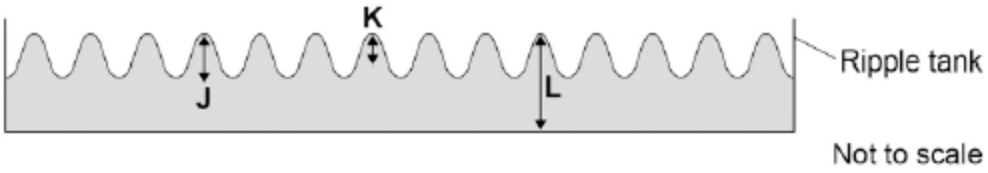
1 Small water waves are created in a ripple tank by a wooden bar. The wooden bar vibrates up and down hitting the surface of the water.

The figure below shows a cross-section of the ripple tank and water.



(a) Which letter shows the amplitude of a water wave?

Tick **one** box.

J ☐

K ☐

L ☐

(1)

(b) The speed of the wooden bar is changed so that the bar hits the water fewer times each second.

What happens to the frequency of the waves produced?

Tick **one** box.

Increases ☐

Does not change ☐

Decreases ☐

(1)

(c) Describe how the wavelength of the water waves in a ripple tank can be measured accurately.

.....

.....

.....

.....

.....

(2)

(d) The speed of a wave is calculated using the following equation.

wave speed = frequency × wavelength

The water waves in a ripple tank have a wavelength of 1.2 cm and a frequency of 18.5 Hz.

How does the speed of these water waves compare to the typical speed of a person walking?

.....

.....

.....

.....

.....

.....

(4)
(Total 8 marks)

2 Waves may be either longitudinal or transverse.

(a) Describe the difference between a longitudinal and a transverse wave.

.....

.....

.....

.....

(2)

(b) Describe **one** piece of evidence that shows when a sound wave travels through the air it is the wave and not the air itself that travels.

.....

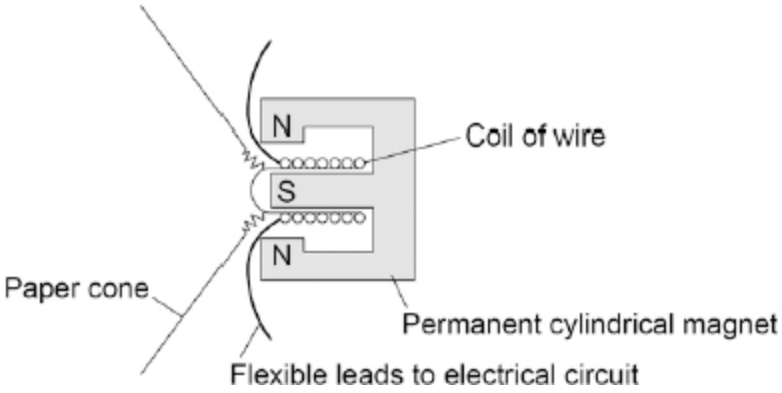
.....

.....

(1)

(c) The figure below shows the parts of a moving-coil loudspeaker.

A coil of wire is positioned in the gap between the north and south poles of the cylindrical magnet.



Explain how the loudspeaker converts current in an electrical circuit to a sound wave.

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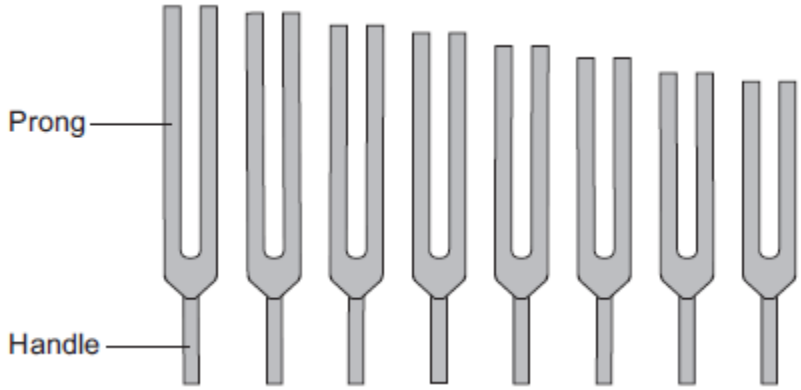
(6)
(Total 9 marks)

3 **Figure 1** shows a set of tuning forks.

Figure 1



A tuning fork has a handle and two prongs. It is made from metal.

When the prongs are struck on a hard object, the tuning fork makes a sound wave with a single frequency. The frequency depends on the length of the prongs.

(a) Use the correct answer from the box to complete each sentence.

direction	loudness	pitch	speed

The frequency of a sound wave determines its ..... .

The amplitude of a sound wave determines its ..... .

(2)

(b) Each tuning fork has its frequency engraved on it. A student measured the length of the prongs for each tuning fork.

Some of her data is shown in the table.

Frequency in hertz	Length of prongs in cm
320	9.5
384	8.7
480	7.8
512	7.5

(i) Describe the pattern shown in the table.

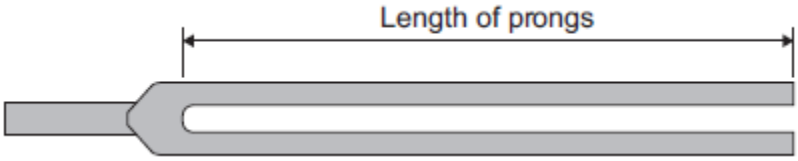
.....

.....

(1)

(ii) **Figure 2** shows a full-size drawing of a tuning fork.

Figure 2



Measure and record the length of the prongs.

Length of prongs = ... cm

(1)

Use the data in the table above to estimate the frequency of the tuning fork in **Figure 2**.

Explain your answer.

.....

.....

.....

.....

.....

Estimated frequency = ... Hz

(3)

(c) Ultrasound waves are used in hospitals.

(i) Use the correct answer from the box to complete the sentence.

electronic	**hydraulic**	**radioactive**

Ultrasound waves can be produced by ..... systems.

(1)

(ii) The frequency of an ultrasound wave used in a hospital is 2×10^6 Hz.

It is **not** possible to produce ultrasound waves of this frequency using a tuning fork.

Explain why.

.....

.....

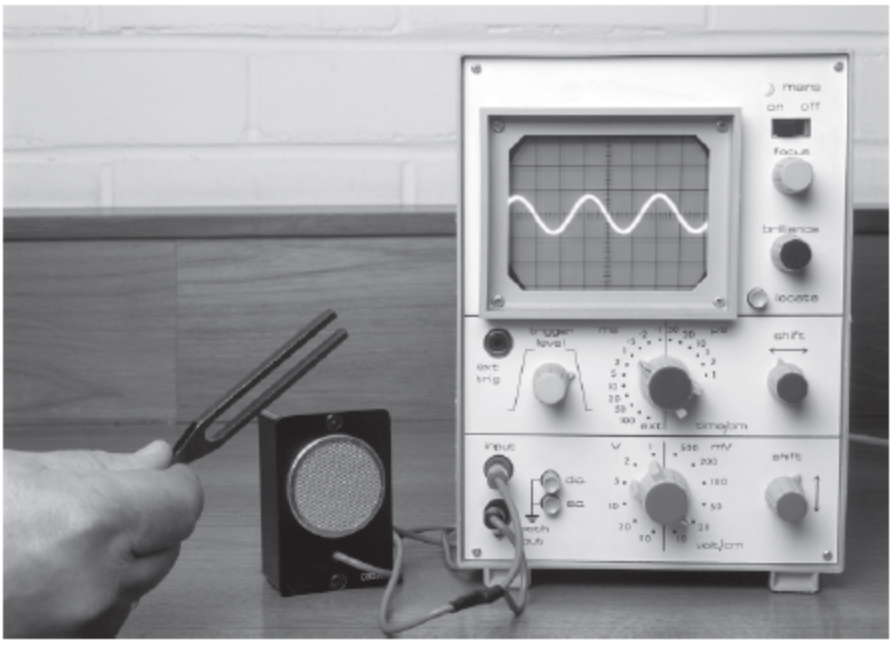
.....

.....

(2)

(d) **Figure 3** shows a tuning fork and a microphone. The microphone is connected to an oscilloscope.

Figure 3

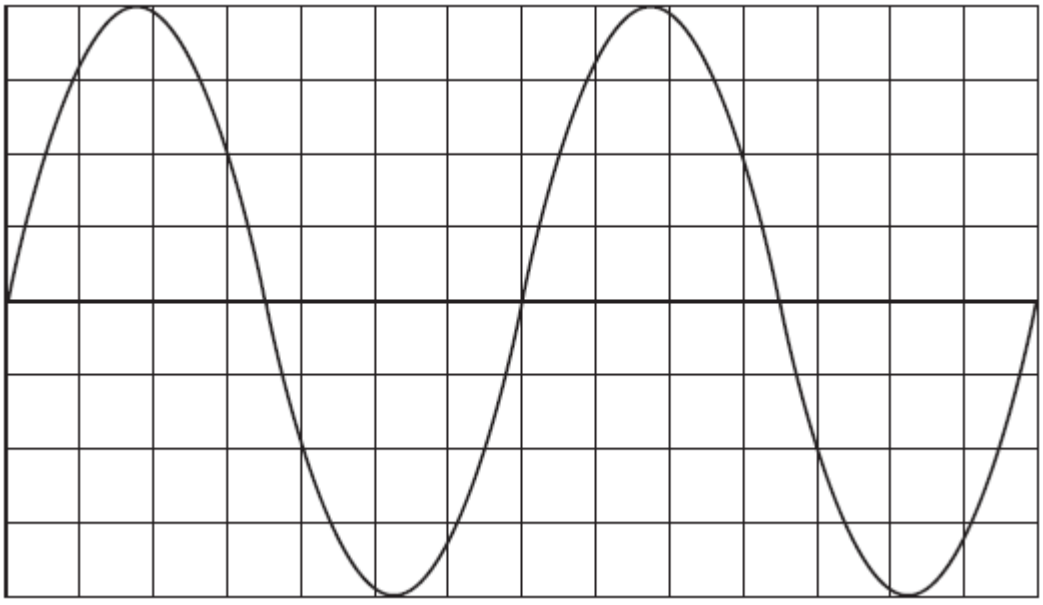


© Sciencephotos/Alamy

When the tuning fork is struck and then placed in front of the microphone, a trace appears on the oscilloscope screen.

Figure 4 shows part of the trace on the screen.

Figure 4



Each horizontal division in **Figure 4** represents a time of 0.0005 s.

What is the frequency of the tuning fork?

.....

.....

.....

Frequency = ... Hz

(3)

(Total 13 marks)

4 A note was played on an electric keyboard.

The frequency of the note was 440 Hz.

(a) (i) What does a frequency of 440 Hz mean?

.....

.....

(1)

(ii) The sound waves produced by the keyboard travel at a speed of 340 m / s.

Calculate the wavelength of the note.

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

.....

.....

.....

Wavelength = ... metres

(3)

(b) **Figure 1** shows a microphone connected to a cathode ray oscilloscope (CRO) being used to detect the note produced by the keyboard.

Figure 1

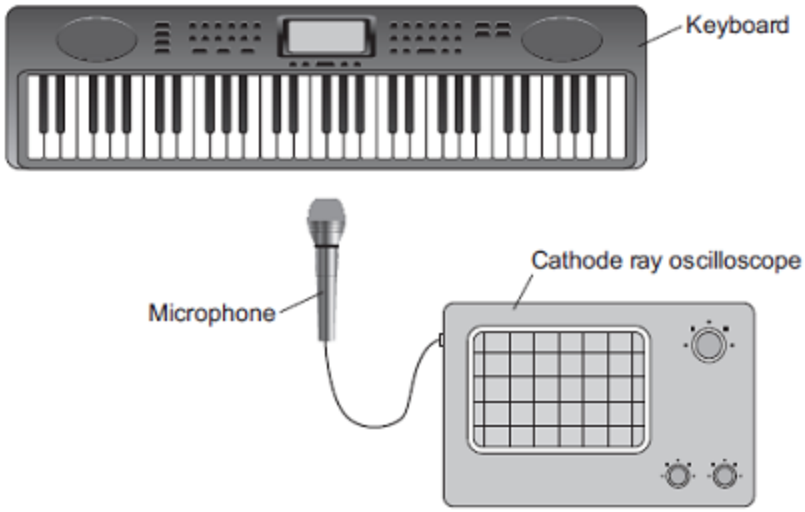
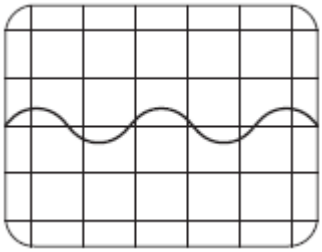


Figure 2 shows the trace produced by the sound wave on the CRO.

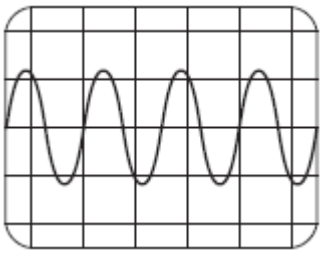
Figure 2



A second note, of different wavelength, was played on the keyboard.

Figure 3 shows the trace produced by the sound wave of the second note on the CRO.

Figure 3



The settings on the CRO were unchanged.

What **two** conclusions should be made about the **second** sound wave produced by the keyboard compared with the **first** sound wave?

Give a reason for each conclusion.

Conclusion 1 .....

.....

Reason .....

.....

Conclusion 2 .....

.....

Reason .....

.....

(4)
(Total 8 marks)

5 (a) What is ultrasound?

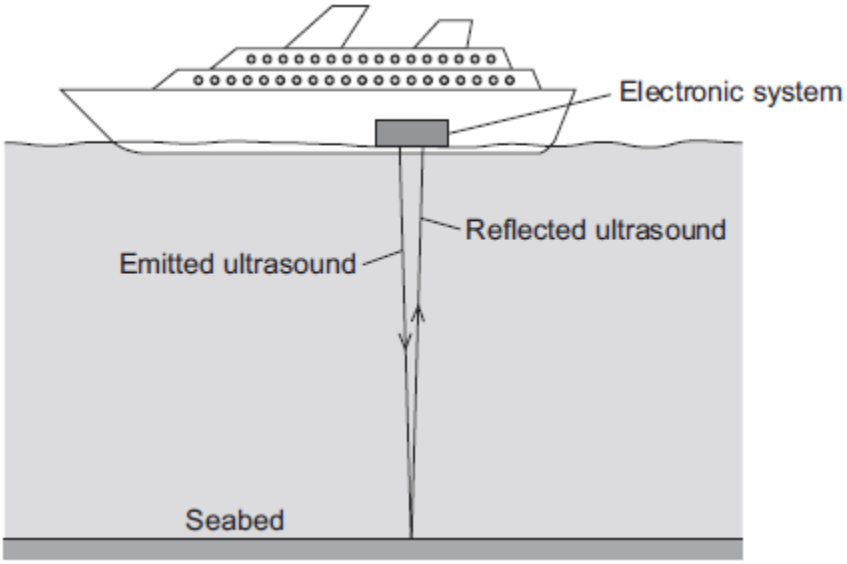
.....

.....

(1)

(b) **Figure 1** shows how ultrasound is used to measure the depth of water below a ship.

Figure 1



A pulse of ultrasound is sent out from an electronic system on-board the ship.

It takes 0.80 seconds for the emitted ultrasound to be received back at the ship.

Calculate the depth of the water.

Speed of ultrasound in water = 1600 m / s

.....

.....

.....

.....

Depth of water = ... metres

(3)

(c) Ultrasound can be used in medicine for scanning.

State **one** medical use of ultrasound scanning.

.....

(1)

(d) Images of the inside of the human body can be made using a Computerised Tomography (CT) scanner. The CT scanner in **Figure 2** uses X-rays to produce these images.

Figure 2

monkeybusinessimages/iStock/Thinkstock

State **one** advantage and **one** disadvantage of using a CT scanner, compared with ultrasound scanning, for forming images of the inside of the human body.

Advantage of CT scanning .....

.....

.....

Disadvantage of CT scanning .....

.....

.....

(2)
(Total 7 marks)

6 (a) Human ears can detect a range of sound frequencies.

(i) Use the correct answers from the box to complete the sentence.

2	**20**	**200**	**2000**	**20 000**

The range of human hearing is from about ..... Hz to ..... Hz.

(2)

(ii) What is ultrasound?

.....

.....

(1)

(iii) Ultrasound can be used to find the speed of blood flow in an artery.

State **one** other medical use of ultrasound.

.....

(1)

(b) The speed of an ultrasound wave in soft tissue in the human body is 1.5×10^3 m / s and the frequency of the wave is 2.0×10^6 Hz.

Calculate the wavelength of the ultrasound wave.

.....

.....

Wavelength = ... m

(2)

(c) When ultrasound is used to find the speed of blood flow in an artery:

- an ultrasound transducer is placed on a person's arm
- ultrasound is emitted by the transducer
- the ultrasound is reflected from blood cells moving **away** from the transducer
- the reflected ultrasound is detected at the transducer.

Describe the differences between the ultrasound waves emitted by the transducer and the reflected waves detected at the transducer.

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(2)
(Total 8 marks)

7 Waves may be longitudinal or transverse.

(a) Describe the differences between longitudinal waves and transverse waves.

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(3)

(b) Radio waves are electromagnetic waves.

Describe how radio waves are different from sound waves.

.....

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.....

(4)
(Total 7 marks)

8 (a) Light waves transfer energy.

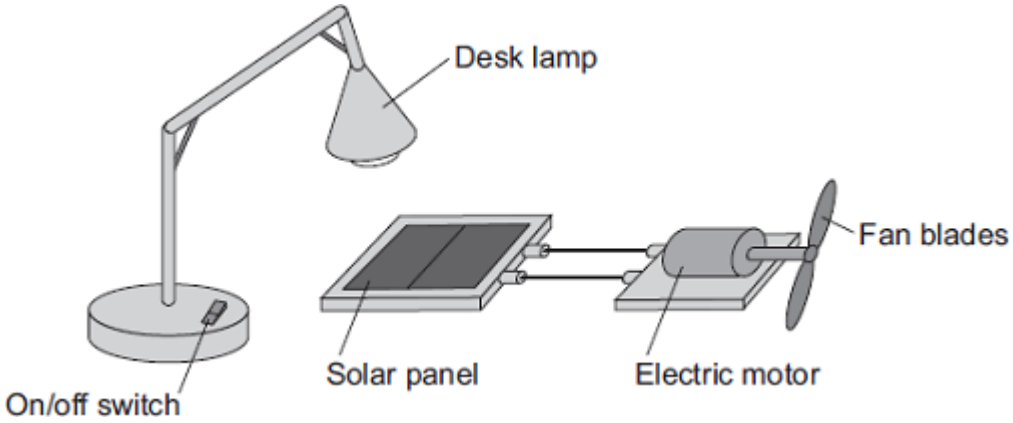
(i) Complete the following sentence.

The oscillations producing a light wave are .....

to the direction of the energy transfer by the light wave.

(1)

(ii) The apparatus in the diagram shows that light waves transfer energy.



Describe how switching the desk lamp on and off shows that light waves transfer energy.

You do **not** need to describe the energy transfers.

.....

.....

.....

.....

(2)

(b) A student holds a wrist watch in front of a plane mirror. The student can see an image of the wrist watch in the mirror.

The diagram shows the position of the wrist watch and the mirror.

Draw a ray diagram showing how the image of the wrist watch is formed.

Mark the position of the image.

(4)

(c) The image of the wrist watch seen by the student is virtual.

What is a virtual image?

.....

.....

(1)
(Total 8 marks)

9 Ultrasound and X-rays are waves used in hospitals to create images of the inside of the human body. To produce the images below, the waves must enter the human body.

Ultrasound scan of an unborn child

© Isabelle Limbach/Thinkstock

X-ray of a broken bone

© itsmejust/iStock

(a) *In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate*.

Describe the features of ultrasound and X-rays, and what happens to each type of wave after it has entered the human body.

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(6)

(b) It would **not** be safe to use X-rays to produce an image of an unborn child.

Explain why.

.....

.....

.....

.....

(2)

(c) Ultrasound can be used for medical treatments as well as for imaging.

Give **one** use of ultrasound for medical treatment.

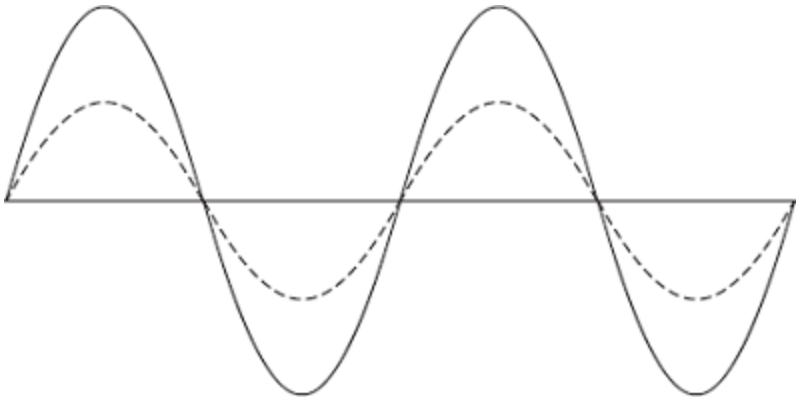
.....

.....

(1)
(Total 9 marks)

10 (a) **Diagram 1** shows two waves.

Diagram 1



(i) Name **one** wave quantity that is the same for the two waves.

.....

(1)

(ii) Name **one** wave quantity that is different for the two waves.

.....

(1)

(iii) The waves in **Diagram 1** are transverse.

Which **one** of the following types of wave is **not** a transverse wave?

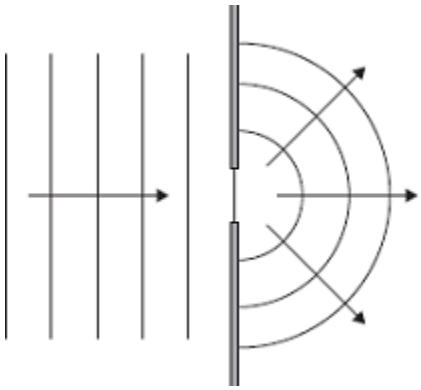
Draw a ring around the correct answer.

gamma rays **sound** **visible light**

(1)

(b) **Diagram 2** shows water waves in a ripple tank moving towards and passing through a gap in a barrier.

Diagram 2



Every second, 8 waves pass through the gap in the barrier. The waves have a wavelength of 0.015 metres.

Calculate the speed of the water waves and give the unit.

.....

.....

.....

Speed = ...

(3)
(Total 6 marks)

11 (a) The table gives information about the frequencies in the hearing ranges of six different mammals.

Name of mammal	Frequencies in hearing range
Bat	20 Hz → 160 kHz
Dog	20 Hz → 30 kHz
Dolphin	40 Hz → 110 kHz
Elephant	5 Hz → 10 kHz
Human	20 Hz → 20 kHz
Tiger	30 Hz → 50 kHz

(i) Which mammal in the table can hear the highest frequency?

.....

(1)

(ii) Give **one** example of a frequency which an elephant can hear but which a tiger **cannot** hear.

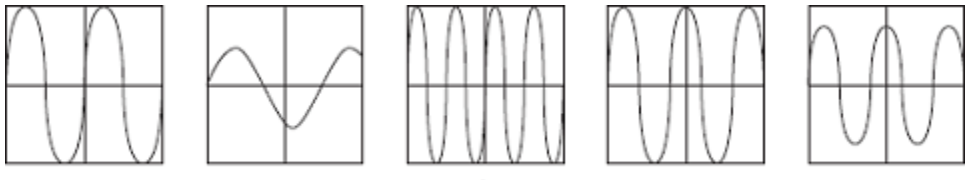
Include the unit in your answer.

Frequency .....

(1)

(b) A sound wave can be represented as a trace on the screen of an oscilloscope.

The diagrams show five traces, **A**, **B**, **C**, **D** and **E**, on the oscilloscope. All the traces aredrawn to the same scale.



(i) Which **three** diagrams show traces with the same amplitude?

Diagrams ..... , ... and ..... .

(1)

(ii) Which **two** diagrams show traces with the same frequency?

Diagrams ..... and ....

(1)

(c) There is no air in space.

Astronauts in space cannot hear sounds from outside their spacesuits.

Explain this.

.....

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.....

(2)
(Total 6 marks)

12 (a) Explain what ultrasound is.

.....

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.....

.....

(2)

(b) Ultrasound is used for pre-natal scanning. This is much safer than using X-rays. However, doctors were only sure ultrasound was safe after experiments on mice.

Do you think the ultrasound experiments on mice were justified?

Explain your answer.

.....

.....

.....

.....

(2)

(c) Explain what scientists should do if they find evidence that ultrasound may be harmful to human health.

.....

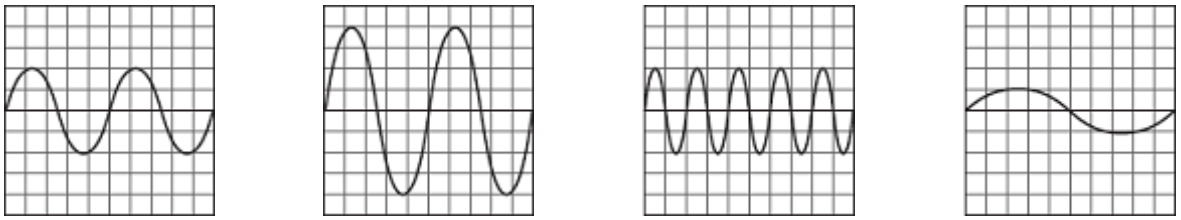
.....

.....

(2)
(Total 6 marks)

13 (a) The diagram shows four sound waves, **J**, **K**, **L** and **M**, represented on an oscilloscope screen.

They are all drawn to the same scale.



J **K** **L** **M**

(i) Which **two** of the waves have the same amplitude?

Wave ..... and wave .....

(1)

(ii) Which of the waves would sound the loudest?

Wave .....

(1)

(iii) Only **one** of the waves is an ultrasound wave.

Which **one** is the ultrasound wave?

Wave .....

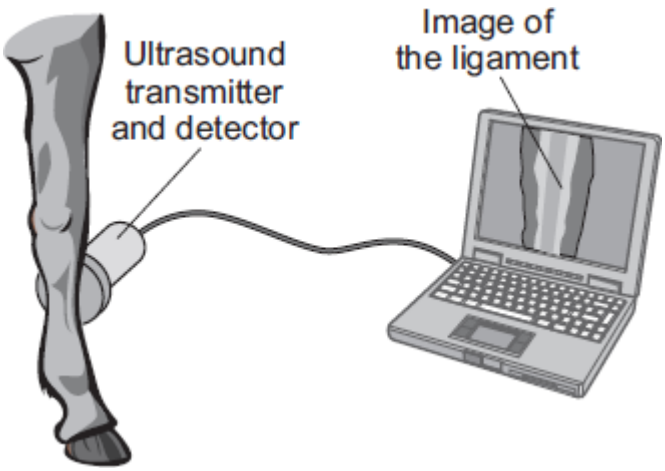
Give a reason for your answer.

.....

.....

(2)

(b) The diagram shows ultrasound being used to examine the ligament inside the leg of a horse.



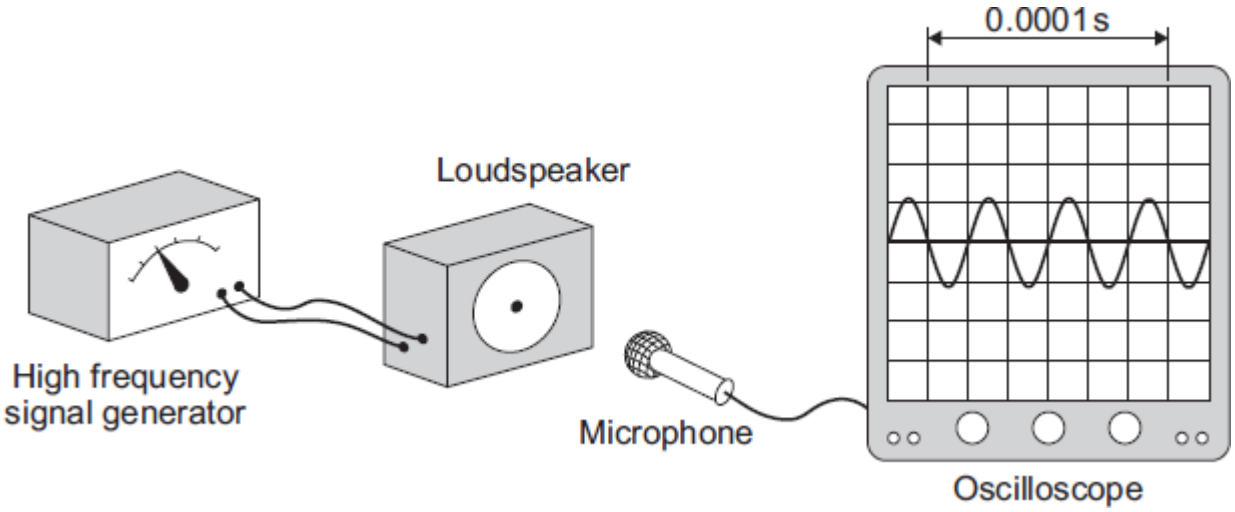
Use words from the box to complete the following sentences.

computer	**detector**	**transmitter**

The ..... sends pulses of ultrasound into the leg. When the ultrasound meets the ligament, some is reflected back to the ..... The reflected pulses are converted by a ..... into an image that can be seen on the screen.

(2)
(Total 6 marks)

14 (a) The diagram shows a microphone being used to detect the output from a loudspeaker.
The oscilloscope trace shows the wave pattern produced by the loudspeaker.



(i) How many waves are produced by the loudspeaker in 0.0001 seconds?

.....

(1)

(ii) How many waves are produced by the loudspeaker every second?
Assume the input to the loudspeaker does not change.

.....

.....

(1)

(iii) A person with normal hearing cannot hear the sound produced by the loudspeaker.

Explain why.

.....

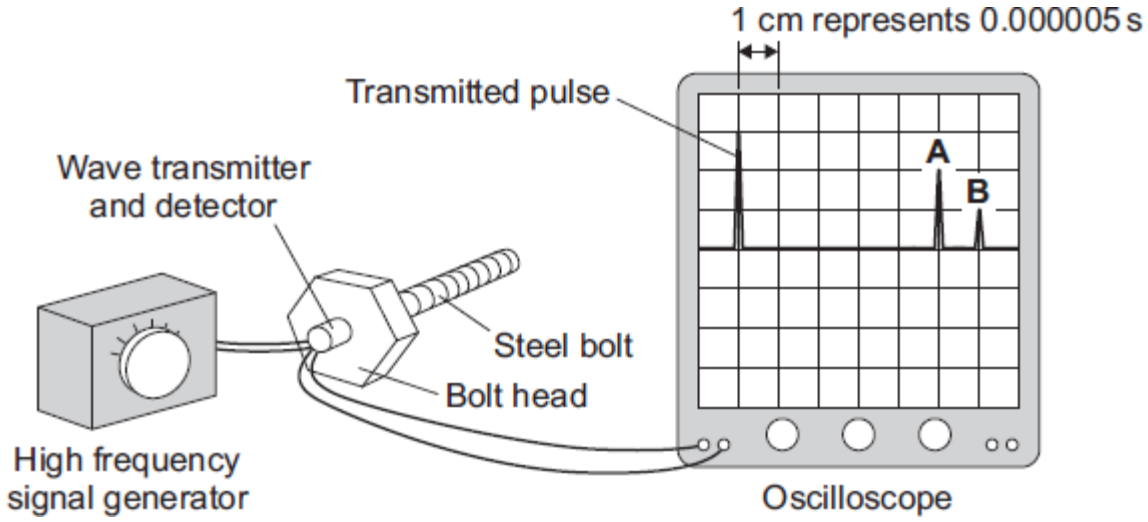
.....

.....

.....

(2)

(b) The diagram shows how a very high frequency sound wave can be used to check for internal cracks in a large steel bolt. The oscilloscope trace shows that the bolt does have an internal crack.



(i) Explain what happens to produce pulse **A** and pulse **B**.

.....

.....

.....

.....

(2)

(ii) Use the information in the diagram and the equation in the box to calculate the distance from the head of the bolt to the internal crack.

distance = speed × time

Speed of sound through steel = 6000 m/s

Show clearly how you work out your answer.

.....

.....

.....

.....

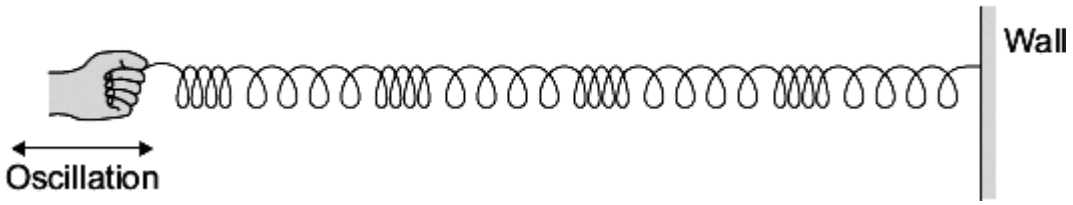
.....

.....

(3)
(Total 9 marks)

15 **Diagram 1** shows a longitudinal wave being produced in a stretched spring.

Diagram 1



(a) A longitudinal wave has areas of compression and areas of rarefaction.

Mark with the letter **C**, **one** area of compression shown in **Diagram 1.**

(1)

(b) **Diagram 2** shows the apparatus a teacher uses to demonstrate that sound can be reflected.

Diagram 2

(i) Using a ruler, draw on **Diagram 2** to show how sound from the loudspeaker is reflected by the sheet of metal to the sound sensor.

(2)

(ii) The teacher replaced the sheet of metal with a sheet of glass.

When he did this, the reading on the sound level meter went down.

Suggest why.

.....

.....

(1)

(iii) The teacher changed the output from the loudspeaker to increase the amplitude of the sound wave produced.

What effect, if any, does this increase of amplitude have on the loudness of the sound?

Draw a ring around the correct answer.

makes the sound quieter	**does not change the loudness of the sound**	**makes the sound louder**

(1)

(iv) The loudspeaker produces a sound wave at a frequency of 850 Hz. The wavelength of the sound wave is 0.4 m.

Calculate the speed of the sound wave.

Show clearly how you work out your answer.

.....

.....

.....

Speed = ... m/s

(2)

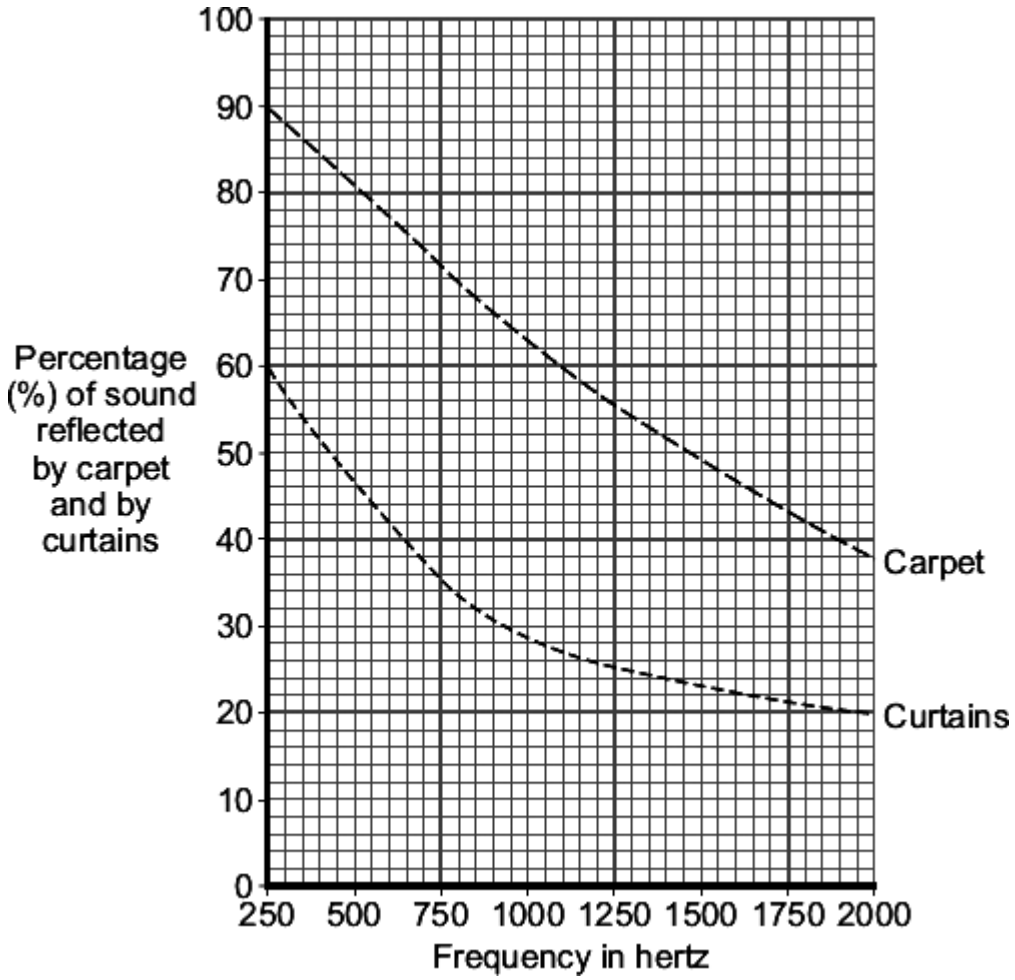
(c) Music concerts are sometimes performed in sports halls. The concerts can be spoilt because of the sound reflected from the floor and walls.

What word is used to describe a reflected sound?

.....

(1)

(d) The graph shows how the percentage of sound reflected from the floor and from the walls of a large room can be reduced by carpets and by curtains.



(i) Over which range of frequencies do curtains reduce the percentage of sound reflected the most?

Tick (✓) **two** boxes.

from 250 Hz to 750 Hz ☐

from 750 Hz to 1250 Hz ☐

from 1250 Hz to 1750 Hz ☐

(1)

(ii) The manager of a sports hall plans to use the hall for regular music concerts. He has enough money to buy either carpet or curtains, but not both.

To improve the sound an audience hears, it would be better to hang curtains on the walls rather than laying a carpet over the floor.

Use the data in the graph to explain why.

.....

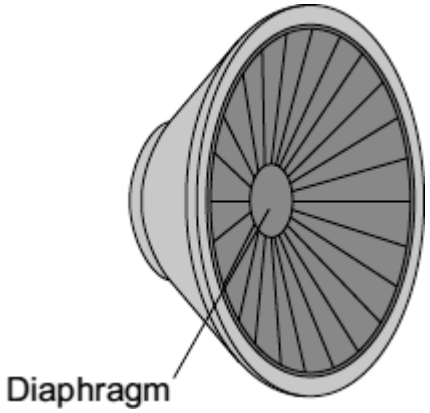
.....

.....

.....

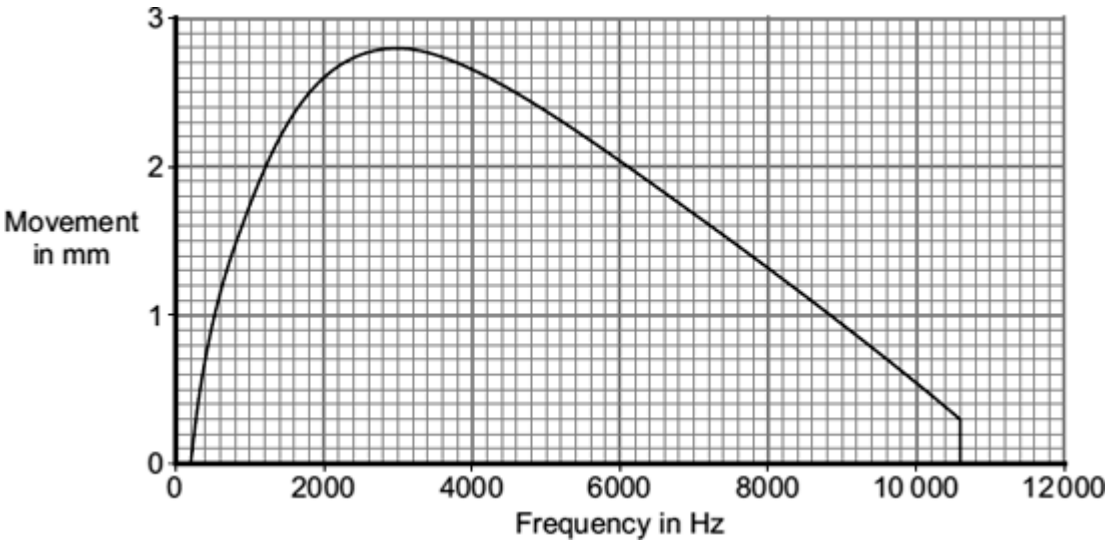
(2)
(Total 11 marks)

16 The diaphragm of a loudspeaker moves in and out.



A team of scientists investigated loudspeakers.

The scientists measured the size of the movement of the diaphragm for signals of different frequencies.
They kept all the other variables constant.
The graph shows the average results for a large number of tests on one of the loudspeakers.



(a) What is the frequency of the highest pitched sound which this loudspeaker produces?

Frequency = ... Hz

(1)

(b) The greater the movement of the diaphragm, the greater the amplitude of the sound produced.

What is the frequency of the loudest sound which this loudspeaker produces?

Show clearly on the graph how you get to your answer and then complete this answer space.

Frequency = ... Hz

(2)

(c) Can this loudspeaker produce the full range of sound which most people can hear?

Put a tick (✓) in the box next to your answer.

Yes ☐ No ☐

Explain the reason for your answer.

.....

.....

.....

.....

(2)

(d) Use **one** word to complete the sentence.

Repeating tests a large number of times and taking the average of the results

improves the ..... .

(1)

(e) Why did the scientists keep all the other variables constant?

.....

.....

(1)

(Total 7 marks)

17 Ultrasound waves are very high frequency sound waves. They cannot be heard by humans.

(a) Ultrasound waves can be used to clean jewellery.

The jewellery is put into a container of cleaning fluid.

Complete each sentence to explain how ultrasound can clean jewellery.

The ultrasound generator makes the molecules of the cleaning fluid

..... . The molecules knock particles of .....

from the surface of the jewellery.

(2)

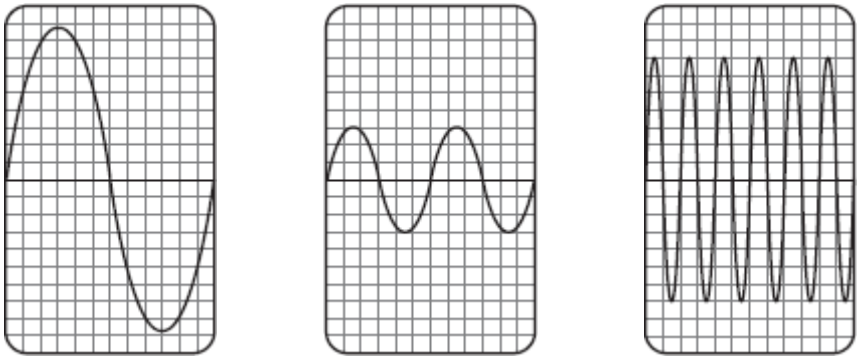
(b) Give a medical use for ultrasound.

.....

(1)

(c) Ultrasound waves can be represented on the screen of a cathode ray oscilloscope (CRO).

The diagrams show three ultrasound waves.
Each wave is represented on an identical CRO screen, **A**, **B** and **C**.



Screen **A** Screen **B** Screen **C**

(i) How many complete waves are shown on screen **B**? .....

(1)

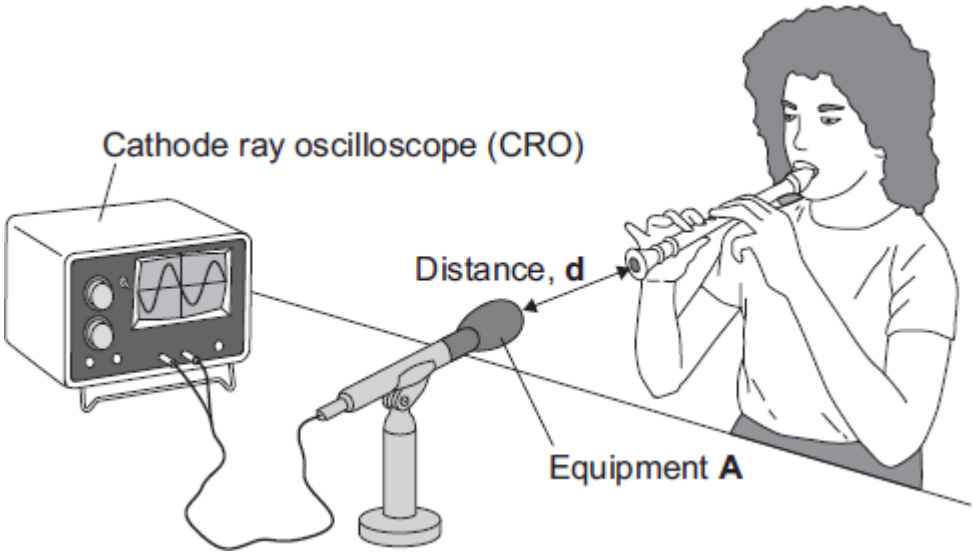
(ii) Which screen shows the waves with the highest frequency?

Screen .....

(1)
(Total 5 marks)

18 A group of students investigates sound waves.

The diagram shows part of their investigation.



(a) Identify the equipment labelled **A**.

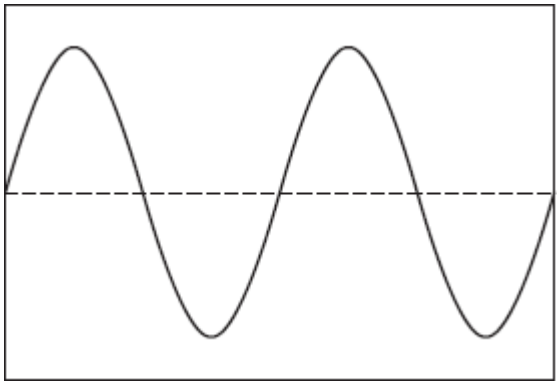
.....

(1)

(b) The student plays the same note in the same way at different distances from equipment **A**.

Another student records the amplitude of the wave shown on the cathode ray oscilloscope (CRO).

(i) Label this wave to show its amplitude.



(1)

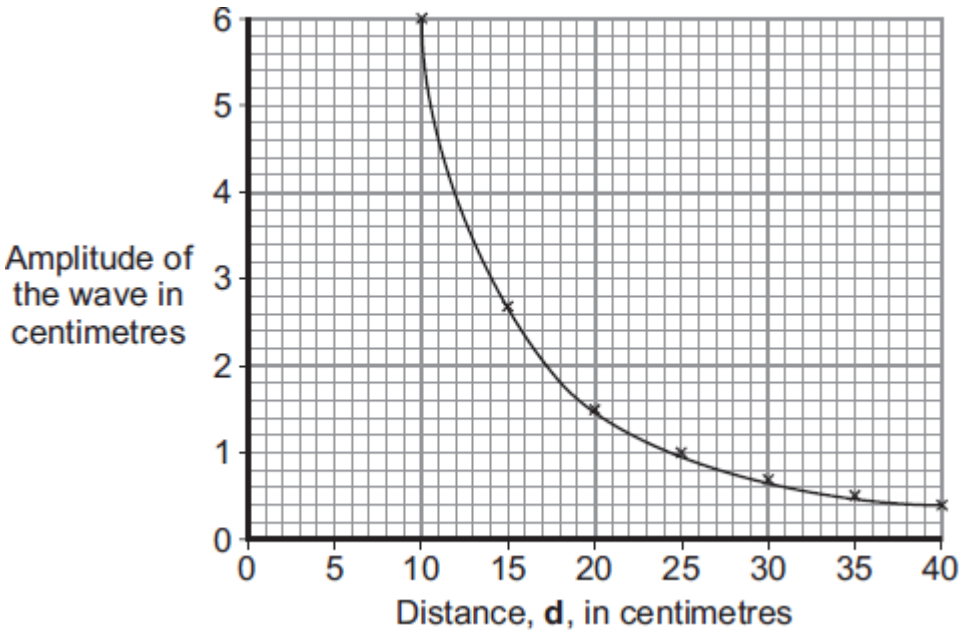
(ii) Complete the sentence.

Increasing the amplitude of a sound wave will increase the .....

of the sound.

(1)

(c) The graph shows the students' average results from several sets of measurements.



Use the graph to find the distance, **d**, in centimetres, at which the average amplitude is likely to be 2 centimetres.

Distance = ... cm.

(1)

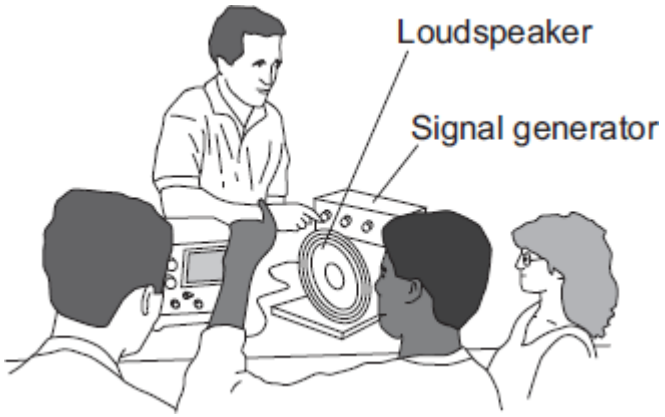
(d) Write a conclusion for this investigation.

.....

.....

(1)

(e) A physics teacher uses a signal generator and a loudspeaker to demonstrate the range of hearing of a group of students.



What is the range of frequencies most humans can hear?

Most humans can hear from ..... Hz to ..... Hz.

(2)
(Total 7 marks)

19 (a) Explain what an ultrasound wave is.

.....

.....

.....

.....

(2)

(b) Ultrasound waves can be used to clean jewellery.

One method is to put the jewellery in a bath of cleaning fluid which contains an electronic oscillator. The electronic oscillator generates ultrasound waves in the cleaning fluid.

Suggest how these waves clean the jewellery.

.....

.....

.....

.....

(2)

(c) Ultrasound is used for pre-natal scanning. This is much safer than using X-rays. However, doctors were only sure it was safe after experiments on mice.

Explain whether or not you think that these experiments were justified.

.....

.....

.....

.....

(2)
(Total 6 marks)

20 (a) This information is from a science magazine.

Electronic systems can be used to produce ultrasonic waves. These waves have a frequency higher than the upper limit for hearing in humans.

Complete the sentence by choosing the correct number from the box.

20	**2000**	**20 000**	**200 000**

The upper limit for hearing in humans is a frequency of ..... Hz.

(1)

(b) An electronic system produces ultrasound with a frequency of 500 kHz.

What does the symbol kHz stand for?

.....

(1)

(c) (i) State **one** industrial use for ultrasound.

.....

(1)

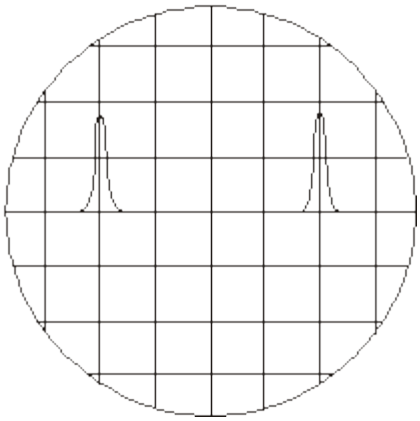
(ii) State **one** medical use for ultrasound.

.....

(1)

(d) An ultrasound detector is connected to an oscilloscope.

The diagram shows centimetre squares on an oscilloscope screen. Each horizontal division represents 2 microseconds.



Calculate the time, in microseconds, between one peak of one ultrasound pulse and the peak of the next.

.....

Time = ... microseconds

(1)

(e) Ultrasounds are partially reflected when they reach a boundary between two different media.

The time taken for the reflection from the boundary to reach the detector can be seen from the screen.

What can be calculated from this time interval?

.....

.....

(2)

(f) Explain what action scientists should take if they find evidence that ultrasonic waves may be harmful to human health.

.....

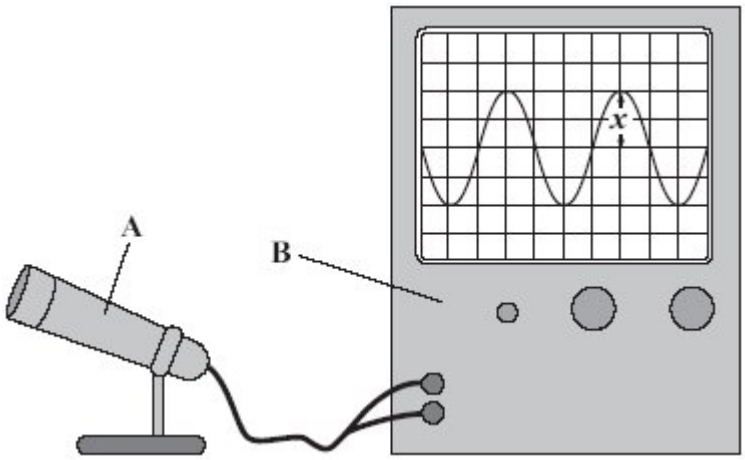
.....

.....

(2)

(Total 9 marks)

21 (a) A student uses two pieces of equipment, **A** and **B**, to display a sound wave.



(i) Use words from the box to complete the sentence.

a loudspeaker	**a microphone**	**an oscilloscope**	**a screen**

A is ..... and **B** is ..... .

(2)

(ii) Use words from the box to complete the sentence.

the amplitude	**half the amplitude**	**the frequency**	**half the frequency**

The distance ***x*** marked on the diagram measures ..... of the sound wave.

(1)

(iii) Complete the sentence.

The distance ***x*** becomes smaller. This is because the sound has

become ..... .

(1)

(b) There is no air in space.

Astronauts in space cannot hear sounds from outside their spacesuits.

Explain this.

.....

.....

.....

.....

(2)
(Total 6 marks)

22 (a) The diagrams show oscilloscope traces for the same musical note played on two different instruments. The oscilloscope settings are not changed.

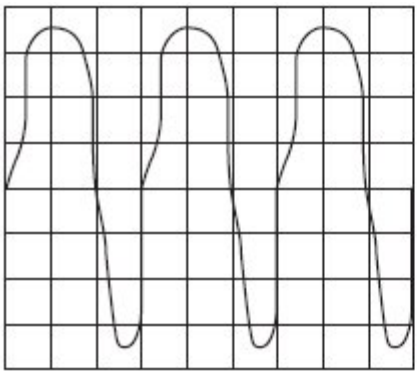


Diagram X

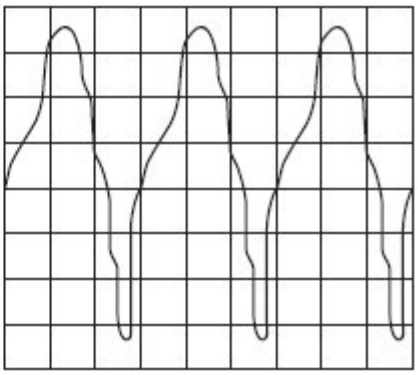


Diagram Y

(i) How can you tell, from the diagrams, that it is the same musical note?

.....

.....

(1)

(ii) How can you tell, from the diagrams, that the musical note has been played on different instruments?

.....

.....

(1)

(b) This passage is from an electronics magazine.

> *Electronic systems can be used to produce ultrasound waves. These waves have a higher frequency than the upper limit for hearing in humans.*
> *Ultrasound waves are partially reflected when they meet a boundary between two different media.*

(i) Approximately what is the highest frequency that humans can hear?

State the number and the unit.

.....

(1)

(ii) What does the word *media* mean when it is used in this passage?

.....

.....

(1)

(iii) What happens to the ultrasound which reaches the boundary between two different media and is **not** reflected?

.....

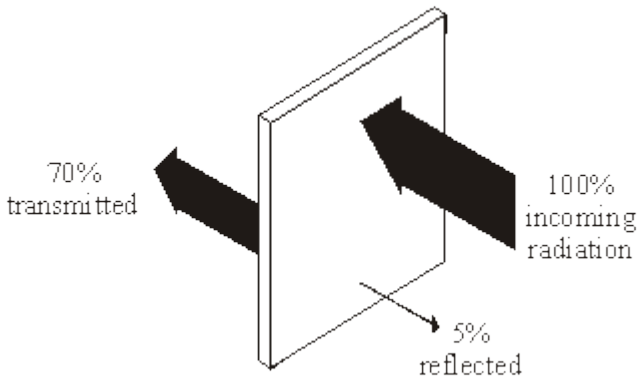
.....

.....

.....

(2)
(Total 6 marks)

23 (a) Infra red radiation can be reflected, absorbed and transmitted by glass.



(i) What percentage of infra red is absorbed by the glass?

.....

(1)

(ii) Complete the following sentence by drawing a ring around the correct word or phrase.

Theabsorbed infra red | increases / does not change / decreases | the temperature of the glass.

(1)

(b) **Two** of the following statements are true. **One** of the statements is false.

Tick (✓) the boxes next to the **two** true statements.

All objectsabsorb infra red radiation.	
Blacksurfaces are poor emitters of infra red radiation.	
A hot objectemits more infra red than a cooler object.	

(1)

(c) The following statement is false.

Blacksurfaces are good reflectors of infra red radiation.

Change **one** word in this statement to make it true.

Write down your **new** statement.

.....

.....

(1)
(Total 4 marks)

24 When sound waves reach a material, some of the energy of the sound is reflected and some is transmitted through the material.

(a) Complete the sentence.

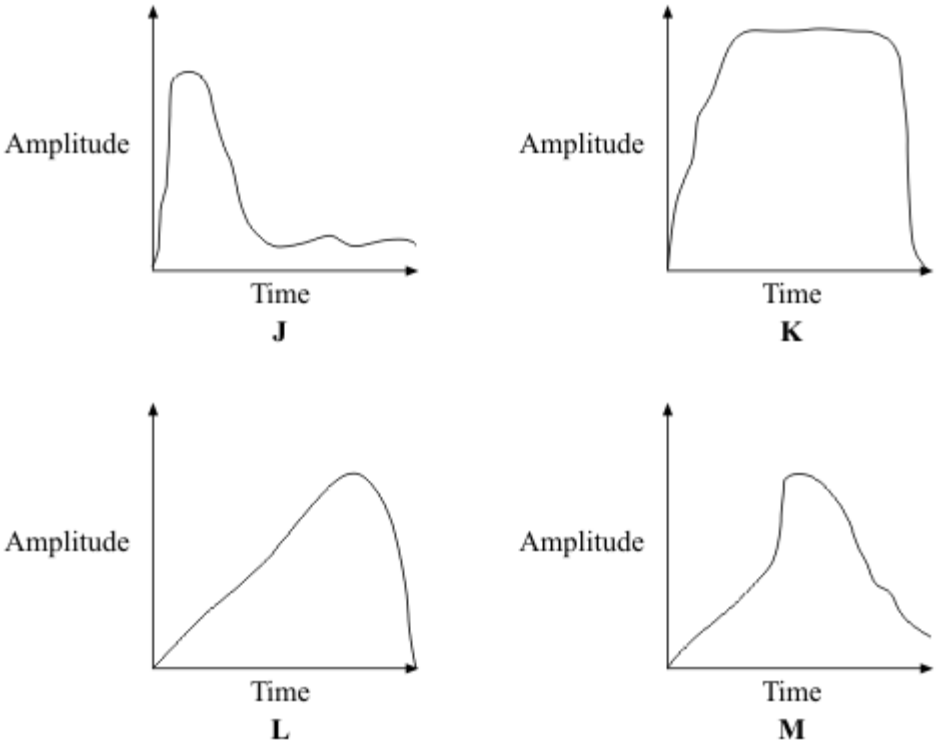
Sound waves are caused by .....

(1)

(b) The graphs **J**, **K**, **L** and **M** represent the sound energy reflected from a surface.

The graphs are all drawn to the same scale.

Which graph shows the greatest total sound energy output from the surface?



Graph .....

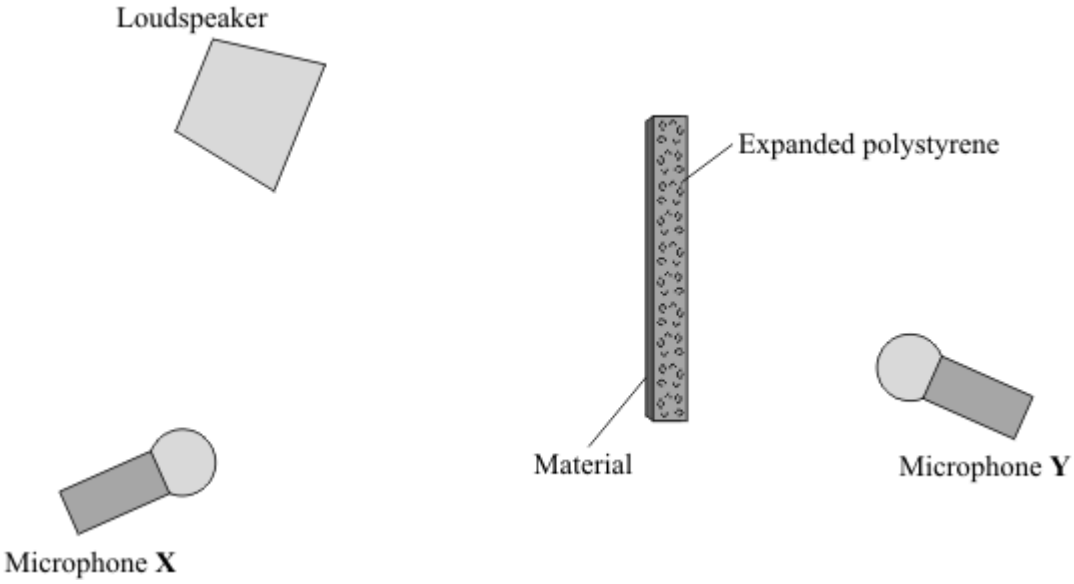
(1)

(c) The proportion of the sound energy which is reflected or transmitted depends on the material which receives the sound.

A student investigates different materials.

The diagram shows how a student sets up her equipment.

(i) Using a pencil and ruler to draw on the diagram, show how microphone **X** receives reflected sound.



(2)

(ii) The student tests four materials. Each sheet of material is 1 mm thick. This has been glued onto a block of expanded polystyrene.

Why does the student use the same size of expanded polystyrene block and the same sound level for each test?

.....

.....

(1)

(iii) The table shows the readings for the sound level transmitted to microphone **Y**.

Soundlevel from loudspeaker in arbitrary units	**Surface material**	**Soundlevel transmitted to microphone Y in arbitrary units**
60	paper	39
60	plaster	18
60	cloth	31
60	wood	15

[A] Which surface material transmits the smallest proportion of the sound?

.....

(1)

[B] What proportion is this?

.....

(1)

(d) People living in a flat have very noisy neighbours who are always playing loud music.

Suggest **one** practical idea to reduce the amount of noise transmitted into the flat through the walls and explain how your idea will work.

.....

.....

.....

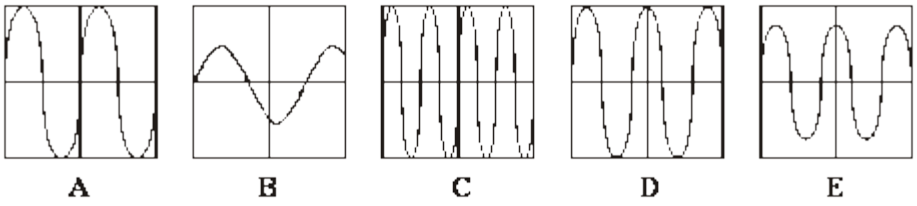
.....

.....

.....

(2)
(Total 9 marks)

25 (a) A student uses a microphone to send different sounds to an oscilloscope. The diagrams show five traces, **A**, **B**, **C**, **D** and **E**, on the oscilloscope. All the traces are drawn to the same scale.



(i) Which **three** diagrams show traces with the same amplitude?

Diagrams ..... , ... and ..... .

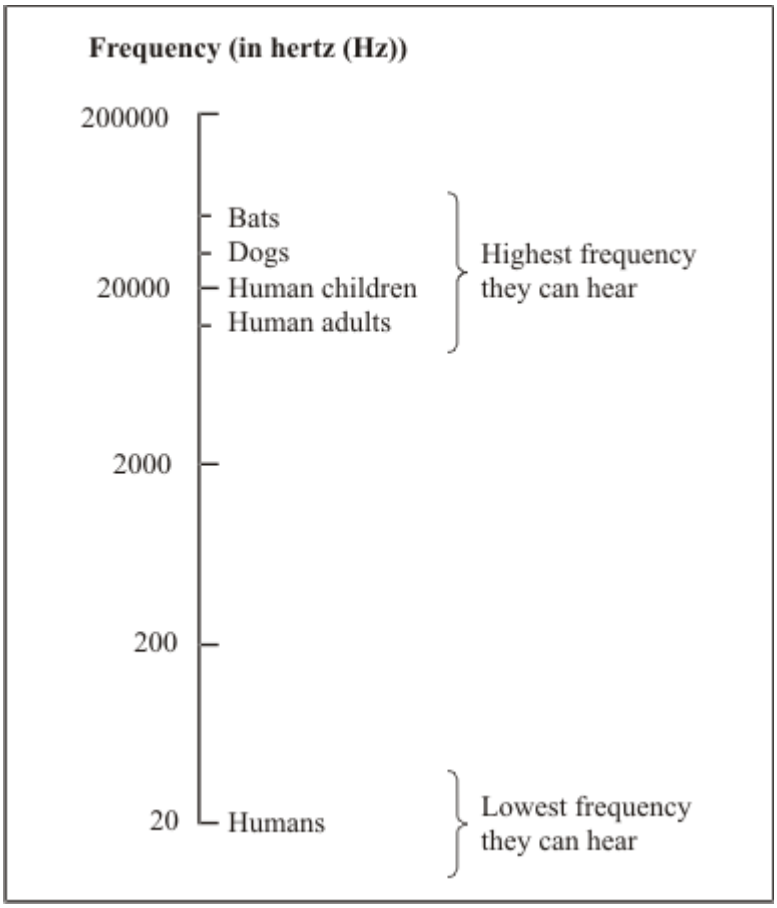
(1)

(ii) Which **two** diagrams show traces with the same frequency?

Diagrams ..... and ..... .

(1)

(b) The diagram shows the sound frequencies which some living things can hear.



(i) What is the widest range of frequencies that a human child can hear?

.....

(1)

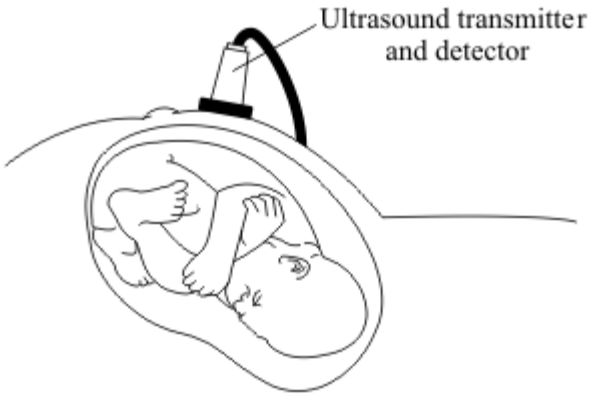
(ii) Why can some dog whistles be heard by dogs but not by humans?

.....

.....

(1)

(c) An ultrasound scan can be used to make a picture of a baby in its mother's womb. An ultrasound transmitter and detector are placed above the mother's womb. Ultrasound goes into the body of the mother and into the body of the baby.



Use the correct words from the box to complete the sentences.

detector	**reflection**	**refraction**	**sound**	**substance**	**transmitter**

(i) When the ultrasound crosses from one ..... to another,

some ultrasound becomes an echo caused by ..... .

(ii) This information is collected by the ultrasound .....

and made into a picture on a screen.

(3)
(Total 7 marks)

26 Ultrasound can be used in industry for detecting internal cracks in metals.

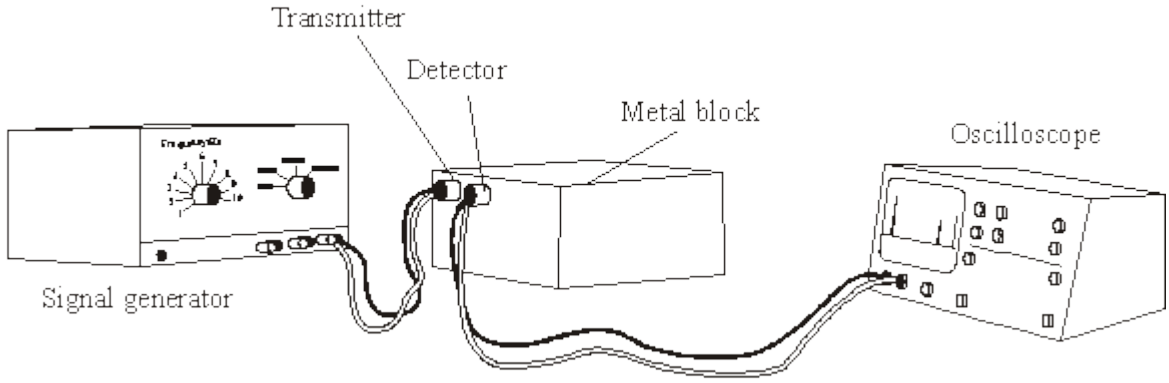
(a) State **two** features of ultrasound.

1 .....

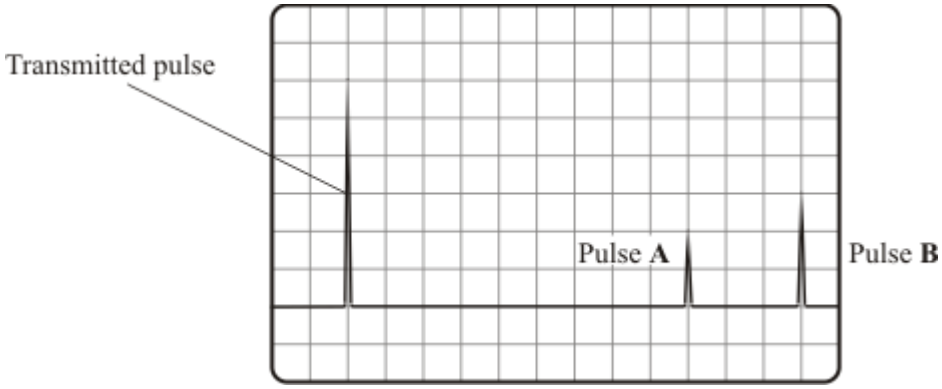
2 .....

(2)

(b) The diagram shows an ultrasound transmitter and detector fixed to the front of a metal block. The block has an internal crack.



The diagram below shows the screen of the oscilloscope connected to the detector.



(i) Explain why pulse **A** and pulse **B** occur.

.....

.....

.....

(2)

(ii) The metal block is 120 mm from front to back. What is the distance, in mm, from the front of the block to the internal crack?

Distance = ... mm

(1)

(Total 5 marks)

27 The picture shows a pre-natal scan obtained using ultrasonic waves.

(i) Explain how ultrasonic waves are used to produce the image of an unborn baby.

.....

.....

.....

.....

(2)

(ii) Give another use for ultrasonic waves.

.....

(1)
(Total 3 marks)

28 (a) What is ultrasound?

.....

.....

(1)

(b) The picture shows a pregnant woman having an ultrasound scan and the image produced by the scan.

To produce the image, a very narrow beam of ultrasound pulses is fired into the mother's body. The reflected pulses are used to build up the image of the unborn baby.

(i) Why is it important to have a very narrow beam of ultrasound waves?

.....

.....

(1)

(ii) Why is it possible to produce a very narrow beam with ultrasound but not with normal sound waves?

.....

.....

(1)

(iii) The image produced by ultrasound is not as clear as an image produced by X-rays. Why is ultrasound used for looking at unborn babies rather than X-rays?

.....

.....

(1)

(iv) Give **two** important pieces of information about an unborn baby which can be gained from the image produced by an ultrasound scan.

1 .....

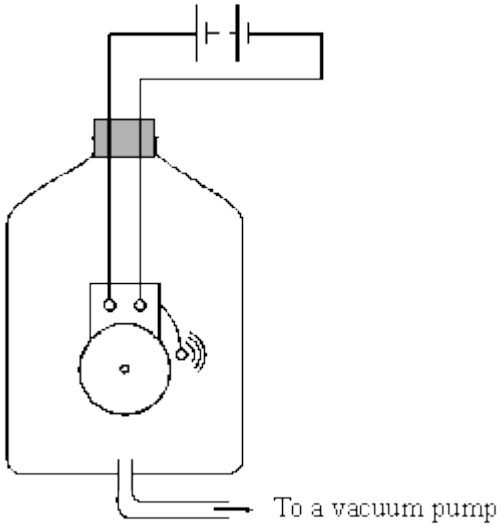
.....

2 .....

.....

(2)
(Total 6 marks)

29 (a) The diagram shows an electric bell inside a glass jar. The bell can be heard ringing.



In the following sentences, cross out the **two** lines that are wrong in each box.

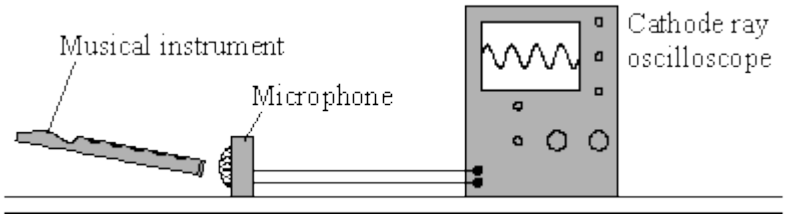
When all the air has been taken out of the glass jar, the ringing sound will

stop. get louder. get quieter.	This is because sound	travels faster travels slower cannot travel

through a vacuum.

(2)

(b) The microphone and cathode ray oscilloscope are used to show the sound wave pattern of a musical instrument.



One of the following statements describes what a microphone does. Tick the box next to the correct statement.

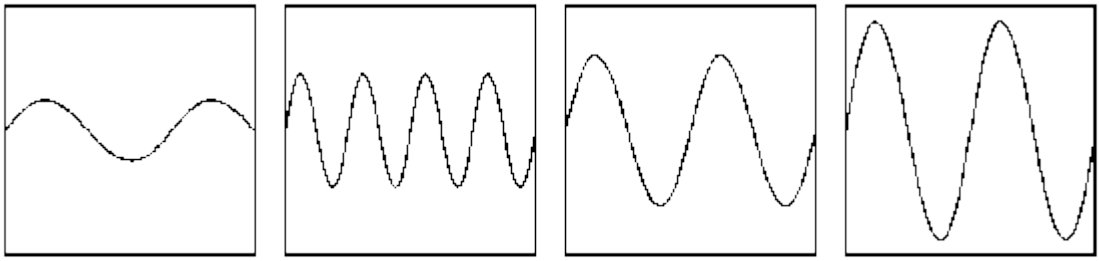
A microphone transfers sound energy tolight energy. ☐

A microphone transfers sound energy toelectrical energy. ☐

A microphone transfers electrical energy tosound energy. ☐

(1)

(c) Four different sound wave patterns are shown. They are all drawn to the same scale.



(i) Which sound wave pattern has the highest pitch?

.....

Give a reason for your answer.

.....

(2)

(ii) Which sound wave pattern is the loudest?

.....

Give a reason for your answer.

.....

.....

(2)
(Total 7 marks)

30 (a) Sound travels through air, water and glass at different speeds. Through which of these materials does sound travel:

the fastest; .....

the slowest? .....

(2)

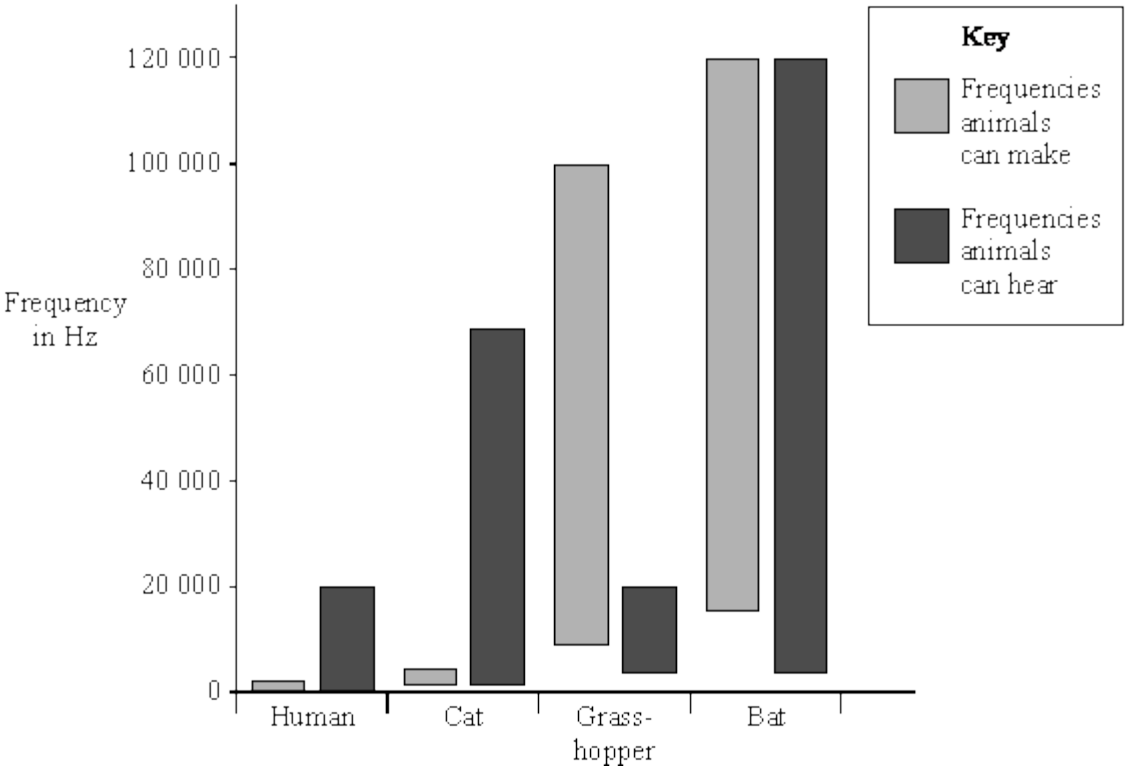
Give a reason for your choice of answers.

.....

.....

(1)

(b) The bar chart shows the frequencies of sound which different animals can make and can hear.



(i) Which of the animals can make sounds which are beyond their own hearing range?

.....

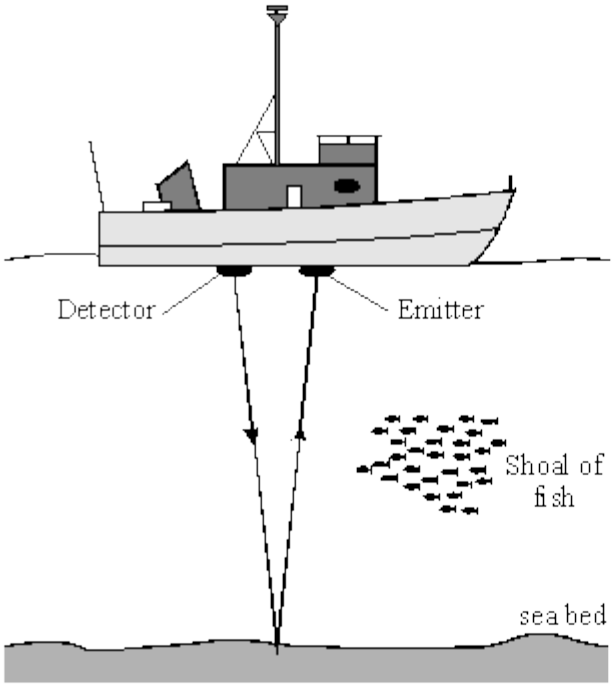
(1)

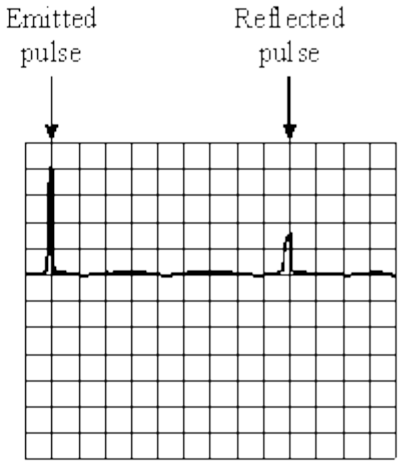
(ii) What name is given to the sounds which a cat can hear but a human cannot?

.....

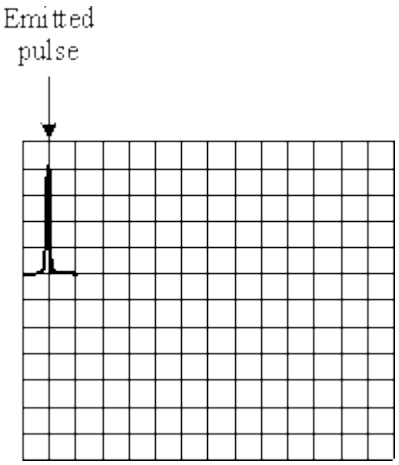
(1)

(c) The diagram shows a trawler searching for a shoal of fish. Pulses of high frequency sound emitted from the trawler are reflected back to the trawler. The pulses are displayed on a cathode ray oscilloscope.





Complete the diagram below to show the pattern seen on the cathode ray oscilloscope as the trawler passes over the shoal of fish.



(2)
(Total 7 marks)

31 Most young people can hear sounds in the frequency range 20 Hz to 20 000 Hz.

(a) Tick the box beside the statement which best describes frequency.

the maximum disturbance caused by a wave	☐
the number of complete vibrations per second	☐
the distance between one crest of a wave and the next one	☐
the distance travelled by a wave in 1 second	☐

(1)

(b) Diagram **X** shows a trace on an oscilloscope screen.

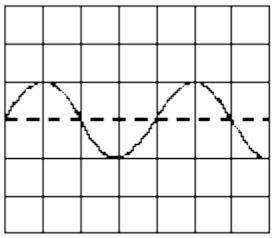


Diagram **X**

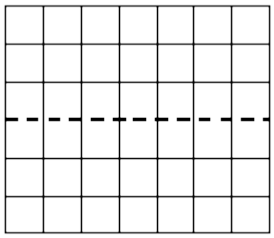


Diagram **Y**

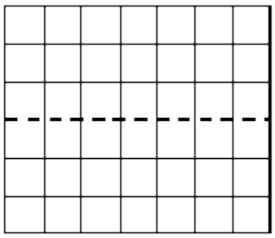


Diagram **Z**

(i) Draw a trace on diagram **Y** which has a higher frequency than that shown in diagram **X**.

(ii) Draw a trace on diagram **Z** which has a larger amplitude than that shown in diagram **X**.

(2)

(c) Choose words from the list below to complete the following sentences.

higher **louder** **lower** **quieter**

(i) A musical note with a high frequency sounds ..... than one with a low frequency.

(ii) A noise of small amplitude sounds ..... than one with large amplitude.

(2)
(Total 5 marks)

32 (a) Complete the following sentence:

Sound is produced when an object .....

(1)

(b) Choose words from the list to complete the following sentences:

higher **louder** **lower** **quieter**

(i) If the frequency is increased, the pitch of the sound becomes

.....

(ii) If its amplitude is increased, the sound becomes

.....

(2)

(c) The diagram shows a pre-natal scan.

(i) What type of waves are used for pre-natal scanning?

.....

(1)

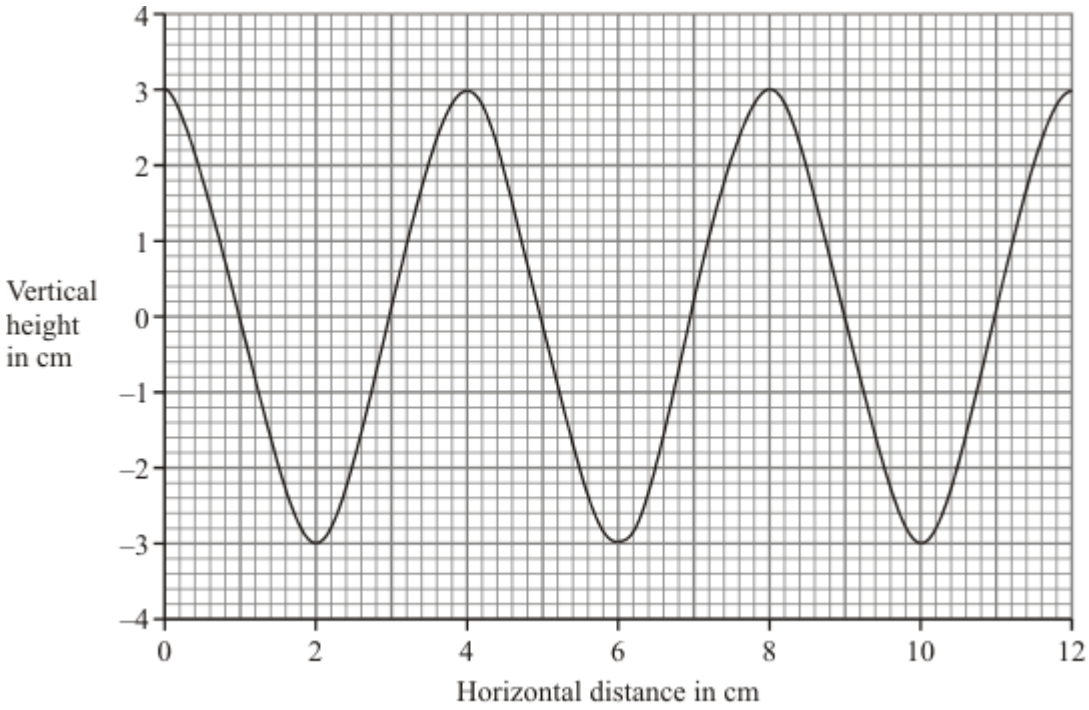
(ii) Explain why we cannot hear these waves.

.....

(2)

(Total 6 marks)

33 The diagram shows a water wave drawn to scale.



(a) What is the wavelength of this water wave? ..... cm

(1)

(b) What is the amplitude? ..... cm

(1)

(c) Twelve waves pass an observer in four seconds.

What is the frequency of the waves? Show clearly how you work out your answer and give the unit.

.....

.....

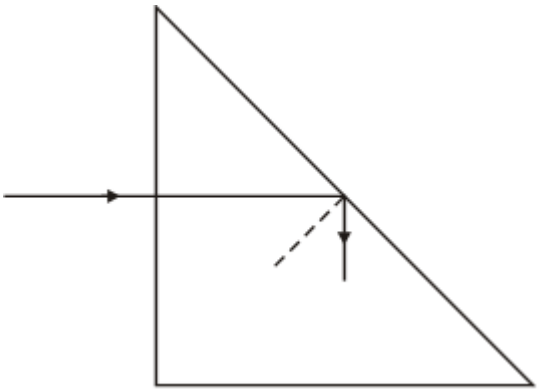
Frequency = ...

(3)

(Total 5 marks)

34 Glass prisms are used in many optical devices.

(a) The diagram shows what happens to a ray of light as it travels through a glass prism.



To gain full marks for this question you should write your ideas in good English. Put them into a sensible order and use the correct scientific words.

Use the words in the box to help you to explain why the ray behaves in this way.

angle	critical	normal

.....

.....

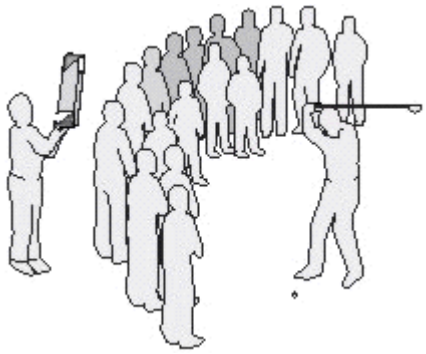
.....

.....

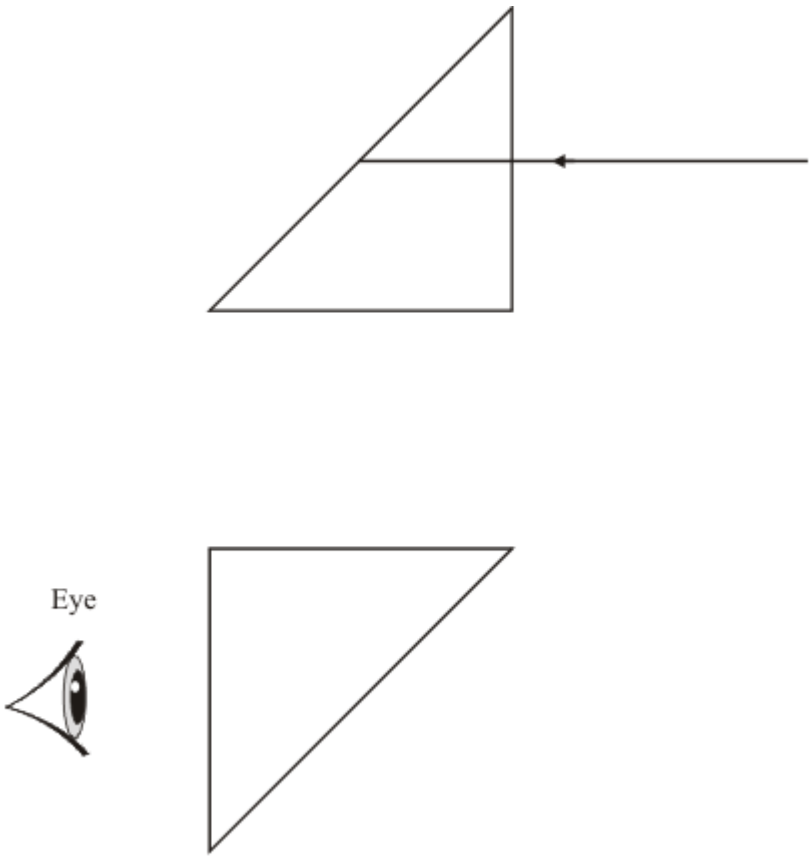
.....

(3)

(b) Periscopes can be used to look over the heads of other people.

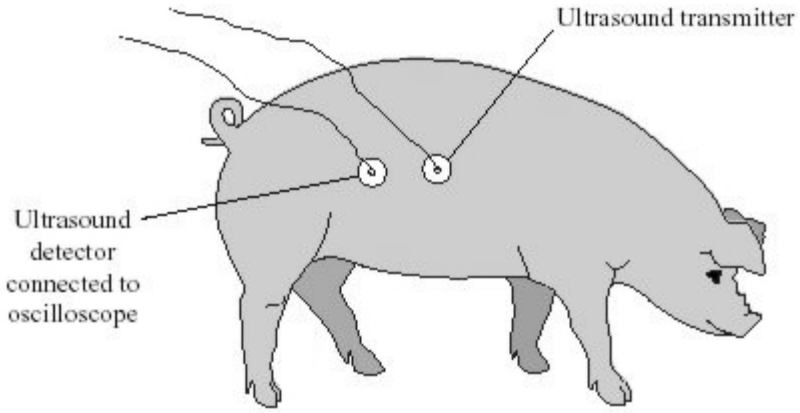


A periscope contains two glass prisms.
Complete the diagram to show the ray of light reaching the person's eye.



(3)
(Total 6 marks)

35 Pigs have a layer of fat in their skin. Underneath the fat is a layer of muscle. Ultrasonic waves are used to measure the thickness of the layer of fat. An ultrasound transmitter and detector are attached to the skin of the pig.



(a) Explain why ultrasound can be used to measure the thickness of the layer of fat.

.....

.....

.....

.....

(2)

(b) The oscilloscope does not measure distance directly.

(i) What does the oscilloscope measure in this case?

.....

.....

(1)

(ii) What other information is needed to calculate the thickness of the layer of fat in a pig?

.....

.....

(1)
(Total 4 marks)

36 The table gives the frequencies of sound that different animals can hear.

Animal	Lowest frequency it can hear in Hz	Highest frequency it can hear in Hz
Human	64	23 000
Dog	67	45 000
Mouse	1 000	91 000
Rat	200	76 000
Cat	45	64 000
Tuna	50	1 100
Canary	250	8 000
Chicken	125	2 000

(a) (i) Which animal can hear the lowest sound frequency?

.....

(1)

(ii) Which animal can hear the smallest range of frequencies?

.....

(1)

(b) (i) What is the name given to sound frequencies higher than those that humans can hear?

.....

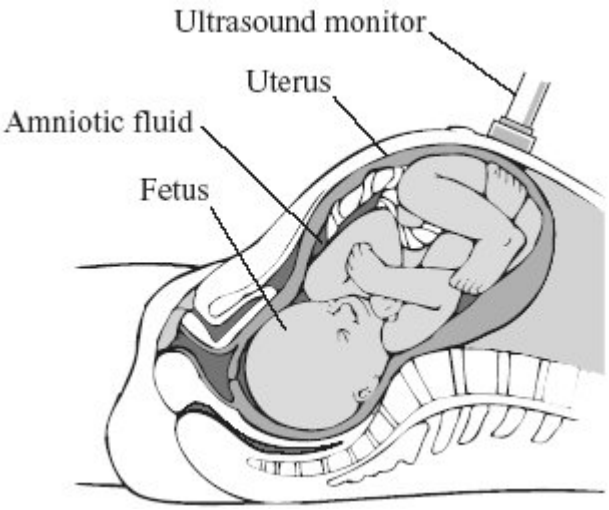
(1)

(ii) Give **one** industrial use of this type of sound.

.....

(1)
(Total 4 marks)

37 The diagram shows an ultrasound monitor being used to scan a fetus.



The table shows the velocity of ultrasound waves in different tissues of the fetus.

Tissue	Velocity of ultrasound in m/s
Amniotic fluid (liquid surrounding fetus)	1540
Bone	3080
Kidney	1561
Liver	1549
Muscle	1585

Explain why we are able to see the different parts of the fetus in an ultrasound scan. You may use information from the table in your answer.

To gain full marks in this question you should write your ideas in good English. Put them into a sensible order and use the correct scientific words.

.....

.....

.....

.....

.....

(Total 4 marks)

38 (a) The student is using a microphone connected to a cathode ray oscilloscope (CRO).

The CRO displays the sound waves as waves on its screen. What does the microphone do?

.....

.....

.....

(2)

(b) The amplitude, the frequency and the wavelength of a sound wave can each be either increased or decreased.

(i) What change, or changes, would make the sound quieter?

.....

(1)

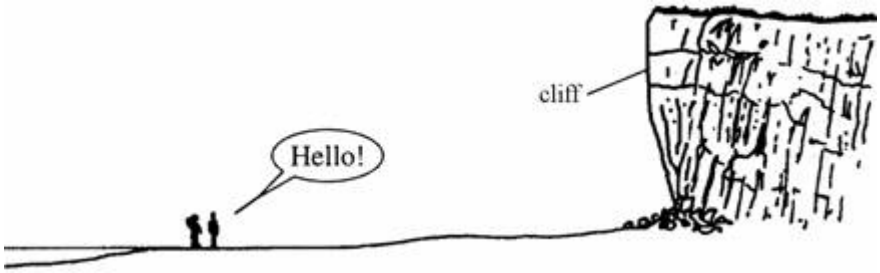
(ii) What change, or changes, would make the sound higher in pitch?

.....

(1)
(Total 4 marks)

39 Two friends are standing on a beach.

When they shout they can hear themselves a second later.



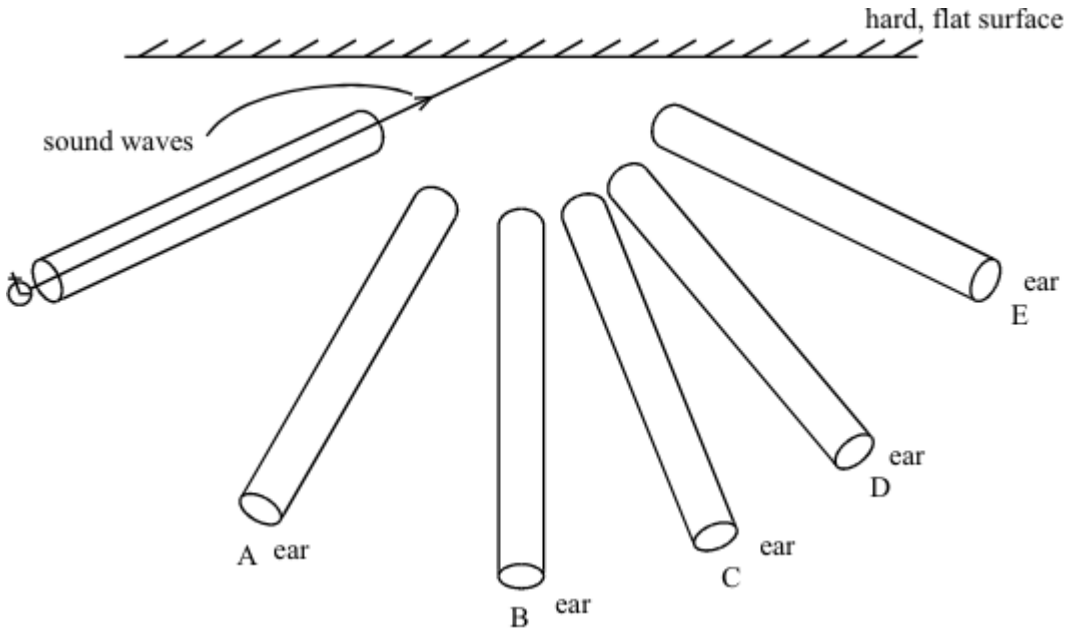
Explain, as fully as you can, why this happens.
(You may answer on the diagram if you want to.)

.....

.....

(Total 2 marks)

40 A hard, flat surface reflects sound just like a plane (flat) mirror reflects light.



You want to hear the reflection (echo) of the ticking watch through a tube.

Which is the best position to put the tube?

Choose from positions A-E on the diagram .....

(You may draw on the diagram if you want to.)

(Total 2 marks)

Mark schemes

1

(a) K

1

(b) Decreases

1

(c) use a metre rule / 30 cm ruler to measure across 10 (projected) waves

accept any practical number of waves number for 10

1

and then divide by 10

1

(d) 1.2 cm = 0.012 m

1

18.5 × 0.012 = 0.22(2) (m / s)

1

*allow 0.22(2) with no working shown for **2** marks*

typical walking speed = 1.5m / s

accept any value e.g. in the range 0.7 to 2.0 m / s

1

so the water waves are slower (than a typical walking speed)

this cannot score on its own

1

[8]

2

(a) in a longitudinal wave the oscillations / vibrations are parallel to the direction of energy transfer.

accept wave travel for energy transfer throughout

1

in a transverse wave the oscillations / vibrations are perpendicular to the direction of energy transfer.

1

(b) accept any sensible suggestion eg a vibrating drum skin does not move the air away to create a vacuum (around the drum)

1

(c) **Level 3 (5–6 marks):**
A detailed explanation linking variations in current to the pressure variations of a sound wave, with a logical sequence.

Level 2 (3–4 marks):
A number of relevant points made, but not precisely. A link between the loudspeaker and a sound wave is made.

Level 1 (1–2 marks):
Some relevant points but fragmented with no logical structure.

0 marks:
No relevant content.

Indicative content

the current in the electrical circuit is varying

the current passes through the coil

the coil experiences a force (inwards or outwards)

reversing the current reverses the force

the size of the current affects the size of the force

the varying current causes the coil to vibrate

the (vibrating) coil causes the cone to vibrate

the vibrating cone causes the air molecules to move

the movement of the air molecules produces the pressure variations in the air needed for a sound wave

the air molecules bunch together forming compressions and spread apart forming rarefactions

6

[9]

3 (a) pitch

1

loudness

1

(b) (i) as length (of prongs) decreases frequency / pitch increases

accept converse

accept negative correlation

ignore inversely proportional

1

(ii) 8.3 (cm)

accept 8.3 ± 0.1 cm

1

(iii) (8.3 cm is) between 7.8 (cm) and 8.7 (cm)

*ecf from part **(ii)***

1

(so *f* must be) between 384 (Hz) and 480 (Hz)

1

410 (Hz) ≤ *f* ≤ 450 (Hz)

*if only the estimated frequency given, accept for **1** mark an answer within the range*

1

(c) (i) electronic

1

(ii) frequency is (very) high

accept frequency above

*20 000 (Hz) **or** audible range*

1

so tuning fork ***or*** length of prongs would be very small (1.2 mm)

1

(d) 285.7 (Hz)

accept any correct rounding 286, 290, 300

*allow **2** marks for 285*

*allow **2** marks for correct substitution 0.0035 = 1 / f*

*allow **1** mark for T = 0.0035 s*

*allow **1** mark for an answer of 2000*

3

[13]

4

(a) (i) 440 (sound) waves produced in one second

accept vibrations / oscillations for waves

1

(ii) 0.773 (metres)

*allow **2** marks for an answer that rounds to 0.773*

*allow **2** marks for an answer of* $0.7\dot{7}\dot{2}$

*allow **2** marks for an answer of 0.772*

*allow **1** mark for correct substitution ie 340 = 440 × λ*

3

(b) (sound is) louder

*do **not** accept the converse*

1

as amplitude is larger

waves are taller is insufficient

1

higher pitch / frequency

1

as more waves are seen

reference to wavelengths alone is insufficient

waves are closer together is insufficient

1

[8]

5 (a) (sound waves) which have a frequency higher than the upper limit of hearing for humans
or
a (sound) wave (of frequency) above 20 000 Hz

sound waves that cannot be heard is insufficient

a wave of frequency 20 000 Hz is insufficient

1

(b) 640

*an answer of 1280 gains **2** marks*

*allow **2** marks for the correct substitution*

ie 1600 × 0.40 provided no subsequent step

*allow **2** marks for the substitution* $\frac{1600 \times 0.80}{2}$

provided no subsequent step

*allow **1** mark for the substitution 1600 × 0.80 provided no subsequent step*

*allow **1** mark for the identification that time (boat to bed) is 0.4*

3

(c) any **one** from:

- pre-natal scanning / imaging
- imaging of a named organ (that is not surrounded by bone), eg stomach, bladder, testicles

  accept heart

  *do **not** allow brain **or** lungs (either of these negates a correct answer)*
- Doppler scanning blood flow

1

(d) advantage

any **one** from:

- (images are) high quality or detailed or high resolution

  clearer / better image is sufficient
- (scan) produces a slice through the body
- image can be viewed from any direction

  allow images are (always) 3D / 360°
- an image can be made of <u>any</u> part (inside the body)

  allow whole body can be scanned
- easier to diagnose **or** see a problem (on the image)

1

disadvantage

any **one** from:

- (the X-rays used **or** scans) are <u>ionising</u>

  allow a description of what ionising is
- mutate cells **or** cause mutations **or** increase chances of mutations

  allow for cells:

  DNA / genes / chromosomes / nucleus / tissue

- turn cells cancerous **or** produce abnormal growths **or** produce rapidly growing cells
- kill cells

  damage cells is insufficient
- shielding is needed

  can be dangerous (to human health) unqualified, is insufficient

1

[7]

6 (a) (i) 20

1

20 000

either order

accept ringed answers in box

1

(ii) (frequency) above human range

accept pitch for frequency

or

(frequency) above 20 000 (Hz)

*do **not** accept outside human range*

*allow ecf from incorrect value in **(a)(i)***

1

(iii) any **one** from:

- pre-natal scanning

  accept any other appropriate scanning use

  *do **not** accept pregnancy testing*
- removal / destruction of kidney / gall stones
- repair of damaged tissue / muscle

  accept examples of repair, eg alleviating bruising, repair scar damage, ligament / tendon damage, joint inflammation

  accept physiotherapy

  accept curing prostate cancer or killing prostate cancer cells
- removing plaque from teeth

  cleaning teeth is insufficient

1

(b) 7.5×10^{-4} (m)

*$1.5 \times 10^3 = 2.0 \times 10^6 \times \lambda$ gains **1** mark*

2

(c) for reflected waves

must be clear whether referring to emitted or detected / reflected waves

if not specified assume it refers to reflected wave

any **two** from:

- frequency decreased
- wavelength increased
- intensity has decreased

allow amplitude / energy has decreased
allow the beam is weaker

2

[8]

7

(a) the oscillation / vibration (causing the wave)

a movement causes the wave is insufficient

1

for a transverse wave is perpendicular to the direction of energy transfer

accept direction of wave travel

1

and for a longitudinal wave is parallel to the direction of energy transfer

accept direction of wave travel

*if no marks awarded allow **1** mark for correctly linking perpendicular with transverse and parallel with longitudinal*

the marks may be scored by the drawing of two correctly labelled diagrams

1

(b) for radio waves:

accept converse for each mark

are transverse

1

travel at speed of light / higher speed

1

have greater frequencies

1

can travel through vacuum

*accept sound waves are not electromagnetic for **1** mark*

1

[7]

8

(a) (i) perpendicular

accept correct description 1

1

(ii) light off – no / slow rotation

1

light on – fast(er) rotation

accept starts rotating

ignore references to energy transfers

1

(b) one ray drawn from wrist watch and reflected by mirror

accept solid or dashed lines

1

two rays drawn from wrist watch and reflected by mirror with i = r for both rays

judge angles by eye

1

one ray traced back behind mirror

accept solid or dashed lines

1

image in correct position

judged by eye

accept image marked where two reflected rays traced back cross behind the mirror

1

(c) cannot be formed on a screen

accept image formed behind the mirror

or

rays of light seem to come from it but do not pass through it

1

[8]

9 (a) Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information in the Marking guidance, and apply a 'best-fit' approach to the marking.

0 marks
No relevant / correct content.

Level 1 (1-2 marks)
There is a basic description of either wave
OR
What happens to either wave when they enter the body. However there is little other detail.

Level 2 (3-4 marks)
There is either:
A clear description of BOTH waves
OR
A clear description as to what happens to BOTH waves inside the body
OR
A clear description of ONE of the waves with clear detail as to what happens to either wave inside the body.

Level 3 (5-6 marks)
There is a detailed description of BOTH of the waves
AND
A detailed description as to what happens to EITHER wave inside the body.

Examples of the points made in the response:

Description of an X-ray

- X-rays are electromagnetic waves / part of the electromagnetic spectrum
  *do **not** allow a description of a property – eg X-rays travel*
- X-rays are (very) high frequency (waves)
  through a vacuum / at the speed of light
- X-rays are (very) high energy (waves)
- X-rays have a (very) short wavelength
- Wavelength (of X-rays) is of a similar size to (the diameter of) an atom
- X-rays are a transverse wave
  correct description acceptable – oscillations / vibrations are perpendicular (at 90°) to direction of energy transfer
- X-rays are ionising radiation

Description of ultrasound

- ultrasound has a frequency above 20 000 (hertz)

  or

  ultra sound is above 20 000 hertz
- ultrasound is above / beyond the human (upper) limit (of hearing)
  accept ultrasound cannot be heard by humans
- ultrasound is a longitudinal wave
  correct description acceptable – oscillations / vibrations (of particles) are parallel (in same direction) to direction of energy transfer

Statement(s) as to what happens to X-rays inside the human body:

- X-rays are absorbed by bone
- X-rays travel through / are transmitted by tissue / skin

Statement as to what happens to ultrasound inside body:

- ultrasound is (partially) reflected at / when it meets a boundary between two different media
- travel at different speeds through different media

(b) (because the X-rays) are <u>ionising</u>

accept a description of what ionising is

1

(they will) damage cells

instead of cell, any of these words can be used:

DNA / genes / chromosomes / nucleus

or

mutate cells / cause mutations / increase chances of mutations

or

turn cells cancerous / produce abnormal growths / produce rapidly growing cells

*do **not** accept they can be dangerous (to human health)*

*do **not** accept damage to soft tissue*

or

kill cells

1

(c) any **one** from:

- removal / destruction of kidney / gall stones
- repair of damaged tissue / muscle

accept examples of repair, eg alleviating bruising, repair scar damage, ligament / tendon damage, joint inflammation

accept physiotherapy

*accept curing prostate cancer **or** killing prostate cancer cells*

- removing plaque from teeth

cleaning teeth is insufficient

1

[9]

10 (a) (i) wavelength

accept frequency

accept speed

1

(ii) amplitude

accept energy

height is insufficient

1

(iii) sound

1

(b) 0.12

*allow **1** mark for correct substitution, ie 8 × 0.015 provided no subsequent step shown*

2

metre per second **or** m/s **or** metre/second

*do **not** accept mps*
units must be consistent with numerical answers

1

[6]

11

(a) (i) bat(s)

1

(ii) any example in the inclusive range 5 ↔ 29 Hz / hertz

appropriate number and unit both required

1

(b) (i) A, C, D

all three required and no other

1

(ii) D, E

both required and no other

1

(c) sound cannot travel through a vacuum / (empty) space / free space

accept there is no medium (for the sound to travel through)
*do **not** accept there is no air (for the sound to travel through)*

1

(because) there is / are nothing / no particles to vibrate

accept because there is / are nothing / no particles between them and the source (of the sound)

1

[6]

12

(a) any **two** from:

- (sound with frequency) above 20 000 hertz / 20 kHz
- frequencies above (human) audible range
- (sound) cannot be heard by humans

2

(b) **either**
two appropriate points gain **1** mark each

either *both pro / con* ***or*** *one of each*

or
one appropriate point (and) appropriate qualification / amplification

examples
other mammals (sufficiently) similar to humans (1)
so results appropriate (1)
unethical to experiment on humans (1)
so it is better to experiment on mice (1)
knowledge / techniques will benefit humans (1)
and also other animals (1)
experiments were justified because ultrasound has proved useful (1)

2

(c) examples

allow a wide variety of appropriate responses

publish / tell doctors / the public (1)
…their evidence / results / research / data (1)

valid point (1)
appropriate example / qualification / expansion / etc (1)

carry out more research / tests (1)
…to make sure / check reliability (1)

allow just 'stop using them / ultrasonic waves' for ***1*** *mark only*
allow using them (only) for industrial purposes for ***1*** *mark only*

2

[6]

13 (a) (i) **J** and **L**

both required, either order

1

(ii) **K**

1

(iii) **L**

1

highest frequency

reason does not score if ***L*** *not chosen*
accept most waves (on screen)
do ***not*** *accept frequency above 20 000(Hz)*
do ***not*** *accept cannot hear it*

1

(b) transmitter

detector

computer

all three in correct order

*allow **1** mark for one correct*

2

[6]

14 (a) (i) 3

1

(ii) 30 000 **or** 10 000 × their (a)(i) correctly calculated

1

(iii) any **two** from:

- frequency is above 20 000 (Hz)
  accept the frequency is 30 000
- frequency is above the upper limit of audible range
- upper limit of audible range equals 20 000 (Hz)
  ignore reference to lower limit
- it is ultrasound/ultrasonic

2

(b) (i) wave (partially) reflected

1

at crack to produce **A** and end of bolt to produce **B**

accept at both ends of the crack

1

(ii) 0.075 (m) allow **2** marks for time = 0.0000125

*allow **1** mark for time = 0.000025*

*answers 0.15 **or** 0.015 **or** 0.09 gain **2** marks*

*answers 0.18 **or** 0.03 gain **1** mark*

the unit is not required but if given must be consistent with numerical answer for the available marks

3

[9]

15 (a) letter C clearly marking a compression

accept C at any point in a compression

if more than one letter C marked
all must be correct

1

(b) (i) straight continuous line drawn from loudspeaker to metal to sound sensor

judge by eye

1

angle I = angle R

judge by eye

ignore any arrows on lines

1

(ii) less sound reflected

accept energy for sound

or

(some) sound passes through the glass

accept (some) sound absorbed by the glass

1

(iii) makes the sound louder

1

(iv) $v = f \times \lambda$

340

*allow **1** mark for correct substitution*
ie 850 × 0.4

provided no subsequent step shown

2

(c) echo

1

(d) (i) from 250 Hz to 750 Hz

1

(ii) curtains reduce (percentage of) sound reflected more (than carpet)

accept curtains absorb more sound (than carpet)

1

for all frequencies (shown)

accept for both marks an answer in terms of walls having a larger (surface) area to reflect sound and curtains reducing the amount of reflected sound more (than carpet)

*answers less noisy or walls / curtains have a larger area gain **1** mark only*

*do **not** accept curtains are cheaper*

1

[11]

16 (a) 10 600 (Hz)

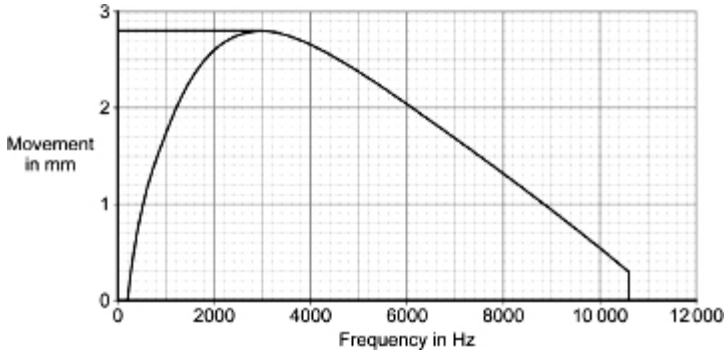
accept 10.6 kHz

1

(b) 3000 (Hz)

*allow **1** mark for a line drawn to show greatest movement (allow only if frequency is between 2800 and 3200)*

accept other indication of correctly using the graph



2

(c) (No)

no marks for just the ticked box

reasons can score even if yes is ticked

(human hearing) range is 20 – 20 000 (Hz)

accept (most) people hear up to 20 000 (Hz) / 20 kHz

1

any **one** from:

- range on graph is within this range
- range on graph starts after 20 Hz
- range on graph is from to 200 – 10 600 (Hz)
- range on graph finishes before 20 000 Hz

1

(d) reliability

this answer only

1

(e) only 1 variable affects dependent variable / size of movement

accept 'results' for 'size of movement'

or

there is only one independent variable

fair test is insufficient

*do **not** accept to control the experiment*

or

to be able to compare (effect of different frequencies)

1

[7]

17 (a) vibrate

*allow move more (vigorously) but **not** just move*

1

dirt / muck / grit / rust / dust etc.

*do **not** accept bacteria*

1

(b) any **one** medical use eg

ignore incorrect biological detail

- scanning unborn babies
- destroying (kidney) stones

1

(c) (i) 2

1

(ii) C

1

[5]

18 (a) microphone

1

(c) (i) vertical line from any maxima or minima to axis

*do **not** penalise minor errors but*

*do **not** allow unless intention is clear*

1

(ii) loudness / volume / intensity / energy

*do **not** accept noise*

1

(c) 17

this answer only

1

(d) the greater the distance, the smaller the amplitude

accept volume / intensity / energy / loudness for amplitude

or

there is a (strong) negative correlation between distance and amplitude

or

there is an inverse square relationship between distance and amplitude

*do **not** accept distance and amplitude are inversely proportional*

1

(e) 20 Hz

either order

1

20,000 Hz

accept 20 kHz provided unit has been clearly changed

1

[7]

19 (a) sound / mechanical / longitudinal (wave)

1

any **one** from:

- above 20 000 hertz / 20kHz
- above (human) audible range
- cannot be heard by humans

1

(b) **either**

particles / molecules / fluid vibrate(s) (1)

(and) knock particles of dirt off the jewellery (1)

or

by the process of cavitation (1)

accept 'formation and collapse of tiny bubbles'

which breaks up / releases dirt from the surface (1)

2

(c) ***either*** *both pro*
or *both con*
or *one of each*

either

two appropriate points gain **1** mark each

or

one appropriate point (and) appropriate qualification / amplification

examples
other mammals (sufficiently) similar to humans (1)
so results appropriate (1)
unethical to experiment on humans (1)
so it is better to experiment on mice (1)
knowledge / techniques will benefit humans (1)
and also other animals (1)
experiments were justified because ultrasound has proved useful (1)

2

[6]

20 (a) 20000

accept any unambiguous indication

1

(b) kilohertz

credit misspellings
credit '1000 hertz' or '1000 Hz'
accept 1000 oscillations/beats/waves <u>per second</u>

1

(c) (i) cleaning (e.g. something delicate such as a watch)

or *quality control/flaw detection*

credit any appropriate extra Specification response
e.g. sonar

1

(ii) pre-natal (scanning)

*do **not** credit just 'scanning'/medical scanning/ scanning a baby*

credit any appropriate extra Specification response
e.g. destruction of (kidney) stones or cleaning teeth

1

(d) 8 (µs)

1

(e) distance (1)

between the boundary and the detector (1)

accept 'between the boundary and the source'

accept any correct use of speed = distance/time

2

(f) examples

publish/tell doctors/the public (1) ... their evidence/results/research/data (1)

carry out more research/tests (1) ... to make sure/check reliability (1)

allow a wide variety of appropriate responses
valid point (1) appropriate example/qualification/expansion/etc. (1)

allow just 'stop using them/ultrasonic waves' (1)

allow using them (only) for industrial purposes (1)

2

[9]

21 (a) (i)

correct order essential

(**A** =) a microphone

1

(**B** =) an oscilloscope

or *cathode ray oscilloscope* ***or*** *CRO*

1

(ii) the amplitude

accept any unambiguous indication

1

(iii) quieter / softer

*do **not** accept less (which could refer to the amplitude, frequency or wavelength)*

1

(b) sound cannot travel through a vacuum / (empty) space / free space

accept there is no medium for the sound to travel through

1

(because) there is / are nothing / no particles to vibrate

accept (because) there is / are nothing / no particles between them and the source (of the sound)

1

[6]

22 (a) (i) same frequency / period / pitch / wavelength

ignore references to amplitude

1

(ii) differences in waveform / shape / quality

accept the diagrams are not identical

1

(b) (i) 20 000 Hz / hertz

or 20 kHz / kilohertz

*in both cases, if the **symbol** rather than the name is used, it must be correct in every detail*

1

(ii) material(s) / substance(s) (through which sound travels)

1

(iii) is absorbed

accept (some) sound (energy) is transformed / transferred as heat / thermal energy

1

is transmitted

accept is refracted
accept changes speed
accept changes velocity

*do **not** accept is diffracted*
*do **not** accept is diffused*
*do **not** accept is dissipated*

1

[6]

23 (a) (i) 25 (%)

*do **not** accept ¼*

1

(ii) increases

1

(b) tick (✓) in top and bottom box

both required

1

(c) SHINY surfaces are good reflectors of infra-red radiation

accept white for shiny

or black surfaces are POOR reflectors of infra-red radiation

accept bad for poor
accept insertion of 'not' before 'good' in statement

or black surfaces are good EMITTERS of infra-red radiation

or black surfaces are good ABSORBERS of infra red radiation

1

[4]

-

24 (a) (mechanical) vibration(s)

***not** just 'particles knocking into each other'*
not reference to 'sound particles'

1

(b) K

1

(c) (i) reflected by the material from loudspeaker to microphone X

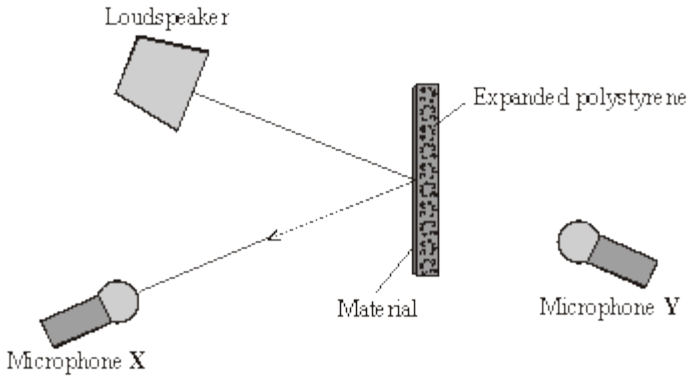
1

shown by straight lines with angle of incidence = angle of reflection (by eye) **and** at least one arrow in the correct direction

*do **not** credit if the direction is contradicted by any incorrect arrow / may be shown by waves / wavefronts in the direction of straight lines*

ignore any sound to Y or which 'misses' the material

example



1

(ii) any **one** from:

- so (the student) can compare results
- so only one (independent) variable
- to get reliable / accurate results
- because (the expanded) polystyrene absorbs some of the sound

*do **not** credit just 'so it's a fair test'*

1

(iii) **[A]** wood

1

[B] either 0.25 **or** 1/4 **or** 25 % **or** 15/60 **or** 1: 3

*do **not** credit 1 : 4*

1

(d) practical suggestion

1

appropriate reason / explanation

example *line / panel the walls with wood / plasterboard / increase the thickness of the plaster (on the walls) (1)*
(this) will absorb / reflect (back) (most / some of) the sound (1)

credit legal suggestions for attempting to limit the noise made by the neighbours
example *ask the neighbours to make less noise (1)*
by limiting the time(s) music played (1)

do ***not*** *credit reference to 'sound particles' for second mark*

1

[9]

25 (a) (i) **A**, **C** and **D**

any order but all three required and no others

1

(ii) **D** and **E**

either order but both required and no others

1

(b) (i) 20000 (Hz) to 20 (Hz)

accept '19980 (Hz)'

or vice-versa

1

(ii) frequency (of dog whistle) too high (for humans to hear) / frequency above 20000 Hz

accept 'it is ultrasound'

accept 'sound from the whistle is ultrasonic'

1

(c) (i) substance

1

reflection

correct order essential

1

(ii) detector

1

[7]

26 (a) any **two** points:

*do **not** credit features which are true of sound in general eg longitudinal waves*

- humans cannot hear ultrasound
- it has a very high frequency / pitch

  *do **not** credit just 'has a high frequency / pitch'*
- above the (upper) limit for humans / above 20 000 Hz

2

(b) (i) ultrasound / waves are reflected

...are bounced is insufficient, but
...echo is acceptable

1

Pulse **A** indicates / is the crack

Pulse **B** *i*ndicates / is the back (of the block or crack)

need to mention both A and B to get this mark

1

(ii) 90 (mm)

accept any answer in the range 88 – 92 (mm)

1

[5]

27 (i) (partly) reflected when they hit a (boundary between two) different media or substance or tissue

accept named substances

*do **not** accept bounce back*

1

time taken for reflected wave (to return) is used to produce the image

1

(ii) any **one** from:

cleaning a delicate mechanism / jewellery

*do **not** accept cleaning*

welding plastics

cutting textiles

mixing emulsion paints

sonar

motion sensors (in burglar alarms)

*do **not** accept burglar alarms*

removing dental plaque

industrial quality control

breaking up kidney stones

treating injuries

1

[3]

28 (a) sound with a frequency above audible

do not accept answer in terms of λ

do not accept sound which cannot be heard unless obvious from context

accept above 20 kHz

1

(b) (i) to show detail **or** to give a clear image/picture

*accept the generators **or** transducers can be small*

accept so the beam does not spread out/beam in focus

***not** 'good picture'*

1

(ii) (much) smaller wavelength

allow higher frequency/pitch

1

(iii) no damage to living cells (provided low power)

accept the converse

*accept no damage to baby **or** not dangerous to baby*

1

(iv) any **two** forms

sex

stage of development
or specific examples

abnormalities

general health

potential problems (at birth)
accept specific examples e.g. umbilical cord around neck

size of head
accept multiple births

2

[6]

29 (a) stop
accept any indication

cannot travel

2

(b) middle box ticked
accept a tick next to the statement even if not in the box
*do **not** accept two ticks*

1

(c) (i) B

highest frequency
accept most waves (in box)
accept 'squashed together'
*do **not** accept 'squashed'*
accept 'close (together)'
accept shortest wavelength

2

(ii) D

largest amplitude

*accept tallest **or** highest wave*
*do **not** accept biggest wave*
*do **not** accept 'high' wave*

2

[7]

30 (a) glass

1

air

must be in correct order

1

closer the particles faster the speed

answer must show a comparison

or

particles in glass closest in air furthest apart

accept the denser the material the faster the sound travels

or

sound travels faster in solids than gases

incorrect explanation negates credit

1

(b) (i) grasshopper

(ii) ultrasound

accept ultrasonic

1

(c) all of reflected pulse closer than given in original diagram

accept a cluster of pulses ignore a reflected pulse in original position any pulse drawn to right of original negates credit

1

reflected pulse smaller than emitted but greater than 1 square high

accept cluster of pulses provided one part fulfils height criteria

2

[7]

31 (a) number of complete vibrations per second

for 1 mark

1

(b) (i) correct trace (more waves), *ignore amplitude*

for 1 mark

1

(ii) correct trace (higher amplitude), *ignore frequency*

for 1 mark

1

(c) (i) higher

for 1 mark

1

(ii) quieter

for 1 mark

1

[5]

32 (a) vibrates (owtte)

for one mark

1

(b) (i) higher

for one mark

1

(ii) louder

for one mark

1

(c) (i) ultrasonic (ultrasound)

for one mark

1

(ii) different frequency / wavelength / pitch

gains 1 mark

but

high frequency / pitch, higher frequency /pitch (lower frequency / pitch *wrong*)

gains 2 marks

2

[6]

33 (a) 4

1

(b) 3

1

(c) 3

correct answer with no working = 2
allow 1 mark for f = number ÷ time
or correct working i.e., 12 ÷ 4
N.B. correct answer from incorrectly recalled relationship / substitution = 0

2

Hz / hertz

accept HZ, hz, hZ
allow waves / cycles per second
allow wps, w/s, cps, c/s

1

[5]

34 (a) Quality of written communication:
Correct use of 2 of the words, angle, critical, normal and reflection

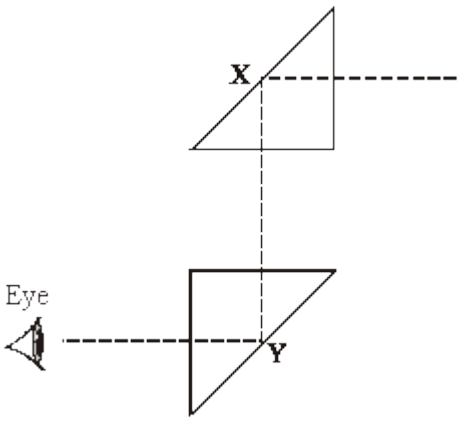
1

any **two** from

- light is reflected / bounces off
- if angle between ray and normal angle of incidence
- is greater than critical angle
- idea that no refraction bending if ray at 90°

2

(b)



*1 mark for reflection at **X** if ray would reach the lower prism*
*1 mark for subsequent reflection at **Y***
1 mark for subsequent ray emerging from prism in direction of front of eye
*accept dotted **or** dashed lines*
ignore any arrows

3

[6]

35 (a) (ultrasound) waves reflected

accept 'bounce off'

1

at boundary / from muscle

1

(b) (i) time

1

(ii) speed of (ultrasound) waves

1

[4]

36 (a) (i) cat

1

(ii) tuna

1

(b) (i) ultrasound

allow ultrasonic

1

(ii) cleaning / quality control / flaw detection / medical scanning / animal scaring / sonar

1

[4]

37 ***Quality of written communication***

correct use of **three** scientific terms from speed / velocity, reflection, density, time, boundary

1

any **three** from:

different tissues have different densities

ultrasound travels at different speeds / velocities in different tissues

reflection

accept bouncing back

from tissue boundaries

time taken to return

3

[4]

38 (a) changes the sound wave(s)

to a varying **or** changing (electric) potential difference **or** p.d. **or** voltage **or** current **or** to an irregular alternating current or a.c. **or** transfers sound energy to electrical energy (1) mark is vibrations **or** pulses **or** of sound **or** in air become electrical waves

do not credit just 'to electricity' ***or*** *'to a.c'*

2

(b) (i) decrease **or** reduce the amplitude

accept less amplitude nothing else added

1

(ii) increase the frequency **or** decrease wavelength

accept higher frequency nothing else added

1

[4]

39

- idea that (in words or on diagram)
- sound reflects / bounces off cliff
- returns the way it came / produces an echo

each for 1 mark

[2]

40

D

gains 1 mark

but E (D + E = 1)

gains 2 marks

[2]