King's College London

UNIVERSITY OF LONDON

This paper is part of an examination of the College counting towards the award of a degree. Examinations are governed by the College Regulations under the authority of the Academic Board.

B.Sc. EXAMINATION

CP/2620 Astrophysics

Summer 1997

Time allowed: THREE Hours

Candidates should answer SIX parts of SECTION A, and TWO questions from SECTION B.

Separate answer books must be used for each Section of the paper.

The approximate mark for each part of a question is indicated in square brackets.

You must not use your own calculator for this paper.
Where necessary, a College calculator will have been supplied.

TURN OVER WHEN INSTRUCTED

$$
\begin{aligned}
\text{gravitational constant G} &= 6.673 \times 10^{-11} \text{Nm}^2\ \text{kg}^{-2}\ . \\
\text{mass of the Sun } M_\odot &= 1.989 \times 10^{30}\ \text{kg}. \\
\text{radius of the Sun } R_\odot &= 6.96 \times 10^{8}\ \text{m}. \\
\text{one parsec} &= 3.085 \times 10^{16}\ \text{m}. \\
\text{speed of light } c &= 2.997 \times 10^{8}\ \text{m s}^{-1}. \\
\text{elementary charge } e &= 1.602 \times 10^{-19}\ \text{C} \\
\text{electron mass } m_e &= 9.109 \times 10^{-31}\ \text{kg}\ . \\
\text{Planck constant } h &= 6.626 \times 10^{-34}\ \text{J s}\ .
\end{aligned}
$$

SECTION A – Answer SIX parts of this section

1.1) How may a blackbody be constructed? Why is it important in astrophysics?

[7 marks]

1.2) How is a good trigonometrical parallax measured for a star? What is the limit in distance for which this method may be used?

[7 marks]

1.3) Give **one** example where x-ray astronomy has produced a new and interesting result.

[7 marks]

1.4) How is a very weak signal from a pulsar processed to make the period measureable?

[7 marks]

1.5) What is the turn-off point of the Hertzsprung-Russell diagram for a star cluster? Why is it of interest to the understanding of globular clusters?

[7 marks]

1.6) What recent evidence in optical or radio astronomy strongly suggested the existence of massive black holes?

[7 marks]

1.7) What are the advantages of solar neutrino detectors that use gallium compared to those that are based on chlorine?

[7 marks]

1.8) Can the time between the core collapse of a massive star and its explosion as a type II supernova be estimated from theory or from experiment?

[7 marks]

SECTION B – Answer TWO questions

2) Describe the classic Cepheid variable stars. Why are they important for checking the theory of stellar evolution?

[20 marks]

Explain the use of such stars in distance estimates. What are the limitations of this method?

[10 marks]

3) Describe γ-ray bursters. Why are they a puzzle to astrophysicists? Discuss the evidence that γ-ray bursts come from neutron stars.

[20 marks]

Absorption lines in the spectrum of one burster are at 21 keV and 42 keV. Explain why these features suggest a strong magnetic field on the surface of the object that produces the bursts, and estimate this field.

[10 marks]

4) Describe modern designs for optical telescopes. Why would it be impractical to build a telescope of double the size but the same design as the 200 inch telescope on Palomar mountain?

[15 marks]

Describe stellar interferometers and the information that they provide. What are the disadvantages when used in astronomy?

[15 marks]

5) Write an essay on pulsars, concentrating on the observations and what may be deduced directly from them.

[20 marks]

A neutron star whose mass is $1.0M_\odot$ and a white dwarf whose mass is $1.5M_\odot$ are separated by $0.02R_\odot$ and are in binary orbit. Calculate in Joules the gravitational potential energy relative to infinite separation of the stars and the orbital kinetic energy. Newtonian mechanics may be used.

[10 marks]

$$\left[\frac{M_1 v_1^2}{a_1} = \frac{G(M_1\, M_2)}{(a_1 + a_2)^2}\right]$$