

Markscheme

May 2017

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 | ALT 1 |  | Does not answer question | |
|  | Unclear | |  | Answer acceptable | ALT 6 |
|  | Omission mark | ALT 3 |  | Power of 10 error | ALT 7 |
|  | 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. | ALT 2 |
|  | 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. | ALT 8 |
|  | Benefit of the doubt | ALT 4 |  | Dynamic; can be sized to highlight area | ALT 9 |
|  | Contradiction | |  | Dynamic; horizontal line that can be expanded | |
|  | Error carried forward | ALT 5 |  | Award 0 marks. 0 marks will be added to the marks panel when this annotation is stamped on the script. | ALT 0 |

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><i>Brown Dwarf:</i> object having a mass just short of being about to trigger nuclear fusion ✓</p> <p><i>Luminosity:</i> total electromagnetic power output «across all wavelengths» from an object ✓</p> | <p>OWTTE Accept any answer with a suitable mass range – approx. 10–100 times the mass of Jupiter.</p> | 2 |
| 2. | <p><i>Comet Name:</i> Halley / Encke / Faye / Olbers ✓</p> <p><i>Origin:</i> Kuiper Belt ✓</p> | <p>Accept any correctly named short-period comet.</p> | 2 |
| 3. | <p>$T^2 \propto R^3$ leading to $\frac{T^2}{R^3} = \text{constant}$</p> $\frac{T_E^2}{R_E^3} = \frac{T_N^2}{R_N^3} \Rightarrow \left(\frac{T_N}{T_E}\right)^2 = \left(\frac{R_N}{R_E}\right)^3 = (30)^3 = 2.7 \times 10^4$ <p>therefore $T_N = 164$ earth years</p> <p>evidence of the correct use of Kepler's 3rd law ✓</p> $\left(\frac{T_N}{T_E}\right)^2 = 2.7 \times 10^4 \quad \checkmark$ <p>164 «earth years» ✓</p> | <p>Note that using a constant defined by $\frac{T_E^2}{R_E^3} = 1$ is also fine.</p> | 3 |

| Question | | Answers | Notes | Total |
|----------|--|---|-------|-------|
| 4. | | by their number OR the higher numbers of sunspots the more active OR activity increases with number ✓ | | 1 |

The Planets

| | | | | | |
|----|--|--|--|--|---|
| 5. | | | addition of greenhouse gases to the atmosphere ✓ which increases the temperature of the Earth/atmosphere ✓ | Accept the addition of a named greenhouse gas to the atmosphere. | 2 |
| 6. | | | meteor: particulate in space which enters the Earth's atmosphere seen by its light OR light produced by a particle when it enters the Earth's atmosphere ✓ meteorite: particulate that reaches the Earth's surface ✓ | | 2 |
| 7. | | | number increases as the spin/period of rotation increases ✓ there are always an odd number in each hemisphere OR there are equal numbers in each hemisphere ✓ | | 2 |
| 8. | | | Io ✓ | | 1 |

Galaxies

| Question | | Answers | Notes | Total |
|----------|--|---|-------|-------|
| 9. | | <p><i>M59: elliptical / E ✓</i></p> <p><i>NGC 4565: spiral / S(b) ✓</i></p> | | 2 |
| 10. | | <p><i>Any two from:</i></p> <p>protons ✓</p> <p>helium nuclei</p> <p>OR</p> <p>[alpha particles ✓]</p> <p>electrons ✓</p> <p>heavy nuclei ✓</p> | | 2 |
| 11. | | <p><i>Any two from:</i></p> <p>population I stars are generally younger stars ✓</p> <p>population I stars need gas to have formed ✓</p> <p>there is no/little gas in the halo ✓</p> <p>most of the gas is in the disk ✓</p> | | 2 |

Cosmology

| Question | Answers | Notes | Total |
|----------|--|----------------------------------|-----------------|
| 12. | <p><i>Redshift:</i> increase in the wavelength of electromagnetic radiation from an object as a result of its recessional motion compared to the observer ✓</p> <p><i>Elliptical Galaxy:</i> Any one [for 1 max] from: galaxy having a smooth elliptical shape OR is elliptical in outline ✓ with a nearly featureless brightness profile ✓ slowly rotate with low angular momentum per unit mass ✓ stellar population is old (population II) ✓ contain very little gas ✓ no signs of star formation ✓</p> | <p>OWTTE</p> | <p>2</p> |
| 13. | <p>spherical ✓ flat ✓ saddle shaped ✓</p> | <p><i>Accept hyperbolic.</i></p> | <p>3</p> |

| Question | | | Answers | Notes | Total |
|----------|--|--|---|--------------|----------|
| 14. | | | <i>Olber's paradox</i> : night sky should look bright not dark ✓ redshift is where the wavelength of light is moved to larger values ✓ light from distant objects has been redshifted out of the visible spectrum ✓ | OWTTE | 3 |
| 15. | | | huge galaxy filament OR huge galactic structure OR one of the largest known structures in space ✓ | | 1 |
