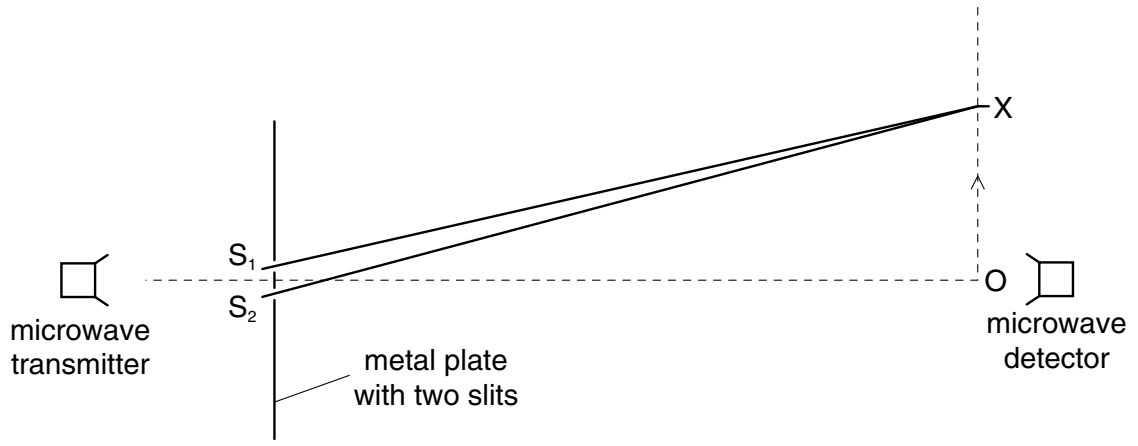
1 The diagram shows an experiment which has been set up to demonstrate two-source interference, using microwaves of wavelength λ. 9702/1/M/J/02



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

Which equation correctly determines the position of X?

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

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

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

A using monochromatic light of higher frequency

B using monochromatic light of a longer wavelength

C decreasing the distance between the screen and the slits

D increasing the distance between the slits

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

What is the spacing of the lines on the grating?

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

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

Why is this?

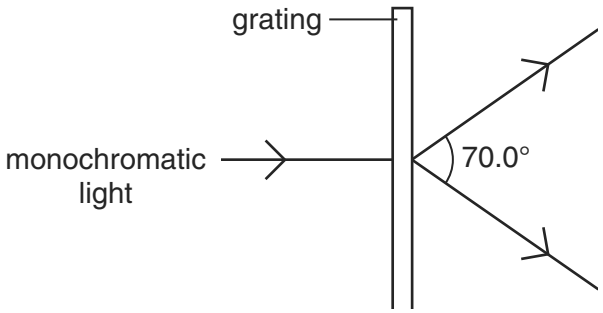
A The lamps are not point sources.

B The lamps emit light of different amplitudes.

C The light from the lamps is not coherent.

D The light from the lamps is white.

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



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

What is the wavelength of the light?

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

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

What is seen on the screen?

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

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

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

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

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

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

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

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

What is the wavelength of the incident light?

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

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

At which distance from the slits would fringes of the same separation y be observed when using blue light of wavelength 400 nm?

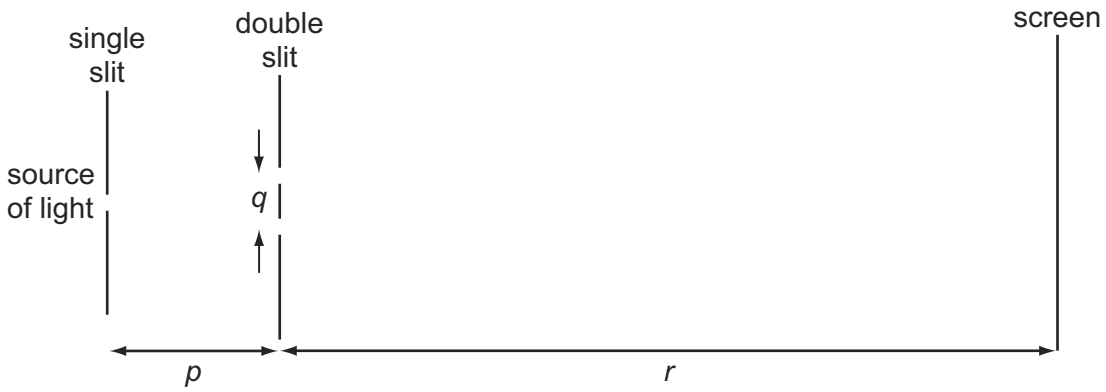
A 0.33 m **B** 0.67 m **C** 0.75 m **D** 1.50 m

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

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

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

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



Which change to the apparatus will increase the fringe spacing?

A decreasing the distance p

B decreasing the distance q

C decreasing the distance r

D decreasing the wavelength of the light

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

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

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

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

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

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

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

A A wave bounces back from a surface.

B A wave passes from one medium into another.

C A wave passes through an aperture.

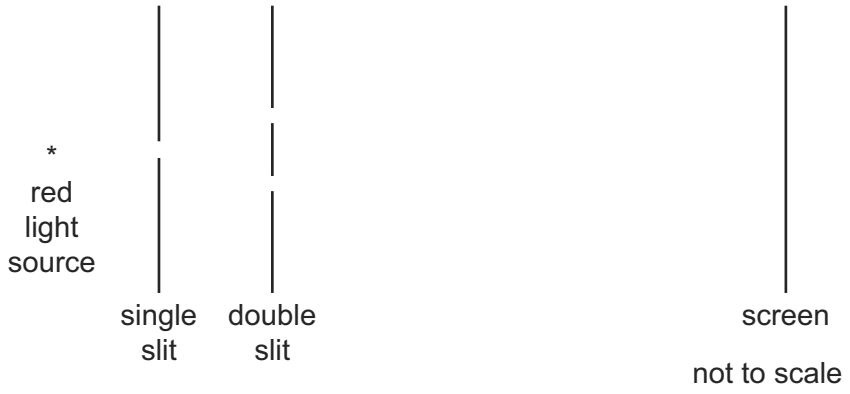
D Waves from two identical sources are superposed.

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

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

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

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



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

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

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

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

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

A increasing the frequency of the waves

B increasing the width of the gap

C reducing the wavelength of the waves

D reducing the width of the gap

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

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

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

What is the fringe separation on the screen?

A 2.5×10^{-7} m

B 1.0×10^{-5} m

C 1.0×10^{-3} m

D 1.0×10^{-1} m

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

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

A The light waves from the sources are not coherent.

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

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

D The light waves from the sources are not monochromatic.

20 A two-slit arrangement is set up to produce interference fringes on a screen. The fringes are too close together for convenient observation when a monochromatic source of violet light is used. 9702/01/M/J/07

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

A Decrease the distance between the screen and the slits.

B Increase the distance between the two slits.

C Increase the width of each slit.

D Use a monochromatic source of red light.

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

What is the wavelength of the blue light?

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

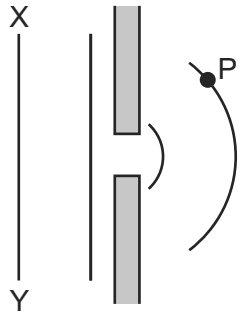
22 A diffraction grating has N lines per unit length and is placed at 90° to monochromatic light of wavelength λ. 9702/01/M/J/08

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

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

23 A monochromatic plane wave of speed c and wavelength λ is diffracted at a small aperture. 9702/12/M/J/12

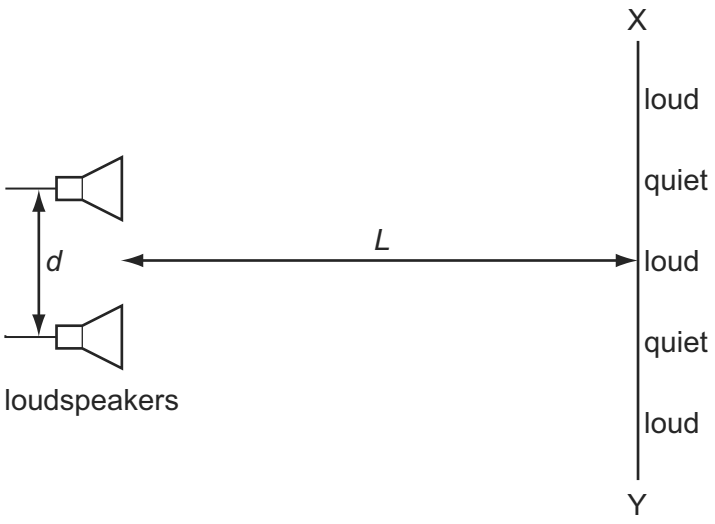
The diagram illustrates successive wavefronts.



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

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

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



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

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

A decreasing distance d.

B increasing distance L.

C decreasing the amplitude.

D increasing the frequency.

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

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

B bending of waves round an obstacle.

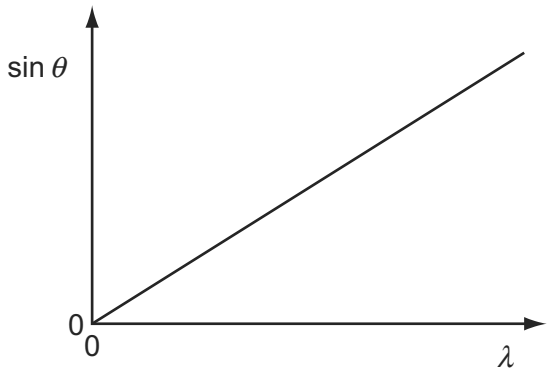
C change of direction when waves cross the boundary between one medium and another.

D splitting of white light into colours.

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

The diagram shows a relation between the deflection angles θ for different values of λ in the n^{th} order interference pattern.

9702/01/M/J/09



What is the gradient of the graph?

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

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

9702/11/O/N/09

What is the total number of transmitted maxima?

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

28 Diagram 1 shows a ripple tank experiment in which plane waves are diffracted through a narrow slit in a metal sheet.

9702/11/M/J/10

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

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

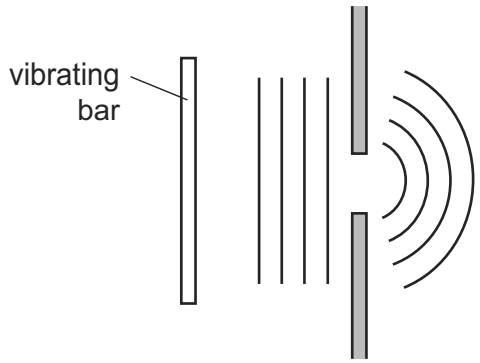


diagram 1

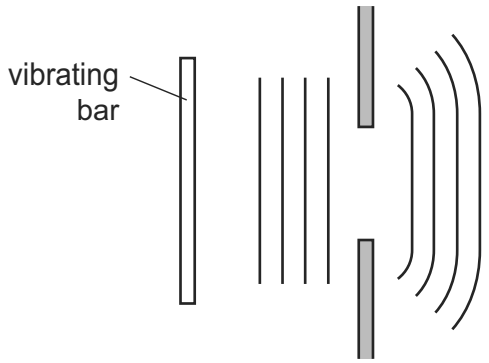


diagram 2

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

A increasing the frequency of vibration of the bar

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

C reducing the amplitude of vibration of the bar

D reducing the length of the vibrating bar

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

9702/12/M/J/13

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

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

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

9702/11/M/J/10

Both a and D are now doubled.

What is the new fringe separation?

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

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

9702/12/M/J/10

Which type of wave are they most likely to be?

A radio waves

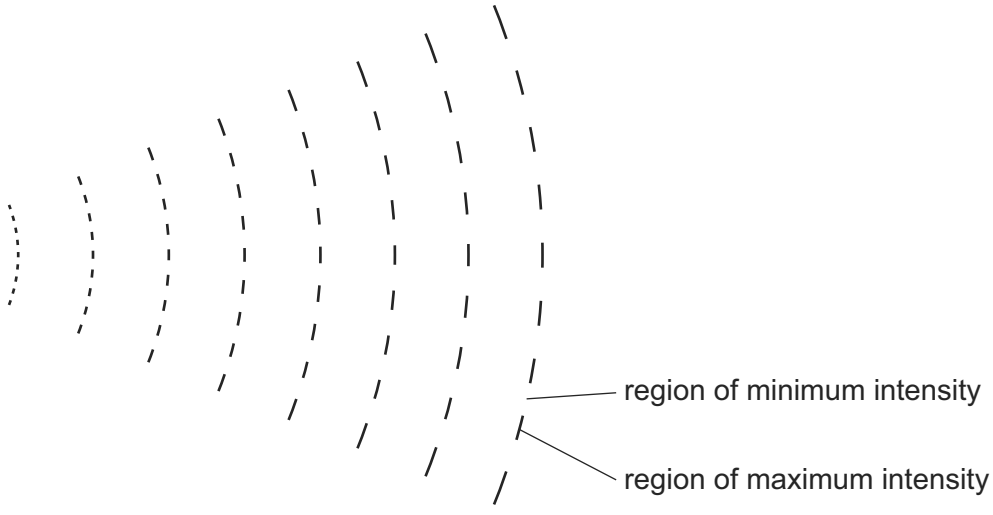
B microwaves

C infra-red waves

D ultraviolet waves

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

9702/12/M/J/15



What can cause this pattern?

A coherence only

B diffraction and interference

C diffraction only

D interference only

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

A coherence

B interference

C polarisation

D refraction

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

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

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

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

35 In a double-slit experiment the distance between the fringes, on a screen, was too small to measure. 9702/11/M/J/15

What would increase the distance between the fringes?

A increasing the distance between the light source and the slits

B increasing the distance between the slits and the screen

C increasing the distance between the slits

D increasing the frequency of the light source

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

A infra-red

B microwave

C ultraviolet

D X-ray

37 Light of wavelength 600 nm is incident on a pair of slits. Fringes with a spacing of 4.0 mm are formed on a screen. 9702/11/M/J/13

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

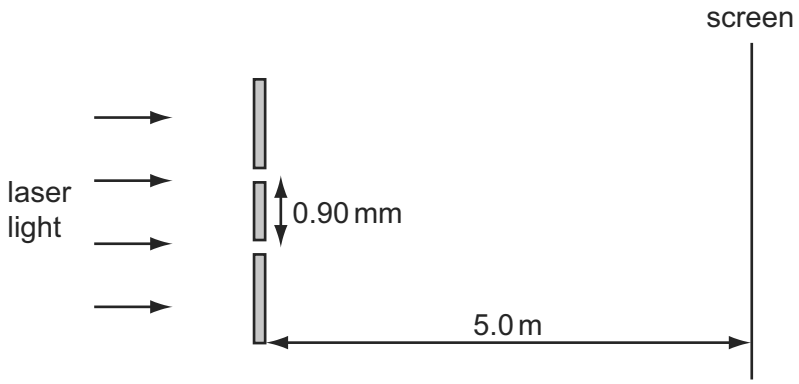
A 1.3 mm

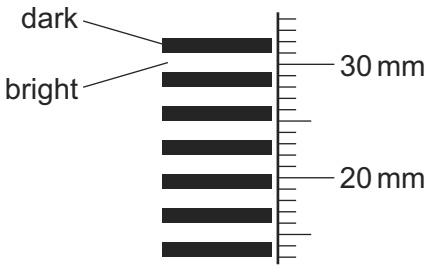
B 3.0 mm

C 5.3 mm

D 12 mm

38 The diagrams show the arrangement of apparatus for a Young's slits experiment and also part of the pattern formed on the screen with a ruler placed next to it. 9702/12/M/J/11

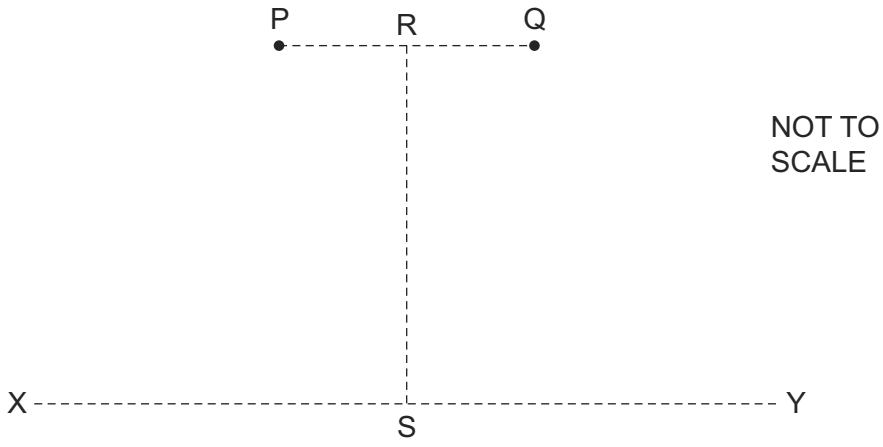




What is the wavelength of the light?

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

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



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

A both RS and XY

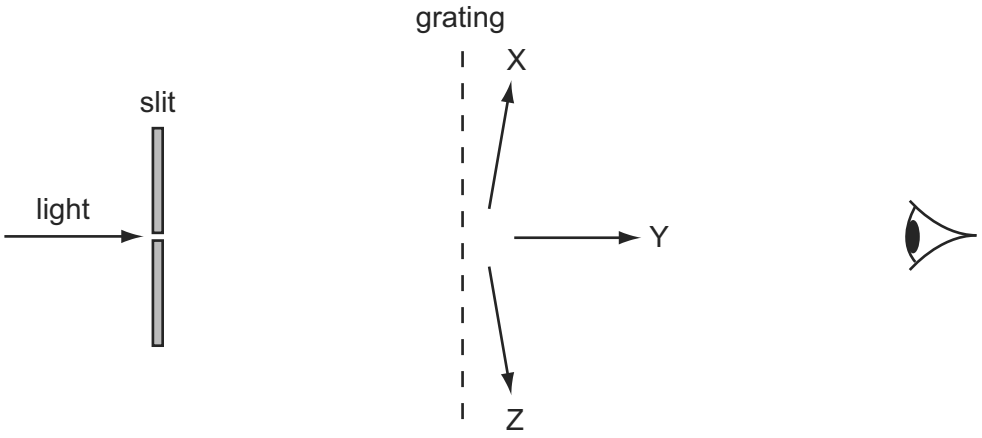
B RS only

C XY only

D neither RS nor XY

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

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

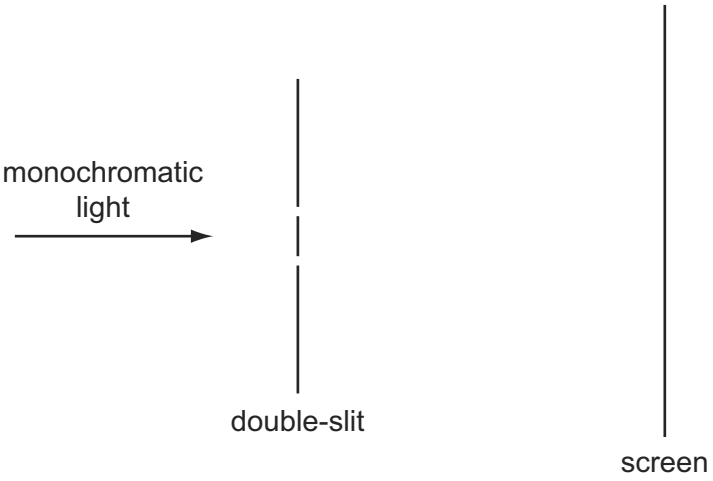


An observer views the slit through the grating at different angles, moving his head from X parallel to the grating, through Y, opposite the slit, to Z parallel to the grating on the opposite side.

How many images of the slit does he see?

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

41 A student sets up apparatus to observe the double-slit interference of monochromatic light, as shown. 9702/13/O/N/13



Interference fringes are formed on the screen.

Which change would increase the distance between adjacent fringes?

A Decrease the distance between the two slits.

B Decrease the width of each slit.

C Move the screen closer to the double-slit.

D Use light of a higher frequency.

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

Which condition enables visible interference fringes to be formed?

A using a white light source

B using incoherent sources

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

D using sources from which the light does not overlap

43 What is meant by diffraction? 9702/13/O/N/13

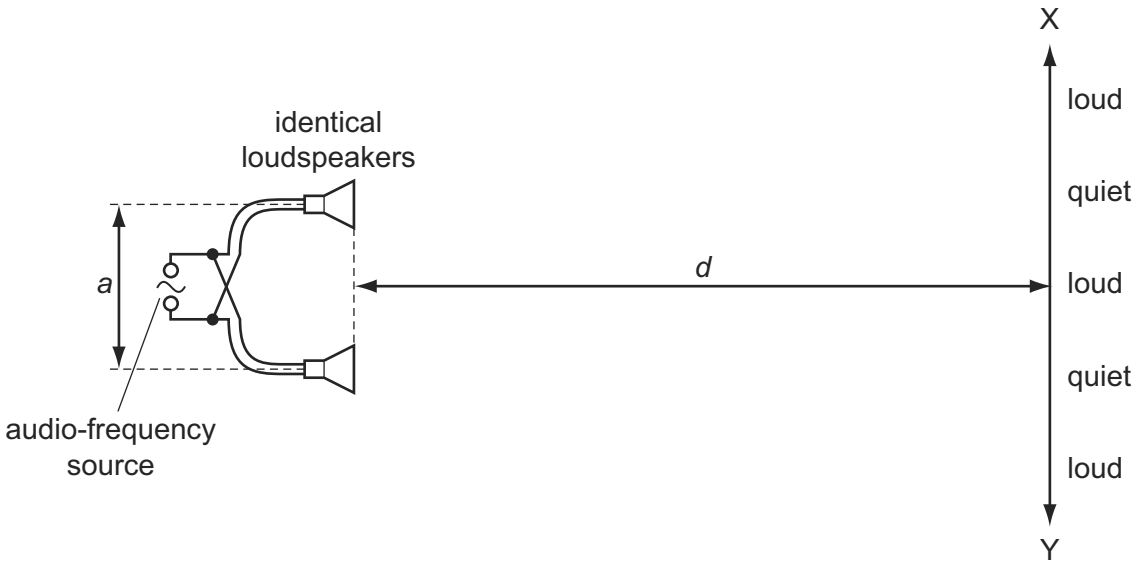
A Addition of two coherent waves to produce a stationary wave pattern.

B Bending of waves round an obstacle.

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

D Splitting of white light into colours.

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



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

How may the distance between loud regions be reduced?

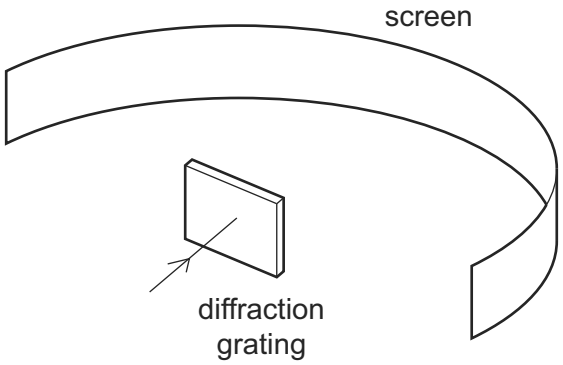
A decreasing the distance *a* between the speakers

B increasing distance *d*

C increasing the frequency of the audio-frequency source

D increasing the power output from the audio-frequency source

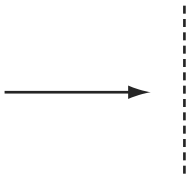
45 Monochromatic light of wavelength 690 nm passes through a diffraction grating with 300 lines per mm, producing a series of maxima on a screen. 9702/12/O/N/12



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

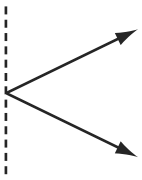
A 4 **B** 5 **C** 8 **D** 9

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

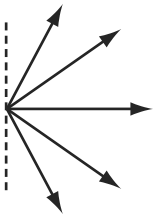


Which diagram shows all the possible directions of the light, after passing through the grating, that give maximum intensity?

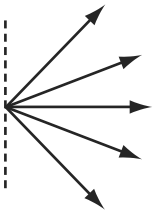
A



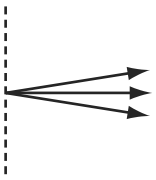
B



C



D



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

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

A microwaves passing a steel post

B radio waves passing a copper wire

C sound waves passing a human hair

D visible light waves passing a gate post

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

What is the total number of transmitted maxima?

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

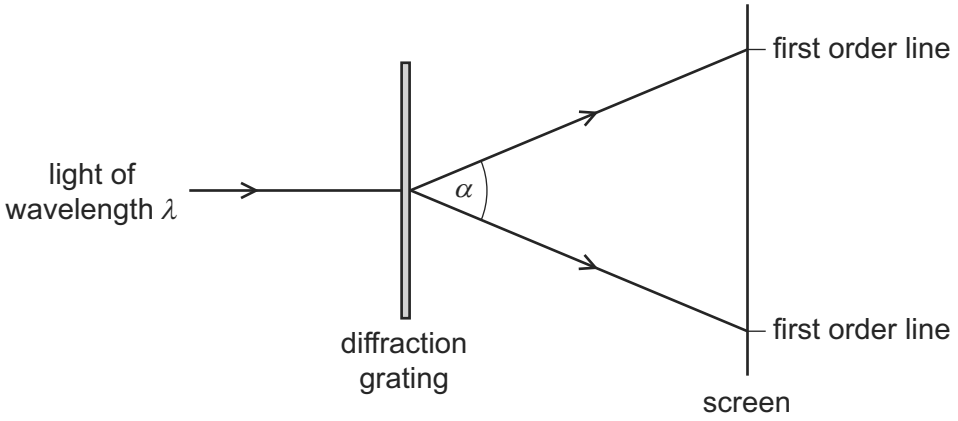
49 Noise reduction headphones actively produce their own sound waves in order to cancel out external sound waves. 9702/11/M/J/13

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

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

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

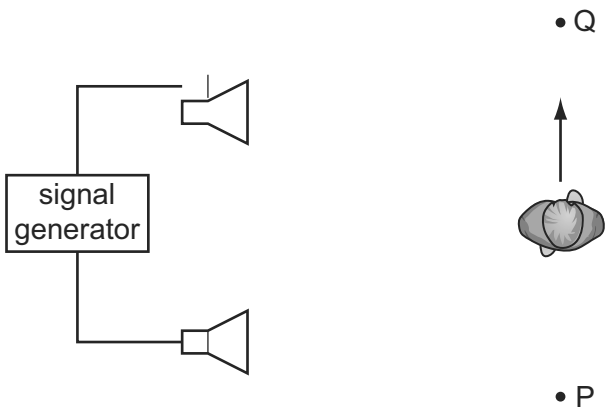
50 Light of wavelength λ passes through a diffraction grating with slit spacing d. A series of lines is observed on a screen. 9702/11/O/N/13



What is the angle α between the two first order lines?

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

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



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

What causes the loudness of the sound to vary?

A diffraction of the sound waves

B interference of the sound waves

C polarisation of the sound waves

D reflection of the sound waves

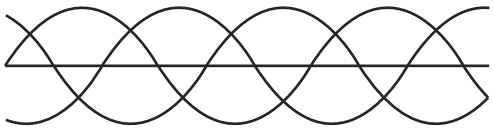
52 The three waves shown in each diagram have the same amplitude and frequency but differ in phase.

9702/13/O/N/13

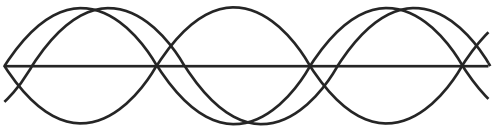
They are added together to give a resultant wave.

In which case is the resultant wave zero?

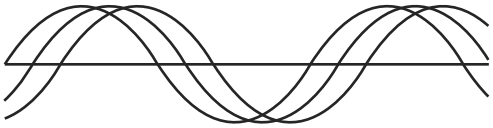
A



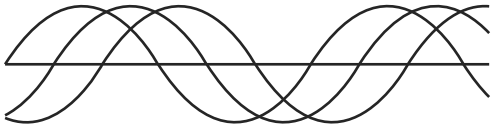
B



C



D



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

9702/12/M/J/14

What is this quantity?

A amplitude

B displacement

C intensity

D wavelength

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

9702/12/M/J/14

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

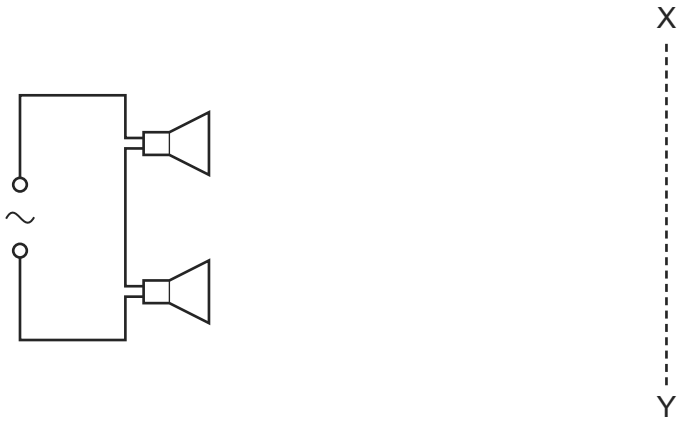
A The diffraction grating maxima are less widely spaced and are less sharp than the two-slit maxima.

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

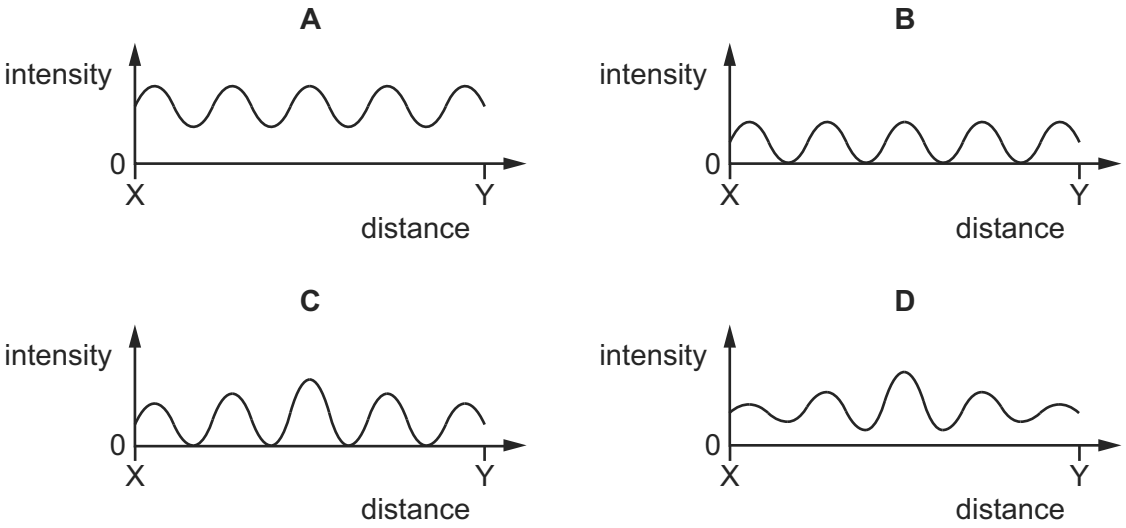
C The diffraction grating maxima are more widely spaced and are less sharp than the two-slit maxima.

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

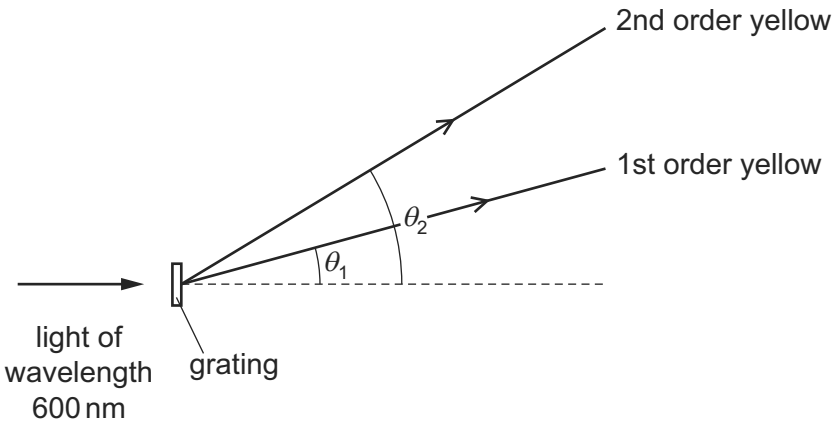
55 Two identical loudspeakers are connected in series to an a.c. supply, as shown. 9702/11/O/N/14



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



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



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

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

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

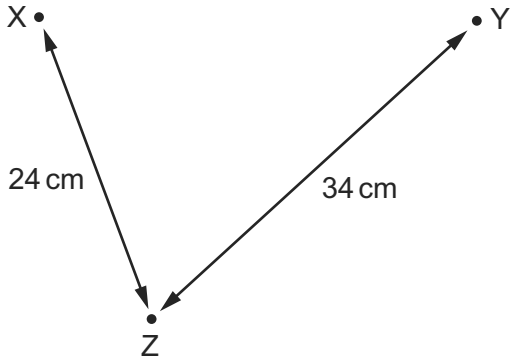
9702/13/O/N/14

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

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

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

9702/13/M/J/15



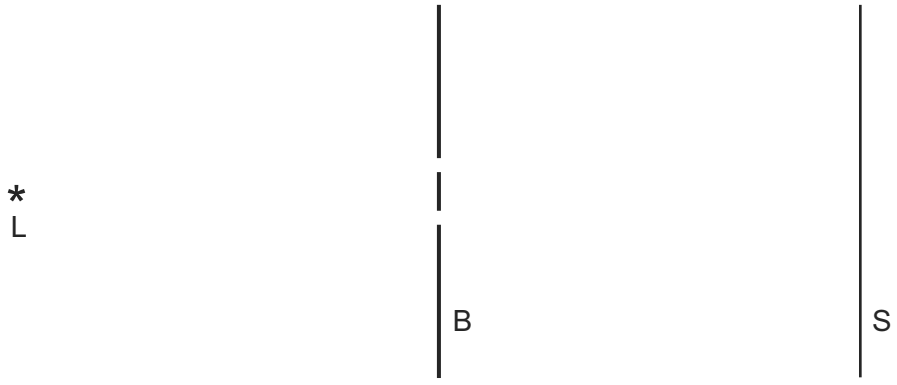
When the wave generators operate in phase, the amplitude of oscillation at Z is zero.

What could be the wavelength of the waves?

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

59 The diagram shows a view from above of a double slit interference demonstration. 9702/11/O/N/11

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.



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

What is the intensity, at the same point, when one of the slits is covered up?

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

60 What is **not** an **essential** condition for an observable interference pattern to occur between the waves from two sources?

9702/12/M/J/15

A The frequencies of the two sources must be equal.

B The sources must be coherent.

C The sources must emit waves of equal amplitude.

D The waves from the two sources must overlap.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
46	47	48	49	50	51	52	53	54	55	56	57	58	59	60