Chem 131 **Name**_____
Exam 3, Ch 13, 16-17.2 **November 6, 2019**
100 Points

Please follow the instructions for each section of the exam. Show your work on all mathematical problems. Provide answers with the correct units and significant figures. Be concise in your answers to discussion questions.

Part 0: Complete all of problems 1-5

1. You have prepared a buffer solution at pH = 4.00. If you take 100 mL of this solution and dilute it to 200 mL with distilled water, what will be the pH of the new solution? (4 points)

   a. Greater than 4.00
   b. Less than 4.00
   c. 4.00
   d. Thursday

   Answer _____

2. The conjugate acid of HPO_4^{2-} is _____. (4 points)

   a. H_3PO_4
   b. $H_2PO_4^-$
   c. PO_4^{3-}
   d. H_3O^+

   Answer _____

3. The effect of adding 0.001 mol KOH to 1.00 L of a solution that is 0.10 M NH_3 and 0.10 M NH_4Cl is to (4 points)

   a. Raise the pH very slightly
   b. Lower the pH very slightly
   c. Raise the pH by several units
   d. Lower the pH by several units

   Answer _____

4. Write one **charge balance** and one **mass balance** expression for a solution that is 0.10 M NaOH, 0.14 M KOH, 0.10 M NaCl and 0.12 M $Ba(OH)_2$. All of the solutes are strong electrolytes. (8 points)

   Charge Balance:

   Mass Balance:

5. Define **three (3)** of the following in one or two sentences each. (6 points)

   a. amphiprotic

   b. van't Hoff factor

   c. molality

   d. diprotic acid

Part I: Complete four (4) of problems 6-10. 10 points each.

6. What is the pH of a solution that contains the strong electrolytes 0.100 M NaOH, 0.140 M KOH, 0.100 M NaCl and 0.115 M $Ba(OH)_2$?

Sapling 16-6, Quiz 7-1

7. Vitamin B_2, riboflavin, is soluble in water. If 0.833 g of riboflavin is dissolved in 18.1 g H_2O, the resulting solution has a freezing point of -0.227°C. What is the molar mass of riboflavin?

Sapling 13-16

8. 50.00 mL of 0.0188 M HCl(aq) is mixed with 75.00 mL of 0.0112 M NaOH(aq). What is the pH of the final solution?

Sapling 16-6

9. In the lab you need to prepare at least 100.0 mL of the following solutions. **Select one of the solutions below** and explain how you would prepare the solution, giving amounts (masses and volumes) of material needed.
   a. 25% NaOH by mass in CH_3OH (density = 0.79 g/mL)
   b. 0.10 mole fraction of $C_6H_{12}O_6$ (molar mass 180.16 g/mol) in water.
   c. 200.0 ppm K^+ in water, using KCl as your source of K^+ (density = 1.00 g/mL)

Sapling 13-1 to 13-5

10. A buffer solution is prepared by dissolving 0.150 moles of hydrofluoric acid ($K_a = 6.30 \times 10^{-4}$) and 0.200 moles of sodium fluoride in 0.500 L of solution.
    a. What is the pH of this buffer? (4 points)

Sapling 17-3, 17-5

Answer_____

    b. What will be the new pH after 25.00 mL of 2.087 M NaOH is added to this buffer solution? (6 points)

Sapling 17-3, 17-5

Answer_____

Part II. Answer three (3) of problems 9-13. Clearly mark the problems you do not want graded. 12 points each.

11. Some ethylene glycol ($C_2H_6O_2$, molar mass 62.07 g/mol) is added to your car's cooling system along with 5.0 kg of water.
    a. If the freezing point of this water-glycol solution is -15.0° C, how many grams of ethylene glycol must have been added?

Sapling 13-17 to 13-17

Answer_____

    b. What is the boiling point of the solution?

Sapling 13-17 to 13-17

Answer_____

12. I've given you the task of preparing a pH 4.75 buffer. You've sought the help of a few of your classmates and have narrowed your choices down to the following list. *Each of these combinations should produce a buffer with pH=4.75.* **Which student's suggestion would provide the best choice to make the highest capacity buffer?** Justify your reasoning by identifying benefits of the "best" choice and the shortcomings of the two unfavorable choices.

Student	Buffer Composition	K_a of weak acid
Annie Yun	0.200M salicylic acid and 0.0032 M sodium salicylate	1.1×10^{-3}
Ty Trate	0.010 M acetic acid and 0.010 M sodium acetate	1.8×10^{-5}
Chris Talls	0.200 M acetic acid and 0.200 M sodium acetate	1.8×10^{-5}

Sapling 17-2 to 17-5

13. Sodium benzoate, used as a preservative in foods, is the conjugate base of benzoic acid**. Calculate the pH of a solution prepared by dissolving 8.24 grams of sodium benzoate in 500.0 mL water**. (The molar mass of sodium benzoate is 144.11 g/mol. The K_a for benzoic acid is 6.3×10^{-5})

Sapling 16-14, 16-20

Answer_____

14. A solution is prepared by mixing the following materials and diluting to a total volume of 2.00 liters: 15.6 grams of sodium sulfide (molar mass 78.05 g/mol), 150.0 mL of 0.500 M sodium hydroxide (molar mass 40.00 g/mol) and 20.00 g of 38.4% by mass sodium chloride (molar mass 58.44 g/mol). **What is the molarity of sodium ion in the resulting solution?** You may assume all of the solutes are strong electrolytes.

Sapling 13-1 to 13-5

Answer_____

Possibly Useful Information

$R = 8.31441\ J\ mol^{-1}\ K^{-1}$	$^oC = K - 273.15$	$R = 0.0821\ L\ atm\ mol^{-1}\ K^{-1}$
$\Delta t_{fp} = k_{fp}m$	$\Delta t_{bp} = k_{bp}m$	$\Pi = MRT = iMRT$
$\Delta G^o = \Delta H^o - T\Delta S^o = -RTlnK$	$\Delta G = \Delta G^o - RTlnQ$	$P_{soln} = X_{solvent}P^o_{solvent}$
$pH = pK_a + \log\left(\frac{[conjugate\,base]}{[weak\,acid]}\right)$	$pH + pOH = 14$	$K_aK_b = K_w = 1.00 \times 10^{-14}$
$1\ atm = 760\ mm\ Hg$	$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$	

Selected Constants

Solvent	Normal Boiling Point (^oC)	k_{bp} ($^oC\ kg/mol$)	Normal Freezing Point (^oC)	k_{fp} ($^oC\ kg/mol$)
Water	100.0	0.51	0	1.86
Benzene	80.1	2.53	5.5	5.12
Ethyl Ether	34.5	2.02	-116.2	1.79
Chloroform	61.2	3.63	-63.5	4.70
cyclohexane	80.7	2.92	6.59	20.8
ethanol	78.4	1.22	–117.3	1.99