

PHY422 Homework Set 12

1. [5 pts] (Goldstein) Evaluate approximately the ratio of mass of the Sun to that of Earth, using only the lengths of the year and of the lunar month (27.3 days), and the mean radii of Earth's orbit (1.49×10^8 km) and of the Moon's orbit (3.8×10^5 km).
2. [5 pts] (Goldstein) At perigee (analog of the perihelion for an orbit around Earth) of an elliptic gravitational orbit a particle experiences an impulse S in the radial direction, sending the particle into another elliptic orbit. Determine the new semimajor axis, eccentricity, and orientation in terms of the old. Note: Use of the Runge-Lenz vector can be beneficial.
3. [5 pts] Johnson 6-5. Consider the effective force on a chunk of mass m_0 , located at the edge of the orbiting body, within the noninertial frame moving at an acceleration consistent with the gravitational potential due to M at the center of the orbiting body. The Roche limit is

$$r < R_M \left(\frac{2 \rho_M}{\rho_m} \right)^{1/3},$$

where R_M is the radius of the central body. Note that electromagnetic forces can keep orbiting bodies together. However, when a body is unstable according to the Roche criterion, it cannot reconstitute itself gravitationally after crumbling such as due to a collision.

4. [5 pts] Johnson 6-7.
5. [5 pts] Johnson 6-10. The form of the force from radiation pressure stems from the fact the momentum of absorbed photons is related to the photon energy with $E = pc$, where c is the speed of light. Likewise, the rate of mass accretion stems from the fact that the energy accrued by the particles in absorbing photons is equivalent to a change in particle mass with $dm = dE/c^2$. The corresponding term in particle acceleration is negligible due to the small magnitude of \dot{r}/c .