AQA GCSE Physics | 8463

SPECIFICATION POINT 4.8.2

Red-shift (physics only)

Past-paper questions

Tier	**Higher**
Question groups	**44**
Available paper years	**2004–2025**

Using this booklet

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

Name: _____ **Date:** _____

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

4.8.2 Red-shift (physics only)

Question 01

June 2004 | 3451H | Original Q12 | Legacy

12 (a) Explain how stars produce energy.

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(2 marks)

(b) What evidence is there to suggest that the Sun was formed from the material produced when an earlier star exploded?

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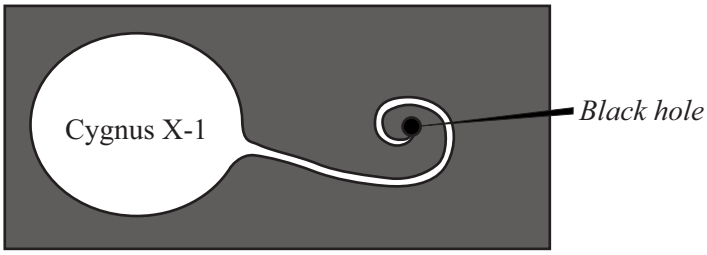
(1 mark)

(c) It is thought that gases from the massive star Cygnus X-1 are spiralling into a black hole.



(i) Explain what is meant by the term *black hole*.

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(2 marks)

(ii) What is produced as the gases from a star spiral into a black hole?

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(1 mark)

4.8.2 Red-shift (physics only)

Question 01 · continued

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(d) The light spectrum from a distant galaxy shows a red shift.

What is meant by *red shift* and what does it tell us about distant galaxies?

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(2 marks)

(e) What name is given to the theory that the Universe started with a massive explosion?

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(1 mark)

9

4.8.2 Red-shift (physics only)

Question 02

June 2004 | 3462H3 | Original Q10 | Legacy

10 (a) Explain how stars produce energy.

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(2 marks)

(b) What evidence is there to suggest that the Sun was formed from the material produced when an earlier star exploded?

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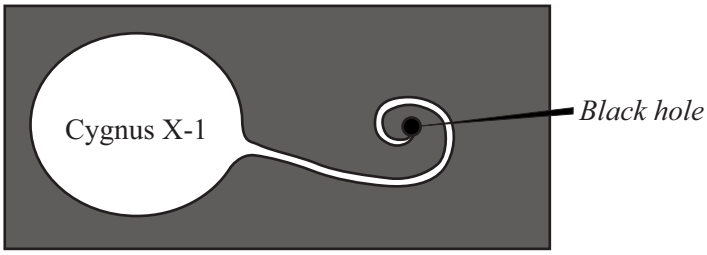
(1 mark)

(c) It is thought that gases from the massive star Cygnus X-1 are spiralling into a black hole.



(i) Explain what is meant by the term *black hole*.

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(2 marks)

(ii) What is produced as the gases from a star spiral into a black hole?

.....

(1 mark)

4.8.2 Red-shift (physics only)

Question 02 · continued

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(d) The light spectrum from a distant galaxy shows a red shift.

What is meant by *red shift* and what does it tell us about distant galaxies?

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(2 marks)

(e) What name is given to the theory that the Universe started with a massive explosion?

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(1 mark)

9

4.8.2 Red-shift (physics only)

Question 03

June 2006 | 3451 | Original Q8 | Legacy

8 (a) The Sun's energy comes from nuclear reactions that convert hydrogen into helium.

What is this type of nuclear reaction called?

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(1 mark)

(b) The Sun has reached the main stable period of its life.

Explain, in terms of the forces acting inside the Sun, what this means.

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(2 marks)

(c) Light from other galaxies shows a *red-shift*. This is used as evidence that the Universe began with a huge explosion.

(i) What causes *red-shift*?

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(1 mark)

(ii) The further away a galaxy is, the bigger the red-shift. Why?

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(1 mark)

4.8.2 Red-shift (physics only)

Question 03 · continued

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(d) Planets, other than the Earth, may be capable of supporting life. Space probes are used to analyse the atmosphere of other planets.

(i) How could this analysis give evidence that organisms may once have lived on the planet?

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(2 marks)

(ii) How are the scientists on the SETI project trying to find evidence for the existence of extra-terrestrial intelligence?

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(2 marks)

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4.8.2 Red-shift (physics only)

Question 04

June 2006 | 3462 | Original Q6 | Legacy

6 (a) The Sun's energy comes from nuclear reactions that convert hydrogen into helium.

What is this type of nuclear reaction called?

.....

(1 mark)

(b) The Sun has reached the main stable period of its life.

Explain, in terms of the forces acting inside the Sun, what this means.

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(2 marks)

(c) Light from other galaxies shows a *red-shift*. This is used as evidence that the Universe began with a huge explosion.

(i) What causes *red-shift*?

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(1 mark)

(ii) The further away a galaxy is, the bigger the red-shift. Why?

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(1 mark)

4.8.2 Red-shift (physics only)

Question 04 · continued

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(d) Planets, other than the Earth, may be capable of supporting life. Space probes are used to analyse the atmosphere of other planets.

(i) How could this analysis give evidence that organisms may once have lived on the planet?

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(2 marks)

(ii) How are the scientists on the SETI project trying to find evidence for the existence of extra-terrestrial intelligence?

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(2 marks)

9

4.8.2 Red-shift (physics only)

Question 05

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.

4.8.2 Red-shift (physics only)

8D Observations are taken by satellites in space.

The information is sent back to Earth using . . .

1 gamma rays.

2 microwaves.

3 ultraviolet rays.

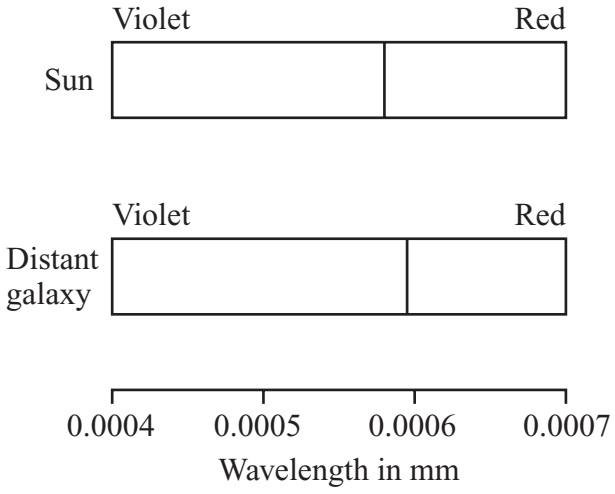
4 X-rays.

Turn over for the next question

4.8.2 Red-shift (physics only)

Question 06

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 06 · continued

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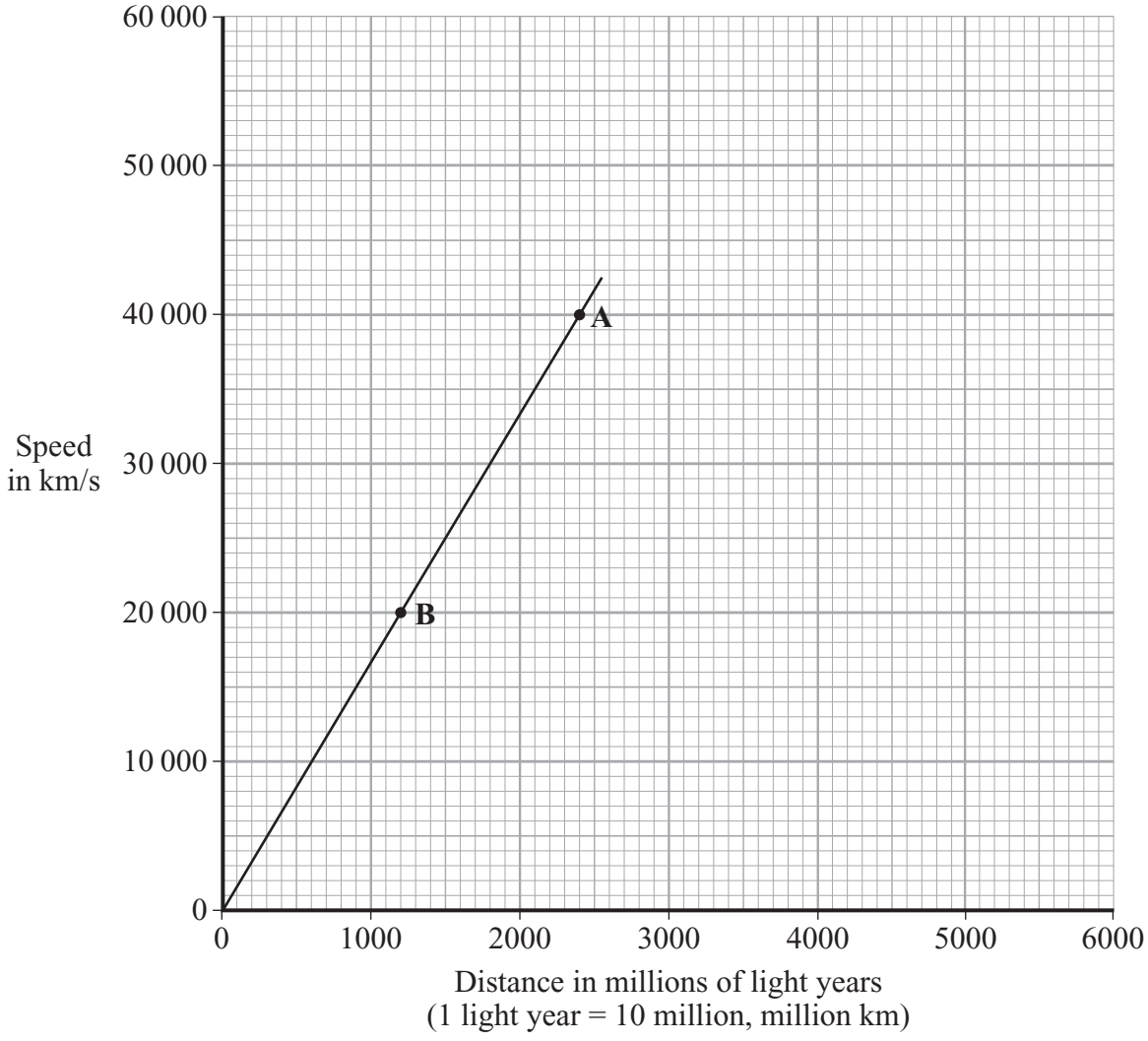
(b) From data collected, a graph can be drawn that links the speed of a galaxy with the distance of the galaxy from the Earth.



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

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.....

(1 mark)

4.8.2 Red-shift (physics only)

Question 06 · continued

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

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

.....

.....

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

(2 marks)

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

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

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(2 marks)

8

4.8.2 Red-shift (physics only)

Question 07

March 2007 | PHY1B | Original Q8 | Legacy

QUESTION EIGHT

Light from every star, in every distant galaxy which has been observed, shows a red-shift.

8A Why has the feature been given this name?

1 Blue light has a longer wavelength than red light.

2 Red light has a higher frequency than blue light.

3 Red light travels at a higher speed than blue light.

4 Red light has a longer wavelength than blue light.

8B Which row in the table correctly describes the movement of galaxies at the present time?

	Relative to Earth	Relative to each other
1	moving away	moving away
2	moving away	moving closer
3	moving closer	moving away
4	moving closer	moving closer

8C Scientists have used their calculations to deduce the movement of galaxies hundreds of millions of years ago.

Which row in the table correctly describes the movement of galaxies hundreds of millions of years ago?

	Relative to Earth	Relative to each other
1	moving away	moving away
2	moving away	moving closer
3	moving closer	moving away
4	moving closer	moving closer

4.8.2 Red-shift (physics only)

8D Red-shift provides direct evidence that the Universe . . .

1 is expanding.

2 is expanding and must have started at the ‘big bang’.

3 is expanding and must have started from a tiny starting point.

4 is expanding and must have started from a tiny starting point at the ‘big bang’.

Turn over for the next question

4.8.2 Red-shift (physics only)

Question 08

June 2007 | PHY1B | Original Q9 | Legacy

QUESTION NINE

Early last century, astronomers noticed that distant galaxies had peculiar light spectra. They noticed that the galaxies' light spectra were shifted towards the red end of the spectrum.

9A Evidence from this type of shift allows scientists to deduce the . . .

1 average density of a galaxy.

2 chemical composition of a galaxy.

3 distance of the galaxy from the Earth.

4 total mass of a galaxy.

9B Red-shift is caused by . . .

1 an observed decrease in frequencies of the electromagnetic radiation leaving the source.

2 electromagnetic waves changing velocity as they travel from more distant galaxies.

3 movement of the Earth along its orbit.

4 an observed decrease in wavelength of the electromagnetic radiation leaving the source.

9C The sequence of colour bands in the visible spectrum is:

red, orange, yellow, green, blue, indigo and violet.

A red-shift could cause . . .

1 the blue band to move towards violet.

2 the red band to move towards orange.

3 the violet band to move towards indigo.

4 the violet band to move towards ultraviolet light.

9D When the light from distant galaxies is analysed, the amount of red-shift is proportional to distance.

This suggests that . . .

1 light from a galaxy three times as far away will have three times the amount of red-shift.

2 light from a galaxy twice as far away will have half the amount of red-shift.

3 the frequency of light leaving a galaxy twice as far away will be doubled.

4 the speed of light reaching the Earth from a distant galaxy will decrease as time passes.

END OF TEST

4.8.2 Red-shift (physics only)

Question 09

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?

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(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*?

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(1 mark)

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

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(1 mark)

4.8.2 Red-shift (physics only)

Question 09 · 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

4.8.2 Red-shift (physics only)

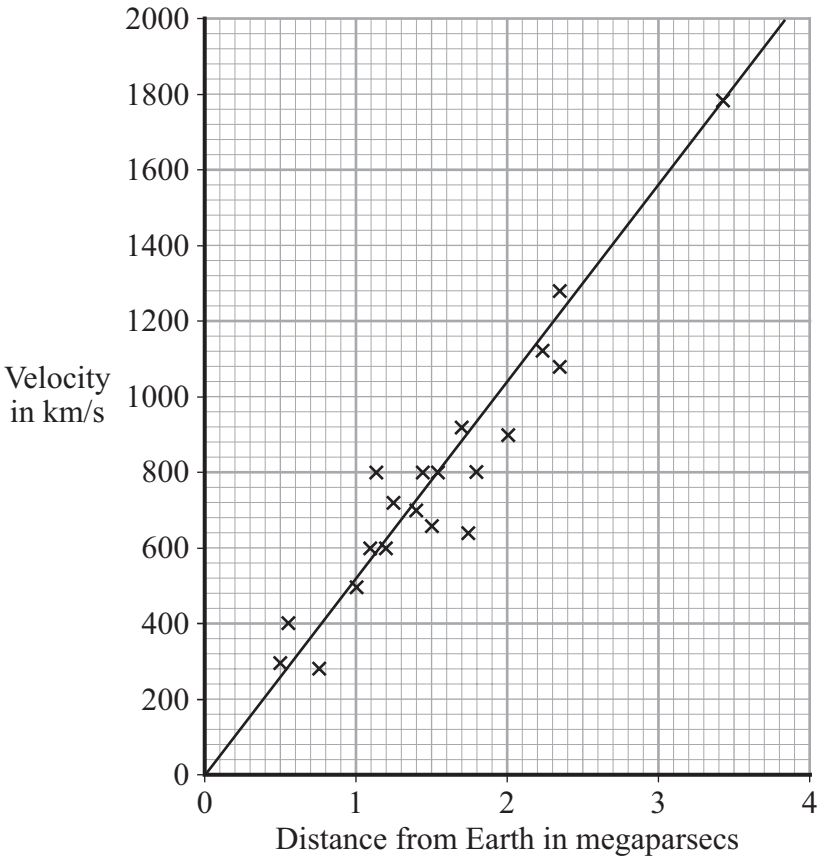
Question 10

November 2007 | PHY1B | Original Q9 | Legacy

QUESTION NINE

The astronomer Hubble calculated the distance of many galaxies from Earth. He also calculated the velocity at which many galaxies are moving away from Earth.

The graph shows some of his results. The distance is given in megaparsecs. One parsec is approximately equal to 30 000 000 000 km.



9A The data in the graph suggests that . . .

1 the further away the galaxy is from Earth, the slower it is moving.

2 all galaxies move at different velocities.

3 the velocity of a galaxy is proportional to its distance away from Earth.

4 there is no relationship between the speed of a galaxy and its distance away from Earth.

9B 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.

9C Modern astronomers calculate that the **actual** value of the Hubble constant is somewhere between 46 and 80 km/s per megaparsec.

This is very different from the number calculated from the graph.

This is because Hubble's measurements had . . .

1 random errors.

2 systematic errors.

3 zero errors.

4 lack of precision.

9D The Andromeda galaxy is moving towards our own Milky Way galaxy.

This means that, as viewed from Earth, light from the Andromeda galaxy will . . .

1 be shifted towards the red end of the spectrum.

2 show an increase in wavelengths.

3 be shifted towards the blue end of the spectrum.

4 show a decrease in frequencies.

END OF TEST

4.8.2 Red-shift (physics only)

Question 11

January 2008 | PHY1H | Original Q6 | Legacy

6 The 'steady state' theory was once a popular alternative to the 'big bang' theory.

The 'steady state' theory suggested that the universe, although expanding, had no origin and it has always existed. As the universe expands, a small amount of matter is created to keep the universe looking exactly the same all of the time.

(a) When considering the origin of the universe, what is the difference between the 'big bang' theory and the 'steady state' theory?

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(2 marks)

(b) The light from distant galaxies shows a *red-shift*.

(i) What is *red-shift*?

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(1 mark)

(ii) Why does red-shift provide evidence to support both the 'big-bang' theory and the 'steady state' theory?

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(2 marks)

(c) The 'steady state' theory was important in encouraging new research into the universe.

Suggest a reason why scientists were keen to carry out new research.

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(1 mark)

4.8.2 Red-shift (physics only)

Question 11 · continued

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(d) Scientists can answer many questions about the universe, but not the question:

'Why was the universe created?'

Suggest a reason why this question cannot be answered by scientists.

.....

.....

(1 mark)

7

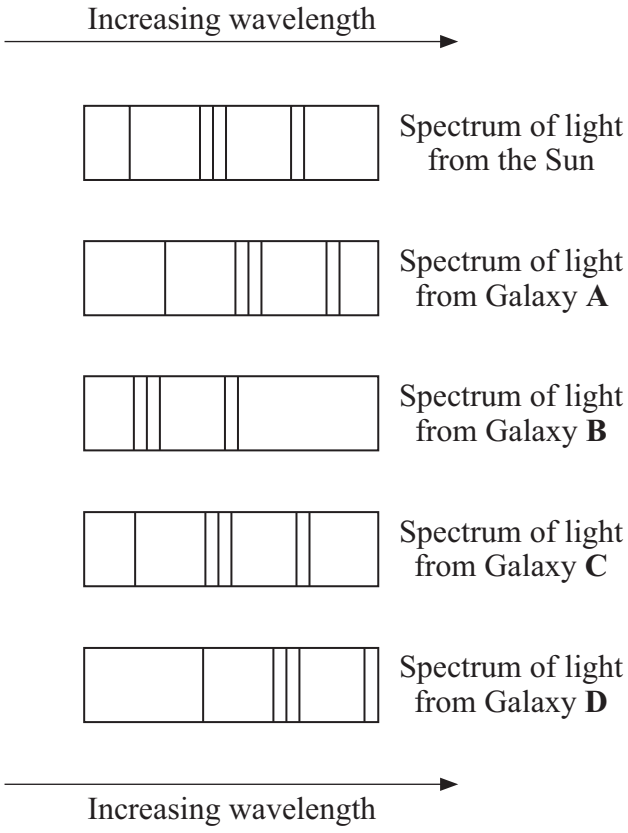
4.8.2 Red-shift (physics only)

Question 12

March 2008 | PHY1BP | Original Q7 | Legacy

QUESTION SEVEN

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



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

1 blue shift

2 green shift

3 yellow shift

4 red shift

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

1 Galaxy **A**

2 Galaxy **B**

3 Galaxy **C**

4 Galaxy **D**

4.8.2 Red-shift (physics only)

Question 12 · continued

7C Which galaxy is moving towards the observer?

1 Galaxy **A**

2 Galaxy **B**

3 Galaxy **C**

4 Galaxy **D**

7D Data from similar investigations shows that . . .

1 most galaxies are moving towards Earth.

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

3 all galaxies move at a constant speed.

4 all galaxies were created at the same time.

Turn over for the next question

4.8.2 Red-shift (physics only)

Question 13

June 2008 | PHY1BP | Original Q1 | Legacy

QUESTION ONE

This question is about what scientists know about the universe.

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

A a false statement

B an observation

C a belief which science cannot prove

D a theory

Statement about the universe	
God created the universe.	**1**
Red-shift, which suggests that galaxies are moving apart.	**2**
The universe was created by a ‘big bang’.	**3**
You can see the universe expanding by looking through a telescope.	**4**

4.8.2 Red-shift (physics only)

Question 14

June 2008 | PHY1BP | Original Q5 | Legacy

QUESTION FIVE

The table gives information about some telescopes.

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

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

1 so that astronomers are not disturbed

2 it is cheaper to build in this location

3 to be closer to the stars it is observing

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

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

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

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

3 to be closer to the stars it is observing.

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

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

1 COBE

2 Spitzer

3 Keck

4 Hopkins

4.8.2 Red-shift (physics only)

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

Which telescope is the largest?

1 Arecibo

2 Spitzer

3 Keck

4 Hopkins

Turn over for the next question

4.8.2 Red-shift (physics only)

Question 15

June 2008 | PHY1BP | Original Q7 | Legacy

QUESTION SEVEN

In 1927, the Belgian priest Georges Lemaitre 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 . . .

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

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

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

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

7B In 1929, Edwin Hubble found experimental evidence that distant galaxies are moving away from us with speeds that are proportional to their distance from the Earth.

This suggests that . . .

1 the universe is contracting.

2 the universe started from a small initial point.

3 the universe has always been the same.

4 the galaxies are getting slower.

7C Later, in 1948, it was suggested that if the universe started with an explosion there should still be cosmic (microwave) background radiation in space left over from the explosion. This microwave radiation was discovered in 1964.

Its discovery . . .

1 proves that the universe started with a ‘big bang’.

2 proves that the universe is expanding.

3 provides strong evidence that the universe started with a ‘big bang’.

4 finally disproves all other theories of the origin of the universe.

4.8.2 Red-shift (physics only)

Question 15 · continued

7D According to the latest theory, the universe was created 13.7 billion years ago.

This figure . . .

1 is both accurate and precise.

2 is a guess.

3 is an estimate based on reliable data.

4 is an estimate based on unreliable data.

Turn over for the next question

4.8.2 Red-shift (physics only)

Question 16

November 2008 | PHY1BP | Original Q6 | Legacy

QUESTION SIX

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

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

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

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

1 Arecibo

2 Spitzer

3 Hopkins

4 XMM Newton

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

1 COBE

2 Spitzer

3 Keck

4 Hopkins

4.8.2 Red-shift (physics only)

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

1 Gamma ray bursts

2 Neutron stars

3 Pulsars

4 Stars

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

1 Nebulae

2 Neutron stars

3 Pulsars

4 Stars

Turn over for the next question

4.8.2 Red-shift (physics only)

Question 17

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.

4.8.2 Red-shift (physics only)

Question 17 · continued

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

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

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

Turn over for the next question

4.8.2 Red-shift (physics only)

Question 18

November 2008 | PHY1BP | Original Q9 | Legacy

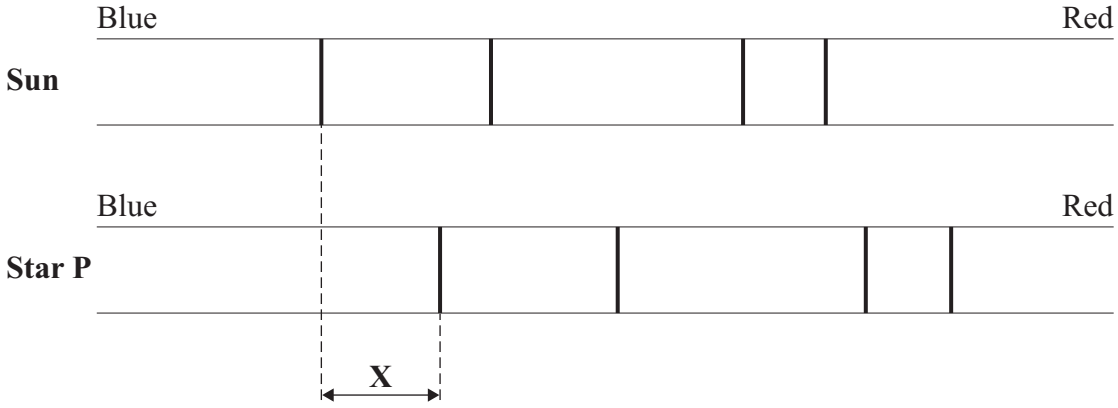
QUESTION NINE

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

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

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

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



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

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

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

4.8.2 Red-shift (physics only)

Question 18 · continued

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

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

1 smaller and in the opposite direction.

2 bigger and in the opposite direction.

3 smaller and in the same direction.

4 bigger and in the same direction.

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

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

He observed that . . .

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

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

3 the most distant galaxies show a blue-shift.

4 the red-shift does not change with distance.

9D Scientists are interested in how the universe began.

Which one of the following statements is correct?

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

2 There is no evidence about how the universe began.

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

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

END OF TEST

4.8.2 Red-shift (physics only)

Question 19

January 2009 | PHY3H | Original Q7 | Legacy

7 Read this statement from a website.

> Immediately after the 'big bang', at the start of the Universe, there were only atoms of the element hydrogen (H).
>
> Now the Universe contains atoms of over one hundred elements.

7 (a) Explain how atoms of the element helium (He) are formed in a star.

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(2 marks)

7 (b) Explain how atoms of very heavy elements, such as gold (Au), were formed.

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.....

(2 marks)

7 (c) Explain how, and when, atoms of different elements may be distributed throughout the Universe.

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.....

(2 marks)

6

4.8.2 Red-shift (physics only)

Question 20

March 2009 | PHY1BP | Original Q7 | Legacy

QUESTION SEVEN

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

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

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

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

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

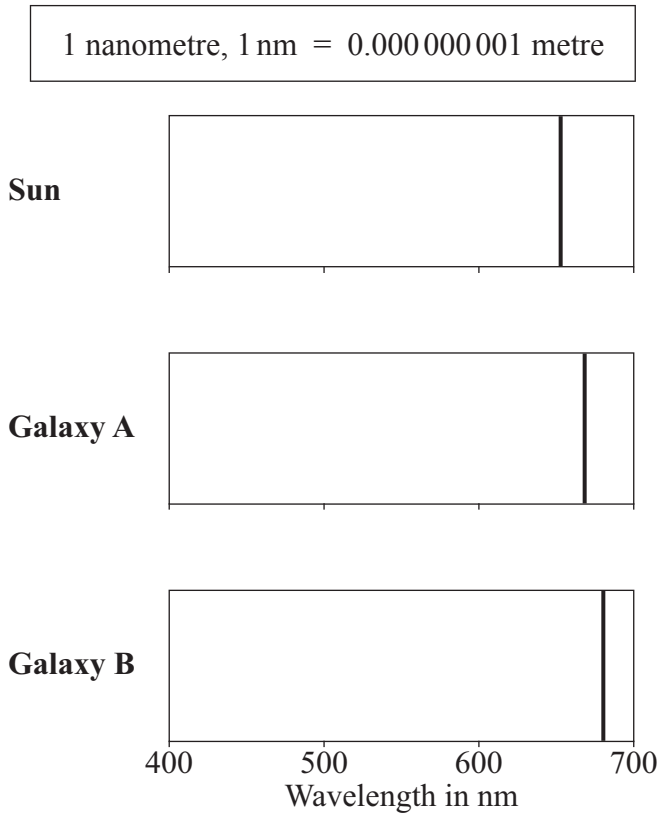
What does this tell them about the wavelength of light arriving on Earth from this galaxy and the movement of Andromeda relative to Earth?

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

Question 20 · continued

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

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



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

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

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

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

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

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

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

2 The universe expanded initially, but is now contracting.

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

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

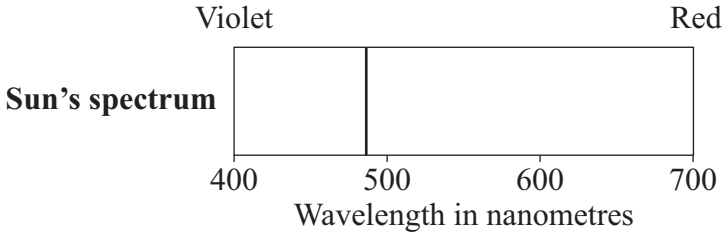
4.8.2 Red-shift (physics only)

Question 21

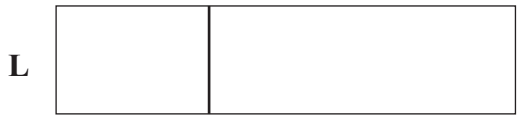
June 2009 | PHY1BP | Original Q8 | Legacy

QUESTION EIGHT

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











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

8A Which galaxy is furthest from the Sun?

1 **K**

2 **L**

3 **M**

4 **N**

4.8.2 Red-shift (physics only)

Question 21 · continued

8B Which galaxy is moving towards the Sun?

1 **K**

2 **L**

3 **M**

4 **N**

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

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

2 the universe contracted initially and then began to expand.

3 the universe expanded initially and then began to contract.

4 the universe has always existed as it is now.

8D What causes red-shift?

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

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

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

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

4.8.2 Red-shift (physics only)

Question 22

November 2009 | PHY1BP | Original Q6 | Legacy

QUESTION SIX

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

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

1 The observed wavelength decreases and the frequency increases.

2 The observed wavelength increases and the frequency decreases.

3 The observed wavelength increases and the frequency increases.

4 The observed wavelengths merge together to form red light.

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

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

1 the galaxies are contracting towards a small point.

2 the galaxies are moving towards each other.

3 the universe is contracting towards a small point.

4 the universe is expanding from an initial small point.

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

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

Which galaxy is furthest from Earth?

1 M60

2 M99

3 NGC 2366

4 NGC 2976

4.8.2 Red-shift (physics only)

Question 22 · continued

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

What does this suggest is happening to the Sun?

1 It is gradually expanding.

2 It is moving away from us.

3 It is moving towards us.

4 It is rotating.

Turn over for the next question

4.8.2 Red-shift (physics only)

Question 23

January 2010 | PHY1H | Original Q6 | Legacy

6 The 'Big Bang' theory is one theory of the origin of the Universe.

6 (a) (i) Explain what is meant by the 'Big Bang' theory.

.....

.....

.....

.....

(2 marks)

6 (a) (ii) The light arriving from distant galaxies provides scientists with evidence to support the 'Big Bang' theory.

Explain how.

.....

.....

.....

.....

(2 marks)

6 (b) At a meeting held in 2005, a group of scientists claimed that new data had been collected that showed the 'Big Bang' theory to be wrong. Other scientists said that there was no reason to doubt the 'Big Bang' theory.

What should scientists do when a theory does **not** appear to be supported by new data?

.....

.....

.....

.....

(2 marks)

4.8.2 Red-shift (physics only)

Question 23 · continued

for mark

6 (c) Scientists can answer many questions about the Universe, but not the question:

Why was the Universe created?

Suggest a reason why this question **cannot** be answered by scientists.

.....

.....

(1 mark)

7

Turn over for the next question

4.8.2 Red-shift (physics only)

Question 24

January 2010 | PHY3H | Original Q7 | Legacy

7 (a) Our star, the Sun, is stable.

Explain what the conditions need to be for a star to remain stable.

.....

.....

.....

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.....

.....

(2 marks)

7 (b) Shortly after the 'big bang', hydrogen was the only element in the Universe.

Explain how the other elements came to be formed.

.....

.....

.....

.....

.....

.....

.....

.....

(3 marks)

5

4.8.2 Red-shift (physics only)

Question 25

March 2010 | PHY1BP | Original Q7 | Legacy

QUESTION SEVEN

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

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

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

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

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

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

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

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

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

1 there are no X-rays in space.

2 the Earth's atmosphere absorbs X-rays.

3 X-rays are harmful to people.

4 X-rays are digital signals.

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

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

1 gamma rays.

2 radio waves.

3 visible light.

4 X-rays.

4.8.2 Red-shift (physics only)

Question 25 · 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

4.8.2 Red-shift (physics only)

Question 26

March 2010 | PHY1BP | Original Q8 | Legacy

QUESTION EIGHT

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

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

1 It has been proved correct by using mathematical models.

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

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

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

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

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

1 galaxies are moving rapidly away from Earth.

2 galaxies furthest away from Earth are expanding.

3 some galaxies are approaching the Earth.

4 stars in the nearest galaxies are becoming red giants.

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

Which row in the table correctly describes these changes?

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

4.8.2 Red-shift (physics only)

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

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

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

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

4 Light from the setting Sun becomes increasingly redder.

Turn over for the next question

4.8.2 Red-shift (physics only)

Question 27

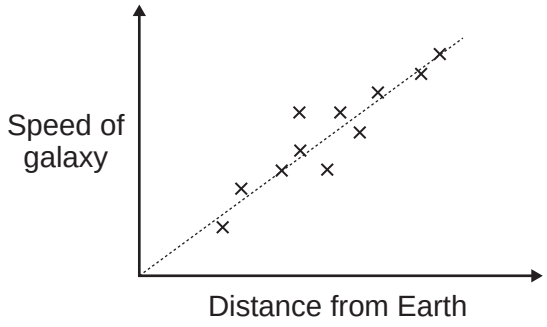
June 2010 | PHY1BP | Original Q8 | Legacy

QUESTION EIGHT

Red-shift measurements can be used to calculate the speed at which a galaxy is moving relative to the Earth.

Astronomers have also measured the distance of some galaxies from the Earth.

They have drawn their results on a graph.



8A The graph shows that . . .

1 all galaxies have the same speed.

2 distant galaxies are moving faster than nearer galaxies.

3 nearer galaxies are moving faster than more distant galaxies.

4 there is no relationship between how far galaxies are from the Earth and how fast they move.

8B Which of the following is the best description of red-shift? . . .

1 The light from galaxies is coloured red.

2 The light from galaxies is mainly at the red end of the spectrum.

3 The wavelength of light from galaxies shows a movement away from the red end of the spectrum.

4 The wavelength of light from galaxies shows a movement towards the red end of the spectrum.

8C Red-shift is described as . . .

1 the increased speed of the electromagnetic radiation as it travels from the galaxy.

2 the observed increase in frequency of the electromagnetic radiation leaving the galaxy.

3 the observed increase in wavelength of the electromagnetic radiation leaving the galaxy.

4 the decreased speed of the electromagnetic radiation as it travels from the galaxy.

4.8.2 Red-shift (physics only)

Question 27 · continued

8D The observation of red-shift gives evidence to support the ‘big bang’ theory.

This theory states that . . .

1 the stars in each galaxy are moving further apart.

2 galaxies started to rotate after the ‘big bang’.

3 new galaxies are created by an explosion in space.

4 the universe started from a single initial point.

Turn over for the next question

4.8.2 Red-shift (physics only)

Question 28

June 2010 | PHY1H | Original Q6 | Legacy

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

What is *red-shift*?

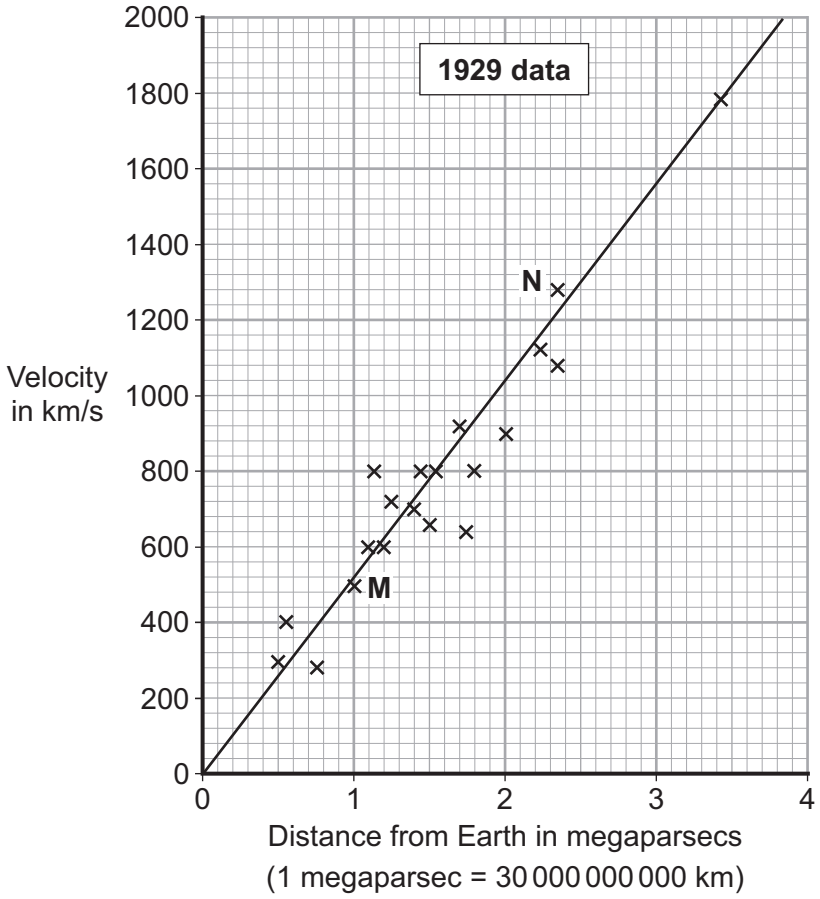
.....

.....

(1 mark)

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

The graph shows some of the data calculated by Hubble.



4.8.2 Red-shift (physics only)

Question 28 · continued

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

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

.....

.....

.....

(2 marks)

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

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

Show clearly how you obtained your answer.

.....

.....

Hubble constant = ... km/s per megaparsec

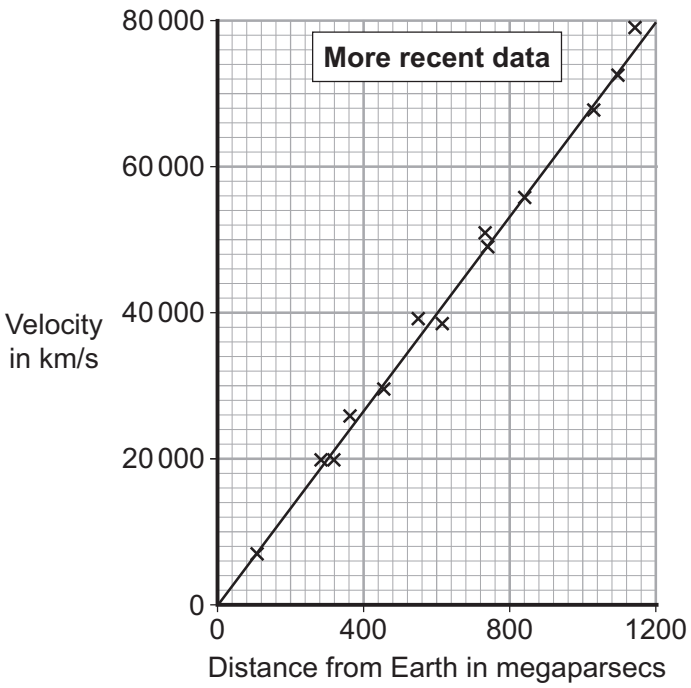
(2 marks)

Question 6 continues on the next page

4.8.2 Red-shift (physics only)

Question 28 · continued

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



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

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

Draw a ring around your answer.

1929 **more recent**

Give a reason for your answer.

.....

.....

(1 mark)

4.8.2 Red-shift (physics only)

Question 28 · continued

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

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

.....

.....

.....

.....

(2 marks)

8

4.8.2 Red-shift (physics only)

Question 29

November 2010 | PHY1BP | Original Q1 | Legacy

QUESTION ONE

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

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

Diagram 1

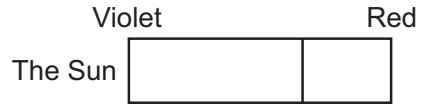
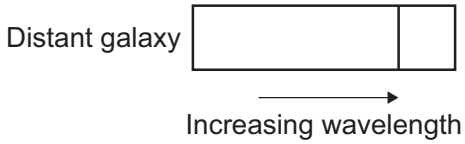


Diagram 2



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

A decreased

B increased

C shifted

D not changed

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

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

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

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

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

4.8.2 Red-shift (physics only)

Question 30

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 . . .

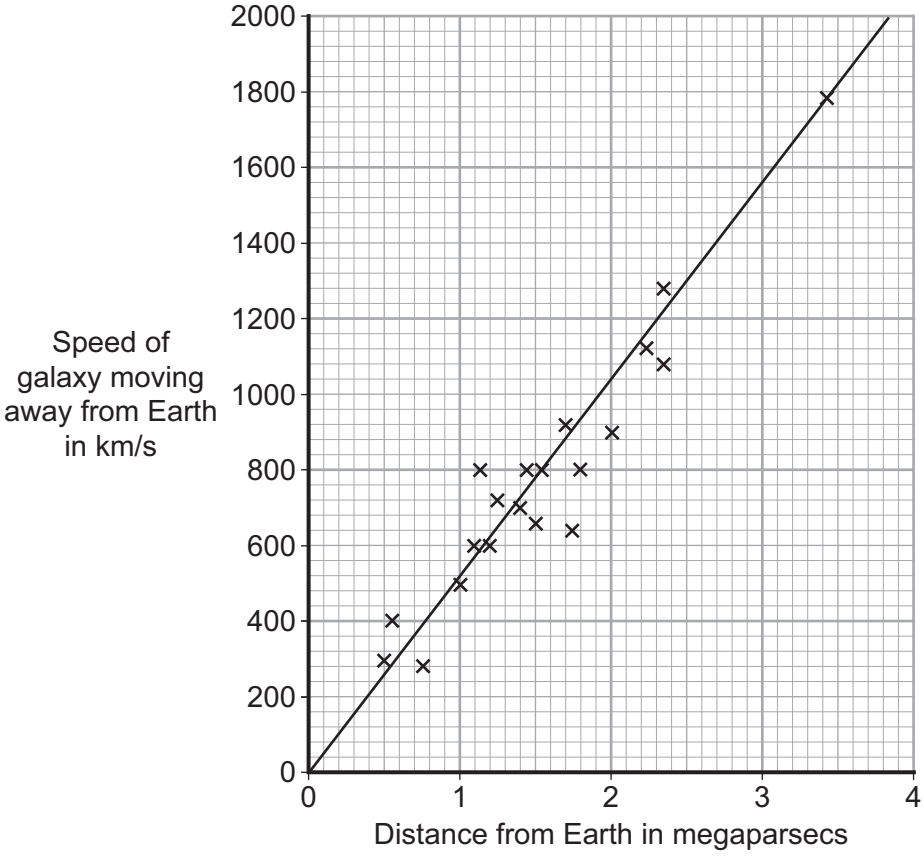
1 decrease in wavelength of the light due to a galaxy moving away from the Earth.

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.



4.8.2 Red-shift (physics only)

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'.

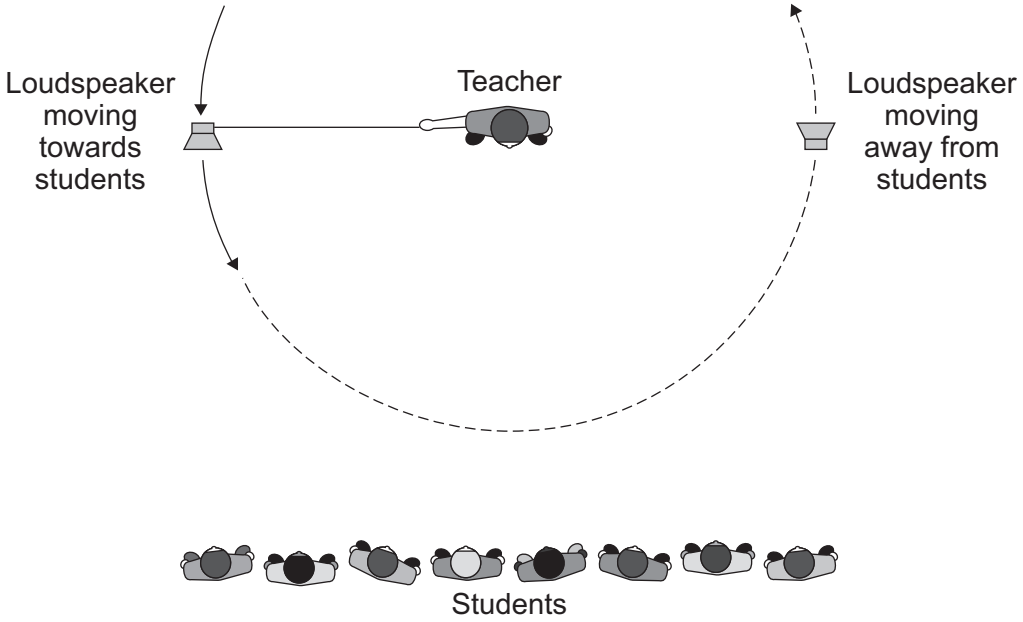
3 provides evidence which eliminates all other theories of the origin of the universe.

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

4.8.2 Red-shift (physics only)

Question 31

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



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

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

.....

.....

(1 mark)

4.8.2 Red-shift (physics only)

Question 31 · continued

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

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

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

Models can help to explain an effect or theory. ☐

Models can prove that a theory is correct. ☐

Models can help to generate new ideas. ☐

(1 mark)

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

.....

.....

.....

.....

(2 marks)

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

What name is given to this theory?

.....

(1 mark)

5

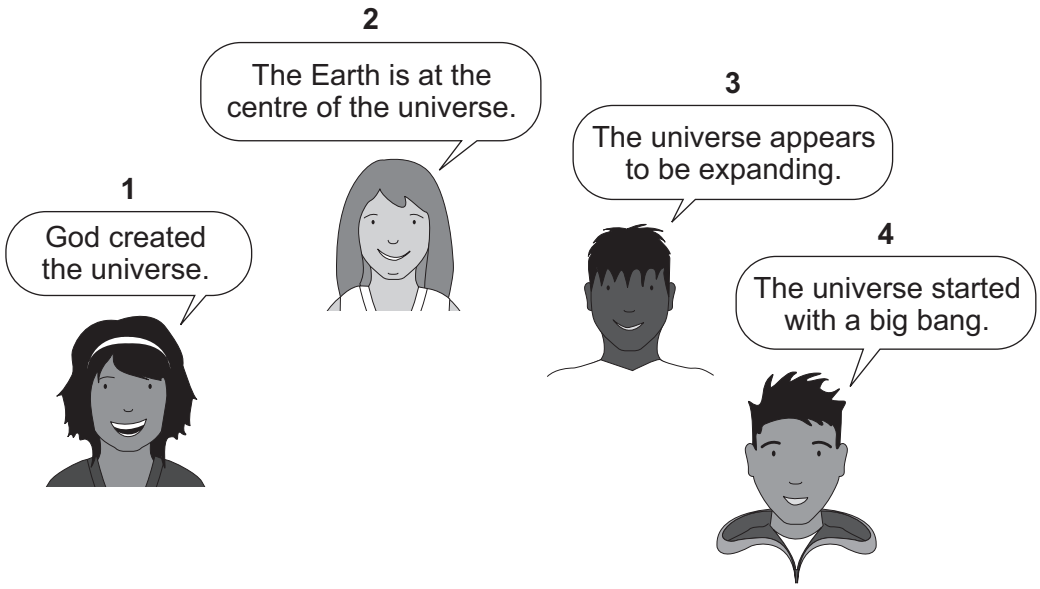
4.8.2 Red-shift (physics only)

Question 32

March 2011 | PHY1BP | Original Q1 | Legacy

QUESTION ONE

Some students are talking about the universe.



Match descriptions, **A**, **B**, **C** and **D**, with the students' statements **1**–**4**.

A a belief that science cannot disprove

B a conclusion based on observations of red-shift

C a theory supported by scientific evidence but not direct observations

D a theory that science has disproved

4.8.2 Red-shift (physics only)

Question 33

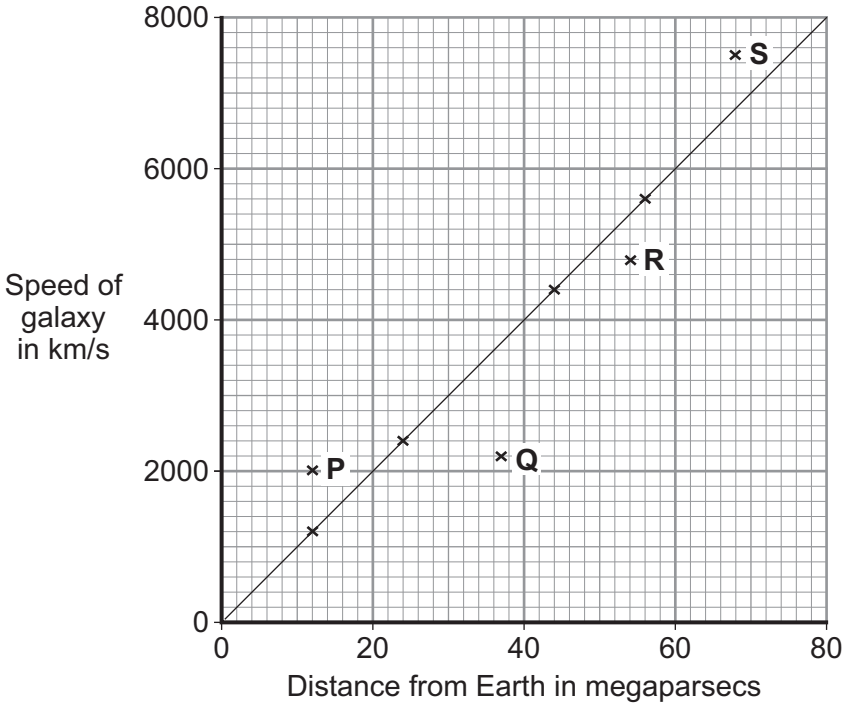
March 2011 | PHY1BP | Original Q5 | Legacy

QUESTION FIVE

In the early part of the twentieth century, Edwin Hubble made the discovery that distant galaxies are moving away from Earth.

He calculated the speeds at which the galaxies are moving away from Earth and their distances from Earth.

The graph shows Hubble's results.



A megaparsec is a unit of distance

5A Which one of the following statements describes what the graph shows?

1 All galaxies have different but constant speeds.

2 Galaxies will eventually reach a maximum speed.

3 Nearer galaxies have the highest speeds.

4 The speed of a galaxy is directly proportional to its distance from Earth.

5B What is the approximate speed, in km/s, of a galaxy 120 megaparsecs away from Earth?

1 10 000

2 11 000

3 12 000

4 13 000

4.8.2 Red-shift (physics only)

Question 33 · continued March 2011 | PHY1BP | Original Q5 | Legacy

5C The light from four galaxies, **P**, **Q**, **R** and **S**, is examined for red-shift.

Which one of the following statements about the amount of red-shift is correct?

1 **P** produces the biggest red-shift.

2 **P**, **Q**, **R** and **S** produce the same red-shift.

3 **Q** and **R** produce the smallest red-shift.

4 **S** produces the biggest red-shift.

5D Some galaxies show a blue-shift.

These galaxies . . .

1 are the most distant galaxies from the Earth.

2 are stationary.

3 are moving towards the Earth.

4 have only just been formed.

4.8.2 Red-shift (physics only)

Question 34

March 2011 | PHY1BP | Original Q7 | Legacy

QUESTION SEVEN

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

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

The table gives information about the three space telescopes.

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

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

This means that the . . .

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

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

3 Herschel telescope is much lighter than the Hubble telescope.

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

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

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

1 Herschel; Hubble; Planck.

2 Hubble; Herschel; Planck.

3 Planck; Herschel; Hubble.

4 Planck; Hubble; Herschel.

4.8.2 Red-shift (physics only)

Question 34 · continued

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

What is the ‘Big Bang’?

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

2 an observation that the universe is expanding

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

4 evidence that distant galaxies are moving away from the Earth

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

The people in the survey are concerned about . . .

1 political and scientific issues.

2 political and environmental issues.

3 economic and environmental issues.

4 economic and ethical issues.

4.8.2 Red-shift (physics only)

Question 35

June 2011 | PHY1BP | Original Q1 | Legacy

QUESTION ONE

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

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

A frequency

B red-shift

C wavelength

D wave speed

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

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

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

4.8.2 Red-shift (physics only)

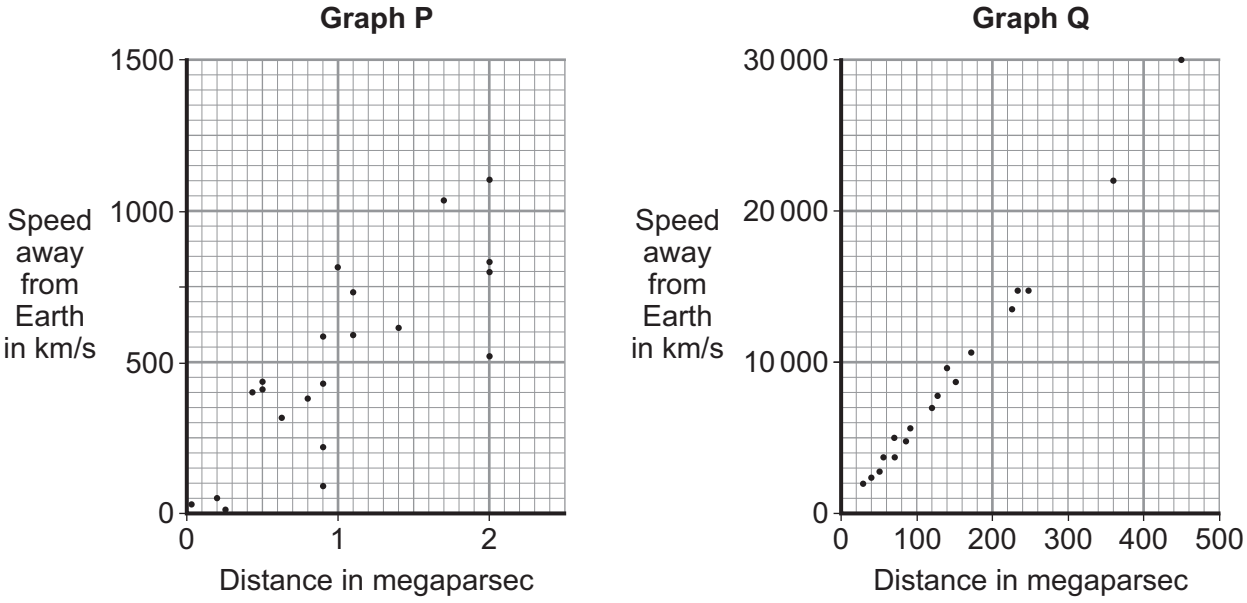
Question 36

June 2011 | PHY1BP | Original Q9 | Legacy

QUESTION NINE

Edwin Hubble investigated the relationship between the speed of a galaxy moving away from the Earth and its distance from the Earth.

Graph P shows his results.



A megaparsec is a very large unit of distance used by astronomers.

Other astronomers have confirmed Hubble's results by surveying other galaxies. **Graph Q** shows the other astronomers' results.

9A The data in **Graph P** suggests that . . .

1 there is no relationship between the speed of a galaxy and its distance from Earth.

2 the galaxies closest to Earth move fastest.

3 the further away a galaxy is from Earth, the slower it is moving.

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

4.8.2 Red-shift (physics only)

The gradient (slope) of the line of best fit is called the Hubble constant. Astronomers have used the value of the Hubble constant to calculate the age of the universe.

9B The value of the Hubble constant obtained from **Graph Q** is thought to be more accurate than Hubble's original value.

This is because . . .

1 the data includes galaxies moving towards the Earth.

2 the data gives a line of best fit passing through the origin, (0,0).

3 the data was obtained from a wide range of galaxies.

4 the data was obtained from only very distant galaxies.

9C From the data in **Graph Q**, an approximate value for the Hubble constant in km/s per megaparsec is . . .

1 0.0017

2 0.017

3 60

4 600

9D A teacher used a balloon to model an expanding universe. Some dots were marked on the balloon, which was then inflated.

Which of the following is **not** a reason for using models in science?

1 They prove a theory is correct.

2 They help us to understand a theory.

3 They give similar results to the real experiment.

4 It is easier to take measurements from a model.

END OF TEST

4.8.2 Red-shift (physics only)

Question 37

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)

4.8.2 Red-shift (physics only)

Question 37 · 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

4.8.2 Red-shift (physics only)

Question 38

November 2011 | PHY1BP | Original Q8 | Legacy

QUESTION EIGHT

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

8A Red-shift occurs because . . .

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

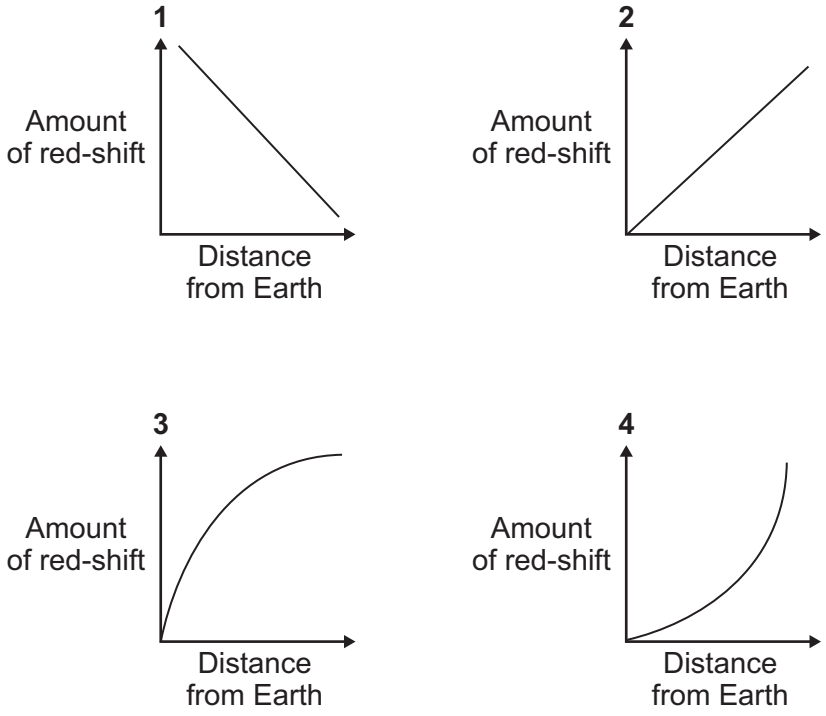
2 the speed of light from galaxies decreases as it travels through space.

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

4 distant galaxies have a relative movement towards the Earth.

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

Which graph shows this relationship?



4.8.2 Red-shift (physics only)

Question 38 · continued

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

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

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

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

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

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

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

Light from these galaxies has . . .

1 an observable decrease in its frequency.

2 an observable decrease in its wavelength.

3 smaller red-shifts than distant galaxies.

4 no change in its wavelength.

4.8.2 Red-shift (physics only)

Question 39

June 2012 | PH1HP | Original Q8 | Legacy

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

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

.....

.....

.....

.....

.....

.....

(3 marks)

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

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

.....

.....

(1 mark)

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

.....

.....

(1 mark)

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

.....

Give a reason for your answer.

.....

.....

(2 marks)

7

4.8.2 Red-shift (physics only)

Question 40

January 2013 | PH1HP | Original Q5 | Legacy

5 Galaxies emit all types of electromagnetic wave.

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

.....

(1 mark)

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

.....

.....

(1 mark)

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

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

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

Use the correct equation from the Physics Equations Sheet.

.....

.....

.....

Frequency = ...

(3 marks)

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

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

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

.....

.....

(1 mark)

4.8.2 Red-shift (physics only)

Question 40 · continued

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

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

.....

.....

.....

.....

(2 marks)

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

.....

.....

(1 mark)

9

4.8.2 Red-shift (physics only)

Question 41

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 …

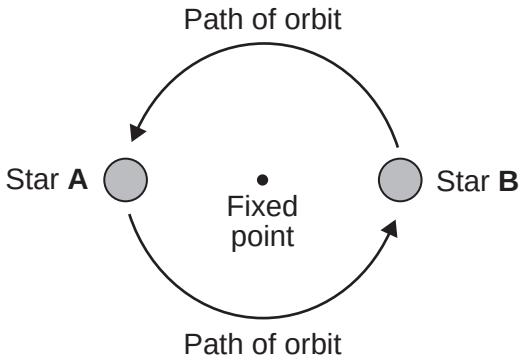
proved the 'Big Bang' theory to be correct. ☐

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.

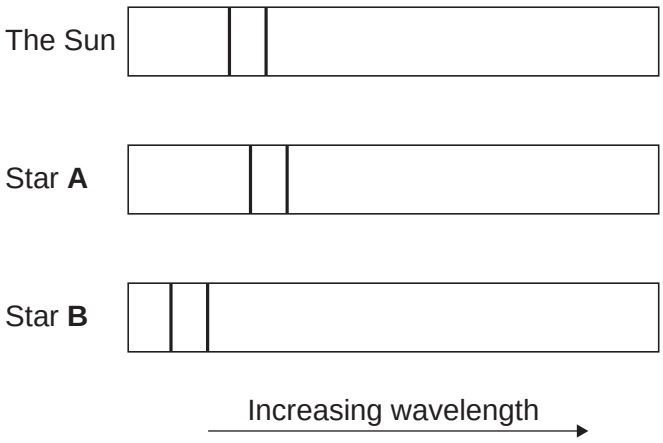


The visible spectrum from stars includes dark lines. These lines are at specific wavelengths.

4.8.2 Red-shift (physics only)

Question 41 · 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

4.8.2 Red-shift (physics only)

Question 42

June 2019 | 8463/2H | Original Q5

0 5 . 1 The light from distant galaxies shows red-shift.

Complete the sentence.

[1 mark]

The term red-shift describes the observed increase

in the _____ of the light from a distant galaxy.

0 5 . 2 The Big Bang theory is one model used to explain the origin of the universe.

How does the Big Bang theory describe the universe when it began?

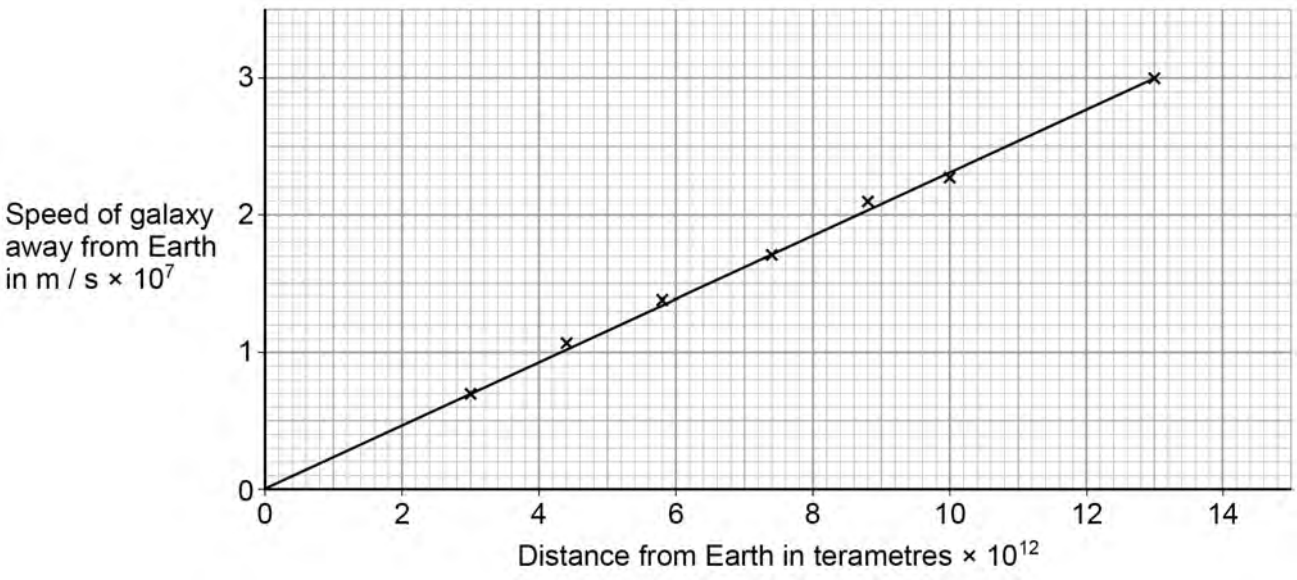
[1 mark]

_____

_____

Figure 9 shows data scientists have calculated from measurements of red-shift.

Figure 9



4.8.2 Red-shift (physics only)

Question 42 · continued

0 5 . 3 Describe the relationship between the speed of a galaxy and the distance the galaxy is from the Earth.

[1 mark]

0 5 . 4 Which of the following is the same as 6×10^{12} terametres?

[1 mark]

Tick (✓) **one** box.

6×10^{15} m ☐

6×10^{18} m ☐

6×10^{21} m ☐

6×10^{24} m ☐

0 5 . 5 Explain how the data in **Figure 9** supports the suggestion that the universe began from a very small region.

[2 marks]

Question 5 continues on the next page

4.8.2 Red-shift (physics only)

Question 42 · continued

0 5 . 6 The Big Bang theory suggested that gravity would slow the rate at which galaxies move away from the Earth.

New observations suggest that distant galaxies are moving away from the Earth at an increasingly fast rate.

What do the new observations suggest is happening to the universe?

[1 mark]

0 5 . 7 New observations and data that do not fit existing theories should undergo peer review.

Give **one** reason why peer review is an important process.

[1 mark]

0 5 . 8 The Andromeda galaxy is moving towards the Earth.

Describe how the wavelength and frequency of the light from Andromeda seem to have changed when viewed from the Earth.

[2 marks]

10

4.8.2 Red-shift (physics only)

Question 43

June 2022 | 8463/2HR | Original Q6

0 6 Galaxies contain billions of stars.

0 6 . 1 Compare the formation and life cycles of stars with a similar mass to the Sun to stars with a much greater mass than the Sun.

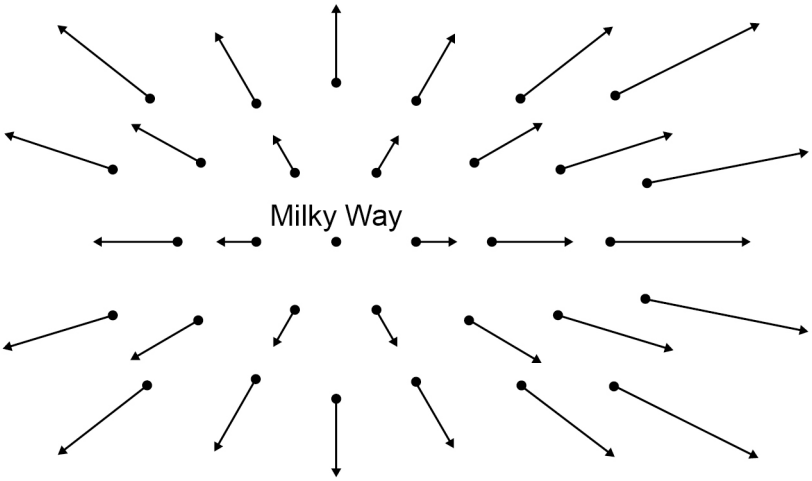
[6 marks]

4.8.2 Red-shift (physics only)

Question 43 · continued

The points on **Figure 11** represent galaxies that are moving away from the Milky Way.

Figure 11



Each arrow represents the velocity of the galaxy relative to the Milky Way.

0 6 . 2 Light from all galaxies represented in **Figure 11** is red-shifted.

Describe what is meant by red-shift.

[2 marks]

0 6 . 3 Explain how **Figure 11** provides evidence for the Big Bang theory.

[2 marks]

0 6 . 4 Sometimes scientists have to change theories about the universe.

Give the reason why.

[1 mark]

11

4.8.2 Red-shift (physics only)

Question 44

June 2025 | 8463/2H | Original Q4

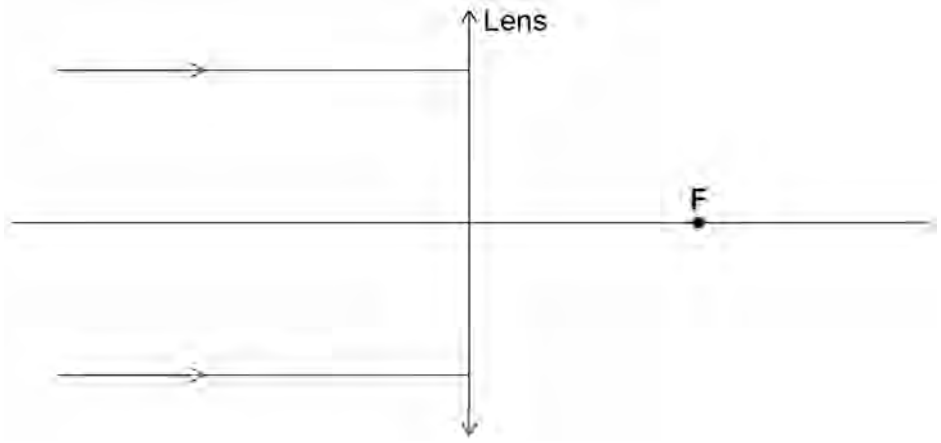
0 4 Telescopes are used to look at distant objects.

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

4.8.2 Red-shift (physics only)

Question 44 · 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

_____.

4.8.2 Red-shift (physics only)

Question 44 · 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