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/1600 Physical Basis of Astronomy

Summer 1996

Time allowed: 3 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

SECTION A – Answer SIX parts of this section

1.1) Draw a diagram to illustrate the ecliptic over the period of a year. Give also, the approximate equatorial coordinates of the Sun for a date around the 21st December in any year.

[7 marks]

1.2) As viewed from the Earth, the phases of the Moon repeat every 29.5 days, a period known as the synodic month. Calculate the number of days taken by the Moon to orbit the Earth, relative to a fixed point in the celestial sphere. (Hint: Consecutive new moons will occur when the Moon has orbited the Earth and then moved on again to lie between the Earth and the Sun).

[7 marks]

1.3) Draw a labelled diagram to illustrate the shape of our galaxy, the Milky Way and indicate approximately, the position where star clusters may be found.

[7 marks]

1.4) With aid of suitable diagrams, describe the circumstances that give rise to partial, total and annular solar eclipses. Why are lunar eclipses more often observed than solar eclipses?

[7 marks]

1.5) Describe what is meant by the term the 'main sequence' of stars. State the main physical property of a star that governs its relative position on the main sequence and give one reason why the star might leave the main sequence of stars.

[7 marks]

1.6) Calculate the apparent magnitude of a star at a distance of 130 light-years with an absolute magnitude of +12. [Note that 1 parsec is approximately 3.26 light-years.]

[7 marks]

1.7) State the two main sources of energy available to the Sun and explain two mechanisms by which the energy output is regulated.

[7 marks]

1.8) Make a sketch of the black-body radiation curve for the Sun, assumed to be at a surface temperature of 6000^0K. Indicate on your sketch the approximate wavelength of the peak in the spectrum. In which band of the spectrum is most of the energy radiated? State the two quantities that are related by Wien's law.

[7 marks]

SECTION B – Answer TWO questions

2) Define, using diagrams as necessary, the following terms: semi-major axis, eccentricity, perihelion, aphelion, inclination, plane of the ecliptic and astronomical unit, in relation to solar-system planetary orbits.

[10 marks]

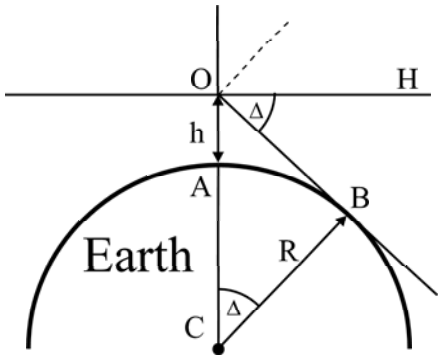
How may the mass of a planet, such as Mars which has a small satellite, be determined.

[10 marks]

Three of the satellite moons of Jupiter: Io, Europa, and Ganymede, orbit the planet at distances of 421,600, 670,900 and 1,070,000 km respectively. Calculate the approximate orbital periods, in days, of the outer two moons if Io has a period of 1.77 days. Assume circular orbits.

[10 marks]

3A) By considering the following diagram and the angles $A\hat{C}B$ and $B\hat{O}H$, or otherwise, show that due to the curvature of the Earth (radius R), the rising and setting times of a star must be adjusted for an observer at O, at a height (h) above sea level, by an amount that is approximately proportional to the square root of this height. What properties of the atmosphere would also affect the apparent rising and setting times of a star to the observer?



[15 marks]

B) On June 14 1987 the equatorial coordinates of Jupiter and the Sun were (1h 27.7m, 7^o $55'$) and (5h 27.1m, 23^o $14'$) respectively. Draw a diagram to show that, for any observer, Jupiter is visible after midnight and before sunrise. Prove this by calculating the local sidereal times of rising and setting of both Jupiter and the Sun for an observer at Greenwich (51^o $27'$ N, 0^o $0'$ W).

[15 marks]

SEE NEXT PAGE

4) Describe the purpose and operation of the "Precision Analogue Photon Address" (PAPA) detector. State the wavelengths over which this type of detector can be used and give physical reasons for any cut-off in response. State the main advantages of the PAPA type detector over that of a "Charge Coupled Device" (CCD) detector.

[15 marks]

Estimate the exposure time to detect 10,000 photons from a star of apparent magnitude +10, imaged by a 2 metre diameter telescope. Assume an overall transmission and detection efficiency of 10% and the use of a filter transmitting in the wavelength range of 450 nm to 650 nm. [Note the accepted figure that a zero magnitude star gives rise to about 10^8 photons per square metre, per second, per nanometer of bandwidth.]

[15 marks]

5) Write short notes on ALL of the following:

(a) White dwarf stars,

[10 marks]

(b) The solar neutrino experiment,

[10 marks]

(c) Quasars.

[10 marks]