Astronomy 45

Introduction to Astrophysics

Problem Set 7 - Due Friday November 15.

1. What is the height of the tides on the Moon induced by the Earth? The lunar radius is 1738 km.

2. 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 $R >> d$.

   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?

3. 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.)