Diploma in Astronomy—First Term 2005-6

Solar System: Problem Paper 4.

29 November 2005

Solutions should be returned by Tuesday 13 December. After that date they can be accepted, but once model solutions are posted, they cannot receive credit for marks (but can count towards completion of the course). You can submit via e-mail or by post. The weighting for each question is given in ().

1. Imagine you were part of a team of engineers in charge of landing an astronaut on Venus. The astronaut would have to be able to descend through the atmosphere and then move around on the surface taking samples of rocks, atmosphere, etc. Survival for 24 hours is required, followed by ascent back to an orbiting spacecraft. Your job is to create an environment suit. (Someone else is designing the lander.) List, in a little essay or paragraph, the specific hazardous conditions that exist in the atmosphere or on the surface, and outline what means the environment suit might use to provide protection against them. [200-300 words] (8)

2. The Galilean Moons are said by experts to have a "Laplace resonance" in their periods, close to but not exactly the simple ratio of 1:2:4 for Io (satellite 1), Europa (2) and Ganymede (3) as given in the text.

(a) This part is about using the right number of significant figures in a calculation. If the mean motion n is defined as $n = 360°/\text{Period(days)}$ and $P_1 = 1.769138\,\text{d}$, $P_2 = 3.551181\,\text{d}$, and $P_3 = 7.154553\,\text{d}$, verify to an appropriately correct number of significant figures that the Laplace resonance

$$n_1 - 3n_2 + 2n_3 = 0$$

is indeed precise. (5)

(Show your working, don't just say, "It is verified," without demonstrating it with numbers.)

(b) By what percentage is the 1:2:4 approximate resonance not accurate? For this part, look at the worst case of the three in which the true ratio is not equal to the approximate one. (4)

(c) In Robert A. Heinlein's 1950 science-fiction novel *Farmer in the Sky* about future colonists on Ganymede, the exciting climax of the story occurs when a rare line-up of the Galilean Satellites takes place and all four are in a line on the same side of Jupiter, causing a huge earthquake (or Ganymede-quake) that threatens the survival of the colony. Use information from the lecture on 29th November, and the textbook, and explain why this could never happen. (3)

Total marks possible: 20