

Markscheme

May 2023

Astronomy

Standard level

















Paper 1

7 pages

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The following are the annotations available to use when marking responses.

Annotation	Explanation	Shortcut	Annotation	Explanation	Shortcut
	Correct point – 1 mark will be added to the score for each tick placed up to the maximum for the question part. Please make sure that the number of ticks = the number of marks			Does not answer question	
	Unclear			Answer acceptable	
	Omission mark			Power of 10 error	
	Arithmetic error			Indicates that the point has been noted, but no credit has been given or to confirm that an examiner has checked a sub-part of a question that has not been answered.	
	Alternative solution			Text box for comments – used for additional marking comments, it can be used in conjunction with a specific tick if that is appropriate. You might like to have a word document of regularly used comments that can be copied and pasted into the text box.	
	Benefit of the doubt			Dynamic; can be sized to highlight area	
	Contradiction			Dynamic; horizontal line that can be expanded	
	Error carried forward			Award 0 marks. 0 marks will be added to the marks panel when this annotation is stamped on the script.	


You **must** make sure you have looked at all pages. Please put the  annotation on any blank page, to indicate that you have seen it.

General Marking Instructions

Assistant Examiners (AEs) will be contacted by their team leader (TL) through RM™ Assessor, by e-mail or telephone – if through RM™ Assessor or by e-mail, please reply to confirm that you have downloaded the markscheme from IBIS. The purpose of this initial contact is to allow AEs to raise any queries they have regarding the markscheme and its interpretation. AEs should contact their team leader through RM™ Assessor or by e-mail at any time if they have any problems/queries regarding marking. For any queries regarding the use of RM™ Assessor, please contact emarking@ibo.org.

1. Each row in the “Question” column relates to the smallest subpart of the question.
2. The maximum mark for each question subpart is indicated in the “Total” column.
3. Each marking point in the “Answers” column is shown by means of a tick (✓) at the end of the marking point.
4. A question subpart may have more marking points than the total allows. This will be indicated by “**max**” written after the mark in the “Total” column. The related rubric, if necessary, will be outlined in the “Notes” column.
5. An alternative word is indicated in the “Answers” column by a slash (/). Either word can be accepted.
6. An alternative answer is indicated in the “Answers” column by “**OR**”. Either answer can be accepted.
7. An alternative markscheme is indicated in the “Answers” column under heading **ALTERNATIVE 1** etc. Either alternative can be accepted.
8. Words inside chevrons « » in the “Answers” column are not necessary to gain the mark.
9. Words that are underlined are essential for the mark.
10. The order of marking points does not have to be as in the “Answers” column, unless stated otherwise in the “Notes” column.
11. If the candidate’s answer has the same “meaning” or can be clearly interpreted as being of equivalent significance, detail and validity as that in the “Answers” column then award the mark. Where this point is considered to be particularly relevant in a question it is emphasized by **OWTTE** (or words to that effect) in the “Notes” column.
12. Remember that many candidates are writing in a second language. Effective communication is more important than grammatical accuracy.
13. Occasionally, a part of a question may require an answer that is required for subsequent marking points. If an error is made in the first marking point then it should be penalized. However, if the incorrect answer is used correctly in subsequent marking points then **follow through** marks should be awarded. When marking, indicate this by adding **ECF** (error carried forward) on the script.
14. Do **not** penalize candidates for errors in units or significant figures, **unless** it is specifically referred to in the “Notes” column.

The Stars

Question		Answers	Notes	Total
1.		 <p>no scale, so M between Earth and Sun AND X on 'sunny' side of the Earth, consistent with position of M ✓</p>	<i>A line from X, through M, should bisect the Sun.</i>	1
2.	a	different countries have different names for stars OR collates international findings OR data is updated as more research is done, so up to date information available ✓	OWTTE	1
2.	b	$b \ll = \frac{9.12 \times 3.84 \times 10^{26}}{4 \times \pi \times (11.68 \times 3.26 \times 9.46 \times 10^{15})^2} \gg = 2.15 \times 10^{-9} \checkmark$ Wm ⁻² ✓		2
2.	c	reference to $L = \sigma AT^4 \checkmark$ $T_A \approx 0.6 T_P \quad T_A^4 = 0.1296 T_P^4 \checkmark$ area $\approx R^2 \quad A_A \approx 414 T_P^2 \checkmark$ large surface area more significant than temperature difference ✓		3 max
2.	d	starts in red giants, K spectral class, above 100 L_\odot line ✓ moves anticlockwise, ends at white dwarfs ✓	<i>Ignore any wiggles</i>	2

The Planets

Question		Answers	Notes	Total	
3.		Any 3 of:	<i>Either of each pair need be stated for the mark, if the other is implied.</i>	3 max	
		terrestrial			gas giants
		warmer so little ice			cooler so ice solid
		mostly metals and silicates			ices prolific
		not enough metals etc. to grow large			eventually massive enough to trap H, He
		begin as dust grains, clumping			
then collisions between clumps form protoplanets					
4.	a	R^* – rate of formation of stars in the galaxy ✓ f_p – fraction of stars with planets ✓ n_e – planets per star with suitable environment ✓	<i>Do not accept symbol alone – it is on the data sheet.</i>	1 max	
4.	b	f_1 – fraction of planets where organic life appears ✓ f_I – fraction of planets that have intelligent life ✓ f_c – fraction of civilization sufficiently advanced to create detectable signals ✓ L – length of time these signals are sent ✓	<i>Do not accept symbol alone – it is on the data sheet.</i>	1 max	
5.	a	heated surface reradiates «to the atmosphere» at different/infrared wavelengths ✓ CO ₂ warms the atmosphere by resonance OR by absorption and reradiating ✓		2	
5.	b	further from Sun, so less influx of heat ✓ smaller planet so thinner atmosphere, «less CO ₂ available» ✓		2	

Galaxies

Question		Answers	Notes	Total
6.	a	consist of low mass stars ✓ consist of old stars ✓ little gas and dust ✓ minimal star formation ✓	<i>Note candidates are not asked for the properties of an elliptical galaxy.</i>	2 max
6.	b	Ia supernova is standard candle OR Ia supernovae have a known maximum luminosity ✓ improves accuracy of distance «and thus all other studies of it» ✓		2
6.	c	supermassive black hole ✓ infalling matter accelerating ✓ emission of radio waves «in two lobes» ✓		3

Cosmology

7.	a	matter distribution in the universe is homogenous and isotropic ✓		1
7.	b	overall, yes it is ✓ on closer inspection, there are temperature fluctuations ✓		2
7.	c	it is weakly supported ✓ superclusters are within the probability of randomness «and thus homogeneity» ✓ the Great Wall is showing more order than expected ✓		2 max