

**Astronomy  
Standard level  
Paper 1**

27 April 2023

**Zone A** morning | **Zone B** afternoon | **Zone C** afternoon

Candidate session number

45 minutes

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**Instructions to candidates**

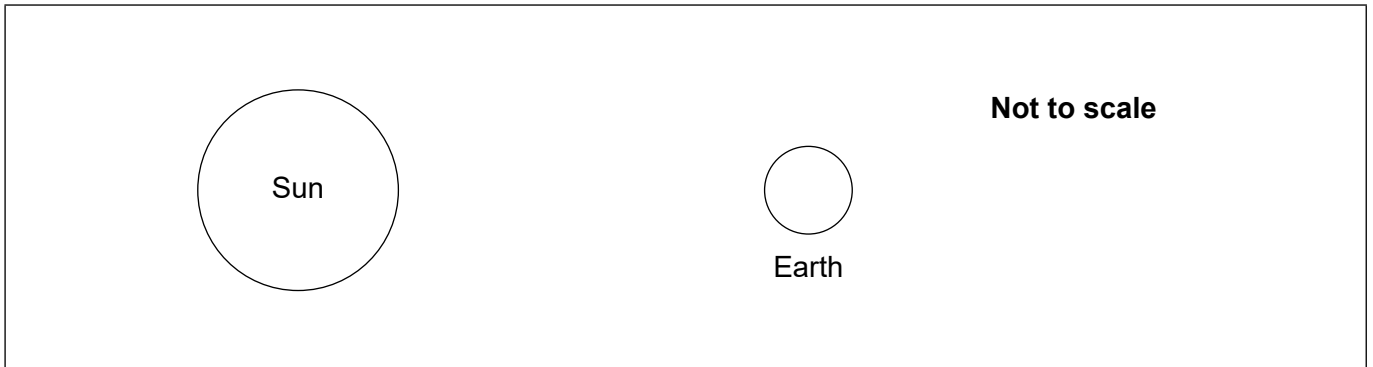
- Write your session number in the boxes above.
- Do not open this examination paper until instructed to do so.
- Answer all of the questions.
- Answers must be written within the answer boxes provided.
- A calculator is required for this paper.
- A clean copy of the **astronomy data booklet** is required for this examination paper.
- The maximum mark for this examination paper is **[30 marks]**.



Answer **all** questions. Answers must be written within the answer boxes provided.

**The Stars**

1. A total **solar** eclipse is observed on Earth. The diagram shows the position of the Sun and Earth (not to scale) during the solar eclipse. Plot the Moon's position using the letter M, and the location of the observation on Earth using the letter X. [1]



2. The following table shows data on two stars, Aldebaran and Porrima.

Star	Aldebaran	Porrima
Spectral class	K5	F0
Parallax angle (mas)	$49.97 \pm 0.75$	$85.58 \pm 0.60$
Distance (pc)	20.0	11.68
Radius (solar)	44.13	2.17
Mass (solar masses)	1.16	1.56
Temperature (K)	3900	6757
Luminosity (solar)	439	9.12

Data from SIMBAD

- (a) SIMBAD is an astronomical database of objects beyond the solar system, based in Strasbourg, France. Explain why there is a need for a database available to all astronomers. [1]

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(This question continues on the following page)



**(Question 2 continued)**

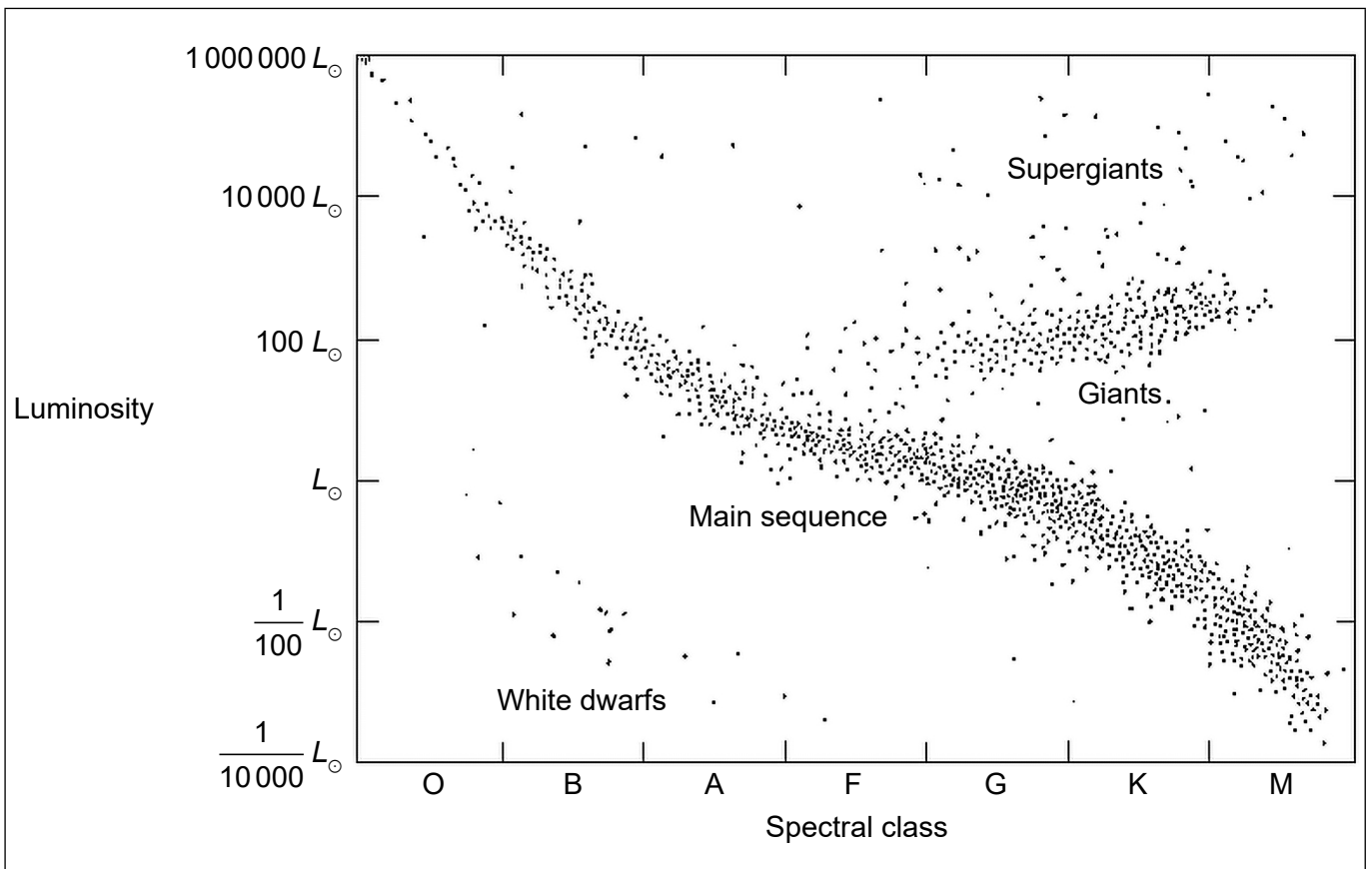
(b) Calculate the apparent brightness of Porrima, as viewed from Earth, and state the units. [2]

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(c) Aldebaran is less massive and cooler than Porrima. Demonstrate why Aldebaran has a greater luminosity. [3]

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(d) On the Hertzsprung-Russell (HR) diagram plot the probable evolutionary future of Aldebaran from now. [2]



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Turn over

**The Planets**

3. The most accepted model of the formation of the planets of our solar system is by accretion. Compare the accretion that formed the terrestrial planets and the gas giant planets. [3]

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4. State **one** variable from the Drake Equation that
- (a) can be reasonably estimated with our present knowledge. [1]

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- (b) is outside our knowledge at this time. [1]

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5. Both Venus and Mars have more carbon dioxide as a percentage of their atmospheres than Earth. Venus is at a much higher temperature than Earth. Mars is much colder.

(a) Outline how carbon dioxide can increase the temperature of a planet. [2]

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(b) Suggest **two** reasons that Mars is colder than Earth. [2]

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**Galaxies**

6. NGC 4261 is an elliptical radio galaxy with an active galactic nucleus (AGN).

(a) Elliptical and lenticular galaxies are often termed “early-type” galaxies. Identify **two** characteristics of “early-type” galaxies. [2]

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(b) A type Ia supernova in NGC 4261 was recorded in 2001. Comment on the importance of this event for the study of NGC 4261. [2]

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(c) Describe the predicted cause of the very strong radio emissions from galaxies such as NGC 4261. [3]

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**Cosmology**

7. (a) State the Cosmological Principle. [1]

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(b) Briefly explain whether the Cosmological Principle is supported by studies of the cosmic microwave background (CMB) radiation. [2]

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(c) Discuss whether the discoveries of galactic superclusters and walls of galaxies support the Cosmological Principle. [2]

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**References:**

- 2.(d) Colose, C., 2011. *Hertzsprung-Russell Diagram for Stars in the Solar Neighborhood*. [graph] Available at: <https://skepticalscience.com/print.php?n=654>. [Accessed 1 March 2021]. SOURCE ADAPTED.



08EP08