



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]



J U N 2 4 7 4 0 8 3 B A 0 1

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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.**

[Turn over]



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
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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
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The eyepiece has a focal length of 22 mm.

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

distance = _____ m

[Turn over]



01.2

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



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[Turn over]

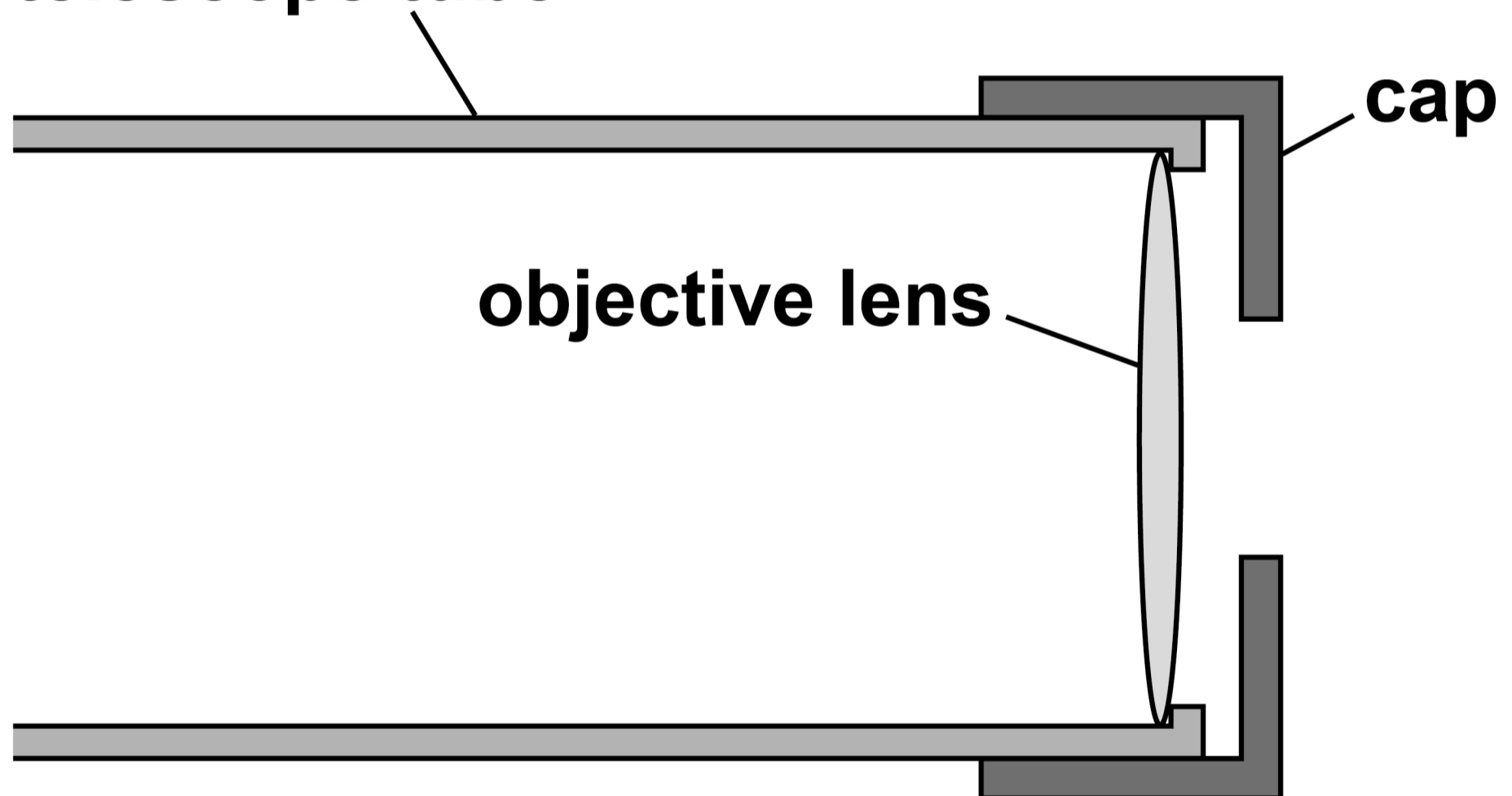


The student places a cap over one end of the telescope. The cap has a circular hole in its centre.

FIGURE 1 shows the end of the telescope, the objective lens and the cap.

FIGURE 1

telescope tube



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]

[Turn over]



0 1 . 4

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

1 _____

2 _____



0	2
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The apparent change in position of a nearby star relative to distant stars is due to an effect known as parallax.

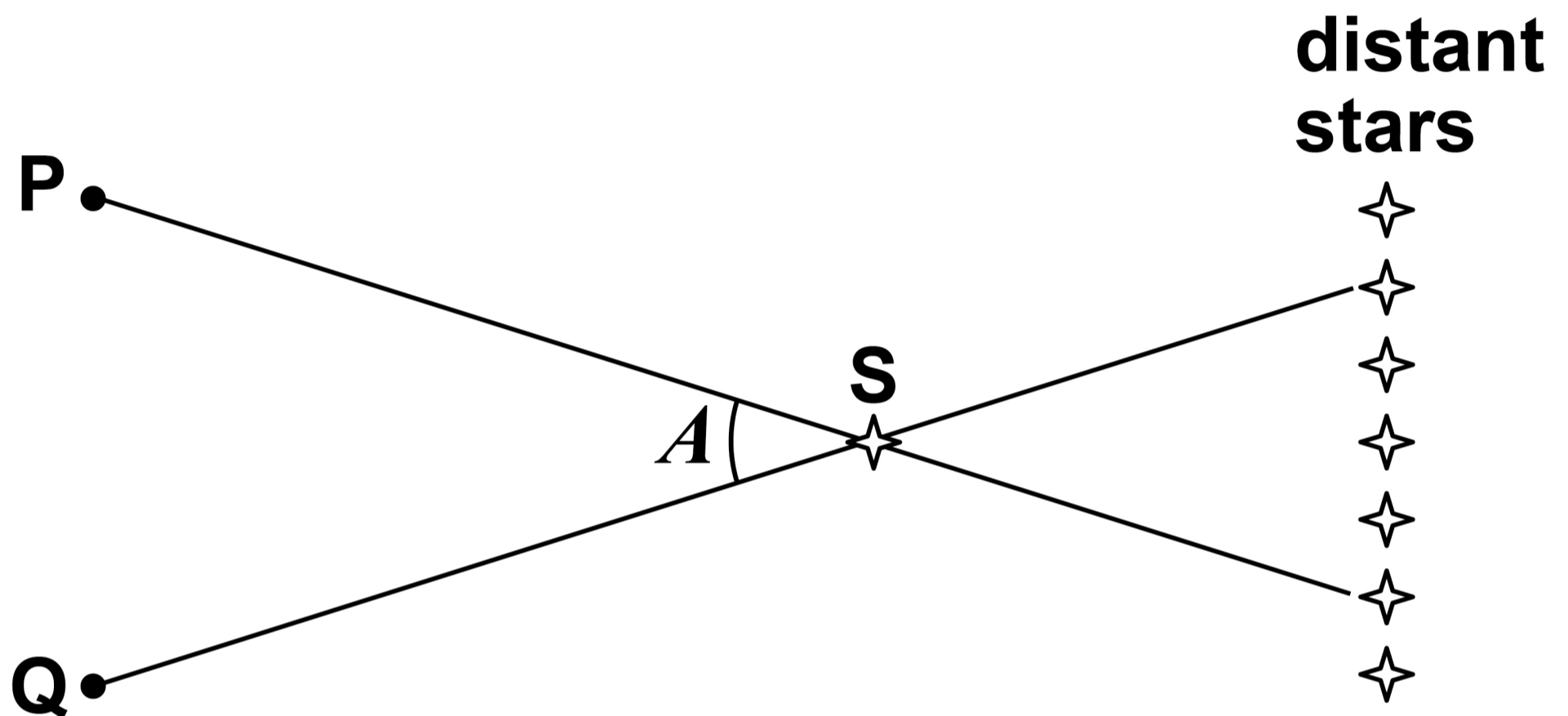
FIGURE 2, on page 14, shows how parallax arises. As the Earth moves from point P to point Q, an observer on the Earth sees the position of a nearby star S change in relation to distant stars.

[Turn over]



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]

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6



03.1

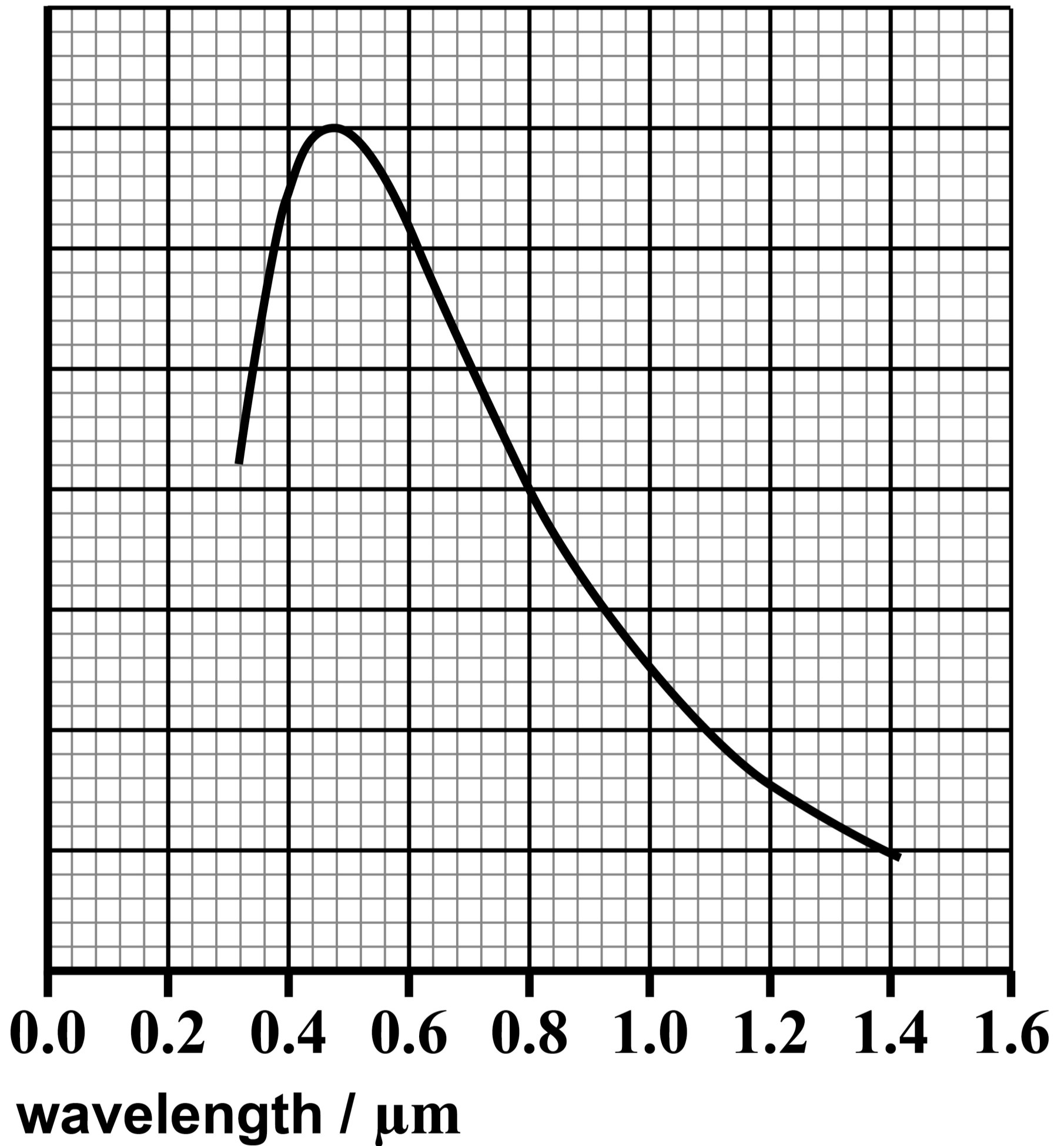
FIGURE 3, on the opposite page, shows the variation of intensity with wavelength for a star.

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



FIGURE 3

intensity



[Turn over]



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



03.3

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

Tick (✓) ONE box. [1 mark]

	TYPE OF STAR	SPECTRAL CLASS
<input type="checkbox"/>	white dwarf	F
<input type="checkbox"/>	main sequence	G
<input type="checkbox"/>	red giant	K
<input type="checkbox"/>	main sequence	F
<input type="checkbox"/>	red giant	G
<input type="checkbox"/>	white dwarf	K

[Turn over]



03.4

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]



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 km s^{-1} .

The distance between the galaxies is 770 kpc .

Discuss whether these data can be used to estimate an age for the Universe.

[2 marks]



[Turn over]



04.2

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]



04.3

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]



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Question	Mark
1	
2	
3	
4	
TOTAL	

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