AQA GCSE Physics | 8463

SPECIFICATION POINT 4.8.1.3

Orbital motion, natural and artificial satellites

Past-paper questions

Tier	**Higher**
Question groups	**51**
Available paper years	**2003–2025**

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.

4.8.1.3 Orbital motion, natural and artificial satellites

Question 01

June 2003 | 3451H | Original Q4 | Legacy

4 (a) The table gives information about some planets.

Name of planet	Gravitational field strength in N/kg	Diameter of planet in thousands of km	Time for 1 orbit around the sun in years
Mercury	4	4.9	0.2
Venus	9	12.0	0.6
Earth	10	12.8	1.0
Jupiter	26	143.0	12.0

(i) Write down the equation that links gravitational field strength, mass and weight.

.....

(1 mark)

(ii) An astronaut has a mass of 75 kg. Calculate the weight of the astronaut on Venus. Show clearly how you work out your answer.

.....

.....

Weight of astronaut = ...newtons

(2 marks)

(iii) Why would the astronaut weigh more on the Earth than on Venus?

.....

.....

(1 mark)

(iv) The radius of the orbit of Jupiter is greater than the radius of the orbit of Mercury, Venus or the Earth. What evidence is given in the table to show this?

.....

.....

(1 mark)

4.8.1.3 Orbital motion, natural and artificial satellites

Question 01 · continued

MARGIN BLANK

(b) *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.*

Explain briefly how stars like the Sun are thought to have been formed.

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(2 marks)

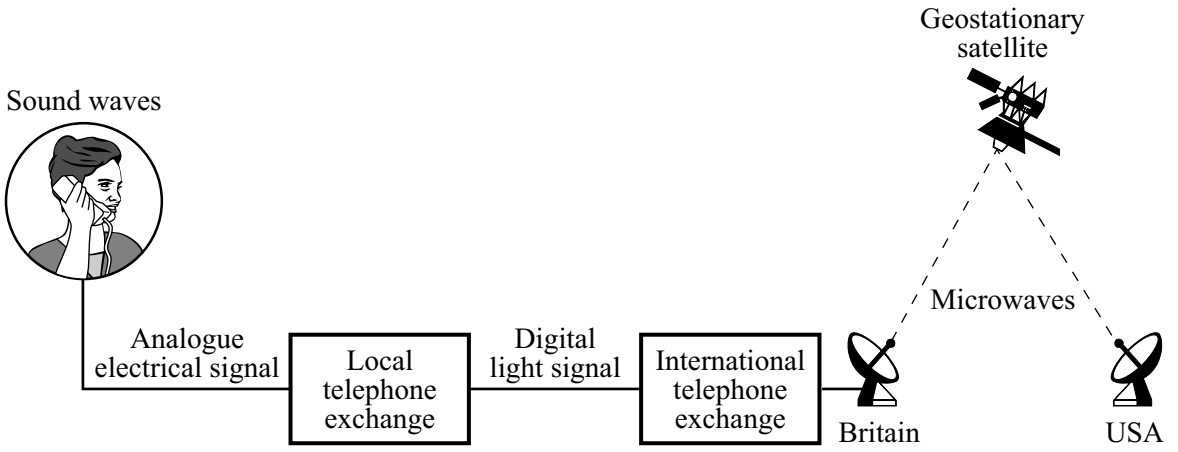
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4.8.1.3 Orbital motion, natural and artificial satellites

Question 02

June 2003 | 3451H | Original Q9 | Legacy

9 (a) The diagram shows, in a simplified form, how a telephone call can be transmitted from Britain to the USA.



(i) What is the difference between an analogue and a digital signal? You may wish to draw a diagram to help your answer.

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(2 marks)

(ii) Explain why the quality of an analogue signal transmitted over a long distance decreases, but the quality of a digital signal transmitted over the same distance does not change.

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(3 marks)

4.8.1.3 Orbital motion, natural and artificial satellites

Question 02 · continued

MARGIN BLANK

(iii) Explain why the satellite used to receive and transmit the microwave signals is placed in a geostationary orbit.

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(2 marks)

(b) The picture shows a pre-natal scan obtained using ultrasonic waves.



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

.....

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.....

.....

(2 marks)

(ii) Give another use for ultrasonic waves.

.....

(1 mark)

10

4.8.1.3 Orbital motion, natural and artificial satellites

Question 03

4 (a) The table gives information about some planets.

Name of planet	Gravitational field strength in N/kg	Diameter of planet in thousands of km	Time for 1 orbit around the sun in years
Mercury	4	4.9	0.2
Venus	9	12.0	0.6
Earth	10	12.8	1.0
Jupiter	26	143.0	12.0

(i) Write down the equation that links gravitational field strength, mass and weight.

.....

(1 mark)

(ii) An astronaut has a mass of 75 kg. Calculate the weight of the astronaut on Venus. Show clearly how you work out your answer.

.....

.....

Weight of astronaut = ...newtons

(2 marks)

(iii) Why would the astronaut weigh more on the Earth than on Venus?

.....

.....

(1 mark)

(iv) The radius of the orbit of Jupiter is greater than the radius of the orbit of Mercury, Venus or the Earth. What evidence is given in the table to show this?

.....

.....

(1 mark)

4.8.1.3 Orbital motion, natural and artificial satellites

Question 03 · continued

MARGIN BLANK

(b) *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.*

Explain briefly how stars like the Sun are thought to have been formed.

.....

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.....

(2 marks)

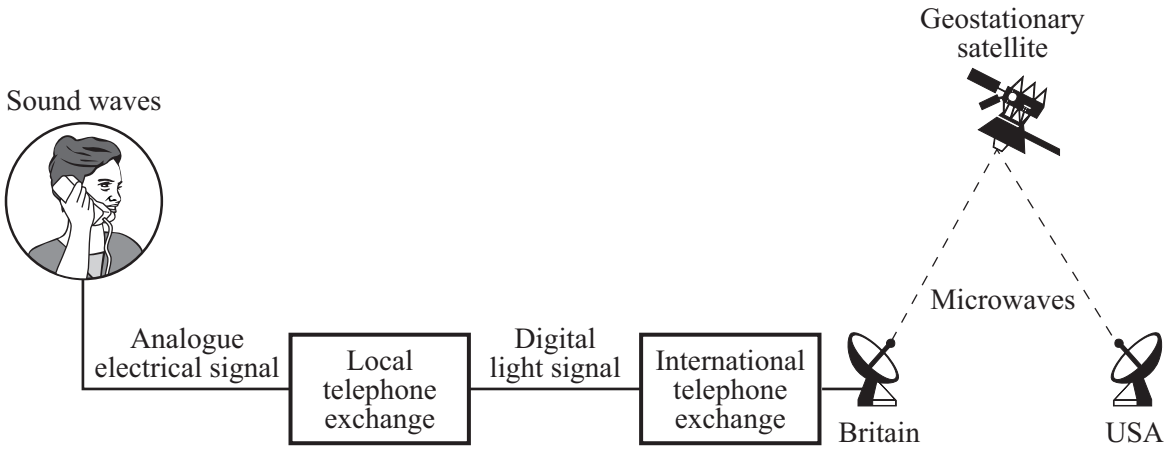
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4.8.1.3 Orbital motion, natural and artificial satellites

Question 04

June 2003 | 3462H3 | Original Q7 | Legacy

7 (a) The diagram shows, in a simplified form, how a telephone call can be transmitted from Britain to the USA.



(i) What is the difference between an analogue and a digital signal? You may wish to draw a diagram to help your answer.

.....

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(2 marks)

(ii) Explain why the quality of an analogue signal transmitted over a long distance decreases, but the quality of a digital signal transmitted over the same distance does not change.

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(3 marks)

4.8.1.3 Orbital motion, natural and artificial satellites

Question 04 · continued

MARGIN BLANK

(iii) Explain why the satellite used to receive and transmit the microwave signals is placed in a geostationary orbit.

.....

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.....

(2 marks)

(b) The picture shows a pre-natal scan obtained using ultrasonic waves.



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

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.....

.....

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(2 marks)

(ii) Give another use for ultrasonic waves.

.....

(1 mark)

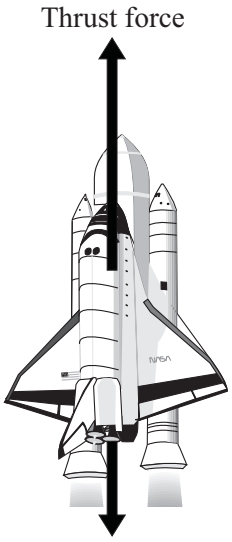
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4.8.1.3 Orbital motion, natural and artificial satellites

Question 05

June 2004 | 3451H | Original Q5 | Legacy

5 (a) The arrows in the diagram represent the size and direction of the forces on a space shuttle, fuel tank and booster rockets one second after launch. The longer the arrow the bigger the force.



(i) Describe the upward motion of the space shuttle one second after launch.

.....

(1 mark)

(ii) By the time it moves out of the Earth's atmosphere, the total weight of the space shuttle, fuel tank and booster rockets has decreased and so has the air resistance.

How does this change the motion of the space shuttle? (Assume the thrust force does not change).

.....

(1 mark)

(b) The space shuttle takes 9 minutes to reach its orbital velocity of 8100 m/s.

(i) Write down the equation that links acceleration, change in velocity and time taken.

.....

(1 mark)

(ii) Calculate, in m/s^2, the average acceleration of the space shuttle during the first 9 minutes of its flight. Show clearly how you work out your answer.

.....

.....

average acceleration =.....m/s^2

(2 marks)

4.8.1.3 Orbital motion, natural and artificial satellites

Question 05 · continued

MARGIN BLANK

(iii) How is the velocity of an object different from the speed of an object?

.....

.....

(1 mark)

(c) The space shuttle can stay in orbit around the Earth for several weeks.



Not to scale

Explain why the space shuttle stays in orbit and does not fall to the Earth.

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(2 marks)

(d) As the shuttle returns to Earth, friction causes its outside temperature to go as high as 1200°C.

Why is the underneath of the shuttle covered with black tiles?

.....

.....

(1 mark)

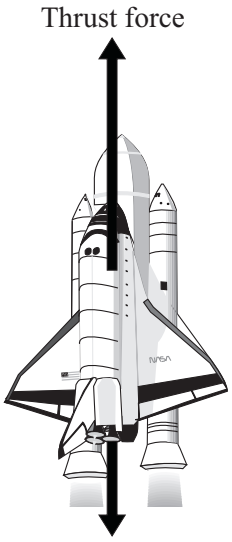
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4.8.1.3 Orbital motion, natural and artificial satellites

Question 06

June 2004 | 3462H3 | Original Q5 | Legacy

5 (a) The arrows in the diagram represent the size and direction of the forces on a space shuttle, fuel tank and booster rockets one second after launch. The longer the arrow the bigger the force.



(i) Describe the upward motion of the space shuttle one second after launch.

.....

(1 mark)

(ii) By the time it moves out of the Earth's atmosphere, the total weight of the space shuttle, fuel tank and booster rockets has decreased and so has the air resistance.

How does this change the motion of the space shuttle? (Assume the thrust force does not change).

.....

(1 mark)

(b) The space shuttle takes 9 minutes to reach its orbital velocity of 8100 m/s.

(i) Write down the equation that links acceleration, change in velocity and time taken.

.....

(1 mark)

(ii) Calculate, in m/s^2, the average acceleration of the space shuttle during the first 9 minutes of its flight. Show clearly how you work out your answer.

.....

.....

average acceleration =.....m/s^2

(2 marks)

4.8.1.3 Orbital motion, natural and artificial satellites

Question 06 · continued

MARGIN BLANK

(iii) How is the velocity of an object different from the speed of an object?

.....

.....

(1 mark)

(c) The space shuttle can stay in orbit around the Earth for several weeks.



Not to scale

Explain why the space shuttle stays in orbit and does not fall to the Earth.

.....

.....

.....

.....

(2 marks)

(d) As the shuttle returns to Earth, friction causes its outside temperature to go as high as 1200ºC.

Why is the underneath of the shuttle covered with black tiles?

.....

.....

(1 mark)

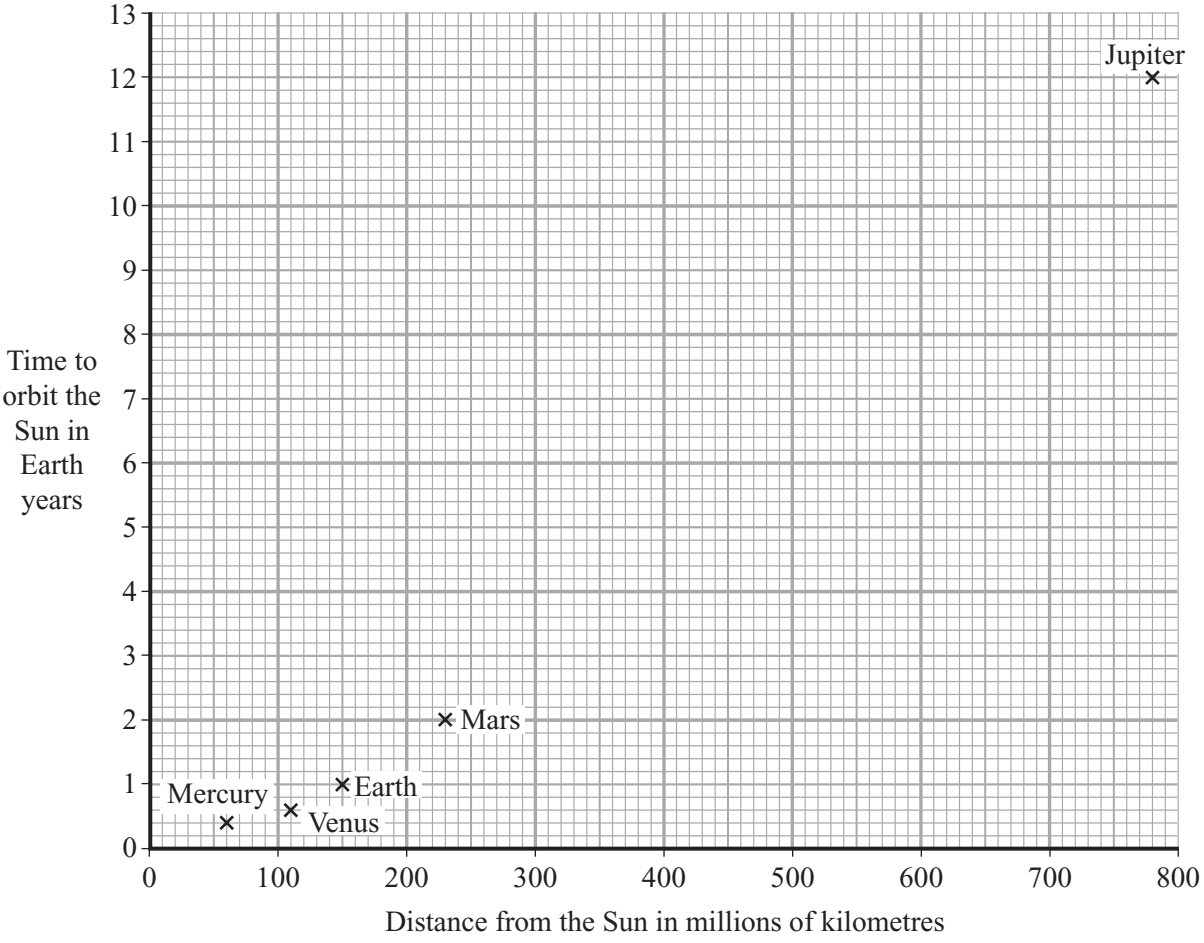
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4.8.1.3 Orbital motion, natural and artificial satellites

Question 07

June 2005 | 3451 | Original Q2 | Legacy

2 (a) The chart shows that the time taken by a planet to orbit the Sun depends on its distance from the Sun.



(i) How does the time taken by a planet to orbit the Sun depend on the distance the planet is from the Sun?

.....

.....

(1 mark)

(ii) Asteroids orbit the Sun. One asteroid is 550 million kilometres from the Sun.

Estimate how long this asteroid takes to orbit the Sun.

Time to orbit the Sun = ... Earth years

(1 mark)

4.8.1.3 Orbital motion, natural and artificial satellites

Question 07 · continued

MARGIN BLANK

(b) The atmosphere on Venus contains a large percentage of a greenhouse gas.

	Mercury	Venus	Earth
Average surface temperature	230 °C	470 °C	20 °C

(i) Which **one** of these gases increases the greenhouse effect? Draw a ring around your answer.

argon **carbon dioxide** **nitrogen** **oxygen**

(1 mark)

(ii) Explain how the information in the table and the chart shows that the atmosphere of Venus produces a greenhouse effect.

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(2 marks)

5

TURN OVER FOR THE NEXT QUESTION

4.8.1.3 Orbital motion, natural and artificial satellites

Question 08

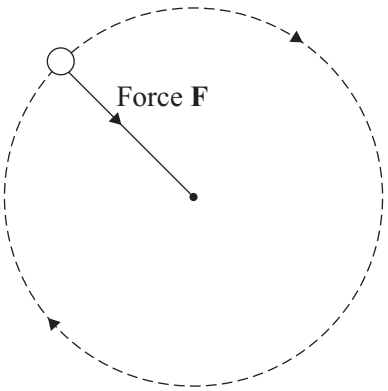
June 2005 | 3451 | Original Q5 | Legacy

5 (a) A student has fastened a ball to a piece of string and is swinging it round in a horizontal circle.



(i) The diagram below shows an overhead view of the movement of the ball.

Add an arrow, from the centre of the ball, to show the direction in which the ball would move if the string broke at this instant.



(1 mark)

(ii) Complete the table to show how force **F** changes if the student changes what he is doing. In each case, all the other factors stay the same.

If the student	Force F needs to
uses a ball with a greater mass	.....
swings the ball at a greater speed	.....
swings the ball with a shorter piece of string	.....

(3 marks)

4.8.1.3 Orbital motion, natural and artificial satellites

Question 08 · continued

MARGIN BLANK

(b) The Moon orbits the Earth in a circular path.

Use words from the box to complete the **three** spaces in the sentence.

direction	**resistance**	**speed**	**velocity**

You may use each word once, more than once or not at all.

The Moon's ..... is constant but its ..... changes because its ..... changes.

(2 marks)

(c) When any object moves in a circular, or nearly circular, path a force must act towards the centre of the circle.

(i) What word is used to describe this force?

.....

(1 mark)

(ii) The Moon orbits the Earth. What provides the force towards the Earth?

.....

(1 mark)

(iii) In an atom, name the particles which are moving in circular paths around the nucleus.

.....

(1 mark)

(iv) In the case of an atom, what word describes the forces which keep these particles moving in circular paths around the nucleus?

.....

(1 mark)

10

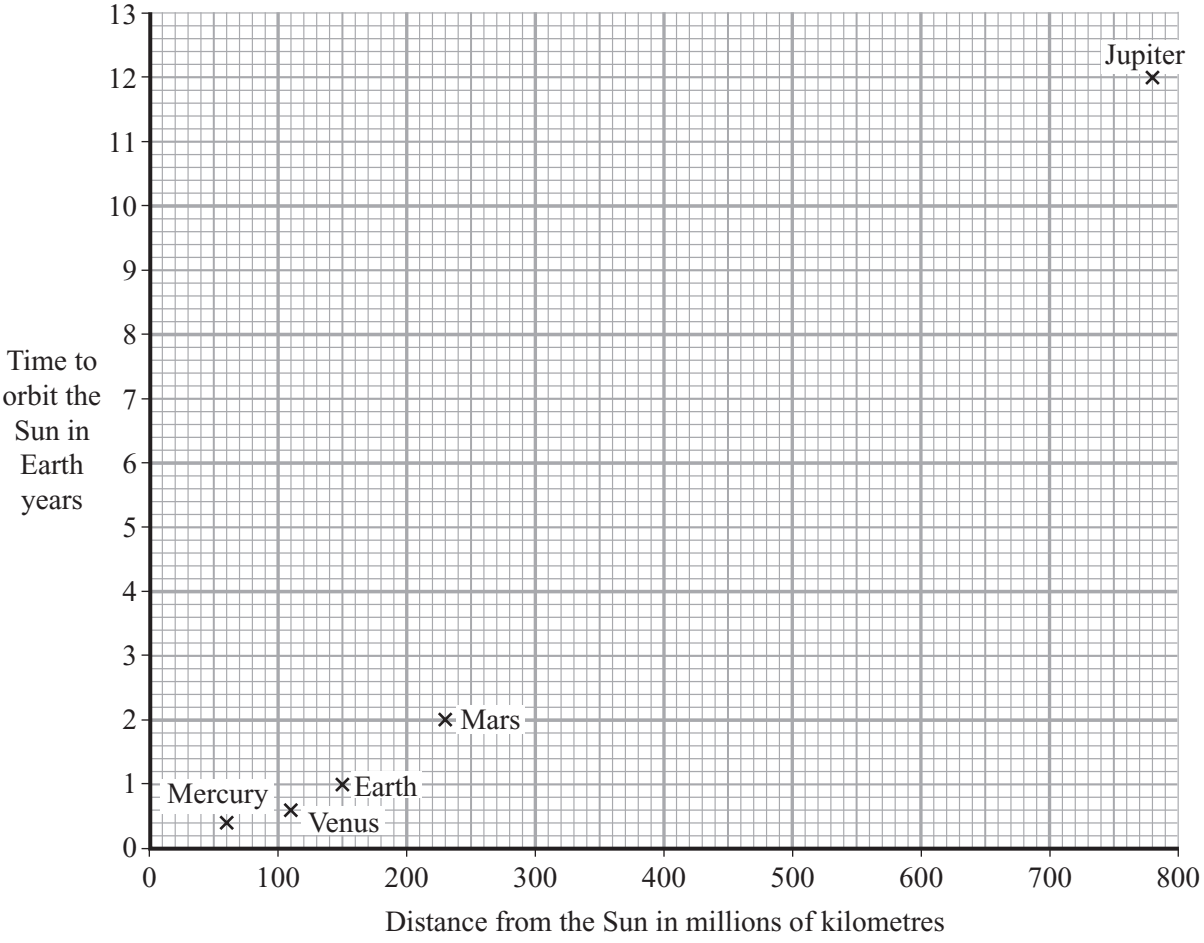
TURN OVER FOR THE NEXT QUESTION

4.8.1.3 Orbital motion, natural and artificial satellites

Question 09

June 2005 | 3462 | Original Q2 | Legacy

2 (a) The chart shows that the time taken by a planet to orbit the Sun depends on its distance from the Sun.



(i) How does the time taken by a planet to orbit the Sun depend on the distance the planet is from the Sun?

.....

.....

(1 mark)

(ii) Asteroids orbit the Sun. One asteroid is 550 million kilometres from the Sun.

Estimate how long this asteroid takes to orbit the Sun.

Time to orbit the Sun = ... Earth years

(1 mark)

4.8.1.3 Orbital motion, natural and artificial satellites

Question 09 · continued

MARGIN BLANK

(b) The atmosphere on Venus contains a large percentage of a greenhouse gas.

	Mercury	Venus	Earth
Average surface temperature	230 °C	470 °C	20 °C

(i) Which **one** of these gases increases the greenhouse effect? Draw a ring around your answer.

argon **carbon dioxide** **nitrogen** **oxygen**

(1 mark)

(ii) Explain how the information in the table and the chart shows that the atmosphere of Venus produces a greenhouse effect.

.....

.....

.....

.....

(2 marks)

5

TURN OVER FOR THE NEXT QUESTION

4.8.1.3 Orbital motion, natural and artificial satellites

Question 10

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.

4.8.1.3 Orbital motion, natural and artificial satellites

Question 10 · 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.

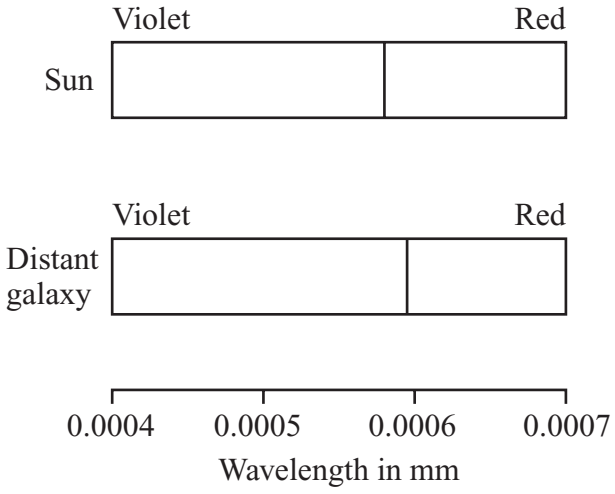
4 X-rays.

Turn over for the next question

4.8.1.3 Orbital motion, natural and artificial satellites

Question 11

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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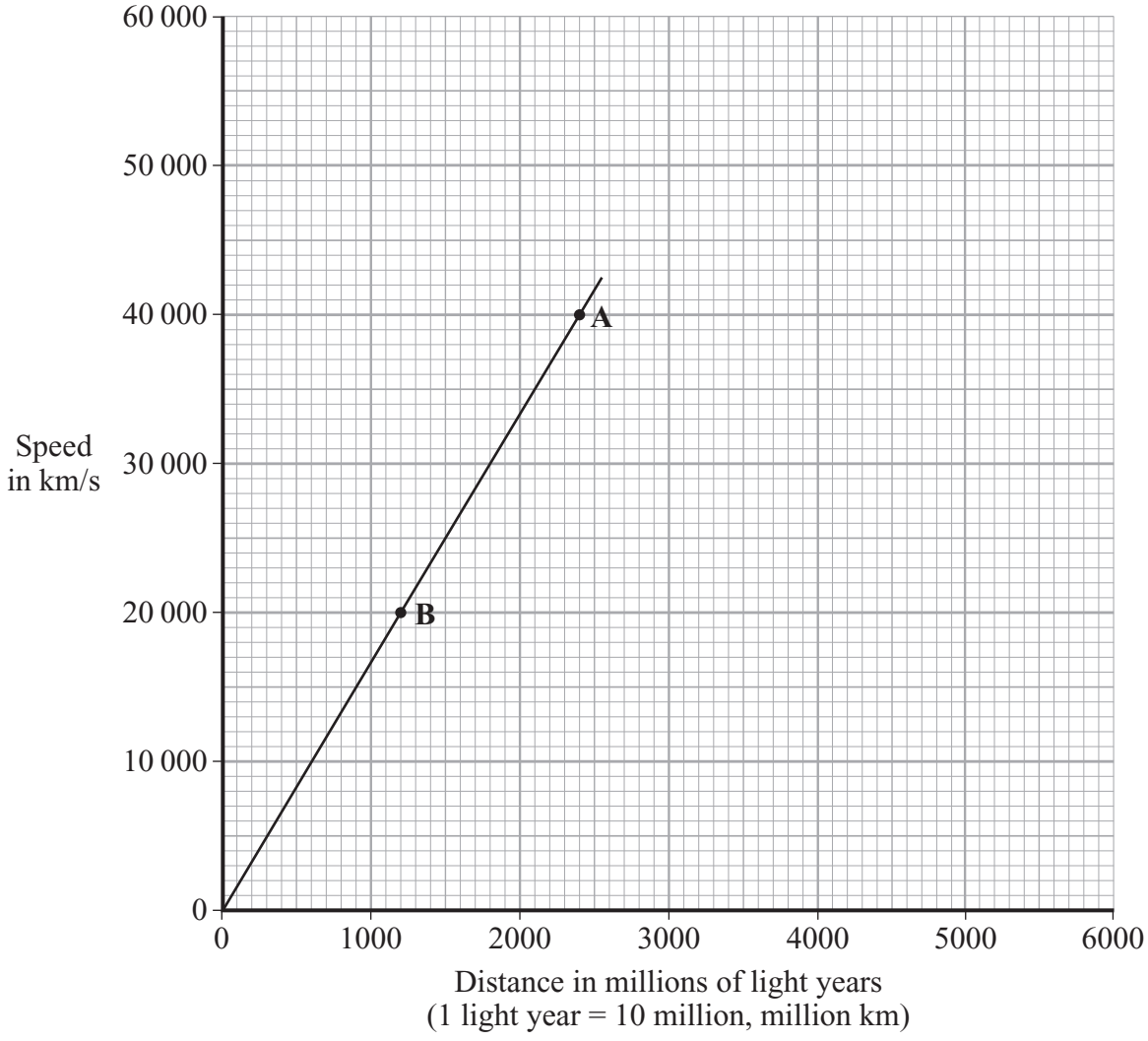
(3 marks)

Question 3 continues on the next page

Question 11 · 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)

4.8.1.3 Orbital motion, natural and artificial satellites

Question 11 · 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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.....

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(2 marks)

8

4.8.1.3 Orbital motion, natural and artificial satellites

Question 12

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.

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(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)

4.8.1.3 Orbital motion, natural and artificial satellites

Question 12 · continued

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

(i) Describe the 'big bang' theory.

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(2 marks)

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

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(1 mark)

8

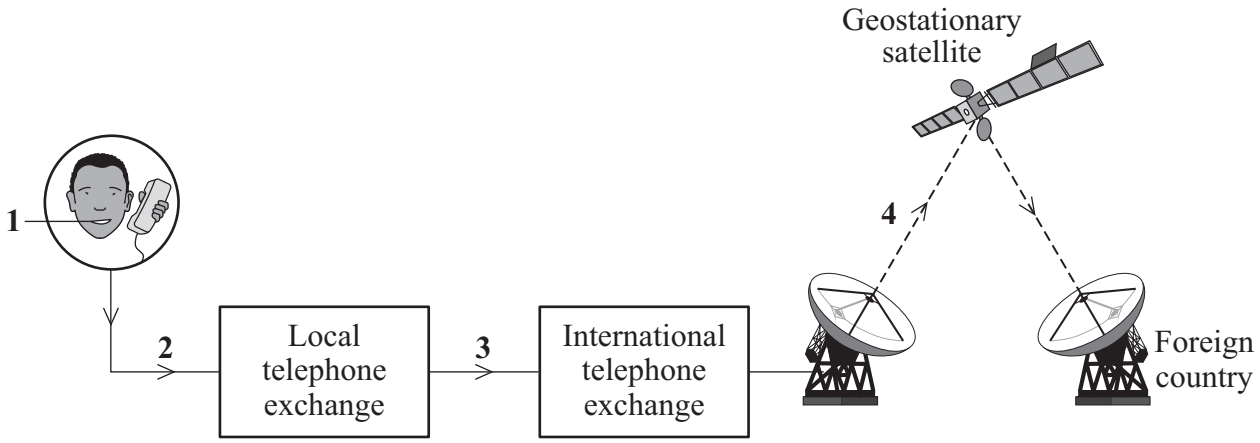
4.8.1.3 Orbital motion, natural and artificial satellites

Question 13

November 2007 | PHY1B | Original Q1 | Legacy

QUESTION ONE

The diagram shows how a telephone call can be made to a foreign country.



Match waves and signals, **A**, **B**, **C** and **D**, with the numbers **1–4** on the diagram.

A analogue electrical signal

B digital light signal

C microwaves

D sound waves

4.8.1.3 Orbital motion, natural and artificial satellites

Question 14

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)

4.8.1.3 Orbital motion, natural and artificial satellites

Question 14 · continued

BLANK

(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?

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.....

(1 mark)

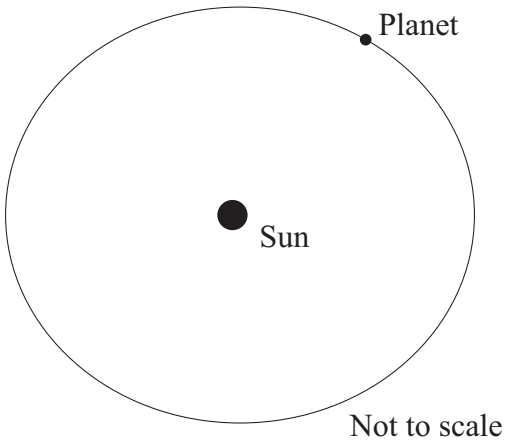
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Turn over for the next question

4.8.1.3 Orbital motion, natural and artificial satellites

Question 15

3 (a) The diagram shows the orbit of a planet in the Solar System. The orbit is in the shape of a slightly squashed circle.



(i) What is the name of this orbit shape?

.....

(1 mark)

(ii) Complete the sentence.

The Sun is at one .....of this shape.

(1 mark)

(iii) What provides the centripetal force which allows the planet to maintain its nearly circular orbit?

.....

(1 mark)

(iv) What is the relationship between the time it takes each planet in the Solar System to complete its orbit and the planet's average distance from the Sun?

.....

.....

(1 mark)

4.8.1.3 Orbital motion, natural and artificial satellites

Question 15 · continued

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(b) Scientists have detected an object orbiting the Sun at a distance of about 17 billion kilometres. Some scientists think that the object, named Sedna, should be classified as a planet. However, some other scientists disagree.

What do you think scientists should do?

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

Scientists should decide by voting. ☐

Scientists should wait until they have more evidence. ☐

Give a reason for your answer.

.....

.....

.....

(1 mark)

5

4.8.1.3 Orbital motion, natural and artificial satellites

Question 16

March 2008 | PHY1BP | Original Q4 | Legacy

QUESTION FOUR

Microwaves have many uses.

4A Microwaves can be used to cook food because they . . .

1 are at a high temperature when they leave the source in the oven.

2 travel straight through the food.

3 encourage the food to combine with oxygen.

4 transfer kinetic energy to the water molecules in the food.

4B Microwaves are used to transmit television broadcasts via a satellite because . . .

1 they can penetrate the atmosphere without significant loss of energy.

2 they do not interfere with aircraft navigation systems.

3 they have a longer wavelength than radio waves.

4 they have a lower frequency than radio waves.

4C More and more television and telephone transmissions use digital signals because digital signals . . .

1 are cheaper to use than analogue signals.

2 cause less risk to health.

3 are less prone to interference.

4 travel faster than analogue signals.

4D Some scientists think that mobile phones may be a health risk.

Their main concern is that the microwaves emitted by mobile phones . . .

1 may cause blistering of the ears.

2 may cause blindness.

3 may cause deafness.

4 may cause damage to genetic material in cells.

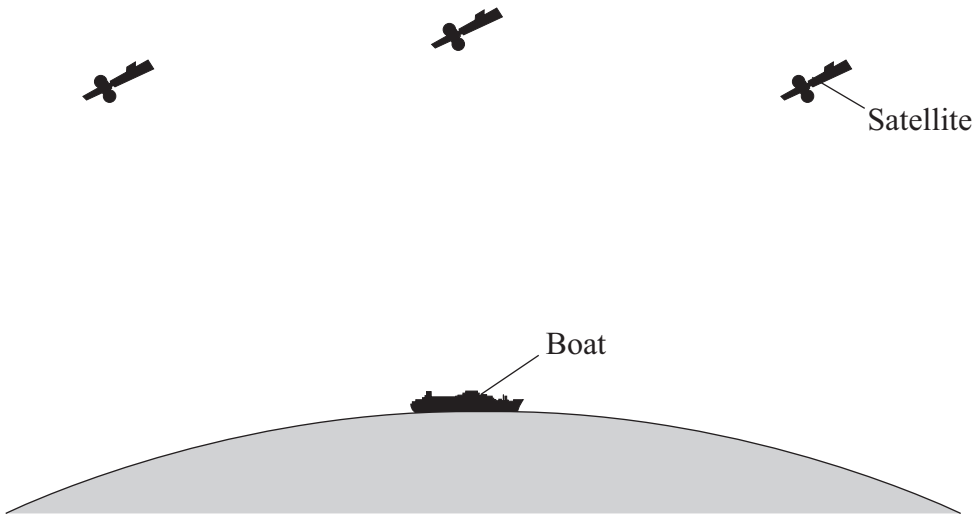
4.8.1.3 Orbital motion, natural and artificial satellites

Question 17

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 17 · 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?

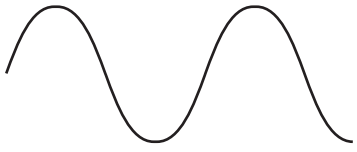
1 3.33 Hz

2 30 000 000 Hz

3 33 000 000 Hz

4 3 000 000 000 Hz

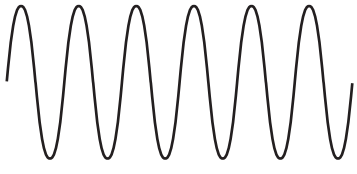
6D Which of these signals could be processed by a computer within the navigation system?



1



2



3



4

4.8.1.3 Orbital motion, natural and artificial satellites

Question 18

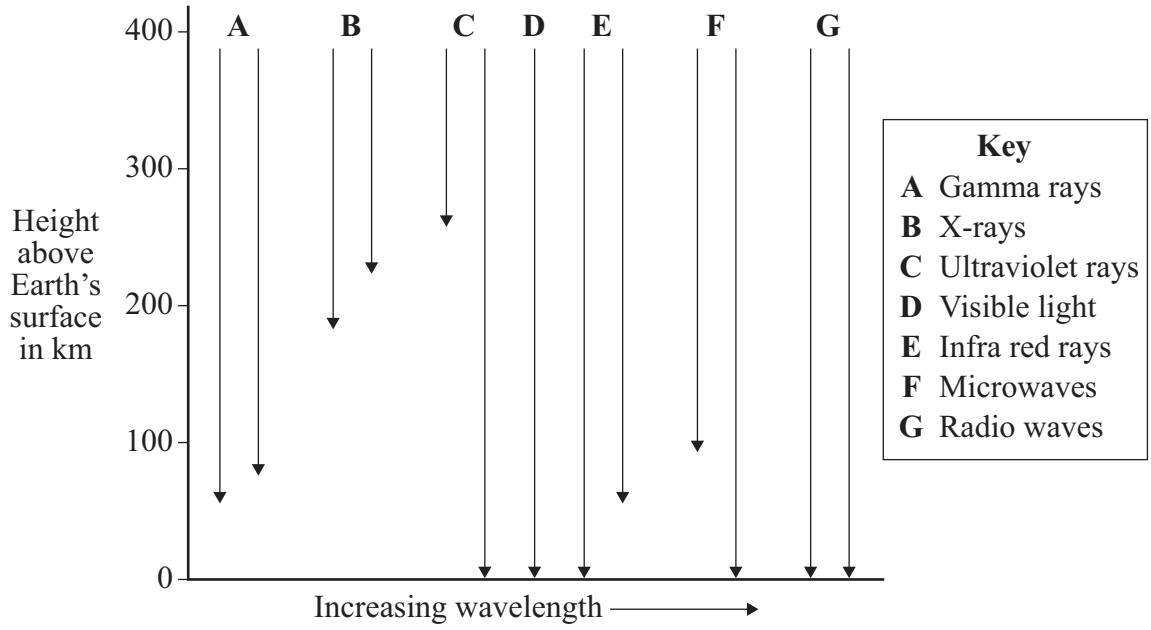
March 2008 | PHY1BP | Original Q9 | Legacy

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

4.8.1.3 Orbital motion, natural and artificial satellites

Question 18 · continued March 2008 | PHY1BP | Original Q9 | Legacy

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

4.8.1.3 Orbital motion, natural and artificial satellites

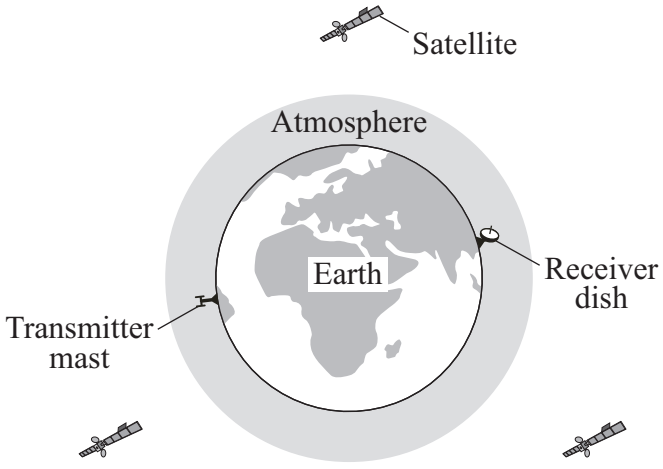
Question 19

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.

Question 19 · continued

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

4.8.1.3 Orbital motion, natural and artificial satellites

Question 20

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.

.....

.....

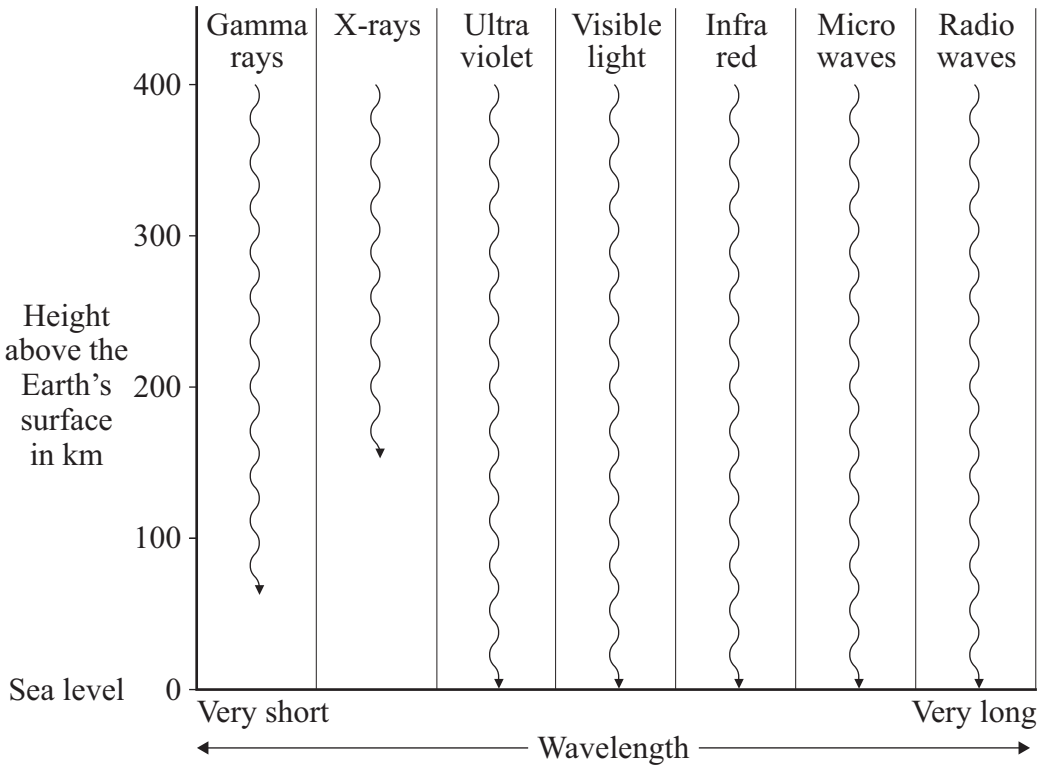
(1 mark)

4.8.1.3 Orbital motion, natural and artificial satellites

Question 20 · 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

4.8.1.3 Orbital motion, natural and artificial satellites

Question 21

June 2008 | PHY3H | Original Q2 | Legacy

2 (a) Thousands of artificial satellites are now in orbit around the Earth. A student used the Internet to collect information about four of them.

The table shows the data that the student collected.

Satellite	Altitude (= height above the surface of the Earth) in kilometres	Period of orbit in hours
A	300	1.5
B	850	1.7
C	20 000	12.0
D	36 000	24.0

2 (a) (i) What conclusion, on the relationship between the altitude of a satellite and its period of its orbit, can the student come to from this data?

.....

.....

(1 mark)

2 (a) (ii) Any conclusion from the data in the table may not be valid for all satellites.

Give **two** reasons.

1 .....

.....

2 .....

.....

(2 marks)

2 (b) The Moon is the Earth's only natural satellite.

Explain how the Moon stays in a nearly circular orbit around the Earth.

.....

.....

.....

(2 marks)

Question 2 continues on the next page

4.8.1.3 Orbital motion, natural and artificial satellites

Question 21 · continued

for mark

2 (c) Two students see a film in which people on a spaceship hear an explosion on another spaceship.

The students think that this is not possible. What scientific evidence supports their opinion?

.....

.....

(1 mark)

2 (d) Some people say that space should not be explored.

Do you agree with them? Explain your answer.

.....

.....

.....

(2 marks)

8

4.8.1.3 Orbital motion, natural and artificial satellites

Question 22

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.

4.8.1.3 Orbital motion, natural and artificial satellites

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

4.8.1.3 Orbital motion, natural and artificial satellites

Question 23

January 2009 | PHY1H | Original Q4 | Legacy

4 Most elements have some *isotopes* which are *radioactive*.

4 (a) What is meant by the terms:

4 (a) (i) *isotopes*

.....

.....

(1 mark)

4 (a) (ii) *radioactive*?

.....

.....

(1 mark)

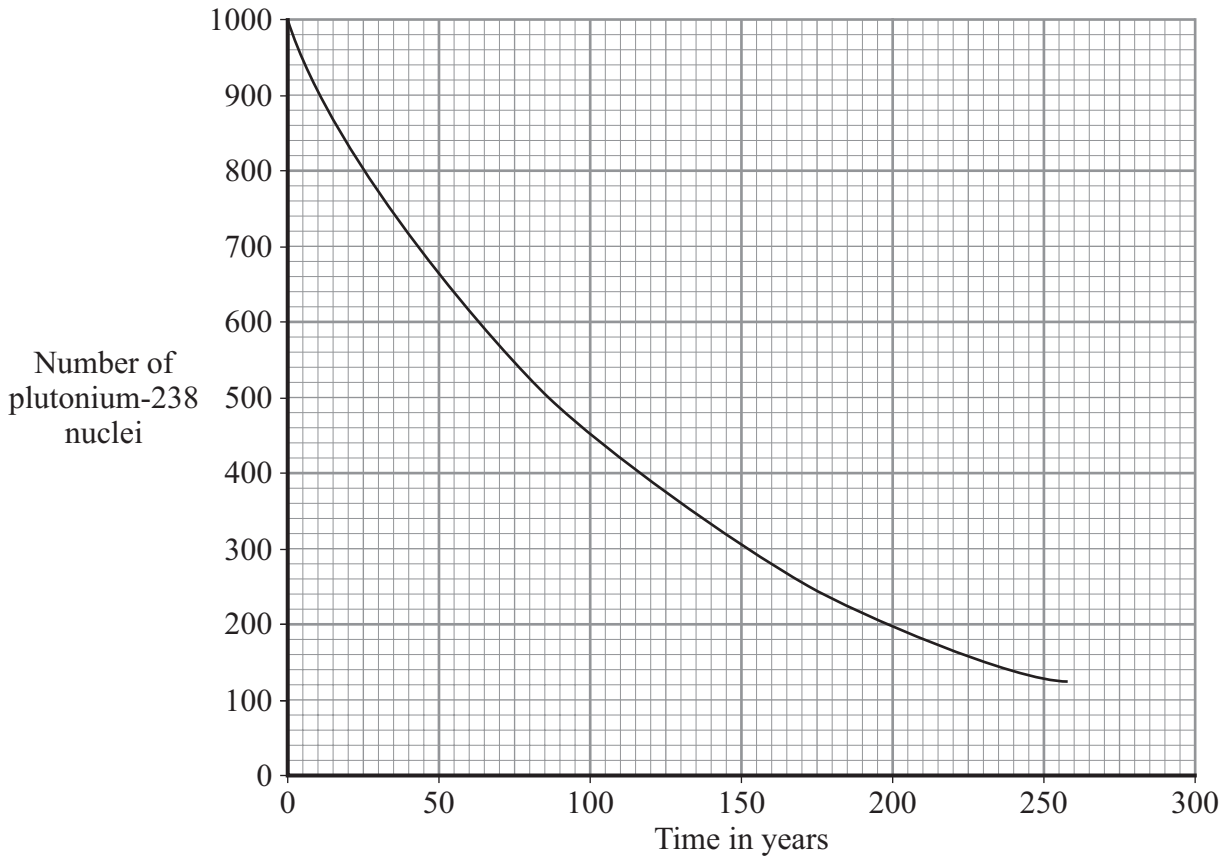
Question 4 continues on the next page

4.8.1.3 Orbital motion, natural and artificial satellites

Question 23 · continued

for mark

4 (b) The graph shows how the number of nuclei in a sample of the radioactive isotope plutonium-238 changes with time.



Use the graph to find the half-life of plutonium-238.

Show clearly on the graph how you obtain your answer.

Half-life = ... years

(2 marks)

4 (c) The Cassini spacecraft launched in 1997 took seven years to reach Saturn.
The electricity to power the instruments on board the spacecraft is generated using the heat produced from the decay of plutonium-238.

4 (c) (i) Plutonium-238 decays by emitting alpha particles.

What is an alpha particle?

.....

(1 mark)

4.8.1.3 Orbital motion, natural and artificial satellites

Question 23 · continued

for mark

4 (c) (ii) During the 11 years that Cassini will orbit Saturn, the output from the generators will decrease.

Explain why.

.....

.....

.....

.....

(2 marks)

4 (d) Plutonium-238 is highly dangerous. A tiny amount taken into the body is enough to kill a human.

4 (d) (i) Plutonium-238 is unlikely to cause any harm if it is outside the body but is likely to kill if it is inside the body.

Explain why.

.....

.....

.....

.....

(2 marks)

4 (d) (ii) In 1964, a satellite powered by plutonium-238 was destroyed, causing the release of radioactive material into the atmosphere.

Suggest why some environmental groups protested about the launch of Cassini.

.....

.....

(1 mark)

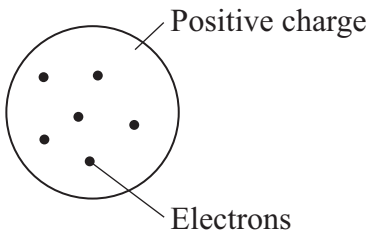
10

4.8.1.3 Orbital motion, natural and artificial satellites

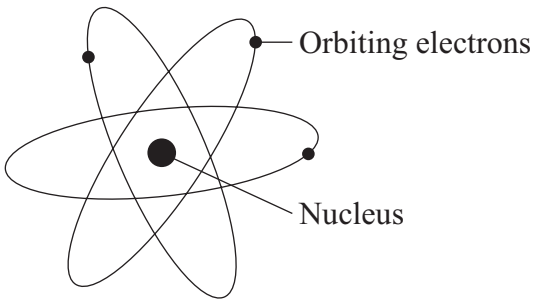
Question 24

January 2009 | PHY2H | Original Q7 | Legacy

7 In the early part of the 20th century, scientists used the 'plum pudding' model to explain the structure of the atom.



Following work by Rutherford and Marsden, a new model of the atom, called the 'nuclear' model, was suggested.



7 (a) Describe the differences between the two models of the atom.

.....

.....

.....

.....

.....

.....

.....

.....

(4 marks)

4.8.1.3 Orbital motion, natural and artificial satellites

Question 24 · continued

for mark

7 (b) In their investigation, Rutherford and Marsden fired positively charged alpha particles at a very thin sheet of gold. Over a period of several months, the scientists made over 100 000 measurements. These measurements showed that:

- a very small number of alpha particles were deflected backwards from the gold foil.

Use the nuclear model to explain this experimental result.

.....

.....

.....

.....

(2 marks)

7 (c) Why did the work of Rutherford and Marsden convince many scientists that the 'plum pudding' model of the atom was incorrect?

.....

.....

.....

.....

(2 marks)

8

4.8.1.3 Orbital motion, natural and artificial satellites

Question 25

January 2009 | PHY3H | Original Q5 | Legacy

5 The table gives data on the Solar System.

Name of planet	Average distance from the Sun in millions of kilometres	Average orbital speed in kilometres per second
Mercury	60	48
Venus	108	35
Earth	150	30
Mars	228	24
Jupiter	778	13
Saturn	1430	9.6
Uranus	2860	6.8

5 (a) A student studies this data and comes to the following conclusion.

> For the planets in the table, the average orbital speed is very nearly inversely proportional to the planet's average distance from the Sun.

5 (a) (i) This conclusion is **not** correct.

Use the data for Saturn and Uranus to explain how the student's conclusion is not correct.

.....

.....

.....

.....

(2 marks)

4.8.1.3 Orbital motion, natural and artificial satellites

Question 25 · continued

for mark

5 (a) (ii) For all the listed planets, write a correct conclusion for the connection between the average distance from the Sun and the orbital speed.

.....

.....

.....

.....

(2 marks)

5 (b) The student knows the following:

The planets all move in ellipses (slightly squashed circles).

What is the connection between this statement and the headings in the table?

.....

.....

.....

.....

(2 marks)

6

4.8.1.3 Orbital motion, natural and artificial satellites

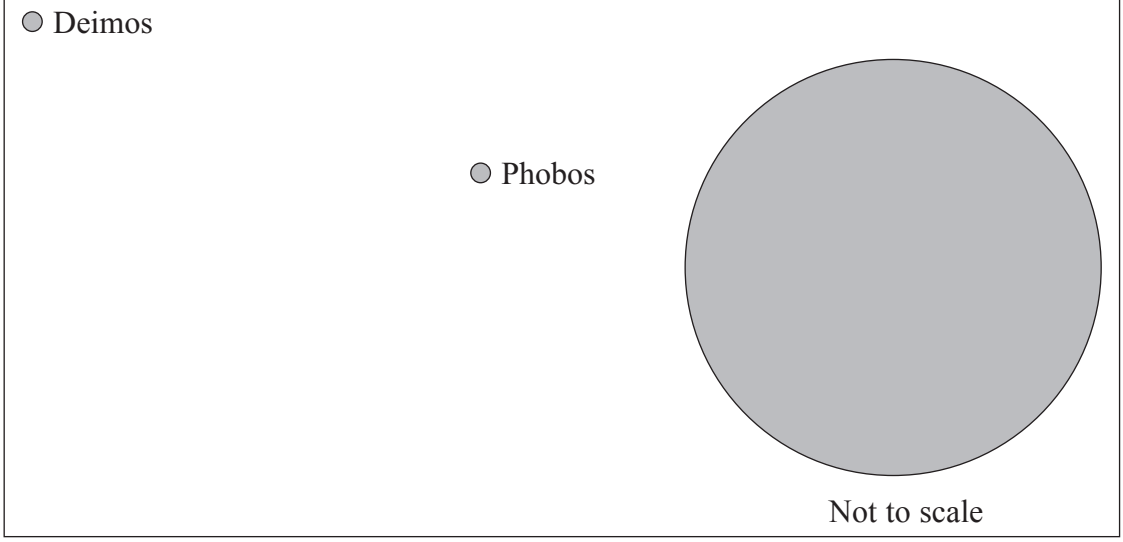
Question 26

6 This page is from a science magazine.

The Red Planet

The two natural satellites, or moons, of Mars are Phobos (fear) and Deimos (terror). They are named after the horses which pulled the chariot of Mars, the god of war in the mythology of Ancient Greece.

Phobos takes less than eight hours to orbit Mars and gets slightly closer every time it does so. Scientists predict that in about 100 million years time it will either be ripped apart by the gravitational force or will crash onto the surface of Mars.



4.8.1.3 Orbital motion, natural and artificial satellites

Question 26 · continued

for mark

6 (a) Suggest how scientists have arrived at their prediction of about 100 million years.

.....

.....

.....

.....

(2 marks)

6 (b) The centripetal force on Phobos is gradually changing as it orbits Mars.

Is the force increasing or decreasing?

.....

Explain your answer.

.....

.....

.....

(2 marks)

6 (c) Scientists expect that the mass of Mars and the mass of Phobos will not increase.

Explain what will happen to the gravitational force on Phobos as it orbits Mars.

.....

.....

.....

.....

(2 marks)

6

4.8.1.3 Orbital motion, natural and artificial satellites

Question 27

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)

4.8.1.3 Orbital motion, natural and artificial satellites

Question 27 · 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.

.....

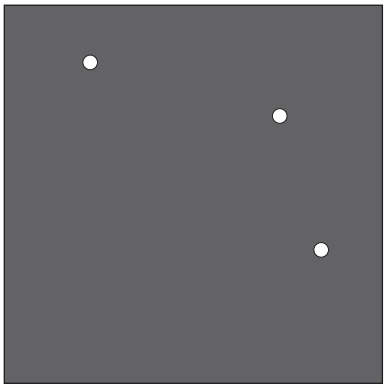
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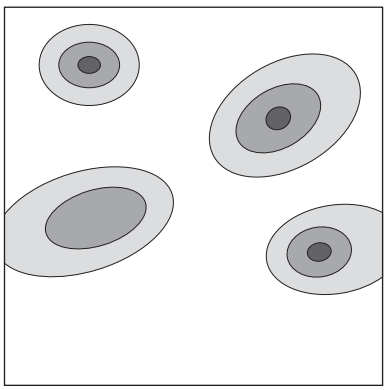
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(2 marks)

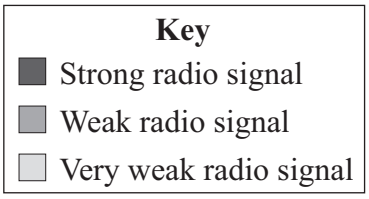
1 (d) The pictures represent the images produced using a visible light telescope and a radio telescope. Both images are of the same part of the sky. The shading on the radio telescope image represents the strength of the radio signals.



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

4.8.1.3 Orbital motion, natural and artificial satellites

Question 28

November 2009 | PHY1BP | Original Q9 | Legacy

QUESTION NINE

Visible light from space can be gathered and focused by optical telescopes.

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

1 as ground-based telescopes.

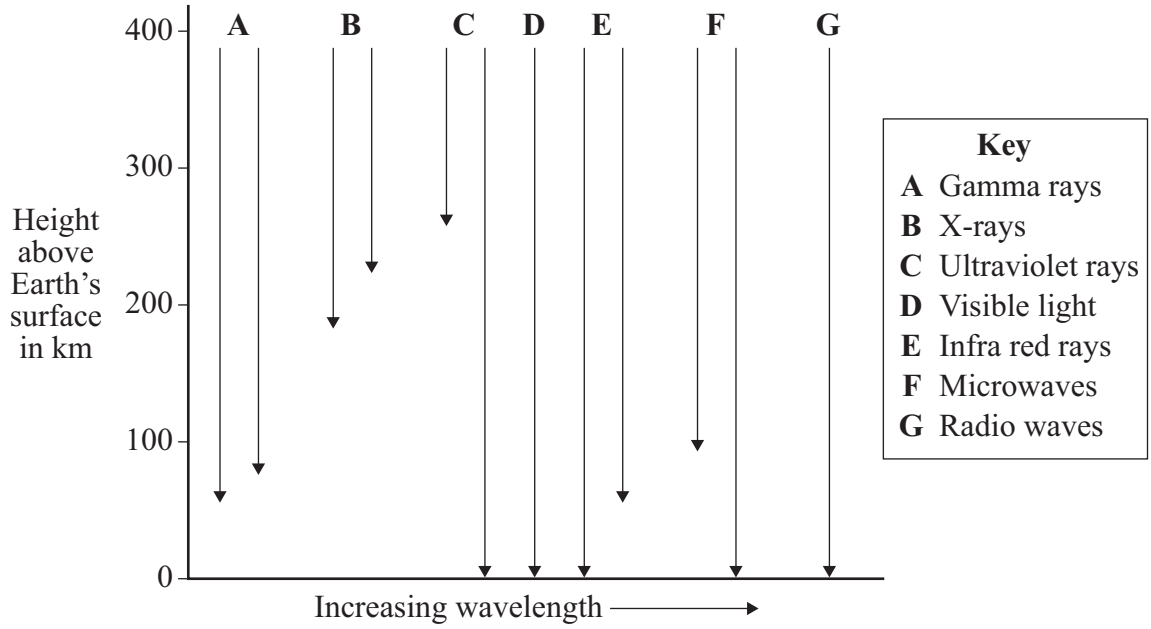
2 at night.

3 to observe a small region of the electromagnetic spectrum.

4 to observe one region of the sky.

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.



9B Radio telescopes are sited on the ground.

This is because radio waves . . .

1 are emitted by many stars.

2 can penetrate the atmosphere.

3 have a shorter wavelength than microwaves.

4 have more energy than infra red waves.

4.8.1.3 Orbital motion, natural and artificial satellites

Question 28 · continued

9C The types of radiation collected by four telescopes, **M**, **N**, **P** and **Q**, are given in the table.

Telescope	Radiation collected
M	infra red waves
N	gamma rays
P	X-rays
Q	microwaves

Which telescopes could be operated from an aircraft flying at an altitude of 12 km?

1 **M** and **N**

2 **N** and **P**

3 **P** and **Q**

4 **Q** and **M**

9D What is the minimum height above the Earth for a satellite to be able to use telescope **P**?

1 50 km

2 70 km

3 180 km

4 250 km

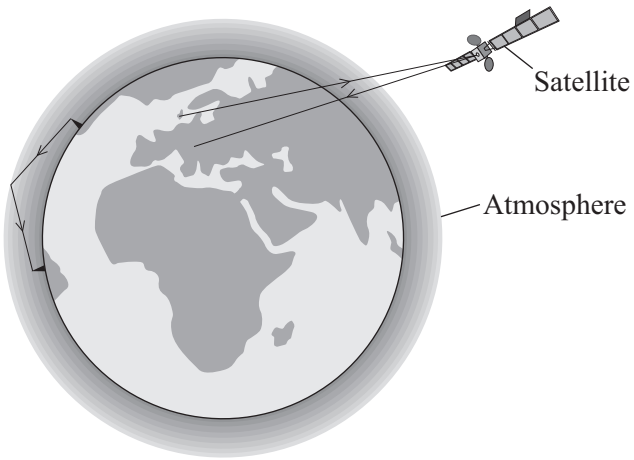
END OF TEST

4.8.1.3 Orbital motion, natural and artificial satellites

Question 29

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.

.....

.....

.....

.....

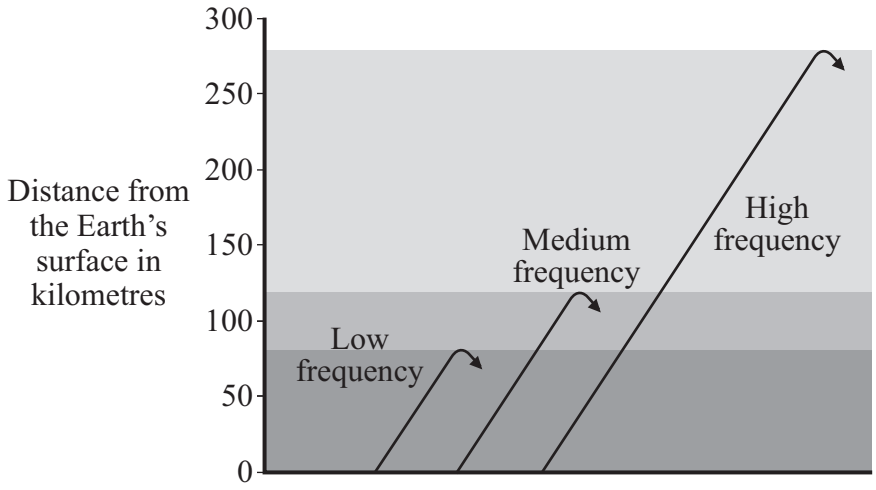
(2 marks)

4.8.1.3 Orbital motion, natural and artificial satellites

Question 29 · 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

4.8.1.3 Orbital motion, natural and artificial satellites

Question 30

1 A student collects data from the Internet about planets in the solar system.
She arranges the data into a table.

Name of the planet	Distance from the Sun in millions of kilometres	Time taken for one orbit of the Sun in years	Time taken to spin on its axis in hours	Average temperature on the side facing the Sun in °C
Mercury	60	0.24	1400	+430
Venus	110	0.60	5800	+470
Earth	150	1	24	+20
Mars	230	2	25	–20
Jupiter	780	12	10	–150
Saturn	1400	30	10	–180
Uranus	2900	84	17	–220
Neptune	4500	160	16	–230

1 (a) Name the **two** variables in the student's table which **always** have the relationship:

As one increases, so does the other.

..... and .....

(1 mark)

1 (b) (i) Give an example of **two** variables in the student's table which **generally** have the relationship:

As one increases, the other decreases.

..... and .....

(1 mark)

4.8.1.3 Orbital motion, natural and artificial satellites

Question 30 · continued

for mark

1 (b) (ii) Which piece of data does not seem to fit the relationship in (b)(i)?

.....

(1 mark)

1 (c) Scientists plan to launch a satellite which will orbit Mars above its equator.
It will be a geostationary satellite.

How many hours will it take to orbit Mars?

..... hours

(1 mark)

1 (d) Mars has two moons.

Neither of them is in a geostationary orbit and they both take different times to orbit the planet.

Which **one** of these statements is correct.
Put a tick (✓) in the box next to your answer.

The two moons will always be above the same point on the surface of Mars. ☐

The two moons will be in different positions at different times. ☐

You can never see both moons at the same time. ☐

(1 mark)

1 (e) Use words from the box to complete the **three** spaces in the passage.

circular	**direction**	**friction**	**gravitational**	**speed**	**universal**

The moons of the planet Neptune move in circular paths around the planet.

They continuously accelerate towards the centre of Neptune.

The acceleration changes the ..... of each moon but does not change its ..... . The force causing the acceleration is a ..... force.

(2 marks)

7

4.8.1.3 Orbital motion, natural and artificial satellites

Question 31

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 . . .

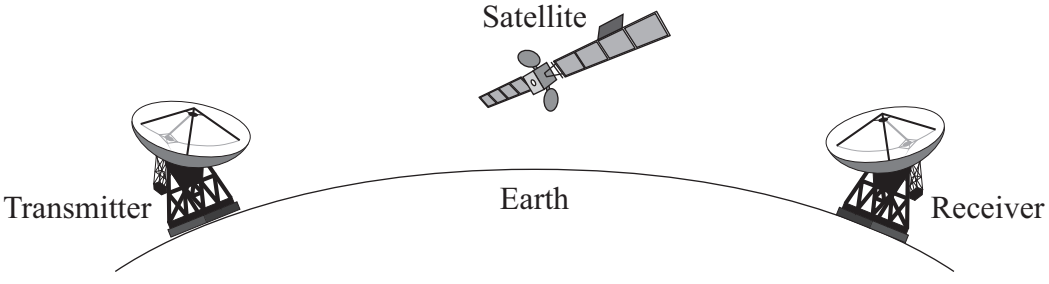
1 analogue signals are less prone to interference.

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.

4.8.1.3 Orbital motion, natural and artificial satellites

Question 31 · 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

4.8.1.3 Orbital motion, natural and artificial satellites

Question 32

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.

4.8.1.3 Orbital motion, natural and artificial satellites

Question 32 · 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

4.8.1.3 Orbital motion, natural and artificial satellites

Question 33

June 2010 | PHY3H | Original Q1 | Legacy

1 (a) A student finds data on the Internet for her project on the Solar System.
She checks this data on other websites.

The table shows the checked data.

Name of planet	Diameter in km	Distance from Sun in millions of km	Period in days
Mercury	4 840	58	87
Venus	12 390	108	224
Earth	12 760	149	365
Mars	6 800	228	686
Jupiter	142 800	778	4 332
Saturn	119 400	1 428	10 759
Uranus	47 600	2 870	30 685
Neptune	48 400	4 497	60 190

1 (a) (i) In the table, the period of each planet is given in days.

What is meant by the *period* of a planet?

.....

(1 mark)

1 (a) (ii) Suggest why the student checks the data on other websites.

.....

.....

(1 mark)

1 (a) (iii) What is the relationship, if any, between a planet's distance from the Sun and its period?

.....

.....

(1 mark)

4.8.1.3 Orbital motion, natural and artificial satellites

Question 33 · continued

1 (a) (iv) What is the relationship, if any, between a planet's diameter and its period?

.....

.....

(1 mark)

1 (b) What is the force which provides the centripetal force to keep planets in their orbits?

.....

(1 mark)

1 (c) What is the name of the galaxy which contains the Solar System?

.....

(1 mark)

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

The universe is made up of

hundreds
thousands
millions
billions

of galaxies. *(1 mark)*

7

4.8.1.3 Orbital motion, natural and artificial satellites

Question 34

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.

4.8.1.3 Orbital motion, natural and artificial satellites

Question 34 · 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

4.8.1.3 Orbital motion, natural and artificial satellites

Question 35

November 2010 | PHY1BP | Original Q7 | Legacy

QUESTION SEVEN

In 1927, a scientist proposed that the universe began with an explosion. His proposal came after astronomers had observed red-shift in light from distant galaxies.

7A Red-shift is an apparent . . .

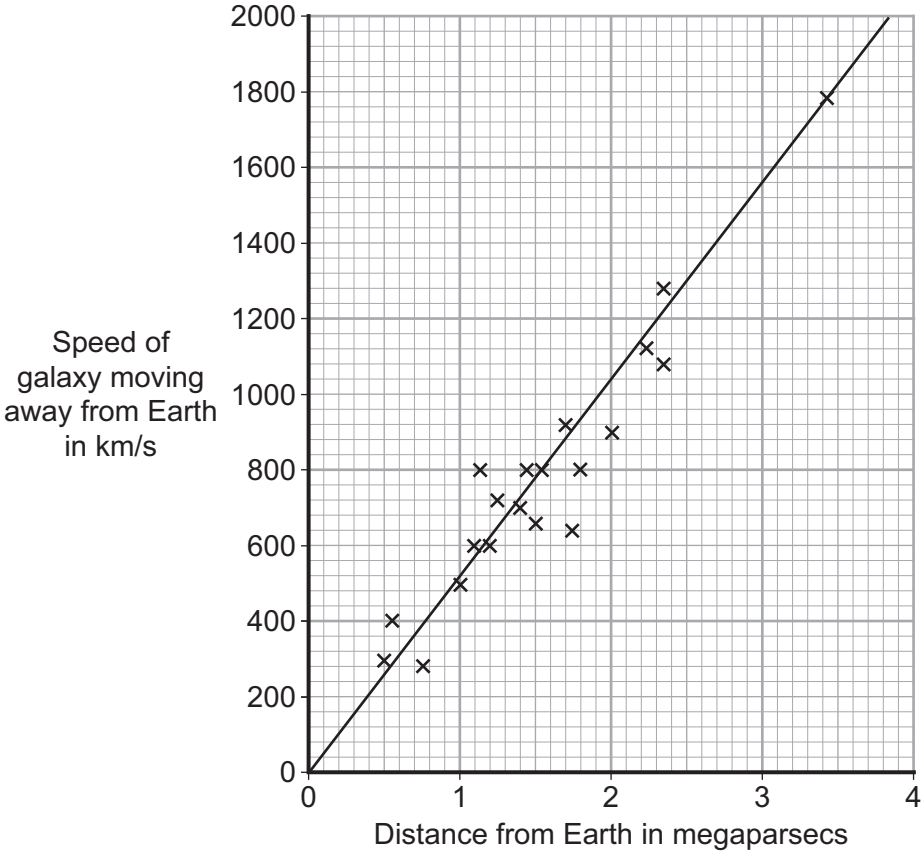
1 decrease in wavelength of the light due to a galaxy moving away from the Earth.

2 increase in wavelength of the light due to a galaxy moving away from the Earth.

3 decrease in wavelength of the light due to a galaxy moving towards the Earth.

4 increase in the wavelength of the light due to a galaxy moving towards the Earth.

The graph shows the results of calculations made by the astronomer Edwin Hubble. He plotted the speed at which the galaxies are moving away from Earth against their distance from Earth. The distance is given in megaparsecs. One parsec is approximately equal to 30 000 000 000 000 km.



4.8.1.3 Orbital motion, natural and artificial satellites

Question 35 · continued November 2010 | PHY1BP | Original Q7 | Legacy

7B Hubble's results suggest that . . .

1 more results are needed before we can say there is a relationship between the speed of a galaxy and the distance of the galaxy from Earth.

2 there is a negative relationship between the speed of a galaxy and the distance of the galaxy from Earth.

3 the speed of a galaxy is directly proportional to the distance of the galaxy from Earth.

4 the graph points are too scattered to give a meaningful relationship.

7C The gradient of the line of best fit on the graph is known as the Hubble constant. The Hubble constant can be used to estimate the age of the universe.

From this data, the approximate value of the Hubble constant in km/s per megaparsec is . . .

1 4

2 500

3 1000

4 2000

7D Hubble's calculations support the 'big bang' theory. The 'big bang' theory says that the universe is expanding.

In 1948, George Gamow predicted that there should be microwave radiation left over from the 'big bang'. This radiation was discovered in the 1960s, and was confirmed by the Cosmic Background Explorer satellite in the early 1990s.

This discovery . . .

1 disproves the involvement of a god in the origin of the universe.

2 gives information to help us know what happened before the 'big bang'.

3 provides evidence which eliminates all other theories of the origin of the universe.

4 provides evidence in support of the 'big bang' theory.

4.8.1.3 Orbital motion, natural and artificial satellites

Question 36

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.

4.8.1.3 Orbital motion, natural and artificial satellites

Question 36 · 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.

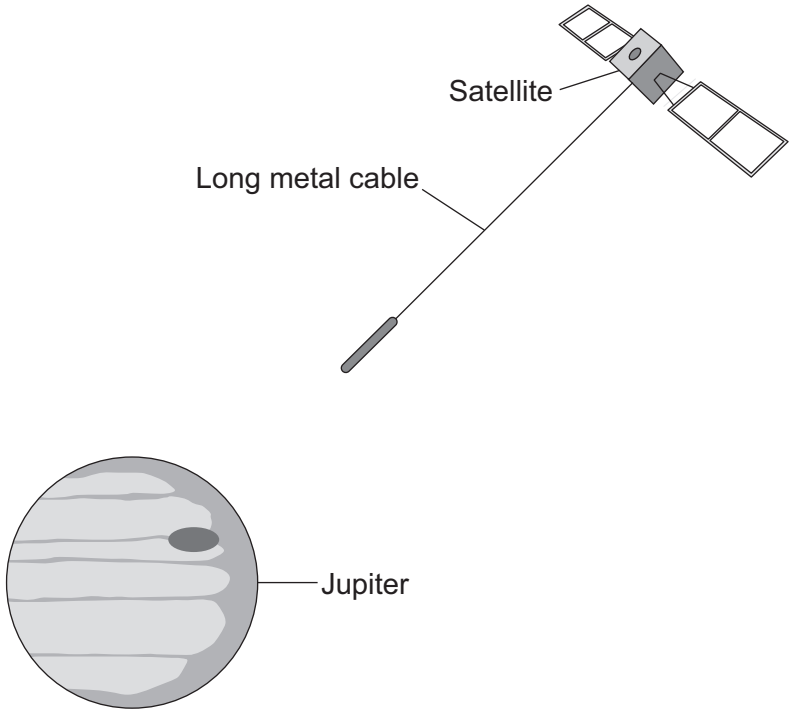
END OF TEST

4.8.1.3 Orbital motion, natural and artificial satellites

Question 37

7 Jupiter has a magnetic field which is more powerful than the magnetic field of any other planet in the Solar System.

Some scientists have suggested that, in the future, a long metal cable could hang from a satellite which orbits Jupiter. The cable would be part of a complete circuit. This arrangement would produce electricity for the satellite.



7 (a) (i) What is the name of the effect that would produce electricity for the satellite?

.....

(1 mark)

7 (a) (ii) Describe how a potential difference is produced across the ends of the metal cable.

.....

.....

.....

.....

(2 marks)

4.8.1.3 Orbital motion, natural and artificial satellites

Question 37 · continued

7 (a) (iii) Why will the potential difference produce an electric current?

.....

.....

(1 mark)

7 (b) Other satellites in the Solar System could use the same effect to produce electricity in a similar way.

Suggest **two** reasons why the potential difference produced for another satellite might be **smaller** than the potential difference for the satellite in the diagram.

1 .....

.....

2 .....

.....

(2 marks)

6

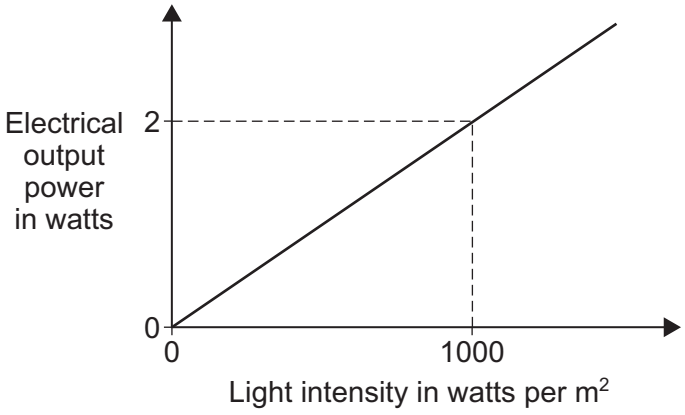
4.8.1.3 Orbital motion, natural and artificial satellites

Question 38

March 2011 | PHY1AP | Original Q9 | Legacy

QUESTION NINE

The diagram shows the electrical output power of a typical solar cell as the light intensity on it changes. The solar cell has a surface area of 100 cm^2.



9A The graph shows that . . .

1 the output power is directly proportional to the light intensity.

2 the output power decreases as the light intensity increases.

3 as the light intensity decreases the output power increases.

4 the output power is not affected by the light intensity.

9B The output power of the solar cell is directly proportional to the area of the cell exposed to light.

A similar solar cell has an area of 50 cm^2. The light intensity was 1000 watts per $metre^2$.

What is the output power of this solar cell?

1 0 watts

2 1 watt

3 2 watts

4 4 watts

4.8.1.3 Orbital motion, natural and artificial satellites

Question 38 · continued

A satellite in space uses solar energy as its power source.
The satellite needs 3 kJ of energy per second.
One square metre of solar cells on the satellite produces 250 joules of energy per second.

9C What area of solar cells is needed to power the satellite?

1 12 m^2

2 83 m^2

3 300 m^2

4 400 m^2

9D The efficiency of the solar cells is 0.2

$$\text{efficiency} = \frac{\text{useful energy transferred by the device}}{\text{total energy supplied to the device}}$$

Considering the total energy requirement of the satellite, how much solar energy falls on the solar cells each second?

1 15 J

2 600 J

3 15 kJ

4 600 kJ

END OF TEST

4.8.1.3 Orbital motion, natural and artificial satellites

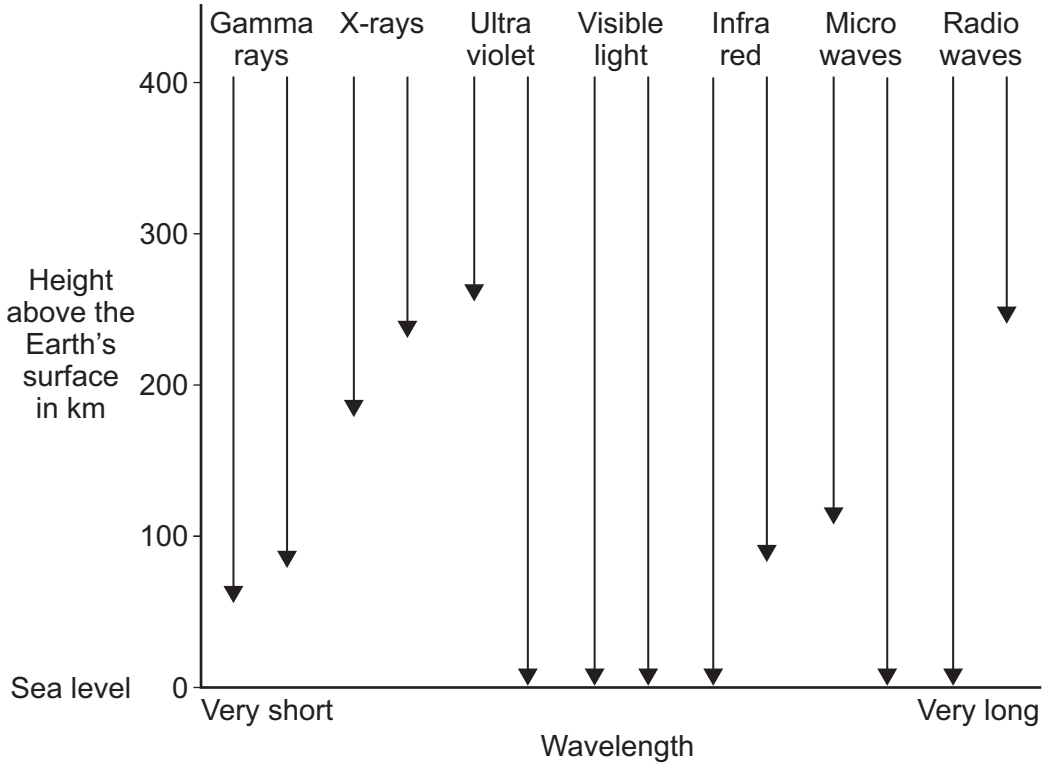
Question 39

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.

4.8.1.3 Orbital motion, natural and artificial satellites

Question 39 · 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

4.8.1.3 Orbital motion, natural and artificial satellites

Question 40

June 2011 | PHY1BP | Original Q8 | Legacy

QUESTION EIGHT

The transmission of television programmes in all areas of the UK is changing from using analogue signals to using digital signals.

8A Which row in the table correctly describes digital signals?

1	continuously variable	can be easily processed by computers
2	continuously variable	cannot be easily processed by computers
3	discrete values only	can be easily processed by computers
4	discrete values only	cannot be easily processed by computers

8B Cable television transmission sends signals along optical fibres made from glass.

One of the reasons for using these fibres is that . . .

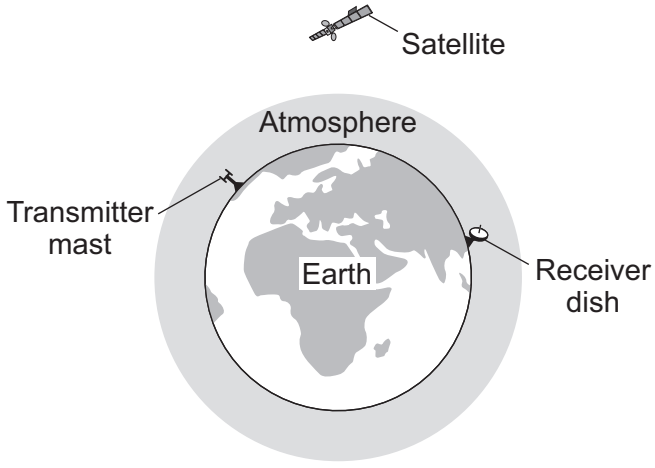
1 radio waves travel faster in glass than they do in air.

2 radio waves can be reflected inside the fibre so that the signal can go round corners.

3 visible light can travel through the walls of the fibre, just as it does through a window.

4 visible light can be reflected inside the fibre so that the signal can go round corners.

8C Satellite television programmes are transmitted from one side of the Earth to the other side.



4.8.1.3 Orbital motion, natural and artificial satellites

Question 40 · continued

Which row in the table correctly describes the type of electromagnetic wave used and the reason for using this type of wave?

	Type of electromagnetic wave	Reason for use
1	microwaves	can travel in a curved path
2	microwaves	can pass through the Earth's atmosphere
3	radio waves	can travel in a curved path
4	radio waves	can pass through the Earth's atmosphere

8D Digital signals are better than analogue signals for transmitting satellite television programmes because . . .

1 they travel at a higher speed in a vacuum.

2 they spread out in all directions from the transmitter.

3 they are less prone to distortion by interference.

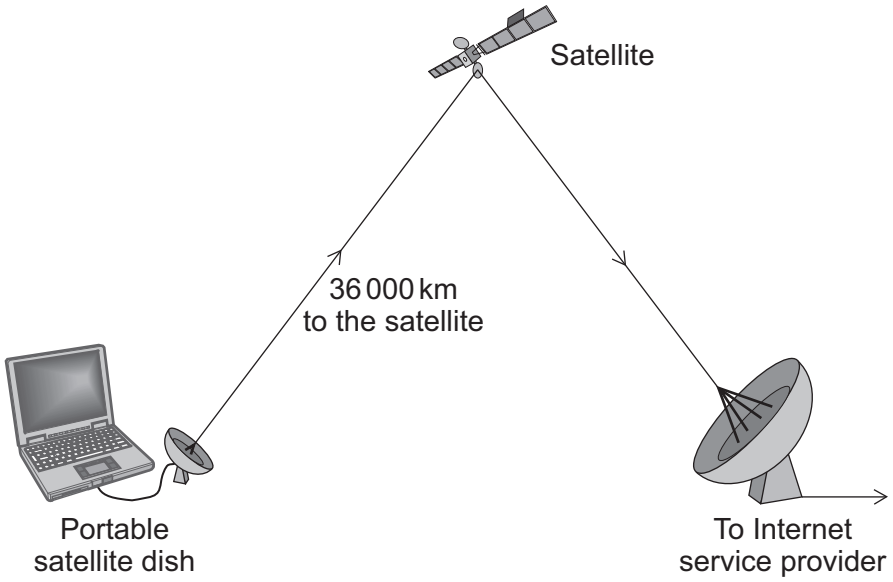
4 when amplified, any interference they have picked up is not amplified.

4.8.1.3 Orbital motion, natural and artificial satellites

Question 41

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)

4.8.1.3 Orbital motion, natural and artificial satellites

Question 41 · 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

4.8.1.3 Orbital motion, natural and artificial satellites

Question 42

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)

4.8.1.3 Orbital motion, natural and artificial satellites

Question 42 · 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

4.8.1.3 Orbital motion, natural and artificial satellites

Question 43

June 2011 | PHY3H | Original Q3 | Legacy

3 Jupiter is the largest planet in the solar system. It has over sixty moons. The four largest moons were observed by Galileo using his telescope over four hundred years ago.

The table displays some of the data on these four largest moons which is now known to scientists.

Name	Distance from Jupiter in kilometres	Time to orbit Jupiter in days	Diameter in kilometres	Mass in quintillion tonnes
Callisto	1 883 000	16.9	4806	108
Europa	671 000	3.6	3130	48
Ganymede	1 070 000	7.2	5268	148
Io	422 000	1.8	3630	89

1 quintillion tonne = 1 000 000 000 000 000 000 tonnes

3 (a) A centripetal force acts on each of these moons.

State clearly what provides the centripetal force.

.....

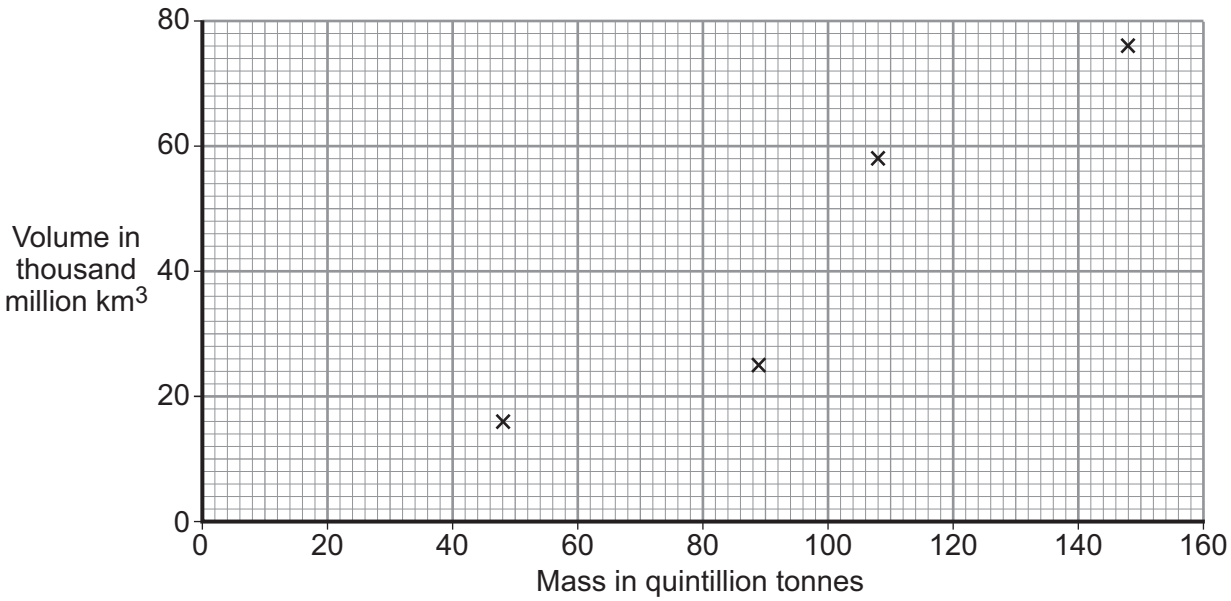
.....

(1 mark)

4.8.1.3 Orbital motion, natural and artificial satellites

Question 43 · continued

3 (b) The graph shows the volume against mass for these large moons.



Use the graph to estimate the volume of a moon with a mass of 20 quintillion tonnes.

Show clearly on the graph how you used it to get to your estimate.

Estimated volume of moon = ... thousand million km^3

(2 marks)

3 (c) For these large moons, what is the relationship, if any, between the moon's *distance* from Jupiter and the *time* it takes for the moon to orbit Jupiter?

.....

.....

(1 mark)

3 (d) One reason why astronomers now have more data on the moons of Jupiter is that present-day astronomers have telescopes which are much more powerful than Galileo's telescope.

Give **one** other reason.

.....

.....

(1 mark)

5

4.8.1.3 Orbital motion, natural and artificial satellites

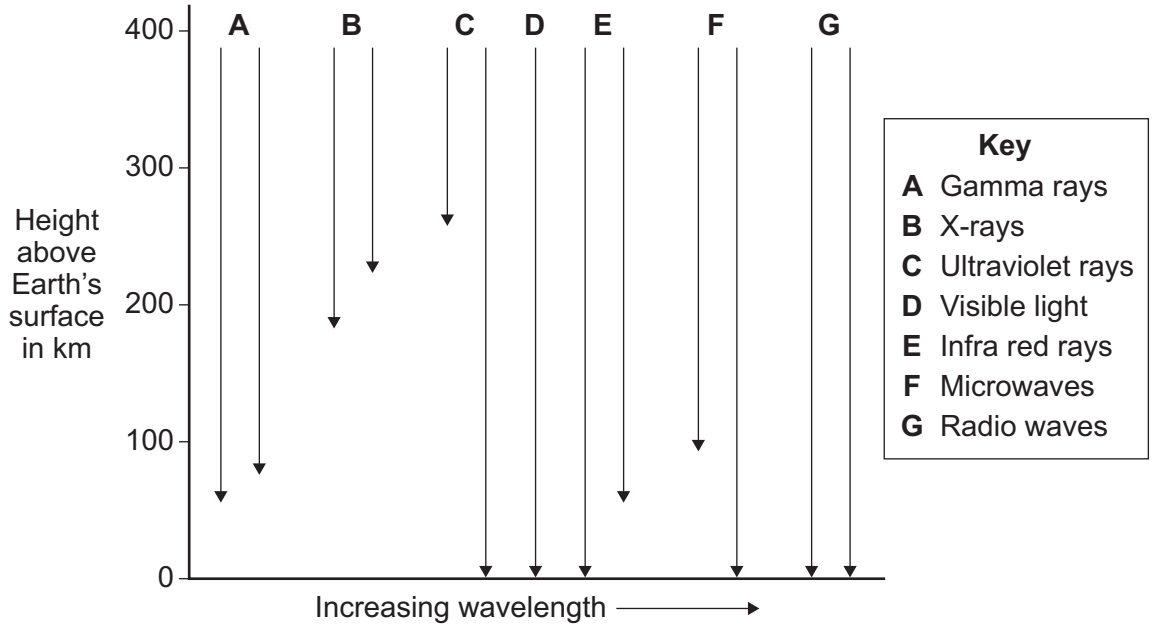
Question 44

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

4.8.1.3 Orbital motion, natural and artificial satellites

Question 44 · 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

4.8.1.3 Orbital motion, natural and artificial satellites

Question 45

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?

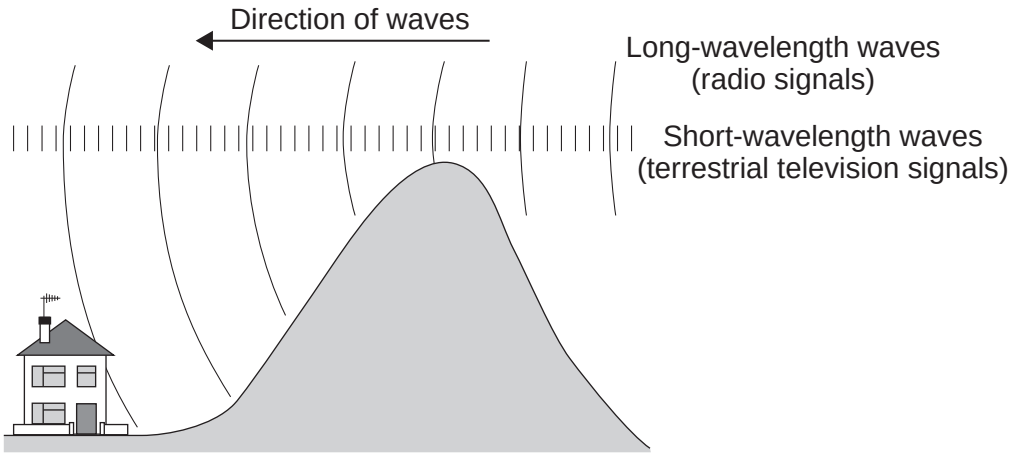
.....

.....

(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.



4.8.1.3 Orbital motion, natural and artificial satellites

Question 45 · 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

4.8.1.3 Orbital motion, natural and artificial satellites

Question 46

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 …

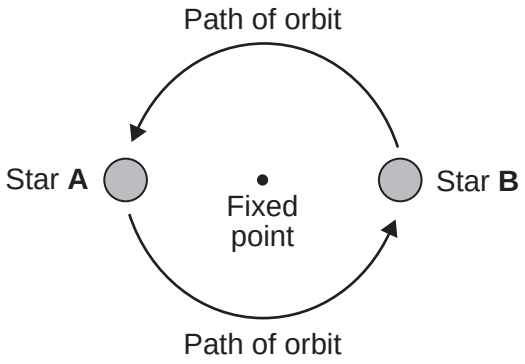
proved the 'Big Bang' theory to be correct. ☐

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.

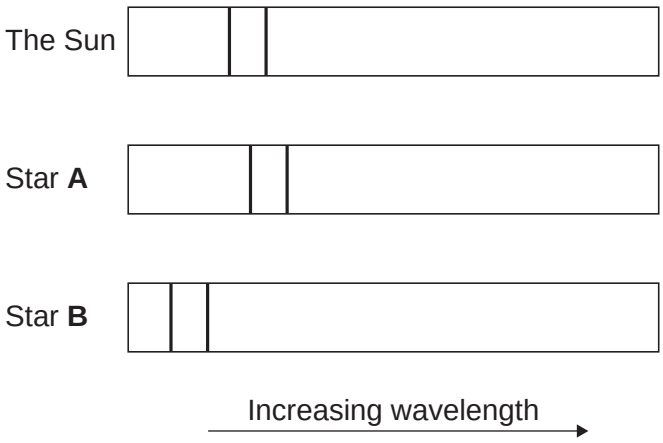


The visible spectrum from stars includes dark lines. These lines are at specific wavelengths.

4.8.1.3 Orbital motion, natural and artificial satellites

Question 46 · 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

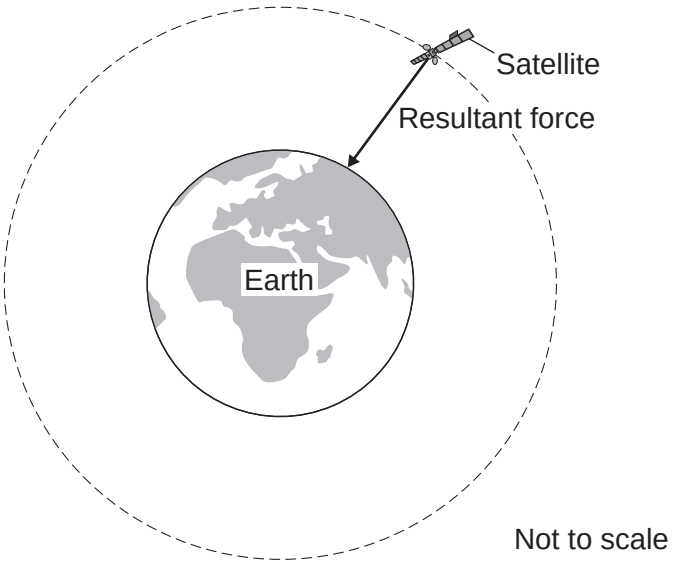
4.8.1.3 Orbital motion, natural and artificial satellites

Question 47

June 2014 | PH3HP | Original Q2 | Legacy

2 Man-made satellites can orbit the Earth, as shown in **Figure 3**.

Figure 3



The satellite experiences a resultant force directed towards the centre of the orbit.

The resultant force is called the centripetal force.

2 (a) What provides the centripetal force on the satellite?

[1 mark]

.....

2 (b) State **two** factors that determine the size of the centripetal force on the satellite.

[2 marks]

1 .....

2 .....

4.8.1.3 Orbital motion, natural and artificial satellites

Question 47 · continued

2 (c) **Table 1** gives data for five different satellites orbiting the Earth.

Table 1

Satellite	Average height above Earth's surface in kilometres	Time taken to orbit Earth once in minutes	Mass of satellite in kilograms
A	370	93	419 000
B	697	99	280
C	827	103	630
D	5 900	228	400
E	35 800	1440	2 030

2 (c) (i) State the relationship, if any, between the height of the satellite above the Earth's surface and the time taken for the satellite to orbit the Earth once.

[1 mark]

.....

.....

2 (c) (ii) State the relationship, if any, between the time taken for the satellite to orbit the Earth once and the satellite's mass.

[1 mark]

.....

.....

Question 2 continues on the next page

4.8.1.3 Orbital motion, natural and artificial satellites

Question 47 · continued

2 (d) Over 300 years ago, the famous scientist Isaac Newton proposed, with a 'thought experiment', the idea of satellites.

Newton suggested that if an object was fired at the right speed from the top of a high mountain, it would circle the Earth.

Why did many people accept Isaac Newton's idea as being possible?

Tick (✓) **one** box.

[1 mark]

Isaac Newton was a respected scientist who had made new discoveries before. ☐

Isaac Newton went to university. ☐

It was a new idea that nobody else had thought of before. ☐

6

4.8.1.3 Orbital motion, natural and artificial satellites

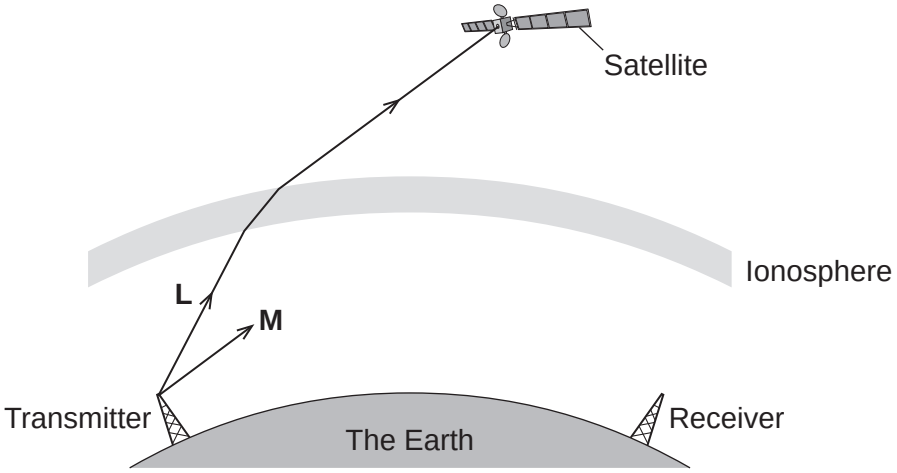
Question 48

June 2015 | PH1HP | Original Q4 | Legacy

4 Different parts of the electromagnetic spectrum are useful for different methods of communication.

Figure 4 shows a transmitter emitting two electromagnetic waves, **L** and **M**.

Figure 4



4 (a) (i) Wave **L** is used to send a signal to a satellite.
Which part of the electromagnetic spectrum does wave **L** belong to?

[1 mark]

.....

4 (a) (ii) What name is given to the process that occurs as wave **L** passes into the ionosphere?

[1 mark]

.....

4 (b) Wave **M** is **reflected** by the ionosphere.

4 (b) (i) On **Figure 4**, draw the path of wave **M** until it reaches the receiver.

[2 marks]

4 (b) (ii) On **Figure 4**, draw a line to show the normal where wave **M** meets the ionosphere.
Label the line **N**.

[1 mark]

4.8.1.3 Orbital motion, natural and artificial satellites

Question 48 · continued

4 (c) Give **two** properties of all electromagnetic waves.

[2 marks]

1 .....

.....

2 .....

.....

7

Turn over for the next question

4.8.1.3 Orbital motion, natural and artificial satellites

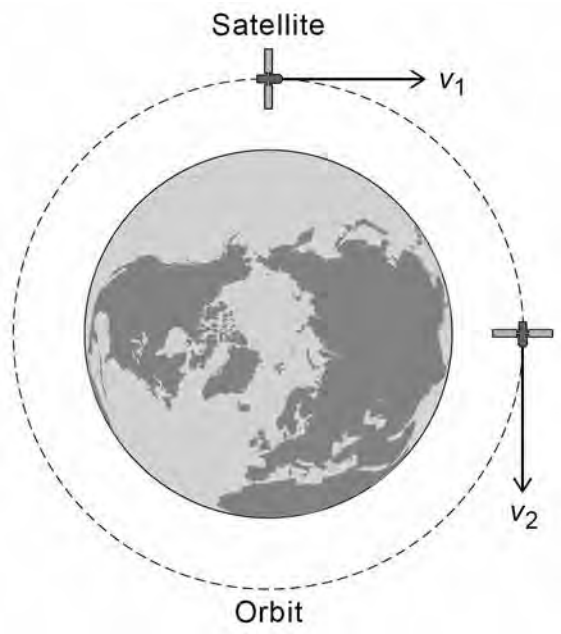
Question 49

June 2018 | 8463/2H | Original Q8

0 8 A satellite is in a circular orbit around the Earth.

Figure 14 shows the velocity of the satellite at two different positions in the orbit.

Figure 14



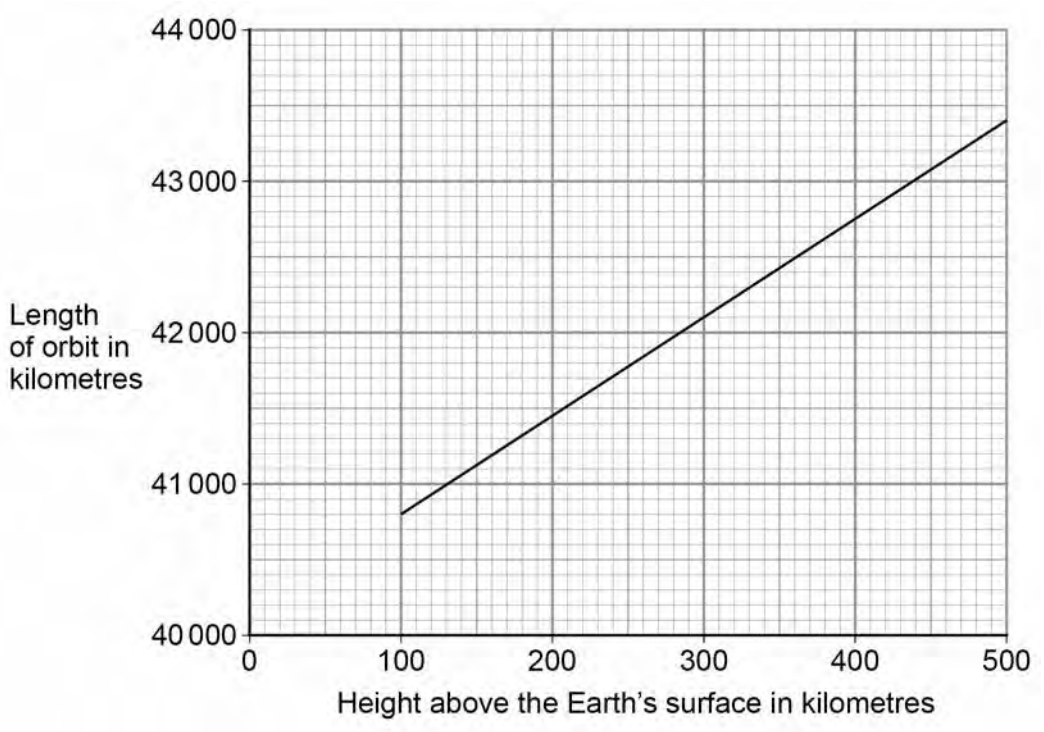
0 8 . 1 Explain why the velocity of the satellite changes as it orbits the Earth.

[3 marks]

Question 8 continues on the next page

0 8 . 2 **Figure 15** shows how the length of a satellite orbit depends on the height of the satellite above the Earth's surface.

Figure 15



A satellite orbits 300 km above the Earth's surface at a speed of 7.73 km/s.

Calculate how many complete orbits of the Earth the satellite will make in 24 hours.

[5 marks]

Number of complete orbits = _____

4.8.1.3 Orbital motion, natural and artificial satellites

Question 49 · continued

In 1772, an astronomer called J Bode developed an equation to predict the orbital radii of the planets around the Sun.

Table 3 shows Bode's predicted orbital radii and the actual orbital radii for the planets that were known in 1772.

Table 3

Planet	Predicted orbital radius in millions of kilometres	Actual orbital radius in millions of kilometres
Mercury	60	58
Venus	105	108
Earth	150	150
Mars	240	228
Jupiter	780	778
Saturn	1500	1430

0 8 . 3 The predicted data can be considered to be accurate.

Give the reason why.

[1 mark]

0 8 . 4 J Bode used his equation to predict the existence of a planet with an orbital radius of 2940 million kilometres.

The planet Uranus was discovered in 1781.

Uranus has an orbital radius of 2875 million kilometres.

Explain why the discovery of Uranus was important.

[2 marks]

11

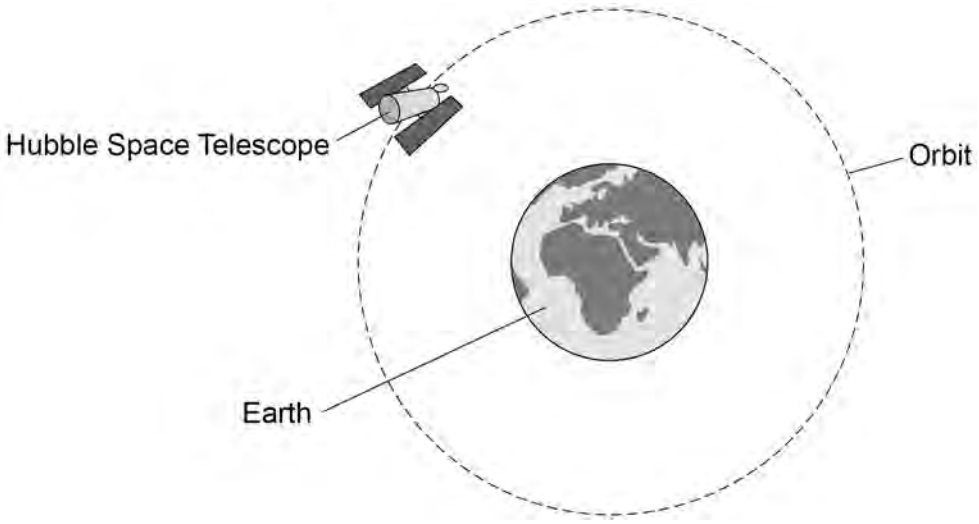
4.8.1.3 Orbital motion, natural and artificial satellites

Question 50

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

4.8.1.3 Orbital motion, natural and artificial satellites

Question 50 · 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]

4.8.1.3 Orbital motion, natural and artificial satellites

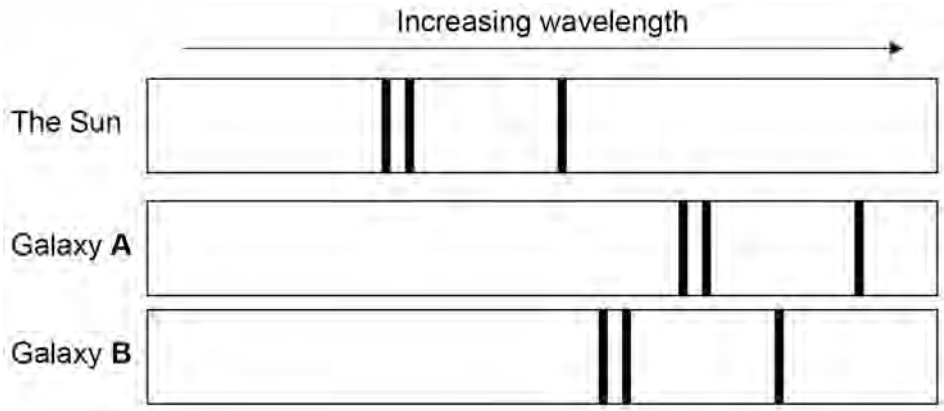
Question 50 · continued

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

4.8.1.3 Orbital motion, natural and artificial satellites

Question 51

June 2025 | 8463/2H | Original Q4

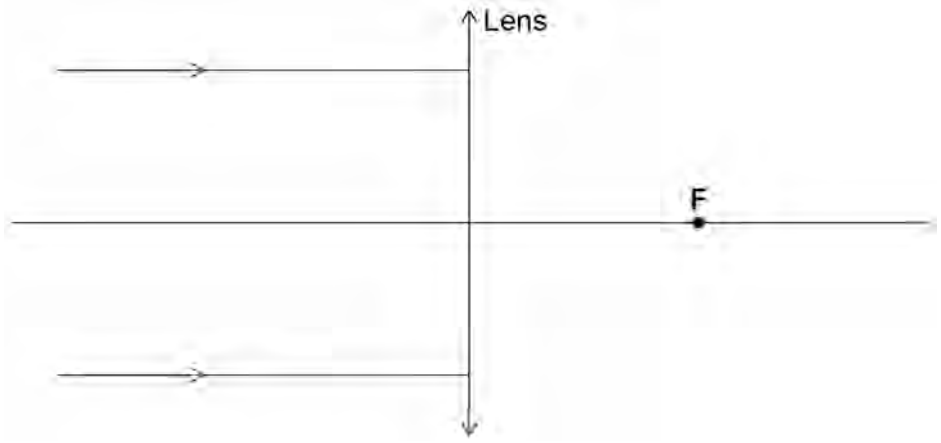
0 4 Telescopes are used to look at distant objects.

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

4.8.1.3 Orbital motion, natural and artificial satellites

Question 51 · 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

_____.

4.8.1.3 Orbital motion, natural and artificial satellites

Question 51 · 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