1. 9702/12/F/M/16 Q23

Diffraction is a term used to describe one aspect of wave behaviour.

What does diffraction make possible?

A the ability to hear around corners

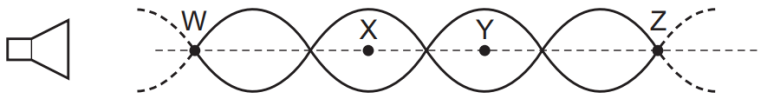
B the ability to hear high frequency and low frequency sound waves

C the ability to hear loud and quiet sounds

D the ability to hear sound through a brick wall

2. 9702/12/F/M/16 Q24

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).



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 air particles oscillate perpendicular to the line WZ.

3. 9702/12/F/M/16 Q25

A musical instrument called a bugle is a long tube with a mouthpiece at one end. The other end is open and flared, as shown.

A musician maintains stationary sound waves with a node at the mouthpiece and an antinode at the other end. The lowest frequency of sound that the bugle can produce is 92 Hz.

Which different frequencies of sound can be produced by the bugle?

A 92 Hz, 138 Hz, 184 Hz, 230 Hz, 276 Hz

B 92 Hz, 184 Hz, 276 Hz, 368 Hz, 460 Hz

C 92 Hz, 276 Hz, 460 Hz, 644 Hz, 828 Hz

D 92 Hz, 276 Hz, 828 Hz, 2484 Hz, 7452 Hz

4. 9702/12/F/M/16 Q26

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.

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

A 7.7° **B** 15.4° **C** 16.7° **D** 32.1°

5. 9702/11/M/J/16 Q25

Continuous water waves are diffracted through a gap in a barrier in a ripple tank.

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

6. 9702/11/M/J/16 Q26

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

What is the total number of intensity maxima observed?

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

7. 9702/11/M/J/16 Q27

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

At which distance from the slits would 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

8. 9702/12/M/J/16 Q25

A stationary wave is set up on a stretched string.

The diagram shows the string at two instants of time when it has maximum displacement.

The oscillations of point P on the string have amplitude *A*.

What is the distance moved by P from the position shown in the diagram after half a time period of the wave?

A 0 **B** *A* **C** 2*A* **D** 4*A*

9. 9702/12/M/J/16 Q26

Which statement is an example of the diffraction of light?

A the addition of the amplitudes of two beams of light which are in phase

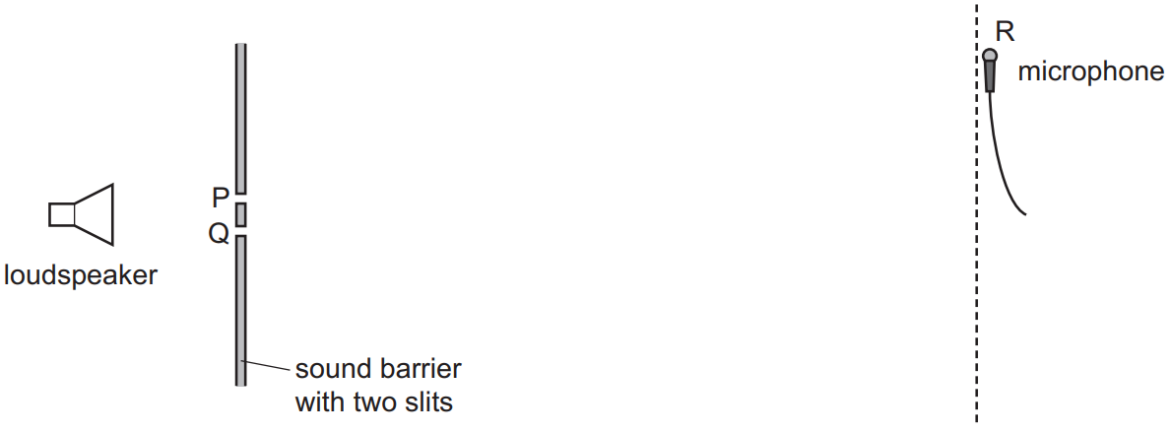
B the change in direction of a beam of light when passing from air into water

C the separation of a beam of white light into a spectrum of colours using a prism

D the spreading of a beam of light as it passes through a small hole

10. 9702/12/M/J/16 Q27

Sound waves of wavelength λ are emitted by a loudspeaker and pass through two slits P and Q. Two sound waves from the slits meet at R.



What is the condition for an intensity maximum (loud sound) to be detected by a microphone at R?

A The amplitudes of the two waves at R must be the same.

B The distance PQ must be smaller than the wavelength λ.

C The two waves from the slits must have travelled the same distance to R.

D The two waves must be in phase at R.

11. 9702/12/M/J/16 Q28

Coherent light passes through a double slit, producing bright and dark fringes on a screen placed parallel to the plane of the double slit. The intensity of the light from each of the slits is initially the same.

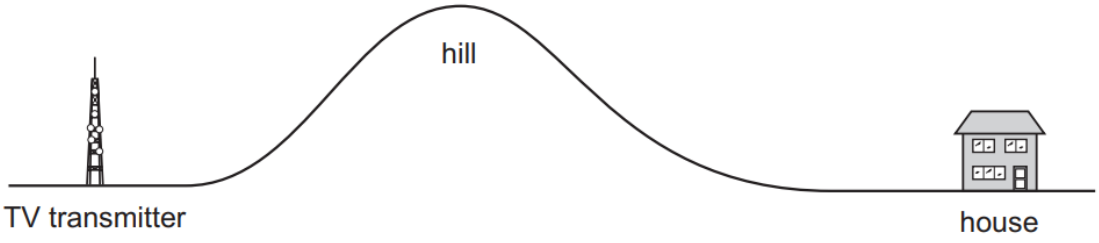
The intensity of the light passing through one of the slits in the double slit is now increased. The frequency of the light remains constant.

What is the effect on the appearance of the fringes on the screen?

	separation of fringes	maximum intensity of dark fringes
A	decreases	no change
B	increases	greater
C	no change	greater
D	no change	no change

12. 9702/13/M/J/16 Q26

A hill separates a television (TV) transmitter from a house. The transmitter cannot be seen from the house. However, the house has good TV reception.



By which wave effect at the hill could the TV signal reach the house?

A coherence

B diffraction

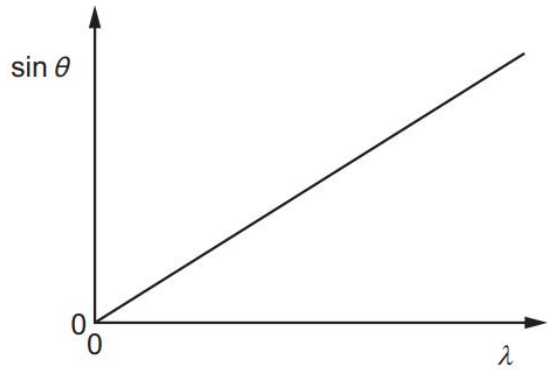
C interference

D reflection

13. 9702/13/M/J/16 Q27

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

The graph shows a relation between the deflection angle θ and λ for different wavelengths 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** $\frac{1}{Nn}$

14. 9702/13/M/J/16 Q28

Which wave phenomenon is **not** needed to explain the pattern of observable fringes produced by a double slit experiment?

A coherence

B diffraction

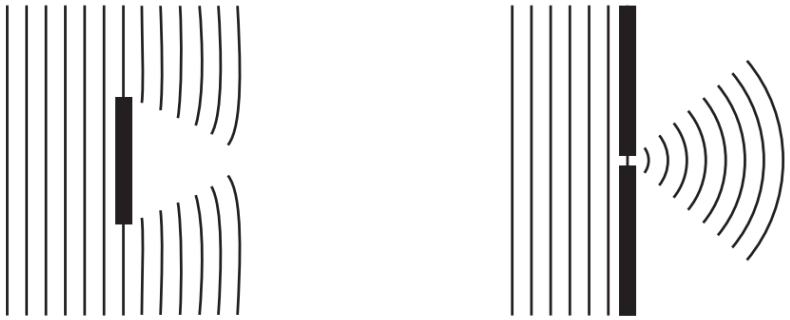
C interference

D reflection

15. 9702/11/O/N/16 Q27

Diagrams X and Y show the passage of water waves around an obstacle and through a gap.

The thick lines are barriers to the waves and each thin line represents a wavefront.



X Y

Which statement is correct?

A Diagrams X and Y both illustrate diffraction.

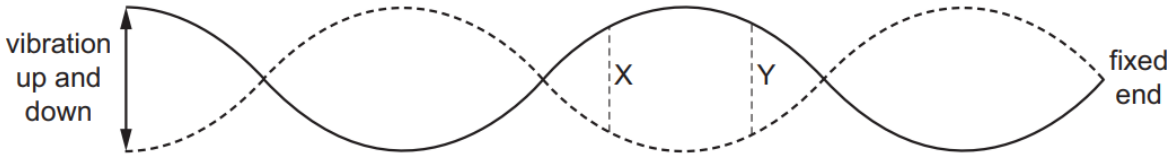
B Diagrams X and Y both illustrate interference.

C Only diagram X illustrates interference.

D Only diagram Y illustrates diffraction.

16. 9702/11/O/N/16 Q28

The diagram shows a long rope fixed at one end. The other end is moved up and down, setting up a stationary wave.



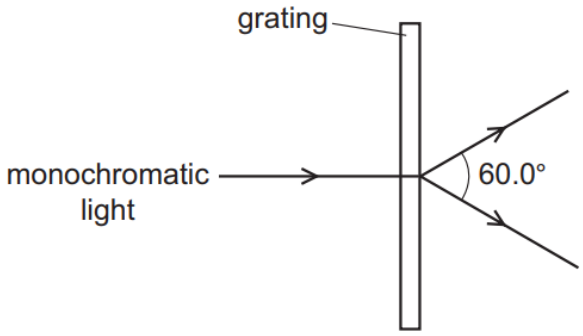
What is the phase difference between the oscillations at X and at Y?

A 0 **B** 45° **C** 90° **D** 135°

17. 9702/11/O/N/16 Q29

A diffraction grating is used to measure the wavelength of monochromatic light.

The spacing of the slits in the grating is 1.15×10^{-6} m. The angle between the first order diffraction maxima is 60.0°, as shown in the diagram.

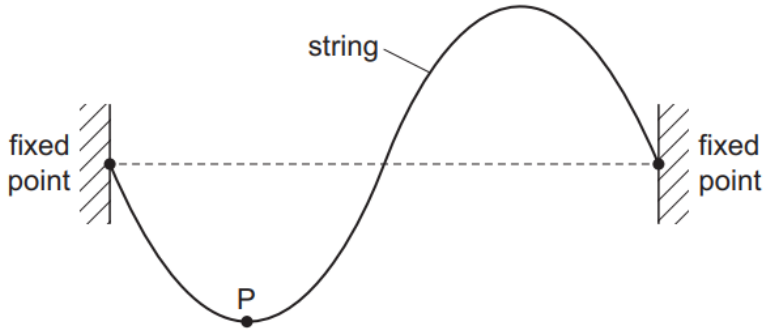


What is the wavelength of the light?

A 288 nm **B** 498 nm **C** 575 nm **D** 996 nm

18. 9702/12/O/N/16 Q26

A stationary wave is formed on a stretched string. The diagram illustrates the string at an instant of time when the displacement of the string is at its maximum.



The frequency of the wave is 250 Hz. Point P on the string has a vertical displacement of –1.0 mm.

What will be the vertical displacement of the point P after a time of 5 ms?

A –1.0 mm **B** zero **C** +0.5 mm **D** +1.0 mm

19. 9702/12/O/N/16 Q27

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.

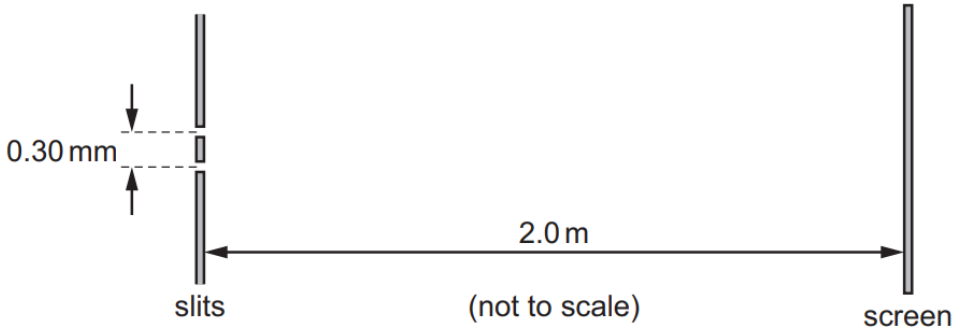
B The bright fringes and the dark fringes all become darker.

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

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

20. 9702/12/O/N/16 Q28

Monochromatic light of wavelength 450 nm passes through two parallel slits 0.30 mm apart. Bright fringes are observed on a screen 2.0 m away.

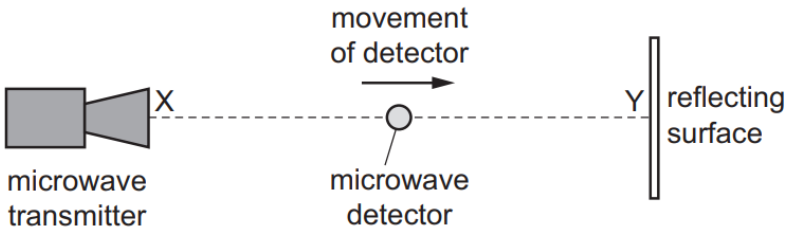


How far apart are the bright fringes on the screen?

A 1.3 mm **B** 1.5 mm **C** 3.0 mm **D** 6.0 mm

21. 9702/12/O/N/16 Q29

A microwave transmitter is placed at a fixed distance from a flat reflecting surface, as shown.



A microwave detector is moved steadily in a straight line from X to Y. A series of maxima and minima of intensity is obtained. The distance between adjacent maxima is 1.5 cm.

What is the frequency of the microwave radiation?

A 1.0×10^8 Hz

B 2.0×10^8 Hz

C 1.0×10^{10} Hz

D 2.0×10^{10} Hz

22. 9702/12/F/M/17 Q27

A progressive wave is incident normally on a flat reflector. The reflected wave overlaps with the incident wave and a stationary wave is formed.

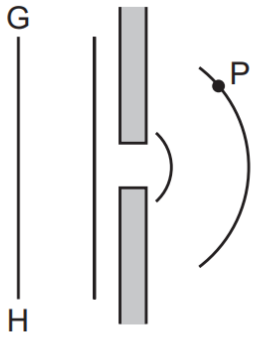
At an antinode, what could be the ratio $\frac{\text{displacement of the incident wave}}{\text{displacement of the reflected wave}}$ at any instant?

A –1 **B** 0 **C** 1 **D** 2

23. 9702/12/F/M/17 Q28

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

The diagram illustrates successive wavefronts.



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

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

24. 9702/12/F/M/17 Q29

In an experiment to demonstrate two-source interference of light, a beam of light is split into two beams using two slits 0.50 mm apart. These two beams are incident on a laboratory wall at a distance of 4.0 m.

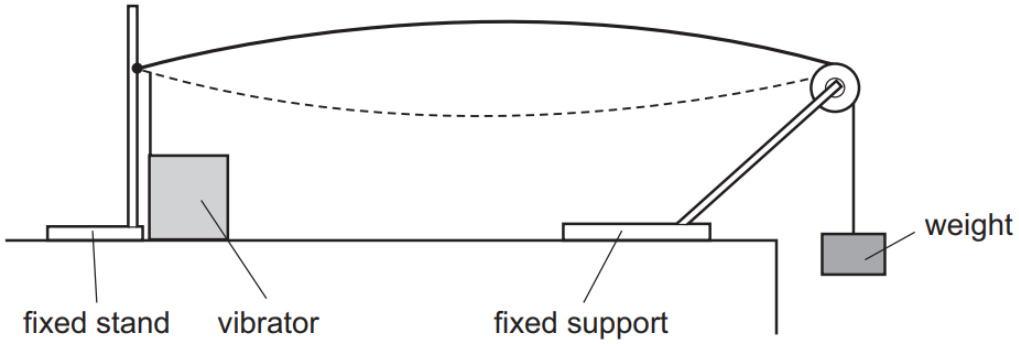
The wavelength of light is 550 nm.

How far apart are two adjacent interference fringes that are formed on the laboratory wall?

A 0.22 mm **B** 0.44 mm **C** 2.2 mm **D** 4.4 mm

25. 9702/11/M/J/17 Q27

The diagram shows a steel wire clamped at one end. The other end is attached to a weight hanging over a pulley.



A vibrator is attached to the wire near the clamped end. A stationary wave with one loop is produced. The frequency of the vibrator 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** $4f$

26. 9702/11/M/J/17 Q28

A parallel beam of light of wavelength 600 nm is incident normally on a diffraction grating. The grating has 300 lines per millimetre.

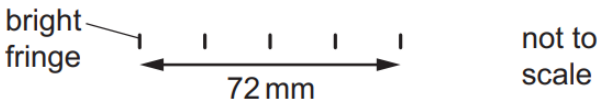
What is the total number of intensity maxima from the grating?

A 1 **B** 3 **C** 11 **D** 13

27. 9702/11/M/J/17 Q29

A pattern of interference fringes is produced using a red laser, a double slit and a screen. The screen is 3.5 m from the double slit. The light from the laser has a wavelength of 640 nm.

The pattern of fringes is shown.



What is the separation of the slits?

A 1.2×10^{-4} m **B** 1.6×10^{-4} m **C** 3.1×10^{-5} m **D** 3.3×10^{-9} m

28. 9702/12/M/J/17 Q27

Which row describes the oscillations of two moving particles in a stationary wave that are separated by a distance of half a wavelength?

	phase difference	amplitude
A	90°	different
B	90°	same
C	180°	different
D	180°	same

29. 9702/12/M/J/17 Q28

A parallel beam of red light of wavelength 700 nm is incident normally on a diffraction grating that has 400 lines per millimetre.

What is the total number of intensity maxima from the grating?

A 6 **B** 7 **C** 8 **D** 9

30. 9702/12/M/J/17 Q29

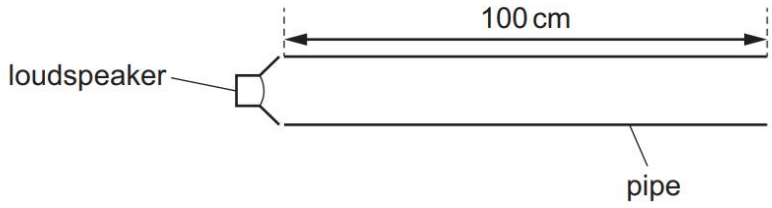
Two wave sources are oscillating in phase. Each source produces a wave of wavelength λ. The two waves from the sources meet at point X with a phase difference of 90°.

What is a possible difference in the distances from the two wave sources to point X?

A $\frac{\lambda}{8}$ **B** $\frac{\lambda}{4}$ **C** $\frac{\lambda}{2}$ **D** λ

31. 9702/13/M/J/17 Q26

A pipe of length 100 cm is open at both ends. A loudspeaker situated at one end of the pipe can emit sound of different wavelengths.



At which wavelength can a stationary wave be produced in the pipe?

A 50 cm **B** 75 cm **C** 150 cm **D** 300 cm

32. 9702/13/M/J/17 Q27

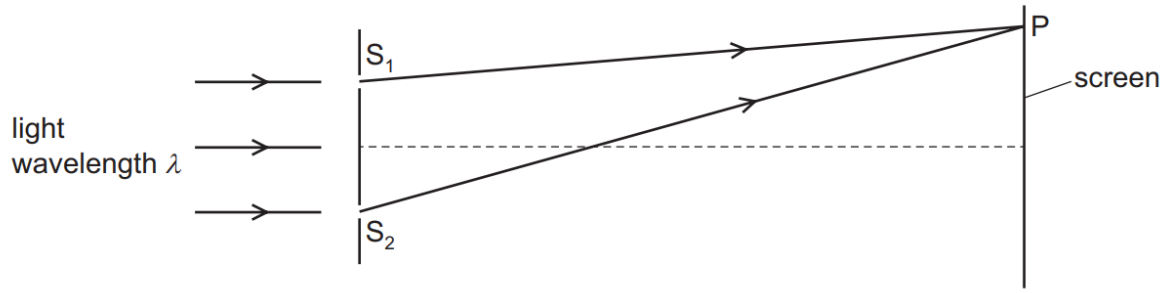
Monochromatic light is incident on a diffraction grating and a diffraction pattern is observed.

Which row shows possible effects of replacing the grating with one that has twice as many lines per millimetre?

	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

33. 9702/13/M/J/17 Q28

Monochromatic light of wavelength λ is incident on two narrow slits S_1 and S_2, a small distance apart. A series of 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 $S_2P - S_1P = \frac{n\lambda}{2}$

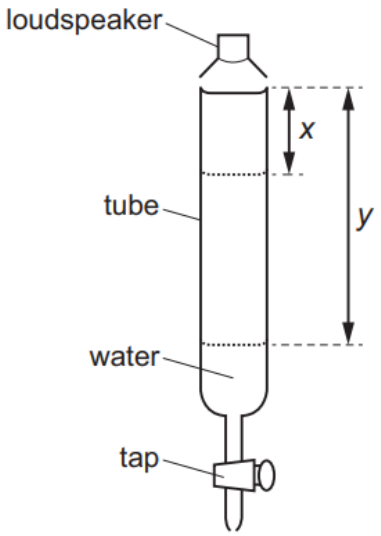
B $S_2P - S_1P = n\lambda$

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

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

34. 9702/11/O/N/17 Q23

A loudspeaker emits a sound wave into a tube initially full of water.



A tap at the bottom of the tube is opened so that water slowly leaves the tube. For some lengths of the air column in the tube, the sound heard is much louder.

The first loud sound is heard when the air column in the tube has length x.

The next time that a loud sound is heard is when the air column in the tube has length y.

What is the wavelength of the sound wave from the loudspeaker?

A $2x$ **B** $4y$ **C** $2(y - x)$ **D** $4(y - x)$

35. 9702/11/O/N/17 Q24

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.

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

A microwaves passing a steel post

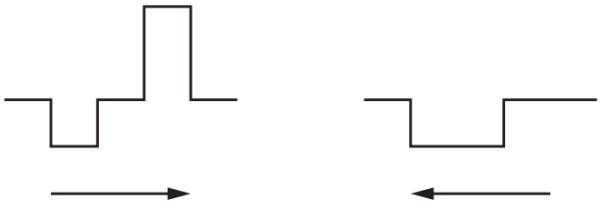
B radio waves passing a copper wire

C sound waves passing a human hair

D visible light waves passing a gate post

36. 9702/11/O/N/17 Q27

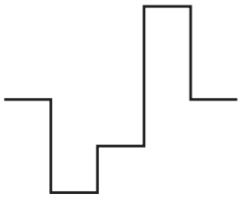
Two signals approach each other, as shown.



At one instant, the signals completely overlap.

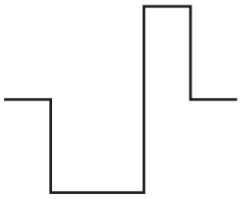
According to the principle of superposition, what is the shape of the resulting signal at this instant?

A

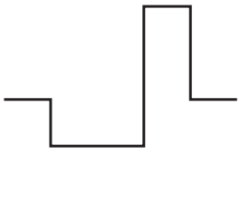


B

C

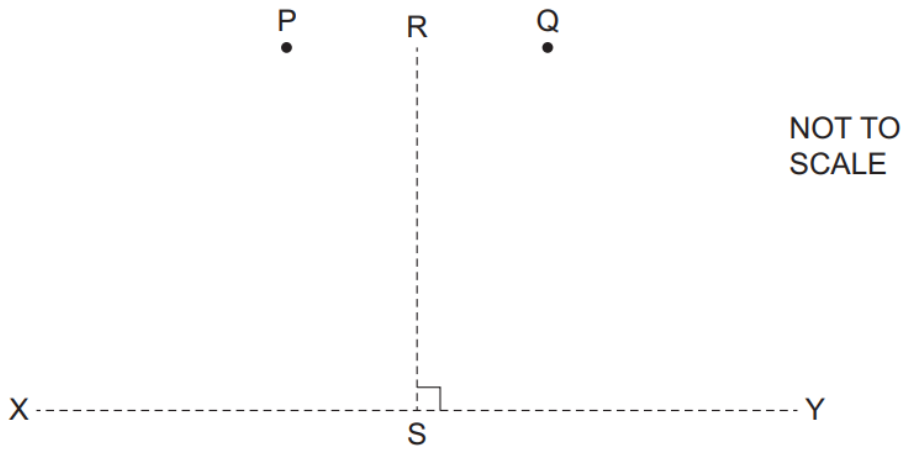


D



37. 9702/11/O/N/17 Q28

Coherent waves are produced at P and at Q and travel outwards in all directions. The line RS is half-way between P and Q and perpendicular to the line joining P and Q. The distance RS is much greater than the distance PQ.



Along which of the lines shown is an interference pattern observed?

A both RS and XY

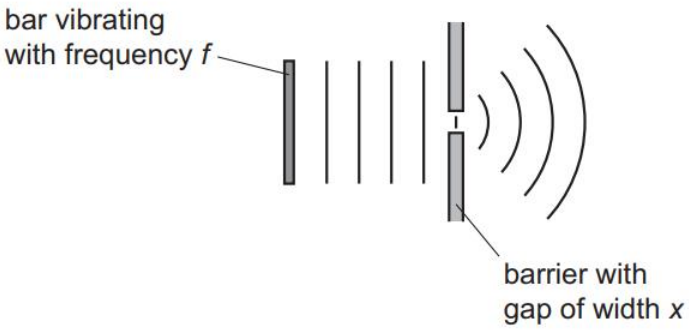
B RS only

C XY only

D neither RS nor XY

38. 9702/11/O/N/17 Q29

A bar vibrates with frequency f to produce water waves in a ripple tank.



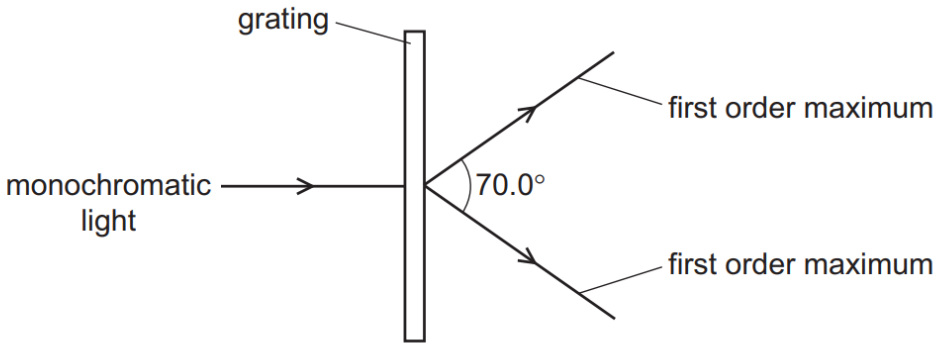
The waves pass through a gap of width x in a barrier so that diffraction occurs.

Which combination of vibration frequency and gap width will produce the smallest angle of diffraction?

	vibration frequency	gap width
A	$\frac{f}{2}$	$\frac{x}{2}$
B	$\frac{f}{2}$	$2x$
C	$2f$	$\frac{x}{2}$
D	$2f$	$2x$

39. 9702/11/O/N/17 Q30

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



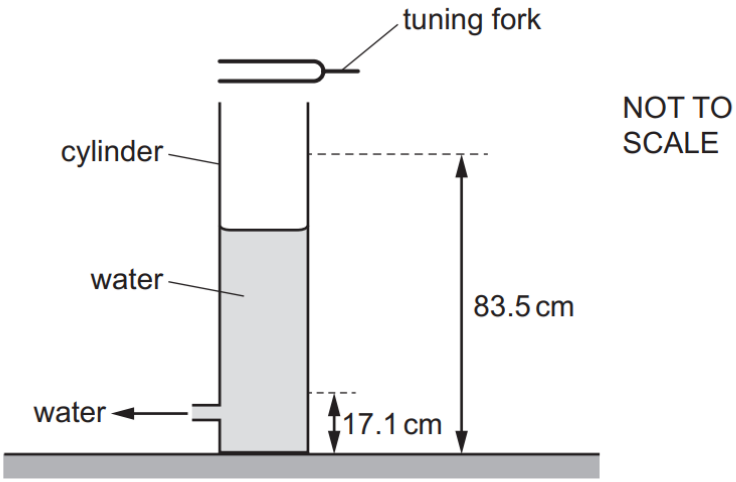
The spacing of the slits in the grating is 1.00×10^{-6} m. The angle between the first order diffraction maxima is 70.0°.

What is the wavelength of the light?

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

40. 9702/12/O/N/17 Q24

A vibrating tuning fork is held above a glass cylinder filled to the top with water. The water level is steadily lowered. A loud sound is first heard when the water level is 83.5 cm above the bench. The next loud sound is heard when the water level is 17.1 cm above the bench.



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

What is the frequency of the tuning fork?

A 128 Hz **B** 256 Hz **C** 384 Hz **D** 512 Hz

41. 9702/12/O/N/17 Q27

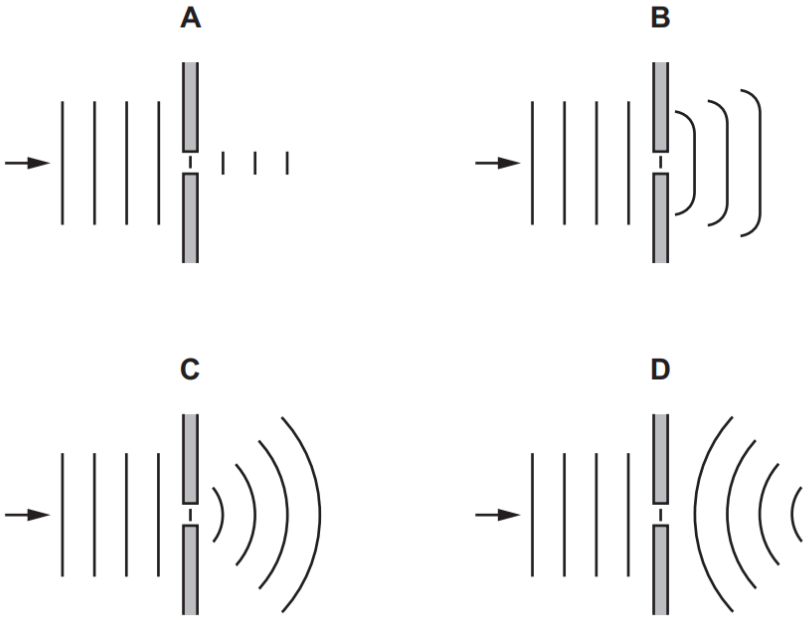
A stationary sound wave has a series of nodes. The distance between the first and the sixth node is 30.0 cm.

What is the wavelength of the sound wave?

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

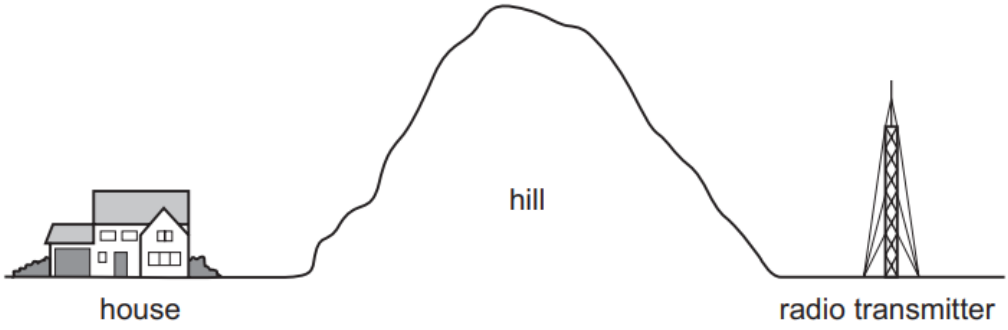
42. 9702/12/O/N/17 Q28

Which diagram shows the diffraction of water waves in a ripple tank?



43. 9702/12/O/N/17 Q29

A hill stands between a radio transmitter and a house, as shown.



The radio transmitter cannot be seen from the house, but radio waves from the transmitter are received at the house.

Why is this?

A The wavelength of light is longer than the wavelength of radio waves so there is more diffraction of light over the hill.

B The wavelength of light is shorter than the wavelength of radio waves so there is more diffraction of light over the hill.

C The wavelength of radio waves is longer than the wavelength of light so there is more diffraction of radio waves over the hill.

D The wavelength of radio waves is shorter than the wavelength of light so there is more diffraction of radio waves over the hill.

44. 9702/12/O/N/17 Q30

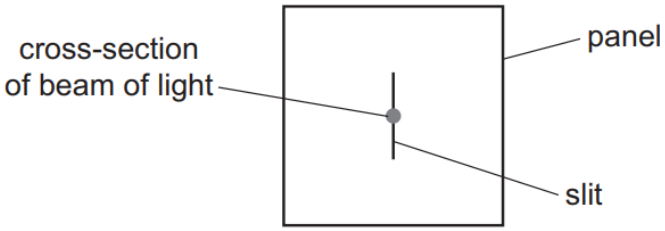
In an experiment to demonstrate double-slit interference using light, the distance from the slits to the screen is doubled and the slit separation is halved. The wavelength of the light is kept constant.

By which factor does the separation of adjacent bright fringes change?

A $\frac{1}{4}$ **B** $\frac{1}{2}$ **C** 2 **D** 4

45. 9702/13/O/N/17 Q29

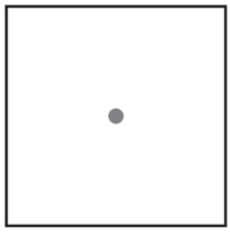
A beam of laser light is directed towards a narrow slit.



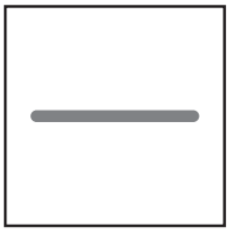
After emerging from the other side of the slit, the light then falls on a screen.

What is the pattern of light seen on the screen?

A

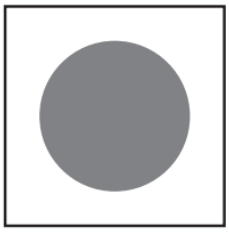


B



C

D

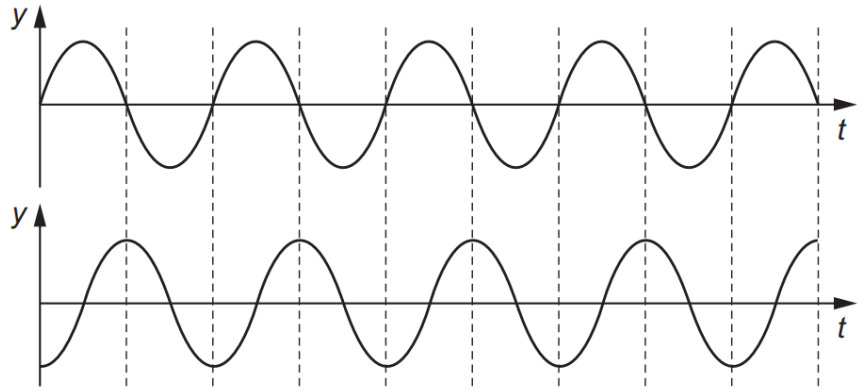


46. 9702/13/O/N/17 Q30

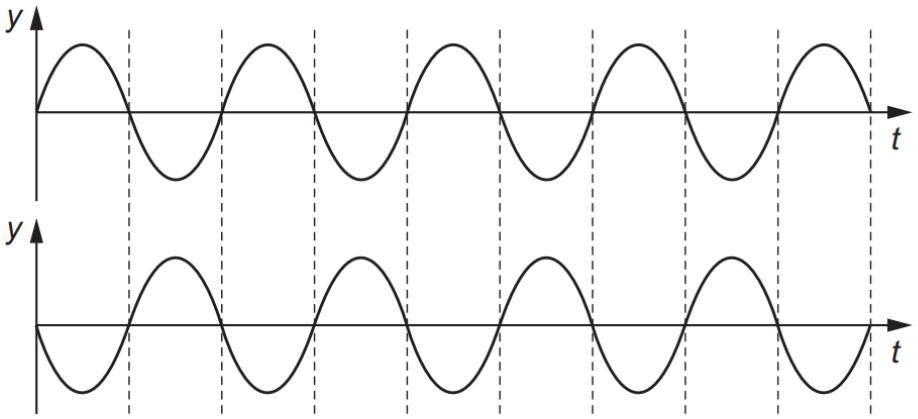
The diagrams show four pairs of waves. In each case the displacement *y* measured at a fixed point is plotted against time *t*.

Which pair of waves is **not** coherent?

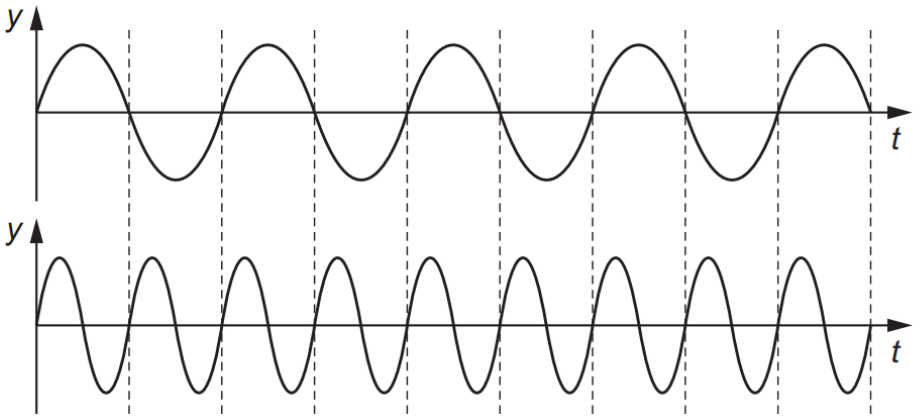
A



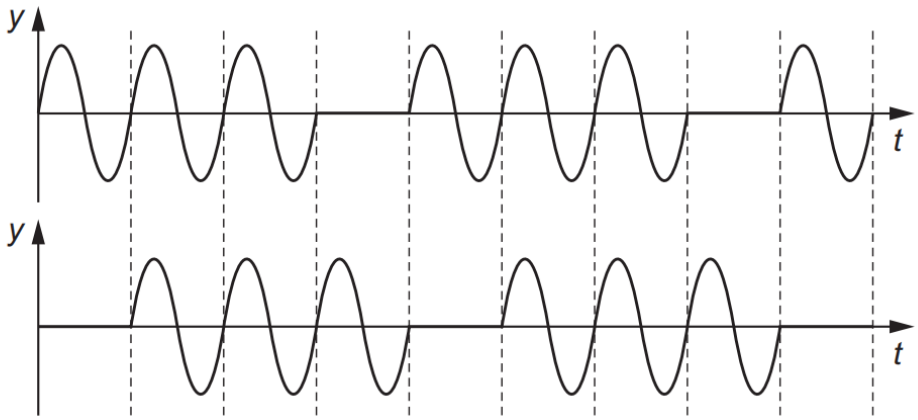
B



C



D



47. 9702/12/F/M/18 Q26

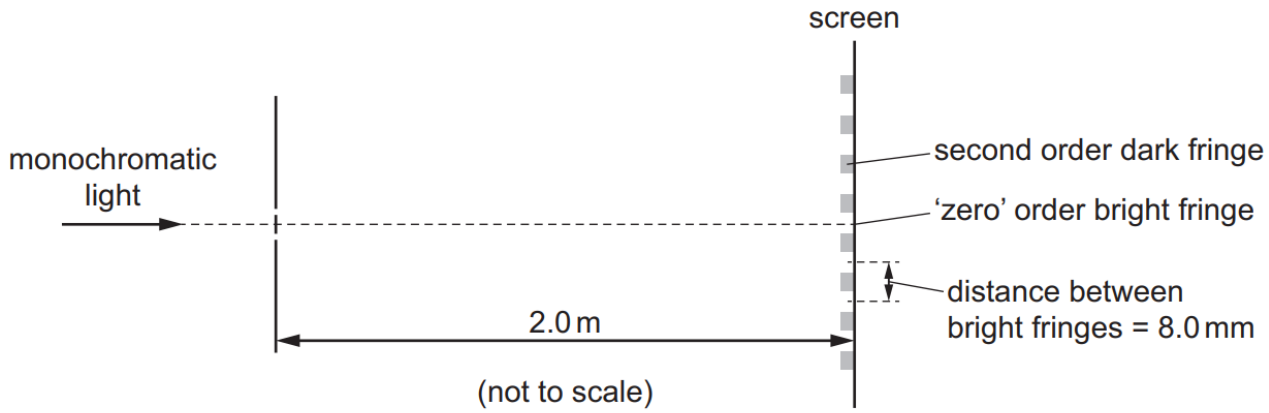
In a double-slit interference experiment, light of frequency 6.0×10^{14} Hz is incident on a pair of slits. Bright fringes that are 3.0 mm apart are observed on a screen some distance away.

What is the separation of the bright fringes when the frequency of the light is changed to 5.0×10^{14} Hz?

A 1.8 mm **B** 2.5 mm **C** 3.0 mm **D** 3.6 mm

48. 9702/12/F/M/18 Q27

Monochromatic light is incident on a pair of narrow slits a distance of 0.1 mm apart. A series of bright and dark fringes are 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 between 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

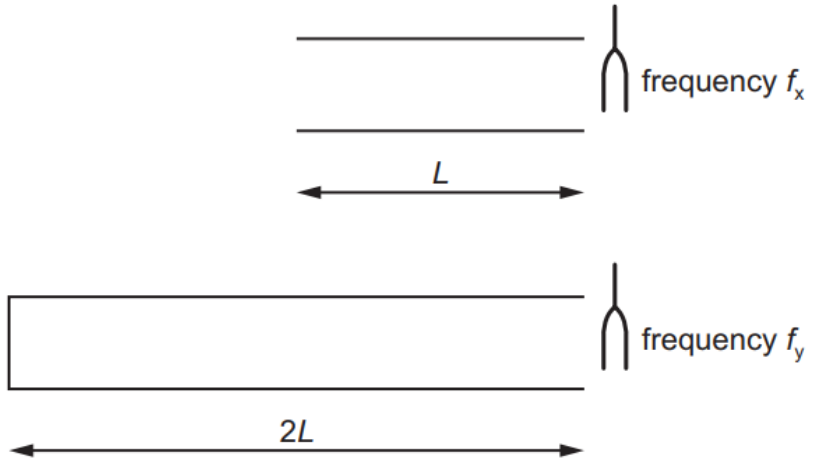
C 6.0×10^{-7} m

D 8.0×10^{-7} m

49. 9702/12/F/M/18 Q28

A tube of length L is open at both ends. A stationary wave is set up in this tube when a tuning fork vibrating with frequency f_x is held at one end. This is the lowest frequency of stationary wave that can be formed in this tube.

Another tube of length $2L$ is closed at one end. A stationary wave is set up in this tube when a tuning fork vibrating with frequency f_y is held at the open end. This is the lowest frequency of stationary wave that can be formed in this tube.



Assume the end correction for each tube is negligible.

Which equation is correct?

A $f_x = \frac{f_y}{4}$ **B** $f_x = \frac{f_y}{2}$ **C** $f_x = 2f_y$ **D** $f_x = 4f_y$

50. 9702/12/F/M/18 Q29

Which statement gives a condition that enables diffraction to occur?

A A source of waves moves towards a stationary observer.

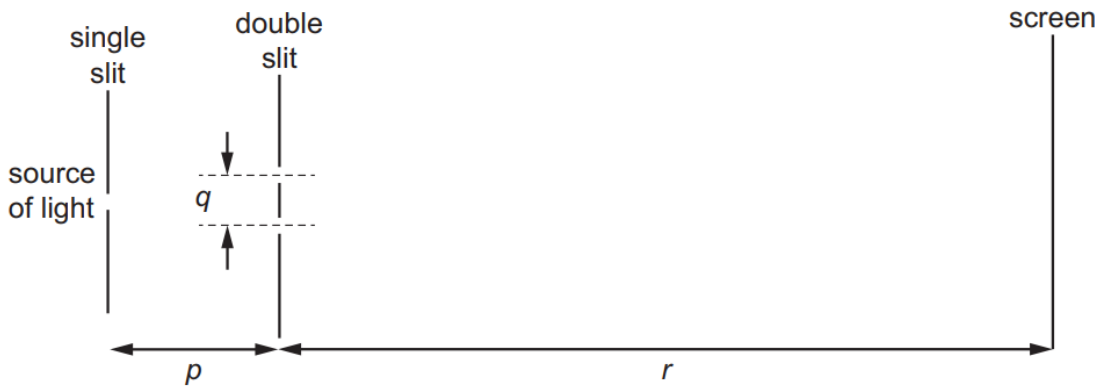
B A wave is partially blocked by an obstacle.

C Two coherent waves are superposed.

D Two waves of equal speed and frequency are travelling through the same part of a medium in opposite directions.

51. 9702/11/M/J/18 Q25

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



Which change to the apparatus will increase the fringe spacing?

A decreasing the distance p

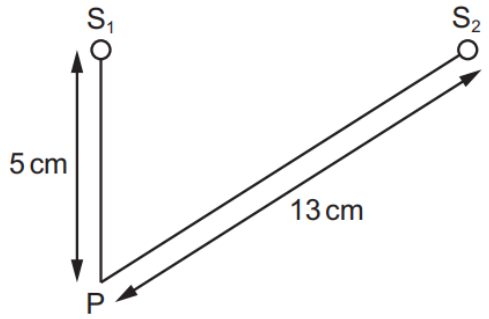
B decreasing the distance q

C decreasing the distance r

D decreasing the wavelength of the light

52. 9702/11/M/J/18 Q26

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



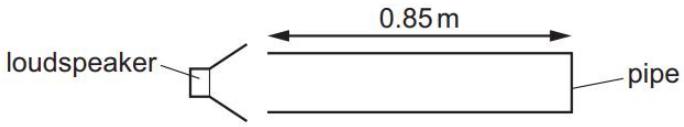
The sources each generate a wave of wavelength 2.0 cm. Each source produces a wave that has amplitude x_0 when it reaches point P.

What is the amplitude of the oscillation at P?

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

53. 9702/11/M/J/18 Q27

A pipe, closed at one end, has a loudspeaker at the open end. A stationary sound wave is formed in the air within the pipe with an antinode at the open end of the pipe.



The length of the pipe is 0.85 m.

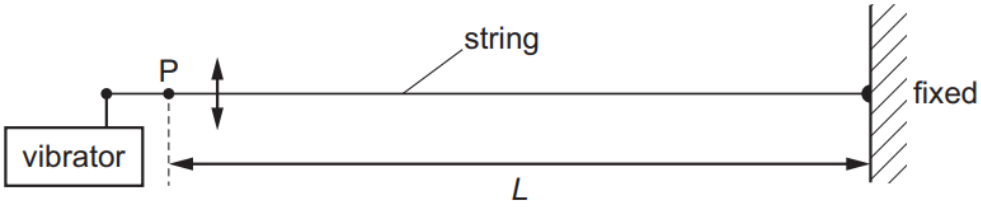
The speed of sound in air is 340 $m\,s^{-1}$.

Which frequency of sound from the loudspeaker would **not** produce a stationary wave?

A 100 Hz **B** 200 Hz **C** 300 Hz **D** 500 Hz

54. 9702/12/M/J/18 Q24

A string is fixed at one end and the other end is attached to a vibrator. The frequency of the vibrator is slowly increased from zero. A series of stationary waves is formed. Assume that for a stationary wave there is a node at point P.



What are the first five wavelengths of the stationary waves that could be formed?

A $2\frac{L}{1}, 2\frac{L}{2}, 2\frac{L}{3}, 2\frac{L}{4}, 2\frac{L}{5}$

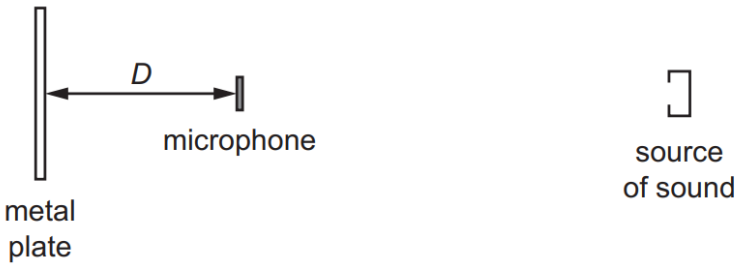
B $2\frac{L}{2}, 2\frac{L}{3}, 2\frac{L}{4}, 2\frac{L}{5}, 2\frac{L}{6}$

C $4\frac{L}{1}, 4\frac{L}{2}, 4\frac{L}{3}, 4\frac{L}{4}, 4\frac{L}{5}$

D $4\frac{L}{1}, 4\frac{L}{3}, 4\frac{L}{5}, 4\frac{L}{7}, 4\frac{L}{9}$

55. 9702/12/M/J/18 Q26

The diagram shows apparatus for the measurement of the frequency of a sound wave.



Sound of the unknown frequency is reflected back from a metal plate. A microphone placed at a distance D from the metal plate detects the sound intensity. A minimum intensity is detected with D = 12.0 cm. The plate is moved further away from the microphone until the next minimum is detected with D = 15.0 cm.

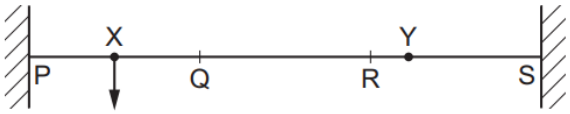
The speed of sound in air is 336 m s^{-1}.

What is the frequency of the sound?

A 56 Hz **B** 112 Hz **C** 5600 Hz **D** 11 200 Hz

56. 9702/12/M/J/18 Q28

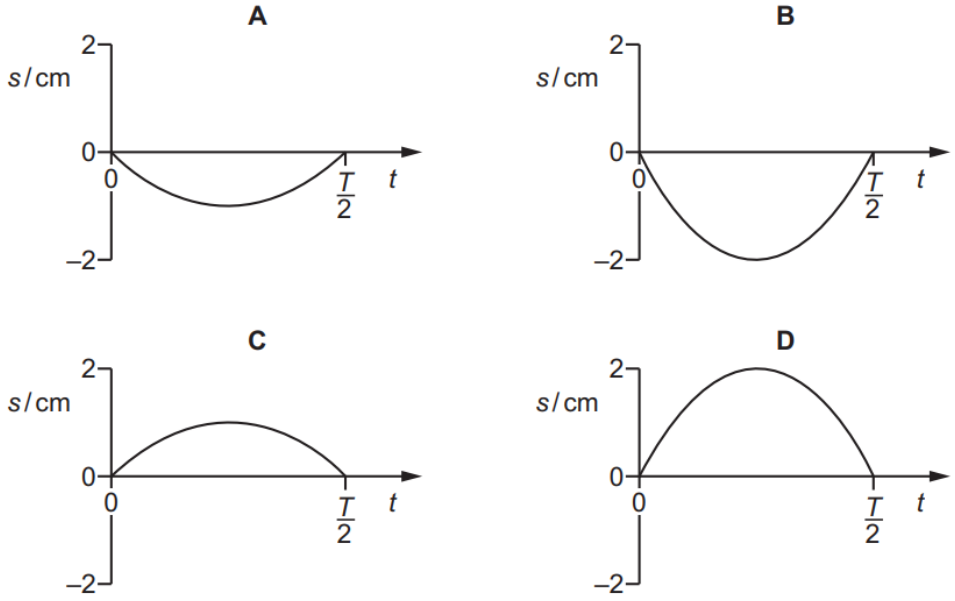
The diagram shows a stationary wave, at time t = 0, that has been set up on a string fixed between points P and S.



The nodes of the stationary wave occur on the string at P, Q, R and S. Point X is moving down at time t = 0. The points on the string vibrate with time period T and maximum amplitude 2 cm.

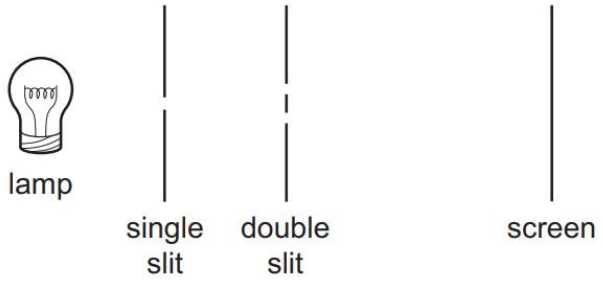
The displacement s is positive in the upward direction.

Which graph best shows the variation with t of the displacement s of point Y on the string?



57. 9702/12/M/J/18 Q29

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

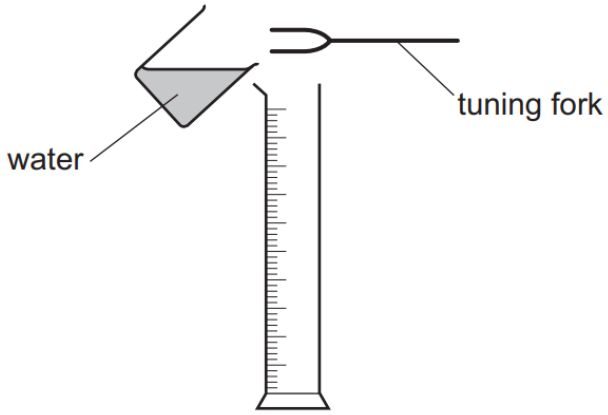
B to make the same amplitude of light incident on each slit

C to provide coherent light

D to provide monochromatic light

58. 9702/13/M/J/18 Q24

A vibrating tuning fork is held over a measuring cylinder, as shown.



Water is then gradually poured into the measuring cylinder. A much louder sound is first heard when the water level is 2.9 cm above the base of the measuring cylinder. A second much louder sound is heard when the water level reaches a height of 67.3 cm above the base.

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

What is the frequency of the tuning fork?

A 128 Hz **B** 256 Hz **C** 512 Hz **D** 1024 Hz

59. 9702/13/M/J/18 Q25

A water wave in a ripple tank is diffracted as it passes through a gap in a barrier.

Which two factors affect the angle of diffraction of the wave?

A the amplitude and frequency of the incident wave

B the amplitude of the incident wave and the width of the gap

C the wavelength and amplitude of the incident wave

D the wavelength of the incident wave and the width of the gap

60. 9702/13/M/J/18 Q26

A double-slit interference pattern using red light of wavelength 7.0×10^{-7} m has a fringe spacing of 3.5 mm.

Which fringe spacing would be observed for the same arrangement of apparatus but using blue light of wavelength 4.5×10^{-7} m?

A 2.3 mm **B** 3.5 mm **C** 5.4 mm **D** 9.0 mm

61. 9702/11/O/N/18 Q26

What may be used to produce stationary waves?

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

62. 9702/11/O/N/18 Q27

What is an example of the diffraction of a wave?

A laser light travelling along an optic fibre

B light waves forming images on a cinema screen

C microwaves passing the edge of a metal plate

D sound waves diverging as they pass through air

63. 9702/11/O/N/18 Q28

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.

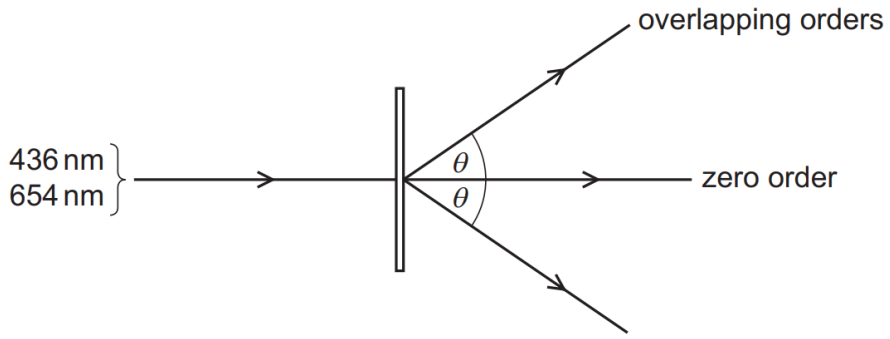
B The lamps emit light of different amplitudes.

C The light from the lamps is not coherent.

D The light from the lamps is white.

64. 9702/11/O/N/18 Q29

A beam of light consists of two wavelengths of 436 nm and 654 nm. A diffraction grating of 5.00×10^5 lines m^{-1} produces a diffraction pattern in which the second order of one of these wavelengths occurs at the same angle θ as the third order of the other wavelength.

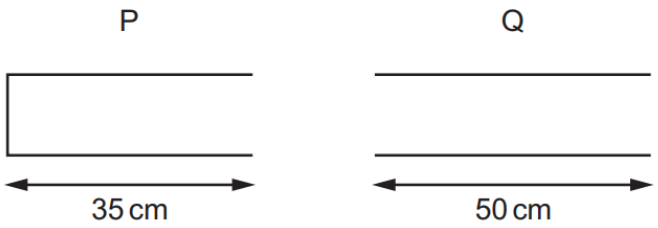


What is the angle θ?

A 19.1° **B** 25.8° **C** 40.8° **D** 78.8°

65. 9702/12/O/N/18 Q27

Progressive sound waves of wavelength 20 cm enter 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

66. 9702/12/O/N/18 Q28

What happens when waves pass through a gap equal to their wavelength?

A There is diffraction and the wavelength decreases.

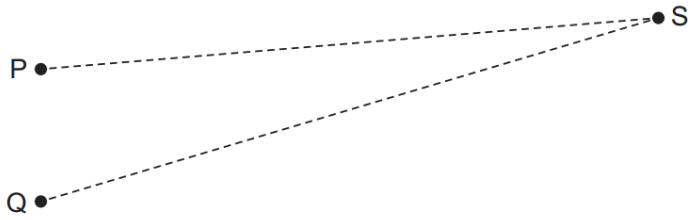
B There is diffraction and the wavelength stays the same.

C There is no diffraction and the wavelength decreases.

D There is no diffraction and the wavelength stays the same.

67. 9702/12/O/N/18 Q29

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.

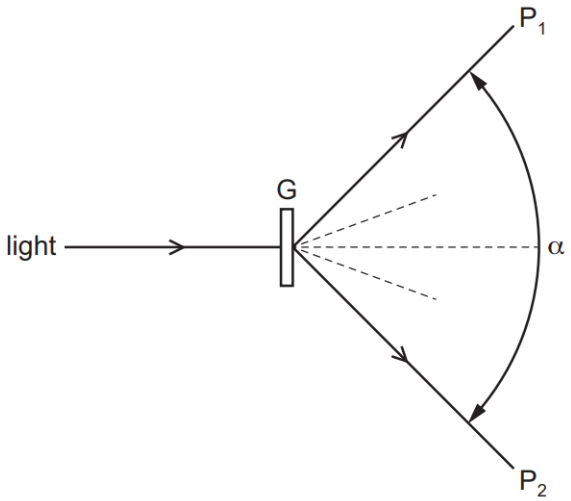
In the expressions shown, *n* is an integer.

Which expression represents the path difference?

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

68. 9702/12/O/N/18 Q30

A parallel beam of monochromatic light of wavelength λ is incident normally on a diffraction grating G. The angle between the directions of the two second-order diffracted beams at P_1 and at P_2 is α, as shown.

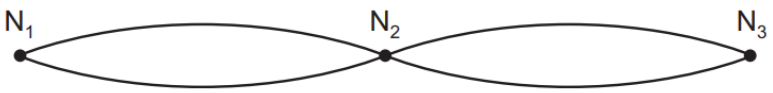


What is the spacing of the lines on the grating?

A $\frac{2\lambda}{\sin\alpha}$ **B** $\frac{\lambda}{\sin\alpha}$ **C** $\frac{2\lambda}{\sin(\alpha/2)}$ **D** $\frac{\lambda}{\sin(\alpha/2)}$

69. 9702/13/O/N/18 Q26

The diagram shows a stationary wave on a string. The stationary 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.

70. 9702/13/O/N/18 Q27

In which situation does diffraction occur?

A A wave bounces back from a surface.

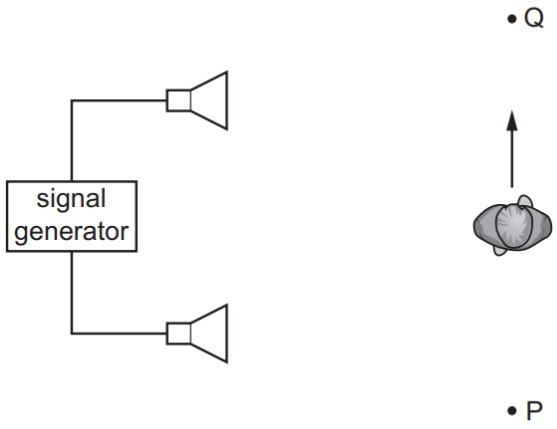
B A wave passes from one medium into another.

C A wave passes through an aperture.

D Waves from two identical sources are superposed.

71. 9702/13/O/N/18 Q28

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

72. 9702/13/O/N/18 Q29

A parallel beam of white light is incident normally on a diffraction grating. The second-order and third-order spectra partially overlap.

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

73. 9702/12/F/M/19 Q24

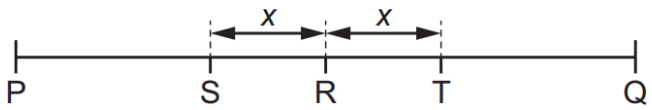
A straight tube is closed at one end and has a loudspeaker positioned at the open end. The frequency of the loudspeaker is initially very low and is increased slowly. A series of loudness maxima are heard. The stationary wave which gives the first maximum has a node at the closed end and an antinode at the open end. The frequency of the loudspeaker is f_1 when the first maximum is heard.

What is the frequency of the loudspeaker when the fourth maximum is heard?

A $\frac{7f_1}{4}$ **B** $2f_1$ **C** $4f_1$ **D** $7f_1$

74. 9702/12/F/M/19 Q27

P and Q are fixed points at the end of a string. A transverse stationary wave of constant maximum amplitude is formed on the string.



P, R and Q are the only points on the string where nodes are formed. S and T are two points on the string at a distance *x* from R.

What is the relationship between points S and T?

A the same amplitude and in phase

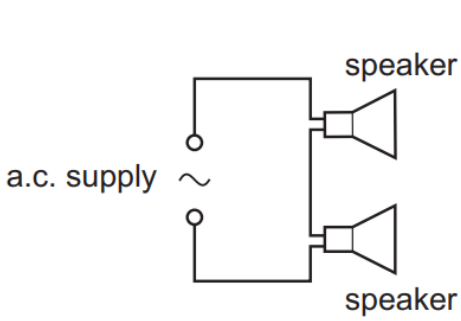
B different amplitudes and in phase

C the same amplitude and a phase difference of 180°

D different amplitudes and a phase difference of 180°

75. 9702/12/F/M/19 Q28

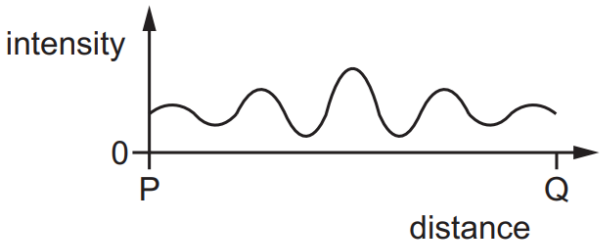
Two identical loudspeakers are connected in series to an a.c. supply, as shown.



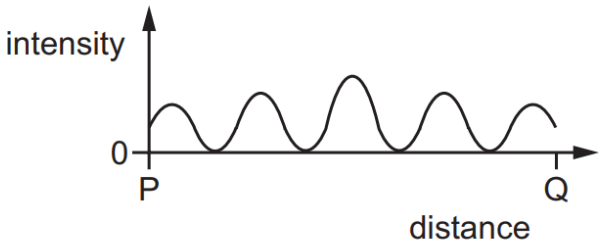
A microphone is moved along the line PQ.

Which graph best shows the variation with distance from P of the intensity of the sound detected by the microphone?

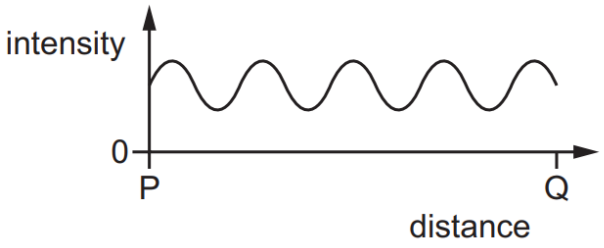
A



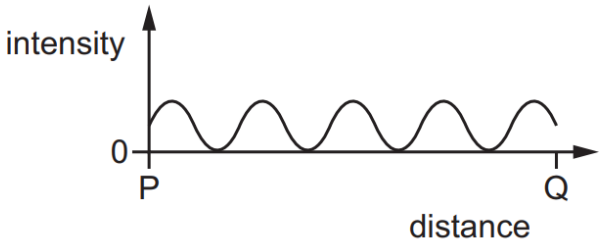
B



C

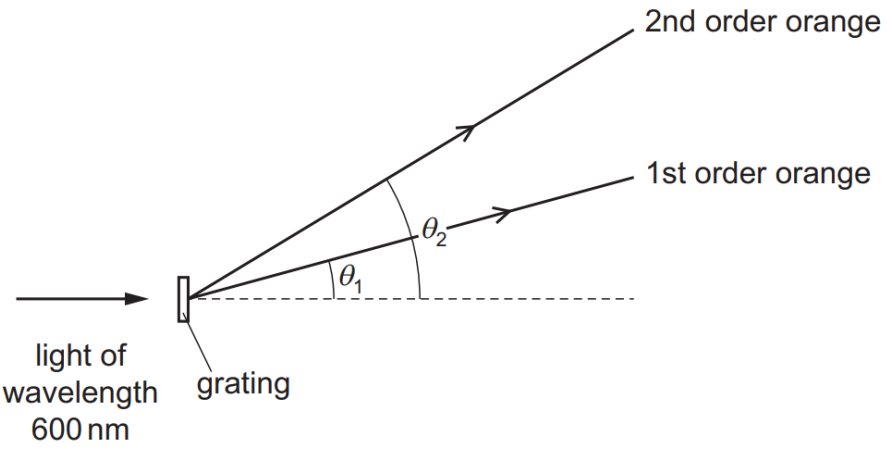


D



76. 9702/12/F/M/19 Q29

A diffraction grating experiment is set up using orange light of wavelength 600 nm. The grating has a slit separation of 2.00 μm.



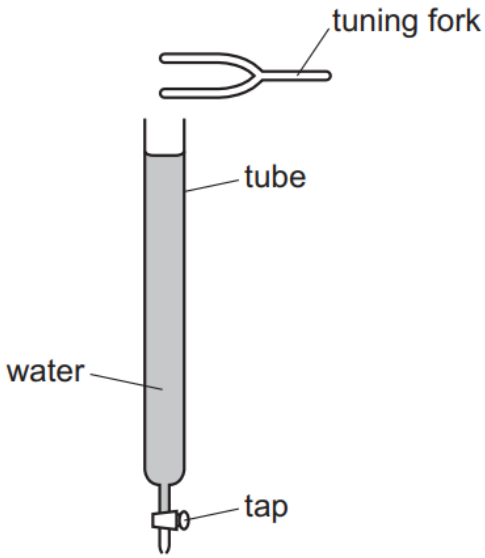
What is the angular separation ($\theta_2 - \theta_1$) between the first and second order maxima of the orange light?

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

77. 9702/11/M/J/19 Q24

A long tube, filled with water, has a tap fitted at its base, as shown.

A tuning fork is sounded above the tube and the water is allowed to run gradually out of the tube.



A louder sound is heard at intervals as the water runs out of the tube. The change in water level between louder sounds is 32 cm.

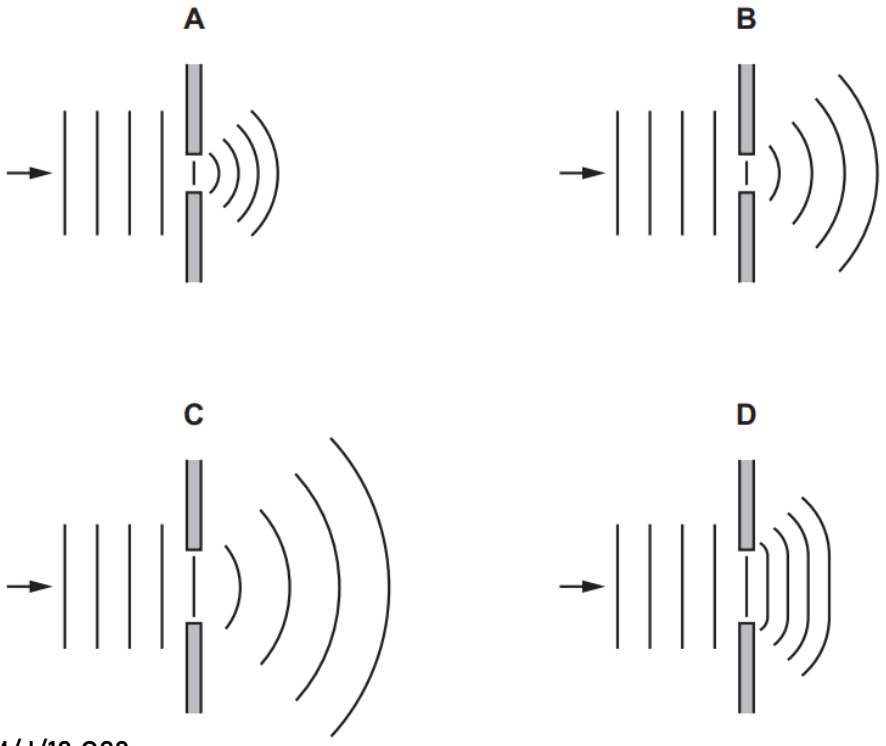
What is the wavelength of the sound in the tube?

A 16 cm **B** 32 cm **C** 64 cm **D** 128 cm

78. 9702/11/M/J/19 Q28

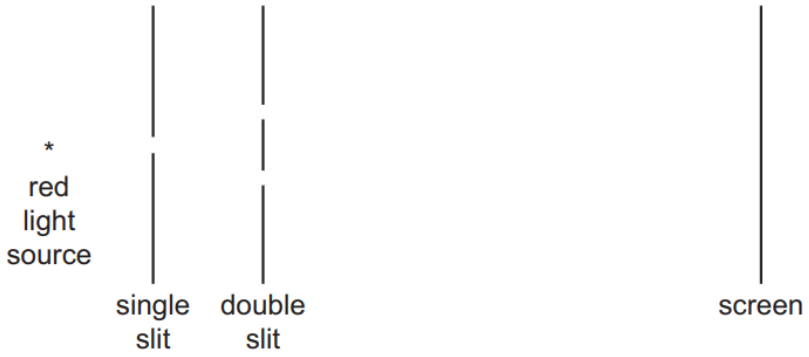
The diagrams show the diffraction of water waves in a ripple tank as they pass through a gap between two barriers.

Which diagram is correct?



79. 9702/11/M/J/19 Q29

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

80. 9702/11/M/J/19 Q30

The interference patterns from a diffraction grating and a double slit are compared.

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

81. 9702/12/M/J/19 Q25

In an experiment to determine the wavelength of sound in air, a stationary wave is set up in an air column.

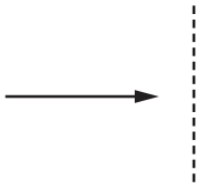
The distance between a node and an adjacent antinode is L.

What is the wavelength of the sound?

A $\frac{1}{2}L$ **B** L **C** $2L$ **D** $4L$

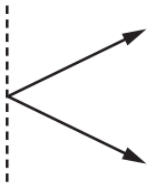
82. 9702/12/M/J/19 Q29

Monochromatic light is directed at a diffraction grating, as shown.

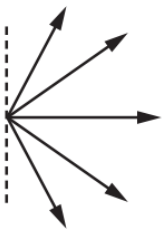


Which diagram could show all the possible directions of the light, after passing through the grating, that give maximum intensity?

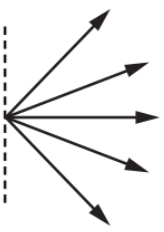
A



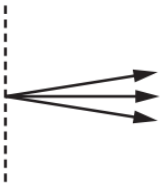
B



C



D



83. 9702/12/M/J/19 Q30

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.

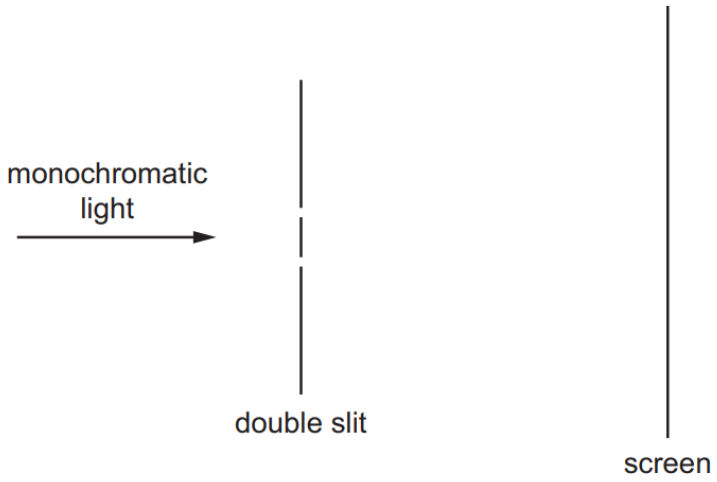
B The light from the two lamps can never be coherent.

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.

84. 9702/12/M/J/19 Q31

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.

85. 9702/13/M/J/19 Q26

An elastic string is attached to an oscillator at one end and clamped at the other end so that the string is horizontal and in tension.

The oscillator is made to oscillate vertically. The frequency of oscillation is gradually increased from zero until a stationary wave is set up in the string. The frequency is then increased further to frequency *f*, when a second stationary wave is set up in the string.

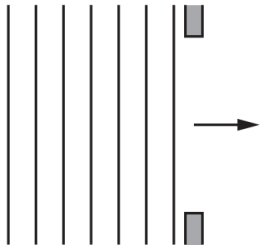
The frequency is then increased further.

At which frequency does a third stationary wave occur?

A 1.2*f* **B** 1.5*f* **C** 2.0*f* **D** 3.0*f*

86. 9702/13/M/J/19 Q27

In an experiment, water waves in a ripple tank are incident on a gap, as shown.



Some diffraction of the water waves is observed.

Which change to the experiment would provide a better demonstration of diffraction?

A Increase the amplitude of the waves.

B Increase the frequency of the waves.

C Increase the wavelength of the waves.

D Increase the width of the gap.

87. 9702/13/M/J/19 Q28

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

(not to scale)

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 $\frac{1}{2}\lambda$.

88. 9702/13/M/J/19 Q29

Apparatus is arranged to show double-slit interference using monochromatic light. The slit separation is 0.10 mm. The distance from the double slit to the screen where the interference pattern is observed is 2.4 m and the fringe width is 12 mm.

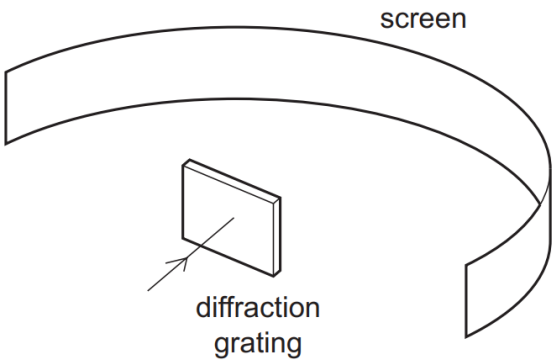
The distance to the screen is now changed to 1.8 m and the slit separation is doubled.

What is the new fringe width?

A 1.5 mm **B** 4.5 mm **C** 6.0 mm **D** 9.0 mm

89. 9702/13/M/J/19 Q30

Monochromatic light of wavelength 690 nm passes through a diffraction grating with 300 lines per mm, producing a series of maxima (bright spots) on a screen.

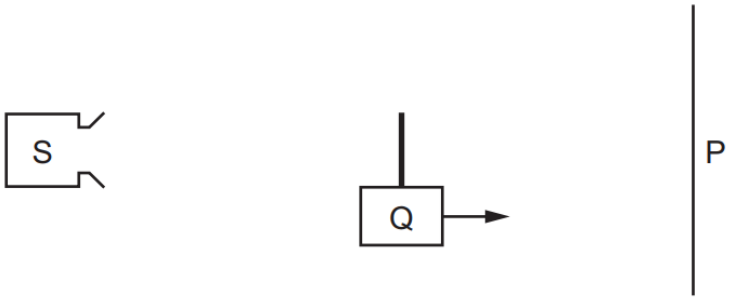


What is the greatest number of maxima that can be observed?

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

90. 9702/11/O/N/19 Q23

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.



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

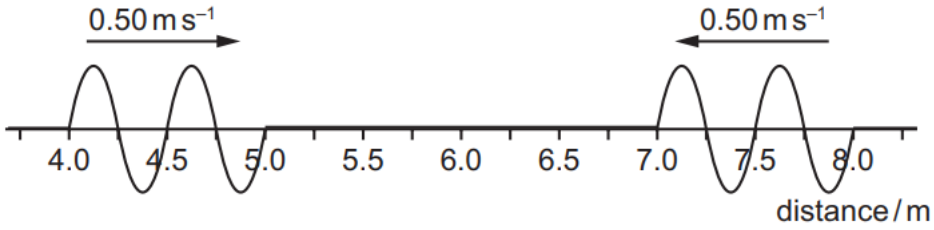
B increases and decreases regularly

C increases steadily

D remains constant

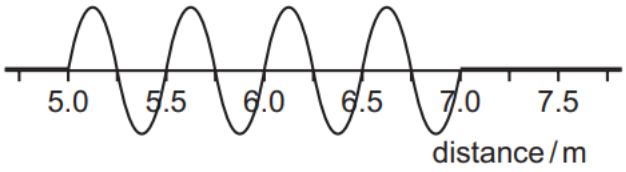
91. 9702/11/O/N/19 Q26

Two wave pulses are travelling towards each other on a long rope. The pulses have the same amplitude and wavelength and are travelling at a speed of $0.50\,m\,s^{-1}$. The diagram shows the rope at time $t = 0$.

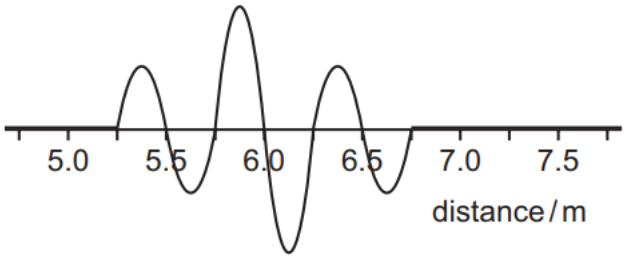


Which diagram shows the rope at time $t = 3.0\,s$?

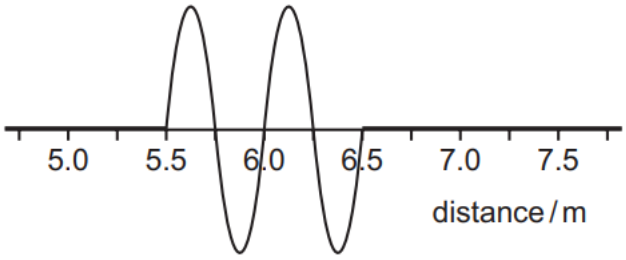
A



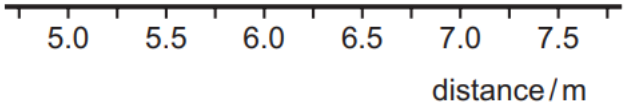
B



C

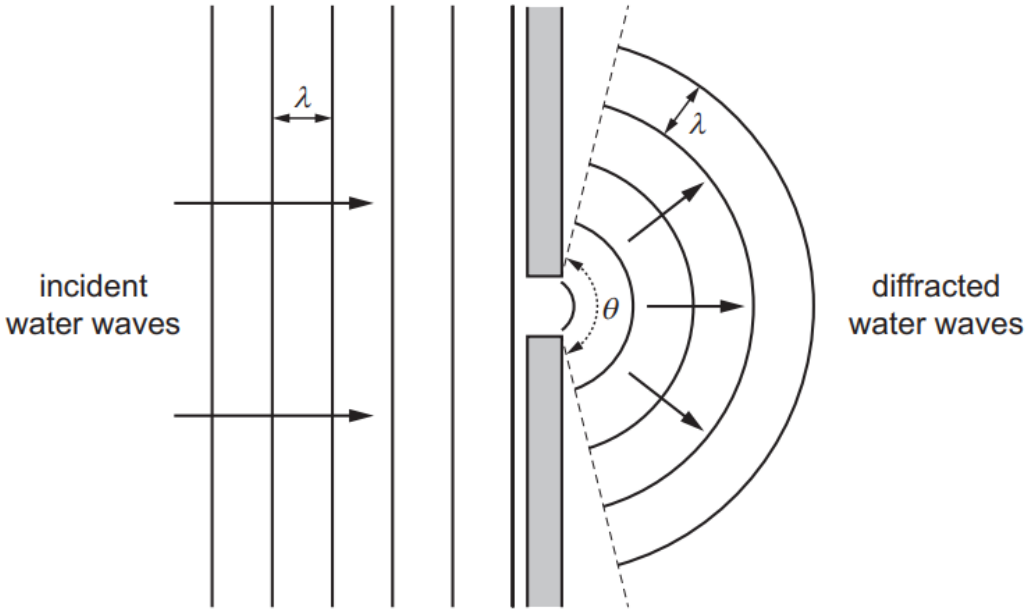


D



92. 9702/11/O/N/19 Q27

Water waves of wavelength λ are incident normally on an obstacle with a narrow gap. The width of the gap is equal to λ. The waves from the gap emerge over an angle θ as shown.



The gap is slowly widened.

Which changes, if any, occur to θ and to the wavelength of the emerging waves?

	θ	wavelength
A	decreases	remains the same
B	increases	remains the same
C	remains the same	decreases
D	remains the same	increases

93. 9702/11/O/N/19 Q28

Light of wavelength 720 nm from a laser X is incident normally on a diffraction grating and a diffraction pattern is observed. Light from a laser Y is then also incident normally on the same grating. The third-order maximum due to laser Y is seen at the same place as the second-order maximum due to laser X.

What is the wavelength of the light from laser Y?

A 480 nm **B** 540 nm **C** 720 nm **D** 1080 nm

94. 9702/11/O/N/19 Q29

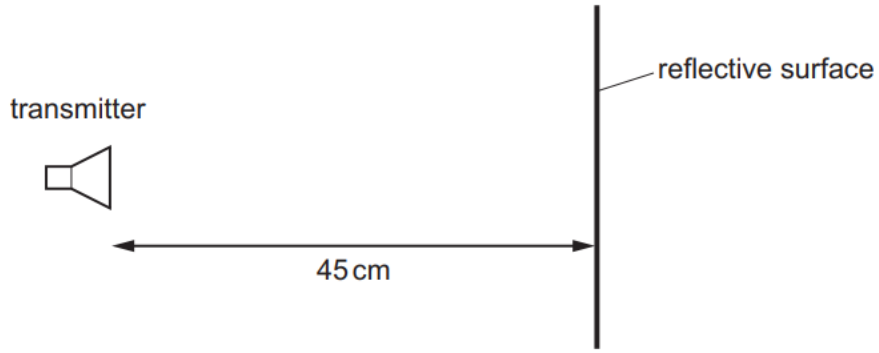
Monochromatic light of frequency f is incident on a diffraction grating of line spacing d. The speed of light is c.

Which expression can be used to determine the highest order of intensity maximum produced by the grating?

A $n = \frac{d}{cf}$ **B** $n = \frac{df}{c}$ **C** $n = \frac{dc}{f}$ **D** $n = \frac{c}{df}$

95. 9702/12/O/N/19 Q25

A transmitter of electromagnetic waves is placed 45 cm from a reflective surface.



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

96. 9702/12/O/N/19 Q26

Which statement about a light wave and a sound wave is correct?

A Both can travel through free space.

B Both have a frequency inversely proportional to their wavelength.

C Both have an intensity proportional to their amplitude.

D Both have oscillations perpendicular to the direction of energy transfer.

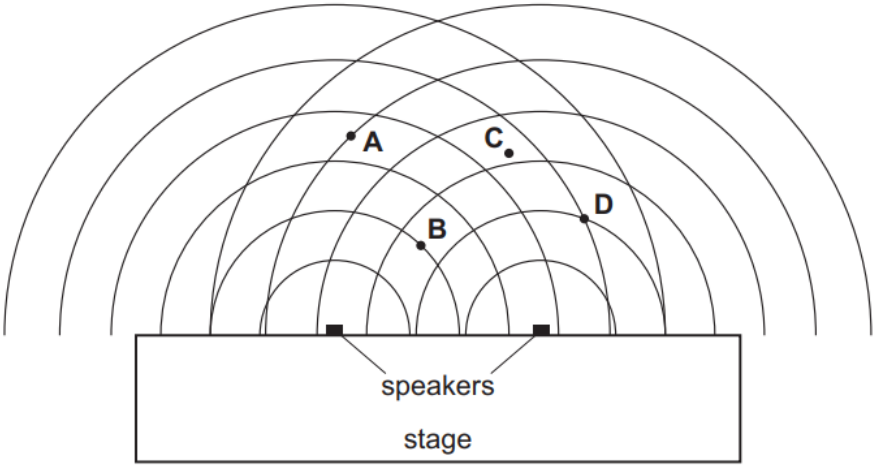
97. 9702/12/O/N/19 Q27

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?



98. 9702/12/O/N/19 Q28

An electromagnetic wave is incident normally on a diffraction grating.

A second-order maximum is produced at an angle of 30° to a normal to the grating.

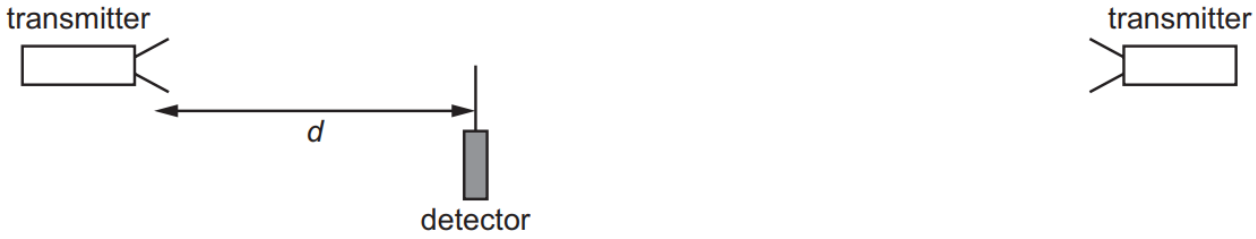
The grating has 5000 lines per cm.

What is the wavelength of the wave?

A 2.5×10^{-7} m **B** 5.0×10^{-7} m **C** 1.0×10^{-6} m **D** 5.0×10^{-5} m

99. 9702/13/O/N/19 Q26

In an experiment to demonstrate a stationary wave, two microwave transmitters, emitting waves of wavelength 4 cm, are set facing each other, as shown.



A detector is moved along a straight line between the transmitters. It detects positions of maximum and minimum signal. The detector is a distance *d* from the left-hand transmitter.

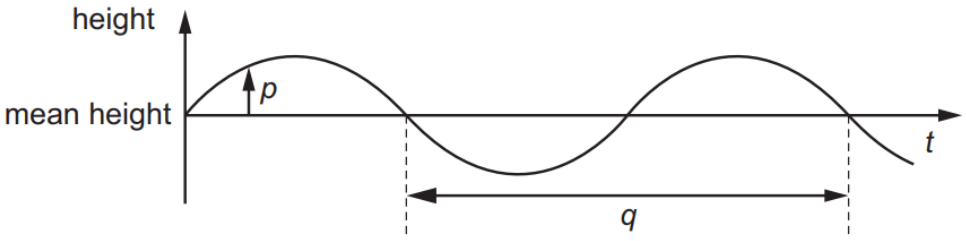
Assume that both transmitters are at antinodes of the stationary wave.

Which row gives a value of *d* for a maximum and for a minimum?

	value of *d* for a maximum / cm	value of *d* for a minimum / cm
A	46	48
B	47	48
C	48	47
D	49	47

100. 9702/13/O/N/19 Q27

The graph shows how the height of the water surface at a point in a harbour varies with time *t* as waves pass the point.

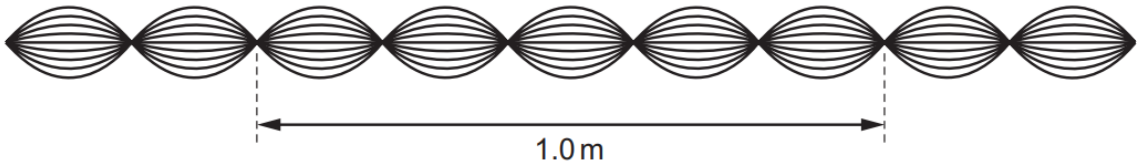


What are *p* and *q*?

	p	*q*
A	displacement	period
B	displacement	wavelength
C	amplitude	period
D	amplitude	wavelength

101. 9702/13/O/N/19 Q28

The diagram shows a sketch of a wave pattern over a short period of time.



Which description of this wave is correct?

A The wave is longitudinal, has a wavelength of 20 cm and is stationary.

B The wave is transverse, has a wavelength of 20 cm and is stationary.

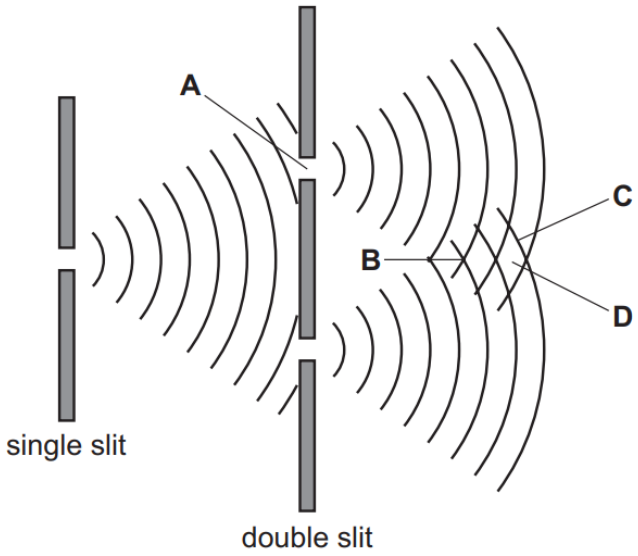
C The wave is transverse, has a wavelength of 40 cm and is progressive.

D The wave is transverse, has a wavelength of 40 cm and is stationary.

102. 9702/13/O/N/19 Q29

The double-slit experiment demonstrates interference between two coherent sources of light waves. In the diagram, the curved lines represent wavefronts.

At which point does complete destructive interference (a minimum) occur?



103. 9702/13/O/N/19 Q30

Light of wavelength 567 nm is incident normally on a diffraction grating. The grating has 400 lines per mm. A number of diffraction maxima are observed on the far side of the grating.

What is the angle between the second-order maximum and the third-order maximum?

A 13.1° **B** 13.9° **C** 15.9° **D** 27.0°

104. 9702/12/F/M/20 Q26

A musical instrument is made using a long tube with a mouthpiece at one end. The other end is open and flared, as shown.

A musician maintains stationary sound waves with a node at the mouthpiece and an antinode at the other end. The lowest frequency of sound that the instrument can produce is 92 Hz.

Which different frequencies of sound can be produced by the instrument?

A 92 Hz, 138 Hz, 184 Hz, 230 Hz

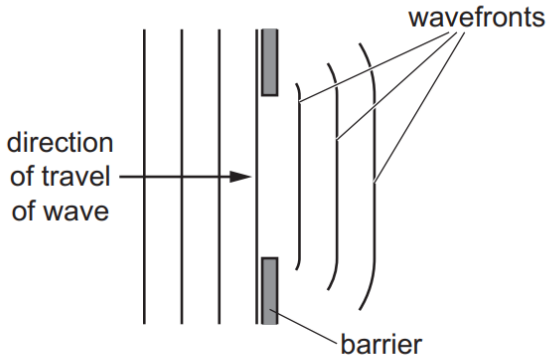
B 92 Hz, 184 Hz, 276 Hz, 368 Hz

C 92 Hz, 276 Hz, 460 Hz, 644 Hz

D 92 Hz, 276 Hz, 828 Hz, 1288 Hz

105. 9702/12/F/M/20 Q27

A water wave passes through a gap between two barriers. The wavefronts spread out as shown.



What is the name of this phenomenon?

A coherence

B diffraction

C interference

D superposition

106. 9702/12/F/M/20 Q28

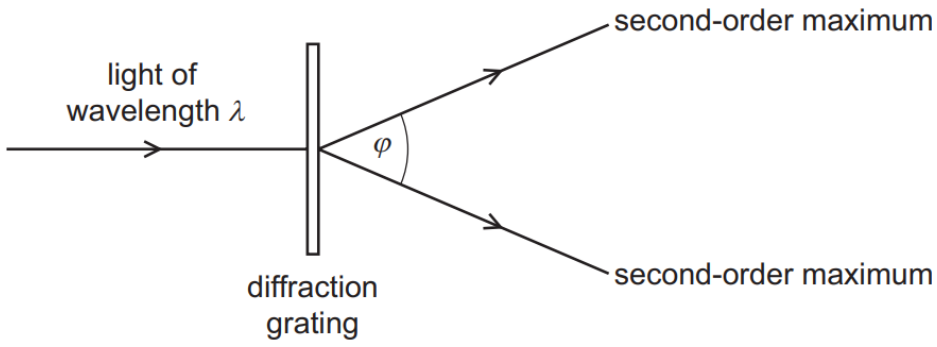
The table shows four possible combinations of values for the laser wavelength, slit separation and slit-screen distance in a two-slit interference experiment to show the interference of visible light on a white screen.

Which combination will result in visible fringes being observed?

	laser wavelength / nm	slit separation / mm	slit-screen distance / m
A	200	0.10	5.0
B	200	100	1.0
C	600	0.10	5.0
D	600	100	1.0

107. 9702/12/F/M/20 Q29

Light of wavelength λ is incident normally on a diffraction grating, as shown.



The angle between the two second-order maxima is φ.

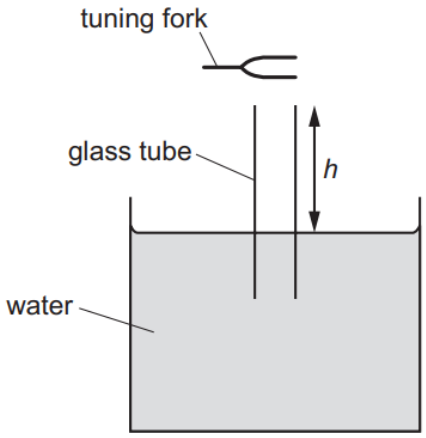
Which expression gives the spacing of the lines on the diffraction grating?

A $\frac{\lambda}{\sin\varphi}$ **B** $\frac{\lambda}{\sin(\varphi/2)}$ **C** $\frac{2\lambda}{\sin\varphi}$ **D** $\frac{2\lambda}{\sin(\varphi/2)}$

108. 9702/11/M/J/20 Q24

A long glass tube is almost completely immersed in a large tank of water. A tuning fork is struck and held just above the open end of the tube as it is slowly raised.

A louder sound is first heard when the height h of the end of the tube above the water is 18.8 cm. A louder sound is next heard when h is 56.4 cm. The speed of sound in air is 330 m s^{-1}.

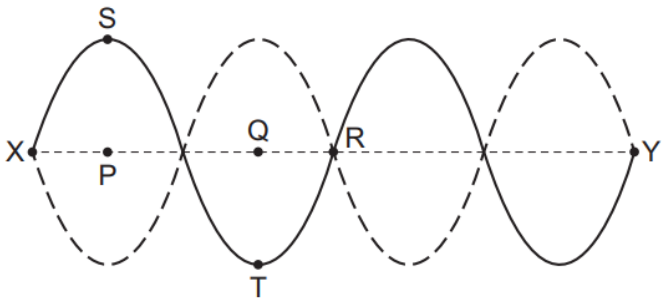


What is the frequency of the sound produced by the tuning fork?

A 220 Hz **B** 440 Hz **C** 660 Hz **D** 880 Hz

109. 9702/11/M/J/20 Q27

The diagram shows a string stretched between fixed points X and Y. There is a stationary wave on the string.



The solid curve shows the string at a position of maximum displacement. The dashed curve shows the other position of maximum displacement. The straight central dashed line shows the mean position of the string. Point S on the string is directly above point P. Point T on the string is directly below Q.

Which statement is correct?

A A short time later, point R on the string will be displaced.

B Points S and T on the string move in opposite directions.

C The distance between P and Q is one wavelength.

D Two points on the string that are equal distances from point R vibrate in phase.

110. 9702/11/M/J/20 Q28

Which statement **must** be true for diffraction to occur when a wave passes through a gap?

A The wave is able to travel in a vacuum.

B The wave is progressive.

C The wave has a large amplitude.

D The wave has a long wavelength.

111. 9702/11/M/J/20 Q29

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

112. 9702/11/M/J/20 Q30

A diffraction grating and a screen are used to determine the single wavelength λ of the light from a source.

What is an essential feature of this experiment?

A A curved screen must be used.

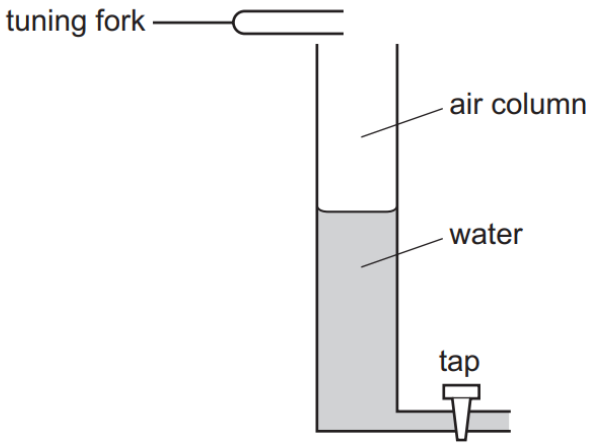
B The diffraction angle θ must be measured for at least two interference maxima.

C The light waves incident on the grating must be coherent.

D The third order intensity maximum must be produced.

113. 9702/12/M/J/20 Q24

The diagram shows an experiment to produce a stationary wave in an air column. A tuning fork, placed above the column, vibrates and produces a sound wave. The length of the air column can be varied by altering the volume of the water in the tube.



The tube is filled and then water is allowed to run out of it. The first two stationary waves occur when the air column lengths are 0.14 m and 0.42 m.

What is the wavelength of the sound wave?

A 0.14 m **B** 0.28 m **C** 0.42 m **D** 0.56 m

114. 9702/12/M/J/20 Q25

A stationary person measures the speed and wavelength of the sound from a horn on a stationary vehicle. The person then repeats the measurements when the vehicle is approaching at a constant speed.

Which row describes the measured wavelength and the measured speed of the sound wave from the moving vehicle when compared with the sound wave from the stationary vehicle?

	wavelength of the sound wave	speed of the sound wave
A	longer	greater
B	shorter	greater
C	longer	same
D	shorter	same

115. 9702/12/M/J/20 Q27

Two progressive waves meet at a point.

Which condition must be met for superposition of the waves to occur?

A The waves must be coherent.

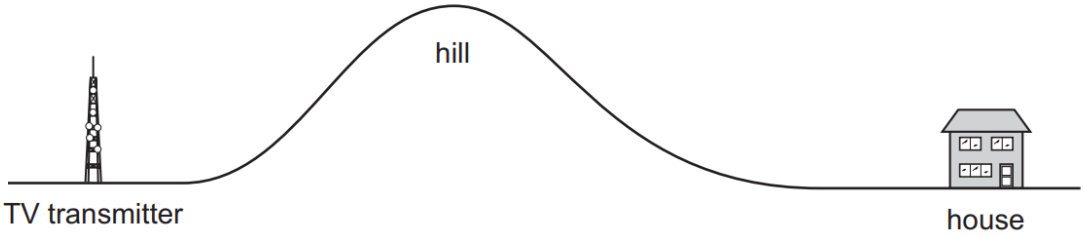
B The waves must be of the same type.

C The waves must be travelling in opposite directions.

D The waves must meet in phase.

116. 9702/12/M/J/20 Q28

A hill separates a television (TV) transmitter from a house. The transmitter cannot be seen from the house. However, the house has good TV reception.



By which wave effect at the hill could the TV signal reach the house?

A coherence

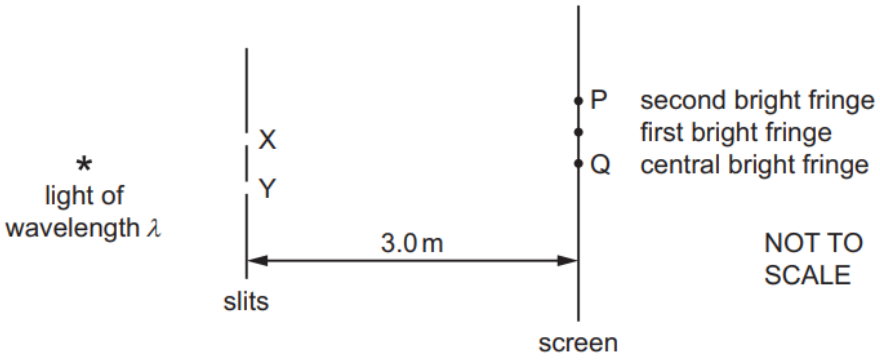
B diffraction

C interference

D reflection

117. 9702/12/M/J/20 Q29

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

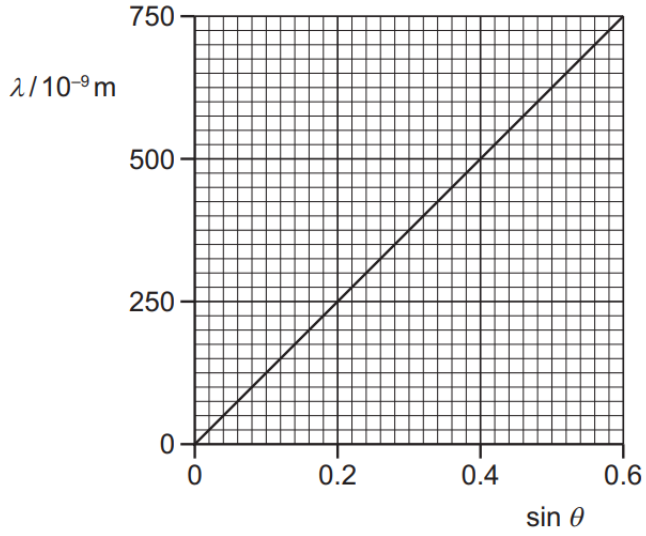
B $3.0 \times 10^{3}\,\lambda$

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

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

118. 9702/12/M/J/20 Q30

Light of wavelength λ is incident normally on a diffraction grating. The angle between the **second**-order maximum and the normal to the grating is θ. The variation with sin θ of λ is shown on the graph.

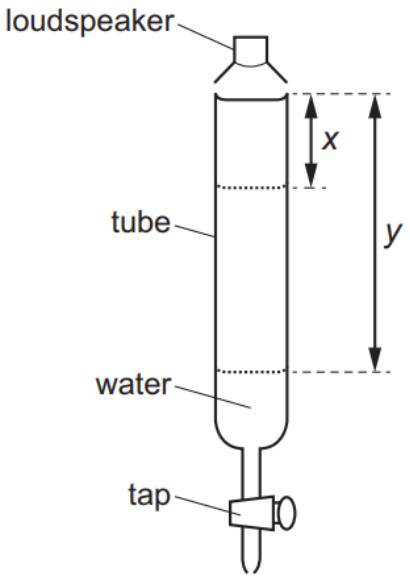


How many lines per millimetre are on the diffraction grating?

A 400 mm^{-1} **B** 625 mm^{-1} **C** 800 mm^{-1} **D** 1250 mm^{-1}

119. 9702/11/O/N/20 Q23

A loudspeaker emits a sound wave into a tube initially full of water.



A tap at the bottom of the tube is opened so that water slowly leaves the tube. For some lengths of the air column in the tube, the sound heard is much louder.

The first loud sound is heard when the air column in the tube has length x.

The next time that a loud sound is heard is when the air column in the tube has length y.

What is the wavelength of the sound wave from the loudspeaker?

A $2x$ **B** $4y$ **C** $2(y - x)$ **D** $4(y - x)$

120. 9702/11/O/N/20 Q26

Which statement concerning a stationary wave is correct?

A All the particles between two adjacent nodes oscillate in phase.

B The amplitude of the stationary wave is equal to the amplitude of one of the waves creating it.

C The wavelength of the stationary wave is equal to the separation of two adjacent nodes.

D There is no displacement of a particle at an antinode at any time.

121. 9702/11/O/N/20 Q27

Which waves would best demonstrate diffraction through a doorway?

A sound waves

B ultraviolet waves

C visible light waves

D X-rays

122. 9702/11/O/N/20 Q28

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.

123. 9702/11/O/N/20 Q29

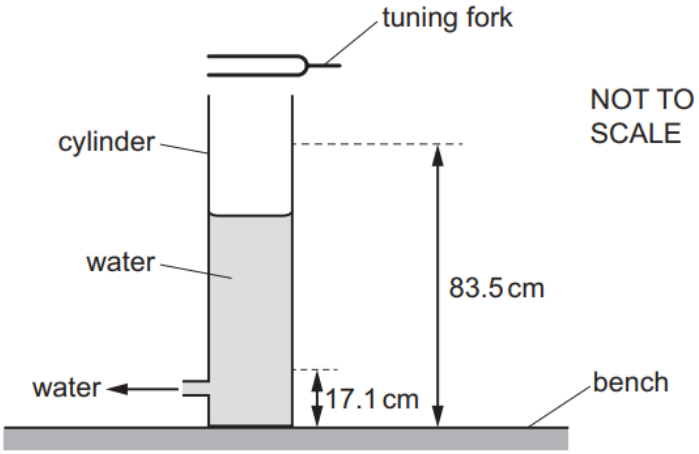
A parallel beam of white light passes through a diffraction grating. Orange light of wavelength 600 nm in the fourth-order diffraction maximum coincides with blue light in the fifth-order diffraction maximum.

What is the wavelength of the blue light?

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

124. 9702/12/O/N/20 Q24

A vibrating tuning fork is held above a glass cylinder filled to the top with water. The water level is steadily lowered. A loud sound is first heard when the water level is 83.5 cm above the bench. The next loud sound is heard when the water level is 17.1 cm above the bench.



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

What is the frequency of the tuning fork?

A 128 Hz **B** 256 Hz **C** 384 Hz **D** 512 Hz

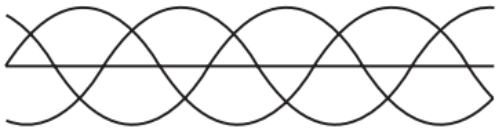
125. 9702/12/O/N/20 Q27

The three waves shown in each diagram have the same amplitude and frequency but different phase.

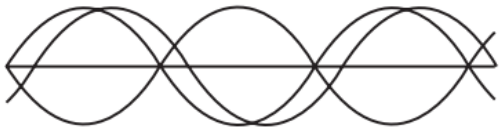
They are added together to give a resultant wave.

In which case is the resultant wave zero at this instant?

A

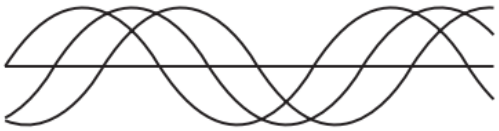


B



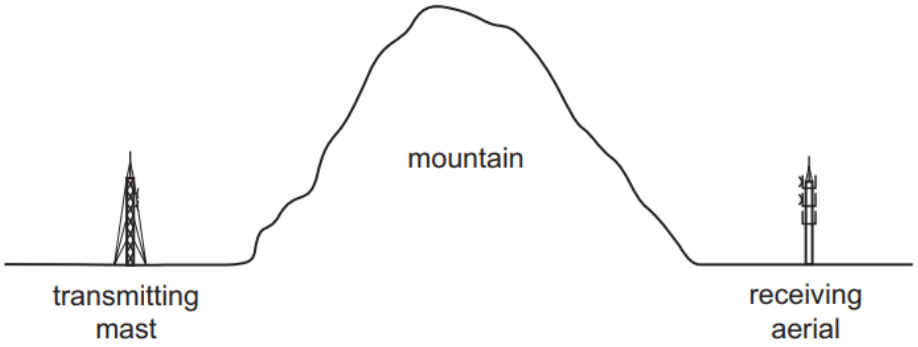
C

D



126. 9702/12/O/N/20 Q28

A transmitting mast sends out microwaves of wavelength 1.5 cm and radio waves of wavelength 1.5 km.



NOT TO SCALE

A receiving aerial behind a mountain can detect the radio waves but not the microwaves.

What is the reason for this?

A The radio waves are coherent but the microwaves are not.

B The radio waves are diffracted around the mountain but the microwaves are not.

C The radio waves are reflected by the mountain but the microwaves are not.

D The radio waves travel at the speed of light but the microwaves do not.

127. 9702/12/O/N/20 Q29

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

128. 9702/12/O/N/20 Q30

Light of a single frequency is incident on a diffraction grating. Seven bright spots are observed on a screen.

Which change will result in an increase in the number of bright spots observed?

A Increase the distance between the grating and the screen.

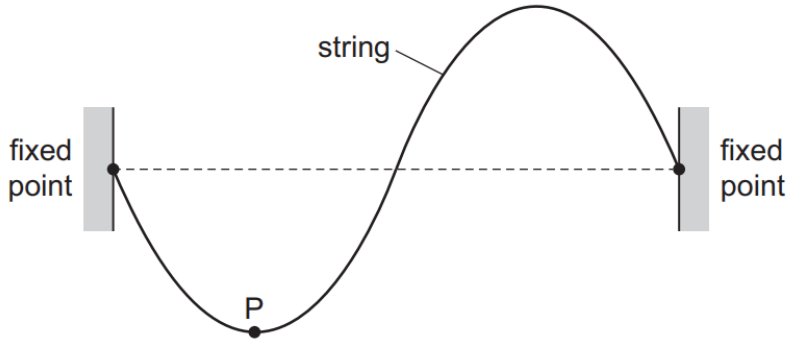
B Increase the frequency of the incident light.

C Increase the intensity of the incident light.

D Increase the number of lines per metre in the grating.

129. 9702/13/O/N/20 Q27

A stationary wave is formed on a stretched string. The diagram illustrates the string at an instant of time when the displacement of the string is at its maximum.



The frequency of the wave is 250 Hz. Point P on the string has a vertical displacement of –1.0 mm.

What will be the vertical displacement of the point P after a time of 5.0 ms?

A –1.0 mm **B** zero **C** +0.5 mm **D** +1.0 mm

130. 9702/13/O/N/20 Q28

What is meant by *diffraction*?

A the change in observed frequency when a wave source moves relative to an observer

B the formation of nodes and antinodes by two progressive waves travelling in opposite directions

C the spreading of a wave around the edge of an obstacle

D the superposition of two waves when they meet

131. 9702/13/O/N/20 Q29

In a dark room, a small source of red light illuminates two slits that are 0.75 mm apart. A few metres beyond the slits, the light falls on a screen producing a series of equally spaced bright lines.

Which change would cause the distance between the bright lines on the screen to be reduced?

A Change the source for one emitting blue light.

B Reduce the distance between the light source and the slits.

C Reduce the distance between the slits to 0.55 mm.

D Reduce the intensity of the light source.

132. 9702/13/O/N/20 Q30

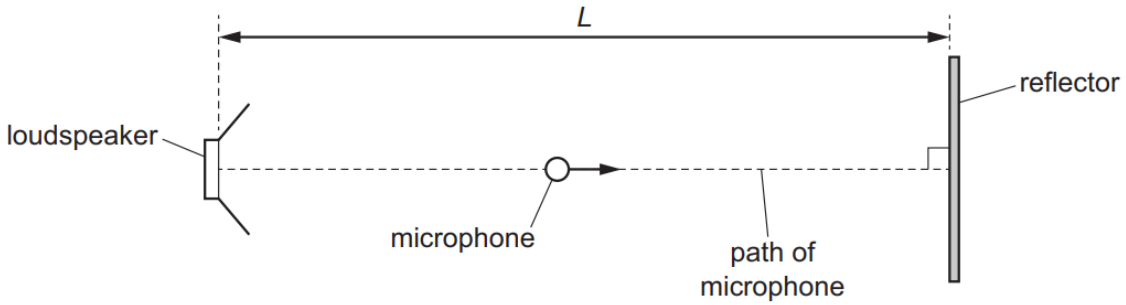
Light of wavelength 5.30×10^{-7} m is incident normally on a diffraction grating. The first-order maximum is observed at an angle of 15.4° to the direction of the incident light.

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

A 7.7° **B** 15.4° **C** 16.7° **D** 32.1°

133. 9702/12/F/M/21 Q23

A loudspeaker emitting a sound wave of a single frequency is placed a distance *L* from a reflecting surface, as shown.



A stationary wave is formed with an antinode at the loudspeaker. A microphone is moved from the loudspeaker to the reflector.

Before the microphone reaches the reflector, it detects four points where the sound intensity is a minimum.

What is the wavelength of the sound wave?

A $\frac{2L}{9}$ **B** $\frac{2L}{8}$ **C** $\frac{4L}{9}$ **D** $\frac{4L}{8}$

134. 9702/12/F/M/21 Q26

Two waves, P and Q, meet at a point X and superpose.

Initially, the two waves meet at X in phase (zero phase difference) so that the resultant wave has an amplitude of 14.0 cm at that point.

The phase difference between the two waves is then changed so that they meet at X with a phase difference of 180°. The resultant wave now has an amplitude of 4.0 cm at X.

What is the amplitude of one of the waves at point X?

A 2.0 cm **B** 5.0 cm **C** 10 cm **D** 18 cm

135. 9702/12/F/M/21 Q27

A water wave is diffracted as it passes through a gap between two barriers in a ripple tank. The wave is observed to 'spread out' as it moves through the gap.

Which two factors both affect the amount of diffraction observed?

A the amplitude and frequency of the incident wave

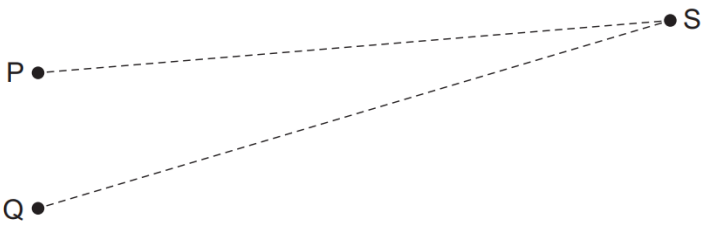
B the amplitude of the incident wave and the width of the gap

C the wavelength and amplitude of the incident wave

D the wavelength of the incident wave and the width of the gap

136. 9702/12/F/M/21 Q28

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



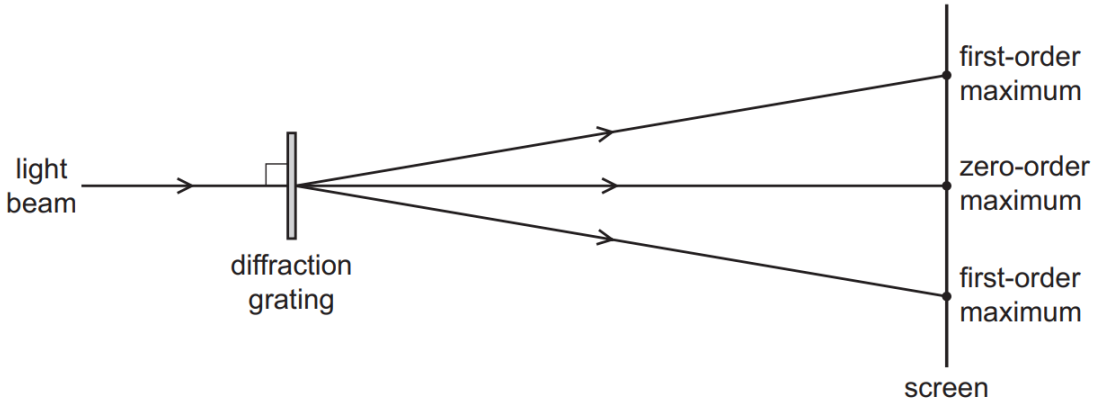
At the point S there is a minimum in the interference pattern produced by waves from the two sources. The distance (QS – PS) is called the path difference.

Which expression could represent the path difference?

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

137. 9702/12/F/M/21 Q29

A beam of red laser light of wavelength 633 nm is incident normally on a diffraction grating with 600 lines per mm.



The beam of red light is now replaced by a beam of blue laser light of wavelength 445 nm. A replacement diffraction grating is used so that the first-order maximum of the blue light appears at the same position on the screen as the first-order maximum of the red light from the original laser.

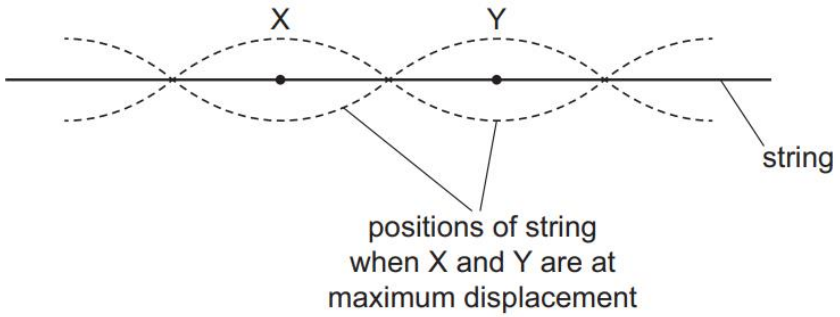
How many lines per mm are there in the replacement diffraction grating?

A 420 mm^{-1} **B** 470 mm^{-1} **C** 600 mm^{-1} **D** 850 mm^{-1}

138. 9702/11/M/J/21 Q26

The diagram shows part of a stationary wave on a string.

X and Y are points on the string. The vibrations at X and Y are 180° out of phase.



What is the distance between X and Y?

A one-quarter of a wavelength

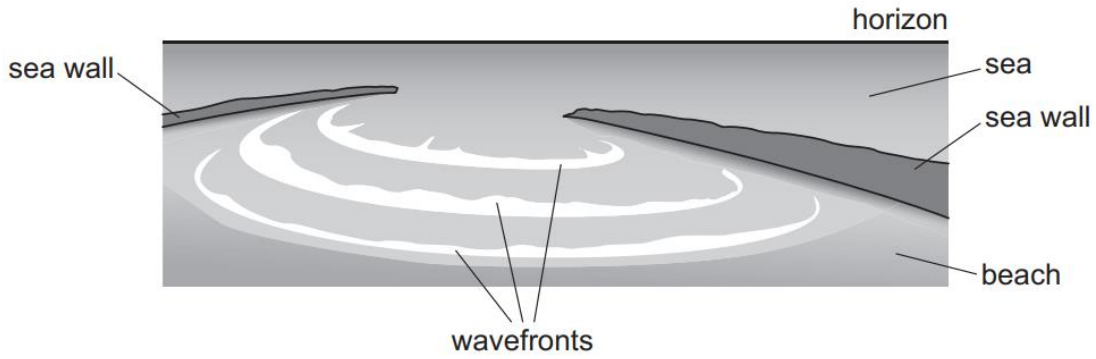
B half a wavelength

C one wavelength

D two wavelengths

139. 9702/11/M/J/21 Q27

Which wave behaviour is shown in the diagram?



A diffraction

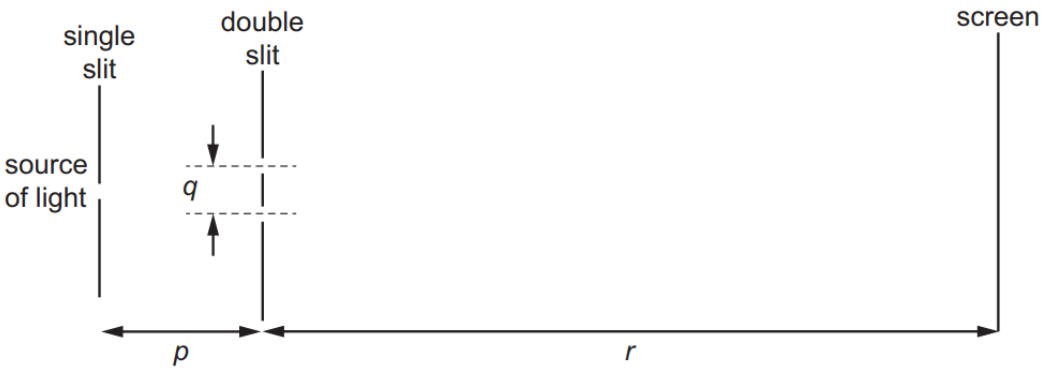
B Doppler shift

C interference

D superposition

140. 9702/11/M/J/21 Q28

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

141. 9702/11/M/J/21 Q29

Light of a single unknown wavelength and blue light of a single wavelength are both incident normally on a diffraction grating. Two diffraction patterns are produced, one for each wavelength of light.

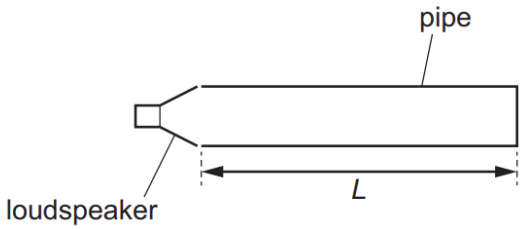
The third-order maximum for the blue light occurs at the same angle as the second-order maximum for the light of unknown wavelength. The wavelength of the blue light is 480 nm.

What is the unknown wavelength?

A 320 nm **B** 720 nm **C** 960 nm **D** 1440 nm

142. 9702/12/M/J/21 Q26

A pipe of length L is open at one end and closed at the other end. A loudspeaker is at the open end and emits a sound wave into the pipe.



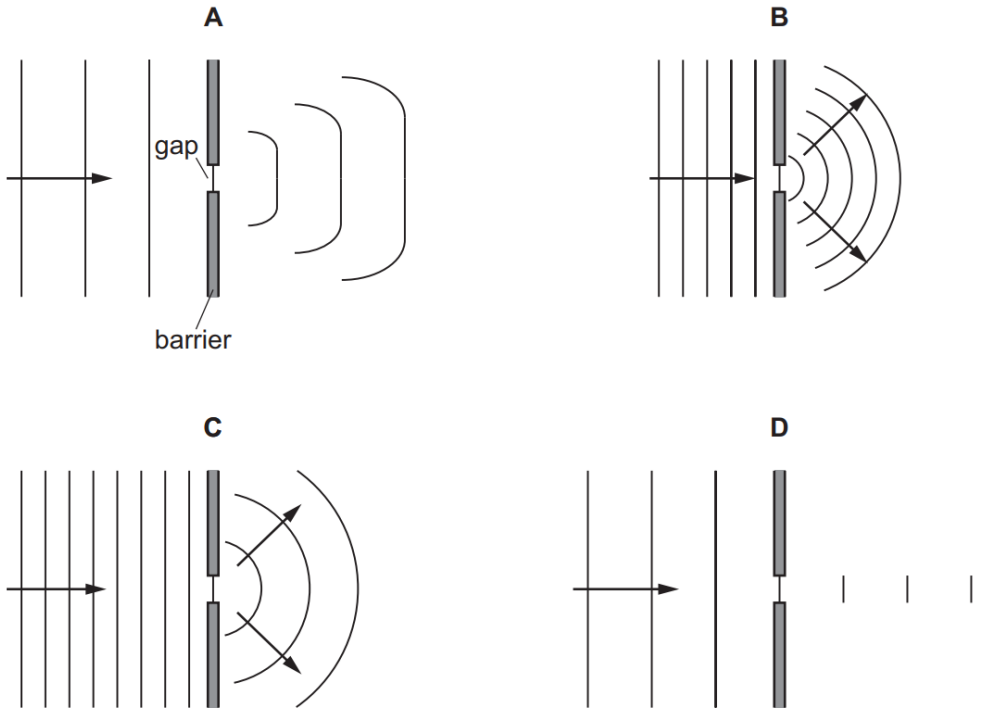
When a stationary wave is formed, there is an antinode at the open end of the pipe.

Which wavelength of sound could be used to produce a stationary wave?

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

143. 9702/12/M/J/21 Q27

Which diagram best shows how water waves diffract when they pass through a gap in a barrier?



144. 9702/12/M/J/21 Q28

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.

145. 9702/12/M/J/21 Q29

A parallel beam of light consists of light of wavelength 420 nm and light of wavelength 630 nm.

The light is incident normally on a diffraction grating.

The diffraction maxima for the two wavelengths overlap only at an angle of 31° from the direction of the incident light beam.

What could be the line spacing of the diffraction grating?

A 1.2 μm **B** 1.6 μm **C** 2.4 μm **D** 3.7 μm

146. 9702/13/M/J/21 Q27

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

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

A The waves must have equal frequencies, but different speeds and wavelengths.

B The waves must have equal speeds, but different wavelengths and frequencies.

C The waves must have equal speeds, frequencies and wavelengths.

D The waves must have equal wavelengths, but different speeds and frequencies.

147. 9702/13/M/J/21 Q28

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

Which size of architectural features in a large concert hall would best diffract sound waves of frequency 0.44 kHz?

A 1.3 mm **B** 750 mm **C** 7.5 m **D** 17 m

148. 9702/13/M/J/21 Q29

A double-slit interference pattern using red light of wavelength 7.0×10^{-7} m has a fringe spacing of 3.5 mm.

Which fringe spacing would be observed for the same arrangement of apparatus but using blue light of wavelength 4.5×10^{-7} m?

A 2.3 mm **B** 3.5 mm **C** 5.4 mm **D** 9.0 mm

149. 9702/13/M/J/21 Q30

A beam of light of a single wavelength is incident normally on a diffraction grating.

The angle of diffraction θ is measured for each order of diffraction n. The distance between adjacent slits in the diffraction grating is d.

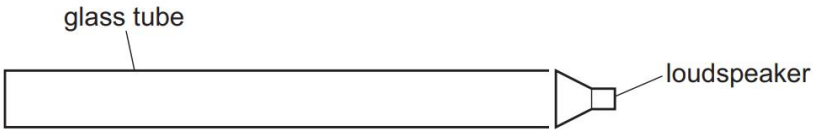
A graph is plotted to determine the wavelength of the light.

Which graph should be plotted and how is the wavelength determined from the graph?

	y-axis	x-axis	wavelength
A	n	$d \sin\theta$	gradient
B	n	$d \sin\theta$	1 / gradient
C	$\sin\theta$	d / n	gradient
D	$\sin\theta$	$d \times n$	1 / gradient

150. 9702/11/O/N/21 Q23

A glass tube is closed at one end and has a loudspeaker at the other end.



A stationary wave is formed with a node at the closed end of the tube when the sound has frequency f_0. There are no other nodes.

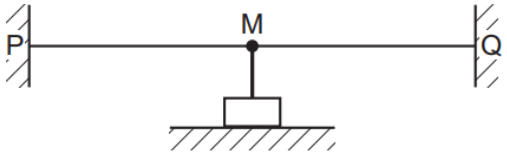
The frequency of the sound is then slowly increased.

What is the frequency of the sound that produces the next stationary wave?

A $1.25f_0$ **B** $1.50f_0$ **C** $2.00f_0$ **D** $3.00f_0$

151. 9702/11/O/N/21 Q26

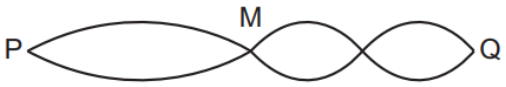
A string is fixed between point P and an oscillator M. Another string is fixed between M and point Q. M is midway between P and Q.



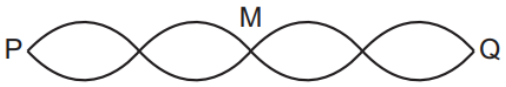
The frequency of the oscillator is adjusted until a stationary wave is formed on both strings. The speed of the wave between P and M is twice the speed of the wave between M and Q.

Which diagram could represent the stationary wave pattern?

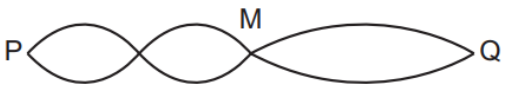
A



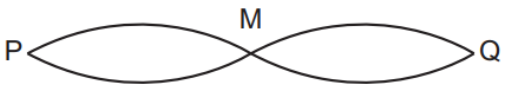
B



C



D



152. 9702/11/O/N/21 Q27

A water wave in a ripple tank is diffracted as it passes through a gap in a barrier.

Which two factors affect the angle of diffraction of the wave?

A the amplitude and frequency of the incident wave

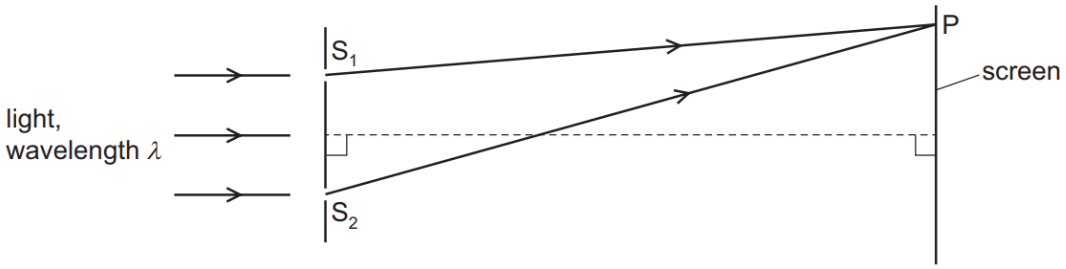
B the amplitude of the incident wave and the width of the gap

C the wavelength and amplitude of the incident wave

D the wavelength of the incident wave and the width of the gap

153. 9702/11/O/N/21 Q28

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

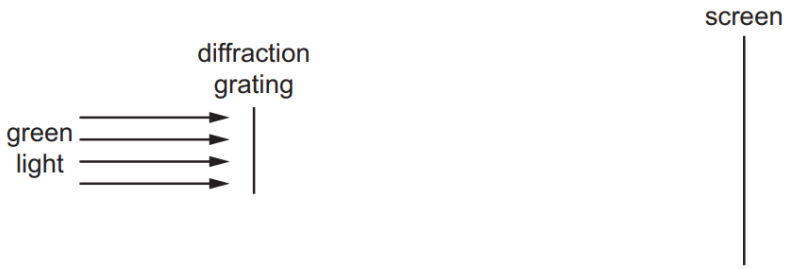
B $S_2P - S_1P = n\lambda$

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

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

154. 9702/11/O/N/21 Q29

Green light is incident normally on a diffraction grating and forms a diffraction pattern on a distant screen.



Which change, on its own, would **decrease** the separation of the diffraction maxima on the screen?

A Increase the distance between the screen and the diffraction grating.

B Replace the diffraction grating with a grating that has a smaller separation between the slits.

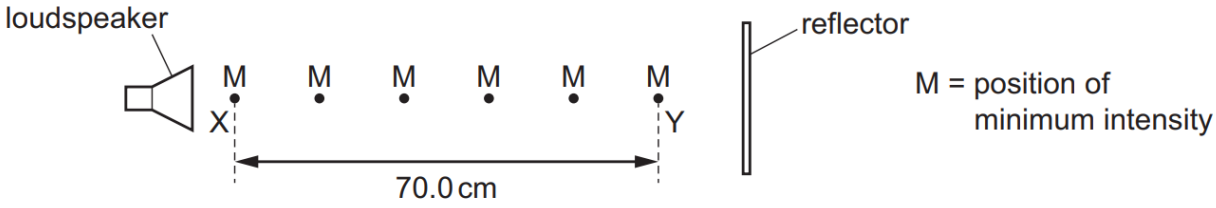
C Replace the diffraction grating with a grating that has fewer slits per unit length.

D Replace the green light with red light.

155. 9702/12/O/N/21 Q24

A sound wave from a loudspeaker is reflected back along its original path by a reflector.

A microphone is initially at point X where the sound intensity is a minimum, as shown.



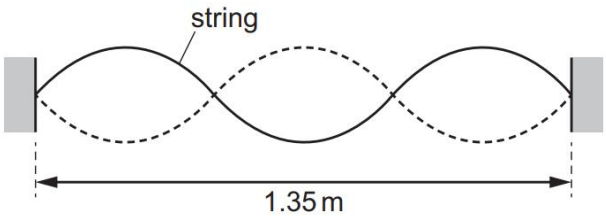
The microphone is moved towards the reflector and passes through four more intensity minima until reaching a fifth minimum at point Y. The distance XY is 70.0 cm.

What is the wavelength of the sound?

A 11.7 cm **B** 14.0 cm **C** 23.3 cm **D** 28.0 cm

156. 9702/12/O/N/21 Q27

A stationary wave is produced on a string that is stretched between two fixed points that are a distance of 1.35 m apart, as shown.



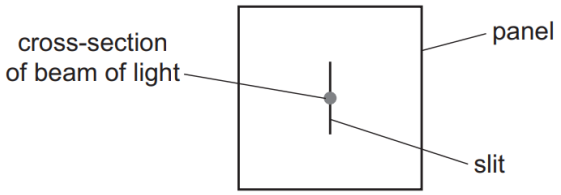
The speed of the waves on the string is 450 m s^{-1}.

What is the frequency of oscillation of the stationary wave?

A 333 Hz **B** 405 Hz **C** 500 Hz **D** 1000 Hz

157. 9702/12/O/N/21 Q28

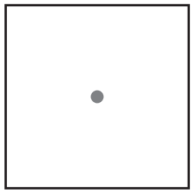
A beam of laser light is directed towards a narrow slit.



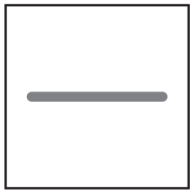
After emerging from the other side of the slit, the diffracted light then falls on a screen.

What is the pattern of light seen on the screen?

A

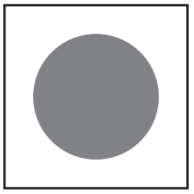


B



C

D



158. 9702/12/O/N/21 Q29

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.

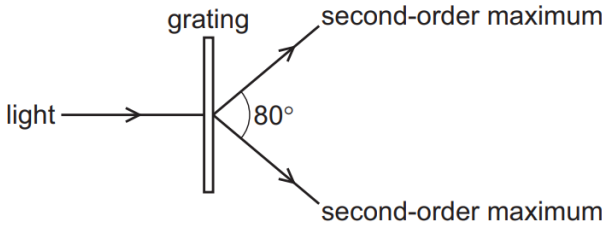
B They must be coherent but not necessarily of the same amplitude.

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

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

159. 9702/12/O/N/21 Q30

Light of wavelength 5.5×10^{-7} m is incident normally on a diffraction grating.



The angle between the second-order diffraction maxima is 80°, as shown.

What is the number of lines per metre of the diffraction grating?

A 5.8×10^{5} lines per metre

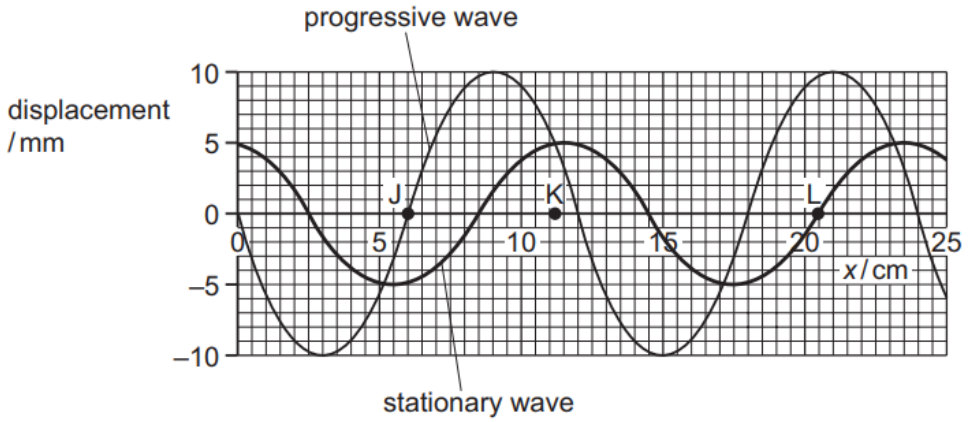
B 9.0×10^{5} lines per metre

C 1.2×10^{6} lines per metre

D 2.3×10^{6} lines per metre

160. 9702/13/O/N/21 Q27

Two progressive waves travel in opposite directions and form a stationary wave. The graph shows the variation with distance *x* of the displacement of the stationary wave and of one of the two progressive waves at the same instant in time.

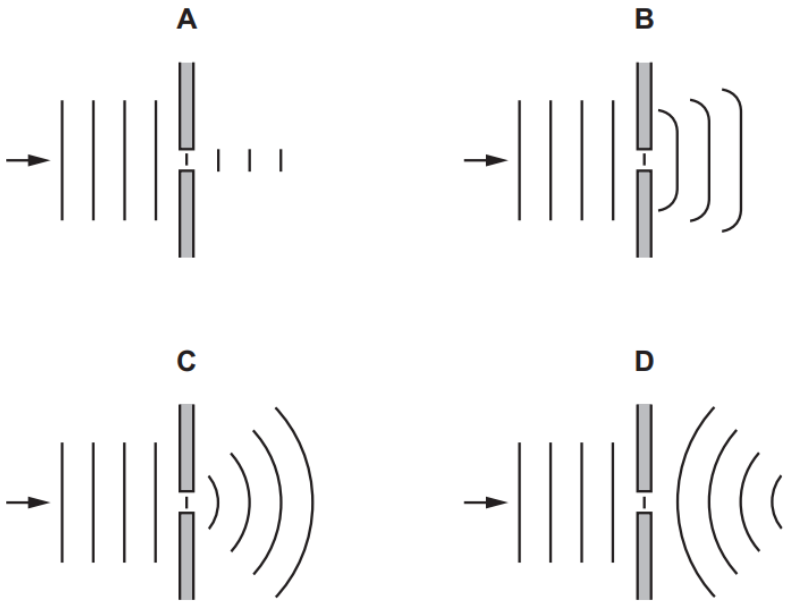


What are the approximate displacements of the **other** progressive wave at the positions J, K and L?

	displacement / mm		
	J	K	L
A	–5	0	–10
B	–5	+5	0
C	0	+5	+10
D	+5	–5	0

161. 9702/13/O/N/21 Q28

Which diagram shows the diffraction of water waves in a ripple tank?



162. 9702/13/O/N/21 Q29

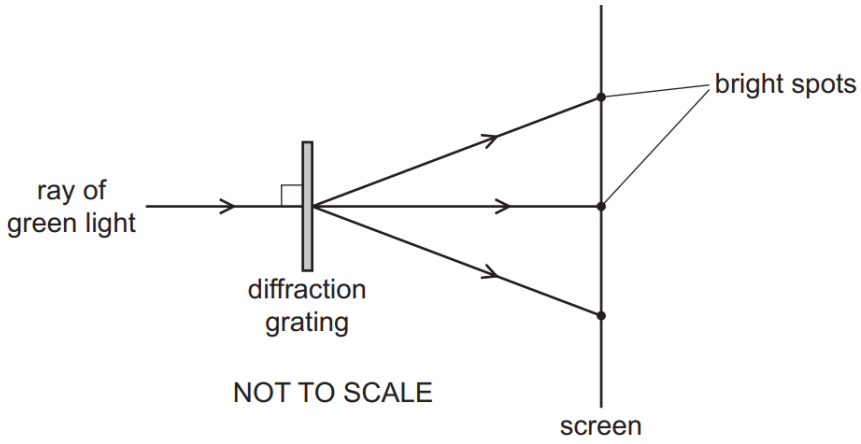
Interference fringes are produced on a screen by double-slit interference using light of wavelength 600 nm. The fringe separation is 4.0 mm and the separation of the slits is 0.60 mm.

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

163. 9702/13/O/N/21 Q30

A ray of green light is incident normally on a diffraction grating. Several bright spots are produced on a screen on the other side of the grating, as shown.



Which pair of changes could result in bright spots at exactly the same angles as previously?

A Use blue light and increase the distance between the grating and the screen.

B Use blue light and increase the number of lines per unit length in the grating.

C Use red light and increase the distance between the grating and the screen.

D Use red light and increase the number of lines per unit length in the grating.

164. 9702/12/F/M/22 Q24

Two coherent progressive waves from different sources meet at a point.

Which condition **must** be satisfied for there to be zero resultant amplitude at the point where the waves meet?

A The two waves must be emitted from their sources with the same intensity.

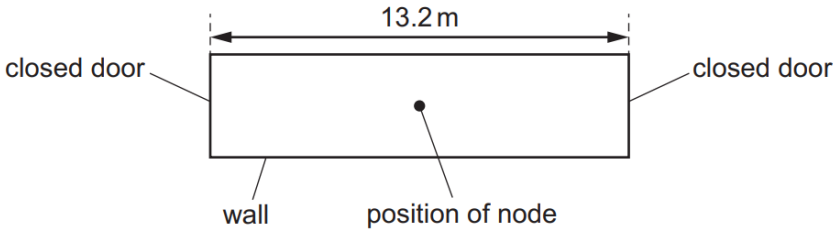
B The two waves must be in phase with each other at the point.

C The two waves must be travelling in opposite directions.

D The two waves must have the same amplitude at the point.

165. 9702/12/F/M/22 Q25

A corridor is 13.2 m long and has closed doors that reflect sound at both ends. The speed of sound in the air in the corridor is 330 m s^{-1}.



What is the lowest frequency of sound that could create a stationary wave in the corridor with a node halfway along it?

A 0.040 Hz **B** 13 Hz **C** 25 Hz **D** 50 Hz

166. 9702/12/F/M/22 Q26

Water waves of wavelength λ are formed in a ripple tank. The waves are diffracted as they pass through a narrow gap of width d (d is greater than λ).

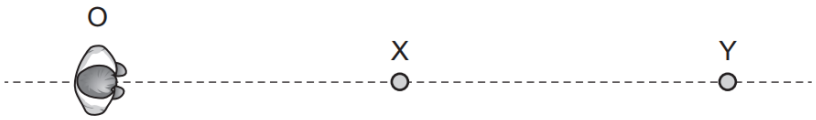
Which gap width and which wavelength will cause the largest decrease in the amount of diffraction?

	gap width	wavelength
A	$\frac{1}{2}d$	$\frac{1}{2}\lambda$
B	$\frac{1}{2}d$	2λ
C	$2d$	$\frac{1}{2}\lambda$
D	$2d$	2λ

167. 9702/12/F/M/22 Q27

Two loudspeakers X and Y emit sound waves that are in phase and of wavelength 0.75 m.

An observer O is able to stand anywhere on a straight line that passes through X and Y, as shown. The observer stands at a point where the sound waves from X and Y meet in phase.



What could be the distances OY and XY?

	distance OY / m	distance XY / m
A	1.25	3.50
B	2.00	2.75
C	2.75	2.00
D	3.25	1.50

168. 9702/12/F/M/22 Q28

Light of a single wavelength is incident normally on a diffraction grating.

The resulting diffraction pattern is displayed on a screen.

Which change makes the first orders of intensity maxima further apart from each other on the screen?

A placing the screen closer to the diffraction grating

B using a diffraction grating with less separation between adjacent slits

C using a diffraction grating with more slits but keeping the same separation between adjacent slits

D using light with a shorter wavelength

169. 9702/11/M/J/22 Q26

A stationary wave is set up on a string that is stretched between two fixed points that are 48 cm apart.

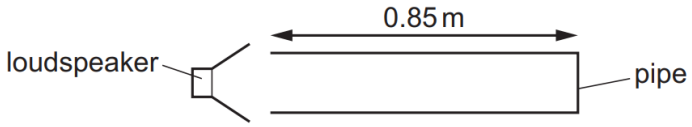
At one instant, the appearance of the string is as shown.

What is the wavelength of the stationary wave?

A 16 cm **B** 32 cm **C** 48 cm **D** 72 cm

170. 9702/11/M/J/22 Q27

A pipe, closed at one end, has a loudspeaker at the open end. For some frequencies of sound from the loudspeaker, a stationary sound wave is formed in the air within the pipe with an antinode at the open end of the pipe.



The length of the pipe is 0.85 m.

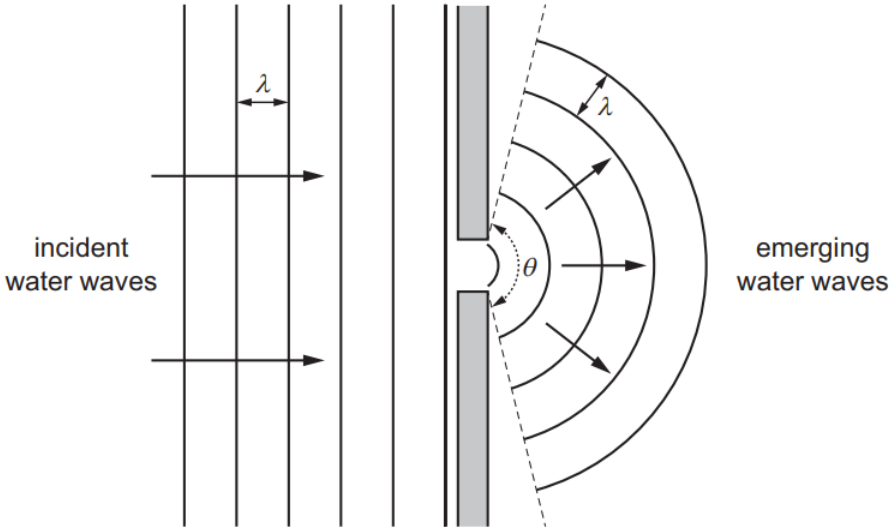
The speed of sound in air is 340 m s^{-1}.

Which frequency of sound from the loudspeaker would **not** produce a stationary wave?

A 100 Hz **B** 200 Hz **C** 300 Hz **D** 500 Hz

171. 9702/11/M/J/22 Q28

Water waves of wavelength λ are incident normally on an obstacle with a narrow gap. The width of the gap is equal to λ. The waves from the gap emerge over an angle θ, as shown.



The gap is slowly widened.

Which changes, if any, occur to θ and to the wavelength of the emerging waves?

	θ	wavelength
A	decreases	remains the same
B	increases	remains the same
C	remains the same	decreases
D	remains the same	increases

172. 9702/11/M/J/22 Q29

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.

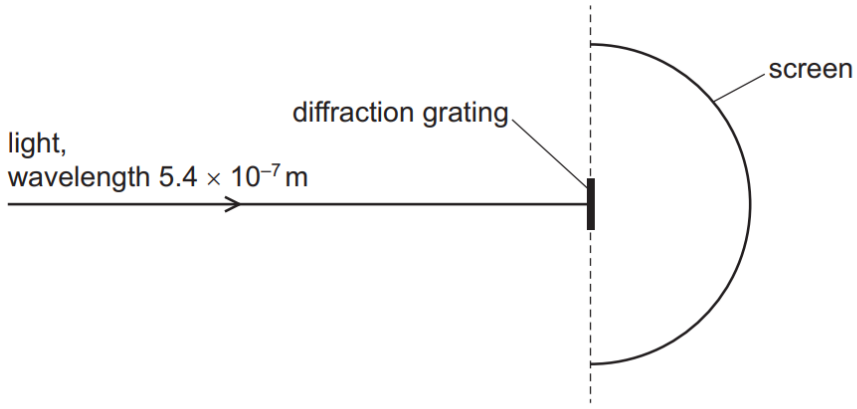
C Increase the distance between the two slits.

D Increase the frequency of the light used.

173. 9702/11/M/J/22 Q30

Light of wavelength 5.4×10^{-7} m is incident normally on a diffraction grating.

The separation between adjacent lines in the grating is 2.0×10^{-6} m. The light that emerges from the grating falls on a semicircular screen, as shown in the view from above.



VIEW FROM ABOVE

The grating is at the centre of the semicircle, and the lines of the grating are vertical.

How many bright dots are formed on the screen?

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

174. 9702/12/M/J/22 Q26

Two polarising filters are placed next to each other so that their planes are parallel.

The first polarising filter has its transmission axis at an angle of 50° to the vertical.

The second polarising filter has its transmission axis at an angle of 20° to the vertical. The angle between the transmission axes of the two polarising filters is 30°.

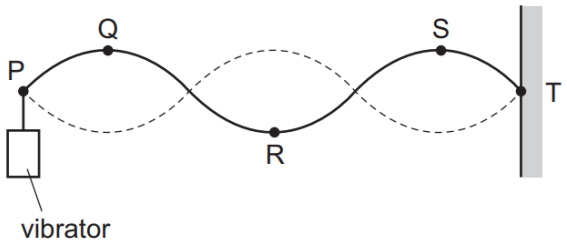
A beam of vertically polarised light of intensity $8.0\,\text{W m}^{-2}$ is incident normally on the first polarising filter.

What is the intensity of the light that is transmitted from the second polarising filter?

A zero **B** $2.5\,\text{W m}^{-2}$ **C** $2.9\,\text{W m}^{-2}$ **D** $6.0\,\text{W m}^{-2}$

175. 9702/12/M/J/22 Q27

A stationary wave on a stretched string is set up between two points P and T.



Which statement about the stationary wave is correct?

A Point R is at a node.

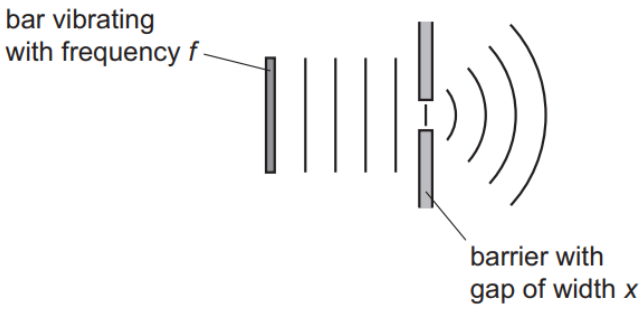
B Points Q and S vibrate in phase.

C The distance between P and T is three wavelengths.

D The wave transfers energy from P to T.

176. 9702/12/M/J/22 Q28

A bar vibrates with frequency *f* to produce water waves in a ripple tank.



The waves pass through a gap of width *x* in a barrier so that diffraction occurs.

Which combination of vibration frequency and gap width will produce the smallest angle of diffraction?

	vibration frequency	gap width
A	$\frac{f}{2}$	$\frac{x}{2}$
B	$\frac{f}{2}$	$2x$
C	$2f$	$\frac{x}{2}$
D	$2f$	$2x$

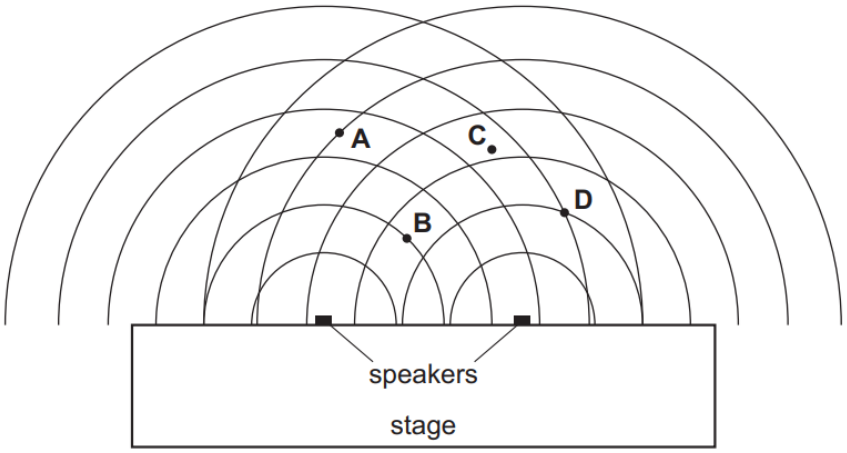
177. 9702/12/M/J/22 Q29

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?



178. 9702/12/M/J/22 Q30

The equation

$$\lambda = \frac{d \sin\theta}{n}$$

is used to calculate the wavelength λ of light in an experiment that uses a diffraction grating. The light from the diffraction grating is displayed on a screen.

What do the symbols *n* and *d* represent?

	n	*d*
A	number of slits in the grating	distance between adjacent slits in the grating
B	number of slits in the grating	distance from grating to screen
C	order of intensity maximum	distance between adjacent slits in the grating
D	order of intensity maximum	distance from grating to screen

179. 9702/13/M/J/22 Q27

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

What is this quantity?

A amplitude

B displacement

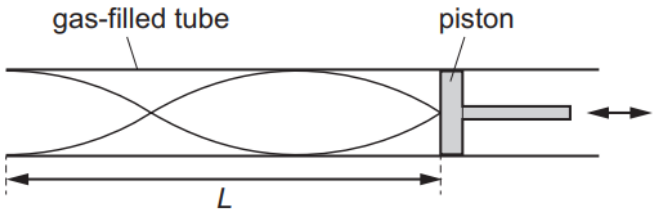
C intensity

D wavelength

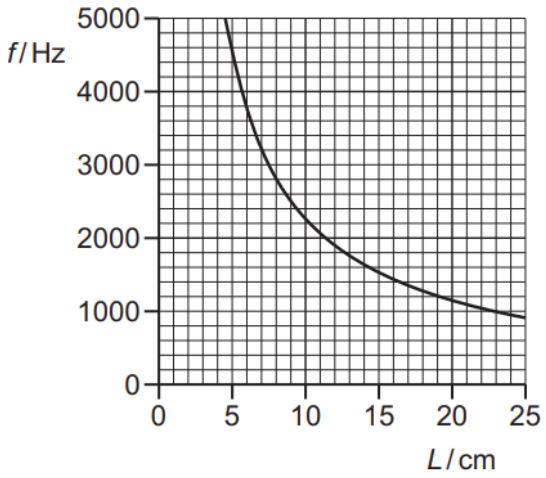
180. 9702/13/M/J/22 Q28

A stationary sound wave is formed in a gas-filled tube of length L, which is closed at one end by a piston. The length of the tube can be altered by moving the piston.

The length of the tube and the frequency of the sound are varied so that the stationary wave always has two antinodes and two nodes, as shown.



The graph shows the variation of the frequency f of the stationary sound wave with the length L of the tube.



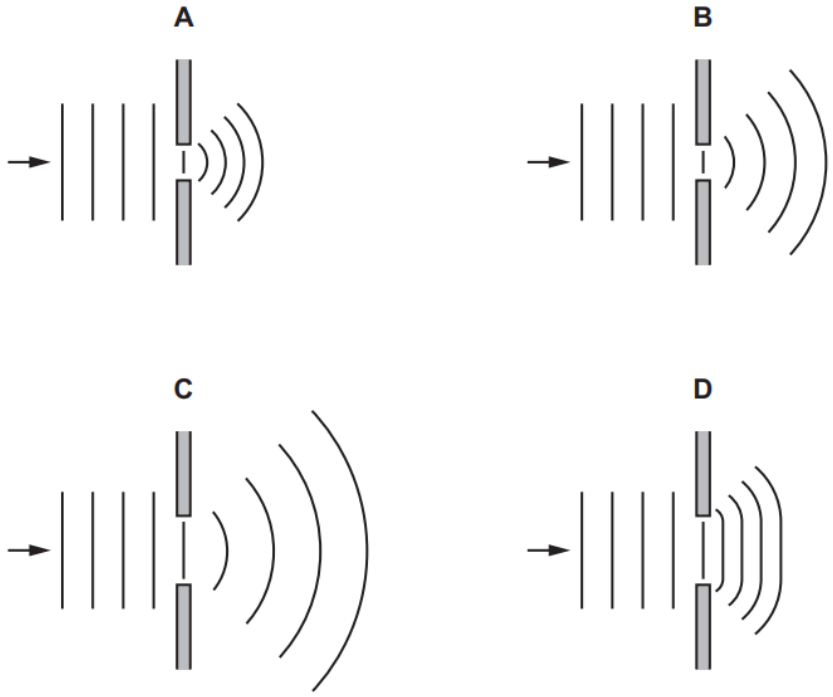
What is the speed of sound in the gas in the tube?

A $150\,m\,s^{-1}$ **B** $230\,m\,s^{-1}$ **C** $300\,m\,s^{-1}$ **D** $340\,m\,s^{-1}$

181. 9702/13/M/J/22 Q29

The diagrams show the diffraction of water waves in a ripple tank as they pass through a gap between two barriers.

Which diagram is correct?



182. 9702/13/M/J/22 Q30

A beam of light from a laser is incident normally on a double slit. Interference fringes are seen on a screen placed parallel to the double slit.

The separation of the two slits is *a*. The distance between the slits and the screen is *D*. The distance between the centres of two adjacent bright fringes is *x*.

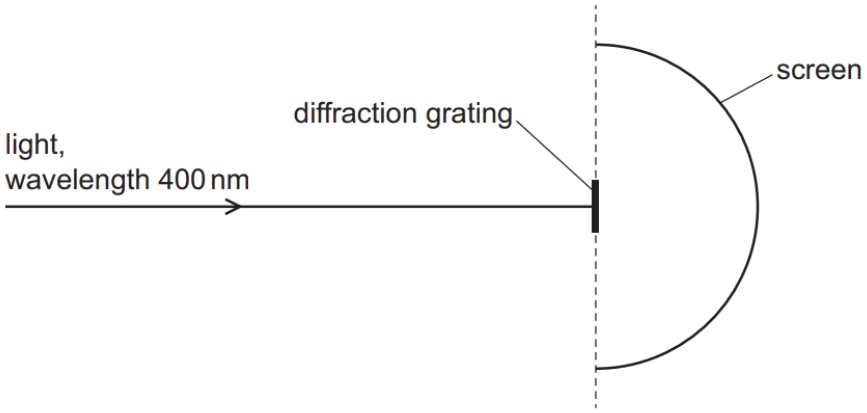
D and *a* are both halved.

What is the distance between the centres of two adjacent bright fringes after these changes?

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

183. 9702/13/M/J/22 Q31

A beam of light of wavelength 400 nm is incident normally on a diffraction grating that has 300 lines per millimetre. The light passes through the grating and produces a series of maxima which are observed on a semicircular screen, as shown.



VIEW FROM ABOVE

What is the total number of maxima observed on the screen?

A 8 **B** 9 **C** 16 **D** 17

184. 9702/11/O/N/22 Q26

Two waves of the same type overlap.

When does the principle of superposition apply?

A always

B only when the waves have the same amplitude

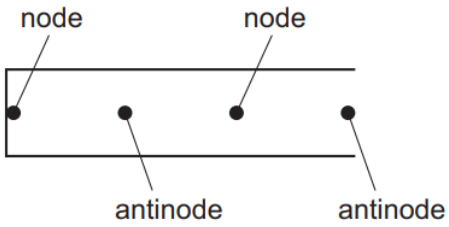
C only when the waves have the same frequency

D only when the waves travel in opposite directions

185. 9702/11/O/N/22 Q27

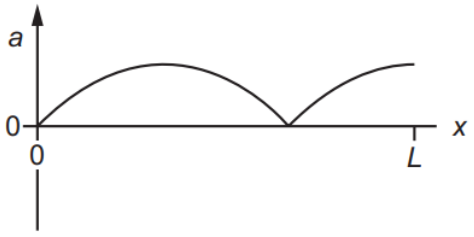
A stationary sound wave is formed in a tube of length *L* that is closed at one end.

The diagram shows the positions of the nodes and antinodes of the stationary wave.

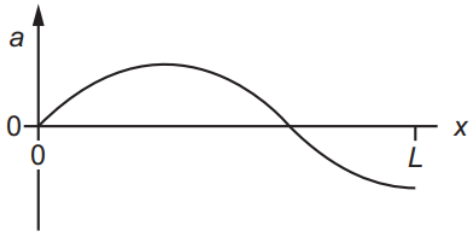


Which graph shows the variation of the amplitude *a* of the wave with distance *x* measured from the closed end of the tube?

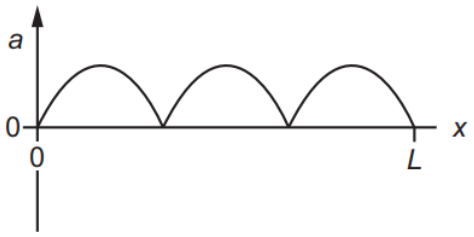
A



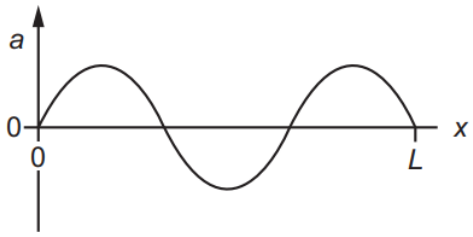
B



C

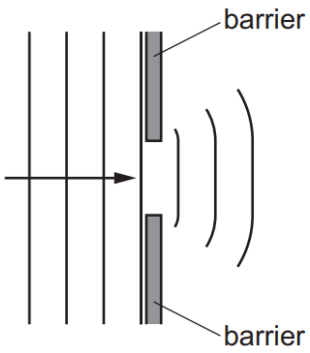


D



186. 9702/11/O/N/22 Q28

A wave on the surface of water passes through a gap between two barriers and is diffracted, as shown.



What happens when the frequency of the wave is halved?

A Less diffraction is observed.

B More diffraction is observed.

C There is no diffraction.

D The same amount of diffraction is observed.

187. 9702/11/O/N/22 Q29

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.

188. 9702/11/O/N/22 Q30

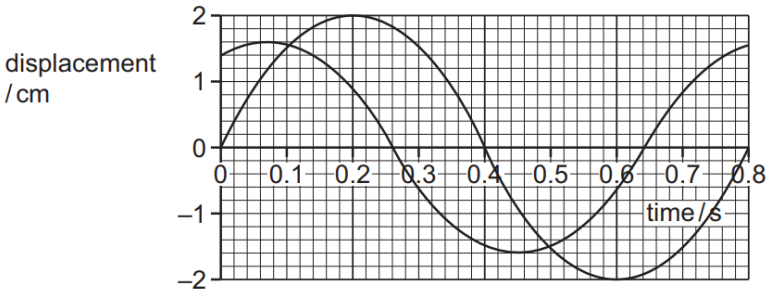
A diffraction grating has 4.00×10^5 lines per metre. A beam of light of wavelength 589×10^{-9} m is incident normally on the diffraction grating.

What is the angle between the second-order maximum and the direction of the incident beam of light?

A 13.6° **B** 27.3° **C** 28.1° **D** 56.2°

189. 9702/12/O/N/22 Q27

Two progressive waves meet at a fixed point P. The variation with time of the displacement of each wave at point P is shown.



The two waves superpose at point P.

What is the resultant displacement at time 0.38 s?

A +1.0 cm **B** –1.0 cm **C** +1.8 cm **D** –1.8 cm

190. 9702/12/O/N/22 Q28

In which situation does diffraction occur?

A A wave bounces back from a surface.

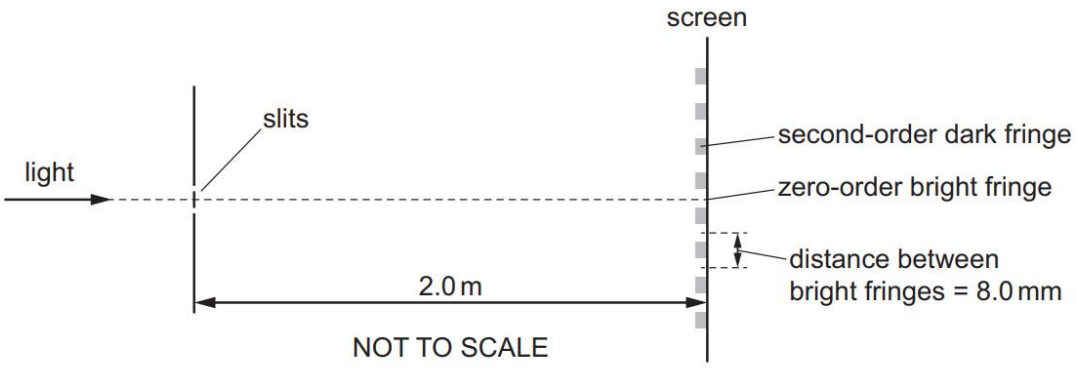
B A wave passes from one medium into another.

C A wave passes through a gap in a barrier.

D Waves from two identical sources are superposed.

191. 9702/12/O/N/22 Q29

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

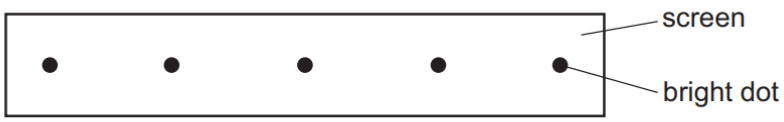
B 4.0×10^{-7} m

C 6.0×10^{-7} m

D 8.0×10^{-7} m

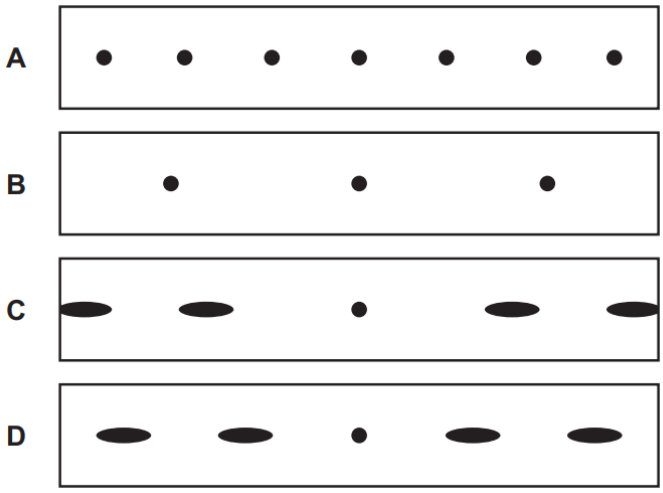
192. 9702/12/O/N/22 Q30

Red light of a single wavelength passes through a diffraction grating. Bright dots are formed on a screen, as shown.



The red light is replaced with white light.

Which diagram, drawn to the same scale, shows a possible pattern of bright light on the screen?



193. 9702/13/O/N/22 Q25

Two progressive waves overlap.

What is an essential condition for the two waves to form a stationary wave?

A The waves are longitudinal.

B The waves are polarised.

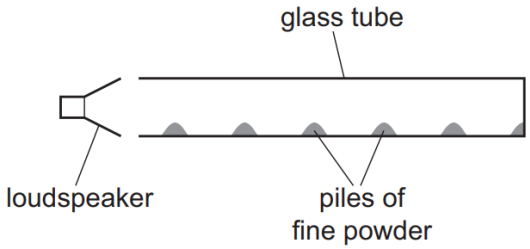
C The waves travel in opposite directions.

D The waves travel in the same direction.

194. 9702/13/O/N/22 Q26

In an experiment to produce a stationary sound wave in air, a fine powder is initially evenly distributed along the length of a horizontal glass tube which is closed at one end.

At the open end of the tube, a loudspeaker emits a sound wave of a constant wavelength. A stationary wave is formed and the powder accumulates in regularly spaced piles, as shown.



Which statement explains the positions of the piles of powder within the tube?

A The piles are where the air molecules vibrate with maximum amplitude.

B The piles are where the air molecules vibrate with minimum amplitude.

C The piles are where the air molecules vibrate with the highest frequency.

D The piles are where the air molecules vibrate vertically.

195. 9702/13/O/N/22 Q27

A sound wave of wavelength 0.50 m passes through a doorway of width 1.0 m between two rooms.

Which change increases the amount of diffraction that takes place?

A Double the amplitude of the sound wave.

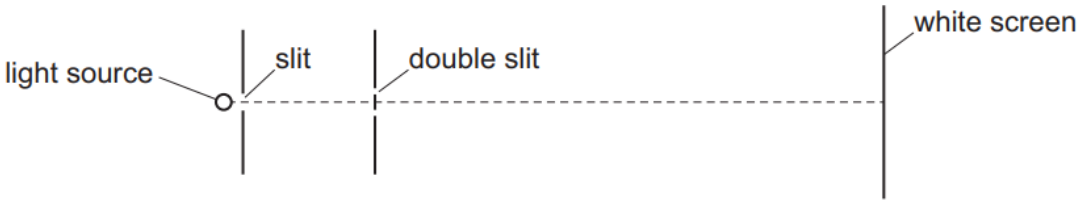
B Double the width of the doorway.

C Halve the frequency of the sound wave.

D Halve the period of the sound wave.

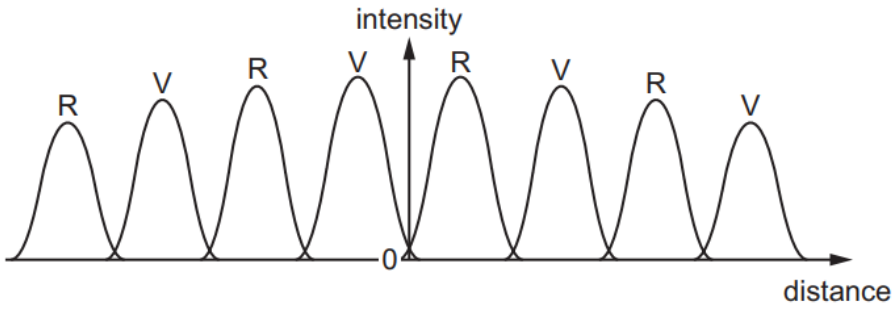
196. 9702/13/O/N/22 Q28

A light source consists of a vertical slit illuminated by red light (R) and violet light (V). The wavelength of R is approximately twice the wavelength of V. A parallel vertical double slit is placed nearby. A white screen is placed so that fringes are formed on it.

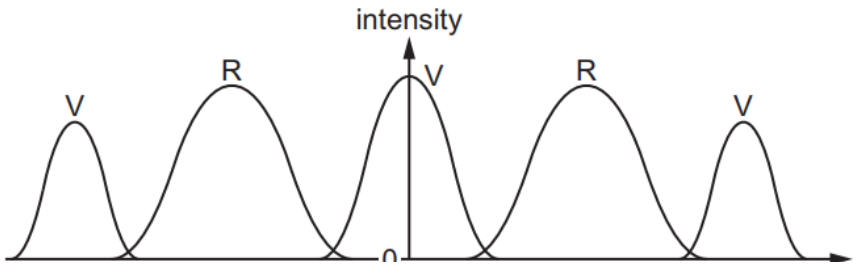


Which graph best represents the interference fringes formed on the screen?

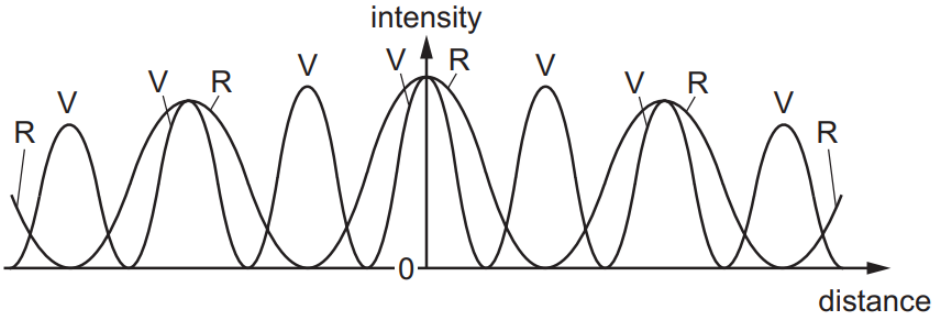
A



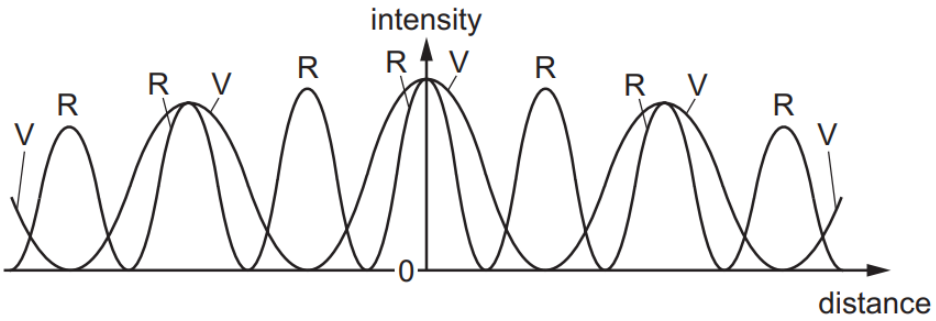
B



C



D



197. 9702/13/O/N/22 Q29

Which property of a light wave can be determined using a diffraction grating?

A amplitude

B intensity

C speed

D wavelength