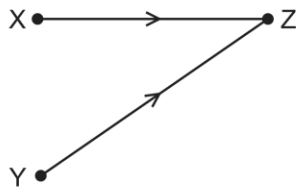
8. Superposition

8.3 Interference

Paper 1

Question Paper

1 Microwaves are emitted from two sources at points X and Y. The two waves meet at point Z. The diagram shows the paths of the two waves.



The waves emitted from points X and Y are coherent.

What is a direct consequence of the two waves being coherent?

A There is a constant difference in the path lengths YZ and XZ.

B There is a constant difference in phase between the two waves at Z.

C There is a constant non-zero difference in frequency of the two waves at Z.

D There is a constant non-zero difference in amplitude of the two waves at Z.

2 Interference fringes of separation *x* are observed on a screen at a distance of 1.00 m from a double slit that is illuminated by yellow light of wavelength 600 nm.

At which distance from the double slit would interference fringes of the same separation *x* be observed when using blue light of wavelength 400 nm?

A 0.33 m **B** 0.67 m **C** 0.75 m **D** 1.50 m

3 Three statements about two progressive waves are listed.

1 The waves have the same frequency.

2 The waves have the same amplitude.

3 The waves are emitted with a constant phase difference.

Which statements **must** be correct for the two waves to be coherent?

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

4 A laser produces a beam of light of wavelength 650 nm. The beam is incident normally on two slits that are a distance of 0.12 mm apart.

A screen is placed parallel to the slits. The bright interference fringes on the screen have a separation of 7.5 cm.

What is the distance between the screen and the two slits?

A 1.4 m **B** 2.8 m **C** 7.0 m **D** 14 m

5 Light of wavelength λ is emitted from two point sources R and S and falls onto a distant screen.



At point P on the screen, the light intensity is zero.

What could explain the zero intensity at P?

A Light from the two sources is emitted 180° out of phase and the path difference to P is $\frac{1}{2}\lambda$.

B Light from the two sources is emitted in phase and the path difference to P is λ.

C Light from the two sources is emitted 90° out of phase and the path difference to P is λ.

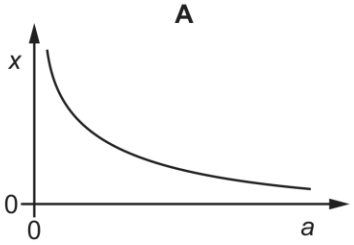
D Light from the two sources is emitted in phase and the path difference to P is $\frac{1}{2}\lambda$.

6 Coherent light of constant wavelength is incident normally on a double slit. Interference fringes are formed on a screen that is a fixed distance from the double slit. The screen is parallel to the double slit.

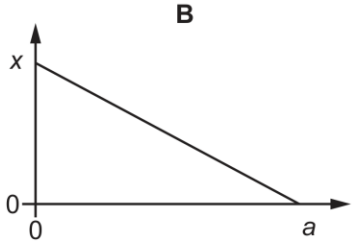
The separation of the slits is varied.

Which graph best shows the variation with slit separation *a* of the spacing *x* of the interference fringes?

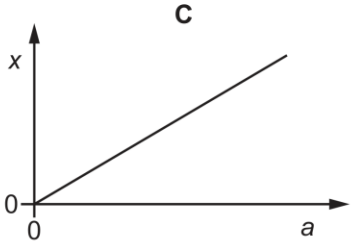
A



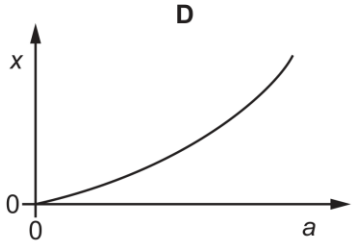
B



C



D



7 Light of a single frequency passes through two narrow slits and produces an interference pattern on a screen some distance away. The interference fringes are very close together.

Which change would **increase** the distance between the fringes?

A Increase the brightness of the light source.

B Increase the distance between the slits and the screen.

C Increase the distance between the two slits.

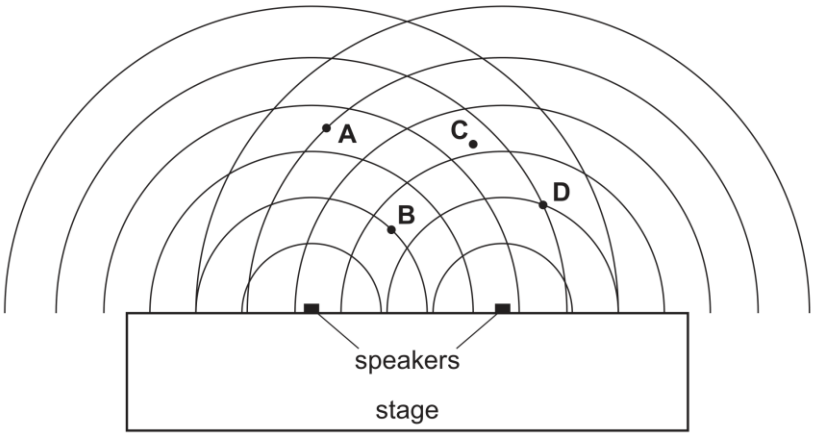
D Increase the frequency of the light used.

8 An outdoor concert has two large speakers beside the stage for broadcasting music.

In order to test the speakers, they are made to emit sound of the same wavelength and the same amplitude.

The curved lines in the diagram represent wavefronts.

Where is the loudest sound heard?



9 Observable interference fringes are produced using light from a double slit. The intensity of the light emerging from each slit is initially the same.

The intensity of the light emerging from one of the slits is now reduced.

How does this affect the interference pattern?

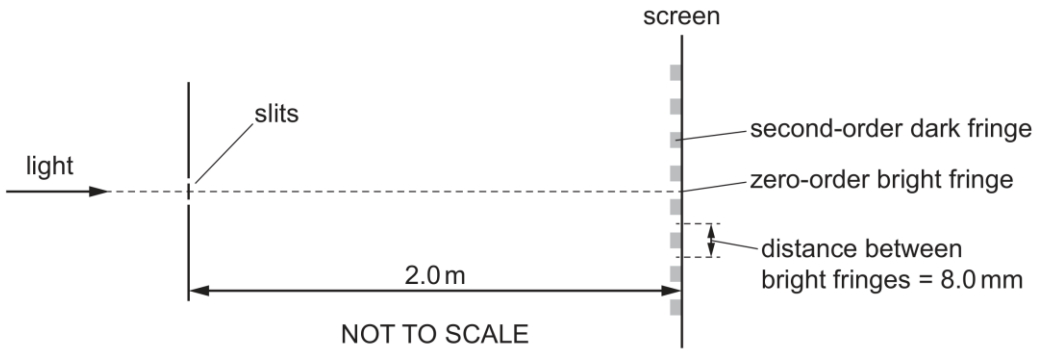
A The bright fringes and the dark fringes all become brighter.

B The bright fringes and the dark fringes all become darker.

C The bright fringes become brighter and the dark fringes become darker.

D The bright fringes become darker and the dark fringes become brighter.

10 Light of a single frequency is incident on a pair of narrow slits that are a distance of 0.10 mm apart. A series of bright and dark fringes is observed on a screen a distance of 2.0 m away. The distance between adjacent bright fringes is 8.0 mm.



What is the path difference of the light waves from the two slits that meet at the second-order **dark** fringe?

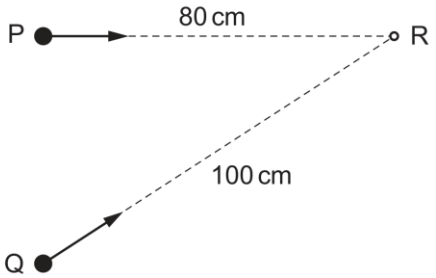
A 2.0×10^{-7} m

B 4.0×10^{-7} m

C 6.0×10^{-7} m

D 8.0×10^{-7} m

11 Two identical waves are produced by sources at points P and Q. The waves travel along different paths to reach point R, as shown.

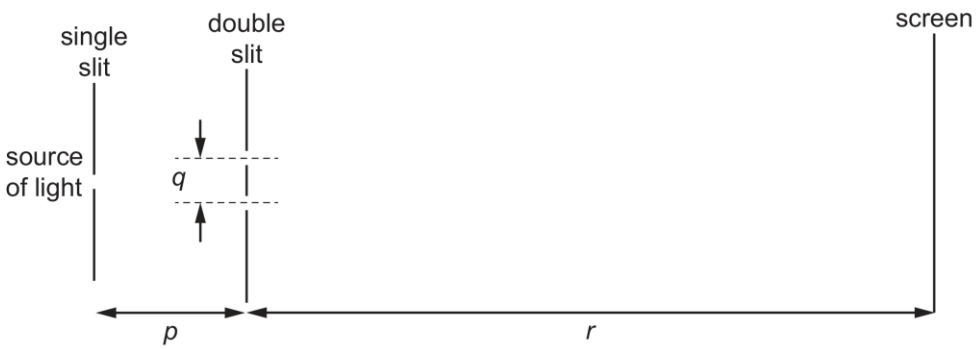


Both waves have a wavelength of 6.0 cm. The waves are in phase at point R.

What is the phase difference between the waves as they leave points P and Q?

A 0° **B** 60° **C** 90° **D** 120°

12 A teacher sets up the apparatus shown to demonstrate a double-slit interference pattern on a screen.



Which change to the apparatus will increase the fringe spacing?

A decrease the distance *p*

B decrease the distance *q*

C decrease the distance *r*

D decrease the wavelength of the light

13 In a two-source interference experiment, light of a single frequency is incident on a double slit.

The light waves emerging from the slits are coherent.

What is meant by *coherent*?

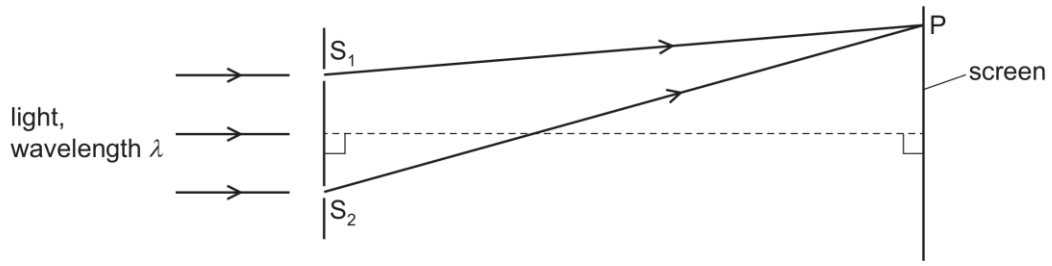
A The waves are in phase.

B The waves have a constant phase difference.

C The waves have the same amplitude.

D The waves interfere constructively wherever they overlap.

14 Light of wavelength λ is incident normally on two narrow slits S_1 and S_2, a small distance apart. Bright and dark fringes are observed on a screen a long distance away from the slits.



The *n*th **dark** fringe from the central bright fringe is observed at point P on the screen.

Which equation is correct for all positive values of *n*?

A $S_2P - S_1P = \frac{n\lambda}{2}$

B $S_2P - S_1P = n\lambda$

C $S_2P - S_1P = (n - \frac{1}{2})\lambda$

D $S_2P - S_1P = (n + \frac{1}{2})\lambda$

15 Two waves, each with a constant amplitude, interfere and produce an interference pattern. The pattern has minima at fixed points where the displacement is zero at all times.

Which statement describes the two waves?

A They must be coherent and of the same amplitude.

B They must be coherent but not necessarily of the same amplitude.

C They must be of the same amplitude but not necessarily coherent.

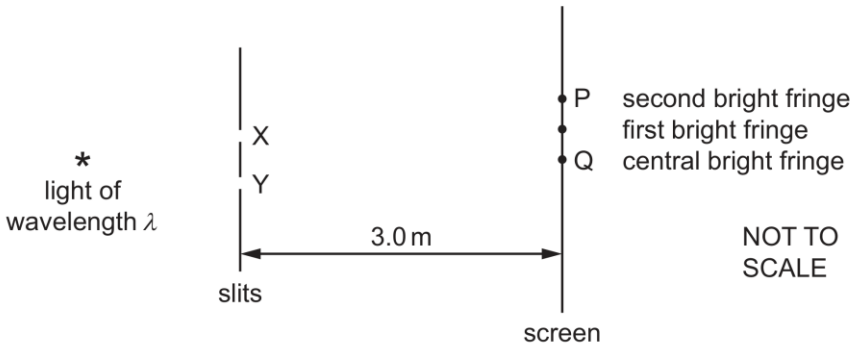
D They must not be coherent or of the same amplitude.

16 Light of a single wavelength is incident normally on two slits that are 0.20 mm apart. Interference fringes are observed on a screen that is 5.4 m away from the slits. The distance between successive bright fringes is 12 mm.

What is the wavelength of the light?

A 440 nm **B** 540 nm **C** 650 nm **D** 900 nm

17 The diagram shows an arrangement for demonstrating two-source interference using coherent light of a single wavelength λ.



An interference pattern is observed on a screen 3.0 m away from the slits X and Y, which have a separation of 1.0 mm.

The central bright fringe is at Q, and the **second** bright fringe from the centre is at P.

What is the distance between Q and P?

A $6.0 \times 10^{3} \lambda$

B $3.0 \times 10^{3} \lambda$

C $6.7 \times 10^{-4} \lambda$

D $3.3 \times 10^{-4} \lambda$

18 Two loudspeakers are placed near to each other and facing in the same direction.

A microphone connected to an oscilloscope is moved along a line some distance away from the loudspeakers, as shown.



Which statement about the waves emitted by the loudspeakers is **not** a necessary condition for the microphone to detect a fixed point along the line where there is no sound?

A The waves must be emitted in phase.

B The waves must be emitted with a similar amplitude.

C The waves must have the same frequency.

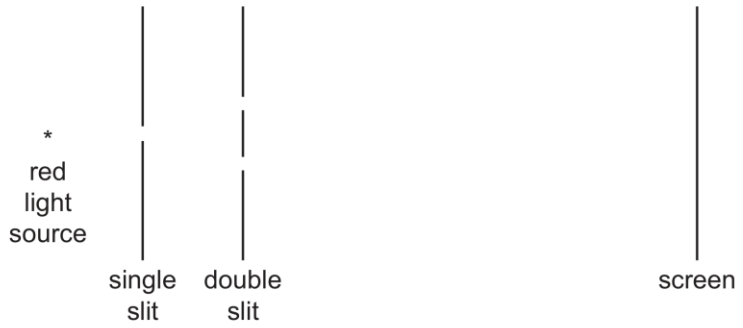
D The waves must have the same wavelength.

19 An experiment is carried out to demonstrate double-slit interference using light of wavelength 500 nm. The distance between bright fringes in the interference pattern is 5 mm.

What are possible values for the distance between the slits and the screen, and the slit separation?

	slit–screen distance	slit separation
A	50 cm	0.5 mm
B	50 cm	5 mm
C	5 m	0.5 mm
D	5 m	5 mm

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



not to scale

Fringes are formed on the screen. The distance between successive bright fringes is found to be 4 mm.

Two changes are then made to the experimental arrangement. The double slit is replaced by another double slit which has half the spacing. The screen is moved so that its distance from the double slit is twice as great.

What is now the distance between successive bright fringes?

A 1 mm **B** 4 mm **C** 8 mm **D** 16 mm

21 Why can an observable interference pattern **never** be obtained between two monochromatic beams of light from different lamps?

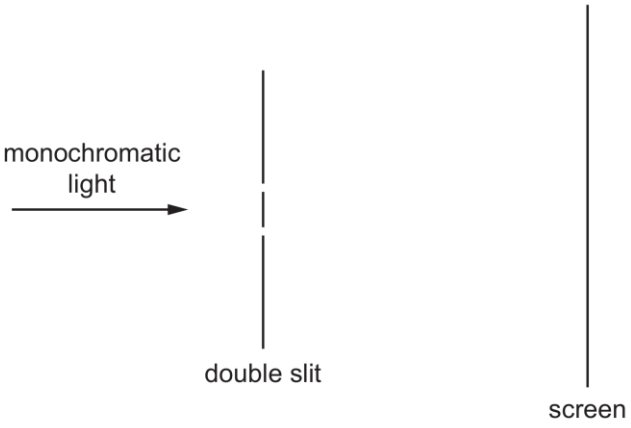
A The frequency of the light from the two lamps can never be the same.

B The light from the two lamps can never be coherent.

C The temperature of the filaments of the two lamps used can never be the same.

D The wavelength of the light from the two lamps must always be different.

22 A student sets up apparatus to observe the double-slit interference of monochromatic light, as shown.



Interference fringes are formed on the screen.

Which change would increase the distance between adjacent fringes?

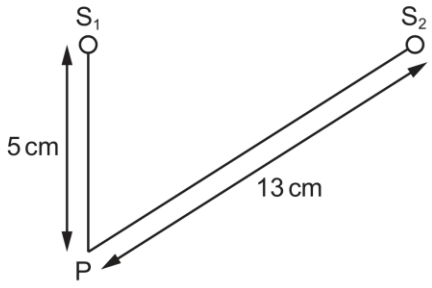
A Decrease the distance between the two slits.

B Decrease the width of each slit.

C Move the screen closer to the double slit.

D Use light of a higher frequency.

23 The diagram shows two sources of waves S_1 and S_2. The sources oscillate with a phase difference of 180°.

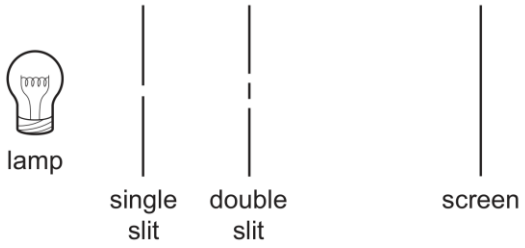


The sources each generate a wave of wavelength 2.0 cm. Each source produces a wave that has amplitude x_0 when it reaches point P.

What is the amplitude of the oscillation at P?

A 0 **B** $\frac{x_0}{2}$ **C** x_0 **D** $2x_0$

24 A two-source interference experiment uses the apparatus shown.



What is the main purpose of the single slit?

A to make a narrow beam of light

B to make the same amplitude of light incident on each slit

C to provide coherent light

D to provide monochromatic light

25 When the light from two lamps falls on a screen, no interference pattern can be obtained.

Why is this?

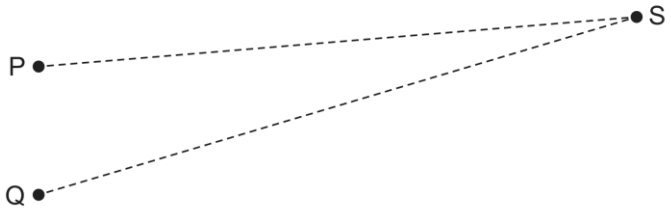
A The lamps are not point sources.

B The lamps emit light of different amplitudes.

C The light from the lamps is not coherent.

D The light from the lamps is white.

26 Two sources of microwaves P and Q produce coherent waves with a phase difference of 180°. The waves have the same wavelength λ.



At the point S there is a minimum in the interference pattern produced by waves from the two sources. The distance (QS – PS) is called the path difference.

In the expressions shown, n is an integer.

Which expression represents the path difference?

A $n\lambda$ **B** $\frac{1}{2}n\lambda$ **C** $(n + \frac{1}{2})\lambda$ **D** $(2n + \frac{1}{2})\lambda$