Physics 167 – Astronomy

Homework #5

Chapter 9

1. It is estimated that there are a million asteroids 1 km across or larger. If one million asteroids 1 km across were all combined into one object, how big would it be? How many 1-km asteroids would it take to make an object as large as Earth? (Hint: Assume the asteroids are spherical.)

2. A relatively small impact crater 20 km in diameter could be made by a comet 2 km in diameter traveling at 30 km/s.
a. Assume that the comet has a total mass of 4.2×10^{12} kg. What is its total kinetic energy?
b. Convert your answer from part (a) to an equivalent in megatons of TNT, the unit used for nuclear bombs. Comment on the degree of devastation such a comet would cause if it struck a populated region of Earth. (One megaton of TNT releases 4.2×10^{15} Joules of energy.)

3. The 5-km asteroid Toutatis passed a mere 1.5 million km from Earth in 2004. Suppose Toutatis were destined to pass somewhere within 1.5 million km of Earth. Calculate the probability that this "somewhere" would have meant that it slammed into Earth. Based on your result, do you think it is fair to call the 2004 passage a "near miss"? Explain. (Hint: You can calculate the probability by considering an imaginary dartboard of radius 1.5 million km in which the bull's-eye has Earth's radius, 6378 km.)

4. It is estimated that there are a trillion comets in the Oort cloud, which extends out to about 50,000 AU. What is the total volume of the Oort cloud, in cubic AU? How much space does each comet have in cubic AU, on average? Take the cube root of the average volume per comet to find the comets' typical spacing in AU. (Hint: For the purpose of this calculation, you can assume the Oort cloud fills the whole sphere out to 50,000 AU.)

5. A few hundred tons of comet dust are added to Earth daily from the millions of meteors that enter our atmosphere. Estimate the time it would take for Earth to get 0.1% heavier at this rate. Is this mass accumulation significant for Earth as a planet? Explain.

6. Suppose that Jupiter had never existed. Describe at least three ways in which our solar system would be different, and clearly explain why.