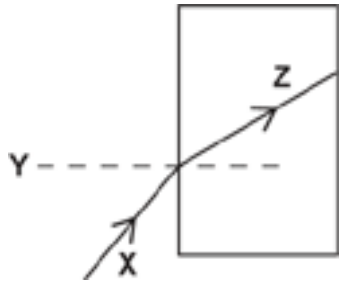
1(a). A student draws a ray diagram to show the refraction of a light ray through a glass block.



X is the incident ray. What are the names of line **Y** and line **Z**?

Y _____

Z _____ **[1]**

(b). A student does an experiment to investigate the reflection of light from a plane mirror.

The diagram shows the equipment the student uses

Describe how the student does the experiment.

In your answer include:

- how the student sets up the equipment
- what the student will measure
- a prediction of what the student will find out from their results.

You can draw a labelled diagram to support your answer.

[6]

2(a). Fig. 16.3 shows how ultrasound pulses can be used to find distances in water.

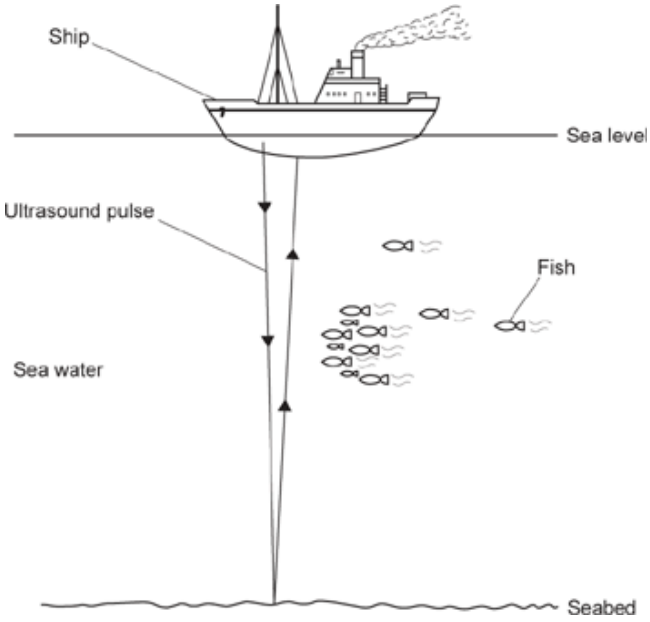


Fig. 16.3

i. Sometimes more than one echo is received by the ship from each ultrasound pulse.

Suggest why.

[1]

ii. An ultrasound pulse takes 0.60 s to travel to the seabed and back to the ship.
The speed of ultrasound in sea water is 1500 m / s.

Calculate the distance from the ship to the seabed.

Use the equation: distance travelled = speed × time

Distance to the seabed =.....m **[3]**

(b). A sound wave has a frequency of 500 Hz.

The speed of sound in air is 330 m / s.

Calculate the wavelength of the sound wave.

Use the equation: wave speed = frequency × wavelength

Wavelength =.....m **[3]**

(c). Fig. 16.1 shows a diagram of a sound wave travelling through air.

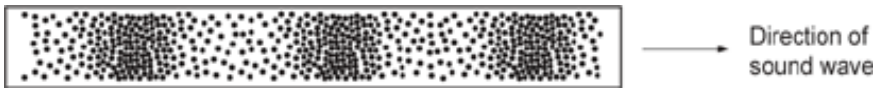


Fig. 16.1

The dots in the diagram represent air particles.

i. Which type of wave is a sound wave?

Put a (ring) around the correct answer.

electromagnetic **longitudinal** **radio** **transverse**

[1]

ii. **Fig. 16.2** shows four diagrams of the air particles after the sound wave has passed.

Which diagram is correct?

Tick (✓) **one** box.

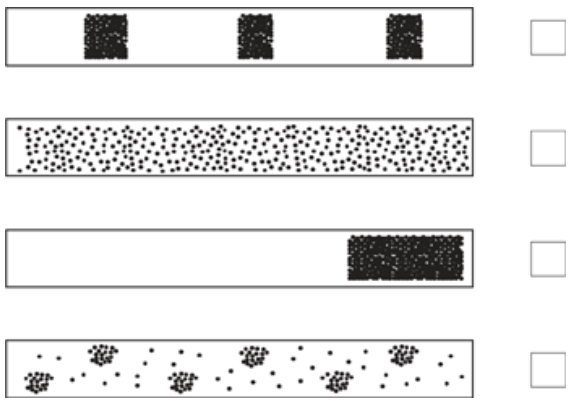


Fig. 16.2

[1]

(d). Complete the sentences to describe what happens to the properties of a sound wave as it travels **from** air **into** water.

Use words from the list.

decreases	**increases**	**stays the same**

The frequency of the sound wave _____

The velocity of the sound wave _____

The wavelength of the sound wave _____ **[2]**

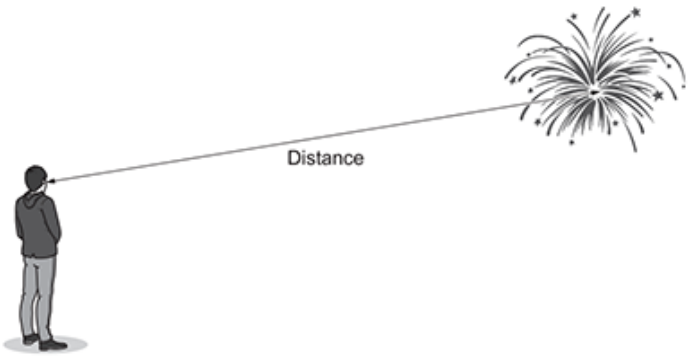
(e). The lists show two groups of words about waves: a **start** of a sentence and an **end** of a sentence.

Draw **one** line from each **start** of the sentence to the matching **end** of the sentence.

Start	End
Amplitude	is an electromagnetic wave.
Light	is the maximum displacement of a wave.
Wavelength	is the distance between one wave peak and the next wave peak.

[2]

3(a). A child is watching a firework display.



The speed of light in air is 3×10^8 m / s.

Explain why the child sees the firework **before** they hear it.

---

[1]

(b). Complete each sentence below about sound travelling through air.

Use the words from the list.

electromagnetic	**longitudinal**	**parallel**
perpendicular	**transverse**	

Sound waves are ..... .

The air particles vibrate ..... to the direction of travel of the wave.

[2]

(c). The child measures the time between seeing and hearing the firework.

The time they measure is 0.42 s.

The speed of sound in air is 330 m / s.

Calculate the distance from the child to the firework.

Give your answer to **2** significant figures.
Use the Data sheet_J249 01/02/03/04, June 2022.

Distance = ... m **[4]**

(d). Explain why the distance calculated above is not the actual distance.

[2]

4.

i. A sailor observes some water waves.

Six complete waves pass the sailor in **one** minute.

Calculate the time period for one wave in seconds.

Time period = ... s **[2]**

ii. A different water wave has a frequency of 0.2 Hz.

The wavelength of the wave is 20 m.

Calculate the speed of the wave.
Use the Data sheet_J249 01/02/03/04, June 2022.

Speed of the wave = ... m / s **[3]**

5. The diagram shows an ultrasound wave hitting a steel block.

What happens to the ultrasound wave?

A It is mainly absorbed.
B It is mainly reflected.
C It is completely refracted.
D It is completely transmitted.

Your answer ☐ **[1]**

END OF QUESTION PAPER