Chemical Oceanography Problem Set 2
March 10, 2009
Due March 24, 2009

All answers are to be submitted by email to maltabet@umassd.edu either in MS Word or Excel format. I will confirm receipt of your assignment by return email. Deadline for submission is 5 PM on March 24th. Late submission will result in the loss of one point per day from the 10 point total**.** You are strongly encouraged to review the problems early to clarify any questions you might have. Do not wait to the day before to ask for assistance, as there may not be a chance to respond. Use email to ask specific questions so as not to use valuable class time on homework. This problem set is designed to be open book and open notes, but you are expected to work individually to obtain your answers. You should show all your work and clearly delineate how you derived your results where pertinent. This problem set constitutes 10 % of your overall grade. **You are expected to work independently to solve these problems.**

ASSUME MOLINITY UNITS ARE EQUIVALENT TO MOLALITY, AND THAT pH IS DIRECTLY CONVERTED TO [H+]

(1.5) 1. A high altitude saline lake (S=35) has a barometric pressure at its surface of 0.62 atm. What are the concentrations in the lake of N_2, O_2 , and Ar when the lake is equilibrated with atmosphere at a temperature of 5°C? If the surface layer warms quickly to 10°C without gas exchange, what is the measured % O_2 saturation? HINT: start with Table 6.4

(2.5) 2. A. Calculate the concentrations of the carbonate system species in µmole/kg for seawater at 15 ^{O}C and S = 35 at pH 8.2 in equilibrium with a pCO_2 of 380 µatm. What is the total dissolved inorganic carbon concentration and carbonate alkalinity for this solution in µmole/kg? Calculate the saturation state for calcite and aragonite. Is this solution undersaturated or supersaturated with respect aragonite and calcite. HINT: convert pCO2 from µatm to atm to get results in mole/kg, then convert to µmole/kg.

B. By the end of this century, atmospheric pCO_2 is likely to be about 800 µatm. ASSUME: that carbonate alkalinity is the same as in part A and equivalent to total alkalinity. Given surface seawater at equilibrium with this doubling of pCO_2, what are the values for the parameters you calculated in part A? Has the saturation state for aragonite and calcite changed? HINT: calculate for different values of lowered pH until the CA value in part A is matched.

(0.8) 3. Does the alkalinity of water (isolated from its surroundings) increase, decrease or stay the same as small quantities of the following are added? Briefly explain. Assume complete disassociation of ionic compounds.

H_2SO_4 NaOH O_2 $MgCO_3$ $KHCO_3$ CO_2 $Cu(NO_3)_2$ NaCl

(2.0) 4. Explain in terms of chemical equilibria why each of the parameters (except ΔCO_2) listed in Millero Table 7.6 changes (or does not) in the direction indicated as a result of the oxidation of organic matter.

(2.0) 5. Explain in terms of chemical equilibria why each of the parameters (except ΔCO_2) listed in Millero Table 7.7 changes (or does not) in the direction indicated as a result of $CaCO_3$ dissolution.

(1.2) 6. In a brief essay, answer the following questions; What are the carbonate saturation, carbonate compensation, and lysocline depths and why do they vary from each other even at the same location? What set of observations are made to determine each? Describe how carbonate equilibria determines these depths; illustrate with pertinent equation(s) for saturation state and graph(s) of vertical variations. Why do differences in saturation, compensation, and lysocline depths occur between ocean basins? Why and how is increasing atmospheric CO_2 likely to change both calcite production in surface waters and preservation in the sediments.