Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

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

General Certificate of Education
Advanced Level Examination
June 2012

Physics A PHYA5/2A

Unit 5A Astrophysics
Section B

Monday 18 June 2012 9.00 am to 10.45 am

For this paper you must have:
- a calculator
- a ruler
- a Data and Formulae Booklet (enclosed).

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.
- Show all your working.

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.

Do not write outside the box

Section B

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

1 (a) (i) Draw a ray diagram to show how a converging lens forms a magnified real image of a real object. Label a principal focus on your diagram.

(2 marks)

1 (a) (ii) Draw a ray diagram to show how a converging lens forms a magnified virtual image of a real object. Label a principal focus on your diagram.

(2 marks)

Do not write outside the box

1 (b) (i) A converging lens of focal length 145 mm is used to produce an image of an object placed 112 mm from the lens.
Calculate the image distance. Give your answer to an appropriate number of significant figures.

answer = ... mm
(3 marks)

1 (b) (ii) State **three** properties of the image.

.....

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.....
(1 mark)

8

Turn over for the next question

Do not write outside the box

2 TRAPPIST is a robotic telescope designed to detect exoplanets, which are planets outside our solar system.

2 (a) The charge coupled device (CCD) attached to TRAPPIST has a *quantum efficiency* of 96% for light of wavelength 750 nm.
Explain what is meant by the quantum efficiency of a CCD.

.....

.....

(1 mark)

2 (b) (i) The optical arrangement of the telescope includes an objective mirror of diameter 0.60 m.
Calculate the minimum angular separation of two objects which can be resolved by the telescope for light of wavelength 750 nm.

answer = ... rad

(1 mark)

Do not write outside the box

2 (b) (ii) One of the nearest exoplanets orbits the star Epsilon Eridani, which is 10.5 light years from Earth. The exoplanet has an elliptical orbit, whose orbital radius varies from 1 AU to 5 AU.
Calculate the maximum angular separation of the star and the planet when viewed from a distance of 10.5 light years.

answer = ... rad
(3 marks)

2 (b) (iii) TRAPPIST detects the presence of exoplanets by measuring the reduction in light intensity that occurs as the planet passes in front of the star.
Explain why it is unlikely that the telescope could be used to observe such planets directly.

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(1 mark)

Question 2 continues on the next page

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2 (c) Different types of telescope are used to detect the various parts of the electromagnetic spectrum. Discuss with reference to **three** different parts of the electromagnetic spectrum, the factors which should be taken into account when deciding the siting and size of telescopes.
The quality of your written communication will be assessed in your answer.

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(6 marks)

12

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3 Bellatrix and Betelgeuse are stars in the constellation of Orion. Some of their properties are summarised below.

	Bellatrix	**Betelgeuse**
absolute magnitude	–6.0	–2.7
apparent magnitude	0.4	1.6
black-body temperature / K	22 000	2 400

3 (a) (i) Explain what is meant by absolute magnitude.

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(1 mark)

3 (a) (ii) Which of the two stars is closer to the Earth? Explain your answer.

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(1 mark)

3 (b) (i) Calculate the wavelength of the peak intensity in the black-body radiation curve of Bellatrix.

answer = ... m

(2 marks)

Turn over ▶

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3 (b) (ii) Sketch the black-body radiation curve for Bellatrix. Label the wavelength axis with a suitable scale.



(3 marks)

3 (c) Detailed analysis of the light from both stars reveals the presence of prominent absorption lines in the spectra.

3 (c) (i) To which spectral class does Bellatrix belong?

.....

(1 mark)

3 (c) (ii) Prominent features in the Bellatrix spectrum are the Balmer absorption lines due to hydrogen. State the other element responsible for the prominent absorption lines in the spectrum of Bellatrix.

.....

(1 mark)

3 (c) (iii) Why does the spectrum of Betelgeuse not contain prominent Hydrogen Balmer absorption lines?

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(1 mark)

10

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4 Cygnus A may be the nearest quasar yet discovered.

4 (a) Cygnus A has a redshift, z, of 0.057.
Calculate the distance to Cygnus A. State an appropriate unit.

answer = ... unit = ...

(4 marks)

4 (b) The first quasars were discovered in the 1950s. What property of quasars led to their discovery?

.....

.....

(1 mark)

5

END OF QUESTIONS

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