Chem 110 **Fall 2014** **Exam III** **Whelan**

SID | | | | | | | | | Last Key First Answer

Question 1 (7 Points)

a) Write a **net ionic equation** to show that **hydrocyanic** acid, behaves as an acid in water.

$HCN(aq) + H_2O(l)$ ⇌ (= or ⇔) H_3O^+ + CN^-

b) Write a **net ionic equation** to show how **barium hydroxide** behaves as a base in water.

$Ba(OH)_2$ = (= or ⇔) Ba^{2+} + $2OH^-$

Question 2 (8 Points)

Assign each species on the **left** to a **category** on the **right**.

a) HF 2
b) $Ba(OH)_2$ 3
c) $(CH_3)_2NH$ 4
d) HNO_3 1

1. Strong Acid
2. Weak Acid
3. Strong Base
4. Weak Base

Question 3 (6 Points)

An aqueous solution has a **hydroxide ion** concentration of **1.0 X 10^{-2}** M.

a) What is the **hydronium ion** concentration in this solution? 1.0×10^{-12} M

b) Is this solution **acidic**, **basic** or **neutral**? Basic

Question 4 (6 Points)

An aqueous solution has a **pH** of **8.30**

a) What is the **pOH** of this solution? 5.70

b) What is the **hydronium ion** concentration in this solution? 5.01×10^{-9} M

c) What is the **hydroxide ion** concentration in this solution? 2.00×10^{-6} M

Question 5 (6 Points)

Arrange the following solutions in order of **increasing acidity**:
1 = **least acidic** ; 3 = **most acidic**

a) Solution with a **pOH** = **8** 2
b) Solution with a **hydroxide ion** concentration = **1×10^{-10}** M 3
c) Solution with a **hydronium ion** concentration = **1×10^{-13}** M 1

Question 6 (3 Points)

Hydrocyanic acid (HCN) has a Ka = **4.0×10^{-10}** @ 25°C. Which of the following **amino acids** has an **acid strength closest** to that of **HCN**?

- ☐ Arginine pKa = 12.0
- ◯ Lysine pKa = 9.0
- ☐ Cysteine pKa = 8.3
- ☐ Histidine pKa = 6.1

Question 7 (9 Points)

In the following net ionic equation:

$$CH_3NH_2(aq) + H_2O(l) \rightleftharpoons CH_3NH_3^+ + OH^-$$

a) CH_3NH_2 is a Bronsted-Lowry **Base**

b) H_2O is a Bronsted-Lowry **acid**

c) The formula of the **product** that acts as a **proton acceptor**: OH^-

Question 8 (6 Points)

a) The formula for the **conjugate acid** of HSO_3^- is: H_2SO_3

b) The formula for the **conjugate base** of HSO_3^- is: SO_3^{2-}

Question 9 (4 Points)

Which of the following aqueous solutions are **buffer solutions**?

- ☐ 0.21M HI + 0.17M KI
- ☐ 0.13M NaOH + 0.24M NaCl
- ☑ 0.16M CH_3COOH + 0.21M CH_3COOK
- ☑ 0.31M HClO + 0.28M KClO
- ☐ 0.26M NH_4NO_3 + 0.37M KNO_3

Question 10 (8 Points)

A buffer solution is made that is **0.432M** in **H_2S** and **0.432M** in **NaHS**

(2 Points) a) If Ka for H_2S is **1.0×10^{-7}**, what is the **pH of the buffer solution**? **7**

(4 Points) b) Write the **net ionic equation** for the reaction that occurs when **0.088mol HBr** is **added** to 1.00 L of the buffer solution.

H_3O^+ + HS^- = $H_2O(l)$ + H_2S

(2 Points) c) The **Buffer capacity** for removal of added **OH^-** is: **0.432** M

Question 11 (5 Points)

A buffer solution is **0.398M** in **HCN** and **0.324M** in **NaCN**. If **Ka** for **HCN** is **4.0×10^{-10}**, what is the **pH of this buffer** solution?

For full credit you must show work

$$pH = pKa + \log_{10}\frac{[CN^-]}{[HCN]}$$

$$= -\log_{10}(4.0 \times 10^{-10}) + \log_{10}\frac{0.324}{0.398}$$

$$= 9.40 + \log_{10}(0.814)$$

$$= 9.40 - 0.09 = 9.31$$

pH = **9.31**

Question 12 (6 Points)

The pKa value for HNO_2 is **3.35**.

(3 Points)

a) Would a buffer prepared from **HNO_2** and **KNO_2** with a **pH of 3.00** be considered to be an effective buffer? (Yes or No) YES

(3 Points)

b) A buffer in which the mole ratio of **KNO_2** to **HNO_2** is **0.46**.

Would this buffer solution have a greater capacity for added acid (**H_3O^+**) or added base (**OH^-**)? OH^-

Question 13 (4 Points)

A small amount of **strong base** is added to a **buffer** made from **HCN** and **NaCN**. What changes if any will occur to the following.

Choose from the following choices:

Increase significantly **Increase** **Increase slightly**
Decrease significantly **Decrease** **Decrease slightly**

a) **pOH** Decrease slightly

b) **[HCN]** Decrease

Question 14 (6 Points)

Whether or not the process is observed in nature, which of the following could account for the following transformations: (Choose all that apply)

a) $^{234}U \rightarrow {}^{230}Th$ — ☐ alpha decay ☐ beta decay ☐ electron capture ☐ positron emission

b) $^{210}Pb \rightarrow {}^{210}Bi$ — ☐ alpha decay ☑ beta decay ☐ electron capture ☐ positron emission

c) $^{51}Cr \rightarrow {}^{51}V$ — ☐ alpha decay ☐ beta decay ☑ electron capture ☑ positron emission

Question 15 (4 Points)

You need to make an aqueous solution of **0.145M iron(III) sulfate** for an experiment in lab, using a **500mL** volumetric flask. How many **grams** of **iron(III) sulfate** should you add?:

For full credit you must show work.

$Fe_2(SO_4)_3$: $2(55.85) + 3(32.07 + 64.00) = 399.91\ g.mol^{-1}$

$\#mol\ Fe_2(SO_4)_3 = 0.145 \times 0.5 = 0.0725$

$0.0725\ mol\ Fe_2(SO_4)_3 \left| \frac{399.91\ g}{1\ mol} \right. = 29.0\ g$

29.0 g

Question 16 6 Points	An aqueous solution of **barium hydroxide** is standardized by titration with a **0.199M** solution of **hydrochloric acid**. If **21.0mL** of base are required to neutralize **18.9mL** of the acid, what is the **molarity** of the **barium hydroxide** solution? *For full credit you must show work and give a balanced chemical equation.* $Ba(OH)_2 + 2\,HCl = 2\,H_2O(l) + BaCl_2$ 21.0 mL 18.9 mL M = ? 0.199 $\#\,mol\ HCl = 0.199 \times 0.0189 = 3.76 \times 10^{-3}\ mol\ HCl$ $3.76 \times 10^{-3}\ mol\ HCl \left| \frac{1\ Ba(OH)_2}{2\ HCl} \right. = 1.88 \times 10^{-3}\ mol\ Ba(OH)_2$ $M = \frac{1.88 \times 10^{-3}}{0.021} = 0.0896$ 0.0896 M
Question 17 6 Points	According to the following reaction, **how many grams of water** will be formed upon the complete reaction of **29.0 grams of oxygen gas** with **excess hydrochloric acid?** hydrochloric acid (aq) + oxygen (g) ⟶ water (l) + chlorine (g) *For full credit you must show work and give a balanced chemical equation.* $4\,HCl + O_2(g) = 2\,H_2O(l) + 2\,Cl_2(g)$ $O_2: 2(16.00) = 32.00\ g.mol^{-1}$ $H_2O: 2(1.01) + 16.00 = 18.02\ g.mol^{-1}$ $29.0\,g\ O_2 \left| \frac{1\ mol}{32.0\,g} \right. = 0.906\ mol\ O_2$ $0.0906\ mol\ O_2 \left| \frac{2\ H_2O}{1\ O_2} \right. = 1.81\ mol\ H_2O$ $1.81\ mol\ H_2O \left| \frac{18.02\,g}{1\ mol} \right. = 32.7\,g$ 32.7 g

Do Not Write Below This

Exam III Score