1(a). Fig. 22.1 shows a ray of red light from a laser entering a rectangular glass block from the air.

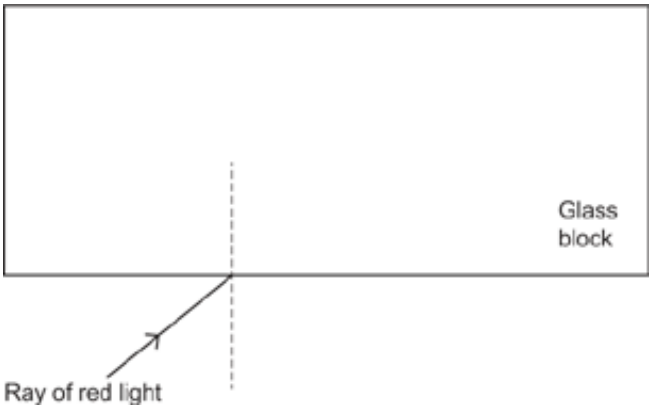


Fig. 22.1

When the red light enters the glass block from the air it will refract.

Draw the path of the refracted ray inside the glass block in **Fig. 22.1**.

[1]

(b). Explain why red light refracts as it enters the glass block.

[2]

2(a). Visible light and infrared radiation are transverse waves.

i. Describe the difference between visible light and infrared radiation using the words **frequency** and **wavelength**.

[2]

ii. Water waves are also transverse waves.

A scientist standing near the sea observes water waves moving past them.

Explain how the scientist can measure the **frequency** of the water waves.

[2]

(b). A green laser emits light with a wavelength of 5.32×10^{-7} m.

The speed of the green light is 3.0×10^{8} m / s.

Calculate the frequency of the laser light.

Use the Equation Sheet June June 2024, J249-01-02-03-04

Give your answer to **2** significant figures.

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

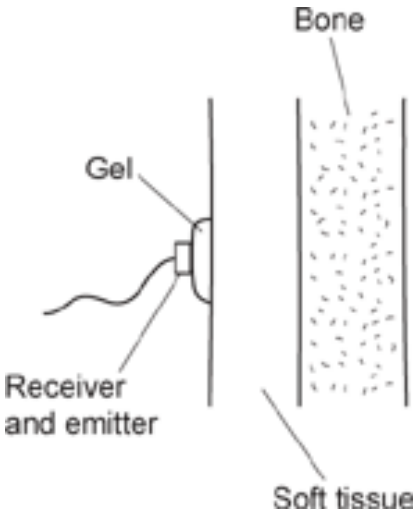
3. A radio wave has a frequency of 88 MHz.

What is 88 MHz converted to kHz?

A 0.088 kHz
B 88 000 kHz
C 88 000 000 kHz
D 88 000 000 000 kHz

Your answer ☐ **[1]**

4. The diagram shows a patient having an ultrasound scan.



The speed of ultrasound in soft tissue is 1500 m / s.

The echo from the boundary between the soft tissue and the bone is received 2.0×10^{-5} s after the ultrasound is emitted.

What is the thickness of the soft tissue?

Ignore the thickness of the gel.

Use the equation: distance travelled = speed × time

A 0.015 m
B 0.030 m
C 0.060 m
D 0.075 m

Your answer ☐ **[1]**

5. What causes the hearing range of humans to decrease as they age?

A Lower frequencies cannot be heard.
B The eardrum vibrates more quickly.
C The pinna gets smaller.
D The shorter hairs in the cochlea stop working first.

Your answer ☐ **[1]**

6. Ultrasound scans are used to take pictures of unborn babies.

Before the ultrasound scan, gel is placed on the skin.

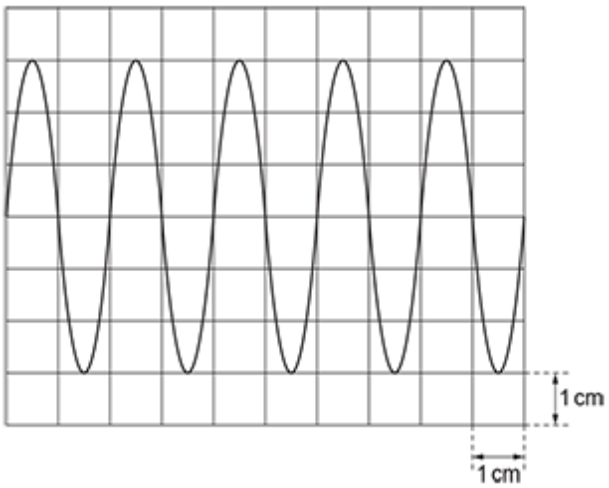
Which sentence explains why the scan **only** works when the gel is used?

A The gel amplifies the ultrasound waves.
B The gel lubricates the skin.
C The gel reflects the ultrasound waves.
D The gel transmits the ultrasound waves.

Your answer ☐ **[1]**

7. An oscilloscope is used to display a wave.

The diagram shows the screen of the oscilloscope.



The horizontal scale is 5 ms / cm.

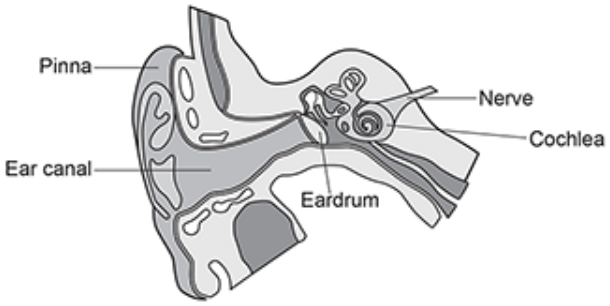
What is the time period of the wave?

A 5 ms
B 10 ms
C 15 ms
D 30 ms

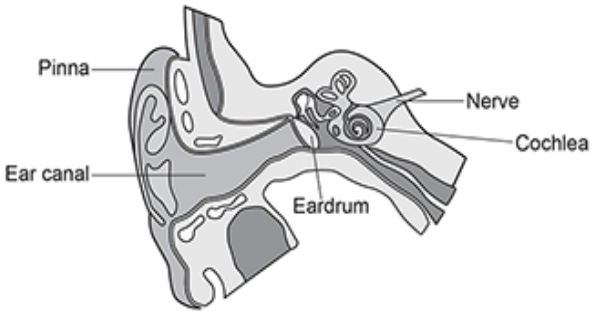
Your answer ☐ **[1]**

8. Which diagram shows the parts of the ear with the correct labels?

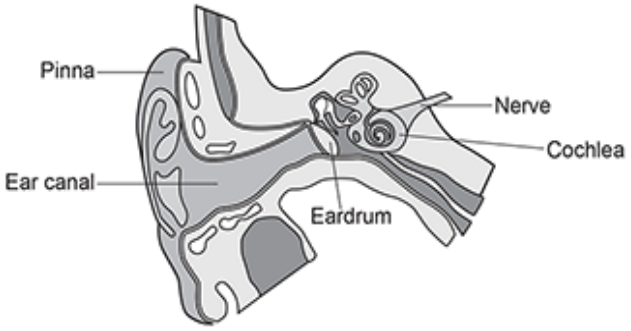
A



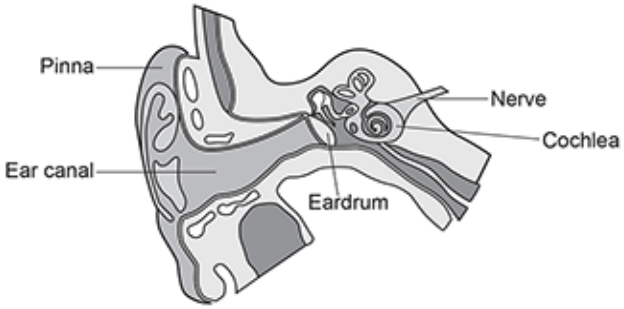
B



C

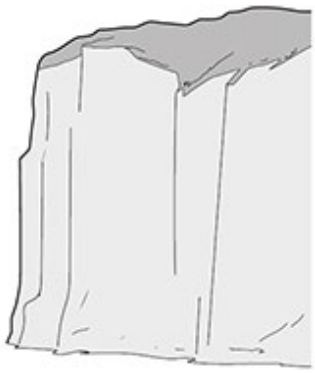


D



Your answer ☐ **[1]**

9(a). A student is trying to calculate how far away they are from a large cliff.



The student claps loudly once.

After a short time, they hear a second clap. The second clap is quieter.

i. Explain why they hear the second clap **and** why the second clap is quieter.

[2]

---

ii. The student measures the time between the first clap and the second clap.

The time taken is 1.40 s.
The speed of sound in air is 330 m / s.

Calculate the distance from the student to the cliff.
Use the Data Sheet.

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

iii. The student measures the time between the first and second clap with a stopwatch.
Suggest **two** reasons why the distance calculated in **(a)(ii)** is **not** accurate.

1 _____

2 _____

[2]

iv. Suggest how the experiment could be improved.

_____

[1]

(b). When the student claps, they hear the sound.

i. Describe how the sound travels from the student's hand to their ear.

_____

_____

_____

[2]

---

ii. Describe how the sound travels through the ear.

_____

_____

_____

[2]

(c). A student makes two different sounds, sound **A** and sound **B**.

	Frequency (Hz)
Sound **A**	600
Sound **B**	1200

Explain how the **wavelength** of sound **A** is different to the wavelength of sound **B**.

[2]

END OF QUESTION PAPER