PROBLEM SET 14
Physics 2021

1. Consider the Kirkwood gap whose orbital period is one-third of Jupiter's 11.86-year period. Calculate the distance from the Sun to this gap.

2. Assume that Ida's tiny moon Dactyl has a density of 2.7 g/cm^3. (a) Calculate the mass of Dactyl in kilograms. For simplicity, assume that Dactyl is a sphere 1.3 km in diameter. (b) Calculate the escape speed from the surface of Dactyl. If you were an astronaut standing on Dactyl's surface, could you throw a baseball straight up so that it would never come down? Professional baseball pitches can throw at speeds around 40 m/s (140 km/h, or 90 mi/h); your throwing speed is probably at bit less.

3. *Sun-grazing comets* come so close to the Sun that their perihelion distances are essentially zero. Find the orbital periods of Sun-grazing comets whose aphelion distances are (a) 100 AU, (b) 1000 AU, (c) 10,000 AU, and (d) 100,000 AU. Assuming that these comets can survive only one hundred perihelion passages, calculate their lifetimes. (*Hint*: Remember that the semi-major axis of an orbit is one-half the length of the orbit's long axis.)

4. A *very* crude model of a typical comet nucleus is a cube of ice (density 1.0 g/cm^3) that is 10 km on a side. (a) What is the mass of this nucleus? (b) Suppose 1% of the mass of the nucleus evaporates away to form the comet's tail. Suppose further that the tail is 100 million (10^8) km long and 1 million (10^6) km wide. Estimate the average density of the tail (in kg/m^3). (c) In 1910 the Earth actually passed through the tail of Comet Halley. At the time there was some concern among the general public that this could have deleterious effects on human health. Was this concern justified? Why or why not?

5. Most asteroids are located in the asteroid belt that lies between 2.1 and 3.3 AU from the Sun. What orbital periods correspond to the inside and outside of the asteroid belt?

6. What is the orbital period of one of the Trojan asteroids?

7. An Oort Cloud comet has an orbital period of 5.5 million years. What is its average distance from the Sun?