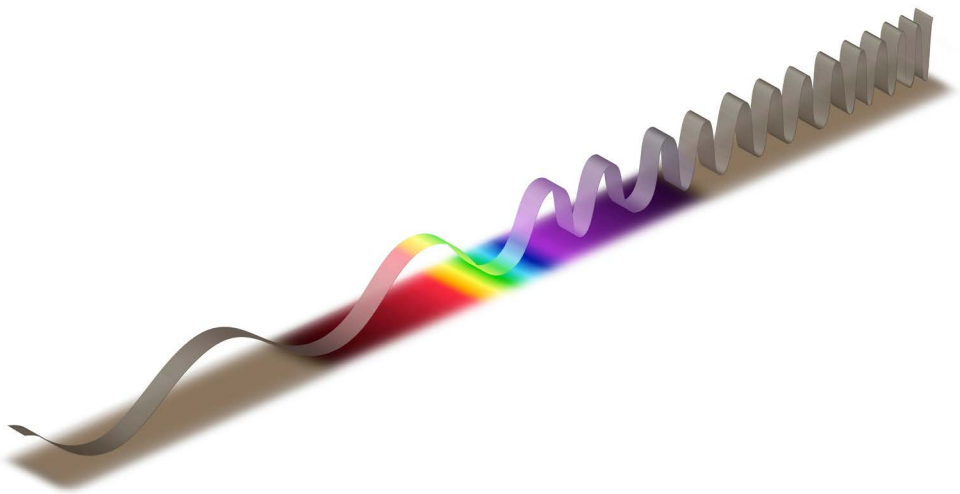
Cambridge Assessment International Education

Space Physics Practice Questions

Cambridge O Level

Physics 5054

To accompany the revised syllabus for examination from 2023.



Version 1

Cambridge Pathway

Contents

Introduction

The purpose of this booklet is to provide additional practice questions and answers for the Space Physics topic which has been introduced to Cambridge O Level Physics (5054) for first assessment in 2023.

Practice questions have been provided to exemplify a range of types of questions which could appear in examinations.

The answers and a typical mark scheme are also provided.

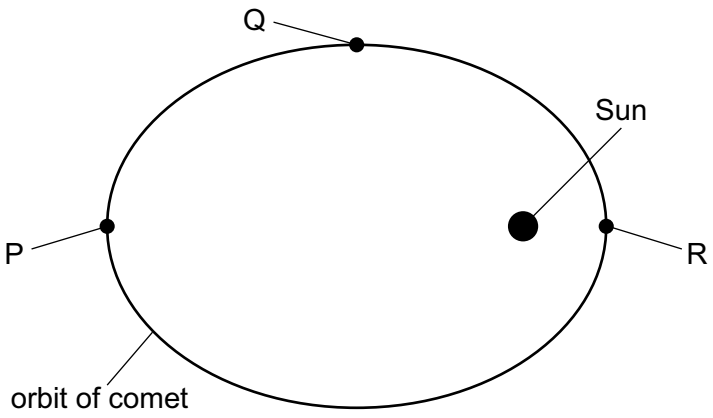
Other support materials are available on the School Support Hub **www.cambridgeinternational.org/support**

Paper 1 example questions

1 Which row in the table correctly lists a galaxy, a planet and a star?

	galaxy	planet	star
A	Milky Way	Mars	Moon
B	Milky Way	Earth	Sun
C	Solar System	Mars	Sun
D	Solar System	Earth	Moon

2 The orbit around the Sun of a comet is not circular. The distance between the Sun and the comet varies, as shown in the diagram.

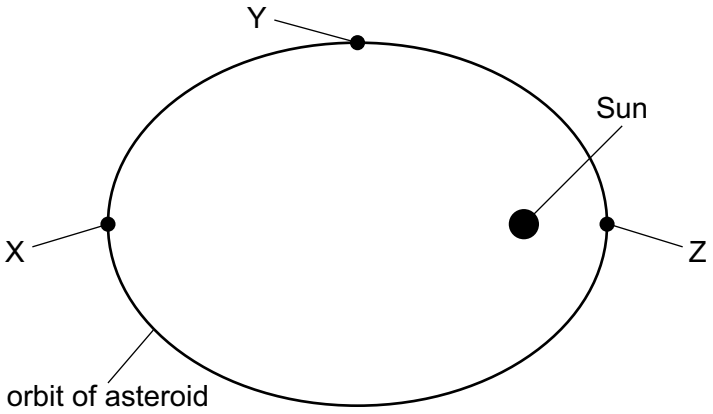


Where, in the orbit, is the speed of the comet the greatest and where is it the smallest?

	speed greatest at	speed smallest at
A	P	R
B	P and R	Q
C	Q	P and R
D	R	P

3 The orbit around the Sun of a particular asteroid (dwarf planet) is not circular. The distance between the Sun and the asteroid varies, as shown in the diagram.

The asteroid possesses both gravitational potential energy (GPE) and kinetic energy (KE).



Which energy transfer takes place as the asteroid moves from X to Y and as it moves from Y to Z?

	moving from X to Y	moving from Y to Z
A	GPE to KE	GPE to KE
B	GPE to KE	KE to GPE
C	KE to GPE	GPE to KE
D	KE to GPE	KE to GPE

4 Ceres and Vesta are two asteroids (dwarf planets) that orbit the Sun. The orbits of Ceres and Vesta are approximately circular.

The Sun's gravitational field at the orbit of Ceres is weaker than that at the orbit of Vesta.

How does the orbital speed of Ceres and its orbital period compare with the orbital speed and orbital period of Vesta?

	orbital speed of Ceres	orbital period of Ceres
A	smaller than that of Vesta	smaller than that of Vesta
B	smaller than that of Vesta	greater than that of Vesta
C	greater than that of Vesta	smaller than that of Vesta
D	greater than that of Vesta	greater than that of Vesta

5 The Sun emits energy in the form of electromagnetic radiation.

Which three components of the electromagnetic spectrum account for almost all of this energy?

A infrared, microwave and ultraviolet

B infrared, microwave and visible light

C infrared, ultraviolet and visible light

D microwave, ultraviolet and visible light

6 When, in the life cycle of a star, are heavy elements produced?

A when a cloud containing hydrogen collapses

B when a protostar becomes stable

C when a red supergiant explodes

D when a white dwarf is formed

7 The statements J, K, L and M describe different stages in the life cycle of a small star.

J A cloud containing hydrogen collapses due to gravitational attraction.
K A red giant is produced.
L A white dwarf is produced.
M Hydrogen undergoes nuclear fusion to produce helium.

What is the order (first to last) in which the stages occur?

A J, M, K, L

B J, M, L, K

C M, J, K, L

D M, J, L, K

8 What provides evidence for the Big Bang Theory?

A the expulsion of heavy elements into space during a supernova explosion

B the increase in the observed wavelength of radiation emitted by distant galaxies

C the nuclear fusion reaction that takes place at the centre of stable stars

D the smaller orbital speeds of the planets that are further from the Sun

Paper 1 example questions mark scheme

Question	Answer	Marks
1	B	**1**
2	D	**1**
3	A	**1**
4	B	**1**
5	C	**1**
6	C	**1**
7	A	**1**
8	B	**1**

Paper 2 example questions

1 The Solar System contains the Sun, planets, moons, asteroids and comets.

(a) State the name of the planet closest to the Sun.

..... [1]

(b) Describe the difference between a planet and a moon.

.....

..... [2]

(c) State **two** differences between an asteroid and a comet.

1 .....

.....

2 .....

..... [2]

(d) The planet closest to the Sun orbits the Sun in 88 days.

State **two** reasons why the Earth takes longer to orbit the Sun than this planet.

1 .....

2 .....
[2]

(e) **(i)** State the time taken for light to travel from the Sun to the Earth.

..... [1]

(ii) Using your answer to **(e)(i)**, calculate the distance from the Sun to the Earth.

Show your working.

distance = ... m [2]

[Total: 10]

2 **(a)** A year, a month and a day can be defined in terms of the motions of the Earth, the Moon and the Sun.

Using these motions, complete the following sentences.

(i) A year is the time for

..... [1]

(ii) A month is the time for

..... [1]

(iii) A day is the time for

..... [1]

(b) Earth, Jupiter and Saturn are three planets in the Solar System.

Table 2.1 gives information about these planets.

Table 2.1

planet	$\frac{\text{orbital speed}}{\text{km / h}}$	time to orbit Sun / years
Earth	1.1×10^5	1.0
Jupiter	4.7×10^4	12
Saturn	3.5×10^4	29

Using data from Table 2.1, calculate the average radius of Saturn's orbit around the Sun.

Give your answer in km.

radius = ... km [3]

(c) Fig. 2.1 shows one alignment with the Sun of Earth, Jupiter and Saturn.

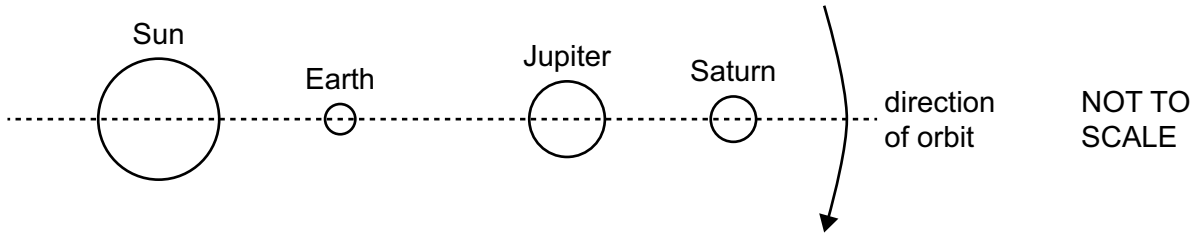


Fig. 2.1

(i) In Fig. 2.1, the three planets and the Sun are in line.

29 years later, Saturn returns to the same position relative to the Sun, but Earth and Jupiter are **not** in the same line.

Use data from Table 2.1 to explain why.

.....

.....

..... [2]

(ii) Complete Fig. 2.2 to show the positions of the three planets exactly 6 years after the diagram in Fig. 2.1.

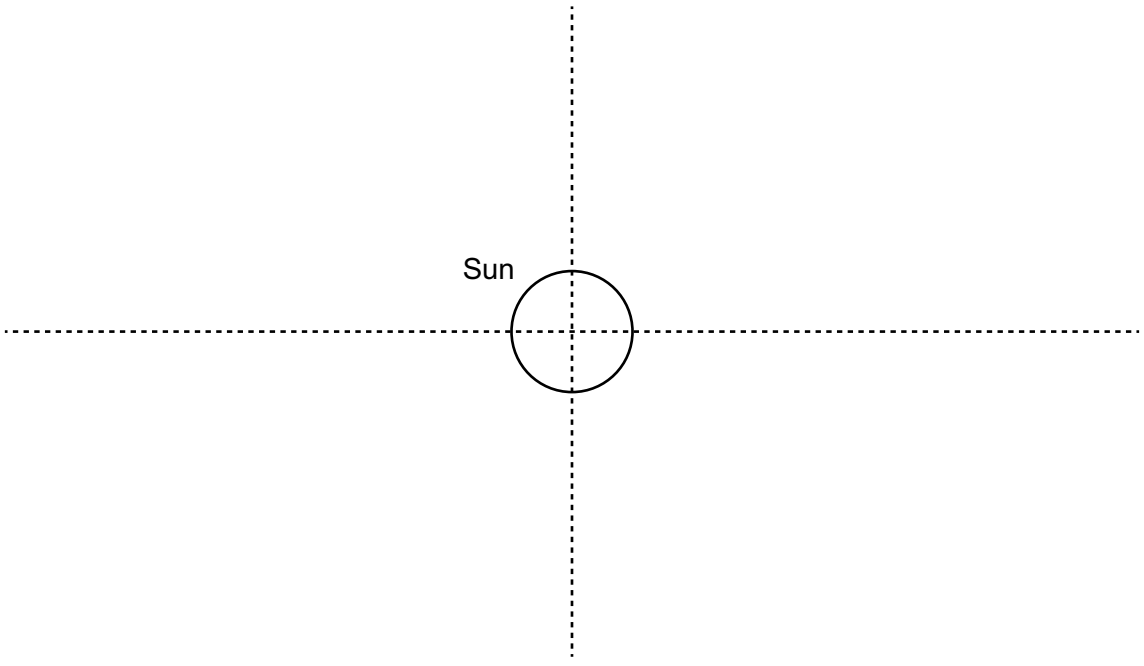


Fig. 2.2

[3]

[Total: 11]

[Turn over

3 Table 3.1 lists some of the planets in the Solar System and their average distances from the Sun.

Table 3.1

planet	average distance from the Sun / km
Mercury	5.8×10^7
	1.1×10^8
Earth	1.5×10^8
	2.3×10^8
Jupiter	7.8×10^8

(a) Complete Table 3.1 by writing in the names of the missing planets. [2]

(b) As the planets move around the Sun, the distance between Earth and Jupiter changes.

Use Table 3.1 to calculate the smallest distance and the largest distance between Earth and Jupiter.

smallest distance = ...

largest distance = ...
[2]

(c) A planet is in orbit around a distant star. As it passes in front of the star, it blocks some of the light of the star from reaching Earth, reducing the brightness of the star as seen from Earth.

Fig. 3.1 shows the view, from Earth, as the planet passes in front of the star.

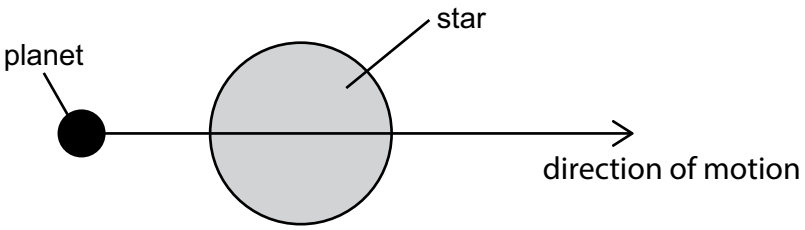


Fig. 3.1

Fig. 3.2 shows an incomplete graph of how the brightness of the star varies with time, as seen from Earth.

The planet is in front of the star from time t_1 to time t_2.

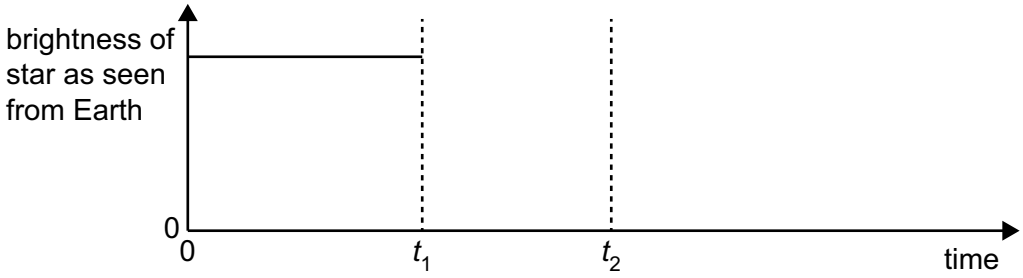


Fig. 3.2

(i) Complete Fig. 3.2 to show how the brightness of the star varies with time. [2]

(ii) Describe how the completed Fig. 3.2 should be changed to show a larger planet passing at the same distance in front of the same star.

.....

.....

..... [2]

(iii) Suggest how an astronomer uses the changes in the brightness of the star to measure the orbital period of the planet round the star.

.....

.....

..... [1]

[Total: 9]

4 When astronomers look at distant galaxies, they find that the frequency of the light from the galaxy is shifted towards the red end of the spectrum.

(a) (i) Apart from visible light, state **two** types of electromagnetic wave that contain most of the energy emitted by a stable star.

..... [1]

(ii) Describe what is meant by the red end of the spectrum.

.....

..... [1]

(b) The speed of recession of a galaxy is the speed at which the galaxy is moving away from Earth.

Astronomers use redshift to measure the speed of recession.

Astronomers can also measure the distance d of the galaxy from Earth. Such large distances are measured in light-years.

Astronomers can estimate the time T that the galaxy has been moving away from Earth using the equation

$$T = \frac{d}{\text{speed of recession}}$$

Table 4.1 shows their estimates for four different galaxies.

Table 4.1

d / light-years	$\frac{\text{speed of recession}}{\text{km/s}}$	T / billions of years
4.9×10^7	1100	13
1.0×10^8	2400	13
3.2×10^8	6700	14
3.9×10^8	9000	13

(i) State what is meant by a galaxy.

.....

..... [2]

(ii) Show that 1.0 light-year is equal to 9.5×10^{15} m.

[3]

(iii) Describe the relationship between the speed of recession of a galaxy and its distance from Earth.

.....

..... [1]

(iv) Explain how the values of *T* provide evidence for the Big Bang Theory of the origin of the Universe.

.....

.....

..... [2]

[Total: 10]

5 **(a)** The Sun produces energy from nuclei of hydrogen. Hydrogen nuclei are positively charged.

(i) Describe the process that produces this energy.

.....

.....

..... [2]

(ii) Explain why this process needs a high temperature to occur.

.....

.....

..... [2]

(b) **(i)** Some stars are initially much more massive than the Sun.

Describe the life cycle of such a star, after it has passed through the stage of being a protostar.

.....

.....

.....

.....

.....

.....

..... [4]

(ii) Although the early Universe contained only light elements such as hydrogen, it now contains a number of very heavy elements.

State in which part of the life cycle of a star these very heavy elements are formed.

.....

..... [1]

[Total: 9]

Generic Marking Principles

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptors for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:

Marks awarded are always **whole marks** (not half marks, or other fractions).

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

GENERIC MARKING PRINCIPLE 4:

Rules must be applied consistently, e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

GENERIC MARKING PRINCIPLE 5:

Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).

GENERIC MARKING PRINCIPLE 6:
Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

Science-Specific Marking Principles

1	Examiners should consider the context and scientific use of any keywords when awarding marks. Although keywords may be present, marks should not be awarded if the keywords are used incorrectly.
2	The examiner should not choose between contradictory statements given in the same question part, and credit should not be awarded for any correct statement that is contradicted within the same question part. Wrong science that is irrelevant to the question should be ignored.
3	Although spellings do not have to be correct, spellings of syllabus terms must allow for clear and unambiguous separation from other syllabus terms with which they may be confused (e.g. ethane / ethene, glucagon / glycogen, refraction / reflection).
4	The error carried forward (ecf) principle should be applied, where appropriate. If an incorrect answer is subsequently used in a scientifically correct way, the candidate should be awarded these subsequent marking points. Further guidance will be included in the mark scheme where necessary and any exceptions to this general principle will be noted.
5	<u>'List rule' guidance</u> For questions that require ***n*** responses (e.g. State **two** reasons …): • The response should be read as continuous prose, even when numbered answer spaces are provided. • Any response marked *ignore* in the mark scheme should not count towards ***n***. • Incorrect responses should not be awarded credit but will still count towards ***n***. • Read the entire response to check for any responses that contradict those that would otherwise be credited. Credit should **not** be awarded for any responses that are contradicted within the rest of the response. Where two responses contradict one another, this should be treated as a single incorrect response. • Non-contradictory responses after the first ***n*** responses may be ignored even if they include incorrect science.

6	Calculation specific guidance Correct answers to calculations should be given full credit even if there is no working or incorrect working, **unless** the question states 'show your working'. For questions in which the number of significant figures required is not stated, credit should be awarded for correct answers when rounded by the examiner to the number of significant figures given in the mark scheme. This may not apply to measured values. For answers given in standard form (e.g. $a \times 10^n$) in which the convention of restricting the value of the coefficient (a) to a value between 1 and 10 is not followed, credit may still be awarded if the answer can be converted to the answer given in the mark scheme. Unless a separate mark is given for a unit, a missing or incorrect unit will normally mean that the final calculation mark is not awarded. Exceptions to this general principle will be noted in the mark scheme.
7	Guidance for chemical equations Multiples / fractions of coefficients used in chemical equations are acceptable unless stated otherwise in the mark scheme. State symbols given in an equation should be ignored unless asked for in the question or stated otherwise in the mark scheme.

Mark categories

B marks	These are independent marks, which do not depend on other marks. For a **B** mark to be awarded, the point to which it refers must be seen specifically in the candidate's answer.
M marks	These are method marks upon which **A** marks later depend. For an **M** mark to be awarded, the point to which it refers must be seen specifically in the candidate's answer. If a candidate is not awarded an **M** mark, the later **A** mark cannot be awarded either.
C marks	These are compensatory marks which can be awarded even if the points to which they refer are not written down by the candidate, providing subsequent working gives evidence that they must have known them. For example, if an equation carries a **C** mark and the candidate does not write down the actual equation but does correct working which shows the candidate knew the equation, then the **C** mark is awarded. If a correct answer is given to a numerical question, all of the preceding **C** marks are awarded automatically. It is only necessary to consider each of the **C** marks in turn when the numerical answer is not correct.
A marks	These are answer marks. They may depend on an **M** mark or allow a **C** mark to be awarded by implication.

Abbreviations and guidance

/	Alternative answers for the same marking point.
underline	Actual word underlined must be used by candidate (grammatical variants accepted).
(brackets)	The word or phrase in brackets is not required but sets the context.
AND / and	Statements on both sides of the **AND** are needed for that mark.
OR / or	Indicates alternative answers, any one of which is satisfactory for scoring the marks.
NOT / not	Indicates that an incorrect answer is not to be disregarded but cancels another otherwise correct alternative offered by the candidate for this mark.
Accept / A	A less than ideal answer which should be marked correct.
Ignore / Ig	Indicates that something which is not correct or irrelevant is to be disregarded.
e.c.f.	'error carried forward'
o.w.t.t.e.	'or words to that effect'
s.f.	'significant figures' – answers are normally acceptable to any number of significant figures $\geqslant 2$. Any exceptions to this general rule will be specified in the mark scheme.
Arithmetic errors	If the **only** error in arriving at a final answer is clearly an arithmetic one, all but the final **A** mark can be awarded. Regard a power of ten error as an arithmetic error.
Transcription errors	If the **only** error in arriving at a final answer is because given or previously calculated data has clearly been misread but used correctly, all but the final **A** mark can be awarded.
Fractions	Only accept these where specified in the mark scheme.
Crossed-out work	Work which has been crossed out and not replaced but can easily be read, should be marked as if it had not been crossed out.

Paper 2 example questions mark scheme

Question	Answer	Marks
1(a)	Mercury	**B1**
1(b)	a moon orbits a planet	**B1**
	a planet orbits a star / the Sun	**B1**
1(c)	any **two** from: comet comes from far away / outside the solar system / highly elliptical orbit / long period / contains ice / has a tail (as it passes the Sun) / loses mass as it passes close to the Sun / comets come in smaller range of sizes / many more asteroids than comets / asteroid made of rock / asteroid made of metals / mostly found between Mars and Jupiter / formed close to the Sun / short period / more circular orbit Candidates must give a valid comparison between a comet and an asteroid in each case, e.g. a comet has a tail but an asteroid does not.	**B2**
1(d)	(Earth) moves slower	**B1**
	circumference of orbit / distance travelled in orbit is larger	**B1**
1(e)(i)	(approximately) 500 s **Accept** 8 minutes	**B1**
1(e)(ii)	(d =) speed × time **or** 3.0×10^8 (m / s) seen	**B1**
	1.5×10^{11} (m)	**A1**

Question	Answer	Marks
2(a)(i)	the Earth to travel round the Sun	**B1**
2(a)(ii)	the Moon to travel round the Earth	**B1**
2(a)(iii)	the Earth to rotate <u>once</u> (on its own axis) / the Earth to complete one rotation	**B1**
2(b)	(d =) vT in any form algebraic or numerical, e.g. ($r = \frac{vT}{2\pi}$)	**C1**
	$3.5 \times 10^4 \times 29 \times 365 \times 24$	**C1**
	1.4×10^9 (km)	**A1**

Question	Answer	Marks
2(c)(i)	Saturn has rotated once and Earth 29 times	**B1**
	Jupiter has rotated 2.4 times (in 29 years) / Jupiter is now less than halfway (round its orbit)	**B1**
2(c)(ii)	Earth on line to right	**B1**
	Jupiter on line to left	**B1**
	Saturn about 75° clockwise, not quite on line downwards	**B1**

Question	Answer	Marks
3(a)	Venus	**B1**
	Mars	**B1**
3(b)	smallest distance 6.3×10^8 km	**B1**
	largest distance 9.3×10^8 km	**B1**
3(c)(i)	reduces at t_1 **and** has a flat section somewhere between t_1 and t_2	**B1**
	after t_2 back to initial level **and** neither change at t_1 or t_2 is vertical	**B1**
3(c)(ii)	lower brightness when light is blocked / flat section at a lower level	**B1**
	time to reduce brightness and time to increase brightness is longer / flat section for a shorter time	**B1**
3(c)(iii)	from t_1 to the next time when the brightness starts to reduce **or** from t_2 to the next time when the brightness starts to increase	**B1**

Question	Answer	Marks
4(a)(i)	infrared and ultraviolet	**B1**
4(a)(ii)	(end with) the longest wavelength **or** lowest frequency	**B1**
4(b)(i)	collection of stars	**C1**
	billions of stars	**A1**
4(b)(ii)	use of 3.0×10^8 m / s	**B1**
	365 (days in a year) **and** 24 (hours in a day) seen	**B1**
	$3.0 \times 10^8 \times 365 \times 24 \times 60 \times 60$ **or** 9.46×10^{15} seen	**B1**

Question	Answer	Marks
4(b)(iii)	further from Earth the greater the speed of recession **or** speed of recession proportional to distance from Earth	**B1**
4(b)(iv)	values are (nearly) the same	**B1**
	all galaxies (and Earth) were together (13–14 billion years ago)	**B1**

Question	Answer	Marks
5(a)(i)	(hydrogen) nuclei come together / fuse	**B1**
	to form helium and release energy	**B1**
5(a)(ii)	high speeds needed	**B1**
	nuclei repel	**B1**
5(b)(i)	becomes a main sequence star / stable star	**B1**
	expands to become a red supergiant	**B1**
	becomes a supernova (and throws off outer layers)	**B1**
	core becomes a neutron star **or** (if original mass large enough) core shrinks to become a black hole	**B1**
5(b)(ii)	in a supernova	**B1**

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