AQA GCSE Physics | 8463

SPECIFICATION POINT 4.6.1.2

Properties of waves

Past-paper questions

Tier	**Higher**
Question groups	**125**
Available paper years	**2004–2025**

Using this booklet

1. Answer the questions in order and show your working.
2. Original question numbers and marks are retained.
3. Print at actual size (100%) for measuring questions.
4. Use the companion answer booklet to check your work.

Name: _____ **Date:** _____

Whole questions are retained for context, so some parts assess other specification points. Current and legacy sources are labelled. Continue on extra paper if needed.

4.6.1.2 Properties of waves

Question 01

June 2004 | 3451H | Original Q14 | Legacy

14 (a) Use the theory of plate tectonics to explain sea floor spreading.

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.....

.....

(2 marks)

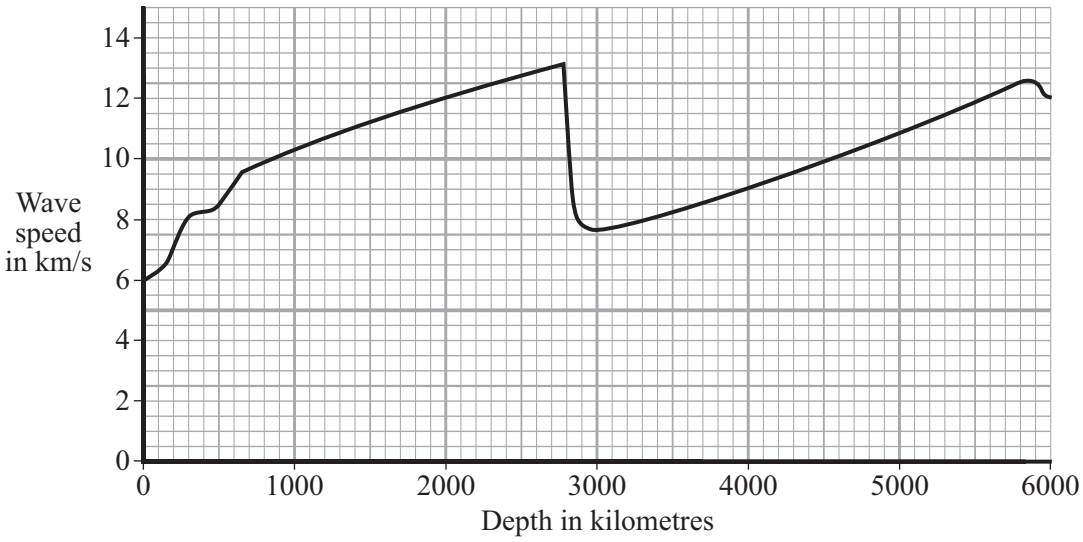
(b) What evidence is there to support the idea of sea floor spreading?

.....

.....

(1 mark)

(c) The diagram shows how the speed of a P-wave produced by an earthquake changes as it travels through the Earth.



(i) Write down the equation that links frequency, wavelength and wave speed.

.....

(1 mark)

(ii) At a depth of 2000 km the P-wave has a wavelength of 24 000 m. Calculate the frequency of the P-wave. Show clearly how you work out your answer.

.....

.....

frequency = ...Hz

(2 marks)

6

4.6.1.2 Properties of waves

Question 02

June 2004 | 3462H3 | Original Q12 | Legacy

12 (a) Use the theory of plate tectonics to explain sea floor spreading.

.....

.....

.....

.....

(2 marks)

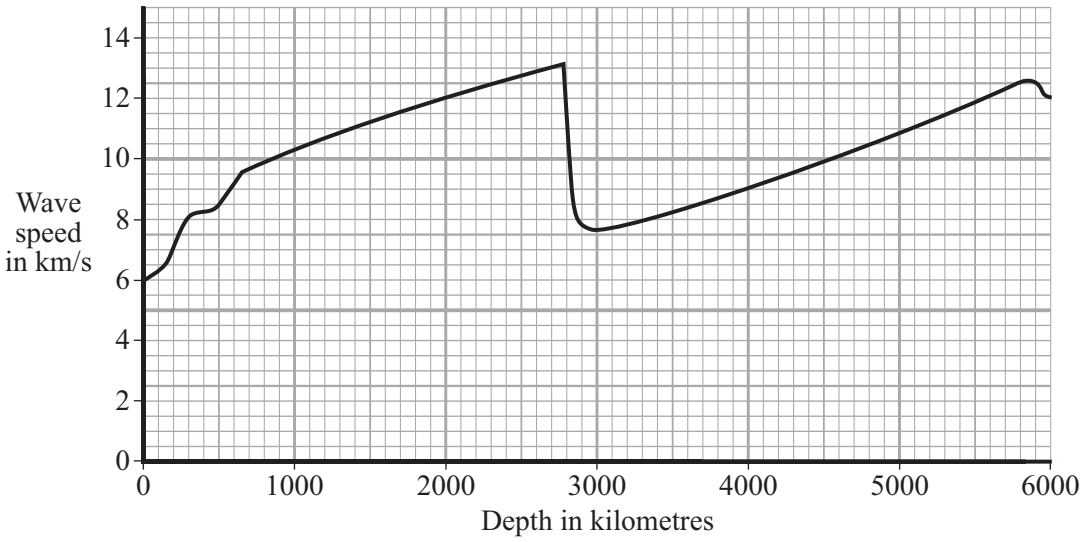
(b) What evidence is there to support the idea of sea floor spreading?

.....

.....

(1 mark)

(c) The diagram shows how the speed of a P-wave produced by an earthquake changes as it travels through the Earth.



(i) Write down the equation that links frequency, wavelength and wave speed.

.....

(1 mark)

(ii) At a depth of 2000 km the P-wave has a wavelength of 24 000 m. Calculate the frequency of the P-wave. Show clearly how you work out your answer.

.....

.....

frequency = ...Hz

(2 marks)

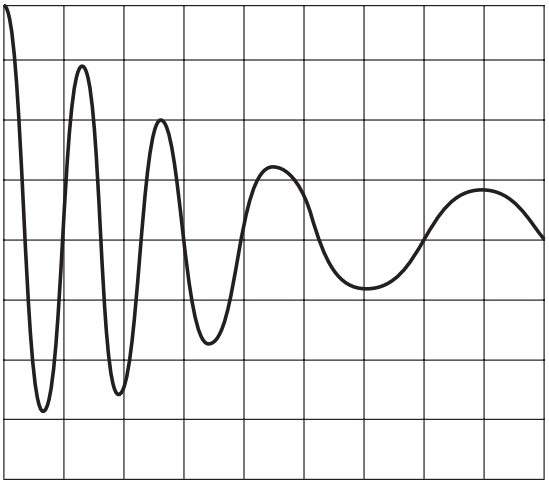
6

4.6.1.2 Properties of waves

Question 03

June 2005 | 3451 | Original Q7 | Legacy

7 (a) A microphone connected to an oscilloscope picks up the sound from a siren. The trace produced on the oscilloscope screen is shown below.



Describe how the wave changes as it goes across the screen from left to right (→).

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

.....

.....

.....

.....

.....

(3 marks)

(b) An African bat produces a sound wave with a frequency of 212 kHz and a wavelength of 0.0016 m.

(i) The sound made by the bat is above the limit of human hearing.
What name is given to this type of sound?

.....

(1 mark)

(ii) Write down the equation that links frequency, wavelength and wave speed.

.....

(1 mark)

(iii) Calculate the speed of this sound wave through the air. Show clearly how you work out your final answer.

.....

.....

Wave speed = ... m/s

(3 marks)

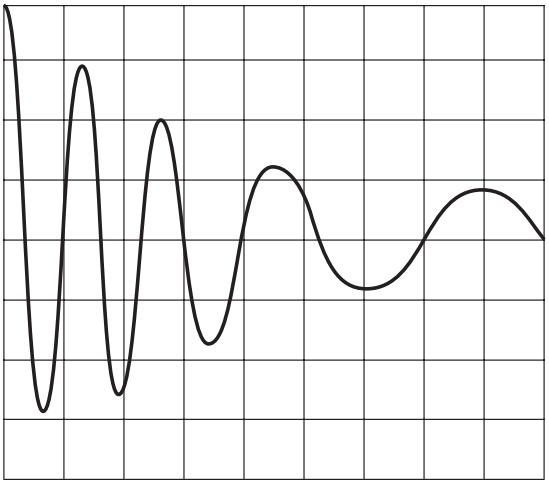
8

4.6.1.2 Properties of waves

Question 04

June 2005 | 3462 | Original Q5 | Legacy

5 (a) A microphone connected to an oscilloscope picks up the sound from a siren. The trace produced on the oscilloscope screen is shown below.



Describe how the wave changes as it goes across the screen from left to right (→).

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

.....

.....

.....

.....

.....

(3 marks)

(b) An African bat produces a sound wave with a frequency of 212 kHz and a wavelength of 0.0016 m.

(i) The sound made by the bat is above the limit of human hearing.
What name is given to this type of sound?

.....

(1 mark)

(ii) Write down the equation that links frequency, wavelength and wave speed.

.....

(1 mark)

(iii) Calculate the speed of this sound wave through the air. Show clearly how you work out your final answer.

.....

.....

Wave speed = ... m/s

(3 marks)

/8

4.6.1.2 Properties of waves

Question 05

June 2006 | 3451 | Original Q2 | Legacy

2 (a) The diagram shows water waves made by a wave machine in a swimming pool.



In 10 seconds 5 complete waves go past a person standing in the pool.

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

Show how you work out your answer.

.....

Frequency = ...

(2 marks)

(b) Water waves are transverse waves.

Give **one** other example of a transverse wave.

.....

(1 mark)

(c) How is a transverse wave different from a longitudinal wave? You may draw a diagram to help you with your answer.

.....

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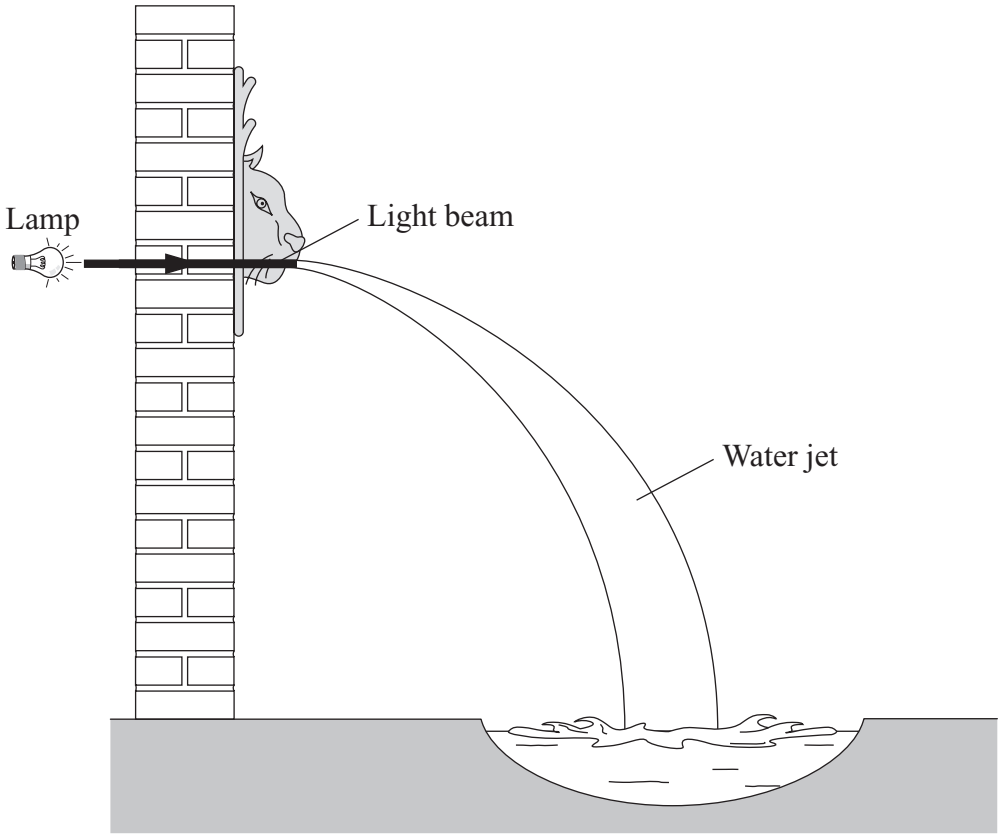
(2 marks)

4.6.1.2 Properties of waves

Question 05 · continued

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(d) The diagram shows a garden fountain. The fountain features a light beam that is totally internally reflected by the water jet.



(i) Draw the path of the light beam through the water jet. *(1 mark)*

(ii) Complete the following sentence by crossing out the **two** lines in the box that are wrong.

For light to be totally internally reflected the angle between the light ray and the normal must be

smaller than
equal to
bigger than

the critical angle.

(1 mark)

7

4.6.1.2 Properties of waves

Question 06

June 2006 | 3462 | Original Q2 | Legacy

2 (a) The diagram shows water waves made by a wave machine in a swimming pool.



In 10 seconds 5 complete waves go past a person standing in the pool.

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

Show how you work out your answer.

.....

Frequency = ...

(2 marks)

(b) Water waves are transverse waves.

Give **one** other example of a transverse wave.

.....

(1 mark)

(c) How is a transverse wave different from a longitudinal wave? You may draw a diagram to help you with your answer.

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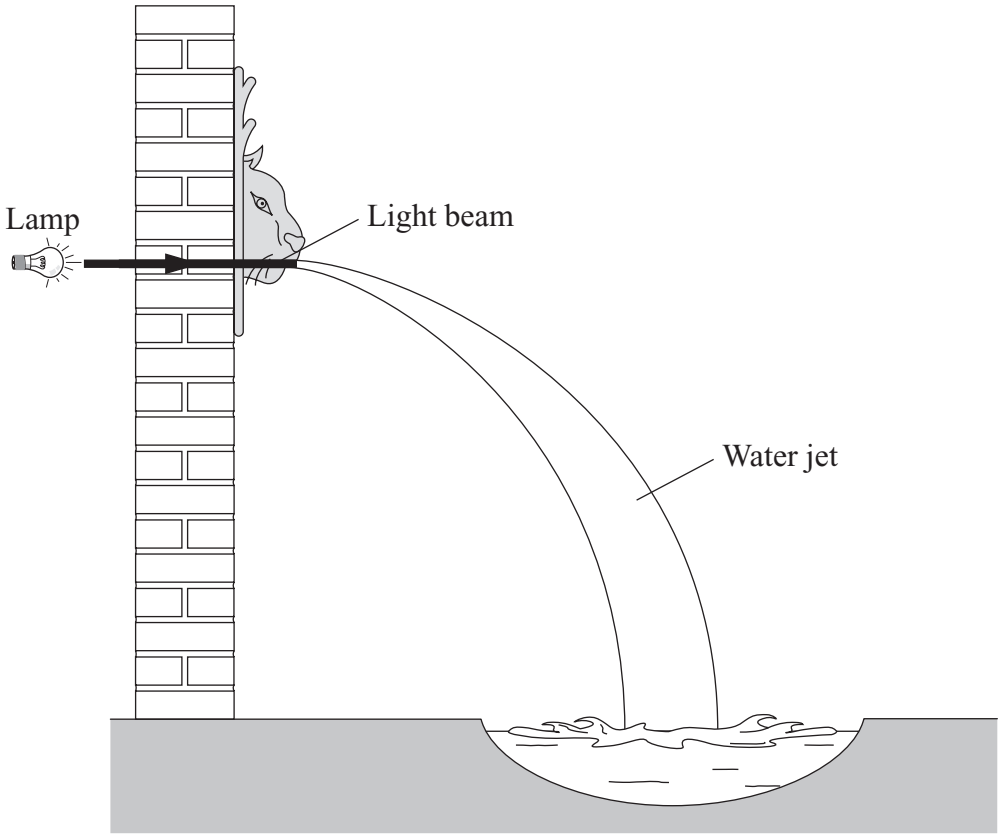
.....

(2 marks)

Question 06 · continued

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(d) The diagram shows a garden fountain. The fountain features a light beam that is totally internally reflected by the water jet.



(i) Draw the path of the light beam through the water jet. *(1 mark)*

(ii) Complete the following sentence by crossing out the **two** lines in the box that are wrong.

For light to be totally internally reflected the angle between the light ray and the normal must be

smaller than
equal to
bigger than

the critical angle.

(1 mark)

7

4.6.1.2 Properties of waves

Question 07

November 2006 | PHY1B | Original Q2 | Legacy

QUESTION TWO

Electromagnetic radiation is often absorbed.

Match words, **A**, **B**, **C** and **D**, with the numbers **1–4** in the sentences.

A current

B energy

C frequency

D substance

When electromagnetic radiation is absorbed, the . . . **1** . . . which absorbs it becomes hotter. This is because the radiation carries . . . **2** . . . . The radiation may create an alternating . . . **3** . . . with the same . . . **4** . . . as the radiation itself.

Turn over for the next question

4.6.1.2 Properties of waves

Question 08

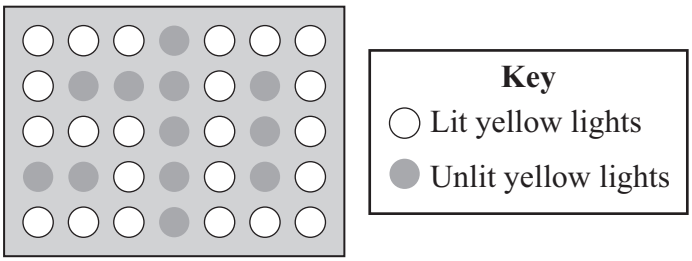
November 2006 | PHY1B | Original Q3 | Legacy

QUESTION THREE

Vehicles on motorways often travel at high speeds. It is important that clear warning signs are used.

Tests were carried out to find the most suitable colour for the lights in the warning sign.

The drawing shows a sign which has yellow lights.



3A Suggest why yellow light is used for the sign.

1 It has a higher frequency than all other colours.

2 It has a longer wavelength than all other colours.

3 It is easier to see than all other colours.

4 It travels faster than all other colours.

3B What determines the colour of the light from the display?

1 its brightness

2 its frequency

3 its power

4 its speed in a vacuum

4.6.1.2 Properties of waves

Question 08 · continued

3C The wavelength of red light is 700 nm and the wavelength of violet light is 300 nm.

What is the likely value of the wavelength of the yellow light from the sign?

1 350 nm

2 450 nm

3 600 nm

4 750 nm

3D The warning sign is switched on by sending a radio signal. The frequency of the signal is 2 000 000 hertz and its wavelength is 150 metres.

Calculate the wave speed of the signal in metres/second.

wave speed = **frequency** × **wavelength**

1 13 333 m/s

2 1 333 333 m/s

3 300 000 000 m/s

4 3 000 000 000 m/s

4.6.1.2 Properties of waves

Question 09

November 2006 | PHY1B | Original Q8 | Legacy

QUESTION EIGHT

Scientists have observed light from different galaxies. They have evidence for a red-shift in the light.

8A What change has occurred to the speed and wavelength of the light to cause the red-shift?

	Speed	Wavelength
1	decreased	stayed the same
2	increased	stayed the same
3	stayed the same	decreased
4	stayed the same	increased

8B Light from a galaxy with a very large red-shift would indicate that the galaxy was . . .

1 close and moving towards the Earth.

2 close and moving away from the Earth.

3 distant and moving towards the Earth.

4 distant and moving away from the Earth.

8C Many scientists support the 'big bang' theory.

This theory states that . . .

1 the galaxies are in fixed positions in space.

2 the galaxies rotate around a central point.

3 the stars are formed when planets collide.

4 the Universe began from a small initial point.

4.6.1.2 Properties of waves

Question 09 · continued

8D Observations are taken by satellites in space.

The information is sent back to Earth using . . .

1 gamma rays.

2 microwaves.

3 ultraviolet rays.

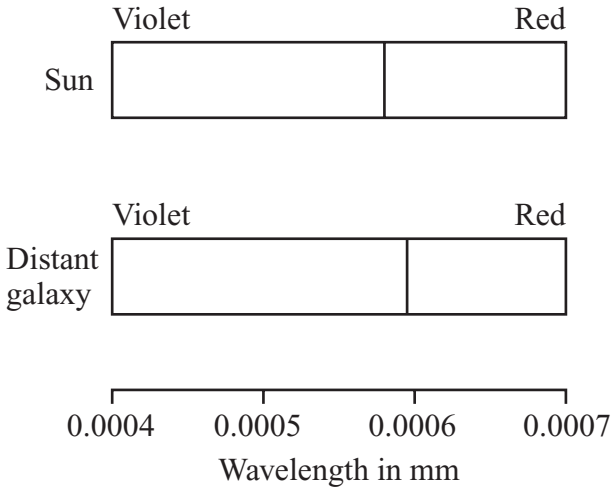
4 X-rays.

Turn over for the next question

4.6.1.2 Properties of waves

Question 10

3 The visible part of the electromagnetic spectrum from a star includes a dark line. This line is at a specific wavelength. The diagram shows the position of the dark line in the spectrum from the Sun and in the spectrum from a distant galaxy.



(a) Explain how the spectrum 'shift' of the dark line supports the theory that the Universe began from a very small point.

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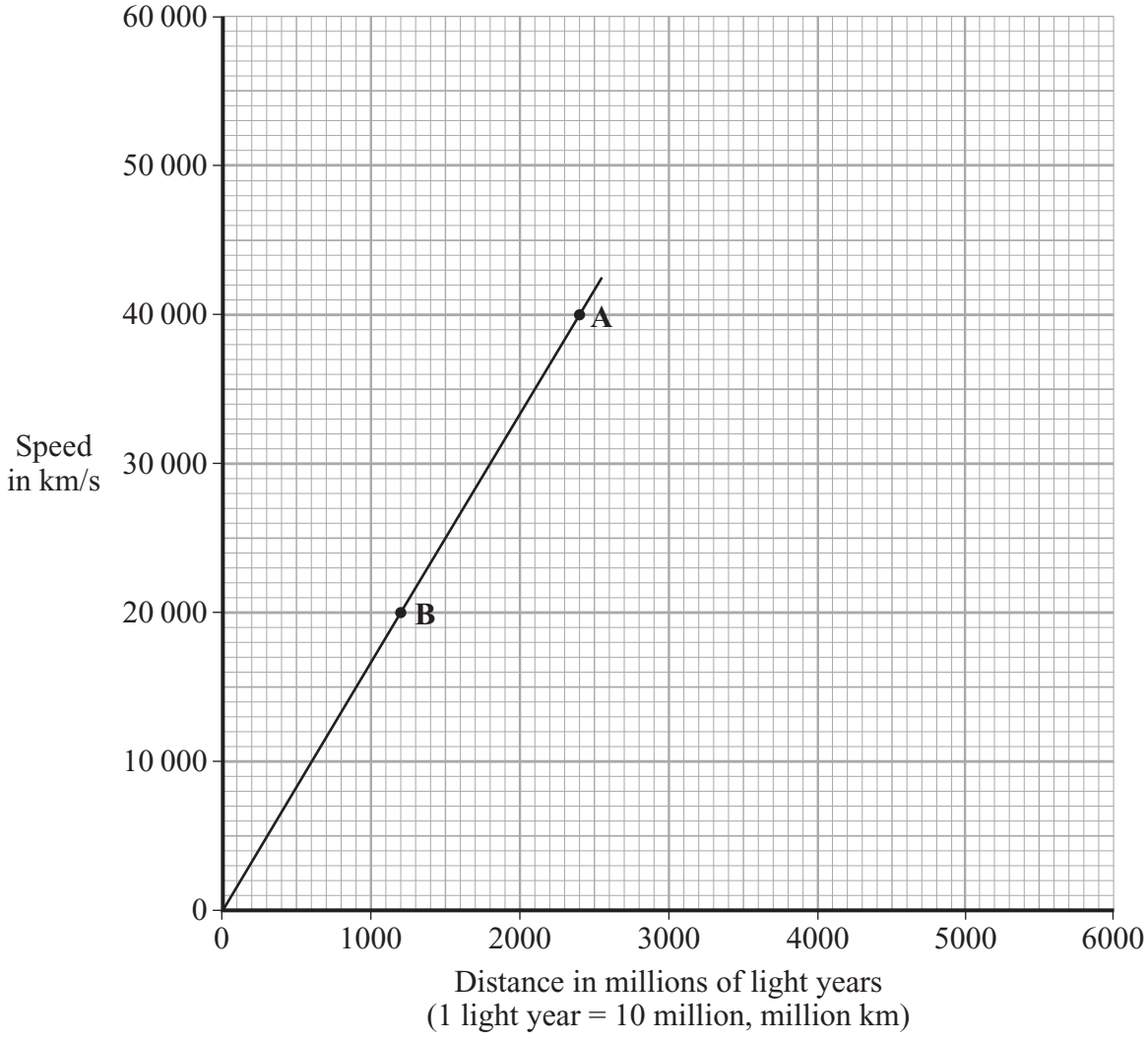
(3 marks)

Question 3 continues on the next page

Question 10 · continued

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(b) From data collected, a graph can be drawn that links the speed of a galaxy with the distance of the galaxy from the Earth.



(i) How does the visible light spectrum from galaxy **A** look different from the visible light spectrum from galaxy **B**?

.....

.....

(1 mark)

4.6.1.2 Properties of waves

Question 10 · continued

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(ii) A third galaxy, **C**, seems to be travelling away from the Earth at about 60 000 km/s.

Estimate how far galaxy **C** might be from the Earth, showing how you use the graph to do this.

.....

.....

Distance between galaxy **C** and the Earth = ... million light years

(2 marks)

(c) Astronomers use telescopes to observe distant galaxies. Since 1990 the Hubble optical telescope has been in orbit around the Earth.

Explain why an optical telescope in space allows astronomers to see further and more clearly than an optical telescope on Earth.

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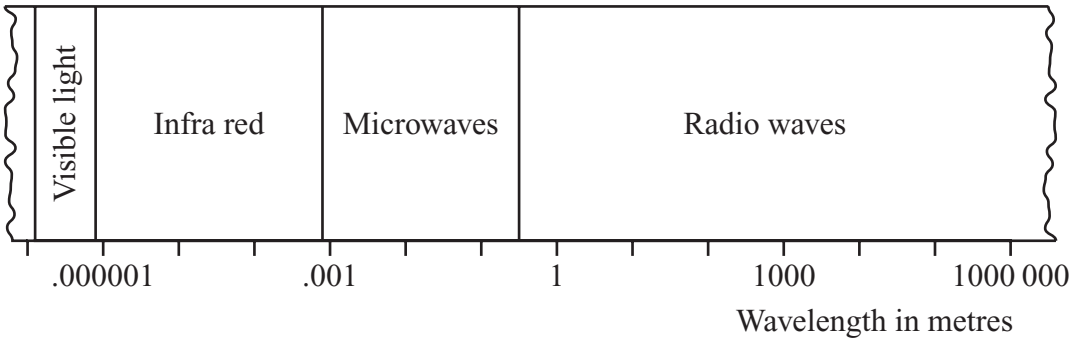
(2 marks)

8

4.6.1.2 Properties of waves

Question 11

5 (a) The diagram represents part of the electromagnetic spectrum.



(i) Visible light travels through air at 300 000 000 m/s.

Why can we assume that radio waves travel through air at the same speed as light?

.....

(1 mark)

(ii) A radio station broadcasts at a frequency of 200 kHz.

Use the following equation to calculate the wavelength of the waves broadcast by this radio station. Show clearly how you work out your answer.

wave speed = frequency × wavelength

.....

.....

Wavelength = ... m

(2 marks)

(iii) Draw a vertical line on the diagram above to show the position of this radio wave in the electromagnetic spectrum.

(1 mark)

(b) Many radio stations now broadcast digital signals instead of *analogue* signals.

(i) What is an *analogue* signal?

.....

(1 mark)

4.6.1.2 Properties of waves

Question 11 · continued

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(ii) Give **one** reason why a radio station would broadcast digital signals instead of analogue signals.

.....

.....

(1 mark)

(c) A student thinks that because energy cannot be destroyed it is not possible to waste energy. So he leaves his radio, TV and computer on all the time, even when there is no one in the house.

Explain why he is wrong about not being able to waste energy.

.....

.....

.....

.....

(2 marks)

8

4.6.1.2 Properties of waves

Question 12

March 2007 | PHY1B | Original Q4 | Legacy

QUESTION FOUR

A student has been learning about the electromagnetic spectrum.

4A Which part(s) of the electromagnetic spectrum can be used for communication?

1 radio waves only

2 radio waves and microwaves only

3 radio waves, microwaves and infra red rays only

4 radio waves, microwaves, infra red rays and visible light

4B Waves of the electromagnetic spectrum travel through space.

When they do, which property is the same for all of them?

1 energy

2 penetration

3 power

4 speed

4C The frequency of a radio signal is increased.

Which is correct?

1 Its speed decreases.

2 Its speed increases.

3 Its wavelength decreases.

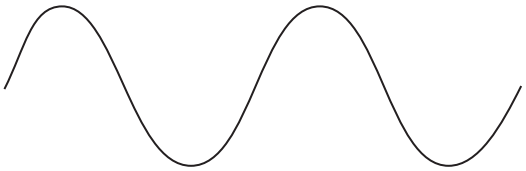
4 Its wavelength increases.

4.6.1.2 Properties of waves

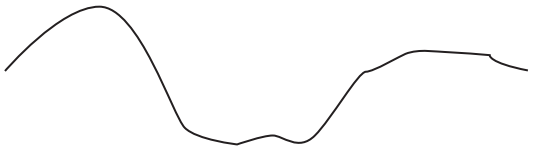
Question 12 · continued

4D Communication signals are often digital. The diagrams show four signals.

E



F



G



H

Which two could be digital?

1 **E** and **F**

2 **F** and **G**

3 **G** and **H**

4 **H** and **E**

4.6.1.2 Properties of waves

Question 13

March 2007 | PHY1B | Original Q7 | Legacy

QUESTION SEVEN

Use the equation to answer parts of this question.

wave speed (metres/second, m/s)	=	frequency (hertz, Hz)	×	wavelength (metres, m)

7A A radio signal is broadcast at a frequency of 1500 kilohertz (kHz) and its speed is 300 million m/s.

What is its wavelength?

1 2 m

2 200 m

3 20 000 m

4 200 000 m

7B A microwave has a wavelength of 10 cm and its speed is 300 million m/s.

What is its frequency?

1 3 million Hz

2 30 million Hz

3 300 million Hz

4 3000 million Hz

7C Infra red signals can be sent through optical fibres.

This is because they are . . .

1 bent by a magnetic field in the optical fibre.

2 diffused through the optical fibre.

3 reflected from the inside surface of the optical fibre.

4 trapped in the centre of the optical fibre.

4.6.1.2 Properties of waves

Question 13 · continued

7D Which statement is true of radio waves?

1 They are mostly absorbed by soft tissue.

2 They do not include television signals.

3 They are not affected by the Earth's atmosphere.

4 They can create an alternating current in an electrical conductor.

Turn over for the next question

4.6.1.2 Properties of waves

Question 14

June 2007 | PHY1B | Original Q7 | Legacy

QUESTION SEVEN

This question is about the transmission of light by optical fibres.

7A Optical fibres can bend light around corners without loss of signal.

This is because . . .

1 absorption of the signal occurs in the optical fibre.

2 following signals push the signals around the corners.

3 reflection of the signal occurs inside the optical fibre.

4 light signals are digital signals.

7B Infra red and visible light are used to send signals along optical fibres.

Compared with other electromagnetic radiations, infra red and visible light . . .

1 have similar frequencies and wavelengths.

2 have very high frequencies and very high wavelengths.

3 have very low frequencies and very low wavelengths.

4 travel at different speeds.

7C Communication by electromagnetic radiation may be by analogue signals.

Which row of the table correctly describes the characteristics of these analogue signals?

	Speed	Signal type
1	constant	continuously varying
2	constant	only on or off
3	varies	continuously varying
4	varies	only on or off

4.6.1.2 Properties of waves

Question 14 · continued

wave speed (metre/second, m/s)	=	frequency (hertz, Hz)	×	wavelength (metre, m)

7D An infra red wave has a wavelength of 0.001 m and a wave speed of 300 000 000 m/s.

The frequency of this wave is:

1 3 Hz

2 30 Hz

3 30 000 Hz

4 300 000 000 000 Hz

Turn over for the next question

4.6.1.2 Properties of waves

Question 15

June 2007 | PHY1H | Original Q4 | Legacy

4 (a) A student listens to the sound waves produced by a car siren. When the car is stationary, the student hears a constant frequency sound.

Describe how the wavelength and frequency of the sound waves heard by the student change when the car is driven away from the student.

.....

.....

.....

.....

(2 marks)

(b) Satellites fitted with various telescopes orbit the Earth. These telescopes detect different types of electromagnetic radiation.

Why are telescopes that detect different types of electromagnetic waves used to observe the Universe?

.....

.....

(1 mark)

(c) In 2005 a space telescope detected a star that exploded 13 billion years ago. The light from the star shows the biggest *red-shift* ever measured.

(i) What is *red-shift*?

.....

.....

(1 mark)

(ii) What does the measurement of its red-shift tell scientists about this star?

.....

.....

(1 mark)

4.6.1.2 Properties of waves

Question 15 · continued

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(d) Red-shift provides evidence for the 'big bang' theory.

(i) Describe the 'big bang' theory.

.....

.....

.....

.....

(2 marks)

(ii) Suggest what scientists should do if new evidence were found that did not support the 'big bang' theory.

.....

.....

.....

(1 mark)

8

4.6.1.2 Properties of waves

Question 16

June 2007 | PHY1H | Original Q5 | Legacy

5 (a) The new Tetra communications system to be used by the police transmits *digital signals* using microwaves of wavelength 75 cm.
The signals travel through the air at 300 000 000 m/s.

(i) What is a *digital signal*?

.....

(1 mark)

(ii) Use the following equation to calculate the frequency of the microwaves used by the Tetra system. Show clearly how you work out your answer.

wave speed = frequency × wavelength

.....

.....

Frequency = ... hertz
(2 marks)

(b) Read the following extract from a newspaper and then answer the questions that follow.

> Residents of Stag Hill Court, a luxury block of flats, are shocked at the plans to site a mobile phone mast on the roof of the flats. They oppose the mast on health grounds, quoting research in Germany that has found a possible increase in cases of cancer around mobile phone masts.
>
> A spokesperson for the telecoms company said, 'The residents should not worry. The research carried out by our own scientists has found no link between ill health and mobile phone masts'.
>
> This has not reassured the residents, who argue that new independent research is urgently needed.

(i) Explain why living near a mobile phone mast could cause ill health.

.....

.....

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.....

.....
(3 marks)

4.6.1.2 Properties of waves

Question 16 · continued

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(ii) Suggest **two** reasons why the residents have **not** been reassured by the research carried out by the telecoms company.

1 .....

.....

2 .....

.....

(2 marks)

8

Turn over for the next question

4.6.1.2 Properties of waves

Question 17

November 2007 | PHY1B | Original Q2 | Legacy

QUESTION TWO

The table gives typical frequencies for different types of electromagnetic radiation.

Match the names of the types of electromagnetic radiation, **A**, **B**, **C** and **D**, with the numbers **1–4** in the table.

A infra red radiation

B ultraviolet radiation

C visible light

D X-rays

Type of electromagnetic radiation	Typical frequency in Hz
1	100 000 billion
2	1 000 000 billion
3	10 000 000 billion
4	100 000 000 billion

4.6.1.2 Properties of waves

Question 18

November 2007 | PHY1B | Original Q5 | Legacy

QUESTION FIVE

There are different types of electromagnetic radiation and nuclear radiation.

5A Which one of the following types of radiation is **not** used for communication?

1 infra red radiation

2 microwaves

3 visible light

4 X-rays

5B Which one of the following types of radiation has the longest wavelength?

1 infra red radiation

2 microwaves

3 visible light

4 X-rays

5C Which one of the following statements is **not** true of **both** ultraviolet radiation and infra red radiation?

1 They can be seen by the human eye.

2 They are members of the electromagnetic spectrum.

3 Each can have a range of different wavelengths and frequencies.

4 They travel at the same speed in a vacuum.

5D Which type of radiation is emitted by the nucleus of an atom of a radioactive isotope?

1 gamma radiation

2 X-rays

3 microwave radiation

4 ultraviolet radiation

4.6.1.2 Properties of waves

Question 19

January 2008 | PHY1H | Original Q5 | Legacy

5 (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
A	1.1 km
B	100 mm
C	0.18 mm

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

(1 mark)

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

Use the equation in the box to calculate the wavelength of the waves broadcast by this station.

wave speed = frequency × wavelength

Show clearly how you work out your answer.

.....

.....

Wavelength = ... m

(2 marks)

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

.....

.....

.....

.....

(2 marks)

4.6.1.2 Properties of waves

Question 19 · continued

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(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 mark)

6

Turn over for the next question

4.6.1.2 Properties of waves

Question 20

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

(a) Complete the sentence.

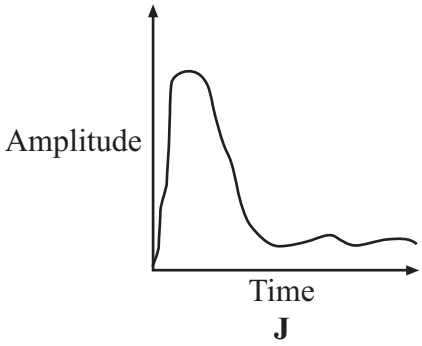
Sound waves are caused by ..... .

(1 mark)

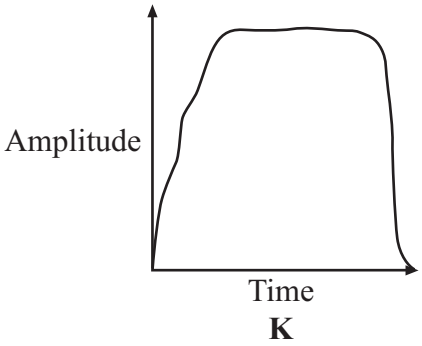
(b) The graphs **J**, **K**, **L** and **M** represent the sound energy reflected from a surface.

The graphs are all drawn to the same scale.

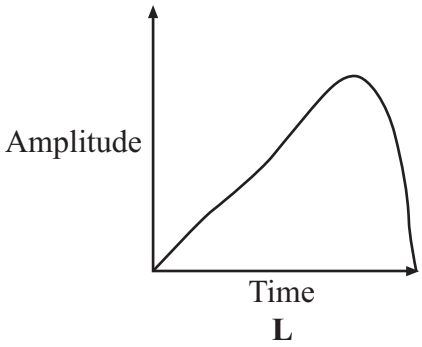
Which graph shows the greatest total sound energy output from the surface?



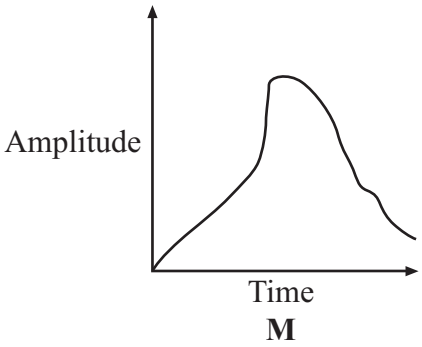
J



K



L



M

Graph .....

(1 mark)

Question 2 continues on the next page

Question 20 · continued

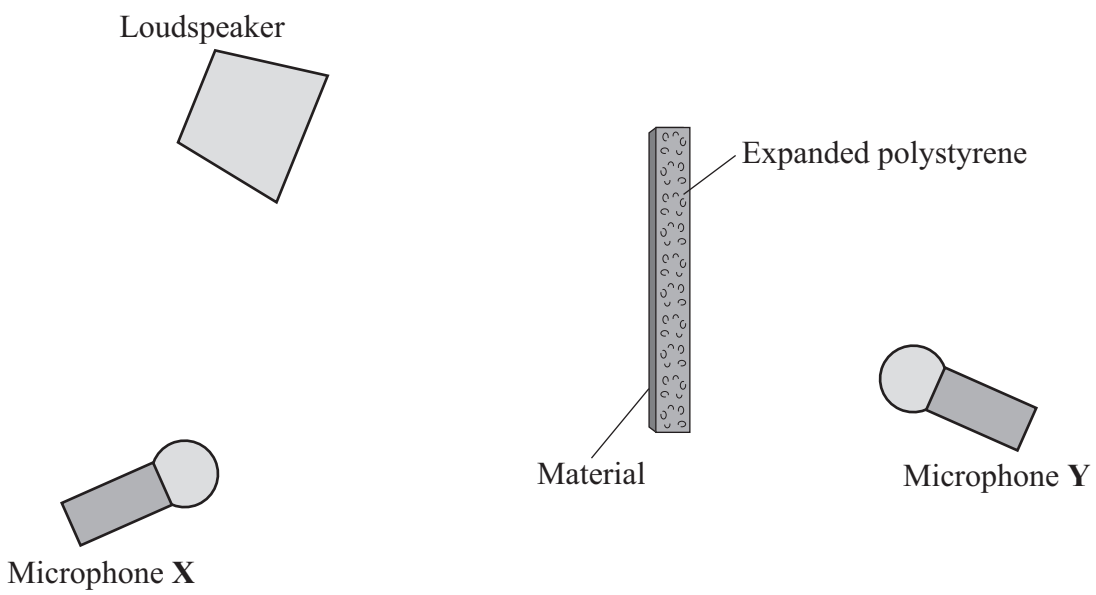
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(c) The proportion of the sound energy which is reflected or transmitted or absorbed depends on the material which receives the sound.

A student investigates different materials.

The diagram shows how a student sets up her equipment.

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



(2 marks)

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

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

.....

.....

(1 mark)

Question 20 · continued

BLANK

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

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

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

.....

(1 mark)

[B] What proportion is this?

.....

(1 mark)

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

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

.....

.....

.....

.....

.....

.....

(2 marks)

9

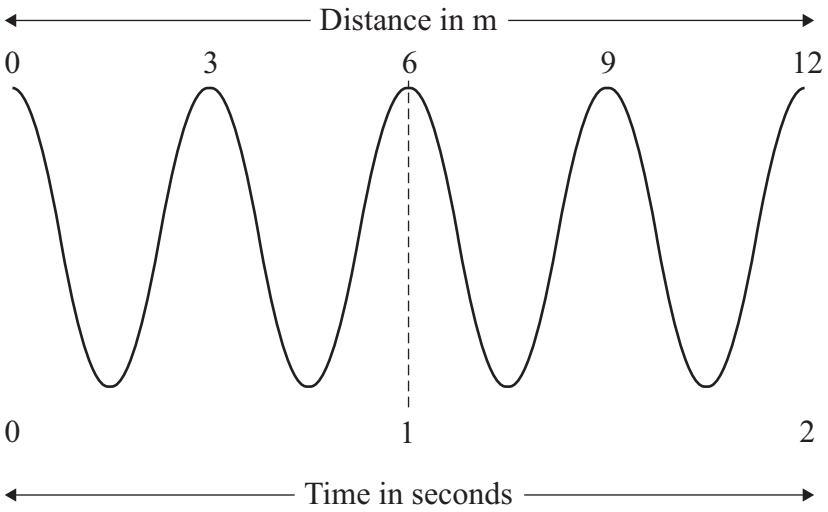
4.6.1.2 Properties of waves

Question 21

March 2008 | PHY1BP | Original Q1 | Legacy

QUESTION ONE

The diagram shows a wave.



wave speed (metre/second, m/s)	=	frequency (hertz, Hz)	×	wavelength (metre, m)

4.6.1.2 Properties of waves

Question 21 · continued

Match figures, **A**, **B**, **C** and **D**, with the numbers **1–4** in the table.

A 2

B 3

C 4

D 6

1	the number of complete waves shown in the diagram
2	the wavelength in metres
3	the frequency in hertz
4	the speed of the wave in metres per second

4.6.1.2 Properties of waves

Question 22

March 2008 | PHY1BP | Original Q2 | Legacy

QUESTION TWO

The electromagnetic spectrum is continuous but the wavelengths within it can be grouped into types.

Match words, **A**, **B**, **C** and **D**, with the numbers **1–4** in the sentences.

A gamma rays

B radio waves

C ultraviolet waves

D visible light

The type of electromagnetic radiation which can be used to send signals along optical fibres is . . . **1** . . . .

The type of electromagnetic radiation which has the highest frequency is . . . **2** . . . .

The type of radiation that has the longest wavelength is . . . **3** . . . .

The type of electromagnetic radiation used in sunbeds for tanning is . . . **4** . . . .

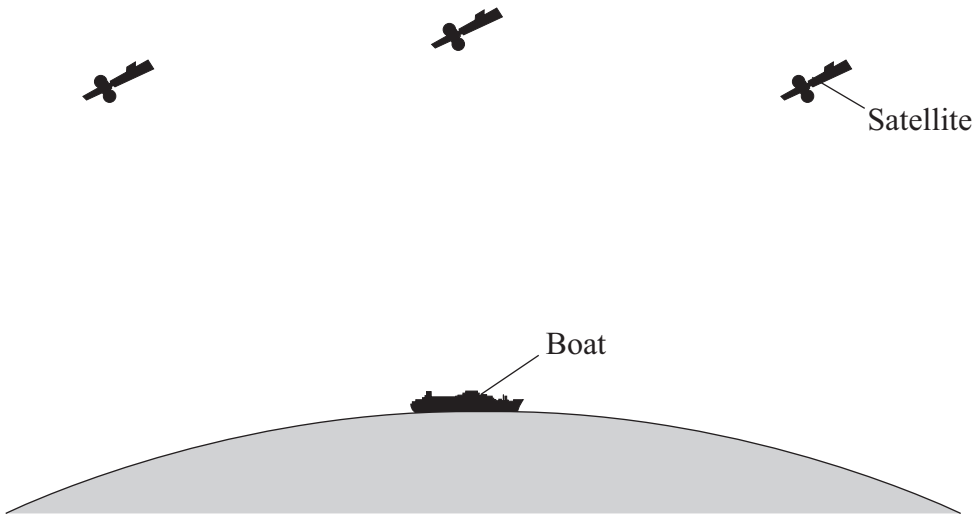
4.6.1.2 Properties of waves

Question 23

March 2008 | PHY1BP | Original Q6 | Legacy

QUESTION SIX

Geostationary satellites can be used for navigation. These satellites remain in the same position above the Earth as the Earth spins on its axis. For accurate navigation, the signals from three satellites are needed.



6A Electromagnetic radiation is used to communicate with the satellites.

Here are two statements about electromagnetic radiation.

X All electromagnetic radiation travels as waves.

Y All forms of electromagnetic radiation travel at the same speed through space.

The correct statements are . . .

1 **X** only.

2 **Y** only.

3 both **X** and **Y**.

4 neither **X** nor **Y**.

Question 23 · continued

6B What effect will signals from the satellite have on the metal aerial on the boat?

1 heat up the metal and destroy some of its atoms

2 heat up the metal and set up an alternating electric current

3 produce microwaves which carry the information to be displayed

4 produce microwaves which set up an alternating electrical current

6C The electromagnetic radiation has a speed of 300 000 000 m/s and a wavelength of 0.1 m.

wave speed (metre/second, m/s)	=	frequency (hertz, Hz)	×	wavelength (metre, m)

What is its frequency?

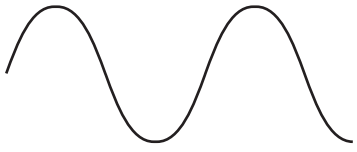
1 3.33 Hz

2 30 000 000 Hz

3 33 000 000 Hz

4 3 000 000 000 Hz

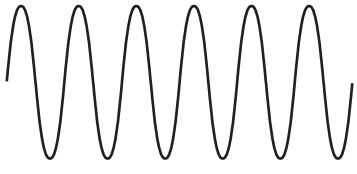
6D Which of these signals could be processed by a computer within the navigation system?



1



2



3



4

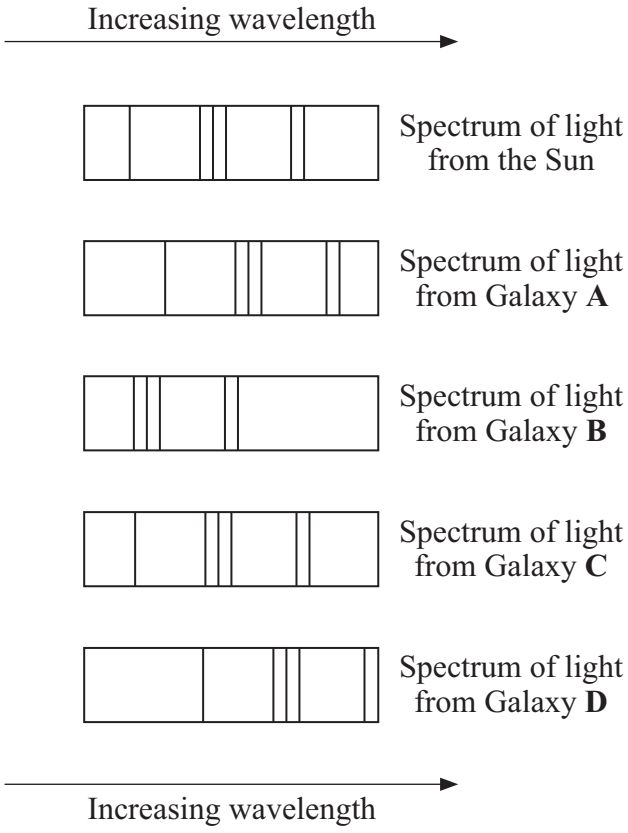
4.6.1.2 Properties of waves

Question 24

March 2008 | PHY1BP | Original Q7 | Legacy

QUESTION SEVEN

The visible part of the electromagnetic spectrum from galaxies includes dark lines. These lines are at specific wavelengths. The diagram shows the position of the dark lines in the spectrum from the Sun and in the spectra from four distant galaxies **A**, **B**, **C** and **D**.



7A What is the name of the phenomenon shown in the spectrum from Galaxy **A**?

1 blue shift

2 green shift

3 yellow shift

4 red shift

7B Which one of the galaxies is furthest away from Earth?

1 Galaxy **A**

2 Galaxy **B**

3 Galaxy **C**

4 Galaxy **D**

4.6.1.2 Properties of waves

Question 24 · continued

7C Which galaxy is moving towards the observer?

1 Galaxy **A**

2 Galaxy **B**

3 Galaxy **C**

4 Galaxy **D**

7D Data from similar investigations shows that . . .

1 most galaxies are moving towards Earth.

2 the further away a galaxy is from Earth, the faster it is moving away from Earth.

3 all galaxies move at a constant speed.

4 all galaxies were created at the same time.

Turn over for the next question

4.6.1.2 Properties of waves

Question 25

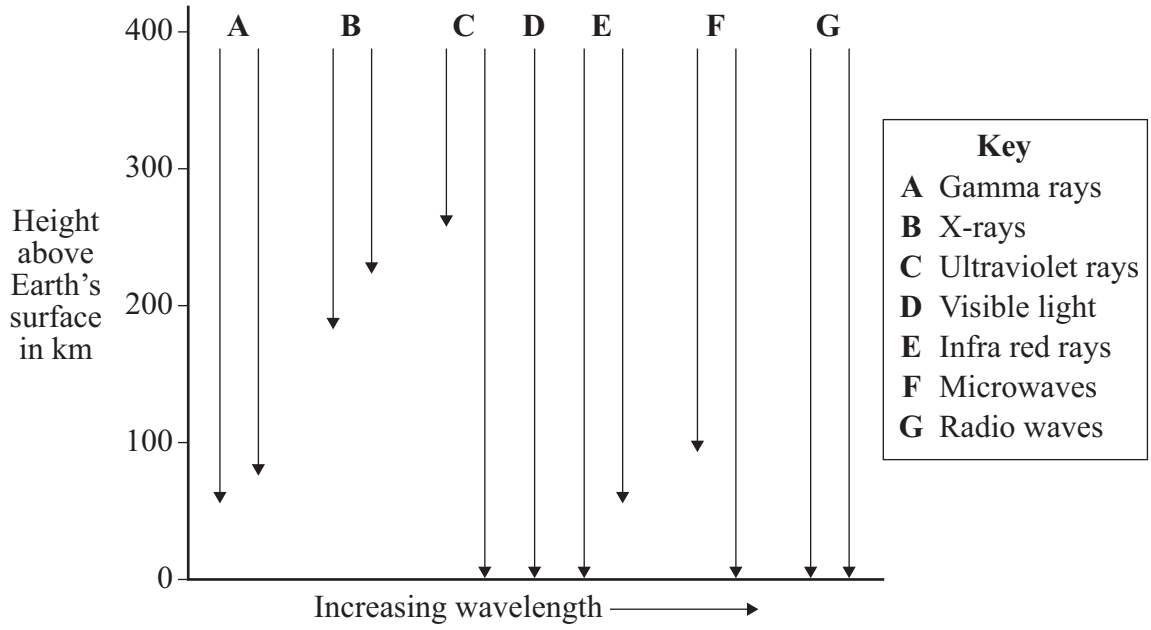
March 2008 | PHY1BP | Original Q9 | Legacy

QUESTION NINE

All forms of electromagnetic radiation from space are used by scientists to explore the Universe.

The diagram shows how far electromagnetic waves can penetrate the Earth's atmosphere.

Where two arrows are shown for a type of electromagnetic radiation, longer and shorter waves penetrate the atmosphere to different depths.



9A Which one of the following statements is true?

1 Gamma radiation penetrates the atmosphere further than all other types of electromagnetic radiation.

2 All frequencies of microwaves reach Earth's surface.

3 No frequencies of radio waves reach Earth's surface.

4 Higher frequencies of ultraviolet radiation are completely absorbed by the atmosphere.

9B What would be the minimum height above the Earth for a satellite carrying a telescope designed to detect gamma rays and X-rays of all wavelengths?

1 50 km

2 70 km

3 180 km

4 230 km

4.6.1.2 Properties of waves

Question 25 · continued

9C Which one of the following correctly describes the data on the diagram?

1 The absorption of electromagnetic radiation by the atmosphere is directly proportional to wavelength.

2 The absorption of electromagnetic radiation by the atmosphere is inversely proportional to wavelength.

3 The shorter the wavelength of electromagnetic radiation, the greater the absorption by the atmosphere.

4 Absorption of electromagnetic radiation does **not** depend only on wavelength.

9D Electromagnetic radiation from distant galaxies is very weak and is therefore very difficult to detect.

The Spitzer space telescope uses liquid helium to keep its scientific instruments at a very low temperature.

Which type of weak electromagnetic radiation would best be detected by instruments kept at this very low temperature?

1 gamma rays

2 X-rays

3 infra red rays

4 ultraviolet rays

END OF TEST

4.6.1.2 Properties of waves

Question 26

June 2008 | PHY1BP | Original Q5 | Legacy

QUESTION FIVE

The table gives information about some telescopes.

Name of telescope	Arecibo	COBE	Spitzer	Keck	Hopkins
Type of radiation detected	radio waves	microwaves	infra red	visible light	ultraviolet
Location of telescope	on the Earth's surface	in space	in space	high on the Earth's surface	in space

5A Why is the Keck telescope located high on the Earth's surface?

1 so that astronomers are not disturbed

2 it is cheaper to build in this location

3 to be closer to the stars it is observing

4 to be above clouds and dust in the Earth's atmosphere

5B The Hopkins telescope is located in space . . .

1 so that the astronomers are not exposed to ultraviolet radiation.

2 because not all ultraviolet radiation penetrates the Earth's atmosphere.

3 to be closer to the stars it is observing.

4 because there is not enough land on the Earth to build telescopes.

5C Which of the telescopes in the table might provide evidence of the red-shift of light from distant galaxies?

1 COBE

2 Spitzer

3 Keck

4 Hopkins

4.6.1.2 Properties of waves

Question 26 · continued

5D The longer the wavelength of the radiation being absorbed, the larger the telescope needs to be.

Which telescope is the largest?

1 Arecibo

2 Spitzer

3 Keck

4 Hopkins

Turn over for the next question

4.6.1.2 Properties of waves

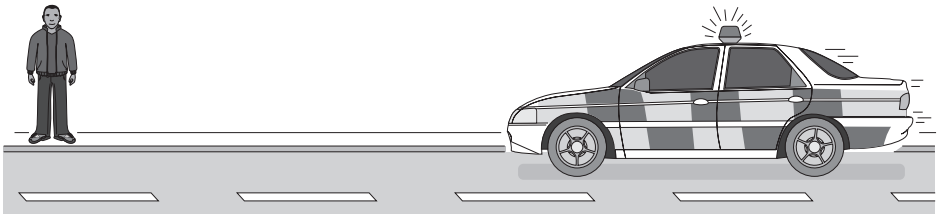
Question 27

June 2008 | PHY1BP | Original Q8 | Legacy

QUESTION EIGHT

The diagram shows a police car moving towards a person who is standing at the side of the road.

The siren on the police car is sounding.



8A As the police car approaches, the person notices that the frequency of the note changes.

The frequency becomes . . .

1 lower because the wavelength increases.

2 lower because the wavelength decreases.

3 higher because the wavelength increases.

4 higher because the wavelength decreases.

8B A driver in another car on the same road did not notice any change in the frequency of the note emitted by the siren.

This was because the cars were travelling in . . .

1 the same direction at the same speed.

2 opposite directions at the same speed.

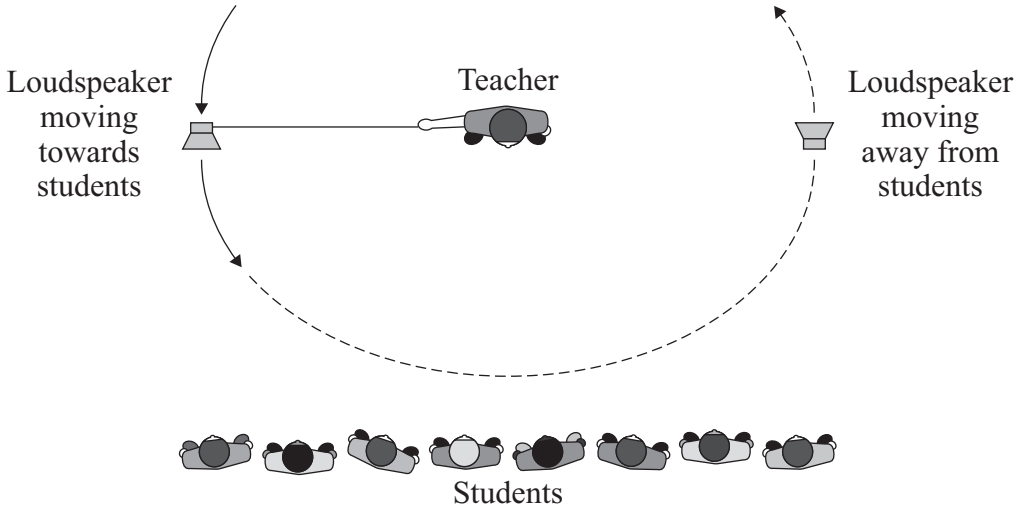
3 the same direction at different speeds.

4 opposite directions at different speeds.

Question 27 · continued

A teacher wanted to demonstrate this effect in her laboratory.

She connected a loudspeaker to a signal generator. The loudspeaker produced a note of constant frequency. The teacher then swung the loudspeaker above her head, as shown in the diagram. The students in the class listened to the sound produced by the loudspeaker.



8C What sound will the students hear as the loudspeaker goes round and round?

1 a note of constant frequency

2 a note of higher frequency

3 a note of lower frequency

4 a note of varying frequency

8D This demonstration is a model for spinning galaxies.

What is the purpose of a model in science?

1 It helps to explain a phenomenon.

2 It proves that a theory is correct.

3 It allows more data to be collected.

4 It is to generate new ideas.

4.6.1.2 Properties of waves

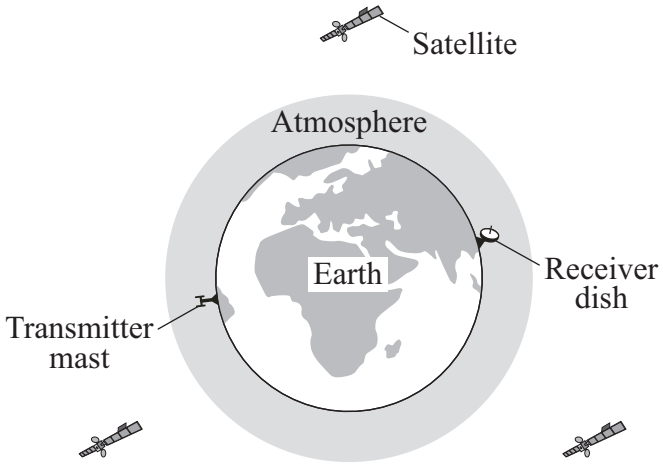
Question 28

June 2008 | PHY1BP | Original Q9 | Legacy

QUESTION NINE

Satellite television broadcasts are transmitted as microwaves. In a vacuum, the microwaves travel at 300 million metres per second.

Television stations are changing the transmission method from analogue signals to digital signals. In a few years' time there will be no analogue television transmissions.



9A Microwaves are used for transmissions to and from satellites because they . . .

1 are never affected by interference.

2 are regarded as 100% safe by scientists.

3 cannot be seen by the human eye.

4 pass through the Earth's atmosphere easily.

9B Digital signals are better than analogue signals for transmitting satellite television programmes because digital signals . . .

1 can only be ON or OFF and so are less prone to distortion by interference.

2 do not need the use of a computer to process them.

3 pass through clouds and are not affected by weather.

4 travel at a higher speed in a vacuum.

4.6.1.2 Properties of waves

Question 28 · continued June 2008 | PHY1BP | Original Q9 | Legacy

9C It is necessary to transmit from the transmitter mast to the receiver dish via a satellite because . . .

1 microwaves will not travel far.

2 microwaves do not travel in a curved path.

3 the Earth is rotating.

4 the waves spread out from the transmitter in all directions into space.

9D A new television channel will transmit via satellites using microwaves with a wavelength of 400 millimetres.

wave speed (metre/second, m/s)	=	frequency (hertz, Hz)	×	wavelength (metre, m)

1 MHz = 1 000 000 Hz

The frequency of the microwaves will be . . .

1 0.75 Hz

2 750 Hz

3 0.75 MHz

4 750 MHz

END OF TEST

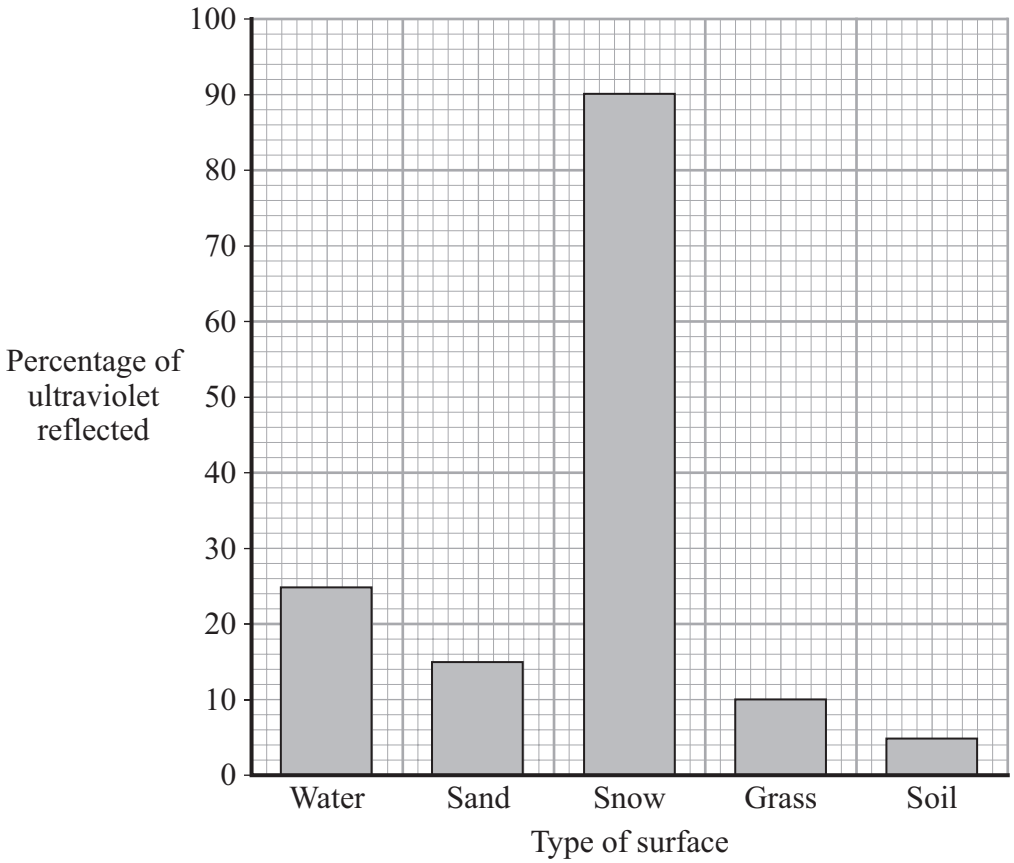
4.6.1.2 Properties of waves

Question 29

June 2008 | PHY1H | Original Q2 | Legacy

2 (a) Ultraviolet (UV) radiation can be reflected or absorbed by a surface.

The percentage of ultraviolet radiation reflected by various surfaces is shown in the bar chart.



2 (a) (i) Which of these surfaces is the best **absorber** of ultraviolet radiation?

.....

(1 mark)

2 (a) (ii) Why has the data been shown as a bar chart rather than a line graph?

.....

.....

(1 mark)

2 (a) (iii) Who is likely to be exposed to more ultraviolet radiation, a skier or a golfer?

Draw a ring around your answer. **skier** **golfer**

Give a reason for your answer.

.....

.....

(1 mark)

Question 2 continues on the next page

4.6.1.2 Properties of waves

Question 29 · continued

for mark

2 (a) (iv) State **one** harmful effect that ultraviolet radiation has on skin.

.....

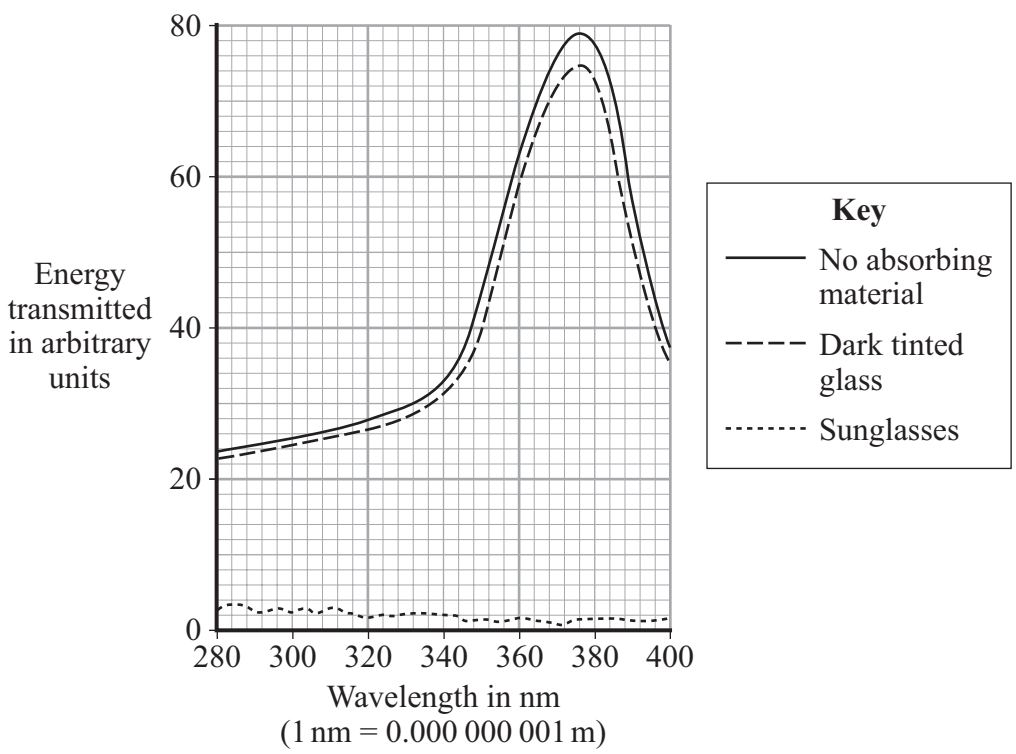
(1 mark)

2 (b) This is a label from a pair of sunglasses.

Sportswear Budget £5

- plastic lenses
- blocks 95% of ultraviolet rays
- UV absorbing up to wavelengths of 400 nm

A student tested the sunglasses by measuring the energy transmitted by the lenses for ultraviolet waves with a range of different wavelengths.
For comparison, the student also measured the transmission of ultraviolet waves through a piece of dark tinted glass.
The results of the tests are shown in the graph.



4.6.1.2 Properties of waves

Question 29 · continued

for mark

2 (b) (i) Explain how the student's results support the claims made on the label.

.....

.....

.....

.....

(2 marks)

2 (b) (ii) Ultraviolet radiation can cause permanent eye damage.

Why should the lenses for sunglasses **not** be made from the dark tinted glass used in the student's tests?

.....

.....

(1 mark)

2 (c) An eye care charity predicts that within 10 years, everyone, when outside, will wear UV protection sunglasses most of the time. This is because the potential damage from ultraviolet radiation is so serious.

2 (c) (i) Which **one** of the following statements is the most likely reason for the prediction made by the eye care charity?

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

Publicity and education will make people aware of the dangers. ☐

The price of UV blocking sunglasses will fall dramatically. ☐

The level of UV in the atmosphere will increase. ☐

(1 mark)

2 (c) (ii) Several manufacturers of sunglasses have said that the research they have carried out supports the view of the eye care charity.

Suggest why the research conducted by the manufacturers could be biased.

.....

.....

(1 mark)

9

4.6.1.2 Properties of waves

Question 30

June 2008 | PHY1H | Original Q3 | Legacy

3 The table gives data about two space telescopes. The Hubble telescope is already in space, but the James Webb telescope is still being built.

Name of telescope	Mirror diameter in metres	Launch Year	Orbit distance from the Earth in kilometres
Hubble	2.4	1990	575
James Webb	6.5	2013	1 500 000

3 (a) Explain why the Hubble telescope produces clearer images than optical telescopes positioned on the Earth.

.....

.....

.....

.....

(2 marks)

3 (b) After the Hubble telescope was launched into space, scientists found that it was not able to focus properly. Astronauts sent into space were able to repair the fault.

The James Webb telescope is to be fully assembled and tested before it is launched into space. Suggest why.

.....

.....

.....

.....

(2 marks)

3 (c) To get the large mirror for the James Webb telescope into space, it will be folded in segments, launched into space and then opened out. This is a complicated process so a working scale model of the optical system has been built.

Suggest **one** reason why building a scale model is a good idea.

.....

.....

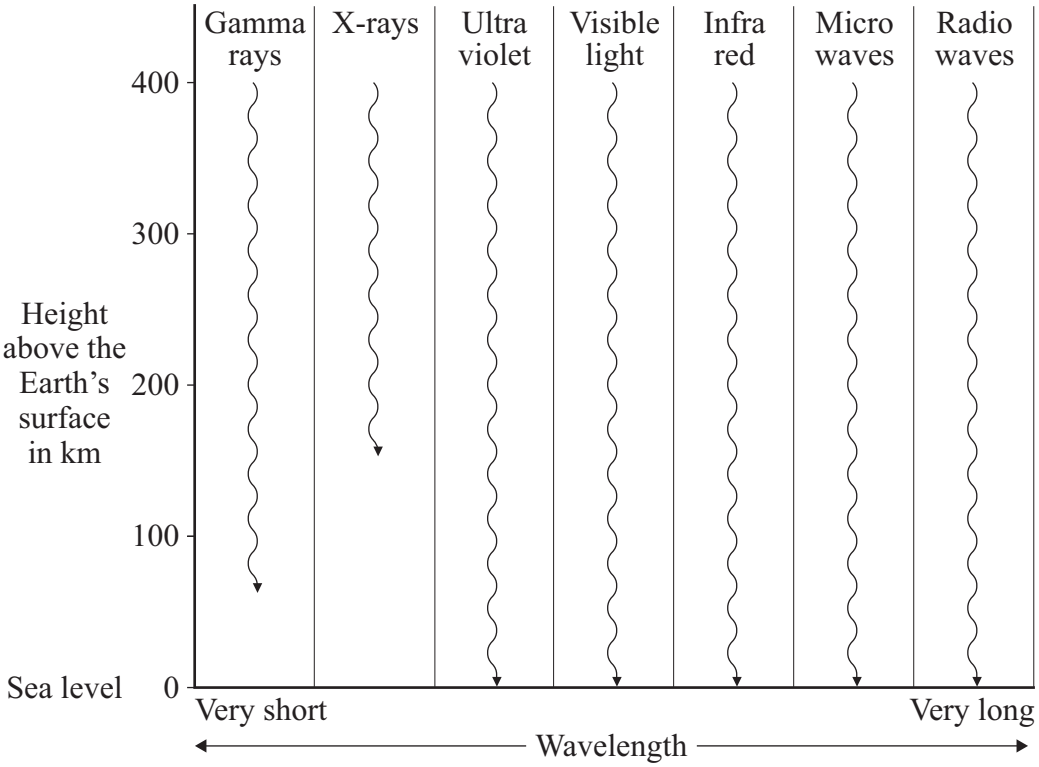
(1 mark)

4.6.1.2 Properties of waves

Question 30 · continued

for mark

3 (d) The diagram shows how far different types of electromagnetic wave can travel through the Earth's atmosphere before being absorbed.



Explain why an optical telescope can be positioned on the Earth but an X-ray telescope must be in space.

.....

.....

.....

.....

(2 marks)

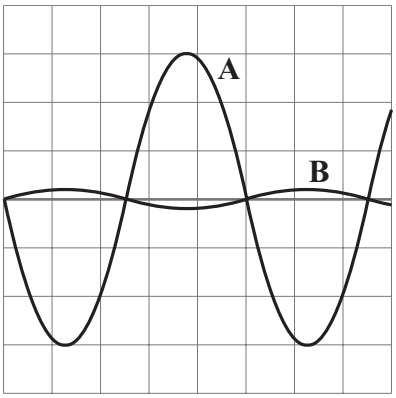
7

4.6.1.2 Properties of waves

Question 31

June 2008 | PHY2H | Original Q4 | Legacy

4 The diagram shows two oscilloscope traces, **A** and **B**.



Trace **A** shows how the potential difference between the live and neutral terminals of an electricity supply changes with time.

4 (a) Describe how the potential of the live terminal varies with respect to the neutral terminal of the electricity supply.

.....

.....

(2 marks)

4 (b) What does trace **B** show?

.....

.....

(1 mark)

4 (c) Each horizontal division on the oscilloscope represents 0.005 s.

4 (c) (i) What is the period of this electricity supply?

.....

Period = ... seconds

(1 mark)

4 (c) (ii) Calculate the frequency of the supply.

.....

Frequency = ... hertz

(1 mark)

5

4.6.1.2 Properties of waves

Question 32

June 2008 | PHY3H | Original Q5 | Legacy

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

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

1 .....

2 .....

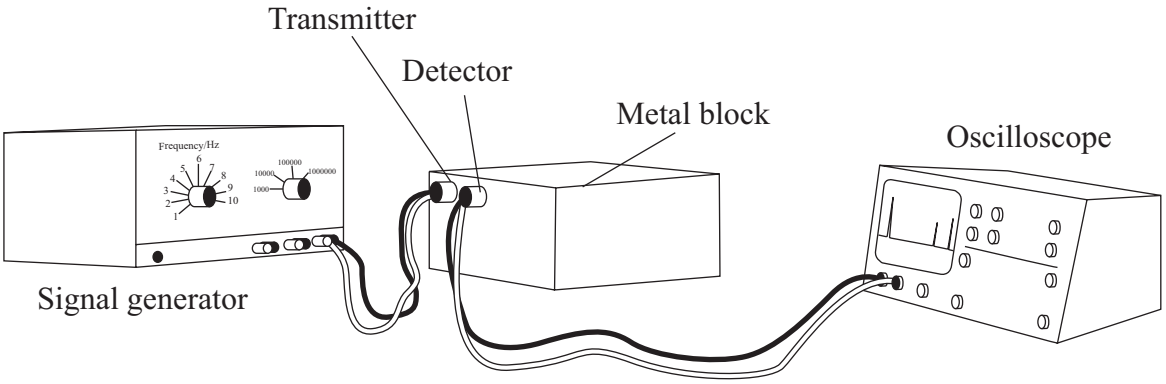
(2 marks)

4.6.1.2 Properties of waves

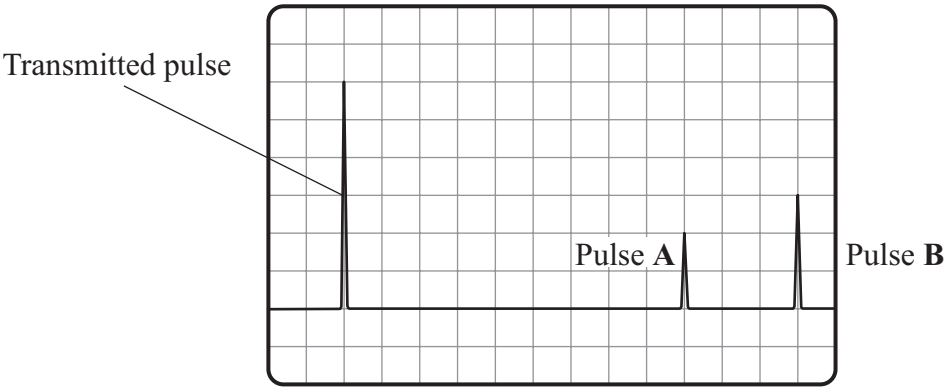
Question 32 · continued

for mark

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



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



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

.....

.....

.....

(2 marks)

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

Distance = ... mm

(1 mark)

5

4.6.1.2 Properties of waves

Question 33

November 2008 | PHY1BP | Original Q5 | Legacy

QUESTION FIVE

This question is about the electromagnetic spectrum and its use in communications.

5A Which one of the following types of electromagnetic wave would **not** be suitable for communications?

1 infra red

2 microwave

3 gamma

4 visible light

5B Which types of electromagnetic waves can be used to send signals along optical fibres?

1 infra red and ultraviolet

2 infra red and visible light

3 infra red, ultraviolet and visible light

4 ultraviolet and visible light

5C By 2012, all TV signals in the UK will be digital.

This will be an improvement over analogue signals because . . .

1 digital signals are less prone to interference.

2 digital signals pick up interference and amplify it.

3 in an analogue signal, interference is treated as part of the original signal.

4 when analogue signals are amplified, interference is amplified.

4.6.1.2 Properties of waves

Question 33 · continued

5D Electromagnetic waves travel at a speed of 300 000 km/s.

wave speed (metre/second, m/s)	=	frequency (hertz, Hz)	×	wavelength (metre, m)

A radio station transmits signals at a wavelength of 1.5 km.

The frequency of the waves is . . .

1 200 Hz

2 200 kHz

3 450 000 Hz

4 450 000 kHz

Turn over for the next question

4.6.1.2 Properties of waves

Question 34

November 2008 | PHY1BP | Original Q6 | Legacy

QUESTION SIX

The tables show the types of radiation observed by different telescopes, and the types of radiation emitted by different parts of the universe.

Name of telescope	Type of radiation
Arecibo	Radio
COBE	Microwave
Hess	Gamma
Hopkins	Ultraviolet
Keck	Visible light
Spitzer	Infra red
XMM Newton	X-rays

Origin of radiation in universe	Main radiation emitted
Pulsars	Radio
Neutron stars	X-rays
Nebulae	Infra red
Stars	Visible light
Gamma ray bursts	Gamma
Big bang	Microwaves

6A Which telescope could be used to hunt for neutron stars in galaxies?

1 Arecibo

2 Spitzer

3 Hopkins

4 XMM Newton

6B Which telescope could be used to analyse the radiation of the universe left over from the 'big bang'?

1 COBE

2 Spitzer

3 Keck

4 Hopkins

4.6.1.2 Properties of waves

Question 34 · continued

6C Which one of the following emits the longest wavelength radiation?

1 Gamma ray bursts

2 Neutron stars

3 Pulsars

4 Stars

6D Which one of the following emits radiation with the highest frequency?

1 Nebulae

2 Neutron stars

3 Pulsars

4 Stars

Turn over for the next question

4.6.1.2 Properties of waves

Question 35

November 2008 | PHY1BP | Original Q8 | Legacy

QUESTION EIGHT

This question is about two space telescopes.

The Hubble space telescope orbits the Earth at a distance of 569 km and detects visible light.

The James Webb space telescope is planned to be launched some time after 2013 and will orbit at about 1.5 million kilometres from the Earth and will detect infra red frequencies (rays).

8A The main advantage of the Hubble telescope being so far from Earth is the improvement in image quality.

This improvement is because . . .

1 there is little atmosphere to distort the data being received.

2 there is no light pollution from cities.

3 there is no gravity to distort the mirror in the telescope.

4 there is no need for access for service or repairs to the mirror in the telescope.

8B The James Webb space telescope should be able to receive data from distant galaxies billions of light years away from the Earth. It is shielded from the Sun to keep it at a temperature of –225°C and will contain a large mirror.

The reason that it is designed to detect infra red frequencies is that . . .

1 all the radiation emitted by the galaxies is in the infra red region of the spectrum.

2 infra red radiation can be detected in the dark.

3 much of the radiation we receive from galaxies is at infra red frequencies due to a significant red-shift.

4 we receive only infra red radiation from the galaxies.

8C The major reason for keeping the mirror so cold is to . . .

1 avoid the need to carry extra fuel to heat it.

2 keep it rigid.

3 minimise the infra red radiation from it which would confuse the data being collected.

4 stop it from melting.

Question 35 · continued

8D There are also radio telescopes on Earth.
The longer the wavelength of the radiation being absorbed, the larger a telescope needs to be.

Which row in the table gives the correct order of size for the telescopes?

	Smallest ← → Largest		
1	James Webb telescope	Hubble telescope	Radio telescope
2	Radio telescope	James Webb telescope	Hubble telescope
3	Hubble telescope	James Webb telescope	Radio telescope
4	Hubble telescope	Radio telescope	James Webb telescope

Turn over for the next question

4.6.1.2 Properties of waves

Question 36

November 2008 | PHY1BP | Original Q9 | Legacy

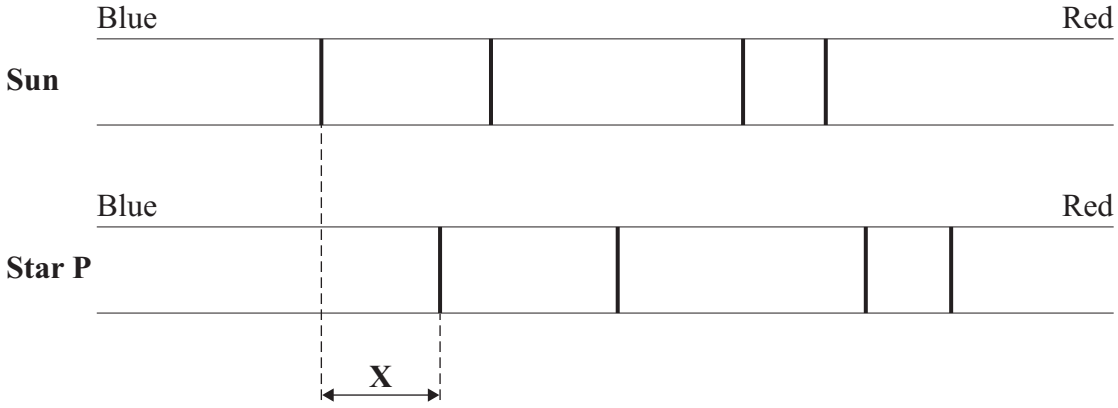
QUESTION NINE

The visible part of the electromagnetic spectrum from a star includes dark lines. These lines are at specific wavelengths.

The diagrams show the positions of the dark lines in the spectrum from the Sun and in the spectrum from a distant star, **P**.

Star **P** is moving away from the observer.

The dark lines in **P**'s spectrum are shown to be displaced.



9A The displacement marked **X** in the diagram is called the red-shift.

What change has occurred to the speed and frequency of the light to cause red-shift?

	Speed	Frequency
1	decreased	stayed the same
2	increased	stayed the same
3	stayed the same	decreased
4	stayed the same	increased

4.6.1.2 Properties of waves

Question 36 · continued

9B Another star, **Q**, is further away from the observer than star **P** and is also moving away from the observer.

The displacement **X** in **Q**'s spectrum, compared with that in **P**'s is . . .

1 smaller and in the opposite direction.

2 bigger and in the opposite direction.

3 smaller and in the same direction.

4 bigger and in the same direction.

9C Edwin Hubble made measurements on the dark lines in the spectra from distant galaxies.

His observations led to the idea that the universe is expanding.

He observed that . . .

1 the further away the galaxy, the smaller the red-shift.

2 the further away the galaxy, the bigger the red-shift.

3 the most distant galaxies show a blue-shift.

4 the red-shift does not change with distance.

9D Scientists are interested in how the universe began.

Which one of the following statements is correct?

1 We now definitely know that the universe began with a 'big bang'.

2 There is no evidence about how the universe began.

3 The current evidence suggests that the universe began at a small point.

4 We now know that the galaxies will continue to get further apart.

END OF TEST

4.6.1.2 Properties of waves

Question 37

January 2009 | PHY1H | Original Q5 | Legacy

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

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

.....

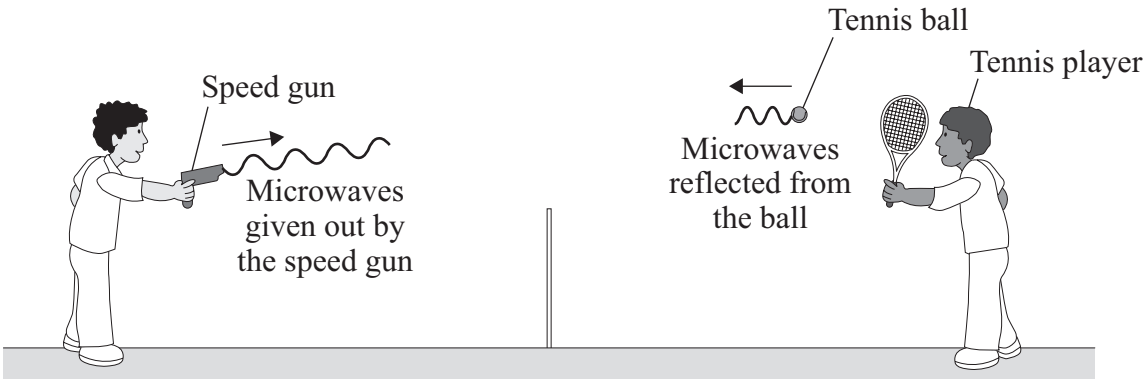
(1 mark)

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

.....

(1 mark)

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



5 (b) (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.

Use the equation in the box to calculate the wavelength of the microwaves emitted from the speed gun.

wave speed = frequency × wavelength

Show clearly how you work out your answer.

.....

.....

Wavelength = ... m

(2 marks)

4.6.1.2 Properties of waves

Question 37 · continued

for mark

5 (b) (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 mark)

5 (b) (iii) Some of the microwaves transmitted by the speed gun are reflected from the moving ball back towards the speed gun.

Describe how the wavelength and frequency of the microwaves change as they are reflected from the moving ball.

.....

.....

.....

.....

(2 marks)

Question 5 continues on the next page

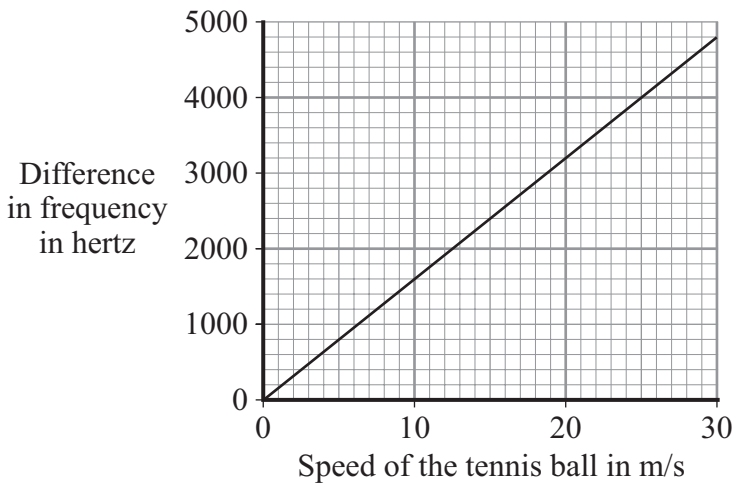
4.6.1.2 Properties of waves

Question 37 · continued

for mark

5 (c) The difference in frequency between the transmitted and reflected waves is detected by the speed gun. This data is processed by a computer chip inside the speed gun, and then displayed as a speed.

5 (c) (i) The graph shows that the difference in frequency between the transmitted and reflected waves is directly proportional to the speed of the moving ball.



Why has a line graph been used to display the data?

.....

.....

(1 mark)

5 (c) (ii) Is it better to transfer the data to the computer as an analogue signal or as a digital signal?

.....

Give a reason for your answer.

.....

.....

(1 mark)

4.6.1.2 Properties of waves

Question 37 · continued

for mark

5 (c) (iii) What is the difference between an analogue signal and a digital signal?

You may draw a labelled diagram to help you with your answer.

.....

.....

.....

.....

(2 marks)

11

4.6.1.2 Properties of waves

Question 38

January 2009 | PHY3H | Original Q1 | Legacy

1 (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 mark)

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

What does the symbol kHz stand for?

.....

(1 mark)

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

.....

(1 mark)

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

.....

(1 mark)

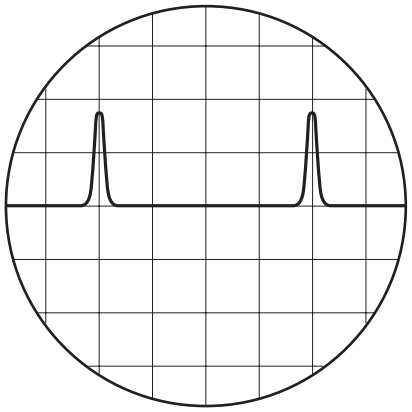
4.6.1.2 Properties of waves

Question 38 · continued

for mark

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 mark)

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 marks)

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

.....

.....

.....
(2 marks)

9

4.6.1.2 Properties of waves

Question 39

March 2009 | PHY1BP | Original Q4 | Legacy

QUESTION FOUR

This question is about electromagnetic waves.

4A Changes may occur in substances when they absorb the energy carried by electromagnetic waves.

Which row in the table is correct?

	An alternating current is created in the substance	The substance becomes hotter
1	always	never
2	sometimes	always
3	sometimes	sometimes
4	never	sometimes

4B Radio waves travel in straight lines. However, some types of radio waves can be received on the opposite side of the Earth from the transmitter.

This happens because the radio waves are . . .

1 absorbed by the atmosphere.

2 interfered with by the atmosphere.

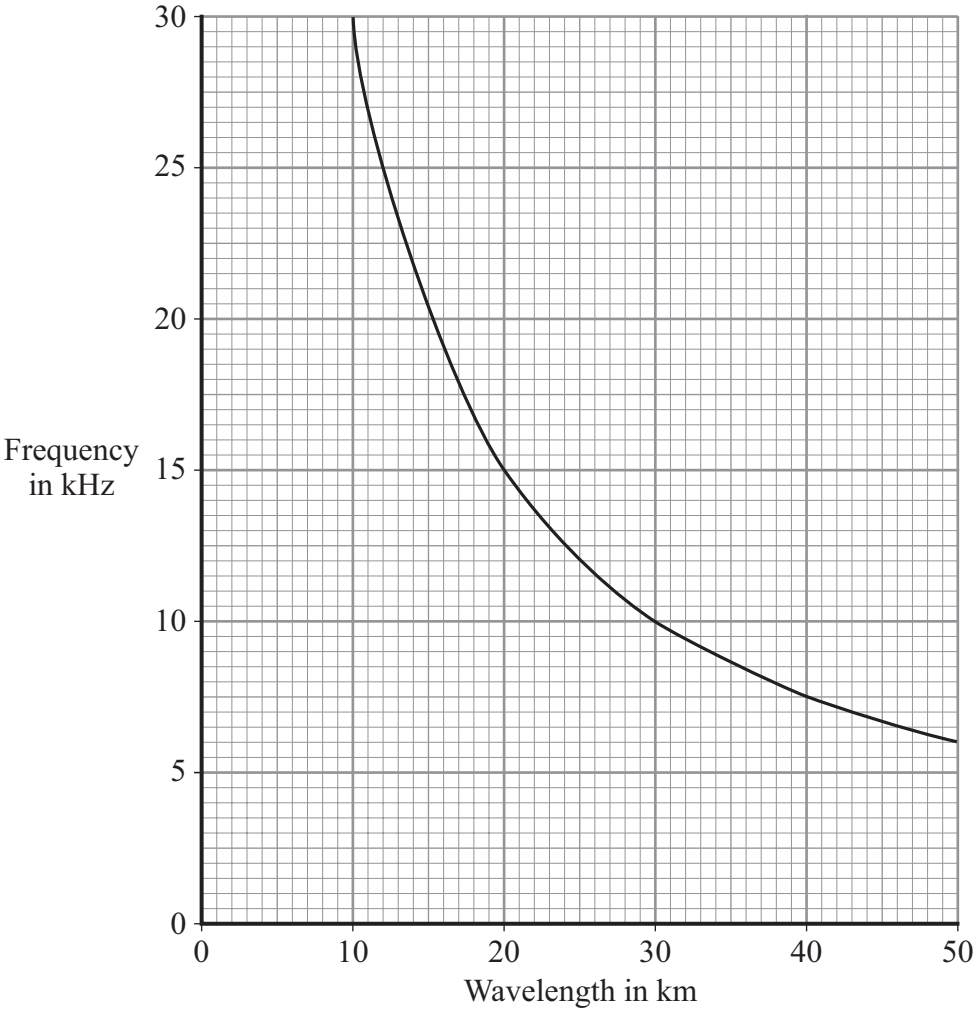
3 reflected by the atmosphere.

4 stopped by the atmosphere.

4.6.1.2 Properties of waves

Question 39 · continued March 2009 | PHY1BP | Original Q4 | Legacy

The graph indicates how the frequency of electromagnetic waves changes with wavelength.



4C The graph shows that when the wavelength doubles, the frequency . . .

1 doubles.

2 halves.

3 quadruples.

4 stays the same.

4D What is the frequency of electromagnetic waves of wavelength 25 000 metres?

1 1.2 kHz

2 1.4 kHz

3 12 kHz

4 14 kHz

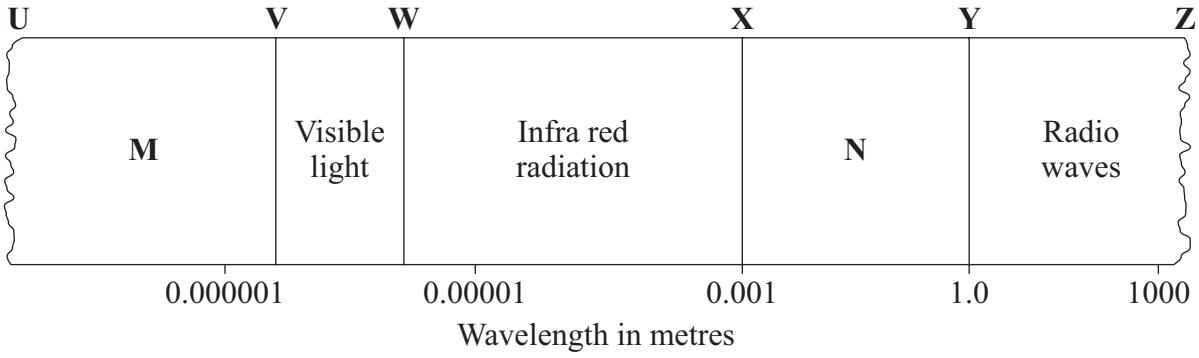
4.6.1.2 Properties of waves

Question 40

March 2009 | PHY1BP | Original Q5 | Legacy

QUESTION FIVE

The diagram shows part of the electromagnetic spectrum.



5A Which row of the table gives the types of electromagnetic radiation that are present in **M** and **N**?

	M	**N**
1	gamma	microwaves
2	gamma	ultraviolet
3	ultraviolet	gamma
4	ultraviolet	microwaves

5B Which section of the electromagnetic spectrum can be used for communications?

1 **U** to **Z**

2 **V** to **Z**

3 **W** to **Z**

4 **X** to **Z**

4.6.1.2 Properties of waves

Question 40 · continued March 2009 | PHY1BP | Original Q5 | Legacy

wave speed (metre/second, m/s)	=	frequency (hertz, Hz)	×	wavelength (metre, m)

All electromagnetic waves travel at a speed of 300 000 000 m/s.

5C BBC Radio 4 is carried by radio waves with a wavelength of 1500 m.

What is the frequency of these waves?

1 0.000 005 Hz

2 0.005 Hz

3 200 kHz

4 450 000 000 kHz

5D Compact fluorescent lamps (CFLs) emit infra red radiation. This radiation can interfere with the infra red signal emitted by remote controls for televisions.

An article about CFLs says that the infra red rays are emitted at a frequency of about 300 kHz.

This is incorrect because this frequency would mean that the wavelength is in . . .

1 the gamma ray part of the electromagnetic spectrum.

2 the microwave part of the electromagnetic spectrum.

3 the radio wave part of the electromagnetic spectrum.

4 the ultraviolet part of the electromagnetic spectrum.

4.6.1.2 Properties of waves

Question 41

March 2009 | PHY1BP | Original Q7 | Legacy

QUESTION SEVEN

This question is about the behaviour of waves as the source of the wave moves, and what this can tell us about the universe.

7A At an air show, an aircraft flies at a steady speed in a straight line over the crowd of spectators.

As the aircraft approaches, how do the wavelength and frequency of the sound wave heard by the spectators differ from the sound emitted by the aircraft?

	Wavelength	Frequency
1	shorter	higher
2	longer	lower
3	longer	the same
4	the same	lower

7B Scientists observing the Andromeda galaxy see that its light is undergoing a blue-shift.

What does this tell them about the wavelength of light arriving on Earth from this galaxy and the movement of Andromeda relative to Earth?

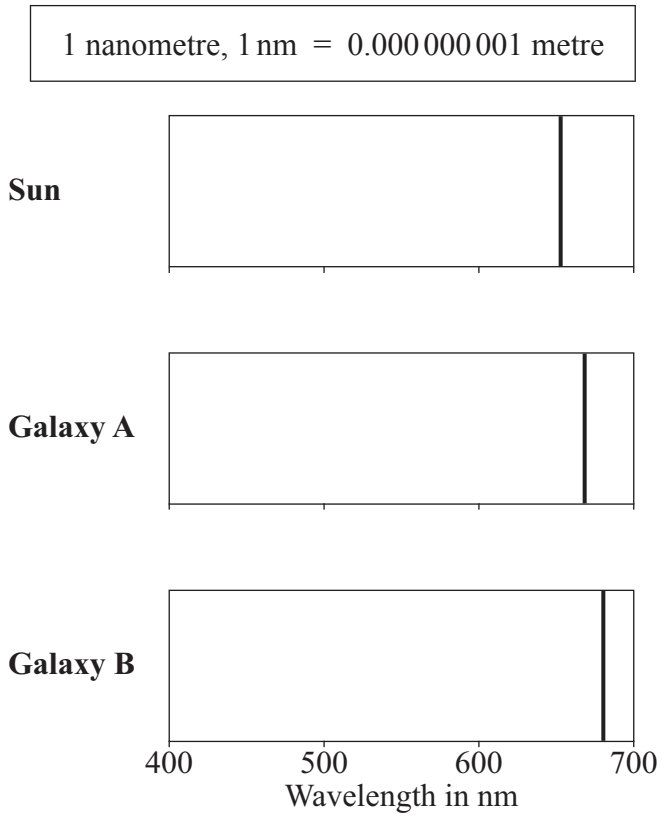
	Wavelength	Movement relative to Earth
1	decreasing	moving away
2	decreasing	moving towards
3	increasing	moving away
4	increasing	moving towards

4.6.1.2 Properties of waves

Question 41 · continued March 2009 | PHY1BP | Original Q7 | Legacy

The visible part of the electromagnetic spectrum from stars includes dark lines. They correspond to chemical elements in the stars and occur at specific wavelengths.

The line in the spectra shown below, from three different sources, represents hydrogen which is found in the Sun's spectrum at a wavelength of 656.3 nm.



7C What does this indicate about galaxies **A** and **B**?

1 Galaxy **A** is colder than galaxy **B**.

2 Galaxy **A** is further away from Earth than galaxy **B**.

3 Galaxy **B** is colder than galaxy **A**.

4 Galaxy **B** is further away from Earth than galaxy **A**.

7D Which of the following theories about the universe does red-shift information support?

1 The universe began from a small initial point and has been expanding ever since.

2 The universe expanded initially, but is now contracting.

3 The universe has always been the size it is now.

4 The universe will eventually run out of energy and collapse.

4.6.1.2 Properties of waves

Question 42

March 2009 | PHY1BP | Original Q9 | Legacy

QUESTION NINE

Ultraviolet radiation is next to X-rays in the electromagnetic spectrum. Ultraviolet radiation consists of three regions: UVA, UVB, and UVC, as shown in the table.

	UVA	UVB	UVC	X-rays	

9A The UVA region of the spectrum has wavelengths between 315 and 400 nm. The visible light region of the spectrum extends to wavelengths of 700 nm.

In what wavelength region will violet light be found?

1 nanometre, 1 nm = 0.000 000 001 metre

1 360 – 400 nm

2 400 – 430 nm

3 620 – 700 nm

4 700 – 760 nm

9B Different types of electromagnetic radiation will penetrate materials to different depths. UVA will penetrate the top and middle layers of human skin. UVB will penetrate the top layer only.

This is surprising because gamma rays . . .

1 penetrate less than X-rays and have a lower frequency than X-rays.

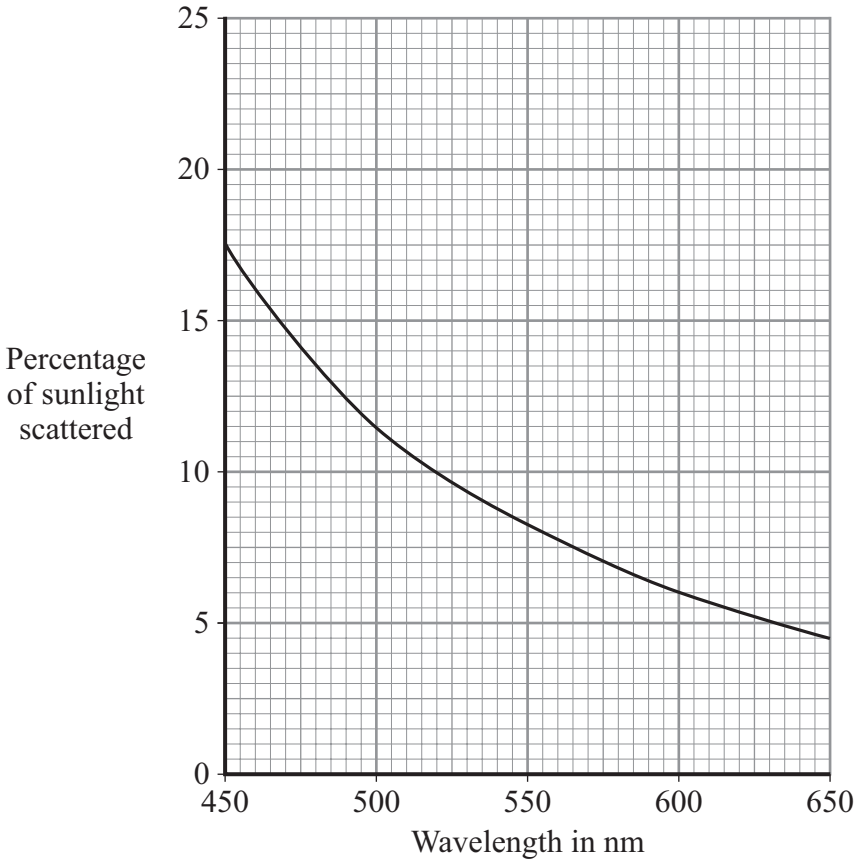
2 penetrate less than X-rays and have a higher frequency than X-rays.

3 penetrate more than X-rays and have a shorter wavelength than X-rays.

4 penetrate more than X-rays and have a longer wavelength than X-rays.

Question 42 · continued

9C The scattering of sunlight by the atmosphere causes the daylight colour of the sky to be blue. The graph shows how the scattering of sunlight changes with the wavelength.



What percentage of direct sunlight reaches the Earth **unscattered** at a wavelength of 500 nm?

1 11.5%

2 37.5%

3 62.5%

4 88.5%

9D How much scattering would you expect from ultraviolet rays?

1 less scattering than from visible light because ultraviolet rays have a lower frequency than visible light.

2 less scattering than from visible light because ultraviolet rays travel more slowly than visible light.

3 more scattering than from visible light because ultraviolet rays have a shorter wavelength than visible light.

4 the same scattering as from visible light because they both travel at the same speed.

END OF TEST

4.6.1.2 Properties of waves

Question 43

June 2009 | PHY1BP | Original Q1 | Legacy

QUESTION ONE

Electromagnetic radiation can be grouped into types. Each type has a different range of wavelengths.

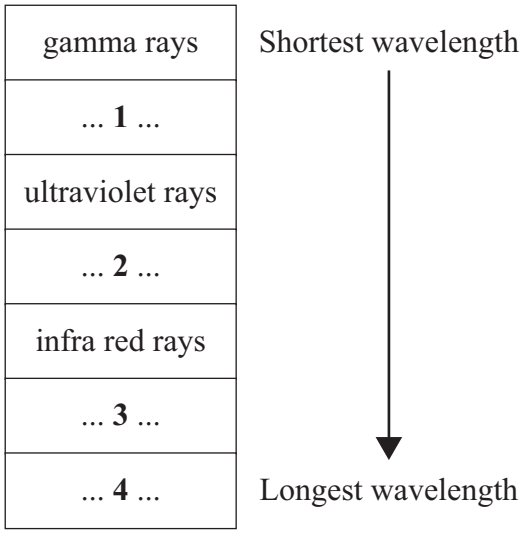
Match types of radiation, **A**, **B**, **C** and **D**, with the numbers **1–4** in the table.

A microwaves

B X-rays

C visible light

D radio waves



4.6.1.2 Properties of waves

Question 44

June 2009 | PHY1BP | Original Q6 | Legacy

QUESTION SIX

Mobile phones make use of microwaves.

Microwave ovens use microwaves of a similar wavelength. These microwaves are absorbed by the water molecules in food.

Human and animal body tissues contain a lot of water molecules. Some people are worried that using mobile phones for long periods of time could lead to some form of brain damage.

Scientists have investigated this worry by exposing laboratory mice to mobile phone radiation and monitoring the mice for signs of brain abnormality.

6A Electromagnetic waves travel at a speed of 300 000 km/s. Some microwaves have a wavelength of 10 cm.

What is the frequency of these microwaves?

wave speed (metre/second, m/s)	=	frequency (hertz, Hz)	×	wavelength (metre, m)

1 30 000 000 Hz

2 300 000 000 Hz

3 3 000 000 000 Hz

4 30 000 000 000 Hz

6B Electromagnetic waves that ionise may cause cancer. The higher the frequency of a wave, the more ionising the radiation.

Which type of radiation is most likely to cause cancer?

1 microwaves

2 infra red

3 ultraviolet

4 X-rays

4.6.1.2 Properties of waves

Question 44 · continued

6C The power output of a microwave oven is at least 500 W.

The power output of mobile phones is limited to 2 W.

What is the most likely reason why this power limit was introduced?

1 to reduce interference between phones

2 to reduce heating effects on the brain

3 to allow phones to use the GPS (Global Positioning System)

4 to allow phones to use a digital signal

6D The tests on mice showed no evidence of brain abnormalities in the mice.

From this, the public can conclude that . . .

1 the results are not accurate because the tests were not carried out on humans.

2 as there is no evidence of danger to mice, there is probably no danger to humans.

3 as there is no evidence of danger to mice, there is no danger to humans.

4 the tests were not sensitive enough to record any evidence.

4.6.1.2 Properties of waves

Question 45

June 2009 | PHY1BP | Original Q7 | Legacy

QUESTION SEVEN

Some types of electromagnetic radiation from space are absorbed by the Earth's atmosphere.

	Short wavelength radio	Short wavelength microwaves	Infra red	Visible light	Ultraviolet	X-rays	Gamma rays
Percentage absorbed by atmosphere	0	95	96	5	98	100	100

Different objects or events in the universe emit different types of electromagnetic radiation.

	Gamma ray bursts	Nebulae	Pulsars	Stars	Universe background radiation
Radiation emitted	gamma rays	infra red	radio	all types	short wavelength microwaves

The planets and moons of the solar system reflect light from the Sun.

7A Early civilisations observed the sky with the naked eye.

Which objects did they see?

1 moons, nebulae and pulsars

2 gamma ray bursts, moons and planets

3 nebulae and pulsars

4 moons, planets and stars

7B Telescopes that could detect electromagnetic waves of the lowest frequency were built in the 20th century. These telescopes are on the surface of the Earth.

From the information in the tables, which of the following, which could not have been observed before, could then be easily observed from the Earth's surface?

1 pulsars

2 gamma ray bursts

3 nebulae

4 stars

4.6.1.2 Properties of waves

Question 45 · continued June 2009 | PHY1BP | Original Q7 | Legacy

7C In 1989, the background radiation from the universe was mapped from a telescope in space.

Why was this **not** done with telescopes based on Earth?

1 Because only 2% of ultraviolet radiation penetrates Earth's atmosphere.

2 Because only 4% of infra red radiation penetrates Earth's atmosphere.

3 Because only 5% of short wavelength microwave radiation penetrates Earth's atmosphere.

4 Because only 95% of visible radiation penetrates Earth's atmosphere.

7D The first table suggests that, with the exception of . . .

1 radio, the percentage of radiation absorbed by the atmosphere, increases with increasing wavelength.

2 radio, the percentage of radiation absorbed by the atmosphere, decreases with increasing wavelength.

3 visible light, the percentage of radiation absorbed by the atmosphere, increases with increasing wavelength.

4 visible light, the percentage of radiation absorbed by the atmosphere, decreases with increasing wavelength.

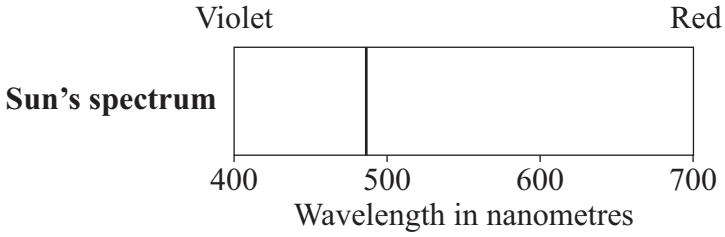
4.6.1.2 Properties of waves

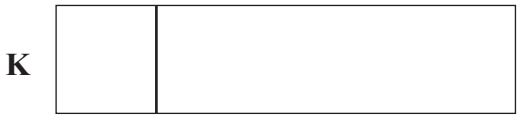
Question 46

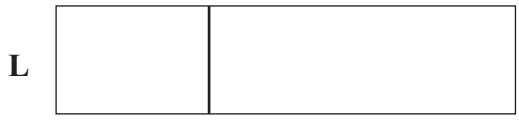
June 2009 | PHY1BP | Original Q8 | Legacy

QUESTION EIGHT

Dark lines on the spectra of light from galaxies represent chemical elements. The lines occur at specific wavelengths.











The line shown on the Sun's spectrum represents hydrogen. **K**, **L**, **M** and **N** are spectra of light from distant galaxies showing the same line.

8A Which galaxy is furthest from the Sun?

1 **K**

2 **L**

3 **M**

4 **N**

4.6.1.2 Properties of waves

Question 46 · continued

8B Which galaxy is moving towards the Sun?

1 **K**

2 **L**

3 **M**

4 **N**

8C Observation and analysis of red-shift suggests that . . .

1 the universe began from a very small initial point and has been expanding ever since.

2 the universe contracted initially and then began to expand.

3 the universe expanded initially and then began to contract.

4 the universe has always existed as it is now.

8D What causes red-shift?

1 a decrease in the frequency of light due to the galaxies moving closer to the Earth

2 a decrease in the frequency of light due to the galaxies moving away from the Earth

3 an increase in the frequency of light due to the galaxies moving closer to the Earth

4 an increase in the frequency of light due to the galaxies moving away from the Earth

4.6.1.2 Properties of waves

Question 47

June 2009 | PHY1H | Original Q1 | Legacy

1 (a) The table lists the names of seven telescopes. Each one of the telescopes is designed to detect a different one of the seven types of electromagnetic wave.
The table is incomplete.

Name of telescope	Type of wave detected
HESS	Gamma
XMM Newton	X-ray
FUSE	Ultraviolet
William Herschel	Visible light
Spitzer	
SPT	Microwave
Lovell	Radio

1 (a) (i) Which **one** of the telescopes is designed to detect the type of wave with the shortest wavelength?

.....

(1 mark)

1 (a) (ii) What type of wave is the Spitzer telescope designed to detect?

.....

(1 mark)

1 (b) The William Herschel telescope is on the Earth's surface. Another telescope, the Hubble telescope, which also detects visible light, orbits the Earth.

How is the image produced by the Hubble telescope better than the image produced by the William Herschel telescope?

.....

Give a reason for your answer.

.....

.....

(2 marks)

4.6.1.2 Properties of waves

Question 47 · continued

for mark

1 (c) Some types of electromagnetic wave are absorbed by water.
The SPT telescope is located in the Antarctic, which is a dry environment.

Explain why it is better to have this type of telescope in a dry environment rather than in a wet, humid environment.

.....

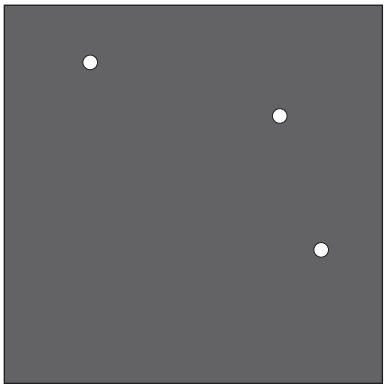
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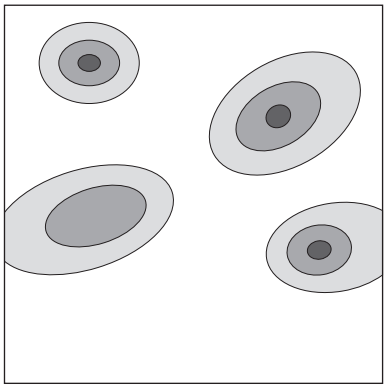
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(2 marks)

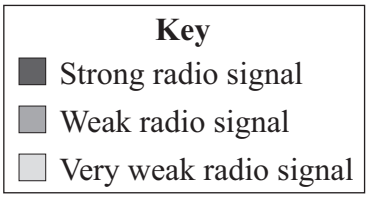
1 (d) The pictures represent the images produced using a visible light telescope and a radio telescope. Both images are of the same part of the sky. The shading on the radio telescope image represents the strength of the radio signals.



Visible light image



Radio telescope image



Suggest what extra information can be gained from the radio telescope image compared with the visible light image.

.....

.....

(1 mark)

7

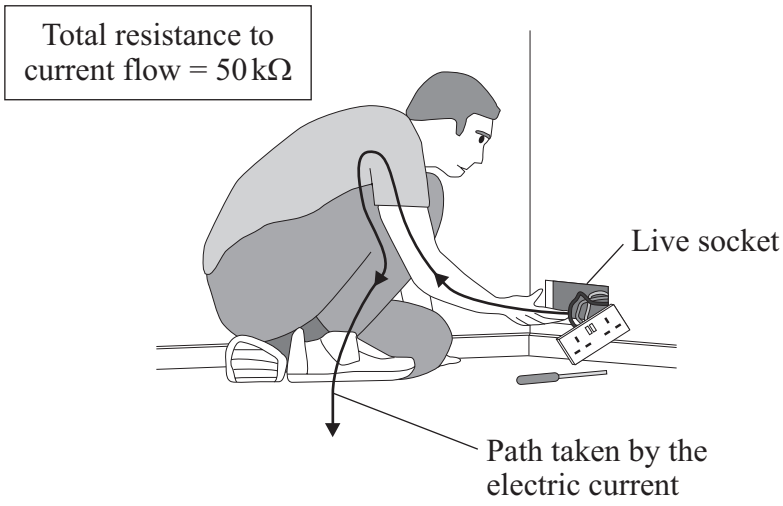
4.6.1.2 Properties of waves

Question 48

June 2009 | PHY2H | Original Q6 | Legacy

6 The diagram shows someone accidentally touching the live wire inside a dismantled 230 volt mains electricity socket.

A current flows through the person giving him an electric shock.



6 (a) (i) Use the equation in the box to calculate the current that will flow through the person.

potential difference = current × resistance

Show clearly how you work out your answer.

.....

.....

Current = ... A

(2 marks)

6 (a) (ii) Rubber is a good insulator.

Explain why it is a good idea for electricians to wear rubber soled boots when working.

.....

.....

.....

.....

(2 marks)

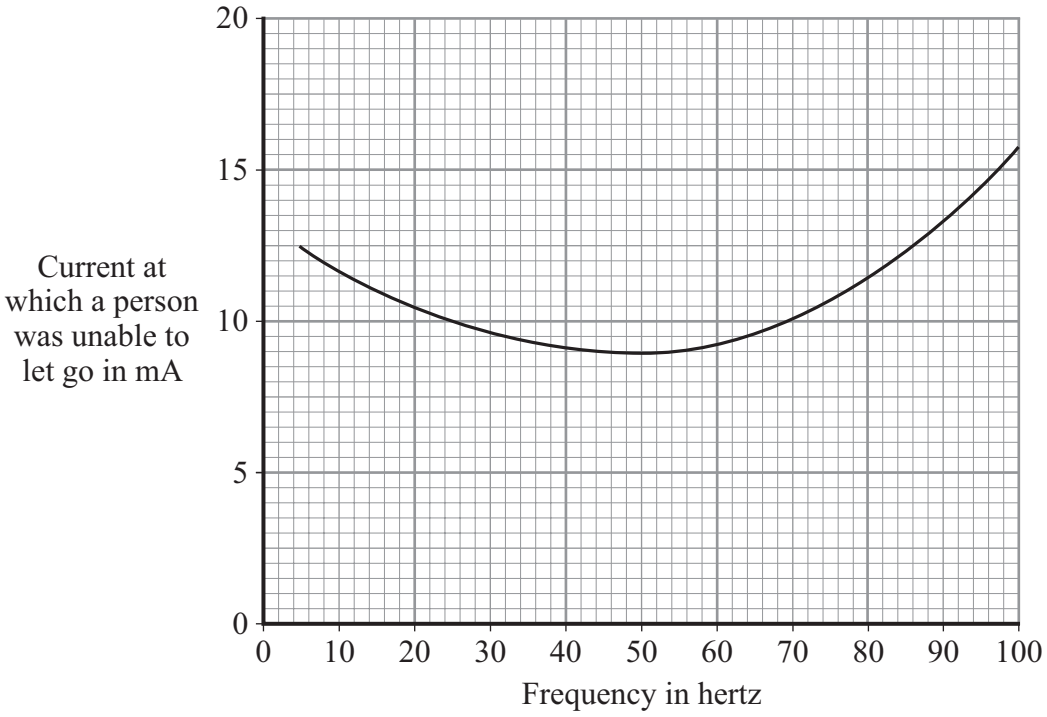
Question 48 · continued

for mark

6 (b) If the current flowing through a person is too high, the person cannot let go of the electrical source.

Different people were tested to see whether the ability to let go of an electrical source depended on the frequency of the current.

The results of the test are shown in the graph.



6 (b) (i) What is the frequency of the mains electricity supply in the UK?

.....

(1 mark)

6 (b) (ii) From a safety point of view, is the frequency of the UK mains electricity supply suitable?

Give a reason for your answer.

.....

.....

(1 mark)

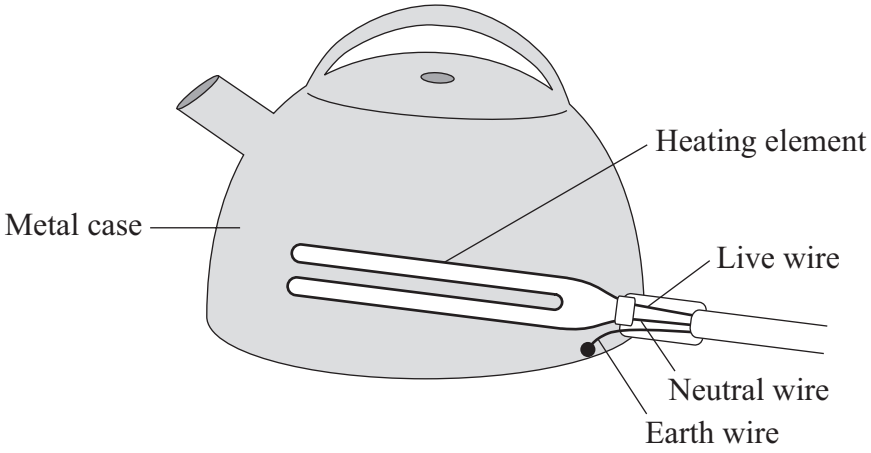
Question 6 continues on the next page

4.6.1.2 Properties of waves

Question 48 · continued

for mark

6 (c) The diagram shows how the electric supply cable is connected to an electric kettle. The earth wire is connected to the metal case of the kettle.



If a fault makes the metal case live, the earth wire and the fuse inside the plug protect anyone using the kettle from an electric shock.

Explain how.

.....

.....

.....

.....

(2 marks)

8

4.6.1.2 Properties of waves

Question 49

June 2009 | PHY3H | Original Q5 | Legacy

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

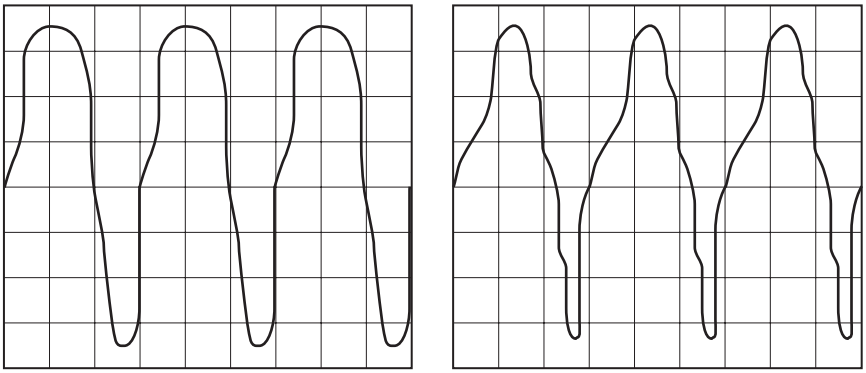


Diagram X **Diagram Y**

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

.....

.....

(1 mark)

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

.....

.....

(1 mark)

4.6.1.2 Properties of waves

Question 49 · continued

for mark

5 (b) This passage is from an electronics magazine.

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

5 (b) (i) Approximately what is the highest frequency that humans can hear?
State the number and the unit.

.....

(1 mark)

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

.....

.....

(1 mark)

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

.....

.....

.....

.....

(2 marks)

6

4.6.1.2 Properties of waves

Question 50

November 2009 | PHY1BP | Original Q5 | Legacy

QUESTION FIVE

The Sun emits different types of radiation. These types of radiation travel from the Sun until they reach the Earth's atmosphere. In the atmosphere, some types of radiation are reflected, some are absorbed and some are transmitted to the Earth's surface, where they cause the Earth to warm up.

Human activity has produced large amounts of carbon dioxide gas which has increased the amount of carbon dioxide in the atmosphere. The carbon dioxide helps to trap the Earth's heat and so contributes to the 'greenhouse' effect, which results in the Earth becoming hotter.

5A On their journey from the Sun to the Earth, all the types of radiation travel with the same . . .

1 energy.

2 frequency.

3 speed.

4 wavelength.

5B The ozone layer in the Earth's atmosphere absorbs some of the Sun's ultraviolet radiation.

Ultraviolet radiation can . . .

1 be detected by your eyes.

2 give your skin a suntan.

3 cool your skin.

4 pass through flesh but not bone.

5C Most of the Sun's infra red radiation is emitted with a wavelength of about 0.5 micrometres. Most of the Earth's infra red radiation is emitted with a wavelength of about 10 micrometres.

Carbon dioxide molecules in the atmosphere can absorb infra red radiation with wavelengths between 2 micrometres and 17 micrometres.

1 micrometre = 1 millionth of a metre

Therefore, the carbon dioxide will . . .

1 absorb the Sun's infra red radiation and absorb the Earth's infra red radiation.

2 absorb the Sun's infra red radiation and transmit the Earth's infra red radiation.

3 transmit the Sun's infra red radiation and absorb the Earth's infra red radiation.

4 transmit the Sun's infra red radiation and transmit the Earth's infra red radiation.

4.6.1.2 Properties of waves

Question 50 · continued

5D As an object gets hotter, its main infra red emission wavelength gets shorter.

If human activity continues to increase the amount of carbon dioxide gas in the atmosphere, then the Earth will emit . . .

1 more energy, with a shorter main emission wavelength.

2 more energy, with the same main emission wavelength.

3 the same energy, with a shorter main emission wavelength.

4 the same energy, with the same main emission wavelength.

Turn over for the next question

4.6.1.2 Properties of waves

Question 51

November 2009 | PHY1BP | Original Q6 | Legacy

QUESTION SIX

Astronomers have observed many distant galaxies and found that the radiation from the galaxies shows a red-shift.

6A What happens to the radiation in red-shift?

1 The observed wavelength decreases and the frequency increases.

2 The observed wavelength increases and the frequency decreases.

3 The observed wavelength increases and the frequency increases.

4 The observed wavelengths merge together to form red light.

6B The astronomers realised that these galaxies are moving away from us.

This led them to produce a theory in which . . .

1 the galaxies are contracting towards a small point.

2 the galaxies are moving towards each other.

3 the universe is contracting towards a small point.

4 the universe is expanding from an initial small point.

6C The data in the table below shows the red-shift of different galaxies. (They are all for the same spectral line.)

Name of galaxy	Red shift in nm
M60	18.8
M99	32.1
NGC 2366	1.3
NGC 2976	0.04

Which galaxy is furthest from Earth?

1 M60

2 M99

3 NGC 2366

4 NGC 2976

4.6.1.2 Properties of waves

Question 51 · continued

6D Astronomers have found that the light from the Sun shows an increase in frequency on one edge and a decrease in frequency on the opposite edge.

What does this suggest is happening to the Sun?

1 It is gradually expanding.

2 It is moving away from us.

3 It is moving towards us.

4 It is rotating.

Turn over for the next question

4.6.1.2 Properties of waves

Question 52

November 2009 | PHY1BP | Original Q7 | Legacy

QUESTION SEVEN

There are two types of radio wave that carry television signals, VHF and UHF.

7A Some UHF waves have a frequency that is ten times bigger than some VHF waves.

The wavelength of these UHF waves, in comparison to the VHF ones, is . . .

1 ten times as big because they travel faster.

2 one tenth as big because they travel faster.

3 ten times as big because they travel at the same speed.

4 one tenth as big because they travel at the same speed.

7B One television channel transmits using waves of frequency 1000 MHz.

wave speed (metre/second, m/s)	=	frequency (hertz, Hz)	×	wavelength (metre, m)

Speed of electromagnetic waves in a vacuum = 300 000 km/s

1 MHz = 1 million hertz

What is the wavelength of these waves?

1 0.3 m

2 3.0 m

3 0.3 km

4 3.0 km

4.6.1.2 Properties of waves

Question 52 · continued

7C All television transmitters in the UK are going to be switched from analogue to digital signals.

Which row in the table is correct?

	Analogue signals	Digital signals
1	continuously varying	more prone to interference and cannot be processed by a computer
2	less prone to interference and can be easily processed by a computer	discrete values only, generally on and off
3	continuously varying	less prone to interference and can be easily processed by a computer
4	discrete values only, generally on and off	continuously varying

7D An aerial receives television signals.

The energy transferred by an electromagnetic wave carrying the television signal . . .

1 makes the aerial hotter so that it can detect the signal.

2 makes the aerial colder so that it can detect the signal.

3 creates an alternating current in the aerial with the same frequency as the wave.

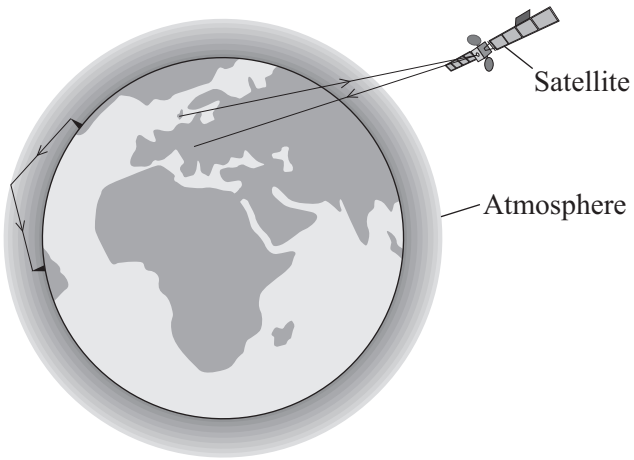
4 creates a direct current in the aerial with the same frequency as the wave.

4.6.1.2 Properties of waves

Question 53

January 2010 | PHY1H | Original Q3 | Legacy

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



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

.....

(1 mark)

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

.....

(1 mark)

3 (b) The diagram shows two types of signal that can be used to send information. One of the signals is an analogue signal. The other is a digital signal.



Describe the differences between an analogue signal and a digital signal.

.....

.....

.....

.....

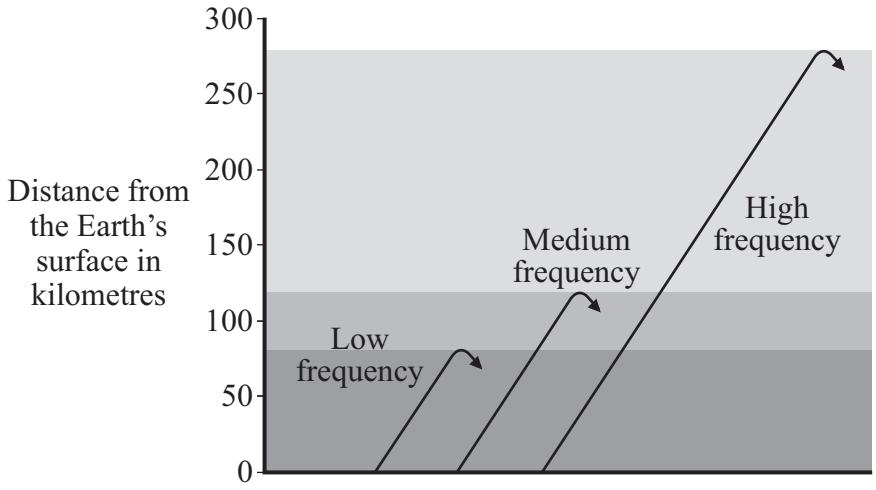
(2 marks)

4.6.1.2 Properties of waves

Question 53 · continued

for mark

3 (c) 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 mark)

3 (d) Electromagnetic waves travel at a speed of 300 000 000 m/s.

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

Use the equation in the box to calculate the frequency, in kilohertz (kHz), of these waves.

wave speed = frequency × wavelength

Show clearly how you work out your answer.

.....

.....

.....

Frequency = ... kHz

(2 marks)

7

4.6.1.2 Properties of waves

Question 54

March 2010 | PHY1BP | Original Q4 | Legacy

QUESTION FOUR

There are two types of communication signal: analogue and digital.

4A Which pair of diagrams correctly shows the patterns for digital and analogue signals?

	Digital signal pattern	Analogue signal pattern
1		
2		
3		
4		

4B One reason for using digital signals rather than analogue signals for communication is that . . .

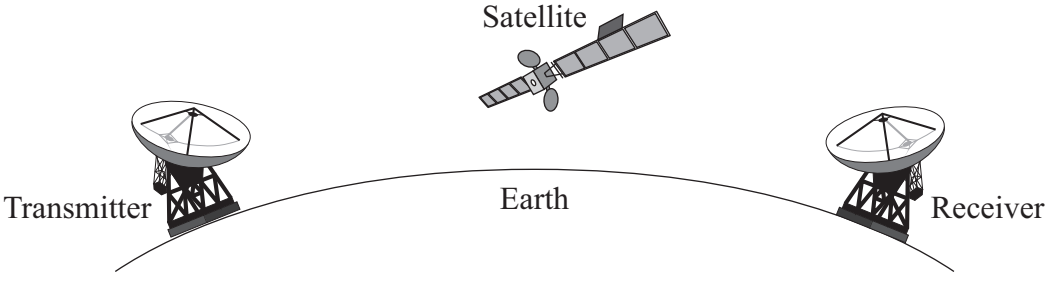
1 analogue signals are less prone to interference.

2 analogue signals can have only two values.

3 digital signals are continuously variable.

4 digital signals can be easily processed by computers.

4C Satellites in orbit around the Earth receive and transmit microwave signals for international telephone communication.



Microwaves are used because . . .

1 they are the only type of electromagnetic wave that can travel through a vacuum.

2 they are not absorbed by the Earth's atmosphere.

3 they follow the curvature of the Earth.

4 they travel faster than radio waves.

4.6.1.2 Properties of waves

Question 54 · continued March 2010 | PHY1BP | Original Q4 | Legacy

4D Properties of waves are often demonstrated in schools using waves on water.

wave speed (metre/second, m/s)	=	frequency (hertz, Hz)	×	wavelength (metre, m)

A wave generator with a frequency of 50 Hz produces water waves with a wavelength of 2 cm.

At what speed do the waves travel?

1 1 m/s

2 25 m/s

3 100 m/s

4 2500 m/s

Turn over for the next question

4.6.1.2 Properties of waves

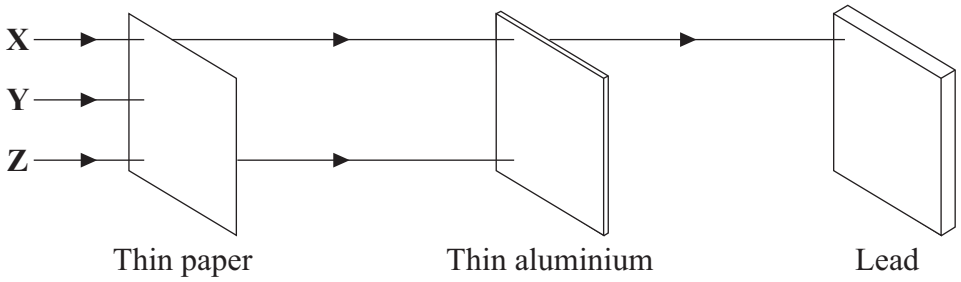
Question 55

March 2010 | PHY1BP | Original Q6 | Legacy

QUESTION SIX

This question is about radioactive substances and the radiation they emit.

The diagram shows how each type of radiation, **X**, **Y** and **Z**, is absorbed by different materials.



6A Which row in **Table 1** shows the correct radiation types?

Table 1

	X	Y	Z
1	beta	alpha	gamma
2	gamma	alpha	beta
3	beta	gamma	alpha
4	gamma	beta	alpha

6B When gamma radiation is absorbed, . . .

1 the absorber increases in mass.

2 the absorber shows a rise in temperature.

3 the radiation will become helium gas.

4 the radiation will transform into light.

4.6.1.2 Properties of waves

Question 55 · continued

6C Which row in **Table 2** correctly describes the three types of radiation?

Table 2

	Alpha	Beta	Gamma
1	an electron from outside the nucleus	a helium nucleus	a short wavelength electromagnetic wave
2	a short wavelength electromagnetic wave	an electron from outside the nucleus	a helium nucleus
3	a helium nucleus	an electron from inside the nucleus	a high frequency electromagnetic wave
4	a helium nucleus	a short wavelength electromagnetic wave	an electron from inside the nucleus

6D The radioactive gas thoron, which has a half-life of 50 seconds, is used in an experiment. At the end of the experiment, the count rate had fallen to $\frac{1}{32}$ of the count rate at the beginning.

The time taken to carry out the experiment was . . .

1 200 seconds.

2 250 seconds.

3 300 seconds.

4 1600 seconds.

4.6.1.2 Properties of waves

Question 56

March 2010 | PHY1BP | Original Q7 | Legacy

QUESTION SEVEN

Some of the world's best telescopes are placed on the tops of mountains. These telescopes detect infra red and visible light waves from distant stars and galaxies.

Some space telescopes detect X-rays from these galaxies. These telescopes are placed above the Earth's atmosphere.

7A The Hubble Space Telescope (HST) has been in orbit around the Earth since 1990. The HST is an optical telescope.

What is the advantage of placing the HST in orbit around the Earth?

1 Light, gathered by the HST, has not been distorted by the atmosphere.

2 Once the HST goes into orbit, it costs nothing to run.

3 The HST can observe the whole sky in one orbit.

4 The HST picks up clearer pictures because it is nearer to space.

7B A ground-based telescope could not detect X-rays from space because . . .

1 there are no X-rays in space.

2 the Earth's atmosphere absorbs X-rays.

3 X-rays are harmful to people.

4 X-rays are digital signals.

7C The longer the wavelength of the radiation being received, the larger the diameter of the receiving dish of the telescope needs to be.

The telescopes with the largest dishes are those detecting . . .

1 gamma rays.

2 radio waves.

3 visible light.

4 X-rays.

4.6.1.2 Properties of waves

Question 56 · continued

7D Images of distant galaxies produced by the Hubble telescope provide evidence to support the idea that the universe . . .

1 has a definite edge.

2 is contracting.

3 is expanding.

4 is neither expanding nor contracting.

Turn over for the next question

4.6.1.2 Properties of waves

Question 57

March 2010 | PHY1BP | Original Q8 | Legacy

QUESTION EIGHT

For many years, scientists have been investigating the universe and how it continues to change.

8A Why is the 'Big Bang' theory currently the most widely accepted theory of the origin of the universe?

1 It has been proved correct by using mathematical models.

2 It has not been revised or changed by scientists for many years.

3 It is based on a combination of scientific and religious facts.

4 It is the best explanation of the current scientific data.

8B Red-shift of light provides evidence about how the universe is changing.

When red-shift is detected, it means that . . .

1 galaxies are moving rapidly away from Earth.

2 galaxies furthest away from Earth are expanding.

3 some galaxies are approaching the Earth.

4 stars in the nearest galaxies are becoming red giants.

8C Red-shift involves a change in frequency and wavelength.

Which row in the table correctly describes these changes?

	Frequency	Wavelength
1	decreases	decreases
2	decreases	increases
3	increases	decreases
4	increases	increases

4.6.1.2 Properties of waves

Question 57 · continued

8D Which one of the following is a similar effect to red-shift?

1 Red light from a lamp being reflected by a mirror.

2 As a police car moves away from you, the sound from the siren seems lower in frequency than it really is.

3 As a train approaches a station, the sound of the train gets louder.

4 Light from the setting Sun becomes increasingly redder.

Turn over for the next question

4.6.1.2 Properties of waves

Question 58

March 2010 | PHY1BP | Original Q9 | Legacy

QUESTION NINE

This question is about electromagnetic radiation.

9A Electromagnetic radiations are . . .

1 disturbances in an electric field.

2 disturbances of the air between source and receiver.

3 waves caused by pressure changes in a vacuum.

4 waves of very high frequency.

9B When electromagnetic radiation reaches a substance, . . .

1 all wavelengths will be absorbed by the substance.

2 all wavelengths will be reflected by the substance.

3 all wavelengths will be transmitted through the substance.

4 some wavelengths may be absorbed, some reflected and some transmitted.

wave speed (metre/second, m/s)	=	frequency (hertz, Hz)	×	wavelength (metre, m)

All electromagnetic waves travel at 300 000 km/s.

9C Most schools have microwave generators that produce microwaves with a wavelength of 3 cm.

What is the frequency of these microwaves?

1 900 kHz

2 10 000 kHz

3 900 000 kHz

4 10 000 000 kHz

9D BBC Radio 4 transmits radio waves at a frequency of 200 kHz.

What is the wavelength of Radio 4?

1 1.5 m

2 600 m

3 1500 m

4 60 km

END OF TEST

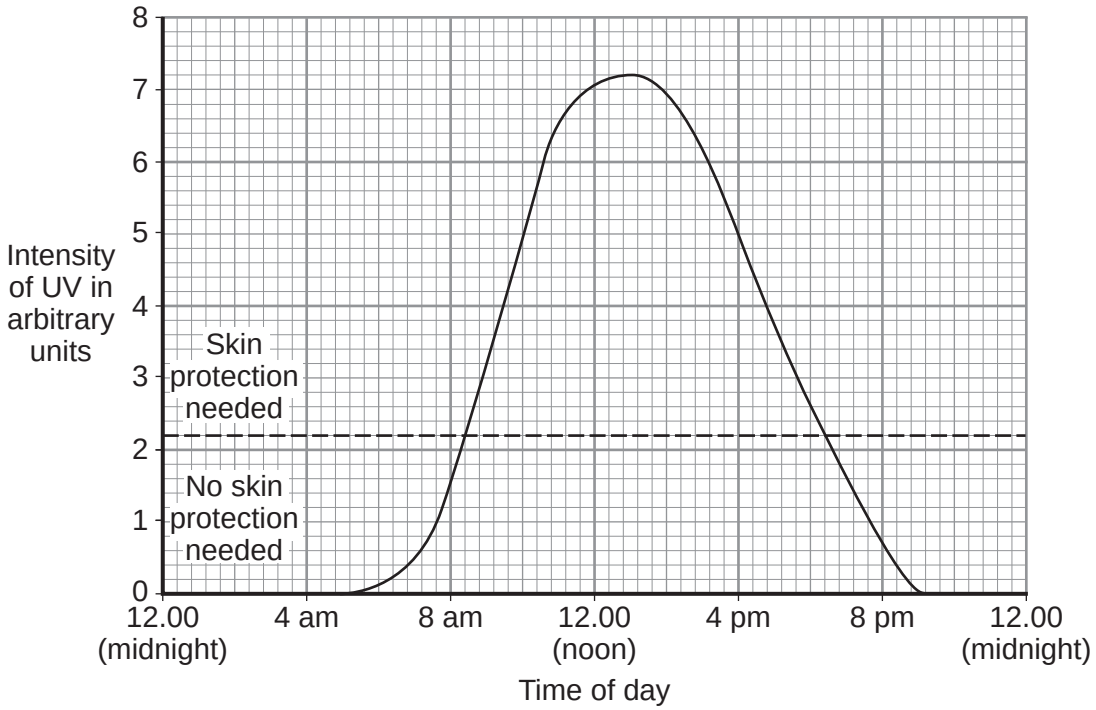
4.6.1.2 Properties of waves

Question 59

June 2010 | PHY1BP | Original Q3 | Legacy

QUESTION THREE

The graph shows how the intensity of ultraviolet (UV) radiation changes during a typical day in June in the UK.



3A The intensity of UV radiation reaches a maximum at . . .

1 9.30 am

2 12.00 noon

3 1.00 pm

4 5.00 pm

4.6.1.2 Properties of waves

Question 59 · continued

3B The dashed line (– – – –) on the graph shows the intensity above which you should protect your skin from UV radiation by using sunscreen cream.

For approximately how long is the intensity of UV radiation high enough to suggest that protection is needed?

1 0 hours

2 7 hours

3 10 hours

4 16 hours

3C For a typical day in December in the UK, how would you expect the graph to be different?

	Peak	Area under the graph
1	higher	the same
2	lower	the same
3	higher	bigger
4	lower	smaller

3D UV radiation travels as an electromagnetic wave.

Which row in the table below correctly shows the speed and frequency of UV compared with the speed and frequency of visible light?

	Speed of UV compared with visible light	Frequency of UV compared with visible light
1	slower	lower
2	same	higher
3	faster	higher
4	same	lower

4.6.1.2 Properties of waves

Question 60 June 2010 | PHY1BP | Original Q6 | Legacy

QUESTION SIX

Radio and television programmes are transmitted through the air over long distances.

The information is carried by electromagnetic waves.

6A Compared with light waves, radio waves . . .

1 have a shorter wavelength and a higher speed.

2 have a lower frequency and the same speed.

3 have a longer wavelength and a lower speed.

4 have a higher frequency and the same speed.

6B A radio programme is broadcast on a wavelength of 1500 metres. The speed of the wave is 300 000 000 m/s.

wave speed (metre/second, m/s)	=	frequency (hertz, Hz)	×	wavelength (metre, m)

The frequency of these waves is . . .

1 200 Hz

2 200 kHz

3 450 000 Hz

4 450 000 kHz

6C Over the next few years, all television signals will be changed from analogue to digital.

One advantage to television broadcasters of using digital signals instead of analogue signals is that . . .

1 they are easier to generate.

2 they are less prone to interference.

3 they can travel faster.

4 they can travel further.

4.6.1.2 Properties of waves

Question 60 · continued

6D Some people are worried about the effects of living close to a powerful radio transmitter.

Close to one transmitter, it was found that the number of children with leukaemia was slightly higher than normal. Leukaemia is a type of cancer of the blood.

What conclusion could you make from this observation?

1 Radio waves cause leukaemia.

2 There may be a connection between radio waves and leukaemia.

3 Adults are less likely than children to develop leukaemia.

4 Children should not be allowed to live near a radio transmitter.

Turn over for the next question

4.6.1.2 Properties of waves

Question 61

June 2010 | PHY1BP | Original Q9 | Legacy

QUESTION NINE

Thermal imaging cameras are used by rescue workers to search for people trapped under rubble after an earthquake. Like all warm objects, the living human body emits infra red radiation. The cameras detect this infra red radiation. Electronic circuits in the camera produce a colour image in which different colours correspond to different wavelengths of infra red radiation.

The table shows the image colour, infra red wavelength and the temperature of the object.

Image colour	Infra red wavelength in micrometres	Temperature of object in °C
Red	9.51	32
Red-orange	9.45	34
Orange	9.4	36
Orange-yellow	9.32	38
Yellow	9.26	40
Yellow-white	9.2	42

9A Two of the values of wavelength in the table show a lower . . .

1 calibration.

2 precision.

3 range.

4 reliability.

9B A scientist wanted to display this data as a line graph.

Which row in the table below shows the scales which would best display the data?

	x-axis (wavelength in micrometres)	y-axis (temperature in °C)
1	0 to 10	0 to 50
2	0 to 10	30 to 50
3	9 to 10	0 to 50
4	9 to 10	30 to 50

4.6.1.2 Properties of waves

Question 61 · continued

9C A thermal image of a small boy is mainly orange.

Under identical conditions, the thermal image of a much larger man would be . . .

1 mainly yellow because the man's body has a greater mass.

2 mainly red because the man's body has a larger surface area.

3 a mixture of red, orange and yellow because the man's body has a larger mass and a larger surface area.

4 mainly orange because the man and the boy have approximately the same body temperature.

9D At night, police officers use thermal imaging cameras to track criminals running away from crime scenes.

These cameras work better at night than during the day because at night . . .

1 the criminals emit more infra red radiation.

2 the cooler surroundings emit less infra red radiation.

3 the cooler surroundings emit less visible light.

4 the criminals wear black clothes.

END OF TEST

4.6.1.2 Properties of waves

Question 62

June 2010 | PHY1H | Original Q4 | Legacy

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

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

1 .....

.....

2 .....

.....

(2 marks)

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

..... and .....

(1 mark)

4 (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.

Use the equation in the box to calculate the frequency of the microwaves used to link the computer to the router.

wave speed = frequency × wavelength

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

.....

.....

.....

Frequency = ...

(3 marks)

4.6.1.2 Properties of waves

Question 62 · continued

4 (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 Wi-Fi. 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.

4 (c) (i) Suggest what the politician could have done to persuade people that what he said was not just an opinion.

.....

.....

(1 mark)

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

.....

.....

(1 mark)

8

4.6.1.2 Properties of waves

Question 63

June 2010 | PHY1H | Original Q6 | Legacy

6 (a) In 1929, the astronomer Edwin Hubble observed that the light from galaxies that are moving away from the Earth showed a *red-shift*.

What is *red-shift*?

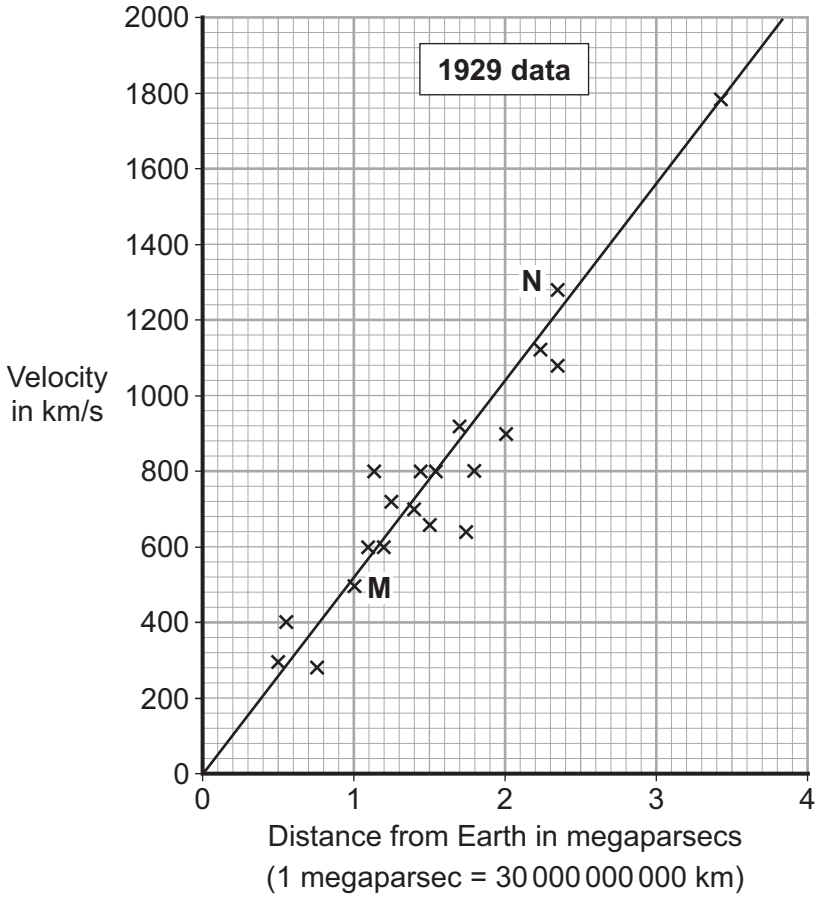
.....

.....

(1 mark)

6 (b) By measuring the red-shift, Hubble was able to calculate the speed at which the galaxies are moving away from the Earth. He was also able to calculate the distance of these galaxies from the Earth.

The graph shows some of the data calculated by Hubble.



4.6.1.2 Properties of waves

Question 63 · continued

6 (b) (i) The data from two galaxies, **M** and **N**, has been included in the graph. The light from galaxy **M** has a smaller red-shift than the light from galaxy **N**.

What does the difference in red-shift tell scientists about the two galaxies, **M** and **N**?

.....

.....

.....

(2 marks)

6 (b) (ii) The gradient of the line drawn on the graph gives a number known as the Hubble constant. The Hubble constant can be used to estimate when the universe began.

Use the graph to calculate the value of the Hubble constant.

Show clearly how you obtained your answer.

.....

.....

Hubble constant = ... km/s per megaparsec

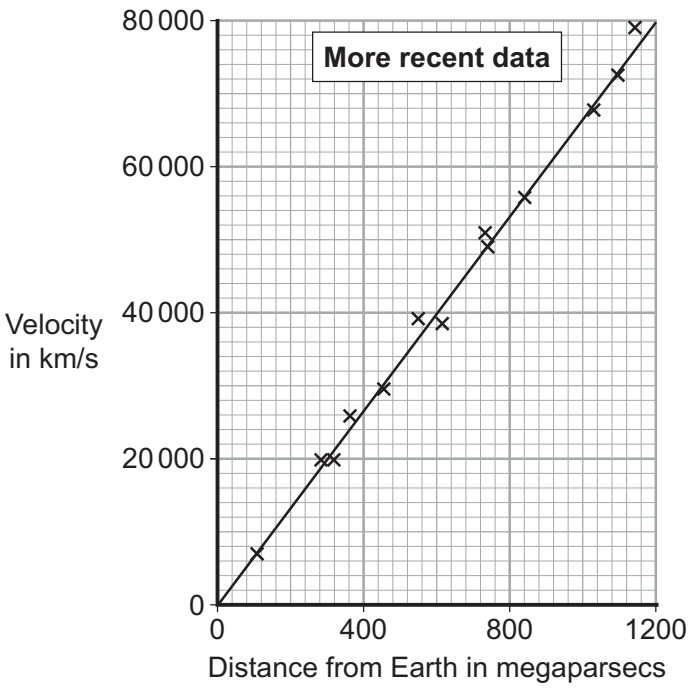
(2 marks)

Question 6 continues on the next page

4.6.1.2 Properties of waves

Question 63 · continued

6 (b) (iii) More recently, data has been obtained from more distant galaxies.



The results from the more recent data give a totally different value for the Hubble constant to the one calculated from the 1929 data.

Which set of data, the 1929 or the more recent, is most likely to give the value closest to the true value for the Hubble constant?

Draw a ring around your answer.

1929 **more recent**

Give a reason for your answer.

.....

.....

(1 mark)

4.6.1.2 Properties of waves

Question 63 · continued

6 (c) The Andromeda galaxy is not moving away from the Earth. It is actually moving towards the Earth. This means that the light from Andromeda shows a blue-shift.

How do the wavelength and frequency of the light from Andromeda seem to have changed when viewed from the Earth?

.....

.....

.....

.....

(2 marks)

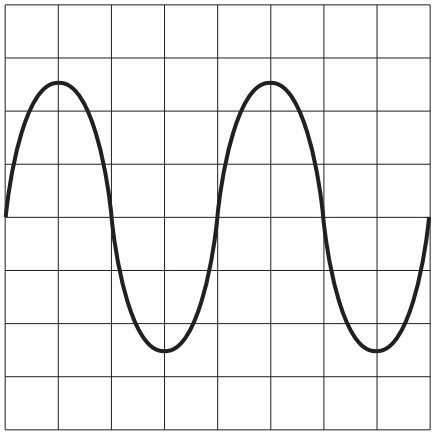
8

4.6.1.2 Properties of waves

Question 64

June 2010 | PHY2H | Original Q6 | Legacy

6 An oscilloscope is connected to an alternating current (a.c.) supply.
The diagram shows the trace produced on the oscilloscope screen.



Each horizontal division on the oscilloscope screen represents 0.002 s.

6 (a) Calculate the frequency of the alternating current supply.

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

.....

.....

.....

Frequency = ...

(3 marks)

6 (b) What is the frequency of the a.c. mains electricity supply in the UK?

.....

(1 mark)

4

4.6.1.2 Properties of waves

Question 65

June 2010 | PHY3H | Original Q2 | Legacy

2 (a) Read this passage from a health leaflet.

> Most children can hear the full range of sounds which can be detected by the human ear. But as people get older, they cannot hear the higher frequencies.

2 (a) (i) Complete this statement.

Most children can detect sounds in the frequency range

..... Hz to ..... Hz.

(1 mark)

2 (a) (ii) What word is used to describe sound with a frequency so high that it cannot be heard by humans?

.....

(1 mark)

2 (b) Read this cutting from a newspaper.

> A shopkeeper has fitted a special loudspeaker outside his store.
> "We used to have gangs of young people out there," he said, "but now, when I switch on the special loudspeaker, they hate the sound and go away."
> Older people are not bothered by the sound because the frequency is too high for them to hear it.

Some people support the use of the special loudspeaker but other people do not.

Give **one** reason against its use.

.....

.....

(1 mark)

2 (c) Machines are often very noisy. They transfer energy, and some of the energy is transformed into sound.

What is the cause of the sound?

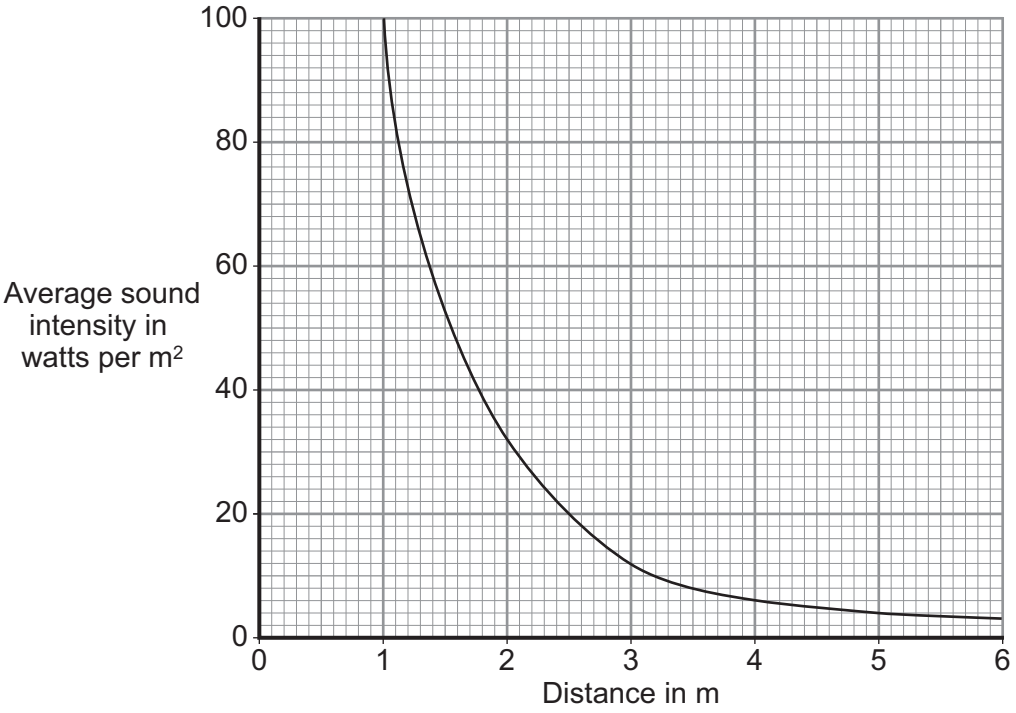
.....

(1 mark)

4.6.1.2 Properties of waves

Question 65 · continued

2 (d) Sound from a machine may damage the hearing of people who work close by. A safety officer measures the sound intensity at different distances from a noisy machine. The average results are shown on the graph.



2 (d) (i) Describe the pattern shown by the graph.

Use one or more examples from the graph to support your description.

.....

.....

.....

.....

(2 marks)

2 (d) (ii) Average results were plotted.

Explain why taking results several times and then calculating average values is more reliable than taking only a single result.

.....

.....

.....

.....

(2 marks)

8

4.6.1.2 Properties of waves

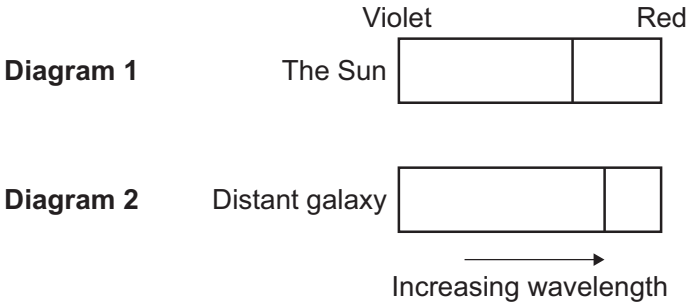
Question 66

November 2010 | PHY1BP | Original Q1 | Legacy

QUESTION ONE

Diagram 1 shows the spectrum of light from the Sun. There is a black line in the spectrum.

Diagram 2 shows the spectrum of light from a distant galaxy. This spectrum has the same black line.



Match words, **A**, **B**, **C** and **D**, with the numbers **1**–**4** in the sentences.

A decreased

B increased

C shifted

D not changed

Edwin Hubble compared the spectrum of light from this distant galaxy to the spectrum of light from the Sun.

Hubble found that the position of the black line had . . . **1** . . . .

This was because the wavelength of the observed light had . . . **2** . . . .

The frequency of the observed light had . . . **3** . . . .

The speed of the light had . . . **4** . . . .

4.6.1.2 Properties of waves

Question 67

November 2010 | PHY1BP | Original Q5 | Legacy

QUESTION FIVE

Fluorescers are substances that are used to make objects look brighter. Fluorescers absorb ultraviolet radiation and re-emit it as visible light. This makes the object glow when exposed to ultraviolet radiation.

- Laundry detergents contain fluorescers to make 'white look even whiter'.
- Dental compounds contain fluorescers to make teeth look brighter.
- Since 1950, fluorescers have been added to white paper to brighten it.

5A A white shirt has been washed in detergent containing a fluorescer.

The white shirt will . . .

1 be much cleaner.

2 glow in the dark.

3 look cleaner.

4 stay cleaner for longer.

5B A dentist paints someone's teeth with enamel containing a fluorescer.

The enamel absorbs ultraviolet radiation from sunlight and then emits light with . . .

1 a higher frequency and a longer wavelength.

2 a higher frequency and a shorter wavelength.

3 a lower frequency and a longer wavelength.

4 a lower frequency and a shorter wavelength.

5C A document is dated 1805. The document glows when it is viewed in ultraviolet light.

The document is likely to . . .

1 be a forgery.

2 have been printed before 1805.

3 have a dull surface.

4 have a shiny surface.

4.6.1.2 Properties of waves

Question 67 · continued

5D The ultraviolet radiation used to view the document has a wavelength of 0.000 000 1 metres.

wave speed (metre/second, m/s)	=	frequency (hertz, Hz)	×	wavelength (metre, m)

Speed of electromagnetic waves = 300 000 000 m/s

What is the frequency of ultraviolet radiation of wavelength 0.000 000 1 metres?

1 30 Hz

2 3 000 000 Hz

3 3 000 000 000 Hz

4 3 000 000 000 000 000 Hz

Turn over for the next question

4.6.1.2 Properties of waves

Question 68

November 2010 | PHY1BP | Original Q6 | Legacy

QUESTION SIX

Waves from different parts of the electromagnetic spectrum are used for communications.

6A Optical fibres can bend light around corners.

This is because the light . . .

1 is absorbed in the optical fibre.

2 is transmitted through the walls of the optical fibre.

3 is reflected inside the optical fibre.

4 travels faster in the optical fibre.

6B A metal aerial absorbs the energy carried by radio waves. This creates an alternating current (a.c.) in the metal and may produce a temperature change.

Which row in the table is correct?

	Frequency of a.c. produced	Temperature of metal
1	higher than the frequency of the radio waves	increases
2	the same as the frequency of the radio waves	increases
3	lower than the frequency of the radio waves	decreases
4	the same as the frequency of the radio waves	decreases

6C Television and telephone signals sent via satellites use microwaves rather than long wavelength radio waves.

This is because microwaves . . .

1 can pass easily through the Earth's atmosphere.

2 can travel through a vacuum.

3 have longer wavelengths than radio waves.

4 travel faster than radio waves.

4.6.1.2 Properties of waves

Question 68 · continued

6D Digital signals are replacing analogue signals in television and telephone transmissions.

Which one of the following statements is correct?

1 Digital signals have discrete values only and are more prone to interference than analogue signals.

2 Digital signals have discrete values only and are less prone to interference than analogue signals.

3 Digital signals vary continuously and are more prone to interference than analogue signals.

4 Digital signals vary continuously and are less prone to interference than analogue signals.

Turn over for the next question

4.6.1.2 Properties of waves

Question 69

November 2010 | PHY1BP | Original Q9 | Legacy

QUESTION NINE

Four hundred years ago, Galileo pointed his small, primitive telescope at the night sky.

His telescope had lenses to focus light from the stars.

Today, much larger optical telescopes use large curved mirrors to focus light. The largest single-piece mirror has a diameter of 8.4 m. If the diameter was made any larger, the mirror would deform under its own weight. Very large telescopes use smaller mirrors linked together.

The table gives the effective diameters of the mirrors in several large optical telescopes.

Telescope	Keck	Giant Magellan Telescope (GMT)	Thirty Metre Telescope(TMT)	Very Large Telescope (VLT)
Effective diameter of mirror in metres	10.0	27.0	30.0	32.8

9A The TMT has nine times the light-collecting power of the Keck telescope mirror.

This is because the light-collecting power of a telescope is . . .

1 directly proportional to the diameter of the mirror.

2 inversely proportional to the diameter of the mirror.

3 directly proportional to the square of the diameter of the mirror.

4 inversely proportional to the square of the diameter of the mirror.

9B The VLT is located in a desert high in the mountains of South America.

The VLT produces sharp images because . . .

1 the VLT is nearer to the stars than optical telescopes at sea level.

2 light rays are more easily reflected higher in the atmosphere.

3 the night sky in the desert is clear and dark.

4 at the top of a mountain the telescope weighs less.

4.6.1.2 Properties of waves

Question 69 · continued

9C Some telescopes are put into orbit round the Earth.

This is so that the telescopes . . .

1 can detect only visible light.

2 can detect only the electromagnetic waves that the Earth's atmosphere absorbs.

3 can detect visible light and sound waves.

4 can detect electromagnetic waves that do not reach the Earth's surface.

9D The smaller the diameter of a telescope, the higher the frequency of the waves that it can detect.

Pulsars are objects in space that emit radio waves. Pulsars were discovered using radio telescopes based on Earth.

The telescope that first detected the radiation from a pulsar had a diameter . . .

1 about the same size as the diameter of an optical telescope because the frequencies it detects are about the same.

2 smaller than the diameter of an optical telescope because the frequencies it detects are lower.

3 larger than the diameter of an optical telescope because the frequencies it detects are higher.

4 larger than the diameter of an optical telescope because the frequencies it detects are lower.

END OF TEST

4.6.1.2 Properties of waves

Question 70

January 2011 | PHY1H | Original Q1 | Legacy

1 Small sailing boats can be fitted with a passive radar device. The device increases the chance that the small boat will be seen on the radar screen of a large ship.
The radar transmitter on the large ship emits microwaves.

1 (a) Microwaves and radio waves are both part of the electromagnetic spectrum.

How are microwaves different from radio waves?

.....

.....

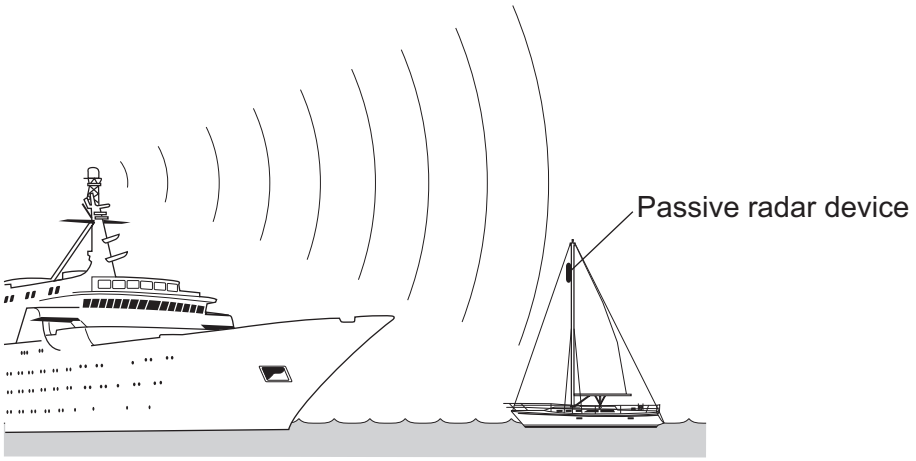
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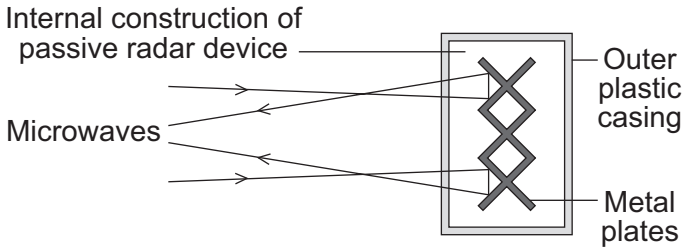
1 (b) How fast do microwaves travel through the air or a vacuum compared to radio waves?

.....

(1 mark)

1 (c) The diagrams show the position of a passive radar device on a small boat and the internal construction of one type of passive radar device.





4.6.1.2 Properties of waves

Question 70 · continued

Microwaves can be absorbed, reflected or transmitted by different materials and types of surface.

Explain what happens to the microwaves from the ship's transmitter when they reach the passive radar device.

.....

.....

.....

.....

(2 marks)

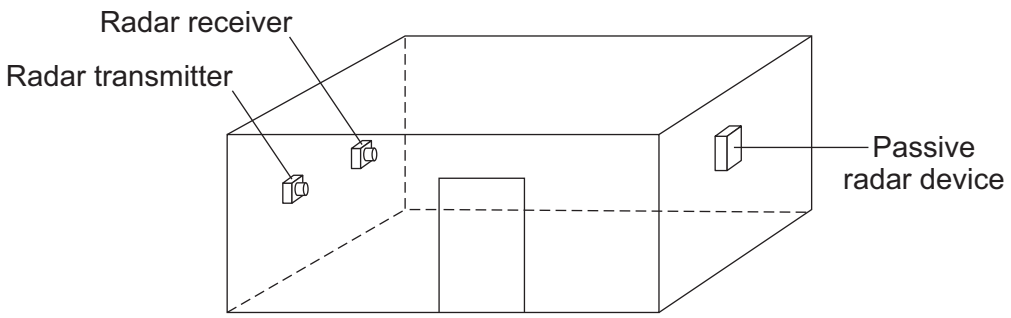
Question 1 continues on the next page

4.6.1.2 Properties of waves

Question 70 · continued

1 (d) Each type of passive radar device has an RCS value. The larger the RCS value, the easier it is for a small boat fitted with the device to be detected.

An independent group of scientists measured the RCS values of 4 different types of device. The RCS value for each device was measured in the same room using the same equipment.



1 (d) (i) Why are the walls of the room covered in a material that absorbs the waves emitted by the radar transmitter?

.....

.....

(1 mark)

1 (d) (ii) Why is it important to use the same room and the same equipment?

.....

.....

(1 mark)

1 (d) (iii) Why is it important that the measurements are made by an independent group of scientists?

.....

.....

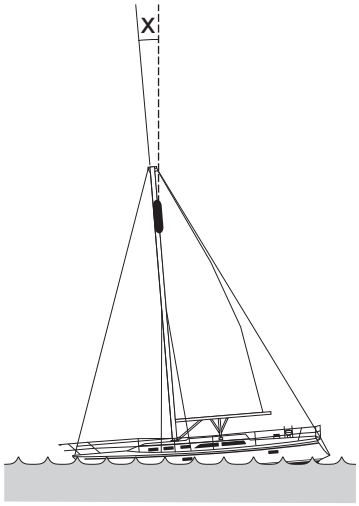
(1 mark)

4.6.1.2 Properties of waves

Question 70 · continued

1 (e) The movement of a small boat causes the mast and device to lean over, therefore the RCS values were measured at different angles.

The table gives the RCS values obtained by the scientists.



Device	Angle X			
	0°	5°	10°	15°
A	1.4	1.6	1.7	1.8
B	4.7	2.6	2.3	1.9
C	9.3	3.3	1.9	1.1
D	4.5	4.8	5.0	4.6

1 (e) (i) Describe how the RCS values for **device A** are different to the RCS values for **device B**.

.....

.....

.....

.....

(2 marks)

1 (e) (ii) The scientists recommended that a passive radar device fitted to a small boat should have:

- the largest possible RCS value
- an RCS value consistently above 2.0

Which **one** of the devices, **A**, **B**, **C** or **D**, would you recommend that someone fits to their boat?

.....

Give a reason for your answer.

.....

.....

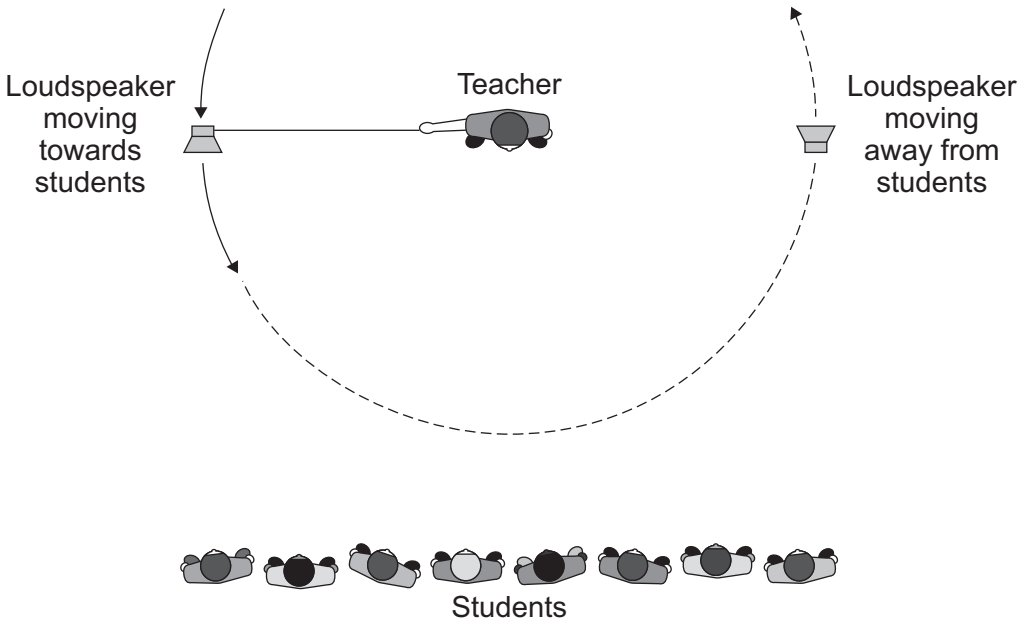
(1 mark)

10

4.6.1.2 Properties of waves

Question 71

2 The diagram shows a teacher using a loudspeaker to demonstrate an important effect. The loudspeaker, which produces a note of constant frequency, is swung around in a circle.



2 (a) As the loudspeaker moves towards the students, the frequency of the note heard by the students increases.

What happens to the note heard by the students as the loudspeaker moves away from them?

.....

.....

(1 mark)

4.6.1.2 Properties of waves

Question 71 · continued

2 (b) The teacher is using the demonstration to model the red-shift in light that is observed from most distant galaxies.

2 (b) (i) Which **one** of the following statements gives the main reason why models are used in science?

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

Models can help to explain an effect or theory. ☐

Models can prove that a theory is correct. ☐

Models can help to generate new ideas. ☐

(1 mark)

2 (b) (ii) Explain how this demonstration can be used as a model for red-shift.

.....

.....

.....

.....

(2 marks)

2 (c) Red-shift provides evidence to support the theory that the Universe began from a very small initial point.

What name is given to this theory?

.....

(1 mark)

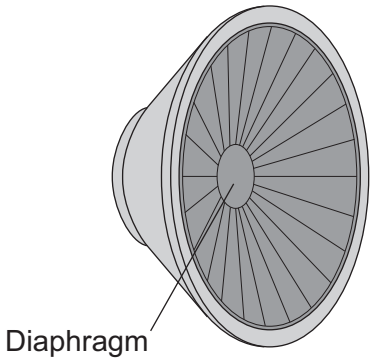
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4.6.1.2 Properties of waves

Question 72

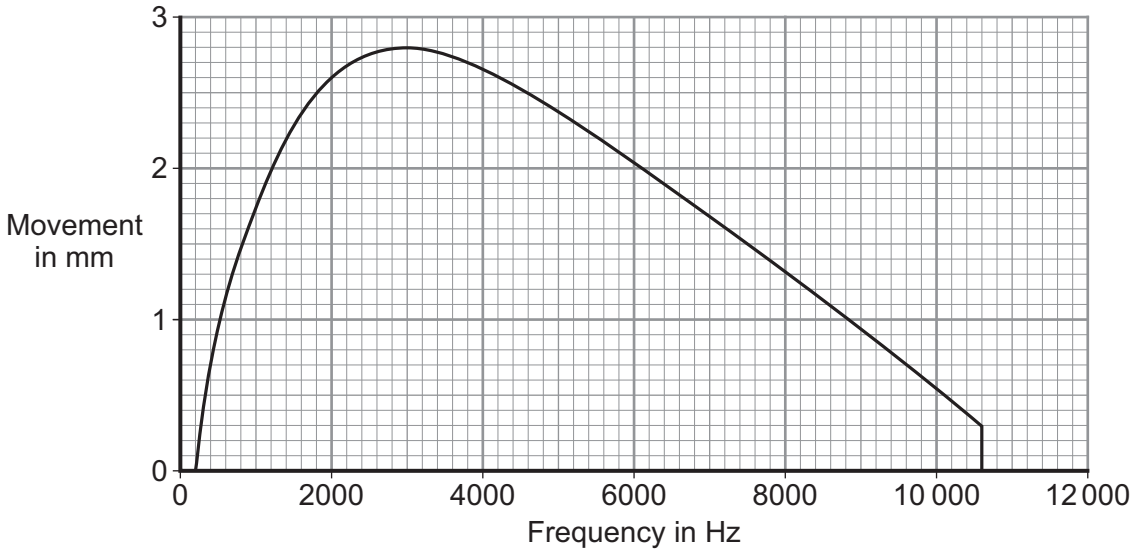
January 2011 | PHY3H | Original Q2 | Legacy

2 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.



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

Frequency = ... Hz

(1 mark)

4.6.1.2 Properties of waves

Question 72 · continued

2 (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 marks)

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 marks)

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 mark)

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

.....

.....

(1 mark)

7

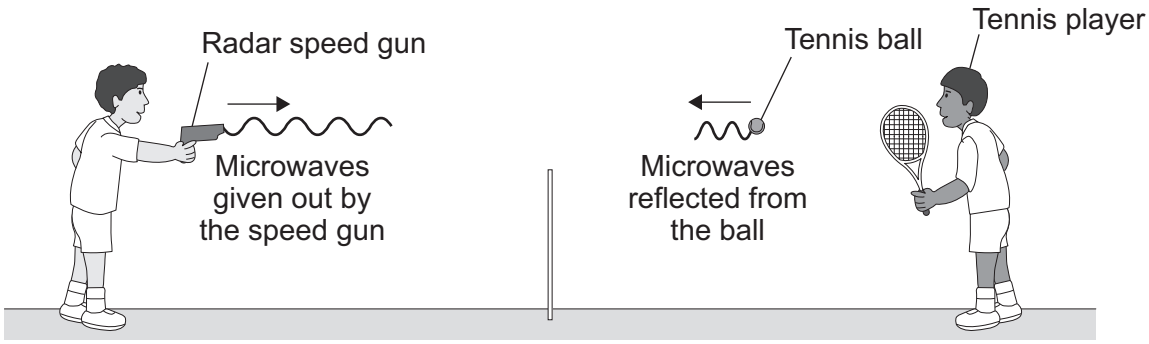
4.6.1.2 Properties of waves

Question 73

March 2011 | PHY1BP | Original Q3 | Legacy

QUESTION THREE

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



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

3A What effect will the absorbed microwaves have on the ball?

1 The temperature of the ball will increase slightly.

2 The ball will go faster.

3 The temperature of the ball will decrease slightly.

4 The ball will go slower.

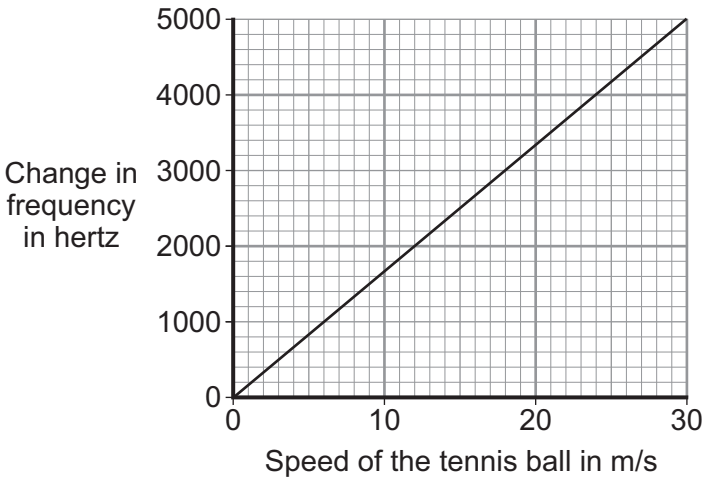
3B Which row in the table describes how the frequency and wavelength of the reflected microwaves are different from the microwaves given out by the speed gun?

	Frequency of reflected waves	Wavelength of reflected waves
1	higher	longer
2	lower	shorter
3	higher	shorter
4	lower	longer

4.6.1.2 Properties of waves

Question 73 · continued

The graph shows how the change in frequency of the microwaves depends on the speed of the ball.



3C The data has been drawn as a line graph because . . .

1 frequency and speed are both categoric variables.

2 frequency and speed are both continuous variables.

3 frequency is a categoric variable and speed is a continuous variable.

4 frequency is a continuous variable and speed is a categoric variable.

3D The speed gun measures the change in frequency as 3000 Hz.

What is the speed of the ball?

1 18 m/s

2 20 m/s

3 21 m/s

4 22 m/s

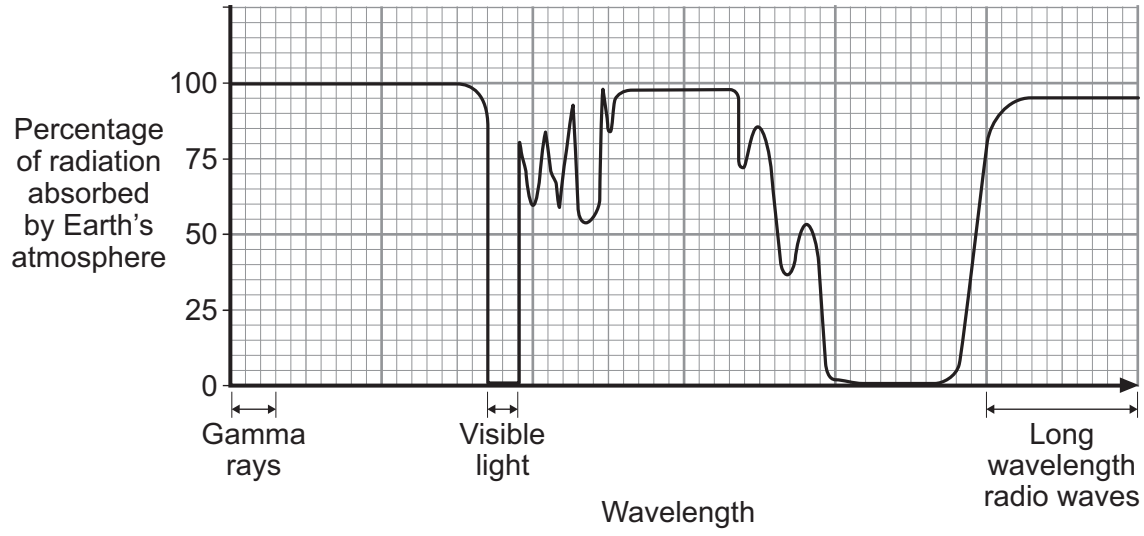
4.6.1.2 Properties of waves

Question 74

March 2011 | PHY1BP | Original Q4 | Legacy

QUESTION FOUR

The diagram shows the absorption of electromagnetic radiation by the Earth's atmosphere.



4A The diagram shows that . . .

1 all wavelengths of gamma radiation reach the Earth's surface.

2 all wavelengths of radio waves reach the Earth's surface.

3 all wavelengths of ultraviolet radiation reach the Earth's surface.

4 all wavelengths of visible light reach the Earth's surface.

4B Some objects in space emit X-rays.

Where would you put a telescope to detect these X-rays?

1 above the Earth's atmosphere

2 at the top of a hill

3 at ground level in a hot desert

4 at ground level in the Antarctic

4.6.1.2 Properties of waves

Question 74 · continued

The table gives information about some space telescopes.

Name	Hubble	Compton	Chandra	Spitzer
Launched in	1990	1991	1999	2003
Detects	infra red rays ultraviolet rays visible light	gamma rays	X-rays	infra red rays

4C Which statement about these space telescopes can be deduced from the information in the table?

1 They all collect data using mirrors.

2 They all detect electromagnetic radiation.

3 They are all in space at present.

4 They were all used to study the Earth.

4D From the information in the table, which one of the following emissions could be detected by one of these space telescopes?

1 alpha particles

2 nuclear radiation

3 radio waves

4 sound waves

4.6.1.2 Properties of waves

Question 75

March 2011 | PHY1BP | Original Q7 | Legacy

QUESTION SEVEN

In 2009, the European Space Agency launched two space telescopes: the Herschel and the Planck.

Also in 2009, the US space shuttle Atlantis was launched. Atlantis carried seven astronauts to service the Hubble space telescope.

The table gives information about the three space telescopes.

	Hubble	Herschel	Planck
Distance from Earth	560 km	1.5 million km	1.5 million km
Radiation detected	Visible light, ultraviolet	Infra red	Microwaves
Cost of 2009 launch	£1 billion (for servicing)	Total for the 2 telescopes - £1.7 billion	
Objects observed	Distant stars and galaxies	Early development of galaxies	Radiation left over from the 'Big Bang'

7A The Hubble and Herschel telescopes both contain mirrors. The diameter of the mirror in the Herschel telescope is 50 % larger than the diameter of the main mirror in the Hubble telescope.

This means that the . . .

1 Herschel mirror is capable of collecting more energy each second than the Hubble mirror.

2 cost of the Herschel telescope is higher than the cost of the Hubble servicing mission.

3 Herschel telescope is much lighter than the Hubble telescope.

4 orbit of the Herschel telescope is much larger than the orbit of the Hubble telescope.

7B The larger the diameter of a telescope mirror, the longer the wavelength of radiation it can detect.

The order of increasing diameters for the space telescopes in the table is . . .

1 Herschel; Hubble; Planck.

2 Hubble; Herschel; Planck.

3 Planck; Herschel; Hubble.

4 Planck; Hubble; Herschel.

4.6.1.2 Properties of waves

Question 75 · continued

7C The table refers to radiation left over from the ‘Big Bang’.

What is the ‘Big Bang’?

1 a theory that the light from distant galaxies shows a red-shift

2 an observation that the universe is expanding

3 a theory that the universe began from a very small initial point

4 evidence that distant galaxies are moving away from the Earth

7D A survey showed that a lot of people living in the UK think that the money spent on the launches in 2009 would have been better spent on feeding starving people in the developing world.

The people in the survey are concerned about . . .

1 political and scientific issues.

2 political and environmental issues.

3 economic and environmental issues.

4 economic and ethical issues.

4.6.1.2 Properties of waves

Question 76

June 2011 | PHY1BP | Original Q1 | Legacy

QUESTION ONE

A source of sound waves is moving away from an observer.

Match words, **A**, **B**, **C** and **D**, with the numbers **1**–**4** in the sentences.

A frequency

B red-shift

C wavelength

D wave speed

Compared with the sound that the source emits, the observer hears a sound with a bigger . . . **1** . . . and a smaller . . . **2** . . . .

There is no change in the . . . **3** . . . .

A similar effect is seen with the light from a distant galaxy. This is called . . . **4** . . . .

4.6.1.2 Properties of waves

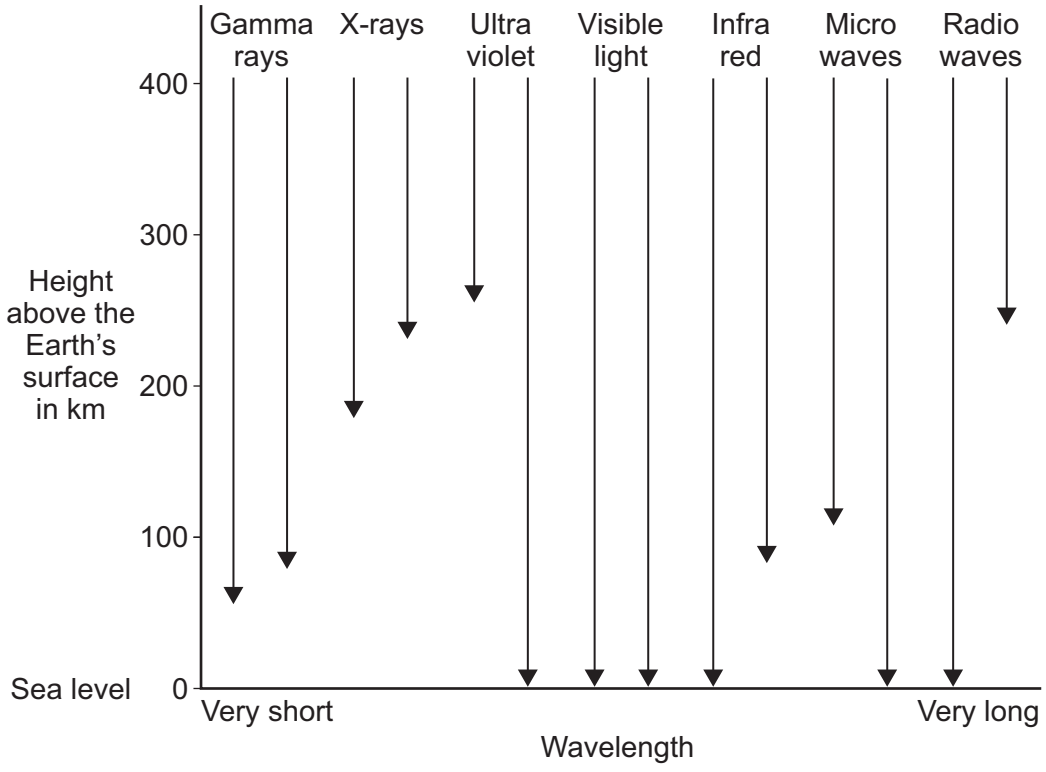
Question 77

June 2011 | PHY1BP | Original Q4 | Legacy

QUESTION FOUR

Telescopes can be based on the Earth's surface or put into orbit in space.

The diagram shows how far electromagnetic waves penetrate the Earth's atmosphere. For some types of electromagnetic radiation, longer and shorter waves penetrate the atmosphere to different depths.



4A Telescopes on Earth detect **all** wavelengths of . . .

1 radio waves only.

2 visible light only.

3 radio waves and visible light.

4 visible light and X-rays.

4B Which of the following statements about the use of telescopes in space is true?

1 The atmosphere distorts the image produced by the telescope.

2 The telescopes are affected by light pollution from the Earth.

3 The telescopes can detect electromagnetic waves that cannot reach the Earth's surface.

4 The telescopes are easy to repair and maintain.

4.6.1.2 Properties of waves

Question 77 · continued

The table gives information about some space telescopes. Each telescope detects a different type of electromagnetic radiation.

Telescope	Wavelength detected in nanometres
INTEGRAL	less than 0.01
Chandra	0.01 – 20
FUSE	20 – 400
Hubble	400 – 700
Spitzer	1000 – 1 000 000

4C The Hubble telescope detects visible light.

Which telescope detects infra red radiation?

1 Chandra

2 FUSE

3 INTEGRAL

4 Spitzer

4D Which telescope detects X-rays?

1 Chandra

2 FUSE

3 INTEGRAL

4 Spitzer

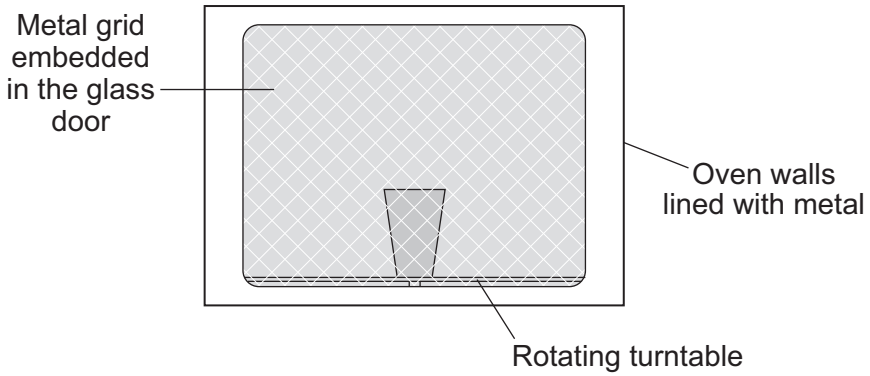
4.6.1.2 Properties of waves

Question 78

June 2011 | PHY1BP | Original Q5 | Legacy

QUESTION FIVE

The diagram shows a microwave oven.



The microwaves have a frequency of 2500 MHz.

1 MHz = 1 000 000 Hz

5A The wave speed of the microwaves is 300 000 000 m/s.

What is the wavelength of the microwaves?

wave speed (metre/second, m/s)	=	frequency (hertz, Hz)	×	wavelength (metre, m)

1 0.12 m

2 1.2 m

3 7.5 m

4 8.3 m

5B Which one of the following statements about electromagnetic radiations best explains why food can be heated by microwaves?

1 All electromagnetic radiations are disturbances in an electric field.

2 All electromagnetic radiations travel through a vacuum at the same speed.

3 All electromagnetic radiations travel as waves.

4 All electromagnetic radiations move energy from one place to another.

4.6.1.2 Properties of waves

Question 78 · continued

5C The inside walls of the microwave oven are lined with metal. The door has a metal grid embedded in the glass.

The reason for using metal is that . . .

1 microwaves create an alternating current in the metal.

2 microwaves reflect off metal surfaces.

3 microwaves are absorbed by metals.

4 microwaves are transmitted by metals.

5D Microwaves are dangerous to living creatures. Microwaves can also affect radio and television reception.

Which feature of the oven shown in the diagram makes sure that microwaves do not escape through the door?

1 the rotating turntable

2 the metal lining

3 the embedded metal grid

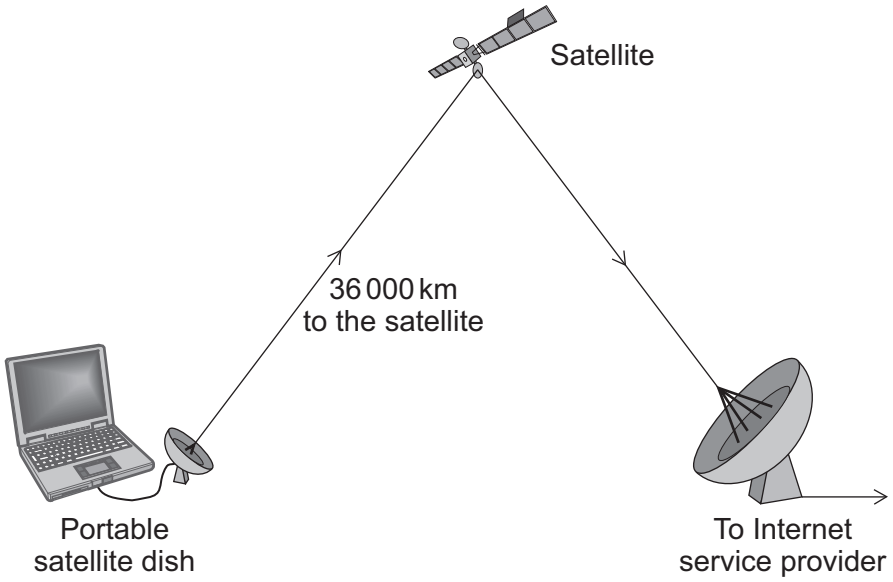
4 the glass

4.6.1.2 Properties of waves

Question 79

June 2011 | PHY1H | Original Q3 | Legacy

3 (a) The diagram shows a computer connected to the Internet using a satellite link.



3 (a) (i) Name the type of electromagnetic wave used to send information to and from the satellite.

.....

(1 mark)

3 (a) (ii) The information is sent to and from the satellite using a *digital signal*.

Describe a *digital signal*.

You may draw a diagram to help you answer.

.....

.....

(1 mark)

4.6.1.2 Properties of waves

Question 79 · continued

3 (a) (iii) Give **one** advantage of sending information as a digital signal rather than as an analogue signal.

.....

.....

(1 mark)

3 (b) Electromagnetic waves travel at a speed of 300 000 000 m/s.
The waves travelling to and from the satellite have a wavelength of 15 cm.

Use the equation in the box to calculate the frequency of these waves.

wave speed = frequency × wavelength

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

.....

.....

Frequency = ...

(3 marks)

3 (c) In 2009, parts of the African country Kenya, were linked to the Internet by a super-fast optical fibre. Before that, all Internet connections had to be made via a satellite link.

3 (c) (i) Complete the following sentence.

Signals can be sent along an optical fibre using either visible light or

..... .

(1 mark)

3 (c) (ii) Suggest a reason why signals sent through the optical fibre arrive faster than signals sent via a satellite link.

.....

.....

(1 mark)

8

4.6.1.2 Properties of waves

Question 80

June 2011 | PHY1H | Original Q5 | Legacy

5 LOFAR is a new type of telescope designed to observe the lowest frequency radio waves. It consists of thousands of simple radio antennae linked to a super-computer. This combines all the signals to give a single output.

5 (a) (i) Give **one** reason, apart from its physical size, why a telescope such as LOFAR is positioned on the Earth and not on a satellite in space.

.....

.....

(1 mark)

5 (a) (ii) Why are the analogue signals from the antennae converted into digital signals before being sent to the computer?

.....

.....

(1 mark)

5 (b) One of the main purposes of the LOFAR telescope is to study the period of time a few hundred thousand years after the big bang. This is done by measuring the *red-shift* of the waves emitted by hydrogen atoms in very distant galaxies.

5 (b) (i) What is *red-shift*?

.....

.....

(1 mark)

5 (b) (ii) The LOFAR telescope has a sensitivity 20 times greater than other radio telescopes.

What does this statement mean?

.....

.....

(1 mark)

4.6.1.2 Properties of waves

Question 80 · continued

5 (b) (iii) The Ancient Greeks believed that the Universe went on forever; it never changed and had no beginning. It had always existed.

How are the ideas put forward by the big bang theory different from the beliefs of the Ancient Greeks?

.....

.....

.....

.....

(2 marks)

5 (c) Some scientists are using the LOFAR super-computer for Earth based investigations. For example, to study the effect of natural gas extraction on ground levels in the Netherlands.

Suggest **one** positive benefit of developing technologies that can be used by many different groups of scientists.

.....

.....

(1 mark)

7

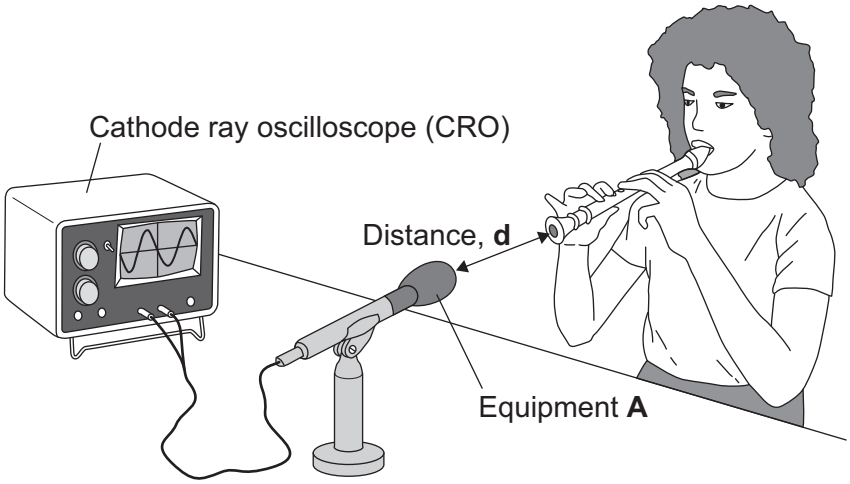
4.6.1.2 Properties of waves

Question 81

June 2011 | PHY3H | Original Q1 | Legacy

1 A group of students investigates sound waves.

The diagram shows part of their investigation.



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

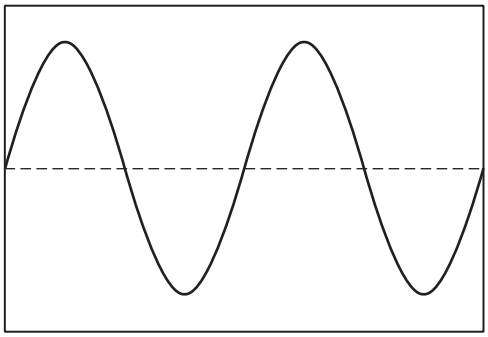
.....

(1 mark)

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).

1 (b) (i) Label this wave to show its amplitude.



(1 mark)

1 (b) (ii) Complete the sentence.

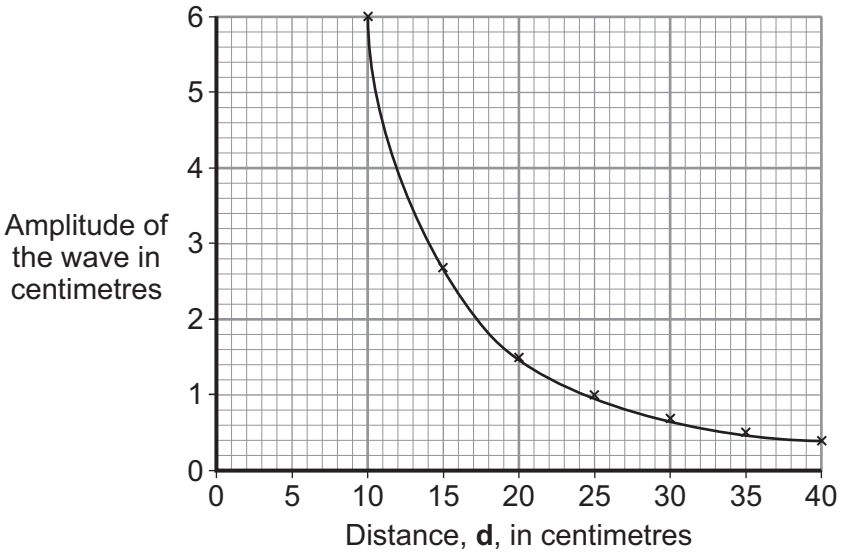
Increasing the amplitude of a sound wave will increase the .....

of the sound. *(1 mark)*

4.6.1.2 Properties of waves

Question 81 · continued

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 mark)

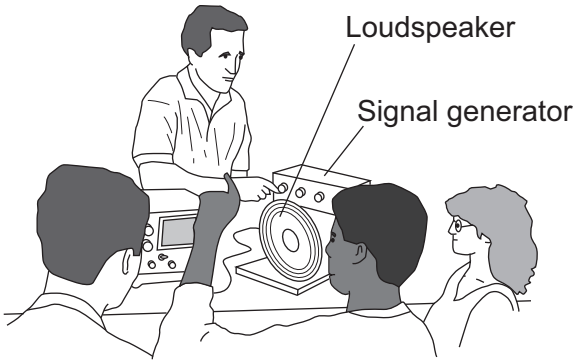
1 (d) Write a conclusion for this investigation.

.....

.....

(1 mark)

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 marks)

7

4.6.1.2 Properties of waves

Question 82

November 2011 | PHY1BP | Original Q1 | Legacy

QUESTION ONE

The frequencies of the waves in the electromagnetic spectrum can be grouped into types.

Match types, **A**, **B**, **C** and **D**, with the descriptions **1**–**4** in the table.

A gamma rays

B infra red rays

C radio waves

D ultraviolet rays

1	They have a higher frequency than X-rays.
2	They have a lower frequency than microwaves.
3	They have a lower frequency than visible light but a higher frequency than microwaves.
4	They have a lower frequency than X-rays but a higher frequency than visible light.

4.6.1.2 Properties of waves

Question 83

November 2011 | PHY1BP | Original Q8 | Legacy

QUESTION EIGHT

The light given out by distant galaxies has the same features as light from a very hot gas in a laboratory. However, the light from distant galaxies is shifted to longer wavelengths. This is called red-shift.

8A Red-shift occurs because . . .

1 the frequency of light increases as it travels through space.

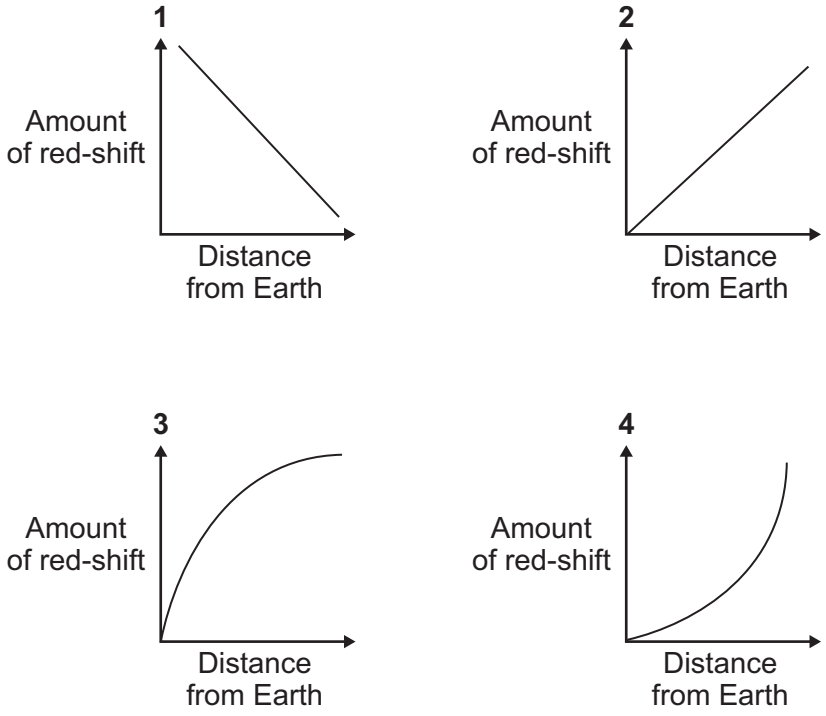
2 the speed of light from galaxies decreases as it travels through space.

3 distant galaxies have a relative movement away from the Earth.

4 distant galaxies have a relative movement towards the Earth.

8B Distant galaxies show an amount of red-shift which is directly proportional to their distance from the Earth.

Which graph shows this relationship?



4.6.1.2 Properties of waves

Question 83 · continued

8C The amount of red-shift can be used to estimate the speed of a galaxy relative to Earth.

This led to the discovery that distant galaxies are . . .

1 moving faster than nearer galaxies and the universe is contracting.

2 moving faster than nearer galaxies and the universe is expanding.

3 moving slower than nearer galaxies and the universe is contracting.

4 moving slower than nearer galaxies and the universe is expanding.

8D There are some galaxies close to the Earth that are moving towards the Earth.

Light from these galaxies has . . .

1 an observable decrease in its frequency.

2 an observable decrease in its wavelength.

3 smaller red-shifts than distant galaxies.

4 no change in its wavelength.

4.6.1.2 Properties of waves

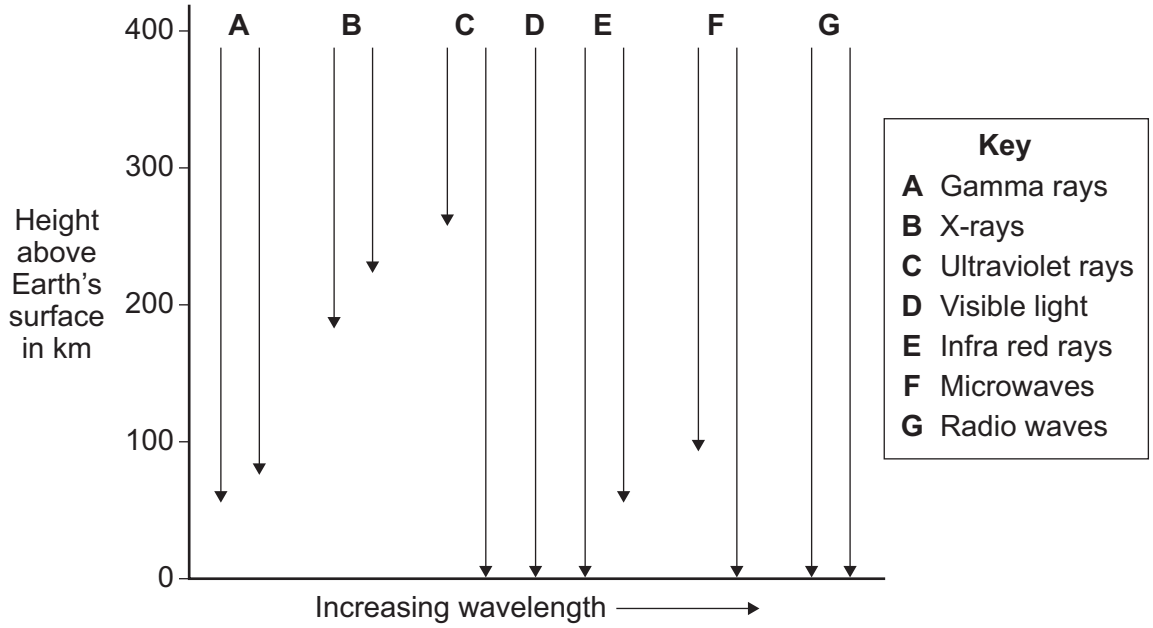
Question 84

November 2011 | PHY1BP | Original Q9 | Legacy

QUESTION NINE

The diagram shows how far electromagnetic waves can penetrate the Earth's atmosphere.

Where two arrows are shown for a particular type of electromagnetic radiation, longer and shorter waves penetrate the atmosphere to different depths.



9A Which one of the following statements is true?

1 Gamma rays penetrate the atmosphere further than all other types of electromagnetic radiation.

2 All frequencies of ultraviolet radiation reach the Earth's surface.

3 No frequencies of radio waves reach the Earth's surface.

4 Higher frequencies of microwaves are completely absorbed by the atmosphere.

9B What would be the minimum height above the Earth for a satellite carrying telescopes designed to detect gamma rays, X-rays and ultraviolet radiation of all wavelengths?

1 50 km

2 70 km

3 180 km

4 260 km

4.6.1.2 Properties of waves

Question 84 · continued

9C Optical telescopes used to observe objects in space are limited because they can be used only . . .

1 as ground-based telescopes.

2 at night.

3 to observe a small region of the electromagnetic spectrum.

4 to observe one region of the sky.

9D Electromagnetic radiation from distant galaxies is very weak and is therefore very difficult to detect.

Some space telescopes use liquid helium to keep scientific instruments at a very low temperature.

Which type of weak electromagnetic radiation would best be detected by instruments kept at a very low temperature?

1 gamma rays

2 X-rays

3 infra red rays

4 ultraviolet rays

END OF TEST

4.6.1.2 Properties of waves

Question 85

June 2012 | PH1HP | Original Q5 | Legacy

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

Both waves:

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

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

1 .....

.....

2 .....

.....

(2 marks)

5 (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?

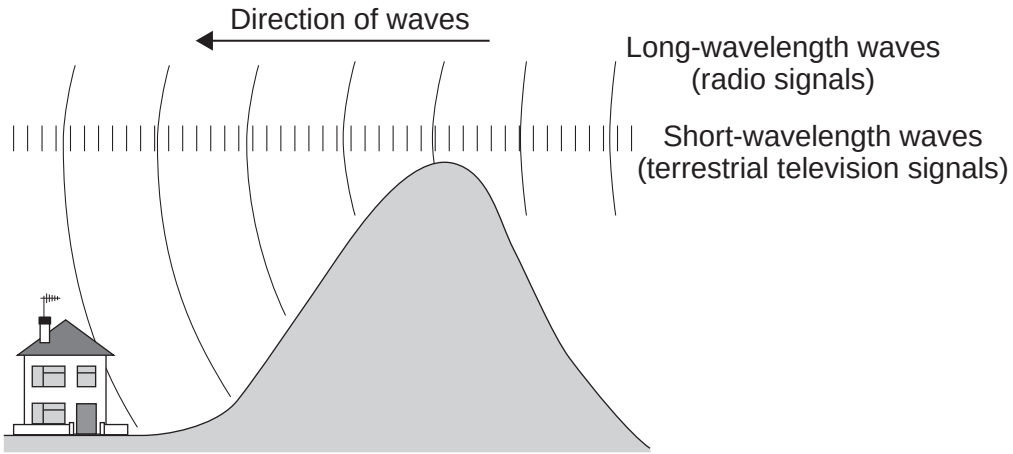
.....

.....

(1 mark)

5 (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.



4.6.1.2 Properties of waves

Question 85 · continued

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

Explain why.

.....

.....

.....

.....

.....

.....

(3 marks)

5 (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 marks)

9

4.6.1.2 Properties of waves

Question 86

June 2012 | PH1HP | Original Q8 | Legacy

8 (a) The 'Big Bang' theory uses red-shift as evidence to explain the beginning of the Universe.

How does the red-shift from distant galaxies provide evidence for the beginning of the Universe?

.....

.....

.....

.....

.....

.....

(3 marks)

8 (b) Cosmic microwave background radiation (CMBR) is a type of electromagnetic radiation. CMBR fills the Universe. It was first discovered in 1965 by two astronomers called Penzias and Wilson.

8 (b) (i) What do scientists believe is the origin of CMBR?

.....

.....

(1 mark)

8 (b) (ii) Why was the discovery of CMBR so important to the scientists believing the 'Big Bang' theory to be correct?

.....

.....

(1 mark)

8 (b) (iii) How is the wavelength of CMBR likely to change, if at all, over the next billion years?

.....

Give a reason for your answer.

.....

.....

(2 marks)

4.6.1.2 Properties of waves

Question 87

January 2013 | PH1HP | Original Q5 | Legacy

5 Galaxies emit all types of electromagnetic wave.

5 (a) (i) Which type of electromagnetic wave has the shortest wavelength?

.....

(1 mark)

5 (a) (ii) State **one** difference between an ultraviolet wave and a visible light wave.

.....

.....

(1 mark)

5 (b) Electromagnetic waves travel through space at a speed of 3.0×10^8 m/s.

The radio waves emitted from a distant galaxy have a wavelength of 25 metres.

Calculate the frequency of the radio waves emitted from the galaxy and give the unit.

Use the correct equation from the Physics Equations Sheet.

.....

.....

.....

Frequency = ...

(3 marks)

5 (c) Scientists use a radio telescope to measure the wavelength of the radio waves emitted from the galaxy in part **(b)** as the waves reach the Earth. The scientists measure the wavelength as 25.2 metres. The effect causing this observed increase in wavelength is called red-shift.

5 (c) (i) The waves emitted from most galaxies show red-shift.

What does red-shift tell scientists about the direction most galaxies are moving?

.....

.....

(1 mark)

4.6.1.2 Properties of waves

Question 87 · continued

5 (c) (ii) The size of the red-shift is **not** the same for all galaxies.

What information can scientists find out about a galaxy when they measure the size of the red-shift the galaxy produces?

.....

.....

.....

.....

(2 marks)

5 (c) (iii) What does the observation of red-shift suggest is happening to the Universe?

.....

.....

(1 mark)

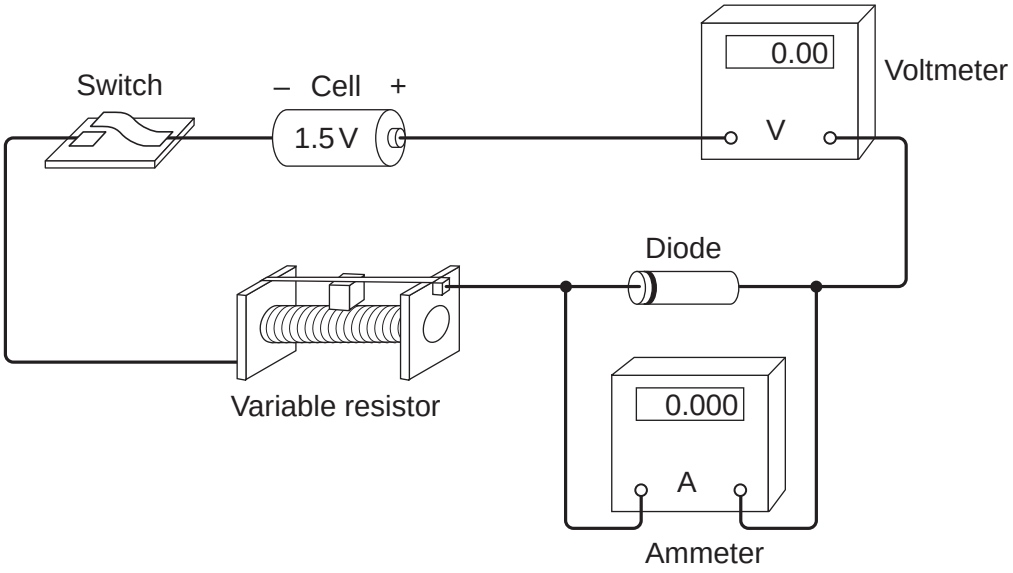
9

4.6.1.2 Properties of waves

Question 88

January 2013 | PH2HP | Original Q4 | Legacy

4 (a) A student set up the circuit shown in the diagram. The student uses the circuit to obtain the data needed to plot a current - potential difference graph for a diode.



4 (a) (i) Draw, in the boxes, the circuit symbol for a diode and the circuit symbol for a variable resistor.

Diode	**Variable resistor**

(2 marks)

4 (a) (ii) The student made two mistakes when setting up the circuit.

What **two** mistakes did the student make?

1 .....

.....

2 .....

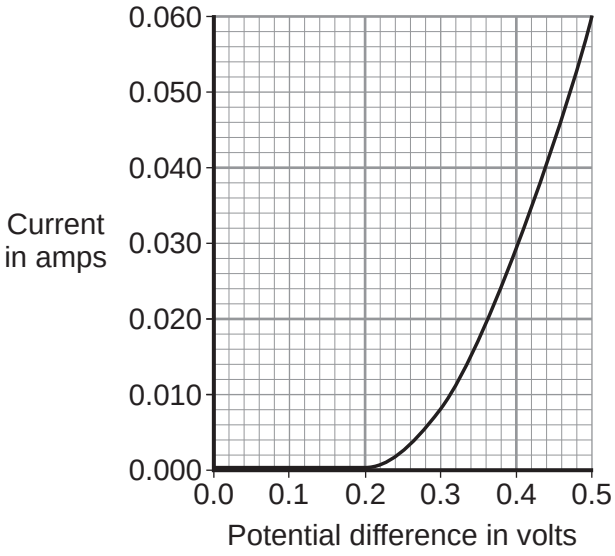
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(2 marks)

4.6.1.2 Properties of waves

Question 88 · continued

4 (b) After correcting the circuit, the student obtained a set of data and plotted the graph below.



4 (b) (i) At what potential difference did the diode start to conduct an electric current?

..... V
(1 mark)

4 (b) (ii) Use data from the graph to calculate the resistance of the diode when the potential difference across the diode is 0.3 V.

Use the correct equation from the Physics Equations Sheet.

.....

.....

.....

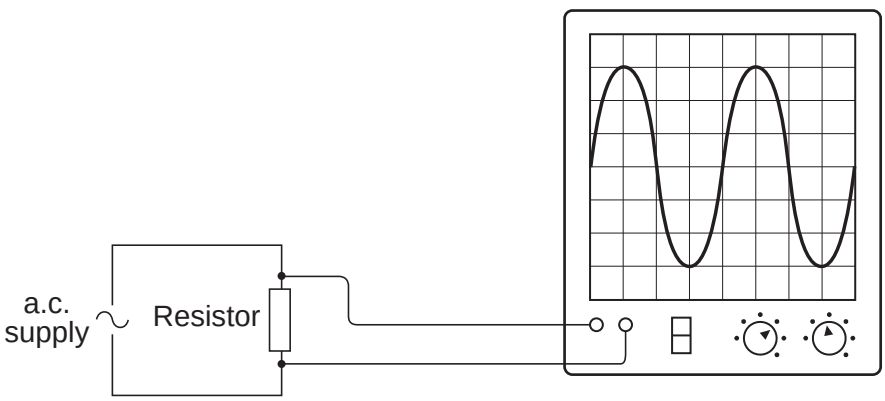
Resistance = ... ohms
(3 marks)

Question 4 continues on the next page

4.6.1.2 Properties of waves

Question 88 · continued

4 (c) The diagram shows the trace produced by an alternating current (a.c.) supply on an oscilloscope.



Each horizontal division on the oscilloscope screen represents a time of 0.01s.

4 (c) (i) Calculate the frequency of the a.c. supply.

.....

.....

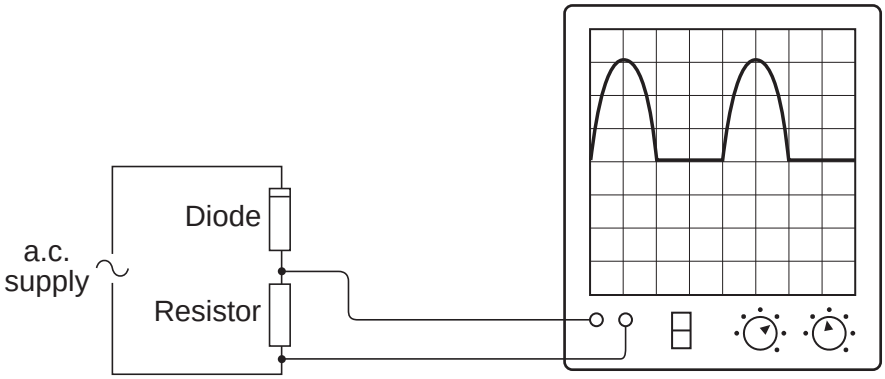
.....

Frequency = ... hertz
(2 marks)

4.6.1.2 Properties of waves

Question 88 · continued

4 (c) (ii) A diode is now connected in series with the a.c. power supply.



Why does the diode cause the trace on the oscilloscope screen to change?

.....

.....

.....

.....

(2 marks)

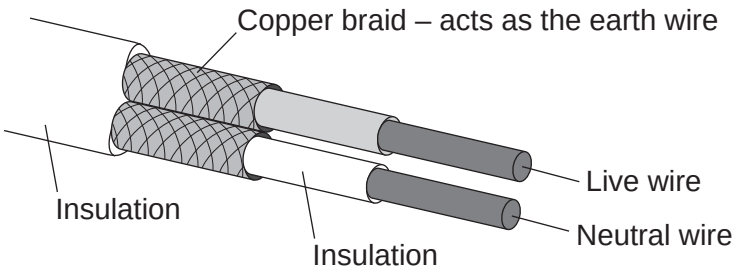
12

4.6.1.2 Properties of waves

Question 89

January 2013 | PH2HP | Original Q6 | Legacy

6 The diagram shows the structure of a cable. The cable is part of an undersoil heating circuit inside a large greenhouse.



6 (a) The cable is connected to the mains electricity supply through a residual current circuit breaker (RCCB). If the cable is accidentally cut the RCCB automatically switches the circuit off.

6 (a) (i) What is the frequency of the mains electricity supply in the UK?

.....

(1 mark)

6 (a) (ii) What happens, as the cable is cut, to cause the RCCB to switch the circuit off?

.....

.....

.....

.....

(2 marks)

6 (a) (iii) A circuit can also be switched off by the action of a fuse.

Give **one** advantage of using a RCCB to switch off a circuit rather than a fuse.

.....

.....

(1 mark)

4.6.1.2 Properties of waves

Question 89 · continued

6 (b) The 230 volt mains electricity supply causes a current of 11 amps to flow through the cable.

6 (b) (i) Calculate the amount of charge that flows through the cable when the cable is switched on for 2 hours and give the unit.

Use the correct equation from the Physics Equations Sheet.

.....

.....

.....

Charge = ...

(3 marks)

6 (b) (ii) Calculate the energy transferred from the cable to the soil in 2 hours.

Use the correct equation from the Physics Equations Sheet.

.....

.....

Energy transferred =..... J

(2 marks)

6 (c) The heating circuit includes a thermistor. The thermistor is buried in the soil and acts as a thermostat to control the increase in the temperature of the soil.

Describe how an **increase** in the temperature of the soil affects the thermistor.

.....

.....

.....

.....

(2 marks)

11

4.6.1.2 Properties of waves

Question 90

June 2013 | PH1HP | Original Q7 | Legacy

7 (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 mark)

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

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

.....

.....

(1 mark)

7 (b) (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 marks)

4.6.1.2 Properties of waves

Question 90 · continued

7 (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 mark)

6

4.6.1.2 Properties of waves

Question 91

June 2013 | PH1HP | Original Q8 | Legacy

8 (a) Observation of the spectra from distant galaxies provides evidence to support the 'Big Bang' theory.

8 (a) (i) Complete the following sentence.

Many scientists think that the 'Big Bang' theory describes the .....

..... .

(1 mark)

8 (a) (ii) Tick (✓) **one** box to complete the sentence.

The discovery of cosmic microwave background radiation was important

because it …

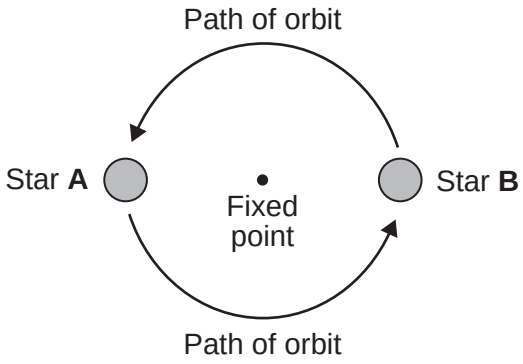
proved the 'Big Bang' theory to be correct. ☐

provided more evidence to support the 'Big Bang' theory. ☐

proved the Universe will continue to expand forever. ☐

(1 mark)

8 (b) Many stars are part of a binary star system. Binary star systems have two stars.

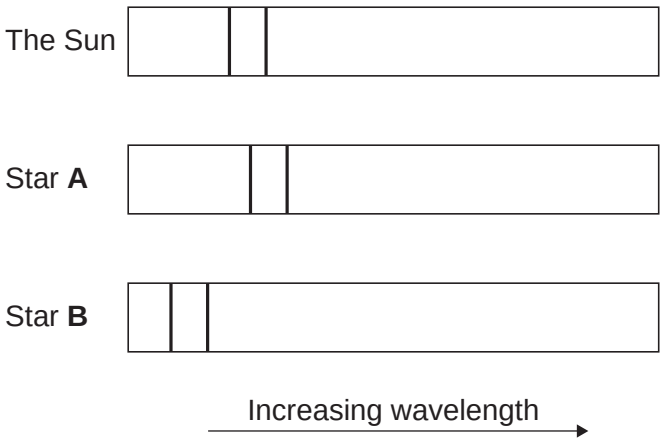


The visible spectrum from stars includes dark lines. These lines are at specific wavelengths.

4.6.1.2 Properties of waves

Question 91 · continued

The diagram shows the position of two dark lines in the spectrum from the Sun. It also shows the same lines in the spectra from two stars **A** and **B** in a binary star system at the same point in time.



8 (b) (i) What name is given to the effect shown in the spectrum from star **A**?

.....

(1 mark)

8 (b) (ii) Scientists have concluded that the two stars in a binary star system orbit around a fixed point between the two stars.

A comparison of the spectra from the two stars in a binary star system provides evidence to support this conclusion.

Explain how.

.....

.....

.....

.....

.....

.....

.....

.....

(3 marks)

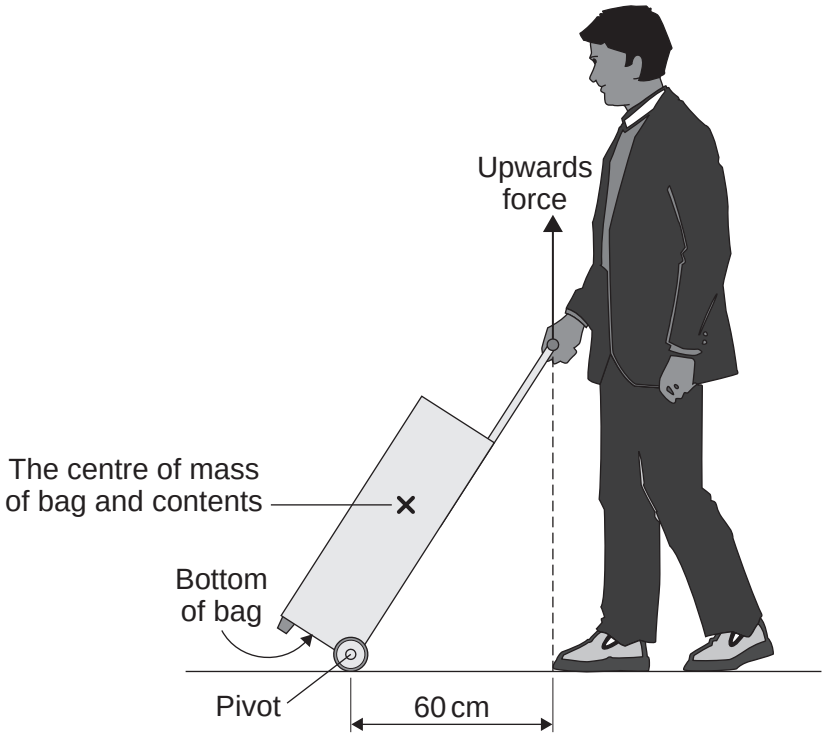
6

4.6.1.2 Properties of waves

Question 92

June 2013 | PH3HP | Original Q6 | Legacy

6 The diagram shows a man standing in an airport queue with his wheeled bag.



6 (a) The man applies an upward force to the handle of his bag to stop the bag from falling. The moment of this force about the pivot is 36 Nm.

Calculate the upward force the man applies to the handle of his bag.

Use the correct equation from the Physics Equations Sheet.

.....

.....

.....

.....

Force = ... N

(2 marks)

4.6.1.2 Properties of waves

Question 92 · continued

6 (b) When the man lets go of the bag handle, the bag falls and hits the floor.

Explain why.

.....

.....

.....

.....

.....

.....

(2 marks)

6 (c) During his holiday the man visits the Foucault Pendulum in Paris, France.
The pendulum makes 10 complete swings every 160 seconds.

Calculate the frequency of the pendulum and give the unit.

Use the correct equation from the Physics Equations Sheet.

.....

.....

.....

.....

Frequency = ...

(3 marks)

7

4.6.1.2 Properties of waves

Question 93

June 2014 | PH1HP | Original Q4 | Legacy

4 A note was played on an electric keyboard.

The frequency of the note was 440 Hz.

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

[1 mark]

.....

.....

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

Calculate the wavelength of the note.

Use the correct equation from the Physics Equations Sheet.

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

[3 marks]

.....

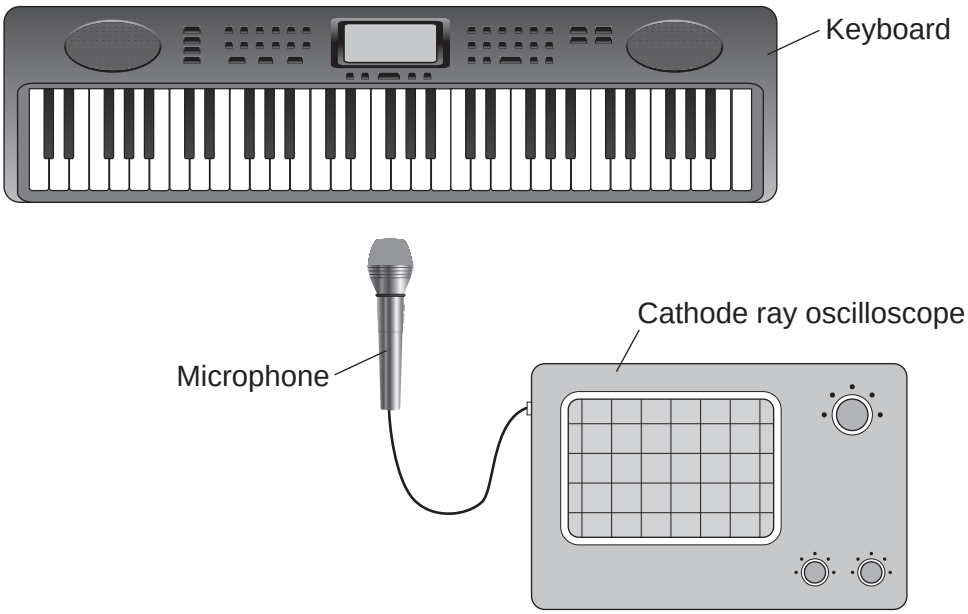
.....

.....

Wavelength = ... metres

4 (b) **Figure 3** shows a microphone connected to a cathode ray oscilloscope (CRO) being used to detect the note produced by the keyboard.

Figure 3

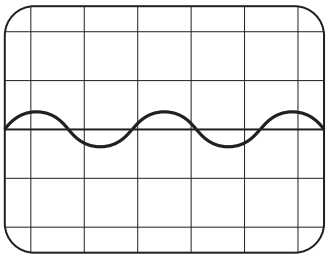


4.6.1.2 Properties of waves

Question 93 · continued

Figure 4 shows the trace produced by the sound wave on the CRO.

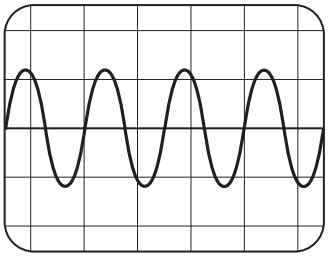
Figure 4



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

Figure 5 shows the trace produced by the sound wave of the second note on the CRO.

Figure 5



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.

[4 marks]

Conclusion 1 .....

.....

Reason .....

.....

Conclusion 2 .....

.....

Reason .....

.....

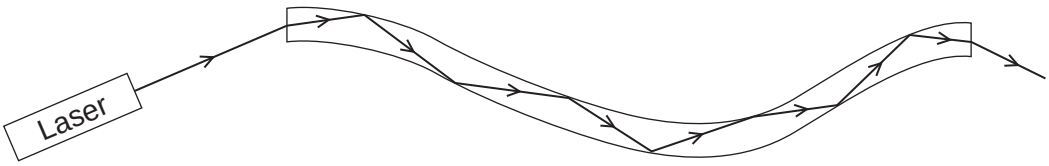
8

4.6.1.2 Properties of waves

Question 94

7 **Figure 11** shows how a ray of light from a laser travels along an optical fibre.

Figure 11



7 (a) Why does the ray of light stay within the optical fibre?

[1 mark]

.....

.....

7 (b) The material used to make the optical fibre has a refractive index of 1.50.

Calculate the critical angle of this material.

Use the correct equation from the Physics Equations Sheet.

[2 marks]

.....

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.....

.....

Critical angle = ... degrees

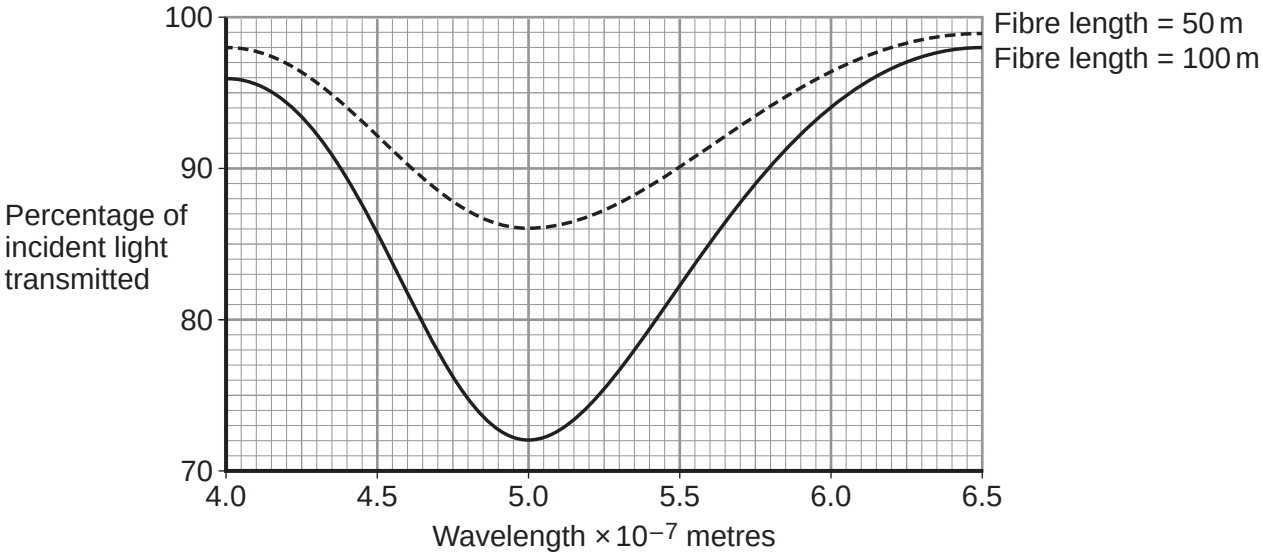
4.6.1.2 Properties of waves

Question 94 · continued

7 (c) Different wavelengths of light can be used to transmit information along optical fibres.

Figure 12 shows how the percentage of incident light transmitted through a fibre varies with the wavelength of light and the length of the fibre.

Figure 12



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

[3 marks]

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6

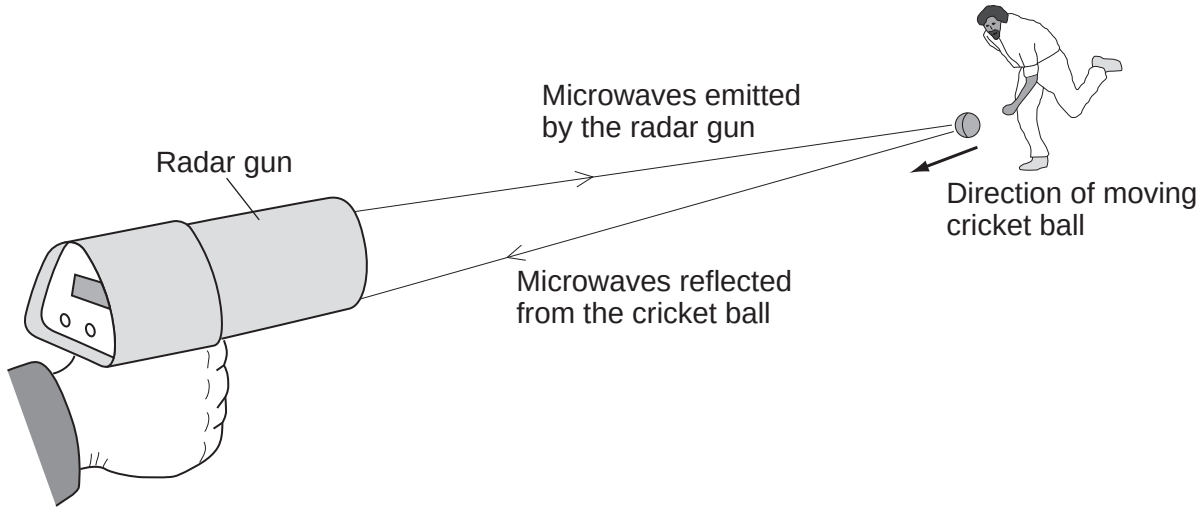
4.6.1.2 Properties of waves

Question 95

June 2015 | PH1HP | Original Q6 | Legacy

6 A radar gun is used to determine the speed of a cricket ball during a cricket match. The radar gun emits a beam of microwaves. The microwaves are reflected from the moving ball, as shown in **Figure 6**.

Figure 6



Comparing the microwaves emitted by the radar gun with the microwaves reflected from the cricket ball enables the speed of the ball to be determined.

6 (a) What is the name given to the effect used to determine the speed of the cricket ball?

[1 mark]

.....

6 (b) Compare the wavelength, frequency and speed of the **reflected** microwaves with the wavelength, frequency and speed of the microwaves emitted by the radar gun.

[3 marks]

.....

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4

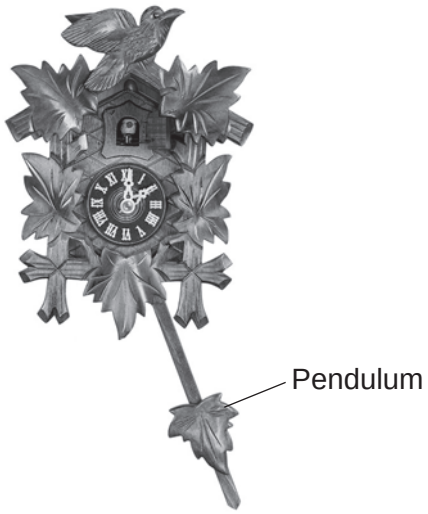
4.6.1.2 Properties of waves

Question 96

June 2015 | PH3HP | Original Q1 | Legacy

1 The clock shown in **Figure 1** uses a pendulum to keep time.

Figure 1



1 (a) The pendulum has a frequency of 0.80 Hz.

Calculate the periodic time of the pendulum.

Use the correct equation from the Physics Equations Sheet.

[2 marks]

.....

.....

.....

Periodic time = ... seconds

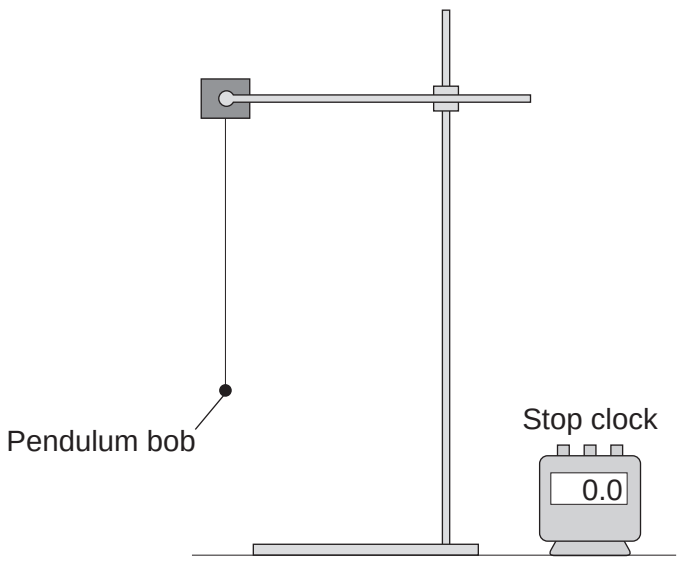
Question 1 continues on the next page

4.6.1.2 Properties of waves

Question 96 · continued

1 (b) A student investigated the factors affecting the oscillation of a pendulum. The student set up a pendulum as shown in **Figure 2**.

Figure 2



The student investigated how many complete oscillations the pendulum made for different lengths of the pendulum and different masses of the pendulum bob.

The results are shown in **Table 1**.

Table 1

Length of the pendulum in millimetres	Mass of the pendulum bob in grams	Number of complete oscillations made by the pendulum in 20 seconds
200	100	22
200	200	22
400	100	15
400	200	15
600	50	13
600	100	13

4.6.1.2 Properties of waves

Question 96 · continued

1 (b) (i) State **two** conclusions that the student should make from the results shown in **Table 1**.
[2 marks]

1 .....

.....

2 .....

.....

1 (b) (ii) The student wants to be more certain that her conclusions are correct.

Suggest **two** ways in which the investigation could be improved.
[2 marks]

1 .....

.....

2 .....

.....

6

4.6.1.2 Properties of waves

Question 97

June 2015 | PH3HP | Original Q3 | Legacy

3 (a) Complete the following sentences.

[2 marks]

Ultrasound waves have a minimum frequency

of ..... hertz.

The wavelength of an X-ray is about the same as

the diameter of ..... .

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

Figure 5 shows one medical use of ultrasound and one medical use of X-rays.

Figure 5





Compare the medical uses of ultrasound and X-rays.

Your answer should include the risks, if any, and precautions, if any, associated with the use of ultrasound and X-rays.

[6 marks]

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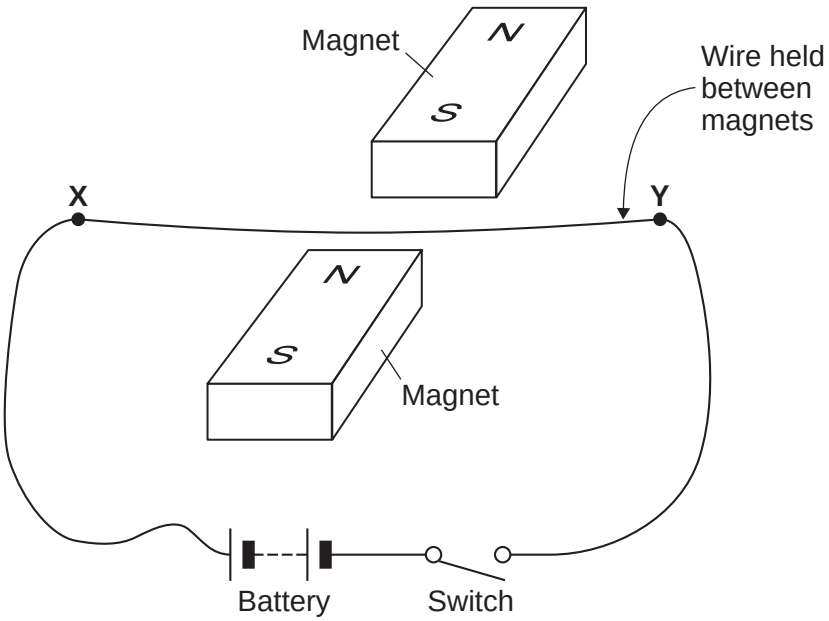
4.6.1.2 Properties of waves

Question 98

June 2015 | PH3HP | Original Q5 | Legacy

5 **Figure 10** shows apparatus set up by a student.

Figure 10



Closing the switch creates a force that acts on the wire **XY**.

5 (a) (i) Explain why a force acts on the wire **XY** when the switch is closed.

[3 marks]

.....

.....

.....

.....

.....

.....

5 (a) (ii) The force causes the wire **XY** to move.
Draw an arrow on **Figure 10** to show the direction in which the wire **XY** will move.

[1 mark]

5 (a) (iii) State the effect that this experiment demonstrates.

[1 mark]

.....

4.6.1.2 Properties of waves

Question 98 · continued

5 (b) The student replaced the battery with a low frequency alternating current (a.c.) power supply.

The student closed the switch.

5 (b) (i) Describe the movement of the wire.

[1 mark]

.....

5 (b) (ii) Give a reason for your answer to part **(b)(i)**.

[1 mark]

.....

.....

.....

7

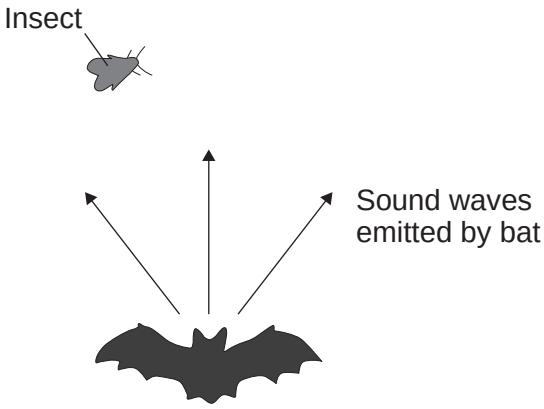
4.6.1.2 Properties of waves

Question 99

June 2016 | PH1HP | Original Q1 | Legacy

1 Bats use the reflection of high pitched sound waves to determine the position of objects. **Figure 1** shows a bat and an insect flying in front of the bat.

Figure 1



1 (a) What determines the pitch of a sound wave?

[1 mark]

Tick (✓) **one** box.

	Tick (✓)
amplitude	
frequency	
speed	

1 (b) State the name given to reflected sound waves.

[1 mark]

_____

4.6.1.2 Properties of waves

Question 99 · continued

1 (c) The bat emits sound waves with a range of wavelengths.

Some of the sound waves will be diffracted by the insect.

Complete the following sentences to explain why.

[2 marks]

Diffraction is caused by the sound waves _____ as they pass the insect.

The most diffraction happens when the wavelength of the sound wave is

_____ the size of the insect.

1 (d) The bat emits a sound wave with a frequency of 25.0 kHz and a wavelength of 0.0136 metres.

Calculate the speed of this sound wave.

Use the correct equation from the Physics Equations Sheet.

[2 marks]

_____

_____

_____

Speed = _____ m/s

1 (e) Sound waves are longitudinal. Describe a longitudinal sound wave.

[2 marks]

_____

_____

_____

_____

8

4.6.1.2 Properties of waves

Question 100

June 2016 | PH3HP | Original Q3 | Legacy

3 X-rays and ultrasound can both be used for scanning internal organs.

3 (a) Ultrasound is used to scan unborn babies but X-rays are **not** used to scan unborn babies.

Explain why.

[3 marks]

3 (b) The behaviour of ultrasound waves when they meet a boundary between two different materials is used to produce an image.

Describe how.

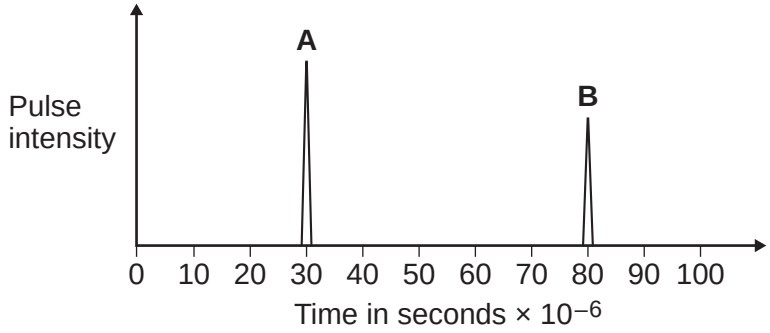
[2 marks]

4.6.1.2 Properties of waves

Question 100 · continued

3 (c) **Figure 4** shows two pulses from a scan of an unborn baby. The emitted pulse is labelled **A**. The returning pulse picked up by the receiver is labelled **B**.

Figure 4



The closest distance between the unborn baby and the mother's skin is 4.0 cm.
Use information from **Figure 4** to calculate the average speed of the pulse.

Use the correct equation from the Physics Equations Sheet.

[3 marks]

Average speed = _____ m/s

Question 3 continues on the next page

4.6.1.2 Properties of waves

Question 100 · continued

3 (d) **Figure 5** shows an X-ray of an arm with a broken bone.

Figure 5



3 (d) (i) Describe how X-rays are able to produce an image of bones.

[3 marks]

_____

_____

_____

_____

_____

_____

3 (d) (ii) Complete the following sentence.

X-rays are able to produce detailed images because their wavelength

is very _____ .

[1 mark]

12

4.6.1.2 Properties of waves

Question 101

June 2017 | PH1HP | Original Q1 | Legacy

1 A laser emits light waves in the visible region of the electromagnetic spectrum.

1 (a) What type of wave are all electromagnetic waves?

[1 mark]

_____

1 (b) The light from a laser has a wavelength of 6.5×10^{-7} m

The speed of light is 3.0×10^{8} m/s

Calculate the frequency of the light from the laser.

Give your answer to 2 significant figures.

Use the correct equation from the Physics Equations Sheet.

[3 marks]

_____

_____

_____

Frequency = _____ Hz

1 (c) What is the approximate range of wavelengths of the electromagnetic spectrum?

Tick (✓) **one** box.

[1 mark]

Range of wavelengths in metres	**Tick (✓)**
10^{-10} to 10^{8}	
10^{-8} to 10^{6}	
10^{-15} to 10^{4}	

5

4.6.1.2 Properties of waves

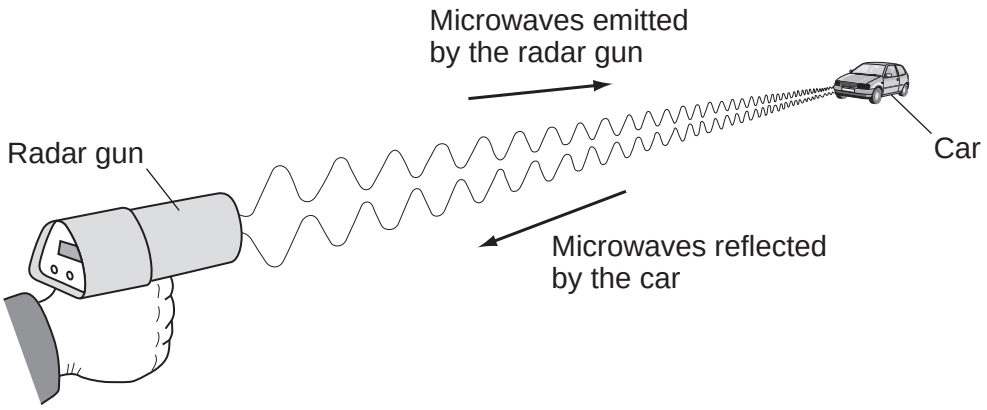
Question 102

June 2017 | PH1HP | Original Q4 | Legacy

4 A radar gun can be used to measure the speed of a car.

Microwaves are emitted by the radar gun and reflected by the car, as shown in **Figure 4**.

Figure 4



4 (a) The microwaves reflected by the moving car have a different frequency from the microwaves emitted by the radar gun.

What is the name of the effect causing this change in frequency?

[1 mark]

_____

4 (b) The data in **Table 2** are measurements taken from three different cars on the same piece of road.

Table 2

Car	Frequency of emitted microwaves in kHz	Frequency of reflected microwaves in kHz
A	27 000 000	27 000 002
B	27 000 000	27 000 000
C	27 000 000	26 999 997

4.6.1.2 Properties of waves

Question 102 · continued

4 (b) (i) State which car in **Table 2** is moving towards the radar gun. Give a reason for your answer.

[2 marks]

Car _____

Reason _____

_____

4 (b) (ii) State which car in **Table 2** is moving the fastest. Give a reason for your answer.

[2 marks]

Car _____

Reason _____

_____

5

Turn over for the next question

4.6.1.2 Properties of waves

Question 103

June 2017 | PH3HP | Original Q4 | Legacy

4 One type of digital camera contains both a converging (convex) lens and a diverging (concave) lens.

4 (a) State the name of the light detector used in digital cameras.

[1 mark]

_____

4 (b) Converging and diverging lenses both produce images.

What type of images can be produced using converging and diverging lenses?

Tick (✓) **one** box for **each** type of lens.

[2 marks]

Converging lens

Real image only ☐

Virtual image only ☐

Both real and virtual images ☐

Diverging lens

Real image only ☐

Virtual image only ☐

Both real and virtual images ☐

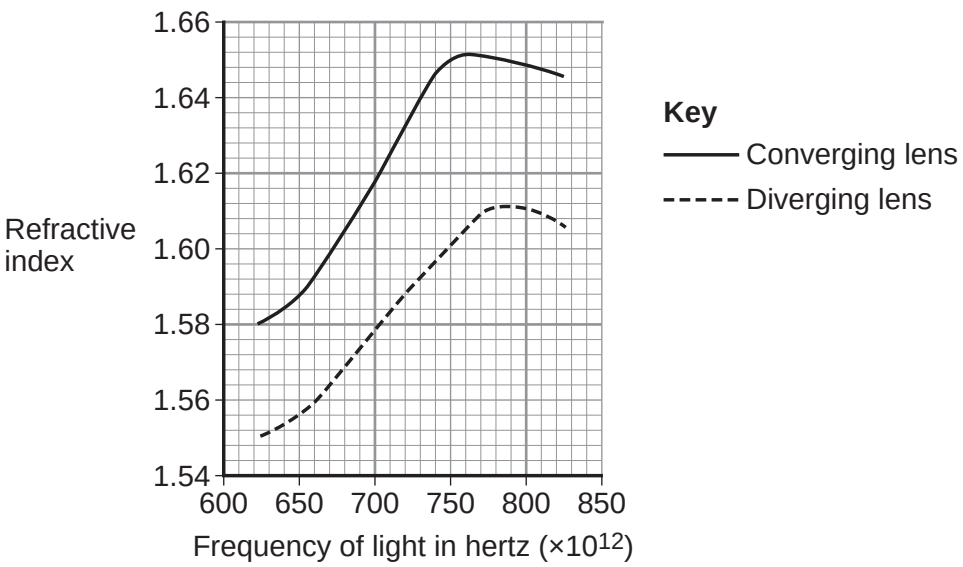
Question 4 continues on the next page

Question 103 · continued

4 (c) Each lens in the digital camera is made from a different type of glass.

Figure 3 shows the relationship between the frequency of light and the refractive index of the glass used to make each lens.

Figure 3



Describe **three differences** between the refractive index of the glass used for the converging lens compared to the glass used for the diverging lens as the frequency of light increases.

[3 marks]

1 _____

_____

_____

2 _____

_____

_____

3 _____

_____

_____

4.6.1.2 Properties of waves

Question 103 · continued

4 (d) At one frequency, the glass of the diverging lens has a refractive index of 1.60
The angle of incidence of a ray of this light on the diverging lens is 20°

Calculate the angle of refraction for the ray of light.

Use the correct equation from the Physics Equations Sheet.

[3 marks]

Angle of refraction = _____ degrees

4 (e) The focal length of the diverging lens is 40 cm.

Calculate the power of the diverging lens. Give the unit.

Use the correct equation from the Physics Equations Sheet.

[3 marks]

Power = _____ unit _____

4 (f) Give **two** factors that affect the power of a lens.

[2 marks]

1 _____

2 _____

14

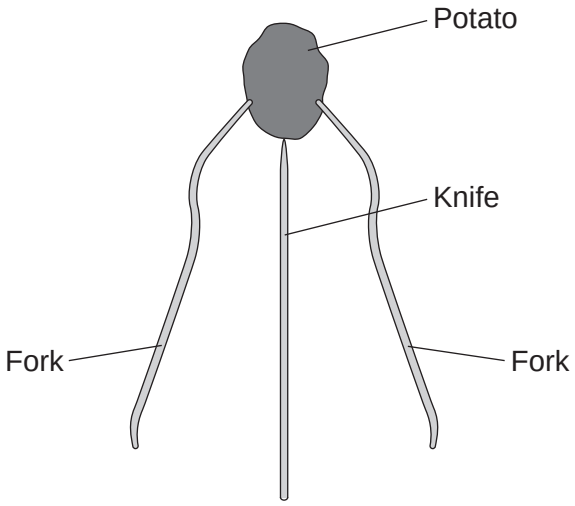
4.6.1.2 Properties of waves

Question 104

June 2017 | PH3HP | Original Q6 | Legacy

6 **Figure 5** shows how two forks can be used to make a potato balance on the end of a knife.

Figure 5



6 (a) (i) Use a cross to mark the centre of mass of the arrangement in **Figure 5**.

[1 mark]

6 (a) (ii) State the meaning of the term ‘centre of mass’.

[1 mark]

4.6.1.2 Properties of waves

Question 104 · continued

6 (b) The potato is tilted to one side and then released. The potato and forks then oscillate from side to side.

The time taken for half an oscillation is 0.4 seconds.

Calculate the frequency of the oscillations.

Use the correct equation from the Physics Equations Sheet.

[2 marks]

_____

_____

_____

Frequency = _____ Hz

4

Turn over for the next question

4.6.1.2 Properties of waves

Question 105

June 2017 | PH3HP | Original Q7 | Legacy

7 Ultrasound has industrial applications as well as medical applications.

One industrial application of ultrasound is testing an aeroplane wing to make sure that there are no cracks.

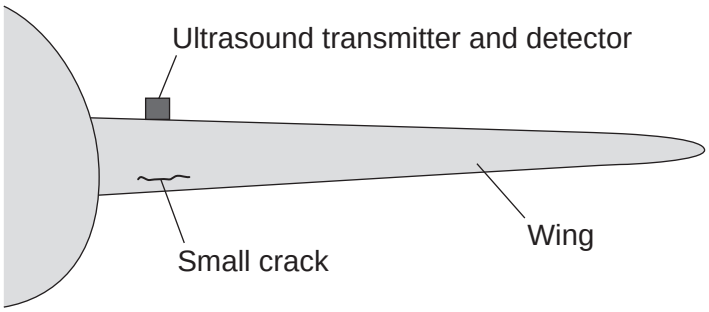
7 (a) State the minimum frequency of an ultrasound wave.

Include the correct unit.

[1 mark]

7 (b) An ultrasound pulse is transmitted from the top of a wing as shown in **Figure 6**.

Figure 6



There is a small crack in the wing. The ultrasound can be used to detect how far the crack is from the surface of the wing.

7 (b) (i) The ultrasound signal on its own does not directly give the distance to the crack.

What measurement is taken to determine the distance to the crack?

[1 mark]

7 (b) (ii) What other information is needed to calculate the distance from the surface of the wing to the crack?

[1 mark]

4.6.1.2 Properties of waves

Question 105 · continued

7 (b) (iii) Describe what happens to the ultrasound pulse when it reaches the small crack.

[2 marks]

7 (c) An aircraft is safe to fly for at least 2000 hours after a crack begins to develop in a wing. The wing is tested after every 500 hours of flying time. If a crack is found the wing is replaced immediately.

If there is a crack in the wing, an ultrasound test will detect the crack 99% of the time.

Suggest why the interval between tests is less than the safe flying time after a crack develops.

[1 mark]

6

4.6.1.2 Properties of waves

Question 106

June 2018 | 8463/2H | Original Q3

0 3 P-waves and S-waves are two types of seismic wave caused by earthquakes.

0 3 . 1 Which **one** of the statements about P-waves and S-waves is correct?

Tick **one** box.

[1 mark]

P-waves and S-waves are transverse. ☐

P-waves and S-waves are longitudinal. ☐

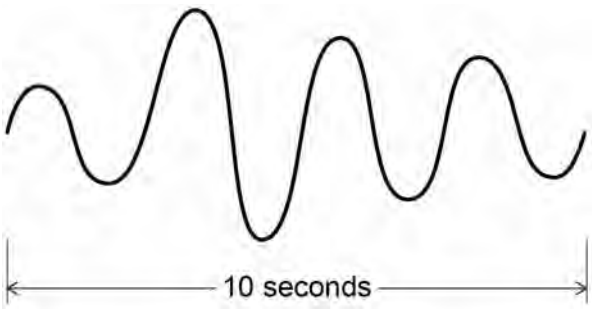
P-waves are transverse and S-waves are longitudinal. ☐

P-waves are longitudinal and S-waves are transverse. ☐

Seismometers on the Earth's surface record the vibrations caused by seismic waves.

Figure 3 shows the vibration recorded by a seismometer for one P-wave.

Figure 3



0 3 . 2 Calculate the frequency of the P-wave shown in **Figure 3**.

[1 mark]

Frequency = _____ Hz

4.6.1.2 Properties of waves

Question 106 · continued

0 3 . 3 Write down the equation which links frequency, wavelength and wave speed.

[1 mark]

0 3 . 4 The P-wave shown in **Figure 3** is travelling at 7200 m/s.

Calculate the wavelength of the P-wave.

[3 marks]

Wavelength = _____ m

0 3 . 5 Explain why the study of seismic waves provides evidence for the structure of the Earth's core.

[2 marks]

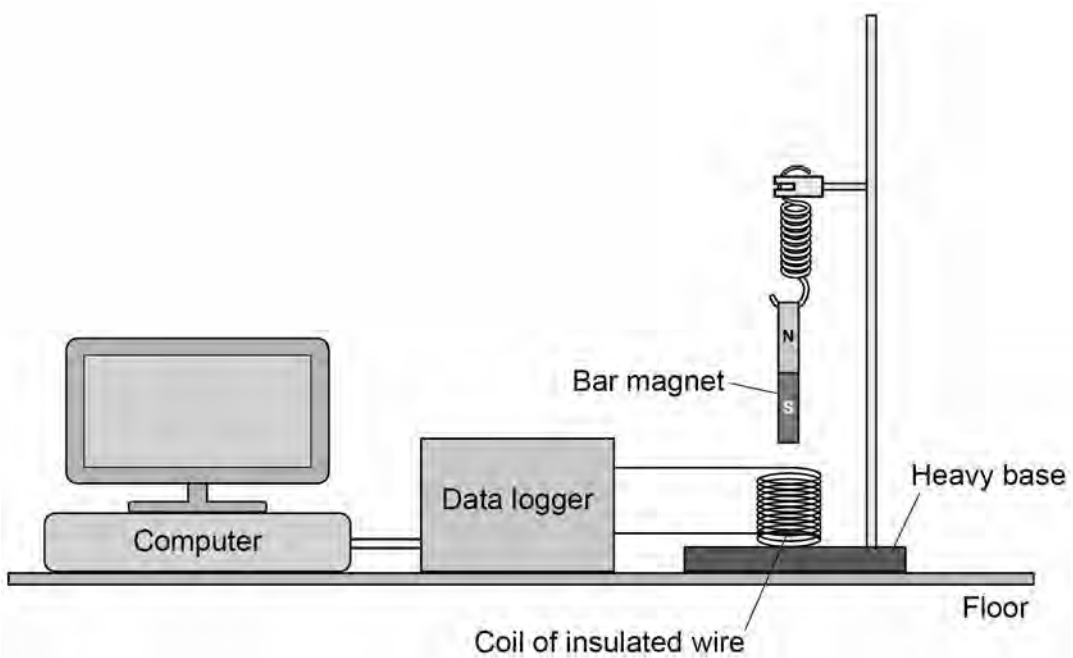
Question 3 continues on the next page

4.6.1.2 Properties of waves

Question 106 · continued

Figure 4 shows a simple seismometer made by a student.

Figure 4



To test that the seismometer works, the student pushes the bar magnet into the coil and then releases the bar magnet.

0 3 . 6 Why does the movement of the bar magnet induce a potential difference across the coil?

[1 mark]

0 3 . 7 Why is the induced potential difference across the coil alternating?

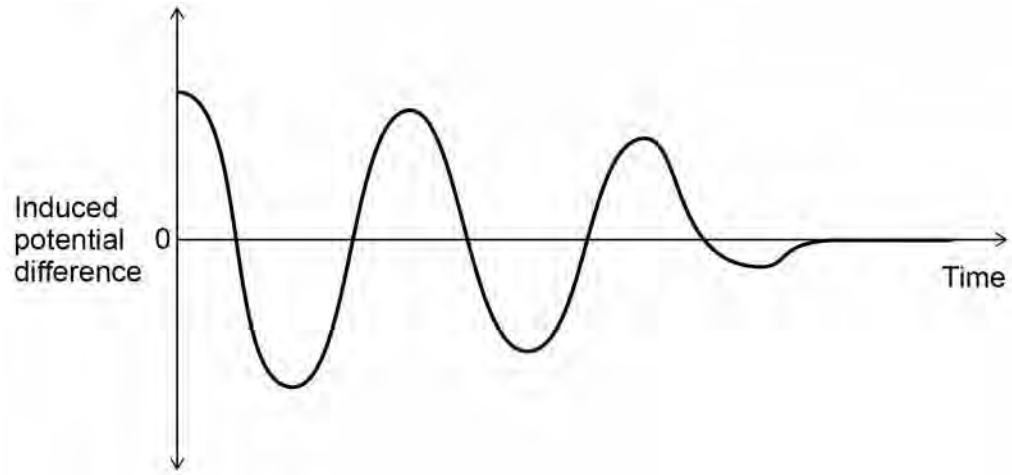
[1 mark]

4.6.1.2 Properties of waves

Question 106 · continued

0 3 . 8 **Figure 5** shows how the potential difference induced across the coil varies after the bar magnet has been released.

Figure 5



Which statement describes the movement of the magnet when the induced potential difference is zero?

Tick **one** box.

[1 mark]

Accelerating upwards. ☐

Constant speed upwards. ☐

Decelerating downwards. ☐

Stationary. ☐

0 3 . 9 The seismometer cannot detect small vibrations.

Suggest **two** changes to the design of the seismometer that would make it more sensitive to small vibrations.

[2 marks]

1 _____

_____

2 _____

_____

13

4.6.1.2 Properties of waves

Question 107

June 2018 | 8463/2H | Original Q9

0 9 Light is usually described as a wave. Light can also be described as a stream of particles.

These are two different scientific models of light.

0 9 . 1 Which statement describes a scientific model?

Tick **one** box.

[1 mark]

A small scale version of a real object. ☐

A way of guessing what will happen. ☐

An idea used to explain observations and data. ☐

0 9 . 2 Why do scientists sometimes have different models like the wave and particle models of light?

[1 mark]

0 9 . 3 Sometimes an old scientific model is replaced by a new model.

Explain why scientists replace an old scientific model with a new model.

Include an example from Physics in your answer.

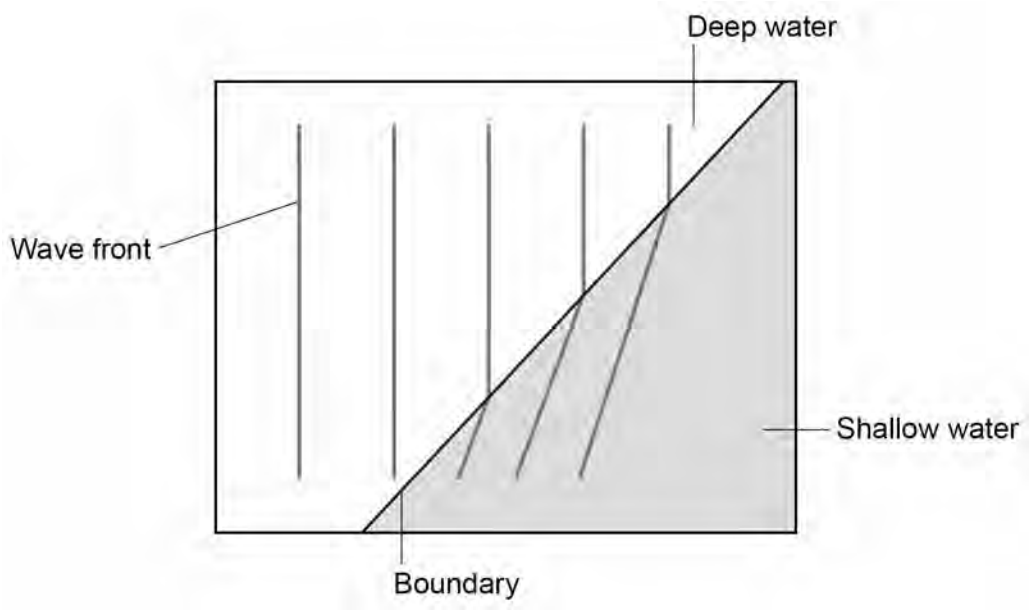
[4 marks]

Question 107 · continued

Some students used water waves in a ripple tank to model the behaviour of light waves.

0 9 . 4 **Figure 16** shows what happens to the wave fronts as they pass the boundary between deep water and shallower water.

Figure 16



Explain why refraction happens at the boundary between the deep water and shallower water.

[3 marks]

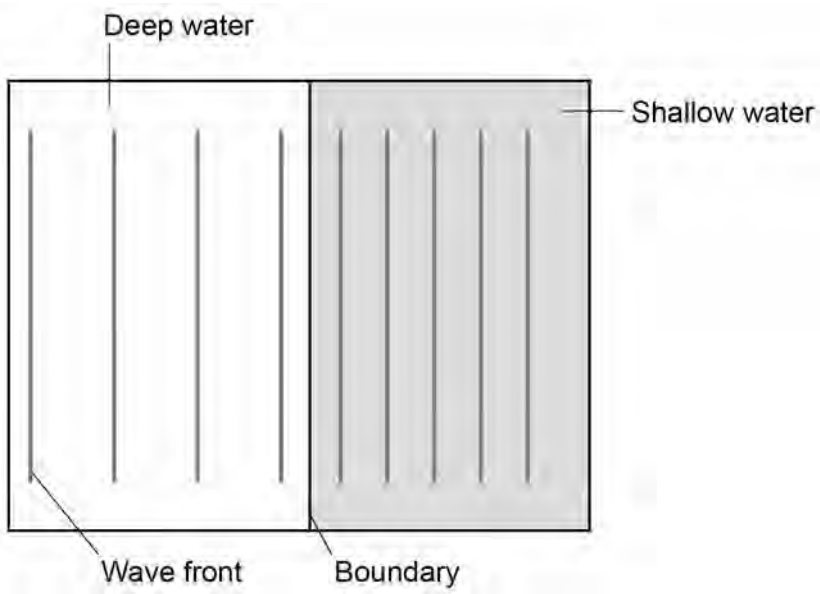
Question 9 continues on the next page

4.6.1.2 Properties of waves

Question 107 · continued

0 9 . 5 **Figure 17** shows the wave fronts travelling parallel to the boundary between deep water and shallower water.

Figure 17



Explain why the wave fronts in **Figure 17** do not refract at the boundary.

[2 marks]

1

4.6.1.2 Properties of waves

Question 108

June 2019 | 8463/1H | Original Q6

0 6 **Figure 7** shows a person using an electric lawn mower.

Figure 7



0 6 . 1 The lawn mower is connected to the mains electricity supply.

What is the frequency of the mains electricity supply in the UK?

[2 marks]

Frequency = _____ Unit _____

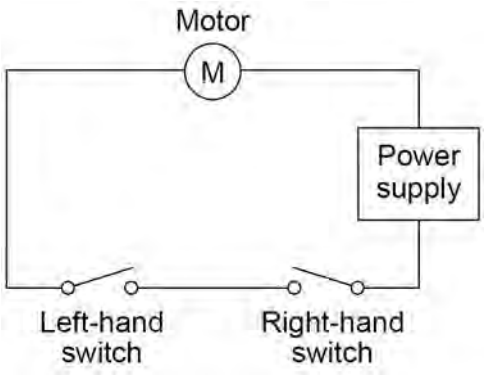
4.6.1.2 Properties of waves

Question 108 · continued

The lawn mower has a switch on each side of the handle.

Figure 8 shows the circuit diagram for the lawn mower.

Figure 8



0 6 . 2 The motor in the lawn mower can only be turned on when the person using it holds the handle of the lawn mower with both hands.

Explain why.

[2 marks]

0 6 . 3 The power input to the motor is 1.8 kW

The resistance of the motor is 32 Ω

Calculate the current in the motor.

[3 marks]

Current = _____ A

4.6.1.2 Properties of waves

Question 108 · continued

0 6 . 4 The useful power output from the motor is 1.5 kW

Calculate the time it takes for the motor to transfer 450 000 J of useful energy.

[3 marks]

Time = _____ seconds

1

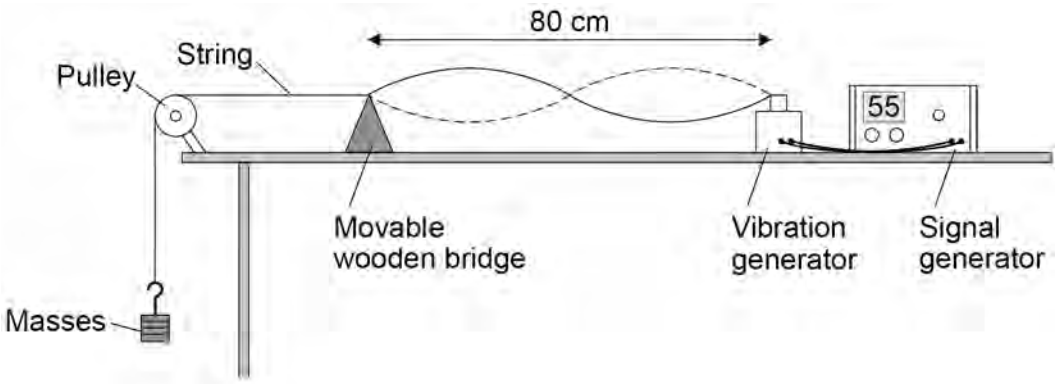
4.6.1.2 Properties of waves

Question 109

June 2019 | 8463/2H | Original Q2

0 2 **Figure 4** shows the apparatus used to investigate the waves in a stretched string.

Figure 4



The frequency of the signal generator is adjusted so that the wave shown in **Figure 4** is seen.

At this frequency the string vibrates between the two positions shown in **Figure 4**.

0 2 . 1 The wavelength of the wave shown in **Figure 4** was measured as 80 cm

What piece of apparatus would have been suitable for measuring this wavelength?

[1 mark]

0 2 . 2 Write down the equation which links frequency, wavelength and wave speed.

[1 mark]

0 2 . 3 The string in **Figure 4** vibrates at 55 Hz

Calculate the wave speed of the wave shown in **Figure 4**.

Use data given in **Figure 4**.

[3 marks]

Wave speed = _____ m/s

4.6.1.2 Properties of waves

Question 109 · continued

0 2 . 4 The frequency of the signal generator is increased.

This makes the wavelength of the wave change.

The wave speed stays the same.

Describe how the apparatus could be adjusted to show one complete wave without reducing the frequency.

[2 marks]

0 2 . 5 A student wants to investigate how the speed of a wave on a stretched string depends on the tension in the string.

The student uses the apparatus in **Figure 4**.

Describe a method the student could use for this investigation.

[4 marks]

4.6.1.2 Properties of waves

Question 110

June 2019 | 8463/2H | Original Q5

0 5 . 1 The light from distant galaxies shows red-shift.

Complete the sentence.

[1 mark]

The term red-shift describes the observed increase

in the _____ of the light from a distant galaxy.

0 5 . 2 The Big Bang theory is one model used to explain the origin of the universe.

How does the Big Bang theory describe the universe when it began?

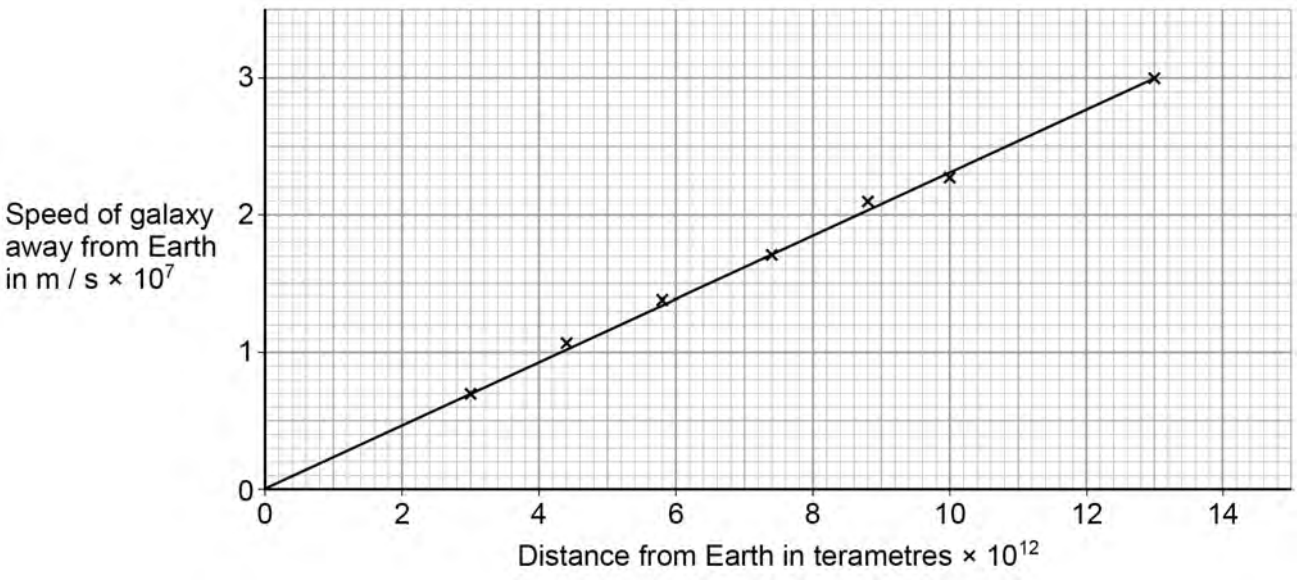
[1 mark]

_____

_____

Figure 9 shows data scientists have calculated from measurements of red-shift.

Figure 9



4.6.1.2 Properties of waves

Question 110 · continued

0 5 . 3 Describe the relationship between the speed of a galaxy and the distance the galaxy is from the Earth.

[1 mark]

0 5 . 4 Which of the following is the same as 6×10^{12} terametres?

[1 mark]

Tick (✓) **one** box.

- 6×10^{15} m ☐
- 6×10^{18} m ☐
- 6×10^{21} m ☐
- 6×10^{24} m ☐

0 5 . 5 Explain how the data in **Figure 9** supports the suggestion that the universe began from a very small region.

[2 marks]

Question 5 continues on the next page

4.6.1.2 Properties of waves

Question 110 · continued

0 5 . 6 The Big Bang theory suggested that gravity would slow the rate at which galaxies move away from the Earth.

New observations suggest that distant galaxies are moving away from the Earth at an increasingly fast rate.

What do the new observations suggest is happening to the universe?

[1 mark]

0 5 . 7 New observations and data that do not fit existing theories should undergo peer review.

Give **one** reason why peer review is an important process.

[1 mark]

0 5 . 8 The Andromeda galaxy is moving towards the Earth.

Describe how the wavelength and frequency of the light from Andromeda seem to have changed when viewed from the Earth.

[2 marks]

10

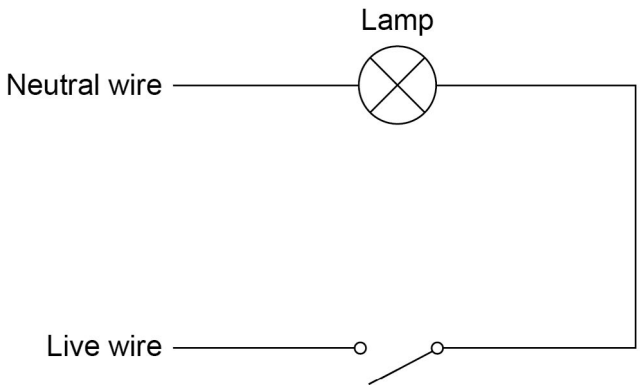
4.6.1.2 Properties of waves

Question 111

November 2020 | 8463/1H | Original Q9

0 9 **Figure 13** shows part of a mains electricity lighting circuit in a house.

Figure 13



0 9 . 1 A fault in the switch caused a householder to receive a mild electric shock before a safety device switched the circuit off.

The mean power transfer to the person was 5.75 W.

The potential difference across the person was 230 V.

Calculate the resistance of the person.

[5 marks]

Resistance = _____ Ω

4.6.1.2 Properties of waves

Question 111 · continued

0 9 . 2 An electrician replaced the switch.

The electrician would have received an electric shock unless the circuit was disconnected from the mains supply.

Explain why.

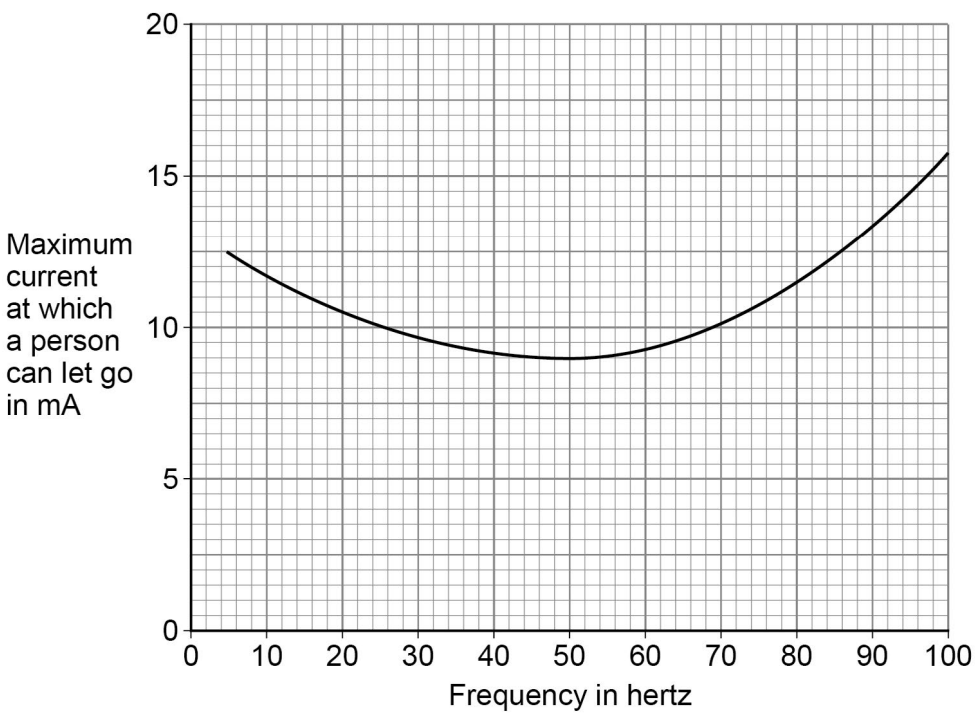
[3 marks]

Question 9 continues on the next page

0 9 . 3 The current from an electric shock causes a person's muscles to contract. The person cannot let go of the electrical circuit if the current is too high.

Figure 14 shows how the maximum current at which a person can let go depends on the frequency of the electricity supply.

Figure 14



The UK mains frequency is 50 Hz.

Explain why it would be safer if the UK mains frequency was **not** 50 Hz.

[2 marks]

10

4.6.1.2 Properties of waves

Question 112

November 2020 | 8463/2H | Original Q2

0 2 . 1 Complete the sentences.

[2 marks]

The Sun is a stable star. This is because the forces pulling inwards caused by _____ are in equilibrium with the forces pushing outwards caused by the energy released by nuclear _____.

0 2 . 2 Write down the equation that links distance travelled (s), speed (v) and time (t).

[1 mark]

_____

0 2 . 3 The mean distance between the Sun and the Earth is 1.5×10^{11} m.

Light travels at a speed of 3.0×10^{8} m/s.

Calculate the time taken for light from the Sun to reach the Earth.

[3 marks]

_____

_____

_____

_____

_____

Time = _____ s

4.6.1.2 Properties of waves

Question 112 · continued

0 2 . 4 Some stars are much more massive than the Sun.

Describe the life cycle of stars much more massive than the Sun, including the formation of new elements.

[6 marks]

Question 2 continues on the next page

4.6.1.2 Properties of waves

Question 112 · continued

0 2 . 5 Stars emit radiation with a range of wavelengths.

Which property of a star does the range of wavelengths depend on?

[1 mark]

Tick (✓) **one** box.

Density ☐

Mass ☐

Temperature ☐

Volume ☐

13

4.6.1.2 Properties of waves

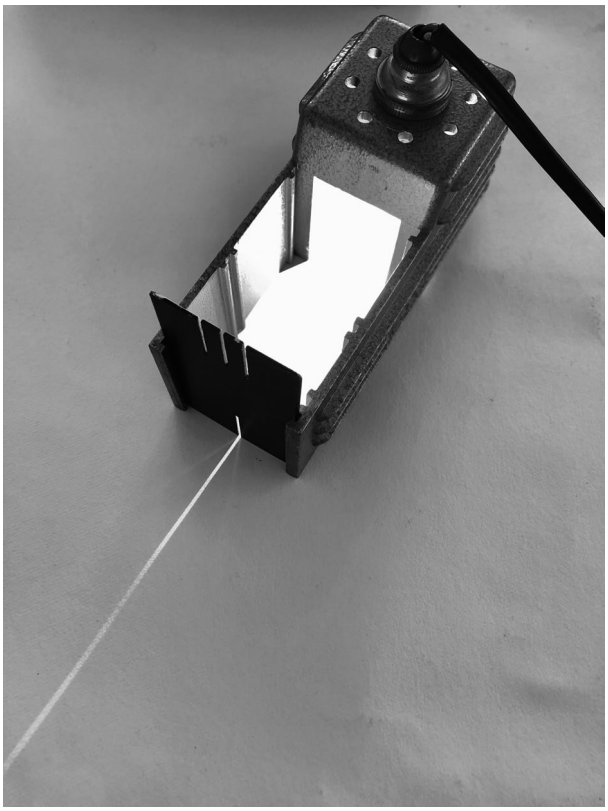
Question 113

November 2020 | 8463/2H | Original Q3

0 3 A student investigated the refraction of light at the boundary between air and glass.

Figure 3 shows the ray box used.

Figure 3



0 3 . 1 The ray of light from the ray box should be as narrow as possible.

Explain why using a wider ray would give less accurate results than using a narrower ray.

[2 marks]

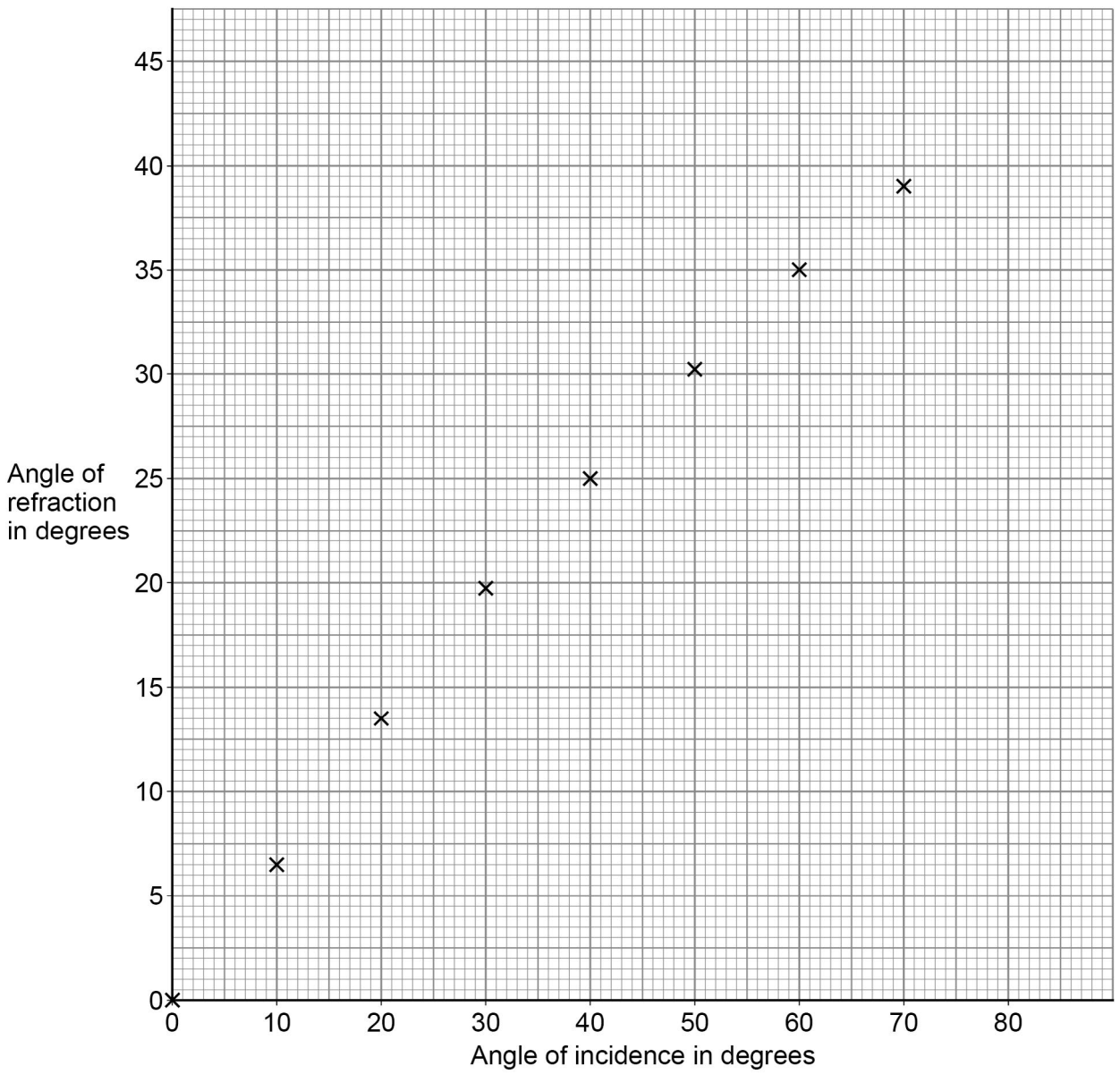
Question 3 continues on the next page

4.6.1.2 Properties of waves

Question 113 · continued

Figure 4 shows the results.

Figure 4



0 3 . 2 Estimate the angle of refraction when the angle of incidence is 80°.

Show on **Figure 4** how you obtained your answer.

[2 marks]

Angle of refraction = _____ °

4.6.1.2 Properties of waves

Question 113 · continued

0 3 . 3 Describe a method the student could have used to obtain the results shown in **Figure 4**.

[6 marks]

0 3 . 4 The student repeated each measurement three times.

When the angle of incidence was 40° the three measured values for the angle of refraction were

28° 25° 22°

Estimate the uncertainty in the angle of refraction when the angle of incidence was 40°.

Show how you determine your estimate.

[2 marks]

Uncertainty = ± _____ °

4.6.1.2 Properties of waves

Question 113 · continued

0 3 . 5 What property of the light wave changes when it is refracted?

[1 mark]

Tick (✓) **one** box.

Colour ☐

Frequency ☐

Velocity ☐

13

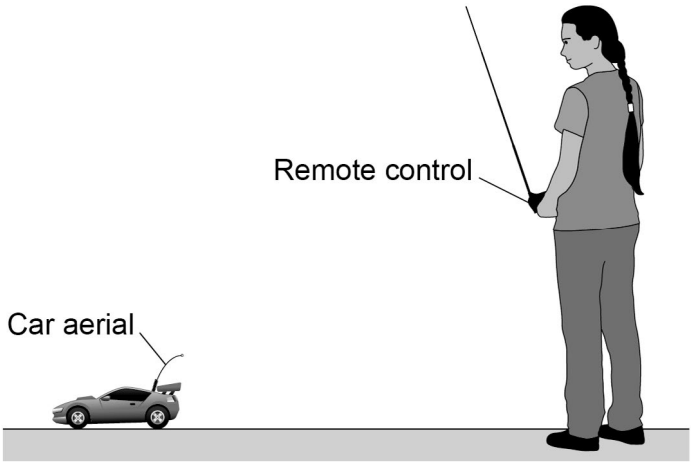
4.6.1.2 Properties of waves

Question 114

November 2020 | 8463/2H | Original Q6

0 6 **Figure 8** shows a student playing with a remote-controlled car.

Figure 8



0 6 . 1 The remote control transmits radio waves to the car aerial.

The transmitted radio waves have a frequency of 320 MHz.

speed of radio waves = 3.0×10^8 m/s

Calculate the wavelength of the radio waves.

Give the unit.

[5 marks]

Wavelength = _____ Unit _____

4.6.1.2 Properties of waves

Question 114 · continued

0 6 . 2 The car aerial is connected to an electrical circuit in the car.

Describe what happens in the electrical circuit when the car aerial absorbs radio waves.

[2 marks]

0 6 . 3 The car produces sound waves.

Give **two** ways in which radio waves are different to sound waves.

[2 marks]

1

2

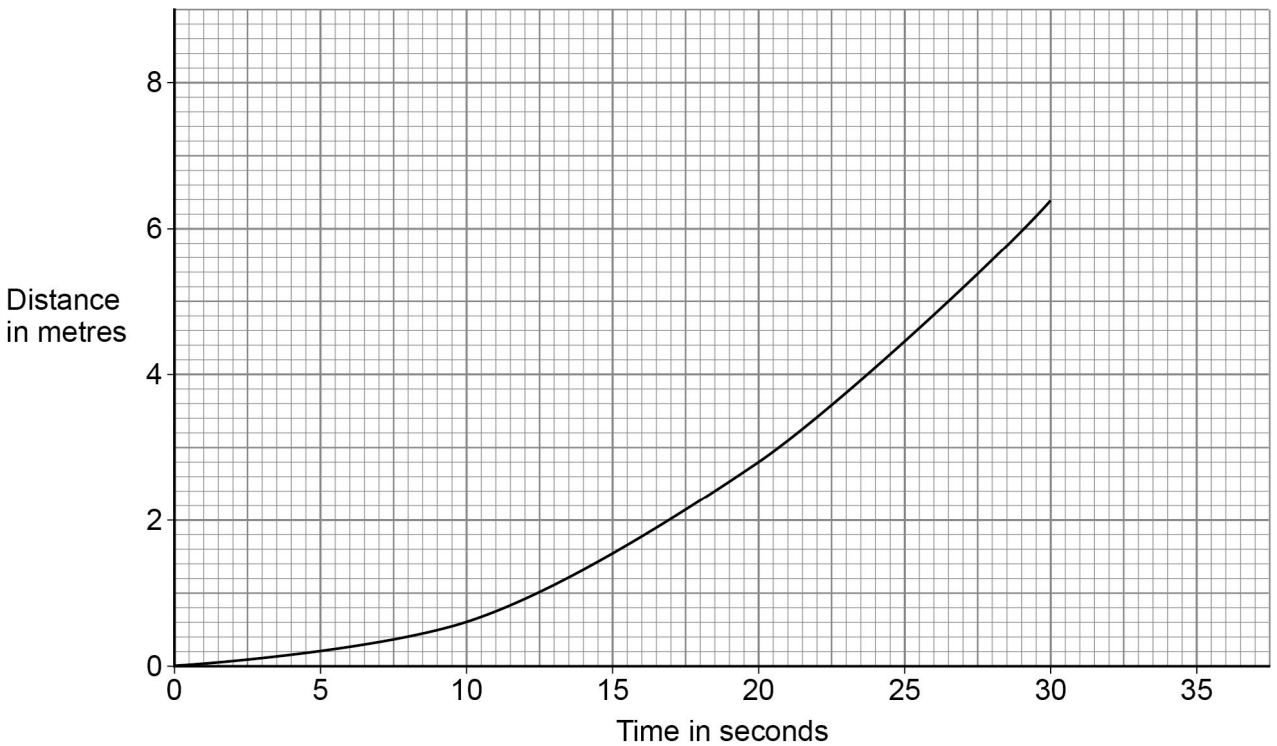
Question 6 continues on the next page

4.6.1.2 Properties of waves

Question 114 · continued

Figure 9 shows the distance-time graph for the first 30 seconds of the car's motion.

Figure 9



0 6 . 4 Describe the motion of the car during the first 30 seconds.

[1 mark]

0 6 . 5 Determine the speed of the car 20 seconds after it started to move.

[4 marks]

Speed = _____ m/s

4.6.1.2 Properties of waves

Question 114 · continued

0 6 . 6 A different car accelerated from 0.12 m/s to 0.52 m/s.

The acceleration of the car was 0.040 m/s^2.

The work done to accelerate the car was 0.48 J.

Calculate the resultant force needed to accelerate the car.

[6 marks]

Resultant force = _____ N

0 6 . 7 Explain why the car has a maximum speed.

[4 marks]

24

4.6.1.2 Properties of waves

Question 115

November 2021 | 8463/2H | Original Q3

0 3 A main sequence star in a distant galaxy is the same size and mass as the Sun.

0 3 . 1 Explain why the star is stable while it is in the main sequence stage of its life cycle.

[2 marks]

0 3 . 2 Describe what will happen to the star between the main sequence stage and the end of the star's life cycle.

You should include the names of the stages in the life cycle of the star.

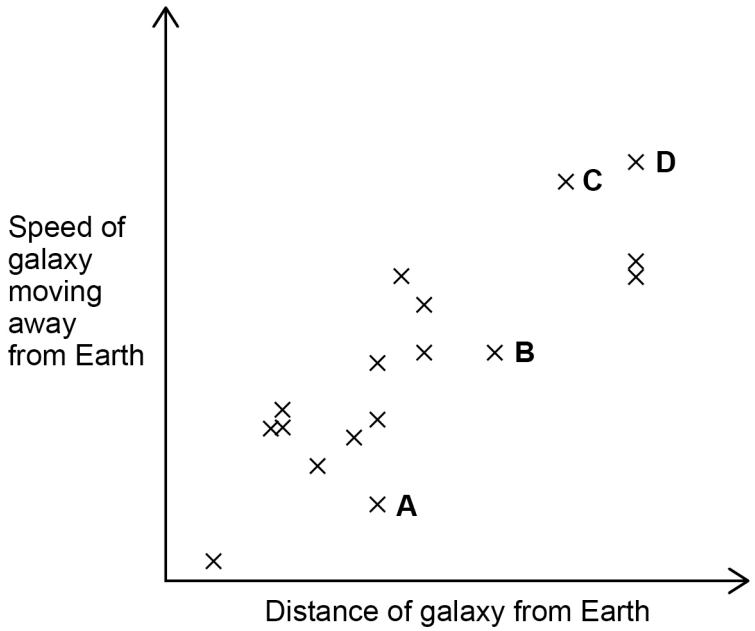
[3 marks]

4.6.1.2 Properties of waves

Question 115 · continued

0 3 . 3 **Figure 5** shows how the speed of galaxies moving away from Earth varies with the distance of the galaxies from Earth.

Figure 5



Which galaxy would show the smallest observed change in the wavelength of visible light?

Give a reason for your answer.

[2 marks]

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

Reason _____

_____

7

4.6.1.2 Properties of waves

Question 116

November 2021 | 8463/2H | Original Q5

0 5 Ultraviolet is a type of electromagnetic wave.

0 5 . 1 Give **one** use of ultraviolet.

[1 mark]

_____

0 5 . 2 An ultraviolet wave has a wavelength of 300 nanometres.

Which of the following is equal to 300 nanometres?

[1 mark]

Tick (✓) **one** box.

3×10^{7} m ☐

3×10^{-7} m ☐

3×10^{9} m ☐

3×10^{-9} m ☐

0 5 . 3 The speed of ultraviolet waves is 3×10^{8} m/s.

Calculate the frequency of the ultraviolet wave.

Use your answer to Question **05.2**

[3 marks]

_____

_____

_____

_____

_____

Frequency = _____ Hz

4.6.1.2 Properties of waves

Question 116 · continued

0 5 . 4 **Table 1** gives the wavelength of an ultraviolet wave and three other electromagnetic waves.

Table 1

	Ultraviolet	Wave E	Wave F	Wave G
Wavelength in nanometres	300	0.1	600	100 000

Draw **one** line from each wave to the name of the wave.

[1 mark]

Wave	Name
Wave E	Infrared
Wave F	Visible light
Wave G	X-rays

0 5 . 5 Electromagnetic waves are transverse.

Some other types of wave are longitudinal.

Describe the difference between transverse and longitudinal waves.

[2 marks]

8

4.6.1.2 Properties of waves

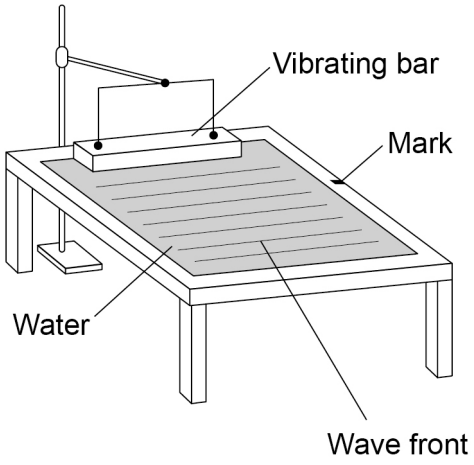
Question 117

November 2021 | 8463/2H | Original Q6

0 6 A teacher demonstrated some features of waves using a ripple tank.

Figure 10 shows the ripple tank.

Figure 10



0 6 . 1 The teacher measured the time taken for 10 wave fronts to pass the mark.

The teacher repeated this measurement three times and calculated the mean.

What is the advantage of repeating measurements and calculating a mean?

[1 mark]

4.6.1.2 Properties of waves

Question 117 · continued

0 6 . 2 The teacher's measurements for the time taken for 10 wave fronts to pass the mark were:

8.4 s 7.8 s 8.1 s

Calculate the mean frequency of the wave.

Give your answer to 2 significant figures.

[5 marks]

Mean frequency (2 significant figures) = _____ Hz

0 6 . 3 In a different investigation, the teacher wanted to determine the speed of water waves in the ripple tank.

The teacher did **not** measure the wavelength of the wave.

Explain how the teacher could determine the speed of the wave.

[3 marks]

9

4.6.1.2 Properties of waves

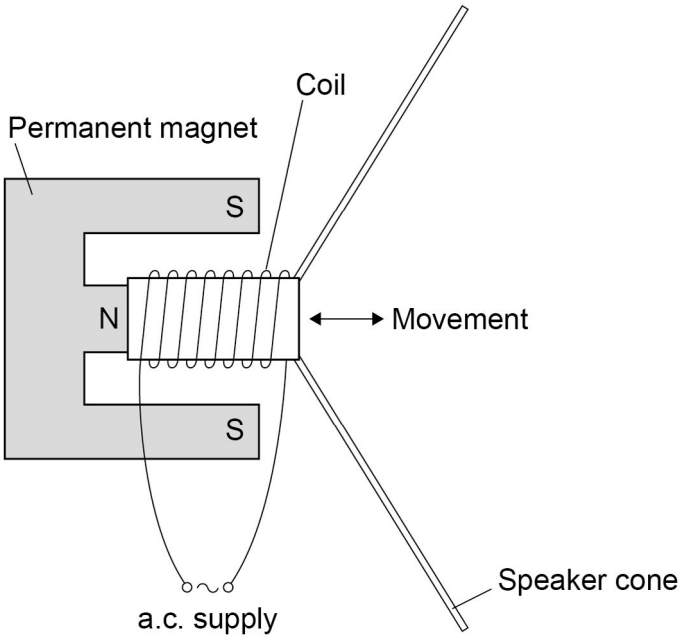
Question 118

November 2021 | 8463/2H | Original Q8

0 8 A student made a moving-coil loudspeaker.

Figure 15 shows a diagram of the loudspeaker.

Figure 15



0 8 . 1 What is the name of the effect used by the moving-coil loudspeaker to produce sound waves?

[1 mark]

4.6.1.2 Properties of waves

Question 118 · continued

0 8 . 2 Explain how a moving-coil loudspeaker produces a sound wave.

[4 marks]

Question 8 continues on the next page

4.6.1.2 Properties of waves

Question 118 · continued

0 8 . 3 A student investigated how the loudness of sound from the loudspeaker depends on:

- the number of turns on the coil
- the frequency of the supply.

Table 2 shows the results.

Table 2

Number of turns	Frequency of supply in Hz	Loudness of sound in arbitrary units
100	200	32
200	400	47
300	600	63

Explain why the results **cannot** be used to make a valid conclusion.

[2 marks]

7

4.6.1.2 Properties of waves

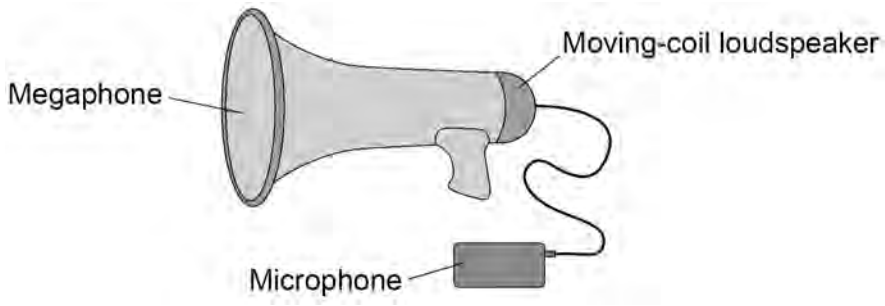
Question 119

June 2023 | 8463/2H | Original Q4

0 4 A megaphone uses a loudspeaker to amplify sounds that are detected by a microphone.

Figure 10 shows a megaphone and microphone.

Figure 10



0 4 . 1 Complete the sentence.

[1 mark]

The microphone is used to convert the pressure variations in sound waves into variations in _____ .

4.6.1.2 Properties of waves

Question 119 · continued

0 4 . 2 The loudspeaker contains a permanent magnet.

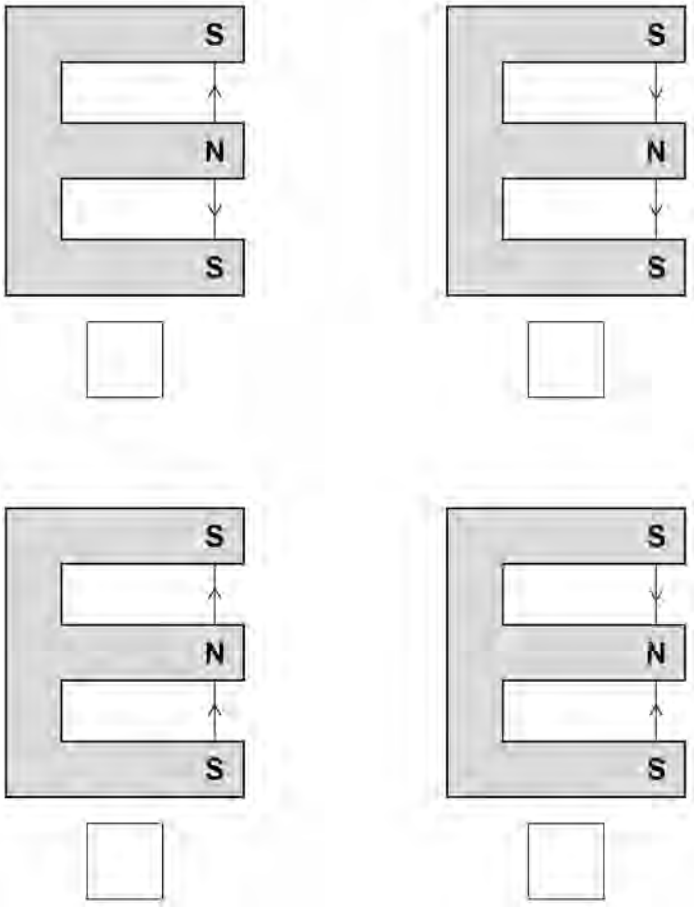
Which diagram in **Figure 11** shows the direction of the magnetic field between the north pole and the south pole of the magnet?

The magnets are shown in cross-section.

[1 mark]

Tick (✓) **one** box.

Figure 11



0 4 . 3 Some magnets are permanent magnets and some are induced magnets.

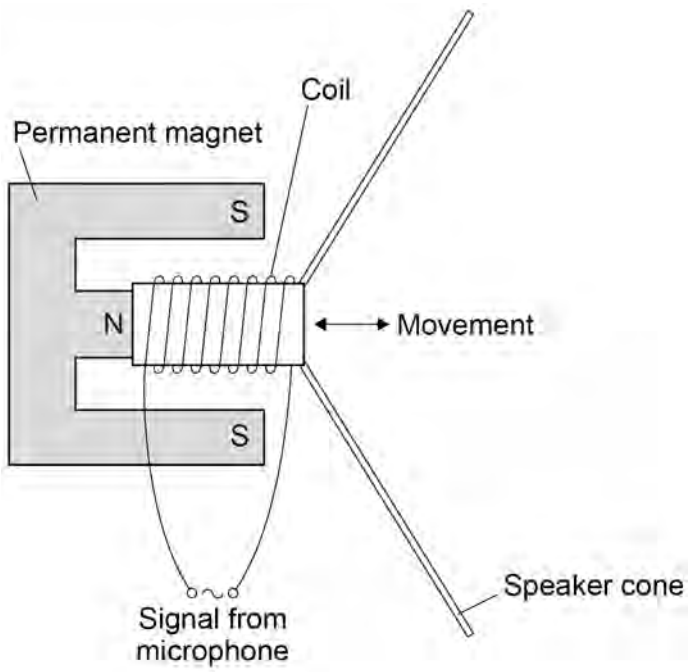
What is an induced magnet?

[1 mark]

Question 119 · continued

Figure 12 shows the parts of the loudspeaker in the megaphone.

Figure 12



A current in the coil of the loudspeaker causes the coil to move.

0 4 . 4 What is the name of the effect that causes the coil to move?

[1 mark]

Tick (✓) **one** box.

- Electromagnet effect ☐
- Induction effect ☐
- Motor effect ☐
- Speaker effect ☐

4.6.1.2 Properties of waves

Question 119 · continued

0 4 . 5 When the current in the coil is 16 mA, the force on the coil is 0.013 N.

The length of the wire that makes up the coil is 6.5 m.

Calculate the magnetic flux density around the coil in the electromagnet.

Use the Physics Equations Sheet.

[4 marks]

Magnetic flux density = _____ T

Question 4 continues on the next page

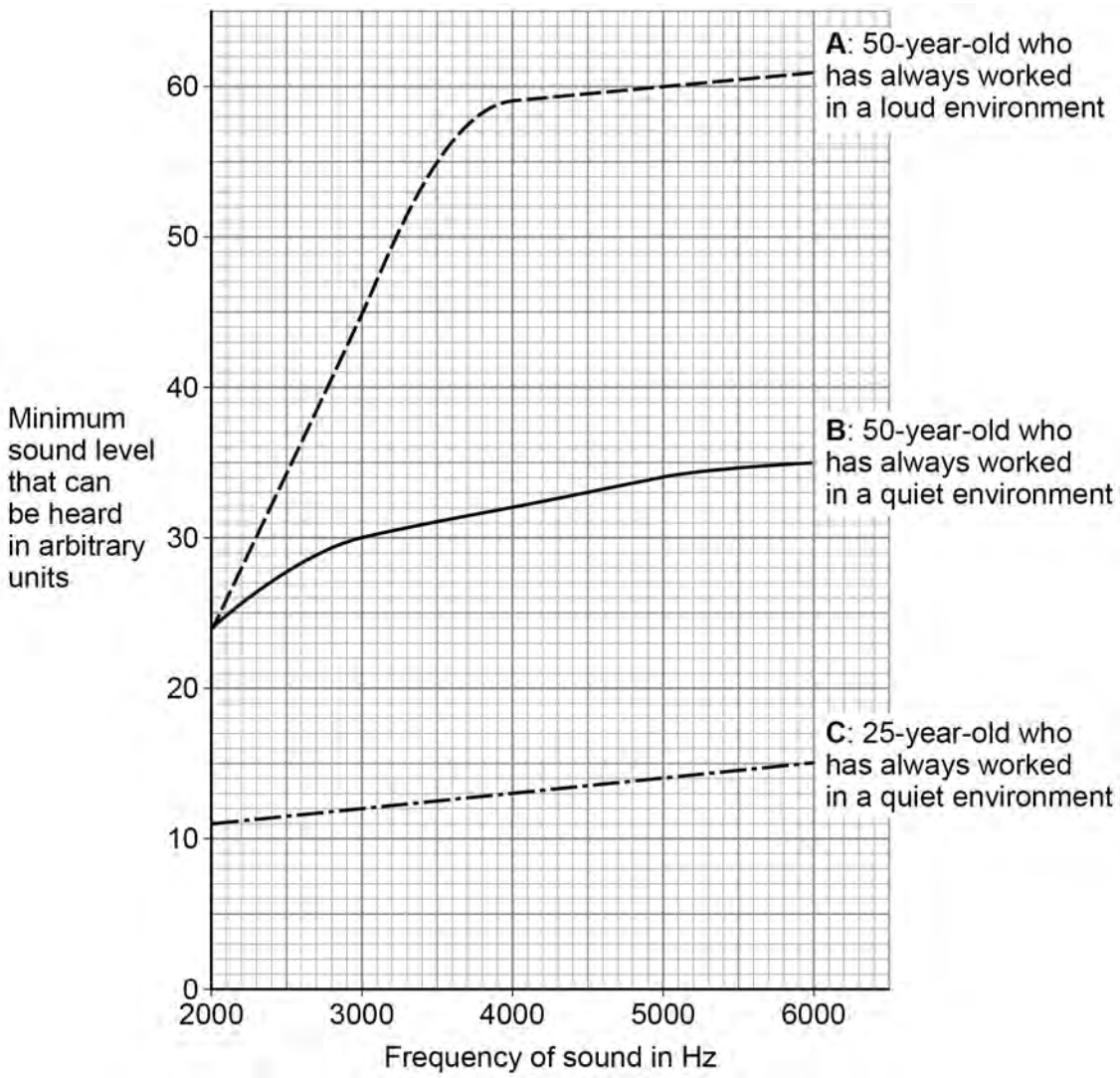
Question 119 · continued

0 4 . 6 Megaphones can produce very loud sounds.

A person's hearing can be affected by age and by working in a loud environment.

Figure 13 shows how frequency affects the minimum sound level that can be heard by three different people, **A**, **B** and **C**.

Figure 13



4.6.1.2 Properties of waves

Question 119 · continued

Compare how different factors affect the minimum sound level that these people can hear.

[4 marks]

12

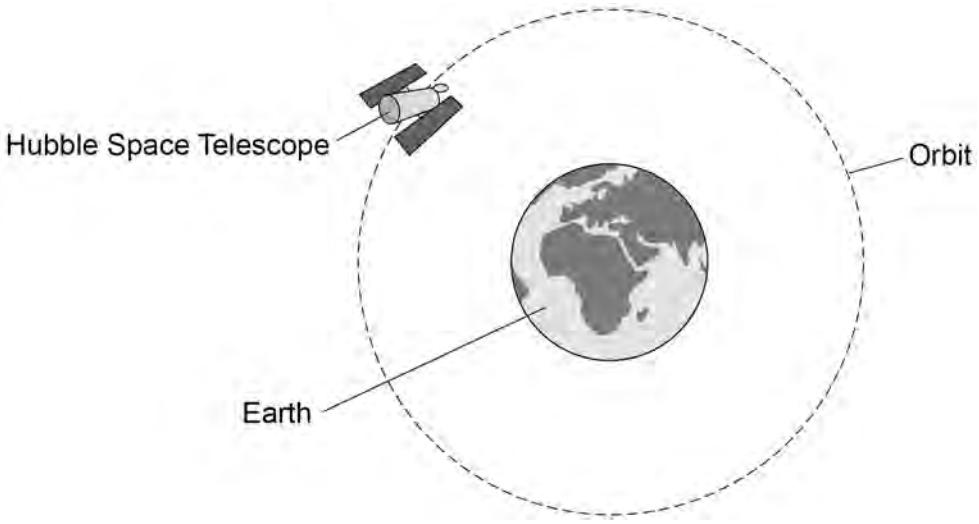
4.6.1.2 Properties of waves

Question 120

June 2023 | 8463/2H | Original Q6

0 6 **Figure 15** shows the Hubble Space Telescope orbiting the Earth.

Figure 15



0 6 . 1 What name is given to objects that orbit a planet?

[1 mark]

Question 6 continues on the next page

4.6.1.2 Properties of waves

Question 120 · continued

0 6 . 2 A space telescope uses microwaves to communicate with the Earth.

A microwave has a wavelength of 12.5 cm.

The speed of microwaves through space is 3.0×10^8 m/s.

Calculate the frequency of the microwave.

Use the Physics Equations Sheet.

Give your answer in standard form.

[5 marks]

Frequency (in standard form) = _____ Hz

0 6 . 3 Explain the effect of the Earth's gravitational force on the motion of the Hubble Space Telescope.

[3 marks]

4.6.1.2 Properties of waves

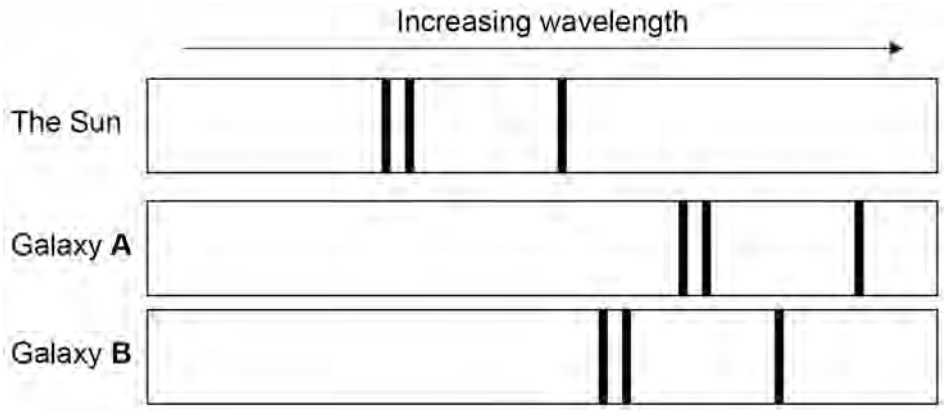
Question 120 · continued

0 6 . 4 The Hubble Space Telescope can detect visible light from distant galaxies.

The visible light spectra from stars and galaxies include dark lines at specific wavelengths.

Figure 16 shows the visible light spectra from the Sun and two galaxies.

Figure 16



Explain what conclusions can be made about galaxies **A** and **B**.

[3 marks]

12

4.6.1.2 Properties of waves

Question 121

June 2024 | 8463/1H | Original Q5

0 5 **Figure 7** shows a student putting a coin into a vending machine that sells food.

Figure 7



0 5 . 1 The vending machine is connected to the mains electricity supply.

What is the frequency and the potential difference of the mains electricity supply in the UK?

[2 marks]

Frequency = _____ Hz

Potential difference = _____ V

Question 121 · continued

The vending machine identifies the value of the coin by measuring the resistance of the coin.

0 5 . 2 The power dissipated by the coin is 340 mW when the current in the coin is 0.75 A.

Calculate the resistance of the coin.

Use the Physics Equations Sheet.

[4 marks]

Resistance = _____ Ω

0 5 . 3 Coins that are dirty are **not** recognised by the vending machine.

Suggest **one** reason why.

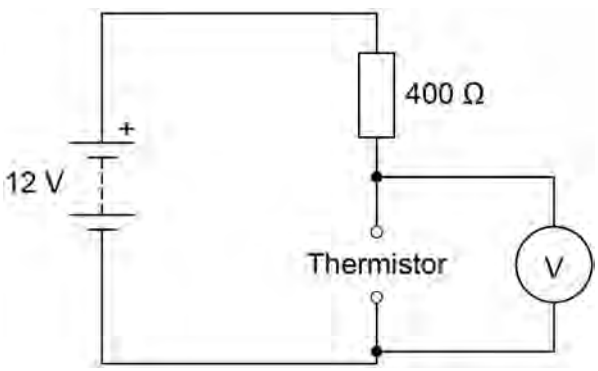
[1 mark]

Question 5 continues on the next page

Question 121 · continued

Figure 8 shows part of a different circuit that is used to monitor the temperature inside the vending machine.

Figure 8



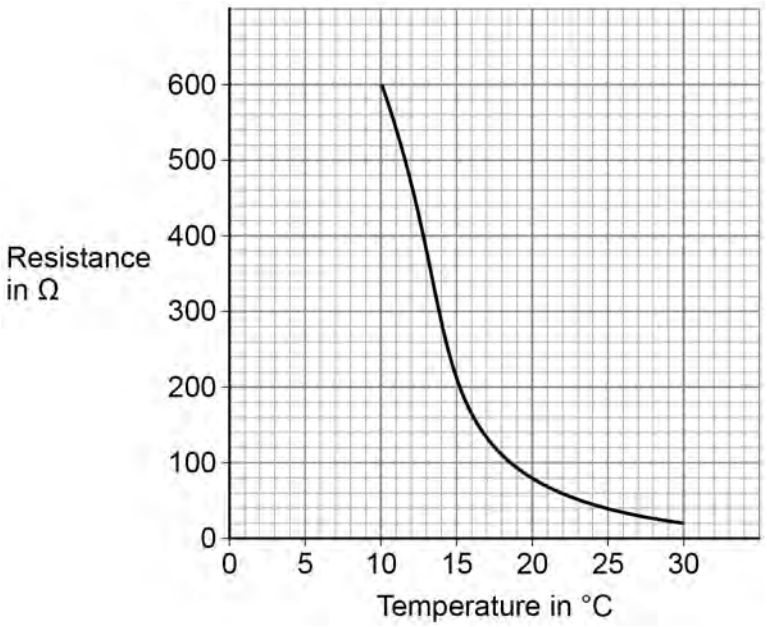
0 5 . 4 The circuit symbol for a thermistor has not been included.

Draw the circuit symbol for a thermistor in the box below.

[1 mark]

Figure 9 shows how the resistance of the thermistor varies with temperature.

Figure 9



0 5 . 5 The cooling system inside the vending machine turns on when the temperature of the thermistor is above 20 °C.

Determine the potential difference across the thermistor when the temperature is 20 °C.

Use the Physics Equations Sheet.

[5 marks]

Potential difference = _____ V

13

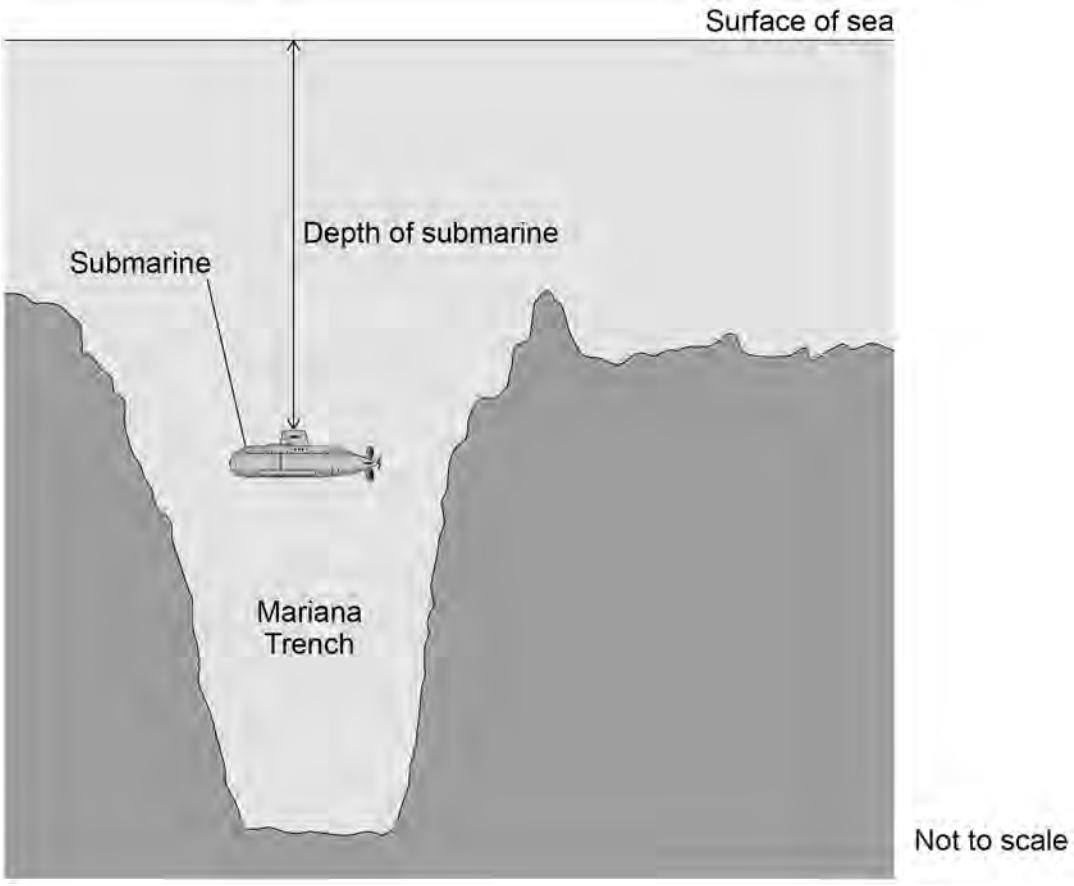
4.6.1.2 Properties of waves

Question 122

0 4 The Mariana Trench is the deepest part of the Pacific Ocean.

Figure 8 shows a submarine going to the bottom of the Mariana Trench.

Figure 8



0 4 . 1 The depth of the submarine increases.

Explain what happens to the pressure on the submarine.

[2 marks]

4.6.1.2 Properties of waves

Question 122 · continued

0 4 . 2 The submarine moved from the surface of the water to the bottom of the Mariana Trench.

The change in pressure was 110 000 kPa.

mean density of sea water = 1026 kg/m^3

gravitational field strength = 9.8 N/kg

Calculate the depth of the Mariana Trench.

Use the Physics Equations Sheet.

[4 marks]

Depth = _____ m

Question 4 continues on the next page

4.6.1.2 Properties of waves

Question 122 · continued

Earthquakes often occur at the Mariana Trench.

P-waves and S-waves are produced by earthquakes.

0 4 . 3 Which statement describes P-waves and S-waves?

[1 mark]

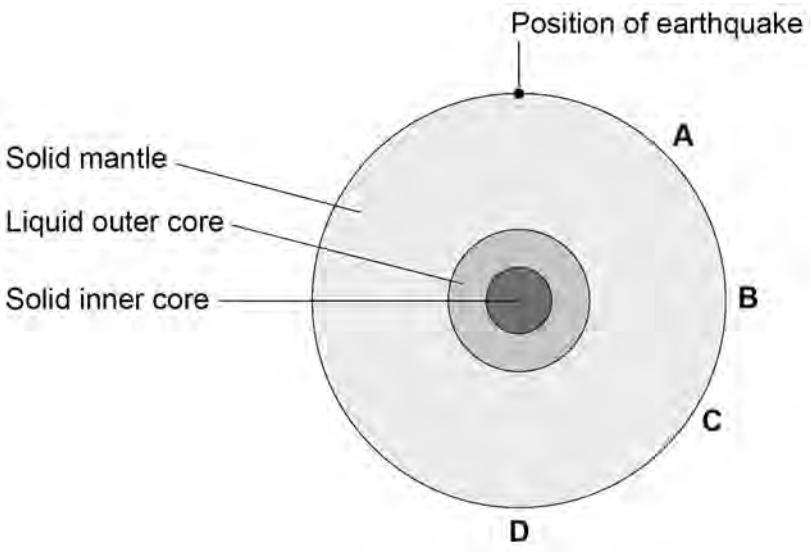
Tick (✓) **one** box.

- Both P-waves and S-waves are longitudinal. ☐
- Both P-waves and S-waves are transverse. ☐
- P-waves are longitudinal and S-waves are transverse. ☐
- P-waves are transverse and S-waves are longitudinal. ☐

0 4 . 4 **Figure 9** shows the layers inside the Earth.

An earthquake occurs at the position shown.

Figure 9



Which letter shows the position where **only** P-waves will be detected?

Give a reason for your answer.

[2 marks]

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

Reason _____

_____

Question 4 continues on the next page

4.6.1.2 Properties of waves

Question 122 · continued

0 4 . 5 An S-wave has a frequency of 3.6 Hz.

The S-wave has a speed of 4.5 km/s.

Calculate the wavelength of this S-wave.

Use the Physics Equations Sheet.

[3 marks]

Wavelength = _____ m

0 4 . 6 A seismometer is a device that detects earthquakes.

P-waves travel at a known speed between an earthquake and a seismometer.

S-waves travel at a slower speed than P-waves.

A P-wave and an S-wave from the earthquake arrive at the seismometer at different times.

Describe the relationship between the distance from the earthquake to the seismometer and the time between the P-wave and the S-wave arriving.

[2 marks]

14

4.6.1.2 Properties of waves

Question 123

June 2024 | 8463/2H | Original Q6

0 6 Radio waves and gamma rays both transfer energy.

0 6 . 1 Give **three** other similarities between radio waves and gamma rays.

[3 marks]

1 _____

_____

2 _____

_____

3 _____

_____

4.6.1.2 Properties of waves

Question 123 · continued

Both radio waves and gamma rays are used in medicine.

0 6 . 2 Give **one** medical use of gamma rays.

[1 mark]

0 6 . 3 Explain why exposure to gamma rays can be harmful but exposure to radio waves is **not** harmful.

[2 marks]

0 6 . 4 Some medical scanners produce radio waves at a specific frequency.

Explain how radio waves are produced at a specific frequency.

[2 marks]

8

4.6.1.2 Properties of waves

Question 124

June 2025 | 8463/2H | Original Q1

0 1 In a thunderstorm, lightning produces visible light waves and sound waves.

0 1 . 1 Describe the similarities and differences between visible light waves and sound waves.

[6 marks]

4.6.1.2 Properties of waves

Question 124 · continued

Use the Physics Equations Sheet to answer questions **01.2** and **01.3**.

0 1 . 2 Which equation links distance (*s*), speed (*v*) and time (*t*)?

[1 mark]

Tick (✓) **one** box.

speed = distance × time ☐

speed = $\frac{\text{distance}}{\text{time}}$ ☐

speed = $\frac{\text{time}}{\text{distance}}$ ☐

0 1 . 3 Lightning strikes the ground 13 200 m from a student.

The speed of sound in air is 330 m/s.

Calculate the time taken for the sound created by the lightning strike to reach the student.

[3 marks]

Time = _____ s

10

4.6.1.2 Properties of waves

Question 125

June 2025 | 8463/2H | Original Q4

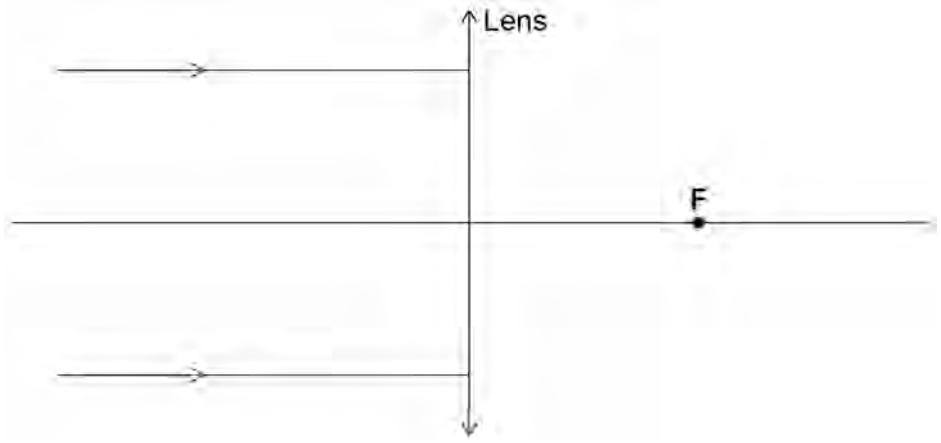
0 4 Telescopes are used to look at distant objects.

Some telescopes use lenses to form an image.

Figure 5 shows two parallel rays of light incident on a lens in a telescope.

The principal focus of the lens is labelled **F**.

Figure 5



0 4 . 1 What type of lens is shown in **Figure 5**?

[1 mark]

0 4 . 2 Complete the ray diagram in **Figure 5**.

[2 marks]

Question 4 continues on the next page

4.6.1.2 Properties of waves

Question 125 · continued

The James Webb Space Telescope can detect electromagnetic radiation beyond the visible spectrum.

0 4 . 3 The shortest wavelength of electromagnetic radiation that can be detected by the James Webb Space Telescope is 0.60 μm.

speed of electromagnetic radiation = 3.0×10^8 m/s

Calculate the frequency of electromagnetic radiation that has a wavelength of 0.60 μm.

Use the Physics Equations Sheet.

[4 marks]

Frequency = _____ Hz

0 4 . 4 Complete the sentence.

[1 mark]

Electromagnetic radiation detected from distant galaxies is red-shifted.

This means that the electromagnetic radiation shows an increase in

_____.

4.6.1.2 Properties of waves

Question 125 · continued

0 4 . 5 Why is the electromagnetic radiation from distant galaxies red-shifted?

[1 mark]

Tick (✓) **one** box.

All observed light from distant galaxies appears red. ☐

Distant galaxies are moving away from our galaxy. ☐

Distant galaxies are moving at the speed of light. ☐

0 4 . 6 The James Webb Space Telescope has detected electromagnetic radiation from many different galaxies.

Electromagnetic radiation from one of the galaxies detected shows the greatest red-shift ever observed.

What conclusion can be made about the distance to this galaxy?

[1 mark]

0 4 . 7 The James Webb Space Telescope is an artificial satellite that orbits the Sun at a constant speed.

Explain why the velocity of the satellite changes as it orbits the Sun.

[3 marks]

13