

Markscheme

May 2019

Astronomy

Standard level

















Paper 1

8 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		Earth at centre AND Sun/planet(s) orbit the Earth ✓		1
1.	b		$\frac{GMm}{r^2} = \frac{mv^2}{r} \text{ AND } v = \frac{2\pi r}{T} \checkmark$ so $\frac{T^2}{r^3} = \frac{4\pi^2}{GM} \text{ «AND } \frac{4\pi^2}{GM} \text{ is a constant as Kepler stated» } \checkmark$		2
1.	c		Newton's applies to any stellar/planetary system, not just our solar system OR Newton's allowed better predictions of planetary positions OR led to discovery of Neptune ✓	Not "elliptical orbits" as Kepler's 1st law was that the orbits are elliptical.	1
2.			S greater distance away from Earth than J ✓ S smaller surface area than J ✓ S further from Sun, so less light is incident «inverse square law» than J ✓ S has lower albedo than J ✓	S further from Sun and Earth is insufficient for [2].	3 max
3.			at the limit, the collapse of the star due to gravitational pressure ✓ is balanced by the electron degeneracy pressure «outwards» OR Pauli exclusion principle for electrons ✓		2

The Planets

Question			Answers	Notes	Total
4.			<p>closer to the protostar «inside the frost line» only the silicates and metals condense/form particles ✓</p> <p>further away from the protostar «outside the frost line» hydrogen compounds condense/form particles ✓</p> <p>the particles accrete to form the planetary cores ✓</p> <p>rocky planets are formed from silicates and metals</p> <p>OR</p> <p>gaseous planets are formed from hydrogen compounds ✓</p>		3 max
5.			<p>plane of planetary orbits close to each other ✓</p> <p>planetary orbits approximately circular ✓</p> <p>all planets revolve in the same sense «direction» ✓</p>		2 max
6.	a		not supported as temperature in the stratosphere has decreased ✓	<i>“not supported” is insufficient for the mark.</i>	1
6.	b		<p>IR from the Sun does not heat the atmosphere «significantly» ✓</p> <p>when reradiated from the surface «at different/longer wavelengths» can be absorbed by greenhouse gases ✓</p> <p>so, the lower atmosphere «troposphere» will be heated more than the stratosphere ✓</p>		3

Galaxies

Question			Answers	Notes	Total
7.			supernovae are very bright so can be seen over great distances ✓ maximum luminosity is predictable ✓ have characteristic light curves so they are readily identifiable ✓		2 max
8.	a		determination of e based on $e = 1 - \frac{b}{a}$ where b is the minor/shorter axis and a is the major/longer axis «and rounded to nearest integer» ✓ value is $10 \times e$ ✓	<i>The equation without explanation is not sufficient for the MP1 (as it is on the data sheet).</i> <i>Full explanation (axes) without reference to the equation is acceptable for MP1.</i>	2
8.	b		Sb has spiral arms, E3 has no arms ✓ Sb is roughly circular « e approximates 0» but E3 more elliptical « $e = 0.3$ » ✓ Sb light is «predominantly» from young/blue stars, E3 light is «predominantly» from old/red stars ✓ Sb stars orbit in uniform direction, E3 the motion is more random ✓ Sb has more cold gas than E3 ✓	<i>Sb and E3 must be clearly contrasted eg: “Sb has spiral arms” is insufficient for MP1.</i> <i>Reference to different viewing angles is irrelevant (but appreciated).</i> <i>Diagram may be used.</i>	3 max

Cosmology

Question			Answers	Notes	Total
9.	a		<p>if universe is infinite then at any point in the sky there will eventually be a star ✓</p> <p>«using the idea of shells of stars» a shell of radius R has a brightness $\propto \frac{1}{R^2}$</p> <p>AND</p> <p>the number of stars «at distance R» $\propto R^2$ ✓</p> <p>$\frac{R^2}{R^2} = 1$ thus, each shell has the same brightness «and the sky is infinitely bright» ✓</p>	<i>Marks can be gained in a diagram.</i>	3
9.	b		<p>expansion/Inflation means the light is red-shifted so less is visible light ✓</p> <p>universe is no longer thought to be infinite ✓</p> <p>not all matter emits visible light ✓</p> <p>objects such as dark nebulae and dust absorb light ✓</p>		2 max