

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 2000

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
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$$\begin{aligned}
\text{gravitational constant } G &= 6.673 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2} . \\
\text{mass of the Sun } M_{\odot} &= 1.989 \times 10^{30} \text{ kg} . \\
\text{speed of light } c &= 2.998 \times 10^8 \text{ m s}^{-1} . \\
\text{elementary charge } e &= 1.602 \times 10^{-19} \text{ C} \\
\text{electron mass } m_e &= 9.109 \times 10^{-31} \text{ kg} . \\
\text{Planck constant } h &= 6.626 \times 10^{-34} \text{ J s} .
\end{aligned}$$

SECTION A – Answer SIX parts of this section

- 1.1) Define the luminosity of a star. Define the absolute magnitude of a star and discuss how this quantity may be determined. What quantities are usually plotted in the Hertzsprung-Russell diagram and where on the diagram is the ‘main sequence’?
- [7 marks]
- 1.2) Describe the method of trigonometrical parallax for finding the distance of a star. State *one* other method for finding distances that does not rely on some form of calibration from previously known distances of astronomical objects. (The Sun-Earth distance is known.)
- [7 marks]
- 1.3) What evidence is there that some gamma-ray bursters come from objects in our own Galaxy and some come from cosmological distances? A gamma-ray burster shows a cyclotron resonance absorption line at 28 keV. What is the corresponding magnetic field in Tesla?
- [7 marks]
- 1.4) How may timing measurements of a pulsar be used to find its direction with respect to the Earth’s orbit?
- [7 marks]
- 1.5) What are properties of Cepheid type stars, and why are such stars used in distance measurements?
- [7 marks]
- 1.6) Why are pulsar signals subject to dispersion on their passage to the Earth? What is ‘de-dispersion’ when applied to signals from a pulsar?
- [7 marks]
- 1.7) Why does the Crab Nebula emit strongly polarized light?
- [7 marks]

- 1.8) What is the *observational* distinction between type I and type II supernovae?
[7 marks]

SECTION B – Answer TWO questions

- 2) What may be deduced from the observation of (a) visual binaries, (b) spectroscopic binaries and (c) eclipsing binaries?
[14 marks]

Two objects whose masses are M_1 and M_2 are in binary orbit. Show that

$$4\pi^2 \frac{(a_1 + a_2)^3}{P^2} = G(M_1 + M_2)$$

where a_1 and a_2 are the radii of the circular orbits about the centre of mass and P is the period.

[6 marks]

An x-ray source is located in a binary system. One star whose period is 6.4 days has orbital velocity of 211 km/sec with respect to the centre of mass. Spectroscopic data suggest this star is a red giant whose mass, by comparison with other such stars, is $\approx 1M_\odot$. The light is not eclipsed. The visible light from the other object is a blue glow with no absorption lines. What can be deduced about the mass and nature of this other object?

[10 marks]

You may use

$$\frac{(M_2/M_1)^3}{(1 + M_2/M_1)^2} = \frac{PV^3}{2\pi G M_1 [\sin(i)]^3}$$

where V is the velocity and i is the angle between the plane of the orbit and the plane of the sky.

- 3) Why are neutrinos produced in the interior of the Sun?
[5 marks]

Describe experiments that are being undertaken on Earth to detect neutrinos originating from the Sun, paying attention to the different detection techniques involved.

[18 marks]

What explanation has been given for the discrepancy between the observed neutrino flux and the flux predicted by the Standard Solar Model?

[7 marks]

- 4) Discuss the problems that are associated with the operation of large optical telescopes and describe improvements in design which have been made in an attempt to overcome these problems.

[15 marks]

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

[15 marks]

- 5) Write an essay on Supernovae.

[30 marks]