

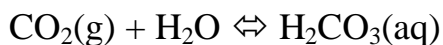
Lecture 13: Acid-Base equilibria (continued)

recall the K_a is the acid dissociation constant (or acidity constant)

Carbonate system – acid-base equilibria

water is naturally acidic due to dissolution of CO_2 gas in water

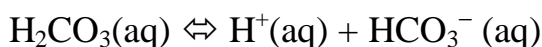
will now calc pH using 2 relevant equil



$$K_H = [\text{H}_2\text{CO}_3]/P_{\text{CO}_2}$$

given conc of $\text{CO}_2 = 360$ ppm (0.00036 atm) and $K_s = 3.2 \times 10^{-2}$ M/atm

$$[\text{H}_2\text{CO}_3] = 1.1 \times 10^{-5} \text{ M}$$



$$K_a = [\text{H}^+][\text{HCO}_3^-]/[\text{H}_2\text{CO}_3]$$

given $K_a = 4.45 \times 10^{-7}$ and $[\text{H}_2\text{CO}_3]$ from above can calc $[\text{H}^+]$:

$$K_a = [\text{H}^+][\text{HCO}_3^-]/[\text{H}_2\text{CO}_3]$$

$$4.45 \times 10^{-7} = x^2/(1.1 \times 10^{-5} \text{ M})$$

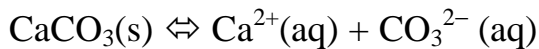
$$[\text{H}^+] = 2.2 \times 10^{-6} \text{ and pH} = 5.65$$

(assuming all other rxns irrelevant)

Carbonate system –equilibria and the solubility product constant (K_{sp})

water dissolves and solvates many inorganic salts, most alkali (Na, K, Cs) and halogen (F, Cl) salts are completely soluble, nearly all others are only slightly soluble

We can calculate the concentration of Ca^{2+} in equilibrium with solid calcite ($CaCO_3(s)$) by assuming all other reactions are irrelevant



$$K_{sp} = [Ca^{2+}][CO_3^{2-}]$$

$$\text{given } K_{sp} = 4.6 \times 10^{-9}$$

$$\text{can calc } [Ca^{2+}] = 6.8 \times 10^{-5} \text{ M}$$

Carbonate system –equilibria and the basicity constant (K_b)

The basicity constant (K_b) is used to describe the reaction of a base (A^-) with water to produce hydroxide ion:

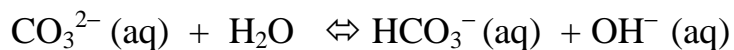


$$K_b = \frac{[HA][OH^-]}{[A^-]} \quad (\text{note we neglect } [H_2O])$$

Important relationship:

$$K_w = K_a K_b = \frac{[H^+][A^-][HA][OH^-]}{[HA][A^-]} = [H^+][OH^-] = 1.00 \times 10^{-14} \quad \text{ALWAYS}$$

Now apply the basicity constant (K_b) to the carbonate system:



$$K_b = \frac{[\text{HCO}_3^{-}][\text{OH}^{-}]}{[\text{CO}_3^{2-}]}$$

$$K_w = K_a K_b = \left(\frac{[\text{H}^{+}][\text{CO}_3^{2-}]}{[\text{HCO}_3^{-}]} \right) \left(\frac{[\text{HCO}_3^{-}][\text{OH}^{-}]}{[\text{CO}_3^{2-}]} \right) = [\text{H}^{+}][\text{OH}^{-}] = 1.00 \times 10^{-14} \text{ ALWAYS}$$

The significance of this relationship is that it relates the acidity and basicity of the acid/base system to the solvent (water).

This relationship can be used as an additional tool for solving more complex equilibria involving many reactions (simultaneous equilibria).