CHEM 131 **Name** ____

Quiz 7 – October 30, 2019

Complete the following problems. Write your final answers in the blanks provided. You must show your work to receive full credit. Show your answers to the correct number of significant figures with the correct units.

1. Calculate the pH and pOH of an aqueous solution that is 0.0100 M HNO_3, 0.0150 M HCl and 0.0125 M H_2SO_4. Assume all of the solutes are strong acids. (8 points)

We have three sources of H^+ in solution, so the total $[H^+]$ must be the sum of the conrtributions from all three sources: $[H^+]_{total} = [H^+]_{HNO3} + [H^+]_{HCl} + [H^+]_{H2SO4}$

These are all strong acids, so each of the dissociation reaction goes to completion. Given that:

$$[H^+]_{HNO3} = \frac{0.0100 \text{ mol } HNO_3}{1 \text{ L}} \times \frac{1 \text{ mol } H^+}{1 \text{ mol } HNO_3} = 0.0100 \text{ M}$$

$$[H^+]_{HCl} = \frac{0.0150 \text{ mol HCl}}{1 \text{ L}} \times \frac{1 \text{ mol } H^+}{1 \text{ mol HCl}} = 0.0150 \text{ M}$$

$$[H^+]_{H2SO4} = \frac{0.0125 \text{ mol } H_2SO_4}{1 \text{ L}} \times \frac{2 \text{ mol } H^+}{1 \text{ mol } H_2SO_4} = 0.0250 \text{ M}$$

$$[H^+]_{total} = 0.0100 \text{ M} + 0.0150 \text{ M} + 0.0250 \text{ M} = 0.0500 \text{ M}$$

$$pH = -\log[H^+]_{total} = -\log(0.0500 \text{ M}) = 1.30$$

$$pOH = 14 – pH = 12.70$$

Answer_____pH = 1.30 pOH = 12.70_______

2. Methylamine (CH_3NH_2), is a monobasic weak base, which can accept a proton from water to form the methylammonium ion ($CH_2NH_3^+$) and hydroxide. If the pH of a 0.00250 M solution of methylamine is 10.92, what is the K_b for methylamine? (8 points)

	CH_3NH_2	+	H_2O	$\rightleftharpoons$	$CH_2NH_3^+$	+	OH^-
I	0.00250		--		0		0
C	-x		--		+x		+x
E	0.00250-x		--		x		x

$$K_b = \frac{[OH^-][CH_2NH_3^+]}{[CH_2NH_2]} = \frac{(x)(x)}{0.00250-x}$$

Since we are given pH, we can calculate the $[OH^-]$, which is x in our K_b expression:

$$pOH = 14 – pH = 3.08$$

$$[OH^-] = 10^{-pOH} = 10^{-3.08} = 8.318 \times 10^{-4} \text{M} = x$$

Inserting this for x in our K_b expression gives

$$K_b = \frac{[OH^-][CH_2NH_3^+]}{[CH_2NH_2]} = \frac{(8.318 \times 10^{-4})^2}{0.00250-8.318 \times 10^{-4}} = 4.15 \times 10^{-4}$$

Answer_____K_b = 4.15 x 10^{-4}_________________

3. Nitrous acid (HNO_2) is a monoprotic weak acid with a pK_a of 3.15. What is the pH of a 0.035M solution of nitrous acid? (8 points)

$$K_a = 10^{-pKa} = 10^{-3.15} = 7.08 \times 10^{-4}$$

	HNO_2	$\rightleftharpoons$ H^+	+ NO_2^-
I	0.0350	0	0
C	-x	+x	+x
E	0.0350-x	x	x

$$K_a = \frac{[H^+][NO_2^-]}{[HNO_2]} = \frac{(x)(x)}{0.0350-x}$$

$$K_a\,(0.0350 - x) = x^2$$
$$0.0350K_a - xK_a = x^2$$
$$x^2 + xK_a - 0.0350K_a = 0$$

Solving the quadratic gives $x = 4.64 \times 10^{-3}$ or -5.35×10^{-3}. Since a negative concentration doesn't make any chemical sense, the reasonable result is $x = [H^+] = 4.64 \times 10^{-3}$M

$$pH = -\log(4.64 \times 10^{-3}M) = 2.33$$

You may attempt to simplify the calculation by assuming x<<0.0350 so that $0.0350 - x \approx 0.0350$. In doing so, the math becomes:

$$[H^+] = (0.0350K_a)^{1/2} = 0.00498\ M.$$
$$pH = 2.30$$

In this case the assumption isn't very good since 0.0350 – 0.00498 = 0.0300 which is significantly different than 0.0350!

Answer_________pH = 2.33_____________

+1 free point to make 25

$pH + pOH = 14$ $\quad$ $K_aK_b = K_w = 1.00 \times 10^{-14}$ $\quad$ $x = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a}$