SPECIMEN MATERIAL

A-level
PHYSICS
(7408/3BA)

Paper 3 - Section B (Astrophysics)

Specimen 2014 Morning Time allowed: 2 hours

Materials
For this paper you must have:
- a pencil
- a ruler
- a calculator
- a data and formulae booklet
- a question paper / answer book for Section A.

Instructions
- Answer **all** questions.
- Show all your working.
- The total time for both sections of this paper is 2 hours.

Information
- The maximum mark for this section is 35.

Please write clearly, in block capitals, to allow character computer recognition.

Centre number ☐☐☐☐☐ Candidate number ☐☐☐☐

Surname ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Forename(s) ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Candidate signature _____

Section B

Answer **all** questions in this section.

0 1 The concave mirrors used in some reflecting telescopes can suffer from spherical aberration.

0 1 . 1 Draw a diagram to show what is meant by spherical aberration when produced by a concave mirror.

[2 marks]

0 1 . 2 The International Ultraviolet Explorer (IUE) and the Gran Telescopio Canarias (GTC) are two examples of reflecting telescopes.

Table 1 summarises some of the properties of the two telescopes.

Table 1

Name	IUE	GTC
Objective Diameter	0.45 m	10.4 m
Location	Geosynchronous Earth orbit	Earth's surface, 2300 m above sea level.
Spectrum detected	Ultraviolet	Visible and Infrared
Typical wavelength detected	2.0×10^{-7} m	1.0×10^{-6} m

Compare the two telescopes in terms of their location, collecting power and minimum angular resolution.

Include calculations to support your comparisons.

[6 marks]

0 1 . 3 The Charge Coupled Device (CCD) is an important part of the detection system of many modern telescopes due to its high quantum efficiency.

Explain what is meant by quantum efficiency and compare the quantum efficiency of a CCD with that of the eye.

[2 marks]

Turn to page 6 for the next question

Turn over for the next question

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

0 2 The Summer Triangle consists of three stars, Altair, Deneb and Vega.
Some of the properties of the three stars are summarised in **Table 2**.

Table 2

	Altair	**Deneb**	**Vega**
surface temperature / K	7700	8500	9600
apparent magnitude	0.77	1.25	0.03
absolute magnitude	2.21	−8.38	0.60

0 2 . 1 The three stars belong to the same spectral class.

State and explain which spectral class they belong to.

[2 marks]

0 2 . 2 Deduce which of the three stars appears brightest.

[2 marks]

0 2 . 3 Calculate the distance from Earth to the closest of the three stars.

[3 marks]

distance = _____ pc

0 2 . 4 Deduce which of the three stars is the largest.

[3 marks]

0 2 . 5 Calculate the wavelength of the peak in the black body radiation curve of Altair.

[2 marks]

wavelength = _____ m

Turn over for the next question

0 3 Antares is a red supergiant star in the constellation of Scorpio. It has a mass about 18 times that of the Sun.
Eventually the star will become a supernova, leaving behind a core that could form a neutron star or a black hole.

0 3 . 1 State what is meant by a supernova.

[1 mark]

0 3 . 2 State the defining properties of a neutron star.

[2 marks]

0 3 . 3 To become a black hole it is likely that the core would have to have a mass at least twice that of the Sun.

Calculate the Schwarzschild radius of a black hole with a mass twice that of the Sun.

[2 marks]

radius = _____ m

0 3 . 4 Some scientists are concerned about the consequences for the Earth of a supernova occurring in a nearby part of the galaxy.

Explain the cause of this concern.

[2 marks]

0 4 In 1999 a planet was discovered orbiting a star in the constellation of Pegasus.

0 4 . 1 State **one** reason why it is difficult to make a direct observation of this planet.

[1 mark]

0 4 . 2 The initial discovery of the planet was made using the radial velocity method which involved measuring a Doppler shift in the spectrum of the star.

Explain how an orbiting planet causes a Doppler shift in the spectrum of a star.

[2 marks]

0 4 . 3 The discovery was confirmed by measuring the variation in the apparent magnitude of the star over a period of time.

Explain how an orbiting planet causes a change in the apparent magnitude of a star. Sketch a graph of apparent magnitude against time (a light curve) as part of your answer.

[3 marks]

END OF QUESTIONS

There are no questions printed on this page.

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