

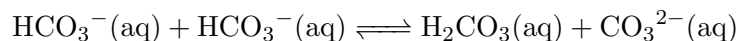
Chapter 7 Challenge Problem Solutions

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- a. The principal equilibrium in a solution of NaHCO_3 is



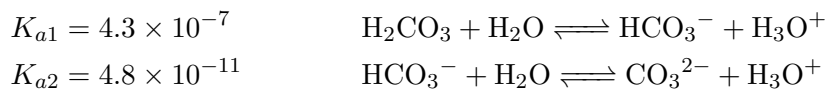
Calculate the value of the equilibrium constant for this reaction.

- b. At equilibrium, what is the relationship between $[\text{H}_2\text{CO}_3]$ and $[\text{CO}_3^{2-}]$?
c. Using the equilibrium



and the result from part b, derive an expression for the pH of the solution in terms of K_{a1} and K_{a2}

Solution: This problem does not initially give information that is necessary to solve the problem. These are the K_{a1} and K_{a2} values for H_2CO_3 , which are instead provided in the appendices of the textbook. The values are as follows



The equilibrium constant (K_{eq}) for the solution is

$$K_{eq} = \frac{[\text{H}_2\text{CO}_3][\text{CO}_3^{2-}]}{[\text{HCO}_3^-]^2}$$

In order to find K_{eq} , we must relate the K_a values, which can be done by separating

the K_{eq} expression into separate parts

$$\begin{aligned}K_{eq} &= \frac{[\text{H}_2\text{CO}_3][\text{CO}_3^{2-}]}{[\text{HCO}_3^-]^2} \\K_{eq} &= \frac{[\text{H}_2\text{CO}_3]}{[\text{HCO}_3^-][\text{H}^+]} \times \frac{[\text{CO}_3^{2-}][\text{H}^+]}{[\text{HCO}_3^-]} \\&= \frac{1}{K_{a2}} \times K_{a2}\end{aligned}$$

Which yields a final answer of

$K_{eq} = 1.1 \times 10^{-4}$
