

GENERAL CERTIFICATE OF SECONDARY EDUCATION

TWENTY FIRST CENTURY SCIENCE

A183/01

PHYSICS A / FURTHER ADDITIONAL SCIENCE A

Unit A183/01: Module P7 (Foundation Tier)

Candidates answer on the question paper
A calculator may be used for this paper

OCR Supplied Materials:

None

Duration: 1 hour

Other Materials Required:

- Pencil
- Ruler (cm/mm)


Candidate Forename		Candidate Surname	
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Centre Number						Candidate Number				
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INSTRUCTIONS TO CANDIDATES

- Write your name clearly in capital letters, your centre number and candidate number in the boxes above.
- Use black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure that you know what you have to do before starting your answer.
- Answer **all** the questions.
- Write your answer to each question in the space provided, however additional paper may be used if necessary.

INFORMATION FOR CANDIDATES

- Your quality of written communication is assessed in questions marked with a pencil (.
- A list of useful relationships is printed on pages 2 and 3.
- The number of marks for each question is given in brackets [] at the end of the question or part question.
- The total number of marks for this paper is **60**.
- This document consists of **16** pages. Any blank pages are indicated.

For Examiner's Use		
	Max	Mark
1	12	
2	16	
3	6	
4	5	
5	11	
6	10	
TOTAL	60	

TWENTY FIRST CENTURY SCIENCE EQUATIONS

Useful Relationships

The Earth in the Universe

$$\text{distance} = \text{wave speed} \times \text{time}$$

$$\text{wave speed} = \text{frequency} \times \text{wavelength}$$

Sustainable Energy

$$\text{energy transferred} = \text{power} \times \text{time}$$

$$\text{power} = \text{voltage} \times \text{current}$$

$$\text{efficiency} = \frac{\text{energy usefully transferred}}{\text{total energy supplied}} \times 100\%$$

Explaining Motion

$$\text{speed} = \frac{\text{distance travelled}}{\text{time taken}}$$

$$\text{acceleration} = \frac{\text{change in velocity}}{\text{time taken}}$$

$$\text{momentum} = \text{mass} \times \text{velocity}$$

$$\text{change of momentum} = \text{resultant force} \times \text{time for which it acts}$$

$$\text{work done by a force} = \text{force} \times \text{distance moved in the direction of the force}$$

$$\text{amount of energy transferred} = \text{work done}$$

$$\text{change in gravitational potential energy} = \text{weight} \times \text{vertical height difference}$$

$$\text{kinetic energy} = \frac{1}{2} \times \text{mass} \times [\text{velocity}]^2$$

Electric Circuits

$$\text{power} = \text{voltage} \times \text{current}$$

$$\text{resistance} = \frac{\text{voltage}}{\text{current}}$$

$$\frac{\text{voltage across primary coil}}{\text{voltage across secondary coil}} = \frac{\text{number of turns in primary coil}}{\text{number of turns in secondary coil}}$$

Radioactive Materials

$$\text{energy} = \text{mass} \times [\text{speed of light in a vacuum}]^2$$

Observing the Universe

$$\text{lens power} = \frac{1}{\text{focal length}}$$

$$\text{magnification} = \frac{\text{focal length of objective lens}}{\text{focal length of eyepiece lens}}$$

$$\text{speed of recession} = \text{Hubble constant} \times \text{distance}$$

$$\text{pressure} \times \text{volume} = \text{constant}$$

$$\frac{\text{pressure}}{\text{temperature}} = \text{constant}$$

$$\frac{\text{volume}}{\text{temperature}} = \text{constant}$$

$$\text{energy} = \text{mass} \times [\text{speed of light in a vacuum}]^2$$

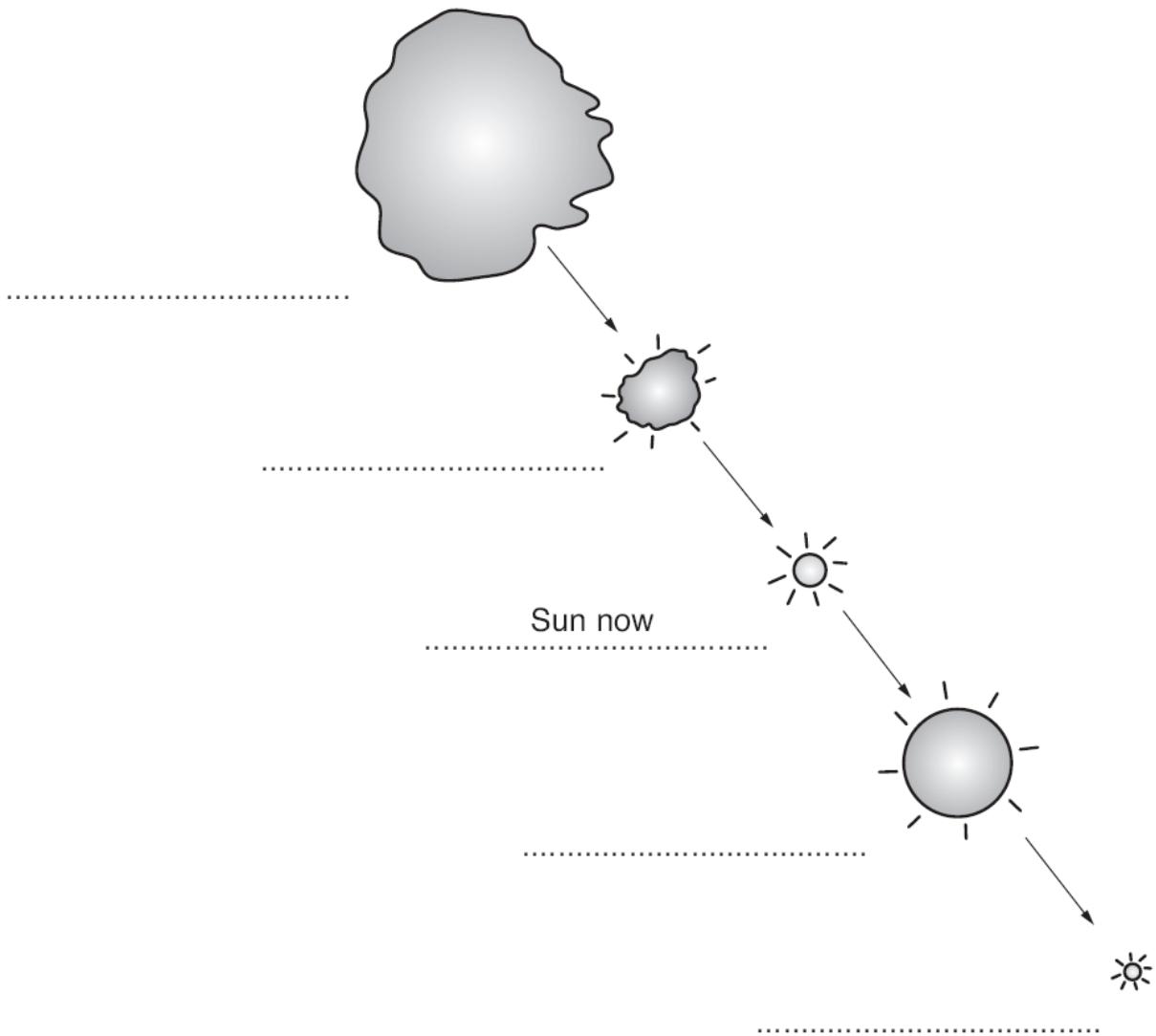
Answer **all** the questions.

1 (a) The diagram shows the stages in the life of our Sun.

(i) Use some of the words from this list to label the different stages on the diagram.

- | | | | |
|--------------|--------------|-------------|-----------|
| cloud of gas | neutron star | protostar | red giant |
| Sun now | supernova | white dwarf | |

The Sun as it appears now has been done for you.



[4]

(ii) A star that is much bigger than our Sun has different stages at the end of its life.
Which two stages in the list only happen in the life of a very large star?

..... and [2]

(b) Nuclear fusion takes place in the core of stars.

In nuclear fusion, elements with small nuclei fuse together to form elements with larger nuclei. Fusion in stars does not normally produce elements larger than iron.

Look at the table.

element	size of nucleus (mass units)
hydrogen	1
helium	4
oxygen	16
silicon	28
iron	56
lead	207
uranium	238

(i) Which element in the table cannot be formed by fusion?

answer [1]

(ii) Use **one** of the elements in the table to complete this sentence.

Red giants or red supergiants form when the stars run out of
in the core.

[1]

(iii) Write down **two** elements from the table, other than helium, which might be produced in a red giant.

Explain your answer.

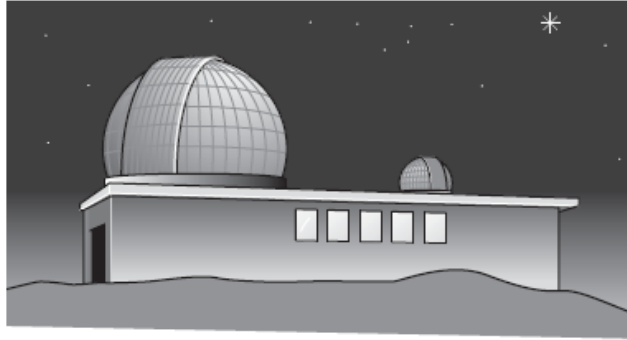
.....
.....
..... [3]

(iv) Name an element from the table which could only be produced in a supernova.

answer [1]

[Total: 12]

2 A group of countries are planning to build a new astronomical observatory.



(a) Write down the geographical location of a major astronomical observatory on Earth.

..... [1]

(b) Describe a good place to build the new observatory.

You should describe the factors that the astronomers would take into account when choosing the place for the new telescope.

What arguments could be made against building the telescope in this place?

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

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[6]

(c) Astronomers will not make the final decision about building the observatory.

Suggest who will make the decision. Give reasons why they will make the decision, and not the astronomers.

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

(d) One group of astronomers thinks the money should be spent sending a telescope into space.

Should the money be spent on a space telescope?

Explain the advantages and disadvantages of a space telescope to justify your answer.

 *The quality of written communication will be assessed in your answer.*

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..... [6]

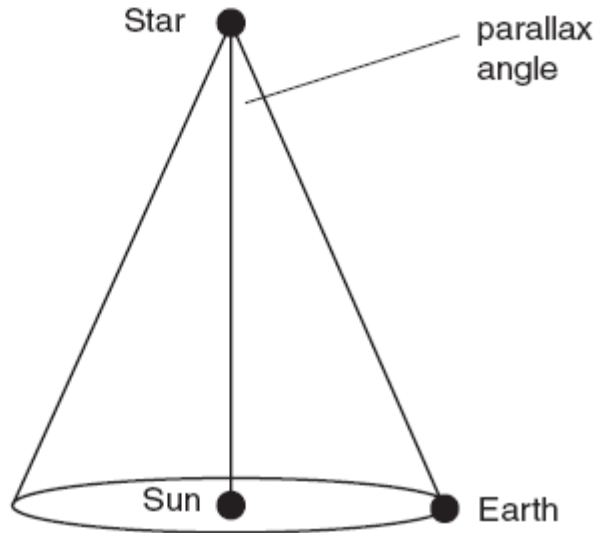
[Total: 16]

3 Sally is studying some nearby stars.

(a) She is using parallax to measure the distance to stars.

She measures the parallax angle.

The diagram shows the parallax angle for a star.



(i) All the stars she measures are more than 1 parsec from the Earth.

Which parallax angle must be **wrong**?

Put a **ring** around the angle that must be wrong.

2 arc seconds

0.1 arc seconds

0.2 arc seconds

0.01 arc seconds

[1]

(ii) Sally records the parallax angle of three stars.

star	parallax angle in seconds of arc
A	0.549
B	0.274
C	0.721

Describe how the distances to star **B** and star **C** compare with the distance to star **A**.

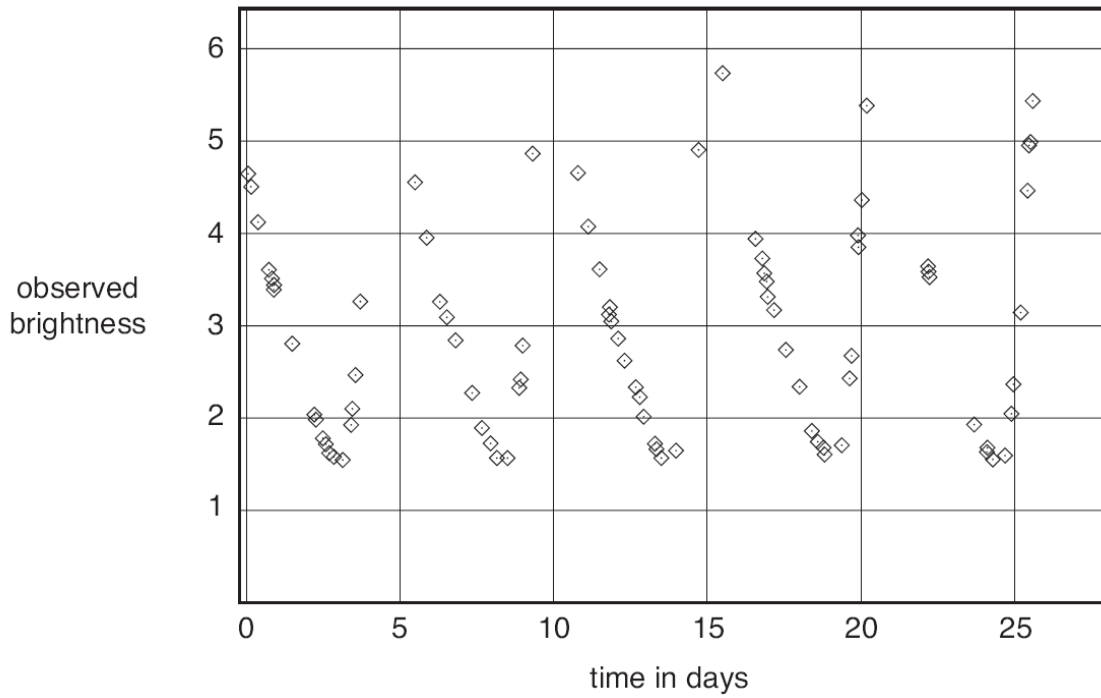
.....

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..... [2]

(b) Sally then makes some observations of a Cepheid variable star.

The graph shows how the observed brightness of the star Delta Cephei changes with time.



(i) What is the brightness of Delta Cephei at its dimmest?

answer [1]

(ii) The period is the time taken for one cycle of brightness.

What is the period of Delta Cephei?

Use the graph to find your answer.

answer [2]

[Total: 6]

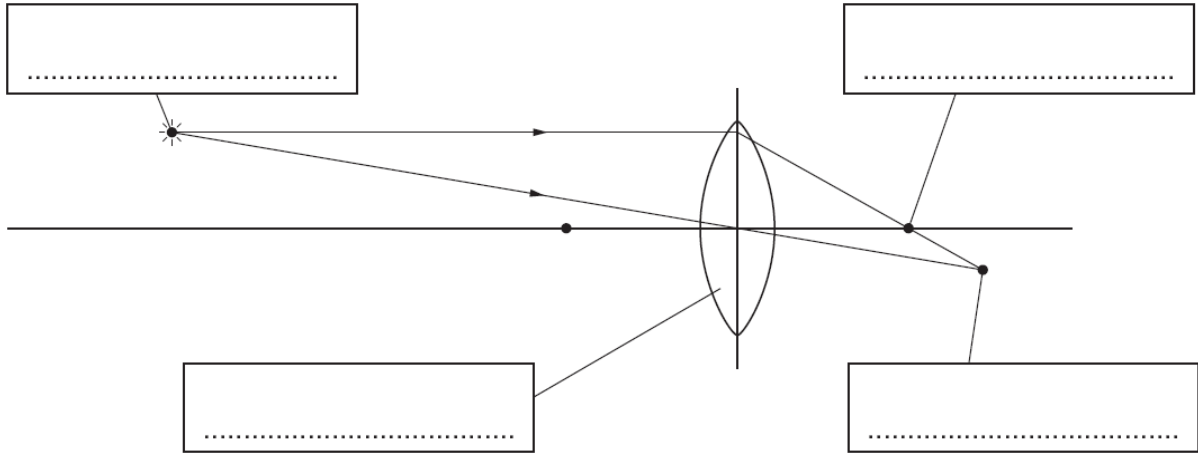
4 Billy is planning to make a telescope to look at distant stars.

He has some lenses made of glass.

(a) He draws a diagram to show how a lens can produce an image from an object.

He forgets to label the diagram with the **lens**, **object**, **image** and **focus**.

Complete the diagram by adding the missing labels.



[3]

(b) Three of Billy's lenses are made from the same glass.



A



B



C

Which lens, **A**, **B** or **C**, is the most powerful?

Explain your answer.

most powerful lens

reason..... [2]

[Total: 5]

5 The photograph shows stars forming.



SciencePhotoLibrary R590/049

When a large amount of gas in space is compressed a star is formed.

(a) What causes the gas to compress?

..... [1]

(b) As the gas compresses, the temperature of the gas increases.

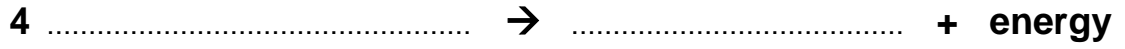
As the temperature increases, the pressure in the gas changes.

Explain what happens to the pressure and how this changes the behaviour of the particles of the gas.

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

(c) When the temperature is high enough, nuclei can fuse together to form new elements. This releases energy.

(i) Complete this fusion reaction with the names of the elements.



[2]

(ii) Describe how energy is released inside the Sun and transferred from the centre of the Sun into space.

 *The quality of written communication will be assessed in your answer.*

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[6]

[Total: 11]

6 In the 1950s there were two main theories about how the Universe began.



Martin Ryle

The Universe started as a burst of energy at one point and rapidly got bigger. Galaxies are all moving outwards from this 'Big Bang'.



Fred Hoyle

I agree that galaxies are moving apart, but I don't think the Universe had a beginning like you say. It has always been the same. New galaxies are being made all the time. They form in the gaps between old galaxies, which are dying out.

(a) Here are some astronomical statements.

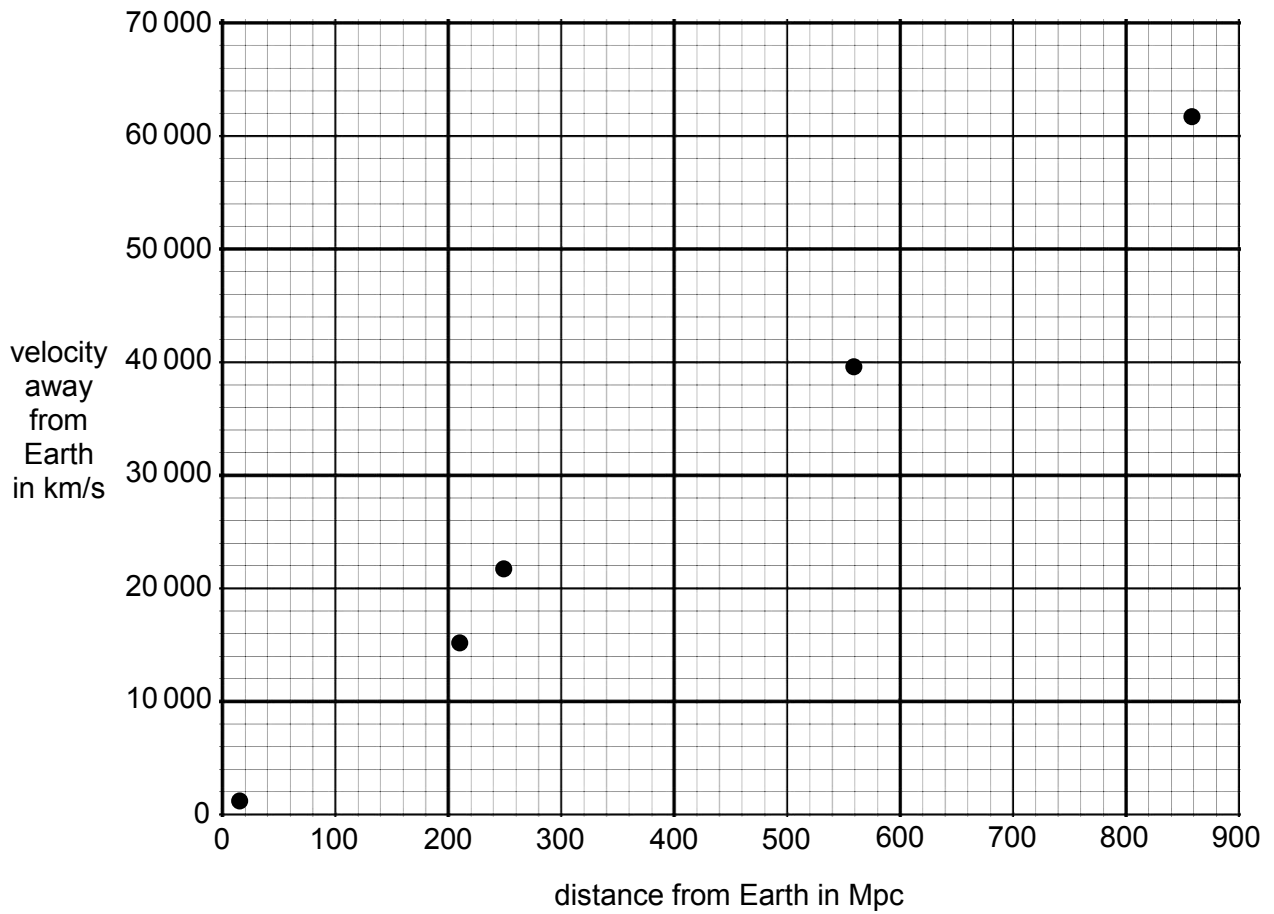
Each statement agrees with what is being said by **Ryle**, or by **Hoyle**, or by **both** of them, or by **neither** of them.

Put a tick (✓) in the correct box after each statement.

statement	Ryle	Hoyle	both	neither
In the past, all the galaxies would have been close together.				
There is no pattern in the age of galaxies.				
The Universe will eventually stop expanding.				

[3]

(b) The graph shows the speed at which some galaxies are moving away from the Earth.



(i) A galaxy has its distance from the Earth measured as 400 Mpc.
Use the graph to predict this galaxy's velocity away from the Earth.

velocity away from the Earth = km/s [1]

(ii) The Hubble constant is now thought to be 72 km/s per Mpc.
Calculate how fast a galaxy at a distance of 1000 Mpc is moving away from the Earth.

velocity away from the Earth = km/s [2]

(c) Hubble's original measurements suggested the constant was about 500 km/s per Mpc.

(i) What can we measure more accurately now and what do we observe to help give more accurate measurements?

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

(ii) The Hubble constant is used to calculate the distance to galaxies.

How does decreasing the Hubble constant affect the distances calculated for distant galaxies?

Explain your answer.

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

[Total: 10]

END OF QUESTION PAPER

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SPECIMEN F

GENERAL CERTIFICATE OF SECONDARY EDUCATION

TWENTY FIRST CENTURY SCIENCE

PHYSICS A / FURTHER ADDITIONAL SCIENCE A

A183/01

Unit A183/01: Module P7 (Foundation Tier)

MARK SCHEME

Duration: 1 hour

MAXIMUM MARK 60

This document consists of 16 pages

Guidance for Examiners

Additional guidance within any mark scheme takes precedence over the following guidance.

1. Mark strictly to the mark scheme.
2. Make no deductions for wrong work after an acceptable answer unless the mark scheme says otherwise.
3. Accept any clear, unambiguous response which is correct, e.g. mis-spellings if phonetically correct (but check additional guidance).
4. Abbreviations, annotations and conventions used in the detailed mark scheme:

/	=	alternative and acceptable answers for the same marking point
(1)	=	separates marking points
not/reject	=	answers which are not worthy of credit
ignore	=	statements which are irrelevant - applies to neutral answers
allow/accept	=	answers that can be accepted
(words)	=	words which are not essential to gain credit
<u>words</u>	=	underlined words must be present in answer to score a mark
ecf	=	error carried forward
AW/owtte	=	alternative wording / or words to that effect
ORA	=	or reverse argument

E.g. mark scheme shows 'work done in lifting / (change in) gravitational potential energy' (1)

work done = 0 marks
work done lifting = 1 mark
change in potential energy = 0 marks
gravitational potential energy = 1 mark
5. Annotations:
The following annotations are available on SCORIS.

✓	=	correct response
×	=	incorrect response
bod	=	benefit of the doubt
nbod	=	benefit of the doubt not given
ECF	=	error carried forward
^	=	information omitted
I	=	ignore
R	=	reject
6. If a candidate alters his/her response, examiners should accept the alteration.

7. Crossed out answers should be considered only if no other response has been made. When marking crossed out responses, accept correct answers which are clear and unambiguous.

E.g.

For a one mark question, where ticks in boxes 3 and 4 are required for the mark:

Put ticks (✓) in the two correct boxes.

<input type="checkbox"/>
<input type="checkbox"/>
<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>
<input type="checkbox"/>

This would be worth 0 marks.

Put ticks (✓) in the two correct boxes.

<input type="checkbox"/>
<input type="checkbox"/>
<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>
<input type="checkbox"/>

This would be worth 1 mark.

Put ticks (✓) in the two correct boxes.

<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>
<input type="checkbox"/>

This would be worth 1 mark.

8. The list principle:
If a list of responses greater than the number requested is given, work through the list from the beginning. Award one mark for each correct response, ignore any neutral response, and deduct one mark for any incorrect response, e.g. one which has an error of science. If the number of incorrect responses is equal to or greater than the number of correct responses, no marks are awarded. A neutral response is correct but irrelevant to the question.

9. Marking method for tick boxes:

Always check the additional guidance.

If there is a set of boxes, some of which should be ticked and others left empty, then judge the entire set of boxes.

If there is at least one tick, ignore crosses. If there are no ticks, accept clear, unambiguous indications, e.g. shading or crosses.

Credit should be given for each box correctly ticked. If more boxes are ticked than there are correct answers, then deduct one mark for each additional tick. Candidates cannot score less than zero marks.

E.g. If a question requires candidates to identify a city in England, then in the boxes

Edinburgh	
Manchester	
Paris	
Southampton	

the second and fourth boxes should have ticks (or other clear indication of choice) and the first and third should be blank (or have indication of choice crossed out).


Edinburgh			✓		✓	✓	✓	✓		
Manchester	✓	x	✓	✓	✓				✓	
Paris				✓	✓		✓	✓		
Southampton	✓	x		✓		✓	✓		✓	
Score:	2	2	1	1	1	1	0	0	0	NR

10. For answers marked by levels of response:
- Read through the whole answer from start to finish**
 - Decide the level** that **best fits** the answer – match the quality of the answer to the closest level descriptor
 - To determine the mark within the level**, consider the following:


Descriptor	Award mark
A good match to the level descriptor	The higher mark in the level
Just matches the level descriptor	The lower mark in the level

- Use the **L1**, **L2**, **L3** annotations in SCORIS to show your decision; do not use ticks.

Question			Expected answers	Marks	Additional guidance
1	(a)	(i)	cloud of gas (1) protostar (1) red giant (1) white dwarf (1)	[4]	order must be correct
		(ii)	supernova (1) neutron star (1)	[2]	accept red supergiant accept black hole
	(b)	(i)	hydrogen	[1]	
		(ii)	hydrogen	[1]	
		(iii)	<i>elements:</i> silicon (1) oxygen (1) <i>explanation:</i> elements must be larger than helium and smaller than iron (1)	[3]	
		(iv)	lead / uranium	[1]	
Total				[12]	

Question		Expected answers	Marks	Additional guidance
2	(a)	Chile / Hawaii / Australia / Canary Islands	[1]	
	(b) 	<p>[Level 3] A balanced answer which contains all the key astronomical factors, and identifies potential arguments against the location. Location is appropriate and consistent with the astronomical factors. Quality of written communication does not impede communication of the science at this level. (5 – 6 marks)</p> <p>[Level 2] A partial answer which may contain only a limited number of factors or arguments against the location. Location is consistent with factors identified. Quality of written communication partly impedes communication of the science at this level. (3 – 4 marks)</p> <p>[Level 1] Answer may be simplistic. Describes a location. An answer which may contain only astronomical factors. Quality of written communication impedes communication of the science at this level. (1 – 2 marks)</p> <p>[Level 0] Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)</p>	[6]	<p>relevant points include:</p> <p>describes a location, e.g. mountain top</p> <p>astronomical factors:</p> <ul style="list-style-type: none"> • high so less atmospheric interference • away from towns/cities to avoid light pollution • many cloudless nights • low pollution and dry air <p>other factors:</p> <ul style="list-style-type: none"> • Cost • Environmental impact • Provides employment <p>note: some factors may be presented as positive or negative e.g. provides employment, but remote location makes it hard to get to work</p> <p>ignore any references to space telescopes or international relations</p>


Question		Expected answers	Marks	Additional guidance
2	(c)	<p><i>who:</i> government / regulators / politicians (1)</p> <p><i>why:</i></p> <p>any two from:</p> <p>they take into account everybody's views ;</p> <p>they balance the benefits and costs ;</p> <p>they are providing the money ;</p> <p>they make the laws/rules/regulations ;</p> <p>scientists are only one group / other groups are affected</p>	[3]	

Question	Expected answers	Marks	Additional guidance
2 (d) 	<p>[Level 3] A balanced answer which contains at least two arguments both for and against. Conclusion is consistent with the arguments. Quality of written communication does not impede communication of the science at this level. (5 – 6 marks)</p> <p>[Level 2] An answer which may contain only one argument for and against or two or more arguments supporting the conclusion. Conclusion is consistent with arguments. Quality of written communication partly impedes communication of the science at this level. (3 – 4 marks)</p> <p>[Level 1] An answer which may contain only one argument and fails to recognise any counter arguments. Conclusion is poorly linked to argument. Quality of written communication impedes communication of the science at this level. (1 – 2 marks)</p> <p>[Level 0] Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)</p>	[6]	<p>advantage: avoids atmospheric distortion / refraction / absorption / twinkle different parts of spectrum available avoids light pollution from cities no clouds very dark</p> <p>disadvantage: cost of putting in space cost/difficulty of maintenance/repair uncertainty of space programme</p> <p>reject closer to stars</p>
	Total	[16]	

Question			Expected answers	Marks	Additional guidance
3	(a)	(i)	2 arc seconds	[1]	
		(ii)	idea that one is closer while the other is further away (1) correct way round, i.e. C closer, B further away (1)	[2]	
	(b)	(i)	1.5	[1]	accept any number between 1.4 and 1.6 inclusive
		(ii)	5 (1) days (1)	[2]	accept any number between 4 and 6 inclusive
Total				[6]	

Question			Expected answers	Marks	Additional guidance
4	(a)		<div style="display: flex; justify-content: space-around; align-items: flex-start;"> <div style="border: 1px solid black; padding: 5px; width: 100px; height: 30px; margin-bottom: 10px;">object</div> <div style="border: 1px solid black; padding: 5px; width: 100px; height: 30px; margin-bottom: 10px;">focus</div> </div> <div style="display: flex; justify-content: space-around; align-items: flex-start;"> <div style="border: 1px solid black; padding: 5px; width: 100px; height: 30px; margin-bottom: 10px;">lens</div> <div style="border: 1px solid black; padding: 5px; width: 100px; height: 30px; margin-bottom: 10px;">image</div> </div>	[3]	all correct = 3 marks 2 or 3 correct = 2 marks 1 correct = 1 mark
	(b)		<i>lens: C</i> (1) <i>reason: greatest/most curved</i> (1)	[2]	accept thickest / fattest / shortest focal length
Total				[5]	




Question		Expected answers	Marks	Additional guidance
5	(a)	gravity	[1]	do not accept 'g force'
	(b)	pressure increases (1) <i>because:</i> any one from: particles move faster / have more kinetic energy ; more frequent/energetic collisions between particles ; particles have increased momentum ; increased forces during collisions between particles	[2]	do not accept 'moves more' or 'vibrates' or just 'more energy' allow collisions with 'edge' or 'boundary' allow 'more collisions'
	(c) (i)	hydrogen (1) helium (1)	[2]	allow H and He (symbols must be correct) ignore any balancing / additional numbers

Question		Expected answers	Marks	Additional guidance
5	(c) (ii) 	<p>[Level 3] Answer correctly describes the processes of energy release in the Sun (hydrogen to helium fusion must be mentioned) and transport and clearly sequences them in the correct order from core to photosphere (then space). Quality of written communication does not impede communication of the science at this level. (5 – 6 marks)</p> <p>[Level 2] Answer may name some processes rather than describing them, and/or may not make the correct order clear. Quality of written communication partly impedes communication of the science at this level. (3 – 4 marks)</p> <p>[Level 1] An incomplete answer, naming some processes without describing them and omitting other processes. Quality of written communication impedes communication of the science at this level. (1 – 2 marks)</p> <p>[Level 0] Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)</p>	[6]	<p>relevant points include: applies generic knowledge of stellar interiors and processes to specific case of the Sun</p> <ul style="list-style-type: none"> energy produced by nuclear fusion, primarily of hydrogen nuclei into helium nuclei / by the fusion of other light elements into heavier elements, in the core of the star <p>then</p> <ul style="list-style-type: none"> energy is transported from core to surface / photosphere, by photons of radiation in inner region and by convection currents in outer region <p>accept reference to radiative zone as inner region and convective zone as outer region</p> <p>then</p> <ul style="list-style-type: none"> photosphere – electromagnetic radiation / photons, emitted / radiated / travels, into space
Total			[11]	

Question		Expected answers					Marks	Additional guidance																				
6	(a)	<table border="1"> <thead> <tr> <th>statement</th> <th>Ryle</th> <th>Hoyle</th> <th>both</th> <th>neither</th> </tr> </thead> <tbody> <tr> <td>In the past ...</td> <td>✓</td> <td></td> <td></td> <td></td> </tr> <tr> <td>no pattern</td> <td></td> <td>✓</td> <td></td> <td></td> </tr> <tr> <td>stop expanding</td> <td></td> <td></td> <td></td> <td>✓</td> </tr> </tbody> </table>					statement	Ryle	Hoyle	both	neither	In the past ...	✓				no pattern		✓			stop expanding				✓	[3]	1 mark per correct row accept any clear and unambiguous response more than one response in any row does not score that row
		statement	Ryle	Hoyle	both	neither																						
		In the past ...	✓																									
		no pattern		✓																								
stop expanding				✓																								
(b)	(i)	28 000					[1]	accept any number from 27 000 to 29 000 inclusive																				
	(ii)	72 x 1000 (1) 72 000 (1)					[2]	correct numerical answer without working shown gains both marks																				
(c)	(i)	<i>measure more accurately: <u>distance</u> (1)</i> <i>observe: Cepheid variables (1)</i>					[2]	allow better measurement of speed/velocity																				
	(ii)	distances get larger/increase (1) recognises idea of inverse relationship (from equation) OR shallower gradient (from graph) (1)					[2]																					
		Total					[10]																					

Assessment Objectives (AO) Grid

(includes quality of written communication )

Question	AO1	AO2	AO3	Total
1(a)(i)	3	1		4
1(a)(ii)	1	1		2
1(b)(i)	1			1
1(b)(ii)	1			1
1(b)(iii)	1	1	1	3
1(b)(iv)		1		1
2(a)	1			1
2(b) 	4	1	1	6
2(c)	1	2		3
2(d) 	3	1	2	6
3(a)(i)		1		1
3(a)(ii)		1	1	2
3(b)(i)		1		1
3(b)(ii)		1	1	2
4(a)	2	1		3
4(b)	1	1		2
5(a)	1			1
5(b)		2		2
5(c)(i)	1	1		2
5(c)(ii) 	4	2		6
6(a)		3		3
6(b)(i)		1		1
6(b)(ii)	1	1		2
6(c)(i)		2		2
6(c)(ii)			2	2
Totals	26	26	8	60

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