

Markscheme

May 2018

Astronomy

















Standard level

Paper 1

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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	A-prominence AND B-filament ✓		1
1.	b	same structure seen at different angles ✓		1
1.	c	allows different layers/features to be seen more clearly ✓	<i>Do not allow "because the Sun is too bright".</i>	1

2.		<p>Earth added, in two positions, annotated [approx.] 6 months apart ✓</p> <p>two lines of sight from Earth to beyond star A, parallax angle (or p or θ) shown at least once ✓</p> <p>distance formula applied to the situation ✓</p> <p>$p = \text{parallax angle}$</p> <p>distance = $\frac{1}{p}$ in parsecs</p> <p>Earth Sun Earth 6 months later</p>	<p><i>No ECF within this answer; marks may be gained from the diagram or written answer.</i></p>	3
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3.		protostar is collapsing due to increasing gravitational attraction ✓ decreased PE causes increased KE OR increased KE (of particles) → increased temperature ✓ black-body radiation governed by temperature OR reference to $\lambda_{\text{max}} T = 2.90 \times 10^{-3}$ ✓ hot enough to be emitting in the visible wavelengths ✓		3
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The Planets

4.			electrical – static charge causing attraction between particles in the nebula ✓ gravitational – larger masses (particles) increase the gravitational attraction acting on smaller masses, moving them together ✓		2
5.	a		on Earth living things break down the CO ₂ to release oxygen OR on Earth CO ₂ can react with the surface, forming carbonates ✓ AND Venus is without living things so can't break down the CO ₂ OR on Venus temperatures are too high to allow formation of carbonates «so high in CO ₂ » ✓	Must refer to both planets for [2].	2
5.	b		greenhouse effect traps re-radiated heat (from the surface) in the atmosphere ✓ amount of re-radiation trapped depends on density of atmosphere and concentration of greenhouse gases ✓ Venus has higher CO ₂ (than Earth) so more heat is trapped in the atmosphere ✓ Venus' atmosphere higher density (than Earth) so almost opaque to re-radiation (also traps heat) ✓		3

6.		transparent to atmosphere ✓ little other radio noise ✓ match wavelengths of hydroxyl and hydrogen, so ETs could use them ✓		2
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Galaxies

7.	a		Population I – spiral arms / spiral disc AND Population II – galactic halo / central bulge ✓		1
7.	b		metals only produced in supernovae ✓ Population I high in metals ✓ <u>therefore</u> formed after several supernovae «so a long time passed before Population I formed» ✓	<i>Third mark may only be awarded if an argument has been made (whether argument correct or incorrect).</i>	3
8.	a		predictable/consistent maximum luminosity ✓ very bright/luminous so can be detected from a great distance ✓	<i>NB. astrophysicists use empirical relationship between luminosity and decay timescale – not required.</i>	2
8.	b		not a common event «even in spiral galaxies» OR even rarer in elliptical galaxies so not practical as an instrument OR that area of sky probably not monitored at time of outburst ✓	<i>Any sensible answer should be awarded the mark.</i>	1

Cosmology

9.	a	$T \approx \frac{1}{H_0} = \frac{1 \times 10^6 \times 3.26 \times 9.46 \times 10^{12}}{55} = 5.6 \times 10^{17} \text{ «s» } \checkmark$	Accept about 1.8×10^{10} years OR 18 billion years.	1
9.	b	rate of expansion / Hubble constant is constant \checkmark		1
9.	c	to check the work of that paper OR to further reduce the uncertainty \checkmark		1
10.		Newton – gravity is a force related to mass OR $F = ma$ \checkmark Einstein – gravity is caused by mass curving spacetime \checkmark		2
