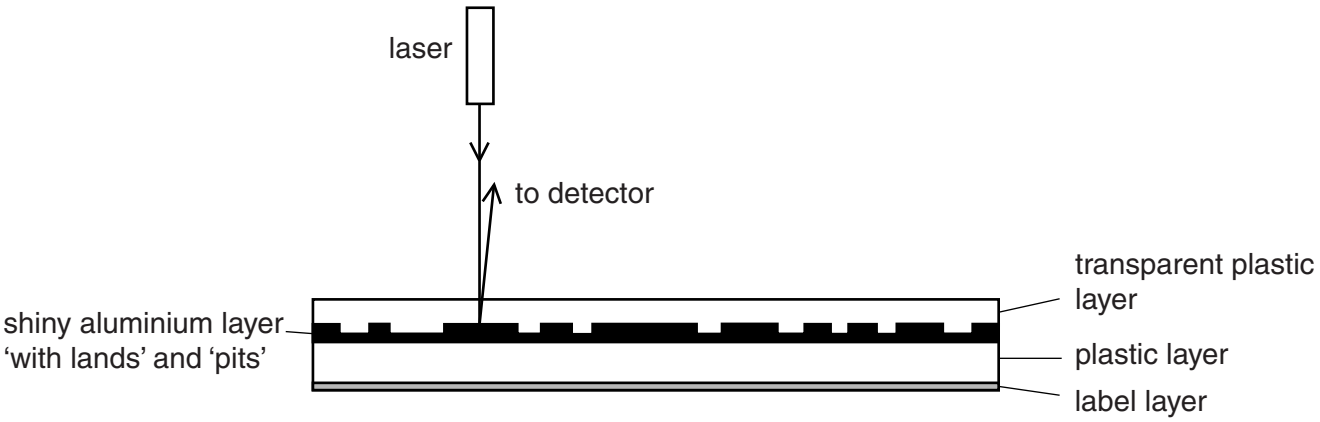
1 CD players use lasers to read information from a disc.

Look at the simplified diagram of the laser and cross-section of part of a disc.



Describe the properties of a laser beam and explain how information is stored and read from the disc.

The quality of written communication will be assessed in your answer to the question.

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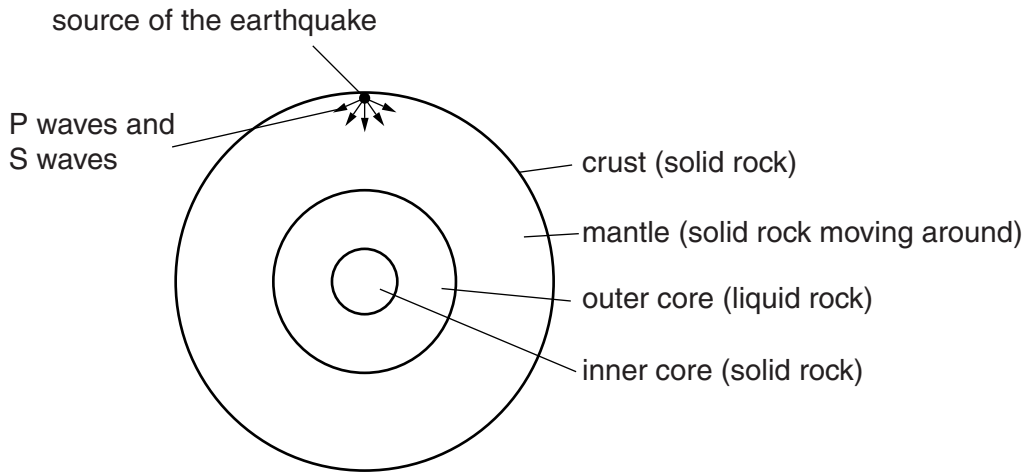
..... **[6]**

2 Look at the diagram of the Earth.

An earthquake produces P waves and S waves.

Look at the diagram. It shows the initial directions of the P waves and S waves.



(a) P waves and S waves are detected by seismometers on the Earth's surface.
Each type of wave from the earthquake is detected at different times by seismometers.

Which type of wave is received first? .....

Explain your answer.

.....

..... **[1]**

(b) Scientists take measurements of P waves and S waves using seismometers.

After an earthquake, scientists can work out the exact position of the earthquake, using these measurements.

Suggest how they do this.

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..... **[2]**

(c) S waves do not travel through the Earth's inner core.

Explain why.

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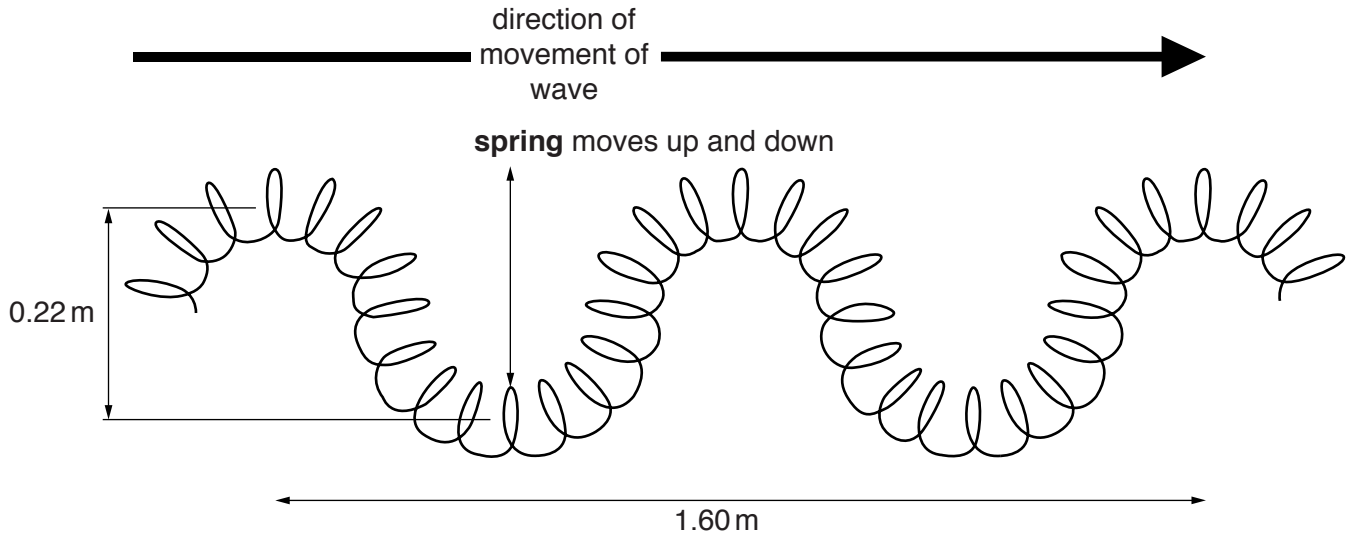
..... **[1]**

(d) P waves and S waves are different.

P waves are longitudinal and S waves are transverse.

Look at the diagram of a model of an S wave made with a slinky spring.



The wave is made by moving the spring up and down with a frequency of 1.2 Hz.

Look at the diagram.

(i) Calculate the **speed** of the wave.

.....

.....

.....

answer ..... m/s **[2]**

(ii) What is the **amplitude** of the wave?

Choose from

0.11 m **0.22 m** **0.80 m** **1.60 m** **1.82 m**

..... **[1]**

3 Rene researches the range of sounds that different people can hear.

(a) Rene's research shows that

'The average person has a hearing range from 20 Hz up to 20 000 Hz'.

Rene tests the hearing range of a group of people.
Look at the data she collects.

Person	Age	Lower frequency limit of hearing in Hz	Upper frequency limit of hearing in Hz	Frequency range of hearing in Hz
Jane	16	22	19 000	18 978
Alec	16	19	20 000	19 981
Dionne	16	24		
Niamh	16	16	21 000	20 984
Evangelos	16	15	20 000	19 985
average	16	19.2	19 800	19 780.8

(i) Rene's original research showed a lower frequency limit of human hearing of 20 Hz.
The data she collects shows an average lower frequency limit of 19.2 Hz.
Suggest reasons for this difference.

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..... **[3]**

(ii) Rene has not completed her table. She has lost some of her results.
Calculate the upper frequency limit of hearing for Dionne.

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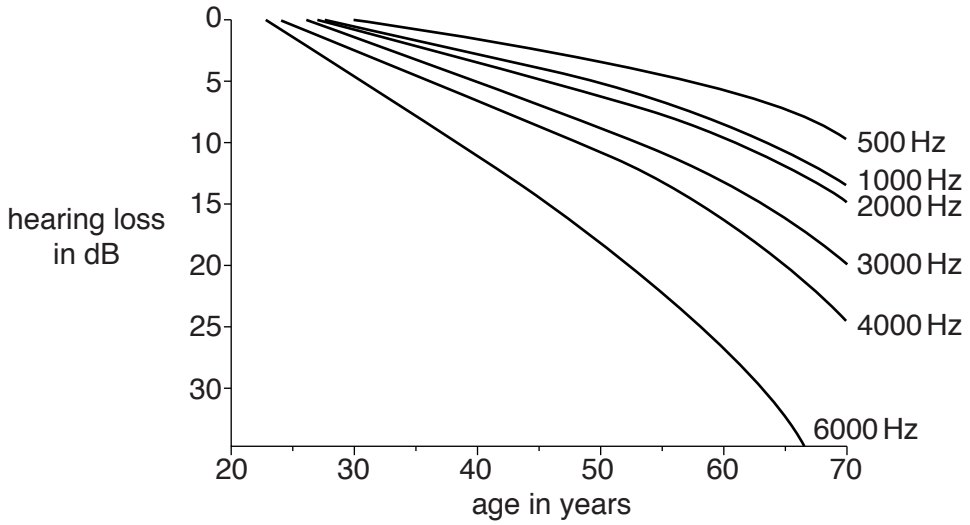
answer .....Hz **[2]**

(b) Look at the data on hearing level loss at different ages.
It shows the hearing loss in dB for different ages at six different frequencies.



(i) Describe the trends shown by the graph.

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..... **[2]**

(ii) Scientists are developing hearing aids to help people hear high frequency sounds.
These hearing aids can detect sounds of frequency 6000 Hz and above and change them to sounds of half that frequency.

60 year olds can have difficulty hearing sounds above 6000 Hz.
Explain how these hearing aids can improve their hearing.
Use the data from the graph in your answer.

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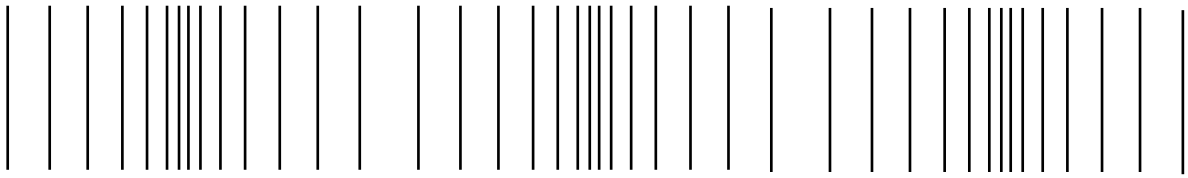
..... **[3]**

4 This question is about waves.

(a) Look at the diagram of a longitudinal wave.



(i) Use the diagram to describe a compression.

.....

..... **[1]**

(ii) Two types of waves are longitudinal and transverse.

The particles in these waves move in different ways.

Compare the movement of particles in longitudinal and transverse waves.

You may use labelled diagrams in your answer.

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..... **[3]**

(b) The frequency of an ultrasound wave is 25 000 Hz.

Can humans hear this ultrasound?

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Explain your answer.

.....

.....

.....

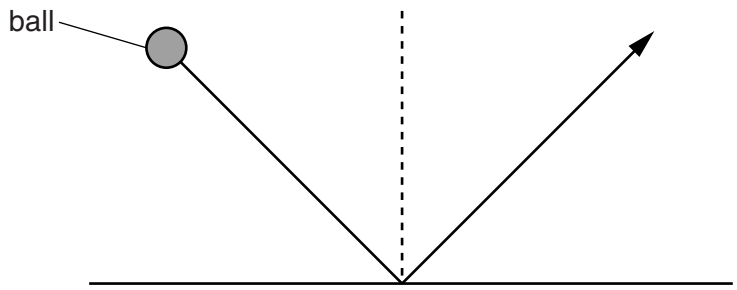
[2]

[Total: 6]

5 In the 1600s two scientists, Newton and Huygens, had different theories about light.

(a) Newton had a particle model which explained reflection.

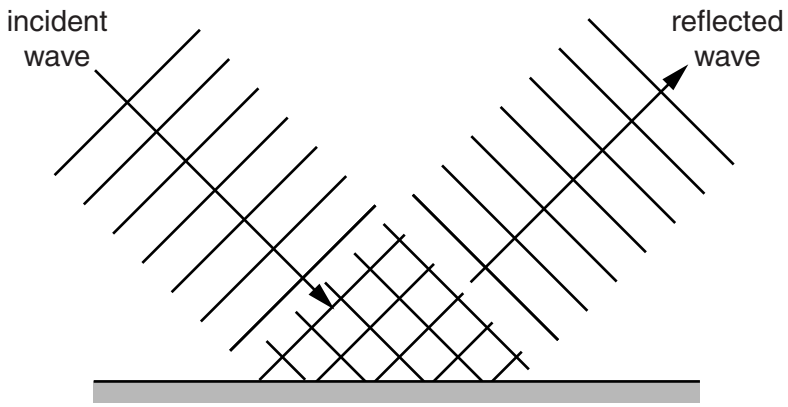
Look at the diagram.



'A ball (particle) hits the surface and bounces off at the same angle'.

Huygens' wave model also explained reflection.

Look at the diagram.



How does Huygens' wave model explain the reflection of light?

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..... **[1]**

(b) Diffraction and interference experiments started to change scientists' confidence in particle and wave models.

The particle theory lost support and the wave theory gained support.

Explain why.

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..... **[2]**

(c) Use the wave model to explain constructive and destructive interference.

Diagrams may be used to help explain your answer.

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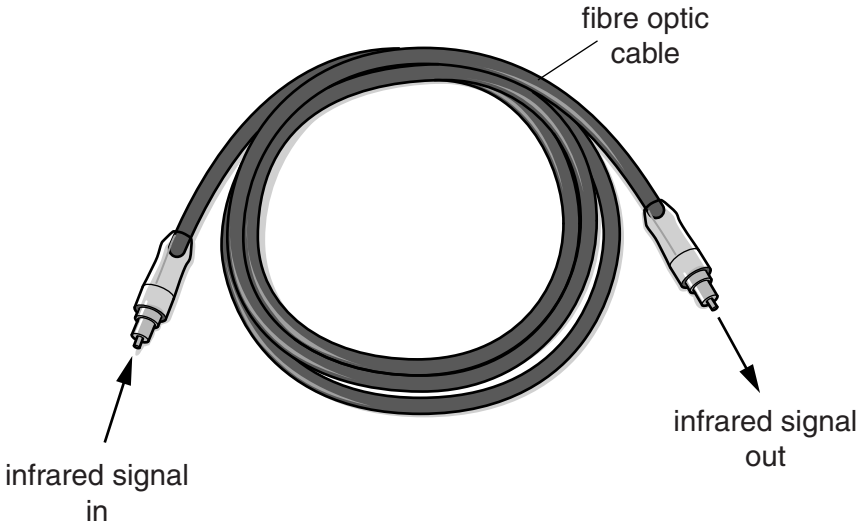
..... **[2]**

[Total: 5]

6 Reeta is learning about different types of waves.

Electromagnetic waves are used for communication.

(a) (i) Infrared waves can transmit signals from one end of a fibre optic cable to the other.



Infrared waves of wavelength 1.5×10^{-6} m travel along this optical fibre.

The speed of the infrared waves in the fibre is 2.2×10^{8} m/s.

Calculate the frequency of the infrared waves.

Give your answer in **standard form** and to **2** significant figures.

.....

.....

.....

.....

answer ..... Hz **[2]**

(ii) When the infrared (IR) radiation leaves the fibre, it is refracted as it enters the air.

Reeta makes a table to compare the speed, wavelength and frequency of the IR signal in the air and in the optical fibre.

Complete the table by putting one tick (✓) in each **row**.

	In air > in fibre	**In air = to that in fibre**	**In air < in fibre**
Speed of IR			
Wavelength of IR			
Frequency of IR			

[2]

(b) Reeta learns that digital signals are used in optical fibres.

Digital signals are used to transmit signals over long distances. As the signal strength falls, it is amplified at points along the cable.

Describe and explain the advantages of using **digital** signals for transmitting information along optical fibres.

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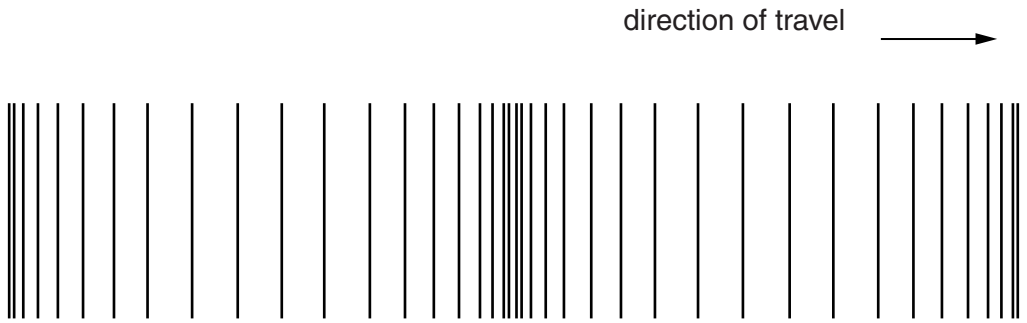
..... **[2]**

[Total: 6]

7 Ultrasound is a longitudinal wave.

(a) Look at the diagram of an ultrasound wave in air.



Use the diagram to describe the differences between a region of compression and a region of rarefaction.

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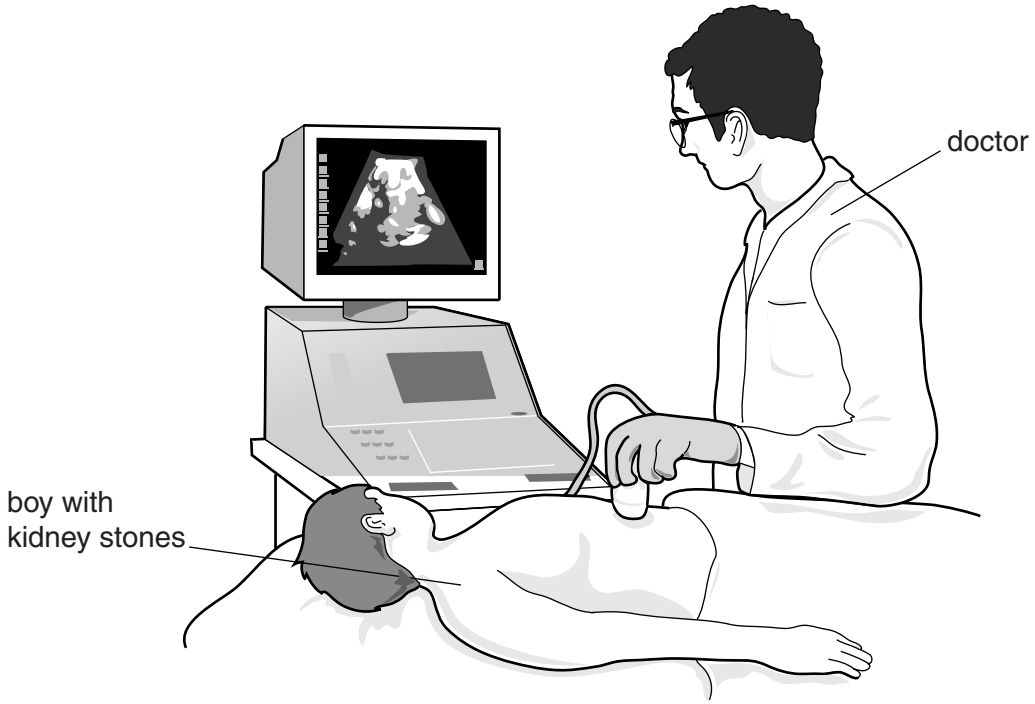
..... **[2]**

(b) Ultrasound can be used to scan the kidney and to break down kidney stones.



(i) Explain how ultrasound breaks down kidney stones.

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..... **[1]**

(ii) Explain why ultrasound is used rather than X-rays to scan the kidney.

.....

..... **[1]**

[Total: 4]

8 Many years ago, scientists tried to find out about light.

Some scientists, such as Newton, described light using a particle model.

Other scientists, such as Huygens, described light using a wave model.

Put ticks (✓) in the boxes to show which properties of light can be explained by each model.

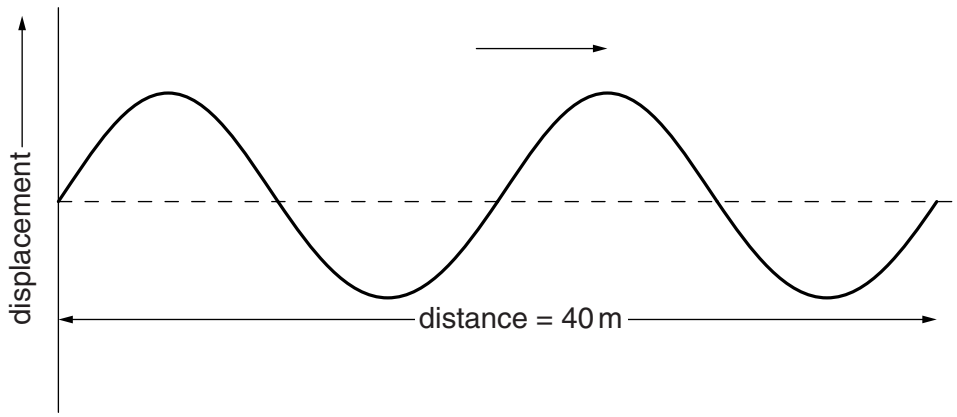
Model	**Property**	
	Reflection	**Interference**
particle model		
wave model		

[2]

[Total: 2]

9 Surfers use water waves on the sea to move fast.

Look at the diagram of the water waves on the sea.



The surfer travels at the same speed as the water waves.

The water waves have a frequency of 0.25 Hz.

Use the information in the diagram to find the wavelength of the waves and calculate the speed of the surfer.

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.....

answer ..... m/s **[2]**

[Total: 2]

10 Light waves carry information along optical fibres.

(a) How does light travel along the length of an optical fibre?

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..... **[1]**

(b) Information can also be carried along copper wires.

Using optical fibres can be a **better** way to carry information.

Suggest reasons why.

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..... **[2]**

(c) A laser produces a beam of light.

How is a beam of light from a laser different from a beam of light from a torch?

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..... **[2]**

[Total: 5]

11 Electromagnetic waves have a range of wavelengths.

(a) Look at the list of electromagnetic waves.

gamma

infrared

visible light

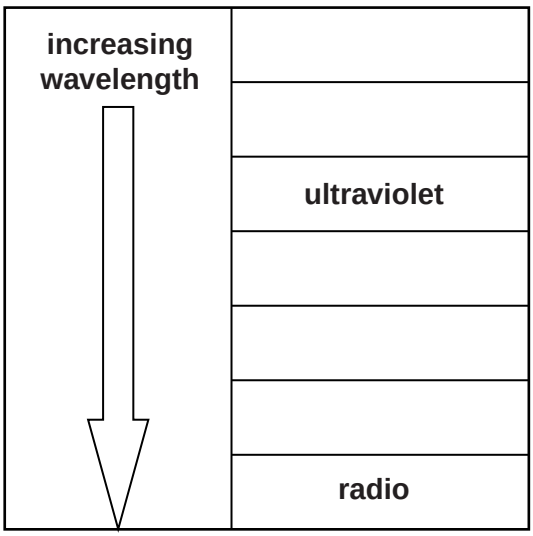
microwave

radio

ultraviolet

X-rays

Complete the table. Put the waves in order of **increasing** wavelength. Two waves have been done for you.



[2]

(b) What is meant by the **frequency** of a wave?

.....

..... **[1]**

(c) Infrared waves have different wavelengths.
They have a range of wavelengths from 0.74×10^{-6} m to 300×10^{-6} m.

The speed of infrared waves in a vacuum is 3.00×10^{8} m/s.

Show that the frequency range of these waves is 4.04×10^{14} Hz.

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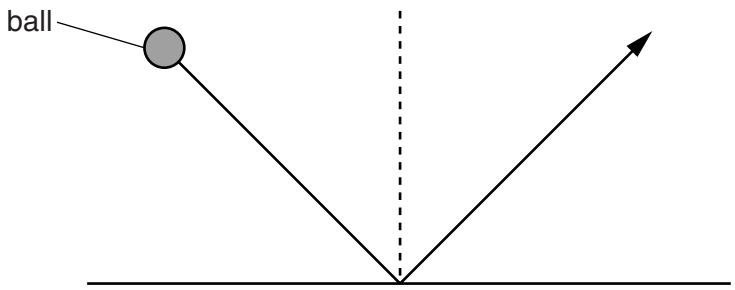
..... **[4]**

[Total: 7]

12 In the 1600s two scientists, Newton and Huygens, had different theories about light.

(a) Newton had a particle model which explained reflection.

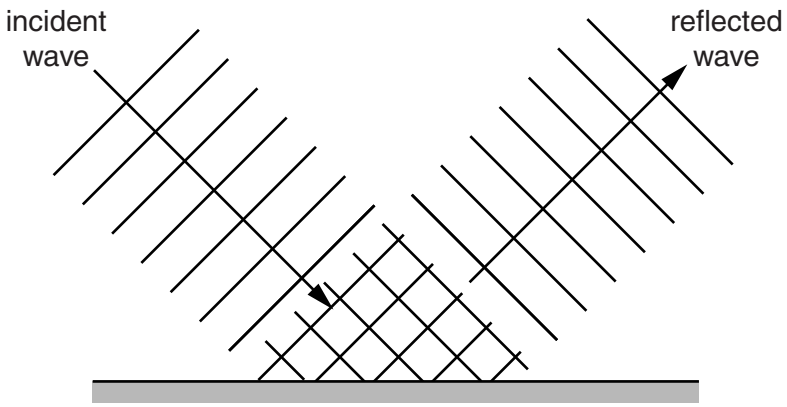
Look at the diagram.



'A ball (particle) hits the surface and bounces off at the same angle'.

Huygens' wave model also explained reflection.

Look at the diagram.



How does Huygens' wave model explain the reflection of light?

.....

..... **[1]**

(b) Diffraction and interference experiments started to change scientists' confidence in particle and wave models.

The particle theory lost support and the wave theory gained support.

Explain why.

.....

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..... **[2]**

(c) Use the wave model to explain constructive and destructive interference.

Diagrams may be used to help explain your answer.

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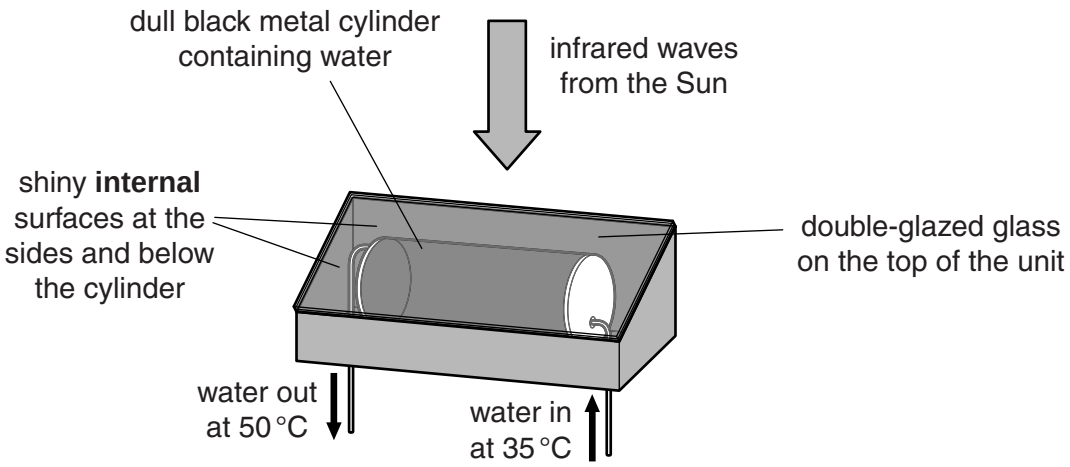
..... **[2]**

[Total: 5]

13 John installs a solar water-heating unit on the roof of his house.

Look at the diagram of the unit.



(a) Energy is transferred through parts of the unit by different methods.

(i) What is the main method of energy transfer from above the glass to the surface of the cylinder?

..... **[1]**

(ii) The black cylinder absorbs energy and transfers it to the water inside.

Explain how the water inside then heats up.

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..... **[2]**

(b) **(i)** These solar water-heating units have an efficiency of 85%.

Calculate the useful energy output for every 200 000 J of energy input.

.....

.....

answer ..... J **[2]**

(ii) Describe how **one** feature of the solar water-heating unit has helped to produce this high level of energy efficiency.

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..... **[1]**

(c) (i) Some infrared waves have a wavelength of 1 mm.

The speed of electromagnetic waves is 3×10^8 m/s.

Show, using a calculation, that the frequency of the infrared waves is 3×10^{11} Hz.

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..... **[2]**

(ii) The infrared waves which heat the metal cylinder have much shorter wavelengths.

Explain how the energy of these waves is different to those with a wavelength of 1 mm.

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..... **[2]**

[Total: 10]