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Please write clearly ir	ו block capitals.	
Centre number	Candidate number	]
Surname		_
Forename(s)		_
Candidate signature	I declare this is my own work.	-

# A-level PHYSICS

Paper 3 Section B Astrophysics

## Materials

For this paper you must have:

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

### 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.
- 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.



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.

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



	Section B
	Answer <b>all</b> questions in this section.
01.1	Draw a ray diagram to show how a converging lens can cause spherical aberration. [1 mark]
	principal axis
0 1.2	Draw a labelled ray diagram for an astronomical refracting telescope in normal adjustment. Show <b>three</b> non-axial rays passing through both lenses. Label the principal foci of the lenses. [3 marks]
	[3 marks]
	principal axis



01.3	The James Lick telescope is an astronomical refracting telescope. When in normal adjustment, the distance between the lenses of the telescope is 17.4 m and the angular magnification is 750 Calculate the focal length of the eyepiece lens. [2 marks]	Do not write outside the box
	focal length =m	
01.4	<ul> <li>The James Lick telescope can be used to identify binary stars.</li> <li>Two techniques are available using this telescope: <ul> <li>using a processed image from a CCD, and</li> <li>direct observation using the naked eye.</li> </ul> </li> <li>Compare the use of a CCD with the use of the naked eye to observe binary stars with this telescope. <ul> <li>[3 marks]</li> </ul> </li> </ul>	
		9



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A partic source This line When c as show	in ar spectral line has a wa in the laboratory. e is also present in the abs observed from Earth, the w vn in <b>Table 1</b> .	sorption spectrum of the prin avelength of the prinary sta	en measured from a mary star of U Cephei. ar's absorption line vari	es
	т	able 1		
		Wavelength / nm		
	maximum value	486.498		
	minimum value	485.672		
			Li ina	]
2.3 Show th	nat the orbital speed of the	e primary star is about 250 k	m s <sup>-1</sup> . <b>[3 mar</b> l	ks]
2.3 Show th	nat the orbital speed of the	e primary star is about 250 k	tm s <sup>-1</sup> . [3 marl	ks]
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2.3 Show th	nat the orbital speed of the	e primary star is about 250 k	am s <sup>-1</sup> . [3 mar	ks]



02.4	Calculate the orbital radius of the primary star. [2 marks]
	orbital radius = m
02.5	Which absorption lines would be most prominent in the spectrum of the primary star? Tick ( $\checkmark$ ) <b>one</b> box.
	hydrogen
	hydrogen and helium
	ionised metals
	neutral metals
02.6	A different eclipsing binary star system is thought to consist of a white dwarf star and a neutron star.
	Discuss how astronomers could confirm this. [2 marks]



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Do not write outside the box

0 3 3C 273 was the first quasar to be discovered. IC 1101 is one of the largest galaxies known. Table 2 shows some information about these objects.			
Table 2			
Distance / Mpc	Apparent magnitude	Absolute magnitude	
760	12.8	x	uasar 3C 273
320	14.7	-22.8	laxy IC 1101
[1 mark]	led to its discovery.	roperty of the quasar that	. 1 State the p
t –27	of quasar 3C 273 is abou	the absolute magnitude <b>X</b>	. 2 Show that
	-	-	
[2 marks]			



0 3 3	Assume that the quasar and the galaxy are both viewed from the same d	istance.	Do not write outside the box
	Explain which would be the brighter object.		
	Go on to calculate the ratio $\frac{\text{brightness of brighter object}}{\text{brightness of dimmer object}}$ .	[3 marks]	
	ratio =		
03.4	The black hole at the centre of IC $1101$ has a mass of $7.1\times 10^{11}M_{\rm S}$ where $M_{\rm S}$ is the mass of the Sun.		
	Calculate the average density within the event horizon of the black hole.	[3 marks]	
1	average density =	$kg m^{-3}$	9
		Turn over ►	















Question number	Additional page, if required. Write the question numbers in the left-hand margin.



Do not write outside the box

Question number	Additional page, if required. Write the question numbers in the left-hand margin.



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