

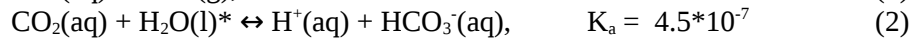
## CE 37200: Environmental Impact Assessment

### Homework 4

### Chapter 5 (chemical reactions)

Due: Mar. 13

CO<sub>2</sub> in the atmosphere can dissolve in the ocean, which can also affect the concentration of carbonate and bicarbonate ions in the ocean water and its acidity. Suppose that the following reactions are relevant:



\*Note: in the chemical equilibrium expressions, take [H<sub>2</sub>O(l)] = 1 (unit activity)

Suppose also that

$$2[\text{CO}_3^{2-}] + [\text{HCO}_3^-] + [\text{OH}^-] - [\text{H}^+] = 2.5 \times 10^{-3} \text{ M} \quad (5)$$

(Oceanographers call this quantity *alkalinity*. It's defined so that reactions 1-4 don't change it.)

(a) Suppose that air at the ocean surface has a pressure of 1 atm and contains 280 ppmv CO<sub>2</sub>. Find the equilibrium concentration in the ocean of all the carbon species (CO<sub>2</sub>(aq), HCO<sub>3</sub><sup>-</sup>(aq), CO<sub>3</sub><sup>2-</sup>(aq)) and the water pH.

(b) Repeat your calculations if the atmosphere CO<sub>2</sub> concentration increases to 400 ppmv.

(c) Give the percentage difference in the equilibrium concentration of each species between (a) and (b).

(d) Consider the reaction



Suppose that [Ca<sup>+2</sup>] in the ocean is 0.0105 M. How much CaCO<sub>3</sub> can precipitate per L ocean water under the CO<sub>3</sub><sup>2-</sup> concentration you found in (a)? What about for (b)? Based on your results, explain why increasing the amount of CO<sub>2</sub> in the atmosphere threatens ocean organisms such as coral. (For more information, look up "ocean acidification").