Acid-Base Chemistry: Understanding Ocean Acidification and the Destruction of Coral Reefs

Part 1: What is an Acid?

- Draw a picture representing what you think HCl looks like when it is in water.

- Write two chemical equations that chemists use to represent dissociation of HCl in water.

Write a chemical equation that represents the following strong acids when they are placed in water.

1. HI

2. HNO_3

3. H_2SO_4

Discussion: What is the difference between a strong and weak acid? Use chemical equations to illustrate your thinking.

- Write the chemical equation that represents dissociation of HF in water.

Part 2: What is a base?

- Draw a molecular level picture representing what you think NaOH looks like when it is in water.

- Write the chemical equation that represents dissociation of NaOH in water.

- What about weak bases....how would you represent NH_3 in water with a chemical equation?

- Write the chemical equation that represents the following strong bases when they are placed in water.

1. KOH

2. $Al(OH)_3$

3. $Ca(OH)_2$

Part 3: Bronsted-Lowry Definition of Acids and Bases

							K_c
$HCl(g)$	+	$H_2O(aq)$	$\rightarrow$	$H_3O^+(aq)$	+	$Cl^-(aq)$	2×10^4
$NH_3(aq)$	+	$H_2O(l)$	$\rightleftharpoons$	$NH_4^+(aq)$	+	$OH^-(aq)$	3.3×10^{-7}
$HCN(aq)$	+	$H_2O(l)$	$\rightleftharpoons$	$H_3O^+(aq)$	+	$CN^-(aq)$	1.1×10^{-11}

1. For the third equation above, build a model representing the reaction. Then act out the reaction several times with the models. Finally, draw a molecular level picture representing the reaction and label the acids and bases on your white board.

2. Which chemical species are the Bronsted-Lowry acids and bases in the forward reactions?

3. Is it possible for a substance to act as both and acid and a base? Explain.

4. Which do you think is considered the stronger acid, HCl or HCN? Explain

5. Build and draw this Conjugate acid-base pair: HCO_3^-/CO_3^{2-} and have a discussion about which one is the acid, which one is the base, and why they have the -1 and -2 charges?

6. The following reactions are important environmental processes. Identify the conjugate acid-base pairs.

a. $H_2PO^{4-}(aq) + CO_3^{2-}(aq) \rightleftharpoons HPO_4^{2-}(aq) + HCO_3^{-}(aq)$

b. $H_2O(l) + SO_3^{2-}(aq) \rightleftharpoons OH^{-}(aq) + HSO_3^{-}(aq)$

7. Predict the net direction for each of the following reactions (assume equal initial concentrations of all species):

$$H_2PO_4^{-}(aq) + NH_3(aq) \rightleftharpoons HPO_4^{2-}(aq) + NH_4^{+}(aq)$$

$$H_2O(l) + HS^{-}(aq) \rightleftharpoons OH^{-}(aq) + H_2S(aq)$$

Part 4: Problem Solving

1.

$[H^+]$	pH	pOH	A/B/N
3.0×10^{-4}			
1.0×10^{-7}			
7.3×10^{-3}			

2. The pH of rainwater collected in a certain region of the northeastern United States on a particular day was 4.82. What is the H+ ion concentration of the rainwater?

3. The OH^- ion concentration of a blood sample is 2.5×10^{-7} *M*. What is the pH of the blood?

4. What is the pH of a 0.235 *M* monoprotic acid whose K_a is 5.7×10^{-4}?

5. Phenylacetic acid ($C_6H_5CH_2COOH$, simplified here as HPAc) builds up in the blood of persons with phenylketonuria, an inherited disorder that, if untreated, causes mental retardation and death. A study of the acid shows that the pH of 0.13M HPAc is 2.62. What is the Ka of phenylacetic acid?

6. What is the pH of a 0.500M ethylamine($C_2H_5NH_2$) solution?($K_b = 6.4 \times 10^{-4}$)

7. Ascorbic acid ($H_2C_6H_6O_6$; H_2Asc for this problem), known as vitamin C, is a diprotic acid ($K_{a1} = 1.0x10^{-5}$ and $K_{a2} = 5x10^{-12}$) found in citrus fruit. Calculate [H_2Asc], [$HAsc^-$], [Asc^2], and the pH of 0.050M H_2Asc.

8. Sodium acetate (CH_3COONa, or NaAc for this problem) has applications in photographic development and textile dyeing. What is the pH of 0.25 M NaAc? K_a of acetic acid (HAc) is $1.8x10^{-5}$.

Part 5: Ocean Acidification

1. a. Write the equations that represent the complex equilibrium between CO_2, H_20, HCO_3^- and CO_3^{2-}. Be sure to refer to the articles we've read to make sure you understand these processes.

b. Which of the ions above is decreasing in concentration as the ocean acidifies?

2. Write the equation that represents both the formation and destruction of $CaCO_3$.

3. Explain how an increase in atmospheric CO_2 puts our coral reefs and other sea life in danger. Use the equations above in your discussion.