Chemistry 1046 **KEY**
Exam 4
Spring 2000

MULTIPLE CHOICE - CIRCLE THE BEST ANSWER (4 Points Each)

1. For the insoluble substance Bi_2S_3, the expression for the K_{sp} of the substance is

   1. $[Bi^{3+}][S^{-2}]$
   2. [2Bi][3S]
   3. $[Bi^{3+}]^3[S^{-2}]^2$
   4. $[Bi_2S_3]$
   5. $[Bi^{3+}]^2[S^{-2}]^3$

2. What would be the best way to increase the solubility of $Mg(OH)_2(s)$? You could (Hint – Think about what affect OH^{-1} concentration)

   1. add more $Mg(OH)_2$.
   2. add a strong acid.
   3. add a weak acid.
   4. add a strong base.
   5. add a weak base.

3. The solubility of which of the following relatively insoluble substances would NOT be affected by a change in the pH of the solution ?

   1. $SnCl_2$
   2. ZnS
   3. $Cu_3(PO_4)_2$
   4. $Mg(OH)_2$
   5. $BaSO_4$

4. A white precipitate will result when which of the following is mixed with a solution of 6N HCl?

   1. $SnCl_2$
   2. $Hg_2(NO_3)_2$
   3. $Zn(C_2H_3O_2)_2$
   4. NaI
   5. K_3PO_4

5. Which of the following compounds below will dissolve in aqueous ammonia?

   1. $PbCl_2$
   2. AgCl
   3. Hg_2Cl_2
   4. CaF_2
   5. NiI_2

6. What is the maximum molar concentration of Cu^{+2} ions possible in a solution that has a 3.0×10^{-3} M sulfide ion concentration? (K_{sp} for CuS = 8.5×10^{-45})

   1. 2.6×10^{-50}
   2. 3.5×10^{38}
   3. 2.8×10^{-42}
   4. 5.3×10^{-20}
   5. 8.2×10^{-14}

7. Which of the following will react with excess ammonia in solution to give a clear solution (ppt. dissolves)?

1. $PbSO_4$
2. $BaSO_4$
3. CuS
4. $PbCl_2$
5. $HgCl_2$

8. A diprotic acid H_2A has two Ka's, Ka_1 and Ka_2. The equilibrium constant Kd for the reaction $H_2A \rightarrow 2H^+ + A^{-2}$ would be equal to

1. $Ka_1 + Ka_2$.
2. $Ka_1 \times Ka_2$.
3. Ka_1 / Ka_2 .
4. zero.
5. >1, it would be a strong acid

9. In the complex ion $Zn(OH)_4^{-2}$

1. the ligand is nickel and the coordination number is -2.
2. the ligand is hydroxide and the coordination number is 2.
3. the ligand is zinc and the coordination number is +4.
4. the ligand is hydroxide and the coordination number is 4.
5. the ligand is sodium hydroxide and the coordination number is 6.

10. Which of the following might represent the formation constant (K_f) of a common complex ion?

1. 1.0×10^2
2. 3.5×10^{-30}
3. 5.6×10^{12}
4. 0
5. 4.3×10^{-21}

11. An amphoteric substance?

1. reacts with both acids and bases.
2. readily dissolves in water.
3. has two charges at the same time.
4. has both male and female forms.
5. is insoluble in water.

12. Which of the following describes Group I and Group II cations?

1. Group I cations precipitate as chloride salts while Group II cations precipitate as hydroxides.
2. Group I cations precipitate as sulfide salts while Group II cations precipitate as hydroxides.
3. Group I cations precipitate as chloride salts while Group II cations precipitate as sulfides.
4. Group I cations precipitate as hydroxide salts while Group II cations precipitate as chlorides.
5. Group I cations precipitate as phosphate salts while Group II cations precipitate as sulfides.

13. The anode in a galvanic cell and in an electrolytic cell is

1. positive in both cells.
2. the site of oxidation and reduction respectively.
3. the site of reduction and oxidation respectively.
4. the site of oxidation.
5. the site of reduction.

14. A voltaic cell is represented as

$Zn(s)|Zn^{+2}(1.0M)||Cu^{+2}(1.0M)|Cu(s)$

Which of the following statements is false?

1. The mass of the zinc electrode increases during discharge.
2. The copper electrode is the cathode.
3. Electrons flow through the external circuit from the zinc to the copper electrode.
4. Reduction occurs at the copper electrode during discharge.
5. The concentration of Cu^{+2} decreases during discharge.

15. An electrochemical cell has the correct cell notation

$Cr|Cr^{+3}||H^{+}|H^{2}|Pt$

If the concentrations of the ions were 1.0 molar and the pressure of H_2 was 1.0 atmosphere, the _____ would be the cathode and the voltage would be _____. $E°_{red}$ Cr/Cr^{+3} = -.74V,

1. hydrogen electrode, -0.74V.
2. chromium electrode, -0.46V.
3. hydrogen electrode, +.74V.
4. chromium electrode, +.74V.
5. hydrogen electrode, 0.00V.

16. What is the oxidation half-reaction for the following REDOX reaction?

$2KBr(l) \rightarrow 2K(l) + Br_2(g)$

1. $2Br^{-} \rightarrow Br_2 + 2e^{-}$
2. $Br_2 + 2e^{-} \rightarrow 2Br^{-}$
3. $2K^{+} + 2e^{-} \rightarrow 2K$
4. $2K \rightarrow 2K^{+} + 2e^{-}$
5. $2H_2O + 2e^{-} \rightarrow H_2 + 2OH^{-}$

17. Which of the following would be the best reducing agent?

1. Ag^{+}
2. Mg^{+2}
3. Li
4. Fe^{+2}
5. Br^{-}

18. Which of the following would have the greatest potential for oxidation? (Use the table)

1. Zn^{+2}
2. Mn
3. Pb^{+2}
4. O_2
5. Br^-

19. Protection of iron from corrosion can be accomplished by making an electrical connection between iron and certain other metals (cathodic protection). Metals that would provide protection is(are)

a. Cu
b. Sn
c. Ag
d. Hg

1. a. only
2. a. and c. only
3. b. and d. only
4. b. only
5. all would provide protection

20. In the Nernst Equation $E_{cell} = E^0 - (RT/nF)\ln Q$, the term F stands for

1. the voltage you measure.
2. the number of electrons transferred.
3. the equilibrium constant for the reaction.
4. the number of half-cells in the electrochemical cell.
5. the number of Coulombs in one equivalent of electrons.

21. When would an electrochemical cell have a potential of zero volts?

1. When the reaction at the cathode becomes an oxidation reaction.
2. When all concentration reach 1.0 molar.
3. When the standard potential becomes positive.
4. When the system is at equilibrium.
5. When most of the cathode has corroded away.

22. What is the standard potential of the cell below?

$Cd|Cd^{+2}||Sn^{+2},Sn^{+4}|Pt$

1. +0.55V
2. +0.15V
3. +1.17V
4. –0.25V
5. 0.0V

For the REDOX reaction (Questions 23 and 24)

$MnO_4^{1-} + Br^{1-} \rightarrow Mn^{2+} + Br_2$

23. What is the coefficient in front of Br^{1-} after you balance the equation?

1. 2.
2. 5.
3. 6.
4. 8.
5. 10.

24. If the reaction above were placed in an electrochemical cell, which change(s) will result in a decrease in the cell potential as compared to the standard potential of the cell?

a. Increasing the MnO_4^- concentration
b. Decreasing the bromide concentration
c. Decreasing the amount of manganese (II) ion in the cathode half-cell.

1. a. only
2. b. only
3. c. only
4. a. and b. only
5. b. and c. only

25. Why are alkaline batteries "better" than the traditional batteries?

1. The standard potential of an alkaline battery is higher.
2. The alkaline battery contains more chemicals.
3. The traditional battery contains chemicals that corrode the anode.
4. The ammonium ions in an alkaline battery make the pH higher.
5. There is no advantage to an alkaline battery.

Problems (Show all work and pay attention to sig figs and units)

1. The Ksp of magnesium hydroxide is 1.8×10^{-11}. What is its solubility?

$Mg(OH)_2 \rightarrow Mg^{+2} + 2\ OH^{-1}$

$K_{sp} = [Mg^{+2}][OH^{-1}]^2$ Let $[Mg^{+2}] = x$ = solubility, $[OH^{-1}] = 2x$

$1.8x10^{-11} = (x)(2x)^2 = 4x^3$
$x = (4.5x10^{-12})^{1/3}$

$x = 1.7x10^{-4}$ mols/L = 0.0099g/L

2. What is the silver ion concentration in a mixture of solid AgCl and water? Ksp = $1.8x10^{-10}$

$K_{sp} = [Ag^{+1}][Cl^{-1}] = 1.8x10^{-10}$
$[Ag^{+1}] = [Cl^{-1}] = x$
$x^2 = 1.8x10^{-10}$ $x = 1.3x10^{-5} M = [Ag^{+1}]$

3. What is the actual potential of the following electrochemical cell?

$Zn|Zn^{+2}(0.050M)||Cu^{+2}(0.0010M)|Cu$

$E°_{cell} = 1.10V$
R=8.31 J/molK, F=95,600 C/eq
2.303RT/F = 0.0592V at 25°C

$Zn + Cu^{+2} \rightarrow Zn^{+2} + Cu$ 2 electrons transferred = n

$E_{cell} = E°_{cell} - (0.0592 / n) \log Q$

$E_{cell} = 1.10V - (0.0592 / 2) \log ([Zn^{+2}] / [Cu^{+2}])$

$E_{cell} = 1.10V - (0.0592 / 2) \log ([0.050] / [0.0010])$

$E_{cell} = 1.10V - (0.0503) = 1.05V$