Topic C

Multiple choice questions

1 A pendulum undergoes SHM with period T. The mass of the bob is made four times larger. What is the new period of the pendulum?

A $4T$
B $2T$
C T
D $\frac{T}{2}$

2 A pendulum on Earth undergoes SHM with period T. What is the period of this pendulum on a planet where the acceleration of free fall is half that on Earth?

A $\frac{T}{2}$
B $\frac{T}{\sqrt{2}}$
C $T\sqrt{2}$
D $2T$

3 A mass on a vertical spring oscillates with period T when the amplitude of oscillations is x_0. What is the period when the amplitude is changed to $\frac{x_0}{4}$?

A $\frac{T}{16}$
B $\frac{T}{4}$
C $\frac{T}{2}$
D T

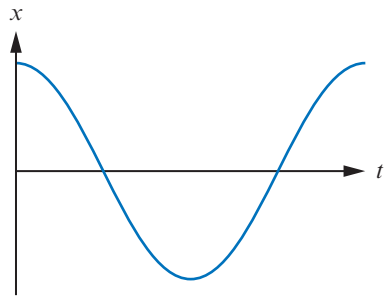
4 The net force F on a system is related to the displacement x from equilibrium. In which case will there be simple harmonic oscillations?

A $F = 2x^2$
B $F = -2x^2$
C $F = 5x$
D $F = -5x$

5 The frequency of oscillations of a mass m attached to a spring is f. What is the frequency when the mass is changed to $4m$?

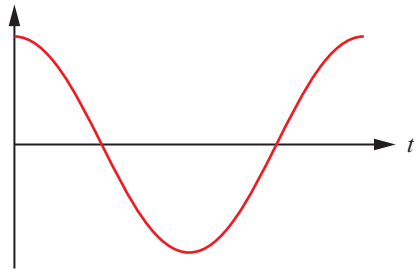
A $\frac{f}{4}$
B $\frac{f}{2}$
C $2f$
D $4f$

6 The graph shows the variation with time of the position of a body in SHM.

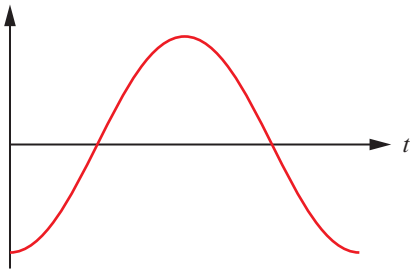


Which graph shows the variation of the velocity of the body?

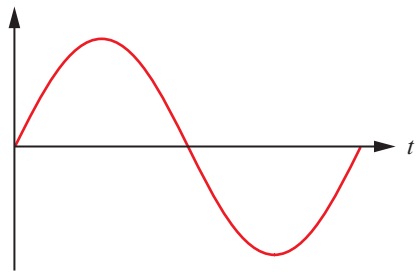
A



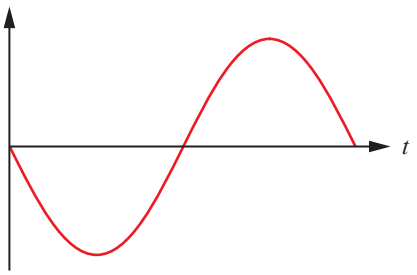
B



C



D



7 The acceleration of a particle in SHM when the displacement is –2.0 cm is +3.0 m s^{-2}.
What is the acceleration when the displacement is 3.0 cm?

A $\frac{3}{2}$ m s^{-2}

B $-\frac{3}{2}$ m s^{-2}

C $\frac{9}{2}$ m s^{-2}

D $-\frac{9}{2}$ m s^{-2}

8 Which statement is correct for simple harmonic oscillations?

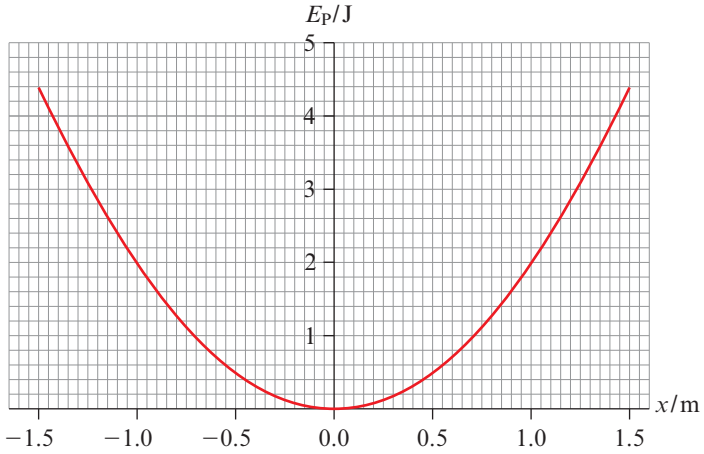
A The acceleration is always opposite to velocity.

B The acceleration is always parallel to velocity.

C The acceleration is opposite to velocity for the first half of the period and parallel in the second half of the period.

D The acceleration is opposite to velocity for a total time equal to half the period and parallel for total time equal to half the period.

9 The graph shows the variation with displacement x of the potential energy of an object in SHM.



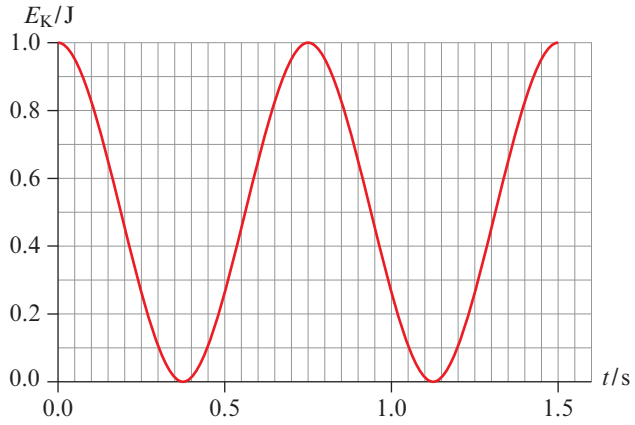
What is the kinetic energy when the displacement is 1.0 m?

A 0.5 J
B 2.0 J
C 2.5 J
D 4.5 J

10 What is correct about the kinetic energy and the potential energy of a body executing SHM at the position of maximum displacement?

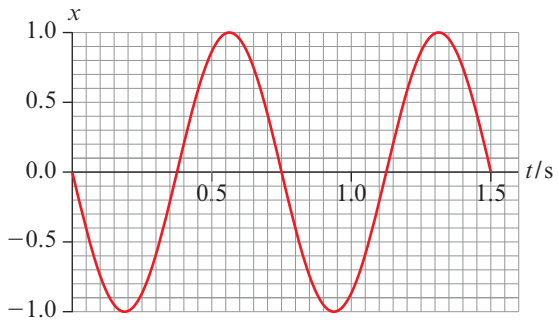
	Kinetic energy	Potential energy
A	maximum	maximum
B	maximum	minimum
C	minimum	maximum
D	minimum	minimum

11 The graph shows the variation with time of the kinetic energy of a particle in simple harmonic oscillations.

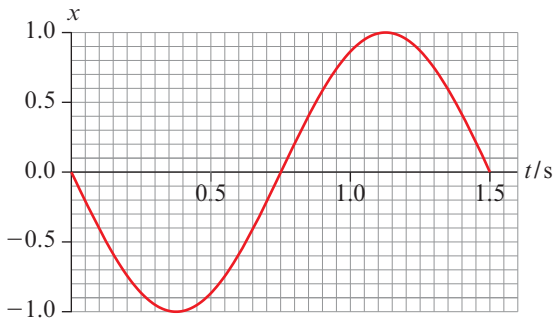


Which is a possible graph of displacement against time?

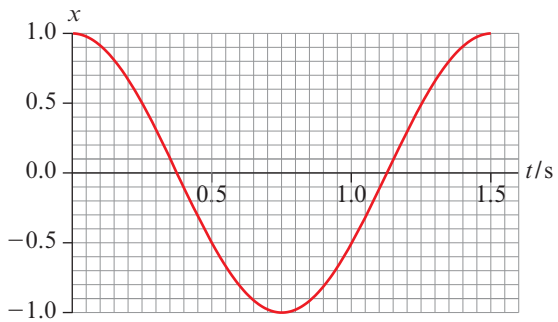
A



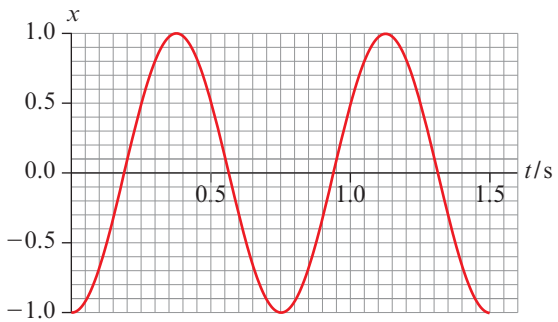
B



C

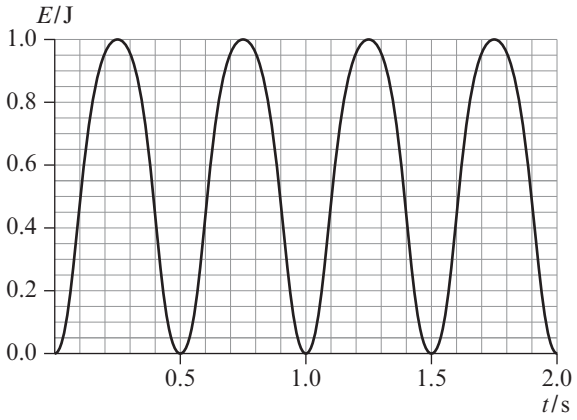


D

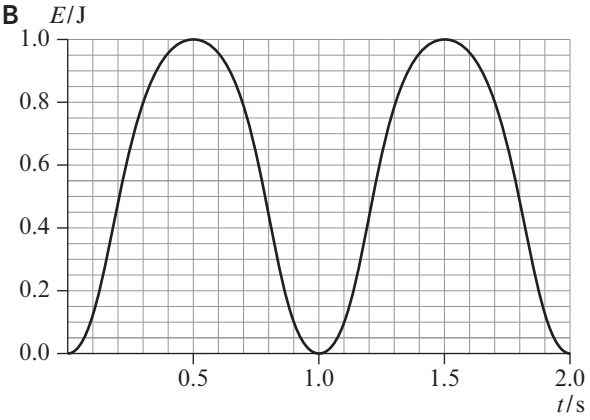


12 Which of the following graphs shows the variation with time of the potential energy of a particle undergoing simple harmonic oscillations with a period of 1.0 s?

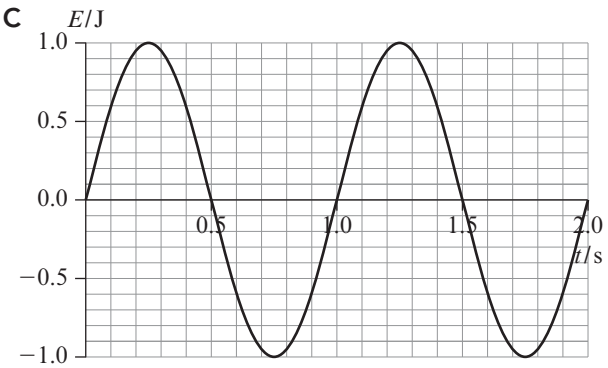
A



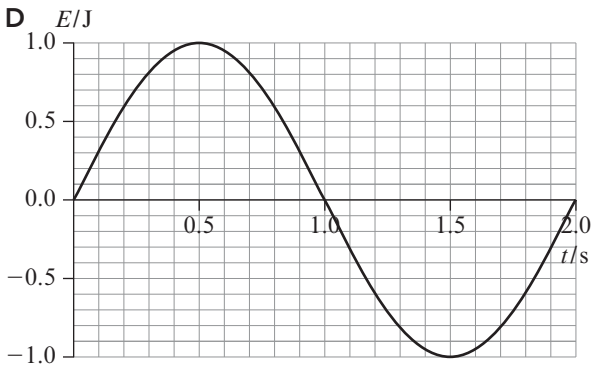
B



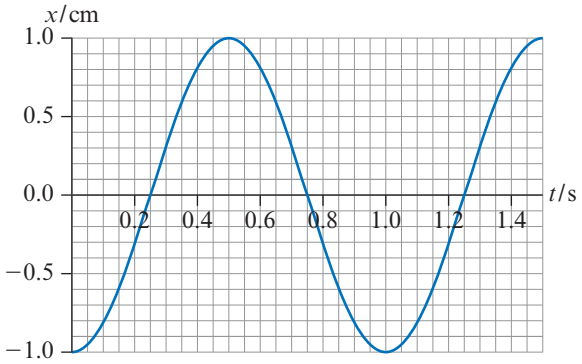
C



D



13 The graph shows the variation with time of the displacement of a particle in SHM.



What is the phase angle for this motion?

A $\frac{\pi}{4}$
B $\frac{\pi}{2}$
C π
D $\frac{3\pi}{2}$

14 The displacement of a particle in simple harmonic motion is given by $x = 5\sin\left(\frac{\pi t}{6} + \frac{\pi}{4}\right)$ where t is in seconds. What is the period of oscillations?

A $\frac{6.0}{\pi}$ s
B $\frac{12}{\pi}$ s
C 6.0 s
D 12 s

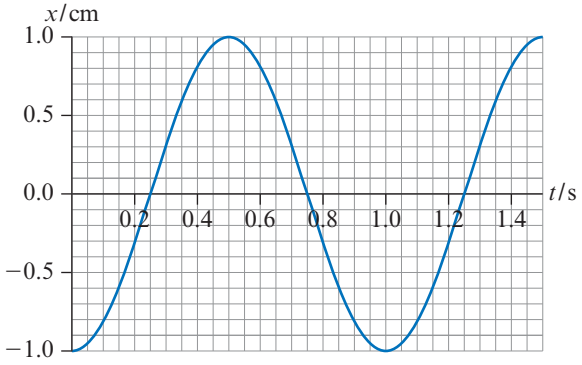
15 The displacement of a particle in simple harmonic motion is given by $x = 6\sin\left(\frac{2t}{3} + \frac{\pi}{2}\right)$, where t is in seconds and x is in meters. What is the maximum speed?

A $4.0\ \text{m s}^{-1}$
B $4.0 \times \pi\ \text{m s}^{-1}$
C $9.0\ \text{m s}^{-1}$
D $9.0 \times \pi\ \text{m s}^{-1}$

16 The displacement of a particle in simple harmonic motion is given by $x = 2\sin(3t + \frac{\pi}{5})$, where t is in seconds and x is in meters. What is the equation for the acceleration?

A $a = 6\sin\left(3t + \frac{\pi}{5}\right)$
B $a = -6\sin\left(3t + \frac{\pi}{5}\right)$
C $a = 18\sin\left(3t + \frac{\pi}{5}\right)$
D $a = -18\sin\left(3t + \frac{\pi}{5}\right)$

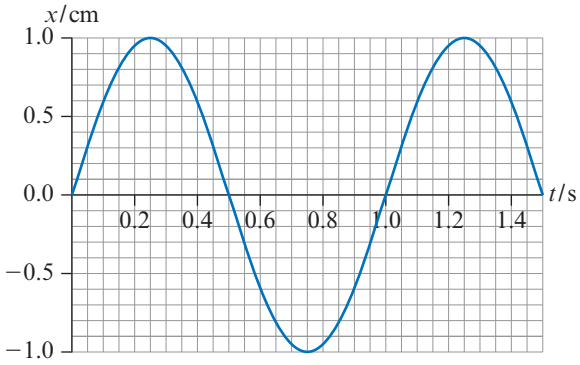
17 The graph shows the variation with time of the displacement of a particle in SHM.



What is the equation for the displacement of the particle?

A $x = \cos(t)$
B $x = -\cos(t)$
C $x = \cos(2\pi t)$
D $x = -\cos(2\pi t)$

18 The graph shows the variation with time of the displacement of a particle in SHM.



What is the equation for the **velocity** of the particle in cm s^{-1}?

A $\cos(2\pi t)$
B $2\pi \cos(2\pi t)$
C $\cos(t)$
D $2\pi \cos(t)$

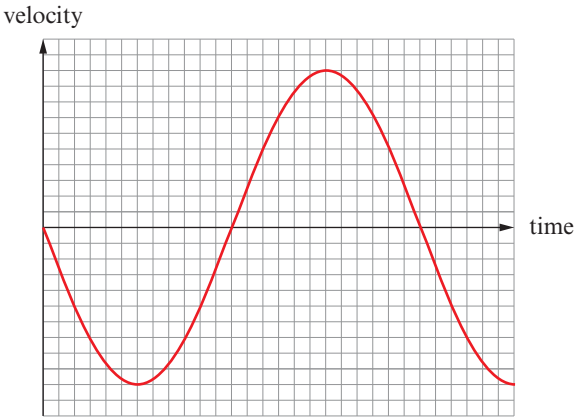
19 The displacement in SHM is given by the expression $x = x_0 \sin\frac{2\pi t}{3}$, where t is in seconds. What is the frequency?

A $\frac{1}{3}$ Hz
B $\frac{3}{2\pi}$ Hz
C $\frac{2\pi}{3}$ Hz
D 3 Hz

20 A particle performs simple harmonic oscillations with amplitude 1 cm and frequency 10 Hz. What is the maximum acceleration of this particle in m s^{-2}?

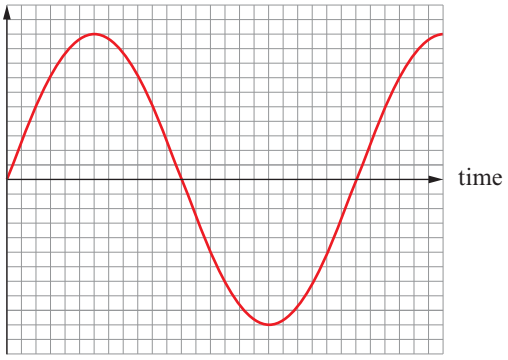
A 0.2π
B 0.4π
C $2\pi^2$
D $4\pi^2$

21 The graph shows the variation with time of the velocity of an object undergoing simple harmonic oscillations.

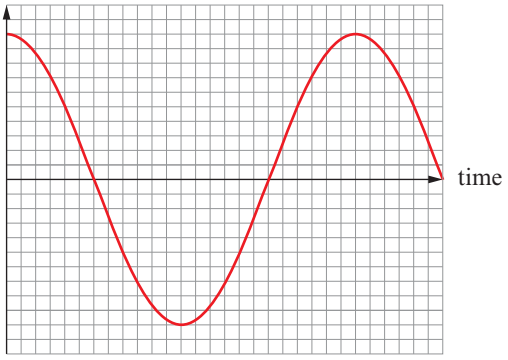


Which graph correctly shows the variation with time of the acceleration of this object?

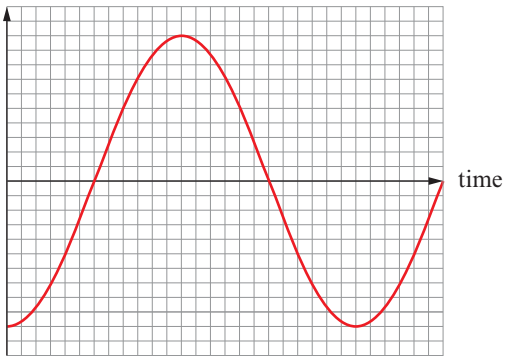
A acceleration



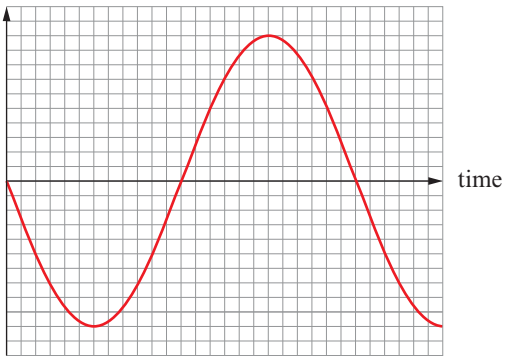
B acceleration



C acceleration



D acceleration



22 In a simple harmonic motion the angular frequency is $\omega = 2$ rad s^{-1}. What is the ratio $\frac{a_{max}}{v_{max}}$ of maximum acceleration to maximum velocity?

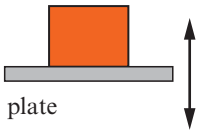
A $\frac{1}{4}$ s^{-1}

B $\frac{1}{2}$ s^{-1}

C 2 s^{-1}

D 4 s^{-1}

23 A horizontal plate is performing vertical harmonic oscillations with amplitude x_0.



A block is on the plate. What is the maximum angular frequency the plate can oscillate at so that the block never loses contact with the plate?

A $\frac{g}{x_0}$

B $\sqrt{\frac{g}{x_0}}$

C $\frac{x_0}{g}$

D $\sqrt{\frac{x_0}{g}}$

24 The total energy of a body in SHM is E. The amplitude of motion is x_0. What is the kinetic energy when the displacement is $\frac{x_0}{2}$?

A $\frac{E}{4}$

B $\frac{E}{2}$

C $\frac{3E}{4}$

D $E\frac{\sqrt{3}}{4}$

25 The total energy of a body in SHM is E, and the period of oscillations is T. The amplitude is halved. What are the new total energy and period?

	Total energy	Period
A	$\frac{E}{2}$	T
B	$\frac{E}{4}$	T
C	$\frac{E}{2}$	$\frac{T}{2}$
D	$\frac{E}{4}$	$\frac{T}{2}$

26 The maximum speed of a body in SHM is v_{max}. The amplitude of motion is x_0. What is the speed of the body when the displacement is $\frac{x_0}{4}$?

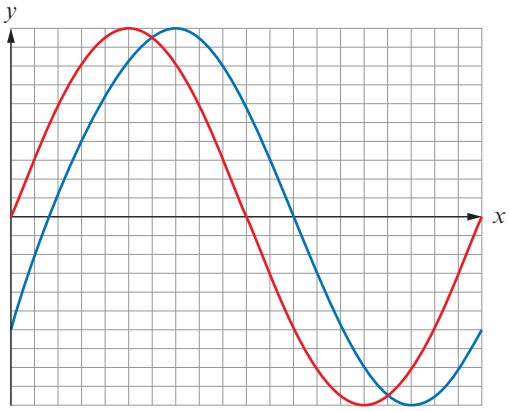
A $\frac{1}{4}v_{max}$

B $\frac{1}{2}v_{max}$

C $\frac{\sqrt{15}}{4}v_{max}$

D $\frac{\sqrt{3}}{2}v_{max}$

27 The diagram shows the variation with distance of the displacement of two travelling waves.



What is the phase difference between the waves?

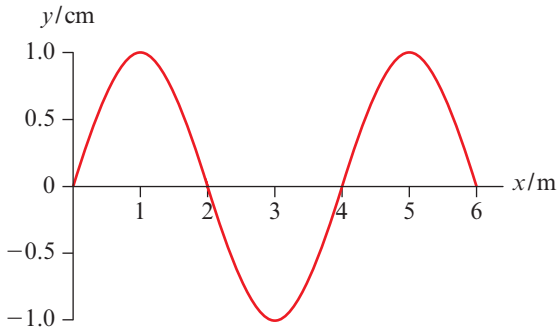
A $\frac{\pi}{10}$

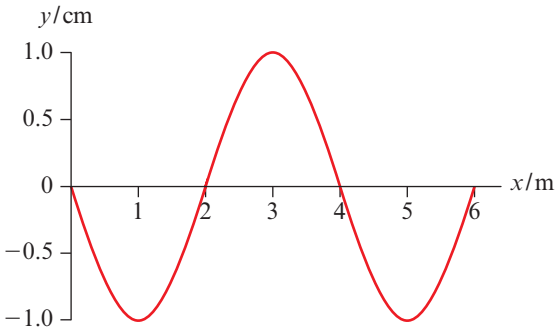
B $\frac{\pi}{5}$

C $\frac{\pi}{4}$

D $\frac{\pi}{2}$

28 The graph on the left shows, at $t = 0$, the variation with distance of the displacement of a travelling wave. The first time the wave looks like that on the graph on the right is at $t = \frac{1}{50}$ s.





What is the speed of the wave?

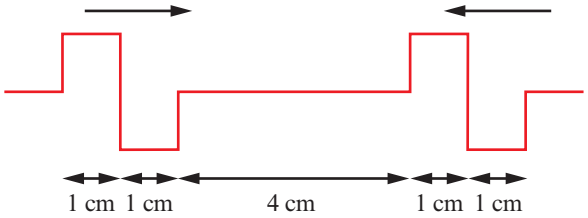
A 10 m s^{-1}

B 20 m s^{-1}

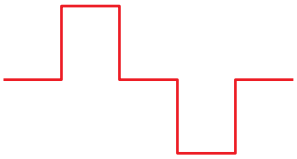
C 100 m s^{-1}

D 200 m s^{-1}

29 The diagram shows, at $t = 0$, two pulses moving towards each other.



Both pulses have speed 2.5 cm s^{-1}. At some later time the pulses will have the following shape.



It is suggested that this happens at

I $t = 0.8$ s
II $t = 1.0$ s
III $t = 1.4$ s

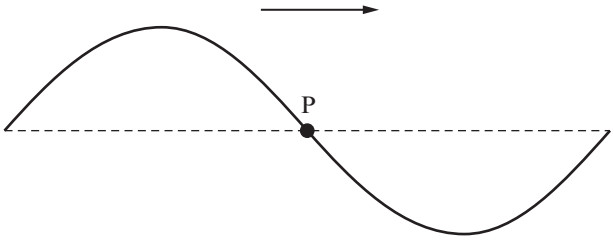
Which is correct?

A I and II
B I and III
C II and III
D II and III.

30 In a ripple tank, waves move with speed 32 cm s^{-1} in the deep end and 24 cm s^{-1} in the shallow end. Waves with wavelength 4.0 cm in the deep end enter the shallow end of the tank. What is the wavelength of the waves in the shallow end?

A 3.0 cm
B 4.0 cm
C 5.3 cm
D 6.0 cm

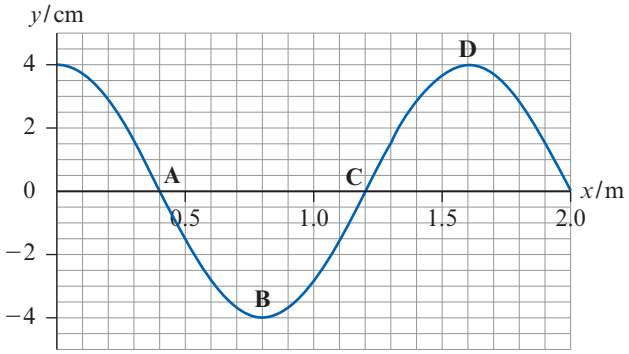
31 The diagram shows a point P on a string at a particular instant of time. A transverse wave is travelling along the string from left to right.



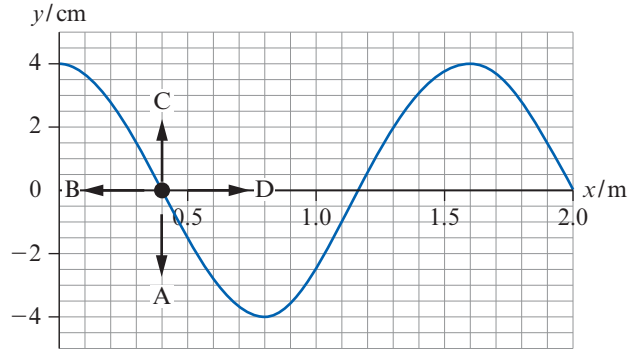
Which row of this table is correct about the direction and the magnitude of the velocity of point P at this instant?

	Direction	Magnitude
A	Up	Maximum
B	Up	Minimum
C	Down	Maximum
D	Down	Minimum

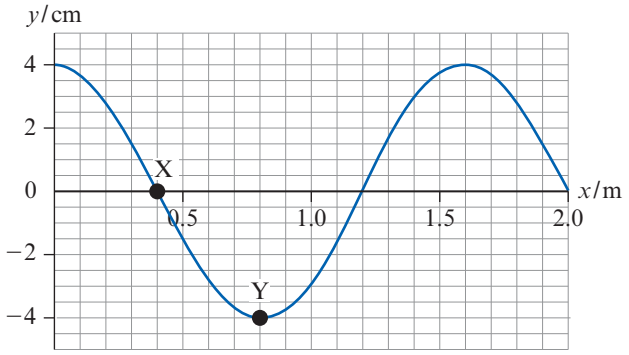
32 The graph shows the variation with distance of the displacement of a longitudinal wave travelling from left to right. Positive displacements indicate motion to the right. Which point is at the centre of a rarefaction?



33 The graph shows the variation with distance of the displacement of a longitudinal wave travelling from left to right. Positive displacements indicate motion to the right. Which arrow shows the velocity of the marked point?



34 The graph shows, at an instant of time, the variation with distance of the displacement of a transverse wave travelling from left to right. Two points have been marked X and Y.



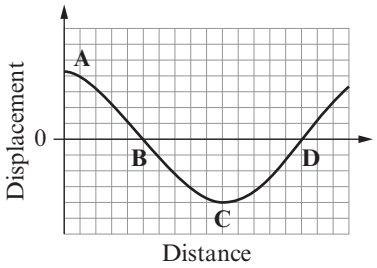
Which point has the greatest speed and which has the greatest acceleration at the instant shown?

	Greatest speed	Greatest acceleration
A	X	X
B	X	Y
C	Y	X
D	Y	Y

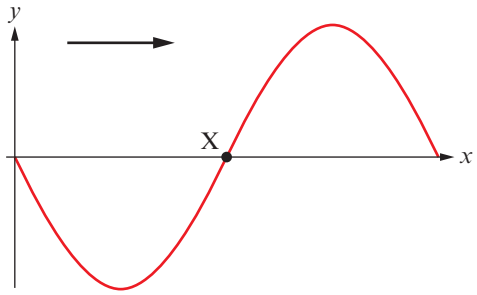
35 One end of a tight horizontal rope is shaken with frequency f so that a travelling wave of wavelength λ is created on the rope. The speed of the wave is v. The rope is now shaken with a frequency $2f$. Which gives the wavelength and speed of this wave?

	Wavelength	Speed
A	2λ	v
B	2λ	$2v$
C	$\frac{\lambda}{2}$	v
D	$\frac{\lambda}{2}$	$2v$

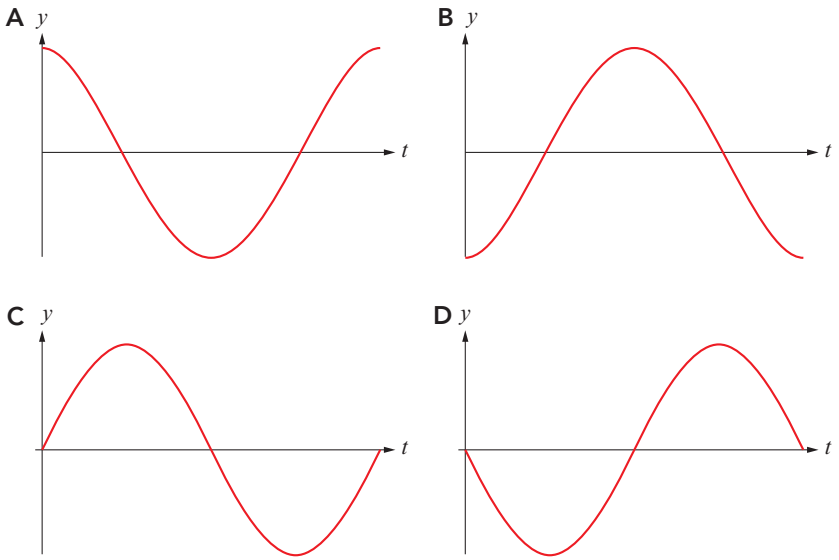
36 The graph shows the displacement of a medium when a longitudinal wave travels through the medium from left to right. Positive displacements correspond to motion to the right. Which point corresponds to the centre of a compression?



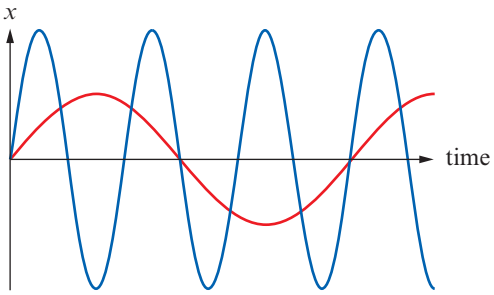
37 The diagram shows, at $t = 0$, the variation with distance x of the displacement y of points in a medium as a wave travels to the right. One particular point in the medium has been marked X.



Which graph shows the variation with time of the displacement of point X?



38 The diagram shows the variation with time of the displacement of two waves. The red wave has period 6.0 s.



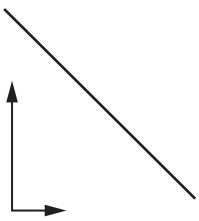
What is the period of the blue wave?

A 1.0 s
B 1.5 s
C 2.0 s
D 3.0 s

39 Which is a correct comparison of an infrared and an ultraviolet electromagnetic wave in vacuum?

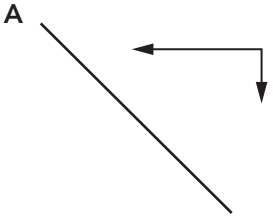
	Wavelength	Speed
A	Same	Same
B	Same	Different
C	Different	Same
D	Different	Different

40 An object, consisting of two arrows at right angles to each other, is placed in front of a mirror as shown.

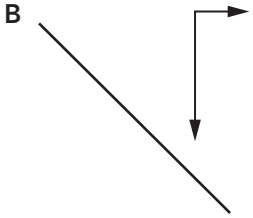


Which diagram correctly shows the image of the object in the mirror?

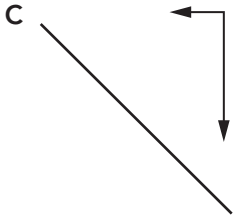
A



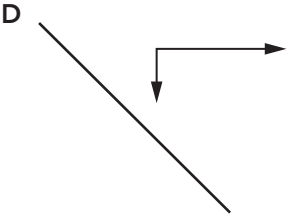
B



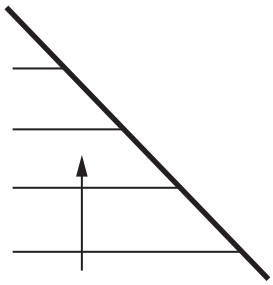
C



D

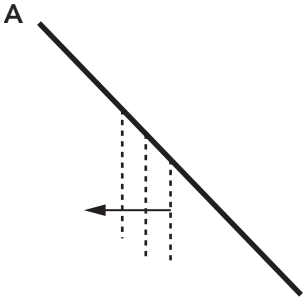


41 The diagram shows four wavefronts incident on a plane surface.

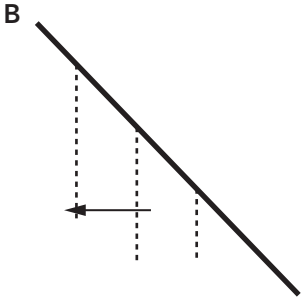


Which diagram shows three correct reflected wavefronts?

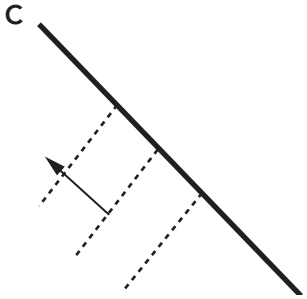
A



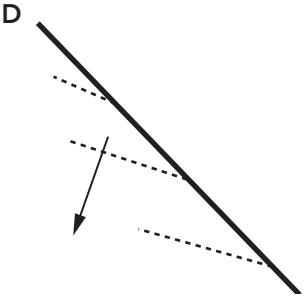
B



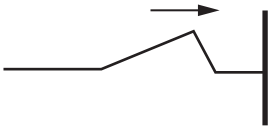
C



D



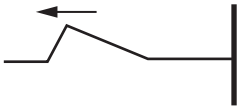
42 The diagram shows a pulse on a string. The right end of the string is fixed.

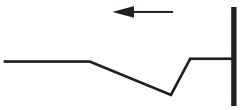


Which diagram shows the reflected pulse?

A 

B 

C 

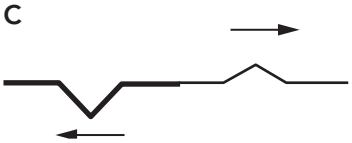
D 

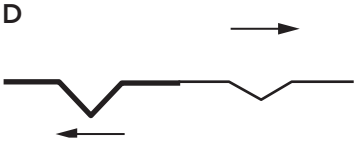
43 A pulse moves on a heavy rope. The heavy rope is joined to a lighter rope as shown.

What is a possible picture of the rope after the pulse arrives at the junction?

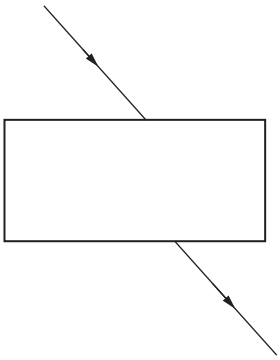
A 

B 

C 

D 

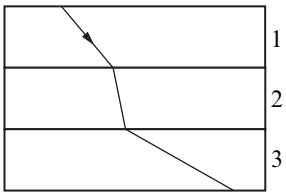
44 A ray of light enters glass from air and exits into air following the path shown.



The path is a consequence of:

A reflection
B refraction
C diffraction
D scattering.

45 A ray of light goes through three different media following the path shown.

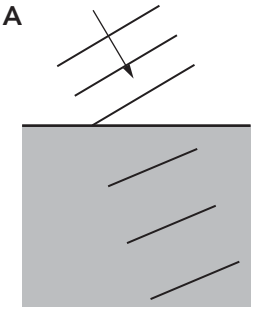


What is correct about the speed of light in the three media?

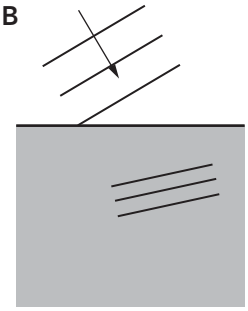
A $c_2 > c_1 > c_3$
B $c_3 > c_2 > c_1$
C $c_2 > c_3 > c_1$
D $c_3 > c_1 > c_2$

46 The diagrams show wavefronts of a wave entering a medium in which the wave speed decreases. Which diagram is correct?

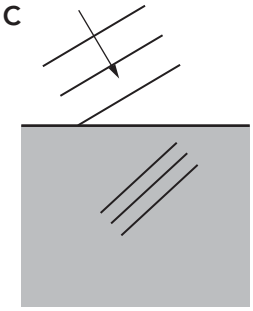
A



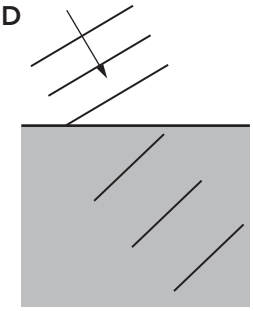
B



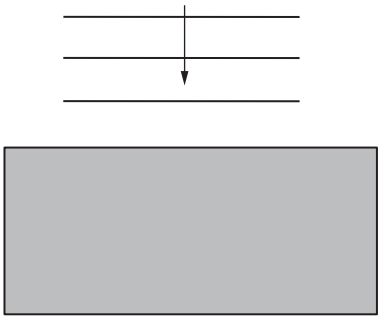
C



D

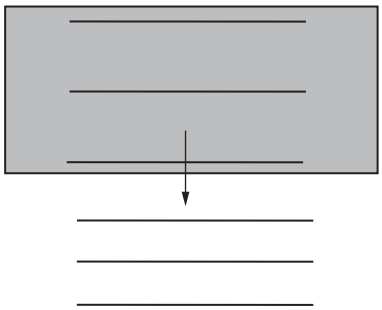


47 Plane wavefronts of light are about to enter a rectangular piece of glass as shown. The glass is surrounded by air.

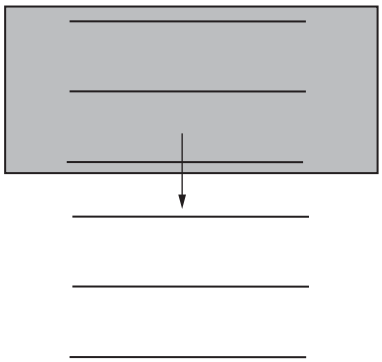


What is the correct diagram for some of the wavefronts in glass and after they exit glass?

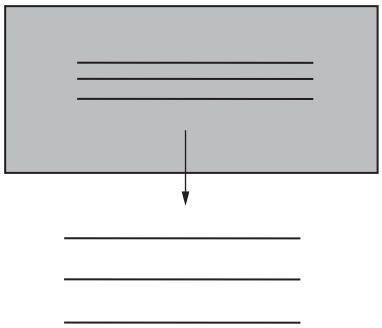
A



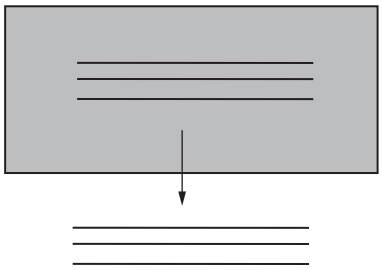
B



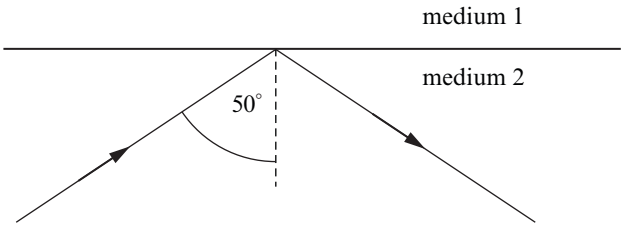
C



D



48 The diagram shows a ray of light incident on the boundary between two transparent media.



What can we deduce from this observation?

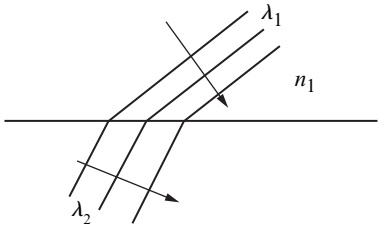
A The critical angle between media 1 and 2 is 50°.

B The speed of light in medium 1 is smaller than that in medium 2.

C The speed of light in medium 1 is greater than that in medium 2.

D The refractive index in medium 1 is greater than that in medium 2.

49 Light of wavelength λ_1 is travelling in a medium of refractive index n_1. The light enters a second medium where the wavelength of light is λ_2.



What is the refractive index of the second medium?

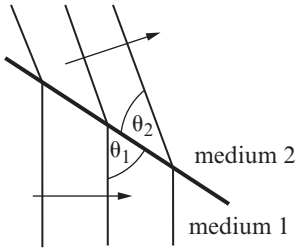
A $\frac{\lambda_1}{\lambda_2} n_1$

B $\frac{\lambda_2}{\lambda_1} n_1$

C $\frac{\lambda_1}{\lambda_2}$

D $\frac{\lambda_2}{\lambda_1}$

50 A wave travels as shown in the wavefront diagram.



The refractive index in medium 1 is n_1 and that in medium 2 is n_2.Which equation is correct?

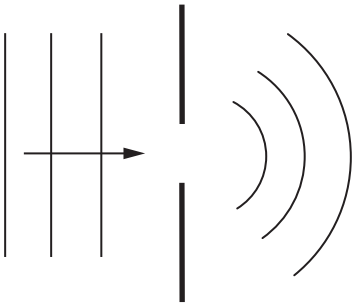
A $\frac{n_1}{n_2} = \frac{\sin\theta_2}{\sin\theta_1}$

B $\frac{n_1}{n_2} = \frac{\sin\theta_1}{\sin\theta_2}$

C $\frac{n_1}{n_2} = \frac{\sin(90^\circ - \theta_2)}{\sin(90^\circ - \theta_1)}$

D $\frac{n_1}{n_2} = \frac{\sin(90^\circ - \theta_1)}{\sin(90^\circ - \theta_2)}$

51 Plane waves diffract through an opening.



The amount of spreading of the wave to the right of the slit would increase by

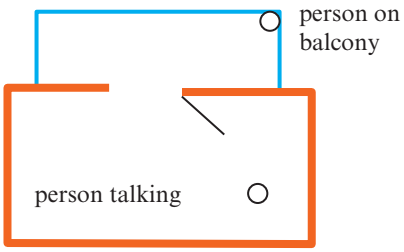
A increasing the opening of the slit

B decreasing the opening of the slit

C decreasing the wavelength

D increasing the amplitude.

52 A person talking in a room can be heard by another person on the balcony. The door to the balcony is open.



What is the **main** reason for which the person on the balcony can hear the person in the room?

A reflection of sound
B refraction of sound
C diffraction of sound
D transmission of sound through the walls.

53 Interference and diffraction can be observed for:

A longitudinal waves only
B transverse waves only
C electromagnetic waves only
D all waves.

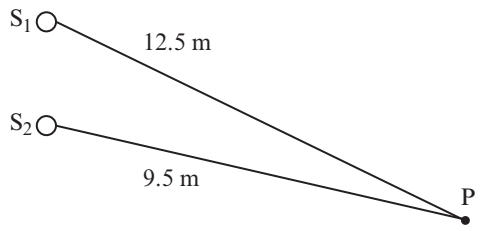
54 Two sources emit sound waves in phase. The path difference at point P is 0.30 m. No sound is observed at P. Which could be the wavelength of sound?

A 0.30 m
B 0.20 m
C 0.15 m
D 0.10 m

55 Interference is observed with two identical coherent sources. The intensity at a point of constructive interference is I. What is the intensity at that point when one source is removed?

A 0
B I
C $\frac{I}{2}$
D $\frac{I}{4}$

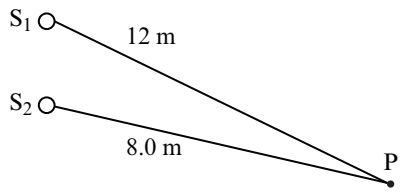
56 S_1 and S_2 are sources of sound of wavelength 2.0 m. The two sources emit waves in phase. The amplitude of each source separately at P is x_0.



What is the amplitude at P?

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

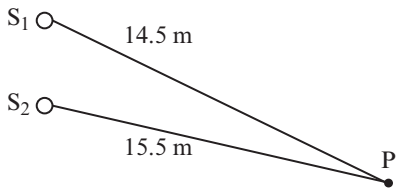
57 S_1 and S_2 are sources of sound of wavelength 2.0 m. The two sources emit waves in phase. The intensity of each source separately at P is I_0.



What is the intensity at P?

A 0
B I_0
C $2I_0$
D $4I_0$

58 S_1 and S_2 are sources of sound of wavelength 0.50 m. The two sources emit waves that are out of phase by π. The intensity of each source separately at P is I_0.



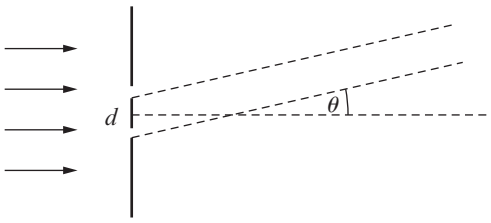
What is the intensity at P?

A 0
B I_0
C $2I_0$
D $4I_0$

59 In a two-slit interference experiment with light, it is observed that the distance between two consecutive bright fringes on a screen is too small to measure. Which change would result in a larger fringe separation?

A Increase the distance between the light source and the slits.
B Increase the separation between the slits.
C Decrease the frequency of light.
D Decrease the distance between the slits and the screen.

60 Coherent light of wavelength λ is incident on two parallel slits that are separated by a distance d. Angle θ is the smallest angle for which the two rays shown interfere destructively on a screen far from the slits.



Which is correct?

A $d\sin\theta = 0$
B $d\sin\theta = \frac{\lambda}{2}$
C $d\sin\theta = \lambda$
D $d\sin\theta = \frac{3\lambda}{2}$

61 Which is correct for standing waves?

A Standing waves can only be formed from transverse waves.
B The rate of energy transfer in a standing wave is proportional to the wave speed.
C Two points separated by half a wavelength have the same phase.
D Two points separated by half a wavelength have the same amplitude.

62 Which is the same for all points on any standing wave?

A the amplitude
B the frequency
C the speed
D the phase.

63 What is correct about the displacement at nodes and antinodes in a standing wave?

	Nodes in a standing wave	Antinodes in a standing wave
A	Zero all the time	Maximum all the time
B	Zero all the time	Maximum at an instant of time
C	Zero at an instant of time	Maximum all the time
D	Zero at an instant of time	Maximum at an instant of time

64 Sound is directed at the open end of a pipe whose other end is closed. The length of the pipe is L, and the speed of sound is c. For which three frequencies of the sound wave will a standing wave be formed in the pipe?

A $\frac{c}{4L}, 2\times\frac{c}{4L}, 3\times\frac{c}{4L}$
B $\frac{c}{2L}, 2\times\frac{c}{2L}, 3\times\frac{c}{2L}$
C $\frac{c}{4L}, 3\times\frac{c}{4L}, 5\times\frac{c}{4L}$
D $\frac{c}{2L}, 3\times\frac{c}{2L}, 5\times\frac{c}{2L}$

65 Two waves of the same frequency travel in the same medium. What must be correct for the amplitude and the direction of travel for these waves to produce a standing wave?

	Amplitude	Direction
A	Same	Parallel
B	Same	Opposite
C	Different	Parallel
D	Different	Opposite

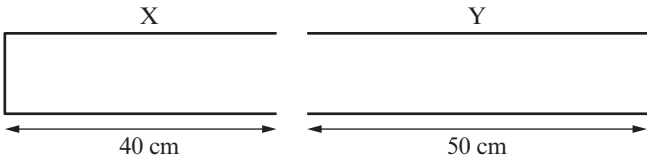
66 A standing wave on a string has a frequency of 20 Hz. The nodes are 0.40 m apart. What is the speed of the travelling waves on the string?

A 0
B 4.0 m s^{-1}
C 8.0 m s^{-1}
D 16 m s^{-1}

67 A pipe of length 8.0 m is open at one end and closed at the other. The speed of sound is 320 m s^{-1}. Which is the lowest frequency of a standing wave that can be established within this pipe?

A 5.0 Hz
B 10 Hz
C 15 Hz
D 30 Hz

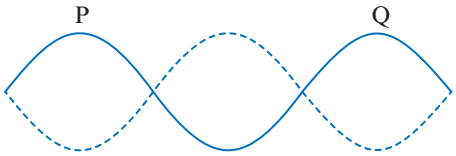
68 Sound waves of wavelength 32 cm are directed towards a closed–open pipe X of length 40 cm and an open–open pipe Y of length 50 cm.



In which pipe or pipes will a standing wave be formed?

A X only
B Y only
C neither X nor Y
D both X and Y.

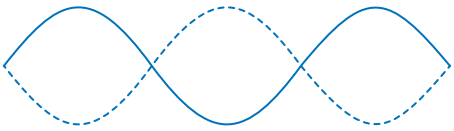
69 A standing wave is established on a string with both ends fixed.



What is the phase difference between points P and Q?

A 0
B $\frac{\pi}{2}$
C π
D $\frac{3\pi}{2}$

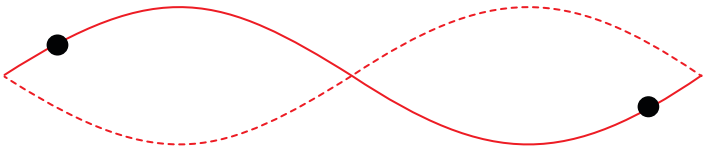
70 A standing wave is established on a string with both ends fixed.



The length of the string is 6.0 m. What is the wavelength of the standing wave?

A 2.0 m
B 4.0 m
C 6.0 m
D 8.0 m

71 The diagram shows a standing wave on a string with both ends fixed. Two particles, X and Y, on the string have been marked. X and Y are equidistant from the ends.



Three statements are made for X and Y:

I They have the same amplitude.

II They have the same average speed during a period.

III They are in phase.

What is correct?

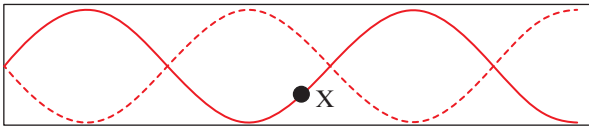
A I and II

B I and III

C II and III

D I, II and III.

72 The diagram represents a standing wave in a tube with one open and one closed end. A particle X in the medium has been marked.



How many **other** particles are there that oscillate with the same amplitude and phase as X?

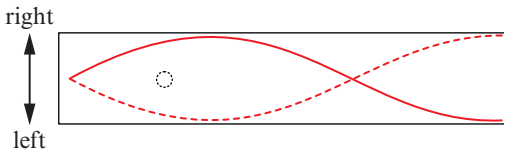
A 1

B 2

C 5

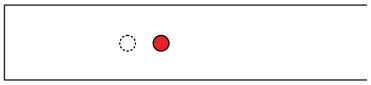
D 6

73 The diagram represents a standing wave in a tube with one open and one closed end. The solid line is the wave at $t = 0$. The dot is the position of a particle in air at $t = 0$.

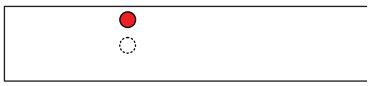


The **equilibrium** position of this particle is shown in red. Which diagram is correct?

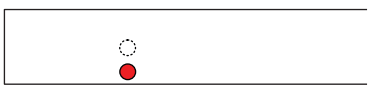
A



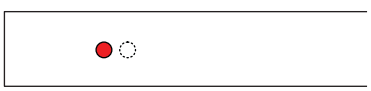
B



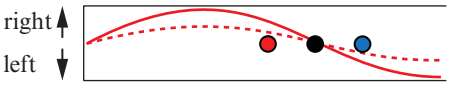
C



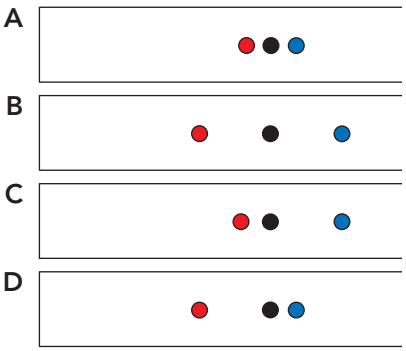
D



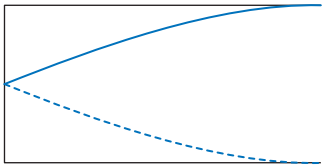
74 The diagram represents a standing wave in a tube with one open and one closed end. The solid line is the wave at $t = 0$, and the dotted line is the wave an instant of time Δt later. The three dots are the **equilibrium** positions of three particles in air.



What are the positions of these particles at $t = 0$?



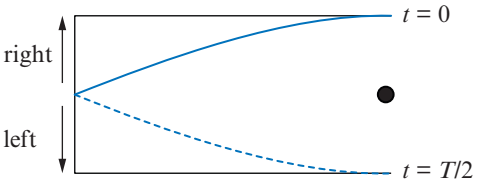
75 A standing wave is established in a tube with one closed and one open end.



How many antinodes will there be when the frequency of the standing wave is tripled?

A 2
B 3
C 4
D 5

76 A standing wave is established in a tube with one closed and one open end. The solid line represents the wave at $t = 0$ and the dotted line at $t = T/2$ where T is the period.



The dot represents the equilibrium position of a particle of air.

What is correct for the velocity and acceleration of this particle at $t = T/4$?

	Velocity	Acceleration
A	Maximum to the left	Zero
B	Maximum to the left	Maximum
C	Maximum to the right	Zero
D	Maximum to the right	Maximum

77 The first harmonic of a standing wave is established in a pipe X with one open and one closed end. The second harmonic of a standing wave is established in a pipe Y that has both ends open.

The frequency of both harmonics is the same. What is the ratio $\frac{L_X}{L_Y}$ of the lengths of the pipes?

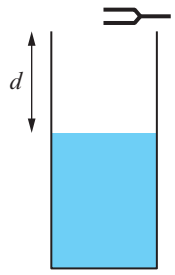
A $\frac{1}{4}$

B $\frac{1}{2}$

C 1

D 2

78 A tube is slowly being filled with water so that the length d of the air column above the water surface is decreasing.



A tuning fork is sounded above the tube and a standing wave is established when d = 63 cm. The next length for which this happens is d = 49 cm.

For which of the following lengths d will a standing wave also be established in the tube?

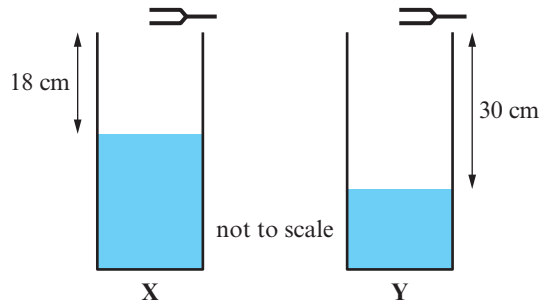
A 42 cm

B 28 cm

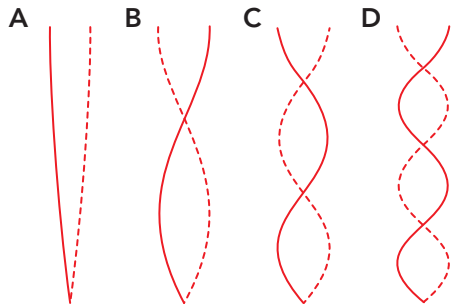
C 14 cm

D 7.0 cm

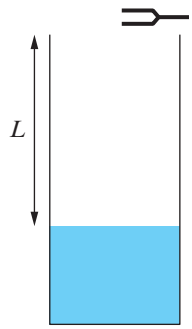
79 The same tuning fork is sounded above tubes X and Y containing some water. **Consecutive** harmonics are established in X and Y when the length of the air column in X is 18 cm and that in Y is 30 cm.



What is the shape of the standing wave in **tube X**?



80 A tuning fork is sounded above a tube partially filled with water. **Consecutive** harmonics are established when the length L of the air column is 21 cm and 15 cm.



More water is put in the tube. What is the length of the air column for which the **next** harmonic will be heard?

A 3.0 cm
B 6.0 cm
C 9.0 cm
D 12 cm

81 A system is oscillating freely with amplitude P. The system is then lightly damped. What will happen to the amplitude of oscillation of the system?

A It will decrease exponentially to zero.
B It will oscillate between values above and below P.
C It will increase to a constant value above P.
D It will decrease to a constant value below P.

82 A real system is oscillating at resonance with a large amplitude. Which of the following is a correct way to describe the oscillations?

A free oscillations
B driven oscillations with no damping
C driven oscillations with light damping
D driven oscillations with heavy damping.

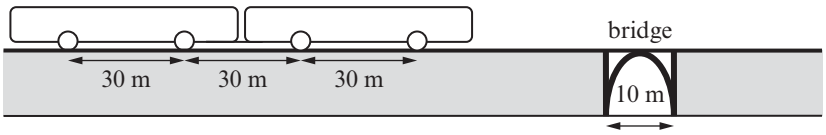
83 In damped oscillations, the damping force is always directed

A parallel to the acceleration
B opposite to the acceleration
C parallel to the velocity
D opposite to the velocity.

84 Very many people walking on a bridge set the bridge moving in small oscillations. The best way to describe these oscillations is that they are

A simple harmonic
B free
C resonant
D driven.

85 A high-speed train whose wheels are 30 m apart passes over a 10 m long bridge. When the wheels are at the middle of the bridge, they exert a force on the bridge structure. The resonant frequency of the bridge is 2.0 Hz.



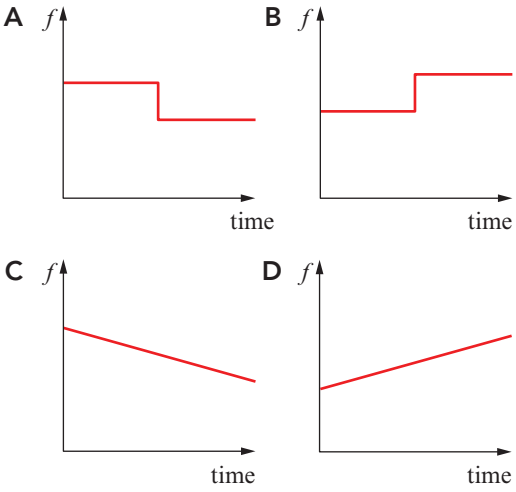
What is the train speed that should be avoided when going over the bridge?

A 5.0 m s^{-1}
B 20 m s^{-1}
C 40 m s^{-1}
D 60 m s^{-1}

86 An observer approaches a stationary source of sound of wavelength λ. The speed of sound is c, and the speed of the observer is $\frac{c}{20}$. What is the wavelength measured by the observer?

A $\frac{21}{20}\lambda$
B λ
C $\frac{19}{20}\lambda$
D $\frac{\lambda}{20}$

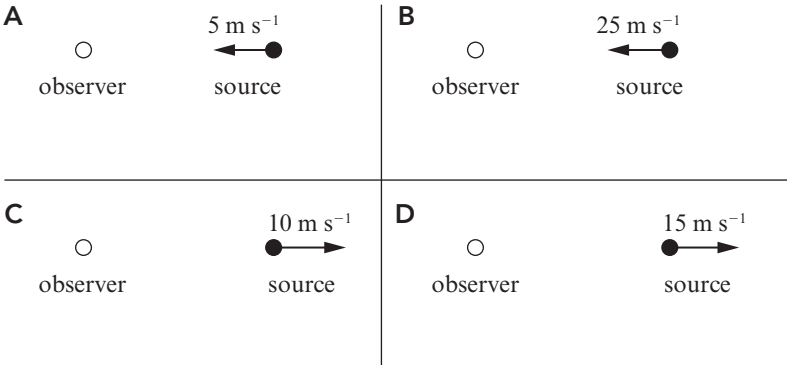
87 A train sounding its horn approaches and then goes away from a train station at constant speed. Which graph shows the variation with time of the frequency, f, heard by an observer at the train station?



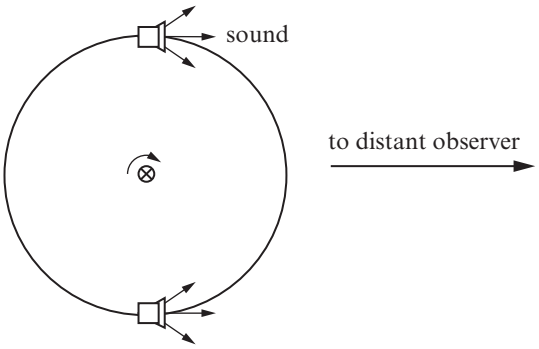
88 A source of light of frequency f and wavelength λ moves away from a stationary observer. The speed of light is c, and the speed of the source is $c/10$. What is the approximate frequency and wavelength measured by the observer?

	Frequency	Wavelength
A	$0.9f$	0.9λ
B	$0.9f$	1.1λ
C	$1.1f$	0.9λ
D	$1.1f$	1.1λ

89 A source of sound travels with the velocity shown. The source emits the same frequency. In which case would a stationary observer record the largest decrease in frequency?



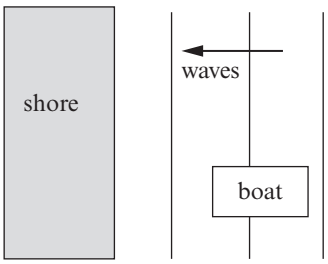
90 Two loudspeakers are attached to a rotating merry-go-round as shown.



A distant observer hears sound of maximum frequency f_{max} and minimum frequency f_{min}. The speed of rotation is increased. What happens to f_{max} and f_{min}?

	f_{max}	f_{min}
A	Increases	Increases
B	Increases	Decreases
C	Decreases	Increases
D	Decreases	Decreases

91 Water waves of wavelength 2.0 m are approaching the shore with speed 4.0 m s^{-1}. An observer in a boat moving at right angles to the shore measures a frequency of 3.0 Hz for the water waves.



What is the velocity of the boat?

A 2.0 m s^{-1} away from the shore

B 2.0 m s^{-1} towards the shore

C 4.0 m s^{-1} away from the shore

D 4.0 m s^{-1} towards the shore.

92 Light of wavelength λ is incident on two parallel slits. An interference pattern is formed on a screen behind the slits. The separation of the slits is decreased. Which of the following is correct about the separation and the width of the bright fringes?

	Separation	Width
A	Increases	Increases
B	Increases	Decreases
C	Decreases	Increases
D	Decreases	Decreases

93 Light of wavelength λ is incident normally on a slit of width b. A screen is placed a distance D from the slit. What is the linear width of the central maximum measured along the screen?

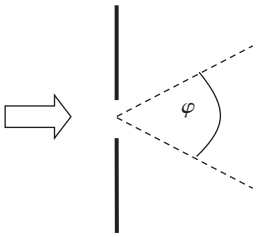
A $\frac{\lambda}{b}$

B $\frac{2\lambda}{b}$

C $\frac{\lambda D}{b}$

D $\frac{2\lambda D}{b}$

94 Light of wavelength λ is incident normally on a slit of width b.



Most of the energy through the slit is restricted within an angular region of width φ. What is φ?

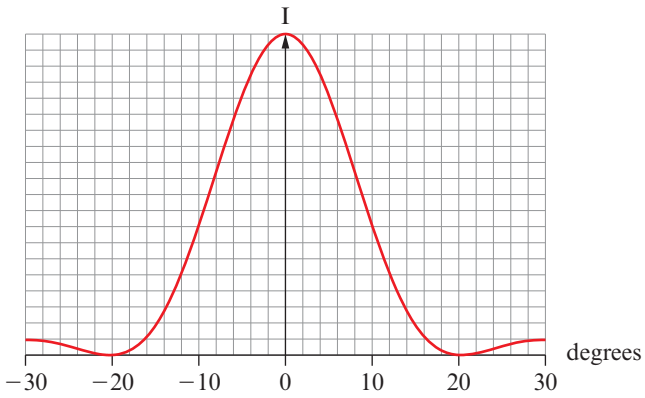
A $\frac{\lambda}{b}$

B $\frac{2\lambda}{b}$

C $\frac{b}{\lambda}$

D $\frac{2b}{\lambda}$

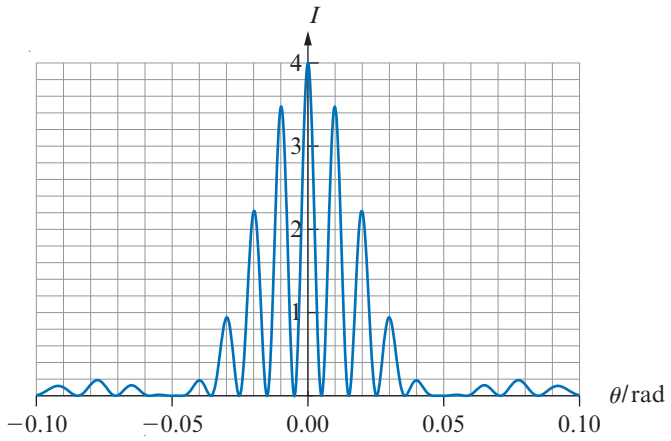
95 The graph shows the single slit diffraction pattern for light of wavelength 600 nm and slit width b.



The light is replaced by light of wavelength 400 nm, and the slit width is reduced to $\frac{2b}{3}$.
What is the angle at which the first diffraction minimum will be observed?

A 13°
B 20°
C 30°
D 45°

96 Light of wavelength 600 nm is incident on two parallel slits. The graph shows how the intensity of light observed on a screen far from the slits varies with diffraction angle θ.



What are **estimates** of the slit separation d and the slit width b using the small angle approximation $\sin\theta \approx \theta$?

	d	*b*
A	12 μm	12 μm
B	12 μm	60 μm
C	60 μm	12 μm
D	60 μm	60 μm

97 A beam of microwaves contain a wavelength 3.0 cm and an unknown wavelength. The beam diffracts. The second order of the unknown wavelength coincides with the third order of the 3.0 cm wavelength. What is the unknown wavelength?

A 0.67 cm
B 1.5 cm
C 2.0 cm
D 4.5 cm

98 Light consisting of two wavelengths, 420 nm and 700 nm, is incident on a diffraction grating. One order in the diffraction pattern due to one wavelength coincides with a different order in the diffraction pattern of the other wavelength. Which are the orders?

A 2 and 3
B 3 and 4
C 2 and 5
D 3 and 5

99 Light of wavelength λ is incident on a diffraction grating with line spacing d. It is known that $d = 4.9\lambda$. How many orders are visible?

A 4
B 5
C 9
D 11

100 Light is incident on N very thin parallel slits, and an interference pattern is formed on a screen a distance away. The number of slits is increased while the separation of two consecutive slits stays the same. Which is correct as N increases?

A The number of secondary maxima decreases.
B The intensity of the secondary maxima increases.
C The primary maxima become narrower.
D The distance between the central maximum and the first primary maximum to the side increases.