

CHEM 1202 - Homework # 6

ANSWER KEY

Acids & Bases # 1

Due Nov 14th, 2006 by 2PM

1. (5 pts) What are the pH's for the following solutions?

a) 1 M HI = **0** b) 0.1 M HClO₄ = **1** c) 10 M LiOH = **15**

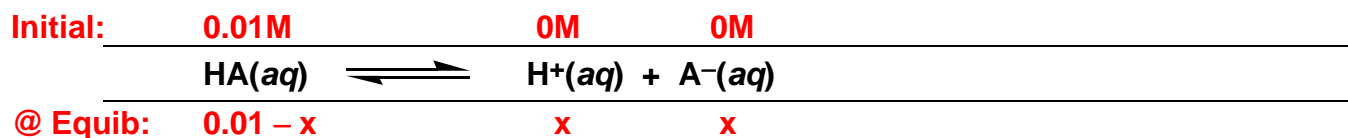
d) 0.001 M NaOH = **11** e) 1×10^{-20} M Ba(OH)₂ = **7**

1×10^{-20} M is much, much lower than the 1×10^{-7} M OH⁻ present in water that it makes no contribution to the pH. It doesn't really matter whether Ba(OH)₂ is a strong or moderate base in this case.

2. (5 pts) Why are strong acids strong acids. Specifically discuss the series HF, HCl, HBr, and HI and why HF is a weak acid and HI is one of the strongest acids known.

Strong acids are strong acids because their conjugate bases (the counter-anions) are extremely weak conjugate bases. The Cl⁻, Br⁻ and I⁻ anions have decreasing affinities for binding H⁺ in aqueous solution (or in the molecular gas phase species for that matter). The larger size of the anions as we go from Cl⁻ to I⁻ means that the negative charge on the anion is spread out over a larger surface area and there is less electrostatic attraction to the H⁺ cation. Remember that the extremely small H⁺ cation has a very concentrated positive charge and will interact the strongest with a small concentrated negative (or multiple negative) charge. The smallest common anion is F⁻, which does have a fairly strong electrostatic attraction to the H⁺ cation, even in water. This makes HF a weak acid compared to HCl, HBr, and HI.

3. (5 pts) Calculate the K_a value of stanoic acid (a monoprotic acid) if a 0.01 M solution has a pH = 4. Clearly show all your work.



BUT, before you go any further, I've given you the pH of the solution in the problem!! So you don't have to solve for x, you already know it!! So all we have to do is take the anti-log of pH 4 to get the concentration of the H⁺ (and A⁻) in solution:

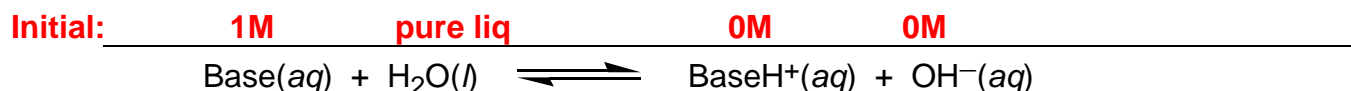
[H⁺] = antilog(-4) = 1×10^{-4} M Substituting this into the equilibrium expression gives us:

$$K_a = \frac{[H^+][OH^-]}{[HA]} = \frac{(1 \times 10^{-4})(1 \times 10^{-4})}{(0.01 - 1 \times 10^{-4})} \approx \frac{1 \times 10^{-8}}{0.01} = 1 \times 10^{-6}$$

Note that we can approximate $0.01 - 1 \times 10^{-4}$ M as ~ 0.01 . So the answer is:

$K_a = 1 \times 10^{-6}$

4. (5 pts) What is the pH of a 1 M solution of the base amyl amine. $K_b = 1 \times 10^{-8}$ Clearly show all your work. Circle the correct answer from those given below. No credit will be given if work is not shown.



Since I was nice and gave you K_b for this basic equilibrium, you can go directly to setting up your equilibrium expression: $K_b = \frac{(x)(x)}{(1-x)} = 1 \times 10^{-8}$

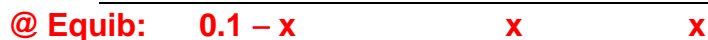
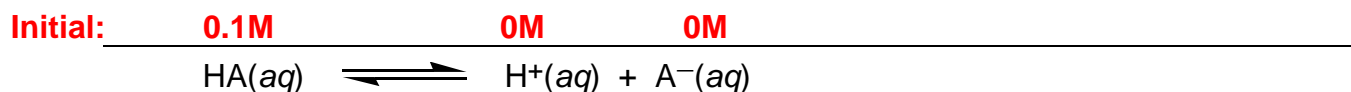
assume that $x \ll 1$, $\frac{(x)(x)}{(1)} = 1 \times 10^{-8}$ or $x^2 = 1 \times 10^{-8}$, or $x = [\text{OH}^-] = 1 \times 10^{-4}$

$\text{pOH} = -\log(1 \times 10^{-4}) = 4$. **BUT THIS IS NOT YOUR ANSWER**, since I asked for the **pH!!**

$\text{pH} = 14 - \text{pOH} = 10$

- a) -2 b) 0 c) 4 d) 7 **e) 10**

5. (5 pts) Calculate the pH of a 0.1 M solution of an acid that has a $\text{p}K_a$ of 5.0. Clearly show all your work. Circle the correct answer from those given below. No credit will be given if work is not shown.



Convert the $\text{p}K_a$ of 5.0 into a K_a value: $K_a = \text{antilog}(-\text{p}K_a) = 1 \times 10^{-5}$ Now, we can set-up and solve for the $[\text{H}^+]$ and the pH.

$$K_a = \frac{(x)(x)}{(0.1-x)} = 1 \times 10^{-5} \quad \text{assume that } x \ll 0.1, \quad \frac{x^2}{(0.1)} = 1 \times 10^{-5}, \quad \text{or } x^2 = 1 \times 10^{-6},$$

or $x = [\text{H}^+] = 1 \times 10^{-3}$ So the $\text{pH} = -\log(1 \times 10^{-3}) = 3$

pH = 3

- a) -1 b) 1 **c) 3** d) 7 e) 11

6. (5 pts) An unknown acid solution has a pH of 5. What important, but simple, piece of information do you need to tell if the solution is a strong or weak acid (aside from the K_a value)?

You need to know the molarity (or concentration) of the solution! The pH by itself only tells you the H^+ concentration, NOT whether the acid it came from is a strong or weak acid. For example, a 1×10^{-6} M solution of HCl has a pH of only 6, which is just barely acidic, but HCl is a strong acid. So unless you know both the pH and concentration of the added acid, you can not directly tell if you are dealing with a strong or weak acid. From the pH and concentration of added acid you can calculate the K_a value, which will tell you if you have a strong, medium or weak acid. Of course, if you have an extremely low pH, like 0 to -1, you have to be dealing with a strong acid since even very concentrated weak acids can't produce that kind of H^+ concentration.