

ASTR120 Homework #4 – (Hamilton)  
due Thursday Oct. 3 (20 Points)

Finish reading Chapter 7. This is the last graded homework before Exam I on Oct. 8! **These problems are all from Chapter 7.**

23. Figure 7.3 shows the spectrum of Saturn's largest satellite, Titan. Can you think of a way that astronomers can tell which absorption lines are due to Titan's atmosphere and which are due to the atmospheres of the Sun and Earth? Explain.

\*24. (a) Find the mass of a hypothetical spherical asteroid 2 km in diameter and composed of rock with average density  $2500 \text{ kg/m}^3$ . (b) Find the speed required to escape from the surface of this asteroid. (c) A typical jogging speed is 3 m/s. What would happen to an astronaut who decided to go for a jog on this asteroid?

\*25. The hypothetical asteroid described in Question 24 strikes the Earth with a speed of 25 km/s. (a) What is the kinetic energy of the asteroid at the moment of impact? (b) How does this energy compare with that released by a 20-kiloton nuclear weapon, like the device that destroyed Hiroshima, Japan, on August 6, 1945? (Hint: 1 kiloton of TNT releases  $4.2 \times 10^{12}$  joules of energy.) Check your answer to this question with the impact calculator at <http://janus.astro.umd.edu/astro/impact/>. How often does an event like this occur on Earth?

W9. Do problem W9 from <http://www.astro.umd.edu/~hamilton/ASTR120/hw/webexp.html>.

\*26. Suppose a spacecraft landed on Jupiter's moon Europa (see Table 7-2), which moves around Jupiter in an orbit of radius 670,900 km. After collecting samples from the satellite's surface, the spacecraft prepares to return to Earth. (a) Calculate the escape speed from Europa. (b) Calculate the escape speed from Jupiter at the distance of Europa's orbit. (c) In order to begin its homeward journey, the spacecraft must leave Europa with a speed greater than either your answer to (a) or your answer to (b). Explain why.

32. Consider a hypothetical trans-Neptunian object located 100 AU from the Sun. (a) What would be the orbital period (in years) of this object? (b) There are 360 degrees in a circle, and 60 arcminutes in a degree. How long would it take this object to move 1 arcminute across the sky? (c) Trans-Neptunian objects are discovered by looking for "stars" that move on the celestial sphere. Use your answer from part (b) to explain why these discoveries require patience. (d) Discovering trans-Neptunian objects also requires large telescopes equipped with sensitive detectors. Explain why.

33. The surfaces of Mercury, the Moon, and Mars are riddled with craters formed by the impact of space debris. Many of these craters are billions of years old. By contrast, there are only a few conspicuous craters on the Earth's surface, and these are generally less than 500 million years old. What do you suppose explains the difference?

38. Liquid metallic hydrogen is the source of the magnetic fields of Jupiter and Saturn. Explain why liquid metallic hydrogen cannot be the source of the Earth's magnetic field.