

## COLLATED QUESTIONS: SOUND AND ULTRASOUND

### 2011(3): Ultrasound



In medical imaging, pulses of ultrasound between 2 MHz and 10 MHz are produced, and the returning echoes are detected by the ultrasound transducer. The echoes from tissue boundaries are picked up by the transducer, and interpreted by a computer to produce an image. Discuss how ultrasound imaging produces a clear image of a chosen object.

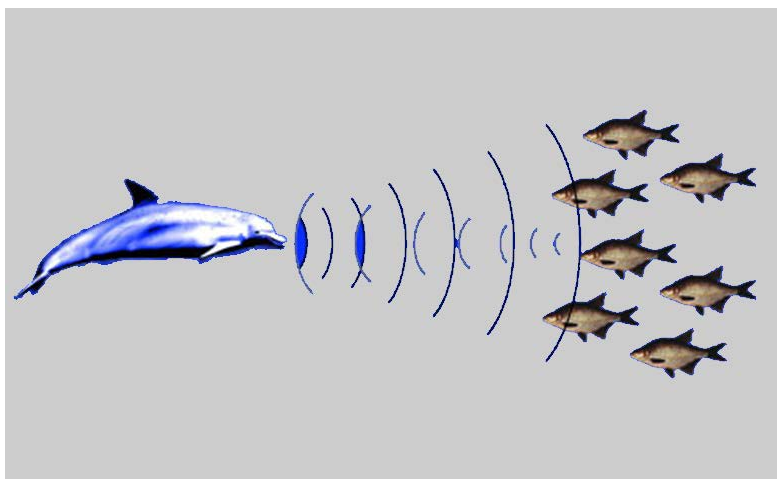
Your answer should include:

- why a **gel** is used between the transducer and the skin
- why **pulses** of ultrasound are used, rather than a continuous wave
- how **echoes** from different tissue boundaries would give information about the object being imaged
- how changing the wave frequency will affect the clarity of the image.

*A diagram may assist your answer.*

### 2010(3): Echo Location

Dolphins emit high pitched, low energy clicking sounds to detect the size and location of an object hundreds of metres away. The peak frequency of the echolocation clicks is 100 kHz and they have a wavelength of 0.015 m.



How long from when it produced a click, would it take for the dolphin to hear the echo, if the target was 130 m away? Show all working.

### 2010(4): Animal signals

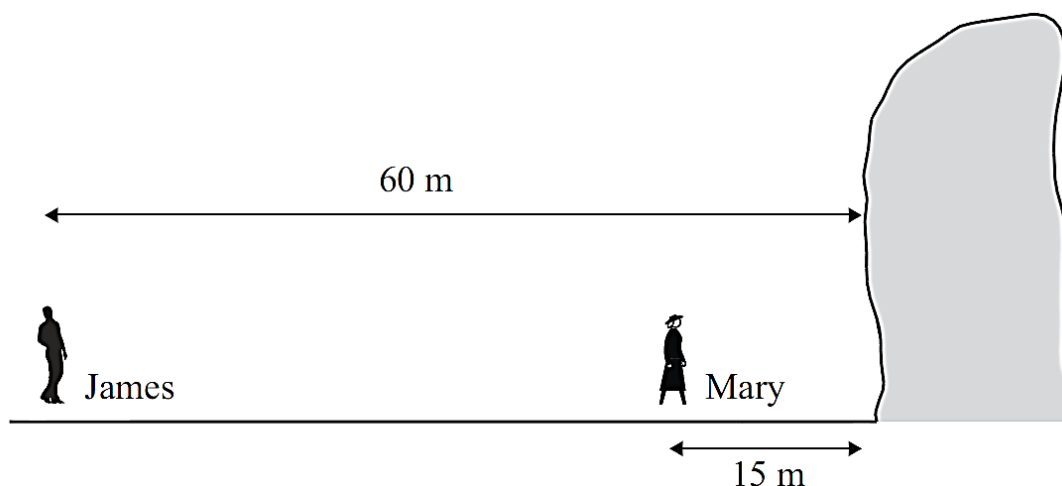
Discuss the advantages and disadvantages of animals hunting for food using high frequency, low energy ultrasound in echolocation, in comparison to low frequency, high energy audible sound.

Your answer should include:

- Relative energy of each type of signal
- Interference
- Diffraction
- The relative transmission of each type of signal through the medium.

### 2009(4): Sound

- (a) James and Mary stand near a cliff face as shown below. When James shouts, he hears his shout echo. When Mary shouts, she doesn't hear her shout echo. The human ear can only distinguish between sounds more than 0.1 seconds apart.

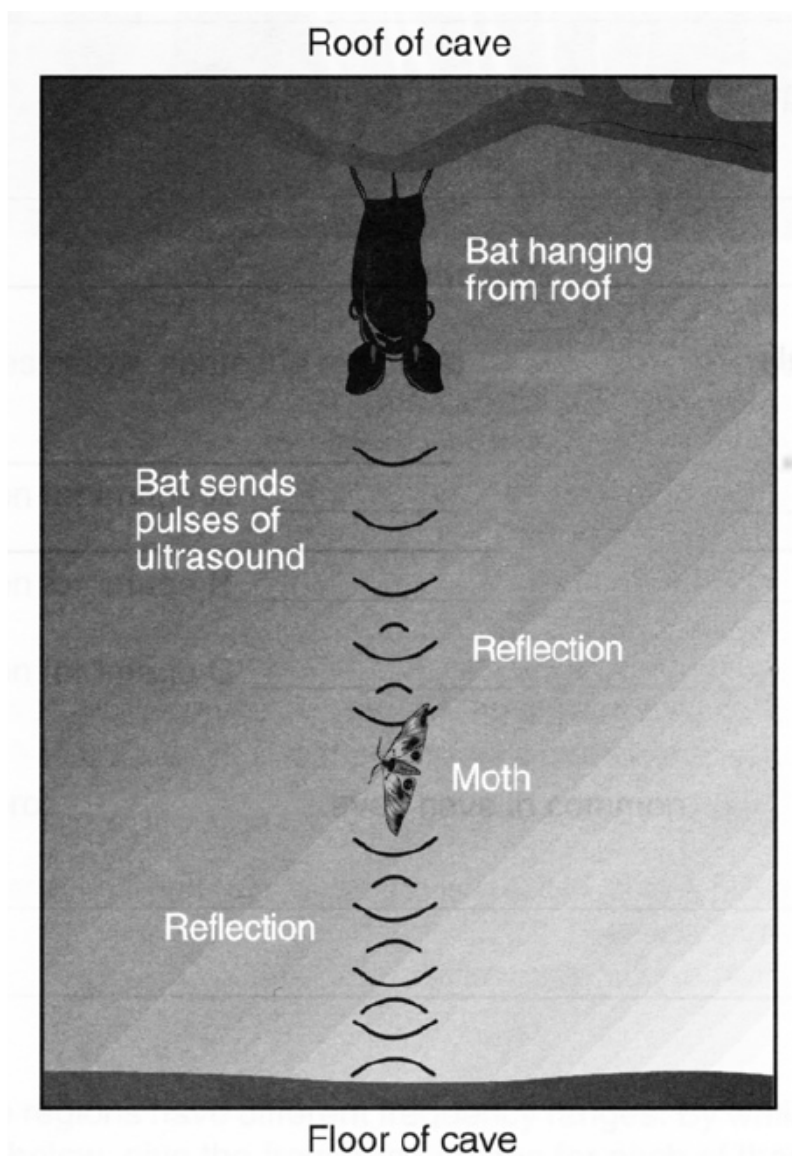


Explain the difference between what James hears and what Mary hears. Include the following in your answer:

- For each person; a calculation of the time from their shout until the echo returns to them (assume the speed of sound to be  $330 \text{ ms}^{-1}$ )
  - An explanation of why James hears his shout echo but Mary does not hear hers.
- (b) A teacher noticed that the cooking room with steel benches and hard polished floor is very noisy whereas the office next door is relatively quiet. The office has carpet on the floor and cork board all around the walls. Discuss why the cooking room is noisier than the office in relation to:
- Absorption
  - Reflection

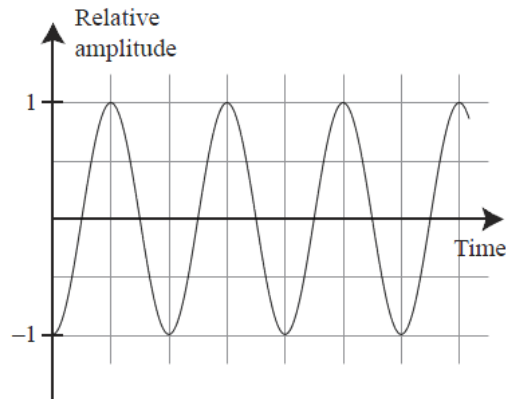
## 2008(2): Sound and Ultrasound

Long-tailed bats use echolocation by producing a series of ultrasonic pulses. These pulses reflect from objects and the echoes are detected when they return to the bats' ears. The time taken for the echo to return to the bat indicates the distance from the object. The most common wavelength of ultrasound used by these bats is 0.008 m.



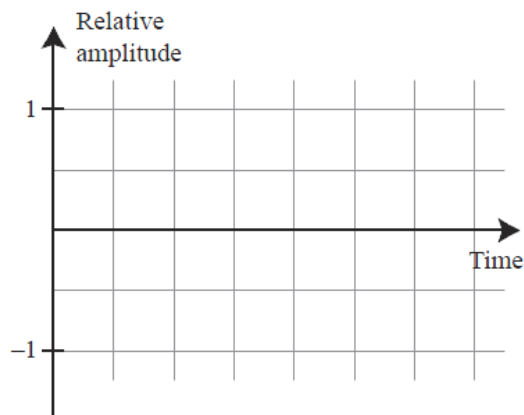
- Calculate the frequency, in hertz, of the most common wave produced by these bats. The speed of sound in air is  $330 \text{ ms}^{-1}$ .
- Sound travels as a longitudinal wave. Describe the movement of the particles in a longitudinal wave. A diagram may assist your answer.
- The floor of the cave is 20 m below the bat. How long would it take for the sound wave to return to the bat's ears once it has been produced? Give your answer to an appropriate number of significant figures. Give an appropriate unit with your answer.

Bats can use echo location to identify the difference between solid objects and soft objects such as moths. The following graph shows the relative amplitude of the pulse sent by the bat.

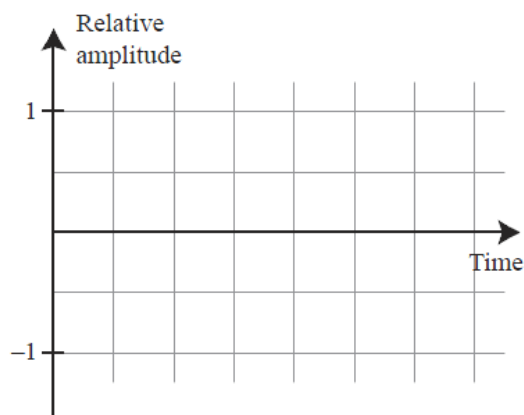


(d) On the grids below sketch a graph showing the possible reflected waves (echoes) received by the same bat from:

(i) The smooth floor of a cave



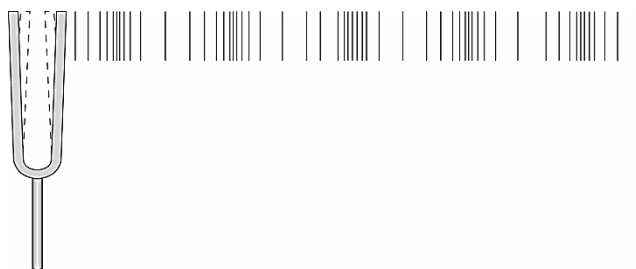
(ii) A moth.



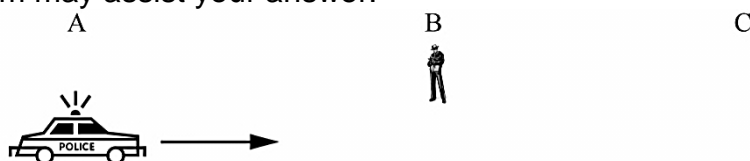
Discuss reasons for any changes the bat would observe in the echo from the moth if the moth was flying directly towards the bat.

## 2007(1): SOUND AND ULTRASOUND

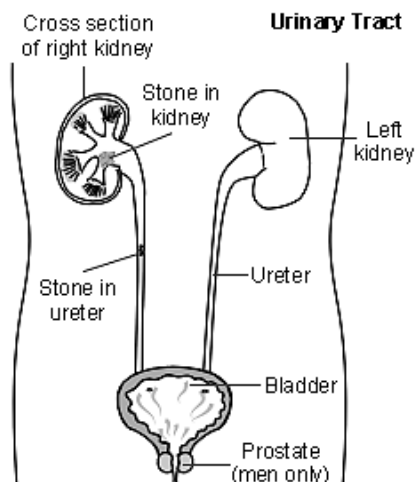
The diagram below shows how sound waves from a tuning fork are transmitted through the air. Each of the lines represents a layer of air and its position at one moment in time.



- (a) On the diagram above clearly **label H** to show one area of high pressure, and **L** to show one area of low pressure.
- (b) (i) The tuning fork above produces a note with a frequency of 215 Hz and a wavelength of 1.5 m. Calculate the speed of the wave shown (show your working and give an appropriate unit with your answer).  
 (ii) Describe the effect that a **longer** tuning fork would have on the frequency of the sound wave produced.
- (c) A police car with its siren sounding travels from point A to point C, as shown below. A person standing at point B notices a change in the **pitch** of the siren as the car passes. Discuss what happens to the pitch, and give reasons for the pitch change as the car travels from A to C. A diagram may assist your answer.



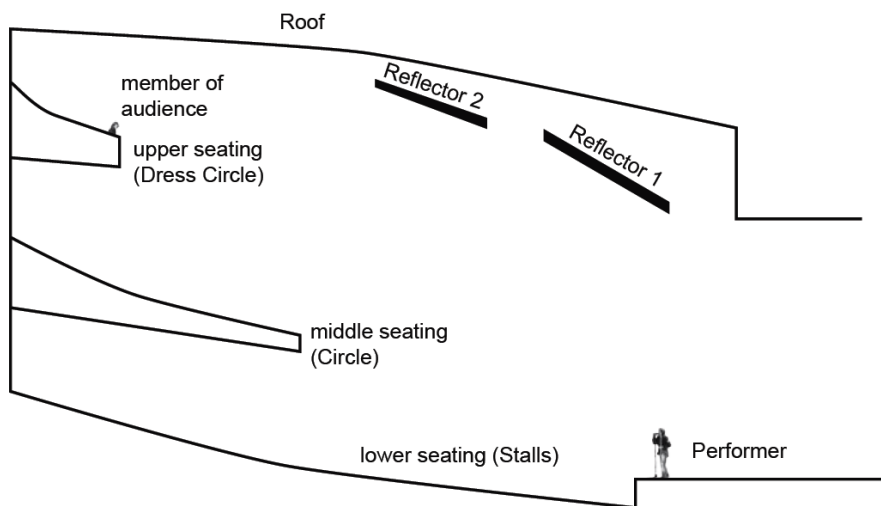
- (d) As the police car moves past point C, the **loudness of the siren** heard by the person at point B reduces. Explain why this happens.
- (e) Kidney stones are hard lumps of calcium salts that can form in the kidneys, causing pain. One application of ultrasound is to take pictures of human kidneys to see if any kidney stones are present. Ultrasound scanning is a technique which uses a scanner to both transmit and detect ultrasound. The following diagram shows where kidney stones can be found in the human body.



Explain how ultrasound waves are able to show the difference between kidney stones and kidney tissue.

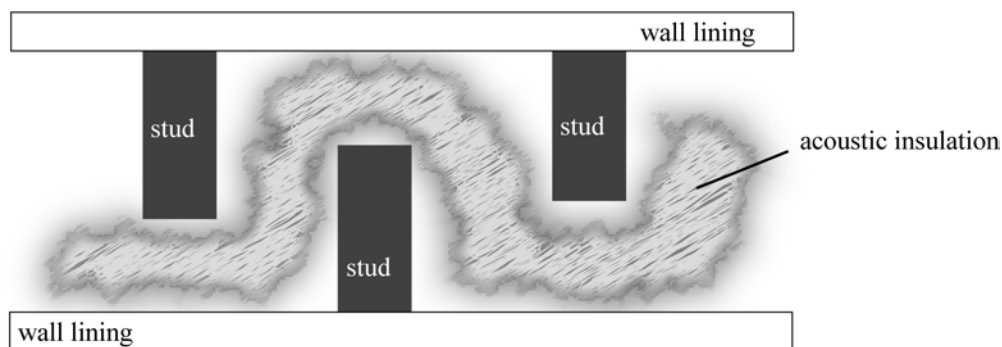
## 2006(4): SOUND AND ULTRASOUND

- (a) While standing inside an empty concert hall with smooth hard walls, a science student notices that the sound of a single clap takes several seconds to die away. Discuss why the sound takes several seconds to die away.
- (b) The diagram below is a side view of a concert hall showing some of the features which enable the sound to be projected to the different seating areas in the auditorium.



- (i) Explain which seating area of the concert hall Reflector 2 is designed to reflect sound into. Draw the path taken by sound waves onto the diagram above to assist your answer.
- (ii) A member of the audience is seated 40 m in a direct line from the performer. The speed of sound through the air is  $330 \text{ ms}^{-1}$ . Calculate how long the sound takes to travel directly through the air from the performer to the audience member. Show all working.
- (c) A recording booth is built beside the concert hall. The walls of the recording booth have been designed to make them as sound-proof as possible. The diagram below shows the structure of the recording booth's walls.

Wall (view from above)



Discuss why the **wall structures** help to keep the recording booth sound-proofed. Refer to the properties of **sound waves** in your answer.

### 2005(3): SOUND AND ULTRASOUND

Sound waves are an example of longitudinal waves.

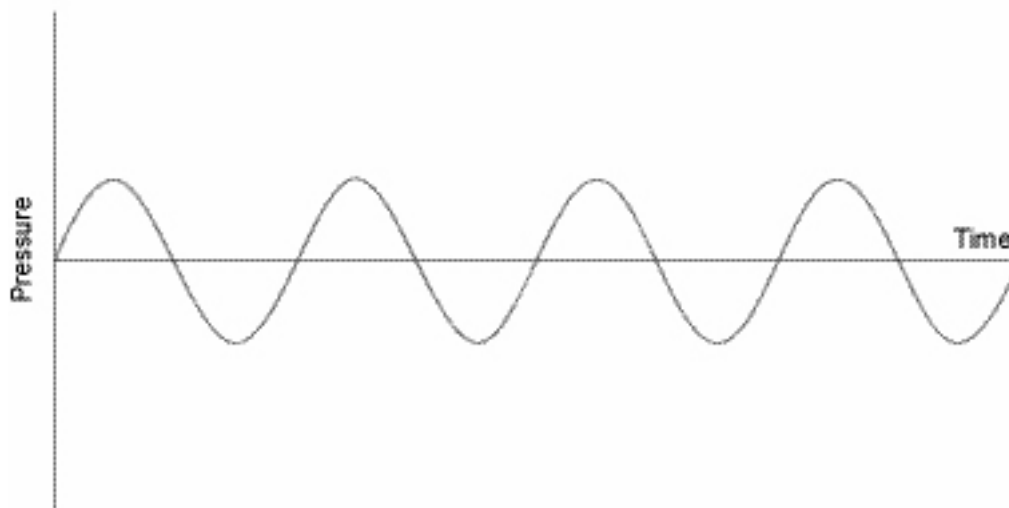
- (a) (i) Describe how particles move in a **longitudinal wave**. A labelled diagram may assist your answer.
- (ii) A science fiction film shows a spacecraft exploding in outer space (which is a vacuum). What would be heard in a neighbouring spacecraft? Explain your answer.
- (b) Ultrasound waves are sound waves with frequencies higher than humans can hear.
- (i) State the range of frequencies that humans can hear.



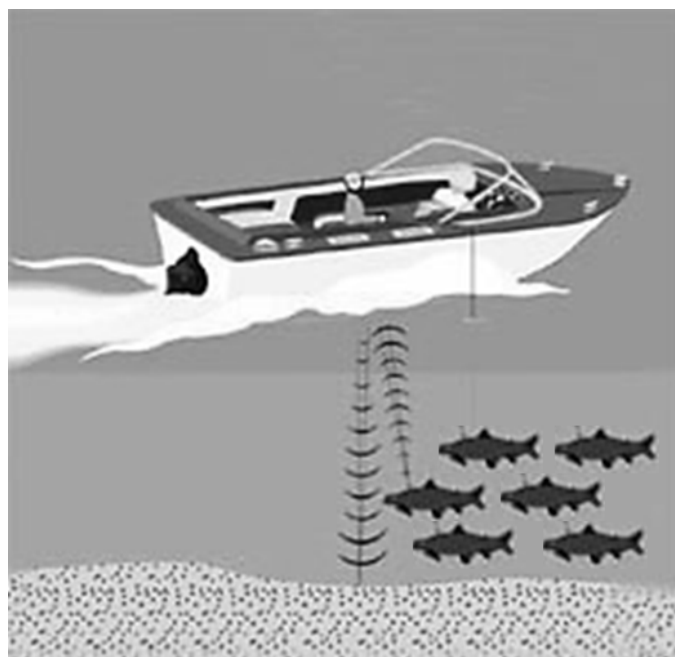
- (ii) One application of ultrasound is to take pictures of human gall bladders to locate gallstones, using ultrasound scanning. Gallstones are lumps containing calcium that develop in some people's gall bladder and can be very painful. Ultrasound scanning is a technique that uses a scanner that both transmits and detects ultrasound. Discuss how ultrasound waves are able to show the difference between gall bladder tissue and gallstones.
- (iii) Ultrasound waves can also break up gallstones into smaller pieces. The fragments can be then passed from the body. Describe how ultrasound would break-up gallstones.
- (iv) An ultrasound scan indicates that a gallstone is present in the gall bladder. The speed of the ultrasound wave is  $1550 \text{ ms}^{-1}$ . The time it takes for the ultrasound pulse to return to the scanner is  $6.5 \times 10^{-5} \text{ s}$ . Calculate how deep the stone is below the surface of the body. Show all working.

## 2004(2): SOUND AND ULTRASOUND

- (a) A car horn is sounded and a graph is plotted of pressure vs. time for the sound wave produced.



- (i) On the graph above clearly **mark** and **label** the amplitude of the wave shown.
- (ii) A second, louder horn is sounded at the same pitch as the first. On the graph above draw the sound wave from the second horn.
- (iii) A cliff is 75 m away. Given that the speed of sound is  $300 \text{ ms}^{-1}$ , how long does it take for the people in the car to hear the echo of the horn? State your answer with the appropriate unit.
- (b) On a fishing trip, a fish finder is used to help locate schools of fish by echo location. The fish finder operates by sending ultrasonic wave pulses into the water and receiving any echoes of these waves as they reflect off solid objects, such as the lake bottom, rocks or fish.



Discuss why the echo received back from the rocky bottom of the lake would be stronger than the echo received from a school of fish at the same depth.