12.400: The Solar System

Problem Set #3

Useful number: $G = 6.67 \times 10^{-11}$ nt m^2 kg^{-2}
Make sure your mass units are in kg, length units in m.
Please show all work *neatly and clearly*. Circle final answer for clarity.

1. Interplanetary Olympics

In the interplanetary Olympics, you are a gold medal contender for the longest measured throw of the javelin. Assuming you throw with a constant speed of 25 meters / second and at an optimum angle for maximum distance:

a. What is the minimum diameter planet where this event should be held so that the judges can make a determination of how far you threw (i.e. it does not escape)?
b. For a planet having this diameter, what is the minimum time it could take for a javelin you throw to circle the planet and strike you in the back? (The velocity doesn't need to equal your maximum of 25 meters / second.)

(Assume an average density for planetary bodies equal to 3000 kg m^{-3})

2. Tidal Forces

Show that the Moon exerts a tidal force on the Earth that is about twice that of the tidal force exerted by the Sun on the Earth.

3. Should We Duck for Cover?

A comet is discovered with the following orbital elements
a=110.0 AU e=0.995 i=89 deg
Ω=180 deg ω=0 deg T=2008 March 21.

a. How close does the comet come to Earth?

b. If Ω=0 deg, how close does the comet come to Earth?

c. What is the comet's velocity at 1 AU?