Chapter 12 Wave Properties Exam Question Pack and Markscheme

Name: _____

Class: _____

Date: _____

Time: **176 minutes**

Marks: **176 marks**

Comments:

1 (a) A lorry has an air horn. The air horn produces sound waves in the air.

(i) Use **one** word to complete the following sentence.

Sound waves cause air particles to ..... .

(1)

(ii) The air horn produces sound waves at a constant frequency of 420 Hz.

The wavelength of the sound waves is 0.80 m.

Calculate the speed of the sound waves.

Use the correct equation from the Physics Equations Sheet.

.....

.....

.....

Speed = ... m/s

(2)

(b) A person standing at the side of the road, as the lorry goes past, hears the sound from the air horn change pitch.

(i) What determines the pitch of a sound?

Draw a ring around the correct answer.

amplitude **frequency** **loudness**

(1)

(ii) As the lorry moves away from the person, the air horn continues to produce sound waves with a wavelength of 0.80 m.

What is the wavelength of the sound waves the person heard?

Draw a ring around the correct answer.

shorter than 0.8 m **equal to 0.8 m** **longer than 0.8 m**

(1)

(iii) The sound waves the person heard from the moving air horn are different to the sound waves the air horn produced.

What name is given to this effect?

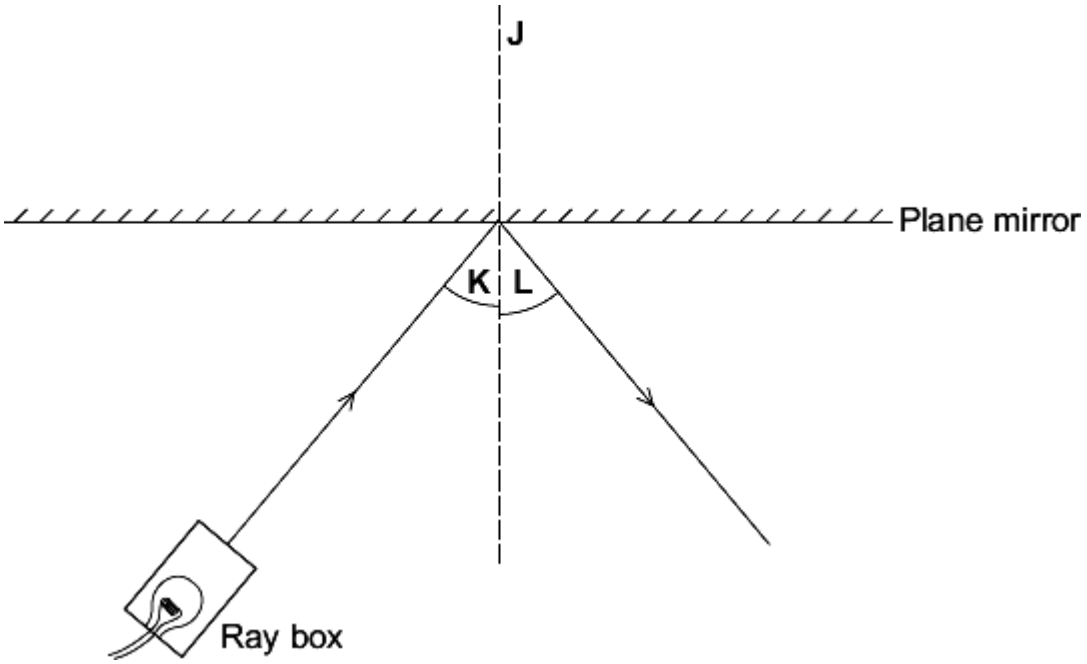
Draw a ring around the correct answer.

diffraction **Doppler** **refraction**

(1)

(Total 6 marks)

2 The diagram shows a ray of light from a ray box that is reflected by a plane mirror.



(a) What name is given to the dashed line labelled **J**?

Draw a ring around the correct answer.

incident **normal** **reflection**

(1)

(b) Draw a ring around the correct answer in the box to complete the sentence.

If the angle marked **K** is halved, then the angle marked **L** will

be doubled.
not change.
be halved.

(1)

(c) A student looking into the mirror can see an image of the ray box.

Which **two** words can be used to describe the image that the student sees?

Draw a ring around the **two** correct answers.

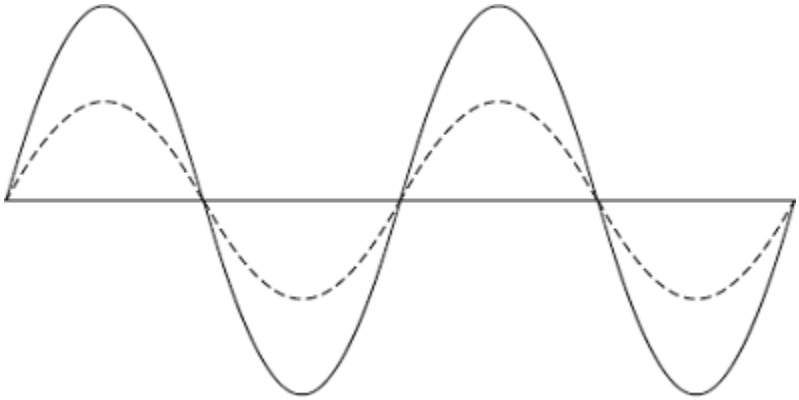
inverted **magnified** **real** **upright** **virtual**

(2)

(Total 4 marks)

3 (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?

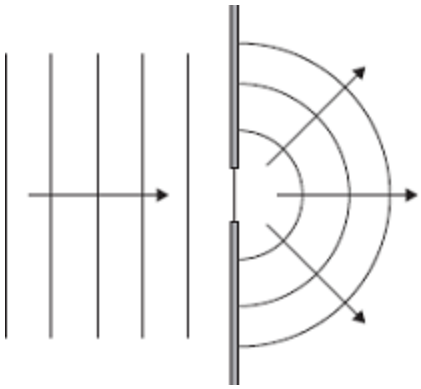
Draw a ring around the correct answer.

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



(i) The water waves spread out after passing through the gap in the barrier.

What name is given to the process causing the waves to spread out?

.....

(1)

(ii) 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.

Use the correct equation from the Physics Equations Sheet.

.....

.....

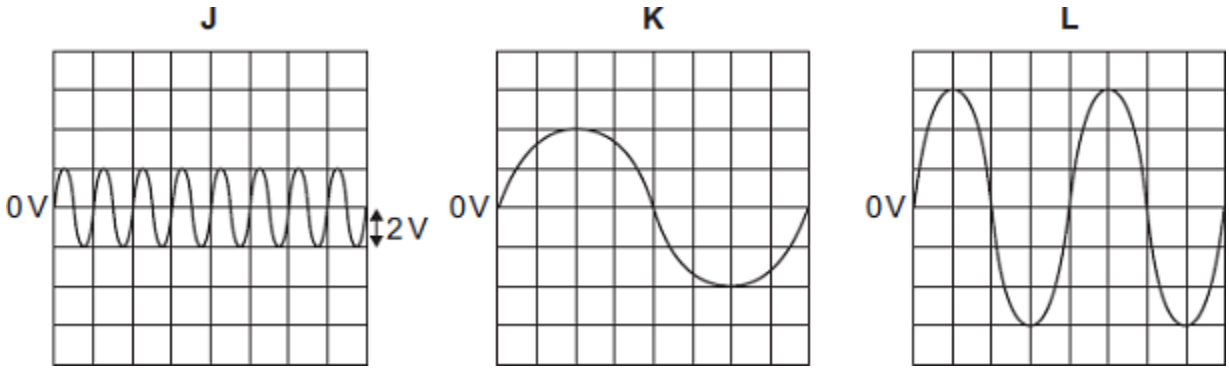
.....

Speed = ...

(3)

(Total 7 marks)

4 The diagrams show oscilloscope traces. Three different alternating current (a.c.) electricity supplies, **J**, **K** and **L**, produce these traces.



In each diagram, one vertical division on the oscilloscope screen represents 2 volts.

(a) Which **one** of the electricity supplies, **J**, **K** or **L**, has the largest peak potential difference?

Write your answer, **J**, **K** or **L**, in the box. ☐

(1)

(b) Calculate the value of the largest peak potential difference.

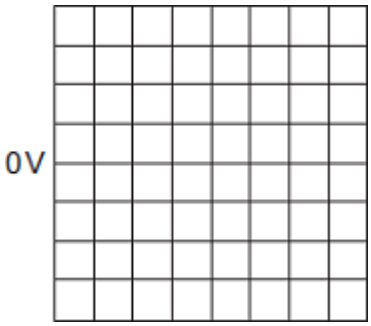
.....

Largest peak potential difference = ... V

(1)

(c) The oscilloscope is now connected across a 3 V battery. The battery supplies direct current (d.c.). The settings on the oscilloscope are **not** changed.

On the diagram below draw the trace you would see on the oscilloscope screen.



(2)

(Total 4 marks)

5 (a) A swimming pool has a wave making machine. The diagram shows the water wave pattern for 3 seconds.

(i) How many water waves are shown in the diagram?

.....

(1)

(ii) What is the frequency of the water waves?

.....

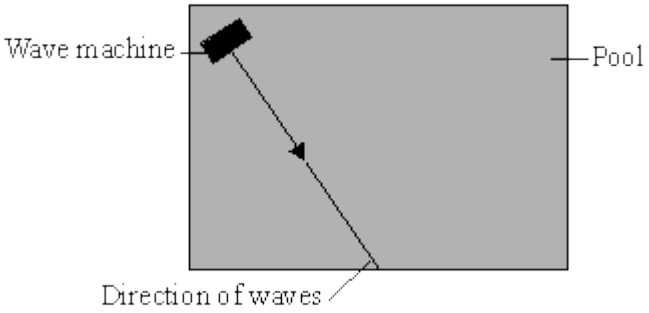
(1)

(iii) Which **one** of the units below is used to measure frequency? Underline your answer.

hertz joule watt

(1)

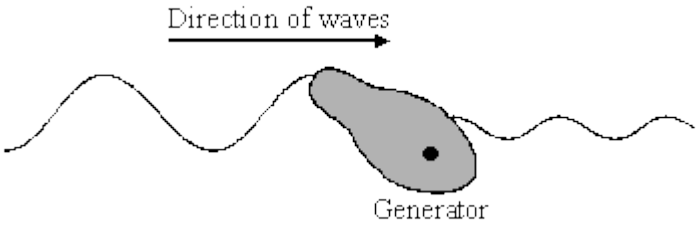
(b) The diagram shows the direction of the waves across the pool. The waves reflect off the side of the pool.



Draw a line on the diagram to show the direction of the waves after they hit the side of the pool.

(1)

(c) The swimming pool is used to test a model of an electricity generator. The waves make the floating generator move up and down. This energy is transferred to electricity.



(i) In the following sentence, cross out the **two** lines that are wrong in the box.

The diagram shoes that the amplitude of the waves

gets larger
stays the same
gets smaller

as the waves pass the generator.

(1)

(ii) What type of energy does the generator transfer to electricity?

.....

(1)

(iii) Energy from ocean waves could be used to generate electricity. Would this be a renewable or non-renewable energy resource?

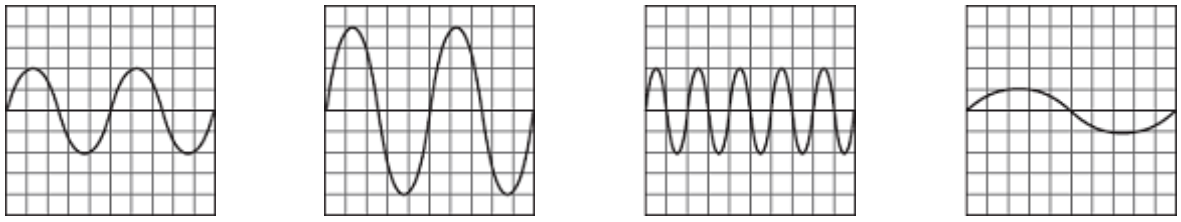
.....

(1)

(Total 7 marks)

6 (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 .....

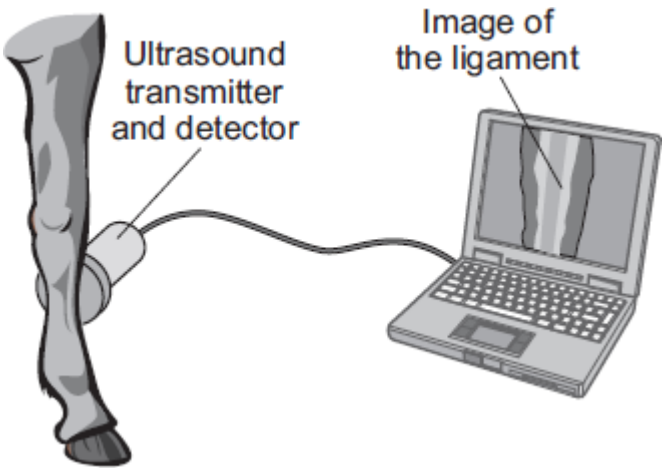
Give a reason for your answer.

.....

.....

(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.

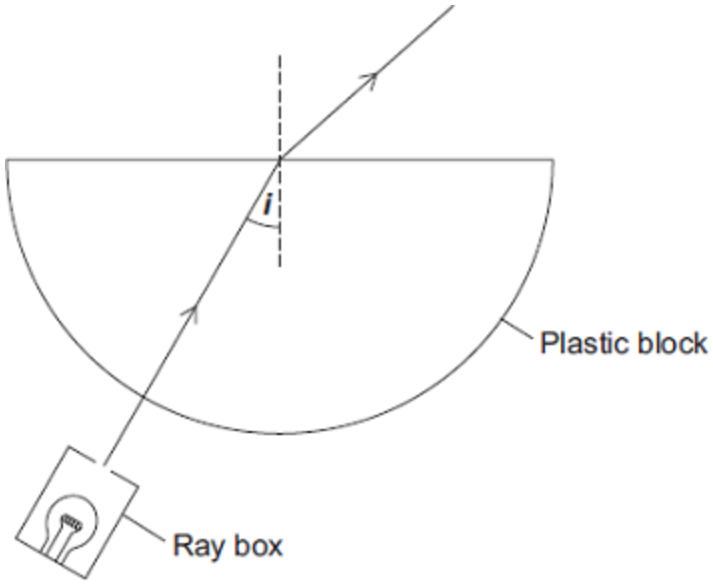
(2)

(Total 6 marks)

7 A student investigated the refraction of light as it passed out of a clear plastic block into the air.

Diagram 1 shows the apparatus the student used.

Diagram 1

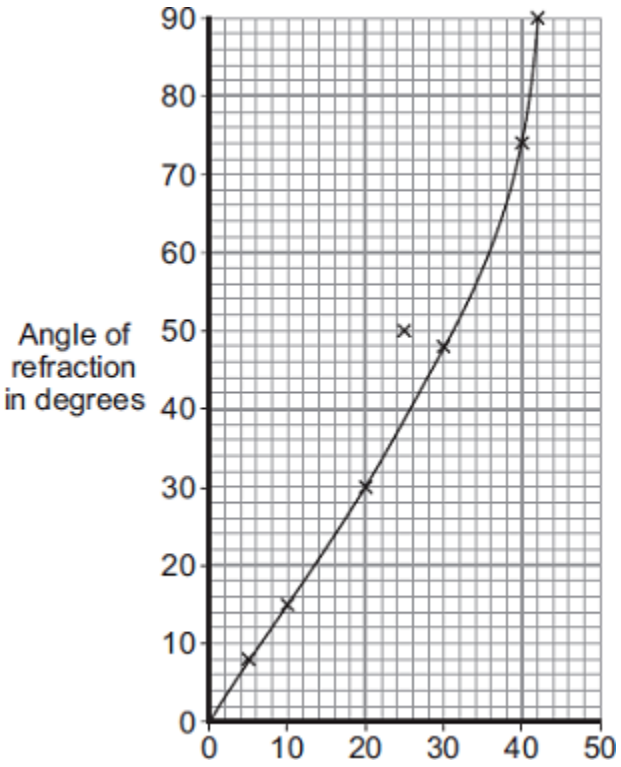


(a) The angle ***i*** is the angle of incidence.

Use the letter ***r*** to mark the angle of refraction on **Diagram 1**.

(1)

(b) The student measured the angle of refraction for different angles of incidence.
The results are shown in the graph.



(i) One of the results seems to be anomalous.

Draw a ring around the anomalous data point on the graph.

(1)

(ii) The student did measure the angles of incidence accurately.

What is likely to have caused the anomalous result?

.....

.....

(1)

(iii) What conclusion can the student make from the results shown in the graph?

Draw a ring around the correct answer to complete each sentence.

The angle of refraction is

less than
equal to
greater than

the angle of incidence.

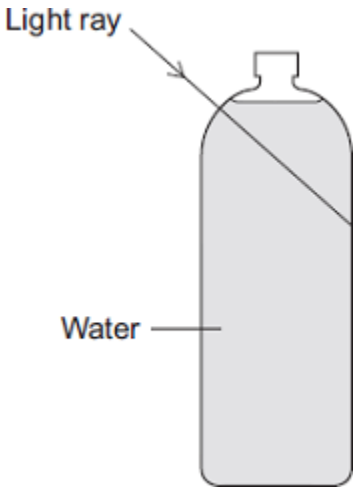
(1)

(c) Light travelling from water into air is refracted in the same way as when light travels from plastic into air.

Diagram 2 shows a large bottle, filled with water. The bottle is made from clear plastic.

Draw on **Diagram 2** the path of the light ray as it passes out of the bottle into the air.

Diagram 2

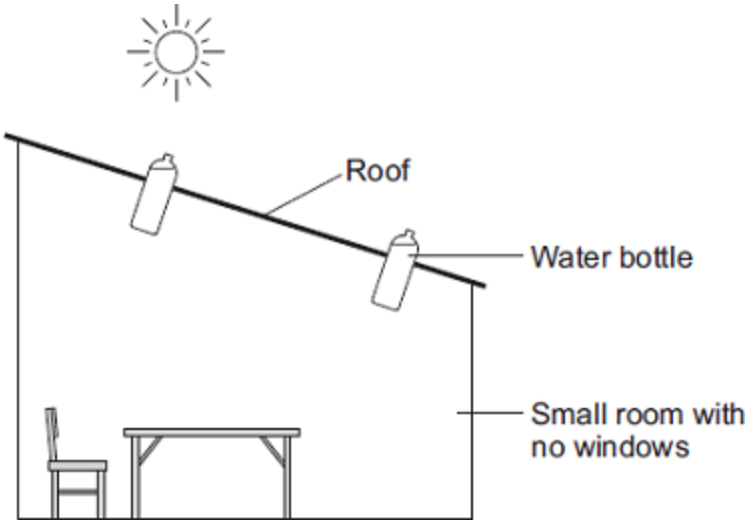


(2)

(d) In some countries, people are too poor to pay for electricity. Some people living in small houses with no natural light use bottles filled with water as a sort of light bulb.

The bottles are fitted into small holes in the roof of the house. Sunlight goes into the bottle of water. When the light leaves the bottle, the light is refracted, causing sunlight to spread into the room.

Diagram 3



(i) What is likely to be the most important outcome of using this simple device to provide light?

Tick (✓) **one** box.

People will have enough light to work inside their homes. ☐

Fewer plastic bottles will be thrown into rubbish tips. ☐

Plastic bottles will increase in value. ☐

(1)

(ii) Suggest **one** disadvantage of using this device compared with using a light bulb.

.....

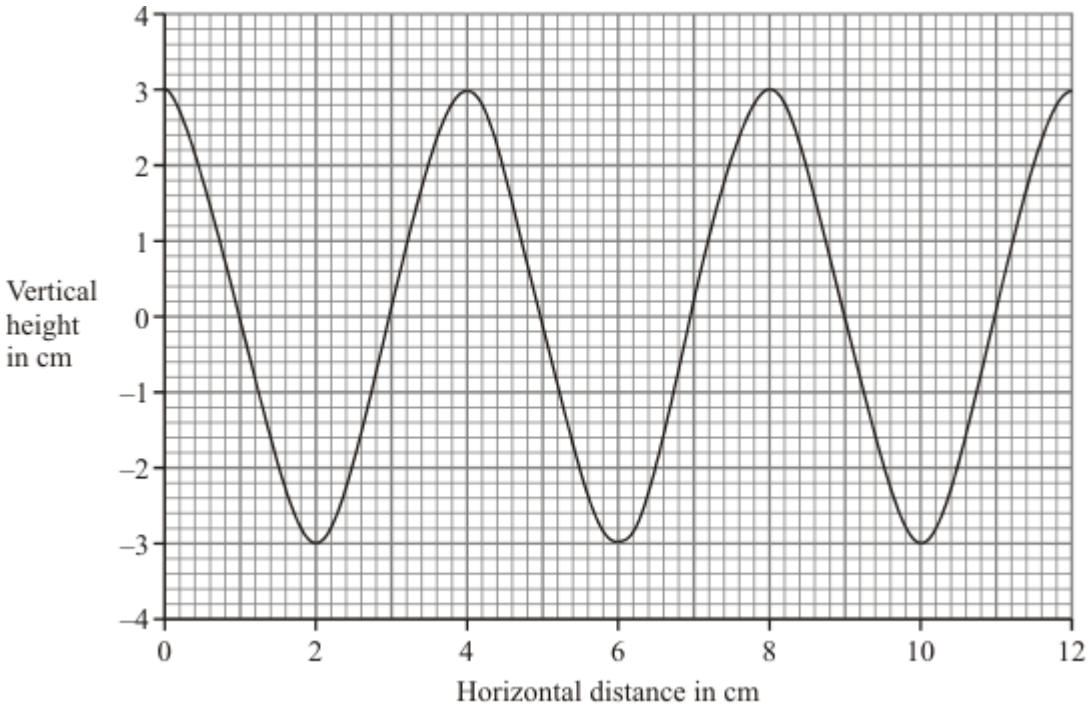
.....

.....

(1)

(Total 8 marks)

8 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.

.....

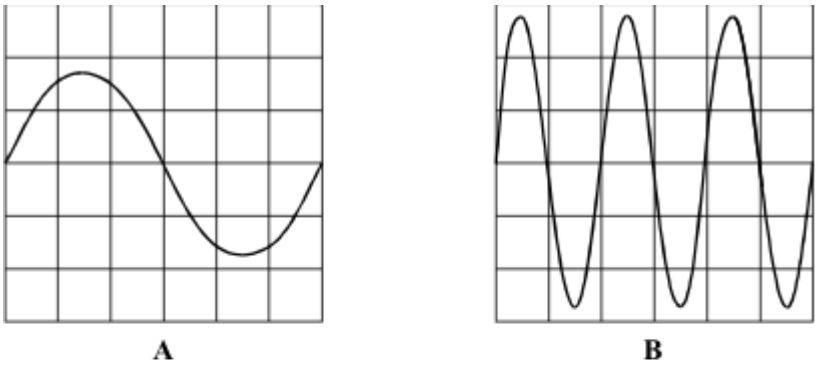
.....

Frequency = ...

(3)

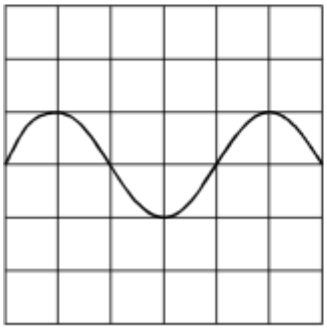
(Total 5 marks)

9 The diagram shows four oscilloscope wave traces. The controls of the oscilloscope were the same for each wave trace.

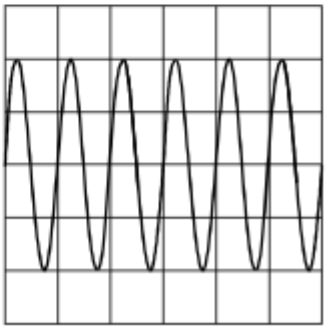


A

B



C



D

Which **one** of the waves traces, **A**, **B**, **C** or **D**, has:

(i) the largest amplitude, ...

(1)

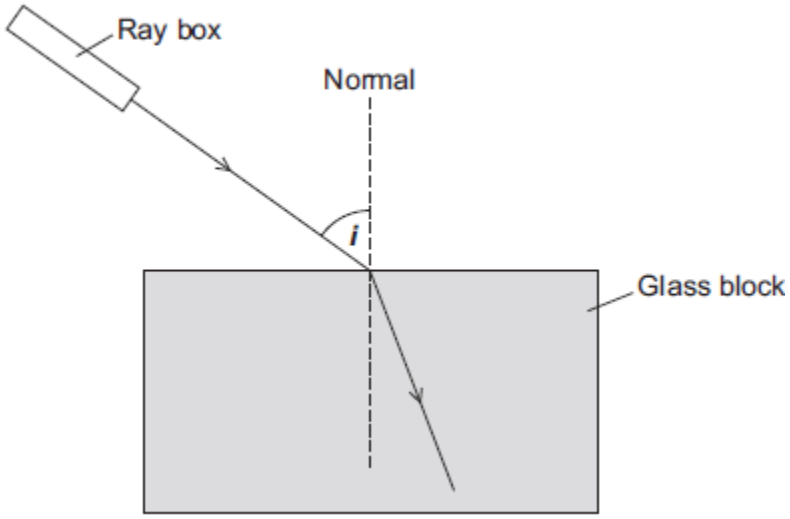
(ii) the lowest frequency? .....

(1)

(Total 2 marks)

10 (a) **Figure 1** shows a ray of light entering a glass block.

Figure 1



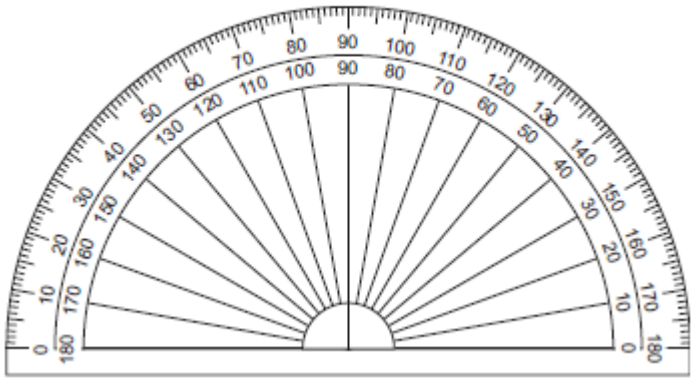
(i) The angle of incidence in **Figure 1** is labelled with the letter ***i***.

On **Figure 1**, use the letter ***r*** to label the angle of refraction.

(1)

(ii) **Figure 2** shows the protractor used to measure angles ***i*** and ***r***.

Figure 2



What is the resolution of the protractor?

Tick (✓) **one** box.

1 degree ☐ 5 degrees ☐ 10 degrees ☐

(1)

(iii) The table shows calculated values for angle ***i*** and angle ***r*** from an investigation.

Calculated values
sin ***i*** = 0.80
sin ***r*** = 0.50

Use the values from the table to calculate the refractive index of the glass.

Use the correct equation from the Physics Equations Sheet.

.....

.....

.....

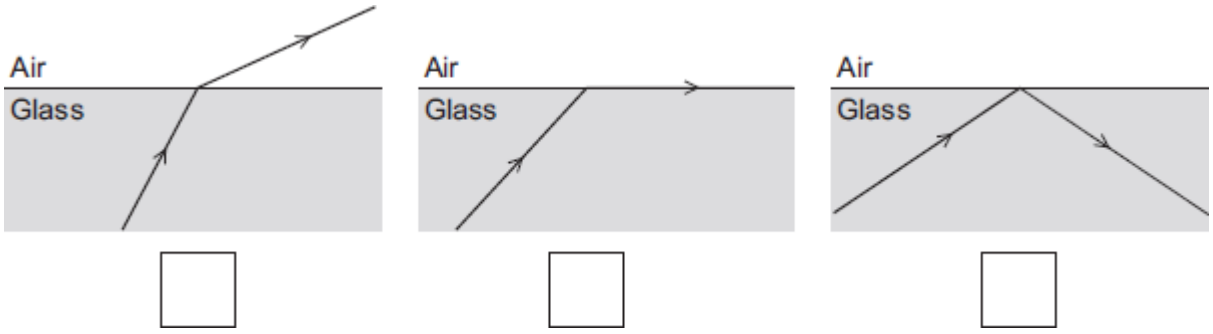
Refractive index = ...

(2)

(b) The diagrams below show a ray of light moving through glass.

Which diagram correctly shows what happens when the ray of light strikes the surface of the glass at the critical angle?

Tick (✓) **one** box.

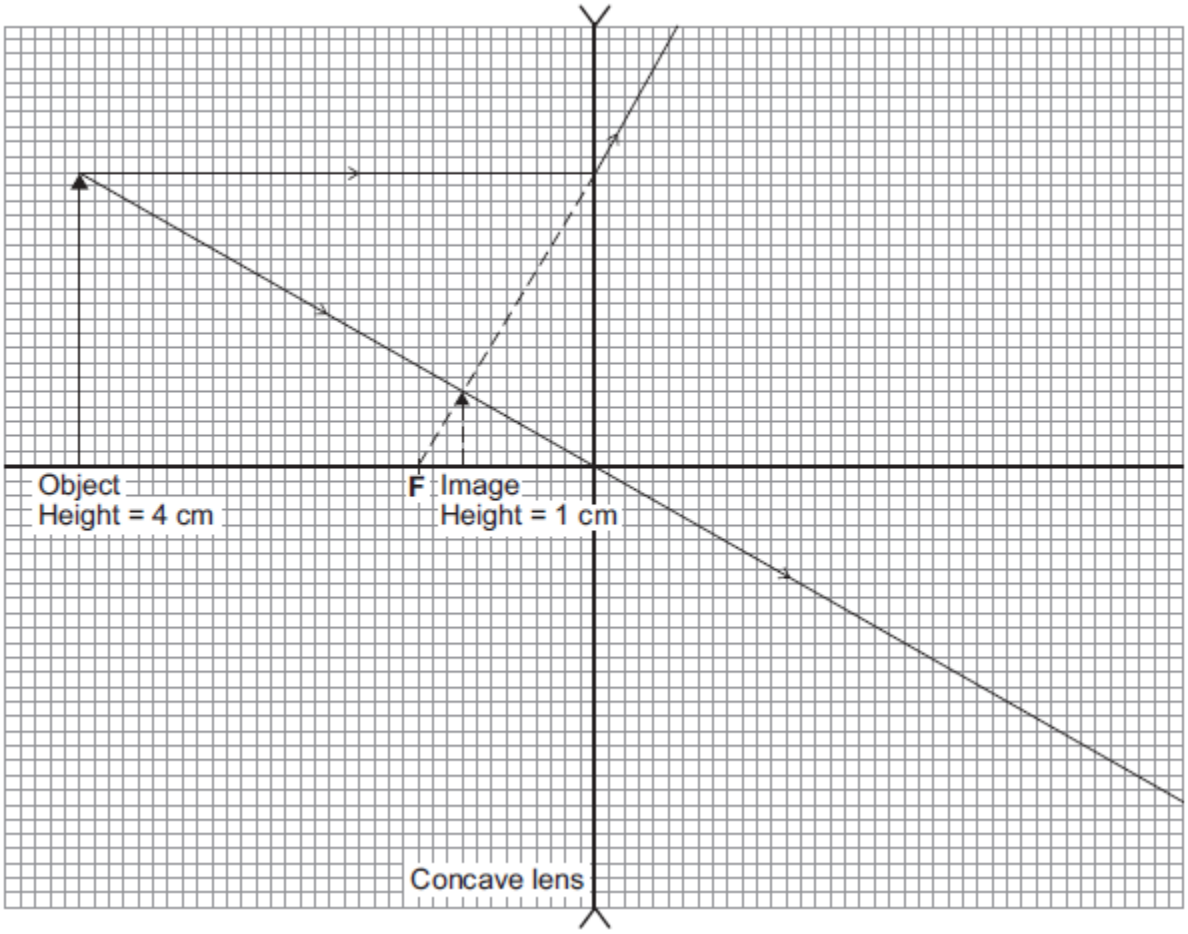


(1)

(c) A concave (diverging) lens is fitted into a door to make a security spyhole.

Figure 3 shows how this lens produces an image.

Figure 3



(i) State **one** word to describe the nature of the image in **Figure 3**.

.....

(1)

(ii) Use data from **Figure 3** to calculate the magnification of the image.

Use the correct equation from the Physics Equations Sheet.

.....

.....

.....

Magnification = ...

(2)

(iii) What is another use for a concave lens?

Tick (✓) **one** box.

A magnifying glass ☐

Correcting short sight ☐

To focus an image in a camera ☐

(1)

(Total 9 marks)

11 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)

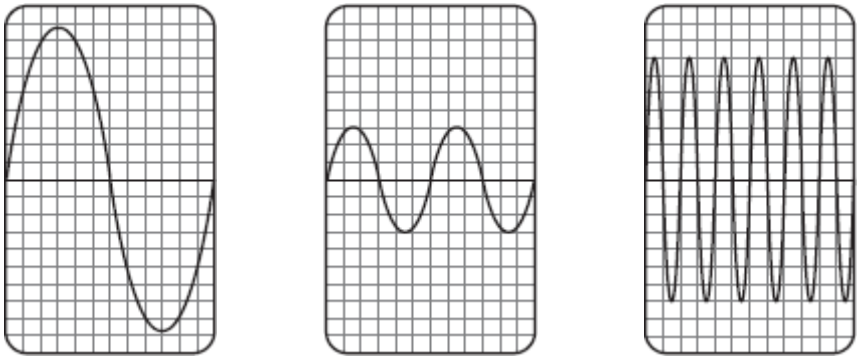
(b) Give a medical use for ultrasound.

.....

(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)

12 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.

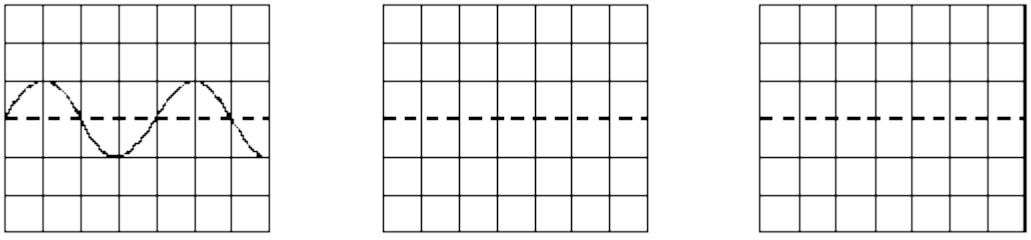


Diagram **X** Diagram **Y** Diagram **Z**

(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)

13 (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.

.....

.....

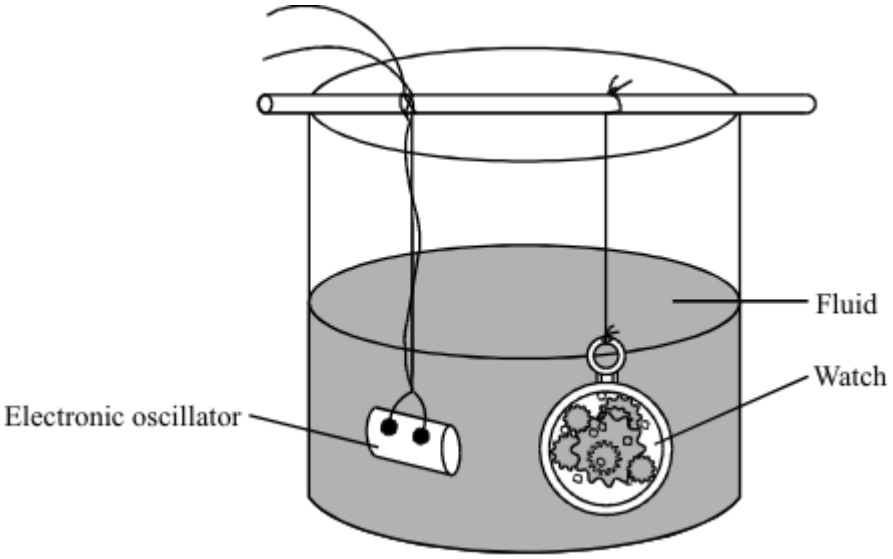
.....

.....

(2)

(Total 6 marks)

14 The diagram shows how ultrasonic waves can be used to clean a watch.



Suggest how this method cleans the watch.

.....

.....

.....

.....

(Total 2 marks)

15 (a) Explain what ultrasound is.

.....

.....

.....

.....

(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.

.....

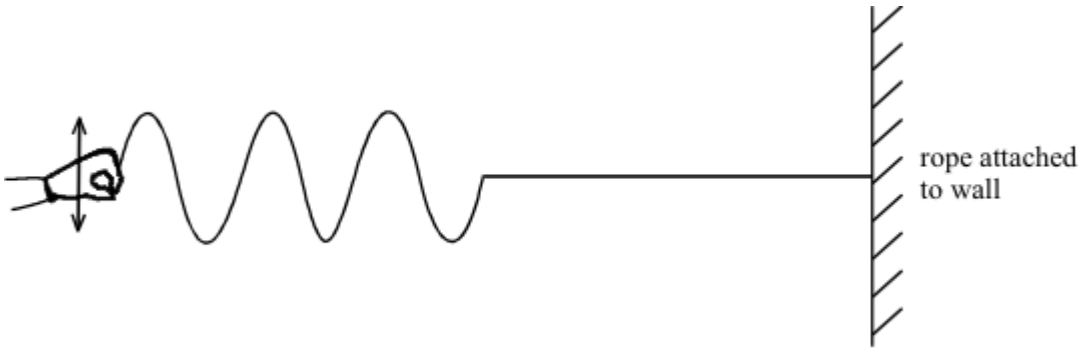
.....

.....

(2)

(Total 6 marks)

16 The diagram shows some waves travelling along a rope.



(a) Show on the diagram

(i) the wavelength of one of the waves

(2)

(ii) the amplitude of one of the waves

(2)

(b) The waves shown on the diagram were produced in two seconds.

What is the frequency of the waves?

.....

(2)

(Total 6 marks)

17 (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)

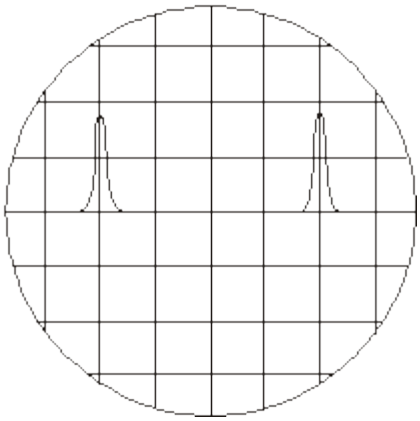
(ii) State **one** medical use for ultrasound.

.....

(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.

.....

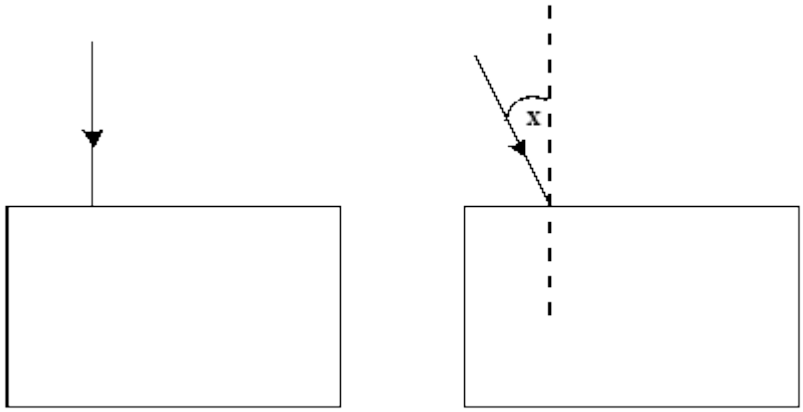
.....

.....

(2)

(Total 9 marks)

18 (a) The diagrams show rays of light. Each ray strikes a surface of a glass block.

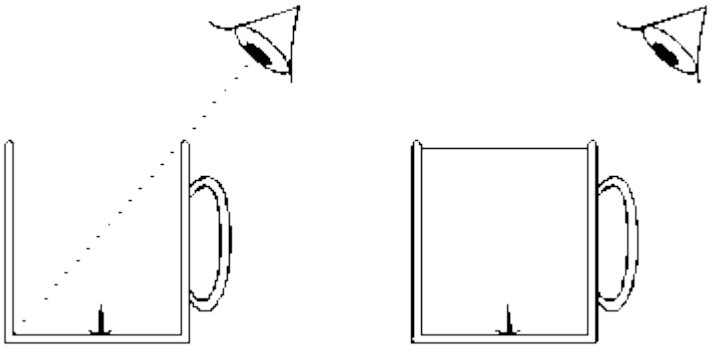


(i) On the diagram draw the path of each ray through the glass block and out into the air again.

(ii) Label another angle on the diagram which is equal to the angle marked **X**. Label this angle **Y**.

(4)

(b) The diagrams show two beakers. Both beakers have a drawing pin inside as shown.



The first beaker is empty. The eye cannot see the drawing pin.
The second beaker is full of water and the eye can see the drawing pin.

Explain how the eye is able to see the drawing pin in the second beaker. You may add to the diagram if it helps your answer.

.....

.....

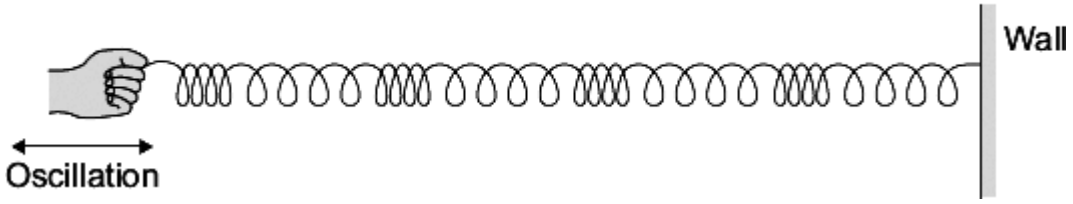
.....

(3)

(Total 7 marks)

19 **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.

Use the correct equation from the Physics Equations Sheet.

Show clearly how you work out your answer.

.....

.....

.....

Speed = ... m/s

(2)

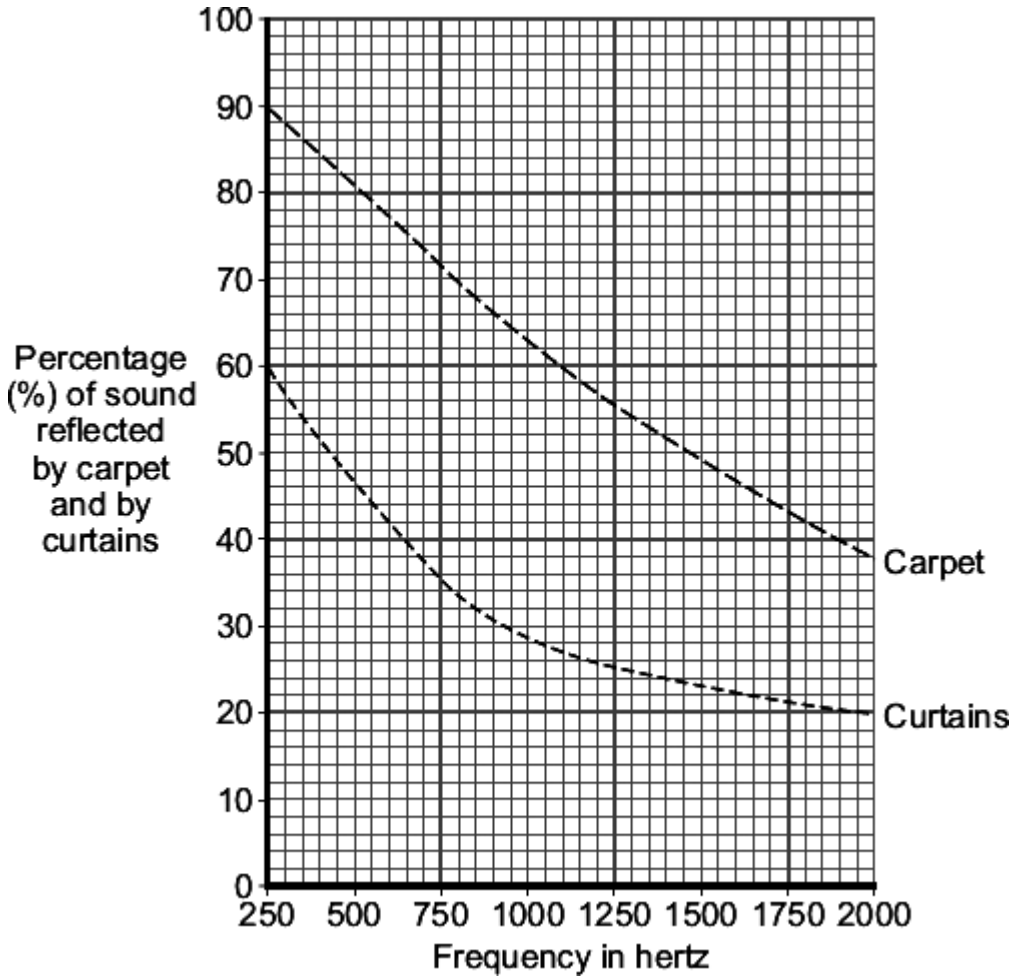
(c) Music concerts are sometimes performed in sports halls. The concerts can be spoilt because of the sound reflected from the floor and walls.

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.

.....

.....

.....

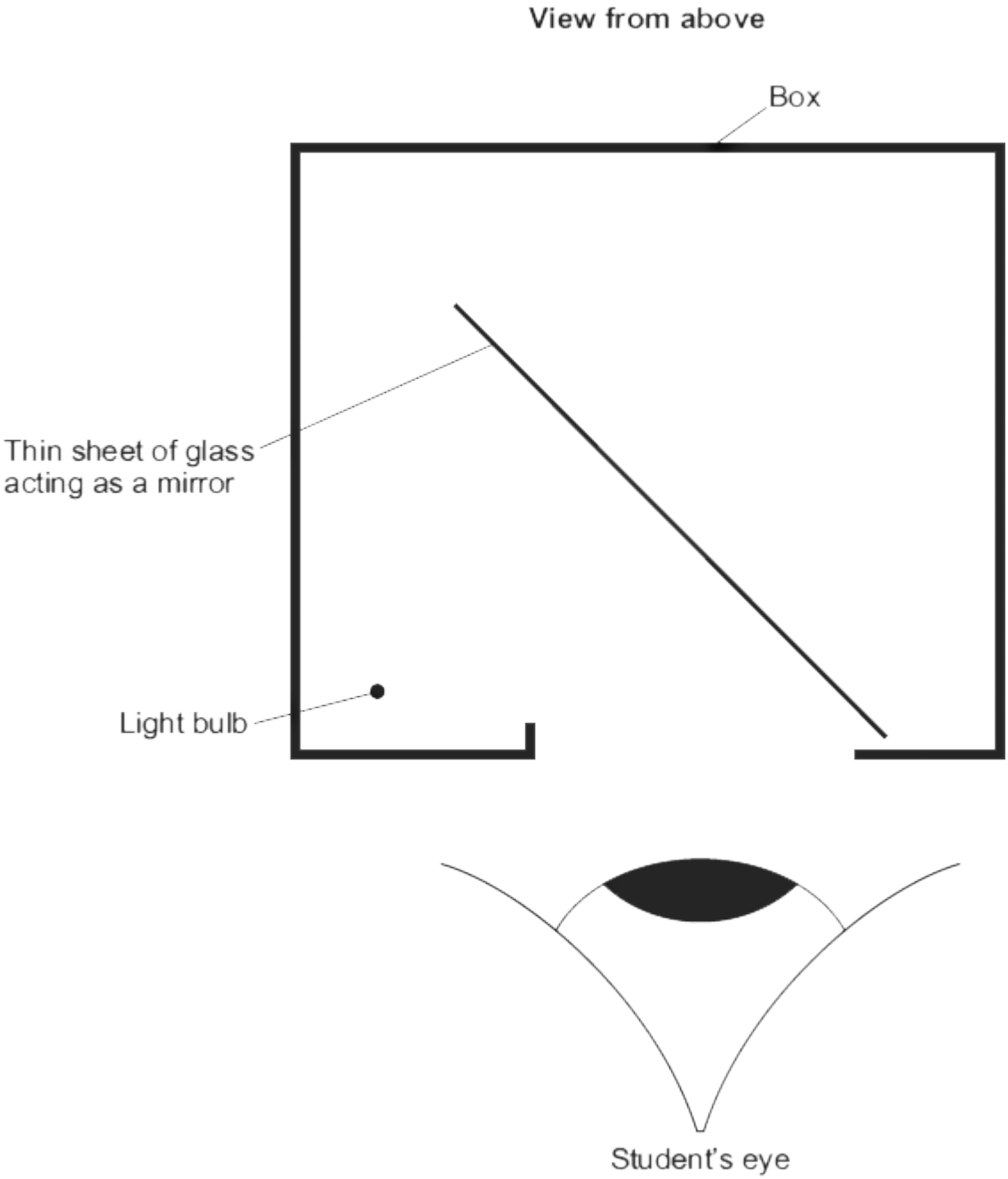
.....

(2)

(Total 11 marks)

20 The diagram shows a model used to demonstrate an illusion known as ‘Pepper’s Ghost’.

A small light bulb and thin sheet of glass are put inside a box. The thin sheet of glass acts as a mirror. Although the light bulb is switched on, a student looking into the box cannot see the bulb. What the student does see is a virtual image of the bulb.



(a) Use a ruler to complete a ray diagram to show how the image of the light bulb is formed. Mark and label the position of the image.

(4)

(b) The image seen by the student is virtual.

Why?

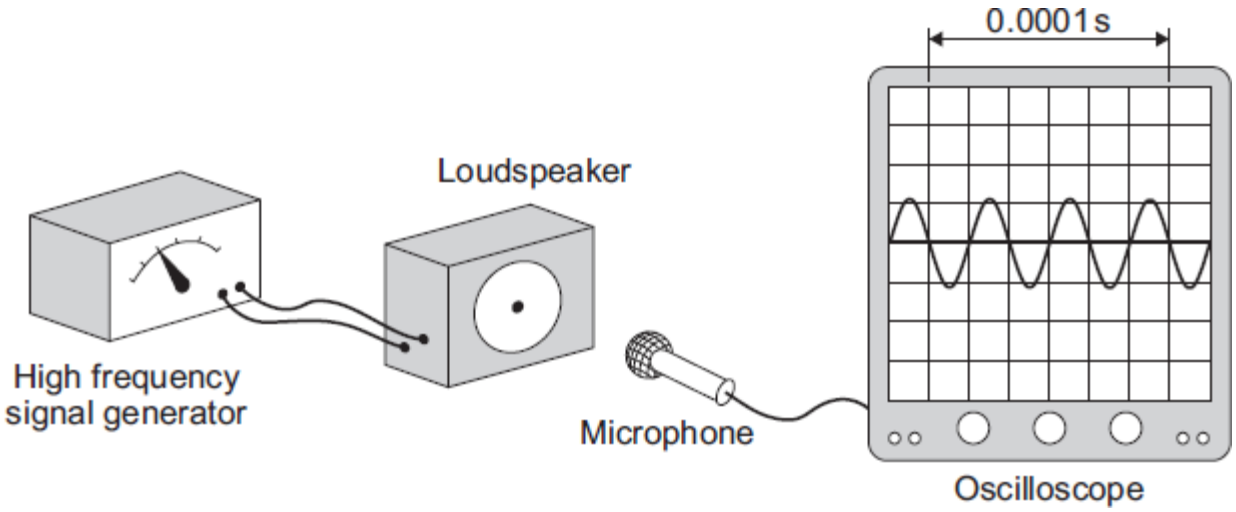
.....

.....

(1)

(Total 5 marks)

21 (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.

.....

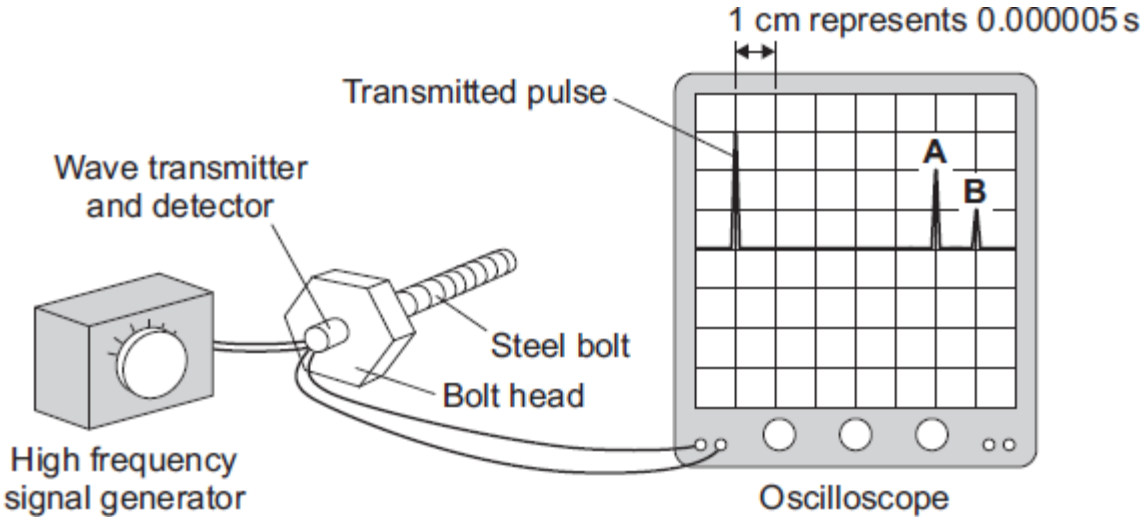
.....

.....

.....

(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)

22 (a) Water waves are transverse waves. Sound waves are longitudinal waves.

(i) Explain the difference between a transverse wave and a longitudinal wave.

You may include labelled diagrams in your answer.

.....

.....

.....

.....

.....

.....

.....

.....

.....

(3)

(ii) Name **one** type of wave that may be either transverse or longitudinal.

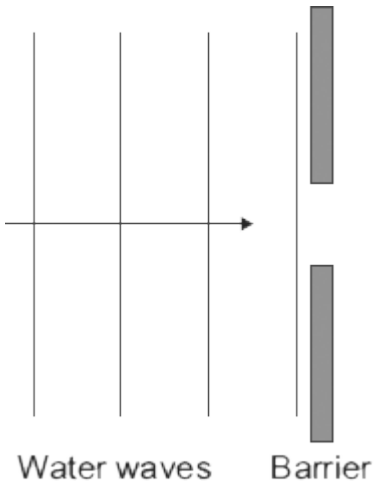
.....

(1)

(b) The diagram shows water waves in a ripple tank moving towards a gap in a barrier.

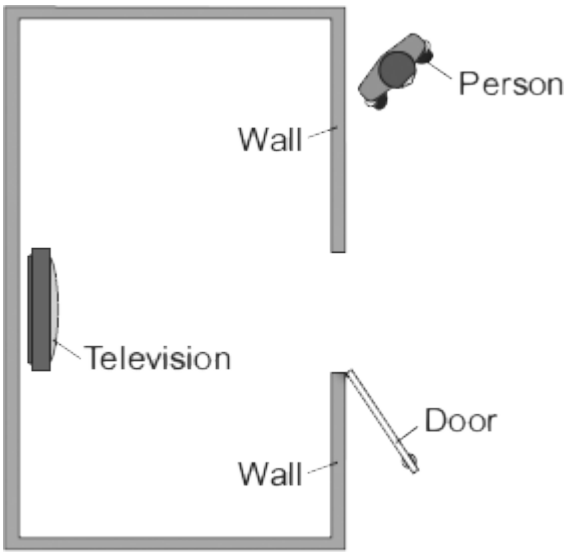
The water waves diffract as they pass through the gap.

Complete the diagram to show the diffracted water waves.



(1)

(c) A television is switched on inside a room. A person outside the room can hear the television, but only when the door is open.



When the door is open, the person can hear the sound but cannot see the television.

Explain why.

.....

.....

.....

.....

(2)

(Total 7 marks)

23 All radio waves travel at 300 000 000 m/s in air.

(i) Give the equation that links the frequency, speed and wavelength of a wave.

.....

(1)

(ii) Calculate the wavelength, in metres, of a radio wave which is broadcast at a frequency of 909 kHz. Show clearly how you work out your answer.

.....

.....

.....

Wavelength = ... metres

(2)

(Total 3 marks)

24 (i) Use the words frequency, wavelength and wave speed to write an equation which shows the relationship between them.

.....

(1)

(ii) Calculate the speed of a sound wave with a frequency of 250 Hz and a wavelength of 1.3 m.

Show how you get to your answer and give the unit.

.....

.....

Speed = ...

(2)

(Total 3 marks)

25 Radio waves and microwaves are two types of electromagnetic wave.

Both waves:

- can be used for communications
- travel at the same speed through air.

(a) Give **two** more properties that are the same for both radio waves and microwaves.

1 .....

.....

2 .....

.....

(2)

(b) Some satellites are used to transmit television programmes. Signals are sent to, and transmitted from, the satellites using microwaves.

What is the property of microwaves that allows them to be used for satellite communications?

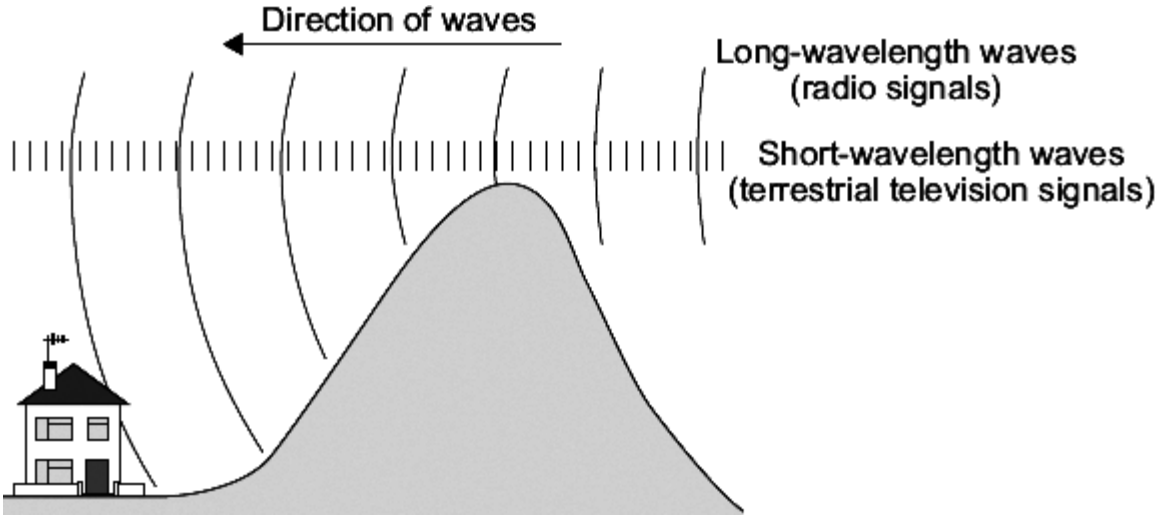
.....

.....

(1)

(c) Terrestrial television does not use satellites.

Terrestrial television signals and radio signals both use radio waves.
Radio signals are transmitted at a longer wavelength than terrestrial television signals.



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In hilly areas it may be possible to receive radio signals but not receive terrestrial television signals.

Explain why.

.....

.....

.....

.....

.....

.....

(3)

(d) Electromagnetic waves travel at a speed of 3.0×10^8 m/s.

A radio station transmits waves with a wavelength of 2.5×10^2 m.

Calculate the frequency of the radio waves.

Use the correct equation from the Physics Equations Sheet.

Show clearly how you work out your answer and give the unit.

.....

.....

.....

Frequency = ...

(3)

(Total 9 marks)

26 (a) Electromagnetic waves form a continuous spectrum with a range of wavelengths.

What is the approximate range of wavelengths of electromagnetic waves?

Tick (✓) **one** box.

10^{-15} metres to 10^4 metres ☐

10^{-4} metres to 10^{15} metres ☐

10^{-6} metres to 10^6 metres ☐

(1)

(b) Infrared waves and microwaves are used for communications.

(i) Give **one** example of infrared waves being used for communication.

.....

.....

(1)

(ii) A mobile phone network uses microwaves to transmit signals through the air. The microwaves have a frequency of 1.8×10^9 Hz and travel at a speed of 3.0×10^8 m/s.

Calculate the wavelength of the microwaves.

Use the correct equation from the Physics Equations Sheet.

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

.....

.....

.....

Wavelength = ... m

(3)

(c) Some scientists suggest there is a possible link between using a mobile phone and male fertility.

The results of their study are given in the table.

Mobile phone use in hours per day	**Sperm count in millions of sperm cells per cm^3 of semen**
0	86
less than 2	69
2 – 4	59
more than 4	50

The results show a negative correlation: the more hours a mobile phone is used each day, the lower the sperm count. However, the results do **not** necessarily mean using a mobile phone causes the reduced sperm count.

Suggest **one** reason why.

.....

.....

(1)

(Total 6 marks)

27 Ultrasound waves can be passed through the body to produce medical images.

When ultrasound waves are directed at human skin most of the waves are reflected.

If a material called a 'coupling agent ' is placed on the skin it allows most of the ultrasound waves to pass through the skin and into the body.

(a) What is 'ultrasound'?

.....

.....

.....

(2)

(b) Two ultrasound frequencies that are used are 1.1 MHz and 3.0 MHz.

The speed of ultrasound in water is 1500 m / s.

Calculate the wavelength of the 3.0 MHz waves in water.

Use the correct equation from of the Physics Equations Sheet.

.....

.....

.....

Wavelength = ... m

(3)

(c) The coupling agent used with ultrasound is usually a gel.

Water would be a good coupling agent.

Suggest why water is **not** used.

.....

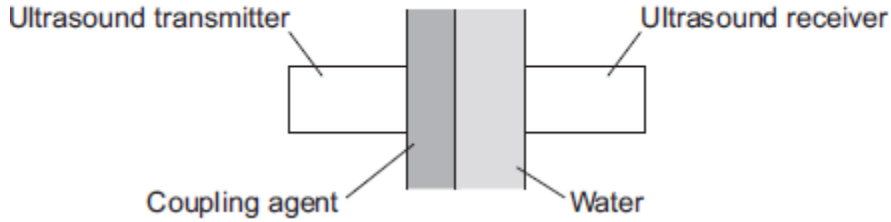
.....

(1)

(d) **Figure 1** shows a coupling agent being tested.

- An ultrasound transmitter emits waves.
- The waves pass through the coupling agent and then through the water.
- The waves are detected by the ultrasound receiver.

Figure 1



A scientist tests different coupling agents.

Suggest which variables she must control.

Tick (✓) **two** boxes.

	Tick (✓)
The amount of light in the room	
The colour of the coupling agent	
The width of the coupling agent	
The width of the water	

(2)

(e) The table shows the results for coupling agents **A**, **B**, **C**, **D**, **E**, **F** and **G**.

They were tested using the two frequencies, 1.1 MHz and 3.0 MHz.

The results show how well the waves pass through the coupling agent compared with how they pass through water. The results are shown as a percentage.

100% means that the coupling agent behaves the same as water.

Coupling agent	Coupling agent percentage using 1.1 MHz	Coupling agent percentage using 3.0 MHz
A	108	100
B	105	100
C	104	98
D	100	98
E	98	98
F	95	99
G	89	88

(i) Which coupling agent allows most ultrasound to pass through at both frequencies? ☐

(1)

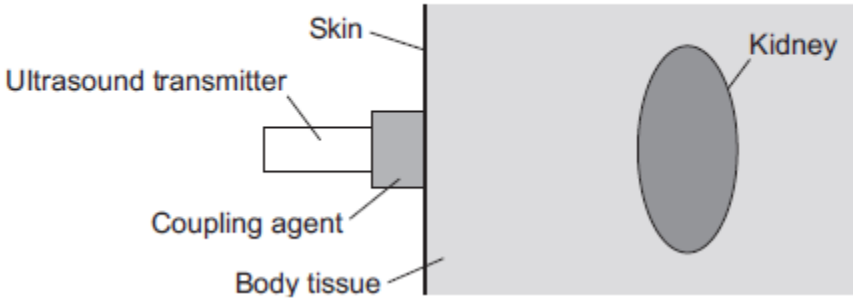
(ii) Which coupling agent performs the same for both frequencies? ☐

(1)

(f) **Figure 2** shows an ultrasound transmitter sending waves into a patient's body.

The waves enter the body and move towards a kidney.

Figure 2



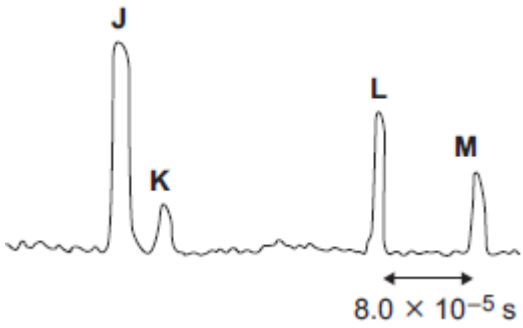
The transmitter also detects the ultrasound waves.

The transmitter is connected to an oscilloscope.

Figure 3 shows the trace on the screen of the oscilloscope.

J represents the intensity of the waves emitted by the transmitter.

Figure 3



(i) Explain the intensities at **K**, **L** and **M**.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(6)

(ii) The speed of ultrasound waves in the body is 1500 m / s.

Use information from **Figure 3** to calculate the maximum width of the kidney.

Use the correct equation from the Physics Equations Sheet.

.....

.....

.....

Maximum width of kidney = ... m

(3)

(Total 19 marks)

1

(a) (i) vibrate / oscillate

accept a correct description

move is insufficient

1

(ii) 336

*allow **1** mark for correct substitution, ie 420 × 0.8(0) provided no subsequent step shown*

2

(b) (i) frequency

1

(ii) longer than 0.8m

1

(iii) Doppler

1

[6]

2

(a) normal

1

(b) be halved

1

(c) upright

1

virtual

1

[4]

3

(a) (i) wavelength

accept frequency

accept speed

1

(ii) amplitude

accept energy

height is insufficient

1

(iii) sound

1

(b) (i) diffraction

accept diffract

a description is insufficient

1

(ii) 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

[7]

4 (a) L

1

(b) 6 (V)

1

(c) horizontal line drawn

1

drawn in correct position

judge by eye

1

[4]

5 (a) (i) 3

1

(ii) 1

accept a definition of frequency ignore units

1

(iii) hertz

1

(b) straight line in correct direction

judge by eye (from 'a' of waves to 's' of across) ignore arrow
accept equal angles shown on waves

1

(c) (i) gets smaller

1

(ii) kinetic

accept movement

1

(iii) renewable

1

[7]

6 (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]

7 (a) angle of refraction correctly identified

accept any correct indication

1

(b) (i) result at i = 25° identified

1

(ii) measuring angle of refraction incorrectly

accept any practical suggestion that would lead to the angle r being incorrect

eg placing the protractor in the wrong place

not marking the refracted ray correctly / accurately / ray box has been moved

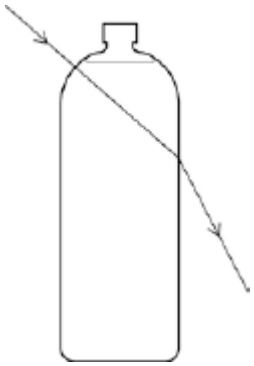
*do **not** accept measured angle i and angle r incorrectly*
*do **not** accept plotted incorrectly*

1

(iii) greater than

1

(c) shown refracting out of the bottle with angle of refraction larger than angle of incidence



*allow **1** mark for refraction shown on correct side of normal with angle of refraction smaller than angle of incidence*

2

(d) (i) People will have enough light to work inside their homes

1

(ii) accept any sensible suggestion

*do **not** accept roof leaks*

eg does not work at night
no control over light cannot switch on and off

eg cannot control brightness

1

[8]

8 (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]

9 (i) B

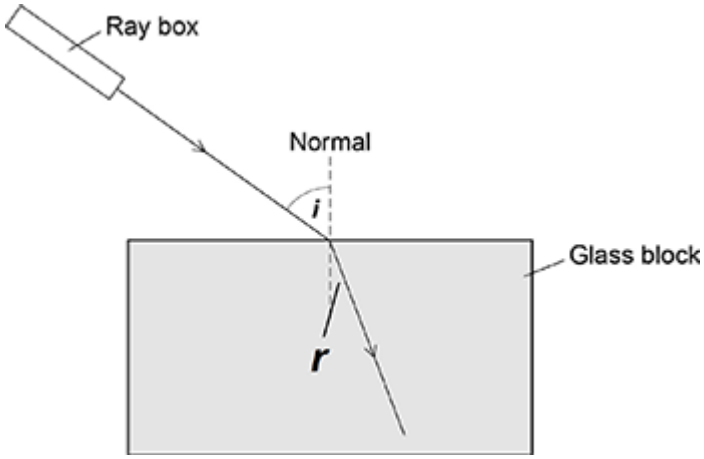
1

(ii) A

1

[2]

10 (a) (i)



1

(ii) 1 degree

1

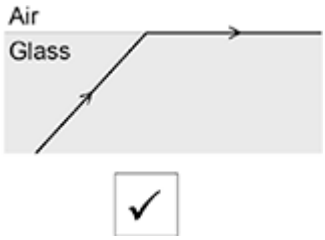
(iii) 1.6

*allow **1** mark for correct substitution, ie 0.80 / 0.5 provided no subsequent step shown*

working showing 1.59(9…..) scores zero

2

(b) 2nd diagram ticked



✓

1

(c) (i) any **one** correct description:

- upright
- virtual
- diminished.

treat multiple words as a list

1

(ii) 0.25

*allow **1** mark for correct substitution, ie 1 / 4 or 5 / 20 provided no subsequent step shown*

ignore any unit

2

(iii) Correcting short sight

1

[9]

11 (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]

12 (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]

13 (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]

14 (ultrasonic) waves **or** vibrations **or** oscillations in fluid

*N.B. must mention fluid **or** liquid*
or *water*

1

idea of shaking dirt particles off watch

allow cavitation / implosion of small bubbles

1

[2]

15 (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]

16 (a) (i) a horizontal distance indicated and labelled

gains 1 mark

but
horizontal distance indicated between identical points on adjacent waves (to within 3-4mm) and labelled

gains 2 marks

2

(ii) peak ↔ trough indicated*

gains 1 mark

but

peak / trough ↔ mean indicated*

(to within 1-2mm either end)*

gains 2 marks
(allow 1 mark if both lines unlabelled or 2 marks if both lines accurately drawn and unlabelled)

2

(b) • 1.5

• hertz / Hz **or** (waves / cycles) per second

for 1 mark each
(do not allow wavelength / hertz per second)

2

[6]

17 (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 <u>boundary</u> and the detector (1)

accept 'between the <u>boundary</u> 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]

18 (a) (i) Ignore arrows on rays
perpendicular rays goes straight in and out
other ray refracts towards normal (not along)
emerges parallel incident ray (by sight) if refraction correct (ignore reflections)

for 1 mark each

3

(ii) emergent angle marked Y if emerges parallel to right of normal

for 1 mark

1

(b) straight ray to water surface refracts/bends
straight to eye/towards surface on right image correctly shown
or states the same mark prose only of diagram incomplete

any 3 for 1 mark each

3

[7]

19 (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]

20 (a) two rays drawn from the bulb and reflected by the glass

*angle **I** = angle **R** judged by eye*

*allow **1** mark for one incident and reflected ray even if angle **I** doesn't equal angle **R***

2

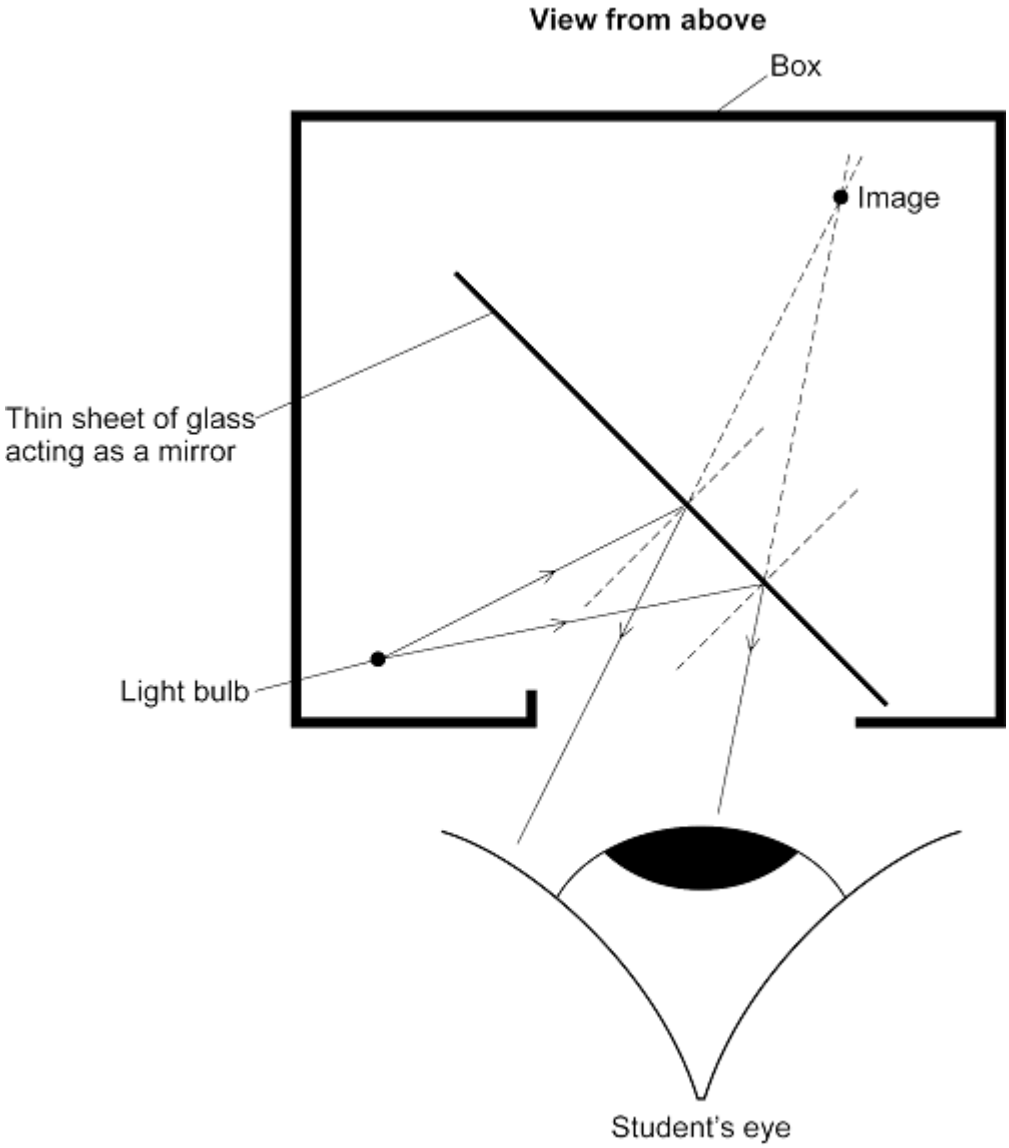
at least one arrow drawn in correct direction

any conflicting arrows negate this mark

ignore any arrows drawn on construction lines behind the glass

1

position of image correct



judged by eye

1

(b) image is formed by virtual / imaginary rays crossing

accept construction lines only show where the light seems to come from

accept the image is behind the glass / mirror

accept image is seen through the glass / mirror

accept (real) rays of light do not pass through the image

accept (real) rays do not cross

accept the image is a reflection (of the object)

accept the image is formed by reflection

*do **not** accept a virtual image can't be formed on a screen*

*do **not** accept the object / image is reflected*

1

[5]

21 (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]

22 (a) (i) the oscillation / vibration (causing the wave)
a movement causes the wave is insufficient

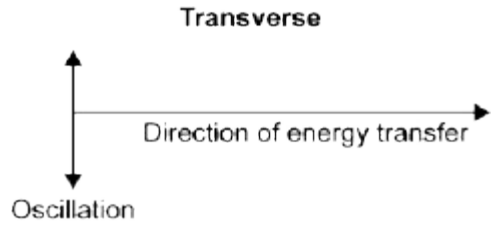
1

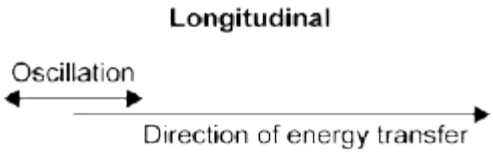
for a transverse wave is perpendicular to the direction of energy transfer
*answers given in terms of direction of wave travel and not energy transfer for both types of wave, score **1** mark for these **two** mark points*

1

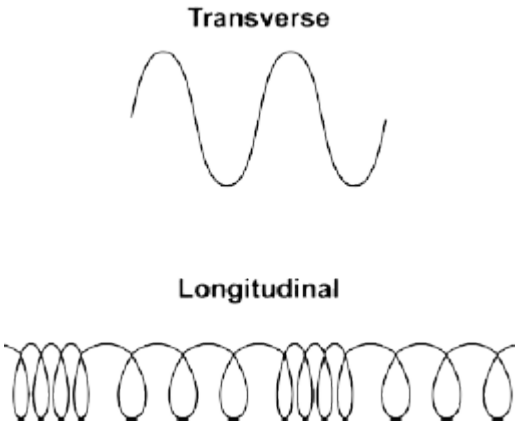
and for a longitudinal wave is parallel to the direction of energy transfer

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





two labelled diagrams showing the general form of a transverse and longitudinal wave gain 1 mark if no other mark has been awarded eg



1

(ii) mechanical wave

accept specific examples, eg waves on a spring / slinky / seismic / earthquake waves

accept water waves

*do **not** accept shock waves*

1

(b) semicircular waves drawn

judged by eye

do not need to be full semicircles

ignore any rays

1

(c) sound (waves) will diffract (towards the person)

1

or

light (waves) do not diffract (towards the person)

(because) width of door way similar to / less than wavelength of sound (waves)

or

(because) width of doorway much greater than wavelength of light (waves)

*a general statement that waves (only) <u>diffract</u> when the width of a gap is similar to the wavelength of the waves can be awarded **1** mark*

1

[7]

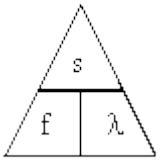
23 (i) speed = frequency × wavelength

accept the equation rearranged

*accept v **or** s = f × λ*

do not allow w for wavelength

do not accept



unless subsequent calculation correct

1

(ii) 330 (m)

allow 1 mark for

$$\lambda = \frac{300\ 000\ 000}{909\ 000}$$

***or** 300 000 000 = 909 000 × λ*

***or** answer of 330000(m) **or** 330033(m)*

2

[3]

24 (i) (wave) speed = frequency × wavelength

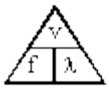
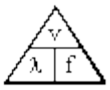
or *any correctly transposed version*

accept $v = f \times \lambda$

or *transposed version*

accept m/s = 1 / s × m

or *transposed version*

or  **or** 

but only if subsequently used correctly

1

(i) 325

1

metres per second

or *m / s* ***or*** *0.325 km/s for 2 marks*

1

[3]

25 (a) any **two** from:

- travel (at same speed) through a vacuum / space

  do ***not*** *accept air for vacuum*
- transverse
- transfer energy
- can be reflected
- can be refracted
- can be diffracted
- can be absorbed
- travel in straight lines

2

(b) can pass through the ionosphere

accept atmosphere for ionosphere

do ***not*** *accept air for ionosphere*

accept travel in straight lines

accept not refracted / reflected / absorbed by the ionosphere

1

(c) diffraction (of waves around hills)

1

wavelength needs to be similar size to the obstacle / gap

1

radio has a long enough wavelength **or** TV doesn't have a long enough wavelength

*an answer TV (waves / signals) have short wavelengths so do not diffract (around the hill) scores **2** marks*

1

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

1.2×10^6 / 1200 000

*allow **1** mark for correct substitution*

ie $3.0 \times 10^8 = f \times 2.5 \times 10^2$

2

hertz / Hz

*do **not** accept hz **or** HZ*

*accept kHz **or** MHz*

*answers 1.2 MHz **or** 1200 kHz gain all **3** marks*

for full credit the unit and numerical value must be consistent

1

[9]

26 (a) 10^{-15} metres to 10^4 metres

1

(b) (i) any **one** from:

- (TV / video / DVD) remote controls
  mobile phones is insufficient
- (short range) data transmission
  accept specific example, eg linking computer peripherals
- optical fibre (signals)
  *do **not** accept Bluetooth*

1

(ii) 0.17

*an answer 17 cm gains **3** marks*

*an answer given to more than 2 significant figures that rounds to 0.17 gains **2** marks*

*allow **1** mark for correct substitution, ie $3 \times 10^8 = 1.8 \times 10^9 \times \lambda$*

3

(c) (maybe) other factors involved

accept a named 'sensible' factor, eg higher stress / sedentary lifestyle / overweight / smoking more / diet / hot office / age

not testing enough people is insufficient

unreliable data is insufficient

1

[6]

27 (a) high frequency sound (waves)

1

with a frequency above limit of human hearing
or with a frequency greater than 20 000 Hz

above limit of human hearing

***or** greater than 20 000 Hz gains maximum **1** mark*

1

(b) $5(.0) \times 10^{-4}$ (m)
or
0.0005 (m)

*$1500 = 3 \times 10^{6}$ λ gains **2** marks*

*answer of 500 gains **2** marks*

*1500 = 3.0 λ gains **1** mark*

3

(c) it will run off the surface of the skin
or
water is not a gel

accept water would evaporate

1

(d) The width of the coupling agent

1

The width of the water

1

(e) (i) A

1

(ii) E

1

(f) (i) **K**

reflection from skin

maximum 5 marks if no mention of reflection

1

very little reflection, so small peak

1

L

reflection from front of kidney

1

large amount of reflection, so large peak

1

M

reflection from back of kidney

1

smaller peak due to absorption of ultrasound in kidney

or

smaller peak as further from source

or

front of the kidney already reflected a lot, so there is now less to be reflected

reflection from a boundary gains 1 mark if no other mark given

1

(ii) 0.06 (m)

or

$6(.0) \times 10^{-2}$

*0.12 (m) gains **2** marks*

*distance = $1500 \times 8 \times 10^{-5} \times 0.5$ gains **2** marks*

*distance = $1500 \times 8 \times 10^{-5}$ gains **1** mark*

3

[19]