Chem 401 Practice for Final Exam

____ 1. Which of the following statements regarding spontaneous changes is **false**?
   a. Spontaneity is favored when heat is released.
   b. Spontaneity is favored when the dispersal of matter is increased.
   c. Spontaneous changes occur at a given state without any outside influence.
   d. Ice melting at 25°C is spontaneous primarily due to the increase in molecular disorder (dispersal of matter).
   e. All exothermic reactions are spontaneous.

____ 2. What is the entropy change of the reaction below at 298 K and 1 atm pressure?

	$N_2(g)$	+	$3H_2(g)$	$\rightarrow$	$2NH_3(g)$
S^0 (J/mol•K)	*S*191.5		130.6		192.3

   a. -198.7 J/K
   b. 76.32 J/K
   c. -129.7 J/K
   d. 303.2 J/K
   e. 384.7 J/K

____ 3. The heat of vaporization of methanol, CH_3OH, is 35.20 kJ/mol. Its boiling point is 64.6°C. What is the change in entropy for the vaporization of methanol?
   a. -17.0 J/mol•K
   b. 3.25 J/mol•K
   c. 17.0 J/mol•K
   d. 104 J/mol•K
   e. 543 J/mol•K

____ 4. Which one of the following reactions has a **positive** entropy change?
   a. $H_2O(g) \rightarrow H_2O(\ell)$
   b. $BF_3(g) + NH_3(g) \rightarrow F_3BNH_3(s)$
   c. $2SO_2(g) + O_2(g) \rightarrow 2SO_3(g)$
   d. $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$
   e. $2NH_4\,NO_3(s) \rightarrow 2N_2(g) + 4H_2O(g) + O_2(g)$

____ 5. Which of the following statements about free energy is false?
   a. If ΔS is negative then ΔH must be negative for a spontaneous process.
   b. ΔS is positive for many spontaneous processes.
   c. ΔG is always negative for spontaneous processes.
   d. ΔG is always positive for nonspontaneous processes.
   e. ΔS must be positive for a process to be spontaneous.

____ 6. Calculate ΔG^0 for the reaction below. The standard molar *entropy* change for the reaction at 298 K is -287.5 J/mol•K.

$$3NO_2(g) + H_2O(\ell) \rightarrow 2HNO_3(aq) + NO(g) + 136.8\ kJ$$

   a. - 51.2 kJ/mol
   b. 85,500 kJ/mol
   c. - 68.4 kJ/mol
   d. - 236 kJ/mol
   e. - 222 kJ/mol

____ 7. Evaluate ΔG^0_{298} for the following reaction at 25°C.

	$2ZnS(s)$	+	$3O_2(g)$	$\rightarrow$	$2ZnO(s)$	+	$2SO_2(g)$
ΔH (kJ/mol)	-205.6		0		-348.3		-296.8
S^0 (J/mol•K)	57.7		205.0		43.64		248.1

a. -951.1 kJ
b. -922.6 kJ
c. -704.2 kJ
d. -835.2 kJ
e. -1902 kJ

____ 8. A process **cannot** be spontaneous (product-favored) if ____.
a. it is exothermic, and there is an increase in disorder
b. it is endothermic, and there is an increase in disorder
c. it is exothermic, and there is a decrease in disorder
d. it is endothermic, and there is a decrease in disorder
e. the entropy of the universe increases

____ 9. For which set of values of ΔH and ΔS will a reaction be spontaneous (product-favored) at all temperatures?
a. ΔH = +10 kJ, ΔS = -5 J/K
b. ΔH = -10 kJ, ΔS = -5 J/K
c. ΔH = -10 kJ, ΔS = +5 J/K
d. ΔH = +10 kJ, ΔS = +5 J/K
e. no such values exist

____ 10. Which of the following expressions does not represent a proper expression for the rate of this reaction?

$2A + 3B \rightarrow F + 2G$

a. $\frac{-\Delta[A]}{\Delta t}$ c. $\frac{\Delta[F]}{\Delta t}$ e. $\frac{-\Delta[A]}{2\Delta t}$

b. $\frac{-\Delta[B]}{3\Delta t}$ d. $\frac{\Delta[G]}{2\Delta t}$

____ 11. In the following reaction, the rate of formation of NH_3 is 0.15 mol/L•min. What is the rate of reaction?

$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$

a. 0.15 mol/L•min
b. 0.075 mol/L•min
c. -0.075 mol/L•min
d. 0.20 mol/L•min
e. 0.30 mol/L•min

____ 12. Suppose a reaction A + B $\rightarrow$ C occurs at some initial rate at 25°C. Which response includes all of the changes below that **could** increase the rate of this reaction?

I. lowering the temperature
II. adding a catalyst
III. increasing the initial concentration of B

a. I c. III e. II and III
b. II d. I and II

____ 13. The gas phase reaction A + B + C $\rightarrow$ D has a reaction rate which is experimentally observed to follow the relationship rate = $k[A]^2[C]$. The reaction is ____ order in A, ____ order in B, and ____ order in C.
a. first, second, third
b. first, second, zero
c. second, zero, first
d. second, first, zero
e. second, zero, zero

____ 14. Which of the following statements regarding the rate constant in the rate law expression is incorrect?
a. Its value increases with temperature.
b. Its value is independent of initial concentration at a given temperature.
c. Its units depend on the overall order of reaction.
d. Its value is experimentally determined.
e. The larger its value, the slower the reaction rate.

____ 15. Given the following data for the $NH_4^+ + NO_2^- \rightarrow N_2 + 2H_2O$ reaction

Trial	$[NH_4^+]$	$[NO_2^-]$	Rate *M*/s
1	0.010 *M*	0.020 *M*	0.020
2	0.015	0.020	0.030
3	0.010	0.010	0.005

The rate law for the reaction is
a. rate = $k[NH_4^+][NO_2^-]$
b. rate = $k[NH_4^+]^2[NO_2^-]$
c. rate = $k[NH_4^+][NO_2^-]^2$
d. rate = $k[NH_4^+]^2[NO_2^-]^2$
e. None of the above

____ 16. Evaluate the specific rate constant for this reaction at 800°C. The rate-law expression is rate = $k[NO]^2[H_2]$. (Choose the closest answer.)

$2NO(g) + 2H_2(g) \rightarrow (g) + 2H_2O(g)$

Experiment	Initial [NO]	Initial $[H_2]$	Initial Rate of Reaction ($M \cdot s^{-1}$)
1	0.0010 *M*	0.0060 *M*	7.9×10^{-7}
2	0.0040 *M*	0.0060 *M*	1.3×10^{-5}
3	0.0040 *M*	0.0030 *M*	6.4×10^{-6}

a. 22 $M^{-2} \cdot s^{-1}$
b. 4.6 $M^{-2} \cdot s^{-1}$
c. 1.3×10^2 $M^{-2} \cdot s^{-1}$
d. 0.82 $M^{-2} \cdot s^{-1}$
e. 0.024 $M^{-2} \cdot s^{-1}$

____ 17. The gas phase reaction below obeys the rate-law expression rate = $k[PCl_5]$. At 400 K the specific rate constant is 0.0371 min^{-1}. How many <u>hours</u> are required to reduce a sample of PCl_5 to **10%** of its original amount?

$PCl_5 \rightarrow PCl_3 + Cl_2$

a. 3.10 hrs
b. 1.03 hrs
c. 186 hrs
d. 3.71 hrs
e. 62 hrs

____ 18. A plot of $\frac{1}{[D]}$ versus time is linear for the reaction D $\rightarrow$ E. What is the kinetic order of the reaction?

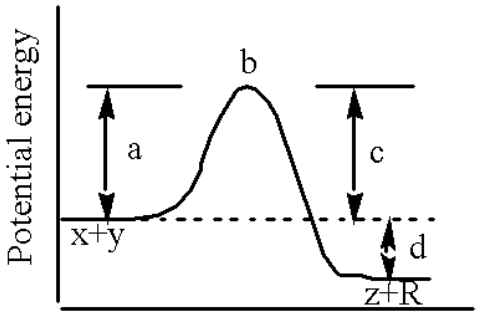
a. second
b. first
c. zero
d. one-half
e. negative one

____ 19. Which idea listed below is not a part of the collision theory of reaction rates?

a. Molecules must be properly oriented when they collide to react.
b. Molecules must collide to react.
c. Molecules must collide with enough kinetic energy to overcome the potential energy stabilization of the bonds.
d. Effective collisions result in a chemical reaction.
e. All molecular collisions result in a reaction.

____ 20. Given the following potential energy diagram for the one-step reaction

X + Y $\rightarrow$ Z + R



The activation energy of the *reverse* reaction is equal to ____.

a. d
b. c plus d
c. c
d. a plus c
e. d minus a

____ 21. Consider the hypothetical reaction shown below.

$2A + C_2 \rightarrow A_2C + C$

Assume that the following proposed mechanism is consistent with the rate data.

A	+	$C_2 \rightarrow AC + C$	slow
AC	+	$A \rightarrow A_2C$	fast
2A	+	$C_2 \rightarrow A_2C + C$	overall

Which one of the following statements must be true? The reaction is ____.

a. first order in A, first order in B, and third order overall
b. second order in C_2 and second order overall
c. first order in A and first order in C_2
d. second order in C_2, zero order in A, and third order overall
e. second order in A and second order overall

____ 22. The specific rate constant, *k*, for a reaction is 0.44 s^{-1} at 298 K, and the activation energy is 245.kJ/mol. Calculate *k* at 398 K. (The universal gas constant = 8.314 J/mol•K.)

$$\ln\left(\frac{k_2}{k_1}\right) = \frac{E_a}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$$

a. 2.71×10^{10} s^{-1}
b. 6.17×10^{10} s^{-1}
c. 1.03×10^{10} s^{-1}
d. 8.32×10^{8} s^{-1}
e. 4.51×10^{9} s^{-1}

____ 23. What is the value of K_c for the reaction $CH_4(g) + H_2O(g) \leftrightarrow CO(g) + 3H_2(g)$ if at equilibrium $[CH_4] = 0.20\ M$, $[H_2O] = 0.20\ M$, $[CO] = 0.50\ M$ and $[H_2] = 1.50\ M$?

a. 19
b. 0.24
c. 0.053
d. 42
e. 16

____ 24. Given: $A(g) + 3B(g) \leftrightarrow C(g) + 2D(g)$

One (1.0) mole of A and 1.0 mole of B are placed in a 5.0-liter container. After equilibrium has been established, 0.50 mole of D is present in the container. Calculate the equilibrium constant, K_c, for the reaction.

a. 1.2
b. 0.68
c. 12
d. 27
e. 1.4×10^{2}

____ 25. The following reaction is initiated and the concentrations are measured after ten minutes:

$A(g) + 3\ B(g) \leftrightarrow AB_3(g)$; $K_c = 1.33 \times 10^{-2}$

$[A] = 1.78\ M$ $[B] = 2.21\ M$ $[AB_3] = 1.19\ M$

Is the reaction in equilibrium?

a. Yes.
b. No, because $Q < K$.
c. No, and the $[AB_3]$ must increase to establish equilibrium.
d. No, because $Q > K$.
e. There is no way to tell.

____ 26. The numerical value of the equilibrium constant, K_c, for the following gas phase reaction is 0.50 at a certain temperature. When a certain reaction mixture reaches equilibrium, the concentration of O_2 is found to be 2.0 *M*, while the concentration of SO_3 is found to be 10 *M*. What is the equilibrium concentration of SO_2 in this mixture?

$$2SO_2(g) + O_2(g) \leftrightarrow 2SO_3(g)$$

a. 0.50 *M*
b. 10 *M*
c. 0.10 *M*
d. 5.0 *M*
e. 1.0 *M*

____ 27. For the following reaction, K_c is 144 at 200°C. If 0.400 mol of both A and B are placed in a 2.00-liter container at that temperature, what will be the concentration of B at equilibrium?

$$A(g) + B(g) \leftrightarrow C(g) + D(g)$$

a. 0.015 *M*
b. 1.64 *M*
c. 0.200 *M*
d. 0.185 *M*
e. 1.13 *M*

____ 28. For the following reaction, which of the changes listed below would cause <u>more reactants</u> to form when equilibrium is re-established?

$$2NOCl(g) + 75\ kJ \leftrightarrow 2NO(g) + Cl_2(g)$$

a. Add a catalyst.
b. Increase the temperature.
c. Decrease the [NO]
d. Increase the volume.
e. Increase the pressure.

____ 29. For the following reaction at equilibrium at 445°C the partial pressures were found to be $[H_2] = 0.45$ atm, $[I_2] = 0.10$ atm and [HI] = 1.53 atm. Calculate K_p for this reaction.

$$H_2(g) + I_2(g) \leftrightarrow 2HI(g)$$

a. 150
b. 34
c. 52
d. 76
e. 4.4

____ 30. A sample of only solid ammonium chloride was heated in a 1.00-L container at 500.°C $NH_4Cl(s) \leftrightarrow NH_3(g) + HCl(g)$. At equilibrium, the pressure of $NH_3(g)$ was found to be 1.75 atm. What is the equilibrium constant, $\boldsymbol{K_c}$, for the decomposition at this temperature?

a. 7.6×10^{-4}
b. 1.2×10^{4}
c. 4.8×10^{-2}
d. 1.9×10^{2}
e. 1.8×10^{-3}

____ 31. Which one of the following pairs of acids and conjugate bases is incorrectly labeled or **incorrectly** matched?

	<u>Acid</u>	<u>Conjugate Base</u>
a.	water	hydroxide
b.	sulfuric acid	sulfate
c.	perchloric acid	perchlorate
d.	nitric acid	nitrate
e.	hydrobromic acid	bromide

____ 32. If a compound is able to react as either an acid or a base, it is said to be which of these?

a. autoionized
b. amphoteric
c. hydrated
d. balanced
e. neutralized

____ 33. Which one of the following is **not** a strong acid?
a. HI
b. HF
c. HNO_3
d. H_2SO_4
e. $HClO_3$

____ 34. Which one of the following is a soluble, strong base?
a. CsOH
b. $Cu(OH)_2$
c. $Fe(OH)_3$
d. $Mn(OH)_2$
e. $Al(OH)_3$

____ 35. Write the balanced **formula unit** equation for the reaction of hydrobromic acid with calcium hydroxide. What is the sum of the coefficients? (Do not forget coefficients of one.)
a. 6
b. 7
c. 3
d. 4
e. 5

____ 36. Neutralization, according to the Lewis theory, involves ____.
a. proton transfer
b. the formation of a gas
c. the formation of an ionic solid
d. the formation of a coordinate covalent bond
e. the combination of a hydrogen ion with a hydroxide ion to form water

____ 37. In the reaction $SnCl_4 + 2Cl^- \rightarrow SnCl_6^{2-}$, the $SnCl_4$ functions as a(an) ____.
a. Brønsted-Lowry acid
b. Brønsted-Lowry base
c. Arrhenius base
d. Lewis acid
e. Lewis base

Chapter 18 Values

The following values will be useful for problems in this chapter.

Acid	K	Substance or Species	K
HF	$K_a = 7.2 \times 10^{-4}$	NH_3	$K_b = 1.8 \times 10^{-5}$
HNO_2	$K_a = 4.5 \times 10^{-4}$	$(CH_3)_3N$	$K_b = 7.4 \times 10^{-5}$
CH_3COOH	$K_a = 1.8 \times 10^{-5}$	$[Co(OH_2)_6]^{2+}$	$K_a = 5.0 \times 10^{-10}$
HOCl	$K_a = 3.5 \times 10^{-8}$	$[Fe(OH_2)_6]^{2+}$	$K_a = 3.0 \times 10^{-10}$
HOBr	$K_a = 2.5 \times 10^{-9}$	$[Fe(OH_2)_6]^{3+}$	$K_a = 4.0 \times 10^{-3}$
HOCN	$K_a = 3.5 \times 10^{-4}$	$[Be(OH_2)_4]^{2+}$	$K_a = 1.0 \times 10^{-5}$
HCN	$K_a = 4.0 \times 10^{-10}$	$[Cu(OH_2)_4]^{2+}$	$K_a = 1.0 \times 10^{-8}$
H_2SO_4	K_{a1} = very large	HBO_2	$K_a = 6.0 \times 10^{-10}$
	$K_{a2} = 1.2 \times 10^{-2}$	$(COOH)_2$	$K_{a1} = 5.9 \times 10^{-2}$
H_2CO_3	$K_{a1} = 4.2 \times 10^{-7}$		$K_{a2} = 6.4 \times 10^{-5}$
	$K_{a2} = 4.8 \times 10^{-11}$	CH_3NH_2	$K_b = 5.0 \times 10^{-4}$

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____ 38. Which one of the following substances is **not** a strong electrolyte?
a. NH_4Cl
b. $HClO_4$
c. HNO_3
d. NH_3
e. $Mg(NO_3)_2$

____ 39. The molar concentration of the Ca^{2+} ion is ____ and the molar concentration of OH^- ion is ____ in 0.015 *M* calcium hydroxide.
a. 0.015 *M*; 0.015 *M*
b. 0.015 *M*; 0.030 *M*
c. 0.030 *M*; 0.015 *M*
d. 0.030 *M*; 0.030 *M*
e. not enough information to calculate

____ 40. Calculate the concentrations of H_3O^+ and OH^- ions in a 0.25 *M* $HClO_4$ solution.
a. $[H_3O^+] = 0.25\ M$, $[OH^-] = 0.25\ M$
b. $[H_3O^+] = 0.25\ M$, $[OH^-] = 4.0\ M$
c. $[H_3O^+] = 0.25\ M$, $[OH^-] = 4.0 \times 10^{-14}\ M$
d. $[H_3O^+] = 0.50\ M$, $[OH^-] = 2.0 \times 10^{-14}\ M$
e. $[H_3O^+] = 1.0 \times 10^{-7}\ M$, $[OH^-] = 1.0 \times 10^{-7}\ M$

____ 41. A solution having a pH of 1.4 would be described as ____.
a. distinctly basic
b. slightly basic
c. neutral
d. slightly acidic
e. distinctly acidic

____ 42. Calculate the pOH of a solution that has the OH^- concentration of 0.50 *M*.
a. 0.50
b. 14.30
c. 6.70
d. 13.70
e. 0.30

____ 43. What is the concentration of H_3O^+ ions in a solution in which pH = 4.32?
a. $4.8 \times 10^{-5}\ M$
b. $6.2 \times 10^{-4}\ M$
c. $5.1 \times 10^{-4}\ M$
d. $8.6 \times 10^{-5}\ M$
e. $3.5 \times 10^{-4}\ M$

____ 44. The pH of a 0.10 *M* solution of a monoprotic acid is 2.85. What is the value of the ionization constant of the acid?
a. 6.3×10^{-5}
b. 3.8×10^{-6}
c. 2.0×10^{-5}
d. 4.0×10^{-8}
e. 7.2×10^{-6}

____ 45. What is the $[OCl^-]$ in 0.10 *M* hypochlorous acid, HOCl? $K_a = 3.5 \times 10^{-8}$
a. $5.9 \times 10^{-5}\ M$
b. $8.4 \times 10^{-4}\ M$
c. $6.1 \times 10^{-4}\ M$
d. $4.2 \times 10^{-6}\ M$
e. $3.6 \times 10^{-7}\ M$

____ 46. Calculate the value of $[H_3O^+]$ in a 0.25 *M* solution of aqueous ammonia. $K_b = 1.8 \times 10^{-5}$
a. 2.1×10^{-3} *M*
b. 4.7×10^{-12} *M*
c. 2.3×10^{-9} *M*
d. 4.3×10^{-10} *M*
e. 2.4×10^{-11} *M*

____ 47. Which of the following anions is the strongest base?
a. ClO^- d. Cl^-
b. ClO_3^- e. I^-
c. ClO_4^-

____ 48. When solid NaCN is added to water, the pH ____.
a. remains at 7
b. becomes greater than 7 because of hydrolysis of Na^+
c. becomes less than 7 because of hydrolysis of Na^+
d. becomes greater than 7 because of hydrolysis of CN^-
e. becomes less than 7 because of hydrolysis of CN^-

____ 49. Calculate the pH of 0.14 *M* NaF solution.
a. 8.09
b. 8.12
c. 8.14
d. 8.18
e. 8.21

Chapter 19 Values
The following equilibrium constants will be useful for some of the problems.

Substance	Constant	Substance	Constant
HCO_2H	$K_a = 1.8 \times 10^{-4}$	H_2CO_3	$K_1 = 4.2 \times 10^{-7}$
HNO_2	$K_a = 4.5 \times 10^{-4}$		$K_2 = 4.8 \times 10^{-11}$
HOCl	$K_a = 3.5 \times 10^{-8}$	$(COOH)_2$	$K_1 = 5.9 \times 10^{-2}$
HF	$K_a = 7.2 \times 10^{-4}$		$K_2 = 6.4 \times 10^{-5}$
HCN	$K_a = 4.0 \times 10^{-10}$	CH_3COOH	$K_a = 1.8 \times 10^{-5}$
H_2SO_4	K_1 = very large	HOCN	$K_a = 3.5 \times 10^{-4}$
	$K_2 = 1.2 \times 10^{-2}$	$C_6H_5NH_2$	$K_b = 4.2 \times 10^{-10}$
HOBr	$K_a = 2.5 \times 10^{-9}$	NH_3	$K_b = 1.8 \times 10^{-5}$

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____ 50. What is the $[H_3O^+]$ of a solution that is 0.0100 *M* in HOCl and 0.0300 *M* in NaOCl?
a. 2.14×10^{-7} *M*
b. 1.45×10^{-7} *M*
c. 7.41×10^{-8} *M*
d. 2.29×10^{-8} *M*
e. 1.17×10^{-8} *M*

____ 51. Which one of the following combinations is **not** a buffer solution?
a. NH_3 - $(NH_4)_2SO_4$
b. HBr - KBr
c. HCN - NaCN
d. NH_3 - NH_4Br
e. CH_3COOH - $NaCH_3COO$

____ 52. It is desired to buffer a solution at pH = 4.30. What molar ratio of CH_3COOH to $NaCH_3COO$ should be used?
a. 1.2/1
b. 0.8/1
c. 0.12/1
d. 2.8/1
e. 6.2/1

____ 53. What is the pH at the point in a titration at which 20.00 mL of 1.000 *M* KOH has been added to 25.00 mL of 1.000 *M* HBr?
a. 1.67
b. 0.95
c. 3.84
d. 2.71
e. 1.22

____ 54. What is the pH of the solution resulting from the addition of 25.0 mL of 0.0100 *M* NaOH solution to 40.0 mL of 0.0100 *M* acetic acid, CH_3COOH?
a. 4.54
b. 4.52
c. 4.94
d. 4.96
e. 5.17

____ 55. How many grams of potassium formate, **KHCOO**, must be added to **500. mL** of a **0.0700 *M*** solution of formic acid, **HCOOH**, to produce a buffer solution with a pH of **3.50**? (Any change in the volume of the solution due to the addition of solid potassium formate is insignificant.)
K_a = $\mathbf{1.8 \times 10^{-4}}$ for HCOOH.
a. 1.0 g
b. 5.2 g
c. 6.7 g
d. 1.7 g

____ 56. Calculate the solubility product constant for aluminum hydroxide. Its molar solubility is 2.9×10^{-9} mole per liter at 25°C.
a. 9.8×10^{-26}
b. 4.9×10^{-26}
c. 7.1×10^{-35}
d. 2.1×10^{-34}
e. 1.9×10^{-33}

____ 57. Magnesium hydroxide is a slightly soluble substance. If the pH of a saturated solution of $Mg(OH)_2$ is 10.49 at 25°C, calculate K_{sp} for $Mg(OH)_2$.
a. 8.8×10^{-16}
b. 4.2×10^{-15}
c. 6.0×10^{-10}
d. 4.4×10^{-14}
e. 1.5×10^{-11}

____ 58. How many grams of $Mn(OH)_3$ will dissolve in 1350 mL of water at 25°C? $K_{sp} = 1.0 \times 10^{-36}$
a. 4.6×10^{-8} g
b. 6.3×10^{-8} g
c. 5.9×10^{-10} g
d. 1.4×10^{-7} g
e. 9.3×10^{-7} g

____ 59. The K_{sp} for $Fe(IO_3)_3$ is 10^{-14}. We mix two solutions, one containing Fe^{3+} and one containing IO_3^- ions at 25°C. At the instant of mixing, $[Fe^{3+}] = 10^{-4}$ *M* and $[IO_3^-] = 10^{-5}$ *M*. Which one of the following statements is true?
a. A precipitate forms, because $Q_{sp} > K_{sp}$.
b. A precipitate forms, because $Q_{sp} < K_{sp}$.
c. No precipitate forms, because $Q_{sp} > K_{sp}$.
d. No precipitate forms, because $Q_{sp} < K_{sp}$.
e. None of the preceding statements is true.

____ 60. A solution contains 0.05 M Au^+, 0.05 M Cu^+, and 0.05 M Ag^+ ions. When solid NaCl is added to the solution, what is the **order** in which the chloride salts will begin to precipitate? $K_{sp(AgCl)} = 1.8 \times 10^{-10}$, $K_{sp(AuCl)} = 2.0 \times 10^{-13}$, $K_{sp(CuCl)} = 1.9 \times 10^{-7}$
a. AuCl > AgCl > CuCl
b. AuCl > AgCl > NaCl
c. AgCl > CuCl > AuCl
d. CuCl > AgCl > AuCl
e. NaCl > CuCl > AgCl

____ 61. Calculate the concentration of Cu^{2+} ions in a 0.010 *M* $[Cu(NH_3)_4]^{2+}$ solution at 25°C.
K_d for $[Cu(NH_3)_4]^{2+} = 8.5 \times 10^{-13}$
a. 1.3×10^{-3} *M*
b. 5.1×10^{-4} *M*
c. 6.3×10^{-5} *M*
d. 8.7×10^{5} *M*
e. 1.3×10^{-6} *M*

____ 62. What is the oxidation number of arsenic in K_3AsO_4?
a. +1 d. +4
b. +2 e. +5
c. +3

____ 63. Balance the following equation. How many HCl are there on the left side of the balanced equation?

$$K_2Cr_2O_7 + Na_2SO_3 + HCl \rightarrow KCl + Na_2SO_4 + CrCl_3 + H_2O$$

a. 1
b. 2
c. 3
d. 4
e. 8

____ 64. Consider the following net ionic equation. Which species is oxidized?

$$MnO_4^- + SO_3^{2-} \rightarrow Mn^{2+} + SO_4^{2-} \text{ (acidic solution)}$$

a. MnO_4^-
b. Mn^{2+}
c. SO_3^{2-}
d. SO_4^{2-}
e. no species is oxidized

____ 65. In **any** electrochemical cell, the anode is **always** ____
a. the positive electrode.
b. the negative electrode.
c. the electrode at which some species gains electrons.
d. the electrode at which some species loses electrons.
e. the electrode at which reduction occurs.

____ 66. Which choice includes all of the following that are **oxidation-reduction reactions** and no others?

I. $BaSO_3(s) \rightarrow BaO(s) + SO_2(g)$
II. $2K(s) + Br_2(\ell) \rightarrow 2KBr(s)$
III. $H_2CO_3(aq) + Ca(OH)_2(aq) \rightarrow CaCO_3(s) + 2H_2O(\ell)$
IV. $SnS_2(s) + HCl(aq) \rightarrow H_2SnCl_6(s) + 2H_2S(aq)$
V. $3Cl_2(g) + 6KOH(aq) \rightarrow 5KCl(aq) + KClO_3(aq) + 3H_2O(\ell)$

a. II, III, and IV
b. I and III
c. II and V
d. I and IV

____ 67. How many coulombs of charge pass through a cell if 2.40 amperes of current are passed through the cell for 85.0 minutes?
a. 2.04×10^2 C
b. 1.33×10^{-1} C
c. 1.22×10^4 C
d. 2.12×10^3 C
e. 3.40 C

____ 68. Which of the following statements about voltaic cells is **false**?
a. Voltaic cells are spontaneous reactions.
b. The cathode is positive.
c. Electrons flow from the cathode to the anode.
d. A salt bridge maintains electrical contact and charge neutrality in the half-cells.
e. The half-reactions take place in separate cells.

____ 69. A voltaic cell is constructed with one cell consisting of an Al electrode in 1.0 *M* Al^{3+} and another cell with an Fe electrode in 1.0 *M* Fe^{2+}. When this cell operates, the Al electrode loses mass and the Fe electrode gains mass. Which of the following represents the reaction that occurs at the <u>positive electrode</u> of this cell?
a. $Al^{3+} + 3e^- \rightarrow Al$
b. $Fe \rightarrow Fe^{2+} + 2e^-$
c. $Al \rightarrow Al^{3+} + 3e^-$
d. $Fe^{2+} + 2e^- \rightarrow Fe$
e. $Fe^{2+} \rightarrow Fe^{3+} + e^-$

____ 70. Which of the following statements about the operation of a standard galvanic cell made of a Cu/ Cu^{2+} half-cell and a Zn/ Zn^{2+} half-cell is **false**?
a. The mass of the copper electrode decreases.
b. The $[Zn^{2+}]$ increases.
c. The $[Cu^{2+}]$ decreases.
d. The salt bridge maintains charge neutrality.
e. The zinc electrode is oxidized.

____ 71. Which of the following describes the net reaction that occurs in the cell, $Cd|Cd^{2+}(1\ M)||Cu^{2+}(1\ M)|Cu$?
a. $Cu + Cd^{2+} \rightarrow Cu^{2+} + Cd$
b. $Cu + Cd \rightarrow Cu^{2+} + Cd^{2+}$
c. $Cu^{2+} + Cd^{2+} \rightarrow Cu + Cd$
d. $Cu^{2+} + Cd \rightarrow Cu + Cd^{2+}$
e. $2Cu + Cd^{2+} \rightarrow 2Cu^+ + Cd$

____ 72. What is the cell potential for a cell constructed by immersing a strip of manganese in a 1.0 *M* $MnSO_4$ solution and a strip of iron in a 1.0 *M* $FeSO_4$ solution and completing the circuit by a wire and a salt bridge?
a. -1.62 V
b. +1.62 V
c. -0.74 V
d. +0.74 V
e. +1.21 V

____ 73. What is the cell potential for the following reaction if the $[Au^+] = 0.0015$ *M* and the $[Fe^{3+}] = 0.033$ *M*?
Relevant half-reactions are $Fe^{3+}(aq) + 3\ e^- \rightarrow Fe(s)$, $E^o_{red} = -0.04$ V and $Au^+(aq) + e^- \rightarrow Au(s)$, $E^o_{red} = 1.69$ V
$Fe\ (s) + 3\ Au^+\ (aq) \rightarrow Fe^{3+}\ (aq) + 3\ Au\ (s)$
a. 1.87 V
b. 1.73 V
c. 1.65 V
d. 1.70 V
e. 1.59 V

____ 74.

Reduction Half-Reaction	Standard Reduction Potential E^0 (volts)
$Mg^{2+} + 2\ e^- \rightarrow Mg(s)$	-2.37
$Ni^{2+} + 2\ e^- \rightarrow Ni(s)$	-0.25

Which of the following reactions will take place **spontaneously**:
a. $Ni^{2+} + Mg^{2+} \rightarrow Ni(s) + Mg(s)$
b. $Ni^{2+} + Mg(s) \rightarrow Ni(s) + Mg^{2+}$
c. $Ni(s) + Mg(s) \rightarrow Ni^{2+} + Mg^{2+}$
d. $Ni(s) + Mg^{2+} \rightarrow Ni^{2+} + Mg(s)$

____ 75. In which one of the following does the **transition metal** have a 3*d*8 electronic configuration?
a. $[Fe(NCS)(OH_2)_5]^{2+}$
b. $[FeF_6]^{4-}$
c. $[CuCl_4]^{2-}$
d. $[Co(NH_3)_6]^{3+}$
e. $[Ni(NH_3)_6]^{2+}$

____ 76. Which one of the following octahedral configurations has **no** low spin configuration?
a. d^4
b. d^7
c. d^8
d. d^6
e. d^5

____ 77. Consider the complex ion $[FeF_6]^{3-}$. Which response includes **all** of the following statements that are **true**, and no false statements?

I. It is paramagnetic.
II. It is a low spin complex.
III. It is a high spin complex.
IV. The oxidation number of iron is +3.

a. I, III, and IV
b. II and III
c. IV
d. I and II
e. II and IV

____ 78. Consider the complex ion $[Fe(CN)_6]^{4-}$. Which of the following responses includes **all** of the **true** statements with respect to this complex ion and the ions from which it was formed, and no false statements?

I. The complex ion is octahedral.
II. Fe^{2+} is a d^5 ion.
III. CN- is a strong field ligand.
IV. CN- is a weak field ligand.
V. The complex ion is a low spin complex.
VI. The complex ion is a high spin complex.
VII. The complex ion contains no unpaired electrons.
VIII. The complex ion contains four unpaired electrons.

a. I, II, III, V, and VII
b. II, III, V, and VII
c. II, IV, VI, and VIII
d. I, II, IV, VI, and VIII
e. I, III, V, and VII

____ 79. Which of the following statements concerning octahedral complexes is incorrect?
a. Strong field ligands produce large crystal field splittings.
b. Weak field ligands produce high spin complexes.
c. Halide ions are strong field ligands.
d. Weak field ligands result in relatively small values for Δ^o.
e. A relatively large value for Δ^o causes a complex ion to absorb relatively high energy (shorter wavelength) light.

____ 80. Complete and balance the following equation. The missing term is ____.

$$^{44}_{21}Sc + {}^{2}_{1}H \rightarrow \_\_\_\_ + {}^{1}_{0}n$$

a. $^{45}_{21}Sc$
b. $^{45}_{22}Ti$
c. $^{42}_{20}Ca$
d. $^{46}_{21}Sc$
e. $^{46}_{22}Ti$

____ 81. If the nucleus $^{106}_{47}Ag$ decays by an electron capture, the resulting isotope would be ____.
a. $^{107}_{47}Ag$
b. $^{106}_{48}Cd$
c. $^{110}_{49}In$
d. $^{105}_{46}Pd$
e. $^{106}_{46}Pd$

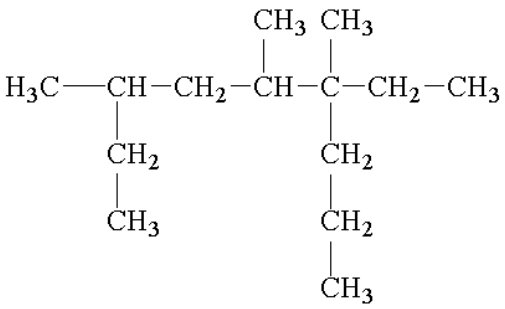
____ 82. The half-life of Tc-99 is 2.13×10^5 years. What is the value of the specific rate constant, *k*?
a. $3.25 \times 10^{-6}\ y^{-1}$
b. $1.41 \times 10^{-6}\ y^{-1}$
c. $4.69 \times 10^{-6}\ y^{-1}$
d. $0.693\ y^{-1}$
e. $1.48 \times 10^{5}\ y^{-1}$

____ 83. Nitrogen-13 has a half-life of 9.97 minutes. How much of a 10.0-g sample remains after 60.0 minutes?
a. 9.2 g
b. 0.15 g
c. 0.35 g
d. 1.2 g
e. 2.5 g

____ 84. The half-life of ^{33}P is 25.3 days. How long will it take for 64.0 g to decay to 1.0 g?
a. 150 d
b. 350 d
c. 210 d
d. 120 d
e. 100 d

____ 85. What is the molecular formula for heptane?
a. C_7H_{14}
b. C_7H_{12}
c. C_9H_{18}
d. C_7H_{16}
e. C_9H_{20}

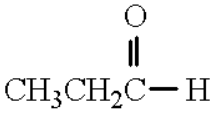
____ 86. The correct IUPAC name for the compound shown below is ____.



a. 3,5,6-trimethyl-6-propyloctane
b. 6-ethyl-3,5,6-trimethylnonane
c. 2-ethyl-4,5-dimethyl-5-propylheptane
d. 2,5-diethyl-4,5-dimethyloctane
e. 3,4,6-trimethyl-3-propyloctane

____ 87. Benzene does **not** have ____.
a. sp^2 hybridized carbons
b. π bonds
c. resonance
d. delocalized electrons
e. tetrahedral carbons

____ 88. Which one of the following is a **tertiary** alcohol?
a. CH_3CH_2OH
b. CH_3OH
c. $CH_3CH(OH)CH_3$
d. $(CH_3)_3COH$
e. None of these answers is a tertiary alcohol.

____ 89.  is an example of a(an) ____.

a. acid
b. aldehyde
c. phenol
d. ketone
e. ether

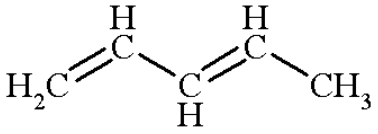
____ 90. ____ is the best known polyamide.

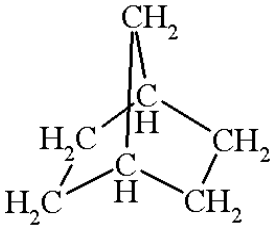
a. nylon
b. Teflon
c. PET
d. neoprene
e. rubber

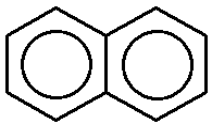
____ 91. Which one of the following alkanes is most likely to be a **solid** at room temperature?

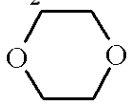
a. methane, CH_4
b. octane, C_8H_{18}
c. dodecane, $C_{12}H_{26}$
d. eicosane, $C_{20}H_{42}$

____ 92. Which one of the following formulas represents an **aromatic** compound?

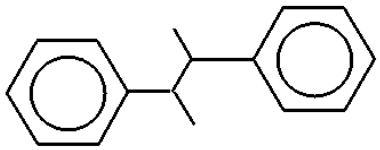
a. 

c. 

b. 

d. 

____ 93. How many hydrogen atoms are in the formula for the compound with the structure shown below?



a. 16
b. 17
c. 18
d. 19
e. 20

Chem 401 Practice Final Exam
Answer Section

MULTIPLE CHOICE

1. ANS: E
2. ANS: A
3. ANS: D
4. ANS: E
5. ANS: E
6. ANS: A
7. ANS: D
8. ANS: D
9. ANS: C
10. ANS: A
11. ANS: B
12. ANS: E
13. ANS: C
14. ANS: E
15. ANS: C
16. ANS: C
17. ANS: B
18. ANS: A
19. ANS: E
20. ANS: B
21. ANS: C
22. ANS: A
23. ANS: D
24. ANS: D
25. ANS: D
26. ANS: B
27. ANS: A
28. ANS: E
29. ANS: C
30. ANS: A
31. ANS: B
32. ANS: B
33. ANS: B
34. ANS: A
35. ANS: A
36. ANS: D
37. ANS: D
38. ANS: D
39. ANS: B
40. ANS: C
41. ANS: E
42. ANS: E
43. ANS: A
44. ANS: C
45. ANS: A
46. ANS: B
47. ANS: A
48. ANS: D
49. ANS: C
50. ANS: E
51. ANS: B
52. ANS: D
53. ANS: B
54. ANS: D
55. ANS: D
56. ANS: E
57. ANS: E
58. ANS: B
59. ANS: D
60. ANS: A
61. ANS: B
62. ANS: E
63. ANS: E
64. ANS: C
65. ANS: D
66. ANS: C
67. ANS: C
68. ANS: C
69. ANS: D
70. ANS: A
71. ANS: D
72. ANS: D
73. ANS: E
74. ANS: B
75. ANS: E
76. ANS: C
77. ANS: A
78. ANS: E
79. ANS: C
80. ANS: B
81. ANS: E
82. ANS: A
83. ANS: B
84. ANS: A
85. ANS: D
86. ANS: B
87. ANS: E
88. ANS: D
89. ANS: B
90. ANS: A
91. ANS: D
92. ANS: B
93. ANS: C