ChEg 498X
Climate Change
Homework #1
Due 1/22/04

These are all back of the envelope type calculations. Do them the best you can.

1. It was mentioned in class that growing corn to be fermented into ethanol gives a "negative" energy. That is, it takes more energy to do this than you get back in the form of ethanol. Explore this issue and give quantitative support to your answer about if you agree with this statement.

2. In the book *Global Climate Change* ed. Spray and McGlothlin, David Dobson estimates the total fossil fuel reserves at 4000 GtC (giga-tons of carbon) and the methane gas hydrates, which are frozen in the ocean at 6000-15000 GTC.

a. How much of this total reserve has been burned to date.
b. A more interesting calculation is to figure out if these numbers are even close to being correct. You may know that at some point in the past, the atmosphere of the earth did not have any oxygen. This makes sense because, oxygen is very reactive and everything that is contacted with oxygen oxidzes. Since the earth core is molten iron, there was remaining unoxided material. So where did the oxygen come from? Most of it must have come from carbon fixation, by plants.

$$CO_2 \rightarrow C + O_2$$

is the simplest reaction. It is also possible that some came from carbonate, but still through plant metabolism. So if we look at how much oxygen is present in the atmosphere today, then there must, somewhere, be fixed carbon (much of it fossil fuels) to match the stoichiometry given above.

Do the calculation and find out your estimate of the total fossil fuels that should be present.

3. Arrhenius is known for another result that is used very often in chemistry. It is that chemical rate constants vary with temperature in the following way:

$$K = k0 \, Exp \, (-Ea/kT).$$

For a typical organic reaction that has an activation energy of 25 kcal/mole, you can get a doubling of the rate of reaction with ~10K changes. Given this, explain the difficulty or at least the obvious limitations with having biological energy sources.

4. Look on my web page at the bottom for some dimensionless groups that you have never heard of.

a. Explain the "message" I am trying to convey and the inherent value of dimensionless groups.
b. List 3 accepted dimensionless parameters and explain their meaning.
c. Make up one for each member of your group. Note that we are going for both humor and irony or better yet, something profound. Think of this as political cartoons for those who can't draw!