Chem 10123, Quiz 4 **Answer Key**
February 19, 2020

1. (9 points) Indicate whether each of the following aqueous solutions is acidic (A), basic (B), or neutral (N). Also, for each solution, write a ***complete, balanced net-ionic equation*** for the major ***equilibrium*** reaction that is occurring in solution.

B $NaBrO_{(aq)}$ $BrO^-_{(aq)} + H_2O \rightleftharpoons HBrO_{(aq)} + OH^-_{(aq)}$

A $(NH_4)_2SO_{4(aq)}$ $NH_4^+{}_{(aq)} + H_2O \rightleftharpoons NH_{3(aq)} + H_3O^+_{(aq)}$

B $C_6H_5N_{(aq)}$ $C_6H_5N_{(aq)} + H_2O \rightleftharpoons C_6H_5NH^+_{(aq)} + OH^-_{(aq)}$

2. A certain solution (call it Solution **A**) is prepared by adding 25.0 g of sodium benzoate "NaA" to 250.0 mL of 1.00 M benzoic acid "HA" ($K_a = 6.50 \times 10^{-5}$) and then diluting to a total volume of 1.00 L. (molar masses: NaA = 144.1, HA = 122.1)

(a) (6 points) **SHOW ALL WORK.** Determine the pH of solution **A**. Include the important ***equilibrium*** reaction. (For benzoic acid, use HA for simplicity.)

(25.0 g NaA) (1 mole / 144.1 g) = 0.173 mole NaA = 0.173 mole A^-

(250 mL) (1.00 mole HA / 1000 mL) = 0.250 mole HA Buffer Solution!

$HA \rightleftharpoons H^+ + A^-$ $K_a = [H^+][A^-] / [HA] = 6.50 \times 10^{-5}$

$[H^+] = K_a [HA] / [A^-] = K_a$ (mole HA) / (mole A^-)

$[H^+] = (6.50 \times 10^{-5})(0.250 \text{ mole}) / (0.173 \text{ mole}) = 9.393 \times 10^{-5}$ M

$pH = -\log(9.393 \times 10^{-5}) = 4.03$

(b) (6 points) **SHOW ALL WORK.** Suppose that 20.0 mL of 5.00 M KOH is added to solution **A**. Write a ***balanced, net-ionic equation*** for any reaction that occurs upon mixing and determine the pH of the final solution.

(20.0 mL) (5.00 mole OH^- / 1000 mL) = 0.100 mole OH^- added

$HA + OH^- \longrightarrow H_2O + A^-$ (neutralization occurs on mixing)

0.250	0.100 moles		0.173 moles
- 0.100	- 0.100		+ 0.100
0.150	0		0.273 (still a buffer solution!)

$[H^+] = K_a [HA] / [A^-] = K_a$ (mole HA) / (mole A^-)

$[H^+] = (6.50 \times 10^{-5})(0.150 \text{ mole}) / (0.273 \text{ mole}) = 3.571 \times 10^{-5}$

$pH = -\log(3.571 \times 10^{-5}) = 4.45$ (pH only slightly higher after 40 % of HA consumed!)