Physics 5I Introduction to Physics I – HONORS SECTION Fall 2011

Homework #1 – Due Monday October 10 (the next Physics 5I class)

Note: Show all the details of your calculations for each answer.

1. (a) John Harte, a Berkeley professor of both physics and biology, has written two excellent books on estimation, *Consider a Spherical Cow* (1988) and *Consider a Cylindrical Cow* (2001). Estimate how many shoes can be made from a cowhide. (Consider both cows and shoes to be cylindrical.)

(b) Estimate the average spacing between water molecules in liquid water, using the facts that liquid water has a density of 1 g/cm^3 and that18 g of water contains 6.02x10^{23} molecules.

(c) Estimate how many atoms are in your body. (Note that you are mostly made of water. Your body is about 61% oxygen, 23% carbon, 10% hydrogen, and 2.5% nitrogen by mass.)

(d) Estimate how many bodies of your size could fit in the sun.

2. Argon is an inert gas that makes up about 1.28% of air by mass. The atomic weight of argon is 39.95 g/mol, and a mole of an ideal gas has a volume of 22.4 liters (at STP: 0 ºC and 1 atmosphere). An average breath is about 1 liter. Estimate how many argon molecules in Moses's last breath are in your next one. State clearly any assumptions that you have to make to answer this question.

3. Although Galileo's observations disproved the astronomical theory due to Claudius Ptolemy describing how the sun and planets move around the earth, they did not prove that the earth moves around the sun. This was first proved observationally by stellar aberration, the apparent motion of stars about their real locations caused by the earth's motion about the sun. This phenomenon was discovered and explained by the British Astronomer James Bradley about 1725. The amount of stellar aberration is determined by the speed of the earth about the sun (30 km/s) and the speed of light (300,000 km/s). (The speed of light had first been measured by the Danish astronomer Ole Roemer in 1676.) Show that the maximum aberrational displacement of a star is about 20 arcseconds. In what directions in the sky will the effect be maximal? (Hint: this is basically the same as the change in the apparent direction of falling raindrops when you are moving, except for the much higher speed of light.)

4. Giancoli, Chapter 3, Problem 94.

5. Giancoli, Chapter 4, Problem 60.