CHEM 131 Quiz 7 – October 30, 2019

Name _____

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 HNO₃, 0.0150 M HCl and 0.0125 M H₂SO₄. 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 contributions from all three sources: $[H^+]_{total} = [H^+]_{HNO3} + [H^+]_{HC1} + [H^+]_{H2SO4}$

These are all strong acids, so each of the dissociation reaction goes to completion. Given that: $[H^{+}]_{HNO3} = \frac{0.0100 \text{ mol } \text{HNO}_3}{1 \text{ L}} \times \frac{1 \text{ mol } \text{H}^+}{1 \text{ mol } \text{HNO}_3} = 0.0100 \text{ M}$ $[H^{+}]_{HC1} = \frac{0.0150 \text{ mol } \text{HC1}}{1 \text{ L}} \times \frac{1 \text{ mol } \text{H}^+}{1 \text{ mol } \text{HC1}} = 0.0150 \text{ M}$ $[H^{+}]_{H2SO4} = \frac{0.0125 \text{ mol } \text{H}_2\text{SO}_4}{1 \text{ L}} \times \frac{2 \text{ mol } \text{H}^+}{1 \text{ mol } \text{H}_2\text{SO}_4} = 0.0250 \text{ M}$ $[H^{+}]_{\text{total}} = 0.0100 \text{ M} + 0.0150 \text{ M} + 0.0250 \text{ M} = 0.0500 \text{ M}$ $pH = -\log[H^+]_{\text{total}} = -\log(0.0500 \text{ M}) = 1.30$ pOH = 14 - pH = 12.70

Answer____pH = 1.30 pOH = 12.70____

2. Methylamine (CH₃NH₂), is a monobasic weak base, which can accept a proton from water to form the methylammonium ion (CH₂NH₃⁺) 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	⇒	$CH_2NH_3^+$	+	OH					
Ι	0.00250				0		0	K _b	=	$[OH^{-}][CH_2NH_3^{+}]$	=	(x)(x)
С	-X				+x		+x			[CH ₂ NH ₂]		0.00250-x
E	0.00250-x				Х		Х					

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

$$pOH = 14 - pH = 3.08$$

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

Inserting this for x in our K_b expression gives

$$K_{b} = \underline{[OH^{-}][CH_{2}NH_{3}^{+}]}_{[CH_{2}NH_{2}]} = \underline{(8.318 \times 10^{-4})^{2}}_{0.00250 - 8.318 \times 10^{-4}} = 4.15 \times 10^{-4}$$

Answer____K_b = 4.15×10^{-4} _____

3. Nitrous acid (HNO₂) 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)

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

 HNO_2 \Rightarrow H⁺ + NO₂⁻ Ι 0.0350 0 0 $K_a = [H^+][NO_2^-] = (x)(x)$ С [HNO₂] 0.0350-x -X +x +x E 0.0350-x Х Х

$$K_{a} (0.0350 - x) = x^{2}$$

$$0.0350K_{a} - xK_{a} = x^{2}$$

$$x^{2} + xK_{a} - 0.0350K_{a} = 0$$

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 $x \le 0.0350$ so that $0.0350 \cdot x \approx 0.0350$. In doing so, the math becomes:

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

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!

	Answ								nswer	rpH = 2.33											
+1 free point to make 25																					
pH + pOH = 14						$K_a K_b = K_w = 1.00 \text{ x } 10^{-14}$									$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$						
	P11	pon	11		$\mathbf{x}_{\mathbf{a}}\mathbf{x}_{\mathbf{b}} = \mathbf{x}_{\mathbf{W}} = 1.00 \times 10$								^ – <u>2a</u>								
IA																	VIIIA				
1A 1	1	Periodic Table of the Elements																			
Hydrogen	2 IIA	13 14 15 16 17 🕇														He					
1.008 3	2A											3A 5	4A	5A	6A 8	7A 9	4.003				
Li	Be											Boron	Carbon	Nitrogen	O Oxygen	Fluorine	Neon				
6.941	9.012											10.811 13	12.011 14	14.007	15.999 16	18.998	20.180				
Na	Mg	3	4	5	6	7	8	9	10	11	12	A	Si	P	S	CI	Ar				
Sodium 22.990	24.305	ШВ 3В	IVB 4B	VB 58	VIB 6B	VIIB 7B	\checkmark	VIII — 8	7	IB 1B	ШВ 2В	Aluminum 26.982	Silicon 28.086	Phosphorus 30.974	Sulfur 32.066	Chlorine 35.453	Argon 39.948				
¹⁹ K	²⁰ Ca	²¹ Sc	²² Ti	²³ V	²⁴ Cr	²⁵ Mn	Fe	²⁷ Co	28 Ni	29 Cu	³⁰ Zn	Ga	³² Ge	33 As	³⁴ Se	³⁵ Br	³⁶ Kr				
Potassium 39.098	Calcium 40.078	Scandium 44.956	Titanium 47,867	Vanadium 50.942	Chromium 51.996	Manganese 54.938	Iron 55.845	Cobalt 58.933	Nickel 58.693	Copper 63.546	Zinc 65.38	Gallium 69.723	Germanium 72.631	Arsenic 74.922	Selenium 78.971	Bromine 79.904	Krypton 83.798				
37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54				
Rubidium	Sr	Yttrium	Zr	Niobium	Mo	TC	Ru	Rhodium	Palladium	Ag	Cd	Indium	Sn	Sb	Tellurium	I	Xe				
85.468	87.62	88.906	91.224 72	92.906	95.95 74	98.907 75	101.07 76	102.906	106.42	107.868	112.414 80	114.818 81	118.711 82	121.760 83	127.6 84	126.904 85	131.294 86				
Ĉs	Ba	57-71	["] Hf	҄Та	ŴW	Re	Ös	″ Ir	^{''} Pt	Âu	Hg	ŮТΙ	^{°°} Pb	Bi	Po	Åt	Rn				
Cesium 132.905	Barium 137.328		Hafnium 178.49	Tantalum 180.948	Tungsten 183.84	Rhenium 186.207	Osmium 190.23	Iridium 192.217	Platinum 195.085	Gold 196.967	Mercury 200.592	Thallium 204.383	Lead 207.2	Bismuth 208.980	Polonium [208.982]	Astatine 209.987	Radon 222.018				
⁸⁷ Fr	* Ra	89-103	104 Rf	105 Db	106 Sa	¹⁰⁷ Bh	¹⁰⁸ Hs	¹⁰⁹ Mt	110 Ds	111 P a	¹¹² Cn	¹¹³ Nh	¹¹⁴ FI	¹¹⁵ Mc	116 LV	¹¹⁷ Ts	118 O C				
Francium 223.020	Radium 226.025		Rutherfordium [261]	Dubnium [262]	Seaborgium [266]	Bohrium [264]	Hassium [269]	Meitnerium [278]	Darmstadtium [281]	Roentgenium [280]	Copernicium [285]	Nihonium [286]	Flerovium [289]	Moscovium [289]	LV Livermorium [293]	Tennessine [294]	Oganesson [294]				
57 58 59 60 61 62 63 64 65 66 67 68 69 70 71																					
Lanthanide Series			thanum Ce	rium Prase	odymium Neod	ymium Prom	ethium San	narium Euro	opium Gad	olinium Te	rbium Dysp	orosium Hol	lmium Er	bium Th	ulium Ytte	rbium Lut	_U tetium				
			140 140 90	0.116 14 91	0.908 14 92	i.243 14 93	4.913 15 94	50.36 15 95	1.964 19 96	57.25 15 97	58.925 16 98	2.500 16 99	4.930 16 100	7.259 16 101	8.934 17 102	3.055 17 103	74.967				
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