OCR GCSE GATEWAY PHYSICS A · J249

PHYSICS



EXAM QUESTION PACK

P5.1 WAVE BEHAVIOUR

SCORE	PERCENTAGE
/150	%

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Gateway Physics A (9-1)

Wave behaviour

Please note that you may see slight differences between this paper and the original.

Candidates answer on the Question paper.

OCR supplied materials:
Additional resources may be supplied with this paper.

Other materials required:
- Pencil
- Ruler (cm/mm)

Duration: Not set

Candidate forename		Candidate surname	

Centre number						Candidate number				

INSTRUCTIONS TO CANDIDATES

- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions, unless your teacher tells you otherwise.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Where space is provided below the question, please write your answer there.
- You may use additional paper, or a specific Answer sheet if one is provided, but you must clearly show your candidate number, centre number and question number(s).

INFORMATION FOR CANDIDATES

- The quality of written communication is assessed in questions marked with either a pencil or an asterisk. In History and Geography a *Quality of extended response* question is marked with an asterisk, while a pencil is used for questions in which *Spelling, punctuation and grammar and the use of specialist terminology* is assessed.
- The number of marks is given in brackets **[ ]** at the end of each question or part question.
- The total number of marks for this paper is **150**.
- The total number of marks may take into account some 'either/or' question choices.

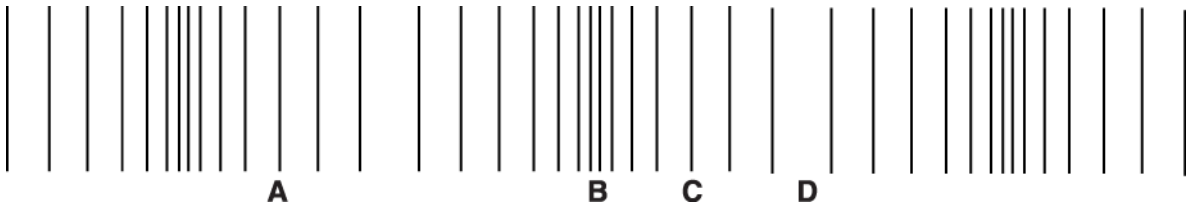
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1(a) Ultrasound is a longitudinal wave.

Look at the diagram of a longitudinal wave.



(i) Which letter **best** shows a compression?

Choose from

A B C D

answer _____

[1]

(ii) Write down the name of the distance between A and C.

_____ [1]

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(b) The frequency of an ultrasound wave is 25 000 Hz.

Can humans hear this ultrasound?

_____

Explain your answer.

---

[2]

2(a) Rene researches the range of sounds that different people can hear.

Rene's research shows that

'The average person has a hearing range from 20 Hz up to 20 000 Hz'.

Rene tests the hearing range of a group of people.
Look at the data she collects.

Person	Age	Lower frequency limit of hearing in Hz	Upper frequency limit of hearing in Hz	Frequency range of hearing in Hz
Jane	16	22	19000	18978
Alec	16	19	20000	19981
Dionne	16	24		
Niamh	16	16	21000	20984
Evangelos	16	15	20000	19985
average	16	19.2	19800	19780.8

(i) Rene's original research showed a lower frequency limit of human hearing of 20 Hz.
The data she collects shows an average lower frequency limit of 19.2 Hz.
Suggest reasons for this difference.

---

[3]

(ii) Rene has not completed her table. She has lost some of her results.
Calculate the upper frequency limit of hearing for Dionne.

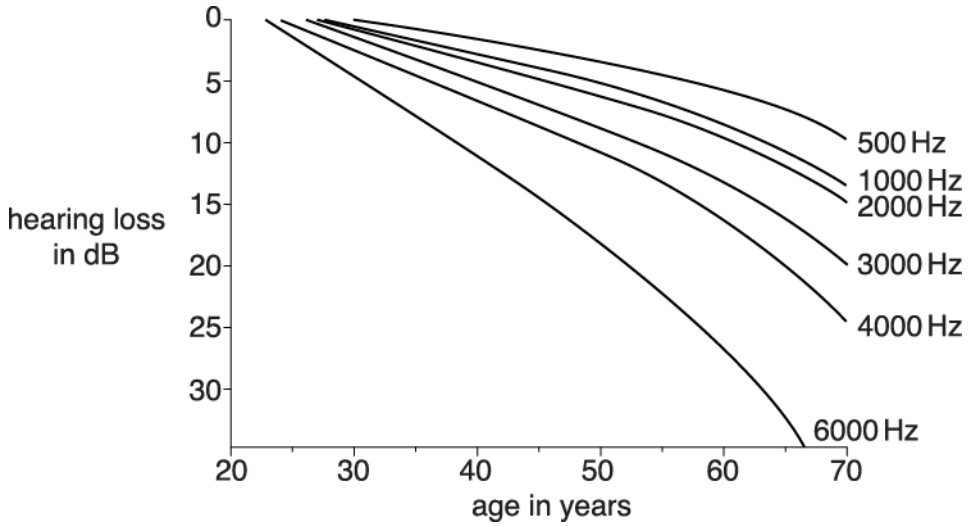
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answer _____ Hz

[2]

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(b) Look at the data on hearing level loss at different ages.
It shows the hearing loss in dB for different ages at six different frequencies.



(i) Describe the trends shown by the graph.

---

[2]

(ii) Scientists are developing hearing aids to help people hear high frequency sounds.
These hearing aids can detect sounds of frequency 6000 Hz and above and change them to sounds of half that frequency.

60 year olds can have difficulty hearing sounds above 6000 Hz.
Explain how these hearing aids can improve their hearing.
Use the data from the graph in your answer.

---

[3]

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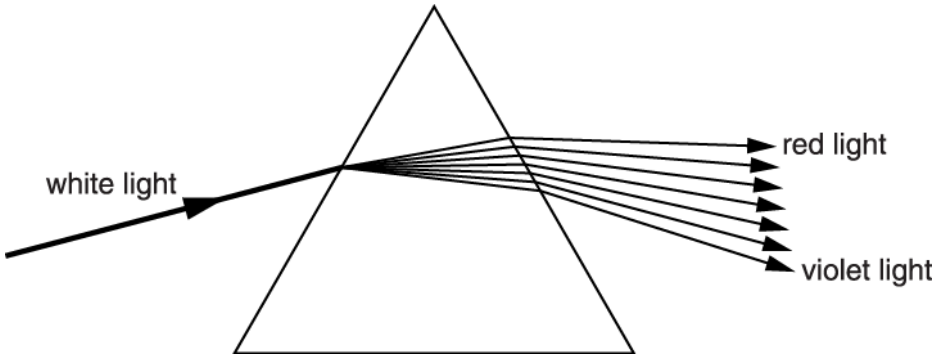
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3 Chantal does some experiments using light.

She shines a beam of white light through a prism.

Look at the diagram.



The white light disperses to produce a visible spectrum of colours.

Explain why the white light disperses and why the colours deviate by different amounts.

The quality of written communication will be assessed in your answer to this question.

[6]

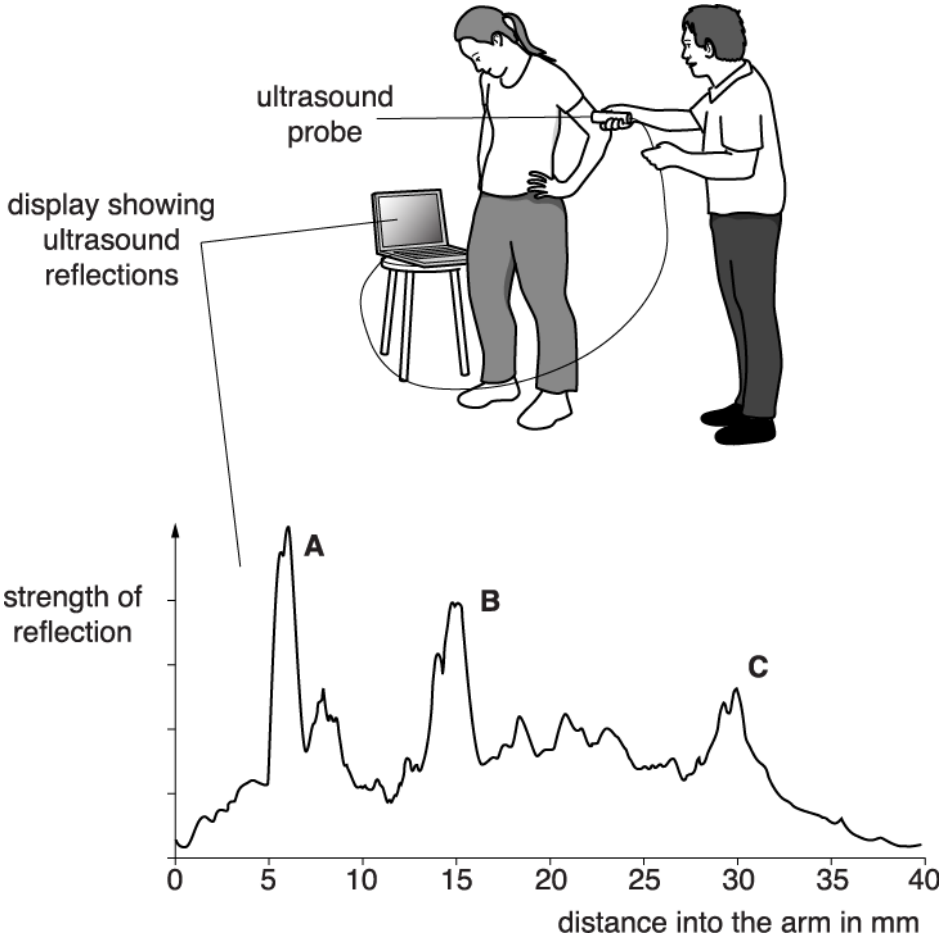
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4 Ultrasound can be used on humans.

Becky has her body fat measured using ultrasound on her arm.



Ultrasound reflects strongly at different tissue layers inside the arm.

The body fat layer is just below the skin.

The different tissue layers in the arm are

- fat-muscle layer
- muscle-muscle layer
- muscle-bone layer

Why is ultrasound used rather than surgery or X-rays to measure body fat?

Explain what the display shows and how it can be used to find the thickness of body fat in Becky's arm.

The quality of written communication will be assessed in your answer to this question.

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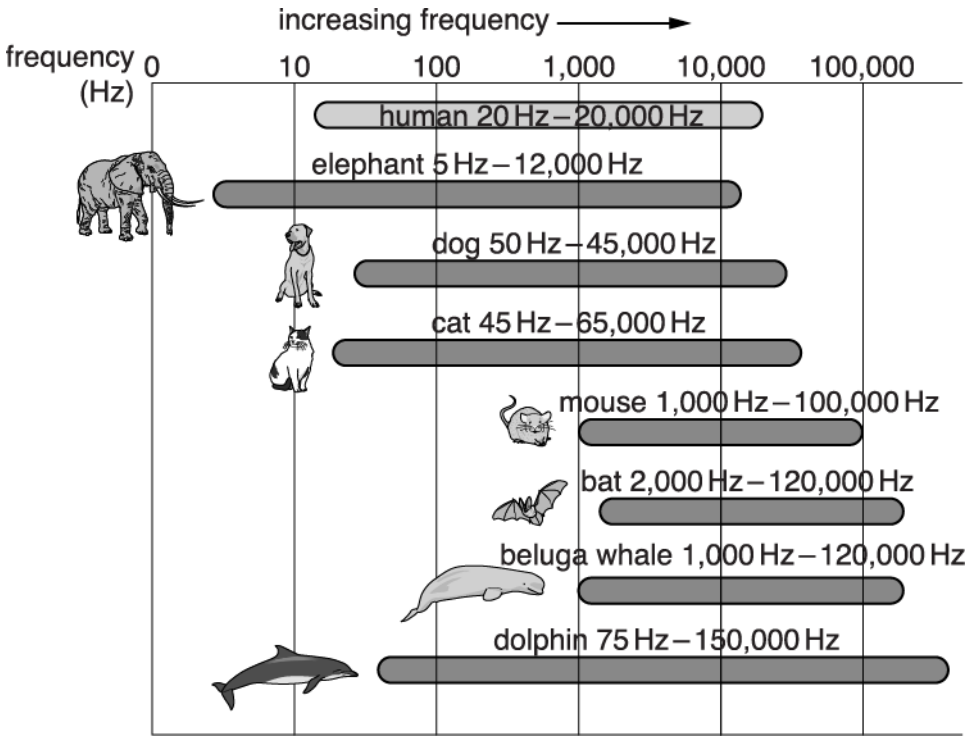
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[6]

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5(a) Rene researches the range of sounds that different animals can hear.
She finds the lowest and highest frequency sounds the animals can hear.

Look at some of her research data.



(i) Which animal can hear the **lowest** frequency?

---------- [1]

(ii) Which animal can hear the **highest** frequency?

---------- [1]

(iii) Which animal has the largest frequency **range** of hearing?

---------- [1]

(b) Rene's research shows that

'The average person has a hearing range from 20 Hz up to 20 000 Hz.'

Rene tests the hearing range of a group of people.

Look at the data she collects.

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Person	Lower frequency limit of hearing in Hz	Upper frequency limit of hearing in Hz	Frequency range of hearing in Hz
Jane	22	19000	18978
Alec	19	20000	19981
Dionne	24	20100	
Niamh	16	19800	19784
Evangelos	15	20000	19985
average	19.2		19760.8

Rene has not completed her table.

(i) Which person has the largest frequency **range** of hearing?

Explain your answer using a calculation.

---

[2]

(ii) Calculate the average upper frequency limit of hearing for this group of people.

---

answer _____ Hz

[2]

(iii) Rene's original research shows a lower frequency limit of human hearing of 20 Hz.

The data she collects shows an average lower frequency limit of 19.2 Hz.

Suggest reasons for this difference.

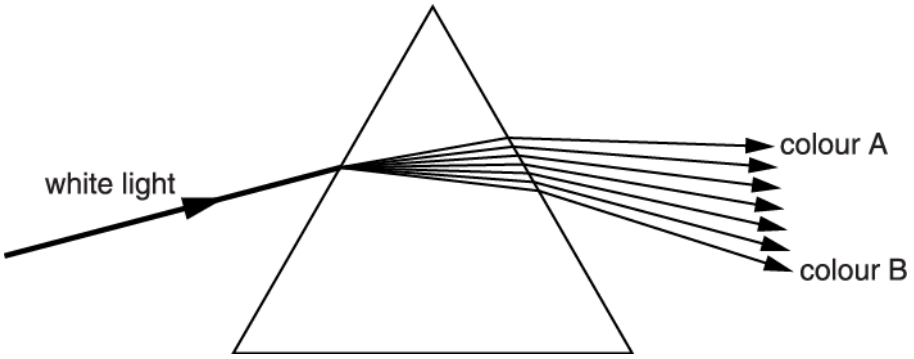
---

[3]

6

Chantal shines a beam of white light through a prism.

Look at the diagram.



Complete the sentences about the light.

Choose from

diffracts

frequency

green

amplitude

red

reflects

refracts

violet

wavelength

When the white light enters the prism it _____ and disperses into its seven colours.

Colour **A** is _____ .

Colour **B** has the smallest _____

[3]

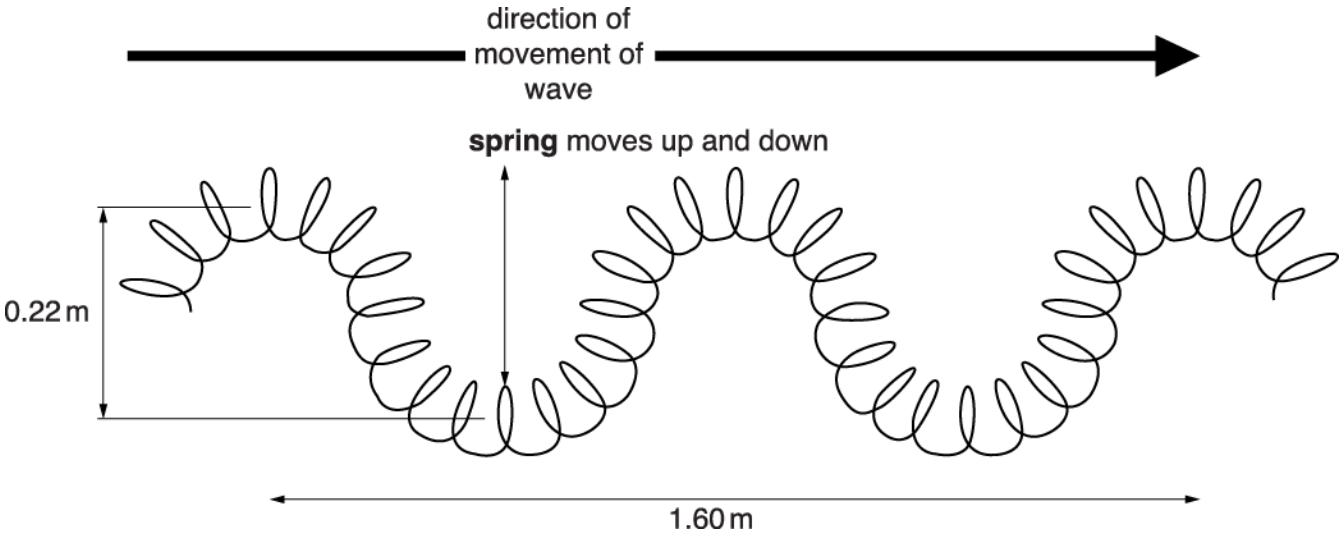
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7 P waves and S waves are different.

P waves are longitudinal and S waves are transverse. Look at the diagram of a model of a wave made with a slinky spring.



The wave is made by moving the spring up and down with a frequency of 1.2 Hz.

Look at the diagram.

(i) Calculate the **speed** of the wave.

---

answer _____ m/s

[2]

(ii) What is the **amplitude** of the wave?

Choose from

0.11 m **0.22 m** **0.80 m** **1.60 m** **1.82 m**

---

[1]

8(a) Loud sounds can be dangerous and can damage human hearing.

Look at the table about the loudness of different sounds.

Source	Sound	Loudness in dB
A	Busy road traffic	70
B	Front row at a music festival	110
C	Large orchestra	98
D	Aircraft at take off	145
E	Normal conversation	60
F	Rustling leaves	10
G	Vacuum cleaner	80
H	MP3 player at maximum volume	100

Sounds above 90 dB can damage hearing.

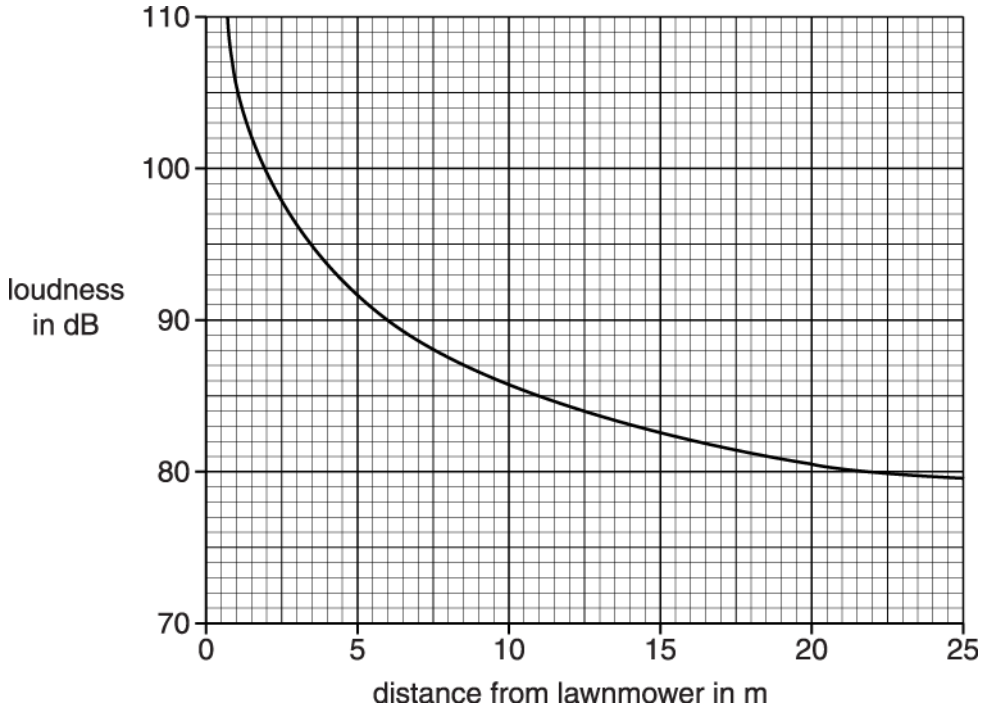
Which sources in the table are above 90 dB?

Choose from **A** **B** **B** **D** **E** **F** **G** **H**

answer _____ **[2]**

(b) Lawnmowers make loud sounds above the safe loudness level of 90 dB.

The graph shows how the loudness changes as you move away from a lawnmower.



(i) Describe how loudness is affected by distance.

---

[2]

(ii) Use the graph to find the loudness when you are 15 m away from the lawnmower.

_____ dB

[1]

(iii) A gardener needs to wear ear protection when using the lawnmower.

People in a house nearby do **not** need ear protection when he is using the lawnmower.

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Suggest reasons why the gardener needs to wear ear protection, but the people in the house do not.

---

[2]

(c) Sounds below 90 dB also can damage hearing if the sounds go on for a long time.

Look at the table on maximum safe exposure times.

Loudness in dB	Maximum safe exposure time
85	8 hours
88	
91	2 hours
94	1 hours
97	30 minutes
100	15 minutes
103	7.5 minutes
106	< 4 minutes

(i) Estimate the maximum safe exposure time for a loudness of 88 dB.

---

[1]

(ii) At 106 dB the maximum safe exposure time is < 4 minutes. What does this mean?

---

[1]

(iii) Ravi lives near a noisy factory.

The maximum safe exposure time to the sound from the factory is 32 hours.

Calculate the loudness of the sound from the factory.

---

[1]

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9 An infrared wave travels at 2.0×10^{8} m/s along an optical fibre.

The wavelength of the infrared wave is 9.0×10^{-7} m.

Calculate the frequency of the infrared wave.

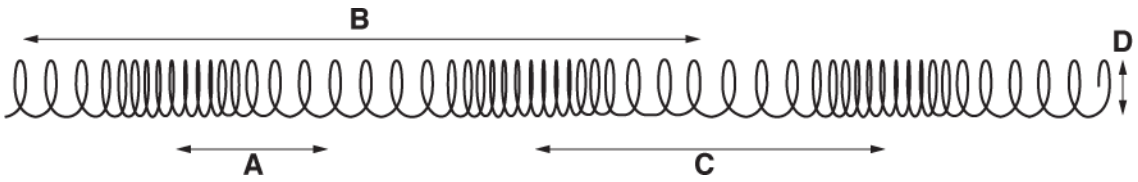
Give your answer to **two** significant figures.

Answer ---------- Hz **[3]**

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10 Ultrasound is a longitudinal wave.

Look at the longitudinal wave in a slinky spring.



(i) Which arrow shows the **wavelength** of this slinky spring?

Choose from **A** **B** **C** **D**

answer ---------- [1]

(ii) We can observe the wave moving in the slinky spring and calculate its frequency.

Why is it **not** possible to use this method to find the frequency of an ultrasound wave?

---

[1]

11 A water wave has a frequency of 5.0 Hz and a wavelength of 3.0 m.

Calculate the speed of the water wave.

Answer ---------- m / s [1]

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12 A student measures the time it takes for the sound from a firework to reach the observer.

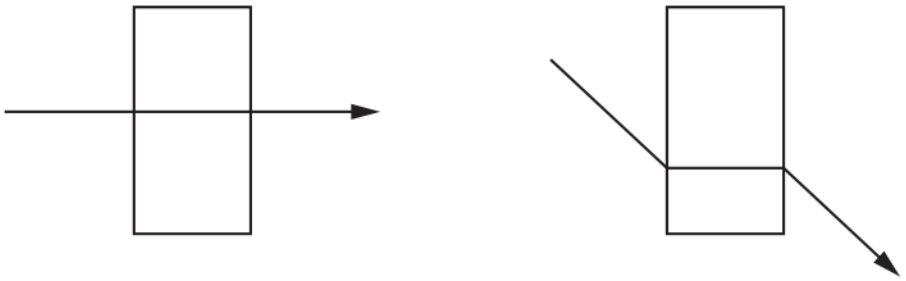
She takes 3 measurements of the time taken for four different distances, **A**, **B**, **C** and **D**.

Distance	Time taken (s)		
	1st measurement	2nd measurement	3rd measurement
A	2.16	2.19	2.17
B	1.99	2.02	1.97
C	1.80	1.81	1.89
D	1.69	1.68	1.71

Which distance **A**, **B**, **C** or **D**, has the largest range of values?

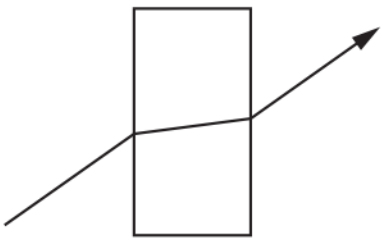
Your answer [ ] [1]

13 Look at the diagrams of a light ray as it passes from air through a glass block.

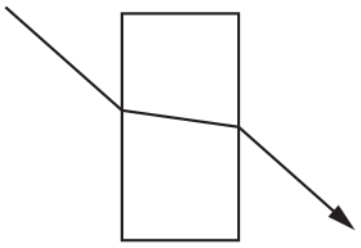


A

B



C



D

Which diagram shows an **incorrect** refraction?

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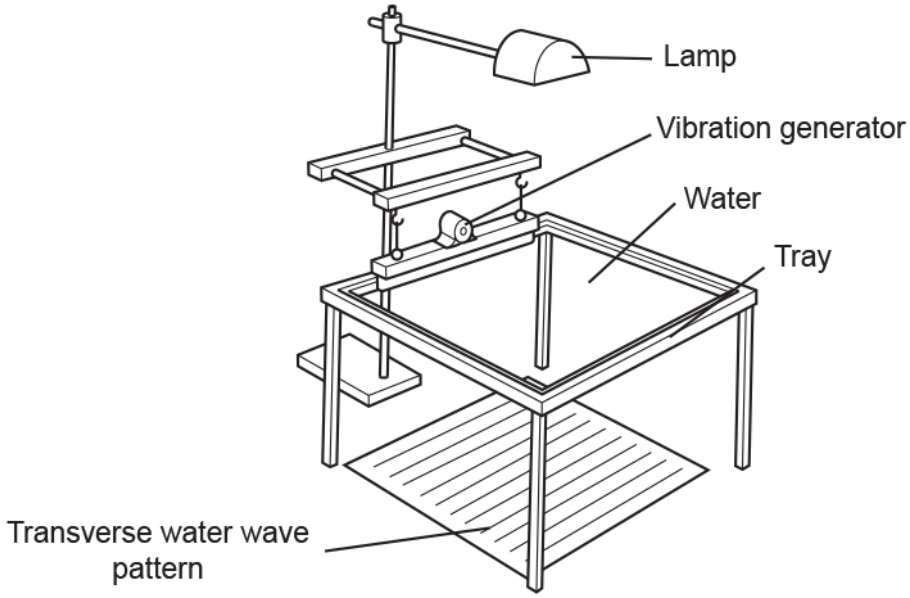
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Your answer 

[1]

14(a) A teacher uses water waves in a ripple tank to demonstrate **transverse** waves.



She makes measurements of the water waves.

The frequency of the water waves is 0.5 Hz.

(i) Calculate the number of water waves produced in 5 seconds.

Answer = ---------- [1]

(ii) The teacher **increases** the frequency of the water waves.

Describe what happens to the speed **and** the wavelength of the water waves.

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[2]

(iii) A student tries to describe water waves in the sea.

'The water waves move up and down. The water particles move all the way across the surface of the sea. This means that water moves in the direction of the waves.'

Part of his explanation is **incorrect**.

Write an improved and correct description about water waves in the sea.

[2]

(b) A student watches a ball game on the school field.

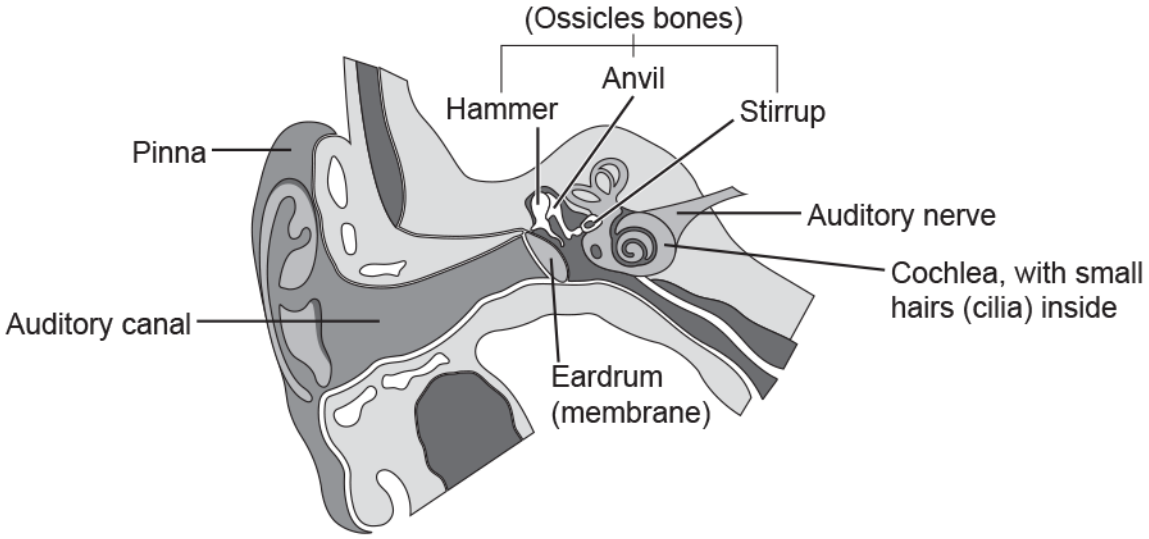
The student sees the ball being hit with a bat but he hears the sound a short time after. This is because the speed of light is much greater than the speed of sound.

Describe an experiment which measures the speed of **sound** in air. In your answer describe the measurements, calculations and procedures needed to gather **accurate** and **reliable** results.

You may draw a diagram as part of your answer.

[5]

(c) Look at the diagram of a human ear.



Sound wave disturbances, outside the ear, transfer energy to the small hairs (cilia) inside the cochlea.

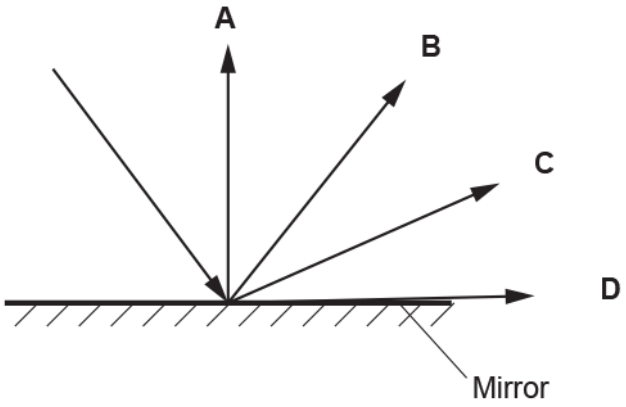
The cochlea then sends nerve impulses along the auditory nerve to the brain.

Explain how sound wave disturbances in the air outside the ear transfer to the small hairs (cilia) inside the cochlea.

---

[3]

15 Which light ray shows the correct reflection from the plane (flat) mirror?



Your answer ☐ [1]

16 A student measures the time it takes for the sound from a firework to reach the observer.

She takes 3 measurements of the time taken for four different distances, **A**, **B**, **C** and **D**.

Distance	Time taken (s)		
	1st measurement	2nd measurement	3rd measurement
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B	1.69	1.68	1.71

Which distance **A**, **B**, **C** or **D**, has the largest range of values?

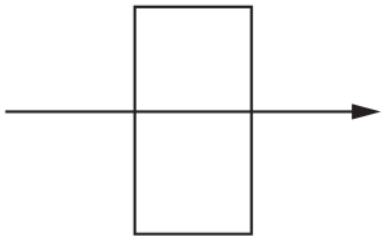
Your answer ☐ [1]

17 Look at the diagrams of a light ray as it passes from air through a glass block.

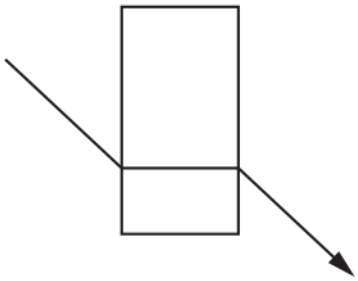
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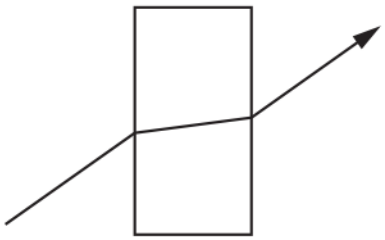
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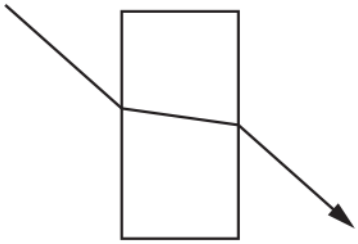
A



B



C

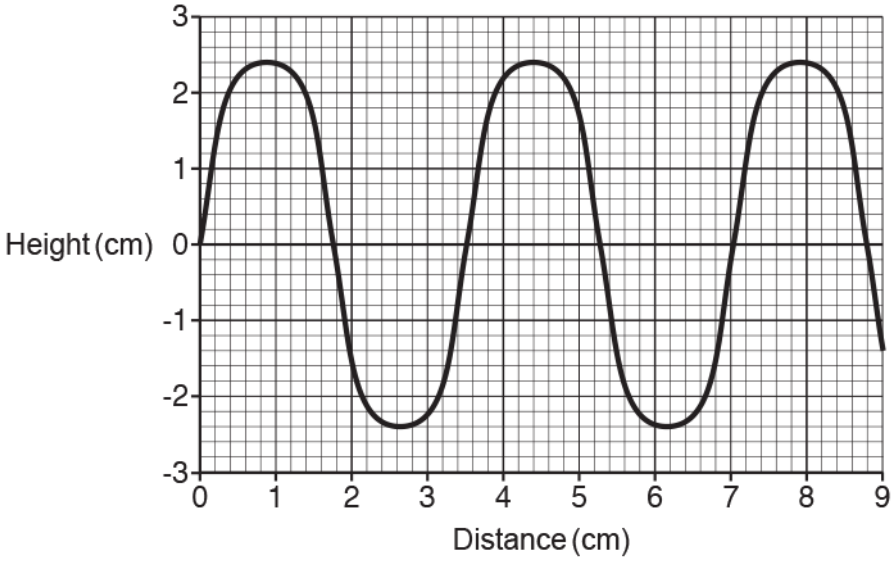


D

Which diagram shows an **incorrect** refraction?

Your answer [ ] [1]

18(a) Look at the diagram of a water wave.



(i) What is the **wavelength** of this wave?

Answer = _____ cm **[1]**

(ii) What is the **amplitude** of this wave?

Answer = _____ cm **[1]**

(iii) The wavelength of the wave is changed to 25 cm. Two waves are produced each second.

Use the equation: Wave speed = Frequency × Wavelength

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Calculate the speed of the wave.

Answer = ---------- m/s [2]

(b) Water waves are transverse and sound waves are longitudinal.

(i) Describe how water particles move in a **transverse** water wave.

---[1]

(ii) Describe how air particles move in a **longitudinal** sound wave.

---[1]

19(a) A student watches a ball game on the school field.

The student sees the ball being hit with a bat but he hears the sound a short time after. This is because the speed of light is greater than the speed of sound.

He decides to do an experiment to measure the speed of sound waves in air.

Describe which measurements he needs to measure this speed.

---[2]

(b) Which equation is used to calculate speed?

---

[1]

(c) Describe one way he could get valid results for this experiment.

---

[1]

20 **Fig. 20.1** shows thinking, braking and stopping distances for the same car travelling at different speeds.

Speed (m/s)	Thinking distance (m)	Braking distance (m)	Stopping distance (m)
8	6	6	12
16	12	24	36
32	24	96	120

Fig. 20.1

Describe how the **thinking distance** changes when the speed doubles.

Use data from the table in your answer.

---

[1]

21 A sound wave travels in air and enters water.

What happens to the sound wave as it enters the water?

	Speed	Frequency	Wavelength
A	decreases	decreases	decreases
B	decreases	stays the same	decreases
C	increases	increases	increases
D	increases	stays the same	increases

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Your answer  [1]

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22 An electromagnetic wave transfers energy.

Which row in the table is correct?

	Electromagnetic wave	Energy transfer
A	Infra-red	From a heating element of a toaster to the bread inside
B	Radio	From a radio to a transmitter
C	Gamma rays	From a high voltage supply to heating water in food
D	X-rays	From bones in the body to an X-ray machine

Your answer [ ] [1]

23 The table contains descriptions of wavelength and frequency.

Which row in the table is correct?

	Wavelength	Frequency
A	Distance between a peak and its neighbouring trough.	Number of waves that go past a point in a second.
B	Distance between neighbouring peaks.	Number of waves that go past a point in a second.
C	Distance between neighbouring troughs.	Time period in seconds.
D	Height of the wave.	Number of waves produced.

Your answer [ ] [1]

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24(a) A student investigates reflection and refraction of light rays.

The student sends a ray of red light into a glass prism.

Fig. 18.1 shows the light ray as it leaves the glass prism.

On **Fig. 18.1** complete the ray of light as it travels towards **and** through the glass prism.

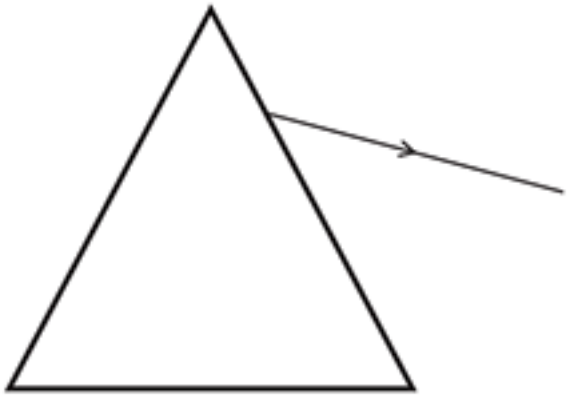


Fig. 18.1

[2]

(b) **Fig. 18.2** shows two mirrors placed at 90° to each other.

A light ray hits one of the mirrors at 45°.

On **Fig. 18.2** complete the ray of light as it reflects from both mirrors.

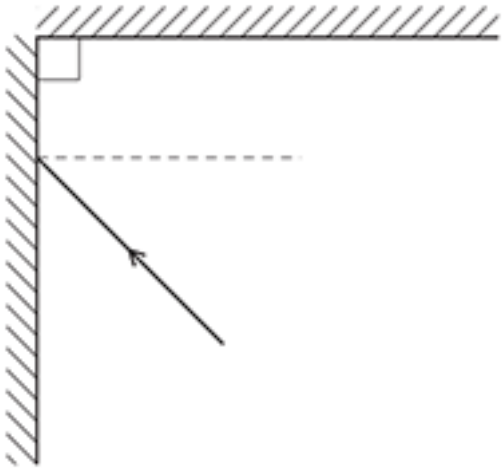


Fig. 18.2

[2]

25(a) Some students try to measure the speed of sound, as shown in **Fig. 24.1**.

One student makes a loud sound by clapping her hands.

The sound of the clap reflects from the gym wall causing an echo.

Another student measures the time between hearing the clap and hearing the echo.

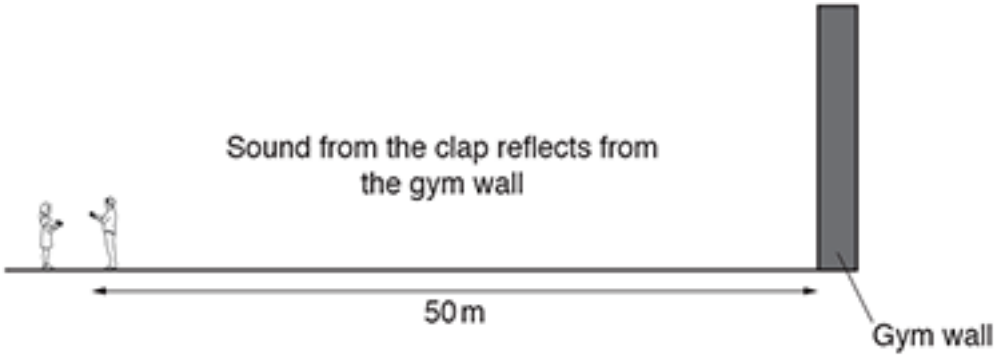


Fig. 24.1

They repeat the experiment three times and record their results in the table below.

Distance to wall (m)	Time 1 (s)	Time 2 (s)	Time 3 (s)	Mean time (s)
50	0.28	0.32	0.54	

(i) The student did not pay attention when recording **time 3**.

Calculate the **mean** time taken for the sound of the clap to return, using suitable values from the table.

Mean time taken = ... s **[1]**

(ii) Calculate the speed of sound for the clap.

Use your answer to **(i)** and the equation: distance travelled = speed × time

Give your answer to significant figures.

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Speed of sound = ... m / s **[4]**

(iii) Describe **two** ways to improve and develop their method.

1 _____

_____

2 _____

_____

[2]

(b) Ultrasound wave pulses are used by vets to scan inner tissues inside animals.

The ultrasound pulses partially reflect from different layers of tissue. These reflected wave pulses (echoes) are collected by the detector as shown in **Fig. 24.2**.

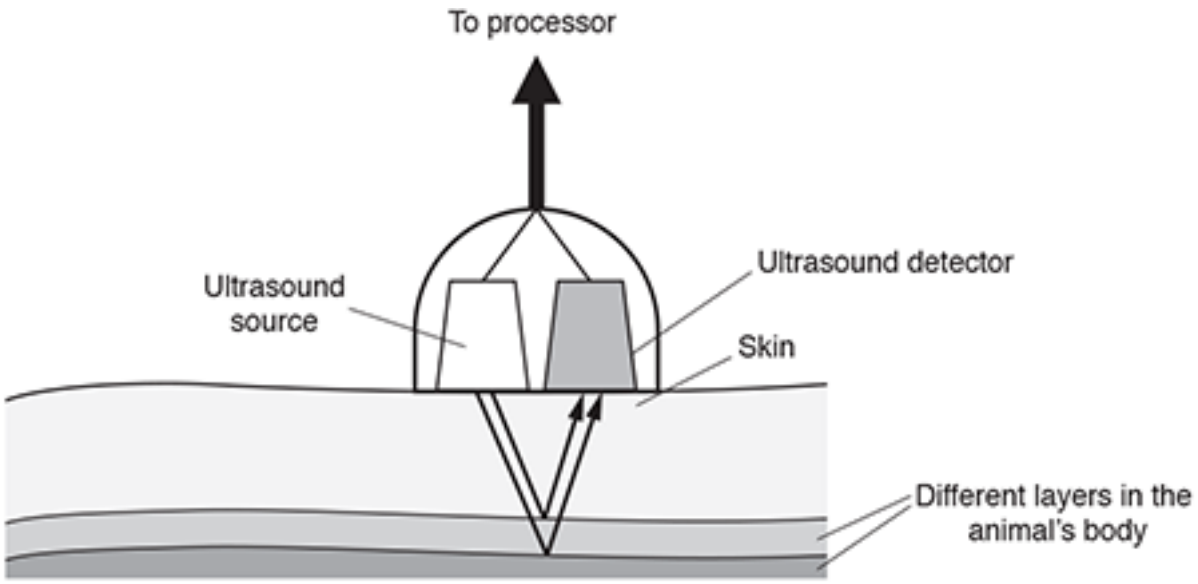


Fig. 24.2

In a scan using ultrasound pulses, three layers of tissue are detected, with each layer having a different thickness.

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Describe and explain how the results from the detector can show:

- that there are three layers
- that each layer has a different thickness.

[3]

26 A teacher measures the speed of water waves in a ripple tank.

What apparatus should she use?

A Ammeter and stopwatch

B Newton-meter and ruler

C Ruler and protractor

D Ruler and stopwatch

Your answer [ ] [1]

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27 Which statement is **true** for electromagnetic waves?

A High frequency electromagnetic waves have a long wavelength.

B High frequency electromagnetic waves have no wavelength.

C Low frequency electromagnetic waves have a long wavelength.

D Low frequency electromagnetic waves have a short wavelength.

Your answer [ ] [1]

28 A sound wave travels in air and enters water.

What happens to the sound wave as it enters the water?

	Speed	Frequency	Wavelength
A	decreases	decreases	decreases
B	decreases	stays the same	decreases
C	increases	increases	increases
D	increases	stays the same	increases

Your answer [ ] [1]

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29 An electromagnetic wave transfers energy.

Which row in the table is correct?

	Electromagnetic wave	Energy transfer
A	Infra-red	From a heating element of a toaster to the bread inside
B	Radio	From a radio to a transmitter
C	Gamma rays	From a high voltage supply to heating water in food
D	X-rays	From bones in the body to an X-ray machine

Your answer [ ] [1]

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30(a) **Fig. 20.1** is a graph of a wave.

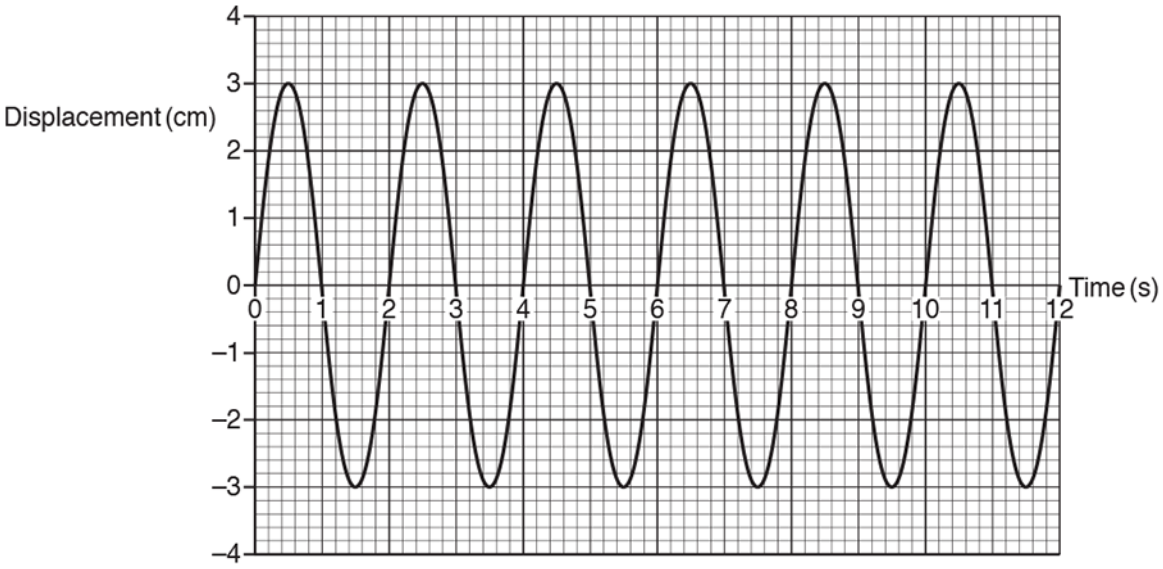


Fig. 20.1

(i) Use the graph in **Fig. 20.1** to work out the time period of the wave.

Time period of the wave = ... s **[1]**

(ii) Use the graph in **Fig. 20.1** to work out the amplitude of the wave.

Amplitude = ... cm **[1]**

(iii) The frequency of the wave in **Fig. 20.1** is 0.5 Hz.

What is meant by the term **frequency**?

---

[1]

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(b) A water wave has a frequency of 0.25 Hz and a wavelength of 6.0 m.

Calculate the speed of the wave.

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

(c) Surface water waves can be modelled using a slinky spring.

A student holds one end of the spring on a table. The other end is fixed to a wall.

Fig. 20.2 shows the spring **viewed from above the table.**

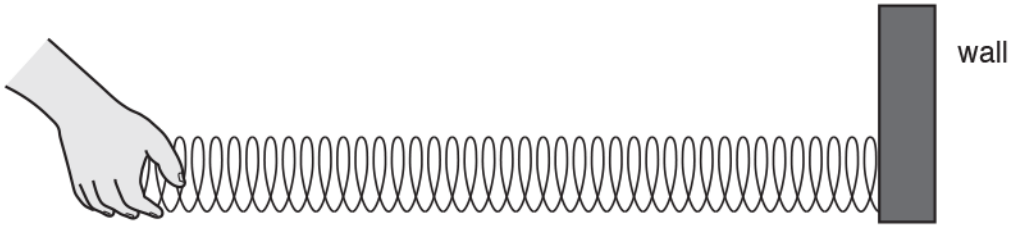


Fig. 20.2

(i) Draw two arrows **on the diagram** in **Fig. 20.2** to show the movement of the student's hand when he makes a **transverse** wave.

[1]

(ii) Describe what happens to the transverse wave at the wall.

---

[1]

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(iii) In **Fig. 20.3** the student stops moving his hand.

This is what the coils in the spring look like after a short time:

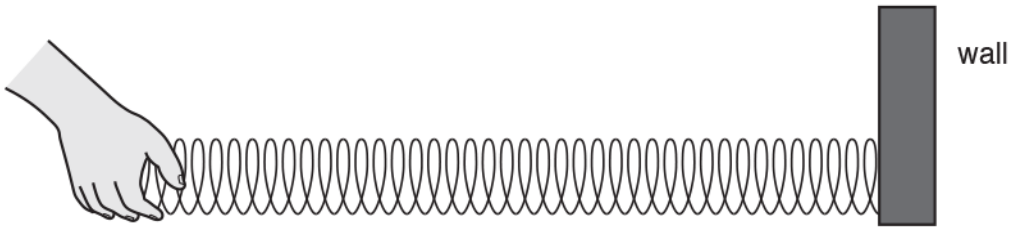


Fig. 20.3

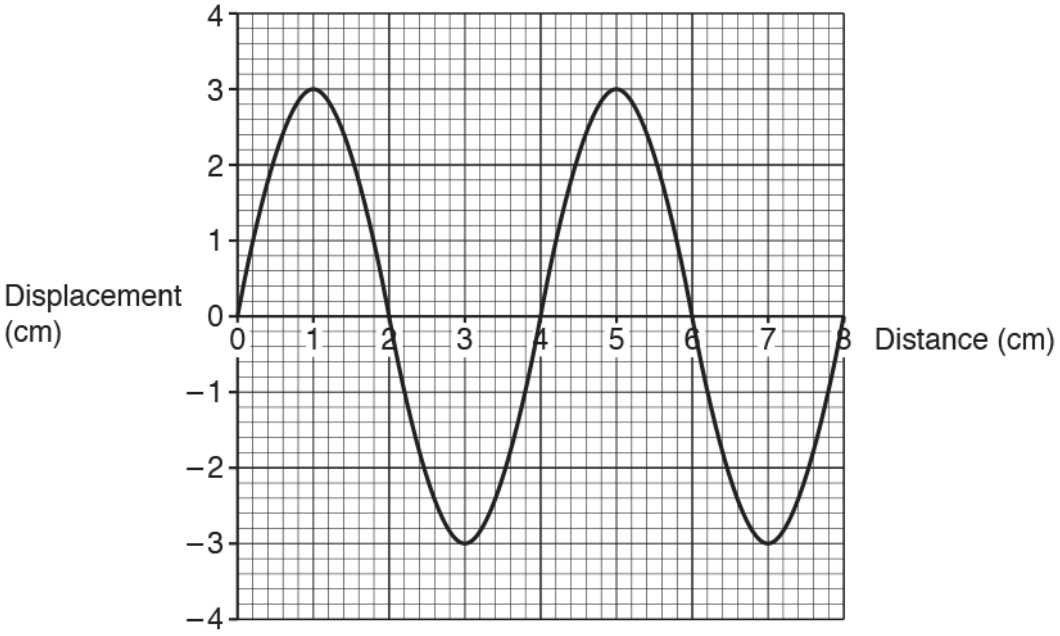
This model of a water wave shows that the wave travels **not** the water.

Explain why.

---

[1]

31 Look at the diagram of a wave.



What is the wavelength of the wave?

A 2 cm
B 3 cm
C 4 cm
D 6 cm

Your answer [ ] [1]

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32(a) Ripples are made on the surface of the water. The ripples can be used to model waves.

(i) State the type of wave modelled by the ripples.

[1]

(ii) Describe how the water molecules move as the wave travels across the pond.

[1]

(iii) 10 ripples hit the side of the pond in 20 seconds.

Calculate the frequency of the ripples.

Frequency = ... Hz **[2]**

(b) Student **A** and student **B** drop stones into a pond.

(i) Student **A** measures the frequency and wavelength of the water ripples. **Table 17.1** shows his results:

Frequency (Hz) of ripples	0.6
Wavelength (m) of ripples	0.1

Table 17.1

Calculate the wave speed of the ripples.

Use the equation: wave speed = frequency × wavelength

Wave speed = ...m / s **[2]**

(ii) Student **B** measures the same ripples as student **A**.

She measures:

- The distance one ripple travels.
- The time it takes the ripple to travel this distance.

Table 17.2 shows student **B**'s results:

Distance ripple travels (m)	2.40
Time taken (s)	30.0

Table 17.2

Name the equipment student **B** uses to measure the distance and time.

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Distance ----------

Time ----------

[2]

(iii) Use results in **Table 17.2** to calculate the wave speed of the ripples.

Wave speed = ...m / s **[1]**

(iv) Student **A** and student **B** obtained different answers for the wave speed of the ripples.

Suggest why.

---

[1]

33 The maximum frequency of sound that a person can hear changes as they get older.

Which row in the table explains this change?

	Maximum frequency of sound a person can hear	What part of the ear is damaged?
A	Decreases with age	Cochlea
B	Decreases with age	Eardrum
C	Increases with age	Cochlea
D	Increases with age	Eardrum

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Your answer 

[1]

34 Six wave peaks hit a wall in one minute.

Determine the frequency of the waves.

A 0.1 Hz
B 6 Hz
C 10 Hz
D 360 Hz

Your answer ☐ [1]

35(a) Ultrasound waves can be used to create an image of part of the inside of a body.

Ultrasound waves have a higher frequency than ripples on the surface of water.

Describe **another** difference between ultrasound waves and ripples on the surface of water.

Explain your answer.

---

[2]

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(b) The graph in **Fig. 19.1** shows how displacement of an ultrasound wave varies with distance.

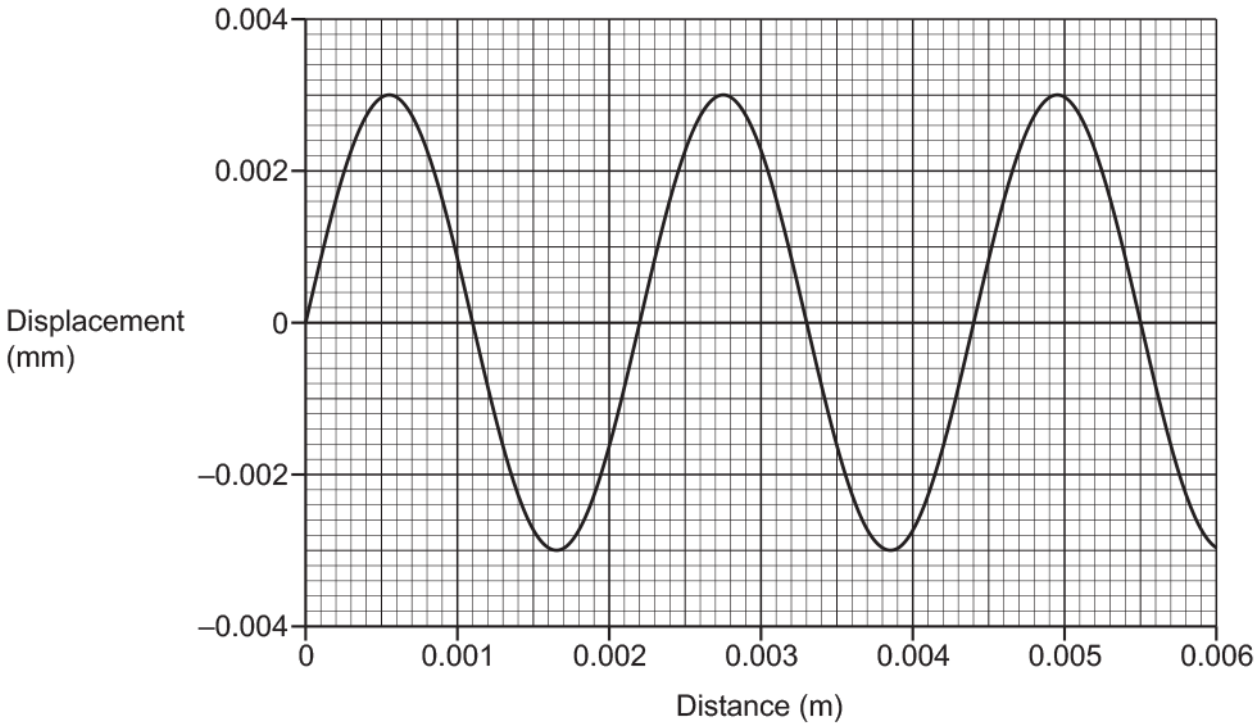


Fig. 19.1

(i) Use the graph in **Fig. 19.1** to determine the wavelength of an ultrasound wave.

Wavelength = ... m **[1]**

(ii) The speed of ultrasound waves in **(i)** is 4500 m / s.

Calculate the frequency of the ultrasound wave in **Fig. 19.1**.

Use the equation: wave speed = frequency × wavelength

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Give your answer in **standard form** and to **2** significant figures.

Frequency = ... Hz **[4]**

(c) Doctors can use an ultrasound scan to measure the size of a person's kidney.

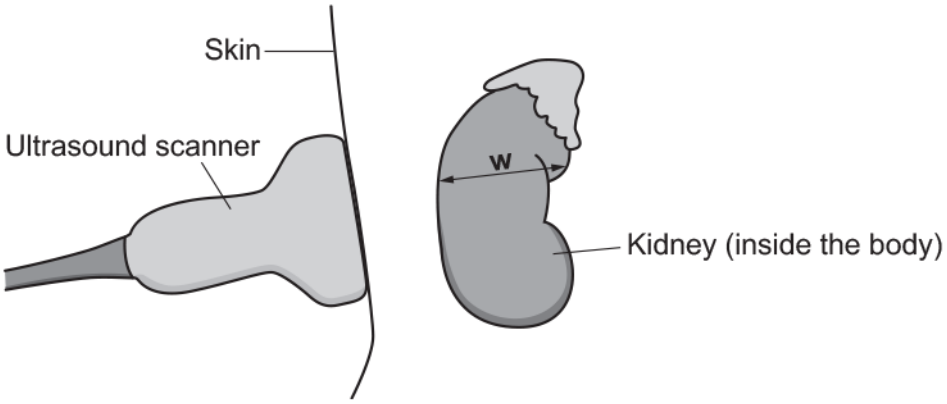


Fig. 19.2

Complete the sentences using the words below.

Each word may be used once, more than once, or not at all.

Increases **Decreases** **Stays the same**

The ultrasound scanner is made from a solid ceramic material.

As the wave enters the body, the speed ..... .

As the wave enters the body, the frequency ..... .

[2]

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(d)

(i) Explain what happens to the ultrasound wave when it reaches the kidney.

[2]

(ii) **Fig. 19.2** shows the thickness of the kidney, **w**.

Explain how ultrasound waves are used to measure **w**.

[2]

(e) A doctor uses an ultrasound scan instead of X-rays to measure the kidneys.

Explain why.

[1]

END OF QUESTION PAPER