

APOLLO

Wave phenomena SL

Physics

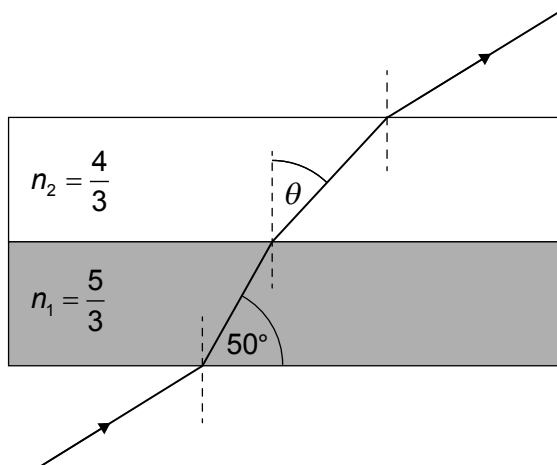
First assessment 2025

9 questions | questions

15. Light passes through two parallel layers as shown.

The refractive indices for light travelling between air and the media are shown in the diagram as n_1 and n_2 .

diagram not to scale



What is θ ?

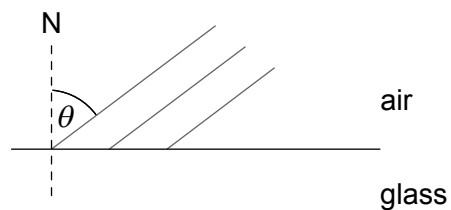
- A. 31°
- B. 38°
- C. 53°
- D. 73°

— 11 —

4425-0110

15. The diagram shows wavefronts of light incident on an air–glass boundary.

The angle between the incident wavefront and the normal, N, is θ .



Which of the following gives the correct expression for the refractive index of the glass, where r is the angle of refraction?

- A. $\frac{\sin \theta}{\sin r}$
- B. $\frac{\sin(90 - \theta)}{\sin r}$
- C. $\frac{\sin r}{\sin \theta}$
- D. $\frac{\sin r}{\sin(90 - \theta)}$

- 16.** S_1 and S_2 are two coherent sound sources with no phase difference. The wavelength of both waves is 0.20 m. P is a point 6.0 m away from S_1 and 6.5 m away from S_2 respectively. At P the amplitude of the wave from S_1 is x_0 and from S_2 is $2x_0$.

What is the resultant amplitude at P?

- A. 0
- B. x_0
- C. $2x_0$
- D. $3x_0$

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2225-0122

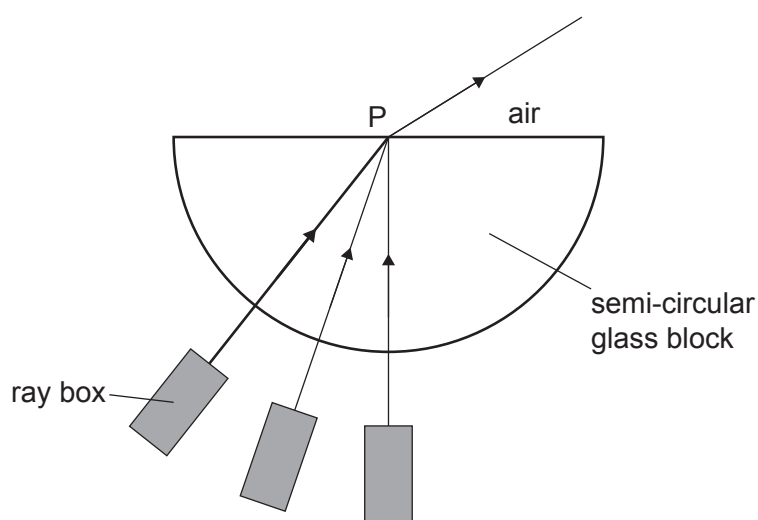
2. A group of students is investigating refraction in a semi-circular glass block.

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 θ_i and refraction θ_r at P and record them on a table.

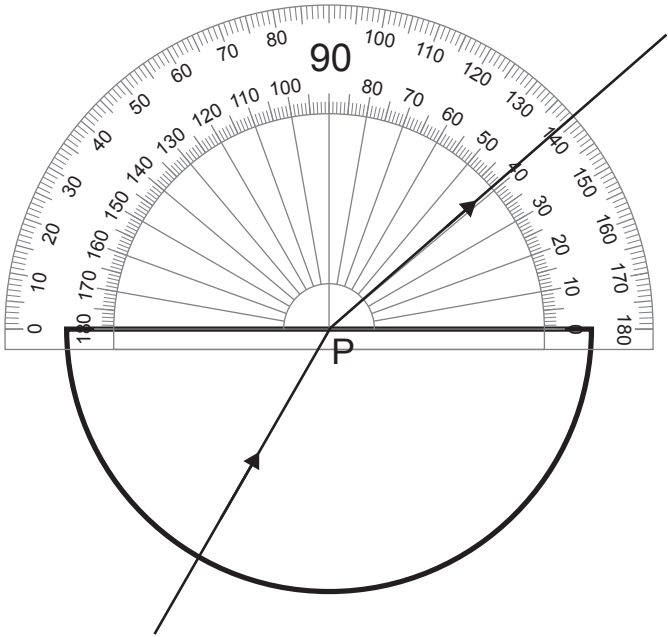


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(Question 2 continued)

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



(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

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2225-0111

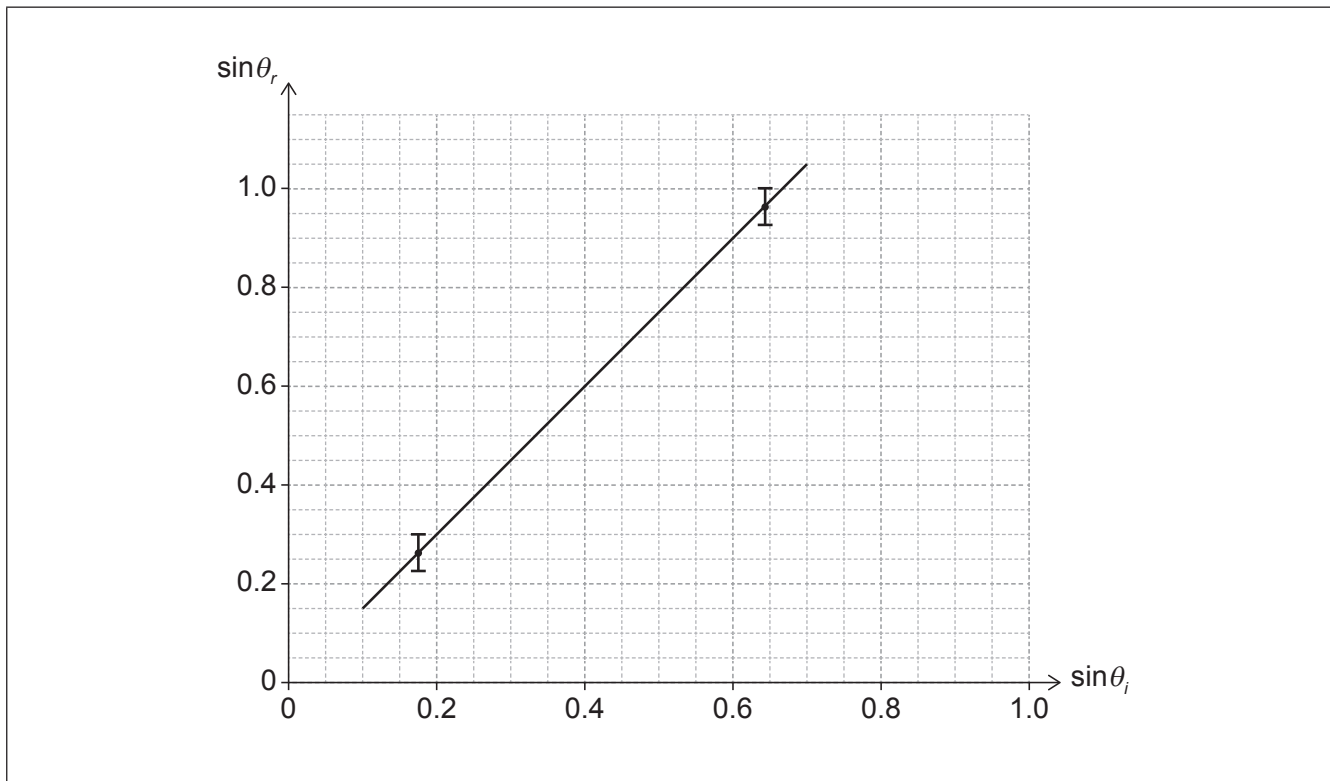
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(Question 2 continued)

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.



- (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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2225-0111

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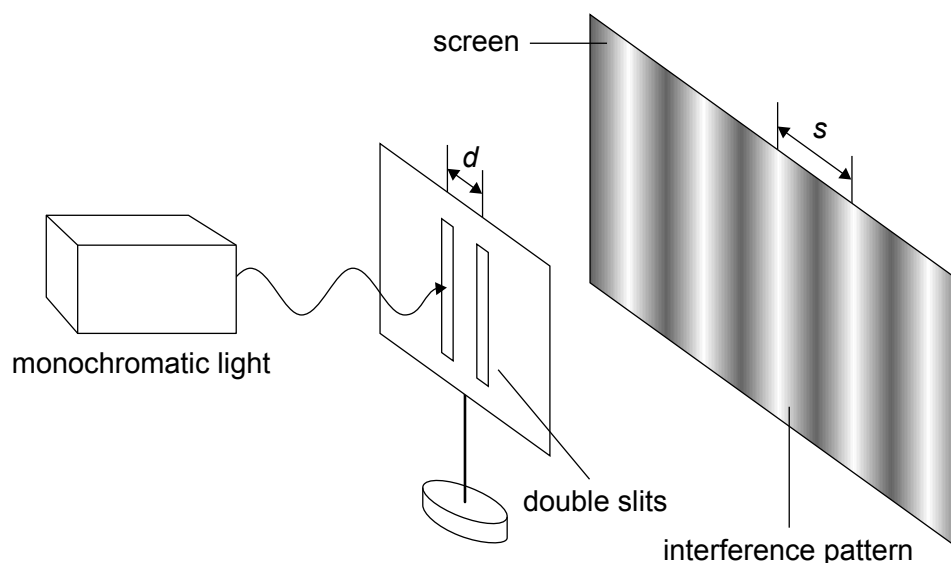


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4425-0111

2. Students set up a double slit experiment to determine the wavelength λ of monochromatic light. A light source is directed at a double slit with **variable** separation d . An interference pattern is formed on a screen at a fixed distance from the slits. The separation of the fringes is s .

At close range the pattern is shown as a set of constructive interference fringes.



- (a) Students use a ruler with millimetre intervals to measure s . Describe a method to determine s such that its absolute uncertainty is reduced.

[2]

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- (b) Discuss the effect on the fractional uncertainty in s when using a smaller value of d .

[2]

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(Question 2 continued)

- (c)

(i)

To determine λ students plot a graph with s on the vertical axis. State the variable that must be plotted on the horizontal axis to obtain a line of best fit that is straight.

[1]

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- (ii)

The calculator value obtained from the graph gives $\lambda = 611.089\text{ nm}$ with a percentage uncertainty of $\pm 5\%$. Deduce how this value should be recorded in a conclusion, including the absolute uncertainty, to the appropriate number of significant digits.

[2]

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4. Two sources of light produce an interference pattern on a screen.

- (a) Explain why the two sources need to be coherent for the interference pattern to be observed.

[2]

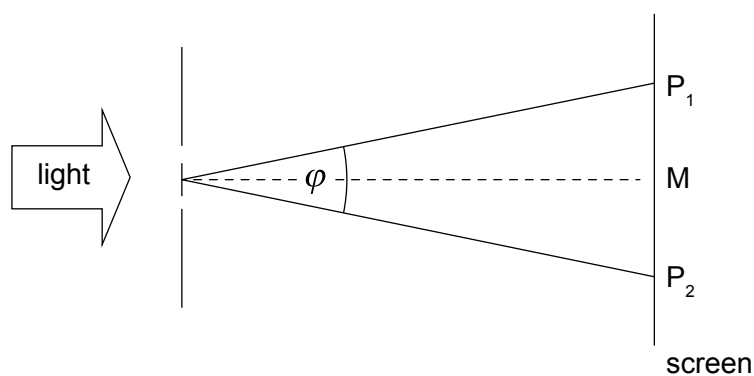
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- (b) Light of wavelength 720 nm is incident on two narrow slits that are separated by 0.12 mm. An interference pattern is observed on a screen. P_1 and P_2 are the points of destructive interference closest to the central maximum M.



- (i) Calculate, in radians, the angular separation ϕ of P_1 and P_2 .

[2]

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- (ii) Suggest how energy conservation is consistent with the fact that the energy at P_1 and P_2 is zero.

[1]

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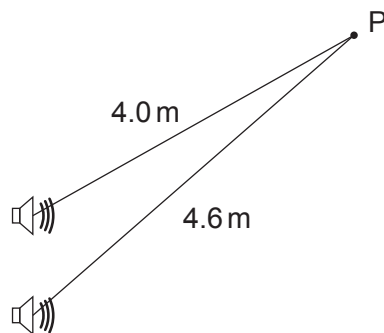


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Turn over
2225-0110

14. Two loudspeakers are driven in phase and emit sound of the same frequency. A minimum intensity of sound is detected at point P.

P is 4.0 m from one loudspeaker and 4.6 m from the other.



What is a possible wavelength of the sound?

- A. 20 cm
- B. 30 cm
- C. 40 cm
- D. 60 cm

- 13.** A sound wave in air is directed towards a water boundary, and part of it is refracted.

Three statements are made about the refracted wave compared to the incident wave.

- I. The wavelength is different.
- II. The amplitude is different.
- III. The frequency is different.

Which of the statements are correct?

- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III

— 5 —

Turn over
0020-0144

- 14.** The critical angle for light passing from a medium into air is 30° .

What is the approximate value for the speed of light in the medium?

- A. $0.5 \times 10^8 \text{ m s}^{-1}$
- B. $1.5 \times 10^8 \text{ m s}^{-1}$
- C. $2.0 \times 10^8 \text{ m s}^{-1}$
- D. $2.6 \times 10^8 \text{ m s}^{-1}$