

APOLLO

Wave phenomena

HL

Physics

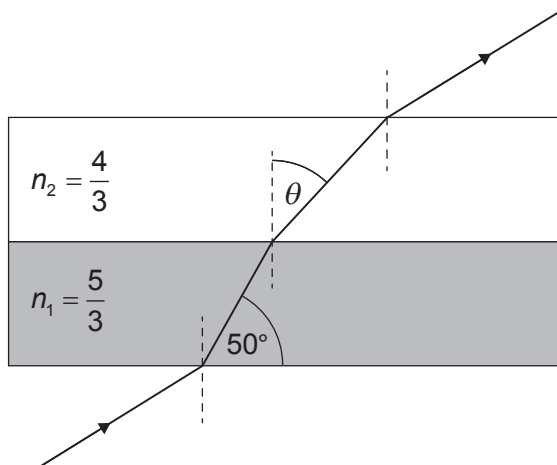
First assessment 2025

18 questions | questions

20. 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 ?

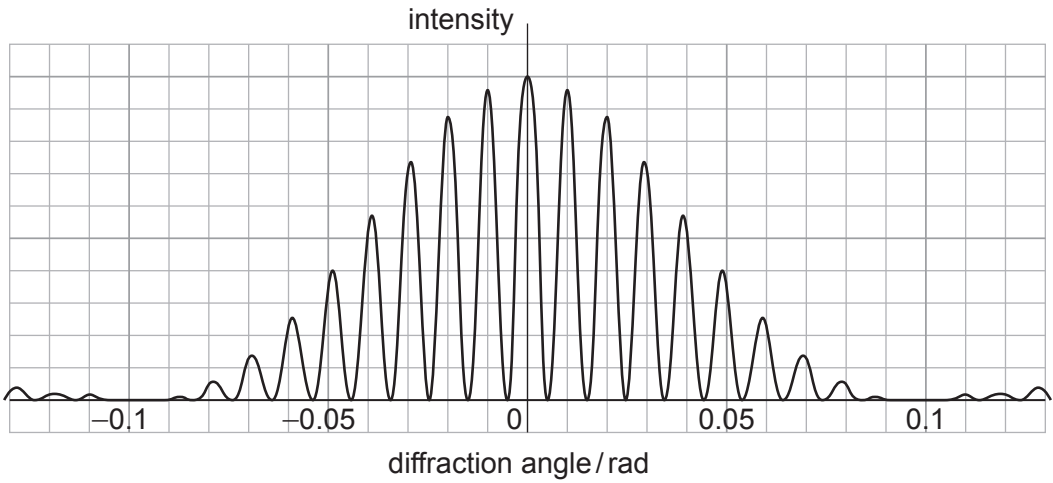
- A. 31°
- B. 38°
- C. 53°
- D. 73°

Turn over

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4425-0101

21. Light of wavelength λ is incident on two parallel slits of width b that are separated by distance d .
- The graph of intensity against diffraction angle is shown.



What are $\frac{\lambda}{d}$ and $\frac{\lambda}{b}$?

	$\frac{\lambda}{d}$	$\frac{\lambda}{b}$
A.	0.1	0.1
B.	0.1	0.01
C.	0.01	0.1
D.	0.01	0.01

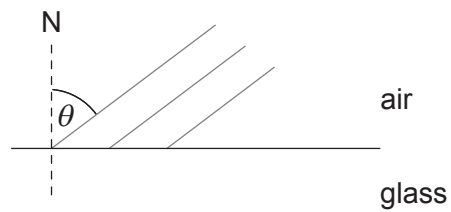
- 23.** Light of wavelength $5.8 \times 10^{-7} \text{ m}$ is normally incident on a diffraction grating that has $400\,000 \text{ lines m}^{-1}$.

How many maxima can be observed with this diffraction grating?

- A. 4
- B. 5
- C. 8
- D. 9

22. 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. $\frac{\sin r}{\sin(90 - \theta)}$

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2225-0713

- 23.** 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. $3x_0$

- 24.** A parallel beam of monochromatic light of wavelength λ passes through a rectangular slit of width b and is incident on a screen at a distance x from the slit.

What is the width of the central maximum of the diffraction pattern on the screen?

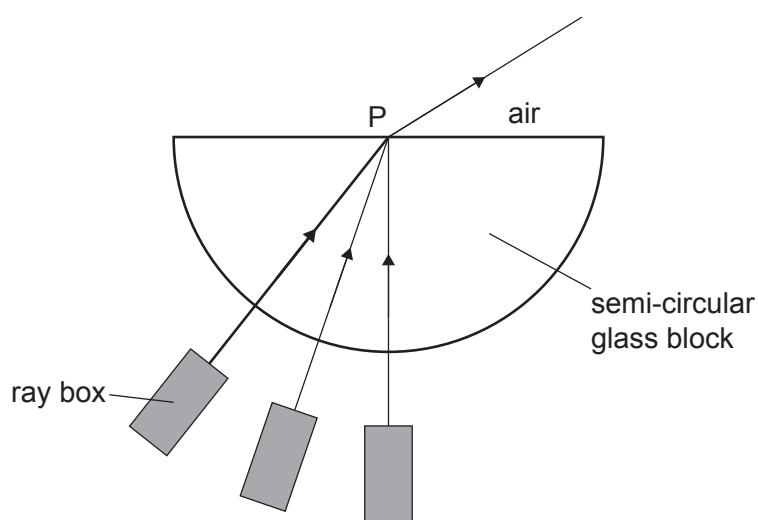
- A. $\frac{\lambda}{b}$
- B. $\frac{2\lambda}{b}$
- C. $\frac{\lambda x}{b}$
- D. $\frac{2\lambda x}{b}$

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]

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.

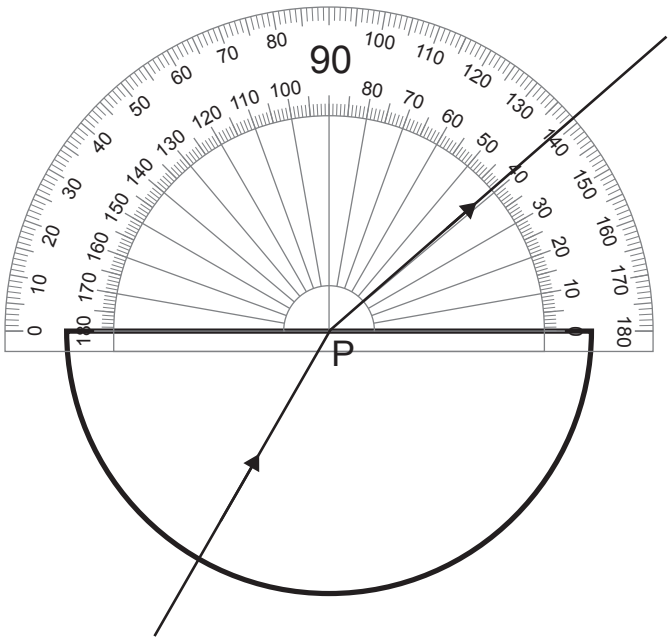


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(Question 2 continued)

(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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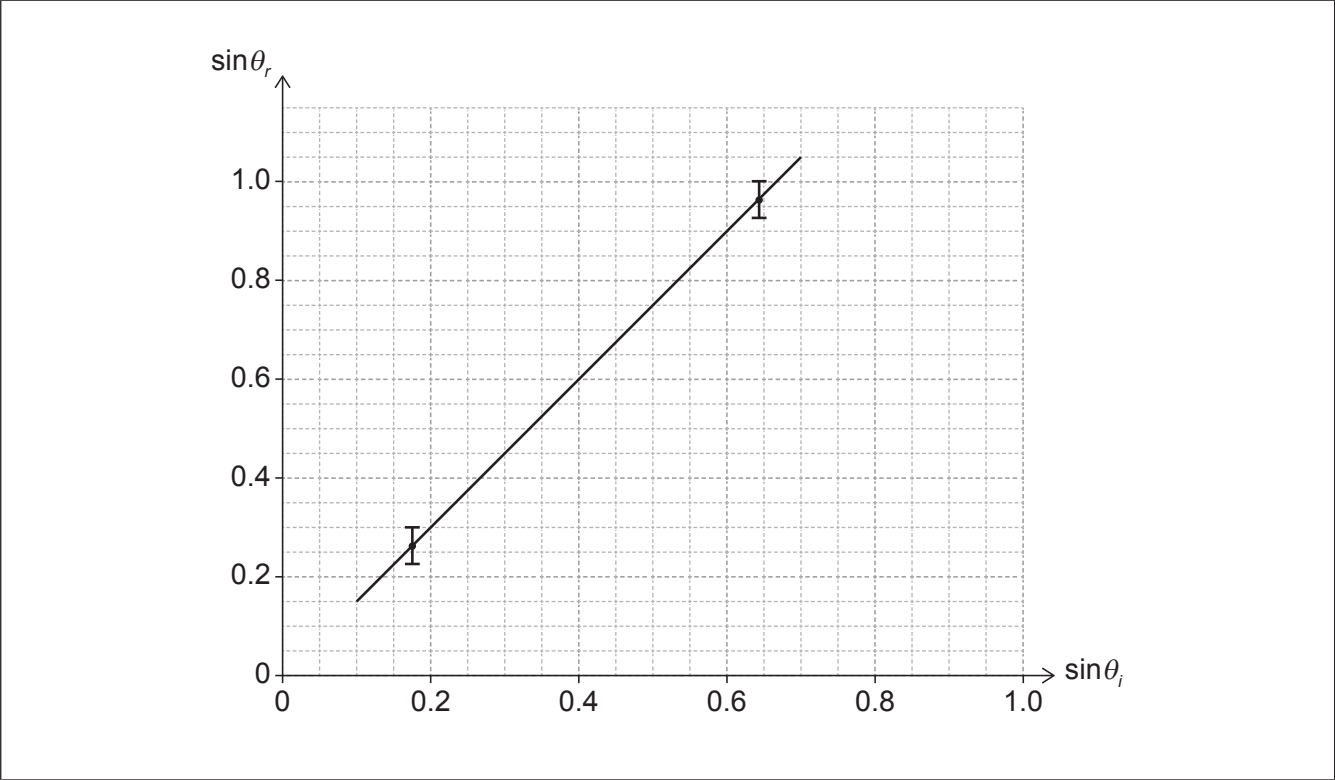
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(Question 2 continued)

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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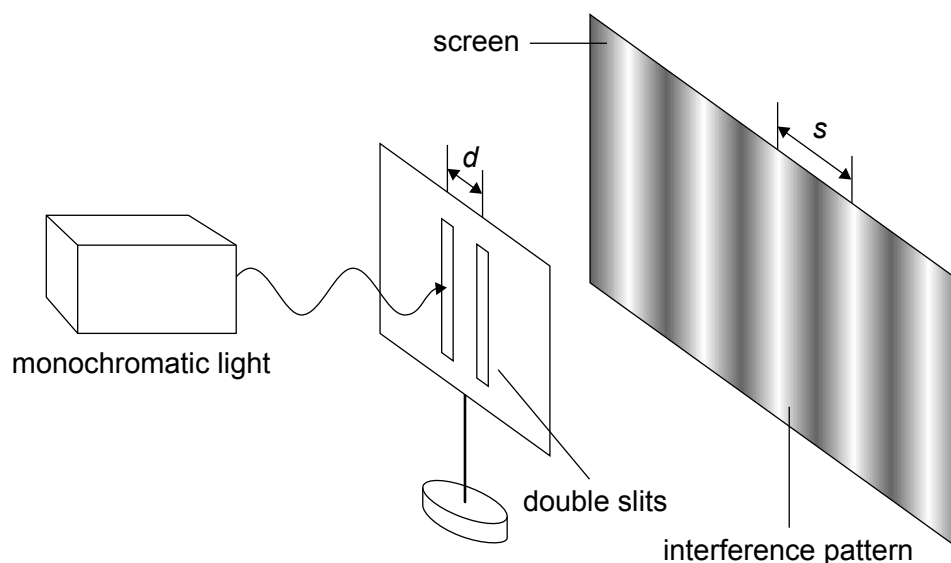


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4425-0100

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]

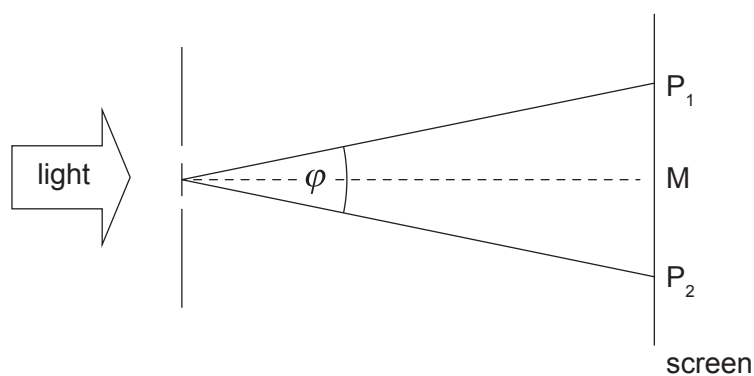
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- (b) Light of wavelength 720 nm is incident on two narrow slits that are separated by 0.12 mm. An interference pattern is observed on a screen. P_1 and P_2 are the points of destructive interference closest to the central maximum M.



- (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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(Question 4 continued)

A beam of light containing all wavelengths in the range [550 nm, 650 nm] is incident normally on a diffraction grating. The grating has 580 lines per mm. A diffraction pattern is observed on a screen as shown.



(c) Outline why the interference at M is constructive. [1]

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(d) Determine the largest order of the diffraction pattern in which all the wavelengths in the incident beam are present. [3]

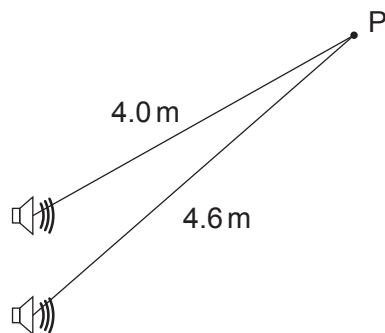
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Turn over

19. 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

20. Monochromatic light of wavelength λ is incident normally on a diffraction grating. The adjacent lines of the diffraction grating are separated by a distance of 2.8λ . How many diffraction maxima are present in the transmitted light?

- A. 2
- B. 3
- C. 5
- D. 7

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0020-0107

20. 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

21. 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?

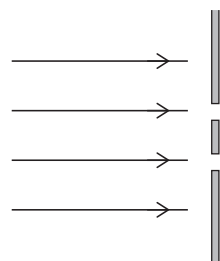
- A. $0.5 \times 10^8 \text{ m s}^{-1}$
- B. $1.5 \times 10^8 \text{ m s}^{-1}$
- C. $2.0 \times 10^8 \text{ m s}^{-1}$
- D. $2.6 \times 10^8 \text{ m s}^{-1}$

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Turn over

0020-0719

- 22.** In a double-slit experiment using coherent light of wavelength λ , the central bright fringe is observed on a screen at point P. A point of destructive interference occurs at point Q. Only one point of constructive interference is observed between P and Q.



double slit

diagram not to scale



screen

What is the path difference at Q?

- A. $\frac{\lambda}{2}$
- B. λ
- C. $\frac{3\lambda}{2}$
- D. 2λ

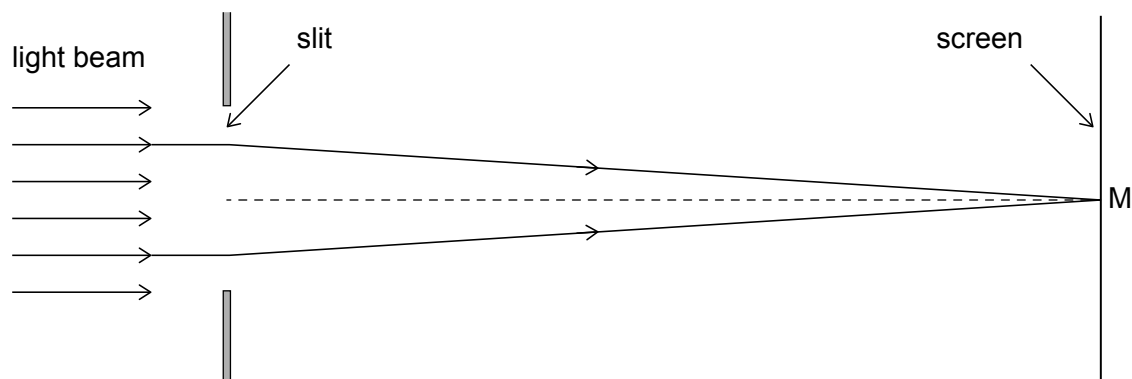
23. Monochromatic coherent light is directed normally at a diffraction grating with N slits per unit length. Nine maxima in intensity are produced on a screen far away.

What change will occur to the angle between successive maxima and the number of observable maxima when the number of slits per unit length is $2N$?

	Angle between successive maxima	Number of observable maxima
A.	increase	decrease
B.	increase	increase
C.	decrease	decrease
D.	decrease	increase

7. A monochromatic light beam is incident on a single slit. M is the point on a screen far from the slit, directly across from the mid-point of the slit. The diagram shows two of the incident rays that reach M after they have diffracted at the slit. These rays are symmetrical with respect to the dotted line.

diagram not to scale



- (a) Outline, by considering pairs of rays arriving at M such as the ones shown, why a maximum in intensity will be observed at M.

[2]

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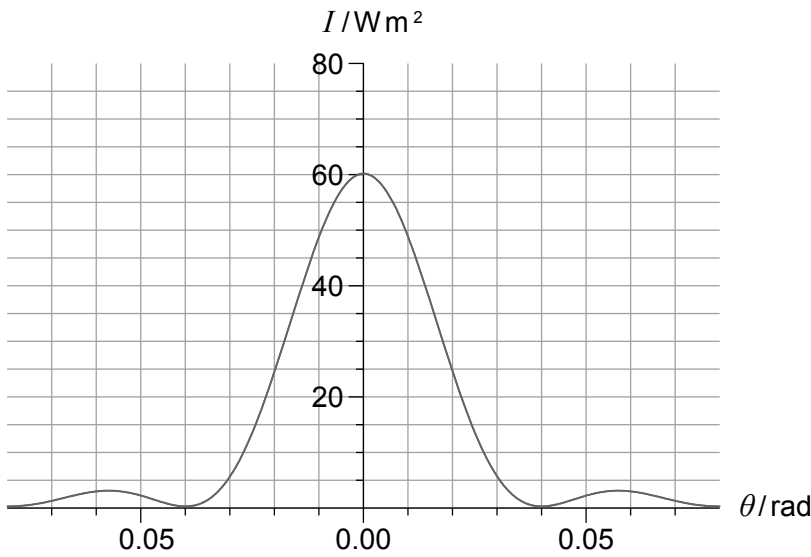
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(Question 7 continued)

(b) The graph shows the variation with diffraction angle θ of the intensity I on the screen.



The slit width is $1.3 \times 10^{-5} \text{ m}$. Calculate the wavelength of the light. [2]

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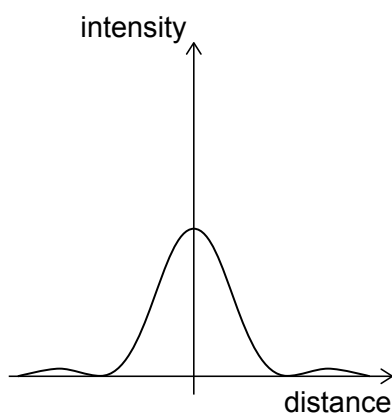
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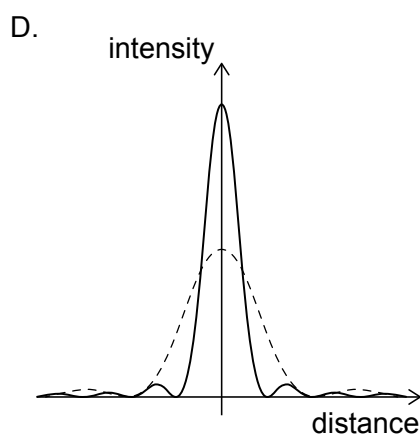
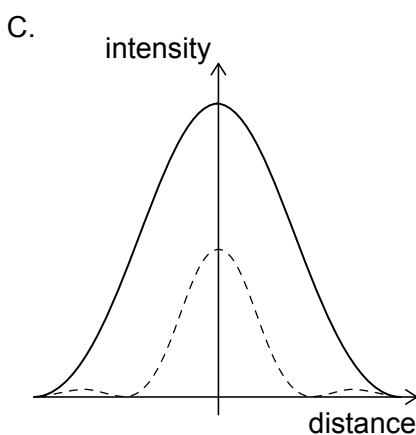
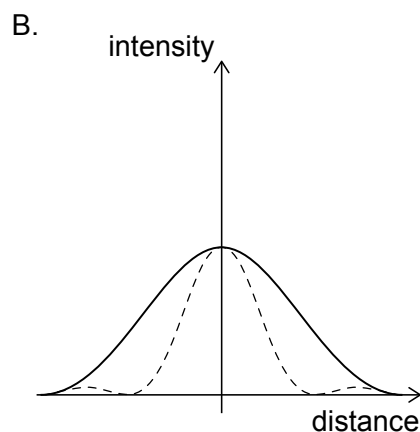
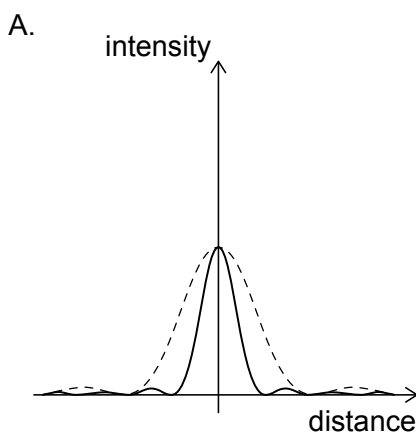


22. Light from a monochromatic source is incident on a single slit and the resulting diffraction pattern is viewed on a screen. The graph shows the variation of intensity with distance on the screen.



The intensity of the source remains the same. The width of the slit is increased.

Which graph correctly shows the variation of intensity after the change? The original curve is shown with a dashed line.



Turn over

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- 23.** Monochromatic light is incident on a diffraction grating. The diffraction pattern from the diffraction grating is then formed on a screen.

Only the central maximum and the first-order maxima can be observed on the screen.

What change will allow the second-order maxima to be observed on the screen?

- A. Decrease the distance between the diffraction grating and the source of light
- B. Increase the distance between the diffraction grating and the screen
- C. Increase the wavelength of the monochromatic light
- D. Reduce the number of lines per unit length of the diffraction grating