ASTR121 Homework #9 - (Hamilton)
due Thursday Apr. 24 (15 Points)

Finishing reading Chapter 22. These problems are from that chapter.

*36. An astronaut flies from the Earth to a distant star at 80% of the speed of light. As measured by the astronaut, the one-way trip takes 15 years. (a) How long does the trip take as measured by an observer on the Earth? (b) What is the distance from the Earth to the star (in light-years) as measured by an Earth observer? As measured by the astronaut?

37. In the binary system of two neutron stars discovered by Hulse and Taylor (Section 22-2), one of the neutron stars is a pulsar. The distance between the two stars varies between 1.1 and 4.8 times the radius of the Sun. The time interval between pulses from the pulsar is not constant: It is greatest when the two stars are closest to each other and least when the two stars are farthest apart. Explain why this is consistent with the gravitational slowing of time (Figure 22-7a).

38. Find the total mass of the neutron star binary system discovered by Hulse and Taylor (Section 22-2), for which the orbital period is 7.75 hours and the average distance between the neutron stars is 2.8 solar radii. Is your result reasonable for a pair of neutron stars? Explain.

42. Long-duration gamma-ray bursters are only observed in galaxies where there is ongoing star formation. Explain how this is consistent with the collapsar model of how these bursters occur.

*46. What is the Schwarzschild radius of a black hole whose mass is that of (a) the Earth, (b) the Sun, (c) the supermassive black hole in NGC 4261 (Section 22-5)? In each case, also calculate what the density would be if the matter were spread uniformly throughout the volume of the event horizon.

*49. Prove that the density of matter needed to produce a black hole is inversely proportional to the square of the mass of the hole. If you wanted to make a black hole from matter compressed to the density of water (1000 kg/m^3), how much mass would you need?