



**Surname** \_\_\_\_\_

**Other Names** \_\_\_\_\_

**Centre Number** \_\_\_\_\_

**Candidate Number** \_\_\_\_\_

**Candidate Signature** \_\_\_\_\_

**A-level**

**PHYSICS**

**Paper 3 Section B Astrophysics**

**7408/3BA**

**Monday 3 June 2019**

**Afternoon**

**Time allowed: The total time for both sections of this paper is 2 hours. You are advised to spend approximately 50 minutes on this section.**

**At the top of the page, write your surname and other names, your centre number, your candidate number and add your signature.**

**[Turn over]**



**For this paper you must have:**

- **a pencil and a ruler**
- **a scientific calculator**
- **a Data and Formulae Booklet.**

## **INSTRUCTIONS**

- **Use black ink or black ball-point pen.**
- **Answer ALL questions.**
- **You must answer the questions in the spaces provided. Do not write on blank pages.**
- **Do all rough work in this book. Cross through any work you do not want to be marked.**
- **If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).**
- **Show all your working.**



## **INFORMATION**

- **The marks for questions are shown in brackets.**
- **The maximum mark for this paper is 35.**
- **You are expected to use a scientific calculator where appropriate.**
- **A Data and Formulae Booklet is provided as a loose insert.**

**DO NOT TURN OVER UNTIL TOLD TO  
DO SO**



## SECTION B

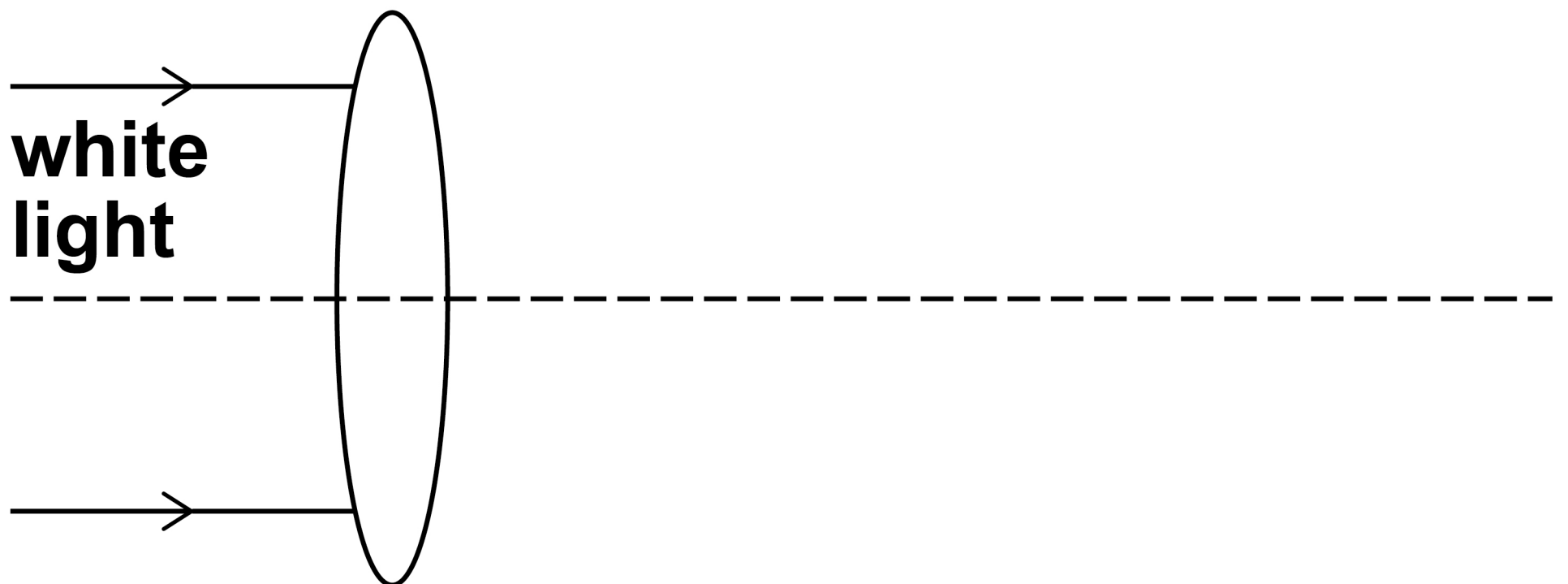
**Answer ALL questions in this section.**

**01.1**

**The lenses used in refracting telescopes can cause chromatic aberration.**

**Complete FIGURE 1 to show how a lens produces chromatic aberration. [1 mark]**

**FIGURE 1**



01.2

**A Cassegrain telescope uses mirrors.**

**What are the shapes of the primary and secondary mirrors in a Cassegrain telescope?**

**Tick (✓) ONE box. [1 mark]**

	<b>Primary mirror</b>	<b>Secondary mirror</b>
<input type="checkbox"/>	<b>concave</b>	<b>concave</b>
<input type="checkbox"/>	<b>concave</b>	<b>convex</b>
<input type="checkbox"/>	<b>convex</b>	<b>concave</b>
<input type="checkbox"/>	<b>convex</b>	<b>convex</b>

**[Turn over]**



01.3

**TABLE 1** contains information about two telescopes, A and B. Each telescope is planned to be the biggest of its type in the world.

**TABLE 1**

Telescope	A	B
Type	Optical reflecting telescope	Radio telescope
Diameter / m	39.3	110
Range of wavelengths detected	350 nm to 1800 nm	2.5 mm to 1000 mm

**Discuss the similarities and differences between optical reflecting telescopes and radio telescopes. Your answer should include references to:**

- **structure**
- **positioning**
- **collecting power.**

**Go on to discuss which telescope, A or B, will give a more detailed image of an astronomical object that emits both radio waves and visible light. [6 marks]**

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10

[illegible]

8



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TABLE 2 shows some properties of the four brightest stars in the constellation Canis Minor.

TABLE 2

Name	Apparent magnitude	Absolute magnitude	Spectral class
Gamma A	4.46	−0.50	K
Gomeisa	2.89	−0.70	B
HD 66141	4.39	−0.13	K
Procyon	0.34	2.65	F



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**Discuss, with reference to the Hipparcos scale, why many star maps show only two stars in the constellation Canis Minor. [3 marks]**

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**02.2**

**State and explain which star in TABLE 2, on page 12, has the most prominent Hydrogen Balmer absorption lines.  
[2 marks]**

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**Deduce which star, Gamma A or HD 66141, has the larger diameter. [3 marks]**

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**Astronomers recently used the radial velocity method to discover an exoplanet orbiting HD 66141.**

**Describe the main features of the radial velocity method in the detection of planets. [2 marks]**

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**[Turn over]**



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**Calculate the distance from the Earth to Procyon.**

**Give an appropriate unit for your answer.  
[3 marks]**

**distance = \_\_\_\_\_ unit \_\_\_\_\_**

<b>13</b>



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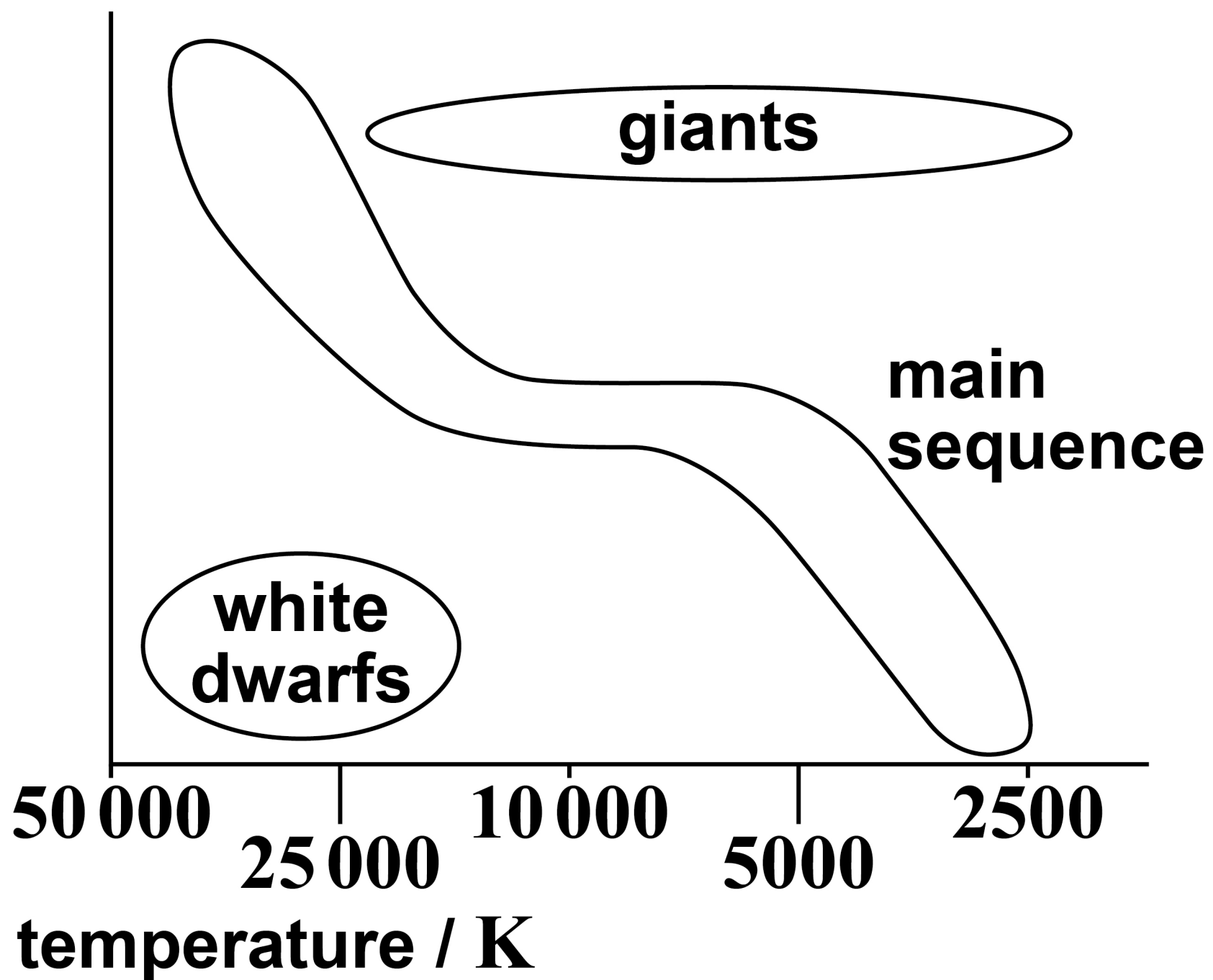


03

**FIGURE 2** is a Hertzsprung-Russell (HR) diagram.

**FIGURE 2**

**absolute  
magnitude**



**03.1**

**Label the absolute magnitude axis with a suitable scale. [1 mark]**

**03.2**

**Label with an S the position of the Sun on the HR diagram. [2 marks]**

**03.3**

**Draw a line on the HR diagram to show the evolution of a star similar to the Sun from formation to white dwarf. [2 marks]**

**03.4**

**Label with a P the position on the HR diagram of a star much redder, and with a greater power output, than the Sun. [1 mark]**

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**A star much more massive than the Sun  
may become a supernova and then a  
black hole.**

**Discuss whether supernovae and black holes can be placed on the HR diagram in FIGURE 2, on page 20. [3 marks]**

[illegible]

**[Turn over]**

9



04.1

**TABLE 3** contains information about two galaxies.

**TABLE 3**

<b>Galaxy</b>	<b>Red shift, <math>z</math></b>	<b>Distance from Earth / ly</b>
<b>NGC 936</b>	$4.8 \times 10^{-3}$	$6.8 \times 10^7$
<b>NGC 3379</b>	$3.0 \times 10^{-3}$	$3.2 \times 10^7$

**Discuss whether these data are consistent with Hubble's Law. [3 marks]**



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[Turn over]

**04.2**

**Quasars are the most distant measurable objects.**

**Discuss ONE problem associated with the determination of the distance from the Earth to a quasar. [2 marks]**

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**END OF QUESTIONS**

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5



**Additional page, if required.**

**Write the question numbers in the left-hand margin.**

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**Write the question numbers in the left-hand margin.**

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**Additional page, if required.**

**Write the question numbers in the left-hand margin.**

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Question	Mark
1	
2	
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TOTAL	

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