

Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										



General Certificate of Education
Advanced Level Examination
June 2010

Physics A

PHYA5/2A

Unit 5A Astrophysics Section B

Tuesday 29 June 2010 1.30 pm to 3.15 pm

<p>For this paper you must have:</p> <ul style="list-style-type: none"> • a pencil and a ruler • a calculator • a Data and Formulae Booklet.
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Time allowed

- The total time for both sections of this paper is 1 hour 45 minutes.
You are advised to spend approximately 50 minutes on this section.

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.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information

- The marks for questions are shown in brackets.
- The maximum mark for this section is 35.
- You are expected to use a calculator where appropriate.
- A *Data and Formulae Booklet* is provided as a loose insert.
- You will be marked on your ability to:
 - use good English
 - organise information clearly
 - use specialist vocabulary where appropriate.



J U N 1 0 P H Y A 5 2 A 0 1

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

Section B

The maximum mark for this section is 35 marks. You are advised to spend approximately 50 minutes on this section.

- 1 (a)** Draw a ray diagram for an astronomical refracting telescope in normal adjustment. Your diagram should show the paths of **three** non-axial rays through both lenses. Label the principal foci of the two lenses.

(3 marks)

- 1 (b)** An early form of this telescope was built by Johannes Hevelius. It was 3.7 m long and had an angular magnification of 50. Hevelius used it to help produce one of the earliest maps of the Moon's surface.
- 1 (b) (i)** Calculate the focal lengths of the objective lens and eyepiece lens in an astronomical telescope of length 3.7 m and angular magnification 50.

focal length of objective lens = m

focal length of eyepiece lens = m

(2 marks)



- 1 (b) (ii) The Triesnecker Crater on the Moon has a diameter of 23 km. Calculate the angle subtended by the image of this crater when viewed through a telescope of angular magnification 50 on the Earth.

$$\text{distance from Earth to Moon} = 3.8 \times 10^5 \text{ km}$$

$$\text{angle} = \dots\dots\dots \text{ rad}$$

(2 marks)

- 1 (c) Early refracting telescopes suffered significantly from chromatic aberration. Draw a diagram to show how a single converging lens produces chromatic aberration.

(2 marks)

9

Turn over for the next question

Turn over ►



- 2 Sirius is a binary system consisting of two stars, Sirius A and Sirius B, the properties of which are summarised below.

	Sirius A	Sirius B
absolute magnitude	1.4	11.2
apparent magnitude	-1.4	8.4
diameter / 10^3 km	2400	12
black-body temperature / K	10 000	25 000

- 2 (a) Calculate the distance to Sirius, giving an appropriate unit.

distance =
(3 marks)

- 2 (b) (i) Calculate the ratio

$$\frac{\text{power output of Sirius A}}{\text{power output of Sirius B}}$$

ratio =
(2 marks)



2 (b) (ii) Show that data in the table suggests that one star is about 8000 times brighter than the other.

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(2 marks)

2 (b) (iii) With reference to the spectra of the two stars, explain why the value in part **b (ii)** is much greater than the answer to part **b (i)**.

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(3 marks)

10

Turn over for the next question

Turn over ►



3 The Chandra X-ray Observatory was launched into orbit in 1999. It is used to observe hot and turbulent regions of space.

3 (a) Explain why X-ray telescopes need to be in orbit.

.....
.....

(1 mark)

3 (b) In 2000, the Chandra telescope was used to observe a *black hole* in Ursa Major.

3 (b) (i) Explain what is meant by a black hole.

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(1 mark)

3 (b) (ii) The black hole is believed to have a mass 7 times that of the Sun. Calculate the radius of its event horizon.

$$\text{mass of the Sun} = 2.0 \times 10^{30} \text{ kg}$$

radius = m
(2 marks)

3 (c) Chandra makes use of a charge coupled device (CCD) to detect the X-ray photons. Describe the processes involved in the detection of photons by a CCD.

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(3 marks)

7



4 (b) Measurements of the shift in the 21 cm H1 line in the spectrum of galaxy M84 suggests that it is receding at a velocity of 900 km s^{-1} .

4 (b) (i) Calculate the value of the red shift, z , for this galaxy.

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$z =$
(1 mark)

4 (b) (ii) Calculate the distance to this galaxy.

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distance = Mpc
(2 marks)

9

END OF QUESTIONS

