AQA

Please write clearly in block capitals.

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I declare this is my own work.

A-level PHYSICS

Paper 3
Section B Astrophysics

Friday 5 June 2020 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.

Materials

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.
- 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	
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.

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Section B

Answer **all** questions in this section.

0 1 . 1 Draw a ray diagram for a Cassegrain telescope.
Your diagram should show the paths of **two** rays up to the eyepiece lens.
The rays should initially be parallel to the principal axis.

[2 marks]

principal axis

0 1 . 2 A spacecraft passes Pluto at a distance of $12\ 500\ \text{km}$. The telescope on board has an aperture of diameter $0.21\ \text{m}$ and operates at a wavelength of $450\ \text{nm}$.

Discuss whether this telescope is suitable for studying a crater with a diameter of approximately $1\ \text{km}$ on Pluto.

[3 marks]

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0 1 . 3 The Hubble telescope has an aperture of diameter $2.4\ \text{m}$.

Compare the collecting power of the Hubble telescope with the telescope on the spacecraft in Question **01.2**.

[2 marks]

0 1 . 4 An astrophysicist had to decide whether to use a reflecting telescope or a refracting telescope on the spacecraft in Question **01.2**.

Discuss which type of telescope to use.

[3 marks]

10

Turn over ►

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0 2 **Table 1** summarises some information about four stars in the constellation Cassiopeia.

Table 1

Name	Colour	Apparent magnitude	Distance / ly
Caph	white	2.3	55
Ruchbah	blue/white	2.7	99
Schedar	orange	2.2	228
Tsih	blue	2.2	610

0 2 . 1 Which star has the highest surface temperature?
Tick (✓) **one** box.

[1 mark]

Caph ☐

Ruchbah ☐

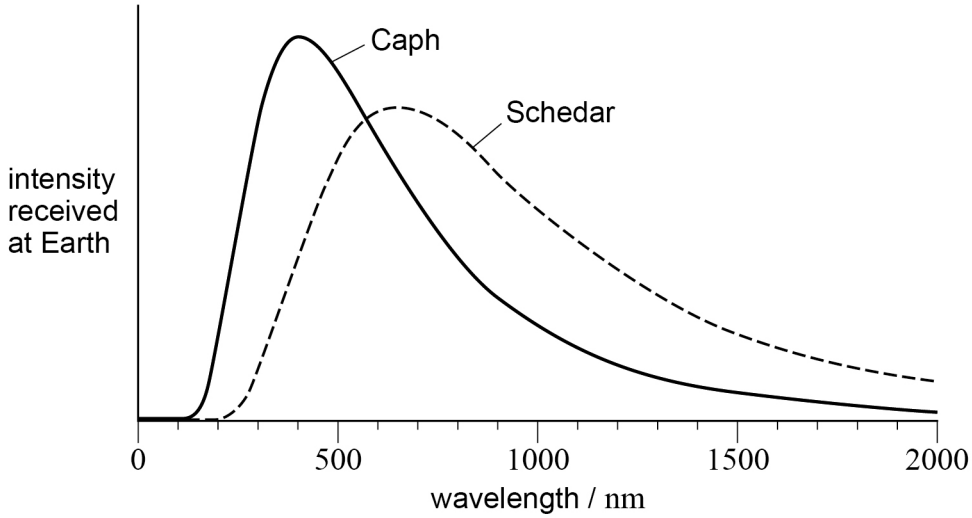
Schedar ☐

Tsih ☐

Do not write outside the box

0 2 . 2 **Figure 1** shows the intensity received at Earth from two of the stars, plotted against wavelength.
The effect of absorption by the Earth's atmosphere is not shown.

Figure 1



Discuss what information can be found from **Figure 1** about the temperature and colour of these stars.
Support your answer with suitable calculations.

[4 marks]

Question 2 continues on the next page

Do not write outside the box

0 2 . 3 State which star in **Table 1** is dimmest on the absolute magnitude scale.

[1 mark]

_____

0 2 . 4 Calculate the absolute magnitude of Schedar.

[3 marks]

absolute magnitude = _____

0 2 . 5 Tsih has a mass over 15 times the mass of the Sun.
Tsih may eventually collapse to form a black hole.

Calculate the radius of the event horizon for a black hole with a mass 15 times that of the Sun.

[2 marks]

radius = _____ m

11

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0 3 Type 1a supernovae can be used as standard candles.

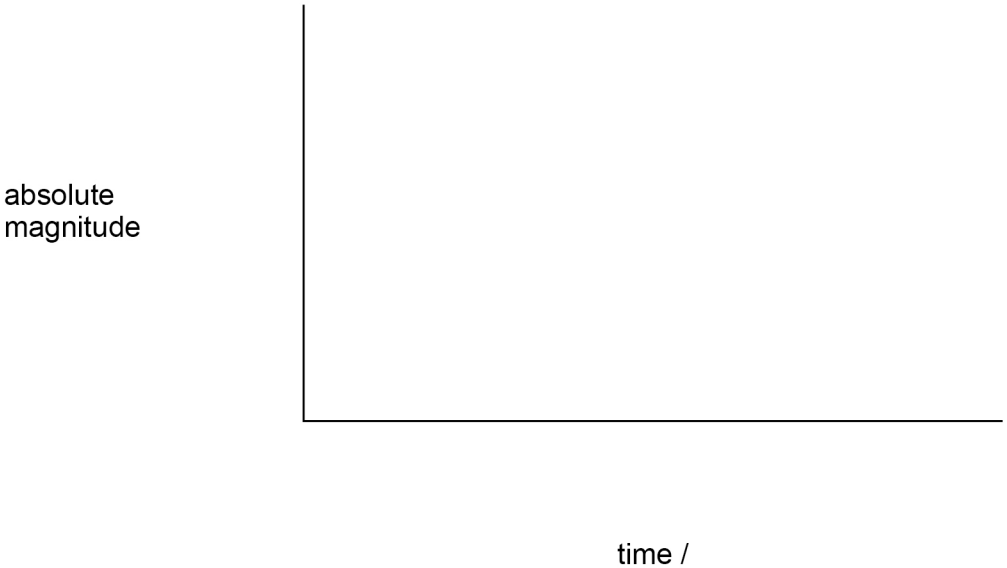
0 3 . 1 State what is meant by a standard candle.

[1 mark]

0 3 . 2 Sketch on **Figure 2** the light curve for a type 1a supernova.
Annotate your graph with suitable scales and a unit for time.

[3 marks]

Figure 2



Question 3 continues on the next page

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0 3 . 3 Measurements of type 1a supernovae are used to find a value for the Hubble constant.

The distance from Earth is known for many type 1a supernovae.

Describe how these values of distance are used, with other data, to find the Hubble constant.

Your answer should include:

- the other data needed and how these data are used
- the graph plotted, including appropriate units for the axes
- how the Hubble constant is obtained and any limitations on the result.

[6 marks]

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Turn over for the next question

10

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0 4 **Table 2** gives data about the supergiant star Melnick 34 and the Sun.

Table 2

Name	Radius / m	Surface temperature / K
Melnick 34	1.4×10^{10}	53 000
Sun	7.0×10^{8}	5 700

0 4 . 1 Calculate $\frac{\text{power output of Melnick 34}}{\text{power output of the Sun}}$.

[2 marks]

answer = _____

0 4 . 2 Discuss why the evolution of a supergiant star in the local part of our galaxy could be dangerous for life on Earth.

[2 marks]

_____

_____

_____

_____

_____

_____

4

END OF QUESTIONS

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