Astronomy 3: The Solar System
Homework #6

Assigned February 25, 2010
DUE <u>THURSDAY</u>, March 4, 2010

For problems requiring math you MUST show your work. Box your final answers and please use scientific notation.

1) Titan's exosphere lies nearly 1400 kilometers above its surface.
a. What is the escape velocity from this altitude?
b. What is the thermal speed of a hydrogen atom at the exospheric temperature of about 200 K?
c. Use these answers (and the method of Mathematical Insight 10.2) to comment on whether thermal escape of hydrogen is likely to be important for Titan.

2) Why is Jupiter so much denser than Saturn? Could a planet be smaller in size than Jupiter but greater in mass?

3) Saturn's ring system is more than 270,000 km wide and only a few tens of meters thick; let's assume 50 meters thick for this problem. Assuming the rings could be shrunk down so that their diameter is the width of a dollar bill (6.6 cm),
a. how thick would the rings be?
b. Compare your answer to the actual thickness of a dollar bill (0.01 cm).

4) Io loses about a 1000 kilograms of sulfur dioxide per second to Jupiter's magnetosphere.
a. At this rate, what fraction of its mass would Io lose in 4.5 billion years?
b. Suppose sulfur dioxide currently makes up 1% of Io's mass. When will Io run out of this gas at the current loss rate?

5) Describe the *atmosphere* of Titan. What did the Cassini/Huygens mission learn about Titan's *surface*?

6) Why do we think Triton is a captured moon?

7) It's estimated that there are a million asteroids 1 kilometer across or larger. If the matter from one million asteroids 1 kilometer across were all combined into one spherical object,
a. how big would it be in radius?
b. How many 1-kilometer asteroids would it take to make an object as large as the Earth?

(To calculate the volume of an asteroid, you can assume they're spherical. So is the Earth. The expression for the volume of a sphere is $4/3 \, \pi R^3$)

8) Where is the asteroid belt located, and why? Briefly explain how orbital resonances with Jupiter have affected the asteroid belt.