

Astronomy 45

Introduction to Astrophysics

Problem Set 6 - Due Friday April 7.

1. What is the height of the tides on the Moon induced by the Earth? The lunar radius is 1738 km.
2. In a visual binary, the stars are $1''$ and $2''$ from the center of mass. The distance is 10 pc and the orbital period is 10 years. The angle $i = 90^\circ$. What are the masses of the stars?
3. a) Two small bodies, each of mass m , lie on a line with a large body of mass M_x . M lies at a distance R from one of the small bodies and a distance $R + d$ from the second. What is d if the gravitational attraction of the small bodies just equals the differential gravitational force caused by their attraction to M ? You may assume that $R \gg d$.
b) A small body of mass m and radius r is falling radially towards M . Treat the small body as consisting of two equal particles separated by a distance d . Within what distance between m and M will the smaller mass be torn apart?
4. A particle starts from rest at an infinite distance from a star of mass M and radius R . The kinetic energy of the particle will be converted to heat and light when it impacts the surface. If the star is a white dwarf with $M = 1 M_\odot$ and $R = 7 \times 10^8$ cm, what is the energy released by 1 g of infalling matter? What fraction is it of the rest mass (mc^2)? If the star were a neutron star with $M = 1.4 M_\odot$ and $R = 10$ km, what would be the energy released? There are sources which emit X-rays with a luminosity of 10^{37} ergs s^{-1} . If this is produced by material pulled from a companion star onto the surface of a neutron star, how much mass must be transferred per second, measured in solar masses? (For $m = 1$ g, $mc^2 = 9 \times 10^{20}$ ergs.)