

PROBLEM SET 13

Physics 2021

1. Demonstrate that Rhea obeys Kepler's Third Law.
2. Suppose the orbital period of one moon is exactly five-thirds as long as the orbital period of another. How often would the two moons pass one another as they orbit. Give your answer in terms of the orbital period of the inner moon.
3. Jupiter, its magnetic field, and the charged particles that are trapped in the magnetosphere all rotate together once every 10 hours. Io takes 1.77 days to complete one orbit. Using a diagram, explain why particles from Jupiter's magnetosphere hit Io primarily from behind (that is, on the side of Io that trails as it orbits the planet).
4. Assuming material is ejected from Io into Jupiter's magnetosphere at the rate of 1 ton per second (1000 kg/s), how long will it be before Io loses 15% of its mass? How does your answer compare with the age of the Solar System?
5. Suppose the Earth's Moon were removed and replaced in its orbit by Titan. What changes would you expect to occur in Titan's atmosphere? Would solar eclipses be more or less common as seen from Earth? Explain your answers.
6. (a) Show that the ratio of the orbital periods of Neptune and Pluto is very close to 2:3. (This ratio is thought to result from gravitational interactions between Neptune and Pluto. These interactions prevent Neptune and Pluto from ever getting very close to each other.) (b) Several Kuiper Belt objects have been discovered with the same orbital period and hence the same semimajor axis as Pluto. Explain how these objects, called *Plutinos*, can avoid colliding with Pluto.
7. The brightness of sunlight is inversely proportional to the square of the distance from the Sun. Compare with the brightness of sunlight on the Earth, what is its brightness (a) on Pluto at perihelion and (b) on Pluto at aphelion? (c) How much brighter is it on Pluto at perihelion compare with aphelion? (Even this brightness is quite low. Noon on Pluto is about as dim as it is on Earth a half hour after sunset on a moonless night.)
8. Calculate the maximum angular separation between Pluto and Charon as seen from Earth. (Assume that Pluto is at its minimum distance from the Sun and that Pluto is at opposition as seen from Earth.)
9. Pluto has a temperature of ~ 55 K. Calculate the wavelength at which it is brightest.