Physics 206a

Homework Assignment I
due January 12, 2007

There are a few things you should know about homework in this class. Homework will typically be assigned once per week. Unless otherwise stated, all homework will be due one week after the day on which it is assigned. ***Please*** staple your pages together. Juggling two or three hundred pages becomes impossible unless each person's homework exists as a unit. Folding a corner is worse than no staple at all. I will throw away all but the first page of multipage submissions unless stapled appropriately. The grade will be based on the first page only. Also, write your name on your submission--this seems obvious, but I've had *lots* of "mystery homeworks."

The assigned questions will be drawn from the topics being discussed during the time in which the homework is being done by you, so if you don't know how to do a problem on Monday, wait until Wednesday's lecture before worrying.

A premium is placed in this class on reasoning. Even if your answer is wrong, if it is well-reasoned it will earn nearly full-credit. Answers given without the reasoning used to obtain those answers are automatically wrong. This is not a class about facts, it is a class about thinking about facts.

Please do all of the assigned problems, there is a definite relationship between time spent on homework and exam performance. And above all: **DON'T PANIC!** Help can be gotten during office-hours.

Now, back to our show.

This assignment is weird. At first glance it looks like a collection of nonsense and unanswerables. Physics is full of questions which, when first encountered, leave one thinking "how the heck am I supposed to know that?". Physicists are masters of the art of gathering together the little bit that they do know about a situation in order to arrive at some sort of idea about what they don't know about this situation. Problems of the sort found in this assignment are known as "Fermi problems" after Enrico Fermi, one of the great Physicists of the twentieth century. He was very fond of questions such as this since they provide an excellent exercise for the creative and critical reasoning skills so essential to Physicists. To do the assignment, use whatever resources and reasoning seem sensible to you to answer the questions. Be sure to explain how you arrived at your answers. Full explanations, including all reasoning and a statement of all assumptions inherent in your answers, are essential! Answers lacking reasoning or answers with insufficient explanation are, by definition, wrong. Future assignments will consist of more "normal" questions, but the need to explain your reasoning will still apply.

1. Between the M.U.C. and the library is a roughly circular patch of grass surrounding "the Rock" (if you're new here, ask someone, you'll have no trouble finding it). How many blades of grass are in this patch?

2. Assuming that human beings have inhabited the earth for about 1 million (i.e. 10^6) years, estimate the number of generations that have lived since the first humans.

3. How many piano tuners are there in New York City?

4. An atom is approximately 10^{-8} cm in diameter.
   a) What is its approximate volume?
   b) How many would fit in a box of volume 1 cm^3 (that is, "1 cubic centimeter")?
   c) What is your volume in cm^3?
   d) How many atoms can fit in you?

5. How many kernels are on an ear of corn?

6. An atom weighs approximately 10^{-27} kg.
   a) How many atoms are there in you?
   b) Does this number agree with your answer to problem 4, part (d)? If there is a significant difference between the answers, can you think of a reason for the discrepancy?

7. How many dogs are there in the United States? Based on this, estimate:
   a) How many 1 lb. cans of dog food are sold each year?
   b) How much money is spent on dog food each year?

8. How many miles does an average person walk in a lifetime?

9. Compute the following *without* using a calculator:

a) $10^2 \times 10^3$

b) $10^2 \div 10^3$

c) $10^2 + 10^3$

d) $\dfrac{10^{35} \times 10^{80}}{10^{12} \times 10^{-3}}$

e) $\dfrac{(6 \times 10^{23}) \times (1 \times 10^{-19})}{(2 \times 10^3)}$

10.

a) The number googol is defined as 10^{100}. If a sheet of paper can hold 100 lines of 100 characters each, how many lines are needed to write down 1 googol?

b) 1 googolplex is defined as ten to the power googol (i.e. $10^{googol} = 10^{(10^{100})}$). How many sheets of paper would be needed to write down 1 googolplex <u>without</u> using scientific notation?

11. Please look up the following words in a dictionary and make sure you understand them (no need to hand anything in on this one):

a) Paradigm
b) Hypothesis
c) Theory
d) Empirical