Please write clearly in block capitals.

Centre number | | | | | | Candidate number | | | | |

Surname _____

Forename(s) _____

Candidate signature _____

I declare this is my own work.

A-level PHYSICS

Paper 3
Section B Astrophysics

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.

Materials

For this paper you must have:
- a pencil and a ruler
- a scientific calculator
- a Data and Formulae Booklet
- a protractor.

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- 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).
- Do all rough work in this book. Cross through any work you do not want to be marked.
- Show all your working.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
TOTAL	

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.

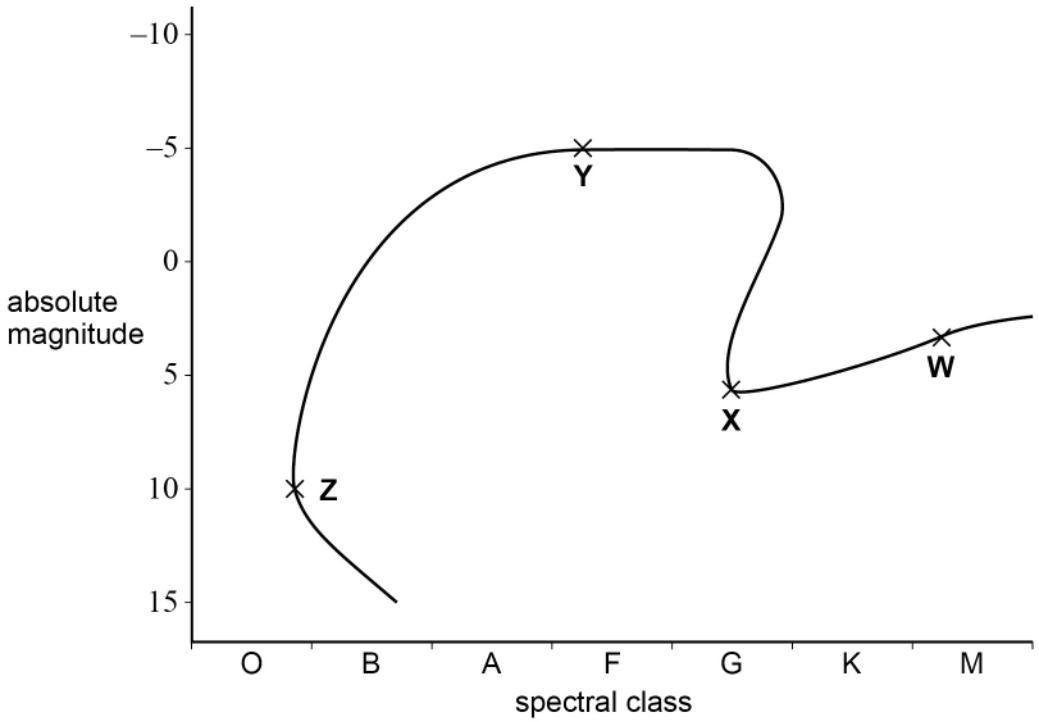
Do not write outside the box

Section B

Answer **all** questions in this section.

0 1 **Figure 1** shows the evolution of a star similar to the Sun on a Hertzsprung-Russell (HR) diagram.

Figure 1



0 1 . 1 State the evolutionary stage of the star at each of the points **W**, **X**, **Y** and **Z**.

[3 marks]

W _____

X _____

Y _____

Z _____

Theta Carinae is a star with a radius five times that of the Sun. It has a surface temperature of 31 000 K.

0 1 . 2 Annotate **Figure 1** with a **T** to show the position of Theta Carinae.

[1 mark]

Do not write outside the box

An astronomer suggests that an Earth-sized planet orbits Theta Carinae.

0 1 . 3 Explain **one** difficulty with using the transit method to detect this planet.

[2 marks]

0 1 . 4 The astronomer suggests that the Earth-sized planet receives a similar amount of power from Theta Carinae as the Earth does from the Sun.

The average power output of the Sun is 3.8×10^{26} W.

Determine the orbital radius of the Earth-sized planet orbiting Theta Carinae.

[5 marks]

orbital radius = _____ m

11

Turn over ►

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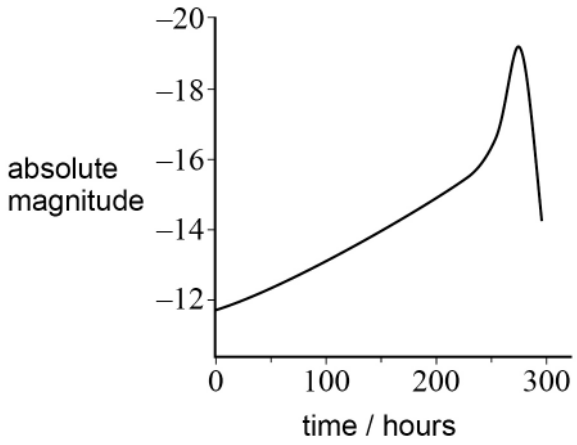
0 2 . 1 Which graph shows the light curve for a typical type 1a supernova?

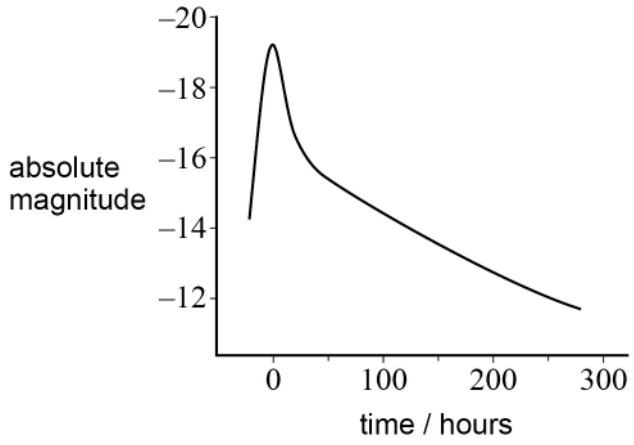
Tick (✓) **one** box.

[1 mark]

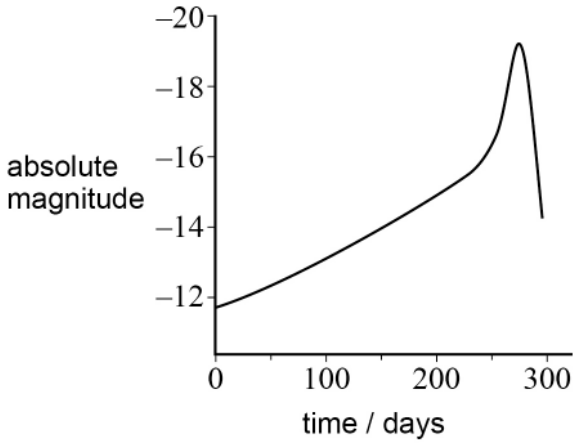
A



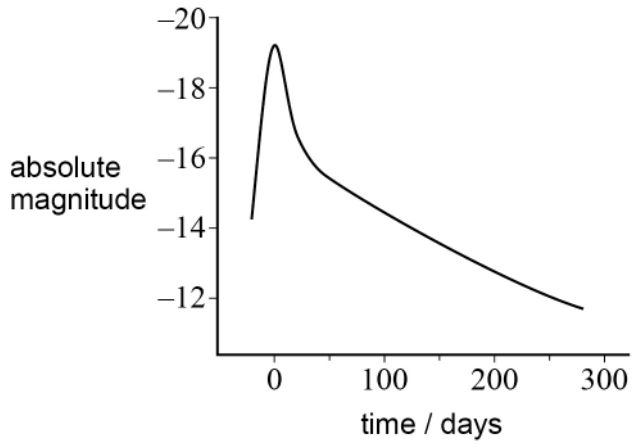
B



C



D



A ☐

B ☐

C ☐

D ☐

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0 2 . 2 The Andromeda galaxy is approximately 7.7×10^5 pc from Earth.

Deduce whether a type 1a supernova which occurred in Andromeda can be observed from Earth with the naked eye.

[3 marks]

4

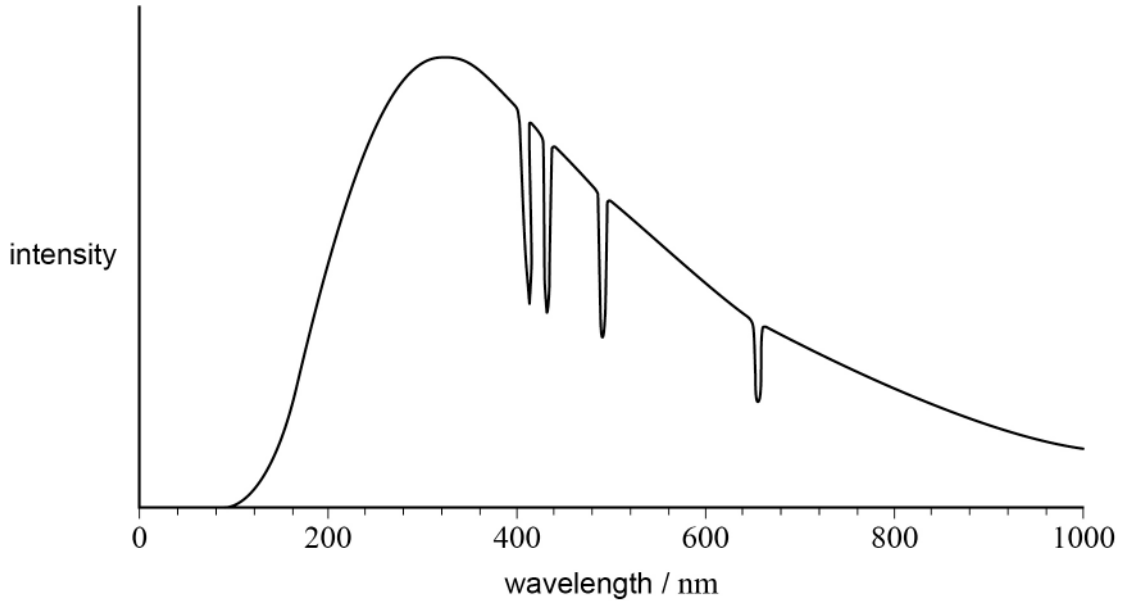
Turn over for the next question

Do not write outside the box

0 3 Miaplacidus and Avior are two stars in the constellation Carina.
Miaplacidus is a class A star.
Avior is a class K star.

Figure 2 shows how the intensity of radiation arriving at the Earth varies with wavelength for **one** of these stars. Only the important features of the variation are shown.

Figure 2



Deduce, with reference to **Figure 2**, the identity of the star.

In your answer you should:

- explain the overall shape of the graph
- describe the processes in the star that lead to the decreases in intensity
- state the identity of the star.

[6 marks]

Do not write outside the box

6

Turn over for the next question

Do not write outside the box

0 4 IC2497 is a galaxy that contained a quasar. It is believed that the quasar stopped emitting radiation several thousand years ago.

0 4 . 1 Suggest why the quasar stopped emitting radiation.

[2 marks]

0 4 . 2 IC2497 has a red shift of 0.0516

Determine the distance from the Earth to IC2497.
Give an appropriate unit for your answer.

[4 marks]

distance = _____ unit = _____

6

Do not write outside the box

0 5 . 1 Explain what is meant by the Rayleigh criterion.

[2 marks]

0 5 . 2 A telescope uses wavelengths in the range 90 nm to 120 nm.

Explain why this telescope must be located in space.

Go on to discuss **one** advantage that this telescope has compared to a telescope with the same aperture that uses visible light.

[3 marks]

Question 5 continues on the next page

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0 5 . 3 **Table 1** shows information about two telescopes.

Table 1

Telescope	Diameter / m	Dish shape
Arecibo	305	spherical
Lovell	76	parabolic

Each telescope detects radio waves with a wavelength of 21 cm.

Compare the performances of the telescopes in **Table 1** when both are used to observe the same faint radio objects.

[3 marks]

8

END OF QUESTIONS

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