

Introduction to Chemical Oceanography Problem Set 2B
Posted March 20, 2018
Due March 29, 2018

All answers are to be submitted by email to both maltabet@umassd.edu either in MS Word or Excel format. Deadline for submission is 3 PM on March 29. Late submission will result in the loss of 0.5 point per day from the 5 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. Essays and short answers must be in your own words. You should show all your work and clearly delineate how you derived your results where pertinent. This problem set constitutes 5 % of your overall grade. **You are expected to work independently to solve these problems.**

USE ONLY MOLINITY UNITS AND ASSUME THAT pH IS DIRECTLY CONVERTED TO [H+] AND IS EQUIVALENT TO ITS ACTIVITY

- (1.0) 1. Characterize the changes in atmospheric CO₂ (and their causes) that have occurred over the last 120,000 years. How do we know about them? What are the major arguments and lines of evidence that recent CO₂ changes will lead to increases in Earth' temperature? Include a discussion of the greenhouse effect.
- (2.0) 2. A. Using appropriate equations and pK values from the lecture slides, calculate the concentrations of the carbonate system species in μmole/kg for seawater at 15 °C and S = 35 at pH 8.00 in equilibrium with current atmospheric pCO₂ of 408.4 μatm (<http://co2now.org>). 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. Compare results with those using the Excel calculator "co2sys ver25".
- B. Late this century or early next, atmospheric pCO₂ may reach 1000 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 pCO₂, what are the values for the parameters you calculated in part A? Has the saturation state for aragonite and calcite changed and if so what are the ramifications for ocean biology? HINT: calculate for different values of lowered pH until the Ac value in part A is matched. Compare results with those using the Excel calculator "co2sys ver25" but using instead the same total alkalinity as in part A.

- (1.0) 3. A. Explain in terms of chemical equilibria why each of the parameters (except ΔCO_2) listed in lecture slide Table 7.6 changes (or does not) in the direction indicated as a result of the oxidation of organic matter. Predict and explain the corresponding changes in a water mass as it ages in the ocean's interior.
- (1.0) 4. In a brief essay, answer the following questions; What are the carbonate saturation, carbonate compensation, and lysocline depths, giving examples? Describe how carbonate equilibria determine these depths; illustrate with pertinent equation(s) for saturation state and graph(s) of vertical variations. Why and how is increasing atmospheric CO_2 likely to change both calcite production in surface waters and preservation in the sediments.