

Key Concept 1- Properties of Waves

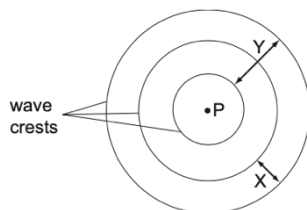
KPI 1.1

1. What happens to the particles of the medium when a wave passes through it?

- A. They are permanently displaced in the direction of the wave.
- ✓ B. They oscillate about their equilibrium positions.
- C. They move along with the wave at the same speed.
- D. They are absorbed by the wave and disappear.

KPI 1.2, 1.3

2. A vertical stick is dipped up and down in water at P. In two seconds, three wave crests are produced on the surface of the water.



Which statement is true?

- A. Distance X is the amplitude of the waves
- B. Distance Y is the wavelength of the waves
- ✓ C. Each circle represents a wavefront
- D. The frequency of the waves is 3 Hz

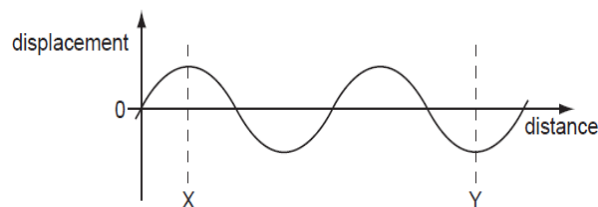
KPI 1.3

3. What is meant by the frequency of a water wave?

- A. the distance between consecutive crests of the wave
- B. the distance moved by the wave per unit time
- C. the maximum vertical displacement of the wave
- ✓ D. the number of crests passing a point per unit time

KPI 1.3

4. The diagram shows a wave.

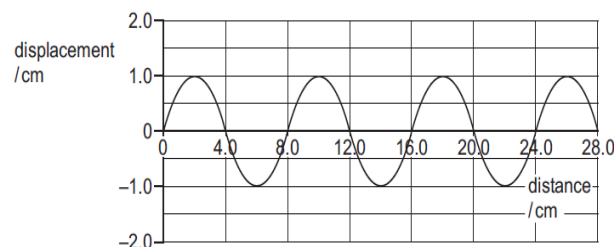


How many wavelengths are there between X and Y?

- A. $2/3$
- B. 1
- ✓ C. $1 \frac{1}{2}$
- D. 3

KPI 1.3

5. The diagram shows a wave.

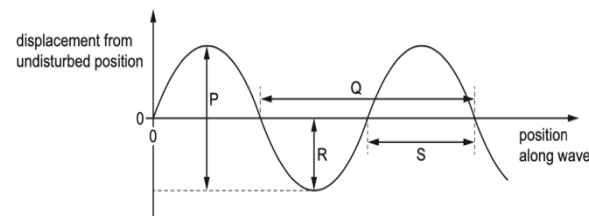


Which row is correct?

	Amplitude	Wavelength
A	1.0 cm	4.0 cm
✓ B	1.0 cm	8.0 cm
C	2.0 cm	4.0 cm
D	2.0 cm	8.0 cm

KPI 1.3

6. The diagram shows a wave.

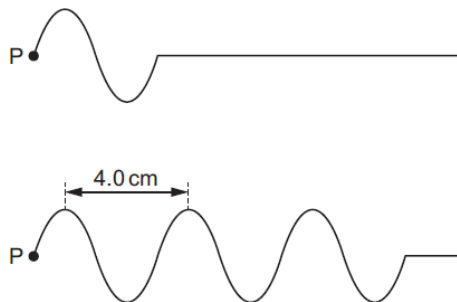


Which dimensions describe the properties of the wave?

- A. P = amplitude, S = speed
- B. P = speed, Q = wavelength
- ✓ C. R = amplitude, Q = wavelength
- D. R = amplitude, S = wavelength

KPI 1.4

7. The diagrams show a wave on the surface of the water in a tank at times 1.0 s apart. The wave is produced at P and travels to the right.



Which row gives the frequency and the speed of this water wave?

	Frequency (in Hz)	Speed (in cm/s)
A	2.0	4.0
✓ B	2.0	8.0
C	4.0	4.0
D	4.0	8.0

KPI 1.3

8. Which is the best description of the speed of a water wave?

- A. the distance between one wave crest and the next
- B. the distance between the crest of a wave and a trough.
- C. the distance that a particle of water moves up and down in one second
- ✓ D. the distance that a wavefront moves along the surface in one second

KPI 1.4

9. The wavelength of blue light changes from $4.7 \times 10^{-7} \text{ m}$ to $3.5 \times 10^{-7} \text{ m}$ as it passes from air to water. What is the speed of this light in water?

- A. $7.4 \times 10^7 \text{ m/s}$
- B. $1.3 \times 10^8 \text{ m/s}$
- ✓ C. $2.2 \times 10^8 \text{ m/s}$
- D. $3.0 \times 10^8 \text{ m/s}$

KPI 1.5

10. Which row correctly describes the vibrations of a transverse wave and also gives a correct example of a transverse wave?

	Description of Vibration	Example of a Transverse Wave
A	Right-angles to wave direction	Sound
✓ B	Right-angles to wave direction	Water wave
C	Parallel to the wave direction	Sound
D	Parallel to the wave direction	Water wave

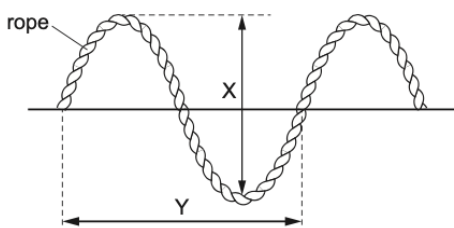
KPI 1.5

11. Which group contains only transverse waves?

- A. infra-red waves, light waves, sound waves
- ✓ B. infra-red waves, light waves, ultra-violet waves
- C. infra-red waves, ultra-violet waves, sound waves
- D. light waves, sound waves, ultra-violet waves

KPI 1.5, 1.3

12. The diagram represents a wave on a rope.



Which type of wave is shown and which labelled arrow shows the wavelength of the wave?

- | | type of wave | wavelength |
|------|--------------|------------|
| A. | longitudinal | X |
| B. | longitudinal | Y |
| C. | transverse | X |
| ✓ D. | transverse | Y |

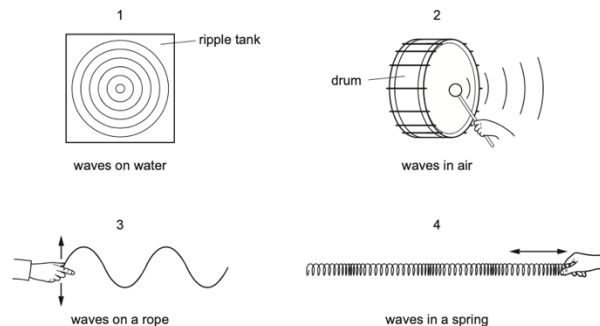
KPI 1.5, 1.6

13. Which row shows an example of a transverse wave and an example of a longitudinal wave?

- | | Transverse | Longitudinal |
|-----|------------|--------------|
| A | Light | Radio |
| ✓ B | Radio | Sound |
| C | Sound | Water |
| D | Water | Light |

KPI 1.6

14. The diagrams show examples of wave motion.

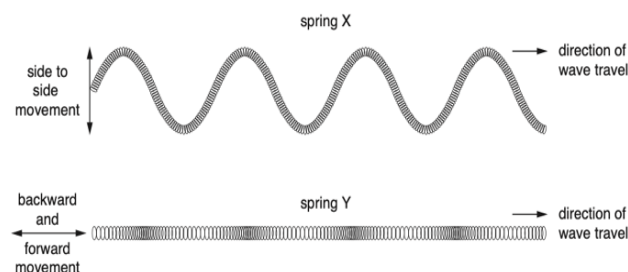


Which waves are longitudinal?

- A. 1 only
- B. 2 and 3 only
- C. 2, 3 and 4
- ✓ D. 2 and 4 only

KPI 1.5, 1.6

15. Waves are sent along two long springs X and Y as shown.



How should the wave motions in X and Y be described?

- | | Spring X | Spring Y |
|------|--------------|--------------|
| A. | longitudinal | longitudinal |
| B. | longitudinal | transverse |
| ✓ C. | transverse | longitudinal |
| D. | transverse | transverse |

KPI 1.7

16. Water waves are reflected at a plane surface. Which property of the waves is changed by the reflection?

- ✓ A. Direction
- B. Frequency
- C. Speed
- D. Wavelength

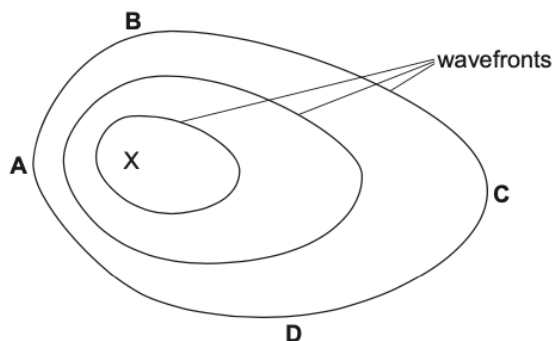
KPI 1.7

17. In which situation is the wavelength of the wave changed?

- ✓ A. light from the Sun passing from air into water
- B. radio waves travelling from an Earth satellite to the Moon
- C. sound reflecting from a wall
- D. water waves passing through a narrow gap

KPI 1.7

18. Waves travel more quickly on the surface of water when the water is deep. A stone is dropped at point X into a pool of varying depth. The diagram shows the first three wavefronts on the surface of the pool. The region between X and which labelled point is likely to be the deepest?



- A. A
- B. B
- ✓ C. C
- D. D

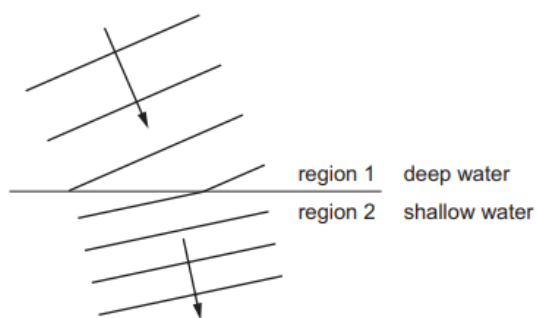
KPI 1.7, 1.9

19. A tank contains water. Ripples are produced on the surface of the water. What causes the ripples to refract?

- A. The cold water in the tank is replaced by warm water
- ✓ B. The ripples change speed as they move from deep to shallow water
- C. The ripples hit the wall of the tank
- D. The ripples pass through a narrow gap

KPI 1.7, 1.9

20. The diagram shows wavefronts on the surface of water, viewed from above.

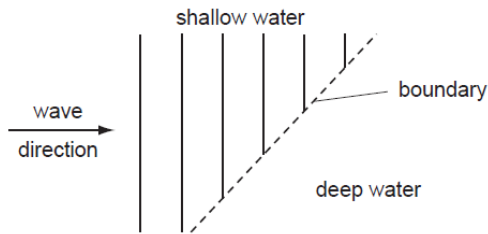


Which row is correct for the wavefronts moving from region 1 to region 2?

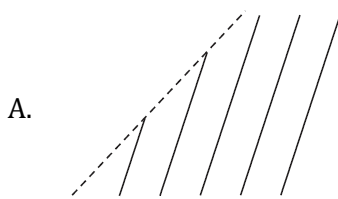
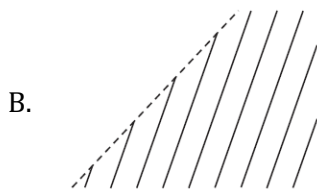
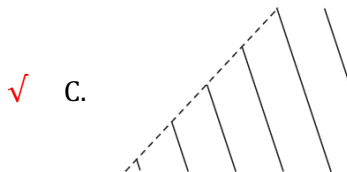
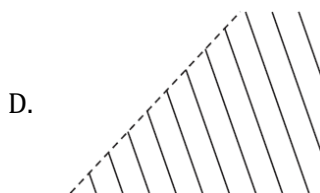
	Name of process	The speeds of the wavefronts in regions 1 and 2 are
A	Diffraction	different
B	Diffraction	the same
✓ C	Refraction	different
D	Refraction	the same

KPI 1.7, 1.9

21. Plane water waves travel from a shallow region into a deeper region. They travel more quickly in the deeper water.

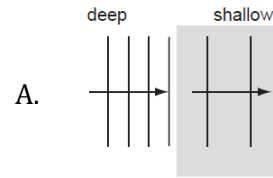
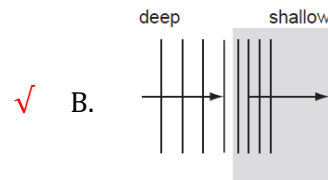
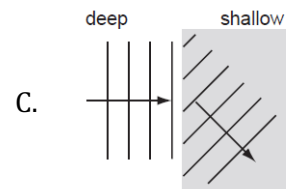
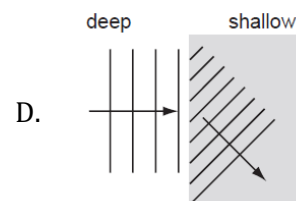


Which diagram shows the wave pattern in the deeper water?



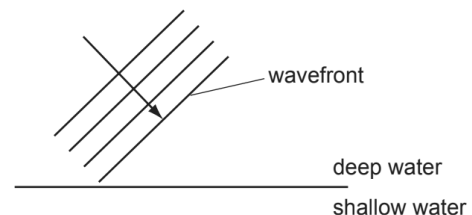
KPI 1.7, 1.9

22. Water waves travel more slowly in shallow water than in deep water. Which diagram shows what will happen to plane waves in deep water when they enter shallow water?



KPI 1.7, 1.9

23. The diagram represents water waves about to move into shallow water from deep water.

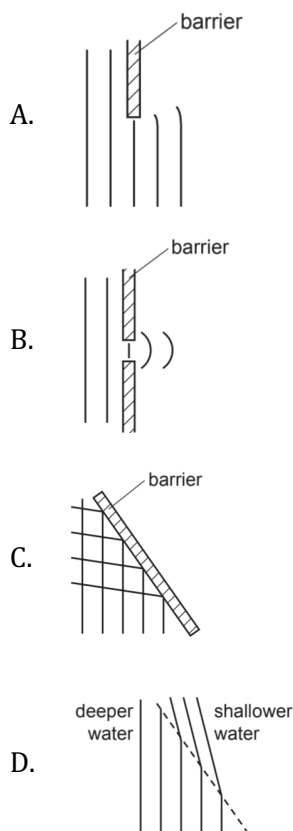


Which property of the waves remains the same after the waves move into shallow water?

- ✓ A. frequency
- B. speed
- C. wavefront direction
- D. wavelength

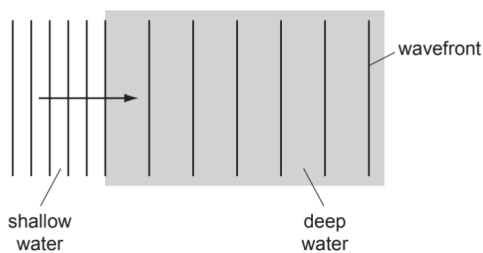
KPI 1.7, 1.9

24. The diagrams represent water waves in a tank. Which diagram represents waves that change speed?



KPI 1.7, 1.9

25. Waves in a tank pass from shallow to deep water. The wavefront diagram is shown.

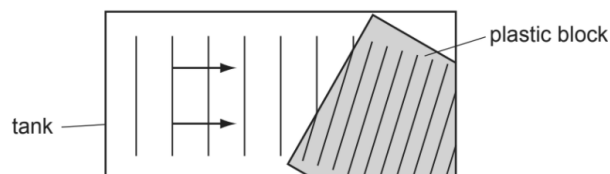


Which quantity increases as the waves enter the deep water?

- A. amplitude
- B. frequency
- C. wave energy
- ✓ D. wavelength

KPI 1.7, 1.9

26. Water waves in a tank pass over a thin plastic block as shown.

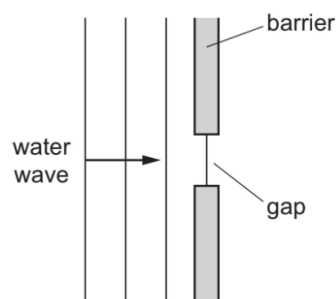


What happens to the waves as they reach the plastic block?

- A. They are diffracted because they slow down
- B. They are diffracted because they speed up
- ✓ C. They are refracted because they slow down
- D. They are refracted because they speed up

KPI 1.7, 1.8

27. A water wave in a shallow tank passes through a gap in a barrier.



What happens to the speed and what happens to the wavelength of the wave as it passes through the gap?

- | | speed | wavelength |
|-----|------------------|------------------|
| A | decreases | decreases |
| B | decreases | remains constant |
| C | remains constant | decreases |
| ✓ D | remains constant | remains constant |

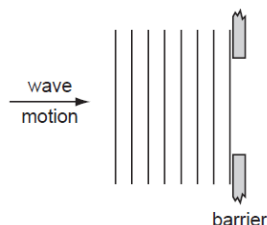
KPI 1.7, 1.8

28. Below are four statements about the diffraction of a wave on the surface of water. Which statement is correct?

- A. Diffraction involves a change in the speed of the wave
- B. Diffraction involves a change in the wavelength of the wave
- ✓ C. When a wave passes through a gap, its direction changes
- D. When a wave passes through a gap, its frequency changes

KPI 1.8, 1.10

29. In a ripple tank experiment, plane water-waves meet a straight barrier with a wide gap in it.

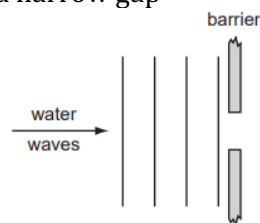


Which diagram shows the wave pattern beyond the barrier?

- A.
- B.
- C.
- ✓ D.

KPI 1.8, 1.10

30. In a ripple tank, water waves move towards a barrier with a narrow gap

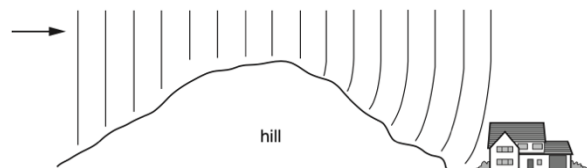


Which diagram best shows the waves beyond the barrier?

- A.
- B.
- C.
- ✓ D.

KPI 1.7, 1.8

31. Radio waves are received at a house at the bottom of a hill.

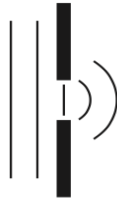


The waves reach the house because the hill has caused them to be ____.

- ✓ A. diffracted
- B. radiated
- C. reflected
- D. refracted

KPI 1.8, 1.10

32. Students A, B, C and D, investigate the diffraction of water waves through a gap.



Each student uses a different gap size and a different wavelength for the water waves. Which student produces the waves which have the most diffraction?

	gap size (cm)	wavelength (cm)
✓ A.	2.0	1.8
B.	3.0	2.1
C.	4.0	2.0
D.	5.0	0.9

KPI 1.8

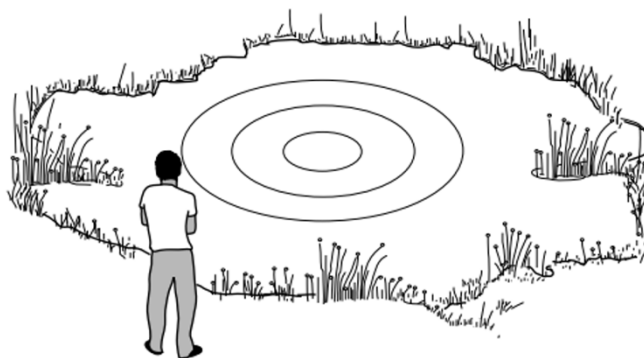
33. A wave passes through a gap and diffraction causes the wave to spread out. Which wave spreads out the most?

- ✓ A. large wavelength through a gap slightly larger than the wavelength
- B. large wavelength through a gap much smaller than the wavelength
- C. small wavelength through a gap much larger than the wavelength
- D. small wavelength through a gap much smaller than the wavelength

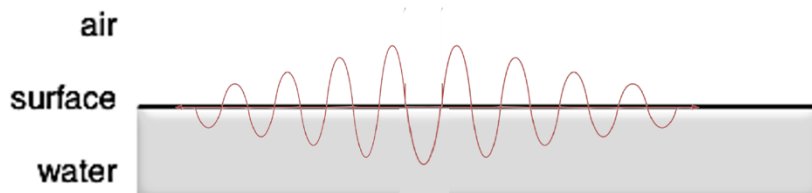
Free Response:

KPI 1.2, 1.3

1. The boy shown in the figure below has just thrown a number of stones into a pond, one after the other. The figure shows the crests of the waves a short time after the stones landed in the water.

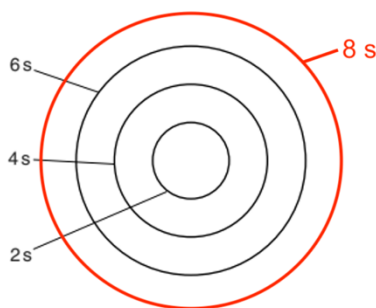


- a. On the figure, mark with a cross the point where the stones hit the water.
Clear cross/dot at center of the waves
- b. The figure below shows a section through the surface of the water before the stones land. On the figure below, sketch what the section of the surface might look like at the instant shown in the figure in part (a).



(Wave approximating to a “sine” wave, equal spacing, amplitude greater at center than at the ends, waves above and below equilibrium line)

- c. Later, the boy throws a single stone into the water. Figure below shows, from above, the position of the wavefront at 2 s, 4 s and 6 s after the stone landed.

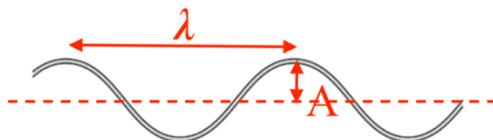


- i. From the figure, what can be deduced about the speed of the wave?
The speed is constant in all directions as the spacing between the wavefronts is the same.
- ii. On the figure, draw the wavefront 8 s after the stone landed.

KPI 1.2, 1.3, 1.5

2. A long rope, fixed at one end, is being used by a student to demonstrate transverse waves.

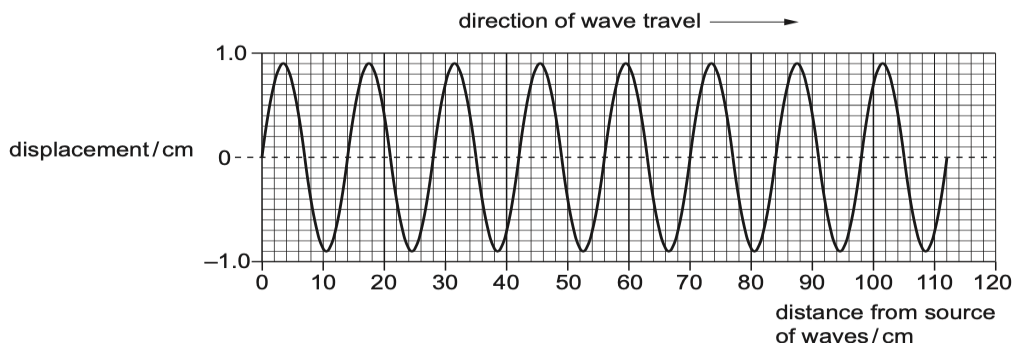
- a. State what the student does to the rope to produce the transverse wave.
shake end of rope (e.g. from side to side/up and down)
- b. The figure below shows a section of the rope when the transverse wave is present.



- i. On the figure, show a distance, labelled λ , corresponding to the wavelength of the wave,
distance from crest to crest / trough to trough / any 2 adjacent points in phase, labelled λ
- ii. distance, labelled A , corresponding to the amplitude of the wave.
distance from central horizontal line to peak or trough, labelled A
- iii. Suggest what the student could do to reduce the wavelength of the wave.
Increase the rate of shaking the end of the rope to increase its frequency/shake quickly.

KPI 1.3

3. The figure below represents a travelling wave at an instant in time.



- a. Determine the amplitude of the wave.

Amplitude = 0.9 cm

- b. Determine the wavelength of the wave.

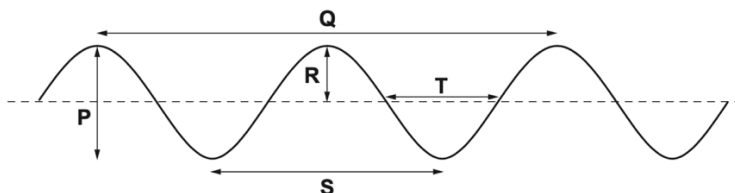
$$\text{Wavelength} = \frac{\text{Distance from the source}}{\text{number of waves}} = \frac{112}{8} = 14 \text{ cm}$$

- c. It takes 2.0 s for a source to emit the wave shown in the figure. Calculate the frequency of the wave.

$$\text{Frequency} = \frac{\text{Number of complete waves}}{\text{time taken}} = \frac{8}{2.0 \text{ s}} = 4 \text{ Hz}$$

KPI 1.3, 1.5, 1.6

4. The figure below shows a transverse wave.



- a. Give the label letter **P, Q, R, S** or **T** for the arrow which represents:

- i. the amplitude of the wave

Amplitude of wave = R

- ii. the wavelength of the wave.

Wavelength of wave = S

- b. A student stands next to a pond and observes water waves on its surface. She counts 12 complete waves passing a point in the pond in a time of 8.0 s. Calculate the frequency of the water waves.

$$\text{Frequency} = \text{number of complete waves per second: } f = \frac{12}{8} = 1.5 \text{ Hz}$$

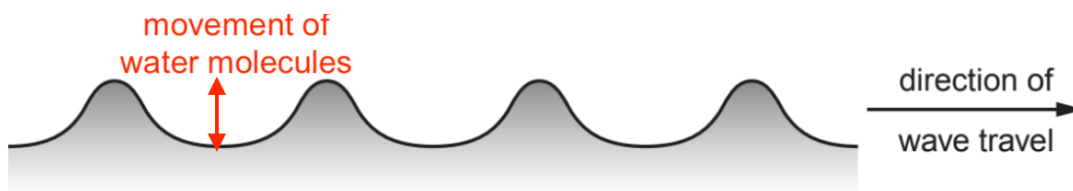
- c. The figure above shows a transverse wave. Describe the difference between transverse and longitudinal waves. You may draw a labelled diagram.

Vibrations OR oscillations in transverse waves are perpendicular/ at right angles to the direction of energy transfer/ wave travel.

In longitudinal waves are in same direction OR parallel to the direction of energy transfer/ wave travel.

KPI 1.2, 1.3

5. The figure below shows a section through a series of waves on water.



- On the figure above, mark clearly the direction in which the water molecules are moving.
Vertical movement clearly indicated.
- From Fig. above, measure the wavelength of the water wave.
2.5–2.7 cm
- The amplitude of the water waves is increased. State how the appearance of the water waves would differ from that shown in Fig. above.
The waves will be taller/ higher (can show on diagram)

KPI 1.4

6. A tsunami is a giant water wave. It may be caused by an earthquake below the ocean. Waves from a certain tsunami have a wavelength of $1.9 \times 10^5 \text{ m}$ and a speed of 240 m/s .

Calculate the frequency of the tsunami waves.

$$v = f\lambda$$

$$240 \text{ m/s} = f(1.9 \times 10^5 \text{ m})$$

$$f = 1.26 \times 10^{-3} \text{ Hz}$$

KPI 1.5, 1.6

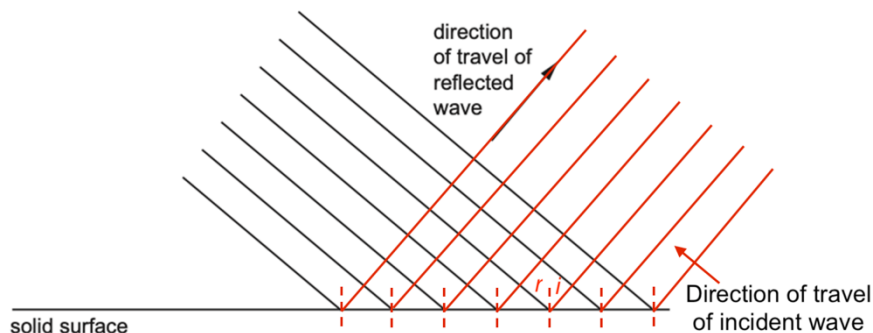
7. Waves are either transverse or longitudinal. Write either “transverse” or “longitudinal” in the space alongside each of the following descriptions.

Description	Type of wave
This type of wave has vibrations at right angles to the direction in which the wave energy is traveling	Transverse
This type of wave has vibrations along the direction in which the wave energy is traveling	Longitudinal
A sound wave is an example of this type of wave	Longitudinal
A ripple on the surface of water is an example of this type of wave	Transverse

KPI 1.4, 1.7

8. Figure below shows crests of a sound wave after reflection from a solid surface.

- a. On the figure, draw **three** crests of the incident wave.



Three wavefronts parallel to each other, with wavelengths same as reflected and the wavefronts at same angle to barrier as original.

- b. The wave has a wavelength of 36 cm and a speed of 1.2 m/s. Calculate the frequency of the wave.

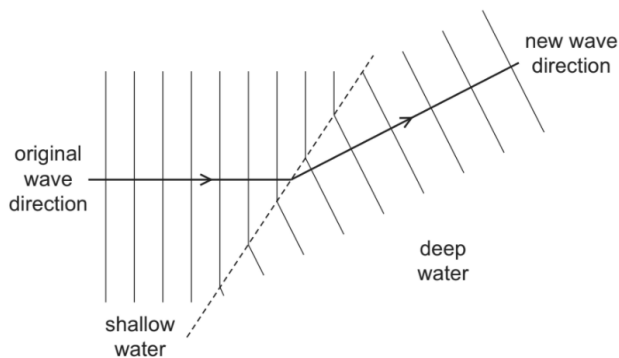
$$v = f\lambda$$

$$1.2 \text{ m/s} = f(0.36 \text{ m})$$

$$f = 3.3 \text{ Hz}$$

KPI 1.7

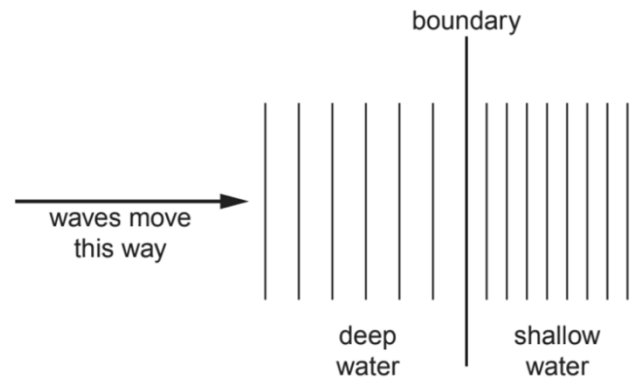
9. The figure below shows a water wave crossing a boundary from shallow water to deep water.



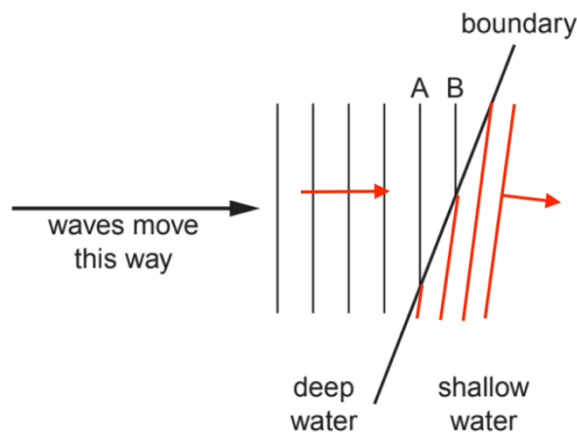
- a. Name the process that takes place at the boundary between the shallow water and the deep water.
Refraction
- b. Tick one box corresponding to the property of the wave that is the same in the shallow water as in the deep water.
- ☐ amplitude
 - ☒ **frequency**
 - ☐ speed
 - ☐ wavelength

KPI 1.4, 1.7

10. Some plane waves travel on the surface of water in a tank. They pass from a region of deep water into a region of shallow water. The figure shows what the waves look like from above.



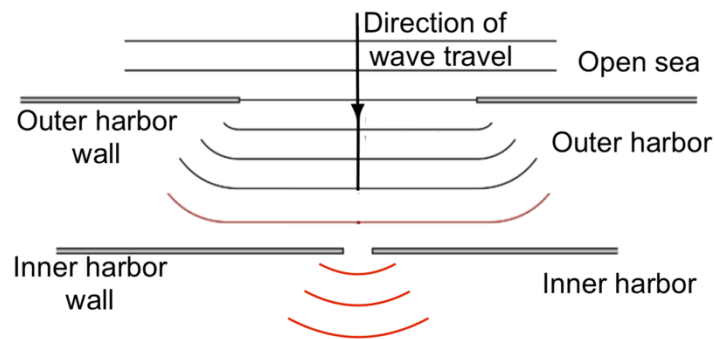
- a. State what happens at the boundary, if anything, to
 - i. the frequency of the waves,
same / unchanged / nothing
 - ii. the speed of the waves,
reduced / slows down
 - iii. the wavelength of the waves.
reduced
- b. The waves have a speed of 0.12 m/s in the deep water. Wave crests are 0.08 m apart in the deep water. Calculate the frequency of the source producing the waves. State the equation that you use.
 $v = f\lambda$
 $0.12 \text{ m/s} = f(0.08 \text{ m})$
 $f = 1.5 \text{ cycles/second}$
- c. The figure below shows identical waves moving towards the boundary at an angle.



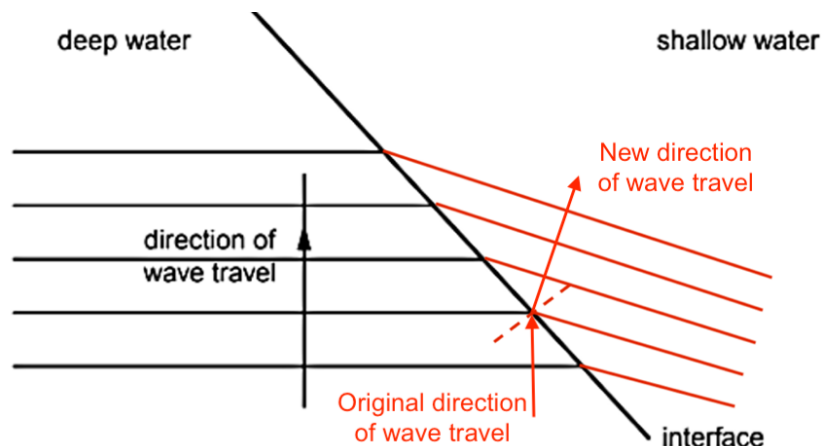
On the figure, draw carefully the remainder of waves A and B, plus the two previous waves which reached the shallow water. You will need to use your ruler to do this.

KPI 1.7, 1.8,

11. The figure below shows an aerial view of wavefronts passing from the open sea into an outer harbor.



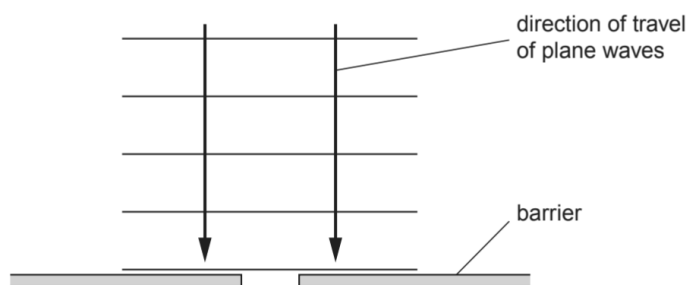
- The wavefronts in the outer harbor are curving at their ends. Name the process that is occurring at the entrance to the harbor.
Diffraction
- On the figure, carefully complete the wave pattern as the wavefronts progress through the outer harbor and into the inner harbor. Show the rest of the wave pattern in the outer harbor and three wavefronts in the inner harbor.
- The figure below shows an aerial view of wavefronts in deep water approaching a region of shallow water where they travel more slowly.



- Name the process that occurs as the wavefronts pass from deep to shallow water.
Refraction
- Complete the figure to show possible positions of the five wavefronts in the shallow water.
Parallel, straight waves joined onto original waves.
Straight waves, sloping down to the right OR with constant reduced λ .

KPI 1.4, 1.7, 1.8

12. The figure below shows a scale drawing of plane waves approaching a gap in a barrier.



- a. On the figure above, draw in the pattern of the waves after they have passed the gap.

On the diagram:

- Clear attempt at arcs of circles, at least 3
- Same wavelength as incoming waves, by eye
- Centre of curvature of arcs at center of gap, by eye

- b. The waves approaching the barrier have a wavelength of 2.5 cm and a speed of 20 cm/s. Calculate the frequency of the waves.

$$v = f\lambda$$

$$20 \text{ cm/s} = f(2.5 \text{ cm})$$

$$f = 8.0 \text{ waves/second}$$

- c. State the frequency of the diffracted waves.

Same as (b)