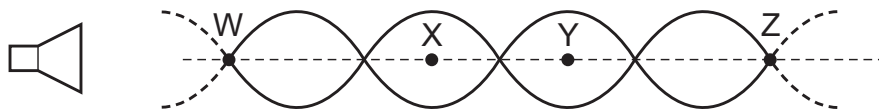


1. Question | 9702 Feb-March 2016 P1 V2 Q24

- 24** The diagram represents the pattern of stationary waves formed by the superposition of sound waves from a loudspeaker and their reflection from a metal sheet (not shown).



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.

2. Question | 9702 Feb-March 2016 P1 V2 Q25

- 25** 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

3. Question | 9702 Feb-March 2016 P1 V2 Q26

- 26** 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°

4. Question | 9702 May-June 2016 P1 V1 Q24

- 24** Which statement concerning a stationary wave is correct?
- A** All the particles between two successive 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.

5. Question | 9702 May-June 2016 P1 V1 Q26

- 26** 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

6. Question | 9702 May-June 2016 P1 V1 Q27

- 27** 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

- 27** 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.

8. Question | 9702 May-June 2016 P1 V2 Q28

- 28** 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.

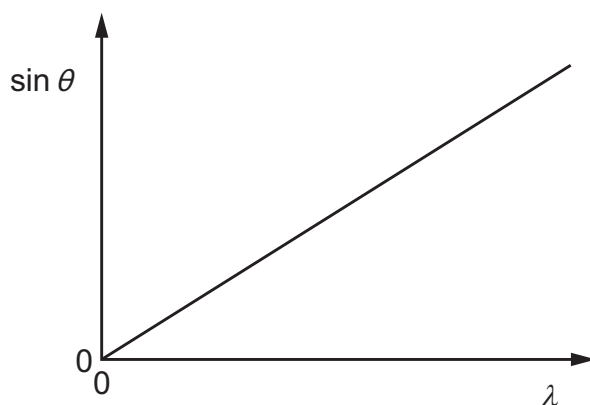
What is the effect on the appearance of the fringes on the screen?

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

9. Question | 9702 May-June 2016 P1 V3 Q27

- 27** 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** $\frac{1}{Nn}$

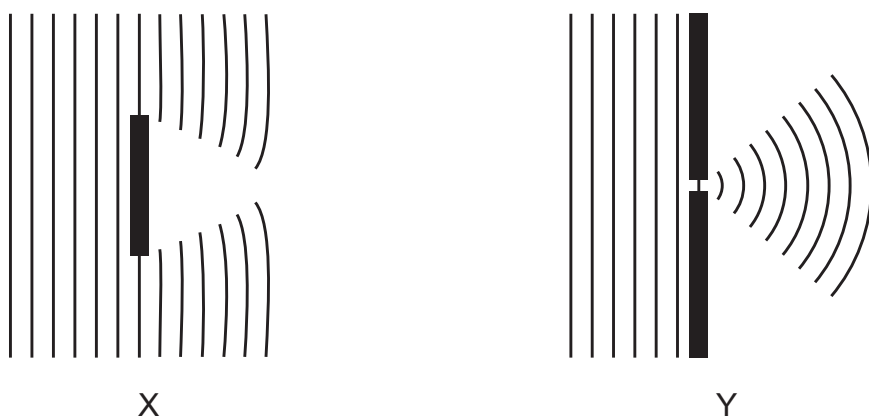
10. Question | 9702 May-June 2016 P1 V3 Q28

- 28** 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

11. Question | 9702 Oct-Nov 2016 P1 V1 Q27

- 27** 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.



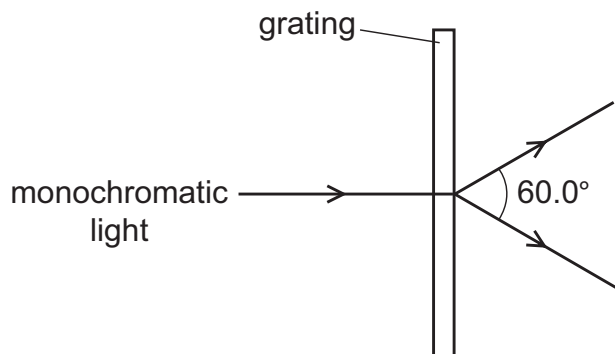
Which statement is correct?

- 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.

12. Question | 9702 Oct-Nov 2016 P1 V1 Q29

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

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

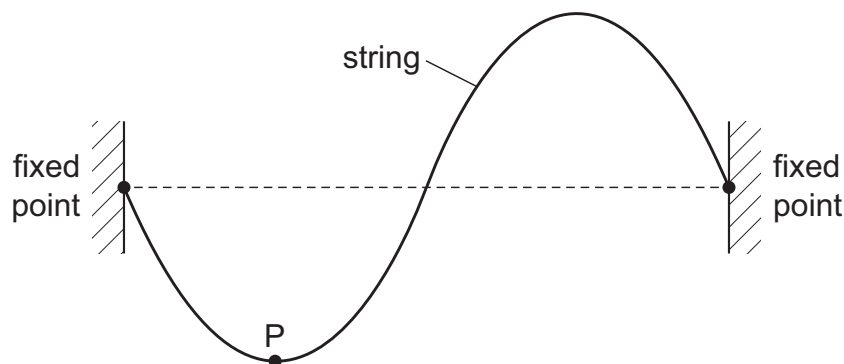


What is the wavelength of the light?

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

13. Question | 9702 Oct-Nov 2016 P1 V2 Q26

26 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** $+0.5 \text{ mm}$ **D** $+1.0 \text{ mm}$

14. Question | 9702 Oct-Nov 2016 P1 V2 Q27

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

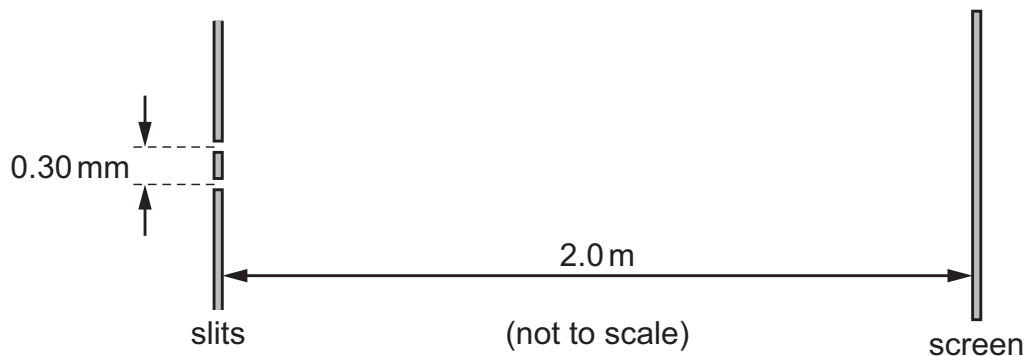
The intensity of the light emerging from one of the slits is now reduced.

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.

15. Question | 9702 Oct-Nov 2016 P1 V2 Q28

- 28** 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.

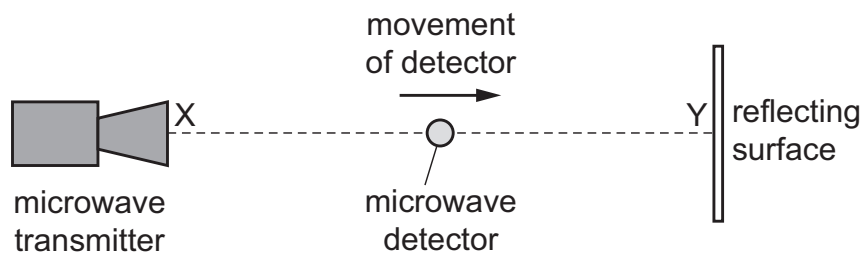


How far apart are the bright fringes on the screen?

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

16. Question | 9702 Oct-Nov 2016 P1 V2 Q29

- 29** 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.

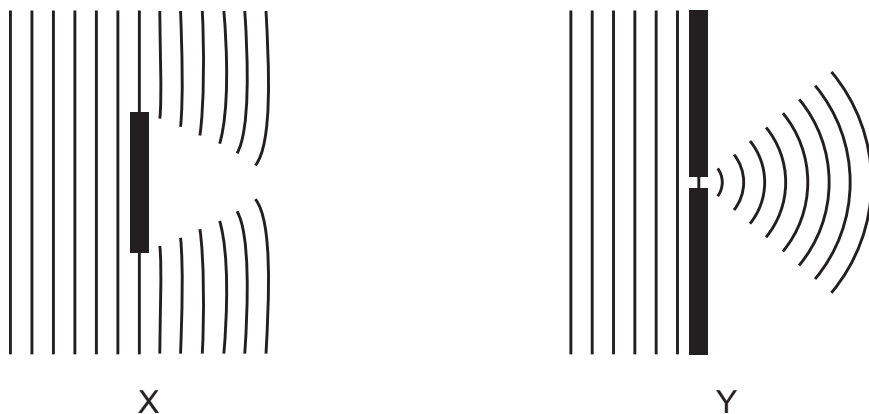
What is the frequency of the microwave radiation?

- A** $1.0 \times 10^8 \text{ Hz}$
- B** $2.0 \times 10^8 \text{ Hz}$
- C** $1.0 \times 10^{10} \text{ Hz}$
- D** $2.0 \times 10^{10} \text{ Hz}$

17. Question | 9702 Oct-Nov 2016 P1 V3 Q27

- 27** 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.



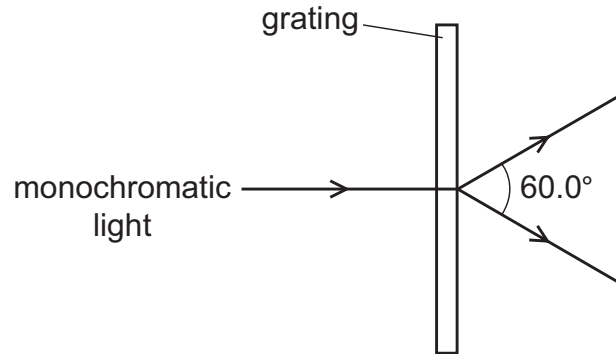
Which statement is correct?

- 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.

18. Question | 9702 Oct-Nov 2016 P1 V3 Q29

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

The spacing of the slits in the grating is $1.15 \times 10^{-6} \text{ m}$. 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

19. Question | 9702 Feb-March 2017 P1 V2 Q27

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

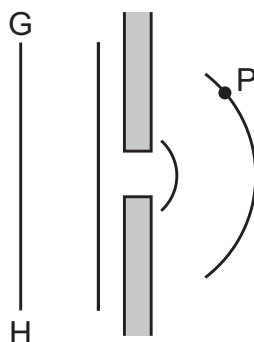
At an antinode, what could be the ratio $\frac{\text{displacement of the incident wave}}{\text{displacement of the reflected wave}}$ at any instant?

- A** -1 **B** 0 **C** 1 **D** 2

20. Question | 9702 Feb-March 2017 P1 V2 Q28

28 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 $\frac{4\lambda}{c}$

21. Question | 9702 Feb-March 2017 P1 V2 Q29

- 29** 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 .

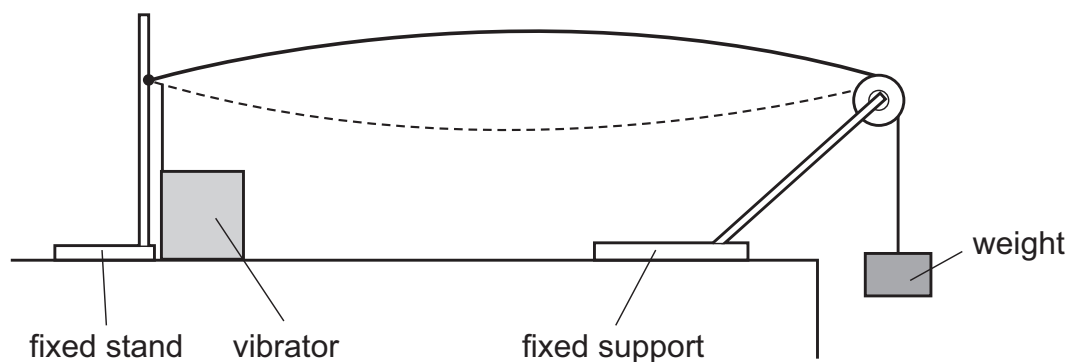
The wavelength of light is 550 nm .

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

22. Question | 9702 May-June 2017 P1 V1 Q27

- 27** 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** $4f$

23. Question | 9702 May-June 2017 P1 V1 Q28

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

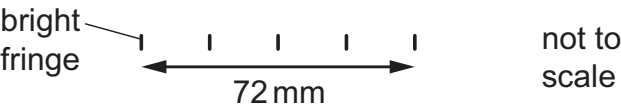
What is the total number of intensity maxima from the grating?

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

24. Question | 9702 May-June 2017 P1 V1 Q29

29 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** $1.2 \times 10^{-4} \text{ m}$ **B** $1.6 \times 10^{-4} \text{ m}$ **C** $3.1 \times 10^{-5} \text{ m}$ **D** $3.3 \times 10^{-9} \text{ m}$

25. Question | 9702 May-June 2017 P1 V2 Q27

27 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

26. Question | 9702 May-June 2017 P1 V2 Q29

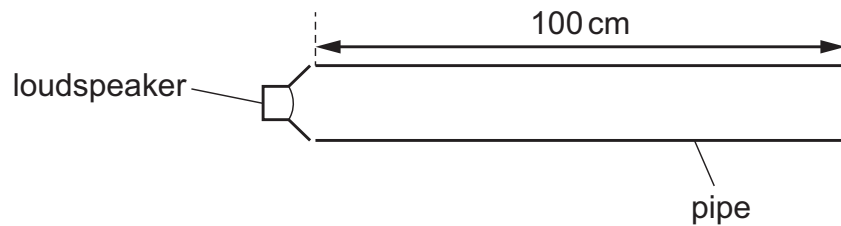
- 29** Two wave sources are oscillating in phase. Each source produces a wave of wavelength λ . The two waves from the sources meet at point X with a phase difference of 90° .

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

27. Question | 9702 May-June 2017 P1 V3 Q26

- 26** 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?

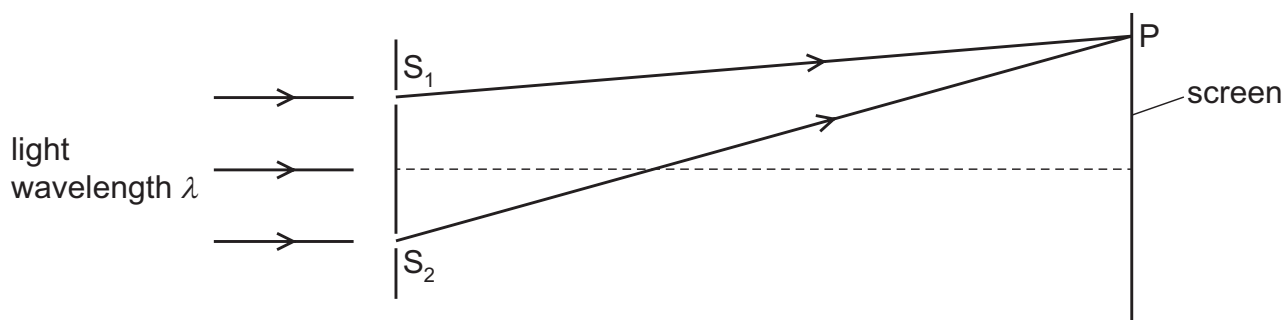
- A** 50 cm **B** 75 cm **C** 150 cm **D** 300 cm

27 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

- 28** 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.

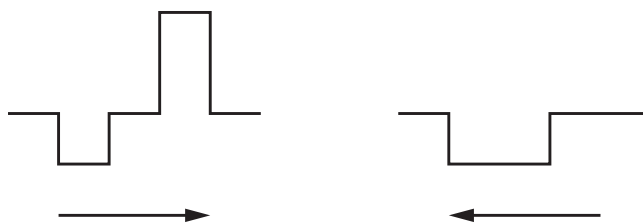


The n th **dark** fringe from the central bright fringe is observed at point P on the screen.

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

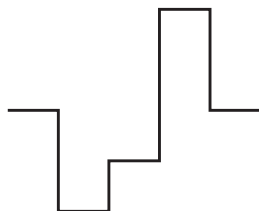
27 Two signals approach each other, as shown.



At one instant, the signals completely overlap.

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

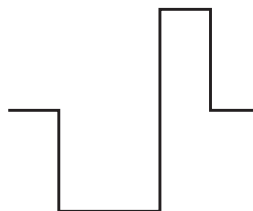
A



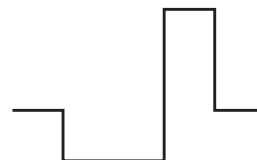
B



C

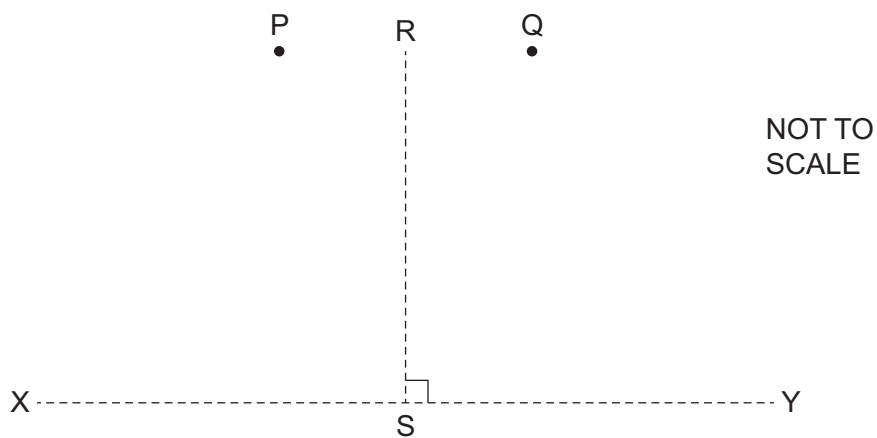


D



31. Question | 9702 Oct-Nov 2017 P1 V1 Q28

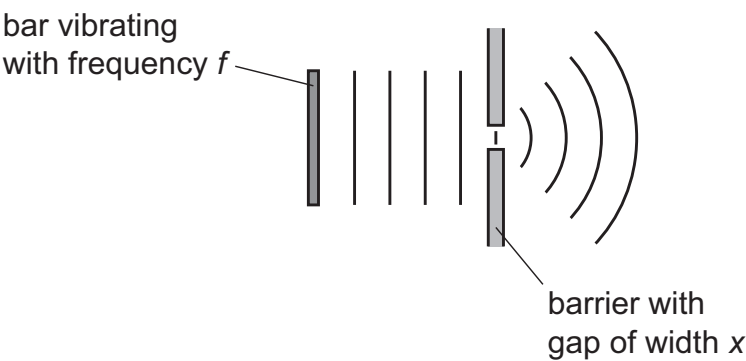
- 28** Coherent waves are produced at P and at Q and travel outwards in all directions. The line RS is half-way between P and Q and perpendicular to the line joining P and Q. The distance RS is much greater than the distance PQ.



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

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



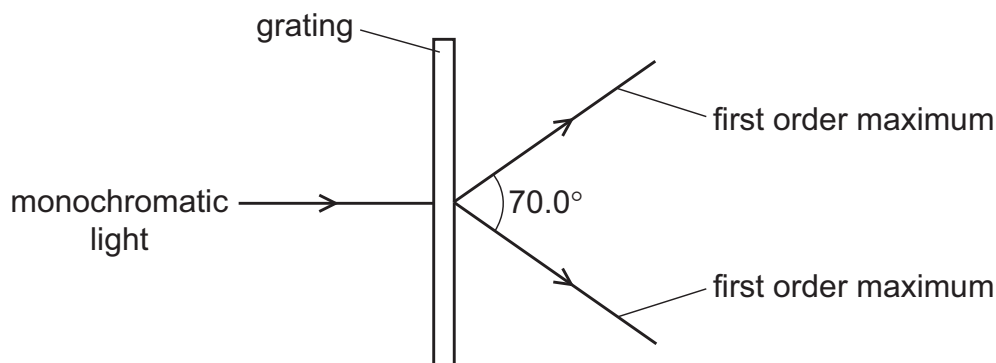
The waves pass through a gap of width x in a barrier so that diffraction occurs.

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	$2f$	$2x$

33. Question | 9702 Oct-Nov 2017 P1 V1 Q30

- 30** 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 $1.00 \times 10^{-6} \text{ m}$. 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

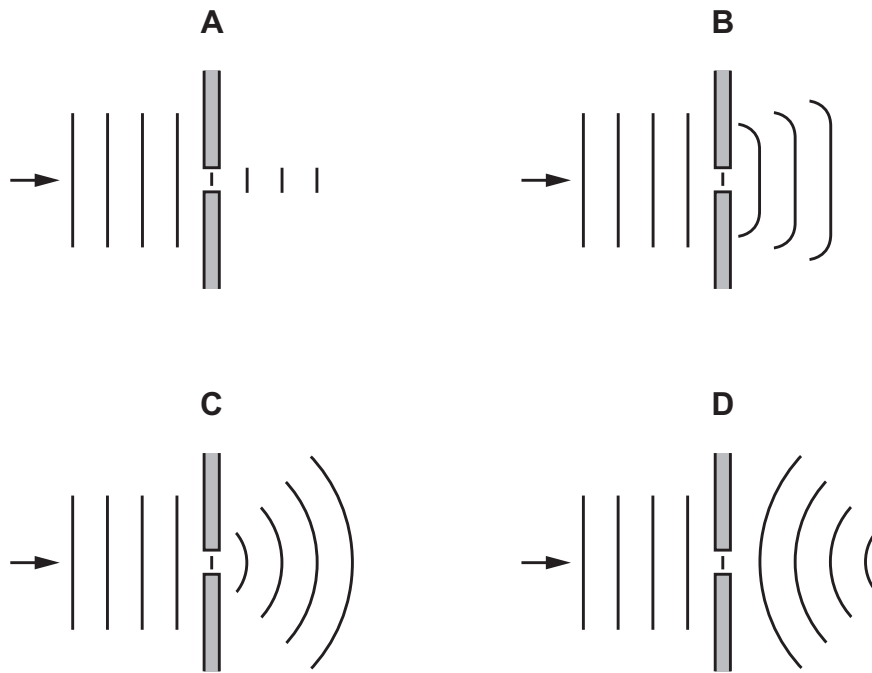
34. Question | 9702 Oct-Nov 2017 P1 V2 Q27

- 27** 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

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



36. Question | 9702 Oct-Nov 2017 P1 V2 Q29

29 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.

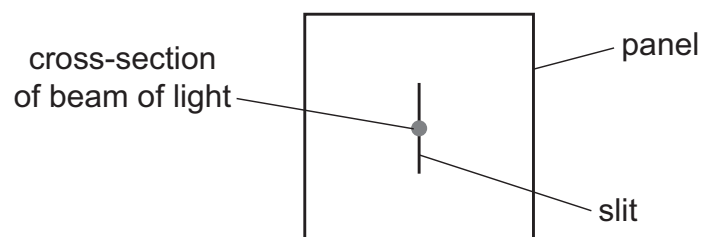
37. Question | 9702 Oct-Nov 2017 P1 V2 Q30

30 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?

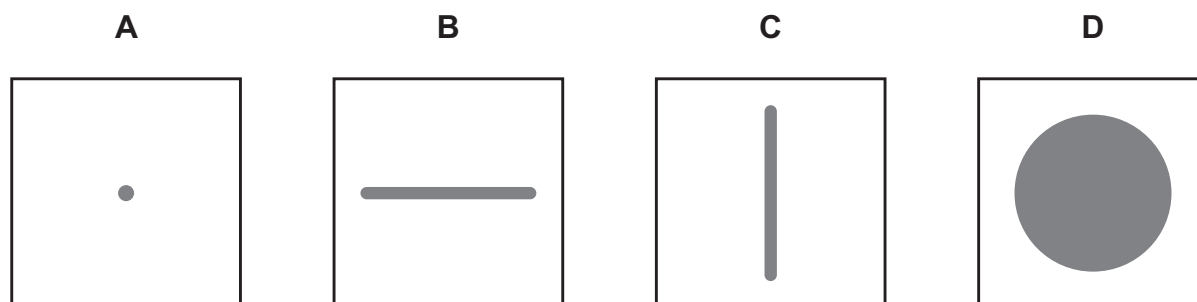
- A** $\frac{1}{4}$ **B** $\frac{1}{2}$ **C** 2 **D** 4

29 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.

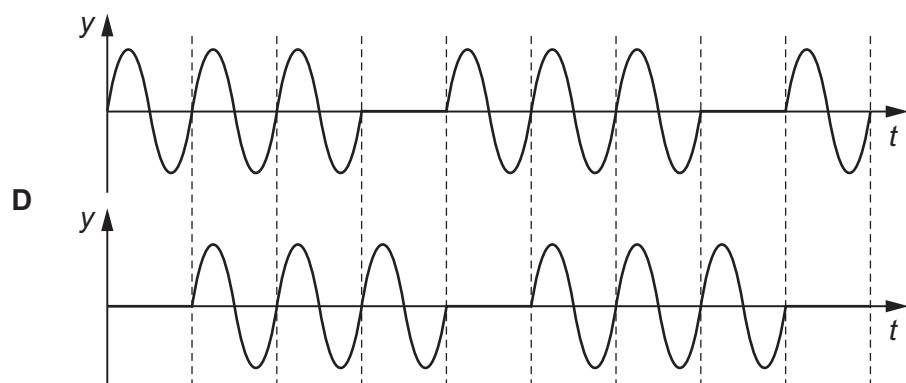
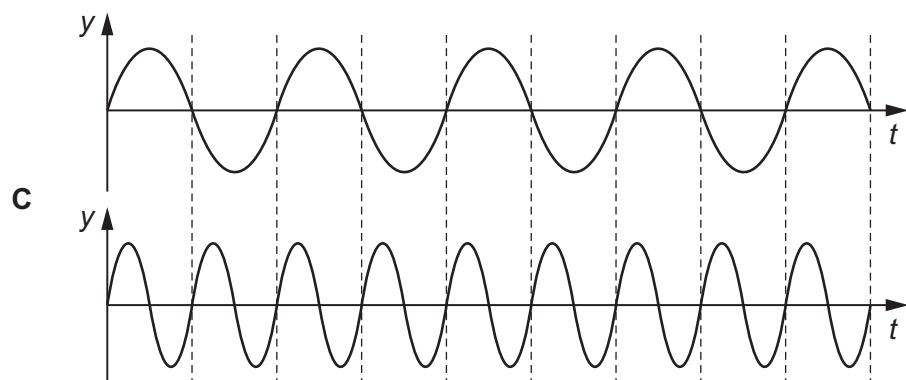
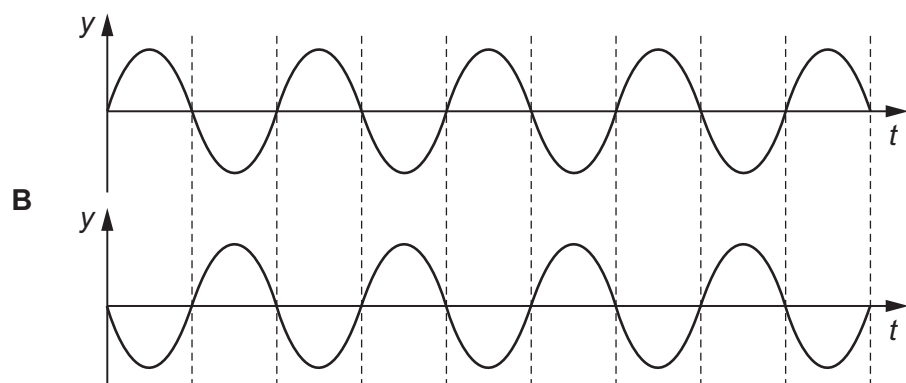
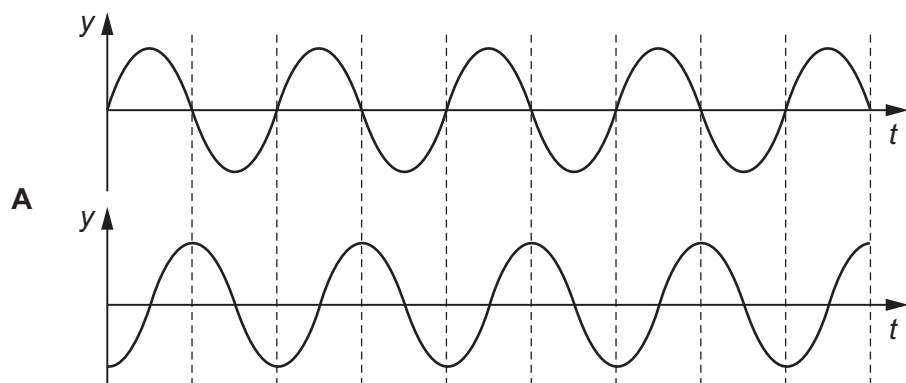
What is the pattern of light seen on the screen?



39. Question | 9702 Oct-Nov 2017 P1 V3 Q30

- 30** 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?



40. Question | 9702 Feb-March 2018 P1 V2 Q26

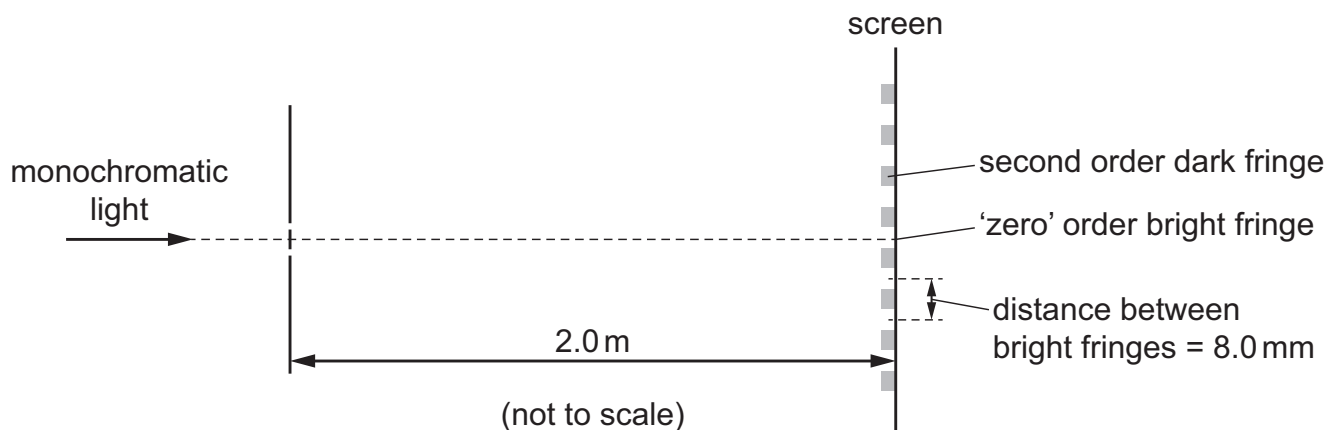
- 26** In a double-slit interference experiment, light of frequency 6.0×10^{14} Hz is incident on a pair of slits. Bright fringes that are 3.0 mm apart are observed on a screen some distance away.

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

41. Question | 9702 Feb-March 2018 P1 V2 Q27

- 27** 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.



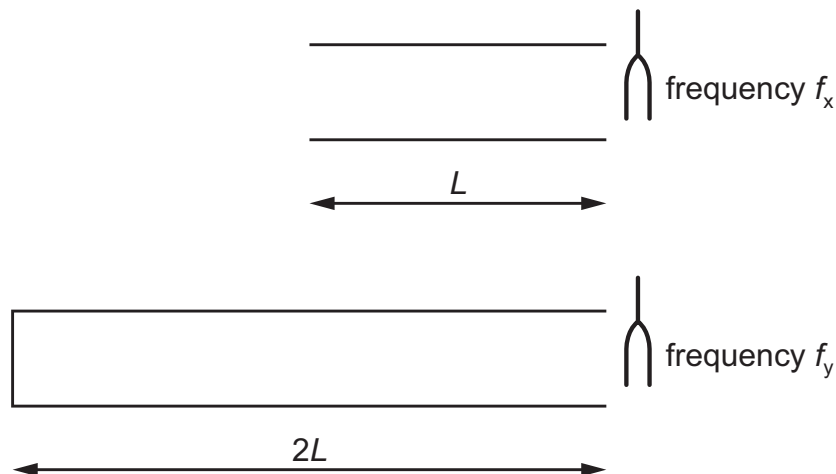
What is the path difference between the light waves from the two slits that meet at the second order dark fringe?

- A** 2.0×10^{-7} m
B 4.0×10^{-7} m
C 6.0×10^{-7} m
D 8.0×10^{-7} m

42. Question | 9702 Feb-March 2018 P1 V2 Q28

- 28** 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.

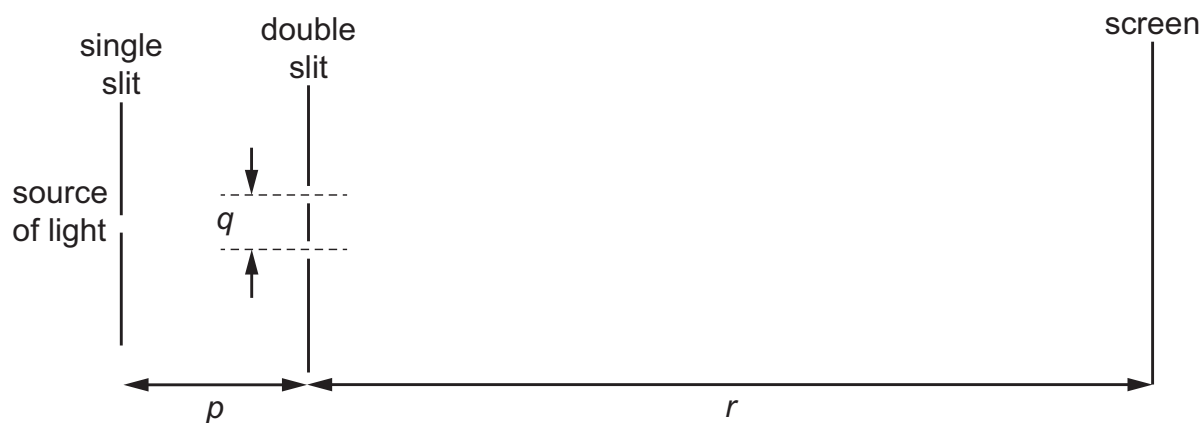
Which equation is correct?

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

43. Question | 9702 Feb-March 2018 P1 V2 Q29

- 29** 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.

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

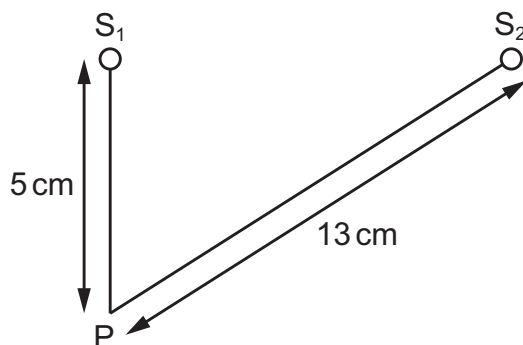


Which change to the apparatus will increase the fringe spacing?

- A** decreasing the distance p
- B** decreasing the distance q
- C** decreasing the distance r
- D** decreasing the wavelength of the light

45. Question | 9702 May-June 2018 P1 V1 Q26

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



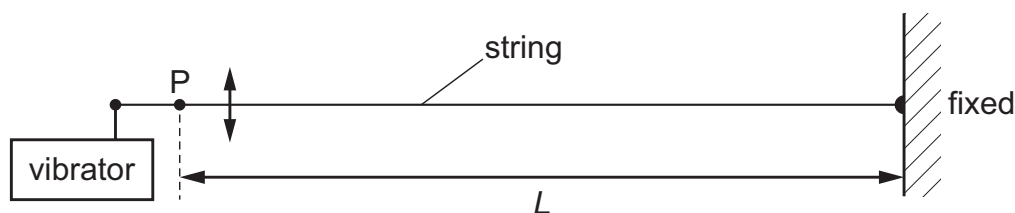
The sources each generate a wave of wavelength 2.0 cm. Each source produces a wave that has amplitude x_0 when it reaches point P .

What is the amplitude of the oscillation at P ?

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

46. Question | 9702 May-June 2018 P1 V2 Q24

- 24** 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** $4\frac{L}{1}, 4\frac{L}{3}, 4\frac{L}{5}, 4\frac{L}{7}, 4\frac{L}{9}$

47. Question | 9702 May-June 2018 P1 V2 Q26

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



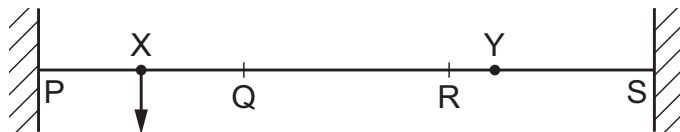
Sound of the unknown frequency is reflected back from a metal plate. A microphone placed at a distance D from the metal plate detects the sound intensity. A minimum intensity is detected with $D = 12.0\text{ cm}$. The plate is moved further away from the microphone until the next minimum is detected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

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

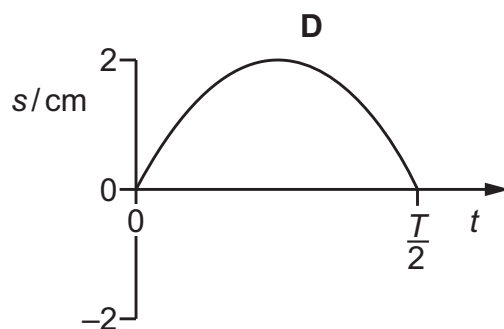
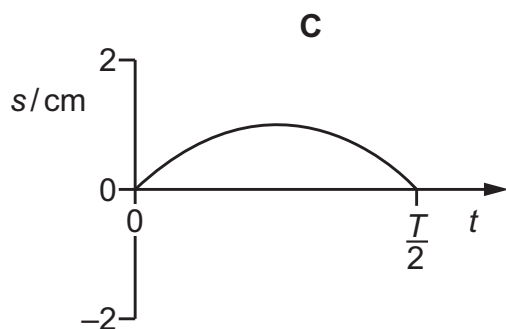
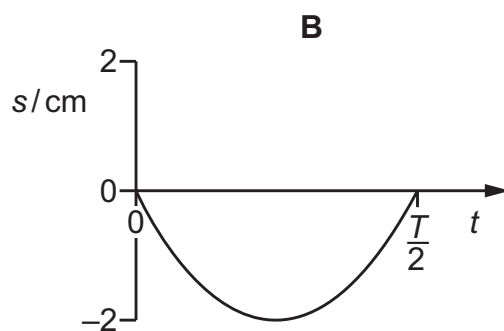
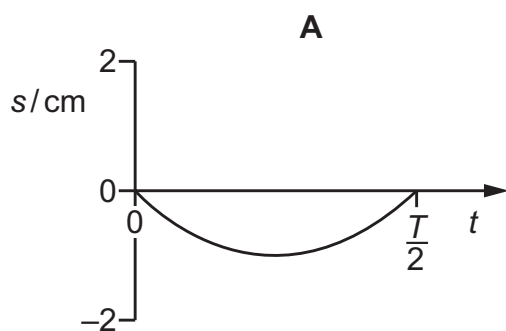
- 28** The diagram shows a stationary wave, at time $t = 0$, that has been set up on a string fixed between points P and S.



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.

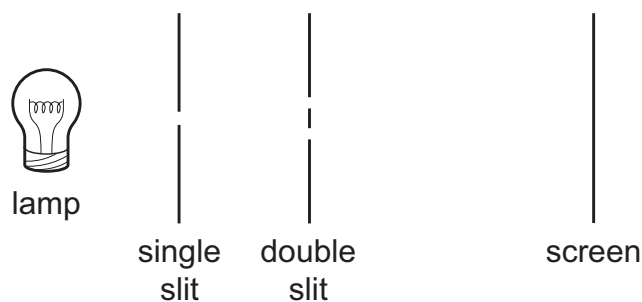
The displacement s is positive in the upward direction.

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



49. Question | 9702 May-June 2018 P1 V2 Q29

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

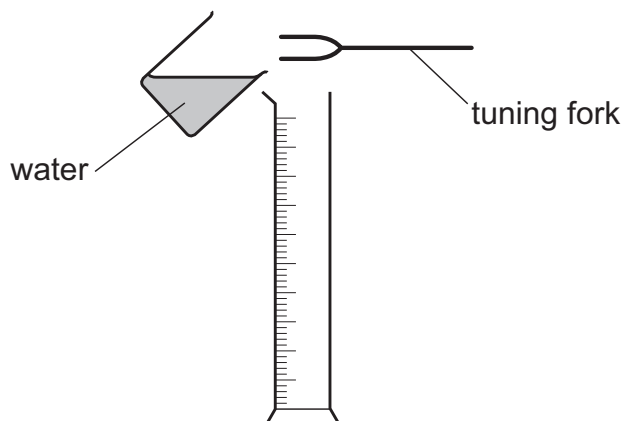


What is the main purpose of the single slit?

- 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

50. Question | 9702 May-June 2018 P1 V3 Q24

24 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

51. Question | 9702 May-June 2018 P1 V3 Q25

25 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

52. Question | 9702 May-June 2018 P1 V3 Q26

26 A double-slit interference pattern using red light of wavelength $7.0 \times 10^{-7} \text{ m}$ 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 $4.5 \times 10^{-7} \text{ m}$?

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

53. Question | 9702 Oct-Nov 2018 P1 V1 Q27

27 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

54. Question | 9702 Oct-Nov 2018 P1 V1 Q28

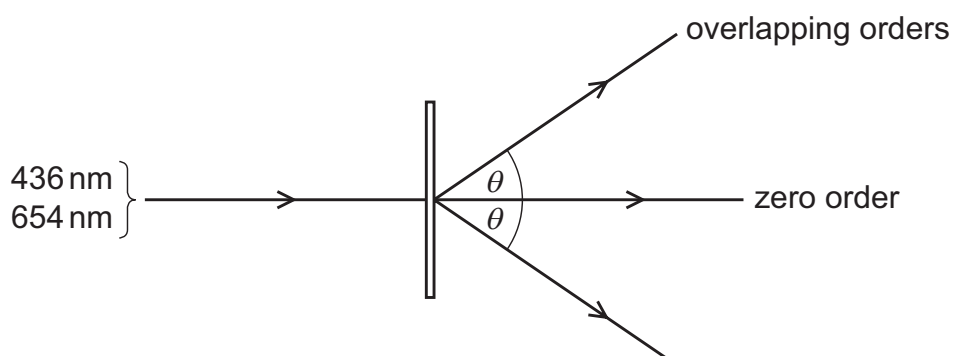
28 When the light from two lamps falls on a screen, no interference pattern can be obtained.

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.

55. Question | 9702 Oct-Nov 2018 P1 V1 Q29

- 29** A beam of light consists of two wavelengths of 436 nm and 654 nm. A diffraction grating of $5.00 \times 10^5 \text{ lines m}^{-1}$ 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.

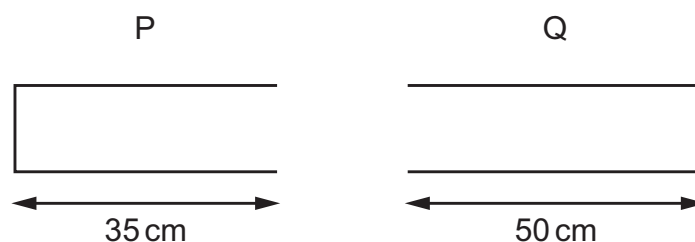


What is the angle θ ?

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

56. Question | 9702 Oct-Nov 2018 P1 V2 Q27

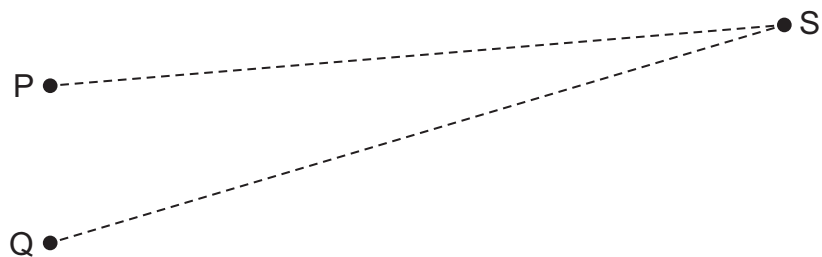
- 27** Progressive sound waves of wavelength 20 cm enter the air columns in a closed pipe P and an open pipe Q. The lengths of the pipes are shown.



In which pipe or pipes are stationary waves formed?

- A** P and Q
B P only
C Q only
D neither P nor Q

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



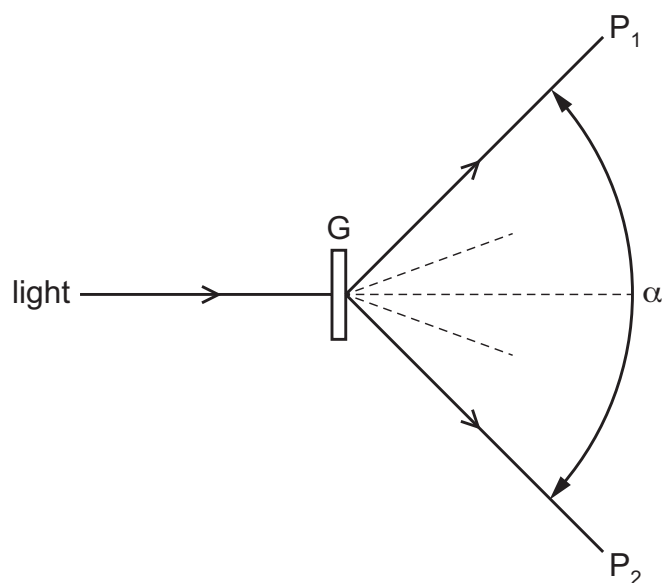
At the point S there is a minimum in the interference pattern produced by waves from the two sources. The distance $(QS - PS)$ is called the path difference.

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** $(2n + \frac{1}{2})\lambda$

- 30** 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.

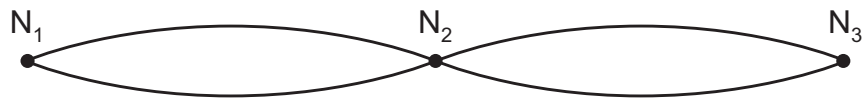


What is the spacing of the lines on the grating?

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

59. Question | 9702 Oct-Nov 2018 P1 V3 Q26

- 26** The diagram shows a stationary wave on a string. The stationary wave has three nodes N_1 , N_2 and N_3 .



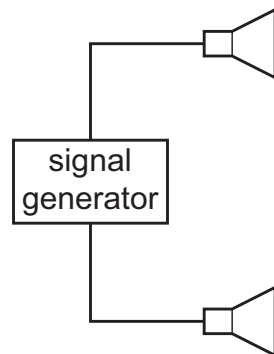
Which statement is correct?

- 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.

60. Question | 9702 Oct-Nov 2018 P1 V3 Q27

- 27** 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.

28 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?

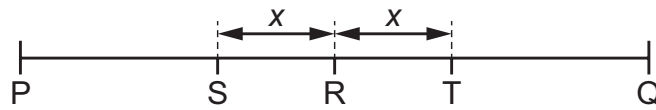
- A** diffraction of the sound waves
- B** Doppler shift of the sound waves
- C** interference of the sound waves
- D** reflection of the sound waves

- 29** 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

- 27** 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.

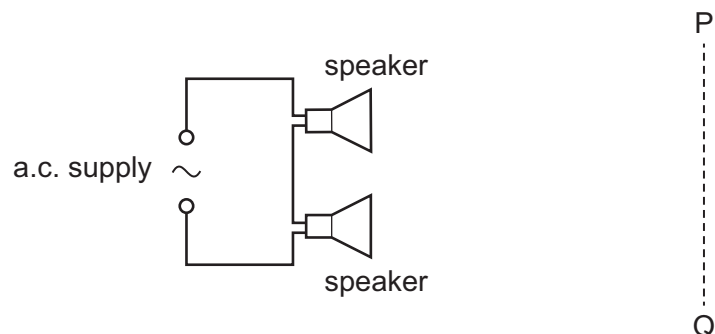


P, R and Q are the only points on the string where nodes are formed. S and T are two points on the string at a distance x from R.

What is the relationship between points S and T?

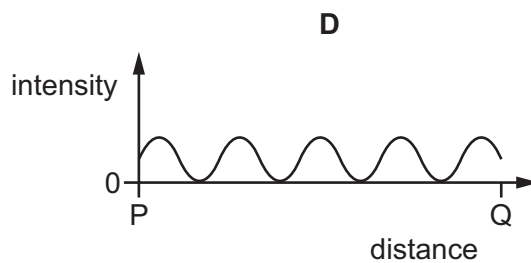
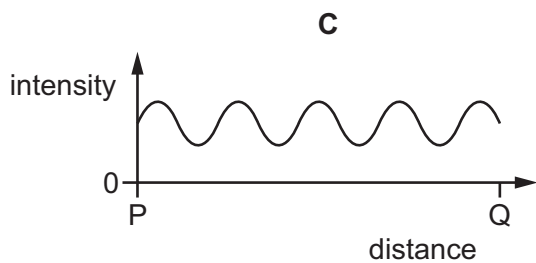
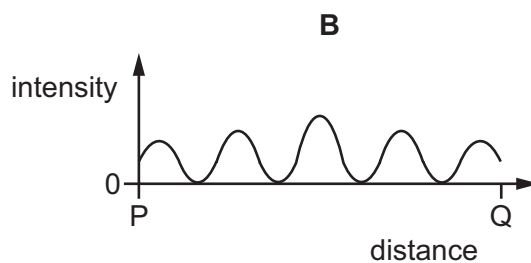
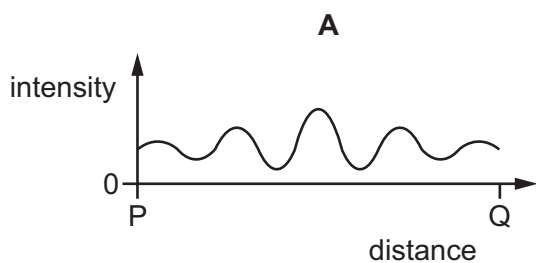
- A** the same amplitude and in phase
- B** different amplitudes and in phase
- C** the same amplitude and a phase difference of 180°
- D** different amplitudes and a phase difference of 180°

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

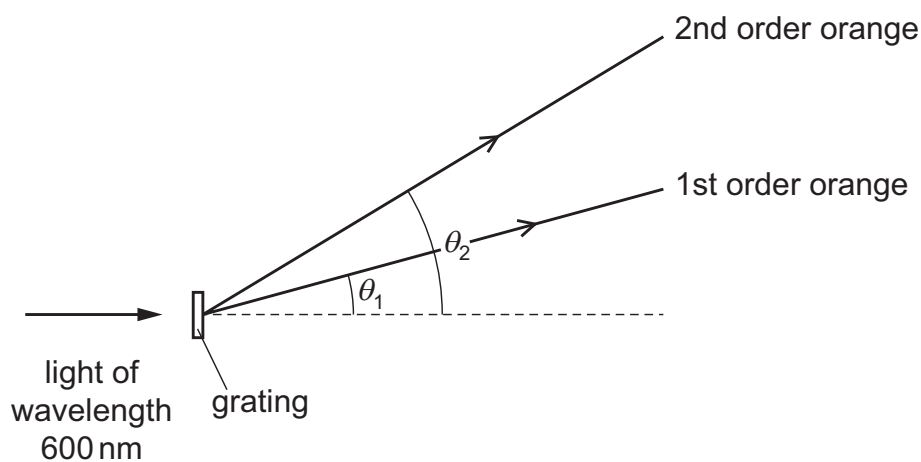


A microphone is moved along the line PQ.

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



- 29** A diffraction grating experiment is set up using orange light of wavelength 600 nm. The grating has a slit separation of $2.00\ \mu\text{m}$.



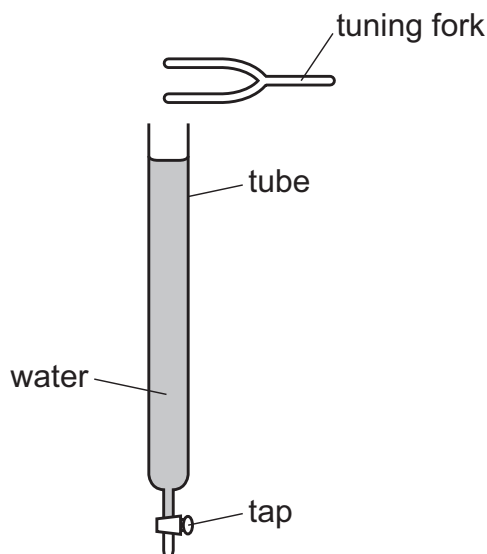
What is the angular separation ($\theta_2 - \theta_1$) between the first and second order maxima of the orange light?

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

66. Question | 9702 May-June 2019 P1 V1 Q24

24 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

67. Question | 9702 May-June 2019 P1 V1 Q27

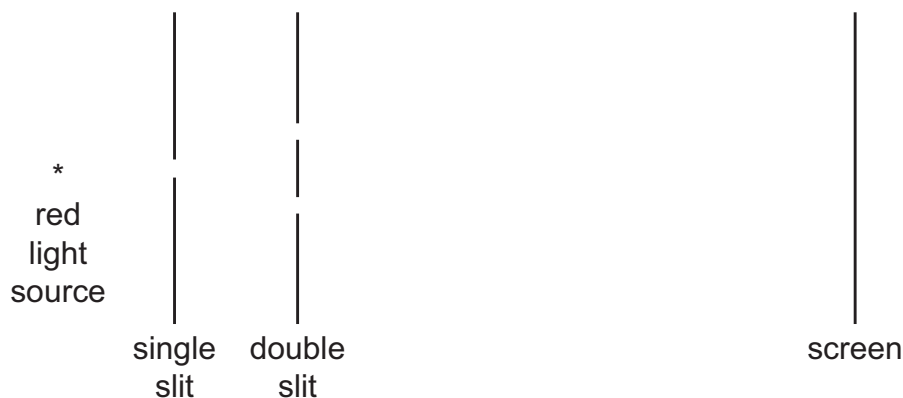
27 Two progressive waves of frequency 300 Hz superpose to produce a stationary wave in which adjacent nodes are 1.5 m apart.

What is the speed of the progressive waves?

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

68. Question | 9702 May-June 2019 P1 V1 Q29

29 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

69. Question | 9702 May-June 2019 P1 V1 Q30

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

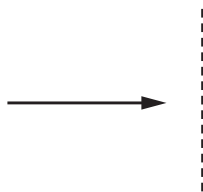
Using the diffraction grating, yellow light of the first order is seen at 30° to the normal to the grating.

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?

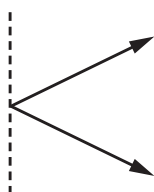
- A** 2.5×10^{-7} m
B 1.0×10^{-5} m
C 1.0×10^{-3} m
D 1.0×10^{-1} m

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

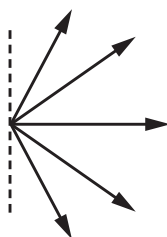


Which diagram could show all the possible directions of the light, after passing through the grating, that give maximum intensity?

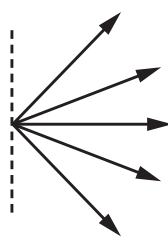
A



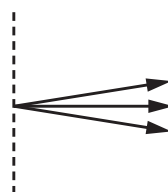
B



C



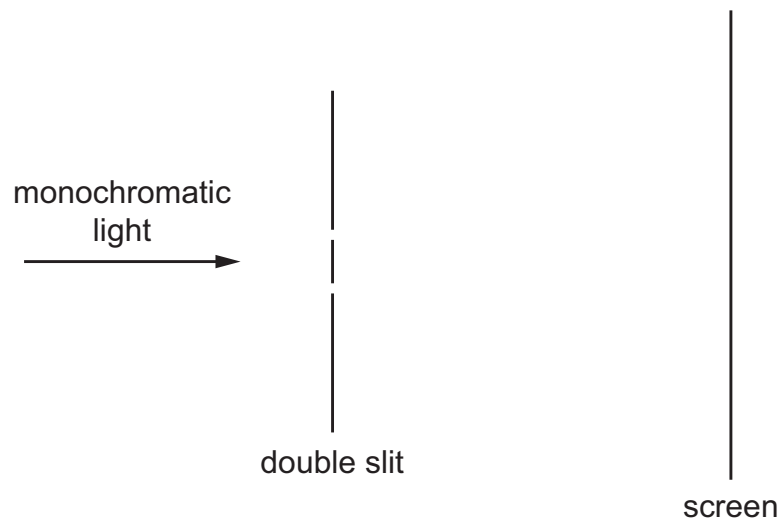
D



- 30** 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.

72. Question | 9702 May-June 2019 P1 V2 Q31

- 31** 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.

73. Question | 9702 May-June 2019 P1 V3 Q26

- 26** 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.

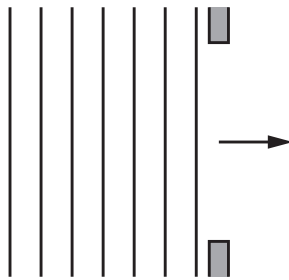
The frequency is then increased further.

At which frequency does a third stationary wave occur?

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

74. Question | 9702 May-June 2019 P1 V3 Q27

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



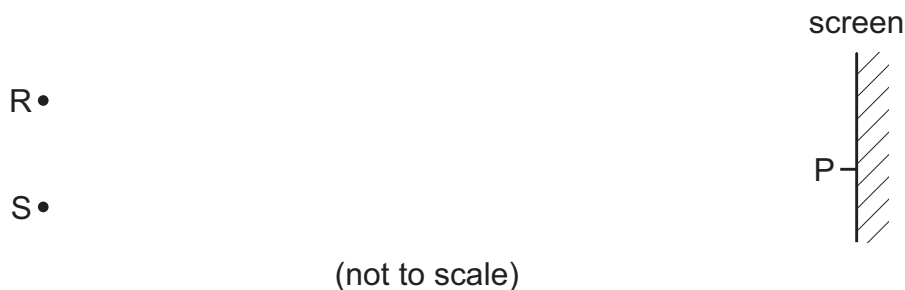
Some diffraction of the water waves is observed.

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.

75. Question | 9702 May-June 2019 P1 V3 Q28

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



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

What could explain the zero intensity at P?

- A** Light from the two sources is emitted 180° out of phase and the path difference to P is $\frac{1}{2}\lambda$.
- B** Light from the two sources is emitted in phase and the path difference to P is λ .
- C** Light from the two sources is emitted 90° out of phase and the path difference to P is λ .
- D** Light from the two sources is emitted in phase and the path difference to P is $\frac{1}{2}\lambda$.

76. Question | 9702 May-June 2019 P1 V3 Q29

- 29** 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 .

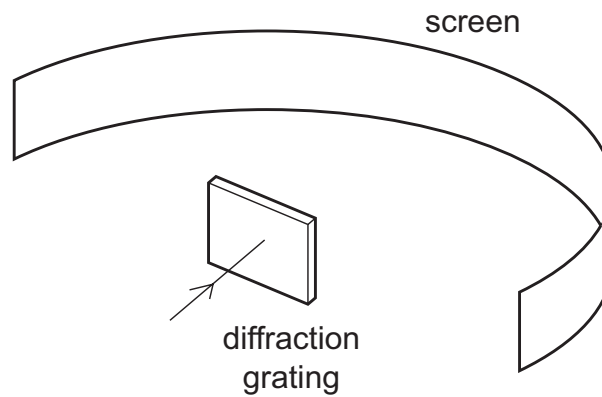
The distance to the screen is now changed to 1.8 m and the slit separation is doubled.

What is the new fringe width?

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

77. Question | 9702 May-June 2019 P1 V3 Q30

- 30** 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.

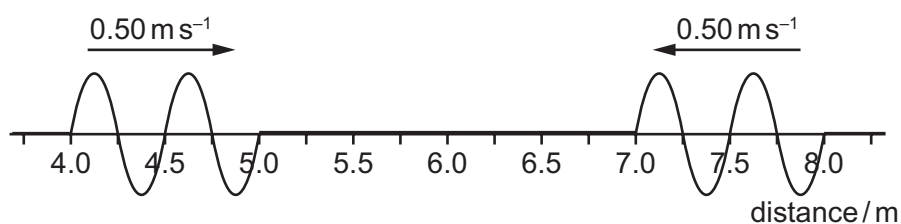


What is the greatest number of maxima that can be observed?

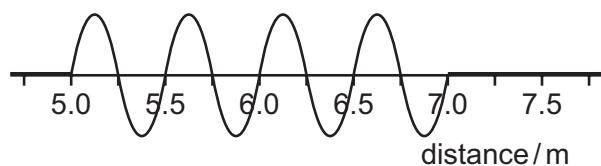
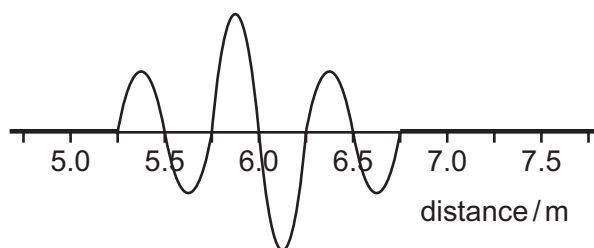
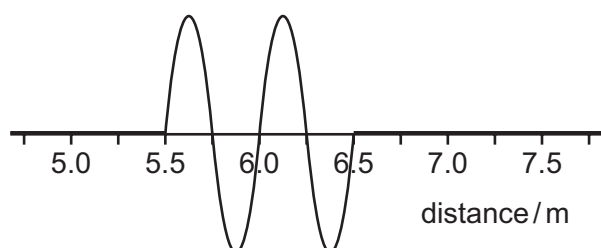
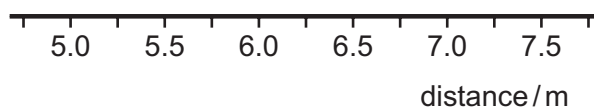
- A** 4 **B** 5 **C** 8 **D** 9

78. Question | 9702 Oct-Nov 2019 P1 V1 Q26

- 26** 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 ms^{-1} . The diagram shows the rope at time $t = 0$.

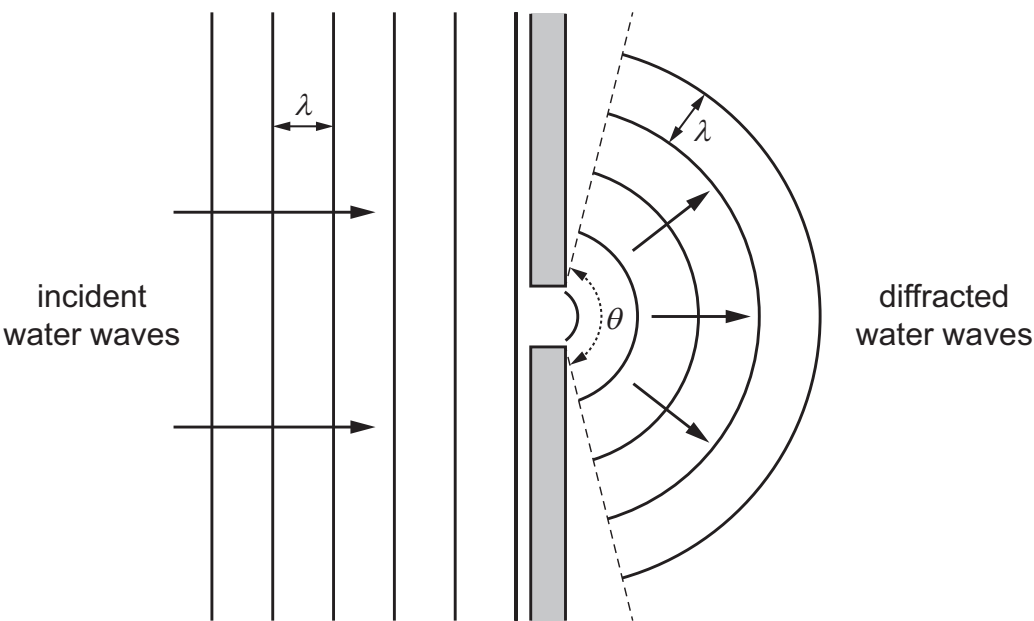


Which diagram shows the rope at time $t = 3.0 \text{ s}$?

A**B****C****D**

79. Question | 9702 Oct-Nov 2019 P1 V1 Q27

- 27** 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

80. Question | 9702 Oct-Nov 2019 P1 V1 Q28

- 28** 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

81. Question | 9702 Oct-Nov 2019 P1 V1 Q29

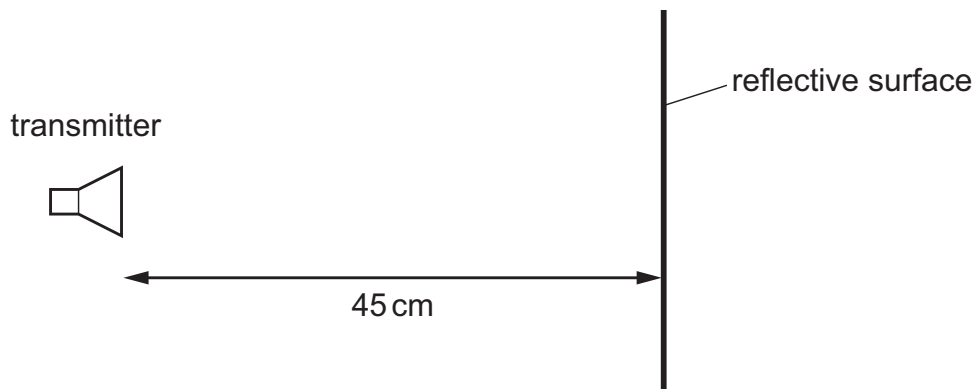
- 29** Monochromatic light of frequency f is incident on a diffraction grating of line spacing d . The speed of light is c .

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** $n = \frac{c}{df}$

82. Question | 9702 Oct-Nov 2019 P1 V2 Q25

- 25** 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

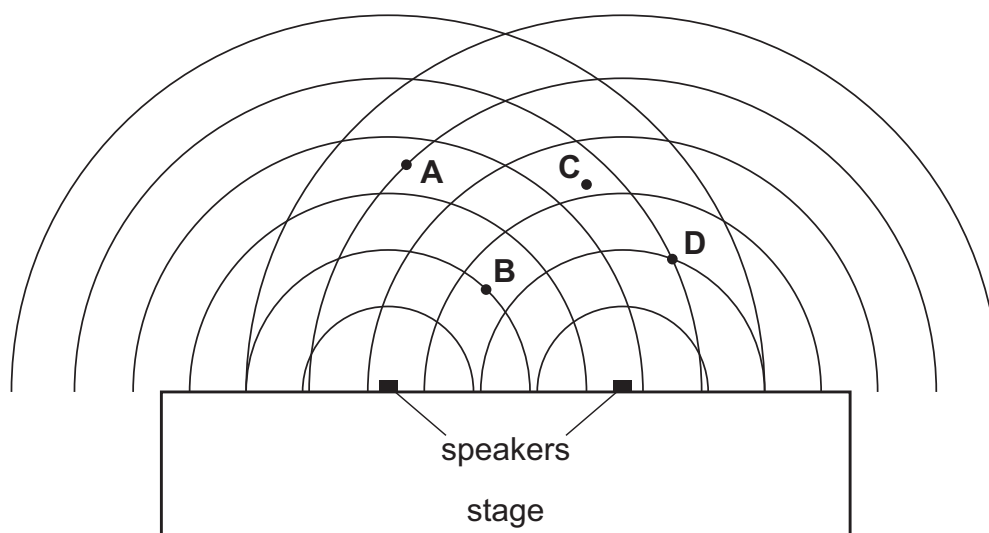
83. Question | 9702 Oct-Nov 2019 P1 V2 Q27

27 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?



84. Question | 9702 Oct-Nov 2019 P1 V2 Q28

28 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** $2.5 \times 10^{-7} \text{ m}$ **B** $5.0 \times 10^{-7} \text{ m}$ **C** $1.0 \times 10^{-6} \text{ m}$ **D** $5.0 \times 10^{-5} \text{ m}$

85. Question | 9702 Oct-Nov 2019 P1 V3 Q26

26 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.

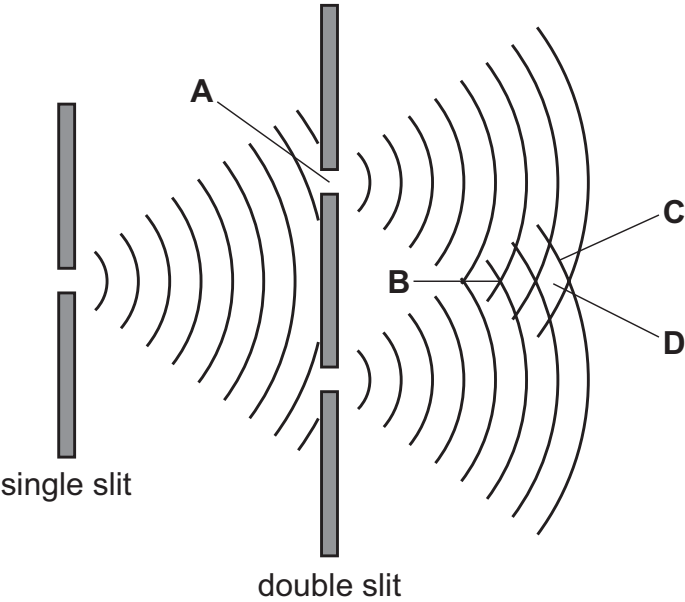
Which row gives a value of d for a maximum and for a minimum?

	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

86. Question | 9702 Oct-Nov 2019 P1 V3 Q29

29 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?



87. Question | 9702 Oct-Nov 2019 P1 V3 Q30

- 30** 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°

88. Question | 9702 Feb-March 2020 P1 V2 Q26

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

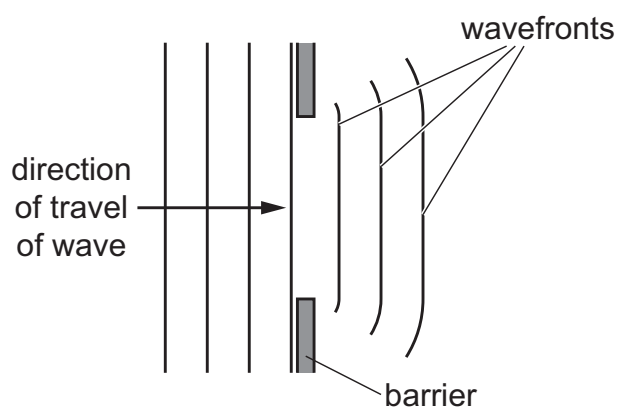


A musician maintains stationary sound waves with a node at the mouthpiece and an antinode at the other end. The lowest frequency of sound that the instrument can produce is 92 Hz.

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

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



What is the name of this phenomenon?

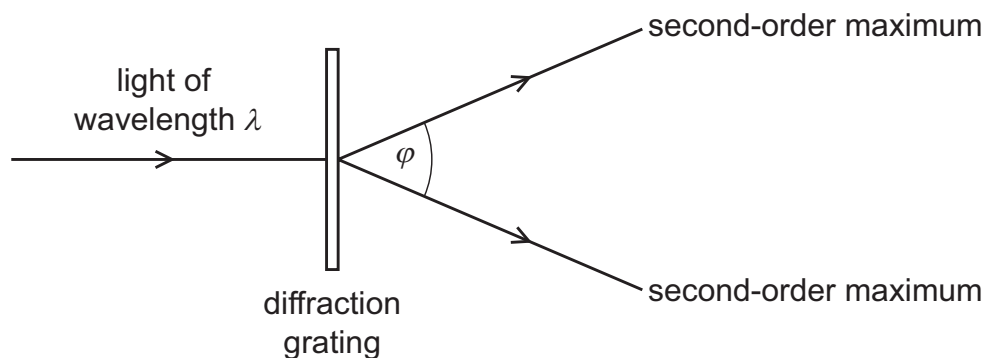
- A** coherence
- B** diffraction
- C** interference
- D** superposition

- 28** 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

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



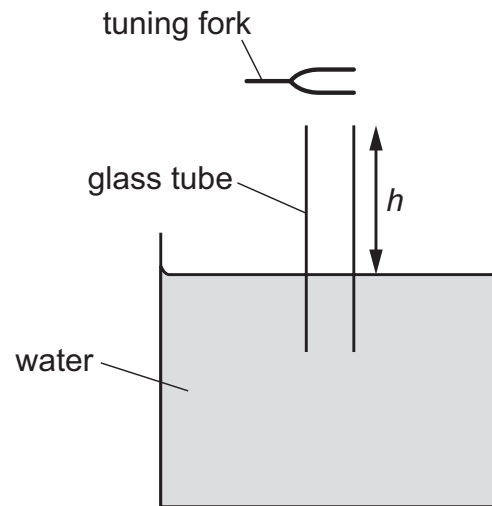
The angle between the two second-order maxima is φ .

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** $\frac{2\lambda}{\sin (\varphi / 2)}$

- 24** 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} .

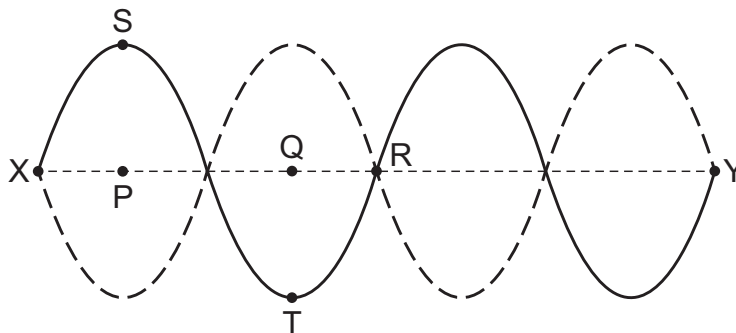


What is the frequency of the sound produced by the tuning fork?

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

93. Question | 9702 May-June 2020 P1 V1 Q27

- 27** 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.

94. Question | 9702 May-June 2020 P1 V1 Q29

- 29** 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

95. Question | 9702 May-June 2020 P1 V1 Q30

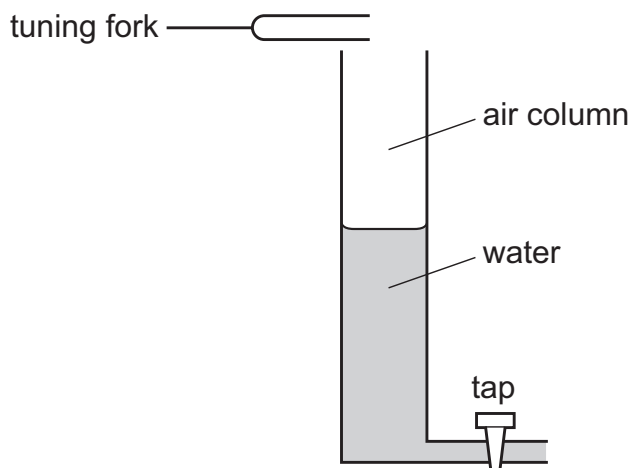
- 30** A diffraction grating and a screen are used to determine the single wavelength λ of the light from a source.

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.

96. Question | 9702 May-June 2020 P1 V2 Q24

- 24** 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

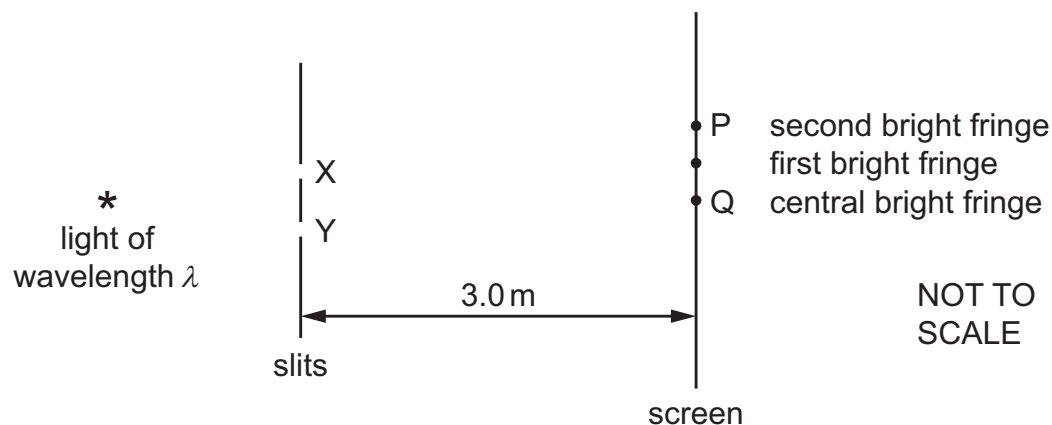
97. Question | 9702 May-June 2020 P1 V2 Q27

- 27** 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.

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



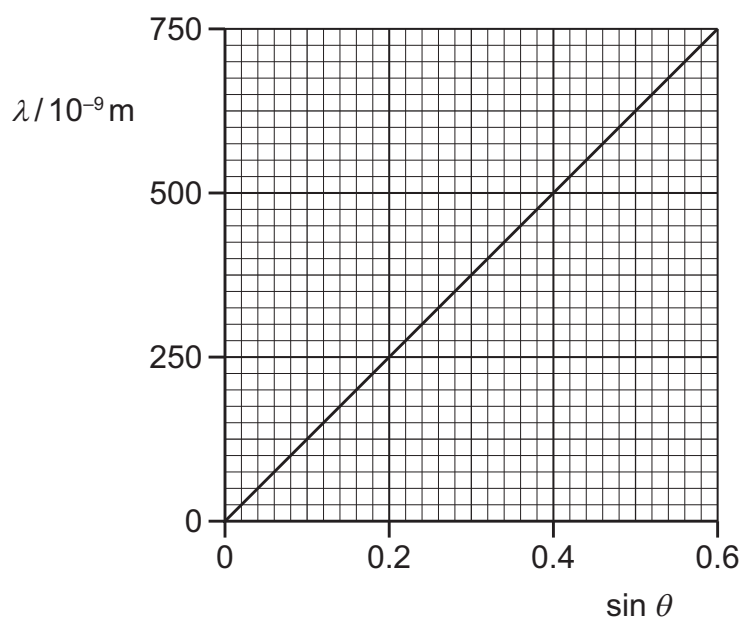
An interference pattern is observed on a screen 3.0 m away from the slits X and Y, which have a separation of 1.0 mm.

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

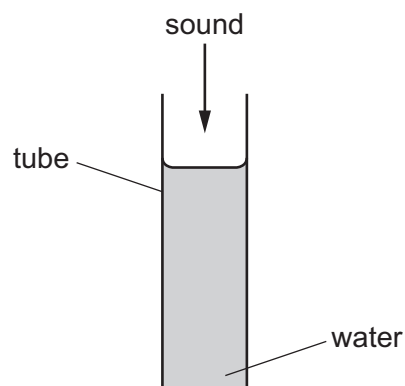
- 30** Light of wavelength λ is incident normally on a diffraction grating. The angle between the **second**-order maximum and the normal to the grating is θ . The variation with $\sin \theta$ of λ is shown on the graph.



How many lines per millimetre are on the diffraction grating?

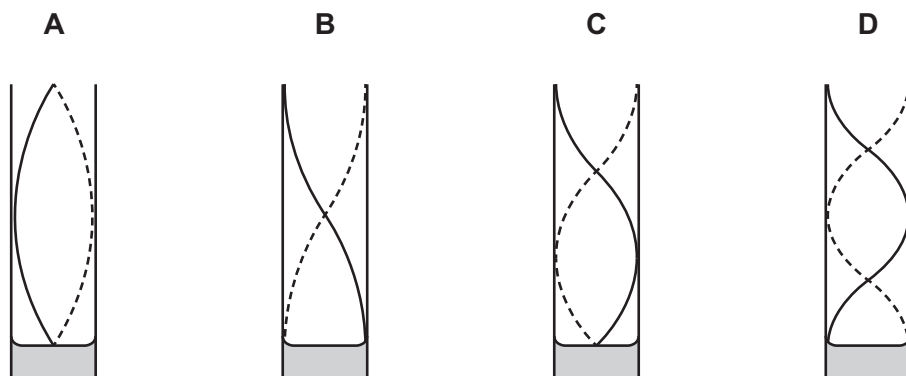
- A** 400 mm^{-1} **B** 625 mm^{-1} **C** 800 mm^{-1} **D** 1250 mm^{-1}

- 27** A vertical tube is partially filled with water. A sound wave moves down the tube and is reflected by the surface of the water. The frequency of the sound wave is gradually increased from zero until a much louder sound is heard.



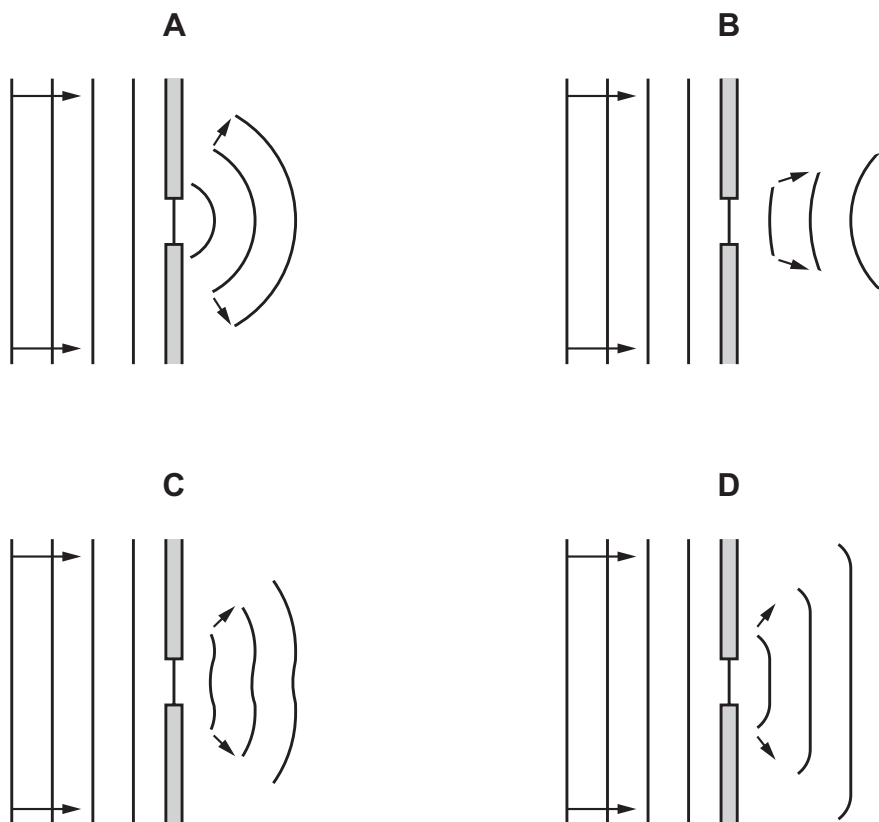
Water is then removed from the tube until a second louder sound is heard.

Which diagram shows the new pattern of the stationary wave that is formed?



28 Water waves in a ripple tank are made to pass through a small gap as shown.

Which diagram shows the waves after they have passed through the gap?



29 A double-slit interference experiment is set up using green light.

A pattern of interference fringes is formed on a screen.

Which single change will increase the separation of the fringes?

- A** increase the width of each slit
- B** move the screen nearer to the double slit
- C** use slits that are further apart
- D** use red light instead of green light

103. Question | 9702 May-June 2020 P1 V3 Q30

- 30** Light of a single wavelength from a distant point source falls normally onto a diffraction grating positioned with its lines vertical.



The plane of the diffraction grating is at right angles to the incident light. A student looks at the grating from a position near to the grating.

What could the student see?

- A** a central point source with a series of point source images on either side
- B** a central vertical line with a series of spectra on either side
- C** a series of fine vertical lines
- D** a single point source

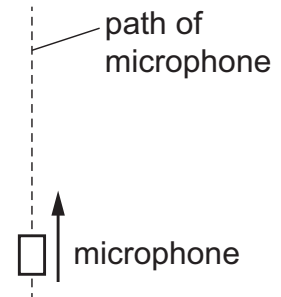
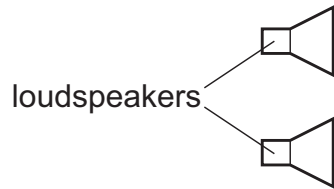
104. Question | 9702 Oct-Nov 2020 P1 V1 Q26

- 26** 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.

28 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.

106. Question | 9702 Oct-Nov 2020 P1 V1 Q29

- 29** 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?

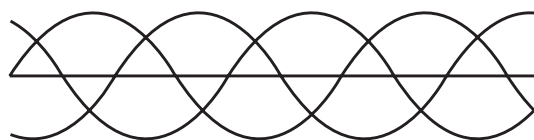
- A** 450 nm **B** 480 nm **C** 500 nm **D** 750 nm

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

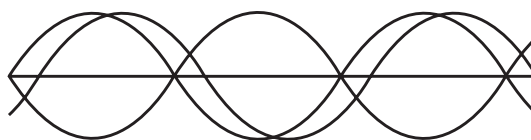
They are added together to give a resultant wave.

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

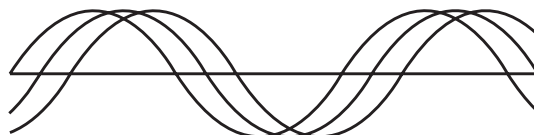
A



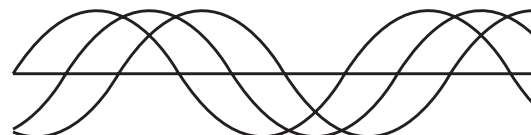
B



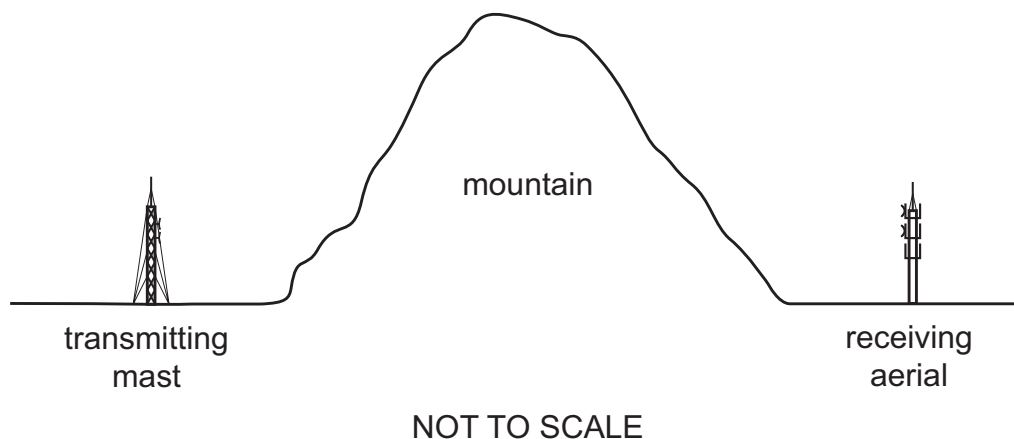
C



D



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



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.

- 29** 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

- 30** 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.

111. Question | 9702 Oct-Nov 2020 P1 V3 Q22

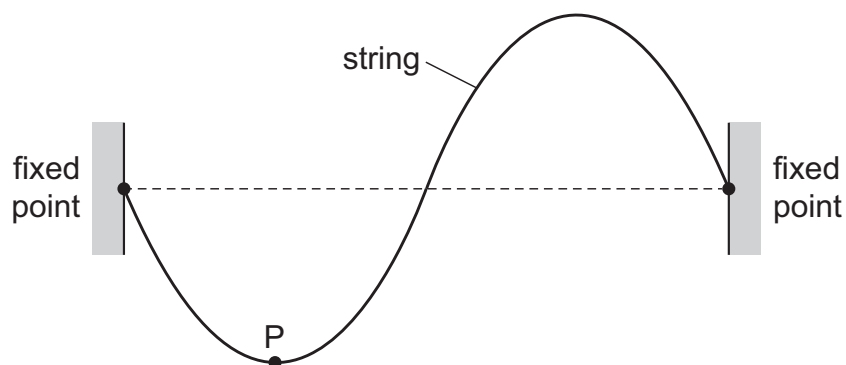
- 22** Two waves X and Y have the same frequency. The amplitude of X is $1.5A_0$ and the amplitude of Y is $2.5A_0$. The waves meet at a point and superpose to form a resultant wave.

For the resultant wave, what is the ratio $\frac{\text{maximum possible intensity}}{\text{minimum possible intensity}}$?

- A** 1.7 **B** 2.8 **C** 4.0 **D** 16

112. Question | 9702 Oct-Nov 2020 P1 V3 Q27

- 27** 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

113. Question | 9702 Oct-Nov 2020 P1 V3 Q28

28 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

114. Question | 9702 Oct-Nov 2020 P1 V3 Q29

29 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.

115. Question | 9702 Oct-Nov 2020 P1 V3 Q30

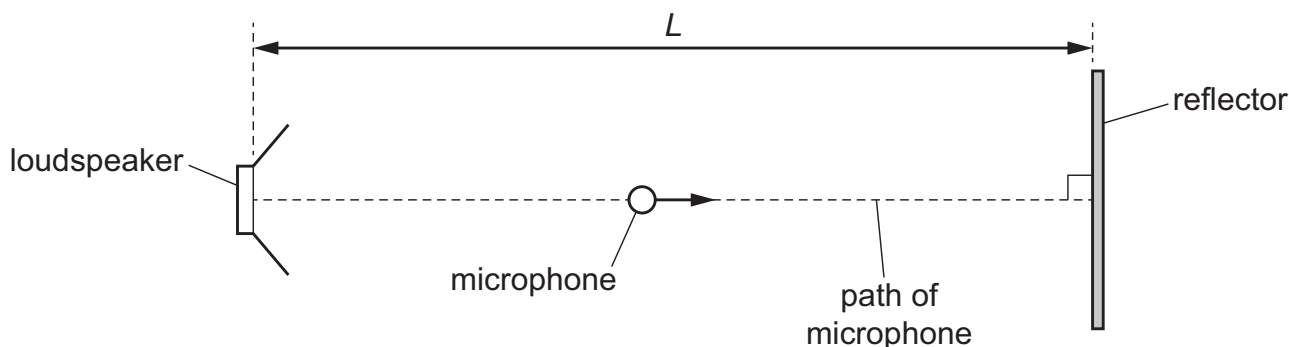
30 Light of wavelength 5.30×10^{-7} m is incident normally on a diffraction grating. The first-order maximum is observed at an angle of 15.4° to the direction of the incident light.

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°

116. Question | 9702 Feb-March 2021 P1 V2 Q23

- 23** 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** $\frac{4L}{8}$

117. Question | 9702 Feb-March 2021 P1 V2 Q26

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

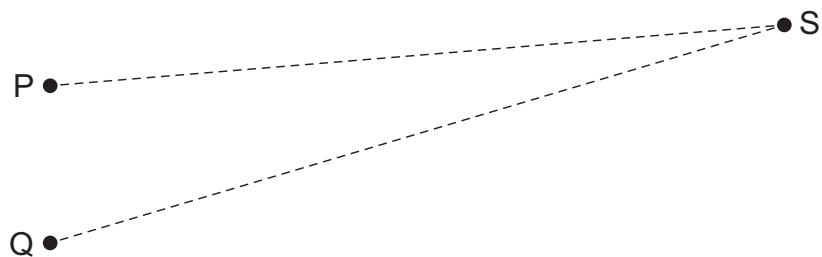
Initially, the two waves meet at X in phase (zero phase difference) so that the resultant wave has an amplitude of 14.0 cm at that point.

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

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

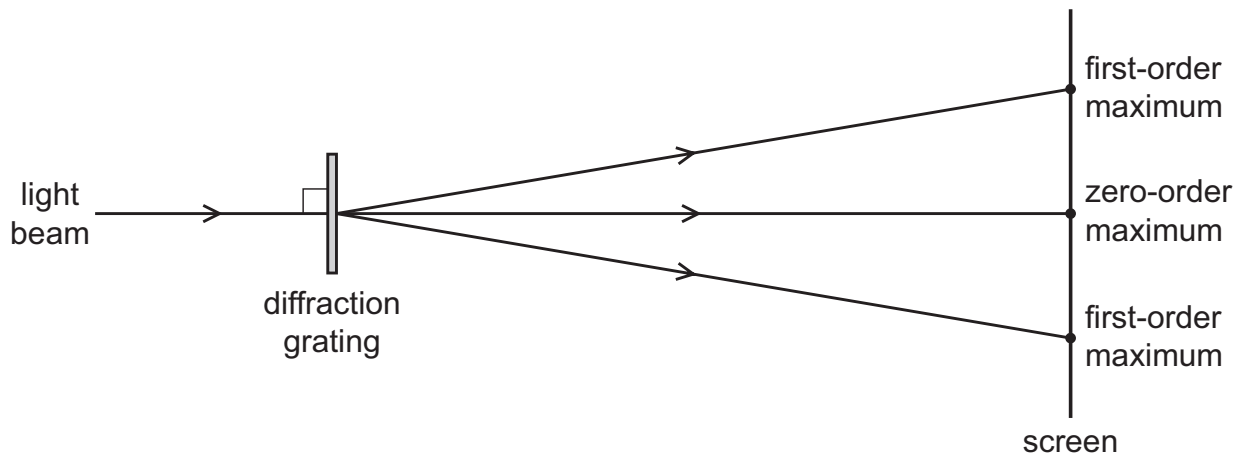


At the point S there is a minimum in the interference pattern produced by waves from the two sources. The distance $(QS - PS)$ is called the path difference.

Which expression could represent the path difference?

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

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



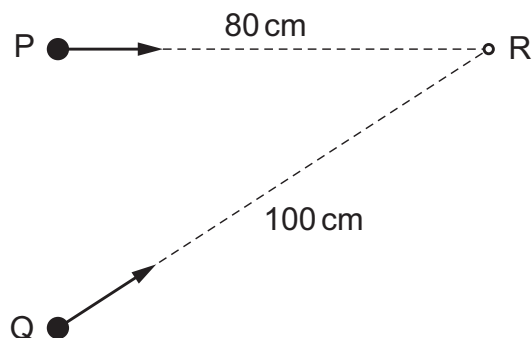
The beam of red light is now replaced by a beam of blue laser light of wavelength 445 nm. A replacement diffraction grating is used so that the first-order maximum of the blue light appears at the same position on the screen as the first-order maximum of the red light from the original laser.

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}

120. Question | 9702 May-June 2021 P1 V1 Q21

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



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

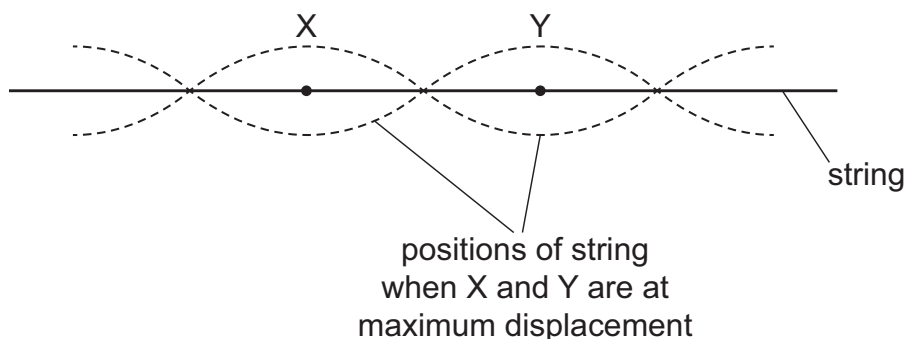
What is the phase difference between the waves as they leave points P and Q?

- A** 0° **B** 60° **C** 90° **D** 120°

121. Question | 9702 May-June 2021 P1 V1 Q26

- 26** The diagram shows part of a stationary wave on a string.

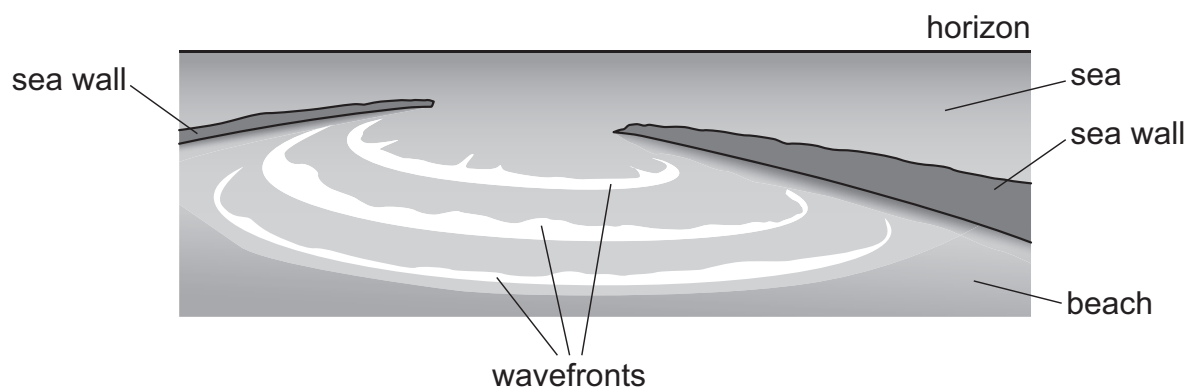
X and Y are points on the string. The vibrations at X and Y are 180° out of phase.



What is the distance between X and Y?

- A** one-quarter of a wavelength
B half a wavelength
C one wavelength
D two wavelengths

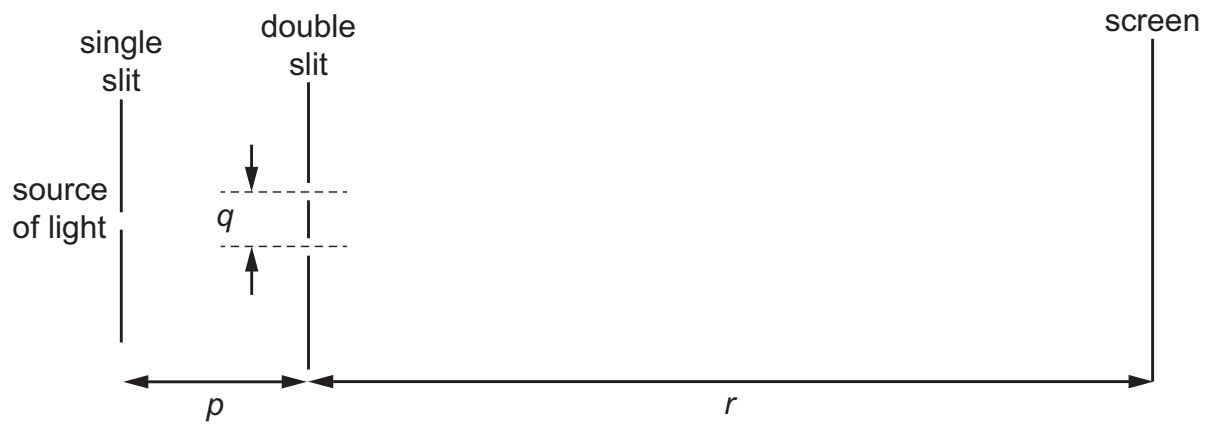
27 Which wave behaviour is shown in the diagram?



- A** diffraction
- B** Doppler shift
- C** interference
- D** superposition

123. Question | 9702 May-June 2021 P1 V1 Q28

- 28** 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

124. Question | 9702 May-June 2021 P1 V1 Q29

- 29** 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.

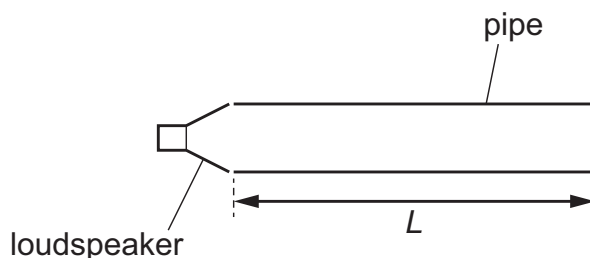
The third-order maximum for the blue light occurs at the same angle as the second-order maximum for the light of unknown wavelength. The wavelength of the blue light is 480 nm.

What is the unknown wavelength?

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

125. Question | 9702 May-June 2021 P1 V2 Q26

- 26** 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** $2L$

126. Question | 9702 May-June 2021 P1 V2 Q28

- 28** 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.

127. Question | 9702 May-June 2021 P1 V2 Q29

- 29** 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

128. Question | 9702 May-June 2021 P1 V3 Q27

- 27** 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.

129. Question | 9702 May-June 2021 P1 V3 Q29

- 29** A double-slit interference pattern using red light of wavelength $7.0 \times 10^{-7} \text{ m}$ 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 $4.5 \times 10^{-7} \text{ m}$?

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

130. Question | 9702 May-June 2021 P1 V3 Q30

30 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 .

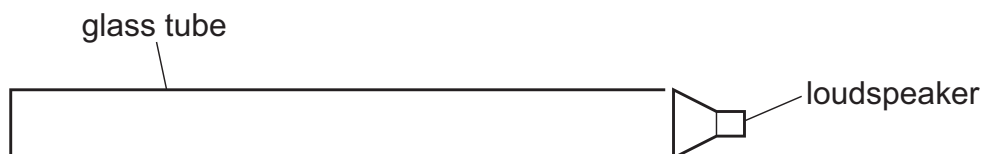
A graph is plotted to determine the wavelength of the light.

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

131. Question | 9702 Oct-Nov 2021 P1 V1 Q23

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



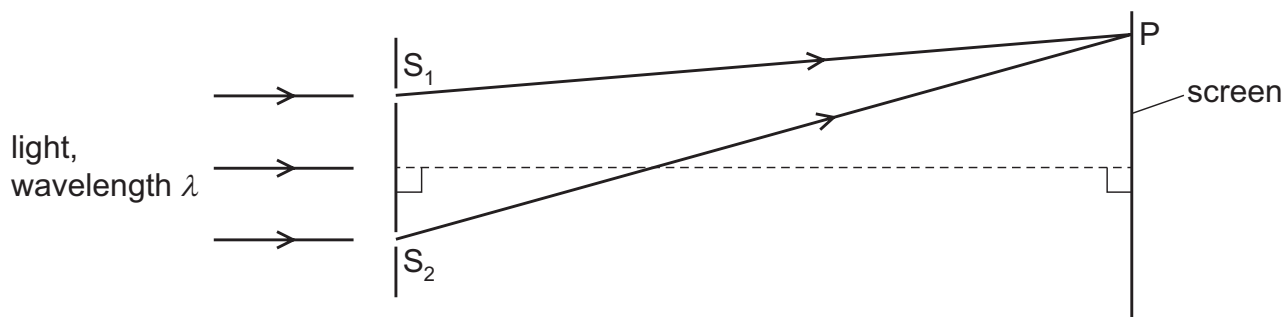
A stationary wave is formed with a node at the closed end of the tube when the sound has frequency f_0 . There are no other nodes.

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** $3.00f_0$

- 28** 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.



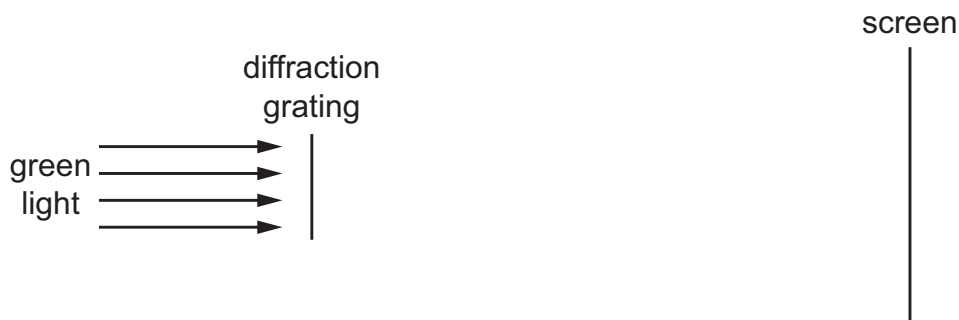
The n th **dark** fringe from the central bright fringe is observed at point P on the screen.

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

133. Question | 9702 Oct-Nov 2021 P1 V1 Q29

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



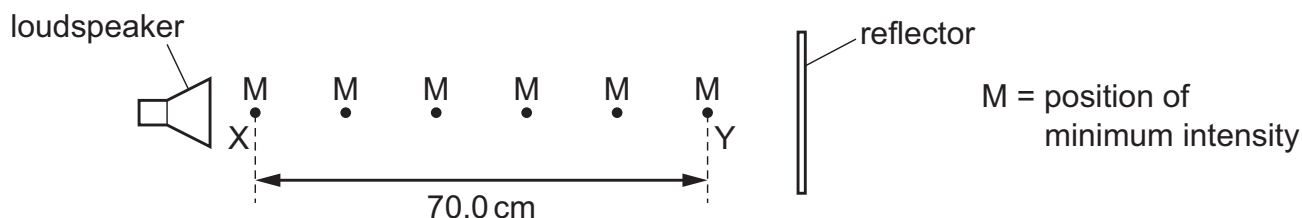
Which change, on its own, would **decrease** the separation of the diffraction maxima on the screen?

- 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.

134. Question | 9702 Oct-Nov 2021 P1 V2 Q24

- 24** 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.



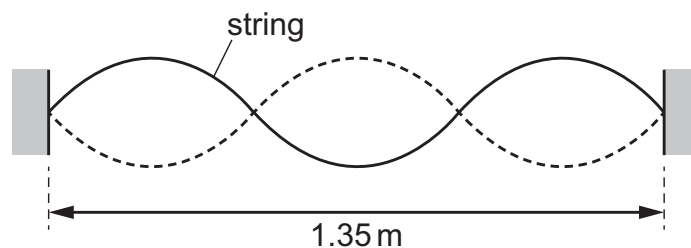
The microphone is moved towards the reflector and passes through four more intensity minima until reaching a fifth minimum at point Y. The distance XY is 70.0 cm.

What is the wavelength of the sound?

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

135. Question | 9702 Oct-Nov 2021 P1 V2 Q27

- 27** 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.



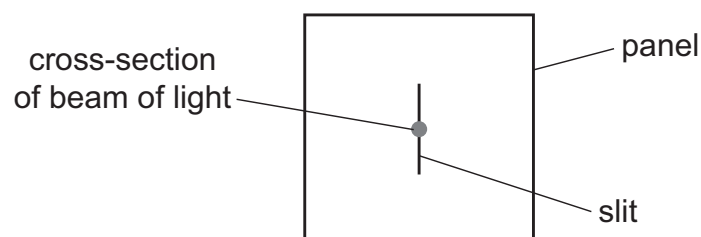
The speed of the waves on the string is 450 m s^{-1} .

What is the frequency of oscillation of the stationary wave?

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

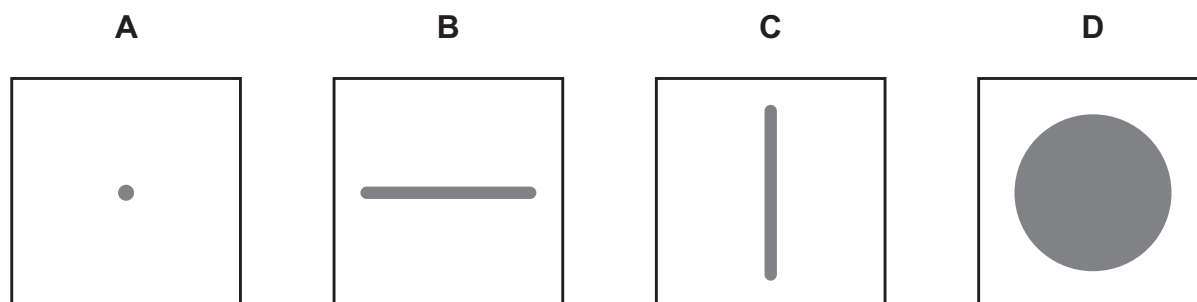
136. Question | 9702 Oct-Nov 2021 P1 V2 Q28

- 28** 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?



137. Question | 9702 Oct-Nov 2021 P1 V2 Q29

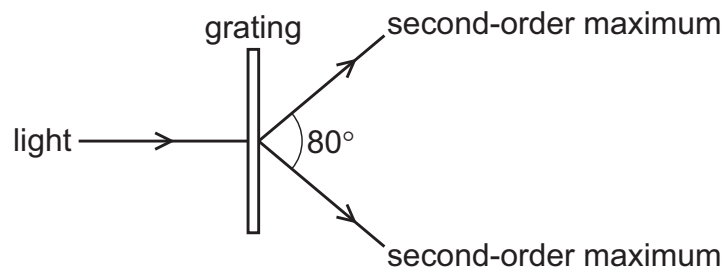
- 29** Two waves, each with a constant amplitude, interfere and produce an interference pattern. The pattern has minima at fixed points where the displacement is zero at all times.

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.

138. Question | 9702 Oct-Nov 2021 P1 V2 Q30

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



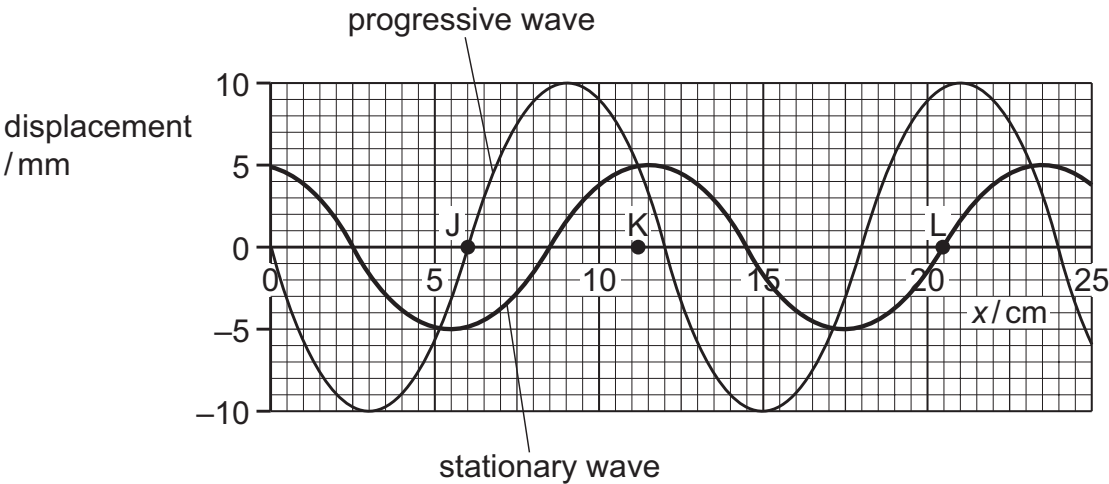
The angle between the second-order diffraction maxima is 80° , as shown.

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

139. Question | 9702 Oct-Nov 2021 P1 V3 Q27

27 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

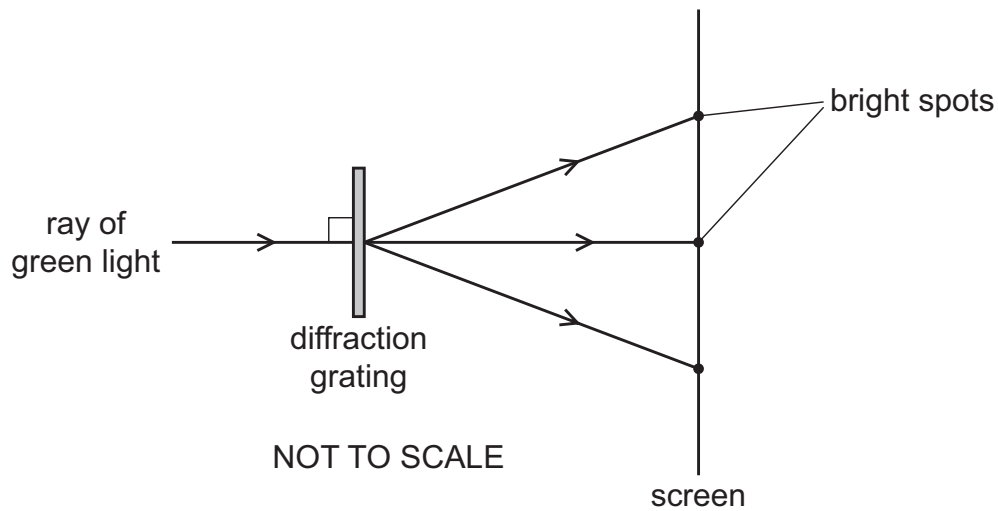
140. Question | 9702 Oct-Nov 2021 P1 V3 Q29

29 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

- 30** 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.

142. Question | 9702 Feb-March 2022 P1 V2 Q24

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

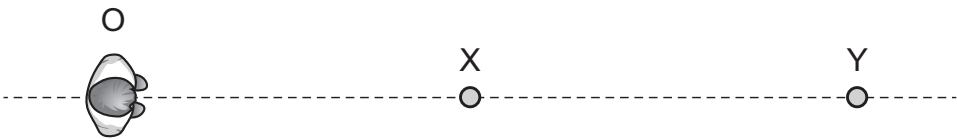
Which condition **must** be satisfied for there to be zero resultant amplitude at the point where the waves meet?

- 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.

143. Question | 9702 Feb-March 2022 P1 V2 Q27

27 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

144. Question | 9702 Feb-March 2022 P1 V2 Q28

28 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

145. Question | 9702 May-June 2022 P1 V1 Q26

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

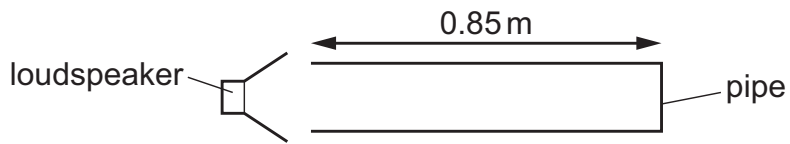
At one instant, the appearance of the string is as shown.



What is the wavelength of the stationary wave?

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

- 27** 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.



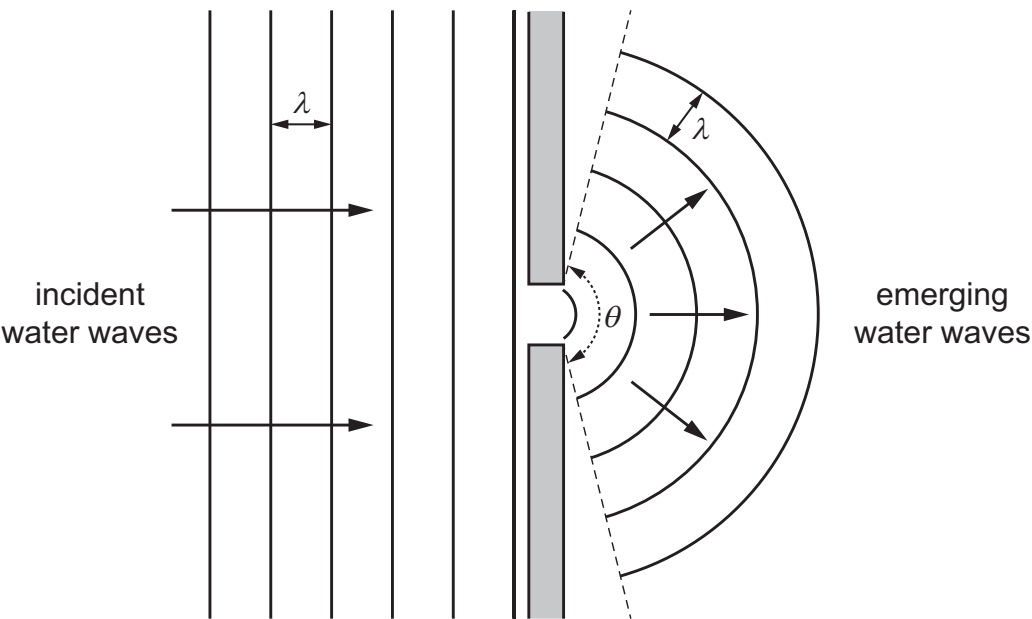
The length of the pipe is 0.85 m.

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

28 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

148. Question | 9702 May-June 2022 P1 V1 Q29

- 29** 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.

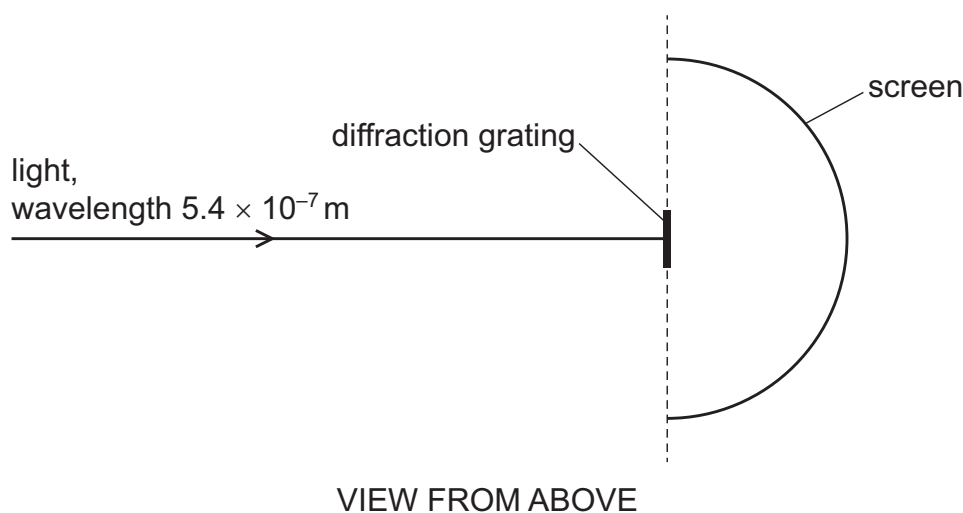
Which change would **increase** the distance between the fringes?

- 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.

149. Question | 9702 May-June 2022 P1 V1 Q30

- 30** Light of wavelength $5.4 \times 10^{-7} \text{ m}$ is incident normally on a diffraction grating.

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

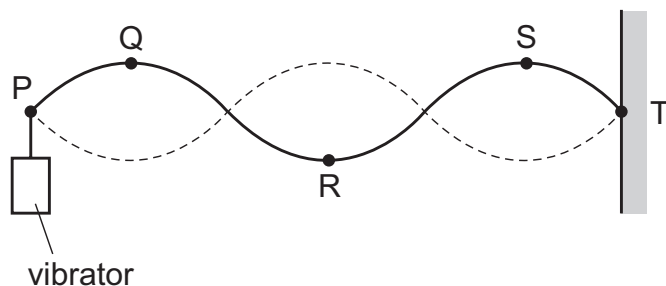


The grating is at the centre of the semicircle, and the lines of the grating are vertical.

How many bright dots are formed on the screen?

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

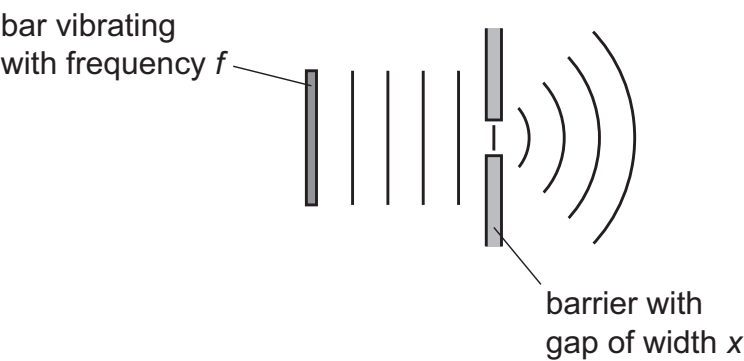
27 A stationary wave on a stretched string is set up between two points P and T.



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.

28 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	$2f$	$2x$

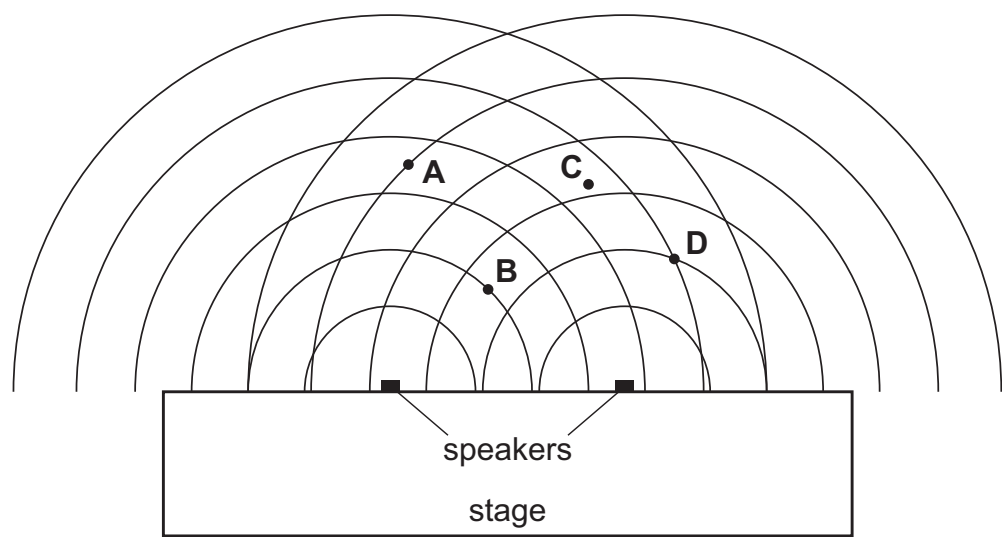
152. Question | 9702 May-June 2022 P1 V2 Q29

29 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?



153. Question | 9702 May-June 2022 P1 V2 Q30

30 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

154. Question | 9702 May-June 2022 P1 V3 Q27

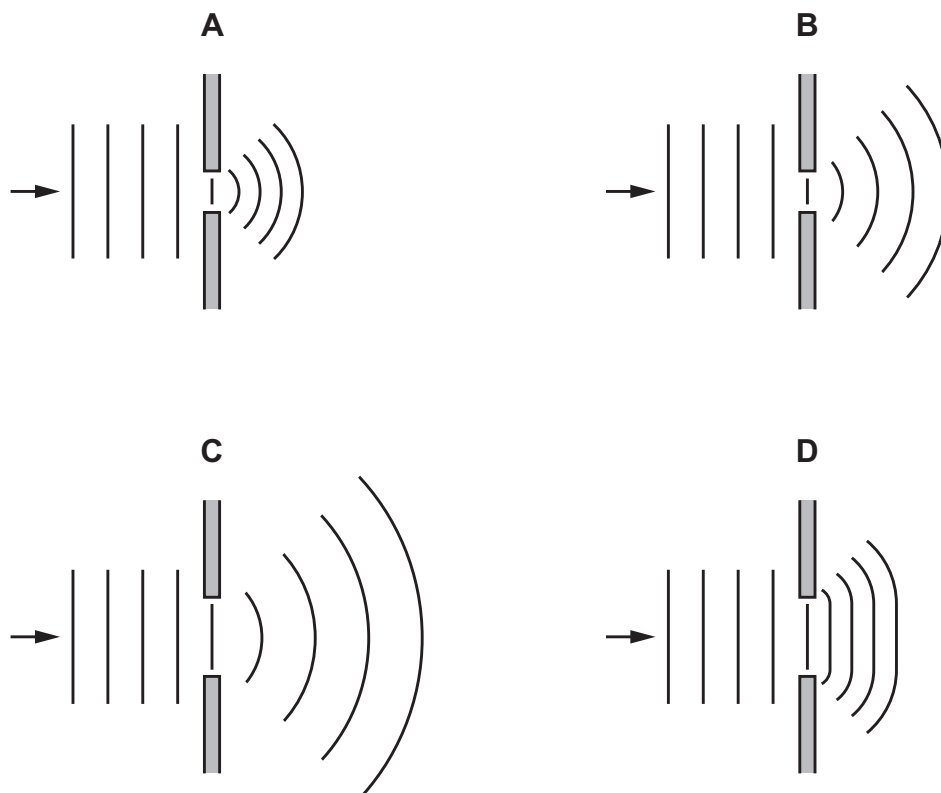
- 27** The principle of superposition states that a certain quantity is added when two or more waves meet at a point.

What is this quantity?

- A** amplitude
- B** displacement
- C** intensity
- D** wavelength

- 29** 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?



- 30** 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 .

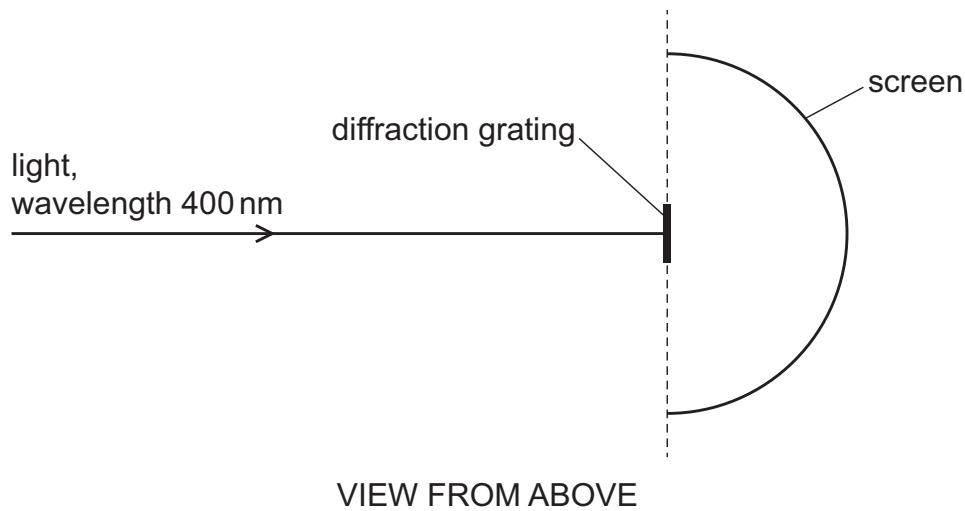
D and a are both halved.

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

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

157. Question | 9702 May-June 2022 P1 V3 Q31

- 31** 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.



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

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

158. Question | 9702 Oct-Nov 2022 P1 V1 Q26

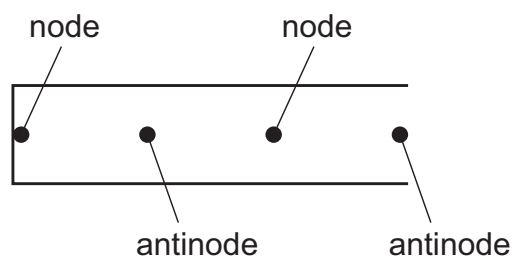
- 26** Two waves of the same type overlap.

When does the principle of superposition apply?

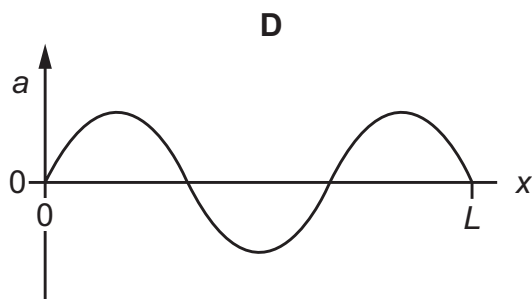
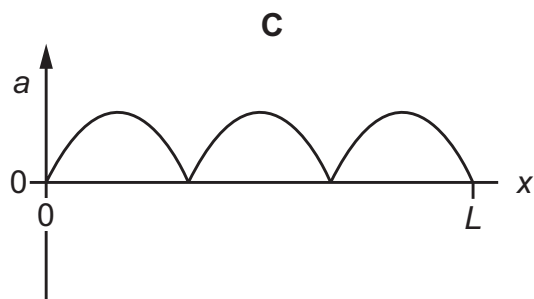
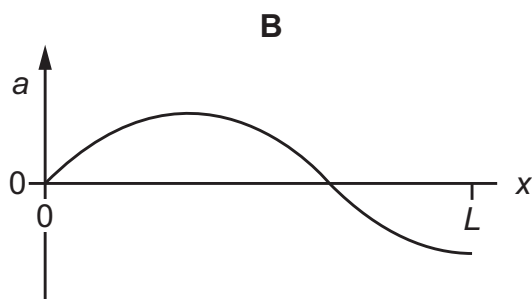
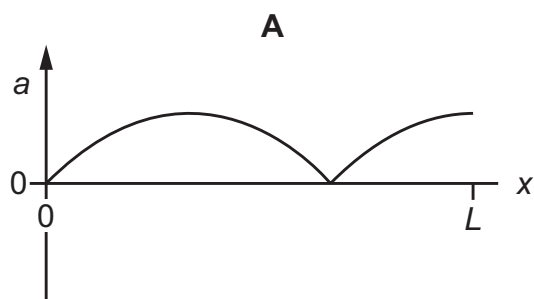
- A** always
B only when the waves have the same amplitude
C only when the waves have the same frequency
D only when the waves travel in opposite directions

27 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.

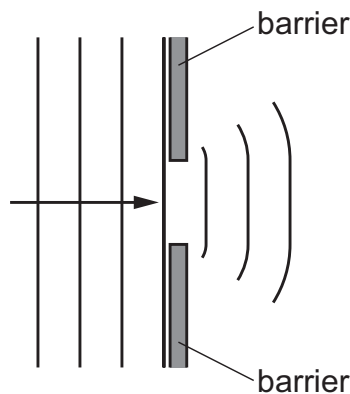


Which graph shows the variation of the amplitude a of the wave with distance x measured from the closed end of the tube?



160. Question | 9702 Oct-Nov 2022 P1 V1 Q28

- 28** 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.

161. Question | 9702 Oct-Nov 2022 P1 V1 Q29

- 29** 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.

162. Question | 9702 Oct-Nov 2022 P1 V1 Q30

- 30** 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°

163. Question | 9702 Oct-Nov 2022 P1 V2 Q26

- 26** The wavelength of sound in air may be determined by using stationary waves.

In one experiment, a loudspeaker produces a sound wave of constant frequency which is reflected directly back along its original path by a metal plate approximately 1 m away. A microphone connected to a cathode-ray oscilloscope (CRO) is moved between the loudspeaker and plate to identify regions of high sound intensity ('loud' spots) and low sound intensity ('quiet' spots).

The wavelength of the sound is determined using the **least** possible number of measured quantities.

Which row shows the quantities that are needed?

	frequency of sound	mean separation of 'quiet' spots	speed of sound in air
A	✓	✓	x
B	✓	x	✓
C	✓	x	x
D	x	✓	x

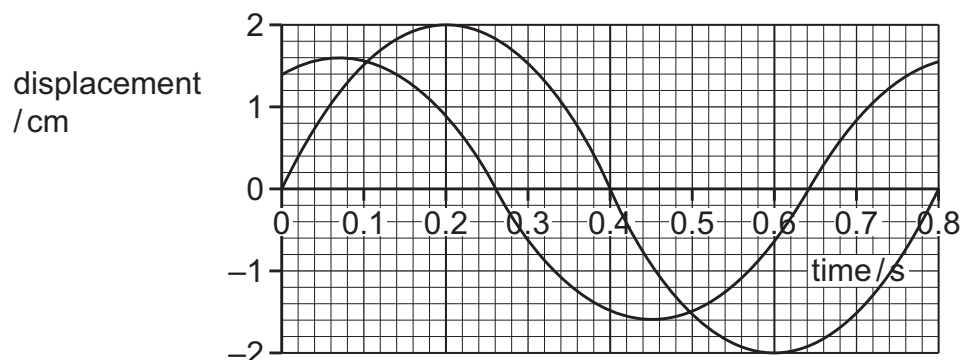
key

✓ = needed

x = not needed

164. Question | 9702 Oct-Nov 2022 P1 V2 Q27

- 27** 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.

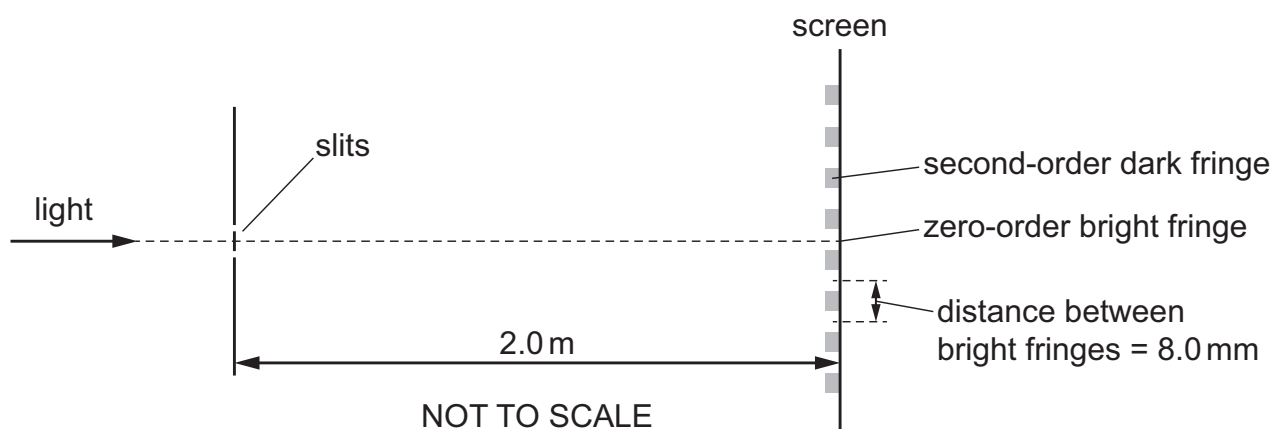
What is the resultant displacement at time 0.38 s?

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

165. Question | 9702 Oct-Nov 2022 P1 V2 Q28

- 28** 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.

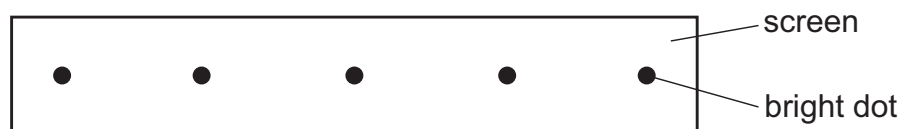
- 29** Light of a single frequency is incident on a pair of narrow slits that are a distance of 0.10 mm apart. A series of bright and dark fringes is observed on a screen a distance of 2.0 m away. The distance between adjacent bright fringes is 8.0 mm.



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

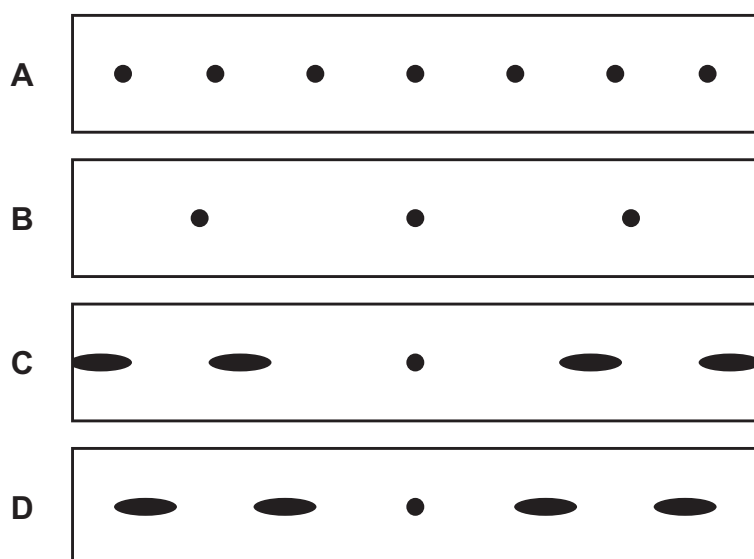
- A** $2.0 \times 10^{-7} \text{ m}$
- B** $4.0 \times 10^{-7} \text{ m}$
- C** $6.0 \times 10^{-7} \text{ m}$
- D** $8.0 \times 10^{-7} \text{ m}$

- 30** 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?



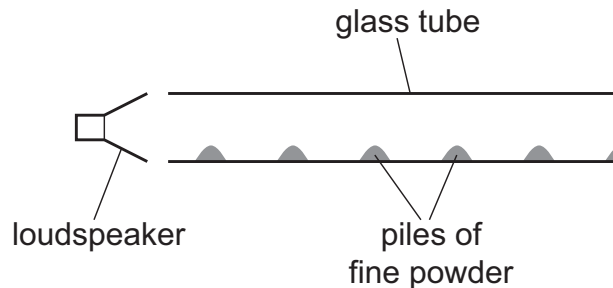
- 25** Two progressive waves overlap.

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.

- 26** 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.

9702 Physics Paper 1 - Superposition

Topical questions | 256 questions

170. Question | 9702 Oct-Nov 2022 P1 V3 Q27

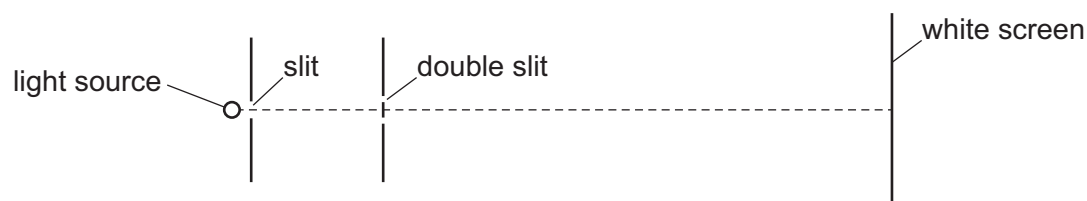
- 27** A sound wave of wavelength 0.50 m passes through a doorway of width 1.0 m between two rooms.

Which change increases the amount of diffraction that takes place?

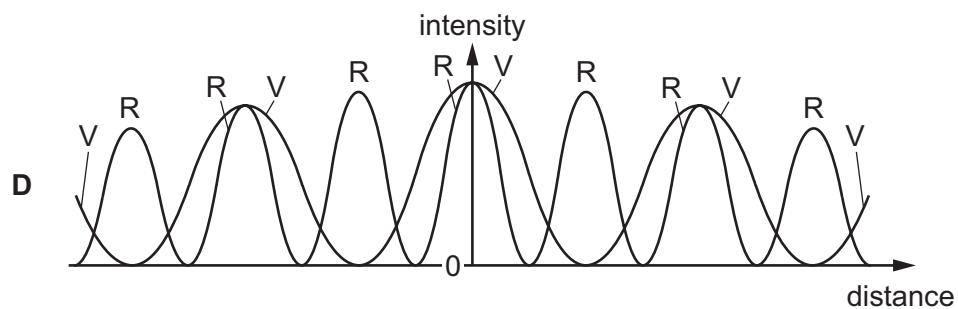
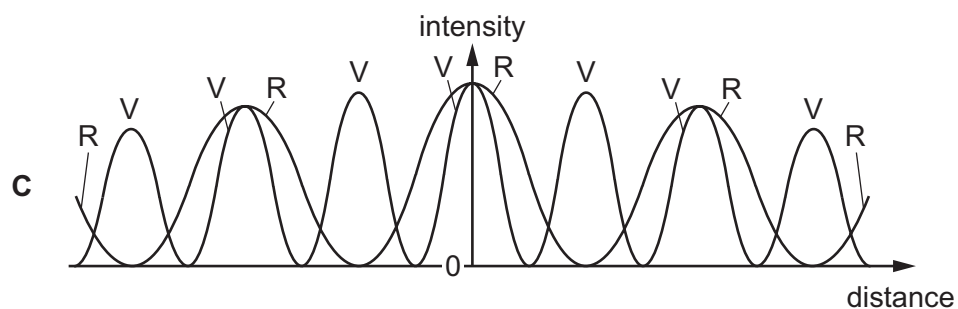
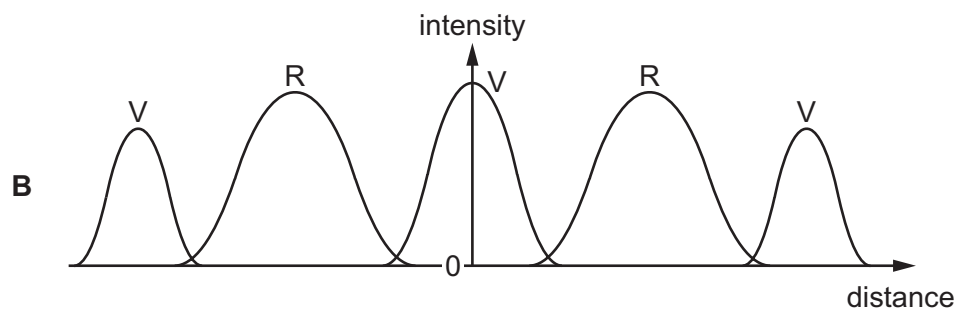
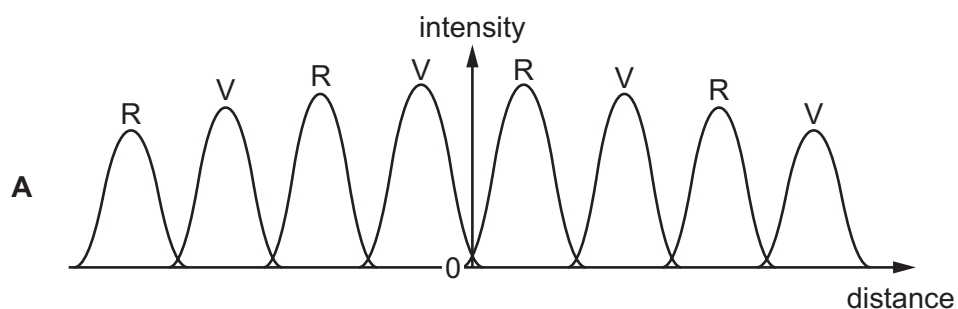
- A** Double the amplitude of the sound wave.
- B** Double the width of the doorway.
- C** Halve the frequency of the sound wave.
- D** Halve the period of the sound wave.

171. Question | 9702 Oct-Nov 2022 P1 V3 Q28

- 28** 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?



172. Question | 9702 Oct-Nov 2022 P1 V3 Q29

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

- A** amplitude
- B** intensity
- C** speed
- D** wavelength

173. Question | 9702 Specimen 2022 P1 Q27

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

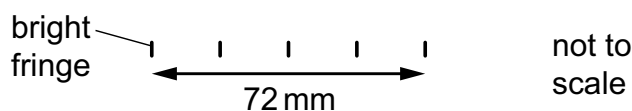
What is the total number of intensity maxima from the grating?

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

174. Question | 9702 Specimen 2022 P1 Q28

28 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** $1.2 \times 10^{-4} \text{ m}$ **B** $1.6 \times 10^{-4} \text{ m}$ **C** $3.1 \times 10^{-5} \text{ m}$ **D** $3.3 \times 10^{-9} \text{ m}$

175. Question | 9702 Feb-March 2023 P1 V2 Q25

- 25** 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

176. Question | 9702 Feb-March 2023 P1 V2 Q26

- 26** Two waves of equal frequency and amplitude are travelling in opposite directions along a stretched string. When they meet, they form a stationary wave with three nodes and two antinodes.

The frequency of both waves is doubled and a new stationary wave is formed.

How many antinodes are there in the new stationary wave?

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

177. Question | 9702 Feb-March 2023 P1 V2 Q28

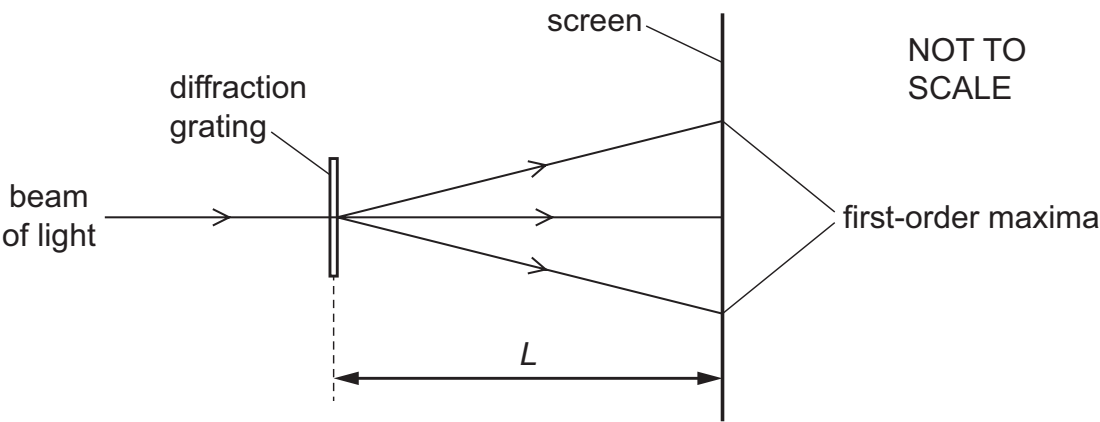
- 28** Waves are emitted from two coherent sources.

Which statement about the waves must be correct?

- A** They are in phase.
- B** They are transverse waves.
- C** They have a constant phase difference.
- D** They have the same amplitude.

178. Question | 9702 Feb-March 2023 P1 V2 Q29

29 The diagram shows a screen that is a distance L from a diffraction grating. The grating has a total number of N lines. Any two adjacent lines are a distance d apart. A beam of parallel light of wavelength λ is incident normally on the grating.



Which quantities affect the distance between the first-order diffraction maxima on the screen?

	d	λ	L	N
A	✓	✓	✓	✗
B	✓	✓	✗	✗
C	✓	✗	✓	✓
D	✗	✓	✗	✓

key
✓ = affects the distance
✗ = does not affect the distance

179. Question | 9702 May-June 2023 P1 V1 Q25

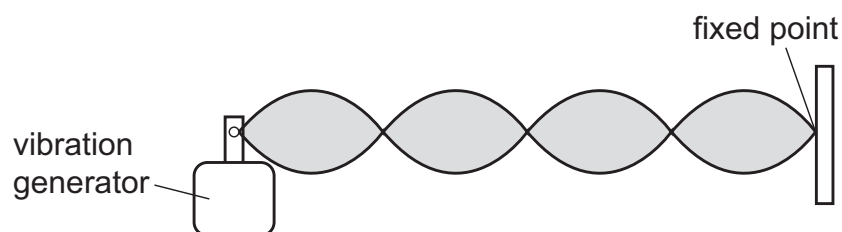
25 Two progressive waves meet at a point.

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.

26 A string is stretched between a vibration generator and a fixed point.

When the vibration generator is vibrating at a frequency f , a stationary wave with five nodes is created on the stretched string, as shown. There is a node at the end of the string that is attached to the vibration generator.



The frequency of vibration of the vibration generator is slowly increased.

What is the next frequency that produces a stationary wave on the string?

- A** $1.25f$ **B** $1.50f$ **C** $1.75f$ **D** $2.00f$

181. Question | 9702 May-June 2023 P1 V1 Q28

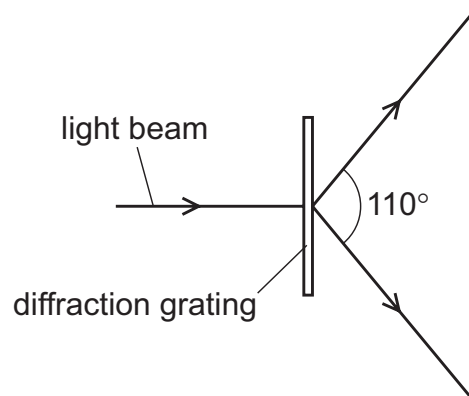
- 28** A laser produces a beam of light of wavelength 650 nm . The beam is incident normally on two slits that are a distance of 0.12 mm apart.

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

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

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

29 A beam of light from a laser is incident normally on a diffraction grating.



The diagram shows only the **second**-order maxima that are produced.

The grating has a line spacing of 1.0×10^{-6} m. The angle between the two second-order maxima is 110° .

What is the wavelength of the light?

- A** 4.1×10^{-7} m
- B** 4.7×10^{-7} m
- C** 8.2×10^{-7} m
- D** 9.4×10^{-7} m

- 25** A stationary wave is formed by two progressive waves travelling in opposite directions along the same line of travel.

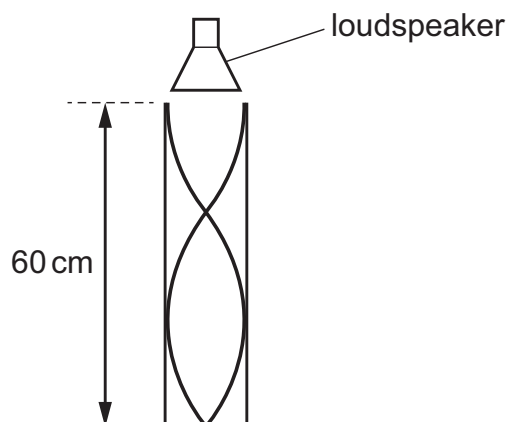
Which statement about the two progressive waves is **not** correct?

- A** They must have a constant phase difference.
- B** They must have the same frequency.
- C** They must have the same wavelength.
- D** They must travel at the same speed.

184. Question | 9702 May-June 2023 P1 V2 Q26

- 26** The sound from a loudspeaker placed above a tube causes resonance of the air in the tube.

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



The tube has height 60 cm.

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

What is the frequency of the sound?

- A** 430 Hz **B** 570 Hz **C** 850 Hz **D** 1700 Hz

185. Question | 9702 May-June 2023 P1 V2 Q28

- 28** The diagram shows a view from above of a double-slit interference demonstration.

L is a monochromatic light source with a vertical filament. B is a barrier with two narrow vertical slits and S is a screen upon which interference fringes form.

NOT TO
SCALE

*
L

B

S

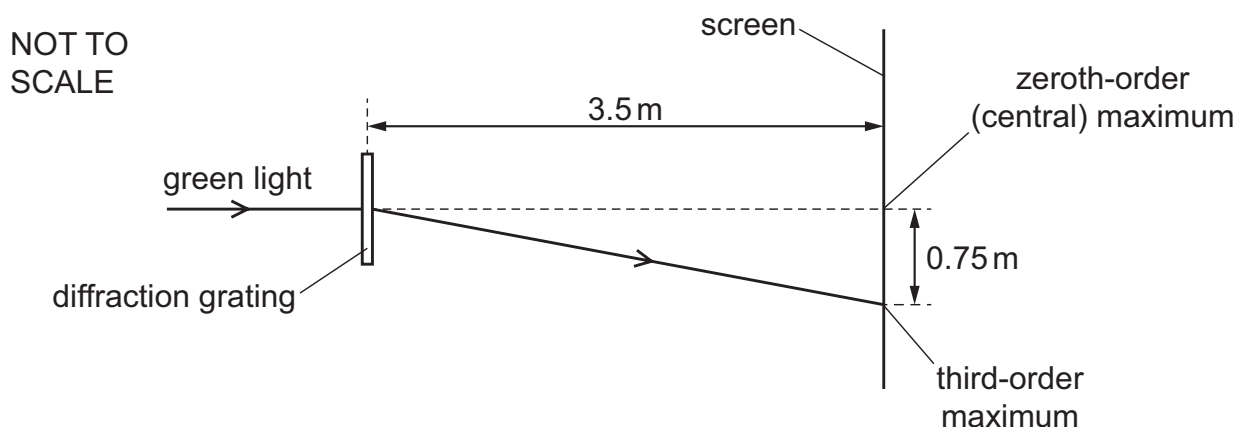
The intensity is I at the point on the screen where the centre of the fringe pattern forms.

When one of the slits is covered, what is the intensity at the same point on the screen?

- A** $\frac{I}{\sqrt{2}}$ **B** $\frac{I}{2}$ **C** $\frac{I}{2\sqrt{2}}$ **D** $\frac{I}{4}$

- 29** Green light of wavelength 550 nm is incident normally on a diffraction grating and produces a diffraction pattern on a screen placed 3.5 m from the diffraction grating.

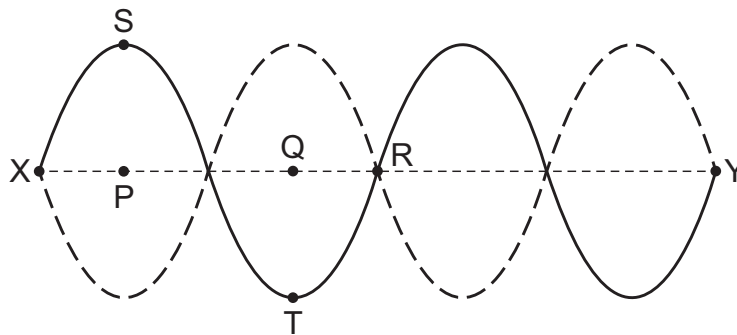
The **third**-order maximum on the screen is a distance of 0.75 m from the zeroth-order (central) maximum.



What is the distance between two adjacent slits in the diffraction grating?

- A** $2.6 \times 10^{-6} \text{ m}$
- B** $7.7 \times 10^{-6} \text{ m}$
- C** $7.9 \times 10^{-6} \text{ m}$
- D** $1.0 \times 10^{-5} \text{ m}$

- 25** 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 at time t_0 . The dashed curve shows the other position of maximum displacement. The straight central dashed line shows the mean position of the string.

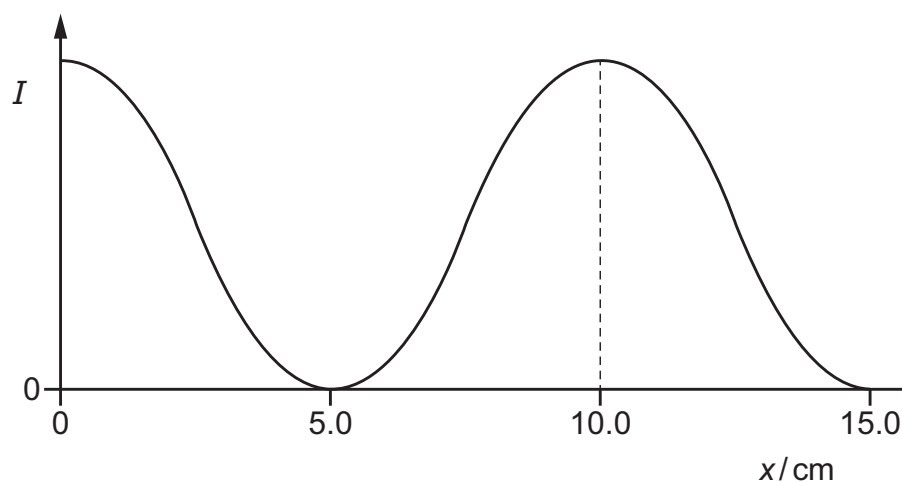
Point S on the string is directly above point P. Point T on the string is directly below point Q.

Which statement is correct?

- A** A short time after t_0 , point R on the string will be displaced.
- B** A short time after t_0 , points S and T on the string move in opposite directions.
- C** The distance between P and Q is one wavelength.
- D** Two moving points on the string that are equal distances from point R vibrate in phase.

188. Question | 9702 May-June 2023 P1 V3 Q26

26 The variation with distance x of the intensity I along a stationary sound wave in air is shown.



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

What is the frequency of the sound wave?

- A** 1700 Hz **B** 2300 Hz **C** 3400 Hz **D** 6800 Hz

189. Question | 9702 May-June 2023 P1 V3 Q27

27 An experiment is set up to demonstrate the diffraction of water waves in a ripple tank.

The waves pass through a gap of width w and some diffraction of the waves is observed.

The wavelength of the waves is now doubled.

What is the new gap width needed to cause the same amount of diffraction as before?

- A** $0.5w$ **B** w **C** $2w$ **D** $4w$

190. Question | 9702 May-June 2023 P1 V3 Q28

- 28** Two coherent electromagnetic waves are travelling in a vacuum. The two waves meet at a point. At this point, the two waves have different intensities.

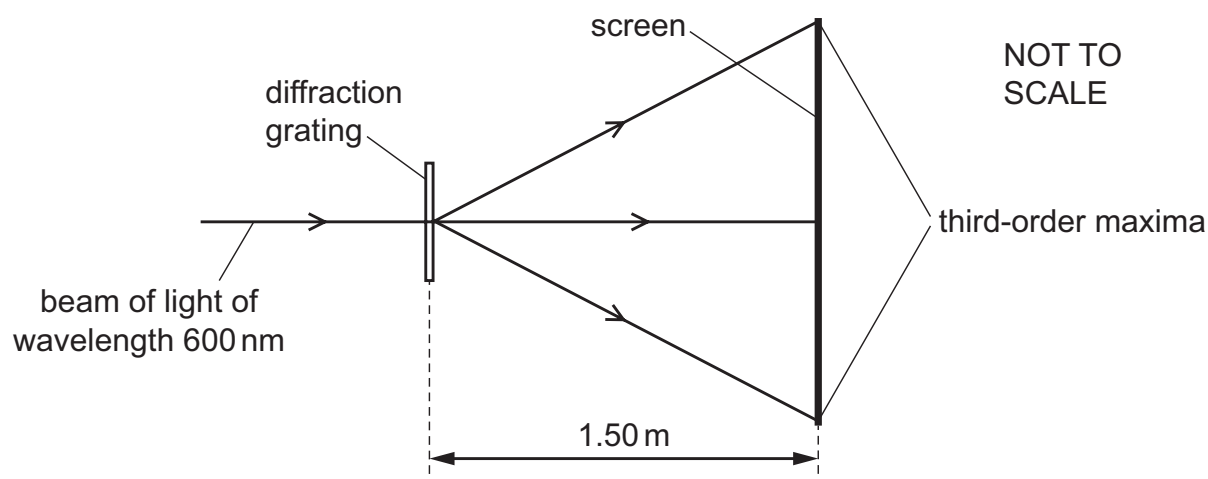
Which statement about the waves is **not** correct?

- A** They have a constant phase difference at the point.
- B** They have the same amplitude at the point.
- C** They have the same frequency.
- D** They travel at the same speed.

191. Question | 9702 May-June 2023 P1 V3 Q29

- 29** A parallel beam of light of wavelength 600 nm is incident normally on a diffraction grating.

The distance between adjacent slits in the grating is 2.0×10^{-6} m. A screen is placed parallel to the grating, at a distance of 1.50 m from the grating. **Third-order** diffraction maxima are observed at the two ends of the screen, as shown.



What is the distance between the two ends of the screen?

- A** 1.4 m
- B** 2.7 m
- C** 3.1 m
- D** 6.2 m

192. Question | 9702 Oct-Nov 2023 P1 V1 Q25

- 25** In an experiment, a stationary wave is formed on a string stretched horizontally between two fixed points.

Which statement about the experiment is correct?

- A** At certain times, the string between two nodes is horizontal with all points having zero displacement.
- B** Each point on the string between two antinodes has an oscillation of the same amplitude.
- C** The number of nodes is equal to the number of antinodes.
- D** Two adjacent antinodes oscillate in phase.

193. Question | 9702 Oct-Nov 2023 P1 V1 Q26

- 26** A musical organ produces notes by blowing air into a set of pipes that are open at one end and closed at the other.

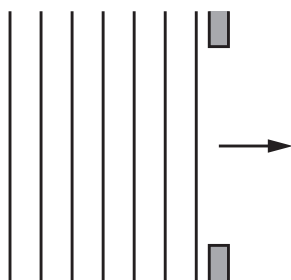
The speed of sound in the air in the pipes is 320 m s^{-1} .

What is the lowest frequency of sound produced by a pipe of length 10 m?

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

194. Question | 9702 Oct-Nov 2023 P1 V1 Q27

27 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.

195. Question | 9702 Oct-Nov 2023 P1 V1 Q28

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



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

What could explain the zero intensity at P?

- A** Light from the two sources is emitted 180° out of phase and the path difference to P is $\frac{1}{2}\lambda$.
- B** Light from the two sources is emitted in phase and the path difference to P is λ .
- C** Light from the two sources is emitted 90° out of phase and the path difference to P is λ .
- D** Light from the two sources is emitted in phase and the path difference to P is $\frac{1}{2}\lambda$.

196. Question | 9702 Oct-Nov 2023 P1 V1 Q29

- 29** A beam of red light of wavelength 720 nm is incident normally on a diffraction grating and produces a diffraction pattern on a screen placed parallel to the grating.

The beam of red light is replaced with a beam of electromagnetic radiation of wavelength X , which is incident normally on the same diffraction grating.

The third-order maximum for the electromagnetic radiation of wavelength X is at the same position on the screen as the second-order maximum for the red light.

What is wavelength X ?

- A** 480 nm **B** 540 nm **C** 960 nm **D** 1100 nm

197. Question | 9702 Oct-Nov 2023 P1 V2 Q25

- 25** What can explain how stationary waves are formed from progressive waves?

- A** diffraction
B polarisation
C superposition
D the Doppler effect

198. Question | 9702 Oct-Nov 2023 P1 V2 Q26

- 26** A pipe has a length of 2.0 m. It is open at one end and closed at the other end.

A stationary sound wave is set up within the pipe. There are four nodes (N) and four antinodes (A) within the length of the pipe.



What is the wavelength of the sound wave?

- A** 0.57 m **B** 1.1 m **C** 1.3 m **D** 1.6 m

27 A teacher is explaining diffraction to a group of students.

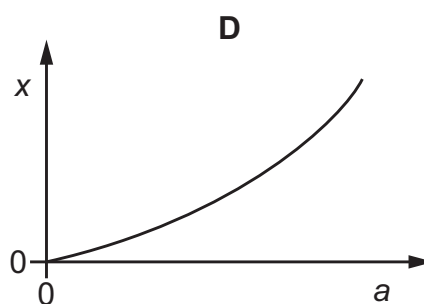
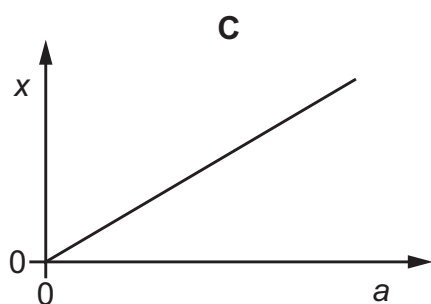
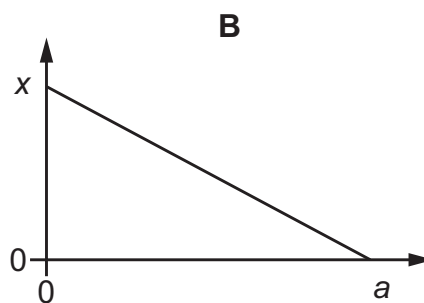
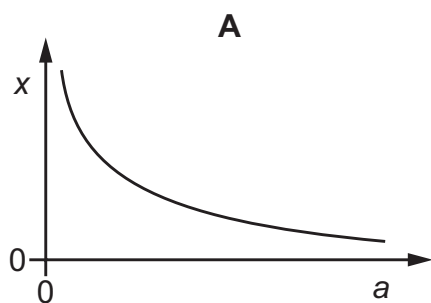
Which piece of apparatus is most appropriate for the teacher to use to demonstrate diffraction?

- A** a long spring
- B** a ripple tank
- C** a rope
- D** a stretched string

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

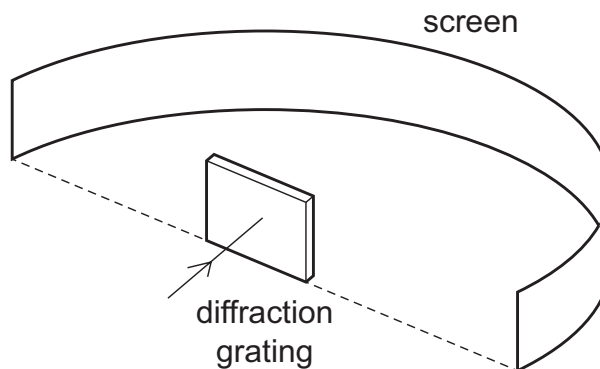
The separation of the slits is varied.

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



201. Question | 9702 Oct-Nov 2023 P1 V2 Q29

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



What is the total number of bright spots that are produced?

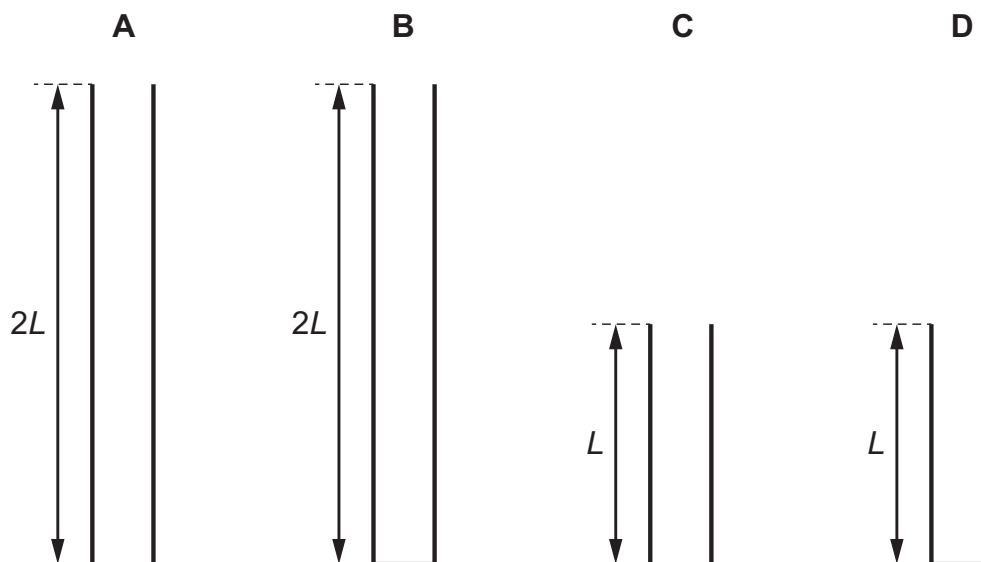
- A** 4 **B** 5 **C** 8 **D** 9

202. Question | 9702 Oct-Nov 2023 P1 V3 Q25

- 25** 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.

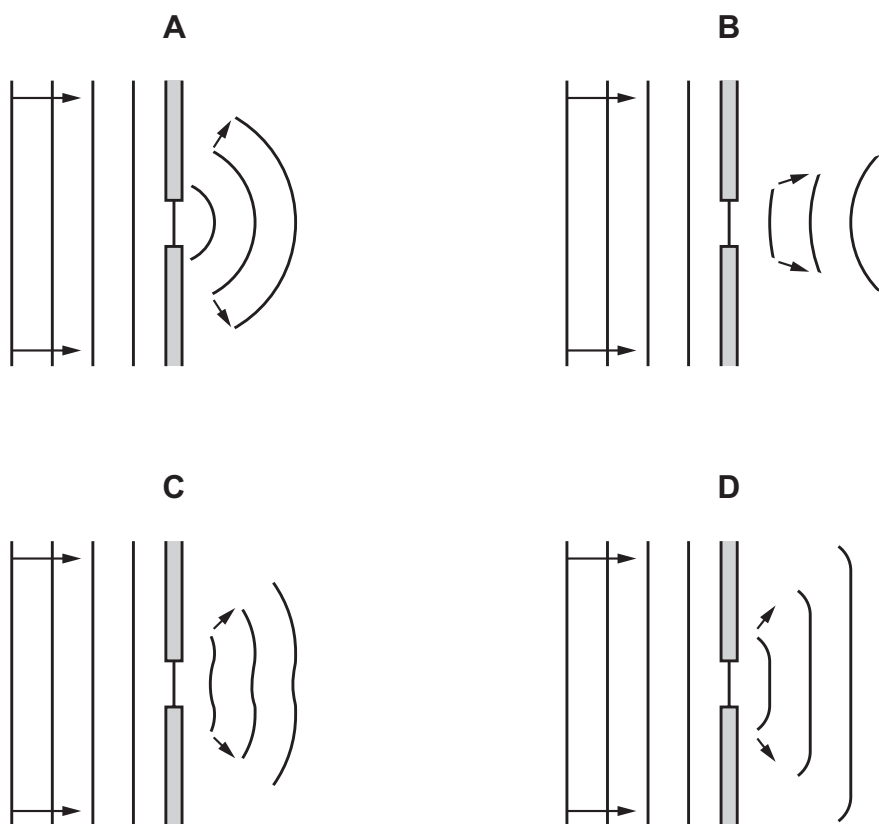
- 26** Stationary sound waves can be formed in the air columns of pipes. One type of pipe is closed at one end and open at the other end. Another type of pipe is open at both ends.

Which pipe can form a stationary sound wave with the lowest frequency?



27 Water waves in a ripple tank are made to pass through a small gap, as shown.

Which diagram shows the waves after they have passed through the gap?



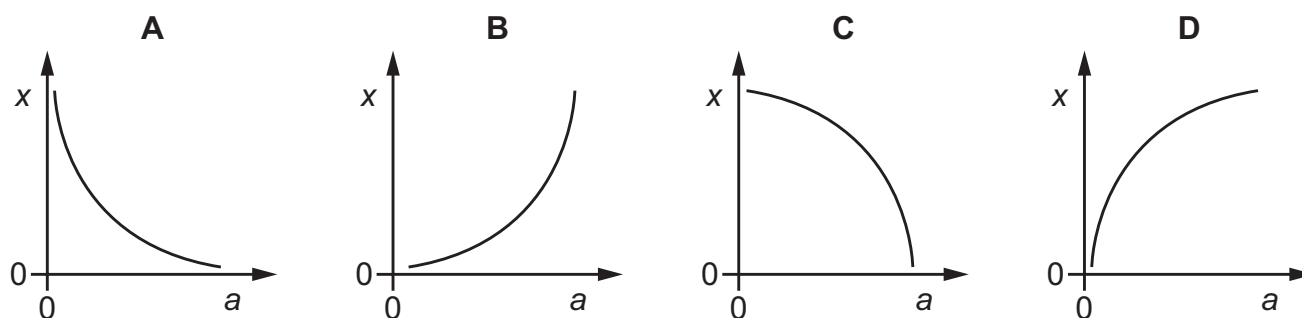
205. Question | 9702 Oct-Nov 2023 P1 V3 Q28

- 28** Light of a single wavelength is incident normally on a double slit. The slit separation can be varied.

A screen is placed a fixed distance away from the double slit. The screen and double slit are parallel. A pattern of bright interference fringes is observed on a screen.



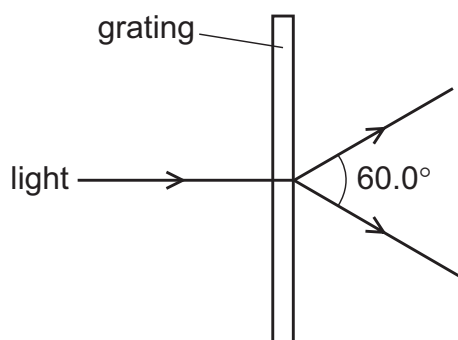
Which graph best shows the variation of the separation x of the bright interference fringes with the slit separation a ?



206. Question | 9702 Oct-Nov 2023 P1 V3 Q29

- 29** A diffraction grating is used to measure the wavelength of 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.

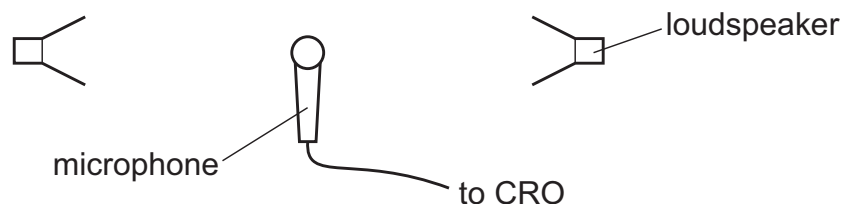


What is the wavelength of the light?

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

207. Question | 9702 Feb-March 2024 P1 V2 Q29

- 29** Two loudspeakers are connected to the same signal generator. The signal generator produces a single frequency. The loudspeakers face each other so that a stationary sound wave is set up in the region between the loudspeakers.



A microphone is connected to a cathode-ray oscilloscope (CRO) and positioned between the two loudspeakers.

The microphone is moved along a line joining the two loudspeakers.

The signal on the CRO shows 5 maximum amplitudes as the microphone moves. The microphone moves a distance of 2.0 m from the position that gives the first maximum to the position that gives the fifth maximum.

What is the wavelength of the sound wave?

- A** 0.40 m **B** 0.50 m **C** 0.80 m **D** 1.0 m

208. Question | 9702 Feb-March 2024 P1 V2 Q30

- 30** Two wave sources emit coherent waves.

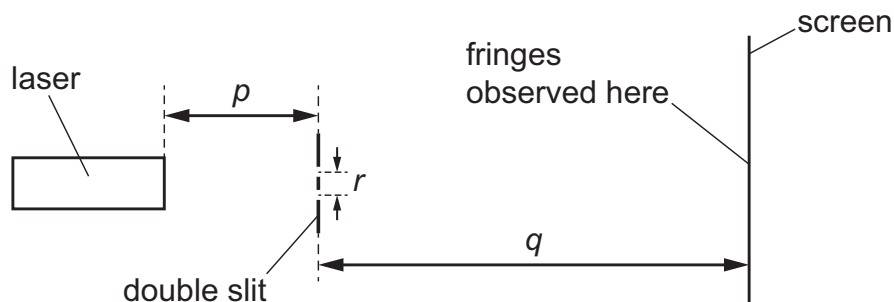
Which condition **must** be correct for the coherent waves?

- A** The waves are emitted in phase.
B The waves are emitted and move in opposite directions.
C The waves are emitted with a constant phase difference.
D The waves are emitted with the same amplitude.

209. Question | 9702 Feb-March 2024 P1 V2 Q31

31 A student sets up an experiment to investigate double-slit interference.

The student uses light of a single wavelength from a laser to illuminate a double slit so that a pattern of interference fringes is observed on the screen.



The student finds that the fringes are very close together.

What could the student **decrease** in order to increase the separation of the fringes on the screen?

- A** the distance p from the laser to the double slit
- B** the distance q from the double slit to the screen
- C** the separation r of the slits
- D** the wavelength of the light from the laser

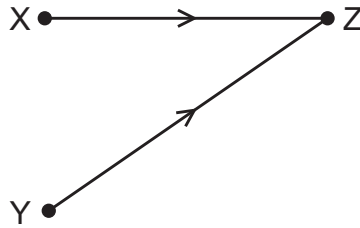
210. Question | 9702 May-June 2024 P1 V1 Q26

26 Light of frequency 6.7×10^{14} Hz in a vacuum is incident normally on a diffraction grating that contains 4.0×10^5 lines m^{-1} .

What is the angle between the adjacent second and third order intensity maxima?

- A** 12°
- B** 21°
- C** 33°
- D** 54°

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



The waves emitted from points X and Y are coherent.

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

- A** There is a constant difference in the path lengths YZ and XZ.
- B** There is a constant difference in phase between the two waves at Z.
- C** There is a constant non-zero difference in frequency of the two waves at Z.
- D** There is a constant non-zero difference in amplitude of the two waves at Z.

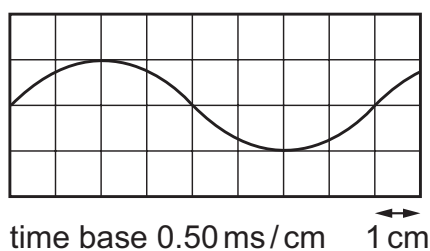
23 A stationary sound wave is set up between a loudspeaker and a wall.

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

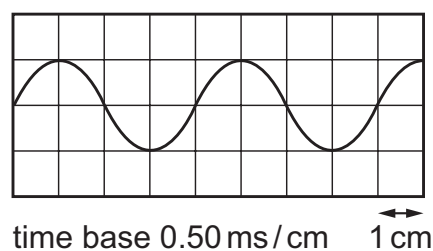
The distance between X and Y is 33 cm. The speed of sound in air is 330 m s^{-1} .

Which diagram could represent the CRO trace of the sound received at X?

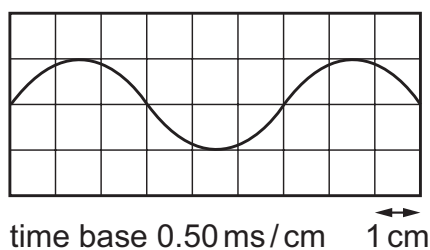
A



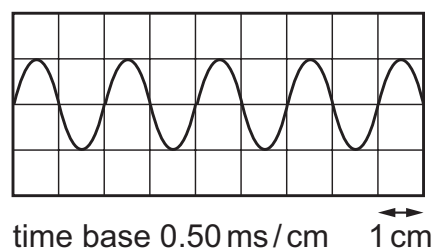
B



C



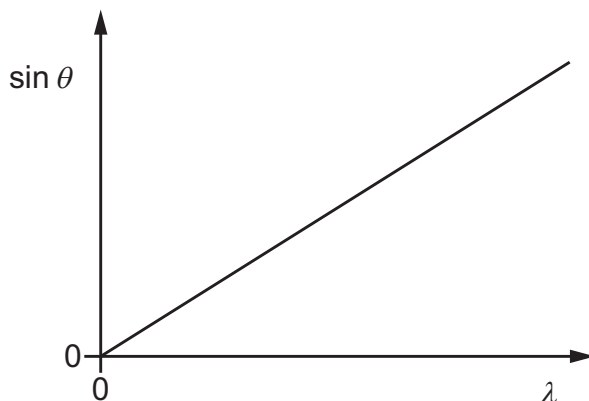
D



213. Question | 9702 May-June 2024 P1 V2 Q26

- 26** A diffraction grating with N lines per metre is used to diffract light of various wavelengths λ .

The graph shows the relation between the diffraction 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** $\frac{1}{Nn}$

214. Question | 9702 May-June 2024 P1 V2 Q27

- 27** A stationary sound wave is formed in the air column inside a tube that is open at both ends.

The stationary wave has three nodes.

How many antinodes does it have?

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

215. Question | 9702 May-June 2024 P1 V2 Q28

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

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

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

216. Question | 9702 May-June 2024 P1 V3 Q27

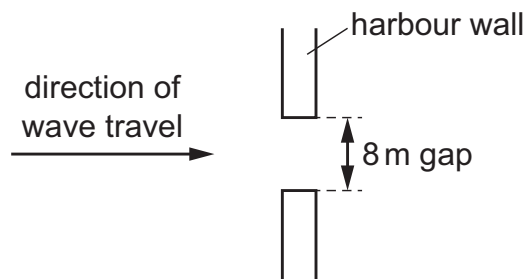
27 Two waves superpose. A resultant wave pattern is formed.

Which statement about the two waves **must** be correct?

- A** They have the same amplitude.
- B** They are of the same type.
- C** They are transverse waves.
- D** They travel in opposite directions.

217. Question | 9702 May-June 2024 P1 V3 Q28

28 A water wave passes through a gap in a harbour wall and diffracts. The gap has a width of 8 m.



The wave travels directly towards the gap.

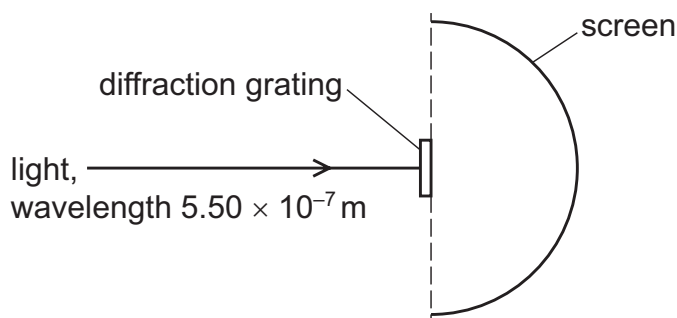
For which wavelength is the diffraction of the wave greatest?

- A** 1 m
- B** 2 m
- C** 4 m
- D** 8 m

218. Question | 9702 May-June 2024 P1 V3 Q29

29 Light of wavelength $5.50 \times 10^{-7} \text{ m}$ from a laser is incident normally on a diffraction grating.

The diffracted light is incident on a semicircular screen, as shown in the view from above.



A total of 9 bright dots are formed on the screen.

The grating is at the centre of the semicircle. The lines of the grating are vertical. The separation between adjacent lines in the grating is d .

What is a possible value of d ?

- A** $2.25 \times 10^{-6} \text{ m}$ **B** $2.80 \times 10^{-6} \text{ m}$ **C** $4.40 \times 10^{-6} \text{ m}$ **D** $4.95 \times 10^{-6} \text{ m}$

219. Question | 9702 Oct-Nov 2024 P1 V1 Q27

27 Three statements about two progressive waves are listed.

- 1 The waves have the same frequency.
- 2 The waves have the same amplitude.
- 3 The waves are emitted with a constant phase difference.

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

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

220. Question | 9702 Oct-Nov 2024 P1 V1 Q28

28 Waves P and Q have the same amplitude. The waves meet in phase at point X and interfere to give a resultant wave with intensity I .

The amplitude of wave P is doubled.

What is the new intensity of the resultant wave at X, in terms of I ?

- A** $0.44I$ **B** $1.5I$ **C** $2.3I$ **D** $3.0I$

9702 Physics Paper 1 - Superposition

Topical questions | 256 questions

221. Question | 9702 Oct-Nov 2024 P1 V1 Q30

- 30** Light of wavelength λ is incident normally on a diffraction grating with a total number of N lines in width w .

A second order maximum is observed at an angle of diffraction θ .

What is N ?

- A** $\frac{w\lambda}{\sin\theta}$ **B** $\frac{2w\lambda}{\sin\theta}$ **C** $\frac{w\sin\theta}{2\lambda}$ **D** $\frac{w\sin\theta}{\lambda}$

222. Question | 9702 Oct-Nov 2024 P1 V2 Q28

- 28** What happens when two waves superpose at a point?

- A** Their amplitudes are added together.
B Their displacements are added together.
C Their frequencies are added together.
D Their velocities are added together.

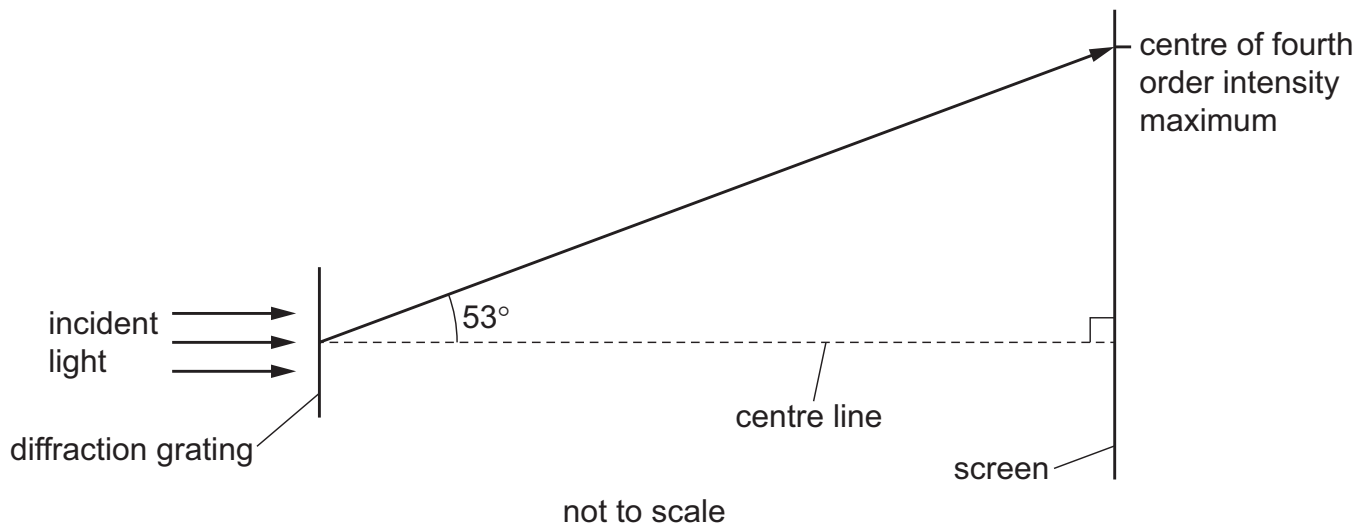
223. Question | 9702 Oct-Nov 2024 P1 V2 Q29

- 29** An electromagnetic wave is diffracted as it passes through a single slit. The width of the slit is larger than the wavelength of the wave.

Which change will decrease the amount of diffraction of the wave?

- A** Decrease the frequency of the wave.
B Decrease the time period of the wave.
C Decrease the width of the slit.
D Increase the wavelength of the wave.

30 The diagram shows visible light incident normally on a diffraction grating.



A pattern of intensity maxima forms on the screen. A line connecting the centre of the fourth order intensity maximum with the centre of the diffraction grating forms an angle of 53° with the centre line. The grating has a line spacing of $2.7 \times 10^{-6} \text{ m}$.

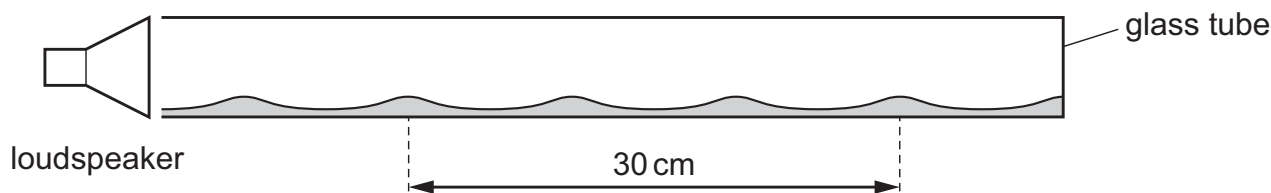
What is the wavelength of the incident light?

- A** $4.1 \times 10^{-7} \text{ m}$ **B** $5.4 \times 10^{-7} \text{ m}$ **C** $1.6 \times 10^{-6} \text{ m}$ **D** $2.2 \times 10^{-6} \text{ m}$

- 31** A horizontal glass tube, closed at one end, has a layer of dust laid inside it on its lower side. Sound is emitted from a loudspeaker that is placed near the open end of the tube.

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

The distance between four heaps of dust is 30 cm.



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

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

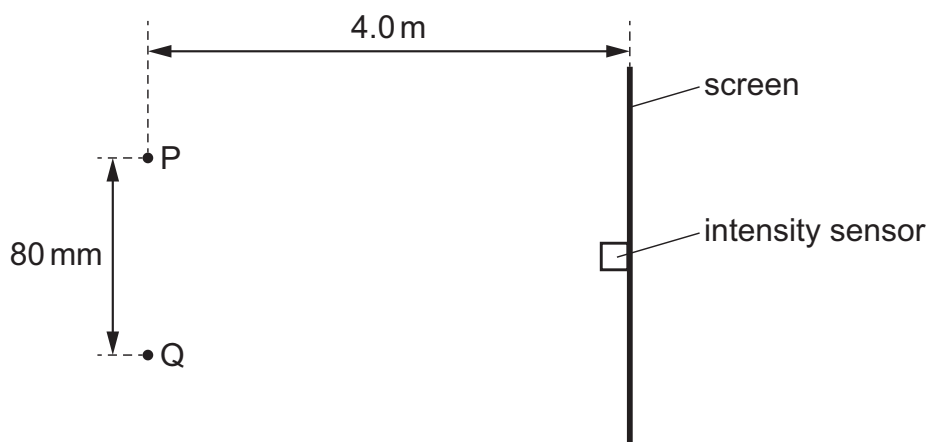
- A** 1650 Hz **B** 2200 Hz **C** 3300 Hz **D** 6600 Hz

28 A stationary wave is set up in a stretched string.

Which distance is equal to the wavelength of the wave?

- A** double the distance between adjacent antinodes
- B** half the distance between adjacent nodes
- C** the distance between adjacent antinodes
- D** the distance between a node and an adjacent antinode

- 29** A source of coherent light is incident on two slits, P and Q, which are placed 80 mm apart. The light has a single frequency of 1.5×10^{12} Hz. The light from the slits meets on a screen that is a distance of 4.0 m from the slits. The screen is parallel to a line joining the slits.



not to scale

An intensity sensor is placed on the screen at the midpoint of the interference pattern such that the intensity reading is a maximum. The intensity sensor is moved along the screen.

The sensor travels through two intensity minima, two intensity maxima and stops in the middle of the third intensity minimum.

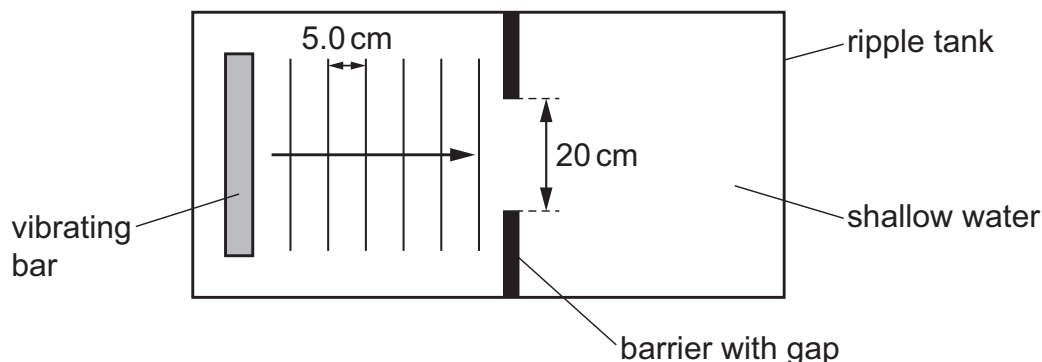
Which distance does the sensor move through?

- A** 4.0 mm **B** 10 mm **C** 25 mm **D** 50 mm

228. Question | 9702 Oct-Nov 2024 P1 V3 Q30

30 A vibrating bar produces surface water waves in a ripple tank.

The wavelength of the waves is 5.0 cm and they pass through a gap of width 20 cm.



Which change will increase the amount of diffraction that is observed?

- A** decreasing the distance between the bar and the gap
- B** decreasing the frequency of the wave
- C** increasing the amplitude of the wave
- D** increasing the width of the gap

229. Question | 9702 Feb-March 2025 P1 V2 Q27

27 Light waves are emitted from two sources.

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

- A** The waves must be polarised.
- B** The waves must **not** be polarised.
- C** The waves must be coherent.
- D** The waves must have equal amplitudes.

230. Question | 9702 Feb-March 2025 P1 V2 Q29

29 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°

231. Question | 9702 May-June 2025 P1 V1 Q29

- 29** One wave has an amplitude of $2A$. A second wave has an amplitude of $\frac{A}{2}$. The waves are otherwise identical.

The two waves travel in opposite directions and overlap.

What is the ratio $\frac{\text{maximum amplitude of combined wave}}{\text{minimum amplitude of combined wave}}$?

- A** $\frac{3}{2}$ **B** $\frac{5}{3}$ **C** $\frac{5}{2}$ **D** 4

232. Question | 9702 May-June 2025 P1 V1 Q30

- 30** Light of wavelength 680 nm is incident normally on a diffraction grating with $450 \text{ lines mm}^{-1}$.

What is the angle of diffraction of the second-order maximum in the diffraction pattern that is produced?

- A** 1.8° **B** 3.5° **C** 18° **D** 38°

233. Question | 9702 May-June 2025 P1 V1 Q31

- 31** A hollow tube is closed at one end and open at the other.

A stationary sound wave of the lowest possible frequency, 820 Hz, is produced in the tube.

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

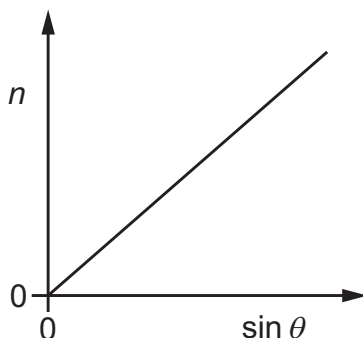
What is the length of the tube?

- A** 10 cm **B** 20 cm **C** 40 cm **D** 160 cm

234. Question | 9702 May-June 2025 P1 V2 Q29

29 A student uses a diffraction grating to determine the wavelength of visible light from a source.

The diffraction grating has 300 lines per mm. The student measures the angle θ of each order n of the intensity maxima. A graph of n against $\sin \theta$ is plotted. The line of best fit for the plotted points is shown and has gradient G .



Which expression represents the wavelength, in m, of the visible light in terms of G ?

- A** $3 \times 10^5 G$ **B** $3.3 \times 10^{-6} G$ **C** $\frac{3.3 \times 10^{-6}}{G}$ **D** $\frac{300}{G}$

235. Question | 9702 May-June 2025 P1 V2 Q30

30 Two waves meet.

What is **not** a necessary condition for the waves to produce a stationary wave?

- A** They must be of the same type.
B They must have the same period.
C They must have the same wavelength.
D They must travel in the same direction.

236. Question | 9702 May-June 2025 P1 V2 Q31

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

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

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

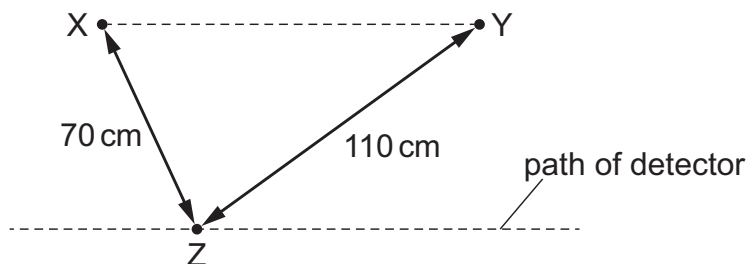
What is the new fringe separation?

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

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

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

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



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

What is a possible wavelength of the waves?

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

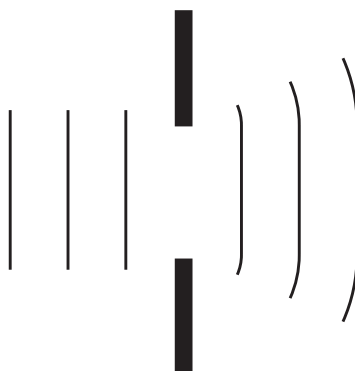
29 Two waves of the same type overlap.

When does the principle of superposition apply?

- A** always
- B** only when the waves have the same amplitude
- C** only when the waves travel in opposite directions
- D** only when the waves have the same frequency

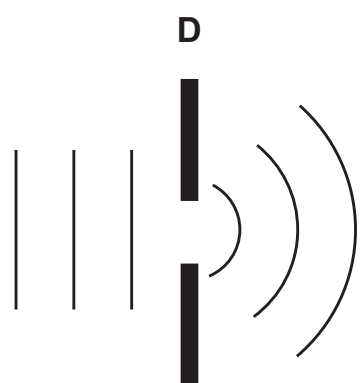
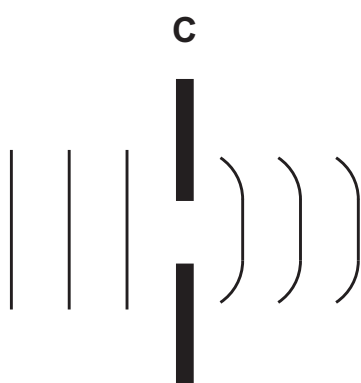
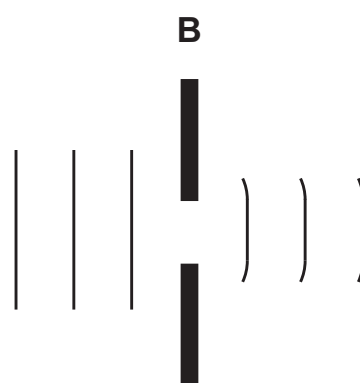
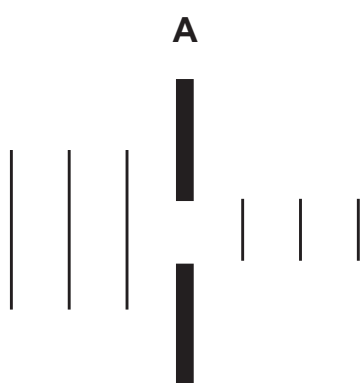
30 A ripple tank contains water at a constant depth.

A water wave of constant frequency travels towards a gap in a barrier placed in the ripple tank.



The gap is made smaller.

Which diagram represents the wave before and after the barrier?



240. Question | 9702 May-June 2025 P1 V3 Q31

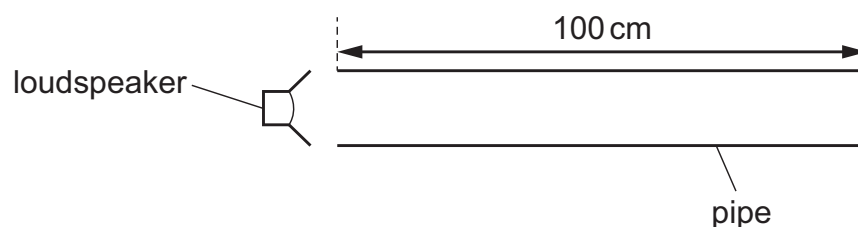
- 31** Light of a single frequency from two coherent sources interferes to produce a pattern of bright and dark fringes on a screen.

Which change results in a larger fringe separation?

- A** increasing the distance between the sources and the screen
- B** increasing the distance between the two sources
- C** increasing the frequency of the light
- D** increasing the intensity of the light

241. Question | 9702 May-June 2025 P1 V4 Q25

- 25** 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.

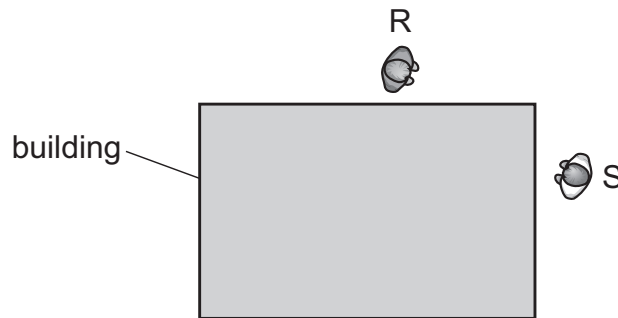


Which wavelength can produce a stationary wave in the pipe?

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

242. Question | 9702 May-June 2025 P1 V4 Q26

- 26** A student makes a sound at point R near a building. A second student, standing at point S around the corner of the building, hears the sound. The building is a solid structure and there are no other structures nearby.



Which effect best explains how the student at point S is able to hear the student at point R?

- A** diffraction
- B** interference
- C** polarisation
- D** reflection

243. Question | 9702 May-June 2025 P1 V4 Q27

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

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

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

- A** Decrease the distance from the double slit to the screen.
- B** Decrease the separation of the slits.
- C** Replace the red light with blue light.
- D** Replace the red light with green light.

244. Question | 9702 May-June 2025 P1 V4 Q28

28 An electromagnetic wave is incident normally on a diffraction grating.

A second-order maximum is produced at an angle of 30° to the direction of the incident light.

The grating has 5000 lines per cm.

What is the wavelength of the wave?

- A** $2.5 \times 10^{-7} \text{ m}$ **B** $5.0 \times 10^{-7} \text{ m}$ **C** $1.0 \times 10^{-6} \text{ m}$ **D** $5.0 \times 10^{-5} \text{ m}$

245. Question | 9702 Oct-Nov 2025 P1 V1 Q28

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

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

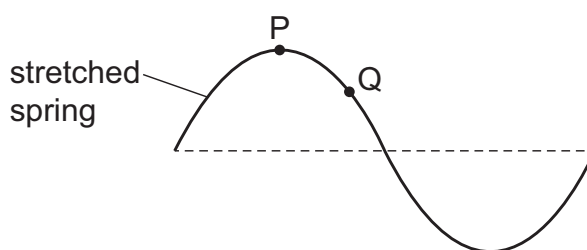


What is the slit separation?

- A** $8.5 \times 10^{-3} \text{ m}$ **B** $2.4 \times 10^{-4} \text{ m}$ **C** $1.9 \times 10^{-4} \text{ m}$ **D** $4.8 \times 10^{-5} \text{ m}$

246. Question | 9702 Oct-Nov 2025 P1 V1 Q29

29 The diagram shows a stationary wave on a stretched spring at an instant in time.



Two particles on the spring, P and Q, are shown.

Which statement about the vibrations of P and Q is correct?

- A** They have different frequencies.
B They have the same amplitudes.
C They have different periods.
D They are always in phase.

247. Question | 9702 Oct-Nov 2025 P1 V1 Q30

30 Green laser light passes through a diffraction grating and forms an interference pattern.

The diffraction grating contains 400 lines per mm.

The wavelength of the laser light is 550 nm.

What is the highest order diffraction maximum produced by the grating?

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

248. Question | 9702 Oct-Nov 2025 P1 V2 Q29

29 The equation $n\lambda = d\sin\theta$ can be used with a diffraction grating to find the wavelength of visible light.

Which quantity is **not** correct for use in this equation?

	symbol	quantity
A	d	distance from grating to screen
B	λ	wavelength of light
C	n	order of intensity maximum
D	θ	diffraction angle of intensity maximum

249. Question | 9702 Oct-Nov 2025 P1 V2 Q30

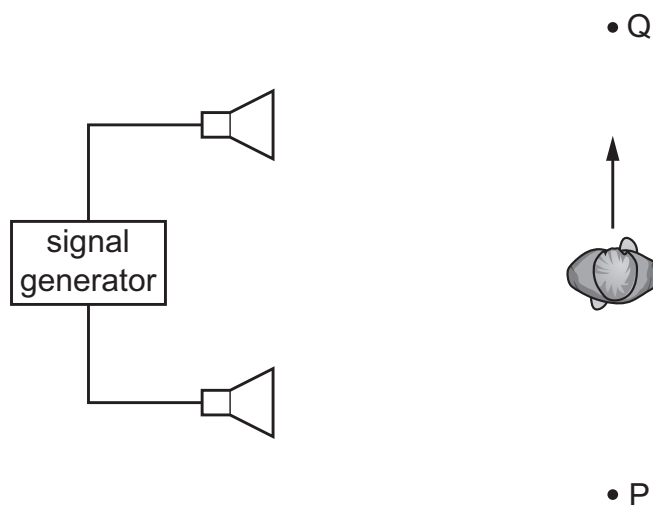
30 Two progressive sound waves move in opposite directions and superpose to form a stationary wave.

Which statement describes an antinode of this stationary wave?

- A** a position where the phase difference between the two waves is always 0°
B a position where the phase difference between the two waves is always 180°
C a position where the stationary wave has maximum amplitude
D a position where the stationary wave has minimum amplitude

250. Question | 9702 Oct-Nov 2025 P1 V2 Q31

31 A student connects two loudspeakers to a signal generator.



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

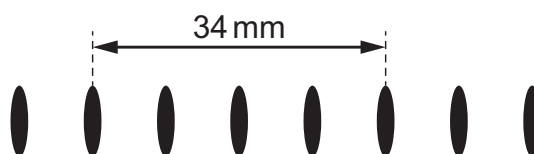
What causes the loudness of the sound to vary?

- A** diffraction of the sound waves
- B** Doppler shift of the sound waves
- C** interference of the sound waves
- D** reflection of the sound waves

251. Question | 9702 Oct-Nov 2025 P1 V3 Q28

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

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

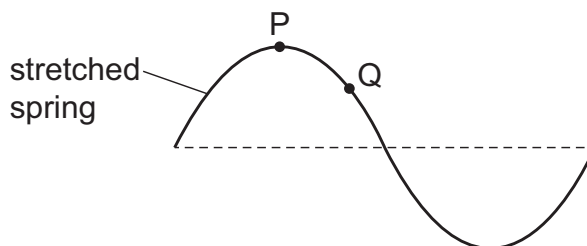


What is the slit separation?

- A** $8.5 \times 10^{-3} \text{ m}$
- B** $2.4 \times 10^{-4} \text{ m}$
- C** $1.9 \times 10^{-4} \text{ m}$
- D** $4.8 \times 10^{-5} \text{ m}$

252. Question | 9702 Oct-Nov 2025 P1 V3 Q29

- 29** The diagram shows a stationary wave on a stretched spring at an instant in time.



Two particles on the spring, P and Q, are shown.

Which statement about the vibrations of P and Q is correct?

- A** They have different frequencies.
- B** They have the same amplitudes.
- C** They have different periods.
- D** They are always in phase.

253. Question | 9702 Oct-Nov 2025 P1 V3 Q30

- 30** Green laser light passes through a diffraction grating and forms an interference pattern.

The diffraction grating contains 400 lines per mm.

The wavelength of the laser light is 550 nm.

What is the highest order diffraction maximum produced by the grating?

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

254. Question | 9702 Oct-Nov 2025 P1 V4 Q29

- 29** A wire is fixed at both ends and is vibrated by a source of frequency f . A stationary wave is formed on the wire with a total of two antinodes.

The frequency of the source is increased to $3f$ and a new stationary wave is formed.

What is the total number of antinodes on the new wave?

- A** 4 **B** 5 **C** 6 **D** 9

255. Question | 9702 Oct-Nov 2025 P1 V4 Q30

- 30** 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

256. Question | 9702 Oct-Nov 2025 P1 V4 Q31

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

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

What is meant by coherent waves?

- A** The two waves are emitted with the same frequency.
B The two waves are emitted with constant phase difference.
C The two waves are emitted with the same intensity.
D The two waves are emitted with zero phase difference.