

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



JUN10PHYA52A01

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
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**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.

.....  
.....  
.....

*(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)**.

.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....

*(3 marks)*

10
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**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.

.....  
.....

(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.

.....  
.....  
.....  
.....  
.....

(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  $900 \text{ km s}^{-1}$ .

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

.....  
.....  
.....

$z =$  .....  
(1 mark)

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

.....  
.....  
.....

distance = ..... Mpc  
(2 marks)

9

**END OF QUESTIONS**

