Answer THREE questions from Section A and THREE questions from Section B.

You are advised to spend no more than 10 minutes on each Section A answer, and about 30 minutes on each Section B answer.

The numbers in square brackets indicate the provisional allocation of maximum marks for sub–sections of the question.

SECTION A

1. Describe Bohr's model of the hydrogen atom. [4]

   How does it lead to the production of emission and absorption lines? [3]

2. How does the size of the Galaxy compare to the separation between it and its nearest neighbours in the Local Group? [4]

   Briefly describe the sizes of Superclusters and Voids of galaxies. [3]

3. Describe briefly the origins of the system of apparent visual magnitude and its principal properties. [4]

   Why might two stars, having identical intrinsic luminosities, appear to have different apparent visual magnitudes? [3]

4. State the main constituents of the atmosphere of the planet Uranus, and explain what gives it a strong bluish colour when viewed visually with a large telescope. [4]

   Give a brief account of the discovery of the rings of Uranus. [3]

5. Captain Kirk has discovered three small, distant, retrograde moons, in inclined eccentric orbits, with diameters in the range of 10-50 kilometres, orbiting a gas giant planet in the (fictional) Beta Gamma star system. Spock reports that they have surface temperatures of 100, 105, and 103 K and the following densities:

1,200 kg/m^3; 2,800 kg/m^3; 1,900 kg/m^3.

Summarise what he might deduce about the overall composition and origin of these bodies from both the orbital and density information. Use your knowledge of analogous bodies in our own solar system to guide your deductions. [7]

6. Summarise the composition, temperature, and density of the atmosphere of Venus. What is the main constituent of the clouds? [3]

The atmosphere of Earth is very different from that of Venus, being 21% oxygen, 78% nitrogen, 1% argon, plus water vapour and traces of carbon dioxide. Briefly outline current theories that explain why the atmosphere of Venus is so different today from the atmosphere of the Earth, even though the two planets are similar in size and density. [4]

SECTION B

7. List the different regions of the electromagnetic spectrum in terms of their wavelengths. [7]

   Describe the different types of observations of astronomical objects that can be made in different regions of the spectrum. [7]

   Briefly discuss the transmission of radiation through the Earth's atmosphere, stating what processes prevent its transmission in different wavelength regions. [6]

8. Give an account of the structure of our Galaxy, utilising a labelled diagram. [8]

   How are stars at the centre of our Galaxy observed and what is the main problem connected with such observations? [4]

   Galactic structure may be inferred from the motion of stars and gas via the Doppler shift. Provide a brief account of how the Doppler shift works. [4]

   Can all information on the velocity of an object relative to the Earth be found from the Doppler effect, and if not how might we obtain the missing information? [4]

9. Why are observations of binary stars important to astronomers? [4]

   Briefly describe the different ways that visual, spectroscopic and eclipsing binaries may be identified. [12]

   In a binary system one star has a similar luminosity and temperature to the Sun, while the second has three times the radius and is four times hotter. How much more luminous is this star? [4]

10. Write short essays (including diagrams if appropriate) on any TWO (and only two) of the following three topics:

A. The north-south crustal dichotomy of Mars, and recent (2000-2003) evidence for the presence of large amounts of water ice in the soil layers near the surface of Mars. [10]

B. The Kuiper Belt. [10]

C. Comets, addressing their orbital characteristics, their physical structure and appearance as they approach the Sun, and their origin. Diagrams may be used where appropriate. [10]

11. State Kepler's Three Laws of Planetary Motion. [9]

Draw a sketch of the orbit of a comet with $e = 0.7$ (approximately) and label the following: Sun, comet, perihelion, aphelion, semi-major axis a, semi-minor axis b. Which part corresponds to the distance $a(1-e)$? Which part corresponds to $a(1+e)$? Where does the comet have the fastest speed? The slowest? [3]

State Newton's more general form of Kepler's Third Law, using units of astronomical units for distance, years for time, and solar masses for mass. [2]

A binary star is discovered with a period of 22.7 years and a semi-major axis of 12.5 AU. Use this information to calculate the sum of the masses of the two stars. [6]

12. Consider the giant planet Jupiter, and its satellite system, and answer the following questions.

What is the mass of Jupiter, compared to the Earth? What is its composition, and what is its internal structure? Include a brief description of its magnetic field. [8]

Briefly describe Jupiter's atmosphere. [4]

Give an account of three of the Galilean moons: Io, Europa, and Ganymede. Explain why Io has much more internal heating than the other two. Include some mention of their orbital periods and any relationship between them. [8]

ASTRDP11/2004 **END OF PAPER**