



Surname \_\_\_\_\_

Other Names \_\_\_\_\_

Centre Number \_\_\_\_\_

Candidate Number \_\_\_\_\_

Candidate Signature \_\_\_\_\_

# A-level PHYSICS

Paper 3      Section B      Astrophysics

## 7408/3BA

Thursday 14 June 2018      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.**

**At the top of the page, write your surname and other names, your centre number, your candidate number and add your signature.**

**[Turn over]**



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**For this paper you must have:**

- a pencil and a ruler
- a scientific calculator
- a Data and Formulae Booklet.

## **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.
- 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**

The Griffith Observatory in Los Angeles includes an astronomical refracting telescope (Griffith telescope) with an objective lens of diameter 305 mm and focal length 5.03 m

**0 1 . 1**

Calculate the wavelength of light for which the Griffith telescope has a minimum angular resolution of  $1.8 \times 10^{-6}$  rad [2 marks]

wavelength = \_\_\_\_\_ m



**01.2** The Griffith telescope is used to observe two point objects which subtend an angle of  $1.8 \times 10^{-6}$  rad at the unaided eye.

The typical human eye has a minimum angular resolution of approximately  $3.2 \times 10^{-4}$  rad

Calculate the focal length of the eyepiece lens so that an observer can just resolve the two objects when observing them through the Griffith telescope. [3 marks]

focal length = \_\_\_\_\_ m

[Turn over]



**0 1 . 3** The asteroid Apophis has a diameter of 325 m

It has been calculated that, in 2029, its distance of closest approach to the Earth's surface will be  $3.0 \times 10^4$  km

The Griffith telescope may be used to view Apophis using the eyepiece calculated in question 01.2

Deduce whether this telescope is suitable to obtain a detailed view of Apophis.  
Support your answer with a calculation.  
[3 marks]





- 0 2 . 1** Sketch, on the axes in FIGURE 1, the black-body radiation curve for a typical star. [2 marks]

**FIGURE 1**

intensity /  
arbitrary units



- 0 2 . 2** Explain, with reference to the SI units involved, how the curve you have drawn can be used to determine the black-body temperature of the star. [3 marks]

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- 0 2 . 3** Two stars, 61 Cygnus A and 61 Cygnus B, can be seen very close together in the constellation Cygnus. Early astronomers were unsure whether the two stars form a binary system, or simply appear in the same line of sight. TABLE 1 shows some of the properties of the two stars.

TABLE 1

	Temperature / K	Radius / km	Apparent magnitude
61 Cygnus A	4500	$4.7 \times 10^5$	5.2
61 Cygnus B	4100	$4.1 \times 10^5$	6.1

Evaluate whether the data support the suggestion that the two stars form a binary system.

In your answer you should

- compare the two stars as seen by an observer on Earth
- support your evaluation with suitable calculations.

[6 marks]

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**0 2 . 4** What is the spectral class of 61 Cygnus A?  
Tick (✓) the correct box. [1 mark]

**A**

**F**

**G**

**K**

<b>12</b>

**[Turn over]**



**0 3 . 1** Describe the links between galaxies, black holes and quasars. [2 marks]

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**03.2** At a distance of  $5.81 \times 10^8$  light year, Markarian-231 is the closest known quasar to the Earth. The red shift  $z$  of Markarian-231 is 0.0415

Use these data to estimate an age, in seconds, of the Universe. [4 marks]

age = \_\_\_\_\_ s

[Turn over]



**0 3 . 3** A typical quasar is believed to be approximately the size of the solar system, with a power output similar to that of a thousand galaxies.

**Estimate, with reference to the inverse-square law, how much further the most distant visible quasar is likely to be compared to the most distant visible galaxy. [3 marks]**

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**END OF QUESTIONS**

<b>6</b>



**There are no questions printed on this page**

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
<b>TOTAL</b>	

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**IB/M/Jun18/LO/7408/3BA/E2**

