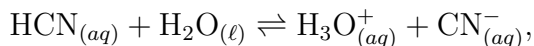


Chemistry 192
Problem Set 3
Spring, 2018

1. Problem 3, page 782, textbook
2. Calculate the pH and pOH of the following solutions of strong acids or bases:
 - (a) 0.0125 M $\text{HCl}_{(aq)}$
Answer: pH=1.903, pOH=12.10
 - (b) 0.0460 M $\text{NaOH}_{(aq)}$
Answer: pOH=1.337, pH=12.66
 - (c) 1.75×10^{-8} M $\text{HCl}_{(aq)}$
Answer: pOH=7.04, pH=6.96
 - (d) 1.75×10^{-8} M $\text{NaOH}_{(aq)}$
Answer: pH=7.04, pOH=6.96
3. Problem 14, page 782, textbook
Answer: pOH=2.297, pH=11.70
4. Problem 19, page 782, textbook
Answer: pOH=3.796, pH=10.20
5. Problem 20, Page 782, textbook
Answer: pOH=1.71, pH=12.29
6. Calculate the volume of a 0.100 M aqueous KOH solution that must be added to 100. ml of a 0.100 M aqueous HCl solution to obtain a solution having a pH=2.000.
Answer: $V=81.8$ mL
7. Given that sodium hydroxide is a strong base, calculate the pH of an aqueous 7.5×10^{-8} M sodium hydroxide solution. **Answer:** 7.16
8. Calculate the pH and percent ionization of a 2.00 M aqueous HCN solution given that for the reaction



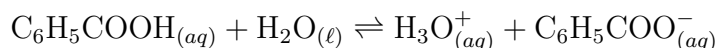
$$K_a = 4.1 \times 10^{-10}.$$

Answer: pH=4.54

9. The pK_a of phenol (C_6H_5OH) when acting as a weak acid in aqueous solution is 9.99. Calculate the pH of a 2.0 M phenol solution.

Answer: pH=4.84

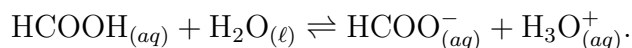
10. When a 0.072 M aqueous solution of benzoic acid reacts



the pH is found to be 2.68. Calculate the pK_a for the reaction.

Answer: $pK_a = 4.20$

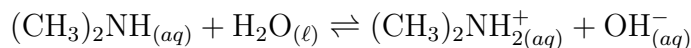
11. Formic acid ($HCOOH$) is a monoprotic acid with acid dissociation reaction



The pH of a 1.20×10^{-3} M formic acid solution is found to be 3.41. Calculate K_a and pK_a for formic acid.

Answer: $pK_a = 3.73$

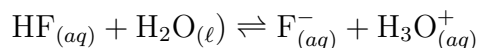
12. Dimethylamine ionizes according to the reaction



A 0.95 M solution of dimethylamine is found to have a pH of 12.32. Calculate the pK_b of the reaction.

Answer: $pK_b = 3.32$

13. Hydrofluoric acid ($HF_{(aq)}$) is formed when gas-phase hydrogen fluoride ($HF_{(g)}$) is dissolved in water according to the reaction

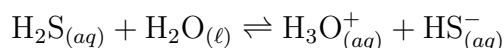


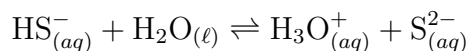
The pK_a of hydrofluoric acid is 3.18. Calculate the pH of a solution that forms when 0.25 grams of gas-phase HF are dissolved in water to make 1.2 L of solution. Approximations do not work for this problem. **Answer:** pH=2.66

14. Ethylamine, $C_2H_5NH_2$, is a weak base in aqueous solution. The pH of a 1.0 M aqueous ethylamine solution is measured to be 12.32. Calculate the pK_b of ethylamine.

Answer: $pK_b=3.35$

15. The two values for the pK_a of hydrosulfuric acid according to the reactions

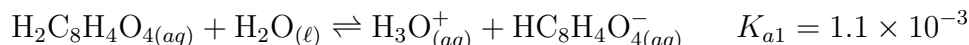




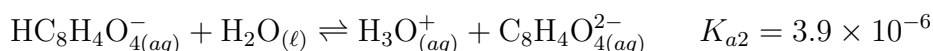
are respectively 7.00 and 19.0. Calculate the concentrations of all species present in a 0.0100 and 0.00100 M aqueous solution of hydrosulfuric acid.

Answer: 0.0100 M $[\text{H}_3\text{O}^+] = [\text{HS}^-] = 3.16 \times 10^{-5}$, $[\text{H}_2\text{S}] = 0.0100$ M, $[\text{S}^{2-}] = 1.00 \times 10^{-19}$

16. When phthalic acid combines with water, two equilibrium reactions occur



and



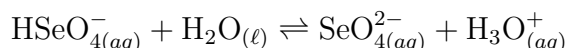
Calculate the pH and concentrations of all species present in a 0.010 M phthalic acid solution.

Answer: pH=2.55, $3.9 \times 10^{-6} = [\text{C}_8\text{H}_4\text{O}_4^{2-}]$

17. Germanic acid (H_2GeO_3) is a diprotic acid with $\text{p}K_a$'s for the two protons in aqueous solution given by $\text{p}K_{a,1} = 9.01$ and $\text{p}K_{a,2} = 12.30$. Calculate the equilibrium concentrations of HGeO_3^- , GeO_3^{2-} and H_3O^+ and the pH for a 1.50 M aqueous solution of germanic acid. Approximations work for this problem.

Answer: pH=4.42, $[\text{HGeO}_3^-] = 3.8 \times 10^{-5}$ M, $[\text{GeO}_3^{2-}] = 5.0 \times 10^{-13}$ M

18. Selenic acid (H_2SeO_4) is a diprotic acid. Like sulfuric acid, the first proton is essentially 100% ionized in aqueous solution. The second proton dissociates according to the reaction



with a $\text{p}K_a = 1.92$. Consider a 0.10 M solution of selenic acid. Calculate the equilibrium concentrations of HSeO_4^- and SeO_4^{2-} , and the pH of the solution at equilibrium. Approximations work for the dissociation equilibrium.

Answer: $[\text{SeO}_4^{2-}] = 1.2 \times 10^{-2}$ M, $[\text{HSeO}_4^-] = 0.10$ M (to two significant figures), $[\text{H}_3\text{O}^+] = 0.11$ M, pH=0.96