WAVE SUPERPOSITION

Challenging **MCQ** questions by The Physics Cafe

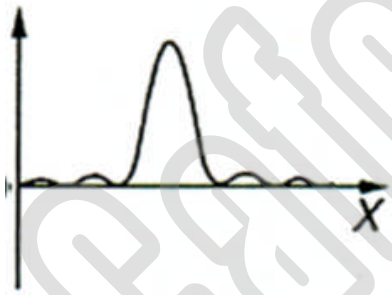
Compiled and selected by The Physics Cafe

1 Two coherent monochromatic waves of equal amplitude are brought together to form an interference pattern on a screen.

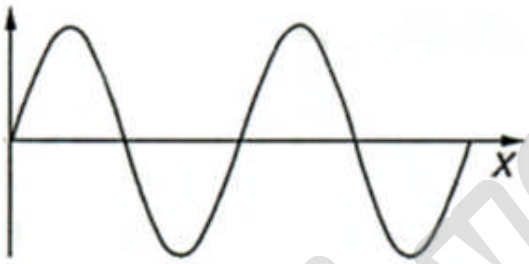
Which of the following graphs could represent the variation of intensity with position x across the pattern of fringes.

A

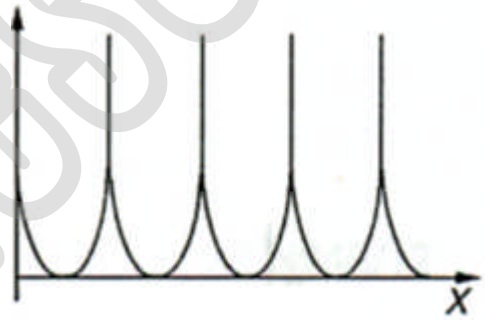
B



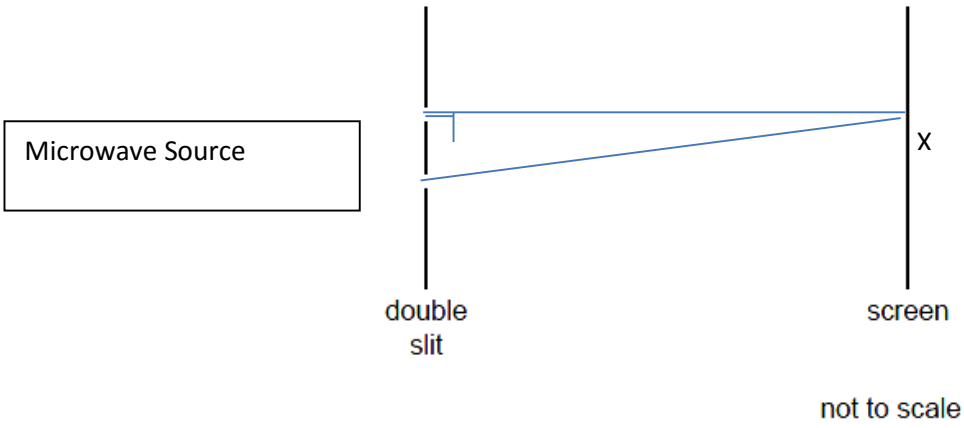
C



D



2 A double-slit interference experiment is set up as shown.



Fringes are formed on the screen which is 40.0 cm away. The distance between the slits is 9.0 cm apart. The microwave source has a wavelength of 2.0 cm and intensity of *I*.

What is the resultant intensity at X?

A Zero **B** *I* **C** 2*I* **D** 4*I*

3 A double-slit interference of green-coloured light was set up as shown and interference fringes are formed on the screen.

Which change would increase the distance between adjacent fringes?

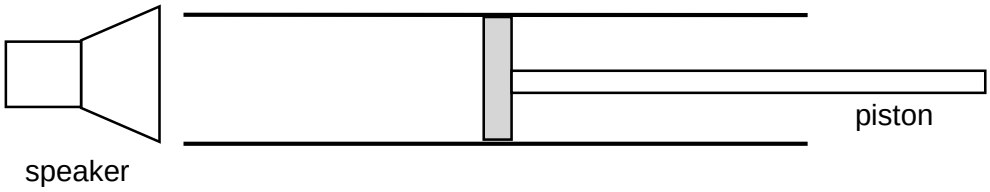
A Use orange-coloured light.

B Reduce the width of each slit.

C Use a double-slit where the slits are further apart.

D Move the double-slit closer to the screen.

4 A speaker producing sound of frequency 2500 Hz is placed at the open end of a closed pipe containing a gas.



As the piston is moved along the pipe, a series of 6 loud sounds was heard. The first loud sound was observed when the piston was 4.0 cm away from the open end, and the sixth loud sound was observed when the piston was 37 cm away from the open end.

What is the speed of sound in the gas?

A 270 m s^{-1} **B** 330 m s^{-1} **C** 370 m s^{-1} **D** 400 m s^{-1}

5 A blue laser light is used in a Young's double-slit experiment.

Which of the following will be observed when a change is made to the experiment?

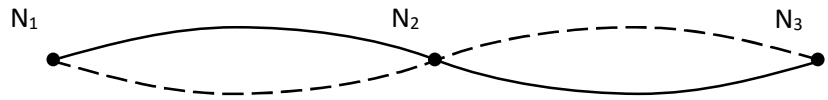
	Change to experiment	Observation
A	Covering one of the slits completely.	No fringe pattern is seen.
B	Moving the source of light nearer to the double slits.	Fringe separation will increase.
C	Covering one of the slits with a polaroid.	No change in position of central bright fringe.
D	Replacing the blue laser light with a red laser light.	Central bright fringe will shift upwards.

6 The mercury spectrum contains two intense yellow lines with wavelengths of 577.0 nm and 579.1 nm respectively. Light from a mercury lamp is incident normally on a diffraction grating ruled with 4300 lines per centimetre. To distinguish the two yellow lines clearly, it is desirable that there should be an angular separation of at least 0.30° between the two lines.

Which order of diffraction can be used?

A 2nd order **B** 3rd order **C** 4th order **D** 5th order

7 The diagram shows a standing wave on a string. The standing wave has three nodes N_1, N_2 and N_3.



Which statement is correct?

A All points on the string vibrate in phase.

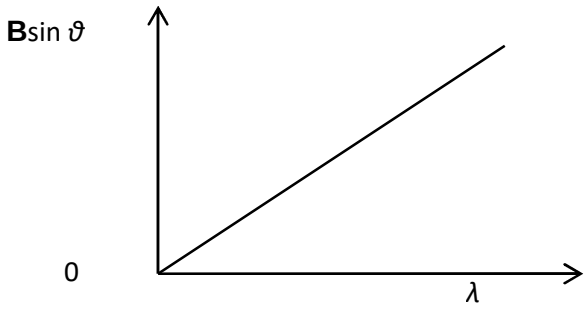
B All points on the string vibrate with the same amplitude.

C Points equidistant from N_2 vibrate with the same frequency and in phase.

D Points equidistant from N_2 vibrate with the same frequency and the same amplitude.

8 A diffraction grating with N lines per metre is used to deflect light of various wavelengths λ.

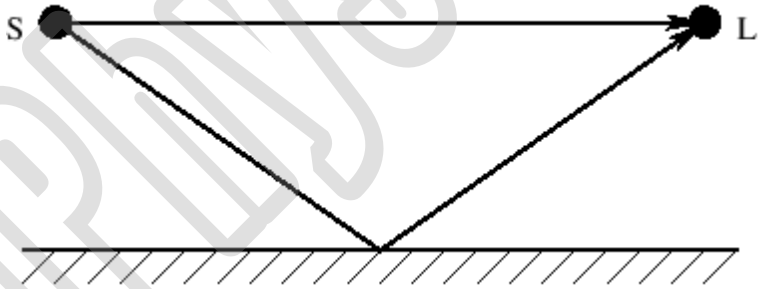
The diagram shows a relation between the deflection angles of ϑ for different values of λ in the n^{th} order interference pattern.



What is the gradient of the graph?

A Nn **B** $\frac{N}{n}$ **C** $\frac{n}{N}$ **D** $\frac{1}{Nn}$

9 A loudspeaker at position S emits sound of a single frequency. The sound travels to Leo who is at position L, both through a straight path and after reflection from a wall as shown.



As Leo walks directly towards the wall, the sound alternates between loud and soft. Which of the following changes would result in an increase in the distance between loud and soft sounds?

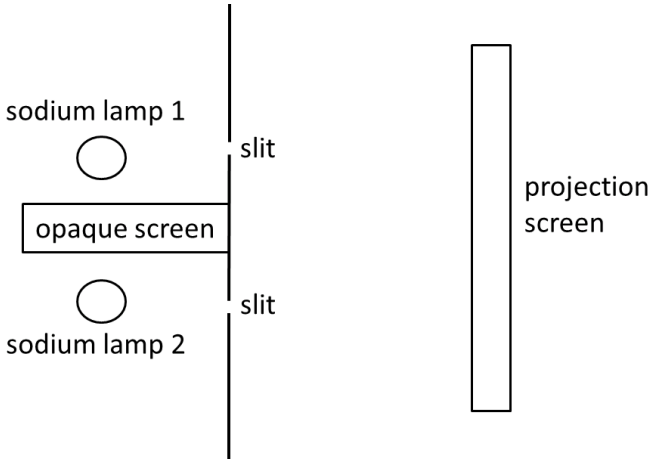
A Increasing the frequency emitted by the loudspeaker.

B Moving the loudspeaker closer to the wall.

C Moving the loudspeaker towards L.

D Increasing the loudness of the sound emitted by the loudspeaker.

10 A sodium lamp produces two distinct yellow lines in the visible part of the spectrum, at 589.0 nm and 589.6 nm. Two such lamps are separated by a screen. The light of both lamps pass through a slit each, as indicated in the figure. It turns out that no interference pattern can be obtained on the projection screen.



Which of the following explains the observation?

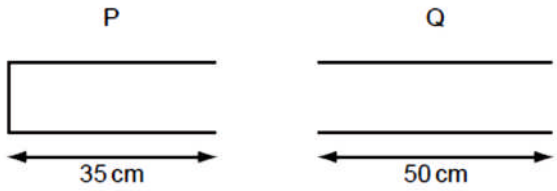
A The lamps are not point sources.

B The light from the lamps do not have exactly the same amplitude.

C The light from the lamps is not coherent.

D The light from the lamps is not monochromatic.

11 Travelling waves of wavelength 20 cm are created in the air columns in a closed pipe P and an open pipe Q. The lengths of the pipes are shown.



In which pipe or pipes are stationary waves formed?

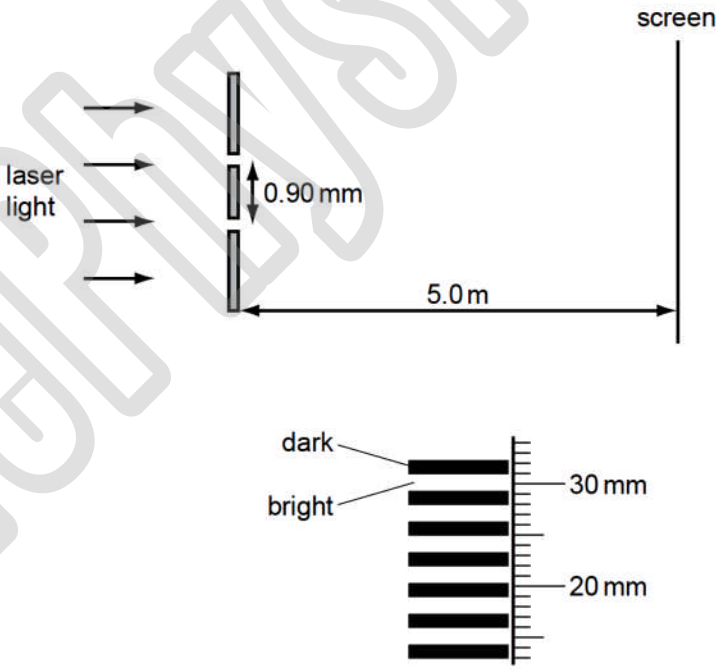
A P and Q

B P only

C Q only

D neither P nor Q

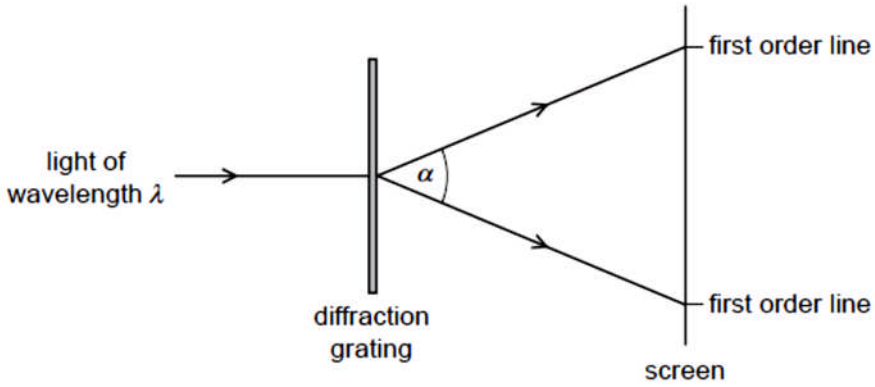
12 The diagrams show the arrangement of the apparatus in a Young's double slit experiment and also part of the pattern formed on the screen with a ruler placed next to it.



What is the wavelength of the light?

A 4.8×10^{-7} m **B** 5.4×10^{-7} m **C** 3.2×10^{-6} m **D** 3.4×10^{-6} m

13 Light of wavelength λ passes through a diffraction grating with slit spacing d. A series of lines is observed on a screen.



What is the angle α between the two first order lines?

A $\sin^{-1}\left(\frac{\lambda}{2d}\right)$ **B** $\sin^{-1}\left(\frac{\lambda}{d}\right)$ **C** $2\sin^{-1}\left(\frac{\lambda}{2d}\right)$ **D** $2\sin^{-1}\left(\frac{\lambda}{d}\right)$

14 A wave is diffracted as it passes through an opening in a barrier.

The amount of diffraction that the wave undergoes depends on both the

A amplitude and frequency of the incident wave.

B wavelength and speed of the incident wave.

C wavelength of the incident wave and the size of the opening.

D amplitude of the incident wave and the size of the opening.

15 Which of the following is always *true* for a stationary wave?

A All particles have the same amplitude.

B No energy is transferred from one end of the wave to the other.

C The particles in the wave oscillate perpendicularly to the direction of wave travel.

D All particles vibrate in simple harmonic motion with the same frequency as the wave.

WAVE SUPERPOSITION WORKED SOLUTIONS

Singapore Top JC MCQ questions with worked solutions

Compiled and selected by The Physics Cafe

1 Ans: **A**

The standard double slit interference pattern is shown in A

2 Ans: **A**

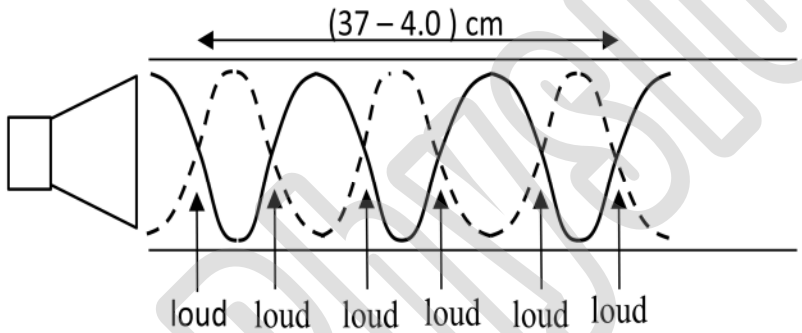
Path difference of 1 cm, destructive interference results.

3 Ans: **A**

Fringe separation, $x = \lambda D/d$, where λ is the wavelength of the light, D is the distance between slits and screen and d is the slit separation.
Options C and D reduces the fringe separation while option A increases fringe separation (as the wavelength of orange light is larger).
Option B has no effect on fringe separation.

4 Ans: **B**

Since 6 nodes form 5 segments,
Distance between adjacent nodes = (37 – 4.0) / 5 = 6.6 cm
Wavelength of sound = 2 x 6.6 = 13.2 cm
Speed of sound = 2500 x 0.132 = 330 m s^{-1}
Be careful: 4 cm $\neq \frac{\lambda}{4}$ because there is an end correction.



5 Ans: **C**

Option C is true as the maximum intensity point will not shift although the maximum intensity will decrease.

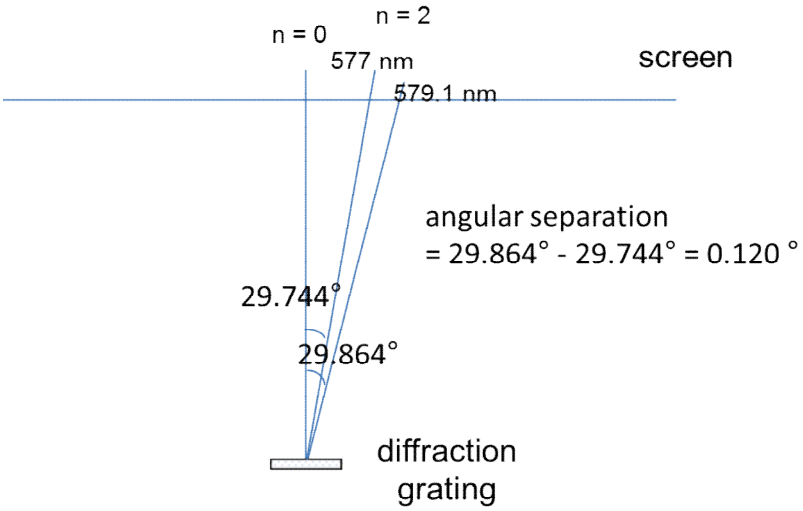
Option A is wrong because a single-slit diffraction pattern will be seen.
Option B is wrong because the fringe separation is not dependent on the distance between light source and slit.
Option D is wrong because replacing the laser light with one of higher wavelength will cause the fringe separation to increase but will not shift the central bright fringe (0^{th} order maximum).

6 Ans: **C**

$$d = \frac{10^{-2}}{4300} = 2.326 \times 10^{-6} \text{m}$$

Using $d \sin\theta = n\lambda$ for both wavelengths 577.0 nm and 579.1 nm for the different orders will give the following:

n	θ / ° for 577.0 nm	θ / ° for 579.1 nm	Δθ / °
2	29.744	29.864	0.120
3	48.090	48.323	0.233
4 (max order)	82.867	84.793	1.926
5	NA	NA	NA



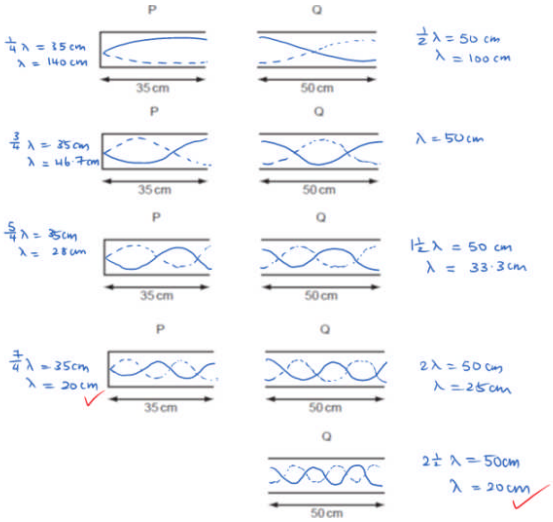
7 Ans: **D**

8 Ans: **A**

9 Ans: **B**

10 Ans: **C**

11 Ans: **A**



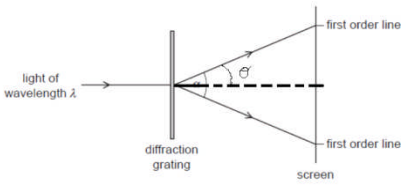
12 Ans: **B**

$$x = \frac{\lambda D}{d}$$

$$\frac{18\times10^{-3}}{6} = \frac{\lambda(5.0)}{0.9\times10^{-3}}$$

$$\lambda = 5.4\times10^{-7}\text{m}$$

13 Ans: **D**



$$d\sin\theta = n\lambda$$

$$\theta = \sin^{-1}\left(\frac{\lambda}{d}\right) \quad \text{for n=1}$$

$$\alpha = 2\theta = 2\sin^{-1}\left(\frac{\lambda}{d}\right)$$

14 Ans: **C**

Amount of diffraction depends on the size of the opening relative to the wavelength

15 Ans: **B**

No energy is transferred in a stationary wave