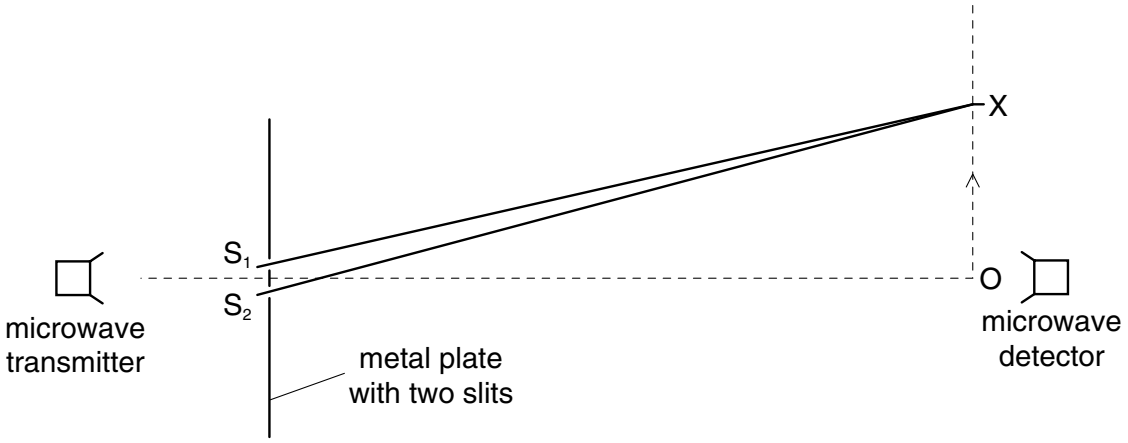
28 The diagram shows an experiment which has been set up to demonstrate two-source interference, using microwaves of wavelength λ. 9702/1/M/J/02



The detector is moved from O in the direction of the arrow. The signal detected decreases until the detector reaches the point X, and then starts to increase again as the detector moves beyond X.

Which equation correctly determines the position of X?

A $OX = \lambda/2$ **B** $OX = \lambda$ **C** $S_2X - S_1X = \lambda/2$ **D** $S_2X - S_1X = \lambda$

29 Two progressive waves of frequency 300 Hz are superimposed to produce a stationary wave in which adjacent nodes are 1.5 m apart. 9702/1/M/J/02

What is the speed of the progressive waves?

A $100\,m\,s^{-1}$ **B** $200\,m\,s^{-1}$ **C** $450\,m\,s^{-1}$ **D** $900\,m\,s^{-1}$

28 Coherent monochromatic light illuminates two narrow parallel slits and the interference pattern that results is observed on a screen some distance beyond the slits. 9702/1/O/N/02

Which change increases the separation between the dark lines of the interference pattern?

A using monochromatic light of higher frequency

B using monochromatic light of a longer wavelength

C decreasing the distance between the screen and the slits

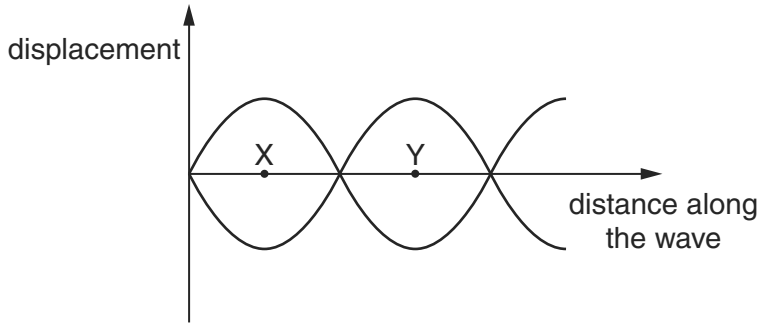
D increasing the distance between the slits

29 Monochromatic light of wavelength 590 nm is incident normally on a diffraction grating. The angle between the two second-order diffracted beams is 43°. 9702/1/O/N/02

What is the spacing of the lines on the grating?

A 0.87 µm **B** 1.6 µm **C** 1.7 µm **D** 3.2 µm

24 The graph represents a stationary wave at two different times. 9702/01/M/J/03



What does the distance XY represent?

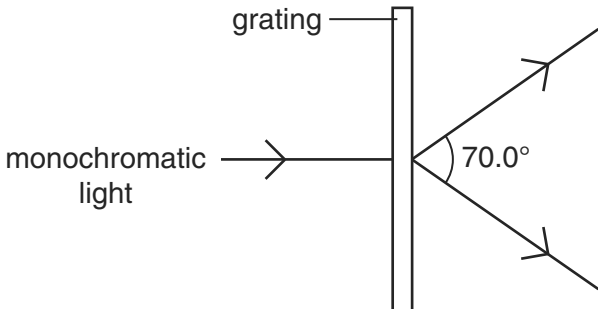
A half the amplitude

B half the frequency

C half the period

D half the wavelength

28 A diffraction grating is used to measure the wavelength of monochromatic light, as shown in the diagram. 9702/01/M/J/03



The spacing of the slits in the grating is 1.00×10^{-6} m. The angle between the first order diffraction maxima is 70.0°.

What is the wavelength of the light?

A 287 nm **B** 470 nm **C** 574 nm **D** 940 nm

27 When the light from two lamps falls on a screen, no interference pattern can be obtained. 9702/01/M/J/03

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.

24 A stationary sound wave has a series of nodes. The distance between the first and the sixth node is 30.0 cm. 9702/01/O/N/03

What is the wavelength of the sound wave?

A 5.0 cm **B** 6.0 cm **C** 10.0 cm **D** 12.0 cm

26 Which of the following may be used to produce stationary waves? 9702/01/O/N/03

A blowing air over the top of an empty bottle

B making a loud sound near a mountain

C passing monochromatic light through a double slit

D passing water waves through a narrow slit

27 In an interference experiment, two slits are illuminated with white light. 9702/01/O/N/03

What is seen on the screen?

A The central fringe is black with black and white fringes on each side.

B The central fringe is black with coloured fringes on each side.

C The central fringe is white with black and white fringes on each side.

D The central fringe is white with coloured fringes on each side.

28 Microwaves of wavelength 3.00 cm are incident normally on a row of parallel metal rods. The separation of the rods is 8.00 cm. The first order diffraction maximum is observed at an angle of 22.0° to the direction of the incident waves. 9702/01/O/N/03

What is the angle between the first and second order diffraction maxima?

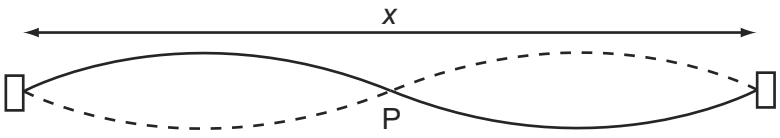
A 22.0° **B** 26.6° **C** 44.0° **D** 48.6°

28 The lines of a diffraction grating have a spacing of 1.6×10^{-6} m. A beam of light is incident normally on the grating. The first order maximum makes an angle of 20 ° with the undeviated beam. 9702/01/M/J/04

What is the wavelength of the incident light?

A 210 nm **B** 270 nm **C** 420 nm **D** 550 nm

27 The diagram represents a stationary wave on a stretched string. 9702/01/O/N/04



What is represented by point P and by the length *x*?

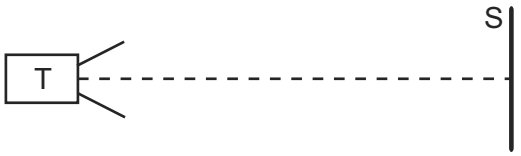
	point P	length *x*
A	antinode	one wavelength
B	antinode	two wavelengths
C	node	one wavelength
D	node	two wavelengths

28 Fringes of separation *y* are observed on a screen 1.00 m from a Young's slit arrangement that is illuminated by yellow light of wavelength 600 nm. 9702/01/O/N/04

At which distance from the slits would fringes of the same separation *y* 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

27 T is a microwave transmitter placed at a fixed distance from a flat reflecting surface S. 9702/01/M/J/05



A small microwave receiver is moved steadily from T towards S and receives signals of alternate maxima and minima of intensity.

The distance between successive maxima is 15 mm.

What is the frequency of the microwaves?

A 1.0×10^7 Hz

B 2.0×10^7 Hz

C 1.0×10^{10} Hz

D 2.0×10^{10} Hz

25 A narrow beam of monochromatic light is incident normally on a diffraction grating. Third-order diffracted beams are formed at angles of 45° to the original direction. 9702/01/O/N/07

What is the highest order of diffracted beam produced by this grating?

A 3rd **B** 4th **C** 5th **D** 6th

26 A sound wave is set up in a long tube, closed at one end. The length of the tube is adjusted until the sound from the tube is loudest. 9702/01/M/J/05

What is the nature of the sound wave in the tube?

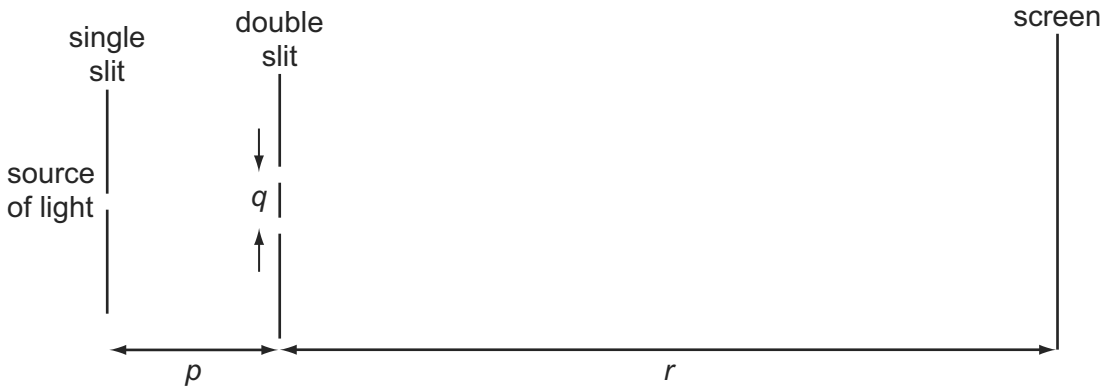
A longitudinal and progressive

B longitudinal and stationary

C transverse and progressive

D transverse and stationary

28 A teacher sets up the apparatus shown to demonstrate a two-slit interference pattern on the screen. 9702/01/M/J/05



Which change to the apparatus will increase the fringe spacing?

A decreasing the distance *p*

B decreasing the distance *q*

C decreasing the distance *r*

D decreasing the wavelength of the light

29 A parallel beam of white light is incident normally on a diffraction grating. It is noted that the second-order and third-order spectra partially overlap. 9702/01/M/J/05

Which wavelength in the third-order spectrum appears at the same angle as the wavelength of 600 nm in the second-order spectrum?

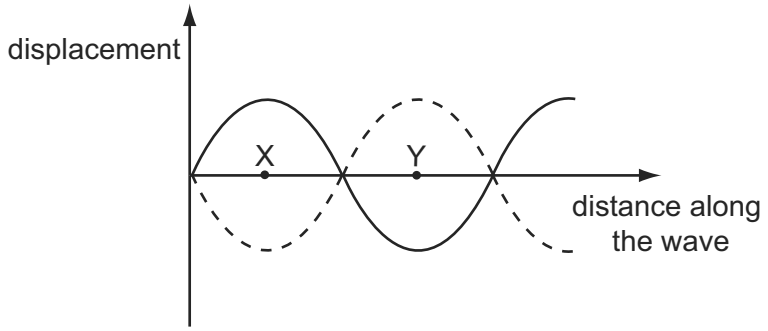
A 300 nm **B** 400 nm **C** 600 nm **D** 900 nm

28 Light of wavelength 700 nm is incident on a pair of slits, forming fringes 3.0 mm apart on a screen.

What is the fringe spacing when light of wavelength 350 nm is used and the slit separation is doubled? 9702/01/O/N/05

A 0.75 mm **B** 1.5 mm **C** 3.0 mm **D** 6.0 mm

26 The graph represents a standing wave at two different times. 9702/01/O/N/05



What does the distance XY represent?

A half the amplitude

B half the frequency

C half the period

D half the wavelength

27 In which situation does diffraction occur? 9702/01/O/N/05

A A wave bounces back from a surface.

B A wave passes from one medium into another.

C A wave passes through an aperture.

D Waves from two identical sources are superposed.

26 Where, in a standing wave, do the vibrations of the medium occur? 9702/01/M/J/06

A only at the nodes

B only at the antinodes

C at all points between the nodes

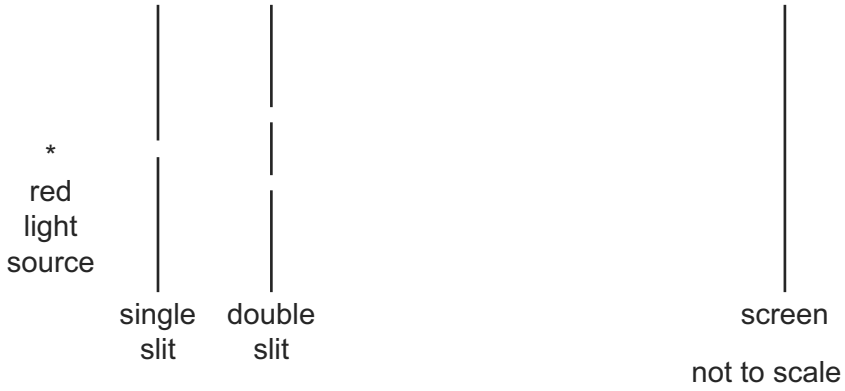
D at all points between the antinodes

27 Monochromatic light is incident on a diffraction grating and a diffraction pattern is observed.

Which line of the table gives the effect of replacing the grating with one that has more lines per metre? 9702/01/M/J/06

	number of orders of diffraction visible	angle between first and second orders of diffraction
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

28 A double-slit interference experiment is set up as shown. 9702/01/M/J/06



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

26 Continuous water waves are diffracted through a gap in a barrier in a ripple tank. 9702/01/O/N/06

Which change will cause the diffraction of the waves to increase?

A increasing the frequency of the waves

B increasing the width of the gap

C reducing the wavelength of the waves

D reducing the width of the gap

27 The interference patterns from a diffraction grating and a double slit are compared. 9702/01/O/N/06

Using the diffraction grating, yellow light of the first order is seen at 30° to the normal to the grating.

The same light produces interference fringes on a screen 1.0 m from the double slit. The slit separation is 500 times greater than the line spacing of the grating.

What is the fringe separation on the screen?

A 2.5×10^{-7} m

B 1.0×10^{-5} m

C 1.0×10^{-3} m

D 1.0×10^{-1} m

28 What may be used to produce stationary waves? 9702/01/O/N/06

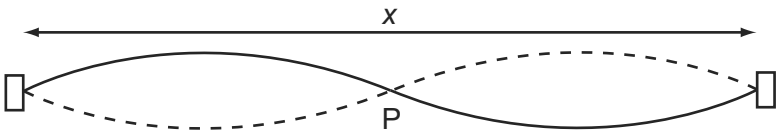
A blowing air over the top of an empty bottle

B making a loud sound near a mountain

C passing monochromatic light through a double slit

D passing water waves through a narrow slit

25 The diagram represents a stationary wave on a stretched string. 9702/01/M/J/07



What is represented by point P and by the length *x*?

	point P	length *x*
A	antinode	one wavelength
B	antinode	two wavelengths
C	node	one wavelength
D	node	two wavelengths

26 A two-slit arrangement is set up to produce interference fringes on a screen. The fringes are too close together for convenient observation when a monochromatic source of violet light is used.

9702/01/M/J/07

In which way would it be possible to increase the separation of the fringes?

A Decrease the distance between the screen and the slits.

B Increase the distance between the two slits.

C Increase the width of each slit.

D Use a monochromatic source of red light.

24 Monochromatic light illuminates two narrow parallel slits. The interference pattern which results is observed on a screen some distance beyond the slits. 9702/01/O/N/07

Which change increases the separation between the dark lines of the interference pattern?

A decreasing the distance between the screen and the slits

B increasing the distance between the slits

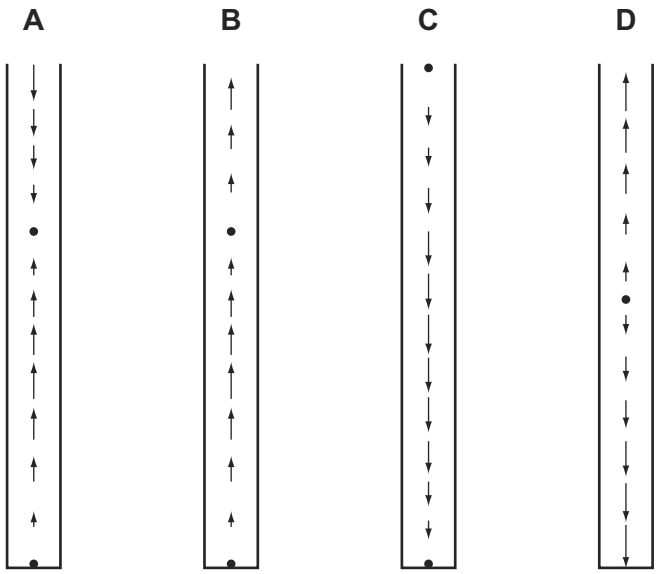
C using monochromatic light of higher frequency

D using monochromatic light of longer wavelength

27 A stationary longitudinal wave is set up in a pipe. 9702/01/M/J/07

In the diagrams below, the length of each arrow represents the amplitude of the motion of the air molecules, and the arrow head shows the direction of motion at a particular instant.

Which diagram shows a stationary wave in which there are two nodes and two antinodes?



27 Sound waves, emitted by a small loudspeaker, are reflected by a wall. 9702/01/M/J/08

The frequency f of the waves is adjusted until a stationary wave is formed with the antinode nearest the wall at a distance x from the wall.

Which expression gives f in terms of x and the speed of sound c?

A $f = \frac{4c}{x}$ **B** $f = \frac{2c}{x}$ **C** $f = \frac{c}{2x}$ **D** $f = \frac{c}{4x}$

28 A diffraction grating has N lines per unit length and is placed at 90° to monochromatic light of wavelength λ. 9702/01/M/J/08

What is the expression for θ, the angle to the normal to the grating at which the third order diffraction peak is observed?

A $\sin\theta = \frac{1}{3N\lambda}$ **B** $\sin\theta = 3N\lambda$ **C** $\sin\theta = \frac{N\lambda}{3}$ **D** $\sin\theta = \frac{3\lambda}{N}$

29 Light of wavelength 700 nm is incident on a pair of slits, forming fringes 3.0 mm apart on a screen.

What is the fringe spacing when light of wavelength 350 nm is used and the slit separation is doubled? 9702/01/M/J/08

A 0.75 mm **B** 1.5 mm **C** 3.0 mm **D** 6.0 mm

27 T is a microwave transmitter placed at a fixed distance from a flat reflecting surface S. 9702/01/O/N/08

A small microwave receiver is moved from T towards S and receives signals of alternate maxima and minima of intensity.

The distance between one maximum and the next is 15 mm.

What is the frequency of the microwaves?

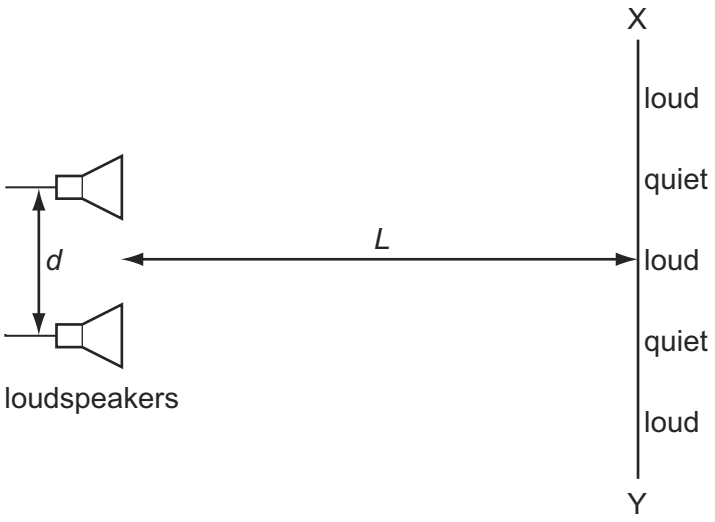
A 1.0×10^7 Hz

B 2.0×10^7 Hz

C 1.0×10^{10} Hz

D 2.0×10^{10} Hz

28 The diagram shows two loudspeakers producing sound waves that are in phase. 9702/01/O/N/08



As a student moves from X to Y, the intensity of the note she hears is alternately loud and quiet.

The distance between adjacent loud and quiet regions may be reduced by

A decreasing distance *d*.

B increasing distance *L*.

C decreasing the amplitude.

D increasing the frequency.

22 Diffraction is the name given to the 9702/01/M/J/09

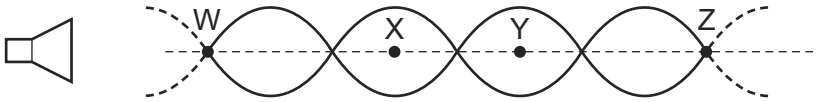
A addition of two coherent waves to produce a stationary wave pattern.

B bending of waves round an obstacle.

C change of direction when waves cross the boundary between one medium and another.

D splitting of white light into colours.

24 The diagram represents the pattern of stationary waves formed by the superposition of sound waves from a loudspeaker and their reflection from a metal sheet (not shown). 9702/01/M/J/09



W, X, Y and Z are four points on the line through the centre of these waves.

Which statement about these stationary waves is correct?

A An antinode is formed at the surface of the metal sheet.

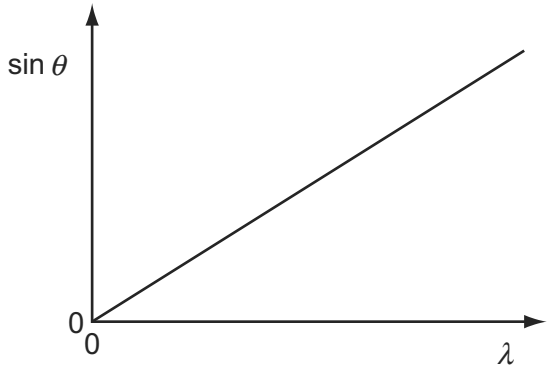
B A node is a quarter of a wavelength from an adjacent antinode.

C The oscillations at X are in phase with those at Y.

D The stationary waves oscillate at right angles to the line WZ.

25 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 θ for different values of λ in the n^{th} order interference pattern. 9702/01/M/J/09



What is the gradient of the graph?

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

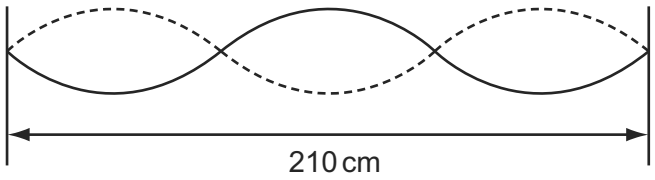
26 A parallel beam of light of wavelength 450 nm falls normally on a diffraction grating which has 300 lines / mm. 9702/11/O/N/09

What is the total number of transmitted maxima?

A 7 **B** 8 **C** 14 **D** 15

26 A stationary wave of frequency 80.0 Hz is set up on a stretched string of length 210 cm.

9702/01/M/J/09

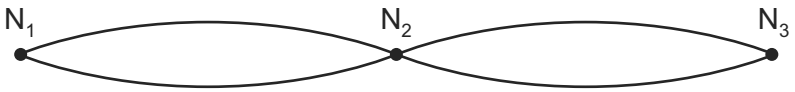


What is the speed of the waves that produce this stationary wave?

A $56.0\,m\,s^{-1}$ **B** $112\,m\,s^{-1}$ **C** $5600\,m\,s^{-1}$ **D** $11\,200\,m\,s^{-1}$

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

9702/11/O/N/09



Which statement is correct?

A All points on the string vibrate in phase.

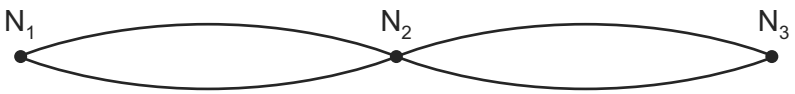
B All points on the string vibrate with the same amplitude.

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.

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

9702/12/O/N/09



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25 A parallel beam of light of wavelength 450 nm falls normally on a diffraction grating which has 300 lines / mm.

9702/12/O/N/09

What is the total number of transmitted maxima?

A 7 **B** 8 **C** 14 **D** 15

23 Using monochromatic light, interference fringes are produced on a screen placed a distance D from a pair of slits of separation a. The separation of the fringes is x. 9702/11/M/J/10

Both a and D are now doubled.

What is the new fringe separation?

A $\frac{x}{2}$ **B** x **C** $2x$ **D** $4x$

24 Diagram 1 shows a ripple tank experiment in which plane waves are diffracted through a narrow slit in a metal sheet. 9702/11/M/J/10

Diagram 2 shows the same tank with a slit of greater width.

In each case, the pattern of the waves incident on the slit and the emergent pattern are shown.

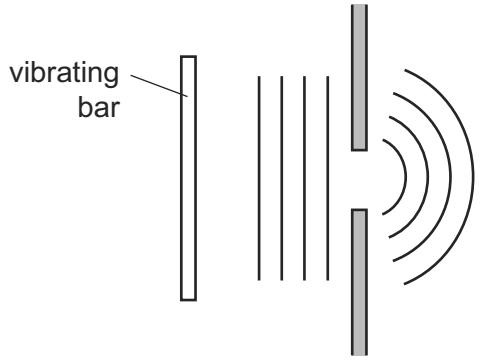


diagram 1

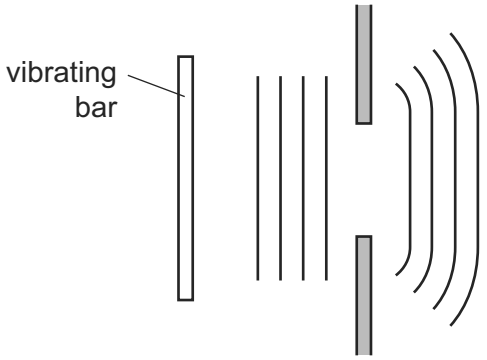


diagram 2

Which action would cause the waves in diagram 1 to be diffracted less and so produce an emergent pattern closer to that shown in diagram 2?

A increasing the frequency of vibration of the bar

B increasing the speed of the waves by making the water in the tank deeper

C reducing the amplitude of vibration of the bar

D reducing the length of the vibrating bar

24 Electromagnetic waves from an unknown source in space were found to be significantly diffracted when passing through gaps of the order of 10^{-5} m. 9702/12/M/J/10

Which type of wave are they most likely to be?

A radio waves

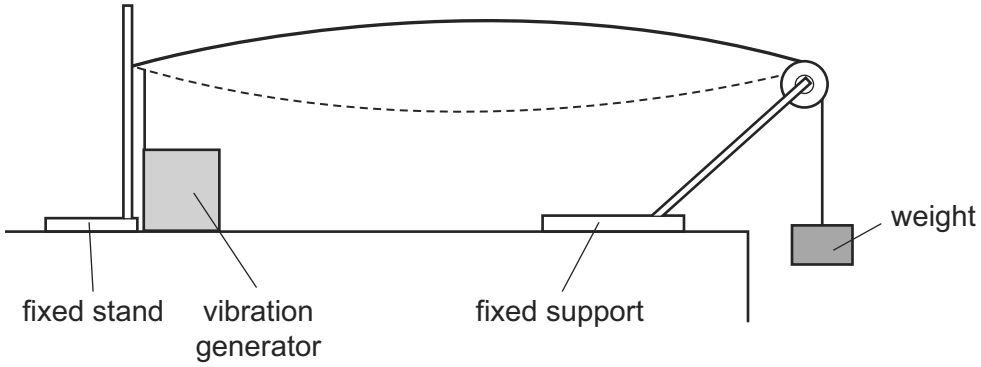
B microwaves

C infra-red waves

D ultraviolet waves

25 The diagram shows a steel wire clamped at one end and tensioned at the other by a weight hung over a pulley.

9702/11/M/J/10



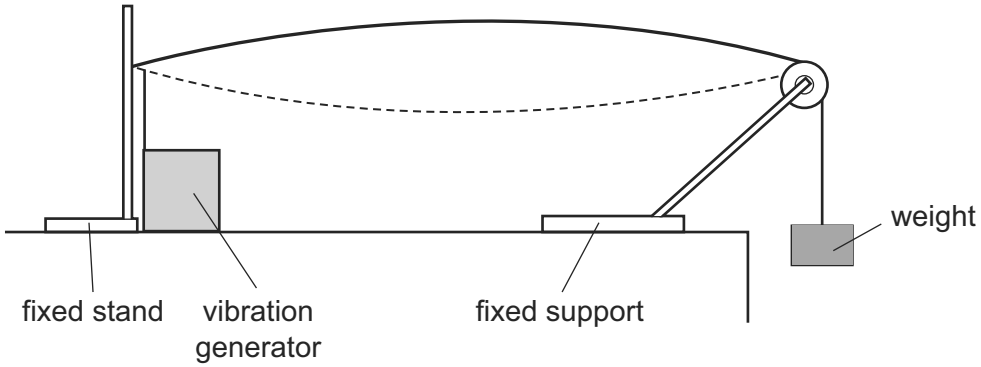
A vibration generator is attached to the wire near the clamped end. A stationary wave with one loop is produced. The frequency of the vibration generator is *f*.

Which frequency should be used to produce a stationary wave with two loops?

A $\frac{f}{4}$ **B** $\frac{f}{2}$ **C** $2f$ **D** $4f$

22 The diagram shows a steel wire clamped at one end and tensioned at the other by a weight hung over a pulley.

9702/12/M/J/10



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Which frequency should be used to produce a stationary wave with two loops?

A $\frac{f}{4}$ **B** $\frac{f}{2}$ **C** $2f$ **D** $4f$

25 Using monochromatic light, interference fringes are produced on a screen placed a distance *D* from a pair of slits of separation *a*. The separation of the fringes is *x*.

9702/12/M/J/10

Both *a* and *D* are now doubled.

What is the new fringe separation?

A $\frac{x}{2}$ **B** x **C** $2x$ **D** $4x$

23 Diagram 1 shows a ripple tank experiment in which plane waves are diffracted through a narrow slit in a metal sheet. 9702/12/M/J/10

Diagram 2 shows the same tank with a slit of greater width.

In each case, the pattern of the waves incident on the slit and the emergent pattern are shown.

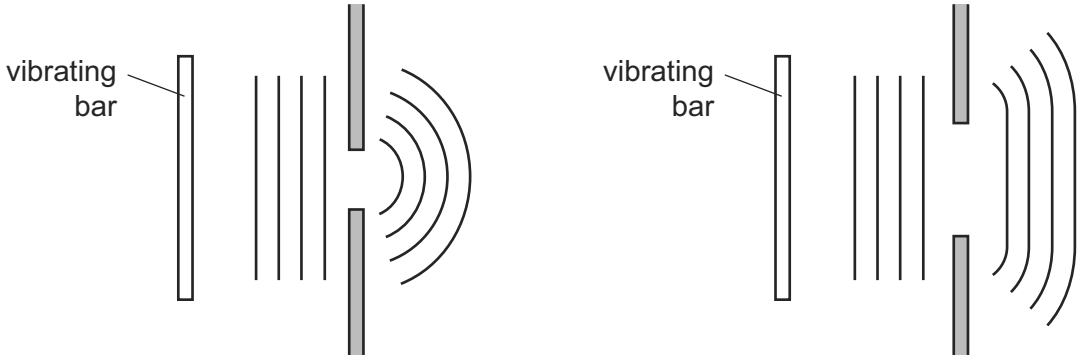

diagram 1 diagram 2

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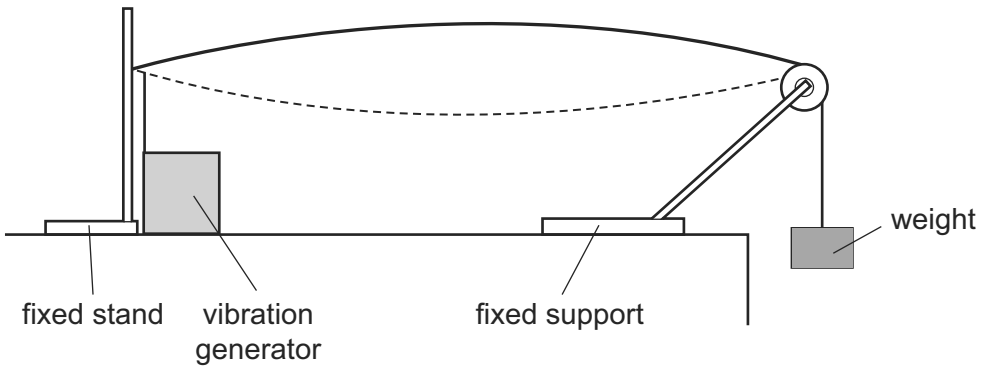
A increasing the frequency of vibration of the bar

B increasing the speed of the waves by making the water in the tank deeper

C reducing the amplitude of vibration of the bar

D reducing the length of the vibrating bar

24 The diagram shows a steel wire clamped at one end and tensioned at the other by a weight hung over a pulley. 9702/13/M/J/10



A vibration generator is attached to the wire near the clamped end. A stationary wave with one loop is produced. The frequency of the vibration generator is f.

Which frequency should be used to produce a stationary wave with two loops?

A $\frac{f}{4}$ **B** $\frac{f}{2}$ **C** $2f$ **D** $4f$

23 Electromagnetic waves from an unknown source in space were found to be significantly diffracted when passing through gaps of the order of 10^{-5} m. 9702/13/M/J/10

Which type of wave are they most likely to be?

A radio waves

B microwaves

C infra-red waves

D ultraviolet waves

25 Diagram 1 shows a ripple tank experiment in which plane waves are diffracted through a narrow slit in a metal sheet. 9702/13/M/J/10

Diagram 2 shows the same tank with a slit of greater width.

In each case, the pattern of the waves incident on the slit and the emergent pattern are shown.

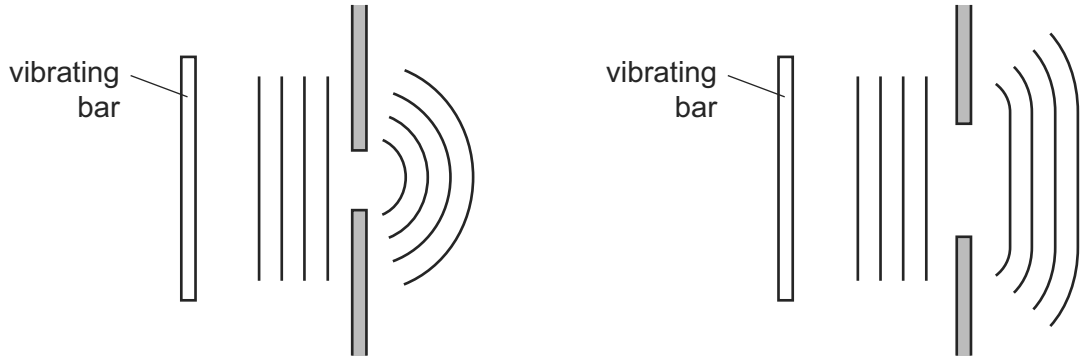


diagram 1 diagram 2

Which action would cause the waves in diagram 1 to be diffracted less and so produce an emergent pattern closer to that shown in diagram 2?

A increasing the frequency of vibration of the bar

B increasing the speed of the waves by making the water in the tank deeper

C reducing the amplitude of vibration of the bar

D reducing the length of the vibrating bar

27 Which electromagnetic wave would cause the most significant diffraction effect for an atomic lattice of spacing around 10^{-10} m? 9702/11/O/N/10

A infra-red

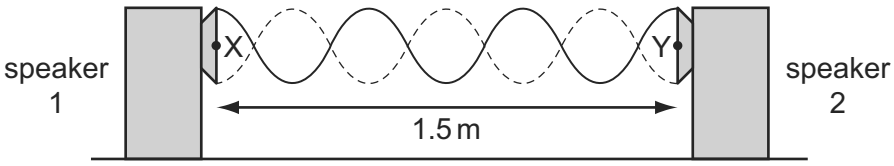
B microwave

C ultraviolet

D X-ray

26 A stationary wave is produced by two loudspeakers emitting sound of the same frequency.

9702/11/O/N/10



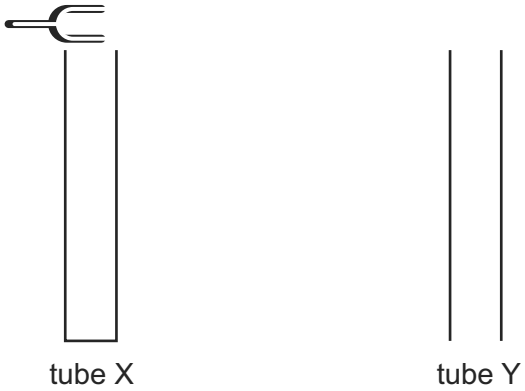
When a microphone is moved between X and Y, a distance of 1.5 m, six nodes and seven antinodes are detected.

What is the wavelength of the sound?

A 0.50 m **B** 0.43 m **C** 0.25 m **D** 0.21 m

25 The diagram shows two tubes.

9702/12/O/N/10



The tubes are identical except tube X is closed at its lower end while tube Y is open at its lower end. Both tubes have open upper ends.

A tuning fork placed above tube X causes resonance of the air at frequency *f*. No resonance is found at any **lower** frequency than *f* with tube X.

Which tuning fork will produce resonance when placed just above tube Y?

A a fork of frequency $\frac{f}{2}$

B a fork of frequency $\frac{2f}{3}$

C a fork of frequency $\frac{3f}{2}$

D a fork of frequency $2f$

26 Which electromagnetic wave phenomenon is needed to explain the spectrum produced when white light falls on a diffraction grating?

9702/11/M/J/11

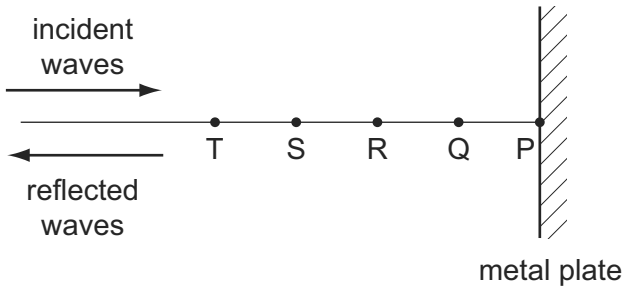
A coherence

B interference

C polarisation

D refraction

26 A microwave transmitter emits waves towards a metal plate. The waves strike the plate and are reflected back along their original path. 9702/12/O/N/10



A microwave detector is moved along the line PT.

Points P, Q, R, S and T are the positions where minima of intensity are observed. These points are found to be 15 mm apart.

What is the frequency of the microwaves?

A 5.0 GHz **B** 6.7 GHz **C** 10 GHz **D** 20 GHz

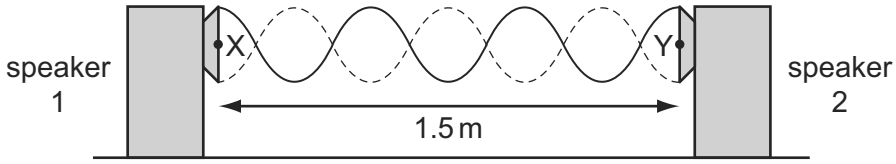
27 A double slit experiment, using light of wavelength 600 nm, results in fringes being produced on a screen. The fringe separation is found to be 1.0 mm. 9702/12/O/N/10

When the distance between the double slits and the viewing screen is increased **by** 2.0 m, the fringe separation increases **to** 3.0 mm.

What is the separation of the double slits producing the fringes?

A 0.4 mm **B** 0.6 mm **C** 0.9 mm **D** 1.2 mm

23 A stationary wave is produced by two loudspeakers emitting sound of the same frequency. 9702/13/O/N/10



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What is the wavelength of the sound?

A 0.50 m **B** 0.43 m **C** 0.25 m **D** 0.21 m

26 Which electromagnetic wave would cause the most significant diffraction effect for an atomic lattice of spacing around 10^{-10} m? 9702/13/O/N/10

A infra-red

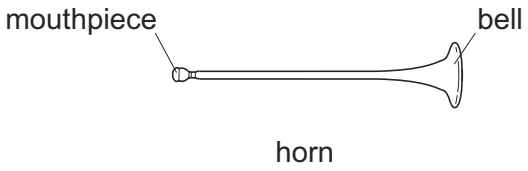
B microwave

C ultraviolet

D X-ray

25 The basic principle of note production in a horn is to set up a stationary wave in an air column.

9702/11/M/J/11



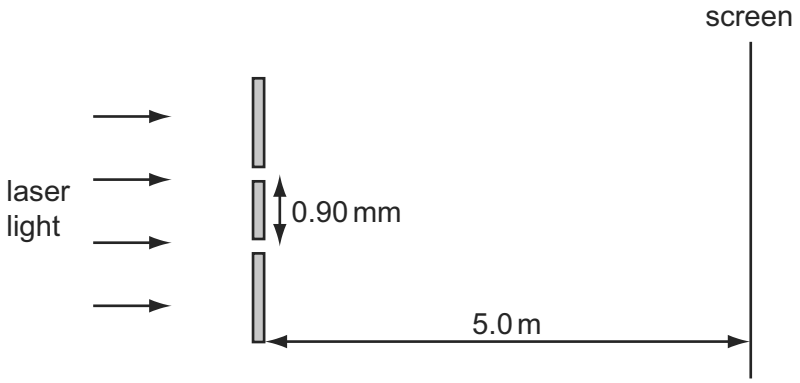
For the lowest note produced by a horn, a node is formed at the mouthpiece and the antinode is formed at the bell. The frequency of this note is 75 Hz.

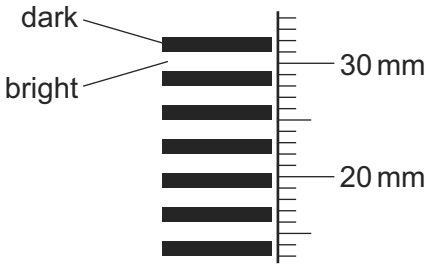
What are the frequencies of the next two higher notes for this air column?

	first higher note / Hz	second higher note / Hz
A	113	150
B	150	225
C	150	300
D	225	375

29 The diagrams show the arrangement of apparatus for a Young's slits experiment and also part of the pattern formed on the screen with a ruler placed next to it.

9702/12/M/J/11

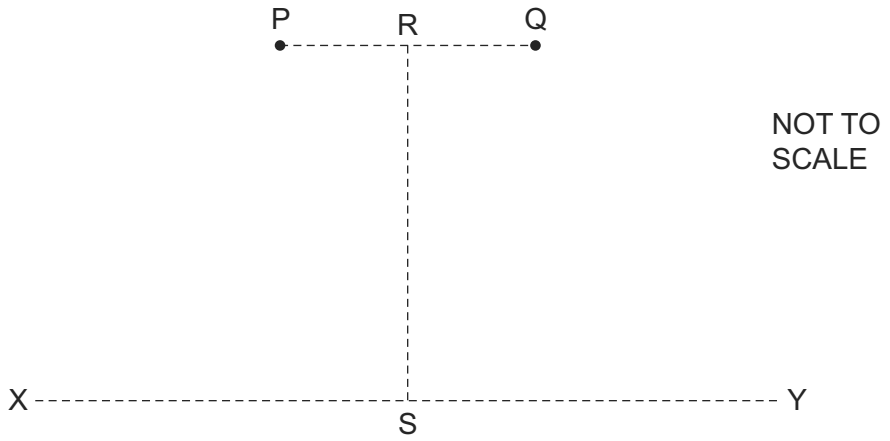




What is the wavelength of the light?

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

30 Coherent waves are produced at P and at Q and travel outwards in all directions. The line RS is halfway between P and Q and perpendicular to the line joining P and Q. The distance RS is much greater than the distance PQ. 9702/11/O/N/11



Along which line, or lines, is an interference pattern observed?

A both RS and XY

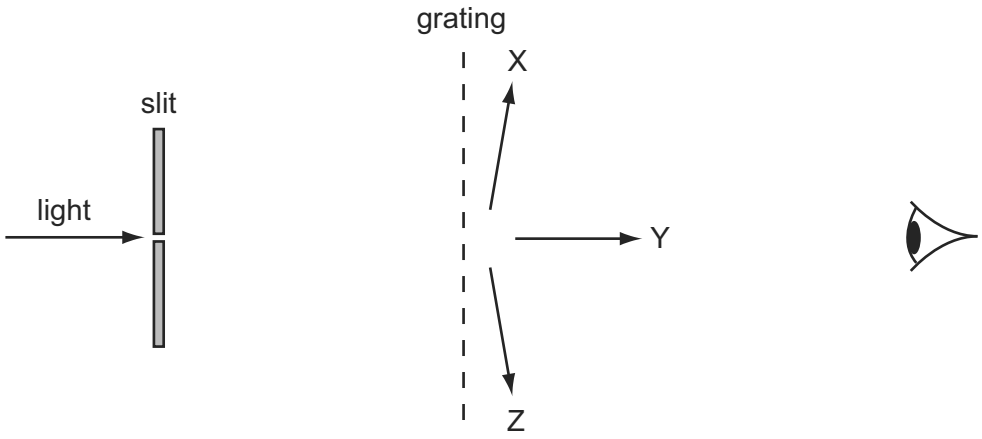
B RS only

C XY only

D neither RS nor XY

26 A diffraction grating with 500 lines per mm is used to observe diffraction of monochromatic light of wavelength 600 nm. 9702/13/M/J/11

The light is passed through a narrow slit and the grating is placed so that its lines are parallel to the slit. Light passes through the slit and then the grating.

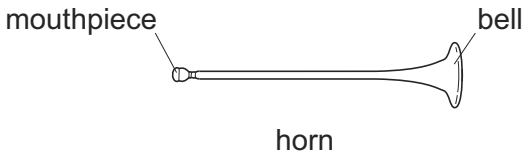


An observer views the slit through the grating at different angles, moving his head from X parallel to the grating, through Y, opposite the slit, to Z parallel to the grating on the opposite side.

How many images of the slit does he see?

A 3 **B** 4 **C** 6 **D** 7

27 The basic principle of note production in a horn is to set up a stationary wave in an air column. 9702/13/M/J/11

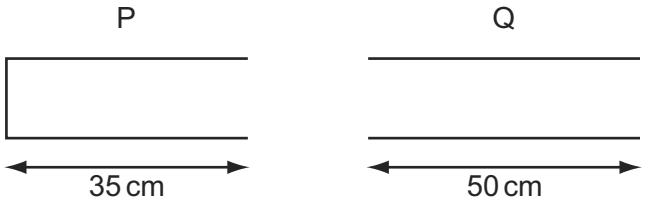


For the lowest note produced by a horn, a node is formed at the mouthpiece and the antinode is formed at the bell. The frequency of this note is 75 Hz.

What are the frequencies of the next two higher notes for this air column?

	first higher note / Hz	second higher note / Hz
A	113	150
B	150	225
C	150	300
D	225	375

29 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. 9702/11/O/N/11



In which pipe or pipes are stationary waves formed?

A P and Q

B P only

C Q only

D neither P nor Q

28 Two light sources produce visible interference fringes only in certain circumstances. 9702/12/O/N/11

Which condition enables visible interference fringes to be formed?

A using a white light source

B using incoherent sources

C using one light source which is polarised at right angles to light from the other source

D using sources from which the light does not overlap

28 In which situation does diffraction occur? 9702/12/M/J/11

A A wave bounces back from a surface.

B A wave passes from one medium into another.

C A wave passes through an aperture.

D Waves from two identical sources are superposed.

25 Which electromagnetic wave phenomenon is needed to explain the spectrum produced when white light falls on a diffraction grating? 9702/13/M/J/11

A coherence

B interference

C polarisation

D refraction

27 A sound wave is set up in a long tube, closed at one end. The length of the tube is adjusted until the sound from the tube is loudest. 9702/12/O/N/11

What is the nature of the sound wave in the tube?

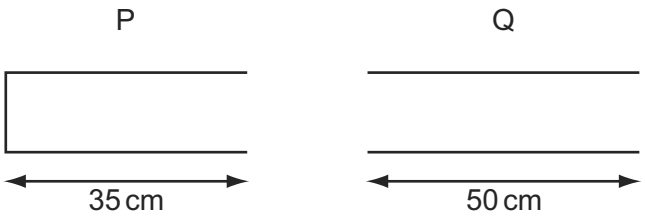
A longitudinal and progressive

B longitudinal and stationary

C transverse and progressive

D transverse and stationary

30 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. 9702/13/O/N/11



In which pipe or pipes are stationary waves formed?

A P and Q

B P only

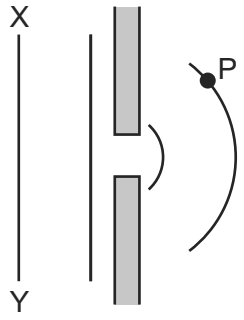
C Q only

D neither P nor Q

29 A monochromatic plane wave of speed c and wavelength λ is diffracted at a small aperture.

9702/12/M/J/12

The diagram illustrates successive wavefronts.

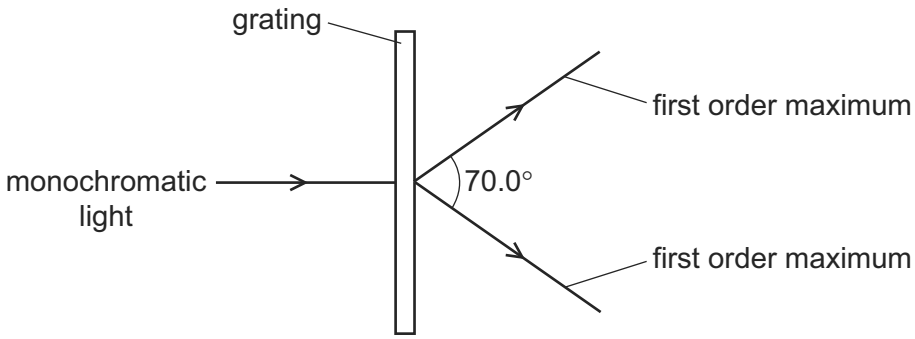


After what time will some portion of the wavefront XY reach point P?

A $\frac{3\lambda}{2c}$ **B** $\frac{2\lambda}{c}$ **C** $\frac{3\lambda}{c}$ **D** $\frac{4\lambda}{c}$

30 A diffraction grating is used to measure the wavelength of monochromatic light, as shown in the diagram.

9702/11/M/J/12



The spacing of the slits in the grating is 1.00×10^{-6} m. The angle between the first order diffraction maxima is 70.0°.

What is the wavelength of the light?

A 287 nm **B** 470 nm **C** 574 nm **D** 940 nm

30 To produce a stationary wave, two waves must travel in opposite directions through the same space.

9702/13/M/J/12

Which statement about the properties of the two waves must also be true?

A The waves must have equal frequency, but a different speed and wavelength.

B The waves must have equal speed, but a different wavelength and frequency.

C The waves must have equal speed, frequency and wavelength.

D The waves must have equal wavelength, but a different speed and frequency.

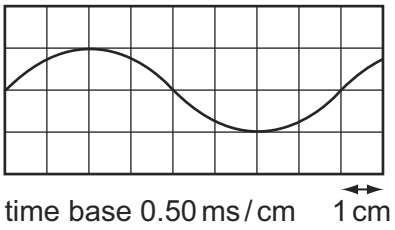
30 A standing sound wave is set up between a loudspeaker and a wall. 9702/12/M/J/12

A microphone is connected to a cathode-ray oscilloscope (c.r.o.) and is moved along a line directly between the loudspeaker and the wall. The amplitude of the trace on the c.r.o. rises to a maximum at a position X, falls to a minimum and then rises once again to a maximum at a position Y.

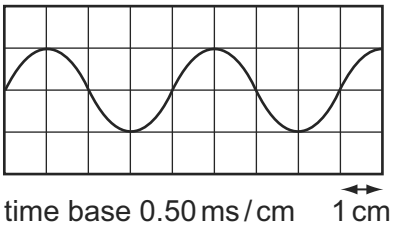
The distance between X and Y is 33 cm. The speed of sound in air is 330 m s^{-1}.

Which diagram represents the c.r.o. trace of the sound received at X?

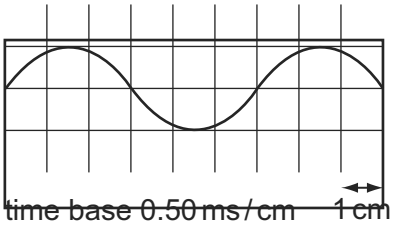
A



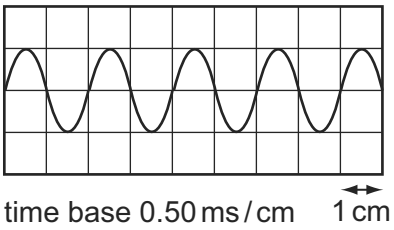
B



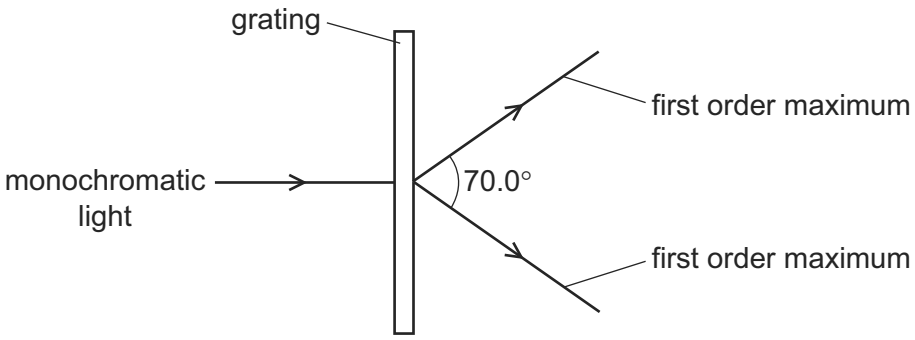
C



D



28 A diffraction grating is used to measure the wavelength of monochromatic light, as shown in the diagram. 9702/13/M/J/12



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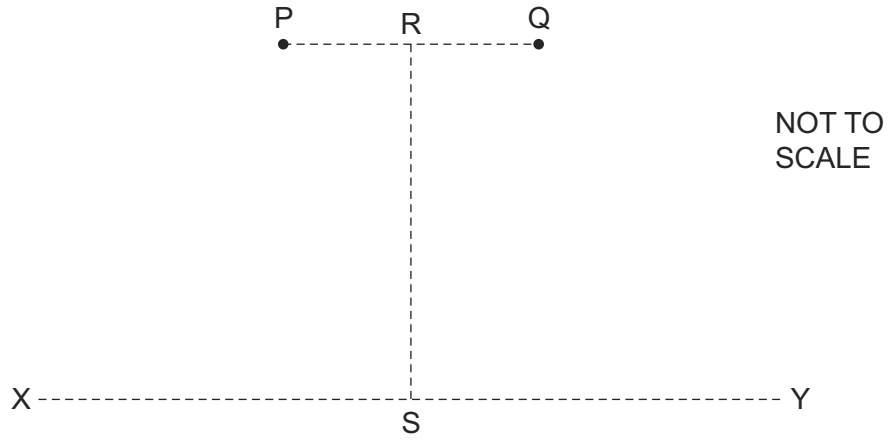
What is the wavelength of the light?

A 287 nm **B** 470 nm **C** 574 nm **D** 940 nm

29 Coherent waves are produced at P and at Q and travel outwards in all directions. The line RS is halfway between P and Q and perpendicular to the line joining P and Q. The distance RS is much greater than the distance PQ. 9702/13/O/N/11



Along which line, or lines, is an interference pattern observed?

A both RS and XY

B RS only

C XY only

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29 To produce a stationary wave, two waves must travel in opposite directions through the same space. 9702/11/M/J/12

Which statement about the properties of the two waves must also be true?

A The waves must have equal frequency, but a different speed and wavelength.

B The waves must have equal speed, but a different wavelength and frequency.

C The waves must have equal speed, frequency and wavelength.

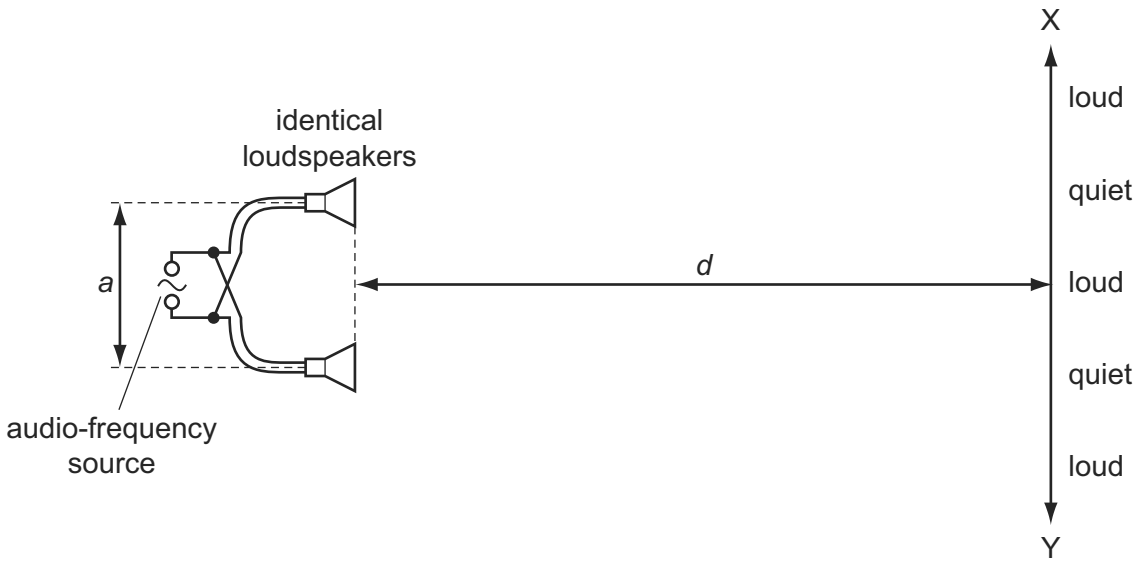
D The waves must have equal wavelength, but a different speed and frequency.

28 A musical organ produces notes by blowing air into a set of pipes that are open at one end and closed at the other. 9702/11/O/N/12

What is the lowest frequency of sound produced by a pipe of length 10 m?
(The speed of sound in the pipe is 320 m s^{-1}.)

A 4 Hz **B** 8 Hz **C** 16 Hz **D** 32 Hz

28 The diagram shows two identical loudspeakers driven in phase by a common audio-frequency source. 9702/12/O/N/12



When a student moves along line XY, she notices that there are variations in the loudness of the sound. The regions in which the sound is heard are alternately loud and quiet as indicated on the diagram.

How may the distance between loud regions be reduced?

A decreasing the distance *a* between the speakers

B increasing distance *d*

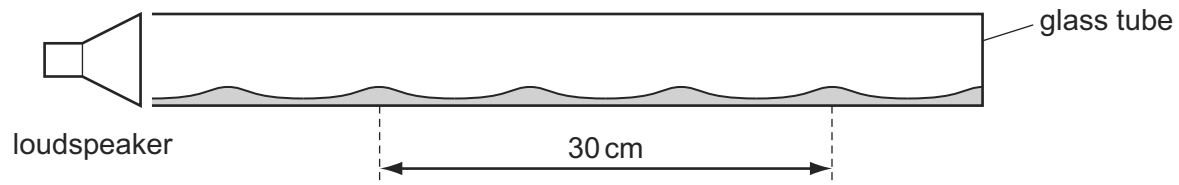
C increasing the frequency of the audio-frequency source

D increasing the power output from the audio-frequency source

29 A horizontal glass tube, closed at one end, has a layer of dust laid inside it on its lower side. Sound is emitted from a loudspeaker that is placed near the open end of the tube. 9702/12/O/N/12

The frequency of the sound is varied and, at one frequency, a stationary wave is formed inside the tube so that the dust forms small heaps.

The distance between four heaps of dust is 30 cm.

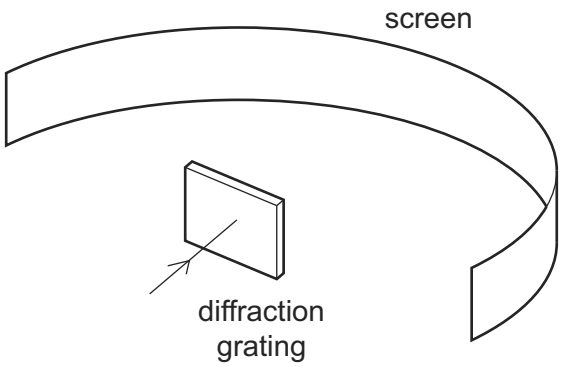


The speed of sound in the tube is 330 m s^{-1}.

What is the frequency of the sound emitted by the loudspeaker?

A 1650 Hz **B** 2200 Hz **C** 3300 Hz **D** 6600 Hz

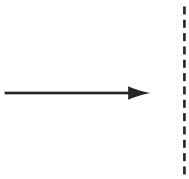
30 Monochromatic light of wavelength 690 nm passes through a diffraction grating with 300 lines per mm, producing a series of maxima on a screen. 9702/12/O/N/12



What is the greatest number of maxima that can be observed?

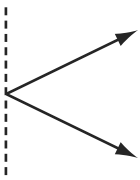
A 4 **B** 5 **C** 8 **D** 9

29 Monochromatic light is directed at a diffraction grating as shown. 9702/11/O/N/12

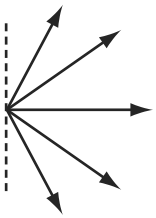


Which diagram shows all the possible directions of the light, after passing through the grating, that give maximum intensity?

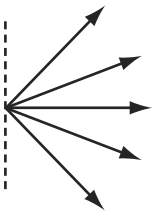
A



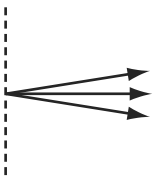
B



C



D



28 Diffraction can be observed when a wave passes an obstruction. The diffraction effect is greatest when the wavelength and the obstruction are similar in size. 9702/13/O/N/12

For waves travelling through air, what is the combination of wave and obstruction that could best demonstrate diffraction?

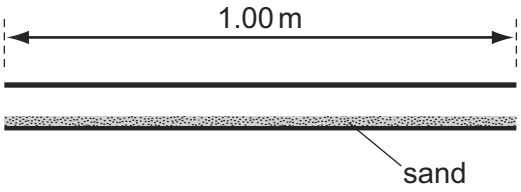
A microwaves passing a steel post

B radio waves passing a copper wire

C sound waves passing a human hair

D visible light waves passing a gate post

26 The diagram shows an air-filled pipe open at both ends. The length of the pipe is 1.00 m and the lower surface of the inside of the pipe is covered with a layer of fine sand. 9702/13/O/N/12



When a source of sound of a single frequency is put near one end of the pipe, the air in the pipe is found to resonate and a pattern in the sand shows that a standing wave containing three nodes is formed within the pipe.

The speed of sound in air is 330 m s^{-1}.

What is the frequency of the sound?

A 330 Hz **B** 495 Hz **C** 990 Hz **D** 1320 Hz

27 A stationary sound wave is formed in a measuring cylinder by blowing across the top, as shown. 9702/13/O/N/12

Which statement is correct?

A The fundamental frequency of the stationary wave decreases when some water is added to the cylinder.

B The stationary wave in the cylinder is caused by the superposition of two waves moving in opposite directions.

C The stationary wave in the cylinder is polarised.

D The stationary wave will have an antinode at the bottom of the cylinder.

27 A parallel beam of red light of wavelength 700 nm is incident normally on a diffraction grating that has 400 lines per millimetre. 9702/13/M/J/13

What is the total number of transmitted maxima?

A 3 **B** 4 **C** 6 **D** 7

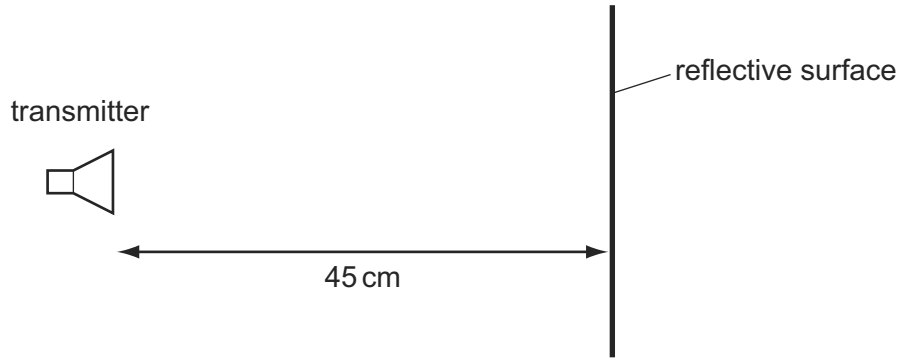
29 Monochromatic light of wavelength 5.30×10^{-7} m is incident normally on a diffraction grating. The first order maximum is observed at an angle of 15.4° to the direction of the incident light.

9702/12/M/J/13

What is the angle between the first and second order diffraction maxima?

A 7.6° **B** 15.4° **C** 16.7° **D** 32.0°

27 A transmitter of electromagnetic waves is placed 45 cm from a reflective surface. 9702/12/M/J/13



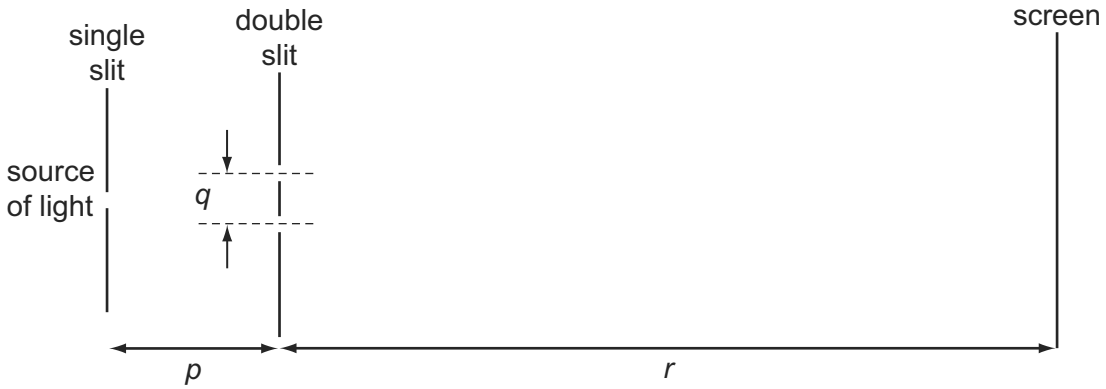
The emitted waves have a frequency of 1.00 GHz. A stationary wave is produced with a node at the transmitter and a node at the surface.

How many antinodes are in the space between the transmitter and the surface?

A 1 **B** 2 **C** 3 **D** 4

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

9702/12/M/J/13



Which change to the apparatus will increase the fringe spacing?

A decreasing the distance *p*

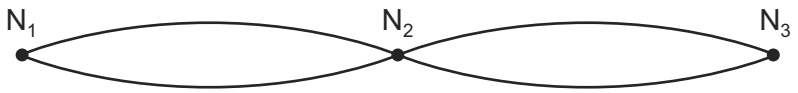
B decreasing the distance *q*

C decreasing the distance *r*

D decreasing the wavelength of the light

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

9702/13/M/J/13



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.

27 Light of wavelength 600 nm is incident on a pair of slits. Fringes with a spacing of 4.0 mm are formed on a screen.

9702/11/M/J/13

What will be the fringe spacing when the wavelength of the light is changed to 400 nm and the separation of the slits is doubled?

A 1.3 mm

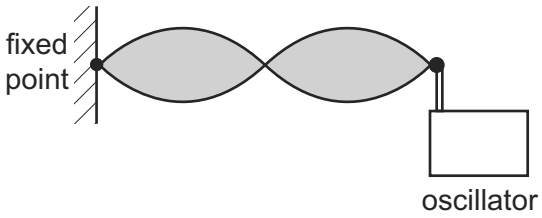
B 3.0 mm

C 5.3 mm

D 12 mm

28 The speed of a transverse wave on a stretched string can be changed by adjusting the tension of the string. A stationary wave pattern is set up on a stretched string using an oscillator set at a frequency of 650 Hz.

9702/11/M/J/13



How must the wave be changed to maintain the same stationary wave pattern if the applied frequency is increased to 750 Hz?

A Decrease the speed of the wave on the string.

B Decrease the wavelength of the wave on the string.

C Increase the speed of the wave on the string.

D Increase the wavelength of the wave on the string.

29 Noise reduction headphones actively produce their own sound waves in order to cancel out external sound waves. 9702/11/M/J/13

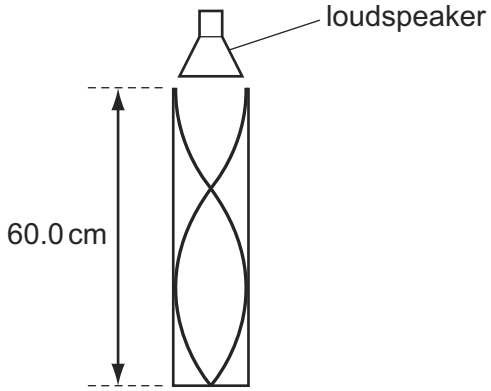
A microphone in the headphones receives waves of one frequency. A loudspeaker in the headphones then produces a wave of that frequency but of a different phase.

What is the phase difference between the external sound wave and the wave produced by the loudspeaker in the headphones?

A 90° **B** 180° **C** 270° **D** 360°

27 The sound from a loudspeaker placed above a tube causes resonance of the air in the tube. 9702/11/O/N/13

A stationary wave is formed with two nodes and two antinodes as shown.

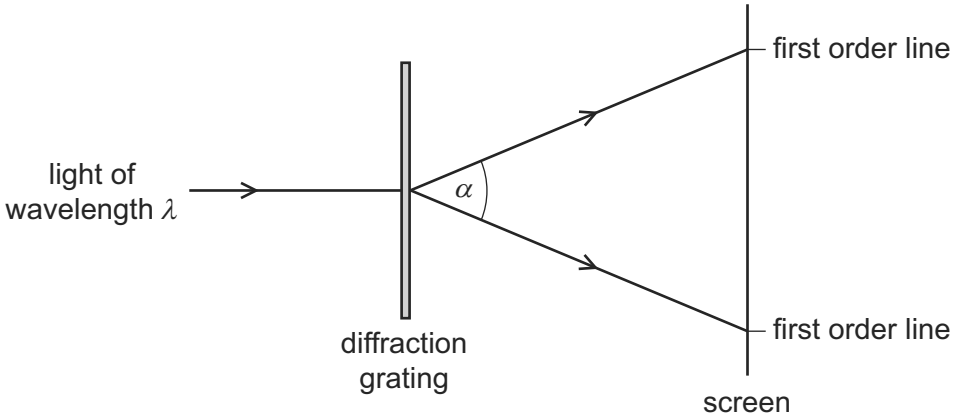


The speed of sound in air is $330\,m\,s^{-1}$.

What is the frequency of the sound?

A 413 Hz **B** 550 Hz **C** 830 Hz **D** 1650 Hz

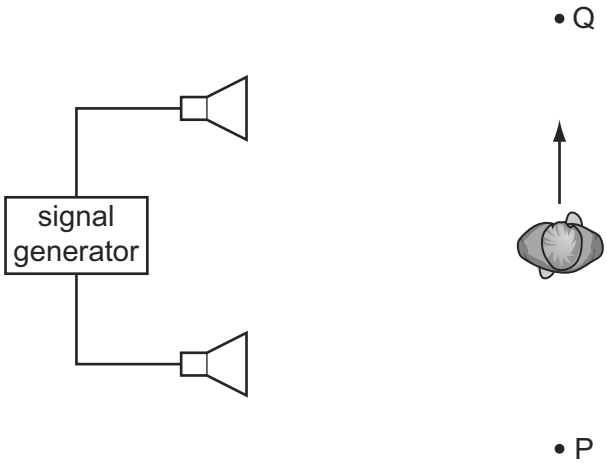
28 Light of wavelength λ passes through a diffraction grating with slit spacing d. A series of lines is observed on a screen. 9702/11/O/N/13



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

29 A student connects two loudspeakers to a signal generator. 9702/11/O/N/13



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 interference of the sound waves

C polarisation of the sound waves

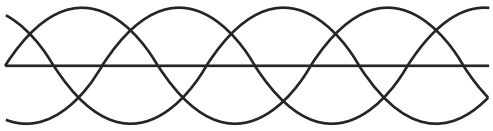
D reflection of the sound waves

26 The three waves shown in each diagram have the same amplitude and frequency but differ in phase. 9702/13/O/N/13

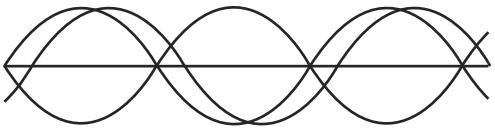
They are added together to give a resultant wave.

In which case is the resultant wave zero?

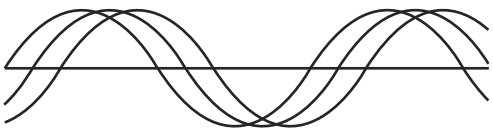
A



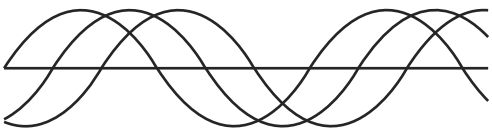
B



C

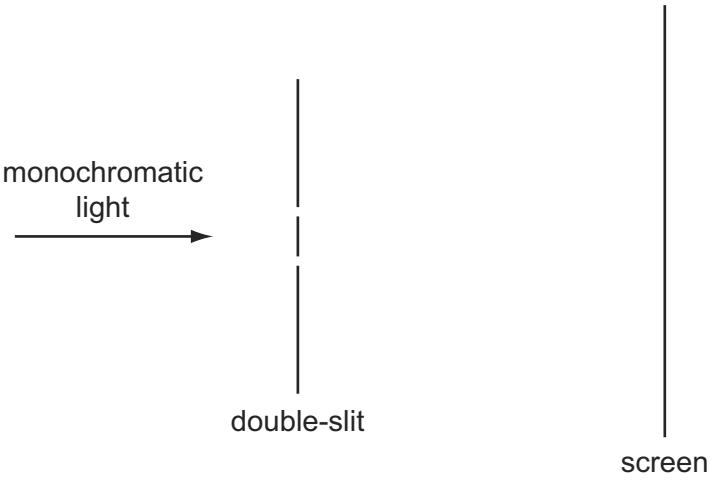


D



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

9702/13/O/N/13



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.

27 A stationary sound wave has a series of nodes. The distance between the first and the sixth node is 30.0 cm.

9702/13/O/N/13

What is the wavelength of the sound wave?

A 5.0 cm **B** 6.0 cm **C** 10.0 cm **D** 12.0 cm

28 What is meant by diffraction?

9702/13/O/N/13

A Addition of two coherent waves to produce a stationary wave pattern.

B Bending of waves round an obstacle.

C Change of direction when waves cross the boundary between one medium and another.

D Splitting of white light into colours.

28 A student attempts to show the interference of light using two identical green LEDs. 9702/13/M/J/14

Which statement explains why the experiement will **not** succeed?

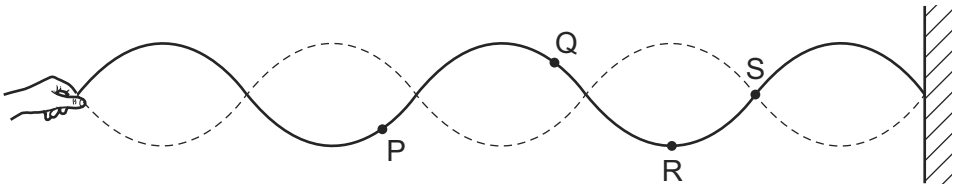
A The light waves from the sources are not coherent.

B The light waves from the sources do not have the same amplitude.

C The light waves from the sources have a range of wavelengths.

D The light waves from the sources are not monochromatic.

29 A stationary wave is set up on a stretched string, as shown. 9702/13/M/J/14



Which statement about the points on the string is correct?

A Point Q vibrates with the largest amplitude.

B Points P and R vibrate in phase.

C Point S is an antinode.

D The horizontal distance between R and S is half the wavelength.

30 Monochromatic light is incident on a diffraction grating and a diffraction pattern is observed.

Which line of the table gives the effect of replacing the grating with one that has more lines per metre?

9702/13/M/J/14

	number of orders of diffraction visible	angle between first and second orders of diffraction
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

26 A parallel beam of white light passes through a diffraction grating. Orange light of wavelength 600 nm in the fourth order diffraction maximum coincides with blue light in the fifth order diffraction maximum. 9702/11/M/J/14

What is the wavelength of the blue light?

A 450 nm **B** 480 nm **C** 500 nm **D** 750 nm

25 The principle of superposition states that a certain quantity is added when two or more waves meet at a point.

9702/12/M/J/14

What is this quantity?

A amplitude

B displacement

C intensity

D wavelength

26 Light passes through a diffraction grating ruled at 1000 lines per cm and the same wavelength of light also passes through two narrow slits 0.5 mm apart. Both situations produce intensity maxima and minima on a screen.

9702/12/M/J/14

Which statement about the separation of the maxima on the screen and the sharpness of the maxima is correct?

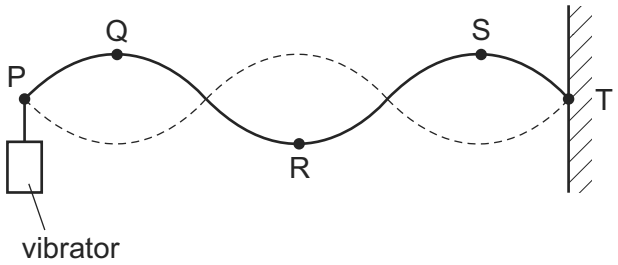
A The diffraction grating maxima are less widely spaced and are less sharp than the two-slit maxima.

B The diffraction grating maxima are less widely spaced and are sharper than the two-slit maxima.

C The diffraction grating maxima are more widely spaced and are less sharp than the two-slit maxima.

D The diffraction grating maxima are more widely spaced and are sharper than the two-slit maxima.

25 A stationary wave on a stretched string is set up between two points P and T. 9702/11/M/J/14



Which statement about the wave is correct?

A Point R is at a node.

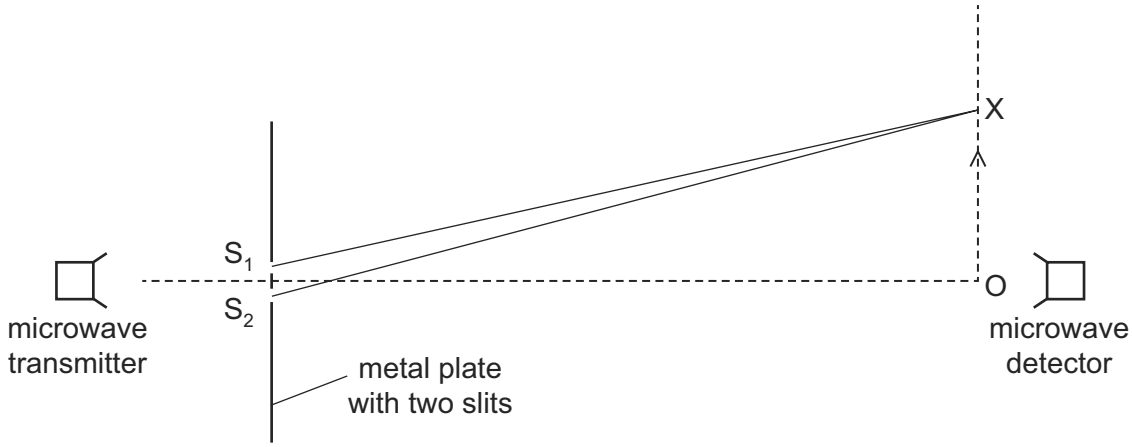
B Points Q and S vibrate in phase.

C The distance between P and T is three wavelengths.

D The wave shown has the lowest possible frequency.

27 The diagram shows an experiment which has been set up to demonstrate two-source interference. Microwaves of wavelength λ pass through two slits S_1 and S_2.

9702/12/M/J/14



The detector is moved from point O in the direction of the arrow. The signal detected decreases until the detector reaches point X, and then starts to increase again as the detector moves beyond X.

Which equation correctly determines the position of X?

A $OX = \lambda$

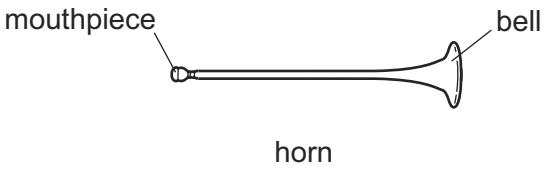
B $OX = \lambda / 2$

C $S_2X - S_1X = \lambda$

D $S_2X - S_1X = \lambda / 2$

27 The basic principle of note production in a horn is to set up a stationary wave in an air column.

9702/11/M/J/14



For any note produced by the horn, a node is formed at the mouthpiece and an antinode is formed at the bell. The frequency of the lowest note is 75 Hz.

What are the frequencies of the next two higher notes for this air column?

	first higher note / Hz	second higher note / Hz
A	113	150
B	150	225
C	150	300
D	225	375

25 A stationary sound wave is produced in a tube. 9702/11/O/N/14

Which statement describes the wave speed?

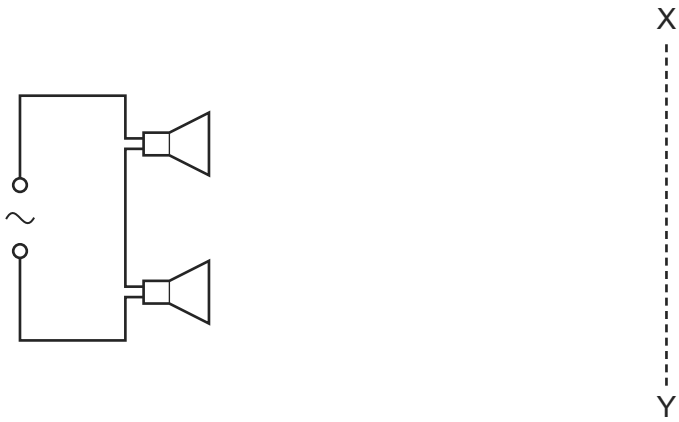
A It is the distance between two adjacent nodes divided by the period of the wave.

B It is the speed at which energy is transferred from one antinode to an adjacent antinode.

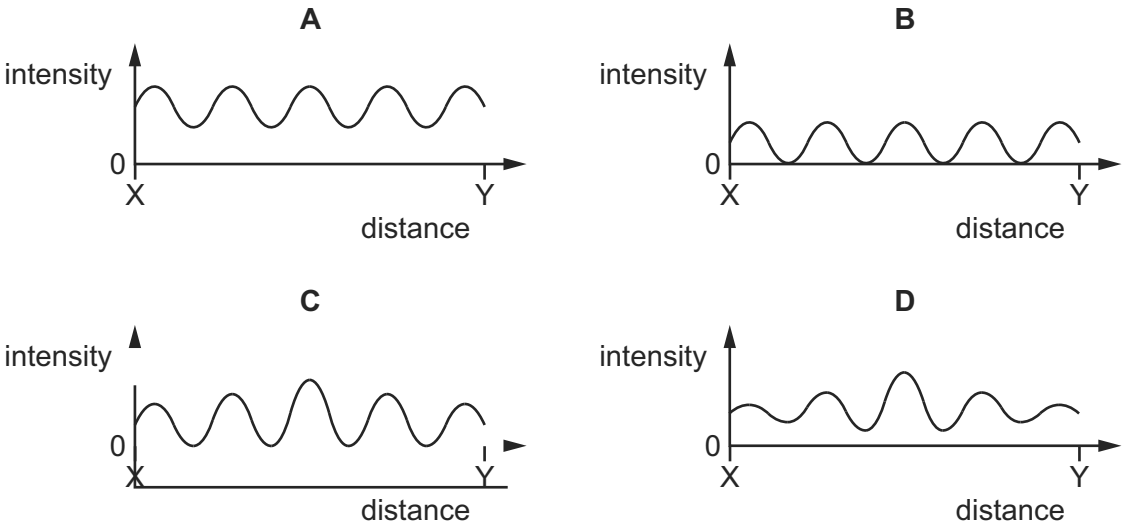
C It is the speed of a particle at an antinode.

D It is the speed of one of the progressive waves that are producing the stationary wave.

26 Two identical loudspeakers are connected in series to an a.c. supply, as shown. 9702/11/O/N/14



Which graph best shows the variation of the intensity of the sound with distance along the line XY?

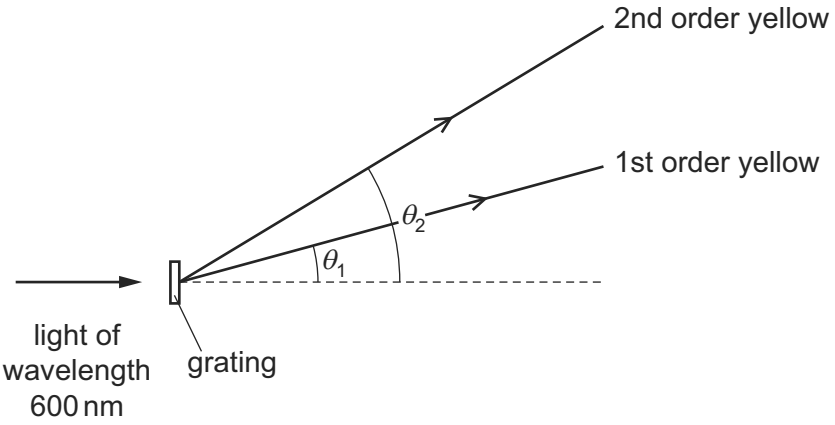


30 Interference fringes are produced on a screen by double-slit interference using light of wavelength 600 nm. The fringe separation is 4.0 mm and the separation of the slits is 0.60 mm. 9702/13/O/N/14

What is the distance between the double slit and the screen?

A 0.25 m **B** 0.40 m **C** 2.5 m **D** 4.0 m

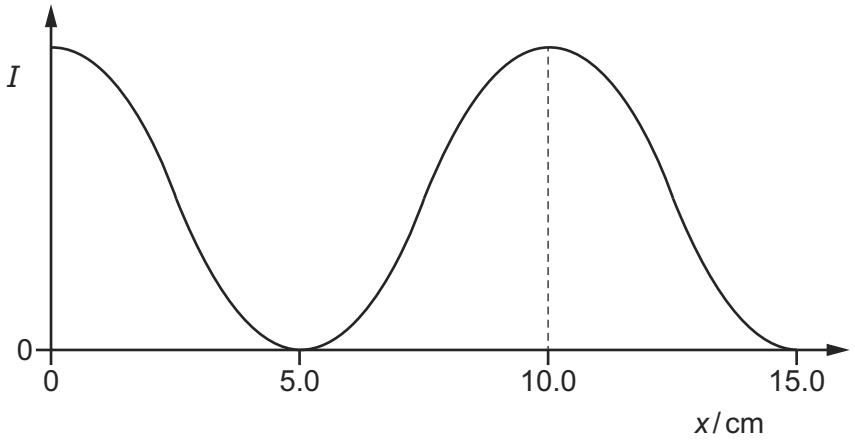
27 A diffraction grating experiment is set up using yellow light of wavelength 600 nm. The grating has a slit separation of 2.00 μm. 9702/11/O/N/14



What is the angular separation ($\theta_2 - \theta_1$) between the first and second order maxima of the yellow light?

A 17.5° **B** 19.4° **C** 36.9° **D** 54.3°

27 The variation with distance x of the intensity I along a stationary sound wave in air is shown by the following graph. 9702/13/O/N/14



The speed of sound in air is 340 m s^{-1}.

What is the frequency of the sound wave?

A 1700 Hz **B** 2270 Hz **C** 3400 Hz **D** 6800 Hz

29 An organ pipe of length l is open at both ends. Notes are produced by the pipe when stationary waves are set up. 9702/13/O/N/14

The speed of sound in the air column is v.

What is the lowest (fundamental) frequency of the note produced by the pipe?

A $\frac{2v}{l}$ **B** $\frac{v}{l}$ **C** $\frac{v}{2l}$ **D** $\frac{v}{4l}$

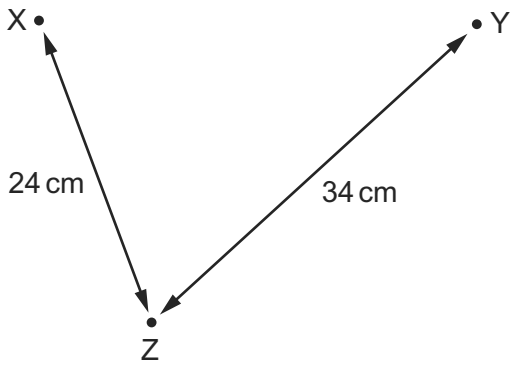
27 The table contains statements about stationary and progressive waves. 9702/13/M/J/15

Which row is correct?

	stationary wave	progressive wave
A	all particles vibrate with the same amplitude	all particles vibrate with the same amplitude
B	energy is transferred along the wave	energy is transferred along the wave
C	particles in adjacent loops vibrate in antiphase	particles vibrate in phase with their immediate neighbours
D	particles one wavelength apart vibrate in phase	particles one wavelength apart vibrate in phase

29 Wave generators at points X and Y produce water waves of the same wavelength. At point Z, the waves from X have the same amplitude as the waves from Y. Distances XZ and YZ are as shown.

9702/13/M/J/15



When the wave generators operate in phase, the amplitude of oscillation at Z is zero.

What could be the wavelength of the waves?

A 2 cm **B** 3 cm **C** 4 cm **D** 6 cm

26 What is **not** an **essential** condition for an observable interference pattern to occur between the waves from two sources? 9702/12/M/J/15

A The frequencies of the two sources must be equal.

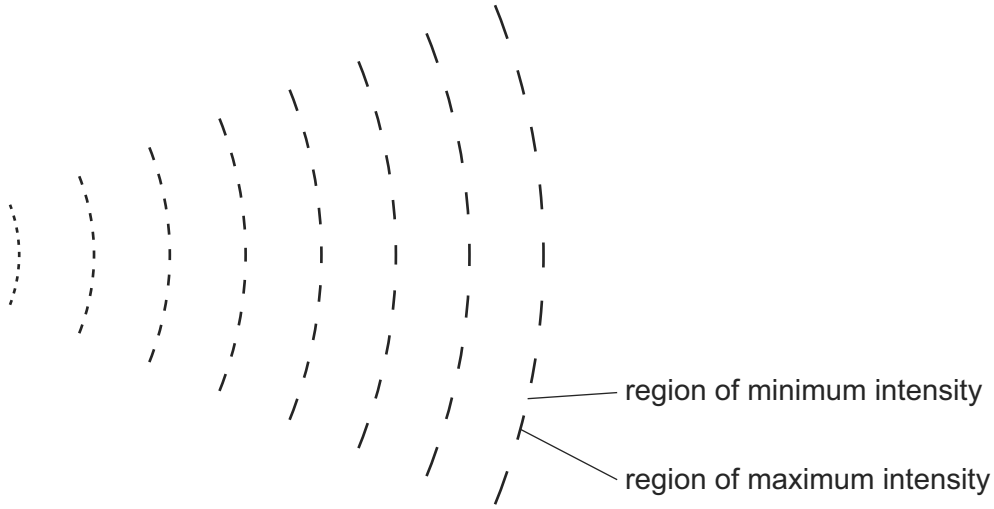
B The sources must be coherent.

C The sources must emit waves of equal amplitude.

D The waves from the two sources must overlap.

28 A pattern of waves was observed without being able to view the source of the waves. The pattern is represented in the diagram.

9702/12/M/J/15



What can cause this pattern?

A coherence only

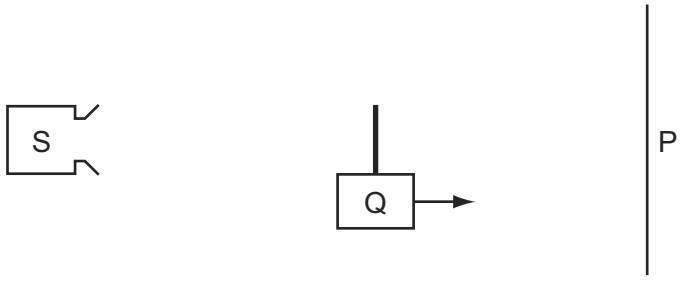
B diffraction and interference

C diffraction only

D interference only

27 Source S emits microwaves with a constant amplitude. The microwaves hit a metal screen P and are reflected. A stationary wave is formed between S and P. The wavelength of the microwaves is much smaller than the distance between S and P.

9702/12/M/J/15



A detector Q is moved at a slow, constant speed from S to P.

What happens to the amplitude of the signal detected by Q?

A decreases steadily

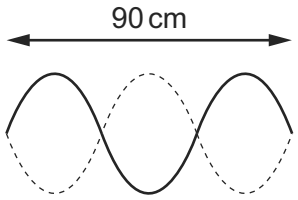
B increases and decreases regularly

C increases steadily

D remains constant

28 The diagram shows a stationary wave on a string at two instants of maximum vertical displacement.

9702/11/M/J/15



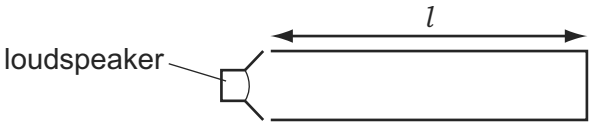
The frequency of the wave is 12 Hz.

What is the speed of the wave?

A $3.6\,m\,s^{-1}$ **B** $7.2\,m\,s^{-1}$ **C** $360\,m\,s^{-1}$ **D** $720\,m\,s^{-1}$

29 A loudspeaker emitting sound of frequency *f* is placed at the open end of a pipe of length l which is closed at the other end. A standing wave is set up in the pipe.

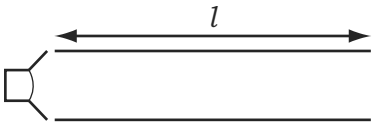
9702/11/M/J/15



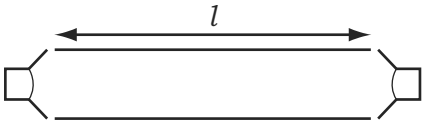
A series of pipes are then set up with either one or two loudspeakers of frequency *f*. The pairs of loudspeakers vibrate in phase with each other.

Which pipe contains a standing wave?

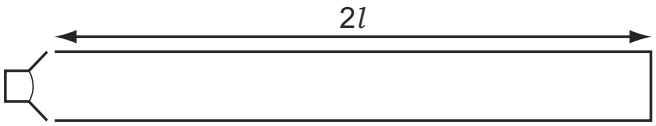
A



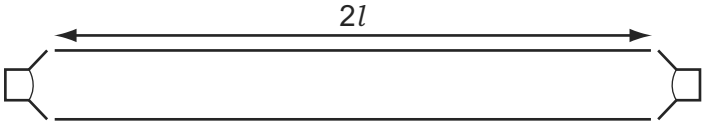
B



C



D



30 In a double-slit experiment the distance between the fringes, on a screen, was too small to measure.

9702/11/M/J/15

What would increase the distance between the fringes?

A increasing the distance between the light source and the slits

B increasing the distance between the slits and the screen

C increasing the distance between the slits

D increasing the frequency of the light source