

**BCIT**  
**Winter 2016**

**Chem 0012**

**Exam #2**

Name: \_\_\_\_\_

Attempt all questions in this exam. Read each question **carefully** and give a complete answer in the space provided.

Part marks given for wrong answers with partially correct reasoning/calculations.

Constants and equations are attached at the back. Data sheets and tables are provided.

*Total points = 30*

**Section I:** Multiple choice (15 points total, 1 point each)

Choose the **BEST** answer to the following questions.

- In a solubility equilibrium, the
  - Rate of dissolving equals the rate of crystallization
  - Neither dissolving nor crystallization are occurring
  - Concentration of solute and solvent are always equal
  - Mass of dissolved solute is greater than the mass of solution
- Which of the following represents the dissociation equation of a salt in water?
  - $\text{KCl(s)} \rightarrow \text{K}^+(\text{aq}) + \text{Cl}^-(\text{aq})$
  - $\text{Ca}^{2+}(\text{aq}) + \text{SO}_4^{2-}(\text{aq}) \rightarrow \text{CaSO}_4(\text{s})$
  - $\text{HCl(aq)} + \text{KOH(aq)} \rightarrow \text{KCl(aq)} + \text{H}_2\text{O}(\ell)$
  - $2\text{Na(s)} + 2\text{H}_2\text{O}(\ell) \rightarrow 2\text{NaOH(aq)} + \text{H}_2(\text{g})$
- There are 10.0 mL of four solutions. One solution each of 0.10 M  $\text{Cl}^-$ , 0.10 M  $\text{Br}^-$ , 0.10 M  $\text{IO}_3^-$ , and 0.10 M  $\text{BrO}_3^-$ . Equal moles of  $\text{AgNO}_3$  are added to each of the four solutions. A precipitate forms in all but one solution. Which solution does not form a precipitate?
  - 0.10 M  $\text{Cl}^-$
  - 0.10 M  $\text{Br}^-$
  - 0.10 M  $\text{IO}_3^-$
  - 0.10 M  $\text{BrO}_3^-$
- Solid  $\text{NaCl}$  is added to a saturated  $\text{AgCl}$  solution. How have  $[\text{Ag}^+]$  and  $[\text{Cl}^-]$  changed when equilibrium has been reestablished?

	$[\text{Ag}^+]$	$[\text{Cl}^-]$
a.	increased	increased
b.	increased	decreased
c.	decreased	increased
d.	decreased	decreased

5. Which of the following expressions represents  $[Fe^{3+}]$  in a saturated  $Fe(OH)_3$  solution?

a.  $[Fe^{3+}] = \frac{K_{sp}}{3[OH^-]}$

b.  $[Fe^{3+}] = \frac{K_{sp}}{[OH^-]^3}$

c.  $[Fe^{3+}] = \sqrt[3]{\frac{K_{sp}}{[OH^-]}}$

d.  $[Fe^{3+}] = K_{sp}[OH^-]^3$

6. What happens when equal volumes of 0.20 M  $BaCl_2$  and 0.20 M  $Pb(NO_3)_2$  are mixed?

- a. only  $PbCl_2$  precipitates
- b. only  $Ba(NO_3)_2$  precipitates
- c. both  $PbCl_2$  and  $Ba(NO_3)_2$  precipitate
- d. no precipitate forms

7. Which of following 1.0 M solutions will have the greatest electrical conductivity?

- a. HI
- b.  $H_2S$
- c. HCN
- d.  $H_3PO_4$

8. The relationship  $\frac{[H_2P_2O_7^{2-}][H_3O^+]}{[H_3P_2O_7^-]}$  is the

- a.  $K_a$  for  $H_3P_2O_7^-$
- b.  $K_b$  for  $H_3P_2O_7^-$
- c.  $K_a$  for  $H_2P_2O_7^{2-}$
- d.  $K_b$  for  $H_2P_2O_7^{2-}$

9. What is produced when  $CH_3NH_2$  acts as a base in water?

- a.  $CH_3NH^-$
- b.  $CH_3NH_3^+$
- c.  $CH_3NH_2^+$
- d.  $CH_3NH_2^-$

10. Which indicator below has  $K_a = 1.0 \times 10^{-6}$ ?

- a. methyl red
- b. phenolphthalein
- c. bromthymol blue
- d. chlorophenol red

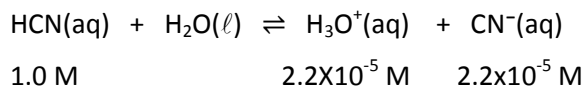
11. Which of the following salt solutions is neutral?

- a. KBr
- b.  $\text{FeCl}_3$
- c.  $\text{Li}_2\text{C}_2\text{O}_4$
- d.  $\text{NaHCO}_3$

12. Which of the following equations describes the predominant equilibrium that occurs at the equivalence point of a titration between  $\text{CH}_3\text{COOH}(\text{aq})$  and  $\text{NaOH}(\text{aq})$ ?

- a.  $\text{H}^+(\text{aq}) + \text{OH}^-(\text{aq}) \rightleftharpoons \text{H}_2\text{O}(\ell)$
- b.  $\text{CH}_3\text{COO}^-(\text{aq}) + \text{H}_2\text{O}(\ell) \rightleftharpoons \text{CH}_3\text{COOH}(\text{aq}) + \text{OH}^-(\text{aq})$
- c.  $\text{CH}_3\text{COOH}(\text{aq}) + \text{NaOH}(\text{aq}) \rightleftharpoons \text{NaCH}_3\text{COO}(\text{aq}) + \text{H}_2\text{O}(\ell)$
- d.  $\text{H}^+(\text{aq}) + \text{CH}_3\text{COO}^-(\text{aq}) + \text{Na}^+(\text{aq}) + \text{OH}^-(\text{aq}) \rightleftharpoons \text{Na}^+(\text{aq}) + \text{CH}_3\text{COO}^-(\text{aq}) + \text{H}_2\text{O}(\ell)$

13. Consider the following equilibrium, where the concentrations are given below the species:



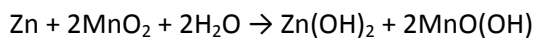
Why is the above solution not considered to be a true buffer solution?

- a. excessive  $[\text{HCN}]$
- b. excessive  $[\text{H}_3\text{O}^+]$
- c. insufficient  $[\text{CN}^-]$
- d. insufficient  $[\text{H}_3\text{O}^+]$

14. What is the oxidation number of iron in magnetite,  $\text{Fe}_3\text{O}_4$

- a.  $+\frac{4}{3}$
- b. +2
- c.  $+\frac{8}{3}$
- d. +3

15. Identify the reducing agent in the following reaction:



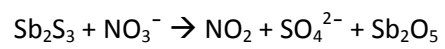
- a. Zn
- b.  $\text{MnO}_2$
- c.  $\text{H}_2\text{O}$
- d.  $\text{Zn}(\text{OH})_2$

**Section II:** Written problems (*15 points total*).

16. What is the maximum number of moles of  $\text{Cl}^-$  that can exist in 500.0 mL of 2.0 M  $\text{AgNO}_3$ ? (2 points)
17. A mixture is prepared by adding 40.8 mL of 0.122 M  $\text{Mg}(\text{NO}_3)_2$  and 31.6 mL of 0.343 M  $\text{Sr}(\text{OH})_2$ . What mass in grams of  $\text{Mg}(\text{OH})_2$  will be formed and what will be the concentration of each of the ions after the reaction? The molar mass of  $\text{Mg}(\text{OH})_2$  is 58.3 g/mol. (5 points)

18. What is the pH of a 0.10 M  $\text{FeCl}_3$  solution? When  $\text{Fe}^{3+}$  is in water it forms  $\text{Fe}(\text{H}_2\text{O})_6^{3+}$ . (4 points)

19. Balance the following redox reaction in basic solution: (4 points)



### Equations and Constants

$$\text{pH} = -\log[\text{H}^+]$$

$$[\text{H}^+] = 10^{-\text{pH}}$$

$$\text{pOH} = -\log[\text{OH}^-]$$

$$[\text{OH}^-] = 10^{-\text{pOH}}$$

$$\text{pH} + \text{pOH} = 14.00 \text{ at } 25^\circ\text{C}$$

$$K_w = 1.0 \times 10^{-14} \text{ at } 25^\circ\text{C}$$

$$K_w = K_a K_b$$

$$\text{pX} = -\log(\text{X})$$

$$\text{X} = 10^{-\text{pX}}$$

$$\text{pH} = \text{p}K_a + \log\left(\frac{[\text{A}^-]}{[\text{HA}]}\right)$$

The solution to the quadratic equation  $ax^2 + bx + c = 0$  is

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$