Please write clearly in block capitals.

Centre number | | | | | | Candidate number | | | | |

Surname _____

Forename(s) _____

Candidate signature _____

A-level PHYSICS A

Unit 5A Astrophysics
Section B

Tuesday 28 June 2016 Morning

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.

Materials

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

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 converging lens of focal length 0.15 m is used as the eyepiece of an astronomical refracting telescope in normal adjustment.

1 (a) The angular magnification of the telescope is 5.0

Calculate the distance between the eyepiece lens and the objective lens of the telescope.

[3 marks]

distance = _____ m

1 (b) A student measures the focal length of the eyepiece lens. She uses it to form an inverted, magnified image of a real object.

1 (b) (i) State **one** other property of the image formed by the lens.

[1 mark]

_____

1 (b) (ii) The image is formed 0.60 m from the lens.
Calculate the object distance.

[2 marks]

object distance = _____ m

Do not write outside the box

1 (b) (iii) Draw a labelled ray diagram to show how the image is formed.
A scale diagram is **not** required.

[3 marks]

1 (c) Further analysis of the lens reveals that the value of its focal length depends on the wavelength of the light used.

What is the name given to the image problem associated with this variation of focal length?
Place a tick (✓) in the right-hand column to show the correct answer.

[1 mark]

	✓ if correct
Rayleigh criterion	
Quantum efficiency	
Chromatic aberration	
Spherical aberration	

10

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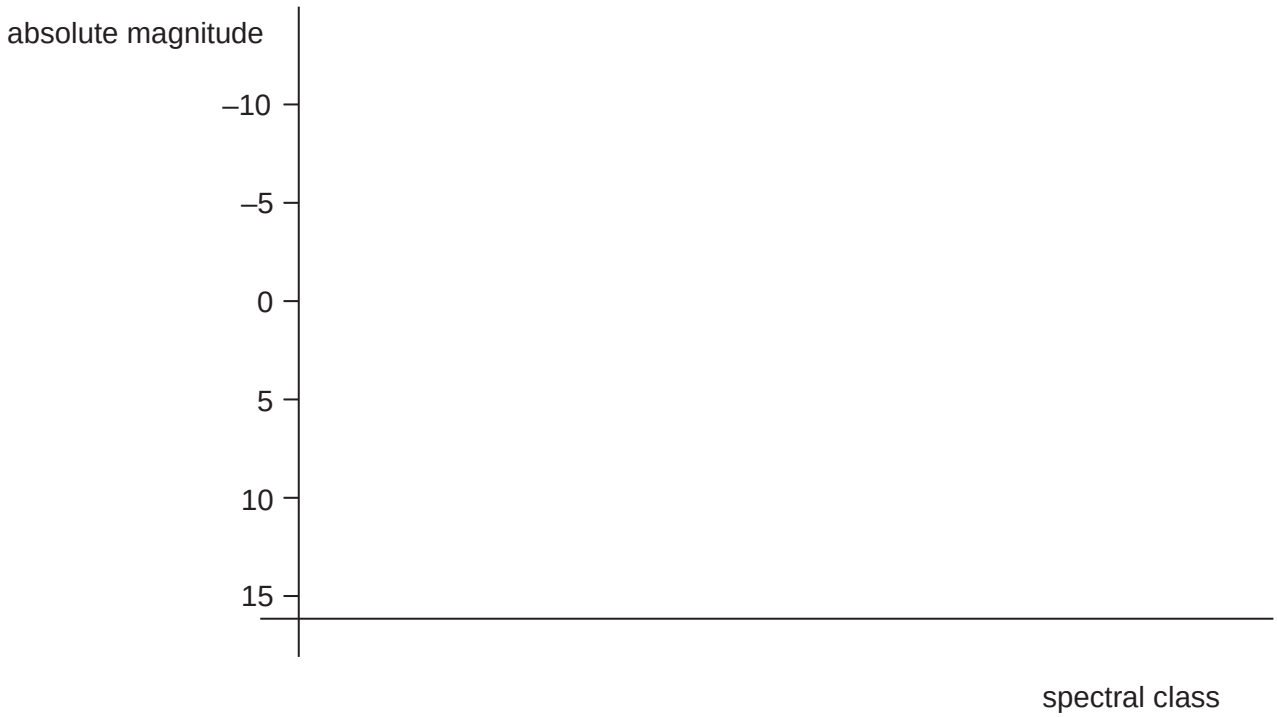
2 (a) **Figure 1** shows the axes of a Hertzsprung–Russell (H–R) diagram.

Figure 1



2 (a) (i) Label the spectral class axis with a suitable scale.

[1 mark]

2 (a) (ii) Complete the H–R diagram by marking the positions of the main sequence, dwarf star and giant star regions.

[2 marks]

2 (b) **Table 1** summarises some of the properties of three stars in the constellation Aries.

Table 1

Star	Apparent magnitude	Temperature / K	Radius / m
Hamal	2.0	4 500	1.0×10^{10}
Sharatan	2.7	9 000	1.8×10^{9}
41 Arietis	3.6	12 000	9.6×10^{10}

Do not write outside the box

2 (b) (i) With reference to the data in **Table 1**, compare the three stars.
Your answer should include a discussion of:

- the appearance to the naked eye of the three stars as seen from Earth
- the spectrum of the three stars
- the region of the Hertzsprung–Russell diagram to which each star belongs.

The quality of your written communication will be assessed in your answer.

[6 marks]

Extra space is available on the next page if needed

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2 (b) (ii) Hamal is 66 light years from the Earth.
Calculate the absolute magnitude of Hamal.

[3 marks]

absolute magnitude = _____

2 (b) (iii) Identify which star is the greatest distance from Earth.
Explain your answer.

[3 marks]

15

Do not write outside the box

3 A charge coupled device (CCD) can be used to capture the image formed by a telescope.

3 (a) Describe the structure of the part of the CCD where the image is formed.

[2 marks]

3 (b) Explain how a CCD builds up a charge pattern that depends on the image formed on it.

[3 marks]

5

Turn over for the next question

Do not write outside the box

4 (a) State which property of the first identified quasar led to its discovery.

[1 mark]

4 (b) 3C48 is a quasar in the constellation Triangulum. It is believed to have a power output 4×10^{11} times greater than that of the Sun. At the Earth, the Sun's intensity is 1.4×10^{17} times greater than that of the quasar.

4 (b) (i) Calculate, using the inverse square law, the distance from Earth to this quasar in AU.

[3 marks]

distance = _____ AU

4 (b) (ii) Measurements of the red shift of the quasar suggest the expansion of the Universe has accelerated since the detected light left the quasar.
State the cause of this acceleration.

[1 mark]

END OF QUESTIONS

5