3

PROPERTIES OF WAVES, INCLUDING LIGHT & SOUND

3.1 GENERAL WAVE PROPERTIES

3.1.1 Describing wave motion

3.1.2 Wave terms

3.1.3 Longitudinal and transverse waves

Learning Outcomes

Candidates should be able to:

Core

- Describe what is meant by wave motion as illustrated by vibration in ropes and springs and by experiments using water waves
- Use the term *wavefront*
- Give the meaning of *speed*, *frequency*, *wavelength* and *amplitude*
- Distinguish between transverse and longitudinal waves and give suitable examples
- Describe the use of water waves to show:
  - reflection at a plane surface
  - refraction due to a change of speed
  - diffraction produced by wide and narrow gaps

Supplement

- Recall and use the equation $v = f\lambda$
- Interpret reflection, refraction and diffraction using wave theory

3.1.1 Describing wave motion

MCQs

1. Water waves in a ripple tank move from a shallow region to a deeper region. Which one of the following options correctly describes the change, if any, in the frequency, wavelength and speed of the waves?

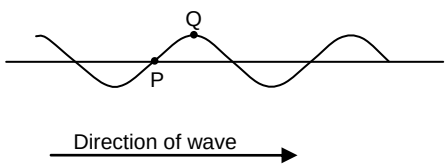
	Frequency	Wavelength	Speed
(A)	Unchanged	Increases	Increases
(B)	Unchanged	Increases	Decreases
(C)	Increases	Increases	Increases
(D)	Decreases	Decreases	Decreases

2. What happens to the speed, frequency and wavelength of light when it enters glass from air?

	Speed	Frequency	Wavelength
(A)	Decreases	Increases	Unchanged
(B)	Increases	Unchanged	Increases
(C)	Unchanged	Decreases	Decreases
(D)	Decreases	Unchanged	Decreases

3. The diagram shows a transverse wave on a rope. The wave is traveling from left to right.

At the instant shown, the points P and Q on the rope have zero displacement and maximum displacement respectively.



Which of the following describes the direction of motion, if any, of the points P and Q at this instant?

	Point P	Point Q
(A)	Downwards	Stationary
(B)	Stationary	Downwards
(C)	Stationary	Upwards
(D)	Upwards	Stationary

4. Transverse progressive sinusoidal waves of wavelength λ are passing vertically along a horizontal rope. P and Q are points on the rope $5\lambda/4$ apart and the waves are traveling from P to Q.

Which one of the following correctly describes Q at an instant when P is displaced upwards but is moving downwards?

	Displacement of Q	Movement of Q
(A)	Upwards	Downwards
(B)	Upwards	Upwards
(C)	Downwards	Upwards
(D)	Downwards	Stationary

5. A vibrator sends ripples across the surface of water. They run closer together as they travel further from the vibrator.

This shows that the ripples

(A) decrease in frequency.

(B) increase in frequency.

(C) slow down.

(D) speed up.

6. A dipper moving up and down makes waves in a ripple tank. What will happen when the dipper frequency is increased?

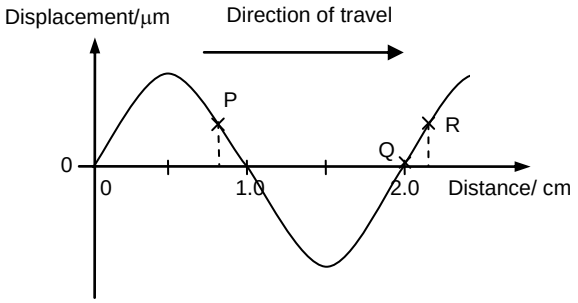
(A) The waves will be closer together.

(B) The wave peaks will be higher and the troughs lower.

(C) The waves will move more quickly across the tank.

(D) The waves will move more slowly across the tank.

7. At a certain instant, a traveling wave through a series of particles has the waveform as shown in the figure below.



Which of the following statements is correct?

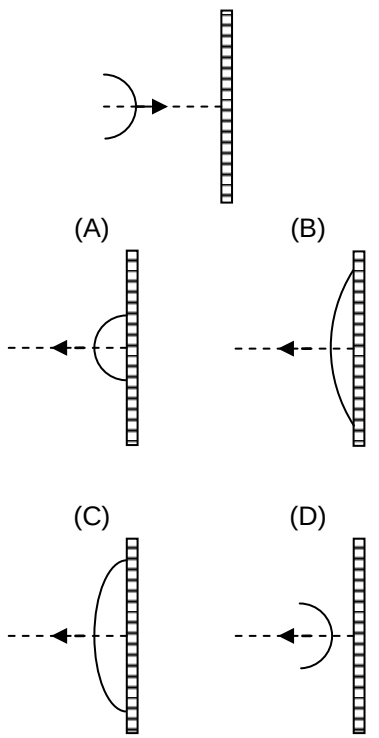
(A) The particles at P and R always have the same displacement.

(B) The particle at Q is momentarily at rest.

(C) The wavelength of the wave is 1.0 cm.

(D) R is moving downwards.

8. As shown in the figure below, a circular pulse is about to strike a straight barrier.
Which of the following shows correctly the reflected pulse?



9. A light cork is placed in a pool of still water. When a stone is thrown into the water, circular waves are observed. Describe the likely motion of the cork.

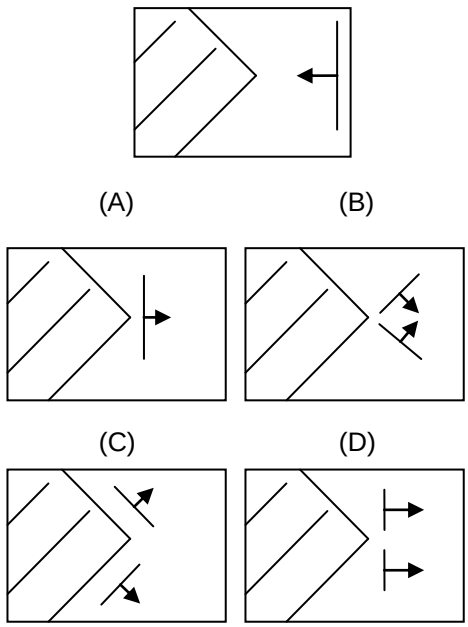
(A) The cork will move in the direction of the wave.

(B) The cork will move in a circular motion.

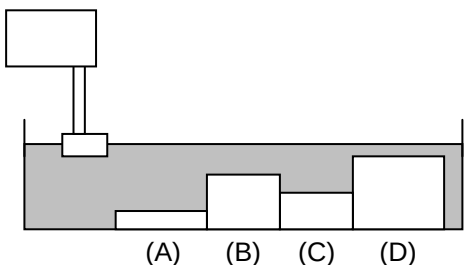
(C) The cork will move up and down.

(D) The cork will remain motionless.

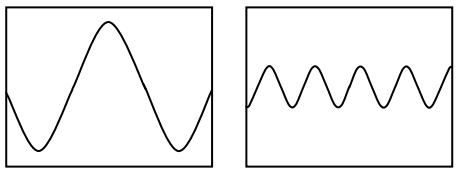
10. The above diagram shows a straight wave approaching a triangular obstacle. Which one of the following pictures best shows the reflected waves?



11. The vibrator in a ripple tank vibrates at a constant frequency. The ripple tank has four different obstacles placed in it. Over which obstacle will the wave generated have the highest speed?



12. A and B whistle into a microphone attached to an oscilloscope and the waveforms produced on the screen are shown below.

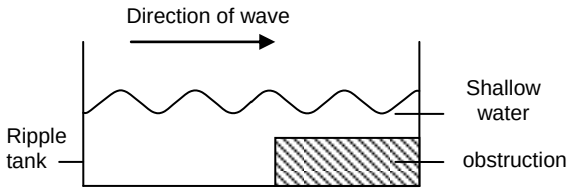


Waveform A Waveform B

Which of the following pairs correctly describes the loudness and the pitch of the sound produced?

	Loudness	*Pitch*
(A)	A is softer	A has a lower pitch
(B)	A is softer	A has a higher pitch
(C)	A is louder	A has a lower pitch
(D)	A is louder	A has a higher pitch

13. The diagram shows waves moving into shallower water.



The wavelength of the waves is reduced because

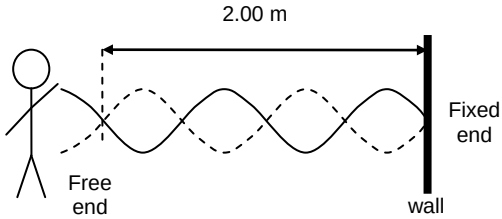
(A) only the frequency increases.

(B) only the velocity increases.

(C) only the velocity decreases.

(D) both the frequency and the velocity decreases.

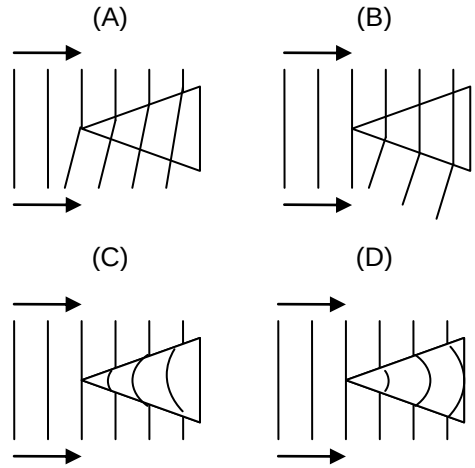
14. The diagram shows waves set up in a rope by a student moving the free end up and down at a steady rate.



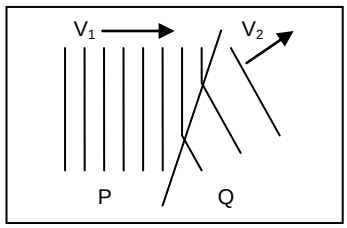
What is the wavelength of the waves shown, and what will be the wavelength when the student doubles the frequency at which the free end is moved up and down?

	wavelength as shown	*wavelength when frequency doubled*
(A)	0.50 m	1.00 m
(B)	0.50 m	0.50 m
(C)	1.00 m	1.00 m
(D)	1.00 m	0.50 m

15. A set of straight water ripples in a ripple tank travels over a thick, triangular Perspex sheet. Which diagram shows the wave pattern?



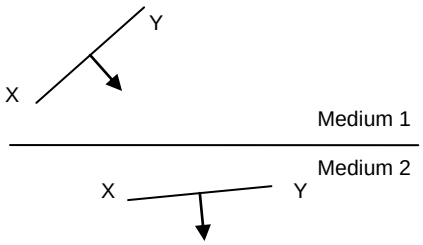
16. The diagram shows the waves in a ripple tank in which the water in parts P and Q is of different depths.



How do the wavelengths and the speeds V_1 and V_2 of the waves compare in P and Q?

	wavelength	*speed*
(A)	greater in P	V_1 is greater
(B)	greater in P	V_2 is greater
(C)	greater in Q	V_1 is greater
(D)	greater in Q	V_2 is greater

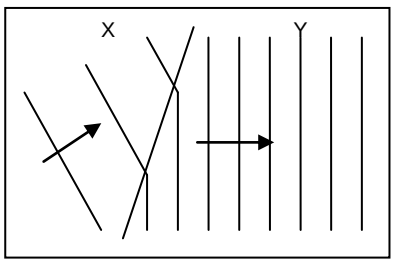
17. The diagram shows the direction of movement of a wave front XY in medium 1 and, later, in medium 2.



How do the speed and frequency of the wave change when the wave front passes into medium 2?

	speed	*frequency*
(A)	decreases	decreases
(B)	decreases	no change
(C)	increases	decreases
(D)	increases	no change

18. The diagram shows water waves traveling from section X to section Y in a ripple tank.



Which statement is correct?

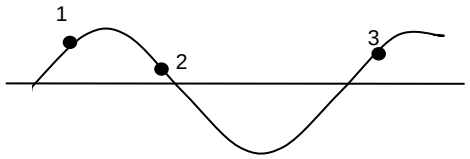
(A) The frequency is lower in section Y.

(B) The water is deeper in section Y.

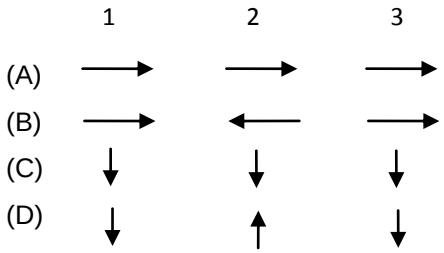
(C) The water is shallower in section Y.

(D) The waves move faster in section Y.

19. The diagram below shows the position of a string at a particular instant of time as a transverse wave travels along it from left to right.

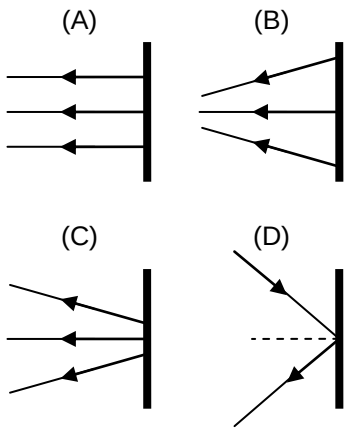


Which one of the following correctly shows the direction of the velocities of the points 1, 2, and 3 on the string?

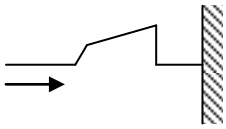


20. The diagram shows the curved waves about to hit a plane barrier.

Which of the following diagrams A to D shows the paths of these waves after they have hit the barrier?

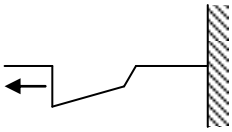


21. A pulse (shown in the diagram below) is sent along a thin cable which is attached to a wall at one end.

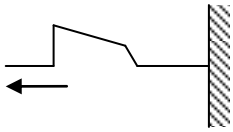


Which of the following diagrams correctly shows the subsequent reflected pulse?

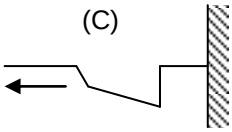
(A)



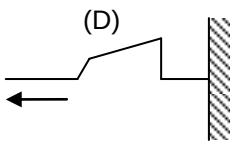
(B)



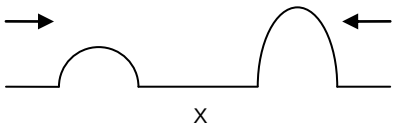
(C)



(D)



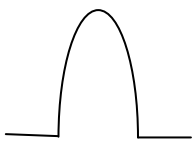
22. The figure below shows two pulses moving along a rope towards point X.



Both pulses arrive at X simultaneously. Which of the diagrams below shows the resulting waveform at X?

(A)

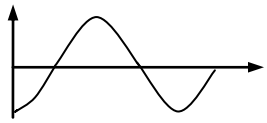
(B)



(C)

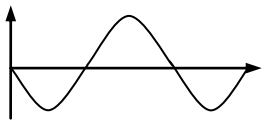
(D)

23. A student generates a transverse wave in a long rope. He makes 2 oscillations in 1.6 seconds.

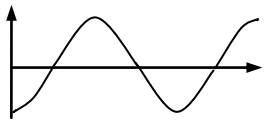


Which of the following correctly represents the shape of the rope one second later?

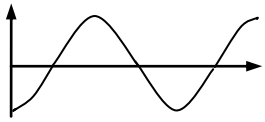
(A)



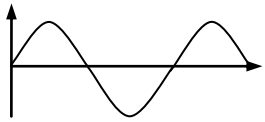
(B)



(C)

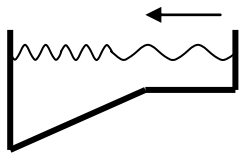


(D)

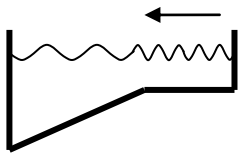


24. A ripple tank contains water of varying depths. Which diagram correctly represents the water waves as they travel from the shallow to the deep region?

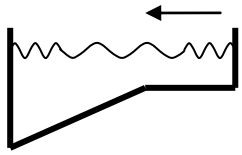
(A)



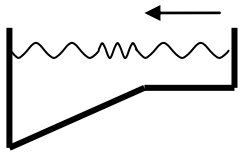
(B)



(C)



(D)



25. When waves approach the shoreline with a gentle slope,

(A) their wavelength increases but the frequency decreases.

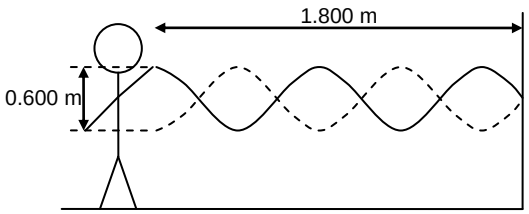
(B) their wavelength decreases but the frequency remains constant.

(C) their speed increases but their frequency remains constant.

(D) their speed and frequency both increase.

Questions – 3.1.1

1. The diagram shows waves set up in a light rope by a student moving the free end up and down at a rate of two cycles per second. The student is 1.800 m from the wall and the other end of the rope is anchored at X. No part of the rope touches the ground at all times and energy loss to surroundings is negligible.



(a) (i) What type of wave is set up in the rope?

(ii) What is the wavelength of the wave set up in the rope?

(iii) Find the speed of the wave.

(iv) What is the amplitude of the wave?

(v) Find the period of the wave.

(b) The student is using up energy at a rate of 20 W in order to keep the rope moving at a steady rate.

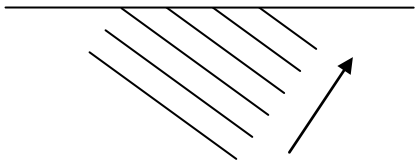
(i) Find the total work done by the student in moving his hand through one cycle.

(ii) The anchor at X has a mass of 2.00 kg and is now allowed to slide freely along the face of the wall. What is the frequency of oscillation of the anchor?

(iii) What is the amplitude of the anchor's oscillation? Assume no energy is lost to the surroundings and g = 10.0 N/kg.

2. The diagram below shows similar plane wave fronts of water waves approaching a boundary S between two regions at a speed of 0.25 m s^{-1}.

The wavelength of the waves is 5.0 mm. After passing through the boundary, the wavelength is 3.0 mm.



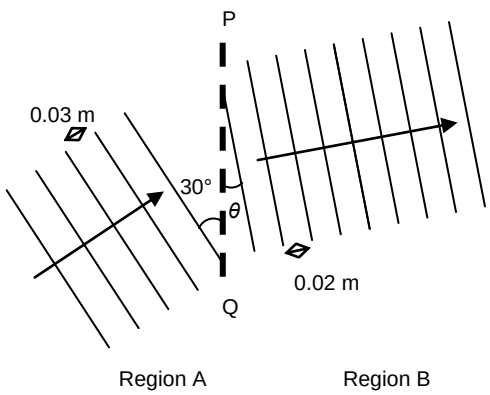
(a) Complete the diagram to show the wave fronts after they have passed through S. Indicate, with an arrow, the direction of the waves after passing through S.

(b) What is the speed of the waves after passing through S?

(c) Calculate the frequency of the waves.

3. Ripple tanks may be used to produce plane water waves. Draw a labeled diagram of a ripple tank used to produce plane water waves. Your diagram should show how the waves are made and how they are observed.

4. In a ripple tank experiment, a train of water waves are produced by a straight vibrator of frequency 10 Hz. The train of waves goes from a region A to another region B of different depths through a straight boundary PQ as shown in the diagram below (not drawn to scale).



The distance between two successive crests of the waves in region A is 0.03 m while that of the waves in region B is 0.02 m.

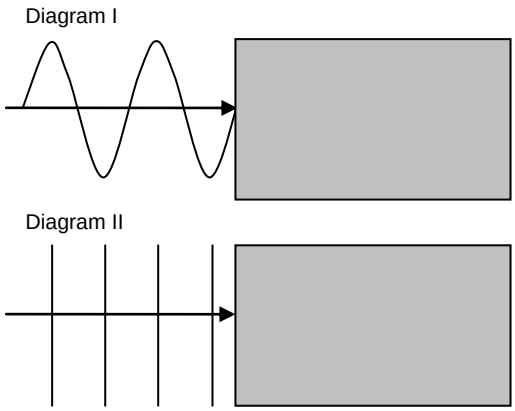
(a) What is the speed of the waves in region A?

(b) What is the speed of the waves in region B?

(c) Which region A or B is deeper? Explain.

(d) If the wavefront in A makes an angle of 30° with PQ, what is the angle ϑ which the wavefront in B makes with PQ?

5. (a) A light wave is moving from air towards the surface of water. Diagram I shows a section through a light wave at right angles to a glass surface and diagram II shows the wavefronts.

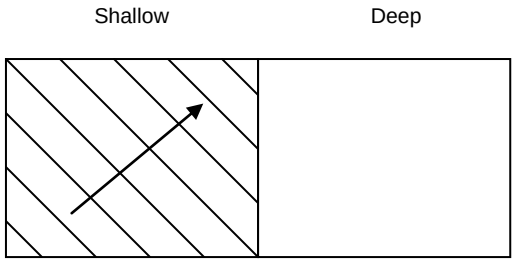


Complete both diagram so that diagram I shows the waves, and diagram II shows the wavefronts, in the glass.

(b) Yellow light has a frequency in air of 5.0×10^8 Hz. Calculate the wavelength of this light given that its speed in air is 3.0×10^8 m s^{-1}.

(c) Name one difference in the property between yellow and orange light.

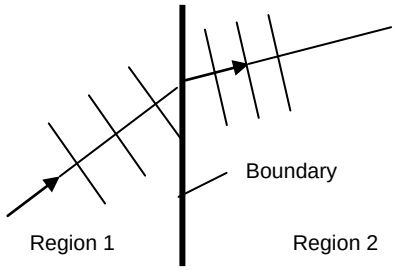
6. The figure shows some oil in a ripple tank which has shallow and deep sections. The waves are produced in the shallow section and move towards the deep end. There is a distance of 0.6 m between wave crests and their frequency is 35 Hz in the shallow section.



(a) What is the velocity of the waves in the shallow section?

(b) Complete the figure above to show the waves in the deep section.

7. (a) Straight water waves in a ripple pass from region 1 to region 2 as shown in the diagram below. The source of the water waves is at a frequency of 10 Hz.



(i) Explain why there is a change in direction and wavelength of the wave as it travels from region 1 to region 2.

(ii) By making measurements on the diagram, determine the

(1) wavelength of incident waves,

(2) wavelength of refracted waves.

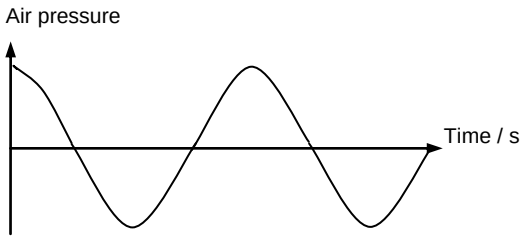
(iii) Hence, calculate the velocity of the

(1) incident waves,

(2) refracted waves.

(b) The graph below shows the variation of air pressure with time of a sound wave.

(Trace this on foolscap paper)



On the same diagram, sketch separate graphs to show another sound wave of

(i) same loudness but of higher pitch,

(ii) same pitch but is louder,

(iii) same pitch and loudness but of different quality.

(Label the graphs accordingly.)

(c) Describe a simple method of determining the speed of sound in air. State clearly,

(i) the apparatus used,

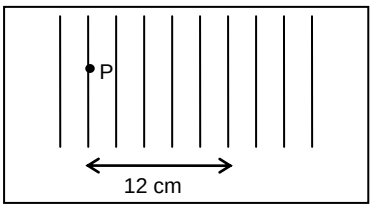
(ii) the procedure,

(iii) how the results are used to calculate the speed of sound.

3.1.2 Waves terms

MCQs

1. A water wave in a ripple tank is shown below.

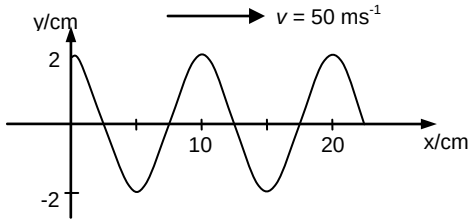


The period of vibration of P is 0.16 s. What is the velocity of the water wave?

(A) 0.75 m s^{-1} (B) 0.19 m s^{-1}

(C) 0.15 m s^{-1} (D) 0.38 m s^{-1}

2. The graph below represents the shape at a particular instant of part of a transverse wave traveling along a string with a speed of 50 m s^{-1} in the +x direction.

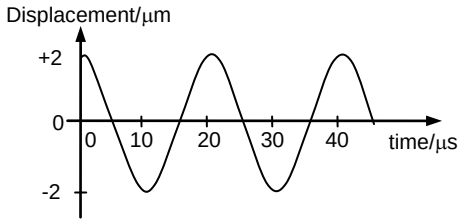


The period of oscillation of the particles of the string is

(A) 1 ms (B) 2 ms

(C) 5 ms (D) 10 ms

3. The figure below represents the simple harmonic motion of a particle in a progressive wave traveling at a speed of 5.0 km s^{-1}.



The wavelength is

(A) 10 mm (B) 15 mm

(C) 50 mm (D) 100 mm

4. A circular bowl of diameter 400 mm contains water at rest. If its side is tapped gently, a completely circular pulse can be produced on the surface of the water which travels inwards with a speed of 250 mm s^{-1}. The radius of the pulse and its direction of travel, 1 second after the pulse is produced, are

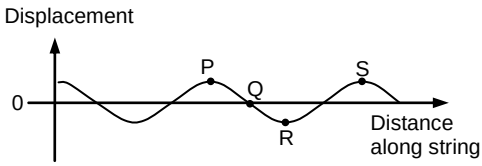
(A) zero, stationary.

(B) 50 mm, outwards.

(C) 50 mm, inwards.

(D) 150 mm, outwards.

5. The graph shows the shape at a particular instant of part of a transverse wave traveling along a string.



Which statement about the motion of elements of the string is correct?

(A) The speed of the element at P is a maximum.

(B) The displacement of the element at Q is zero.

(C) The energy of the element at R is entirely kinetic.

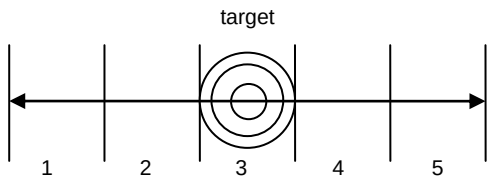
(D) The acceleration of the element at S is a maximum.

6. Visible light has wavelengths between 400 nm and 700 nm, and its speed in a vacuum is 3.0×10^8 m s^{-1}. What is the maximum frequency of visible light?

(A) 1.2×10^{11} Hz (B) 4.3×10^{11} Hz

(C) 4.3×10^{14} Hz (D) 7.5×10^{14} Hz

7. In a fairground shooting game, a gun fires at a moving target. The gun fires by itself at random times. The player has to point the gun in a fixed direction, and the target moves from side to side with a constant frequency.



At which region should the player take a fixed aim in order to score the greatest number of hits?

(A) 3

(B) Either 1 or 5

(C) Either 2 or 4

(D) Any of 1, 2, 3, 4 and 5

8. A wave source of frequency 1000 Hz emits waves of wavelength 0.10 m. How long does it take for the waves to travel 2500 m?

(A) 2.5 s (B) 4.0 s

(C) 25 s (D) 100 s

9. Which of the following is/are the correct unit(s) of frequency

(i) s

(ii) s^{-1}

(iii) Hz

(A) (ii) only (B) (i) only

(C) (i) and (iii) (D) (ii) and (iii)

10. A VHF radio station broadcasts at a frequency of 93.3 MHz. The speed of radio waves is 3.0×10^8 m s^{-1}. What is the wavelength of the waves broadcast by the station?

(A) 3.11×10^{-7} m (B) 0.311 m

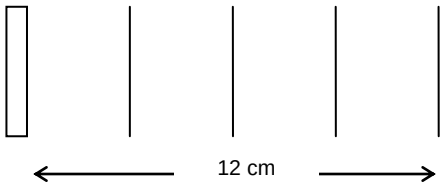
(C) 3.22×10^6 m (D) 3.22 m

11. If the frequency of the high pitched sound is 30 kHz, what is the wavelength of the sound in centimeter(s)? (Speed of sound is 300 m s^{-1})

(A) 100 cm (B) 10 cm

(C) 1 cm (D) 0.1 cm

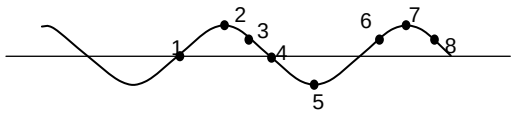
12. A wave generator which makes 5 oscillations a second is used to produce waves in a ripple tank.



Which of these is correct for the waves produces?

	Frequency /Hz	*Wavelength / cm*	*Speed / cm s^{-1}*
(A)	0.5	12	6
(B)	5	3	15
(C)	5	12	240
(D)	20	3	60

13. The figure below shows an instantaneous position of a string as a transverse progressive wave travels along it from left to right.

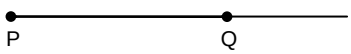


Which two particles have their vibration is phase?

(A) 1 and 4 (B) 3 and 6

(C) 2 and 7 (D) 5 and 7

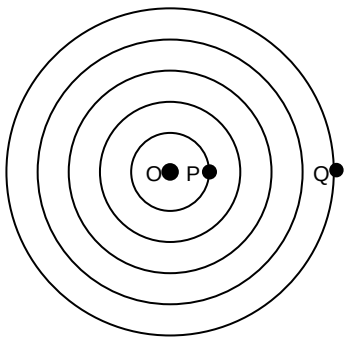
14. P and Q are two points 12 m apart on a string.



Point P is vibrated 4 times a second and the wave reaches Q two seconds later. Find the period and wavelength of the wave.

	Period/ s	*Wavelength/ m*
(A)	0.25	1.5
(B)	0.25	3
(C)	2	1.5
(D)	2	3

15. The following diagram illustrates crest of circular wavefronts radiating from a point source O.



If the time taken for a wavefront to travel from P to Q is 10 s, and the wavelength of the waves is 2 m, the speed of the waves, in m s^{-1}, is

(A) 0.20 (B) 0.80

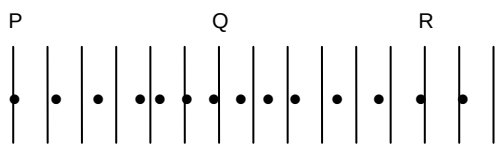
(C) 1.00 (D) 1.25

16. A periodic longitudinal wave that has a period of 0.05 s travels along a coil spring. If the distance between the successive compressions is 0.400 m, what is the speed of the wave?

(A) 0.02 m s^{-1} (B) 0.13 m s^{-1}

(C) 4.00 m s^{-1} (D) 8.00 m s^{-1}

17. The diagram is the full scale drawing of the positions of particles of a medium at a particular instant when a longitudinal wave passes through the medium. The wave travels from left to right. Before the wave arrived, the particles, P, Q and R are passing through their original undisturbed positions.

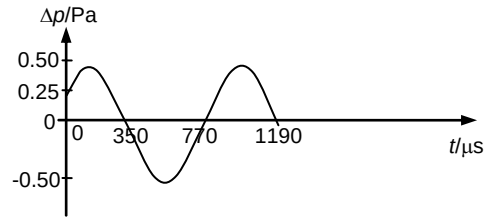


By making measurements on the diagram, find the wavelength and amplitude of the wave.

	Wavelength	*Amplitude*
(A)	5.5 cm	0.5 cm
(B)	5.5 cm	1.1 cm
(C)	12.0 cm	0.5 cm
(D)	12.0 cm	1.1 cm

Questions – 3.1.2

1. The figure below shows the variation with time *t* of Δp, the excess pressure at a point in a progressive sinusoidal wave in air. The speed of the wave is 340 m s^{-1}.



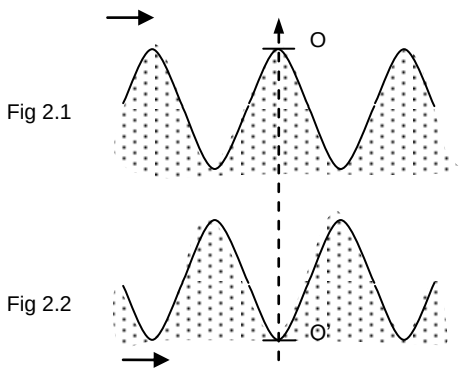
Determine

(a) the amplitude,

(b) the frequency,

(c) the wavelength.

2. Fig 2.1 and 2.2 represents the cross-sections of water waves produce by a plane wave vibrator in a ripple tank. A small fishing boat float is shown on the water surface at O in Fig 2.1. It is shown, 0.1 s later, in position O' in Fig 2.2.



During this time interval, the wave moves to the right and the float drops to a position 2.0cm below position O.

(a) Calculate the frequency of the plane wave vibrator.

(b) If the waves travel across the water at 20 cm s^{-1}, what is their wavelength?

(c) Would the float rise to O again? Explain your answer.

3. Fig 3.1 shows a ripple tank being used to investigate waves on water.

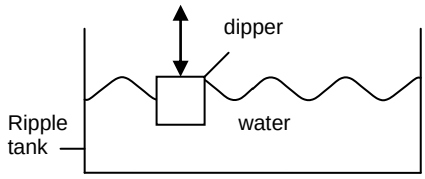


Fig 3.1

Fig 3.2 full scale

The dipper moves up and down 20 times in one second. Fig 3.2 shows, to full scale, a sideways view of the wave on the surface of the water at one instant.

(a) (i) Determine the wavelength of the wave in Fig 3.2.

(ii) Calculate the speed of the water wave. State clearly the equation you used.

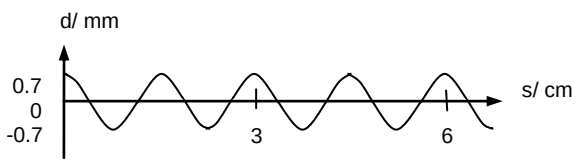
(b) The dipper is now made to move up and down 40 times in one second. The speed of the water wave is unchanged.

(i) On Fig 3.2, draw the sideways view of the new wave.

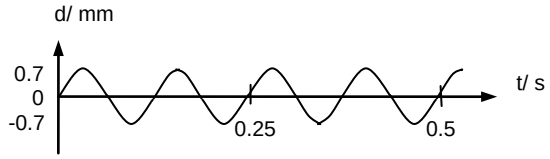
(ii) State the value of the new wavelength of the wave.

4. In a ripple tank experiment, a vibrator is vibrating at a particular constant frequency on a water surface.

The figure below is a graph of the variation of d, the displacement (y-axis), with s, the distance from the vibrator (x-axis), for the ripples on the surface of water in the ripple tank at a particular instant of time.



The figure below is a graph of the variation with time t of the vertical displacement d of the ripple tank vibrator.



Use the graphs to determine

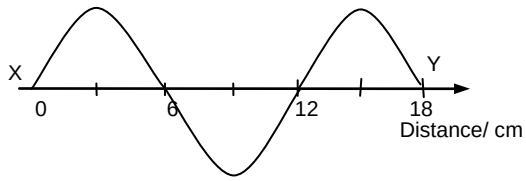
(a) the amplitude of the ripples,

(b) the wavelength of the ripples,

(c) the frequency at which the vibrator is vibrating,

(d) the speed at which the ripples are traveling.

5. (a) The figure below shows the variation of the displacement of a wave with distance along the wave at a particular time.



If the time taken for the wave to move from X to Y is 0.30 s, determine the

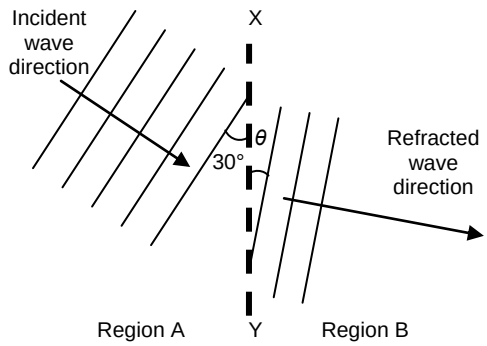
(i) wavelength,

(ii) velocity, and

(iii) frequency of the wave.

(b) Give one difference between water wave and sound wave.

(c) The figure below shows successive wavefronts of waves, produced by a straight vibrator in a ripple tank experiment, traveling from region A to another region B (not drawn to scale).



(i) Describe how two regions of different depths can be set up in a ripple tank.

(ii) If the distance between the crests in region A and region B are 5.0 cm and 3.0 cm respectively, which of the two regions A or B is shallower? Give a reason for your answer.

(iii) If the wavefront in region A makes an angle of 30° with the boundary XY, find the angle θ which the wavefront in region B makes with the boundary.

(iv) Copy the diagram above on lined paper and draw as accurately as possible the position of three more wavefronts in region B.

3.1.3 Longitudinal & transverse waves

MCQs

1. If a wave can be polarised, it must be

(A) an electromagnetic wave.

(B) a longitudinal wave.

(C) a sound wave.

(D) a transverse wave.

2. Water waves are produced in a ripple tank by a ball up and down repeatedly in the middle of the tank. Which of the following can result in a change in the wavelength of water waves produced in the ripple tank?

(A) The frequency of oscillation of the ball.

(B) The force used to push the ball.

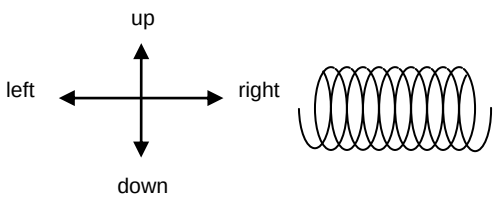
(C) The density of the ripple tank.

(D) The surface area of the ripple tank.

3. Which of he following are examples of a transverse and a longitudinal wave?

	Transverse wave	*Longitudinal wave*
(A)	light	water ripples
(B)	radio	light
(C)	radio	sound
(D)	sound	light

4. A lightly coiled spring is fixed at one end and held by hand at the other.



Which hand movements cause first a compression and then a rarefaction to travel along the spring?

(A) down then up

(B) up and then down

(C) left then right

(D) right then left

5. The table shows examples of transverse and longitudinal waves.

Which line in the table is correct?

	Transverse	*Longitudinal*
(A)	gamma rays	sound
(B)	infra-red	radio
(C)	sound	X-rays
(D)	radio	light

6. The difference between a transverse wave and longitudinal wave is the

(A) wavelength of the wave.

(B) medium through which the wave travels.

(C) speed of the wave.

(D) direction of vibration relative to the wave motion.

7. Which of these waves can only be transverse?

(A) Waves on a stretched string

(B) Radio waves

(C) Sound waves in air

(D) Waves produced by a speaker

8. Which of the following statements is/are true about transverse wave?

(i) It carries energy.

(ii) It has compressions and rarefactions.

(iii) The speed of it depends on the medium.

(iv) The vibration of particles of it is parallel to the direction in which the waves travels.

(v) Ripple is a form of transverse wave.

(A) (i), (ii) and (iii)

(B) (i), (iii) and (v)

(C) (ii), (iii) and (iv)

(D) (ii), (iii) and (v)

9. Which of the following statements about the three waves listed below is correct?

	Water waves	*Sound waves*	*Electromagnetic waves*
(A)	Transverse Stationary	Longitudinal Stationary	Transverse Stationary
(B)	Longitudinal Progressive	Transverse Stationary	Longitudinal Stationary
(C)	Transverse Progressive	Longitudinal Progressive	Transverse Progressive
(D)	Longitudinal Stationary	Transverse Progressive	Longitudinal Progressive

10. Which of the following are longitudinal waves?

(A) Infra-red transmitted through water.

(B) Ultrasonic transmitted through air.

(C) Gamma rays emitted from radioactive sources.

(D) Microwaves used in microwaves ovens.

Questions – 3.1.3

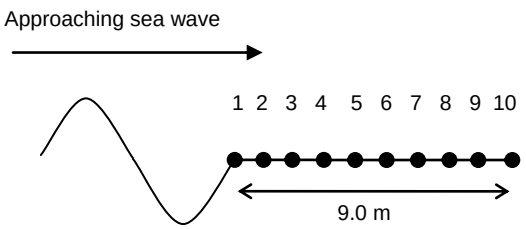
1. Name one physical example of a longitudinal wave motion.
What features do longitudinal waves have in common with transverse waves?

2. When a sound passes through the air, it affects the pressure of the air and the motions of the molecules of the air. Describe briefly how each is affected.

(a) the pressure

(b) the motions of the molecule.

3. The figure below shows a series of floating balls that are used to bound the swimming area outside a beach. The balls are linked by identical light strings and are 1.0 m apart. A sea wave is approaching the balls and ball 1 starts to vibrate.



(a) The wave is a transverse wave. What does it mean by transverse wave?

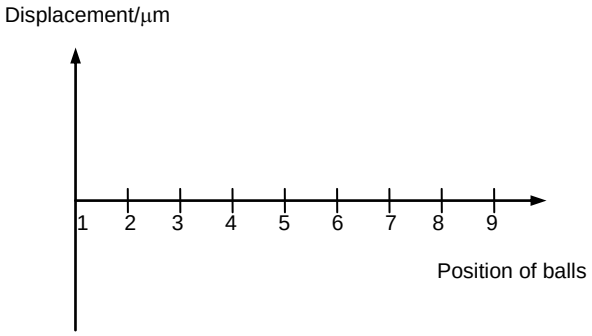
(b) It is observed that ball 1 makes one complete oscillation in 2.0 s. What is the frequency of the wave?

(c) Ball 9 starts to move at the time when ball 1 just finishes one complete oscillation.

(i) What is the wavelength of the wave?

(ii) What is the velocity of the wave?

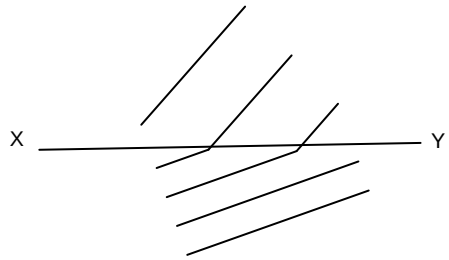
(d) Sketch the displacement-distance graph starting from ball 1 at the time ball 9 starts to vibrate.



4. (a) Distinguish between transverse and longitudinal waves.

Give an example of each type of wave.

(b) The diagram below represents successive wave-fronts of waves traveling on the surface of water in a ripple tank. When the waves reach XY, the direction in which hey travel changes, as shown.



Describe

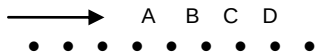
(i) how the initial incident wave-fronts could be produced in a ripple tank,

(ii) how you would arrange to bring about the refraction at XY in the ripple tank.

(c) Measure the wavelength of the waves before and after refraction, and hence calculate the ratio,

$$\frac{\text{Speed of water waves before refraction}}{\text{Speed of water waves after refraction}}$$

5. (a) A, B, C and D in the figure below represent particles in a medium through which waves are passing continuously in the direction indicated by the arrow.



Describe the motion of the particles A, B, C and D when the wave is

(i) transverse and

(ii) longitudinal.

(b) (i) Draw a full-scale diagram of a transverse wave of wavelength 40 mm and amplitude 15 mm. Your diagram should represent the wave at a particular instant and should show at least two wavelengths.

(ii) Calculate the speed of the wave you have drawn if its frequency is 150 Hz.

8

Answer keys:

3.1.1

MCQs

1. A
2. D
3. A
4. B
5. C
6. A
7. D
8. B
9. C
10. C
11. A
12. C
13. C
14. D
15. C
16. D
17. B
18. C
19. D
20. C
21. A
22. B
23. A
24. B
25. B

Questions

1. (a) (ii) 0.800 m
   (iii) 1.60 m/s
   (iv) 0.300 m
   (v) 0.500 s
   (b) (i) 10 J
   (ii) 2 Hz
   (iii) 0.125 m
2. (b) 0.15 m s^{-1}
   (c) 50 Hz
4. (a) 0.3 m s^{-1}
   (b) 0.2 m s^{-1}
   (d) 19.47°
5. (b) 0.6 m
6. (a) 21 m s^{-1}
7. (a)(ii) 1. 0.5cm
   (a)(ii) 2. 0.4 cm
   (a)(iii) 1. 5 cm s^{-1}
   (a)(iii) 2. 4 cm s^{-1}

3.1.2

MCQs

1. C
2. B
3. D
4. B
5. B
6. D
7. B
8. C
9. D
10. D
11. C
12. B
13. C
14. A
15. B
16. D
17. A

Questions

1. (a) 0.50 Pa
   (b) 1190 Hz
   (c) 0.29 m
2. (a) 5 Hz
   (b) 4 cm
   (c) yes
3. (a)(i) 1.4 cm
   (a)(ii) 0.28 m s^{-1}
   (b)(ii) 0.7 cm
4. (a) 0.7 mm
   (b) 0.015 m
   (c) 8.33 Hz
   (d) 0.125 m s^{-1}
5. (a)(i) 0.12 m
   (a)(ii) 0.6 m s^{-1}
   (a)(iii) 5 Hz
   (c)(iii) 17.46°

3.1.3

MCQs

1. D
2. A
3. C
4. D
5. A
6. D
7. B
8. B
9. C
10. B

Questions

3. (b) 0.50 Hz
   (c)(i) 8.0 m
   (c)(ii) 4.0 m s^{-1}
4. (c) 2.5
5. (b)(ii) 6 m s^{-1}