OCR

SPECIMEN H

GENERAL CERTIFICATE OF SECONDARY EDUCATION

TWENTY FIRST CENTURY SCIENCE **A183/02**

PHYSICS A / FURTHER ADDITIONAL SCIENCE A

Unit A183/02: Module P7 (Higher Tier)

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

OCR Supplied Materials:
None

Other Materials Required:
- Pencil
- Ruler (cm/mm)

Duration: 1 hour

Candidate Forename		Candidate Surname	

Centre Number						Candidate Number				

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 **20** pages. Any blank pages are indicated.

For Examiner's Use		
	Max	**Mark**
1	**10**	
2	**10**	
3	**7**	
4	**5**	
5	**6**	
6	**8**	
7	**14**	
TOTAL	**60**	

TWENTY FIRST CENTURY SCIENCE EQUATIONS

Useful Relationships

The Earth in the Universe

distance = wave speed x time

wave speed = frequency x wavelength

Sustainable Energy

energy transferred = power x time

power = voltage x current

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

Explaining Motion

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

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

momentum = mass x velocity

change of momentum = resultant force x time for which it acts

work done by a force = force x distance moved in the direction of the force

amount of energy transferred = work done

change in gravitational potential energy = weight x vertical height difference

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

Electric Circuits

power = voltage x 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

energy = mass x [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 The photograph shows stars forming.

SciencePhotoLibrary R590/049

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

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]**

(b) 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.

4 ..... → ..... **+ energy**

[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: 10]

2 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.

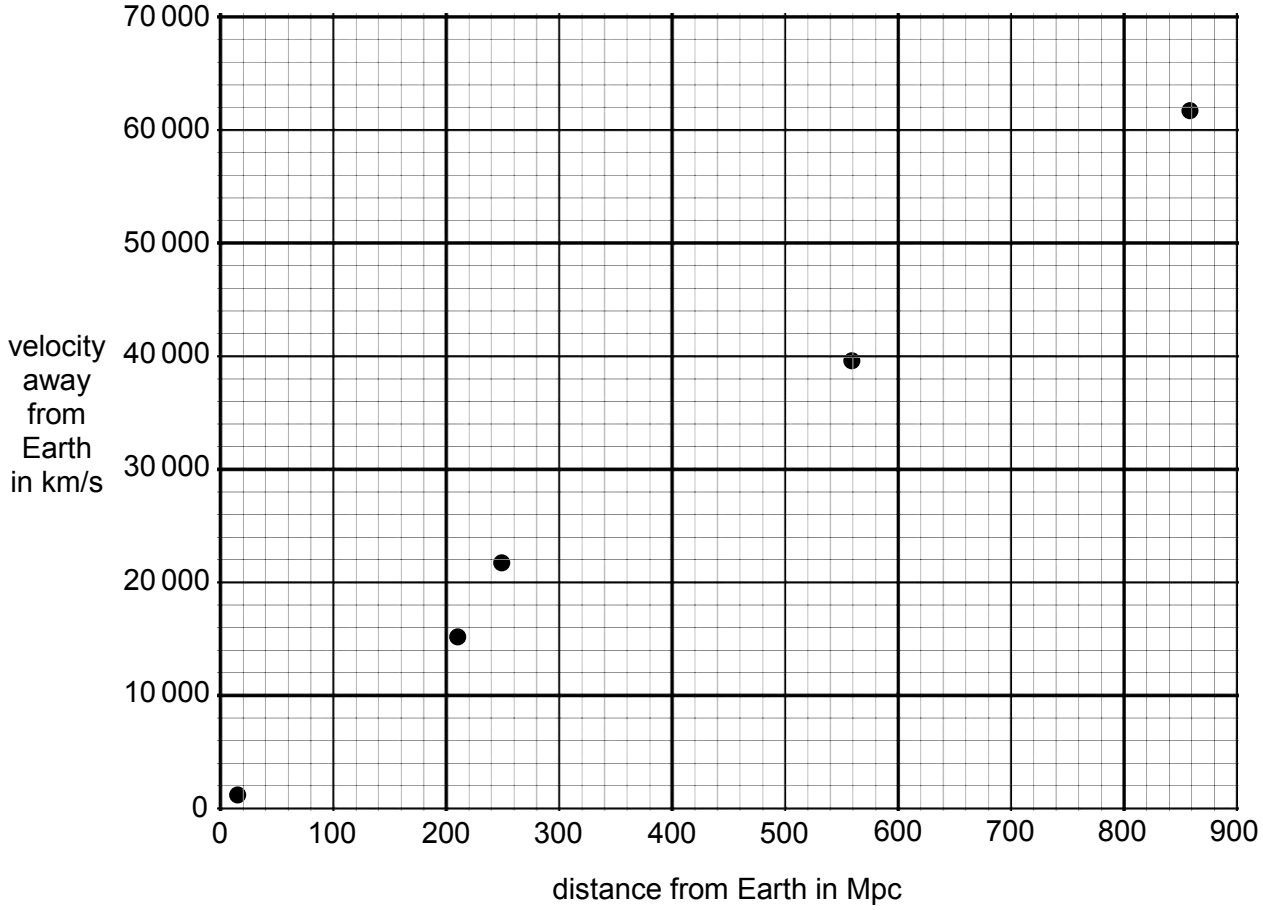
Each statement agrees with what is being said by **Ryle**, or by **Hoyle**, or by **both** of them, or by **neither** of them.

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) Describe the relationship shown by the graph.

.....

.....**[1]**

(ii) Use data from the graph to calculate a value for the Hubble constant.

Show your working.

Hubble constant = ... km/s per Mpc **[4]**

(iii) 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.

.....

.....

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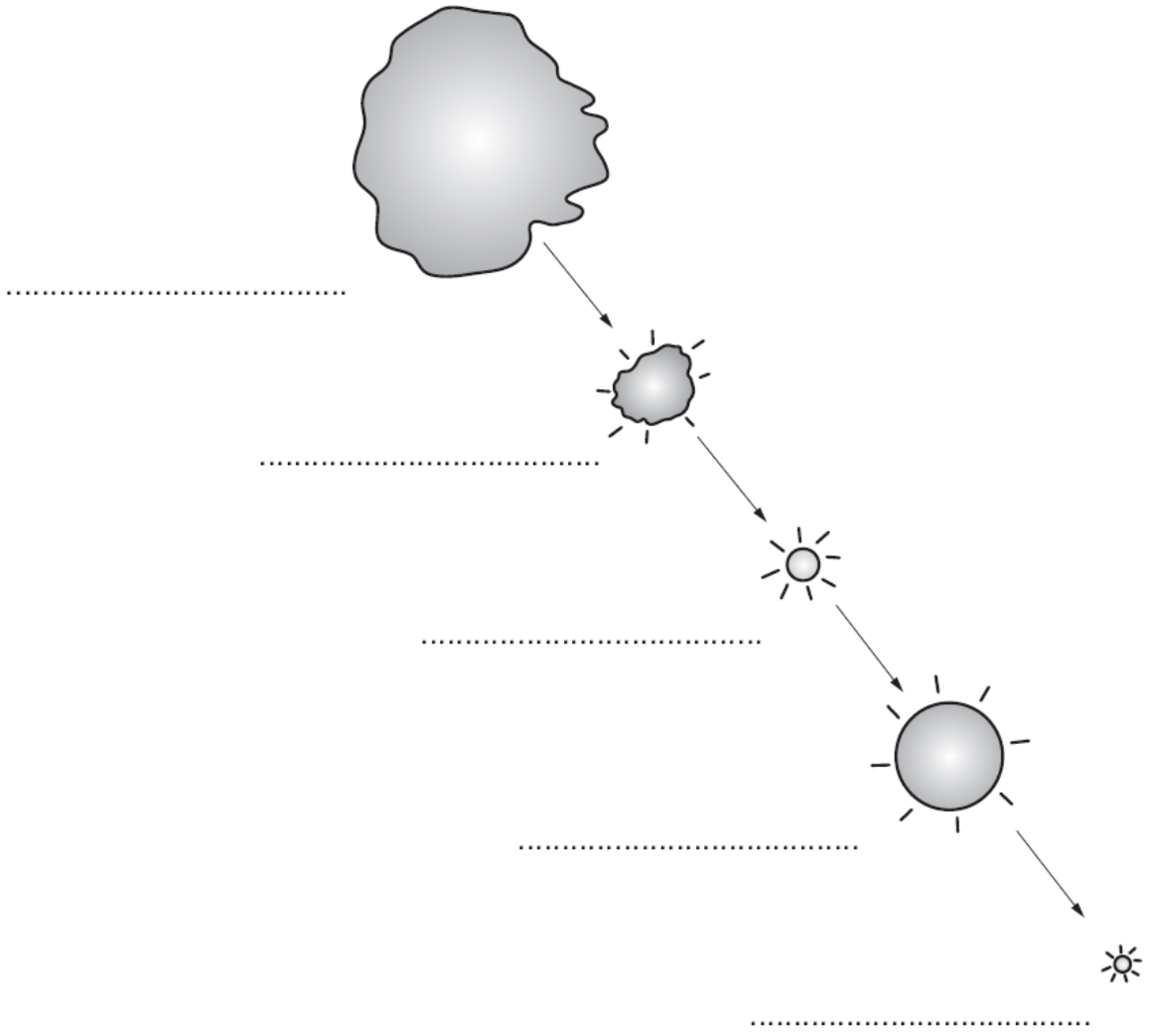
.....**[2]**

[Total: 10]

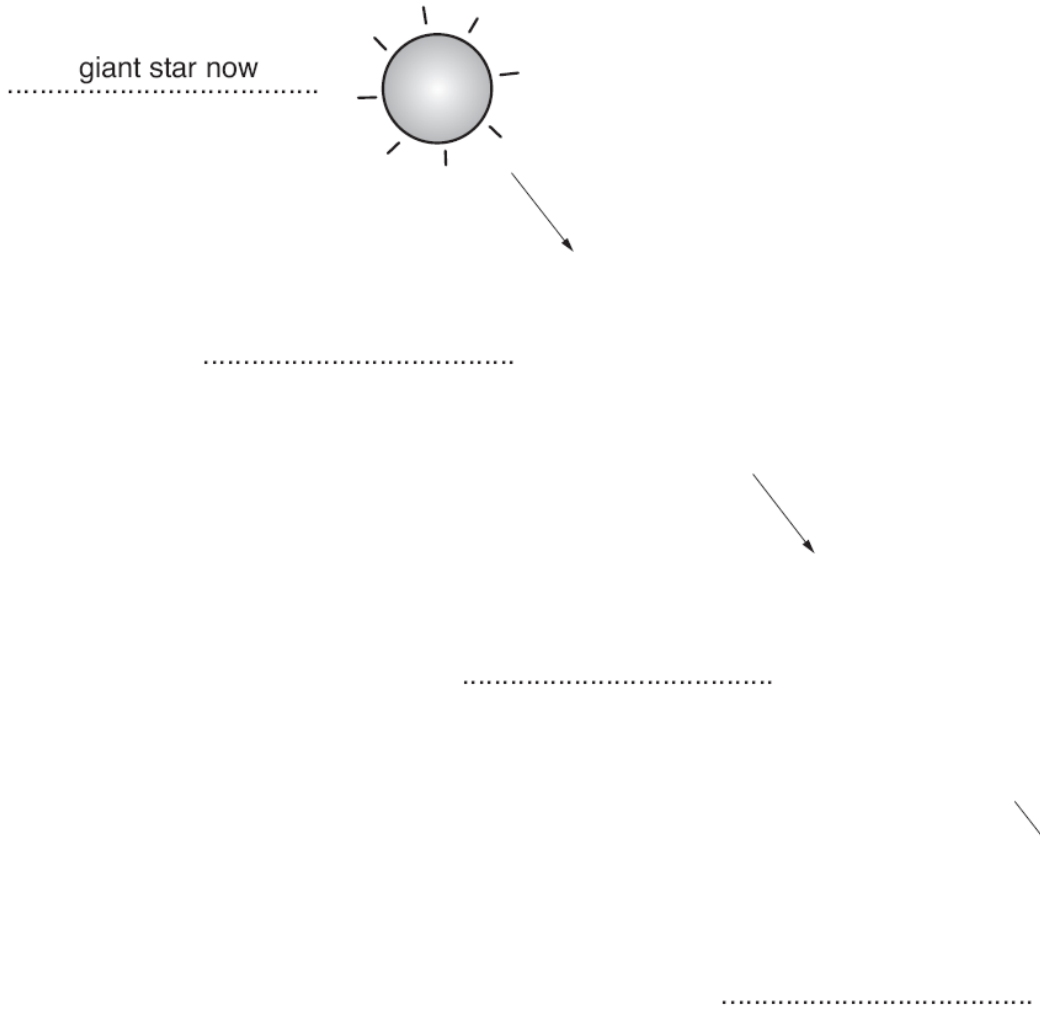
3 (a) The diagram shows the stages in the life of a low mass star such as the Sun.

Complete the labels for the different stages on the diagram.



[4]

(b) Complete and label a similar diagram for the later stages in the life of a star with very high mass.



[3]

[Total: 7]

4 The Hipparcos telescope satellite has measured the parallax angle of nearby stars very precisely.

star	parallax angle in seconds of arc
Barnard's Star	0.549
Tau Ceti	0.274
Epsilon Eridani	0.310
Alpha Canis Majoris (Sirius)	0.379
Alpha Centauri C	0.772
61 Cygni A	0.287

(a) Use the data in the table to answer the following questions.

(i) Which star is closest to the Earth?

.....**[1]**

(ii) Calculate the distance of 61 Cygni A.

distance to 61 Cygni A = ... parsecs **[1]**

(iii) Which star is just over 3.6 parsecs from the Earth?

.....**[1]**

(b) Write down **two** advantages of a telescope making its measurements from space, rather than the Earth.

.....

.....

.....

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

[Total: 5]

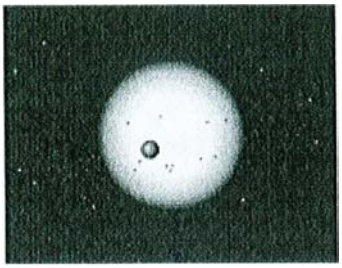
5 Read the newspaper article on evidence for planets.

Extrasolar Planets found?

Some astronomers claim to have found evidence for planets around nearby stars.

The evidence is small variations in brightness of some stars and very small wobbles in the positions of stars.

Some of the results have been published in peer reviewed scientific journals, but only a few have been replicated by other astronomers.



Discuss whether the results should be published in a newspaper or a peer reviewed scientific journal.

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

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.....**[6]**

[Total: 6]

6 (a) The Sun takes 24 hours to move once across the sky.

It takes four minutes less time for the Earth to make one complete rotation on its axis.

Explain why stars take less time to move across the sky than the Sun.

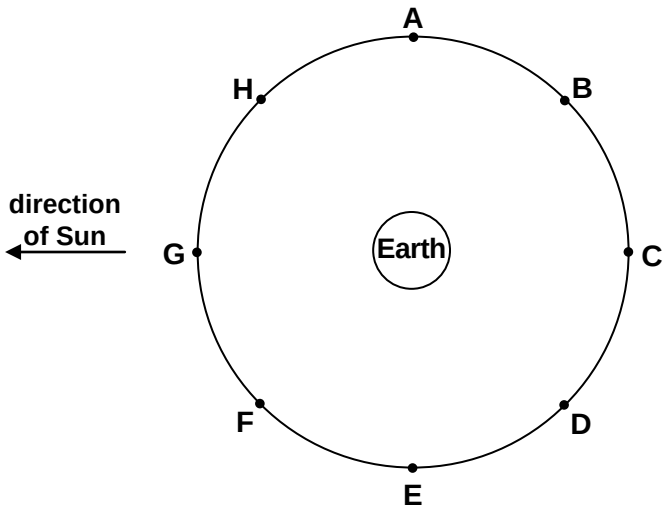
.....

.....

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

(b) The Moon orbits the Earth.

During an orbit it shows different phases.



Sarah sketches the phase of the Moon at three different positions in its orbit.

Complete the table to show the position of the Moon in its orbit, for each phase.

phase of Moon	letter of position in orbit
	
	
	

[3]

(c) The Moon orbits the Earth approximately once a month.

Solar eclipses occur much less often.

Explain what causes a solar eclipse and why they are so rare.

You may use a diagram in your answer.

.....

.....

.....

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

[Total: 8]

7 Billy is making a simple telescope.

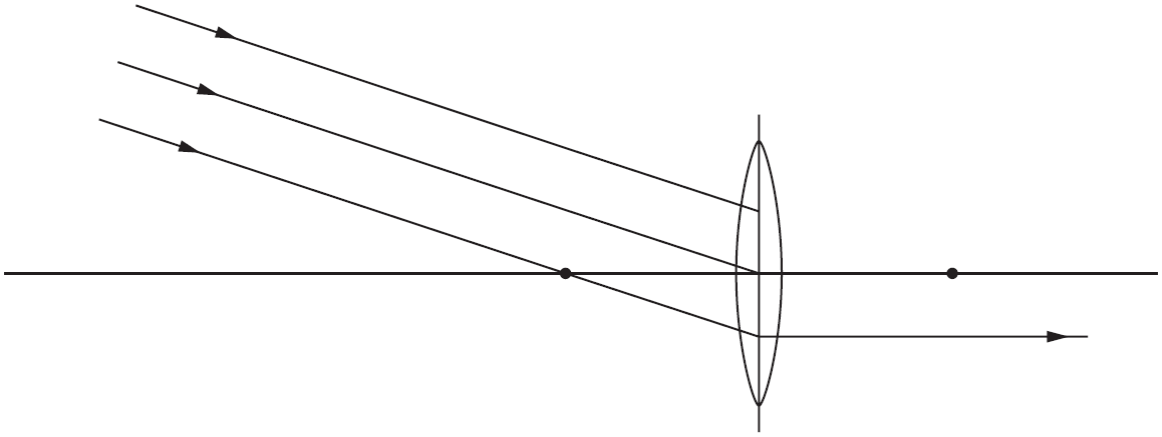
(a) He draws a diagram to show how a lens can produce an image of a distant object.

The focal points of the lens are shown by dots.

He draws three rays coming from the distant object.

Complete the diagram to show how the image is formed.

Label the position of the image on the diagram.



[3]

(b) Billy does some calculations to decide which lenses to use for his telescope.

(i) What is the focal length of a lens with a power 20 dioptres?

You must show your calculation.

focal length = ... m **[2]**

(ii) The lenses he chooses have focal lengths of 0.5 m and 0.01 m.

What will be the magnification of the telescope?

You must show your calculation.

magnification = ...**[2]**

(iii) Would it be suitable to use two lenses of the same focal length?

Explain your answer.

.....

.....

.....**[1]**

(c) Astronomers want to use the largest telescopes they can. Radio telescopes are much bigger than visible light telescopes.

Explain why large telescopes are needed by astronomers. Your answer should consider both visible light and radio telescopes.

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

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.....**[6]**

[Total: 14]

END OF QUESTION PAPER

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SPECIMEN H

GENERAL CERTIFICATE OF SECONDARY EDUCATION

TWENTY FIRST CENTURY SCIENCE

PHYSICS A / FURTHER ADDITIONAL SCIENCE A **A183/02**

Unit A183/02: Module P7 (Higher 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
words	=	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.	Put ticks (✓) in the two correct boxes.	Put ticks (✓) in the two correct boxes.
☐	☐	☒
☐	☐	☒
✓	☒	✓
☒	☒	✓
☐	☐	☐
This would be worth 0 marks.	This would be worth one mark.	This would be worth one 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	✓	×	✓	✓	✓				✓	
Paris				✓	✓		✓	✓	✓	
Southampton	✓	×		✓		✓	✓		✓	
Score:	2	2	1	1	1	1	0	0	0	NR

10. For answers marked by levels of response:
    a. **Read through the whole answer from start to finish**
    b. **Decide the level** that **best fits** the answer – match the quality of the answer to the closest level descriptor
    c. **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

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

Question			Expected answers	Marks	Additional guidance
1	(a)		pressure increases (1) *because:* **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'
	(b)	(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
1	(b) ✎	(ii)	**[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) **[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) **[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) **[Level 0]** Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)	**[6]**	**relevant points include:** applies generic knowledge of stellar interiors and processes to specific case of the Sun • 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 then • energy is transported from core to surface / photosphere, by photons of radiation in inner region • and by convection currents in outer region **accept** reference to radiative zone as inner region and convective zone as outer region then • photosphere – electromagnetic radiation / photons, emitted / radiated / travels, into space
			Total	**[10]**	

<table>
<tr><th colspan="3">Question</th><th>Expected answers</th><th>Marks</th><th>Additional guidance</th></tr>
<tr><td>2</td><td>(a)</td><td></td><td>
<table>
<tr><th>statement</th><th>Ryle</th><th>Hoyle</th><th>both</th><th>neither</th></tr>
<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>
</table>
</td><td>[3]</td><td>1 mark per correct row
accept any clear and unambiguous response
more than one response in any row does not score that row</td></tr>
<tr><td></td><td>(b)</td><td>(i)</td><td>distance from earth is proportional to velocity away from earth / owtte</td><td>[1]</td><td></td></tr>
<tr><td></td><td></td><td>(ii)</td><td>correctly reads 2 velocities from the graph (1)

correctly reads 2 distances from the graph (1)

calculates ratio: velocity / distance (1)

answer = 70 (1)</td><td>[4]</td><td>only 1 mark for only using a single pair of values, if 0,0 used this must be explicit e.g. (61200-0)/(870-0)

credit any answer between 68 and 72 inclusive</td></tr>
<tr><td></td><td></td><td>(iii)</td><td>distances get larger/increase (1)

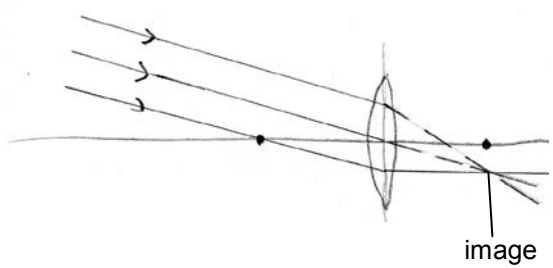
recognises idea of inverse relationship (from equation) OR shallower gradient (from graph) (1)</td><td>[2]</td><td></td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>[10]</td><td></td></tr>
</table>

Question			Expected answers	Marks	Additional guidance
3	(a)			[4]	order must be correct five stages correct = 4 marks four stages correct = 3 marks three stages correct = 2 marks one or two stages correct = 1 mark
			gas cloud / nebula		**accept** 'hydrogen cloud' **do not credit** 'dust cloud' / 'gases' / 'dust and gas'
			protostar		
			main sequence		**accept** 'Sun now' owtte **do not accept** 'Sun' unqualified
			red giant		
			white dwarf		**accept** brown/black dwarf
	(b)			[3]	diagrams are not required if three correct labels given, but order is not correct, award 2 marks if one label is incorrect, and the other two are correct but are not in the right order, award 1 mark
			red supergiant (1)		
			supernova (1)		
			neutron star / black hole (1)		
			Total	[7]	

Question			Expected answers	Marks	Additional guidance
4	(a)	(i)	Alpha Centauri C	[1]	
		(ii)	3.48 **or** $\frac{1}{0.287}$	[1]	
		(iii)	Tau Ceti	[1]	
	(b)		**any two from:** avoids atmospheric refraction / turbulence ; idea of an increased baseline ; avoids light pollution ; can use additional parts of spectrum ; atmosphere absorbs some radiation	[2]	**do not credit** 'no atmosphere' unqualified
			Total	[5]	

Question			Expected answers	Marks	Additional guidance
5	✎		**[Level 3]** Provides a balanced valid conclusion fully based on correct explanations of the function of peer review journals and newspapers. Quality of written communication does not impede communication of the science at this level. (5 – 6 marks) **[Level 2]** Draws a conclusion but may only correctly explain one of peer review or newspaper, may only link to an advantage or disadvantage. Quality of written communication partly impedes communication of the science at this level. (3 – 4 marks) **[Level 1]** May not draw a conclusion. Focuses on newspaper with little / incorrect explanation of peer review or replication. Quality of written communication impedes communication of the science at this level. (1 – 2 marks) **[Level 0]** Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)	**[6]**	**relevant points include:** • both serve different functions, so both are of value **peer review** • other scientists / astronomers evaluate/review/check the claim • before publication • idea of identifying mistakes/errors in the original claim • other scientists can repeat the experiment/observations and get the same results • other scientists can get the same results using a different method **newspaper** • wide circulation • not always reliable • more interested in story than validity of results
			Total	**[6]**	

Question			Expected answers	Marks	Additional guidance
6	(a)		idea that the Earth rotates in the same direction as the Earth orbits the Sun (1) (therefore) the Earth has to make more than one whole rotation for the Sun to move once across the whole sky (1)	[2]	**credit** points expressed clearly via diagrams
	(b)		E (1) D (1) H (1)	[3]	four letters = max. 2 marks five letters = max. 1 mark six or more letters = 0 marks
	(c)		Moon must be between Earth and Sun / Moon blocks light from Sun (for eclipse) (1) lunar orbit tilted (relative to Earth's orbit) (1) so (Moon) often above / below / not in line with Earth and Sun (1)	[3]	**credit** points expressed clearly via diagrams 'Moon blocks Sun' is insufficient ora **accept** for 1 mark 'lunar shadow is very small / eclipse not visible everywhere' must be stated and not just shown on diagram
			Total	[8]	

Question			Expected answers	Marks	Additional guidance
7	(a)		ray through centre of lens continues straight to intersect bottom ray (1) top ray bends in lens then continues as straight line to intercept of central and bottom ray (1) image labelled at intercept of three rays (1) e.g.  	[3]	no mark for a ray if it is continued in more than one direction
	(b)	(i)	re-arrangement: f=1÷P or f=1÷20 (1) 0.05 (1)	[2]	
		(ii)	correct substitution: m= 0.5÷0.01 (1) 50 (1)	[2]	if units given in answer maximum 1 mark
		(iii)	*no because:* magnification = 1 / no magnification	[1]	no mark for "no"; mark is awarded for explanation **ignore** comments about focus or blurring

Question			Expected answers	Marks	Additional guidance
7	(c) ✎		**[Level 3]** Comprehensive explanation of the reasons for telescopes being large, and application of knowledge of relative wavelengths of radio waves and light to diffraction effects. Quality of written communication does not impede communication of the science at this level. (5 – 6 marks) **[Level 2]** May only use one reason for having large telescopes, but applies reason to both types. Quality of written communication partly impedes communication of the science at this level. (3 – 4 marks) **[Level 1]** Attempts to give a reason, but may be inappropriate e.g., diffraction for optical telescopes. Quality of written communication impedes communication of the science at this level. (1 – 2 marks) **[Level 0]** Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)	**[6]**	**relevant points include:** • Little electromagnetic energy / few photons received from faint and/or distant objects • The larger the telescope aperture, the more energy / photons collected • Larger apertures can detect fainter / more distant objects • Radiation is diffracted by the aperture of a telescope • Diffraction is significant when the aperture is comparable to the wavelength • Radio wavelengths are much longer than visible light wavelengths, so radio telescopes need much larger apertures • Less diffraction means a sharper / better focused image **ignore** better image/picture
			Total	**[14]**	

Assessment Objectives (AO) Grid

(includes quality of written communication ✎)

Question	AO1	AO2	AO3	Total
1(a)		2		**2**
1(b)(i)	1	1		**2**
1(b)(ii)✎	4	2		**6**
2(a)		3		**3**
2(b)(i)		1		**1**
2(b)(ii)	1	2	1	**4**
2(b)(iii)			2	**2**
3(a)	3	1		**4**
3(b)	2	1		**3**
4(a)(i)			1	**1**
4(a)(ii)		1		**1**
4(a)(iii)		1		**1**
4(b)	2			**2**
5✎	2	2	2	**6**
6(a)	2			**2**
6(b)		2	1	**3**
6(c)	3			**3**
7(a)	3			**3**
7(b)(i)		2		**2**
7(b)(ii)		2		**2**
7(b)(iii)			1	**1**
7(c)✎	4	2		**6**
Totals	**27**	**25**	**8**	**60**

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