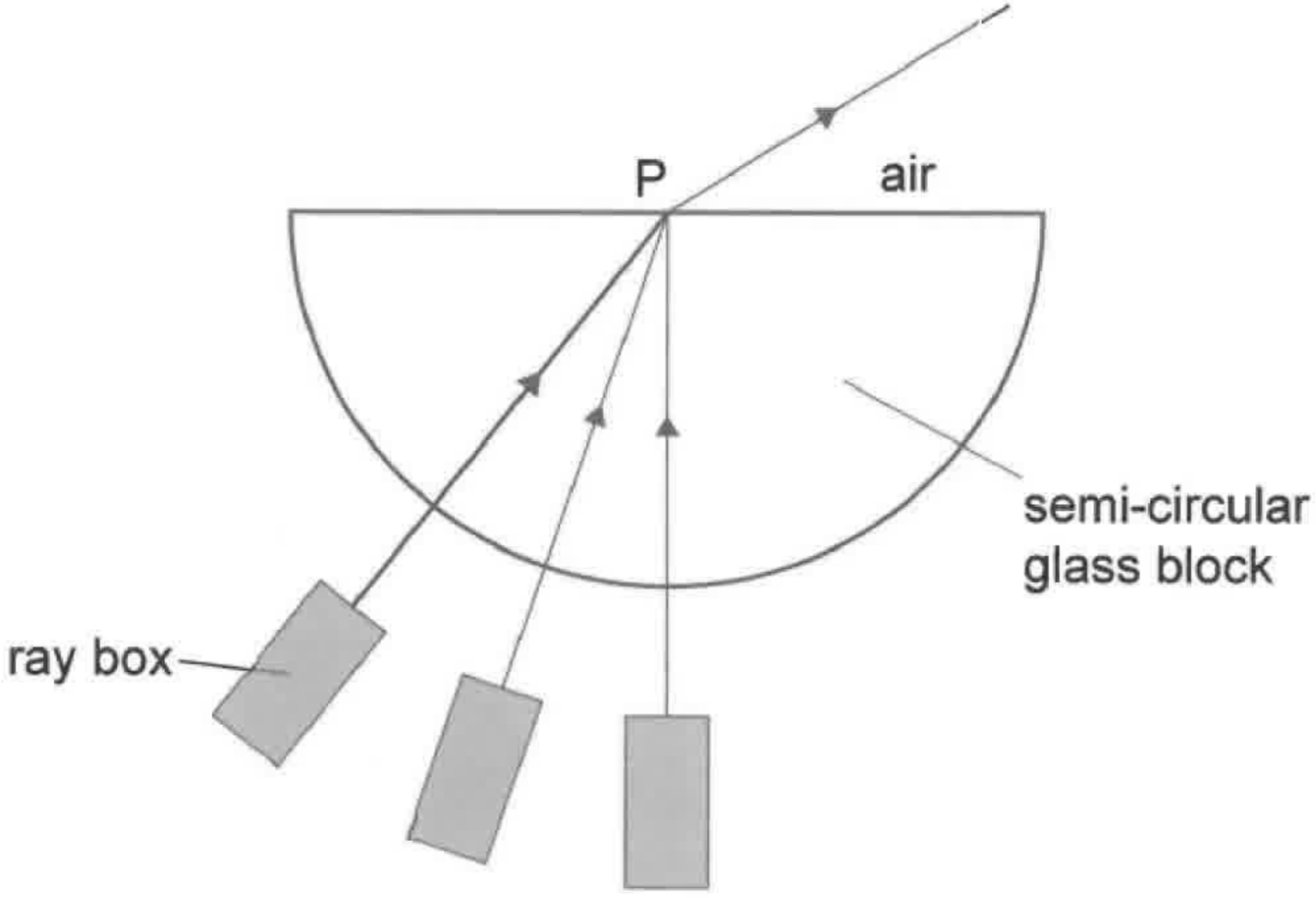

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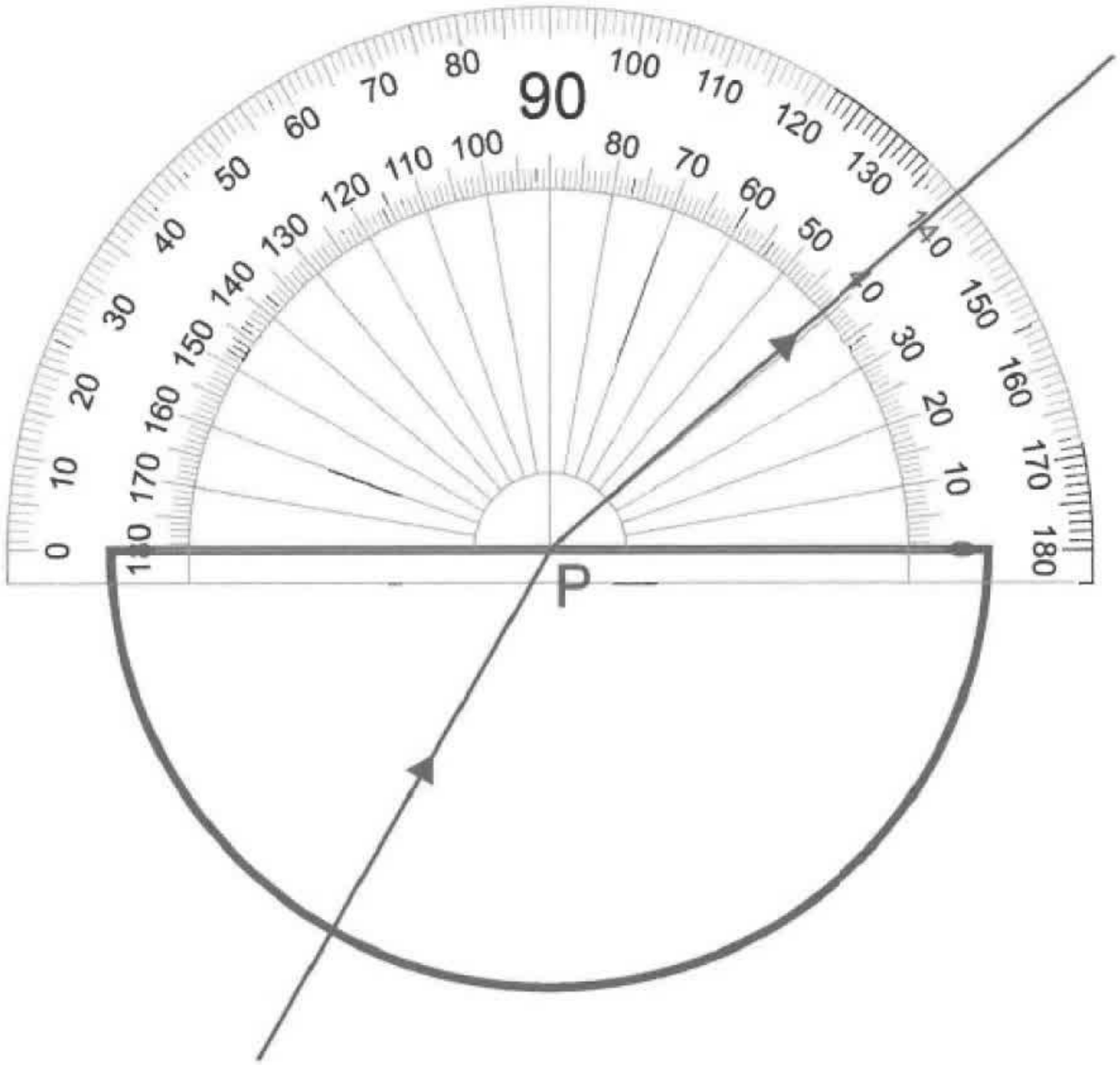
(b) (i) One of their measurements is shown. State θ_r for this measurement. [1]



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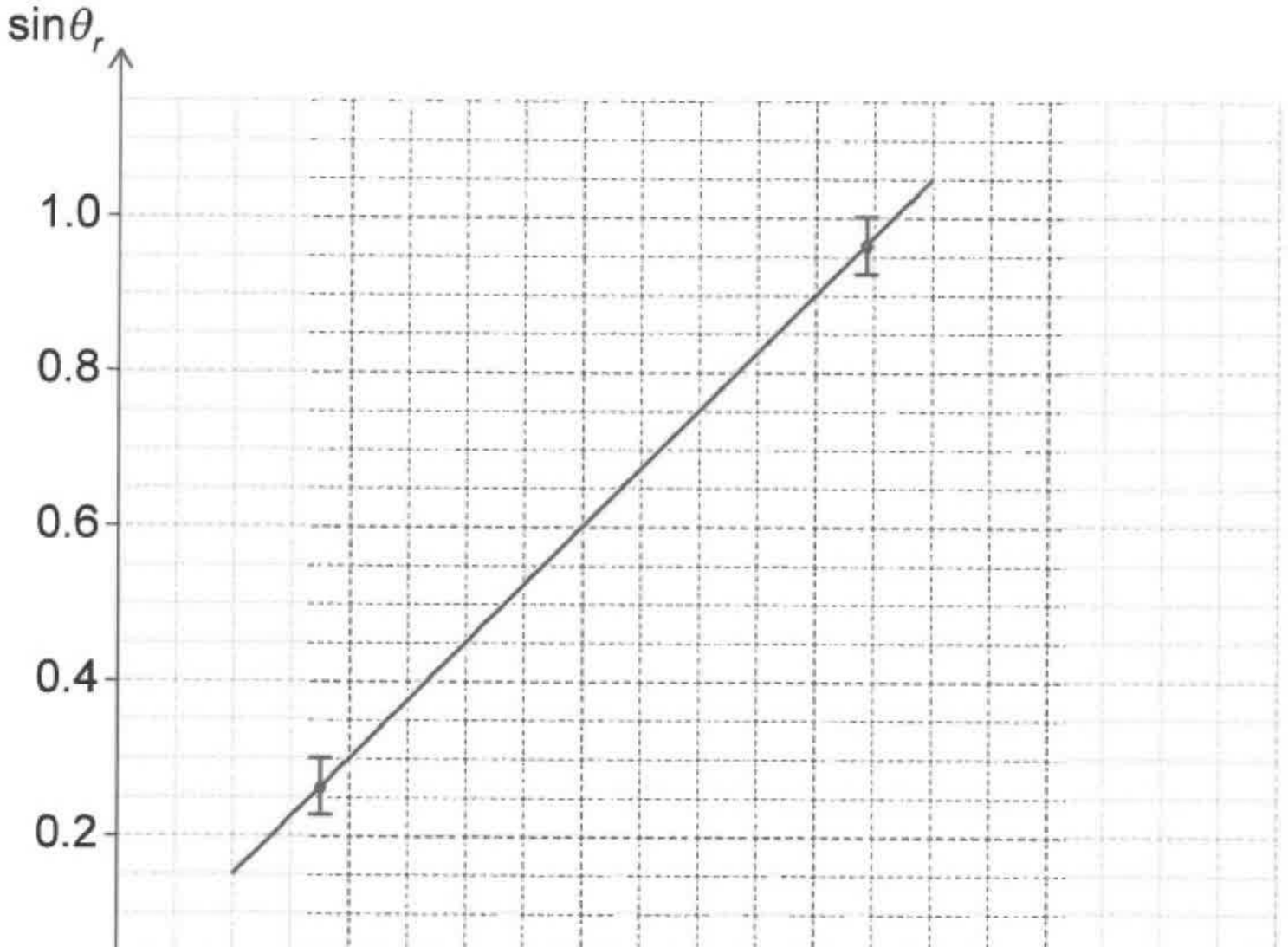
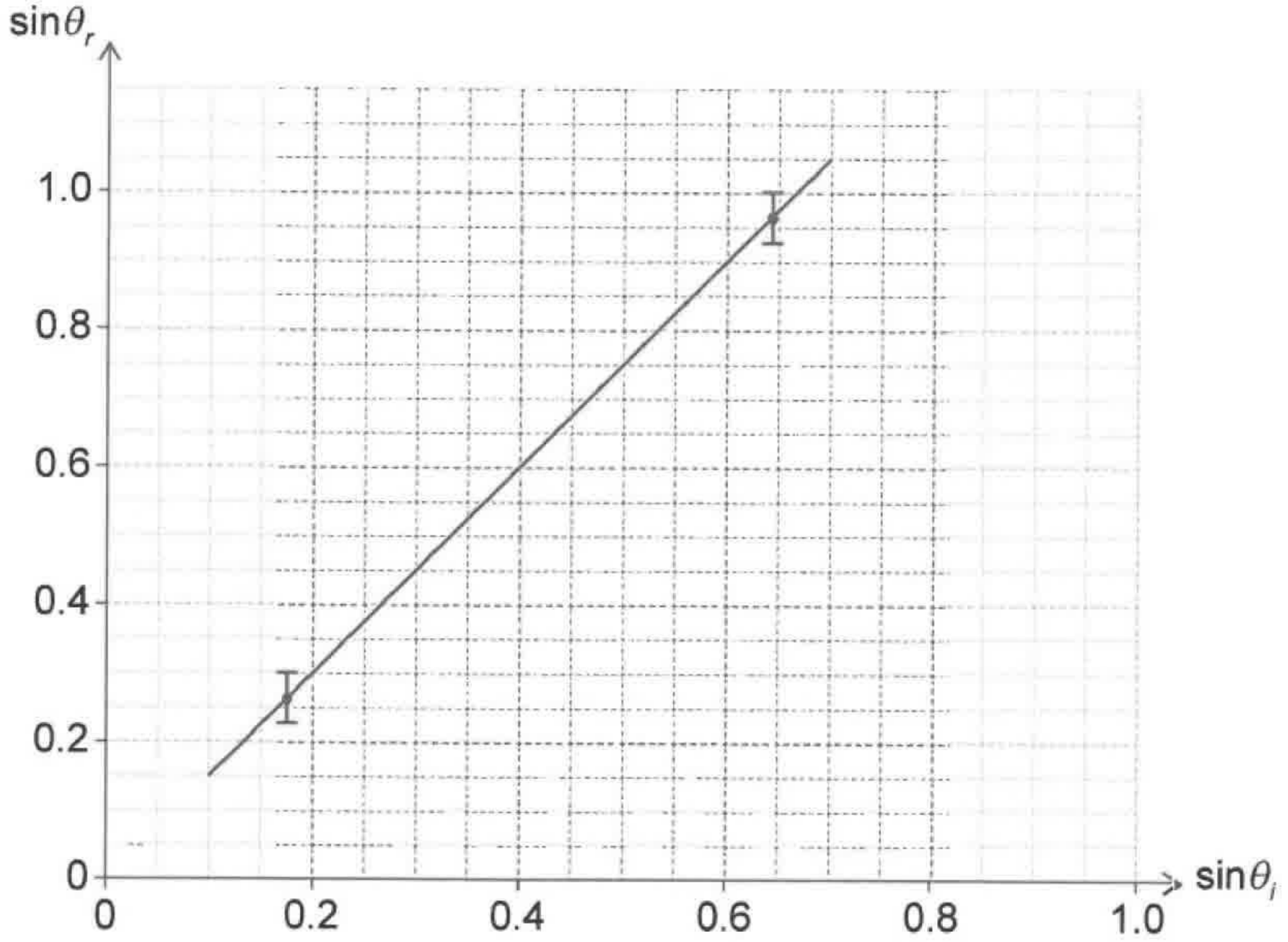
(ii) Complete the table. [1]

θ_i	θ_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

They plot a graph of the variation with the sine of θ_i of the sine of θ_r.

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




sinθ_r
1.0
0.8
0.6
0.4
0.2
0
0
0.2
0.4
0.6
0.8
1.0
sinθ_i

(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

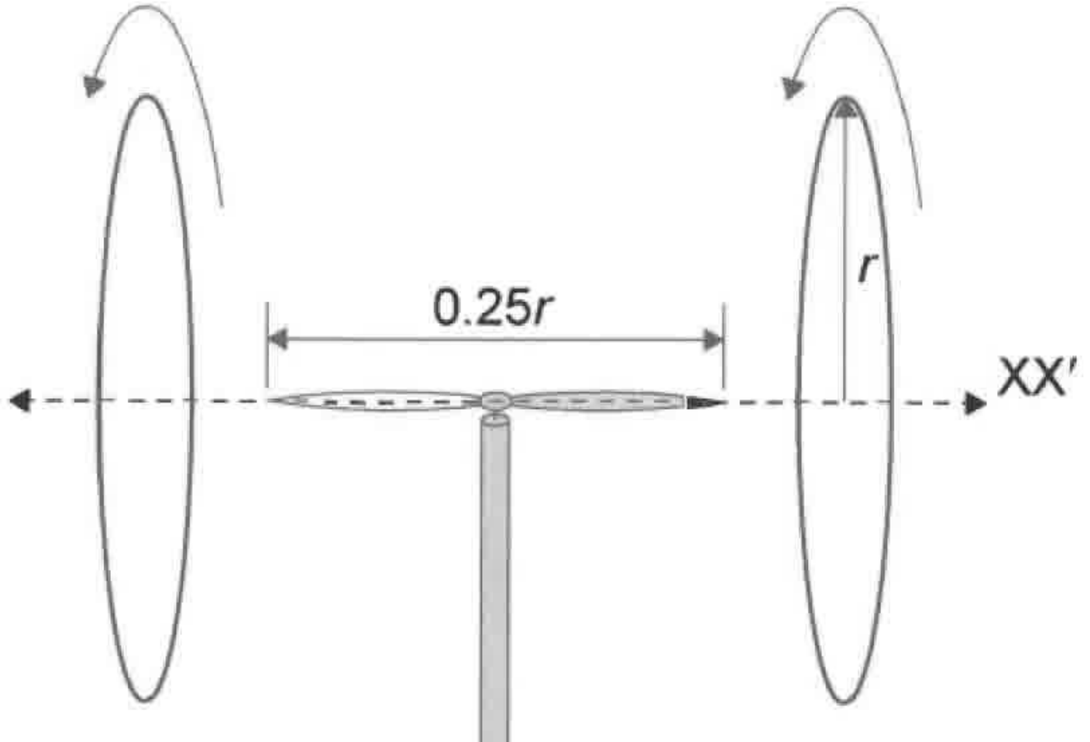

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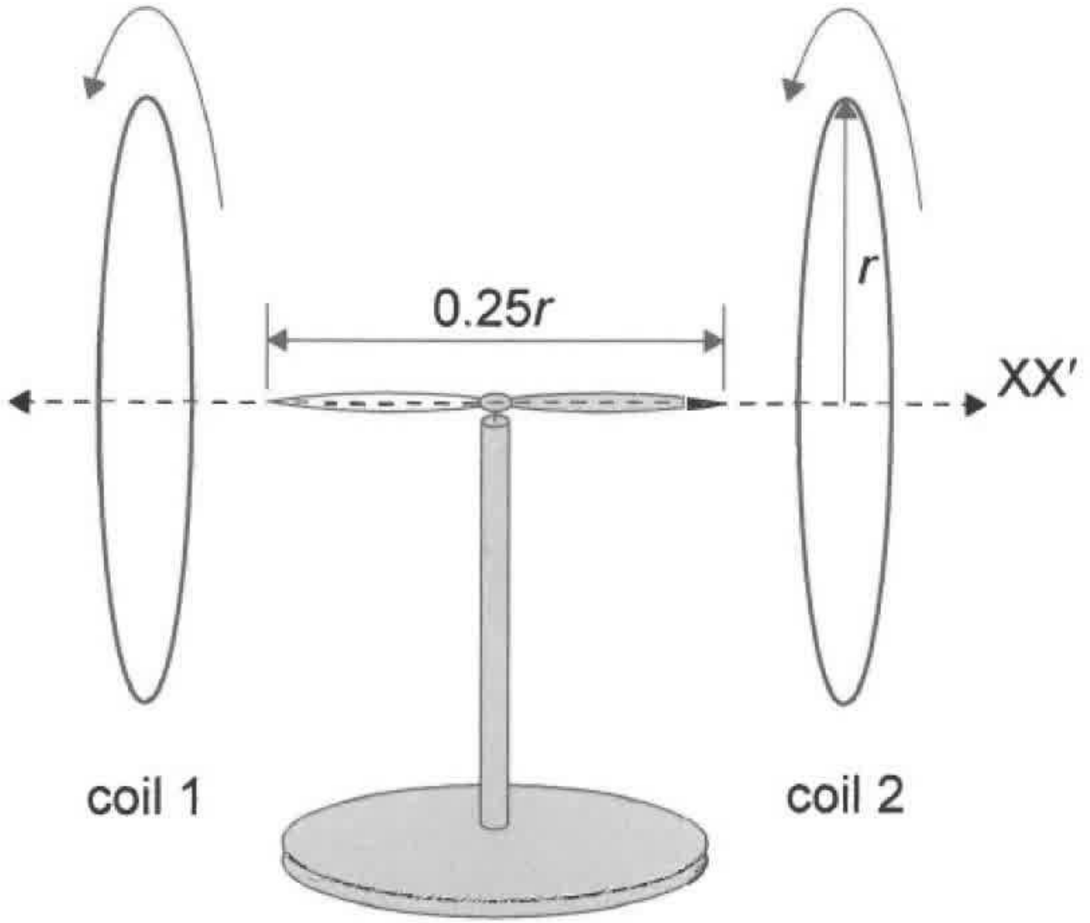
diagram not to scale



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

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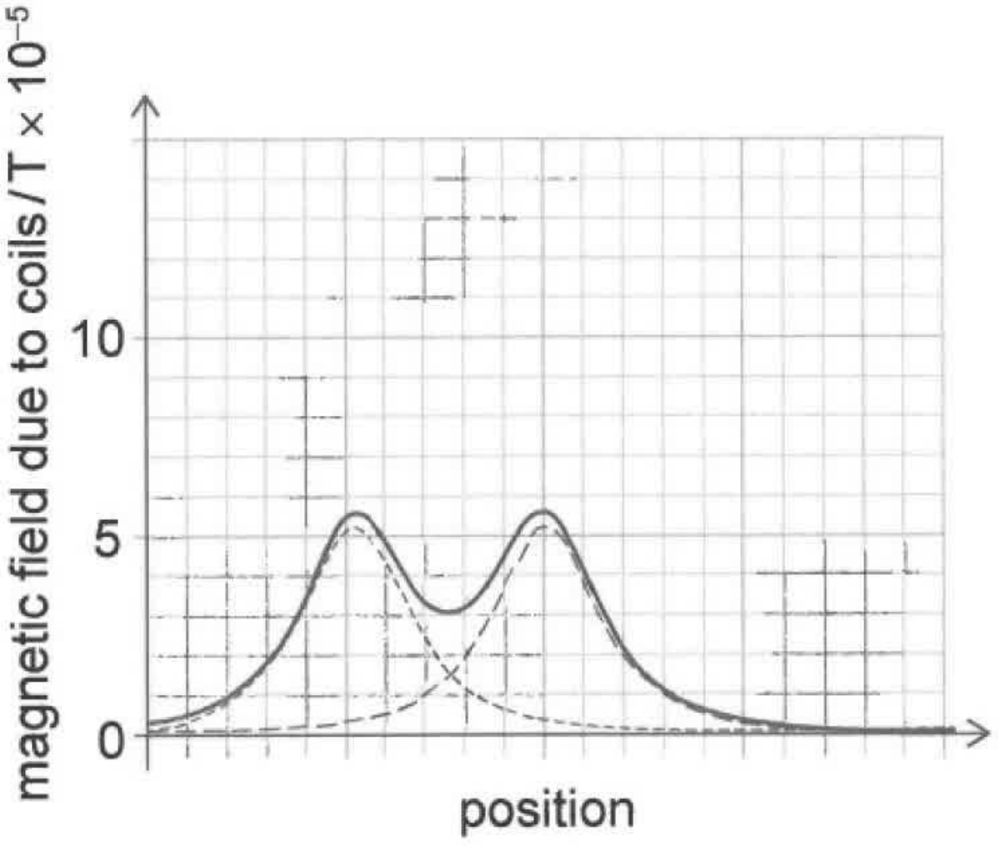
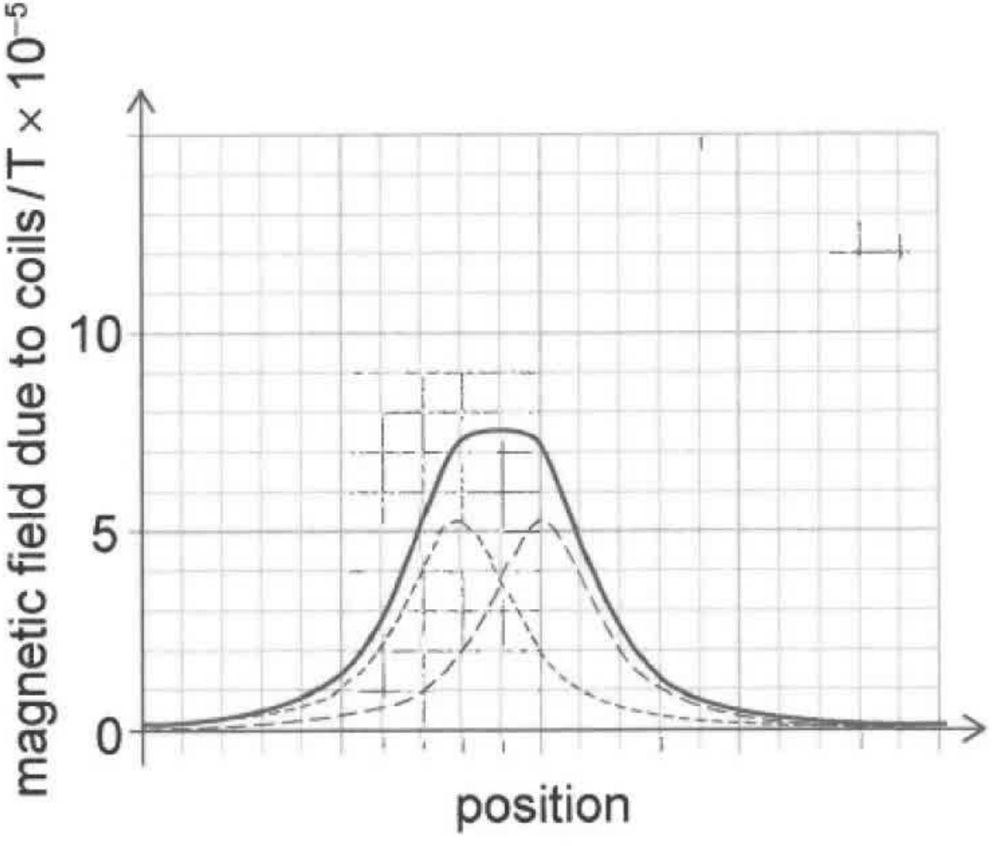
(Question 3 continued)

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

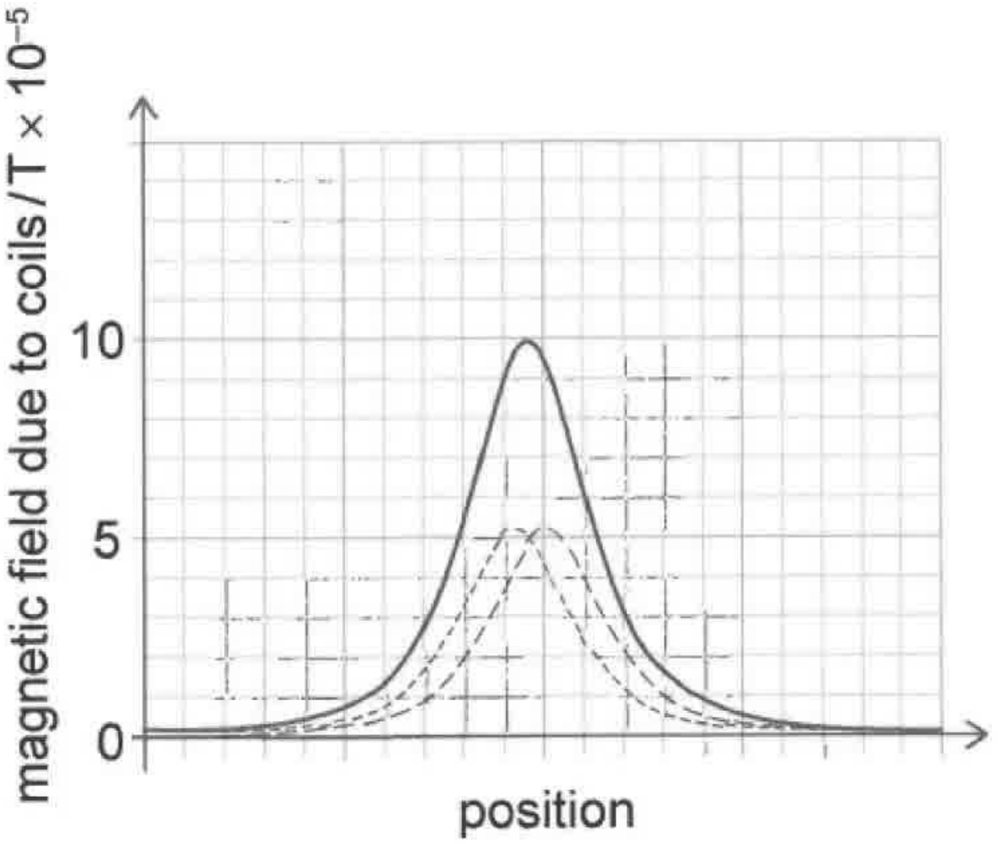
The variation with distance of the magnetic field strength due to each coil and the resultant magnetic field strength for both coils are shown for each of these separations.





position

position



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

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(b) Explain why the students place axis XX′ of the coils in the east-west direction. [2]

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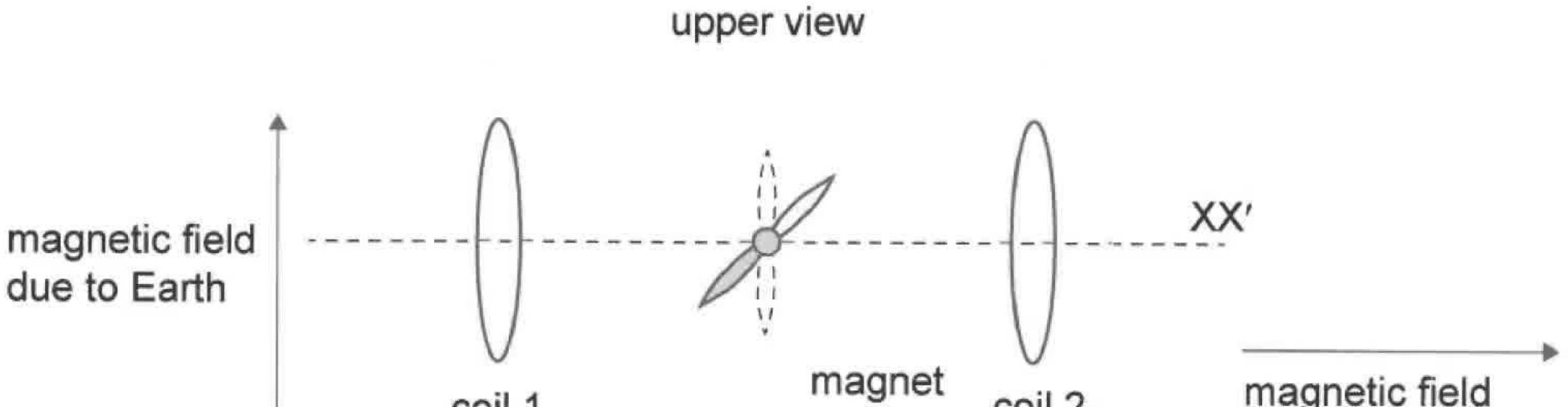
(c) The deflection of the magnet is shown.



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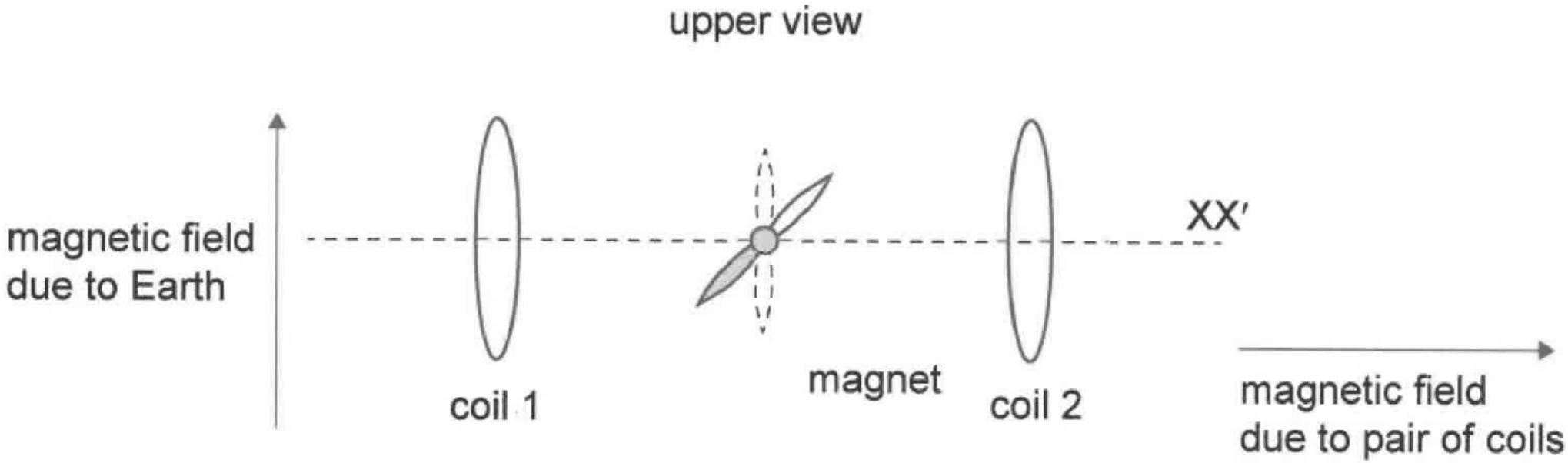

The magnet comes to rest when it makes an angle of 24° to XX′.

Determine, using the graphs, B_H. [2]

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