Ch42020 *[60 marks]*

1. A particle moving in a circle completes 5 revolutions in 3 s. What is the frequency? *[1 mark]*

   A. $\frac{3}{5}$Hz

   B. $\frac{5}{3}$Hz

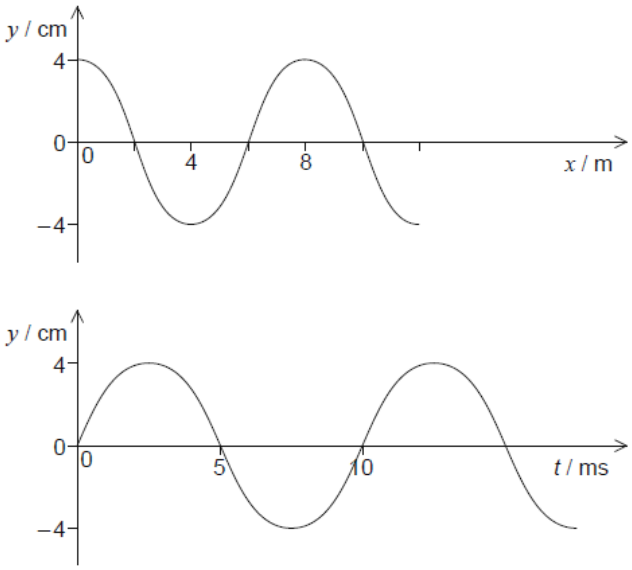
   C. $\frac{3\pi}{5}$Hz

   D. $\frac{5\pi}{3}$Hz

2. A longitudinal wave moves through a medium. Relative to the direction of energy transfer through the medium, what are the displacement of the medium and the direction of propagation of the wave? *[1 mark]*

	Displacement of medium	Direction of propagation of wave
A.	parallel	perpendicular
B.	parallel	parallel
C.	perpendicular	parallel
D.	perpendicular	perpendicular

3. The graphs show the variation of the displacement y of a medium with distance x and with time t for a travelling wave. *[1 mark]*



What is the speed of the wave?

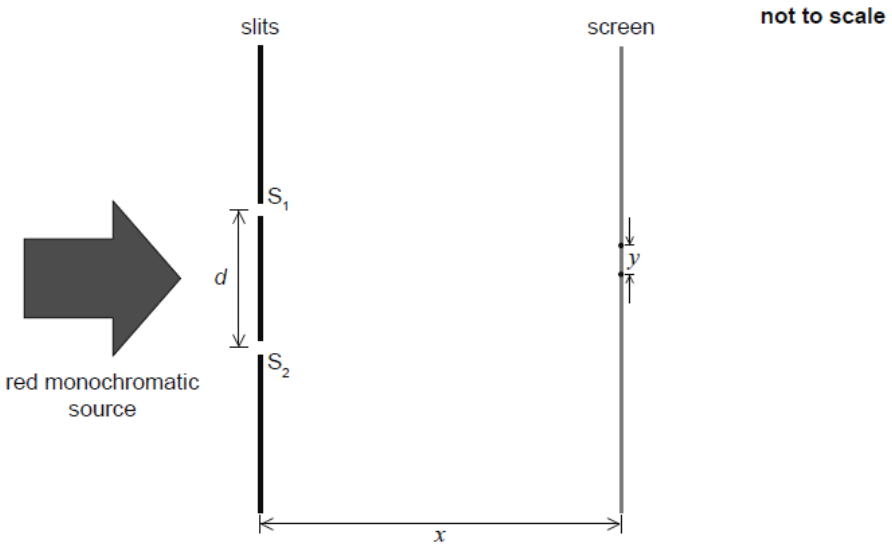
A. $0.6\ \text{m s}^{-1}$

B. $0.8\ \text{m s}^{-1}$

C. $600\ \text{m s}^{-1}$

D. $800\ \text{m s}^{-1}$

4. In a double-slit experiment, a source of monochromatic red light is incident on slits S_1 and S_2 separated by a distance d. A screen is located at distance x from the slits. A pattern with fringe spacing y is observed on the screen. *[1 mark]*



Three changes are possible for this arrangement

I. increasing x

II. increasing d

III. using green monochromatic light instead of red.

Which changes will cause a decrease in fringe spacing y?

A. I and II only

B. I and III only

C. II and III only

D. I, II, and III

5. Two strings of lengths L_1 and L_2 are fixed at both ends. The wavespeed is the same for both strings. They both vibrate at the same frequency. L_1 vibrates at its first harmonic. L_2 vibrates at its third harmonic. *[1 mark]*

What is $\frac{L_1}{L_2}$?

A. $\frac{1}{3}$

B. 1

C. 2

D. 3

6. L is a point source of light. The intensity of the light at a distance 2 x from L is *I*. What is the intensity at a distance 3x from L? *[1 mark]*

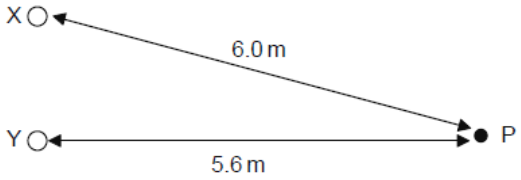
A. $\frac{4}{9}I$

B. $\frac{2}{3}I$

C. $\frac{3}{2}I$

D. $\frac{9}{4}I$

7. X and Y are two coherent sources of waves. The phase difference between X and Y is zero. The intensity at P due to X and Y separately is *I*. The wavelength of each wave is 0.20 m. *[1 mark]*



What is the resultant intensity at P?

A. 0

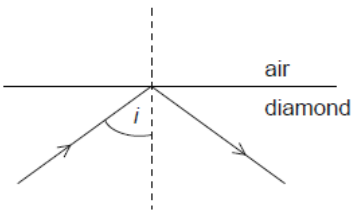
B. *I*

C. 2*I*

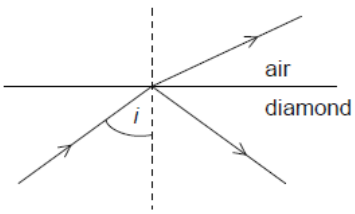
D. 4*I*

8. Light is incident at the boundary between air and diamond. The speed of light in diamond is less than the speed of light in air. The angle of incidence *i* of the light is greater than the critical angle. Which diagram is correct for this situation? *[1 mark]*

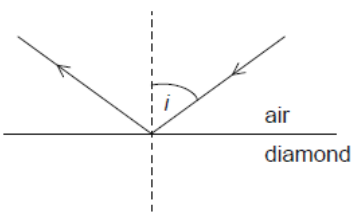
A.



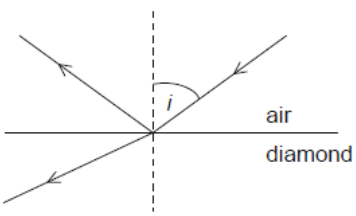
B.



C.

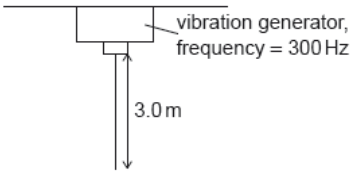


D.



9. A first-harmonic standing wave is formed on a vertical string of length 3.0 m using a vibration generator. The boundary conditions for this string are that it is fixed at one boundary and free at the other boundary. *[1 mark]*

diagram not to scale



The generator vibrates at a frequency of 300 Hz.

What is the speed of the wave on the string?

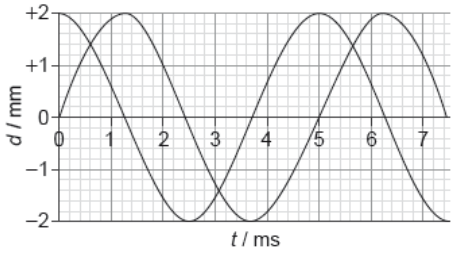
A. 0.90 km s^{-1}

B. 1.2 km s^{-1}

C. 1.8 km s^{-1}

D. 3.6 km s^{-1}

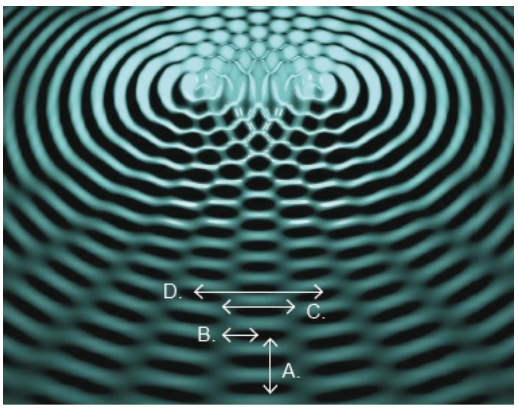
10. Two travelling waves are moving through a medium. The diagram shows, for a point in the medium, the variation with time *t* of the displacement *d* of each of the waves. *[1 mark]*



For the instant when *t* = 2.0 ms, what is the phase difference between the waves and what is the resultant displacement of the waves?

	Phase difference	Resultant displacement / mm
A.	45°	−0.6
B.	90°	2.6
C.	45°	2.6
D.	90°	−0.6

11. The diagram shows an interference pattern produced by two sources that oscillate on the surface of a liquid. *[1 mark]*



[Source: Science Photo Library www.sciencephoto.com]

Which of the distances shown in the diagram corresponds to **one** fringe width of the interference pattern?

12. A system that is subject to a restoring force oscillates about an equilibrium position. *[1 mark]*

For the motion to be simple harmonic, the restoring force must be proportional to

A. the amplitude of the oscillation.

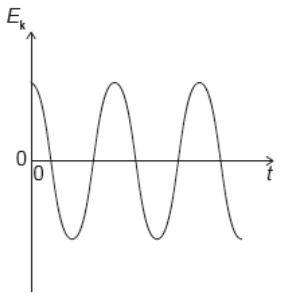
B. the displacement from the equilibrium position.

C. the potential energy of the system.

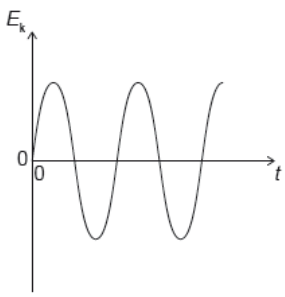
D. the period of the oscillation.

13. A particle is displaced from rest and released at time $t = 0$. It performs simple harmonic motion (SHM). Which graph shows the variation with time of the kinetic energy E_k of the particle? *[1 mark]*

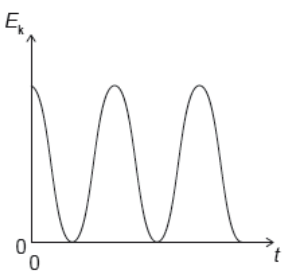
A.



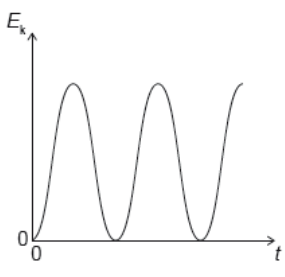
B.



C.



D.



14. Two sound waves from a point source on the ground travel through the ground to a detector. The speed of one wave is 7.5 km s^{-1}, the speed of the other wave is 5.0 km s^{-1}. The waves arrive at the detector 15 s apart. What is the distance from the point source to the detector? *[1 mark]*

A. 38 km

B. 45 km

C. 113 km

D. 225 km

15. What is true about the acceleration of a particle that is oscillating with simple harmonic motion (SHM)? *[1 mark]*

A. It is in the opposite direction to its velocity

B. It is decreasing when the potential energy is increasing

C. It is proportional to the frequency of the oscillation

D. It is at a minimum when the velocity is at a maximum

16. What are the changes in the speed and in the wavelength of monochromatic light when the light passes from water to air? *[1 mark]*

	Change in speed	Change in wavelength
A.	increases	increases
B.	increases	decreases
C.	decreases	increases
D.	decreases	decreases

17. A sound wave has a wavelength of 0.20 m. What is the phase difference between two points along the wave which are 0.85 m apart? *[1 mark]*

A. zero

B. 45°

C. 90°

D. 180°

18. A pair of slits in a double slit experiment are illuminated with monochromatic light of wavelength 480 nm. The slits are separated by 1.0 mm. What is the separation of the fringes when observed at a distance of 2.0 m from the slits? *[1 mark]*

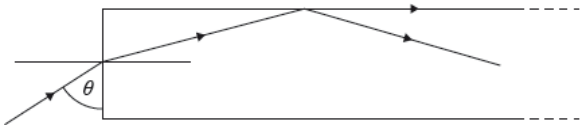
A. 2.4×10^{-4} mm

B. 9.6×10^{-4} mm

C. 2.4×10^{-1} mm

D. 9.6×10^{-1} mm

19. A ray of light passes from the air into a long glass plate of refractive index n at an angle θ to the edge of the plate. *[1 mark]*



The ray is incident on the internal surface of the glass plate and the refracted ray travels along the external surface of the plate.

What change to n and what change to θ will cause the ray to travel entirely within the plate after incidence?

	Change to n	Change to θ
A.	increase	increase
B.	increase	decrease
C.	decrease	increase
D.	decrease	decrease

20. A string stretched between two fixed points sounds its second harmonic at frequency f. *[1 mark]*

Which expression, where n is an integer, gives the frequencies of harmonics that have a node at the centre of the string?

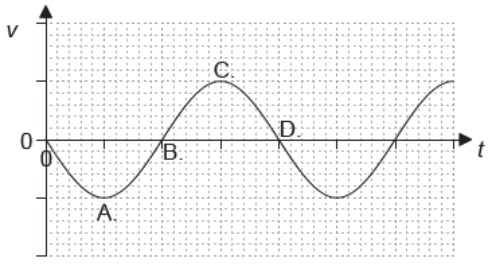
A. $\frac{n+1}{2}f$

B. nf

C. $2nf$

D. $(2n + 1)f$

21. The graph shows the variation with time t of the velocity v of an object undergoing simple harmonic motion (SHM). At which velocity does the displacement from the mean position take a maximum positive value? *[1 mark]*



22. What is the phase difference, in rad, between the centre of a compression and the centre of a rarefaction for a longitudinal travelling wave? *[1 mark]*

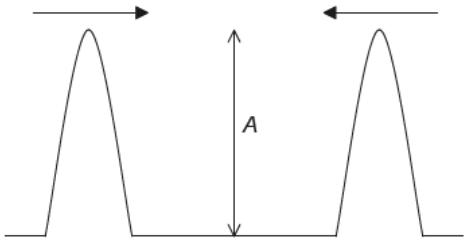
A. 0

B. $\frac{\pi}{2}$

C. π

D. 2π

23. Two wave pulses, each of amplitude *A*, approach each other. They then superpose before continuing in their original directions. What is the total amplitude during superposition and the amplitudes of the individual pulses after superposition? *[1 mark]*



	Total amplitude during superposition	Individual amplitudes after superposition
A.	*A*	less than *A*
B.	*A*	*A*
C.	2*A*	less than *A*
D.	2*A*	*A*

24. The refractive index for light travelling from medium X to medium Y is $\frac{4}{3}$. The refractive index for light travelling from medium Y to medium Z is $\frac{3}{5}$. What is the refractive index for light travelling from medium X to medium Z? *[1 mark]*

A. $\frac{4}{5}$

B. $\frac{15}{12}$

C. $\frac{5}{4}$

D. $\frac{29}{15}$

25. A pipe of fixed length is closed at one end. What is $\frac{\text{third harmonic frequency of pipe}}{\text{first harmonic frequency of pipe}}$? *[1 mark]*

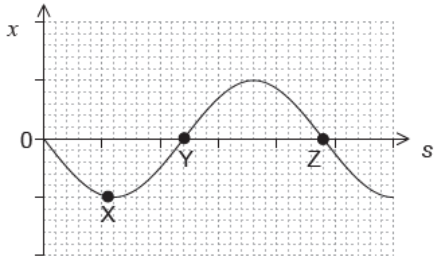
A. $\frac{1}{5}$

B. $\frac{1}{3}$

C. 3

D. 5

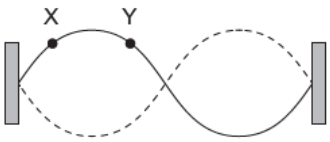
26. The graph shows the variation with position *s* of the displacement *x* of a wave undergoing simple harmonic motion (SHM). *[1 mark]*



What is the magnitude of the velocity at the displacements X, Y and Z?

	X	Y	Z
A.	maximum	zero	maximum
B.	zero	maximum	maximum
C.	maximum	maximum	zero
D.	zero	maximum	zero

27. The diagram shows a second harmonic standing wave on a string fixed at both ends. *[1 mark]*



What is the phase difference, in rad, between the particle at X and the particle at Y?

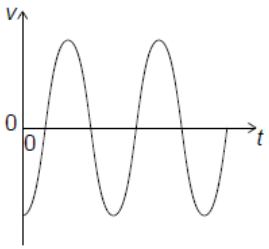
A. 0

B. $\frac{\pi}{4}$

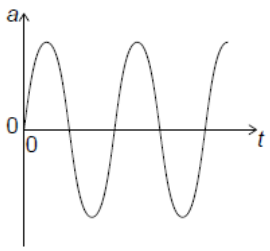
C. $\frac{\pi}{2}$

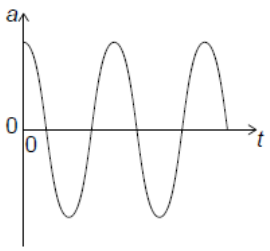
D. $\frac{3\pi}{4}$

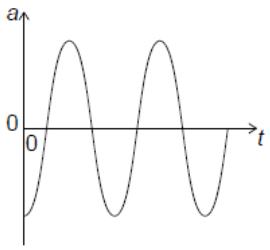
28. A particle undergoes simple harmonic motion (SHM). The graph shows the variation of velocity v of the particle with time t. *[1 mark]*

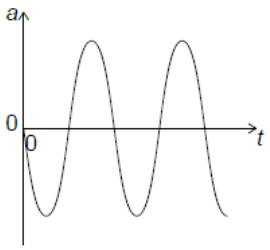


What is the variation with time of the acceleration a of the particle?

A.


B.


C.


D.


29. What statement about X-rays and ultraviolet radiation is correct? *[1 mark]*

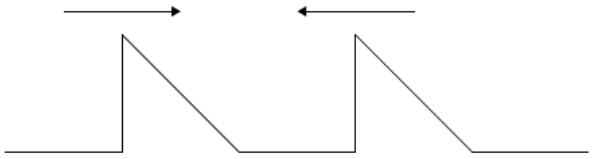
A. X-rays travel faster in a vacuum than ultraviolet waves.

B. X-rays have a higher frequency than ultraviolet waves.

C. X-rays cannot be diffracted unlike ultraviolet waves.

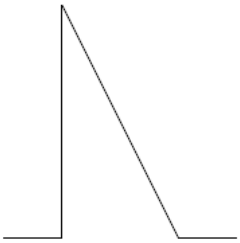
D. Microwaves lie between X-rays and ultraviolet in the electromagnetic spectrum.

30. Two pulses are travelling towards each other. *[1 mark]*

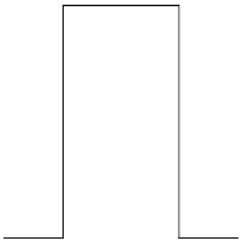


What is a possible pulse shape when the pulses overlap?

A.

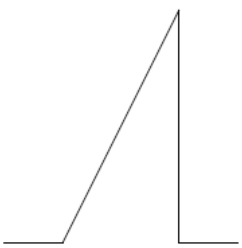


B.



C.

D.

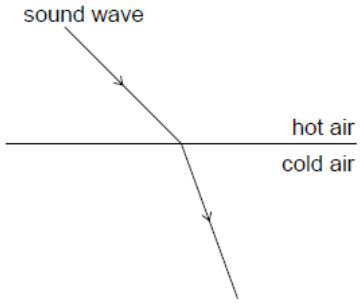


31. Unpolarized light of intensity I_0 is incident on the first of two polarizing sheets. Initially the planes of polarization of the sheets are perpendicular. *[1 mark]*

Which sheet must be rotated and by what angle so that light of intensity $\frac{I_0}{4}$ can emerge from the second sheet?

	Rotated sheet	Angle of rotation
A.	1 only	$\cos^{-1}\frac{\sqrt{2}}{2}$
B.	2 only	$\cos^{-1}\frac{1}{2}$
C.	1 or 2	$\cos^{-1}\frac{\sqrt{2}}{2}$
D.	1 or 2	$\cos^{-1}\frac{1}{2}$

32. When a sound wave travels from a region of hot air to a region of cold air, it refracts as shown. *[1 mark]*



What changes occur in the frequency and wavelength of the sound as it passes from the hot air to the cold air?

	Frequency	Wavelength
A.	unchanged	increases
B.	unchanged	decreases
C.	increases	increases
D.	decreases	decreases

33. In simple harmonic oscillations which two quantities always have opposite directions? *[1 mark]*

A. Kinetic energy and potential energy

B. Velocity and acceleration

C. Velocity and displacement

D. Acceleration and displacement

34. A girl in a stationary boat observes that 10 wave crests pass the boat every minute. *[1 mark]*
What is the period of the water waves?

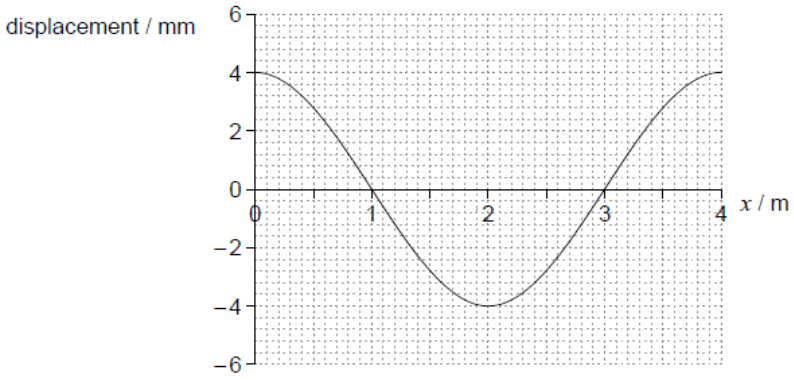
A. $\frac{1}{10}$ min

B. $\frac{1}{10}$ min^{-1}

C. 10 min

D. 10 min^{-1}

35. The graph shows the variation with distance x of the displacement of the particles of a medium in which a longitudinal wave is travelling from left to right. Displacements to the right of equilibrium positions are positive. *[1 mark]*



Which point is at the centre of a compression?

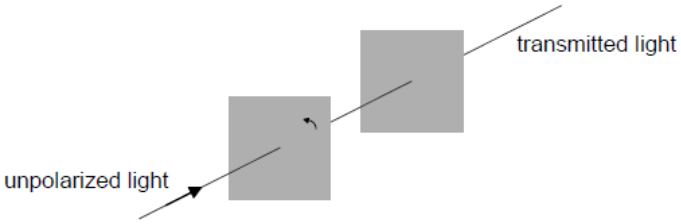
A. $x = 0$

B. $x = 1$ m

C. $x = 2$ m

D. $x = 3$ m

36. A beam of unpolarized light is incident on the first of two parallel polarizers. The transmission axes of the two polarizers are initially parallel. *[1 mark]*



The first polarizer is now rotated about the direction of the incident beam by an angle smaller than 90°. Which gives the changes, if any, in the intensity and polarization of the transmitted light?

	Intensity	Polarization
A.	different	no change
B.	different	different
C.	no change	no change
D.	no change	different

37. The frequency of the first harmonic standing wave in a pipe that is open at both ends is 200 Hz. What is the frequency of the first harmonic in a pipe of the same length that is open at one end and closed at the other? *[1 mark]*

A. 50 Hz

B. 75 Hz

C. 100 Hz

D. 400 Hz

38. A travelling wave of period 5.0 ms travels along a stretched string at a speed of 40 m s $^{-1}$. Two points on the string are 0.050 m apart. *[1 mark]*

What is the phase difference between the two points?

A. 0

B. $\frac{\pi}{2}$

C. π

D. 2π

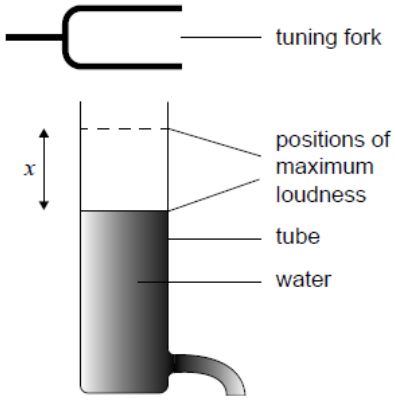
39. Properties of waves are *[1 mark]*

I. polarization
II. diffraction
III. refraction

Which of these properties apply to sound waves?

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

40. Water is draining from a vertical tube that was initially full. A vibrating tuning fork is held near the top of the tube. For two positions of the water surface only, the sound is at its maximum loudness. *[1 mark]*



The distance between the two positions of maximum loudness is *x*.

What is the wavelength of the sound emitted by the tuning fork?

A. $\frac{x}{2}$

B. x

C. $\frac{3x}{2}$

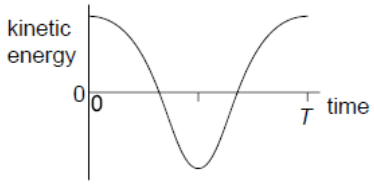
D. $2x$

41. A body undergoes one oscillation of simple harmonic motion (shm). What is correct for the direction of the acceleration of the body and the direction of its velocity? *[1 mark]*

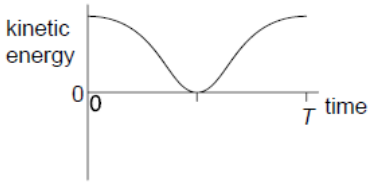
A. Always opposite
B. Opposite for half a period
C. Opposite for a quarter of a period
D. Never opposite

42. A particle oscillates with simple harmonic motion (shm) of period T. Which graph shows the variation with time of the kinetic energy of the particle? *[1 mark]*

A.



B.



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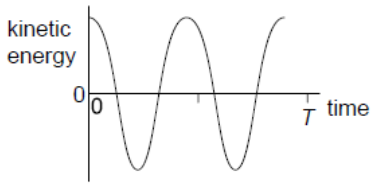
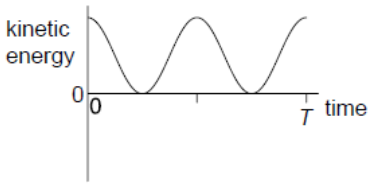
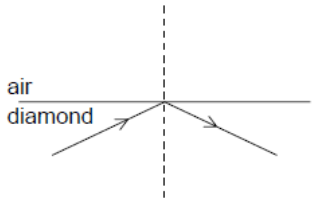


D.

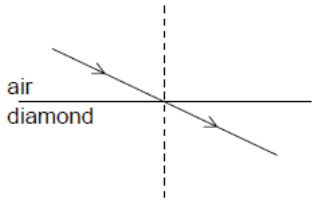


43. A light ray is incident on an air–diamond boundary. The refractive index of diamond is greater than 1. Which diagram shows the correct path of the light ray? *[1 mark]*

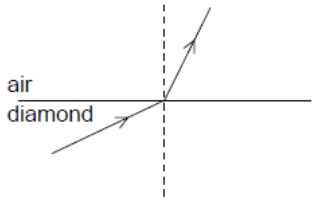
A.



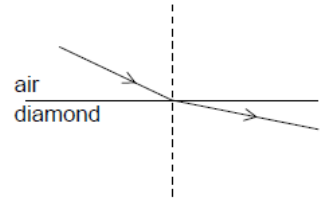
B.



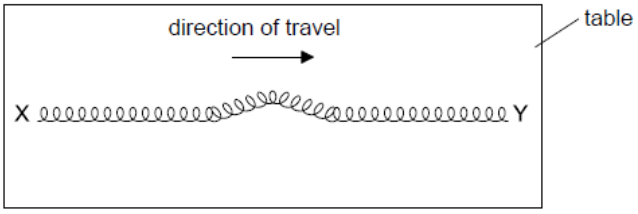
C.



D.



44. A spring XY lies on a frictionless table with the end Y free. *[1 mark]*



A horizontal pulse travels along the spring from X to Y. What happens when the pulse reaches Y?

A. The pulse will be reflected towards X and inverted.
B. The pulse will be reflected towards X and not be inverted.
C. Y will move and the pulse will disappear.
D. Y will not move and the pulse will disappear.

45. A student stands a distance *L* from a wall and claps her hands. Immediately on hearing the reflection from the wall she claps her hands again. She continues to do this, so that successive claps and the sound of reflected claps coincide. The frequency at which she claps her hands is *f*. What is the speed of sound in air? *[1 mark]*

A. $\frac{L}{2f}$

B. $\frac{L}{f}$

C. Lf

D. $2Lf$

46. A point source of light of amplitude A_0 gives rise to a particular light intensity when viewed at a distance from the source. When the amplitude is increased and the viewing distance is doubled, the light intensity is doubled. What is the new amplitude of the source? *[1 mark]*

A. $2A_0$

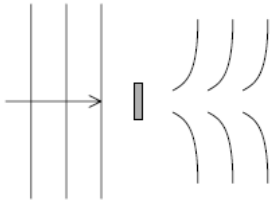
B. $2\sqrt{2}\ A_0$

C. $4A_0$

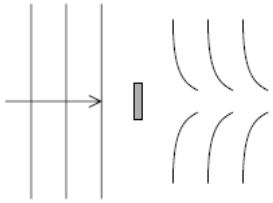
D. $8A_0$

47. Which diagram shows the shape of the wavefront as a result of the diffraction of plane waves by an object? *[1 mark]*

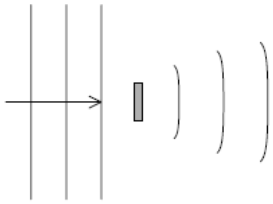
A.



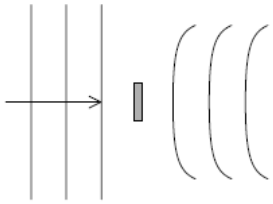
B.



C.



D.



48. A point source emits sound waves of amplitude *A*. The sound intensity at a distance *d* from the source is *I*. What is the sound intensity at a distance 0.5 *d* from the source when the source emits waves of amplitude 2*A*? *[1 mark]*

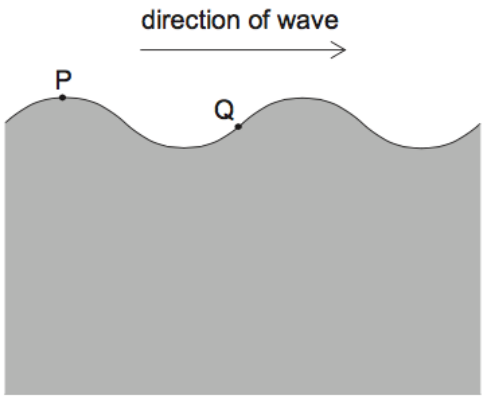
A. 16*I*

B. 4*I*

C. *I*

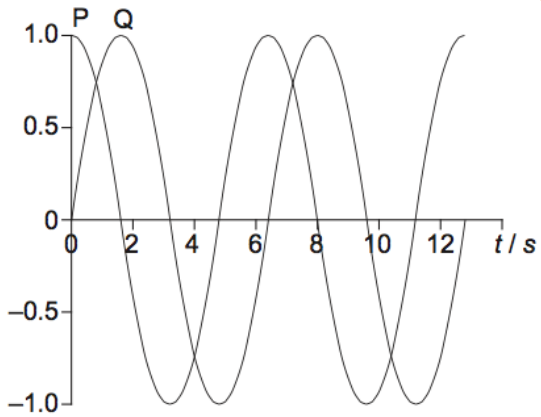
D. $\frac{1}{4}I$

49. A water wave moves on the surface of a lake. P and Q are two points on the water surface. The wave is traveling towards the right. *[1 mark]*

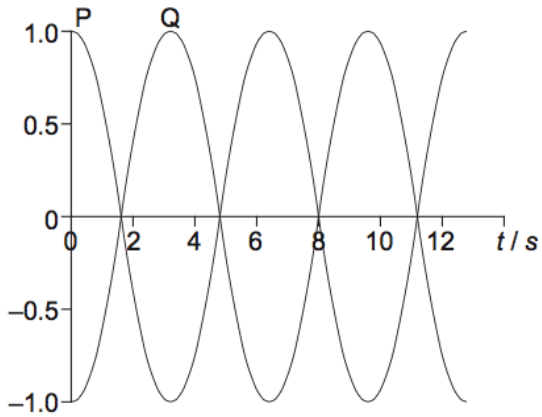


The diagram shows the wave at time $t = 0$. Which graph shows how the displacements of P and Q vary with t?

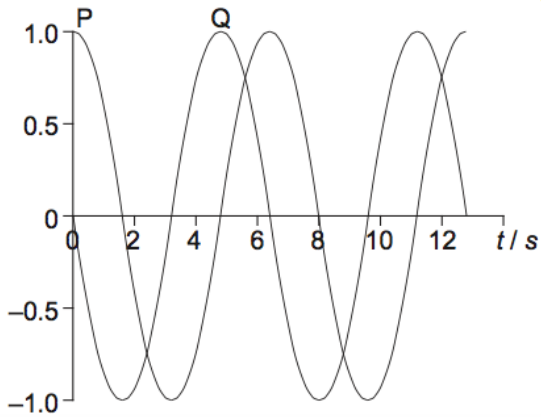
A.



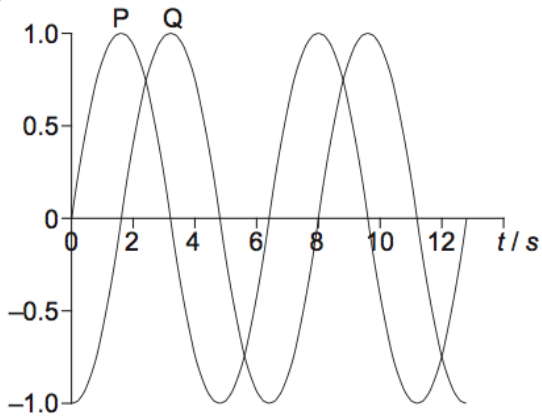
B.



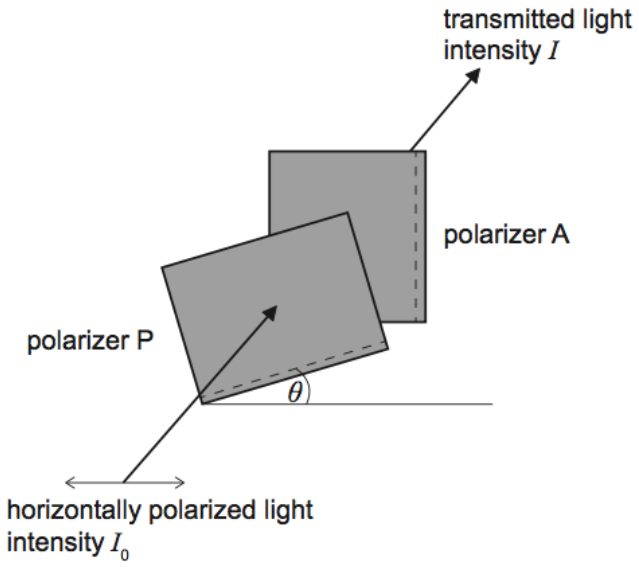
C.



D.

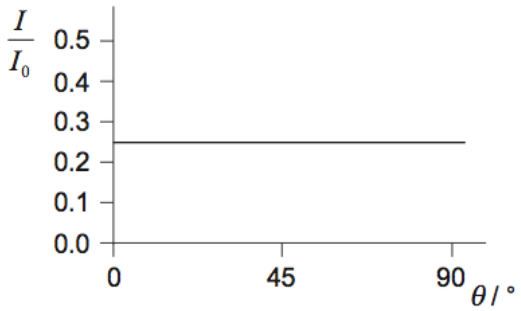


50. Horizontally polarized light of intensity I_0 enters a polarizer P whose polarization axis makes an angle of θ degrees with the horizontal. Light from P is then incident on a polarizer A with fixed vertical polarization axis. *[1 mark]*

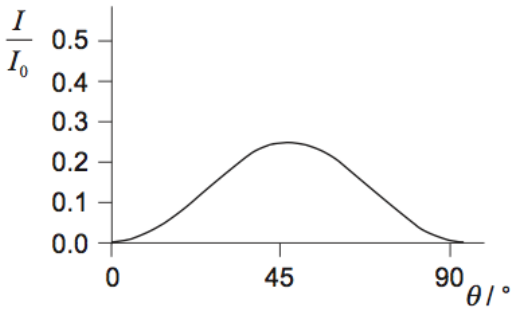


The angle θ is varied from 0 to 90 degrees. Which of the following represents the variation with θ of the intensity I of the light transmitted through A?

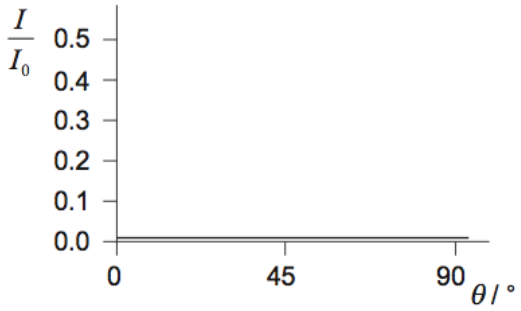
A.



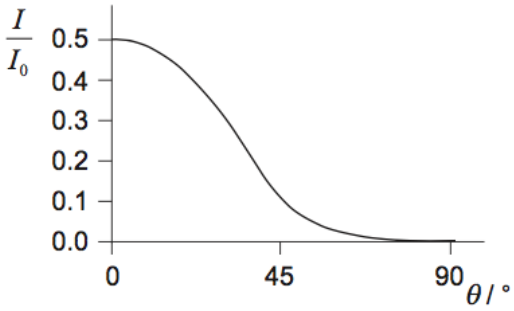
B.



C.



D.



51. A pipe of length L has two open ends. Another pipe of length L' has one open end and one closed end. *[1 mark]*

The frequency of the first harmonic of both pipes is the same. What is $\frac{L'}{L}$?

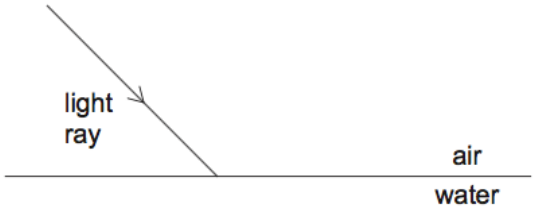
A. 2

B. $\frac{3}{2}$

C. 1

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

52. A light ray passes from air to water as shown. *[1 mark]*



What are the change in the wavelength of the light wave and the change in the angle the ray makes with the normal to the surface?

	Wavelength	Angle with normal
A.	increases	increases
B.	increases	decreases
C.	decreases	increases
D.	decreases	decreases

53. A transverse travelling wave has an amplitude x_0 and wavelength λ. What is the minimum distance between a crest and a trough measured in the direction of energy propagation? *[1 mark]*

A. $2x_0$

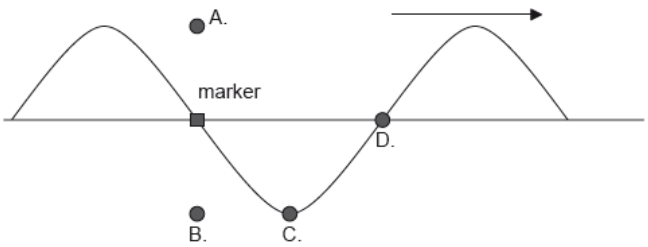
B. x_0

C. λ

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

54. A wave on a string travels to the right as shown. The frequency of the wave is f. At time $t = 0$, a small marker on the string is in the position shown. *[1 mark]*

What is the position of the marker at $t = \frac{1}{4f}$?



55. Electromagnetic waves *[1 mark]*

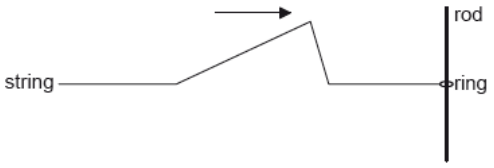
A. always obey an inverse square law.

B. are made up of electric and magnetic fields of constant amplitude.

C. always travel at the same speed in a vacuum.

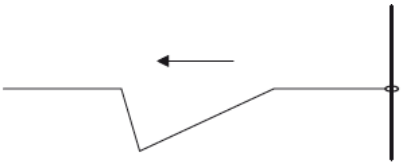
D. are always polarized.

56. A wave pulse travels along a light string which is attached to a frictionless ring. The ring can move freely up and down a vertical rod. *[1 mark]*

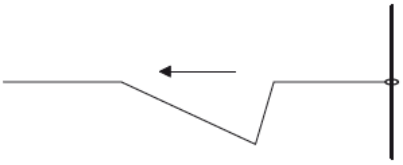


What is the shape of the wave pulse after reflection?

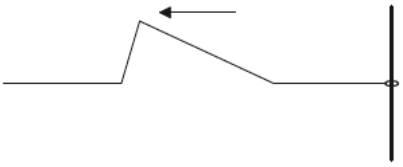
A.



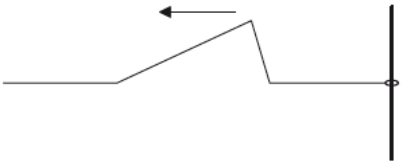
B.



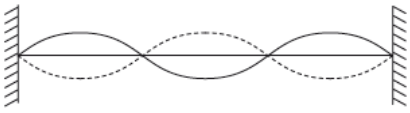
C.



D.



57. A standing (stationary) wave is set up on a string at a particular frequency as shown. *[1 mark]*



How many nodes will be on the string if the frequency is doubled but nothing else is changed?

A. 2

B. 3

C. 7

D. 8

58. Electromagnetic waves pass through a slit in a metal plate with minimal diffraction. The slit has a width of 0.25 m. What is the wavelength of the waves? *[1 mark]*

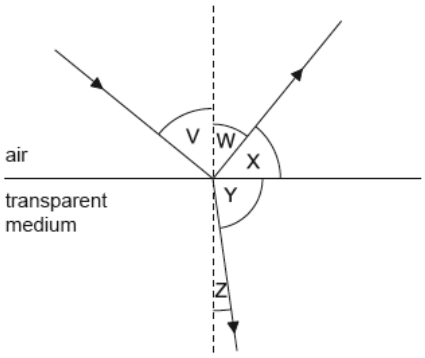
A. Much less than 0.25 m

B. Between 0.10 m and 0.40 m

C. Equal to 0.25 m

D. Much greater than 0.25 m

59. Light is incident from air on the surface of a transparent medium. *[1 mark]*



(angles not drawn to scale)

When V is equal to the Brewster angle, which angle is equal to 90°?

A. $\mathrm{V} + \mathrm{W}$

B. W only

C. $\mathrm{X} + \mathrm{Y}$

D. Z only

60. An object performs simple harmonic motion (SHM) about a central point. The object has velocity *v* and acceleration *a* when it has displacement *x* from the point. *[1 mark]*

Which ratio is constant?

B. $\frac{x}{v}$

C. $\frac{x^2}{a}$

D. $\frac{v}{a}$