



## Waves Questions 1

35 Questions

Name: \_\_\_\_\_

Class: \_\_\_\_\_

Date: \_\_\_\_\_

---

Time:

Marks:

Comments:

---



Frequency = \_\_\_\_\_ Hz

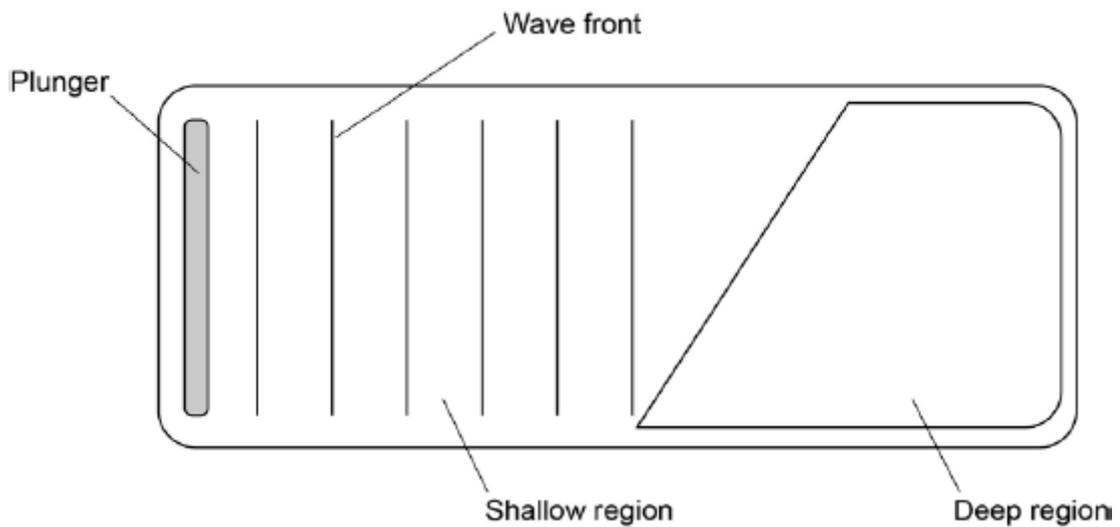
(3)

(Total 9 marks)

**Q2.**

Some students did an investigation to study the behaviour of waves.

The figure below shows a ripple tank that they used to model the behaviour of waves.



- (a) Complete the wave fronts on the figure above.

Show how the wave is refracted as it passes from the shallow region into the deep region.

(1)

- (b) Explain what happens to the waves as they pass into the deep region.

---

---

---

---

(2)

- (c) The waves generated on the surface of the water are transverse waves.

Describe the differences between longitudinal waves and transverse waves.

You may include labelled diagrams to help your answer.

---

---

---

---

---

---

(3)

- (d) Some students investigate the properties of the waves generated in the figure above.

Student **A** says 'the waves move water from one end of the tank to the other'.

Student **B** says 'that's wrong. Only the waves move, not the water'.

Suggest what the students could do to decide which of them is correct.

---

---

---

---

(2)

- (e) Another student uses a ripple tank where all the water is the same depth.

She measures the wavelength of each wave as 0.34 m.

The period of each wave is 0.42 s.

Calculate the speed of the wave.

Use the correct equation from the Physics Equation Sheet.

Give the unit.

Give your answer to three significant figures.

---

---

---

---

---

---

Speed = \_\_\_\_\_

Unit = \_\_\_\_\_

(5)

(Total 13 marks)

**Q3.**

Different parts of the electromagnetic spectrum have different uses.

- (a) The diagram shows the electromagnetic spectrum.

Radio waves	Microwaves	Infrared	Visible light	Ultraviolet	X-rays	Gamma rays
-------------	------------	----------	---------------	-------------	--------	------------



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

<b>amplitude</b>	<b>frequency</b>	<b>speed</b>	<b>wavelength</b>
------------------	------------------	--------------	-------------------

The arrow in the diagram is in the direction of increasing \_\_\_\_\_  
and decreasing \_\_\_\_\_ .

(2)

- (ii) Draw a ring around the correct answer to complete the sentence.

The range of wavelengths for waves in the electromagnetic

spectrum is approximately 

$10^{-15}$ to $10^4$
$10^{-4}$ to $10^4$
$10^4$ to $10^{15}$

 metres.

(1)

- (b) The wavelength of a radio wave is 1500 m.  
The speed of radio waves is  $3.0 \times 10^8$  m / s.

Calculate the frequency of the radio wave.

Give the unit.

---



---



---

Frequency = \_\_\_\_\_

(3)

- (c) (i) State **one** hazard of exposure to infrared radiation.

---

(1)

- (ii) State **one** hazard of exposure to ultraviolet radiation.

---

(1)

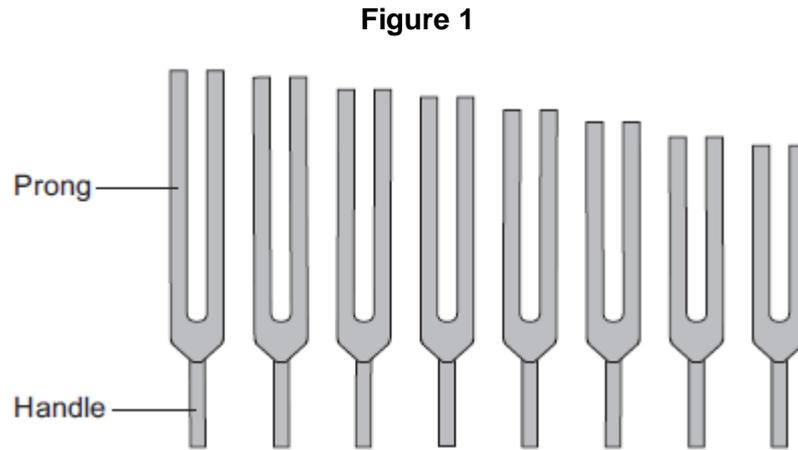
- (d) X-rays are used in hospitals for computed tomography (CT) scans.

- (i) State **one** other medical use for X-rays.



**Q4.**

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



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.

<b>direction</b>	<b>loudness</b>	<b>pitch</b>	<b>speed</b>
------------------	-----------------	--------------	--------------

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.

<b>Frequency in hertz</b>	<b>Length of prongs in cm</b>
320	9.5
384	8.7
480	7.8
512	7.5

(i) Describe the pattern shown in the table.

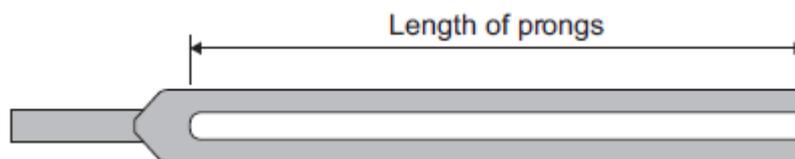
---

---

(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.

<b>electronic</b>	<b>hydraulic</b>	<b>radioactive</b>
-------------------	------------------	--------------------

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

(1)

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

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

Explain why.

---

---

---

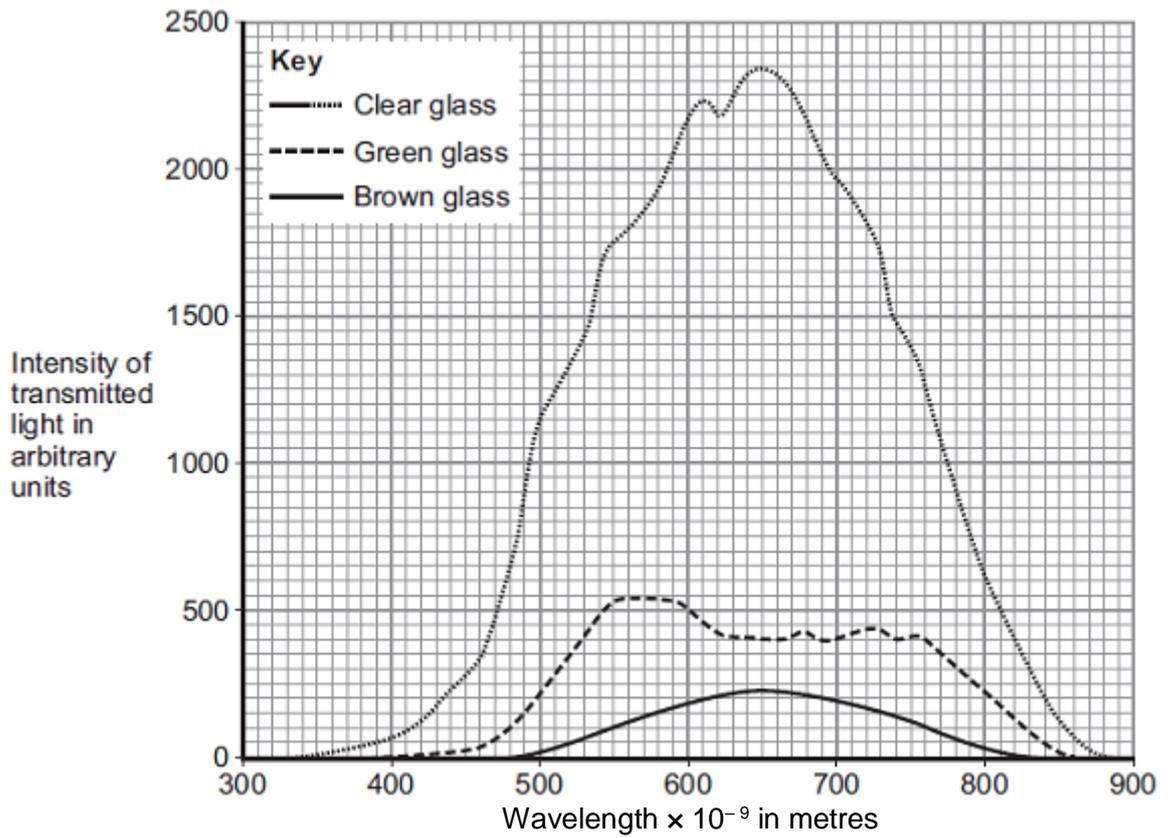
---

(2)

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







- (i) The pieces of glass all had the same thickness.

Suggest why.

---



---

(1)

- (ii) Bottles made of brown glass are suitable for storing beer.

Suggest why.

---



---

(1)

(Total 4 marks)

### Q6.

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.

---

---

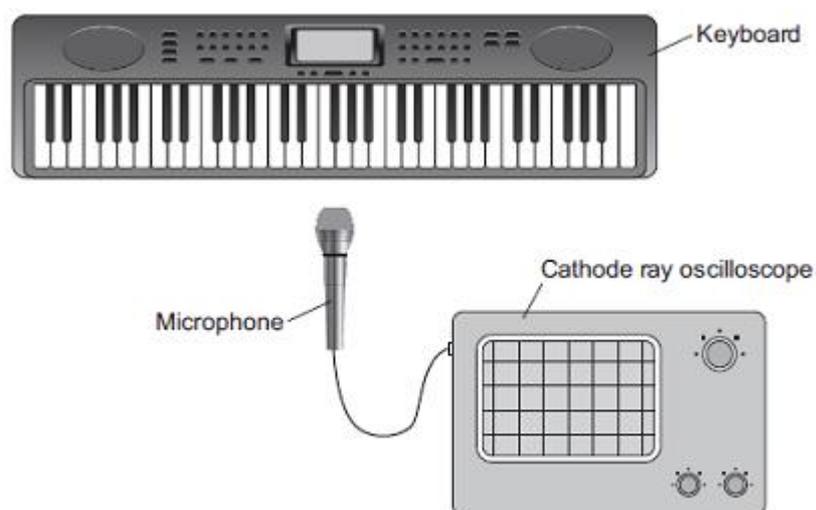
---

Wavelength = \_\_\_\_\_ metres

(3)

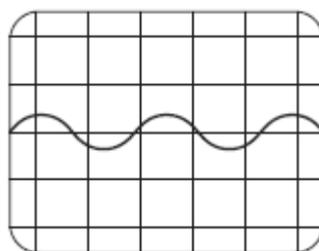
- (b) **Figure 1** shows a microphone connected to a cathode ray oscilloscope (CRO) being used to detect the note produced by the keyboard.

**Figure 1**



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

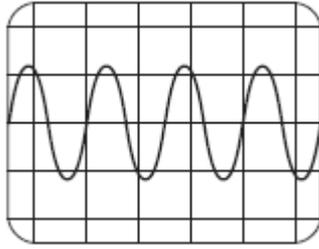
**Figure 2**



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)

**Q7.**

The figure below shows an X-ray image of a human skull.



Stockdevil/iStock/Thinkstock

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

<b>absorbs</b>	<b>ionises</b>	<b>reflects</b>	<b>transmits</b>
----------------	----------------	-----------------	------------------

When X-rays enter the human body, soft tissue \_\_\_\_\_  
X-rays  
and bone \_\_\_\_\_ X-rays.

(2)

(b) Complete the following sentence.

The X-rays affect photographic film in the same way that \_\_\_\_\_ does.

(1)

(c) The table below shows the total dose of X-rays received by the human body when different parts are X-rayed.

Part of body X-rayed	Dose of X-rays received by human body in arbitrary units
Head	3
Chest	4
Pelvis	60

Calculate the number of head X-rays that are equal in dose to one pelvis X-ray.

---



---



---

Number of head X-rays = \_\_\_\_\_

(2)

(d) Which **one** of the following is another use of X-rays?

Tick (✓) **one** box.

- Cleaning stained teeth
- Killing cancer cells
- Scanning of unborn babies

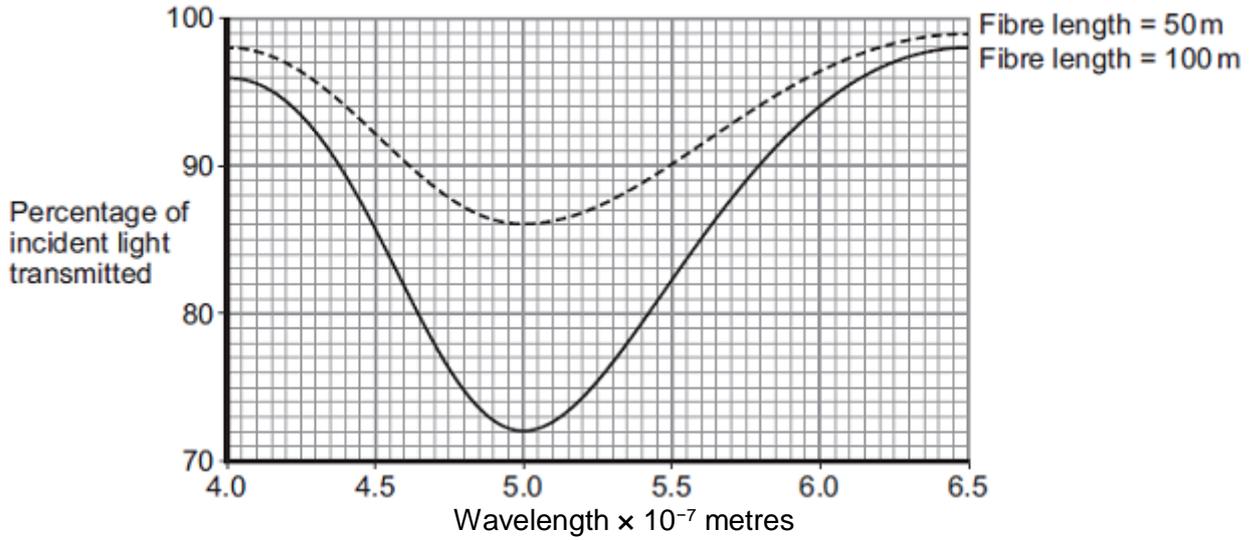
(1)

(Total 6 marks)

**Q8.**

Different wavelengths of light can be used to transmit information along optical fibres.

The graph below shows how the percentage of incident light transmitted through a fibre varies with the wavelength of light and the length of the fibre.



Compare the percentages of incident light transmitted through the two different fibres over the range of wavelengths shown.

---

---

---

---

---

---

---

---

---

---

---

(Total 3 marks)

**Q9.**

Waves may be longitudinal or transverse.

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

---

---

---

---

---

---

---

---

---

(3)

(b) Radio waves are electromagnetic waves.

Describe how radio waves are different from sound waves.

---

---

---

---

---

---

---

---

---

---

(4)

(Total 7 marks)

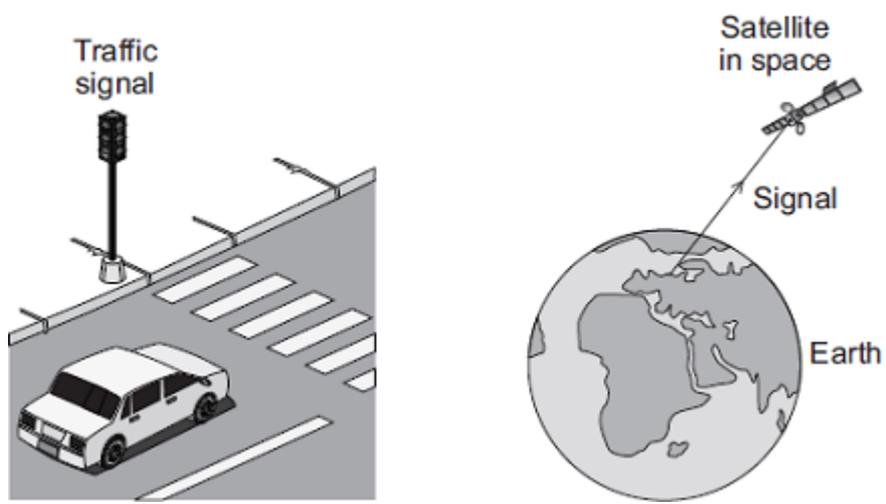
**Q10.**

**Diagram 1** shows four of the seven types of wave in the electromagnetic spectrum.

**Diagram 1**

J	K	L	Visible light	Infrared	Microwaves	Radio waves
---	---	---	---------------	----------	------------	-------------

(a) The **four** types of electromagnetic wave named in **Diagram 1** above are used for communication.



(i) Which type of electromagnetic wave is used when a traffic signal communicates with a car driver?

---

(1)

- (ii) Which type of electromagnetic wave is used to communicate with a satellite in space?

---

(1)

- (b) Gamma rays are part of the electromagnetic spectrum.

Which letter, **J**, **K** or **L**, shows the position of gamma rays in the electromagnetic spectrum?

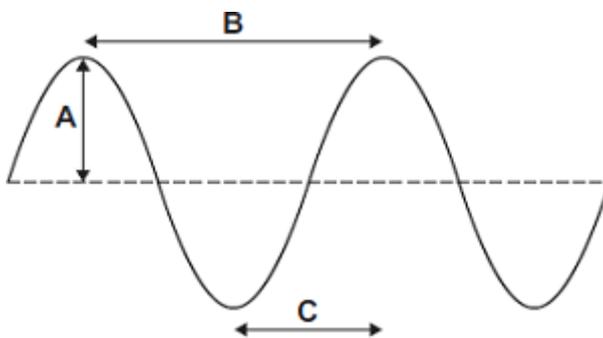
Draw a ring around the correct answer.

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

(1)

- (c) **Diagram 2** shows an infrared wave.

**Diagram 2**



- (i) Which **one** of the arrows, labelled **A**, **B** or **C**, shows the wavelength of the wave?

Write the correct answer, **A**, **B** or **C**, in the box.

(1)

- (ii) Draw a ring around the correct answer to complete the sentence.

The wavelength of infrared waves is 

shorter than
the same as
longer than

 the wavelength of radio waves.

(1)

- (d) Mobile phone networks send signals using microwaves. Some people think the energy a person's head absorbs when using a mobile phone may be harmful to health.

- (i) Scientists have compared the health of people who use mobile phones with the health of people who do not use mobile phones.

Which **one** of the following statements gives a reason why scientists have

done this?

Tick (✓) **one** box.

To find out if using a mobile phone is harmful to health.

To find out if mobile phones give out radiation.

To find out why some people are healthy.

(1)

- (ii) The table gives the specific absorption rate (SAR) value for two different mobile phones.

The SAR value is a measure of the maximum energy a person's head absorbs when a mobile phone is used.

Mobile Phone	SAR value in W/kg
X	0.28
Y	1.35

A parent buys mobile phone **X** for her daughter.

Using the information in the table, suggest why buying mobile phone **X** was the best choice.

---

---

---

---

(2)

(Total 8 marks)

### Q11.

A lorry has an air horn. The air horn produces sound waves in the air.

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

Sound waves cause air particles to \_\_\_\_\_.

(1)

- (b) 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.

---

---

---

Speed = \_\_\_\_\_ m/s

(2)  
(Total 3 marks)

**Q12.**

(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	<input type="checkbox"/>
$10^{-4}$ metres to $10^{15}$ metres	<input type="checkbox"/>
$10^{-6}$ metres to $10^6$ metres	<input type="checkbox"/>

(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  $1.8 \times 10^9$  Hz and travel at a speed of  $3.0 \times 10^8$  m/s.

Calculate the wavelength of the microwaves.

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 <sup>3</sup> 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.

---

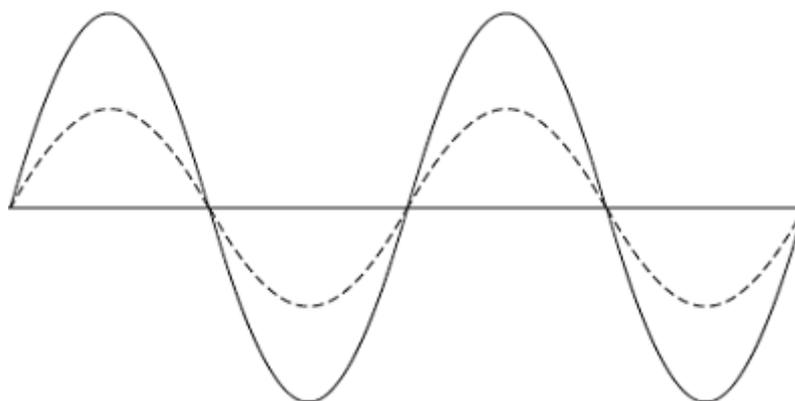
---

(1)  
(Total 6 marks)

### Q13.

- (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**

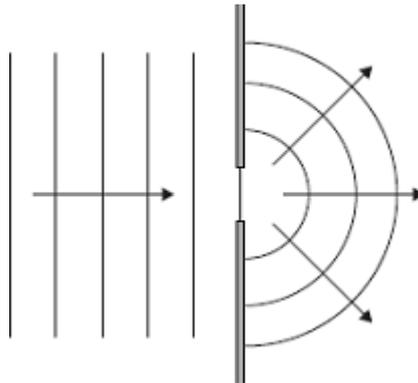
**sound**

**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)

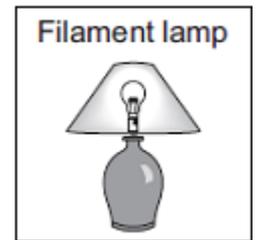
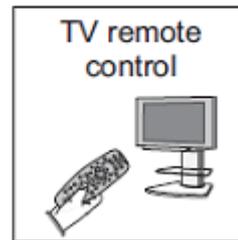
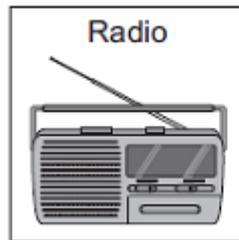
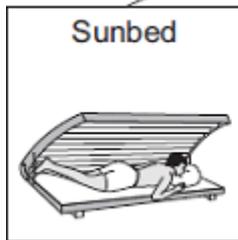
(Total 6 marks)

### Q14.

(a) The diagram shows the electromagnetic spectrum. The pictures show four devices that use electromagnetic waves. Each device uses a different type of electromagnetic wave.

Draw a line from each device to the type of electromagnetic wave that it uses. One has been done for you.

Gamma rays	X-rays	Ultraviolet rays	Visible light	Infra red rays	Microwaves	Radio waves
------------	--------	------------------	---------------	----------------	------------	-------------



(3)

(b) A headline from a recent newspaper article is shown below.

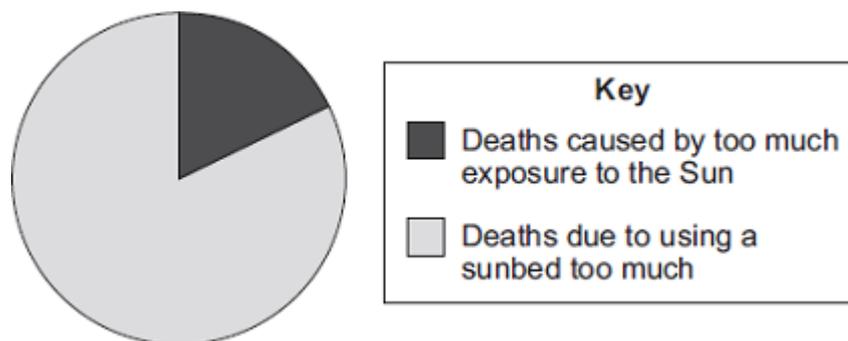


(i) What serious health problem may be caused by using a sunbed too much?

---

(1)

(ii) The pie chart compares the number of deaths in Britain each year which may have been caused by using sunbeds too much, with those which may have been caused by too much exposure to the Sun.



It is difficult for a doctor to be certain that a person has died because of using a sunbed too much.

Suggest why.

---



---

(1)

(iii) A spokesperson for a leading cancer charity said:

‘We want people, especially young people, to know the possible dangers of using a sunbed.’

Why is it important that you know the possible dangers of using a sunbed?

---

---

(1)  
(Total 6 marks)

**Q15.**

Using an optical telescope to look at stars is not always easy because:

- too many street lights often make it too light to see faint stars
- clouds reduce the light getting to the telescope
- atmospheric pollution often distorts the images.

Large optical telescopes are often positioned high up a mountain.

Describe the advantages of positioning a telescope high up a mountain.

---

---

---

---

---

---

---

(Total 3 marks)

**Q16.**

- (a) The wavelengths of four different types of electromagnetic wave, including visible light waves, are given in the table.

Type of wave	Wavelength
Visible light	0.0005 mm
<b>A</b>	1.1 km
<b>B</b>	100 mm
<b>C</b>	0.18 mm

Which of the waves, **A**, **B**, or **C**, is an infra red wave?

---

(1)

- (b) A TV station broadcasts at 500 000 kHz. The waves travel through the air at 300 000 000 m/s.

Calculate the wavelength of the waves broadcast by this station.

Show clearly how you work out your answer.

---

---

Wavelength = \_\_\_\_\_ m

(2)

- (c) What happens when a metal aerial absorbs radio waves?

---

---

---

---

(2)

- (d) Stars emit all types of electromagnetic waves. Telescopes that monitor X-rays are mounted on satellites in space.

Why would an X-ray telescope based on Earth **not** be able to detect X-rays emitted from distant stars?

---

---

(1)

(Total 6 marks)

### Q17.

- (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.

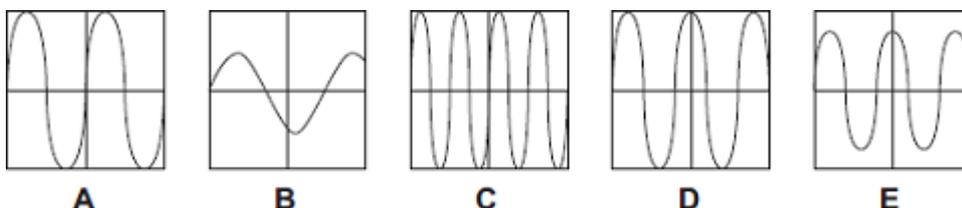
Include the unit in your answer.

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 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)

(c) There is no air in space.

Astronauts in space cannot hear sounds from outside their spacesuits.

Explain this.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

(2)

(Total 6 marks)

### Q18.

(a) The diagram below shows six of the seven types of wave that make up the electromagnetic spectrum.

Gamma rays		Ultraviolet	Visible light	Infrared	Microwaves	Radio waves
------------	--	-------------	---------------	----------	------------	-------------

(i) What type of electromagnetic wave is missing from the diagram?

\_\_\_\_\_

(1)

(ii) Which of the following electromagnetic waves has the most energy?

Draw a ring around the correct answer.

**gamma rays**      **radio waves**      **visible light**

(1)

(iii) Which of the following electromagnetic waves is given out by a TV remote control?

Draw a ring around the correct answer.

**infrared**      **microwaves**      **ultraviolet**

(1)

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

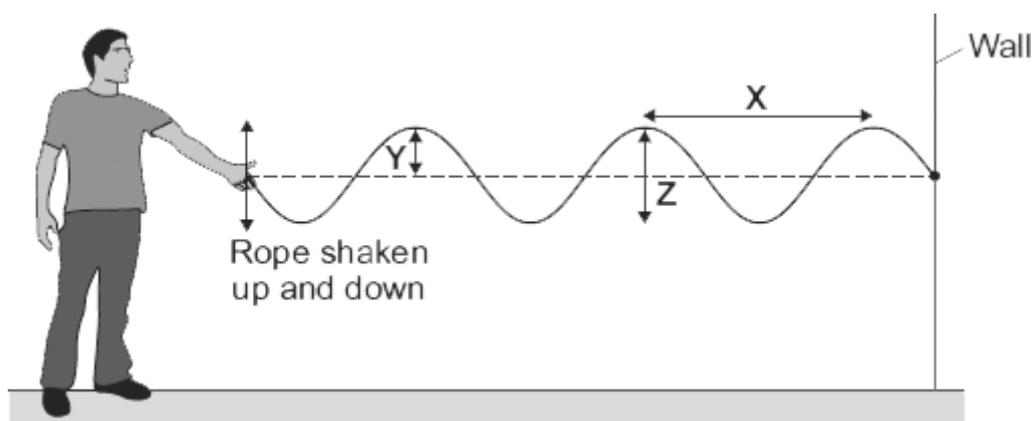
Microwaves travel through a vacuum at

a slower speed than
the same speed as
a faster speed than

radio waves.

(1)

(c) The diagram shows waves being produced on a rope.  
The waves are **not** reflected by the wall.



(i) Draw an arrow on the diagram to show the direction in which the waves transfer energy.

(1)

(ii) Which **one** of the arrows, labelled, **X**, **Y** or **Z**, shows the amplitude of a wave?

Write the correct answer in the box.

(1)

(iii) The waves produced on the rope are transverse.

Name **one** other type of transverse wave.

\_\_\_\_\_

(1)

(d) The rope is shaken up and down, producing 3 waves every second.  
The waves have a wavelength of 1.2 metres.

(i) State the frequency of the waves.

\_\_\_\_\_ Hz

(1)

(ii) Calculate the speed of the waves.

Show clearly how you work out your answer.

\_\_\_\_\_

\_\_\_\_\_

Wave speed = \_\_\_\_\_ m/s

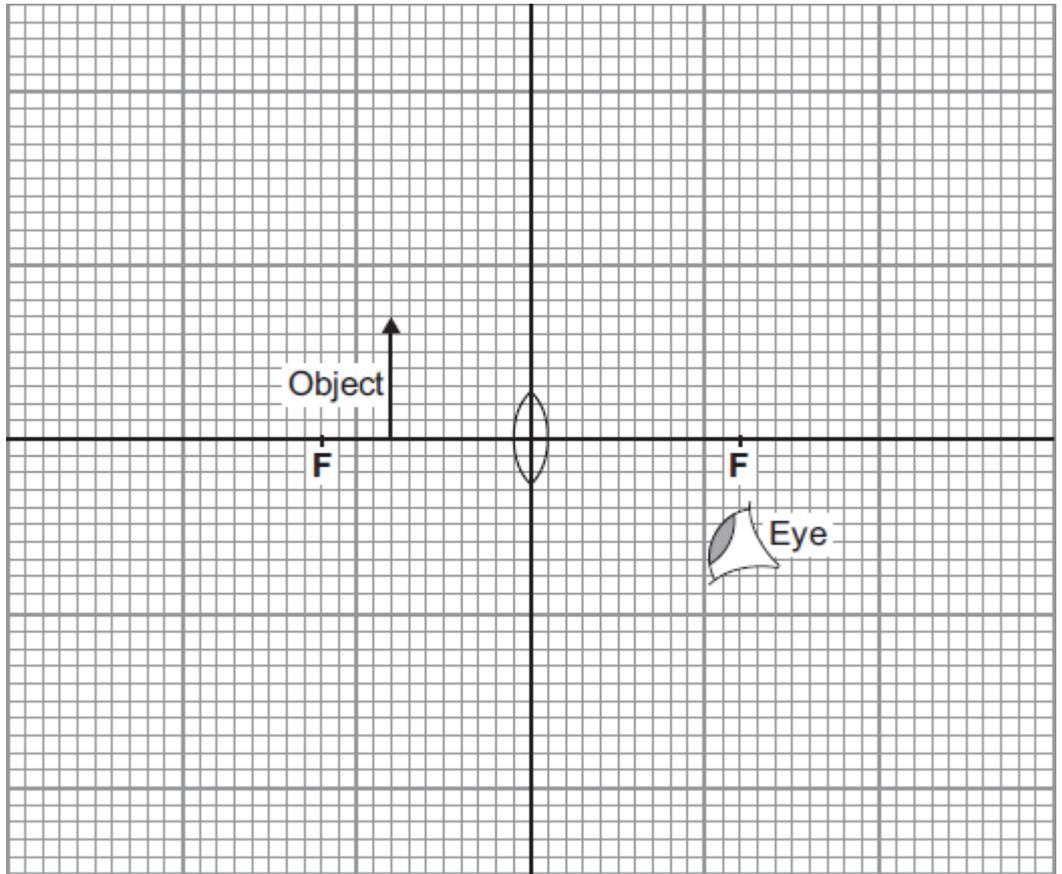
(2)

**(Total 10 marks)**

### Q19.

(a) The diagram shows a converging lens being used as a magnifying glass.

(i) On the diagram, use a ruler to draw two rays from the top of the object which show how and where the image is formed. Represent the image by an arrow drawn at the correct position.



(3)

- (ii) Use the equation in the box to calculate the magnification produced by the lens.

$\text{magnification} = \frac{\text{image height}}{\text{object height}}$
---------------------------------------------------------------------------

Show clearly how you work out your answer.

---



---

Magnification = \_\_\_\_\_

(2)

- (b) A camera also uses a converging lens to form an image.

Describe how the image formed by the lens in a camera is different from the image formed by a lens used as a magnifying glass.

---



---



---



---

(2)

(Total 7 marks)

**Q20.**

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) Electromagnetic waves travel at a speed of  $3.0 \times 10^8$  m/s.

A radio station transmits waves with a wavelength of  $2.5 \times 10^2$  m.

Calculate the frequency of the radio waves.

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

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

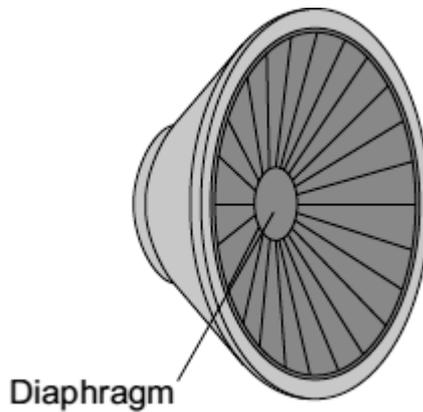
Frequency = \_\_\_\_\_

(3)

(Total 6 marks)

**Q21.**

The diaphragm of a loudspeaker moves in and out.

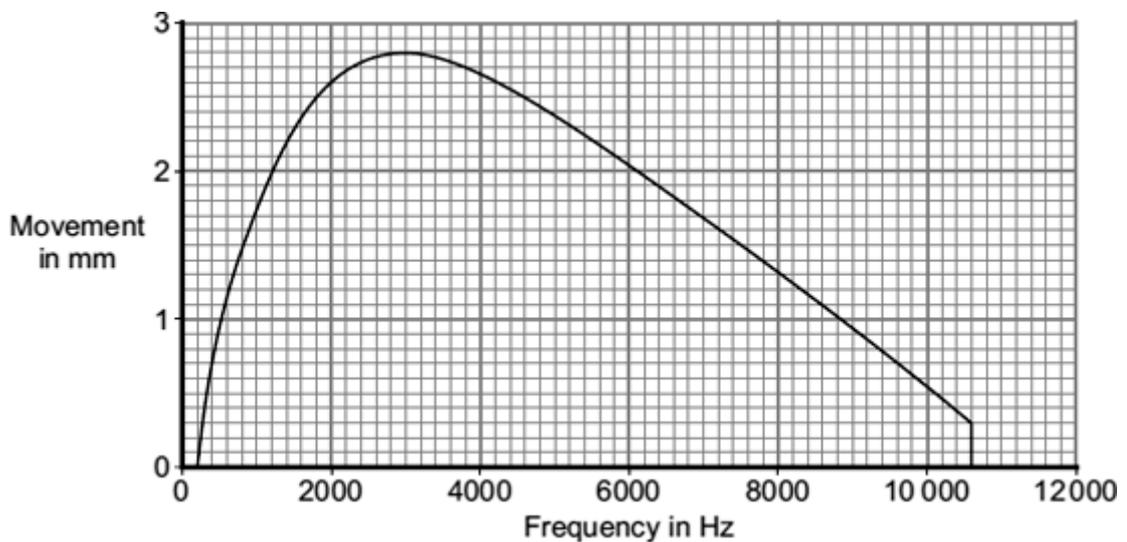


A team of scientists investigated loudspeakers.

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?

---

---

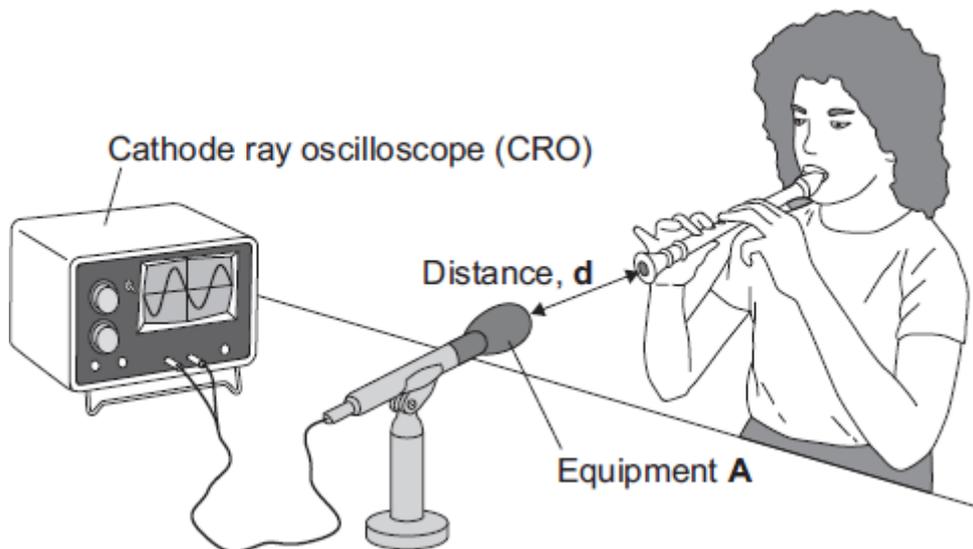
(1)

(Total 7 marks)

### Q22.

A group of students investigates sound waves.

The diagram shows part of their investigation.



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

---

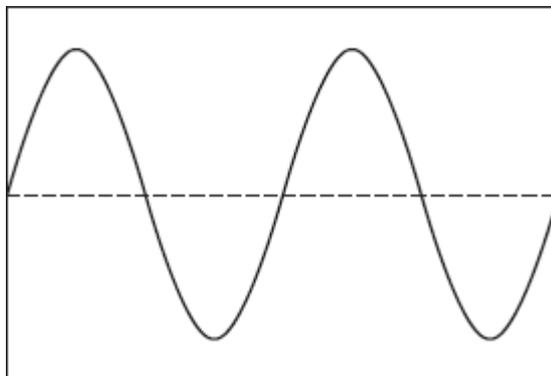
(1)

- (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.



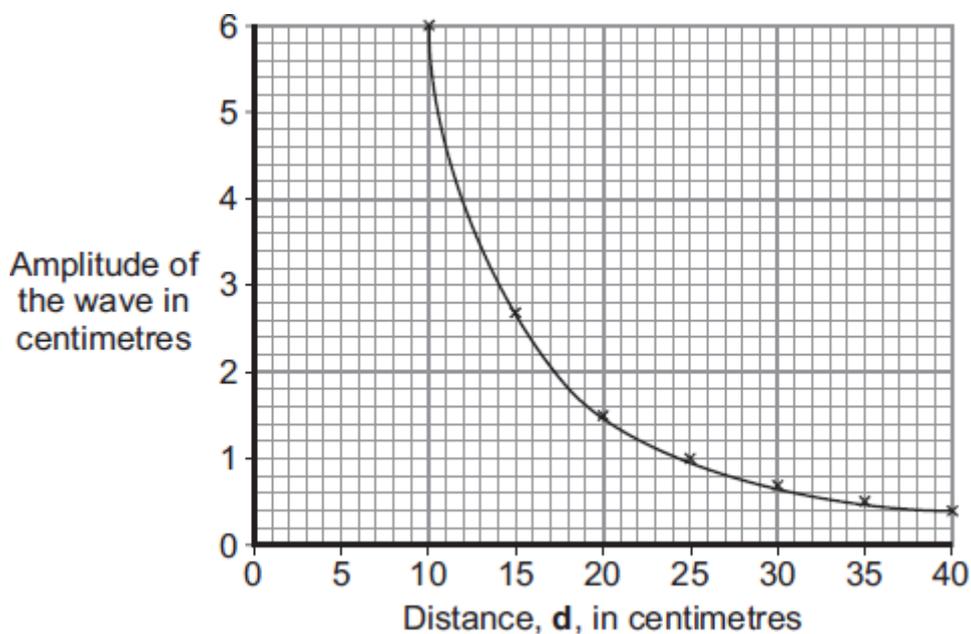
(1)

(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)

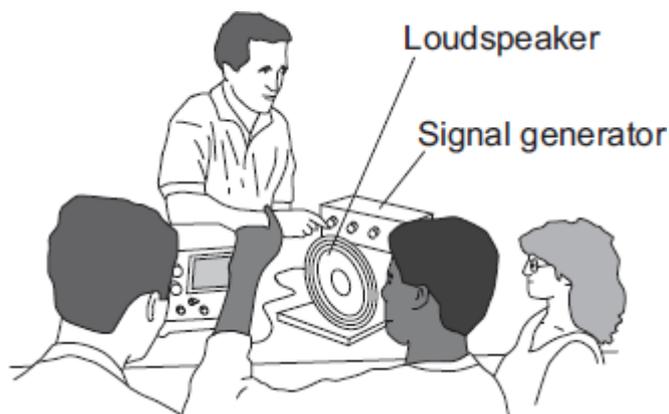
(d) Write a conclusion for this investigation.

---

---

(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?

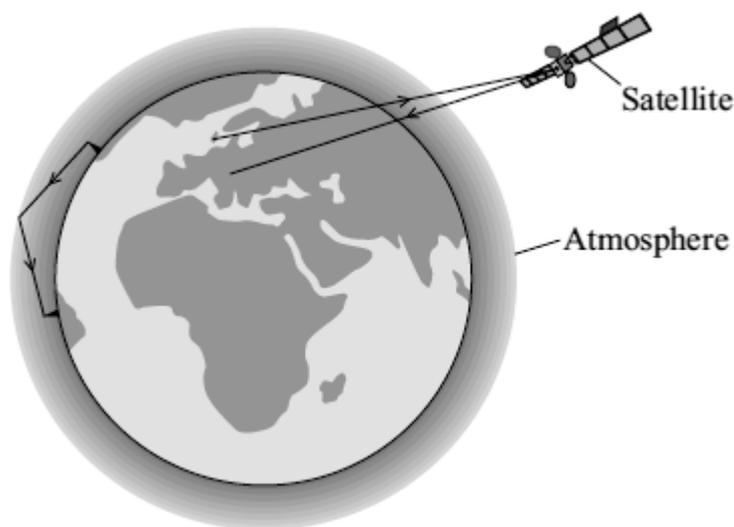
Most humans can hear from \_\_\_\_\_ Hz to \_\_\_\_\_ Hz.

(2)

(Total 7 marks)

**Q23.**

- (a) Electromagnetic waves have many uses. The diagram shows two ways of sending information using electromagnetic waves.



- (i) What type of wave is used to send information to and from satellites?

\_\_\_\_\_

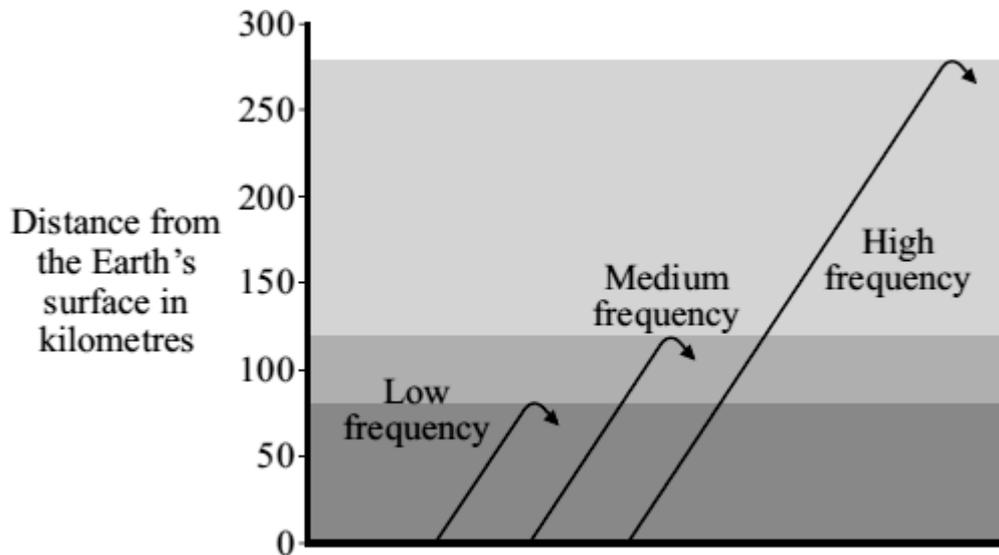
(1)

- (ii) What property of this type of wave makes it suitable for satellite communications?

\_\_\_\_\_

(1)

- (b) Different frequency radio waves travel different distances through the atmosphere before being reflected.



Use the information in the diagram to describe the connection between the frequency of a radio wave and the distance the radio wave travels through the atmosphere before it is reflected.

---



---

(1)

- (c) Electromagnetic waves travel at a speed of 300 000 000 m/s.

A radio station transmits waves with a wavelength of 20 metres.

Calculate the frequency, in kilohertz (kHz), of these waves.

Show clearly how you work out your answer.

---



---



---



---

Frequency = \_\_\_\_\_ kHz

(2)

(Total 5 marks)

**Q24.**

- (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) Which mammal in the table, apart from humans, **cannot** hear ultrasound?

\_\_\_\_\_ (1)

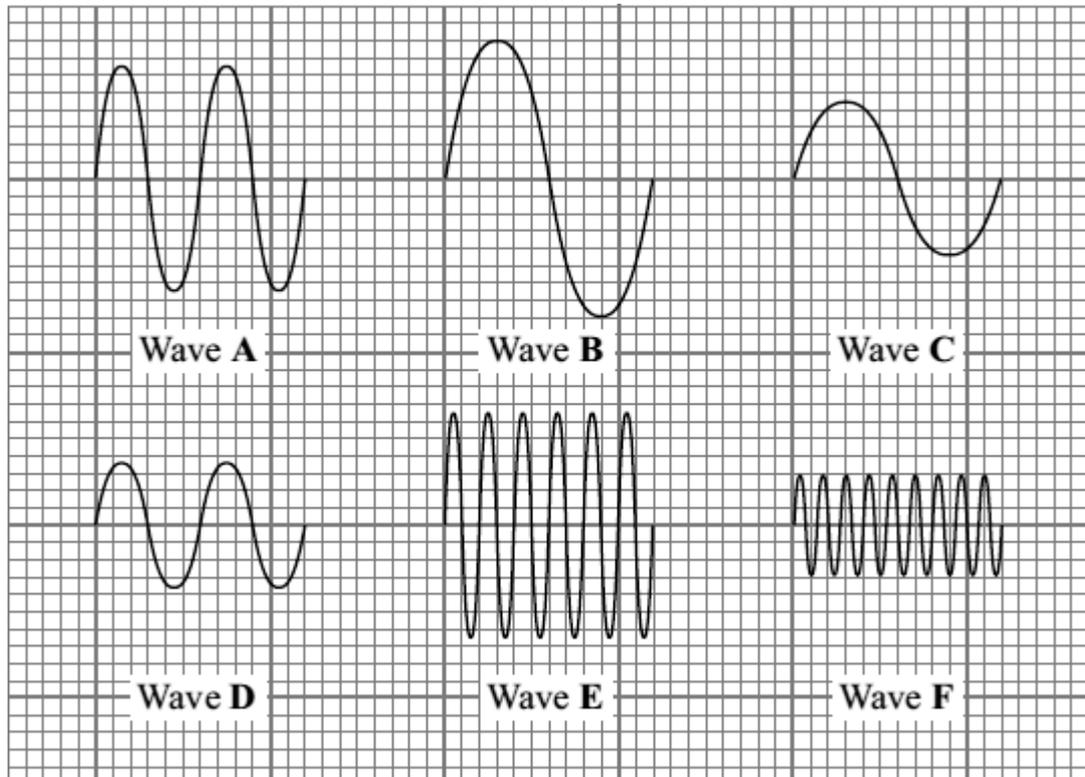
- (iii) Give **one** example of a frequency which an elephant can hear but which a tiger **cannot** hear.

Include the unit in your answer.

Frequency \_\_\_\_\_ (1)

- (b) The diagrams show six sound waves, **A**, **B**, **C**, **D**, **E** and **F**, represented on an oscilloscope screen.

They are all drawn to the same scale.



- (i) Which **one** of the waves has the greatest amplitude?

Wave \_\_\_\_\_ (1)

(ii) Which **one** of the waves has the highest frequency?

Wave \_\_\_\_\_ (1)

(Total 5 marks)

**Q25.**

The diagram shows the seven types of wave that make up the electromagnetic spectrum.

Gamma rays	X-rays	Ultraviolet rays	Visible light	Infra red rays	Micro-waves	Radio waves
------------	--------	------------------	---------------	----------------	-------------	-------------

(a) (i) Microwaves and visible light can be used for communications.

Name **one** more type of electromagnetic wave that can be used for communications.

\_\_\_\_\_ (1)

(ii) Name **one** type of electromagnetic wave that has a longer wavelength than microwaves.

\_\_\_\_\_ (1)

(b) Wi-Fi is a system that joins a laptop computer to the internet without using wires. A 2400 megahertz microwave signal is used to link a computer to a device called a router.

What quantity is measured in hertz?

Draw a ring around your answer.

**frequency                      wavelength                      wave speed** (1)

(c) A politician commented on the increasing use of Wi-Fi. He said: 'I believe that these systems may be harmful to children.'

(i) Suggest **one** reason why more scientific research into the safety of Wi-Fi systems is needed.

\_\_\_\_\_  
\_\_\_\_\_ (1)

(ii) Complete the following sentence by drawing a ring around the correct line in the box.

What the politician said was

- a fact.
- an opinion.
- a prediction.

(1)  
(Total 5 marks)

**Q26.**

(a) Microwaves and visible light are two types of electromagnetic wave. Both can be used for communications.

(i) Give **two** properties that are common to both visible light and microwaves.

1. \_\_\_\_\_

2. \_\_\_\_\_

(2)

(ii) Name **two** more types of electromagnetic wave that can be used for communications.

\_\_\_\_\_ and \_\_\_\_\_

(1)

(b) Wi-Fi is a system that joins computers to the internet without using wires. Microwaves, with a wavelength of 12.5 cm, are used to link a computer to a device called a router. Microwaves travel through the air at 300 000 000 m/s.

Calculate the frequency of the microwaves used to link the computer to the router.

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

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Frequency = \_\_\_\_\_

(3)

(c) Wi-Fi is used widely in schools. However, not everyone thinks that this is a good idea.

A politician commented on the increasing use of WiFi. He said: 'I believe that these systems may be harmful to children.'

However, one group of scientists said that there is no reason why Wi-Fi should not be used in schools. These scientists also suggested that there is a need for further research.

(i) Suggest what the politician could have done to persuade people that what he

said was not just an opinion.

---

---

(1)

- (ii) Why did the group of scientists suggest that there is a need for further research?

---

---

(1)

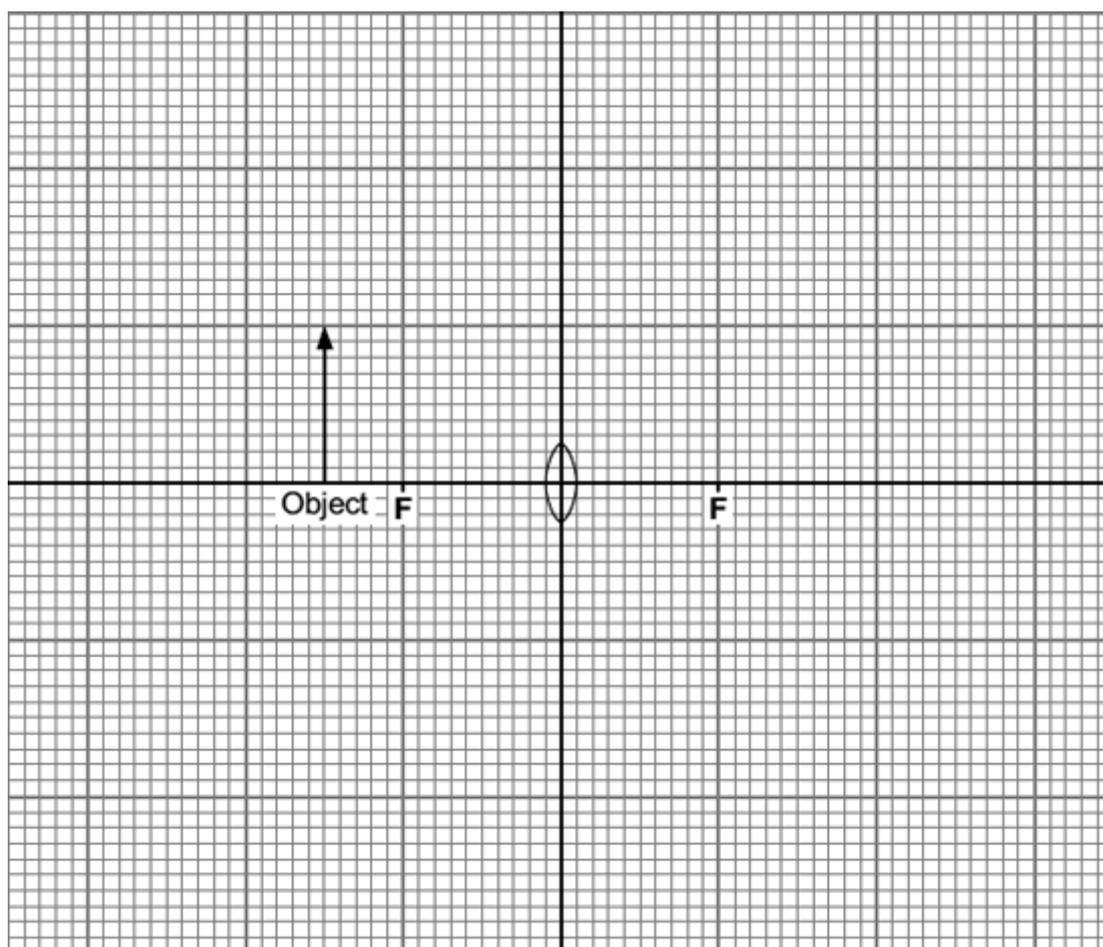
(Total 8 marks)

**Q27.**

A student investigated how the nature of the image depends on the position of the object in front of a large converging lens.

The diagram shows one position for the object.

- (a) Use a ruler to complete a ray diagram to show how the image of the object is formed.



**Key:** F = principal focus

(4)

(b) Describe the nature of this image relative to the object.

---

---

---

(2)  
(Total 6 marks)

**Q28.**

The table shows the electromagnetic spectrum.  
Three types of wave have been missed out.

Gamma rays		Ultraviolet rays	Visible light		Micro-waves		
← Shortest wavelength							Longest wavelength →

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

<b>infra red rays</b>	<b>radio waves</b>	<b>X-rays</b>
-----------------------	--------------------	---------------

(2)

(ii) Which **one** of the following gives a use of gamma rays?

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

- to communicate with satellites
- to see objects
- to kill cancer cells

(1)

(iii) Complete the following sentence by drawing a ring around the correct word in the box.

All electromagnetic waves move 

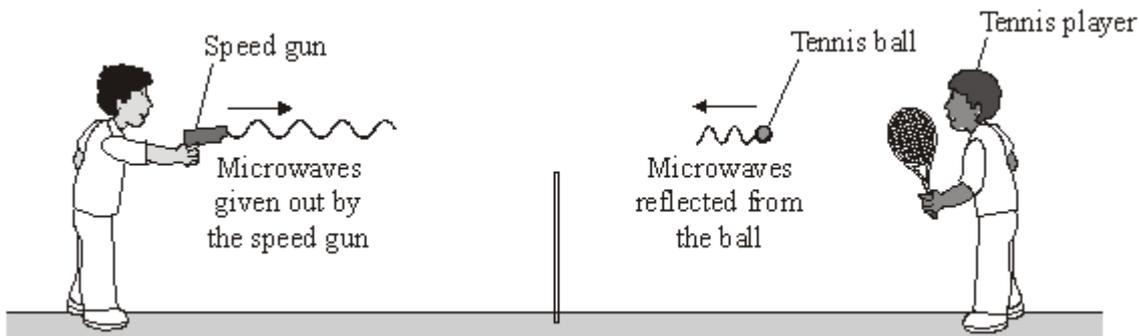
energy
gases
particles

 from one place to another.

(1)  
(Total 4 marks)

**Q29.**

- (a) The picture shows a speed gun being used to measure how fast a tennis player hits the ball.



Some of the microwaves from the speed gun are absorbed by the ball and some are reflected by the ball.

- (i) Complete the following sentence by choosing **one** of the phrases from the box.

<b>longer than</b>	<b>the same as</b>	<b>shorter than</b>
--------------------	--------------------	---------------------

The wavelength of the microwaves reflected from the ball are \_\_\_\_\_ the wavelength of the microwaves from the speed gun.

(1)

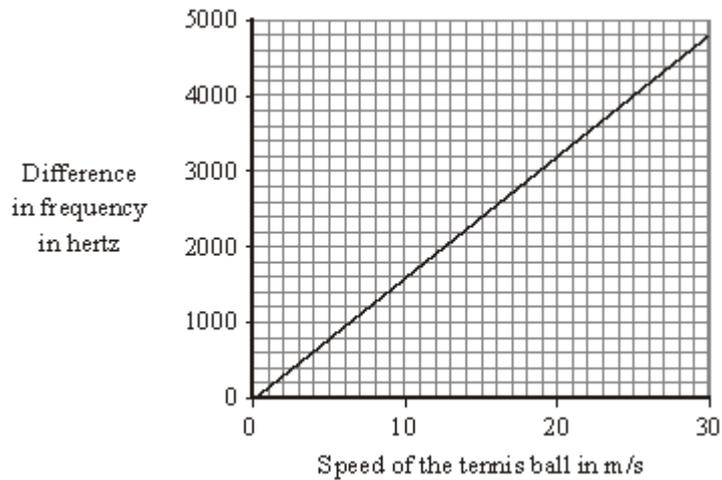
- (ii) Complete the following sentence by drawing a ring around the correct line in the box.

When the ball absorbs microwaves, its temperature will

decrease slightly
not change
increase slightly

(1)

- (b) The microwaves reflected from the ball have a higher frequency than the microwaves from the speed gun. The graph shows how the difference between the two frequencies depends on the speed of the ball.



- (i) Describe the pattern that links the difference between the two frequencies and the speed of the ball.

---



---

(1)

- (ii) The speed gun measures the difference between the two frequencies as 3200 Hz.

Use the graph to find the speed of the tennis ball.  
Show clearly on the graph how you obtain your answer.

Speed of the tennis ball = \_\_\_\_\_ m/s

(2)

- (iii) Which **one** of the following gives the reason why the data has been shown as a line graph and **not** as a bar chart?

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

Frequency and speed are both categoric variables.

Frequency and speed are both continuous variables.

Speed is a continuous variable and frequency is a categoric variable.

(1)

(Total 6 marks)

### Q30.

- (a) Microwaves are one type of electromagnetic wave.

- (i) Which type of electromagnetic wave has a lower frequency than microwaves?

---

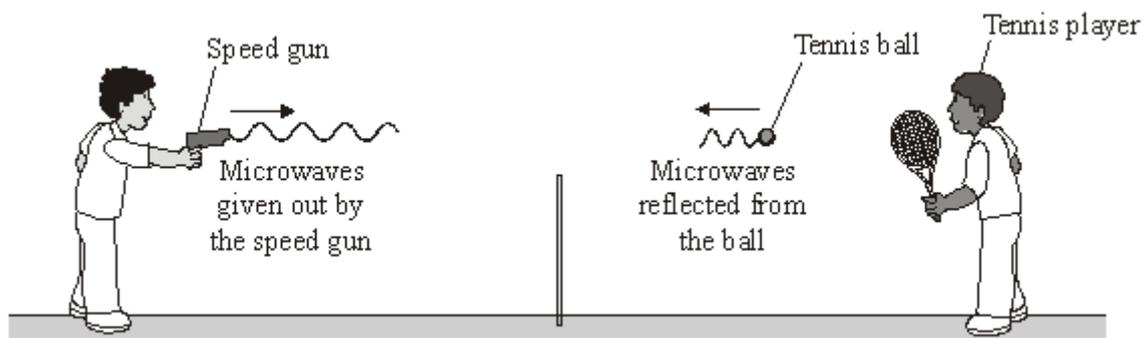
(1)

- (ii) What do all types of electromagnetic wave transfer from one place to another?

---

(1)

- (b) The picture shows a tennis coach using a speed gun to measure how fast the player serves the ball.



- (i) The microwaves transmitted by the speed gun have a frequency of 24 000 000 000 Hz and travel through the air at 300 000 000 m/s.

Calculate the wavelength of the microwaves emitted from the speed gun.

Show clearly how you work out your answer.

---

---

Wavelength = \_\_\_\_\_ m

(2)

- (ii) Some of the microwaves transmitted by the speed gun are absorbed by the ball.

What effect will the absorbed microwaves have on the ball?

---

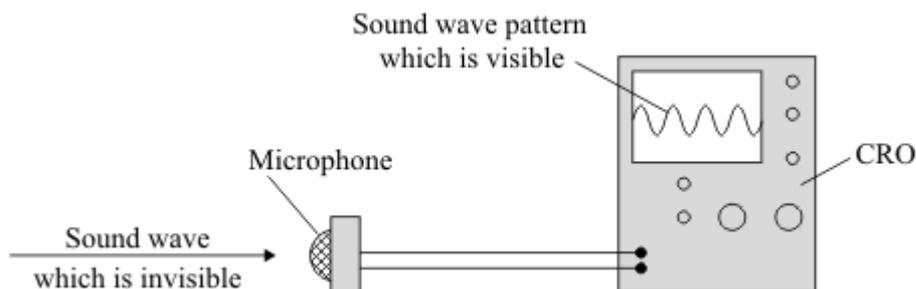
---

(1)

(Total 5 marks)

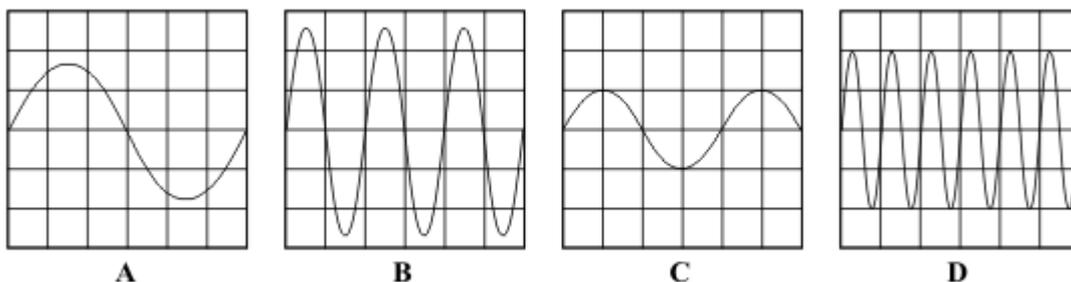
### Q31.

A microphone and a cathode ray oscilloscope (CRO) can be used to show the pattern of a sound wave.



Four sound wave patterns, **A**, **B**, **C** and **D**, are shown.

They are all drawn to the same scale.

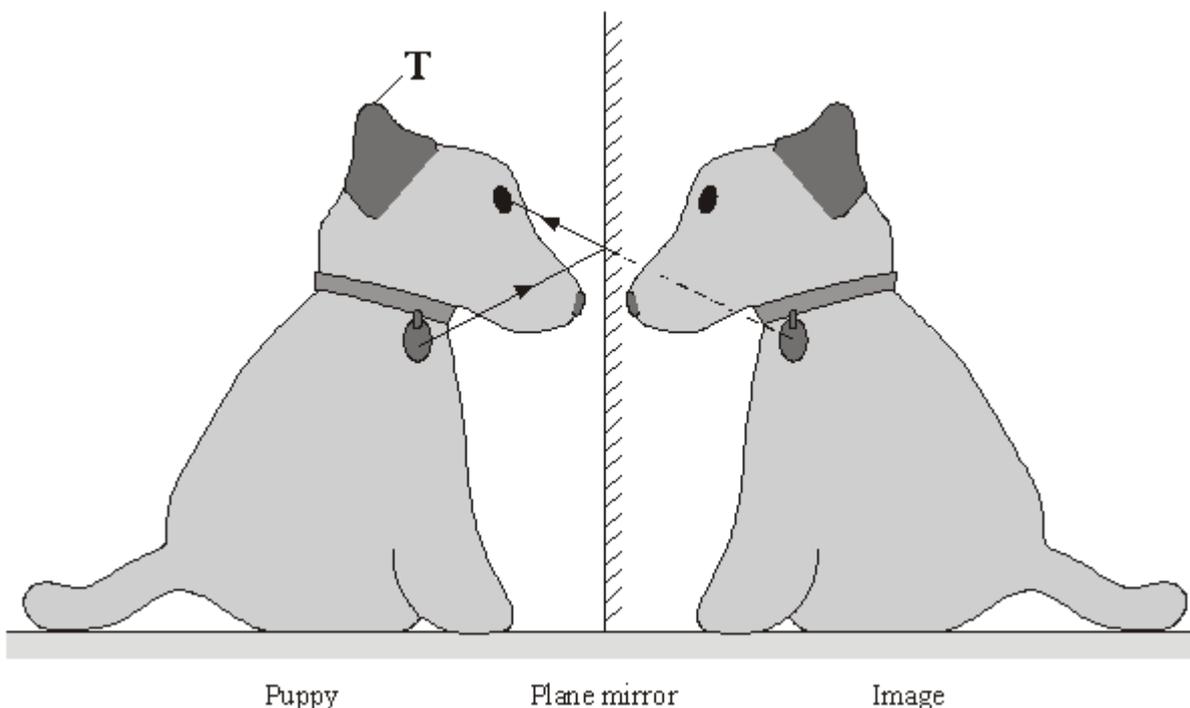


- (a) Which **one** of the patterns has the smallest amplitude? \_\_\_\_\_
- (b) Which **one** of the patterns has the lowest frequency? \_\_\_\_\_

(Total 2 marks)

**Q32.**

A puppy can see an image of himself in a plane mirror.



The diagram shows how the puppy can see his disc.

- (a) On the diagram, use a ruler to draw a ray to show how the puppy can see the top of his ear, which is marked as **T**.
- (b) What is a plane mirror?

---



---

(1)  
(Total 4 marks)

**Q33.**

(a) Some scientists think that there is a link between using a mobile phone and some types of illness. Other scientists disagree. They say that the evidence is limited and unreliable.

(i) Suggest what scientists could do to show a link between using a mobile phone and illness.

---

---

(1)

(ii) How could scientists improve the reliability of the evidence?

---

---

(1)

(iii) Complete the following passage by drawing a ring around the word in the box that is correct.

There has been little or no experimental research into the health of children who use mobile phones.

This is partly because of the 

economic
environmental
ethical

 issues involved in using children in scientific research.

(1)

(b) Before being sold, new mobile phones must be tested and given a SAR value. The SAR value is a measure of the energy absorbed by the head while a mobile phone is being used.

The table gives the SAR value for three mobile phones made by different companies.

To be sold in the UK, a mobile phone must have a SAR value lower than 2.0 W/kg.

Mobile phone	SAR value in W/kg
J	0.18
K	0.86
L	1.40

(i) All companies use the same test to measure a SAR value.

Why is using the same test important?

---

\_\_\_\_\_ (1)

- (ii) Would the companies that make the mobile phones, **J**, **K** and **L**, be correct to claim that these three phones are totally safe to use?

Answer yes or no. \_\_\_\_\_

Give a reason for your answer.

\_\_\_\_\_  
\_\_\_\_\_ (1)

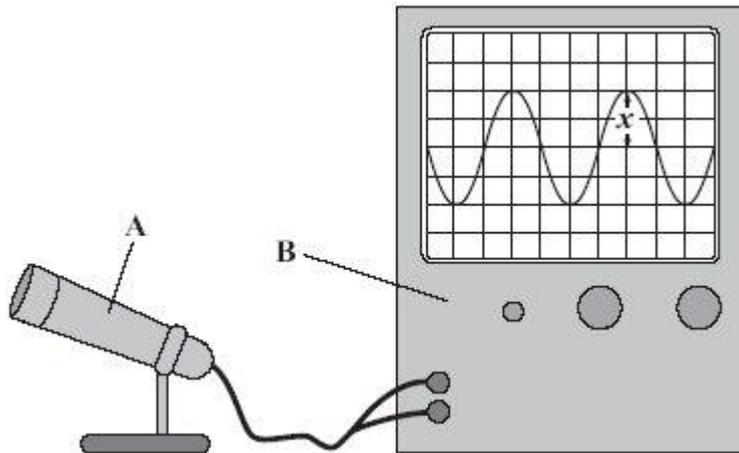
- (c) Devices designed to protect a mobile phone user from microwave radiation are now available.

Why is it important that these devices are tested by scientists who are **not** working for the company that makes the devices?

\_\_\_\_\_  
\_\_\_\_\_ (1)  
**(Total 6 marks)**

**Q34.**

- (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.

---

---

---

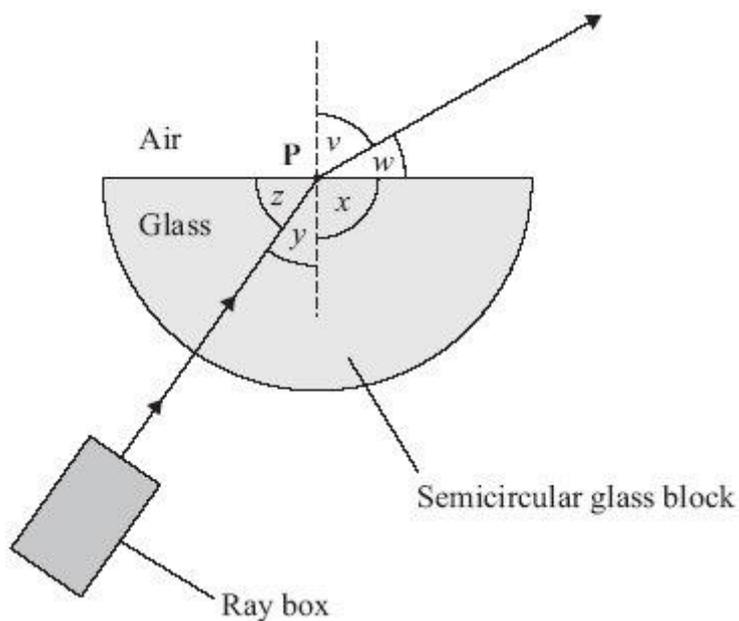
---

(2)

(Total 6 marks)

### Q35.

A student uses a ray box and a semicircular glass block to investigate refraction.



(a) What is the vertical dashed line called?

---

(1)

(b) Which angle,  $v$ ,  $w$ ,  $x$ ,  $y$  or  $z$ , is the angle of refraction?

---

(1)

(c) Why has refraction taken place?

---

---

(1)

(d) In an investigation, a student always aims the light from the ray box at point **P**. She moves the ray box to give different values of angle  $v$ . She records angle  $y$  for each of these values. The table shows her results.

Angle $v$ measured in degrees	Angle $y$ measured in degrees
30	19
40	25
50	31
60	35
70	39
80	41

The student studies the data and comes to the following conclusion.

Angle  $y$  is directly proportional to angle  $v$ .

Her friend says that this conclusion is **not** correct.

(i) Use data from the table to explain why the conclusion is **not** correct.

---

---

(2)

(ii) Write a correct conclusion for the experiment.

---

---

(1)

(iii) Why is your conclusion only valid when angle  $v$  is between  $30^\circ$  and  $80^\circ$ ?

---

---

(1)

(Total 7 marks)

## Mark schemes

### Q1.

(a) any **four** from:

- light waves are transverse whereas sound waves are longitudinal
- light waves travel faster than sound waves
- light waves have a higher frequency than sound waves
- light waves have a shorter wavelength than sound waves
- light waves have oscillations perpendicular (to the direction of energy transfer) whereas sound waves are parallel (to the direction of energy transfer)

4

(b) the baby can be seen in the dark

1

(c) wave speed = frequency  $\times$  wavelength

*accept  $v = f\lambda$*

1

(d)  $3 \times 10^8 = f \times 0.125$

1

$$f = 3 \times 10^8 / 0.125$$

1

$$f = 2.4 \times 10^9 \text{ (Hz)}$$

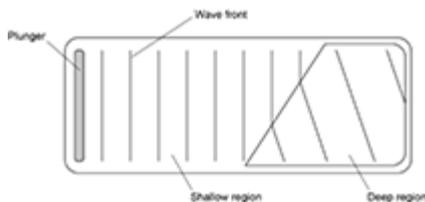
*allow  $2.4 \times 10^9$  with no working for 3 marks*

1

[9]

### Q2.

(a)



*lines should be further apart with the bottom of the wave fronts further to the right than the top*

1

(b) they will speed up

1

so wave (fronts) move further apart

1

(c) longitudinal waves:

- the oscillations are parallel to the direction of energy transfer
- show areas of compression and rarefaction

1

1

transverse waves:

- the oscillations / movement are perpendicular to the direction of energy transfer. 1
  
- (d) place a floating object / plastic duck on the surface of the water 1  
it will stay in the same place **or** only bob up and down if the water doesn't move 1
  
- (e)  $0.42 = 1 / f$  1  
 $f = 2.38$  1  
 $v = 2.38 \times 0.34$  1  
 $= 0.809$   
*allow 0.809 with no working shown for 4 marks* 1  
*incorrect sig. figs max 3 marks*  
m / s 1  
*correct unit*

[13]

**Q3.**

- (a) (i) frequency 1  
wavelength 1
  
- (ii)  $10^{-15}$  to  $10^4$  1
  
- (b)  $2.0 \times 10^5$  2  
*correct substitution of*  
 *$3.0 \times 10^8 / 1500$  gains 1 mark*
  
- Hz 1
  
- (c) (i) (skin) burns 1
  
- (ii) skin cancer / blindness 1
  
- (d) (i) any **one** from: 1
  - (detecting) bone fractures
  - (detecting) dental problems
  - treating cancer
  
- (ii) any **one** from:

- affect photographic film
  - absorbed by bone
  - transmitted by soft tissue
  - kill (cancer) cells
- answer must link to answer given in (d)(i)*

1

(iii)  $9 / 36 = 0.25$   
 $0.5 / 2 = 0.25$   
 $4 / 16 = 0.25$

*accept:*

$36 / 9 = 4$

$2 / 0.5 = 4$

$16 / 4 = 4$

2

conclusion based on calculation

*two calculations correct with a valid conclusion scores 2 marks*

*one correct calculation of  $k$  scores 1 mark*

1

[13]

#### Q4.

(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  $8.3 \pm 0.1$  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

$410 \text{ (Hz)} \leq f \leq 450 \text{ (Hz)}$

*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]

### Q5.

(a) decreases

*correct order only*

1

increases

1

(b) (i) intensity (of transmitted light ) depends on thickness

**or**

to enable a valid comparison

**or**

it is a control variable

*accept absorption depends on thickness*

*it would affect the results is insufficient*

*fair test is insufficient*

1

(ii) transmits the least light

**or**

absorbs the most light

*accept very little light is transmitted*

*do **not** accept transmits none of the light*

*do **not** accept absorbs all of the light*

*any reference to heat negates this mark*

1

[4]

### Q6.

(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 0.772*

*allow 2 marks for an answer of 0.772*

*allow 1 mark for correct substitution ie  $340 = 440 \times \lambda$*

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]

**Q7.**

- (a) transmits  
*correct order* 1
- absorbs 1
- (b) light  
*allow ultra violet **or** UV **or** infrared **or** IR **or** gamma* 1
- (c) 20  
*allow 1 mark for correct working, ie  $\frac{60}{3}$  provided no subsequent step* 2
- (d) Killing cancer cells 1

[6]

**Q8.**

- (for both fibres) increasing the wavelength of light decreases and then increases the percentage / amount of light transmitted  
*accept for 1 mark:*  
*(for both fibres) increasing the wavelength (of light) to 5 (x 10<sup>-7</sup> metres), decreases the (percentage) transmission* 1
- (for both fibres) the minimum transmission happens at 5 (x 10<sup>-7</sup> metres)  
**or**  
 maximum transmission occurs at 6.5 (x 10<sup>-7</sup> metres)  
*accept for a further 1 mark:*  
*(for both fibres) increasing the wavelength of the light from 5 (x 10<sup>-7</sup> metres) increases the amount of light transmitted*  
*increasing wavelength (of light), decreases the percentage transmitted is insufficient on its own* 1

the shorter fibre transmits a greater percentage of light (at the same wavelength)

*accept for 1 mark:*

*Any statement that correctly processes data to compare the fibres*

1

[3]

**Q9.**

(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]

**Q10.**

(a) (i) (visible) light

*accept visible*

1

(ii) microwaves

1

(b) J

1

(c) (i) B

1

(ii) shorter than

1

(d) (i) To find out if using a mobile phone is harmful to health

1

(ii) any **two** from:

- (X has a) low(er) SAR value  
*"it" refers to mobile phone*  
*accept has a low(er) rate*
- (maximum) energy absorbed (by the head) is less  
*accept energy emitted (by phone) is less*  
*accept radiation for energy*
- (if mobiles are harmful) less likely to cause harm  
*accept will not cause harm*  
*accept it is safer*

2

[8]

### Q11.

(a) vibrate / oscillate

*accept a correct description*  
*move is insufficient*

1

(b) 336

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

2

[3]

### Q12.

(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]

**Q13.**

- (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  $8 \times 0.015$  provided no  
 subsequent step shown*

2

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

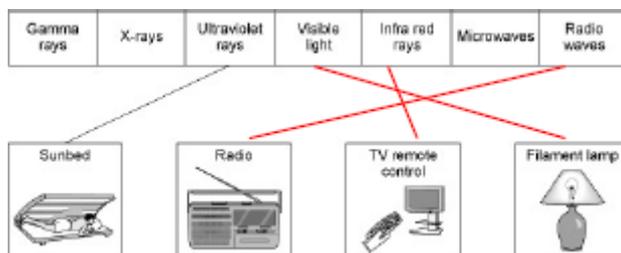
*do **not** accept mps*  
*units must be consistent with numerical answers*

1

[6]

**Q14.**

- (a) all three lines correct



*allow 1 mark for each correct line*  
*if more than one line goes from a device then all lines from  
 that device are wrong*

3

- (b) (i) skin cancer  
*do **not** accept cancer*  
*do **not** accept sunburn*  
*correct answer only*

1

- (ii) other factors may be involved  
*accept may have been in the Sun too long*  
*accept (over)-use of sunbeds and (over)- exposure to the Sun (both) give the same symptoms*  
*accept any other sensible factor that could lead to doubt*  
*do **not** accept irrelevant answers eg may be run over by a car*  
*do **not** accept killed by exposure to the Sun*

1

- (iii) can assess risk  
*answers should be in terms of assessing our own health risk*

**or**

- make your own decision  
*accept so you limit its use / don't use one*  
*do **not** accept so you don't get skin cancer*  
*do **not** accept so you don't get sunburn*

1

[6]

**Q15.**

- less / no light pollution  
*accept no / fewer streetlights*

1

less cloud cover / above clouds

1

- less atmospheric pollution  
*accept air for atmosphere*  
*accept idea of thinner atmosphere*  
*do **not** accept closer to stars*

1

[3]

**Q16.**

- (a) C or 0.18 mm

1

- (b) 0.6 (m)

*allow 1 mark for correct substitution and/or transformation **or***  
*1 mark for changing frequency to Hz*  
*answer 600 gains 1 mark*

2

- (c) creates an alternating current  
*accept 'ac' for alternating current*  
*accept alternating voltage*

1

with the same frequency as the radio wave  
*accept signal for radio wave*  
*accept it gets hotter for 1 mark provided no other marks*

scored

1

- (d) X-rays cannot penetrate the atmosphere  
*accept atmosphere stops X-rays*  
*do **not** accept atmosphere in the way*

or

X-rays are absorbed (by the atmosphere) before reaching Earth  
*ignore explanations*

1

[6]

**Q17.**

- (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]

**Q18.**

- (a) (i) X-ray(s)

1

- (ii) gamma rays

1

- (iii) infrared

1

- (b) the same speed as

1

- (c) (i) horizontal arrow drawn pointing to the right  
*judge by eye*  
*accept drawn anywhere on diagram*

1

(ii) Y

1

(iii) any **one** from:

- any type of electromagnetic wave  
*accept electromagnetic wave(s)*
- water (wave)  
*do not accept seismic waves*
- (earthquake / seismic) S waves  
*do not accept P waves*  
*do not accept earthquakes*

1

(d) (i) 3

1

(ii) 3.6

**or**

their (d)(i)  $\times$  1.2 correctly calculated

$$v = f \times \lambda$$

*allow 1 mark for correct substitution*

*ie 3 or their (d)(i)  $\times$  1.2 provided that no subsequent step is shown*

2

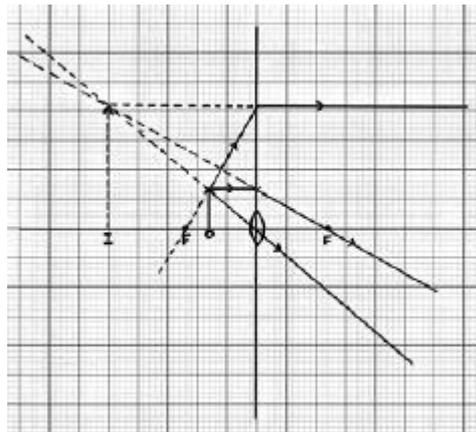
[10]

### Q19.

(a) (i) **two** correct rays drawn

*1 mark for each correct ray*

- ray parallel to axis from top of object **and** refracted through focus **and** traced back beyond object
- ray through centre of lens **and** traced back beyond object
- ray joining top of object to focus on left of lens taken to the lens refracted parallel to axis **and** traced back parallel to axis beyond object



an arrow showing the position **and** correct orientation of the image for their rays

*to gain this mark, the arrow must go from the intersection of the traced-back rays to the axis **and** the image must be on the same side of the lens as the object and above the axis*

1

(ii) (x) 3.0

*accept 3.0 to 3.5 inclusive*

**or**

$$\frac{\text{their image height}}{\text{object height}}$$

correctly calculated

*allow 1 mark for correct substitution into equation using their figures*

*ignore any units*

2

(b) any **two** from:

in a camera the image is:

- real not virtual
- inverted and not upright  
*accept upside down for inverted*
- diminished and not magnified  
*accept smaller and bigger*  
*accept converse answers but it must be clear the direction of the comparison*  
*both parts of each marking point are required*

2

[7]

## Q20.

(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)  $v = f \lambda$

$$1.2 \times 10^6 / 1200\ 000$$

*allow 1 mark for correct substitution*

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

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

[6]

**Q21.**

- (a) 10 600 (Hz)

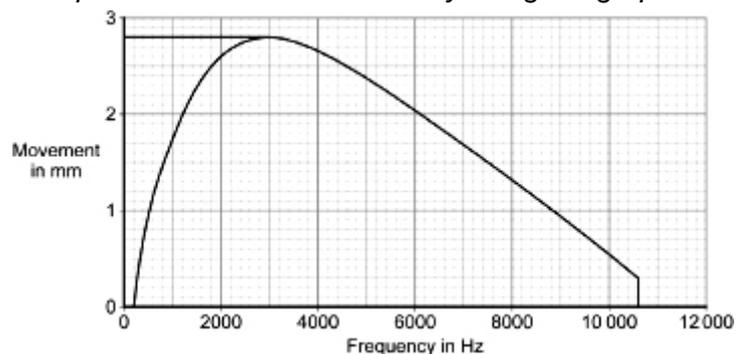
*accept 10.6 kHz*

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]

**Q22.**

- (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

**Q23.**

- (a) (i) microwaves 1
- (ii) can pass through the ionosphere  
*accept travels in a straight line*  
*accept atmosphere for ionosphere*  
*do **not** accept air for ionosphere* 1
- (b) higher the frequency, further the wave travels  
 (into the atmosphere before reflection) 1
- (c) 15 000  
*allow 1 mark for correct transformation and substitution*  

$$\frac{300\,000\,000}{20}$$
*ie* 2  
*an answer of 15 000 000 only gains 1 mark*  
*allow both marks for an answer of 15 MHz (unit must be changed)*  
*an answer of 15 gains no credit*

[5]

**Q24.**

- (a) (i) bat(s) 1
- (ii) elephant(s) 1
- (iii) any example in the inclusive range 5 ↔ 29 Hz / hertz  
*appropriate number and unit both required* 1
- (b) (i) **B** 1
- (ii) **F** 1

[5]

**Q25.**

- (a) (i) infra red (rays)  
*accept IR*  
**or**  
 radio (waves)  
*do **not** accept heat waves*  
*do **not** accept TV waves* 1

(ii) radio (waves)  
*this answer only* 1

(b) frequency 1

(c) (i) *answer should be in terms of establishing if harmful or not harmful ie trying to clear up any uncertainty*  
*do **not** accept answers that assume it is harmful*  
*eg Wi-Fi systems will make you ill*

*need to know if it is harmful / makes you ill*  
*accept idea that safety issue may worry people*  
*accept idea that (more) research may reassure people*  
*accept idea of finding out (the truth)* 1

(ii) an opinion 1

[5]

**Q26.**

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

- travel at the same speed (through a vacuum)  
*accept travel at the speed of light*  
*accept air for vacuum*
- can travel through a vacuum / space  
*do **not** accept air for vacuum*
- transfer energy
- can be reflected
- can be refracted
- can be diffracted
- can be absorbed
- can be transmitted
- transverse  
*accept any other property common to electromagnetic waves*  
*accept travel at the same speed through a vacuum for both marks*  
*do **not** accept both radiated from the Sun*

2

(ii) infra red  
***both** required for the mark*

radio(waves)  
*accept IR for infra red* 1

- (b) 2 400 000 000  
*correct transformation and substitution gains 1 mark*  

$$\frac{300000000}{0.125} \quad \text{or} \quad \frac{300000000}{12.5}$$
*ie*  
*an answer of 24 000 000 gains 1 mark*  
**either** 2 400 000 kHz  
**or** 2 400 MHz scores **3** marks but the symbol only scores the 3<sup>rd</sup> mark if it is correct in every detail
- 2
- hertz  
*accept Hz*  
*do **not** accept hz*
- 1
- (c) (i) presented (scientific) evidence / data  
*do an experiment / investigation is insufficient*
- 1
- (ii) to find out if there is a hazard (or not)  
*accept to find out if it is safe*  
*accept not enough evidence to make a decision*  
*not enough evidence is insufficient*
- 1

[8]

**Q27.**

- (a) any **two** for 1 mark each  
*deduct (1) from the first two marks if a ruler has not been used but the intention is clear*
- ray from the object's arrowhead
- through centre of lens
  - parallel to the axis then, when it reaches the lens, through F on the right
  - through F on the left then, when it reaches the lens parallel to the axis
- example of a 4 mark response*
- if more than two construction lines have been drawn all must be correct to gain 2 marks*  
*construction lines drawn as dashed lines do not score credit*
- 2
- image shown as vertical line from axis to where their rays intersect  
*image need not be marked with an arrowhead but, if it is, it must be correct*
- 1
- ray direction shown  
*only one correct direction*  
*arrow needed but there must not be any contradiction*
- 1

- (b) any **two** from:
- inverted  
*accept 'upside down'*
  - magnified  
*accept 'bigger'*
  - real  
*accept 'not virtual / not imaginary'*  
*one correct feature gains 1 mark*  
*ignore any reference to position*  
*an incorrect feature negates a correct response*
- 2

[6]

**Q28.**

- (i) X-rays
- infra red (rays)
- radio (waves)
- all three in correct order*  
*allow 1 mark for 1 correct*
- 2
- (ii) to kill cancer cells
- 1
- (iii) energy
- 1

[4]

**Q29.**

- (a) (i) shorter than
- 1
- (ii) increase slightly
- 1
- (b) (i) go up in the same ratio  
**or** (directly) proportional **or** as speed (of the tennis ball) increases so does the (difference in) frequency  
*accept as one goes up, so does the other*  
*accept positive correlation*
- 1
- (ii) 20 (m/s)  
*allow 1 mark for showing correct method on graph*  
*(ie horizontal or vertical line anywhere on graph)*  
*if indicated by a cross, must be  $\pm$  half square of correct value)*
- 2
- (iii) frequency and speed are both continuous variables
- 1

**Q30.**

- (a) (i) radio(waves) 1
- (ii) energy 1  
*correct answer only*
- (b) (i) 0.0125 (m) 2  
*allow 1 mark for correct transformation and substitution*
- (ii) make it hot(ter) 1  
*do **not** accept cook it*  
*accept (air) particles inside ball will move faster*  
*accept water in the ball gets hotter*

[5]

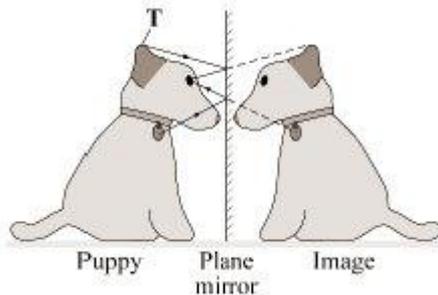
**Q31.**

- (a) C (only) 1
- (b) A (only) 1

[2]

**Q32.**

- (a) reflection at the mirror of ray from tip of real puppy's ear to real puppy's eye (1)  
*may be drawn freehand*
- accurate (1)  
*ruler must have been used and the reflected ray is an extension of the straight line from point virtual ear however the virtual part of the line need not be shown*
- arrow to show correct direction (1)  
*only one arrow needs to be shown but there must be no contradiction*  
*example of (3) mark response*



3

- (b) flat *accept 'it's not curved/bent'*

accept 'it's straight'

1

[4]

**Q33.**

- (a) (i) compare (the health of) mobile phone users with non-mobile phone users

*must be an implied comparison between users and non-users*

*any idea of doing an experiment negates the mark*

1

- (ii) increase the sample size

*accept use more people*

*accept have a large sample size*

*repeat the research / test is neutral*

1

- (iii) ethical

1

- (b) (i) so the phones can be compared (fairly)

*a fair test is insufficient*

*accept different tests (may) give different results*

*do **not** accept to make the results reliable, unless qualified eg all variables are controlled*

*do **not** accept bias unless qualified*

1

- (ii) yes all are below the legal limit / 2 (W/kg)

**or** no and any **one** from:

- even absorbing a small amount of energy may be harmful  
*accept microwaves for energy*  
*accept emits energy absorbed by head / other parts of body*
- no proof that small amounts of energy are not harmful  
*accept because the SAR value is not 0 (W/kg)*

1

- (c) any **one** from:

- to get an independent opinion
- company scientists may be biased  
*accept company scientists may manipulate results*

1

[6]

**Q34.**

- (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]

**Q35.**

- (a) the normal 1
- (b) v 1
- (c) any **one** from:
- light has moved from glass to air / from air to glass  
*accept light has changed medium*
  - speed of light has changed  
*beware of contradictions for this marking point eg light has moved from glass to air and slowed down gets zero*
  - angle of incidence is less than the critical angle  
*or (angle)  $i < (\text{angle}) c$  or (angle)  $y$  is less than the critical angle*
  - change in density (of medium)  
*eg glass is more (optically) dense than air* 1
- (d) (i) ratio of v to y does not give the same answer (in every case)  
**or** value of v doubles value of y does not double 1
- or** increments for v are the same but increments for y are not the same  
*allow for 1 mark a calculation but no conclusion*  
*eg  $30 \rightarrow 60$   $19 \rightarrow 35$  (38)* 1
- (ii) as (angle) v increases, angle y increases

*accept as the angle of incidence increases, the angle of refraction increases*

*or there is a (strong) positive(non-linear) relationship between the variables*

*or ratio of sines is constant*

*do **not** accept angle  $y$  is not directly proportional to angle  $v$*

1

(iii) no evidence outside this range

*OWTTE*

**or** when angle  $y$  is greater than the critical angle total internal reflection occurs

1

[7]