AQA

Surname _____

Forename(s) _____

Centre Number _____

Candidate Number _____

Candidate Signature _____

I declare this is my own work.

A-level
PHYSICS

Paper 3

Section B Astrophysics

7408/3BA

Monday 17 June 2024 Morning

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.

[Turn over]

JUN247408 3BA01

On the front of this book, write your surname and forename(s), your centre number, your candidate number and add your signature.

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.**
- **Answer ALL questions.**
- **You must answer the questions in the spaces provided. Do not write 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.**

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

A student uses a refracting telescope in normal adjustment to make observations of Jupiter.
The telescope has an angular magnification of 75

0 1 . 1

The eyepiece has a focal length of 22 mm.

Determine the distance between the eyepiece and the objective lens. [2 marks]

distance = _____ m

0 1 . 2

When viewed through the telescope, the image of Jupiter subtends an angle of 1.7×10^{-2} rad.

Calculate, in km, the distance between the Earth and Jupiter.

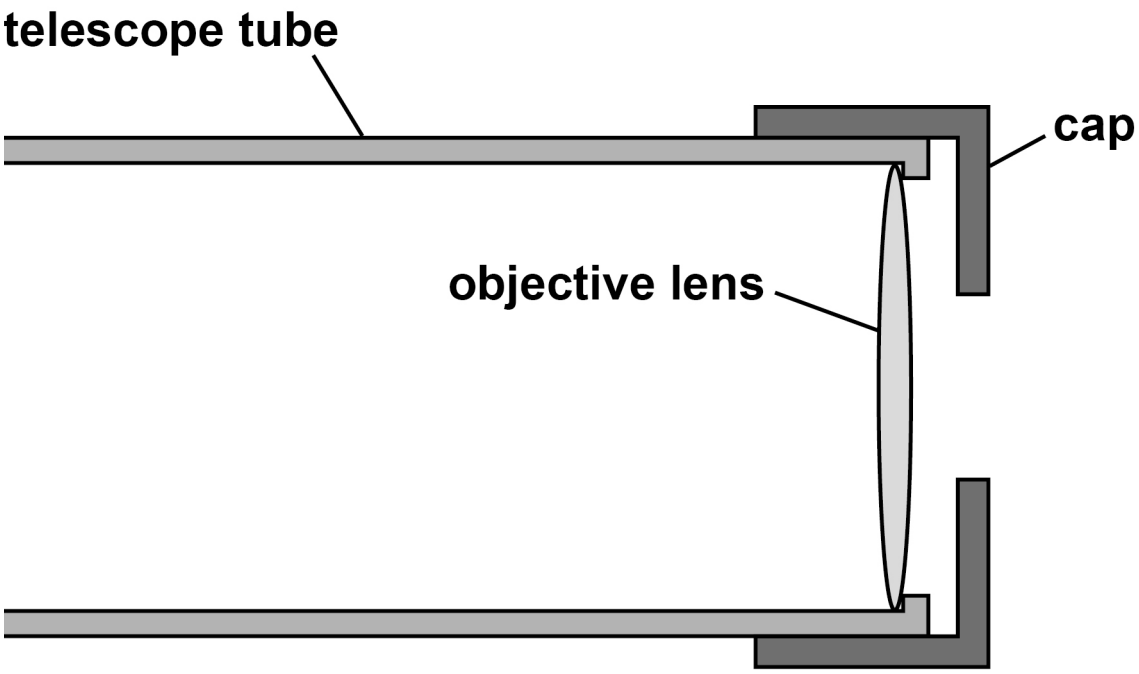
mean radius of Jupiter = 7.0×10^{4} km [2 marks]

distance = _____ km

[Turn over]

The student places a cap over one end of the telescope.
The cap has a circular hole in its centre.
FIGURE 1 shows the end of the telescope, the objective lens and the cap.

FIGURE 1



0 1 . 3

State and explain the effect that the addition of the cap has on the chromatic aberration caused by the lens.
[3 marks]

0 1 . 4

Explain TWO other effects that the addition of the cap has on the image of Jupiter. [4 marks]

1 _____

_____

_____

_____

_____

2 _____

_____

_____

_____

_____

_____

11

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[Turn over]

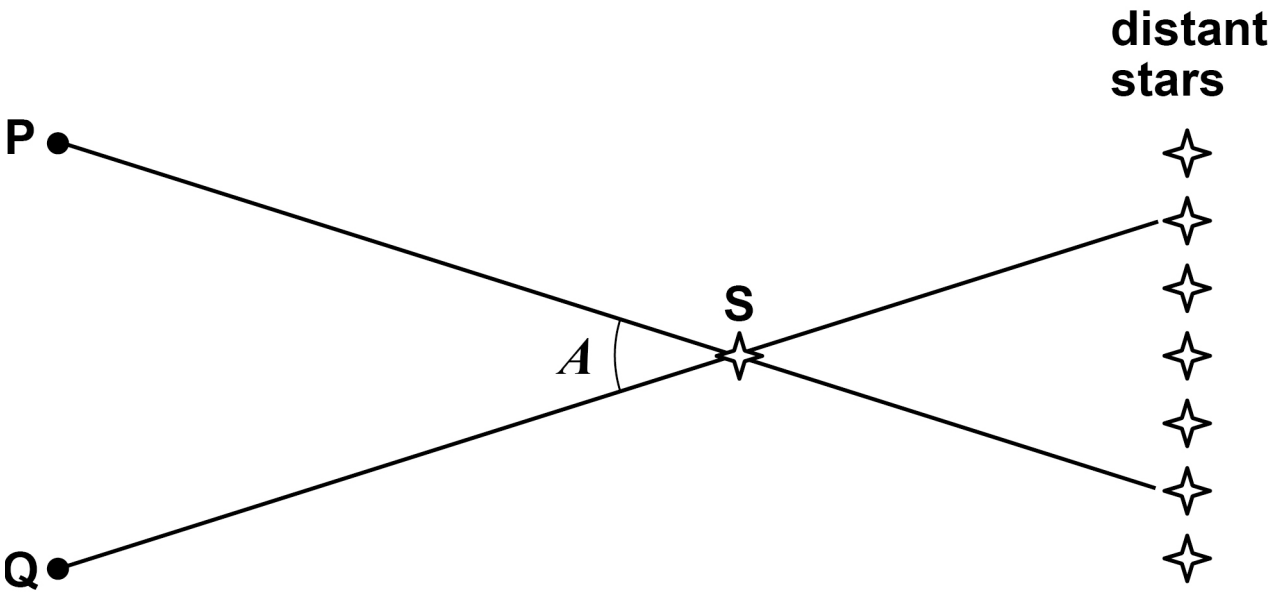
0 2

The apparent change in position of a nearby star relative to distant stars is due to an effect known as parallax.

FIGURE 2 shows how parallax arises. As the Earth moves from point P to point Q, an observer on the Earth sees the position of a nearby star S change in relation to distant stars.

FIGURE 2

The diagram is not drawn to scale.



Angle A is the parallax angle. This angle can be used to determine the distance to a nearby star, provided that the relative motion between the star and the Sun is negligible between observations.

0 2 . 1

The distance from the Sun to S is 79 ly.
The Earth takes 6 months to move from point P to point Q.

Calculate, in degrees, angle A. [2 marks]

A = _____ °

[Turn over]

0 2 . 2

Parallax is used to determine the distance to a different star. Observations of the star produce the following data:

distance determined using parallax = 0.40 pc
apparent magnitude = 13.5
absolute magnitude = 16.7

An astronomer suggests that the star moved significantly relative to the Sun between the two parallax observations.

Discuss whether this suggestion is valid. [4 marks]

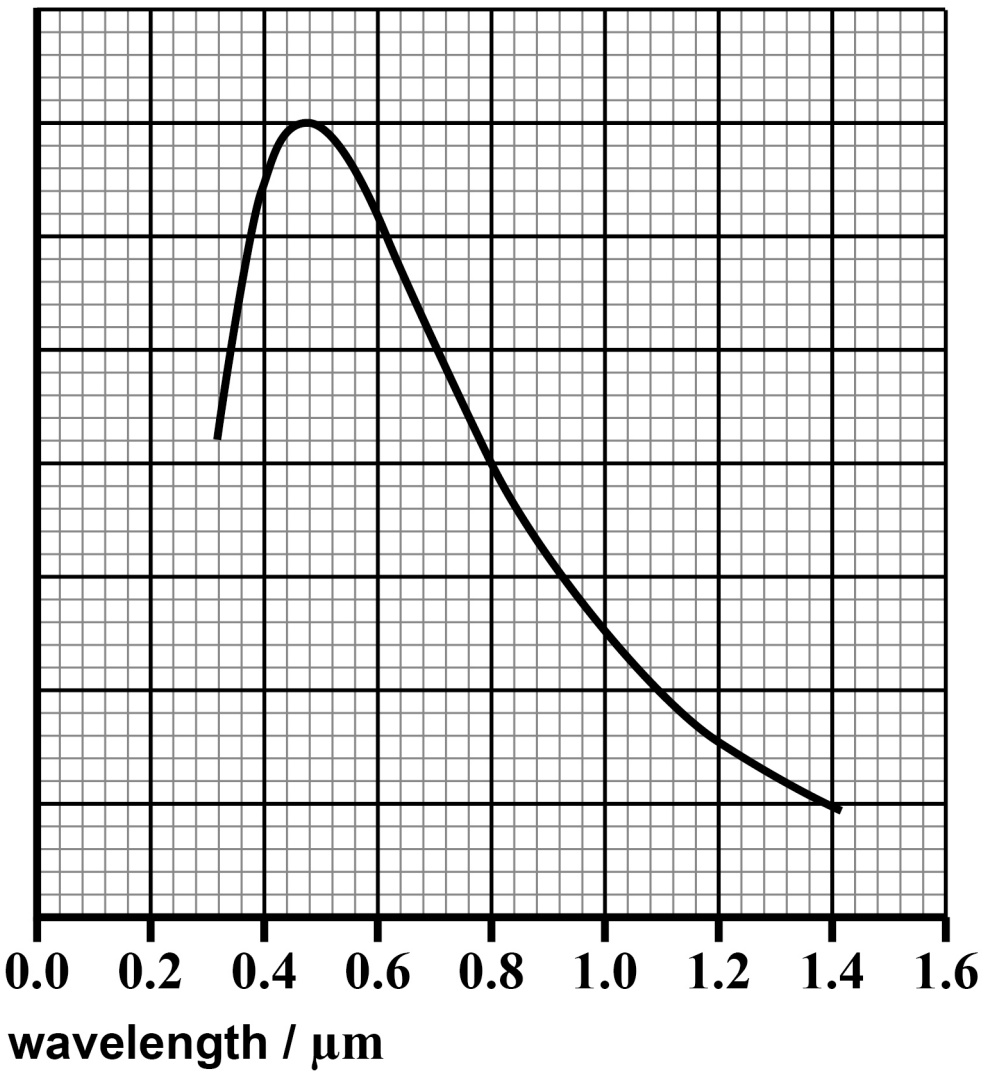
[Turn over]

6

0 3 . 1

FIGURE 3 shows the variation of intensity with wavelength for a star.

FIGURE 3



Show that FIGURE 3 is consistent with a black-body temperature of about 6.0×10^3 K. [2 marks]

0 3 . 2

The radius of the star is 9.6×10^6 m.

Calculate the power output of the star. [2 marks]

power output = _____ W

[Turn over]

0 3 . 3

Which row gives the type and spectral class of the star?

Tick (✓) ONE box. [1 mark]

	TYPE OF STAR	SPECTRAL CLASS
	white dwarf	F
	main sequence	G
	red giant	K
	main sequence	F
	red giant	G
	white dwarf	K

0 3 . 4

The light from the star passes through an interstellar dust cloud before reaching Earth.
The reduction in intensity when light passes through a dust cloud is assumed to be inversely proportional to the wavelength of the light.

An astronomer on the Earth estimates the black-body temperature of the star.

Discuss the effect that the dust cloud has on this estimate. [2 marks]

7

0 4

The Earth is in the galaxy known as the Milky Way. The Andromeda Galaxy is one of the closest galaxies to the Milky Way.

0 4 . 1

The Andromeda Galaxy approaches the Milky Way at a speed of $110\ \text{km s}^{-1}$.
The distance between the galaxies is $770\ \text{kpc}$.

Discuss whether these data can be used to estimate an age for the Universe. [2 marks]

0 4 . 2

There is a supermassive black hole at the centre of the Andromeda Galaxy. The mass of this black hole is 1.60×10^8 solar masses.

Calculate the radius of the event horizon of this black hole.
State an appropriate unit for your answer. [3 marks]

radius = _____

unit = _____

[Turn over]

0 4 . 3

Scientists predict that a quasar will be produced as the Milky Way and the Andromeda Galaxy merge.

Explain what is meant by a quasar.
Go on to suggest why a quasar may be produced as galaxies merge.

In your answer you should:

- **describe the typical properties of a quasar**
- **explain how observations of quasars provide evidence for these properties**
- **suggest the process of quasar formation that is likely when two galaxies merge.**

[6 marks]

[Turn over]

END OF QUESTIONS

11

Additional page, if required.

Write the question numbers in the left-hand margin.

Additional page, if required.

Write the question numbers in the left-hand margin.

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