Astronomy 3 Homework 4 Solution

February 5, 2009

1. **Based on Table 6.1, a) which planet has the shortest day. b) which planet would you expect to have widely contrasting seasons? why? c) suppose your weight is 100kg, how would it change when you go to Mars or Jupiter?**

   a) Jupiter has the shortest day. b) Uranus has the most widely contrasting seasons because its spin axis is nearly perpendicular to its orbital axis. For half a Uranian year, the northern hemisphere will be continuously exposed to the solar radiation which the southern hemisphere will be in the dark. During the second half of an uranian year, climate in the two hemisphere will swap around. c) The surface gravity on Jupiter is 6.5 times that on Mars and 2.5 times that on the Earth. If my weight is 100kg on the Earth, my weight would be 2.5 times heavier on Jupiter and only 0.38 as much on Mars.

2. **Name three properties which scientists use to classify planets into two populations. What are these two groups?**

   These two groups are terrestrial planets and Jovian planets. In Table 8.2 (p203), the difference in their properties are listed. Terrestrial planets have smaller sizes and masses, higher density, and closer to the sun than the Jovian planets. The terrestrial planets are mostly made of rock and metals with solid surface, whereas the Jovian planets are mostly made of hydrogen and helium gas and have no solid surface.

3. **Name three properties which differentiate between comets and asteroids.**

In the box on p205, major differences between asteroids and comets are listed. Asteroids are mostly made of rocks whereas comets are mostly made of ices. Asteroids' orbits are much closer to the Sun and much less eccentric than comets' orbit.

4. **What are the three important processes which led to the formation of protostellar disks during the collapse of gas clouds into young stars?**

   Before its collapse began, the gas that made up the solar nebula was spread out in clouds over a few light years with very low densities. When they can cool to very low temperature, pressure within the clouds can no longer sustain the attraction of gravity. Clouds rapid shrank in size. During their collapse, temperature within the clouds heat up as particles within them crash into one another, converting kinetic into thermal energy. As the clouds' density increases, their rotation rate increases due to the conservation of angular momentum. When their spin speed approaches that of orbital speed of planets, the clouds flatten into protostellar clouds.

5. **Why is almost every solid surface in our solar system scarred by craters?**

   Terrestrial planets are formed through the cohesive collisions between planetesimals. Asteroids are the rocky leftover of planetesimals. The vast majority of the planetesimals have either been accreted by the terrestrial planets or ejected out of the solar system. The impact craters are the scars left behind when an asteroid or a comet collide with a planetary body or another asteroid. This accretion process continues today even though cataclysmic collisions seldom occur today. The Jovian planets lack impact craters because they lack solid surfaces. Although most impact craters have been eroded by water and wind on earth, there are sufficient number of recent events to leave impact imprints in the form of craters.

6. Describe the four categories of materials in the solar nebula by their condensation properties and abundance. Which ingredients are present in terrestrial planets? In Jovian planets?

   Metal, rock, hydrogen compounds, hydrogen and helium gas. Metal condensed at temperature 1,000-1,600 K in the inner so-

lar system near Mercury. Rocks condensed at a temperature 500-1,300K near the present-day location of Venus, Earth and Mars. The most common material in these terrestrial planets are rocks. Hydrogen compounds such as snow and dry ice condense below 150K. They are accreted onto moons of gas giant planets. The hydrogen and helium gas do not condensed and they are mostly accreted by Jovian planets.

7. Why is it necessary for the solid cores to assemble several earth masses before they can capture nebula gas?

   About 98% of the solar nebula was composed of hydrogen and helium gas while the planetesimals only constitute to a tiny fraction of the disks. In the inner solar system, the small mass of proto terrestrial planets does not provide adequate gravity to pull onto them, the relatively hot nebula gas. In the outer solar system, however, the larger size of planetesimals and cooler gas enables the most massive planetesimals to capture gas and hold the abundant hydrogen and helium gas around them. As they accumulate substantial amounts of gas, the gravity of these growing planets grow larger still, allowing them to capture even more gas.

8. Astronauts collected some lunar rocks to be analyzed in a lab. The result of the analysis indicate the presence of a small amount of uranium 238, which decays into lead with a half life about 4.5 billion years. a) In a rock from the lunar high-land, we find 55original uranium remains while the other 45How old is this rock? b) In a rock from the lunar maria, 63original uranium remains while the other 37this rock older or younger than the highland rocks? by how much?

   According to the discussion in 9.1 (p242), the age of a rock is $t = t_{\text{half}} \times \frac{\log_{10}\left(\frac{\text{currentamount}}{\text{originalamount}}\right)}{\log_{10}\left(\frac{1}{2}\right)}$. For part a) we have $t = 4.5\text{Gyr} \times 0.86 = 3.88\text{Gyr}$.

   For part b) we have $t = 4.5\text{Gyr} \times 0.67 = 3\text{Gyr}$. The rock in the Maria is 0.88 Gyr younger than that from the high land.