Chem 110 **Fall 2015** **Exam III** **Whelan**

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

Question 1 (6 Points)

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

$HF(aq) + H_2O(l)$ ⟨=⟩ H_3O^+ + F^-

(= or ⇔)

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

$NH_3(aq) + H_2O(l)$ ⟨=⟩ NH_4^+ + OH^-

(= or ⇔)

Question 2 (8 Points)

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

a) HI 1

b) LiOH 3

c) $(CH_3)_2NH$ 4

d) HCN 2

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

Question 3 (6 Points)

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

a) What is the **hydroxide ion** concentration in this solution? 1×10^{-12} M

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

Question 4 (6 Points)

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

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

b) What is the **hydronium ion** concentration in this solution? 1.99×10^{-6} M

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

Question 5 (6 Points)

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

a) Solution with a **hydroxide ion** concentration = **1×10^{-10} M** 3

b) Solution with a **hydronium ion** concentration = **1×10^{-13} M** 1

c) Solution with a **pOH = 8** 2

Question 6 (6 Points)

The **autoionization** of water is an **endothermic process**: $H_2O(l) + H_2O(l) \rightleftharpoons H_3O^+ + OH^-$
This means that as we **heat water**:

a) The **[OH^-]**

- ☐ Decreases
- ◯ Increases
- ☐ Remains the same

b) The **water becomes**

- ☐ Basic
- ☐ Acidic
- ◯ Remains Neutral

Question 7 (6 Points)

In the following net ionic equation:

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

a) $CH_3NH_3^+$ is a Bronsted-Lowry Acid

b) OH^- is a Bronsted-Lowry Base

c) The formula of the **reactant** that acts as a **proton acceptor**: CH_3NH_2

Question 8 (6 Points)

a) The formula for the **conjugate acid** of $H_2PO_4^-$ is: H_3PO_4

b) The formula for the **conjugate base** of $H_2PO_4^-$ is: HPO_4^{2-}

Question 9 (6 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 **0.44M** in **HCN** and **0.44M** in **NaCN**

(2 Points) a) If Ka for HCN is 4.0×10^{-10}, what is the **pH of the buffer solution**? 9.40

(4 Points) b) Write the **net ionic equation** for the reaction that occurs when a **small quantity** of OH^- is **added** to the buffer solution.

OH^- + $HCN(aq)$ = $H_2O(l)$ + CN^-

(2 Points) c) The **Buffer capacity** for removal of H_3O^+ is: 0.44 M

Question 11 (6 Points)

A buffer solution is **0.398M** in H_2S and **0.324M** in **NaHS**. If **Ka** for H_2S is 1.0×10^{-7}, what is the **pH of this buffer** solution?

For full credit you must show work

$$pH = pKa + \log_{10}\frac{[\text{Buffer base}]}{[\text{Buffer acid}]}$$

$$= -\log_{10}(1\times10^{-7}) + \log_{10}\left(\frac{0.324}{0.398}\right)$$

$$= 7.00 + \log_{10}(0.814)$$

$$= 7.00 - 0.09$$

$$= 6.91$$

pH = 6.91

Question 12 (9 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

c) **[CN^-]** Increase

Question 13 (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 (5 Points)

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

For full credit you must show work.

$FeSO_4$: $55.85 + 32.07 + 4(16.00) = 151.92\ g.mol^{-1}$

$\#\ mol\ FeSO_4 = 0.145(0.500) = 0.0725$

$0.0725\ mol\ FeSO_4 \left| \frac{151.92\ g}{1\ mol} \right. = 11.0\ g$

11.0 g

Question 16
6 Points

An aqueous solution of **calcium hydroxide** is standardized by titration with a **0.199M** solution of **hydrobromic acid**.
If **21.4mL** of base are required to neutralize **18.9mL** of the acid, what is the **molarity** of the **calcium hydroxide** solution?

For full credit you must show work and give a balanced chemical equation.

$Ca(OH)_2 + 2\ HBr = CaBr_2 + 2\ H_2O$

21.4 ml 18.9 ml

M = ? 0.199M

$\#\ mol\ HBr = 0.199(0.0189) = 3.76 \times 10^{-3}$

$$3.76 \times 10^{-3}\ mol\ HBr \left| \frac{1\ Ca(OH)_2}{2\ HBr} \right. = 1.88 \times 10^{-3}\ mol\ Ca(OH)_2$$

$$M = \frac{1.88 \times 10^{-3}}{0.0214} = 0.0879$$

0.0879 **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 hydrochloric acid** with **excess oxygen gas?**

hydrochloric acid (aq) + oxygen (g) ⟶ water (l) + chlorine (g)

For full credit you must show work and give a balanced chemical equation.

$4\ HCl + O_2 = 2\ H_2O + 2\ Cl_2$

HCl : 1.01 + 35.45 = 36.46 g.mol^{-1} H_2O : 2(1.01) + 16.00 = 18.02 g.mol^{-1}

$$29.0\ g\ HCl \left| \frac{1\ mol}{36.46\ g} \right. = 0.755\ mol\ HCl$$

$$0.755\ mol\ HCl \left| \frac{2\ H_2O}{4\ HCl} \right. = 0.397\ mol\ H_2O$$

$$0.397\ mol\ H_2O \left| \frac{18.02\ g}{1\ mol} \right. = 7.17\ g$$

7.17 **g**

Do Not Write Below This

Exam III Score