

Markscheme

May 2022

Astronomy

Standard level

















Paper 1

9 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.	

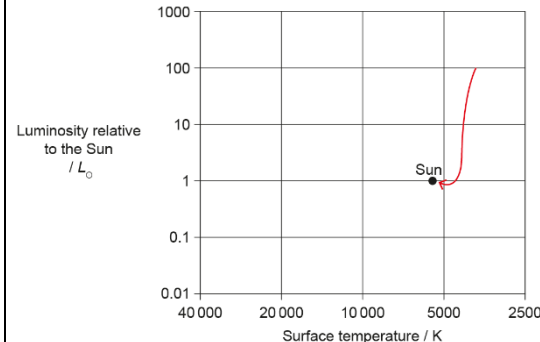
You **must** make sure you have looked at all pages. Please put the  annotation on any blank page, to indicate that you have seen it.

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.

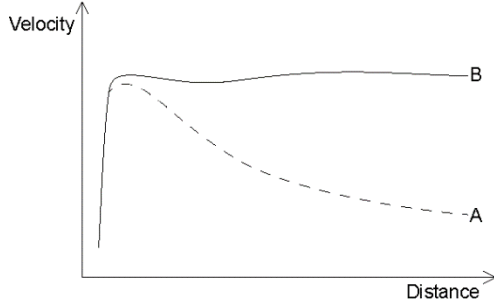
The Stars

Question			Answers	Notes	Total
1.	a		helium OR ${}^4_2\text{He}$ ✓		1
1.	b		«CNO cycle» in hotter/more massive stars OR P-P chain cooler/less massive ✓		1
1.	c		needs «very» hot event/very high kinetic energies of particles ✓ Supernova of massive star ✓ to enable r-process ✓ «to enable fusion of elements beyond iron»		2 max
2.	a		line, starting above $10 L_{\odot}$ and below $1000 L_{\odot}$ AND a bit right of the Sun ✓ a vertical line down AND a kink to the left and up a tiny bit to the Sun ✓	 <p>MP2: Do not allow a simple straight vertical line.</p>	2
2.	b		matter falling into the protostar increases average kinetic energy/temperature ✓ high temperature causes radiation ✓	Cause given as fusion automatically earns zero, no matter what else is said	2

The Planets

Question			Answers	Notes	Total
3.			at the same radius, escape velocity $\propto \sqrt{\text{mass}}$ ✓ H “lightest” element/less massive therefore H has lower escape velocity ✓ «so» H is more likely to have sufficient speed to escape the Earth ✓	<i>MP1: Equation given on data sheet – so must show simplification</i> <i>MP2 and MP3: Allow converse argument for N for 2nd and 3rd marks</i>	3
4.	a		«layers of the Earth have» different densities ✓ greater density sinks/lower density rises ✓	<i>Do not accept heavier and lighter as suitable descriptors of density</i>	2
4.	b		«iron outer core is liquid» due to heating by gravitation/radioactive decay ✓ convection/geodynamo causes motion in the liquid iron ✓ motion induces a magnetic field «in a complicated way» ✓		3 max
4.	c		redirection of solar radiation/ionized particles/solar wind away from the Earth's surface ✓ protects ozone layer ✓ used for navigation «humans and birds etc» ✓	<i>Do not accept magnetic field blocks UV rays</i>	1 max

Galaxies

Question			Answers	Notes	Total
5.	a	i	E = <u>elliptical</u> and 7 = flattened ✓	OWTTE The correct term, <i>elliptical</i> , is required. The description of the shape can be worded in various ways	1
5.	a	ii	any one of the listed characteristics ✓ <i>characteristics:</i> featureless, older galaxy, little or no interstellar gas, few open star clusters, stellar motion radial «rather than by rotation like in S»	Ignore extra characteristics unless contradictory	1
5.	b		summary of information OR indicate patterns of data, enabling hypotheses OR indicate properties of the universe ✓	Any reasonable, scientific answer	1
6.	a		curve same to start, but dropping from maximum «like line A in the diagram» ✓		1
6.	b		stars further from the galactic mass/centre/bulge were expected to reduce velocity «after an initial rise» ✓ because Newtonian/Keplerian relationship between period/speed and distance ✓	Accept use of appropriate formula for 2 nd mp	2

Question			Answers	Notes	Total
7.	a		type Ia supernovae occur rarely but Cepheids are more common ✓ type Ia supernovae only last for a short time but Cepheids are periodic/can be observed all the time ✓		1 max
7.	b		type Ia supernovae «are brighter so» can be observed at greater distance ✓		1

Cosmology

Question			Answers	Notes	Total
8.	a		parallel lines never meet ✓ straight lines extend to infinity ✓ Euclidean geometry is obeyed ✓	OWTTE	2 max
8.	b		expansion slowing AND stops at infinity ✓		1
8.	c		rapid/exponential expansion of space in the early universe ✓	<i>Do not allow expansion without an indication that it was a unique event</i>	1
8.	d		isotropic universe ✓ homogenous universe ✓ no magnetic monopoles ✓ flat ✓		1 max