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

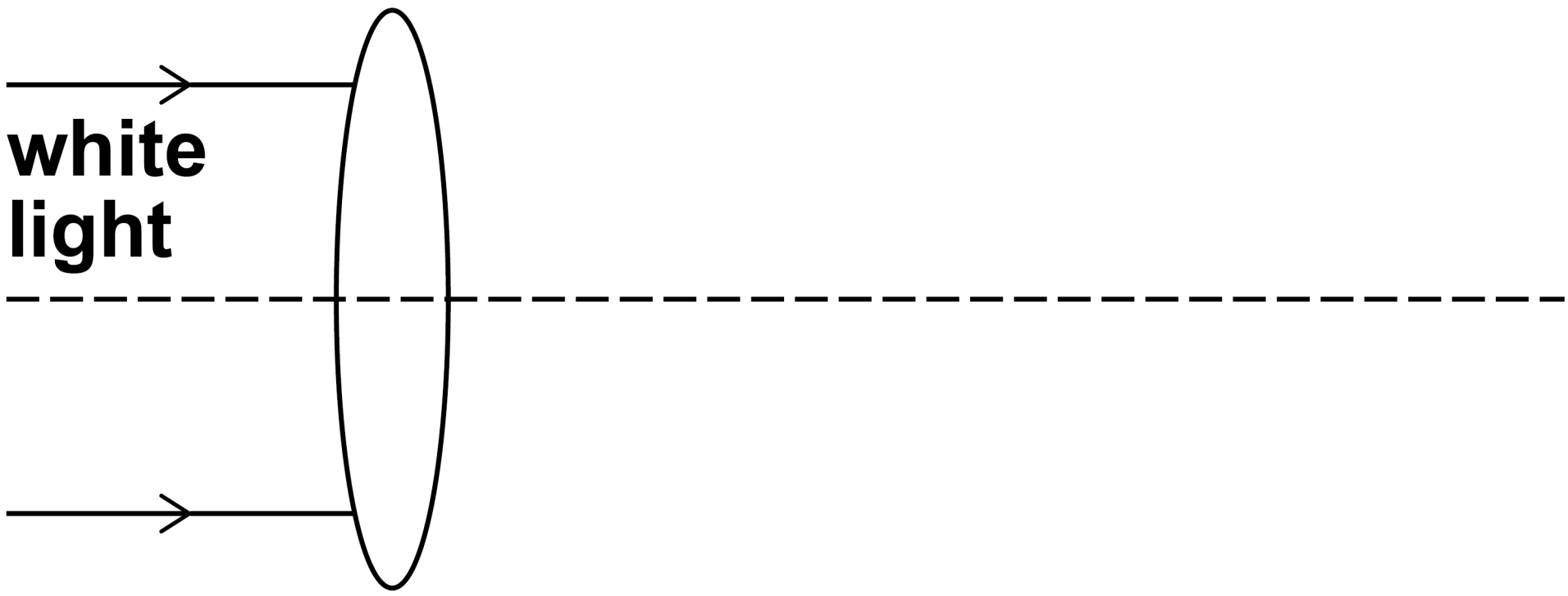
Answer ALL questions in this section.

0 1 . 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



0 1 . 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]

	Primary mirror	Secondary mirror
	concave	concave
	concave	convex
	convex	concave
	convex	convex

0 1 . 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]

[Turn over]

8

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[Turn over]

0 2

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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[Turn over]

0 2 . 1

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

0 2 . 2

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

0 2 . 3

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

0 2 . 4

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]

0 2 . 5

Calculate the distance from the Earth to Procyon.

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

distance = _____ unit _____

13

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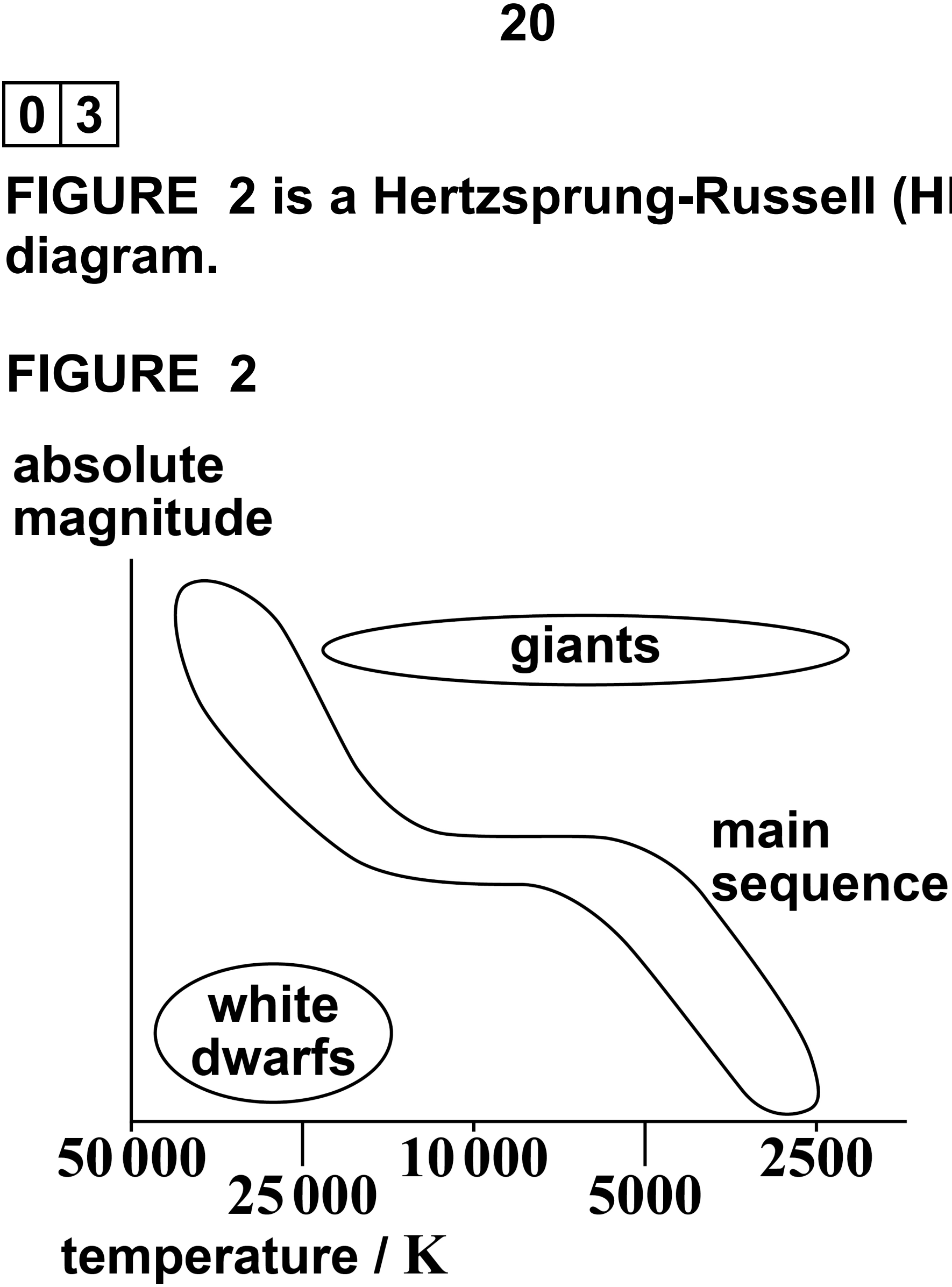
0	3

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

FIGURE 2



0 3 . 1

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

0 3 . 2

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

0 3 . 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]

0 3 . 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]

[Turn over]

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0 3 . 5

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]

0 4 . 1

TABLE 3 contains information about two galaxies.

TABLE 3

Galaxy	Red shift, z	Distance from Earth / ly
NGC 936	4.8×10^{-3}	6.8×10^{7}
NGC 3379	3.0×10^{-3}	3.2×10^{7}

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

[Turn over]

0 4 . 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]

END OF QUESTIONS

5

Additional page, if required.

Write the question numbers in the left-hand margin.

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For Examiner's Use	
Question	Mark
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