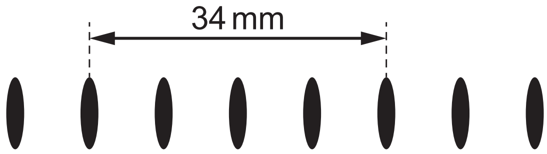
28 A student carries out a double-slit experiment using a laser emitting red light of wavelength of 680 nm. The light is incident normally on a double slit.

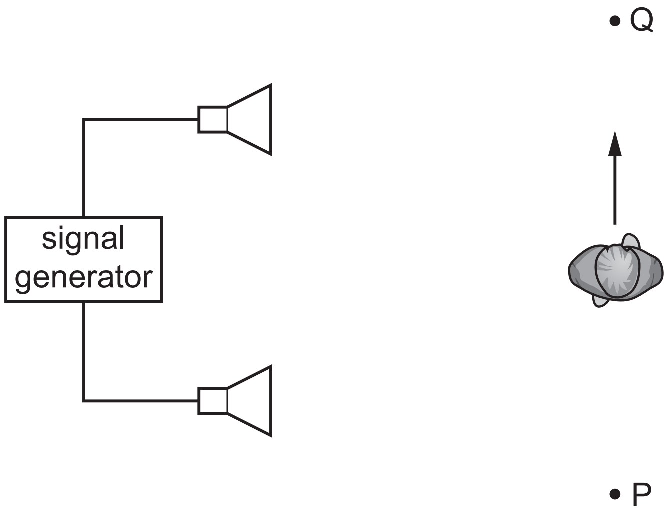
The diagram shows part of the pattern of bright fringes visible on a screen at a distance of 2.4 m from the slits. The distance across five bright fringes is measured as 34 mm.



What is the slit separation?

A 8.5×10^{-3} m **B** 2.4×10^{-4} m **C** 1.9×10^{-4} m **D** 4.8×10^{-5} m

31 A student connects two loudspeakers to a signal generator.



As the student walks from P to Q, he notices that the loudness of the sound rises and falls repeatedly.

What causes the loudness of the sound to vary?

A diffraction of the sound waves

B Doppler shift of the sound waves

C interference of the sound waves

D reflection of the sound waves

31 Two light sources are used to produce an interference pattern.

Interference fringes appear when the two sources emit waves that are coherent.

What is meant by coherent waves?

A The two waves are emitted with the same frequency.

B The two waves are emitted with constant phase difference.

C The two waves are emitted with the same intensity.

D The two waves are emitted with zero phase difference.

4 A laser emits visible light of a single frequency in a vacuum. The light is incident normally on a double slit and then forms a pattern of bright and dark fringes on a screen, as shown in Fig. 4.1.

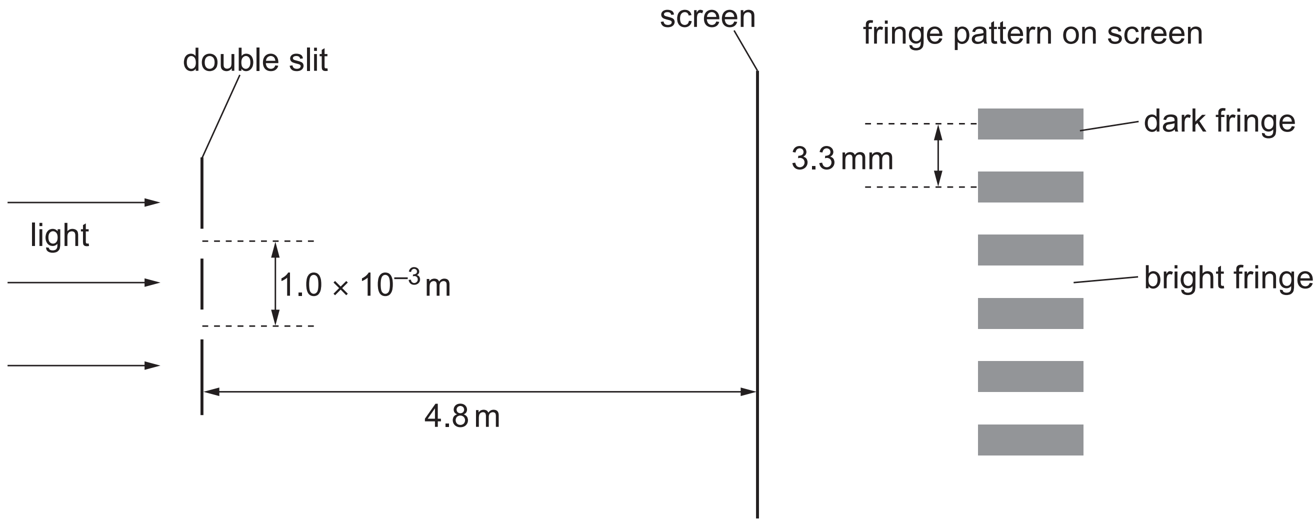


Fig. 4.1 (not to scale)

The separation of the slits is 1.0×10^{-3} m. The distance from the slits to the screen is 4.8 m. The distance between the centres of adjacent dark fringes on the screen is 3.3 mm.

(a) Explain how the pattern of bright and dark fringes is formed.

....

....

....

....

.... [3]

(b) Calculate the frequency of the light emitted by the laser.

frequency = ... Hz [4]

(c) The double slit is removed. A second laser is placed beside the first laser. The second laser produces visible light of a different frequency from that of the first laser. The beams of light from the two lasers overlap on the screen.

Explain why a steady pattern of bright and dark fringes is **not** formed on the screen.

....

.... [1]

[Total: 8]

31 Light of a single wavelength is incident normally on a double slit. Interference fringes are observed on a screen.

The distance from the double slit to the screen is 0.60 m and the fringe separation is 1.8 mm.

The distance from the double slit to the screen increases by 0.90 m.

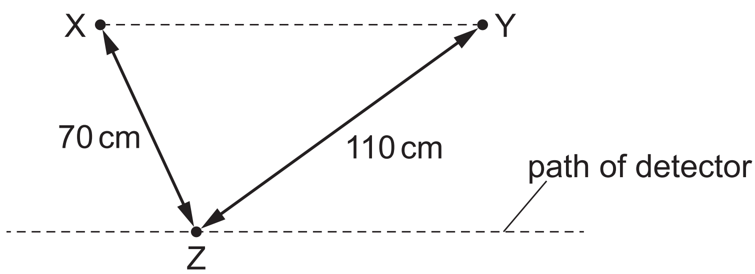
What is the new fringe separation?

A 1.2 mm **B** 2.7 mm **C** 4.5 mm **D** 5.4 mm

28 Electromagnetic waves of equal wavelengths are emitted from two sources, X and Y. The waves are emitted from X and Y with a phase difference of 180°.

A detector moves along a path that is parallel to the line XY and detects a pattern of intensity maxima and minima.

The diagram shows the arrangement of the sources and the path of the detector.



An intensity maximum is detected at point Z. Length XZ is 70 cm and length YZ is 110 cm.

What is a possible wavelength of the waves?

A 10 cm **B** 16 cm **C** 20 cm **D** 40 cm

27 Red light of a single wavelength from a laser is incident on a double slit.

A pattern of interference fringes is observed on a flat screen that is placed parallel to the double slit.

Which change increases the separation of the interference fringes on the screen?

A Decrease the distance from the double slit to the screen.

B Decrease the separation of the slits.

C Replace the red light with blue light.

D Replace the red light with green light.

4 **(a)** State the principle of superposition.

....

....

.... [2]

(b) Light of wavelength 7.2×10^{-7} m is incident normally on a double slit, as shown in Fig. 4.1.

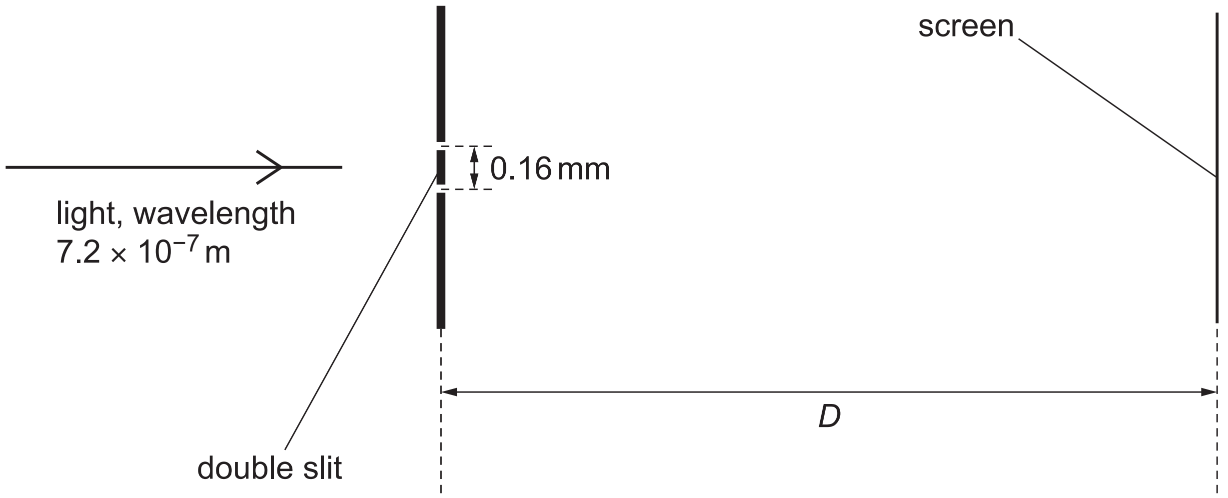


Fig. 4.1 (not to scale)

A screen is at a distance D from the double slit. The double slit and the screen are parallel.

The separation of the slits in the double-slit arrangement is 0.16 mm. The resulting interference pattern on the screen contains nine dark fringes, as shown in Fig. 4.2.

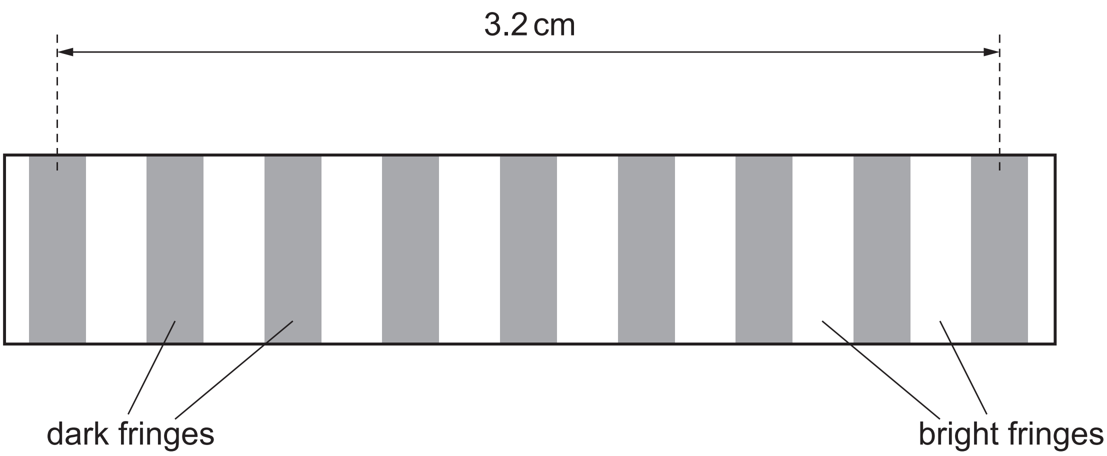


Fig. 4.2 (not to scale)

The distance between the centres of the first and ninth dark fringes is 3.2 cm.

(i) Calculate D.

D = ... m [3]

(ii) The slit separation is now gradually decreased from 0.16 mm to 0.04 mm. The distance between the centres of adjacent dark fringes is x.

On Fig. 4.3, sketch the variation of x with slit separation.

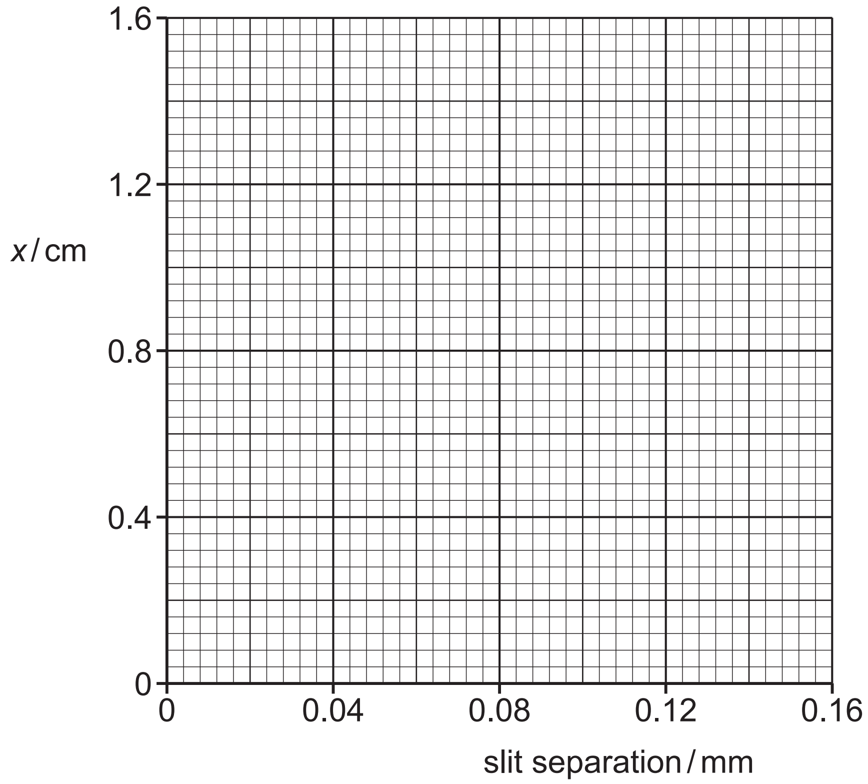


Fig. 4.3

[3]

[Total: 8]

27 Light waves are emitted from two sources.

What is a necessary condition for observable interference fringes to be produced?

A The waves must be polarised.

B The waves must **not** be polarised.

C The waves must be coherent.

D The waves must have equal amplitudes.

6 Two coherent sources X and Y of microwaves of frequency 2.5×10^{10} Hz are a distance of 0.18 m apart in a vacuum, as shown in Fig. 6.1.

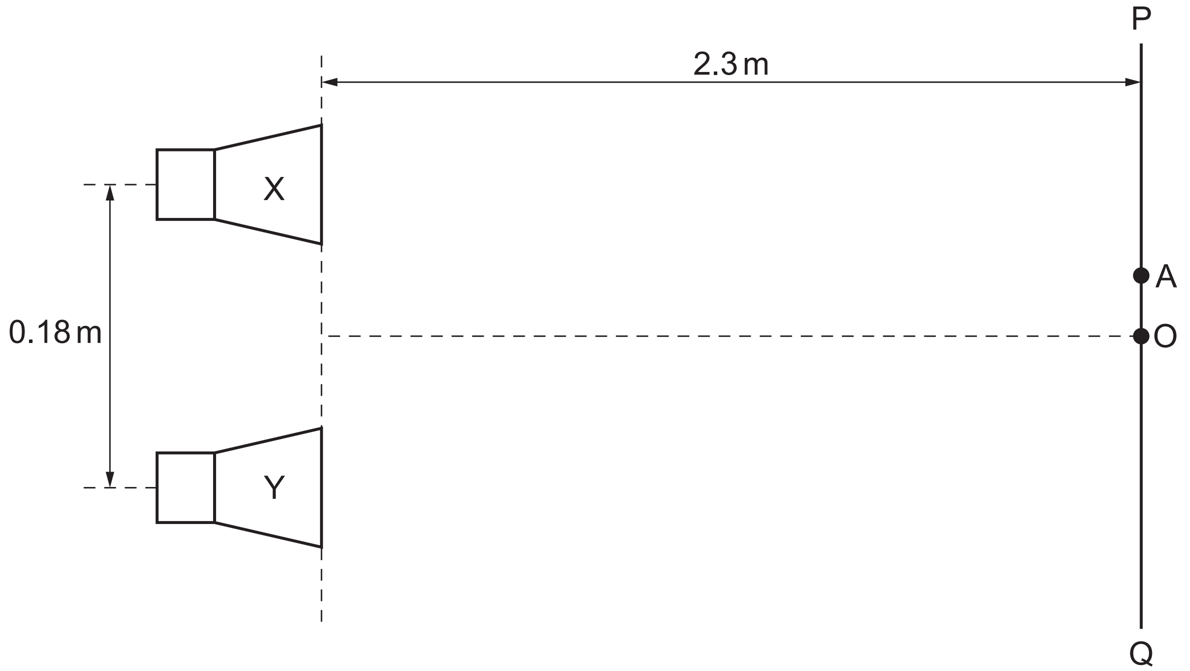


Fig. 6.1 (not to scale)

There is a phase difference of 90° between the waves emitted at the two sources.

A microwave detector moves along the line PQ, which is parallel to the line joining the two sources and 2.3 m away from it.

Point O is on the line PQ at a position that is equidistant from the two sources.
Point A is the position on line PQ where the intensity of the microwaves is the greatest.

(a) **(i)** Explain why the position of greatest intensity is **not** at point O.

....

....

....

.... [2]

(ii) On Fig. 6.1, draw a cross (×) to show the position of the point on line PQ where the intensity minimum that is the closest to point O occurs. Label this point B. [2]

(b) **(i)** Show that the wavelength of the microwaves is 0.012 m.

[2]

(ii) For point A on line PQ, determine the difference in the distances Δx travelled by the microwaves from X and the microwaves from Y.

Δx = ... m [1]

(iii) Use the formula for the double-slit interference of light to calculate the distance between adjacent intensity maxima on line PQ.

distance = ... m [2]

[Total: 9]