Mark Scheme (Results)

June 2023

Pearson Edexcel
GCSE Astronomy 1AS0/02
Paper 2

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June 2023
Publications Code 1AS0_02_2306_MS

General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

Question number	Answer	Mark
1 (a)(i)	NOT A – a comet NOT B – a galaxy NOT C – a globular cluster **D – Jupiter and its moons**	1

Question number	Answer	Mark
1 (a)(ii)	NOT A – a binary star system **B – a globular cluster** NOT C – an open cluster NOT D – Jupiter and its moons	1

Question number	Answer	Mark
1 (a)(iii)	**A – a binary star system** NOT B – a galaxy NOT C – a globular cluster NOT D – an open cluster	1

Question number	Answer	Mark
1 (b)(i)	NOT A – the aurora NOT B – a comet **C – a galaxy** NOT D – an open cluster	1

Question number	Answer	Mark
1 (b)(ii)	NOT A – a binary star system NOT B – a globular cluster NOT C – a galaxy **D – an open cluster**	1

Question number	Answer	Mark
1 (b)(iii)	NOT A – the aurora **B – a comet** NOT C – a galaxy NOT D – an open cluster	1

Question number	Answer	Mark
2 (a)	**A – coma** NOT B – crust NOT C – mantle NOT D – outer core	1

Question number	Answer	Mark
2 (b)(i)	**A – Capture Theory** NOT B – Co-accretion Theory NOT C – Convergence Theory NOT D – Giant Impact Theory	1

Question number	Answer	Mark
2 (b)(ii)	NOT A – Capture Theory **B – Co-accretion Theory** NOT C – Convergence Theory NOT D – Giant Impact Theory	1

Question number	Answer	Mark
2 (c)	maria / mare / seas	1

Question number	Answer	Mark
2 (d)	Reduce/eliminate star trails / turn star lines into points (of light) (1) Any **one** point from: • use a telescope that tracks the stars • use a telescope that has a drive (to compensate for the Earth's rotation) • use a telescope with a mount/tripod • take the picture with a shorter exposure time	2

Question number	Answer	Mark
3 (a)(i)	Can use a parachute (to reduce speed when landing) / air braking or friction can be used to slow the probe	**1**

Question number	Answer	Mark
3 (a)(ii)	Lander requires heat shielding when entering the atmosphere / friction (from atmosphere) will cause heating	**1**

Question number	Answer	Mark
3 (b)(i)	Time = 208 days (3) Calculation: $time = \frac{55\,000\,000}{11\,000}$ *or* $\frac{55\,000\,000}{264\,000}$ substitution (1) $time = 5\,000\ (hours)$ (1) $time = 208\,days$ (1) An answer of 5000 scores (2) even if no working is shown.	**3**

Question number	Answer	Mark
3 (b)(ii)	Any **one** point from: • distance travelled may be greater than minimum distance • path of the space probe may not be a straight line • space probe may orbit Earth/Mars before landing • space probe will have an average speed less than its maximum speed • space probe will have to accelerate/decelerate	**1**

Question number	Answer	Mark
4 (a)(i)	Planetary (nebula)	**1**

Question number	Answer	Mark
4 (a)(ii)	Absorption (nebula) AND emission (nebula) (in any order)	**1**

Question number	Answer	Mark
4 (a)(iii)	Planetary (nebula) AND supernova (remnant) (in any order)	**1**

Question number	Answer	Additional guidance	Mark
4 (a)(iv)	Any **three** points from: • black hole/accretion disc is too small (to resolve) • black hole cannot be seen in the visible part of the spectrum/is visible in X-ray or gamma ray part of the spectrum • black hole may not be present in the supernova remnant/neutron star was produced during supernova event • black hole could be obscured by (the gas/dust from) the nebula	Do NOT allow black hole is too dim/faint Black holes do not emit light AND black holes absorb light is only one marking point	**3**

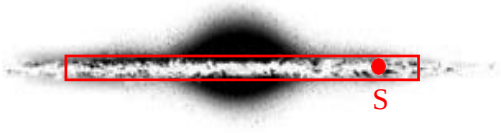
Question number	Answer	Mark
4 (b)(i)	NOT A – star V **B – star W** NOT C – star Y NOT D – star Z	**1**

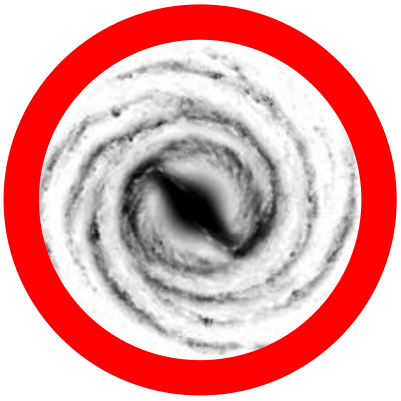
Question number	Answer	Mark
4 (b)(ii)	**A – star V** NOT B – star W NOT C – star X NOT D – star Z	**1**

Question number	Answer	Mark
4 (b)(iii)	NOT A – star V **B – star W** NOT C – star X NOT D – star Y	**1**

Question number	Answer	Mark
5 (a)(i)	NOT A – barred spiral NOT B – elliptical **C – globular** NOT D – irregular	1

Question number	Answer	Mark
5 (a)(ii)	We are observing our Galaxy from within it (1) and are therefore not able to easily see its shape/structure (1)	2

Question number	Answer	Mark
5 (b)(i)	Position of the Sun indicated in the plane of the galaxy and no more than 2/3 from the centre.  	1

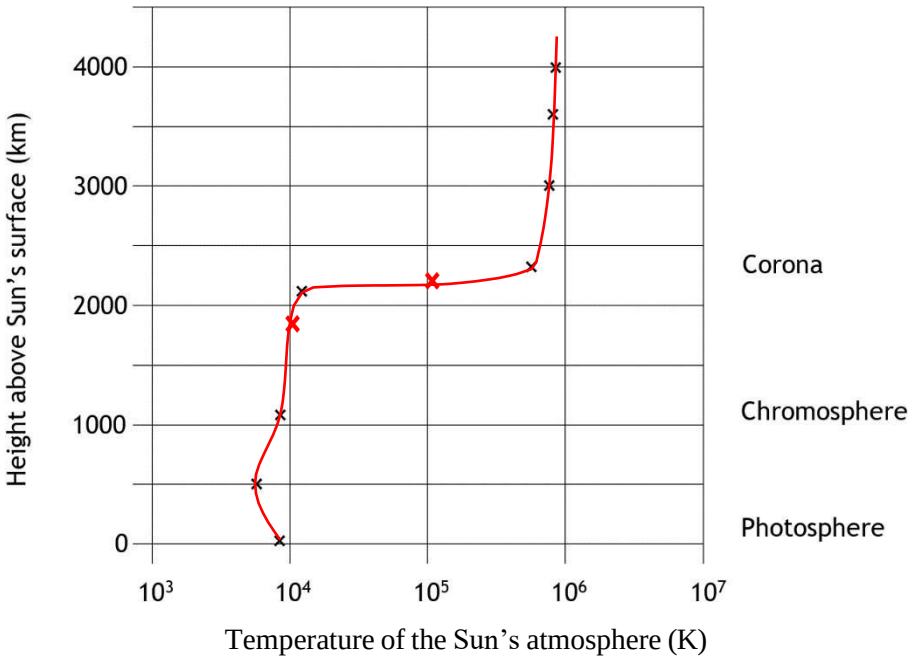
Question number	Answer	Mark
5 (b)(ii)	Distribution of dark matter drawn as a ring beyond the spiral arms. Galaxy located at the centre of the ring. 	1

Question number	Answer	Additional guidance	Mark
5 (b)(iii)	Globular clusters (form a halo/shell and) are distributed above and below the plane of the galaxy (1) This can be shown clearly in a view of the side/Figure 10 OR This cannot be shown clearly on a view from above/Figure 11 (1) Note: Second marking point is dependant on first being awarded	Clearly labelled diagram showing side view with halo of globular cluster is awarded one mark Second mark must explain why the side view is more suitable	**2**

Question number	Answer	Mark
5 (c)	Observational data shows that the mean distance between galaxies does not following current gravitational models (1) There must be an energy/force increasing the rate of expansion of the Universe (1)	**2**

Question number	Answer	Mark
6 (a)(i)	NOT A – convective zone NOT B – core **C – photosphere** NOT D – radiative zone	1

Question number	Answer	Mark
6 (a)(ii)	NOT A – convective zone **B – core** NOT C – photosphere NOT D – radiative zone	1

Question number	Answer	Mark
6 (b)(i)	Both points plotted correctly (2) Suitable smooth, continuous best fit line drawn through the data points (1)  NOTE: Condone candidates ignoring point at 500km as anomalous and "straight lining" between other two points. Also ignore deviations due to mis-plots of points.	3

Question number	Answer	Mark
6 (b)(ii)	2200 (km) (allow range 2100 – 2300) Allow equivalent height with alternative units provided the units are stated	**1**

Question number	Answer	Mark
6 (b)(iii)	10^6 (K) (allow range $10^{5.9}$ to $10^{6.5}$ or 7.9×10^5 to 3.2×10^6)	**1**

Question number	Answer	Mark
6 (b)(iv)	Graph shows that there are sudden temperature changes with distance / graph is non-linear (1) Therefore, cannot assume that the temperature trend will continue at greater heights / cannot extrapolate with confidence (1) Graph is not proportional is awarded no marks	**2**

Question number	Answer	Mark
7 (a)(i)	Any **two** points from: • refracting telescopes use a lens/reflecting telescopes use a mirror • reflecting telescopes reflect light/refracting telescopes refract light • reflecting telescopes have a secondary (mirror) • refracting telescopes have a longer focal length for similar diameter objectives • reflecting telescopes can have larger objective (mirrors) • reflecting telescopes can use multiple mirrors • refracting telescopes suffer from chromatic aberration (reflecting telescopes do not)	**2**

Question number	Answer	Mark
7 (a)(ii)	Any **one** from: • Galilean telescope has a diverging/concave/negative lens/eyepiece • Keplerian telescope has a converging/convex/positive eyepiece Allow: Galilean telescope has image lens before the focal point (of objective)/Keplerian telescope has image lens after focal point (of objective) Galilean telescope has a diverging/concave/negative **objective** is awarded no mark Telescope type has to be specified for mark to be awarded	**1**

Question number	Answer	Mark
7 (b)(i)	Ring system of Saturn was observed from a different angle or perspective (1) and (ring system) could not be seen/resolved when viewed edge on (thus 'moons' disappeared). (1)	**2**

Question number	Answer	Mark
7 (b)(ii)	19.6 (20) (2) Calculation: $Magnification = \frac{f_o}{f_e} = \frac{980}{50}$ *or* $\frac{98.0}{5.0}$ (1) $Magnification = 19.6$ (1) An answer of 1.96 gains 1 mark	**2**

Question number	Answer	Mark
7 (b)(iii)	A small field of view results in a small circle/angle of sky (visible through the eyepiece) (1) However, Saturn's ring system is a small angle/does not have a large angular size. (1) Note: Saturn is small is awarded no marks	**2**

Question number	Answer	Mark
7 (c)	170 000 or 172 000 or 1.7×10^5 (km) (2) Calculation: Convert 8.5 AU into km $8.5 \times 1.5 \times 10^8 (= 1.275 \times 10^9)$ (1) $diameter\ of\ Saturn's\ rings = \frac{5.0 \times 10^{-7} \times 1.275 \times 10^9}{0.0037}$ $diameter\ of\ Saturn's\ rings = 1.72 \times 10^5$ (1) An answer of 0.0011 gains 1 mark	**2**

Question number	Answer	Mark
7 (d)	Mark awarded for possible change made AND its corresponding effect on the image **telescope 2** Increased objective/lens/mirror diameter — Increased resolution Increased objective/lens/mirror diameter — Increased light gathering power / image appears brighter Decreased focal length of objective/increased focal length of eyepiece — Decreased magnification / increased field of view Accept reverse arguments. No reference to a specific telescope gains no mark.	**3**

Question number	Answer	Mark
8 (a)	Heliocentric parallax: • Can only be used for nearby stars/has a small maximum range/parallax angle can be too small to measure (accurately) (1) or • Takes a long time to get a distance measurement (1) The period of Cepheid variables: • Can only be used if the star is a Cepheid variable (1) Use of the Hertzsprung-Russell diagram: • Some stars (K and M type) can either lie on the main sequence or giant branch (thus leading to two possible values for absolute magnitude/distance) (1)	**3**

Question number	Answer	Mark
8 (b)	3 260 (light years) (4) Calculation: $\text{Absolute magnitude M} = -5$ (1) $M = m + 5 - 5\log d$ $-5 = 5 + 5 - 5\log d$ $\log d = 3$ (1) $d = 1000\ (parsecs)$ (1) $d = 1000 \times 3.26 = 3\,260\ (light\ years)$ (1)	**4**

Question number	Answer	Mark
8(c)		6

Level	Mark	Descriptor
	0	No rewardable material.
Level 1	1-2	Lacks clarity. Basic interpretation and evaluation of the method but is limited and narrow in scope. Appraisal of potential improvements is unsupported.
Level 2	3-4	Some structure. Interpretation and evaluation of the method that attempts to synthesise and integrate knowledge. Potential improvements are partially supported by evidence of analysis of the method.
Level 3	5-6	Comprehensive and well structured. Interpretation and evaluation of the method demonstrates synthesising and integrating knowledge throughout the response. Potential improvements supported throughout showing well developed scientific reasoning that is clear, coherent and logically structured.

Indicative content guidance

The indicative content below is not prescriptive, and candidates are not required to include all of it. Other relevant material not suggested below must also be credited. Relevant points may include:

Reference stars are not close to delta Cephei	Select reference stars closer to delta Cephei
Both reference stars appear brighter than delta Cephei	Select a reference star fainter than delta Cephei
Only two reference stars have been used	Select more reference stars
A photograph was taken once a week	Reduce the time interval between photographs (e.g. take a photograph each day)
Large field of view / constellation of Cepheus is small / delta Cephei not centred in the image	Increase magnification / decrease field of view / centre delta Cephei in the image
Determination of period	Plot a light curve of delta Cephei to determine a more accurate period

Question number	Answer	Mark
9 (a)	NOT A – average length of time for which civilisations can communicate NOT B – average rate of star formation NOT C – fraction of life-supporting planets that develop life **D – fraction of stars that are visible from Earth**	1

Question number	Answer	Mark
9 (b)	Any **three** points from: • Brown dwarf is too cold • Planet's surface is too cold • Planet is too far from Brown dwarf • Planet is a gas giant • Planet does not support liquid water • Insufficient light (intensity) on the planet's surface • to be sufficiently warm, planet would be very close to brown dwarf and could lie within the Roche limit/break apart	3

Question number	Answer	Mark
9 (c)(i)	Any **two** from: • There is (liquid) water <u>below the surface</u> of Enceladus (1) • Due to tidal gravitational forces (from Saturn) heating its interior (1) • Plumes of water have been observed (from the surface of Enceladus) (1)	2

Question number	Answer	Mark
9 (c)(ii)	Goldilocks (habitable) Zone would be closer to the brown dwarf (1) Because the (surface) temperature of the brown dwarf is less than the Sun's / Brown dwarf produces less energy than the Sun (1) Accept reverse argument. Do not accept a **smaller** Goldilocks Zone	2

<table>
<tr><th>Question number</th><th>Answer</th><th>Mark</th></tr>
<tr><td>9 (d)</td><td>
Marking instructions
Markers must apply the descriptors in line with the general marking guidance and the qualities outlined in the levels-based mark scheme below.
<table>
<tr><th>Level</th><th>Mark</th><th>Descriptor</th></tr>
<tr><td></td><td>0</td><td>No rewardable material.</td></tr>
<tr><td>Level 1</td><td>1-2</td><td>Lacks clarity.
Basic interpretation and evaluation of the data/information may be attempted but will be limited and narrow in scope.
The response will contain basic information with little linkage between points made. Lines of reasoning may be attempted but are incomplete or lack clarity. A conclusion may be attempted but lacks support.</td></tr>
<tr><td>Level 2</td><td>3-4</td><td>Some structure.
Interpretation and evaluation of the data/information that attempts to synthesise and integrate relevant knowledge.
The response shows some linkages and lines of reasoning with some structure, leading to a conclusion that is partially supported.</td></tr>
<tr><td>Level 3</td><td>5-6</td><td>Comprehensive and well structured.
Comprehensive interpretation and evaluation of the data/information that demonstrates the skills of synthesising and integrating relevant knowledge throughout the response.
The response shows a well-developed, sustained line of scientific reasoning which is clear, coherent and logically structured, leading to a supported conclusion.</td></tr>
</table>
Indicative content guidance
The indicative content below is not prescriptive, and candidates are not required to include all of it. Other relevant material not suggested below must also be credited. Relevant points may include:

Apparent magnitude does not help inform whether or not the planet lies within the Goldilocks zone
Absolute magnitude can be linked with distance to make a conclusion
Spectral type (surface temperature) can be linked with distance to make a conclusion

<table>
<tr><th>Star</th><th>Conclusion as to whether the planet is located within Goldilocks zone</th></tr>
<tr><td>A</td><td>A NO – Spectral type similar to Sun. Star is 2.5^{10} ≈10,000 times more powerful, but planet is 10 times further away (so intensity of radiation received at planet is 100 times lower), so overall intensity is 10,000/100 = 100 times greater</td></tr>
<tr><td>B</td><td>NO – planet is close to a very hot star</td></tr>
<tr><td>C</td><td>YES – absolute magnitude the same as the Sun, and spectral type very close to the Sun. Planet is the same distance as Earth from Sun.</td></tr>
<tr><td>D</td><td>NO – Low power star (possibly white dwarf) and planet at a large distance</td></tr>
</table>
</td><td>6</td></tr>
</table>

Question number	Answer	Mark
10 (a)	Support for the Big Bang theory: Universe was smaller in the past (1) that is consistent with a single creation event/explosion (1) Allow: Explanation for present day Helium abundance in Universe (1) Support for the Steady State theory: (Universe is expanding) equally in all directions (1) Universe maintains a constant density / continuous creation of matter (1)	**4**

Question number	Answer	Mark
10 (b)	Universe has evolved/changed over time (1) Any **one** from: • because there are no quasars located close to us (1) and are therefore not present in our older Universe/present time. (1) • because quasars are only distant objects/have large red shifts (1) and are therefore only present in our young Universe/past. (1)	**3**

Question number	Answer	Mark
10 (c)	6 510 (km/s) (4) Calculation: $Quasar\ A: \dfrac{532.5 - 520.5}{520.5} = \dfrac{v_A}{3.0 \times 10^5}$ $Quasar\ B: \dfrac{543.8 - 520.5}{520.5} = \dfrac{v_B}{3.0 \times 10^5}$ Correct substitution for **either** quasar A or quasar B (1) $Quasar\ A: v_A = 6\,920\ (km/s)$ (1) $Quasar\ B: v_B = 13\,430\ (km/s)$ (1) $Difference\ in\ radial\ velocity = 13\,430 - 6\,920 = 6\,510\ (km/s)$ (1)	**4**

Question number	Answer	Mark
10 (d)	The Moon passed in front of the quasar thus blocking the radio source/optical source (1) Astronomers recorded the <u>time</u> at which the radio source disappeared (1) Optical telescopes observed which object disappeared at this time (1)	**3**