CHE 107 FINAL EXAMINATION December 12, 2011

University of Kentucky Department of Chemistry

READ THESE DIRECTIONS CAREFULLY BEFORE STARTING THE EXAMINATION!

It is *extremely* important that you fill in the answer sheet EXACTLY as indicated, otherwise your answer sheet may not be processed; ALL entries are to be made on SIDE 1 of the answer sheet. Use a #2 pencil (or softer); fill in the circles completely and firmly. Erasures must be complete. Use only the following categories:

NAME:	Print your name starting at the first space, LAST NAME first, then a space, followed by your FIRST NAME, then another space, followed by your MIDDLE INITIAL. Fill in the correct circles below your printed name corresponding to the letters of your name; for the spaces, fill in the top blank circle.
STUDENT NUMBER:	This is **VERY IMPORTANT!** Under IDENTIFICATION NUMBER, put in your **8 DIGIT STUDENT ID NUMBER** (**do not use the 9 at the beginning of your number**) beginning in column A and continuing through column H, column I will be blank, (do NOT use column J at this time); be sure to fill in the correct circles (a common error to be avoided is mistaking "0" for "1").
TEST FORM:	Fill in the "4" blank in the J column under IDENTIFICATION NUMBER (to indicate Hour Examination IV).
SPECIAL CODES:	Use for course and section number; in positions K-P write in one of the following: Dr. Ades 107-001, 107-002
SIGNATURE:	You **MUST** sign the examination answer sheet (bubble sheet) on the line directly above your printed name. Use your legal signature.

Answering Questions:

Starting with answer "1" on SIDE 1, fill in the circle indicating the one best answer for each of the **60 questions** in this examination. Your score is the sum of the appropriate credit for each response.

Grading and Reporting:

The examination scores will be posted in Blackboard as soon as possible after the examination. If an error has occurred in scoring your answers, inform your instructor within 48 hours of the posting of your score.

BE SURE THAT YOUR TEST HAS 60 QUESTIONS, A PERIODIC TABLE, AND TWO SHEETS OF SCRATCH PAPER. You may NOT use your own scratch paper during this examination. Cell phones, computer, and pagers are to be turned off and out of sight during the exam. **All** exam paper, scratch paper, and scantrons must be handed in at the end of the exam. You may **not** take any exam materials away from the exam room.

Questions 1 – 15 cover Exam I material

1. Which of the following displays both dispersion and dipole-dipole forces?

   A. C_2F_6
   B. CO_2
   C. SO_3
   D. PF_3

2. Which of the following has the molecule with the **higher** boiling point listed **first**?

   A. N_2, O_2
   B. CH_3F, CH_3Cl
   C. NH_3, PH_3
   D. CH_3CH_3, $CH_3CH_2CH_3$

3. The intermolecular force(s) responsible for the fact that CH_4 has the lowest boiling point in the series CH_4, SiH4, GeH_4, SnH_4 is/are

   A. hydrogen bonding.
   B. dispersion forces.
   C. mainly hydrogen bonding but also dipole-dipole forces.
   D. dispersion and dipole-dipole forces.

4. To determine the ΔH_{vap} of a compound from experimental data, one plots

   A. P vs T
   B. ln P vs $1/T$
   C. P vs $1/T$
   D. ln P vs T

5. How much heat is needed to melt 225 g of acetone, $C_3H_6O(s)$ at -94.8^oC, which is the normal freezing point of $C_3H_6O(s)$? The ΔH_{fus} of $C_3H_6O(s)$ is 5.69 kJ/mol and the specific heat capacity is 2.15 J/g•^{o} C.

   A. 13.5 kJ
   B. 83.4 kJ
   C. 484 kJ
   D. 22.1 kJ

6. A substance with strong intermolecular forces will have a

A. low boiling point.
B. low vapor pressure.
C. small heat of vaporization.
D. low critical temperature and pressure.

7. A compound crystallizes in a cubic lattice with X ions on the corners, and Y ions in the body center and on the faces. What is the empirical formula of the compound?

A. XY_2
B. XY_3
C. X_2Y_3
D. XY_4

8. Barium metal crystallizes in a body-centered cubic lattice with a density of 3.50 g/cm^3. What is the edge length of the barium unit cell?

A. 507 pm
B. 412 pm
C. 137 pm
D. 319 pm

9. A solid has a boiling point of 1200^oC and is a nonconductor of electricity. This solid most likely is a(n)

A. molecular solid.
B. ionic solid.
C. network covalent solid.
D. metallic solid.

10. Which of the following liquids would **not** be a good solvent for HI?

A. CO_2
B. H_2CO
C. NH_3
D. CH_3OH

11. $CO_2(g)$ is **most** soluble in water at ___partial pressure of CO_2 and ___temperature.

A. low, low
B. low, high
C. high, low
D. high, high

12. What is the molality of an aqueous 1.69 M $(NH_4)_2SO_4$ solution? The density of the solution is 1.117 g/mL.

A. 1.89 *m*
B. 1.51 *m*
C. 1.96 *m*
D. 1.89 *m*

13. The ideal value of the van't Hoff factor , *i*, for $(NH_4)_2SO_3$ is

A. 7
B. 5
C. 3
D. 1

14. What is the freezing point of an aqueous solution that contains 0.100 mole of NaCl **and** 0.100 mole of $Al(NO_3)_3$ in 1.00 kg of water? K_f for water is 1.86°C/*m*.

A. –0.372 °C
B. –1.12 °C
C. –0.930 °C
D. –1.74 °C

15. Which of the following aqueous solutions will have the **highest** osmotic pressure?

A. 0.50 M $C_6H_{12}O_6$
B. 0.30 M $NaNO_3$
C. 0.15 M $CaCl_2$
D. 0.15 M $(NH_4)_2SO_4$

Questions 16 – 30 cover Exam II material

16. The rate of consumption of Br^- at some point in time for the reaction below is 2.00 M/s. What is the rate of consumption of H^+ at the same time?

$$5Br^-(aq) + BrO_3^-(aq) + 6H^+(aq) \rightarrow 3Br_2(aq) + 3H_2O(l)$$

A. 2.40 M/s
B. 3.60 M/s
C. 0.600 M/s
D. 2.00 M/s

17. For the reaction $2NO(g) + Cl_2(g) \rightarrow 2NOCl(g)$, which one of the following can you **correctly assume**?

A. The rate law is: rate = $k[NO]^2[Cl_2]$.
B. The rate law cannot be determined from the data given.
C. The reaction is first order in NO(*g*).
D. The reaction is second order.

18. A reaction is second order in A and second order in B. What is the effect on the rate of the reaction when the concentration of A is tripled and the concentration of B is doubled?

A. The rate increases by a factor of 18.
B. The rate quadruples.
C. The rate increases by a factor of 36.
D. The rate increases by a factor of 16.

19. What data should be plotted for the reaction

$$A \rightarrow \text{Products}$$

to show that the experimental data fits a zero-order reaction (is a straight line plot)?

A. [A] vs time
B. [A] vs temperature
C. ln[A] vs time
D. $\frac{1}{[A]}$ vs time

20. Initial rate data (shown below) for the reaction $A(g) + B_2(g) \rightarrow AB_2(g)$ were collected.

[A](M)	$[B_2]$ (M)	initial rate (M/s)
2.00	1.00	0.300
4.00	1.00	0.600
4.00	2.00	0.848

What is the rate law for the reaction?

A. Rate = $k[A][B_2]^{1/2}$
B. Rate = $k[A][B_2]^{3/2}$
C. Rate = $k[B_2]^{-1/2}$
D. Rate = $k[A][B_2]$

21. The gas phase reaction

$$2NOBr \rightarrow 2NO + Br_2$$

was monitored as a function of time. A plot of 1/[NOBr] versus time yields a straight line with slope 0.800 $M^{-1}s^{-1}$. If the initial concentration of NOBr is 0.250 M and the reaction mixture initially contains no products, what is the concentration of **NO** after 20.0 s?

A. 0.100 M
B. 0.200 M
C. 0.050 M
D. 0.150 M

22. Which of the following is true for a reaction when the temperature is **lowered**?

A. The rate constant decreases and the activation energy increases.
B. The rate constant and the activation energy decrease.
C. The rate constant increases and the rate decreases.
D. The rate constant and the rate decrease.

23. The following mechanism has been proposed for a gas phase reaction.

$NO_2 + SO_2 \rightarrow NO + SO_3$
$NO_2 + SO_2 \rightarrow NO + SO_3$
$2\ NO + O_2 \rightarrow 2NO_2$

Which one of the following is a reaction intermediate for the reaction?

A. NO_2
B. SO_2
C. SO_3
D. NO

24. Which of the following statements is **true**?

A. A $K_{eq} << 1$ implies that the forward reaction is favored.
B. At equilibrium, the rate of the forward reaction is equal to the rate of the reverse reaction.
C. At equilibrium, all chemical reactions have stopped.
D. The equilibrium state can only be reached by starting with reactants only.

25. What is K_c for the reaction

$$SO_2(g) + NO_3(g) \leftrightarrows SO_3(g) + NO_2(g)$$

given

$$2SO_3(g) \leftrightarrows 2SO_2(g) + O_2(g) \quad K_c = 2.3 \times 10^{-7}$$
$$2NO_3(g) \leftrightarrows 2NO_2(g) + O_2(g) \quad K_c = 1.4 \times 10^{-3}$$

A. 3.2×10^{-10}
B. 3.0×10^{3}
C. 1.3×10^{-2}
D. 78

26. Solid NH_4Cl is introduced into an evacuated vessel at some temperature. The following reaction takes place.

$$NH_4Cl(s) \leftrightarrows NH_3(g) + HCl(g)$$

At equilibrium, $K_p = 0.400$ for the reaction at the same temperature. What is the **total** gas pressure at equilibrium? (Some of the solid is present also.)

A. 0.800 atm
B. 1.26 atm
C. 0.200 atm
D. 1.60 atm

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27. A mixture of 0.100 mol of NO, 0.0500 mol of H_2, and 0.100 mol of H_2O is placed in a 1.00 L reaction vessel at 300 K and the following equilibrium established:

$$2NO(g) + 2H_2(g) \leftrightarrows N_2(g) + 2H_2O(g)$$

At equilibrium $[N_2] = 0.010$ M. What is the equilibrium concentration of NO?

A. 0.010 M
B. 0.090 M
C. 0.120 M
D. 0.080 M

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28. The reaction

$$2H_2(g) + O_2(g) \leftrightarrows 2H_2O(g)$$

is exothermic. Which of the following conditions of temperature and pressure will maximize the formation of **the products?**

A. high temperature, high pressure
B. high temperature, low pressure
C. low temperature, high pressure
D. low temperature, low pressure

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29. $K = 29$ at 25 °C and $K = 0.0011$ at 100 °C. Therefore, the reaction is

A. exothermic
B. endothermic
C. isotonic
D. ergonomic

30. What is the conjugate base of OH^-?

A. H_2O
B. H_3O^+
C. O^{2-}
D. OH^-

Questions 31 – 45 cover Exam III material

31. What is the hydronium ion concentration in an aqueous solution when pH= 3.44?

A. 3.6×10^{-4} M
B. 2.8×10^{-11} M
C. 3.6×10^{-10} M
D. 2.8×10^{-10} M

32. Which one of the following statements is **true** for an aqueous 1.00 M solution of **$HClO_2$**?

A. The pH is 0.00
B. $[H_3O^+] = [ClO_2^-]$
C. $[ClO_2^-] = 0.500$ M
D. $[H_3O^+] = 1.00$ M

33. What is the **original molarity** of an aqueous solution of chloroacetic acid ($HC_2H_2O_2Cl$) whose pH is 1.95? K_a for chloroacetic acid is 1.4×10^{-3}.

A. 0.10 M
B. 0.011 M
C. 0.022 M
D. 0.090 M

34. What is the pH of an aqueous solution that is 0.50 M in HNO_3 and 0.50 M in boric acid (H_3BO_3)? $K_a = 5.4 \times 10^{-10}$ for H_3BO_3.

A. 0.69
B. 0.00
C. 0.30
D. The K_a for HNO_3 is needed to calculate the pH.

35. Which one of the following will form a **basic** solution in water?

A. NH_4Br
B. $CH_3NH_3NO_3$
C. NaI
D. KCN

36. What is the pH of a 0.45 M hydroxylammonium chloride, $HONH_3Cl$, solution? $K_b = 1.1 \times 10^{-8}$ for hydroxylamine, $HONH_2$.

A. 9.85
B. 3.19
C. 4.15
D. 11.10

37. Which one of the following is the **weakest** base?

A. OI^-
B. OBr^-
C. OCl^-
D. OF^-

38. When **ammonium chloride** (NH_4Cl) is added to an aqueous solution of **ammonia** (NH_3), the pH of the solution

A. increases.
B. decreases.
C. is unchanged.
D. is 0.00

39. Which of the following combinations would be **best** to prepare a buffer whose pH is 4.00?

A. NH_4Cl/NH_3
K_b for $C_5H_5NH = 1.8 \times 10^{-5}$

B. $C_{10}H_{15}N_2Br/C_{10}H_{14}N$
K_b for $C_{10}H_{14}N_2 = 1.0 \times 10^{-6}$

C. HF/NaF
K_a for HF$= 3.5 \times 10^{-4}$

D. HClO/NaCl
K_a for HClO$= 2.9 \times 10^{-8}$

40. Addition of which of the following **will** destroy the buffering ability of 1.00 L of a solution that contains 1.50 mol HNO_2 and 1.00 mol $NaNO_2$? Assume no volume change.

A. 1.00 mol NaOH

B. 0.50 mol HCl

C. 0.10 mol NaOH

D. 1.20 mol HCl

41. What is the pH of a solution made by mixing 100.00 mL of 0.100 M ammonia (NH_3) with 20.00 mL of 0.200 M HCl? K_b for ammonia is 1.8×10^{-5}.

A. 9.17

B. 9.43

C. 4.04

D. 8.98

42. A 100.0 mL sample of 0.500 M butanoic acid is titrated with 0.500 M KOH. What is the pH at the equivalence point of the titration? K_a for butanoic acid is 1.5×10^{-5}.

A. 9.11

B. 4.74

C. 4.70

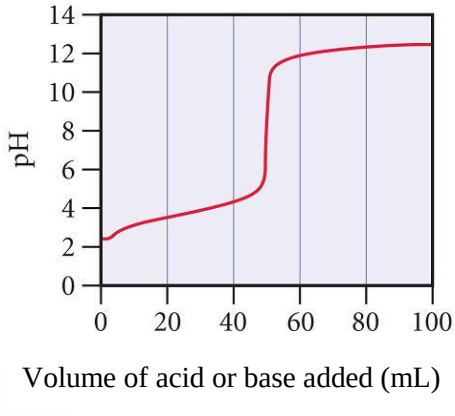
D. 10.26

43. An indicator has a $K_a = 2 \times 10^{-7}$. The nonionized form of the indicator is yellow and the ionized form is blue. What is the color of the indicator in a solution whose pH is 4.2?

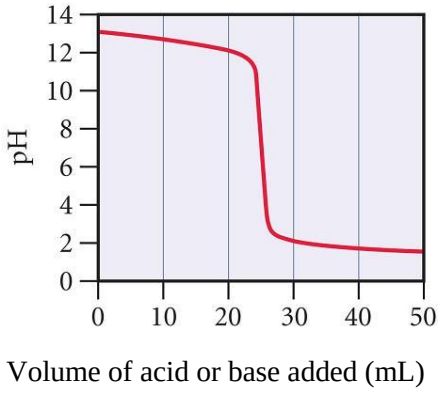
A. yellow
B. green
C. yellow-green
D. blue

44. Which one of the following curves represents the titration of a 0.10 M strong base by a strong acid?

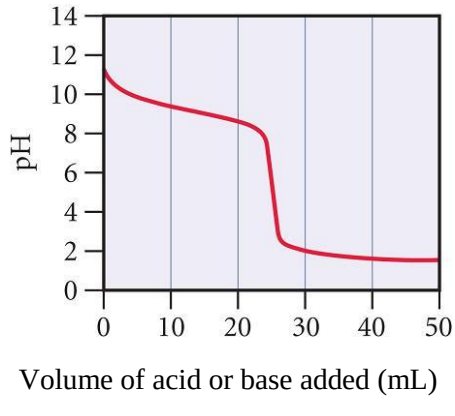
A.



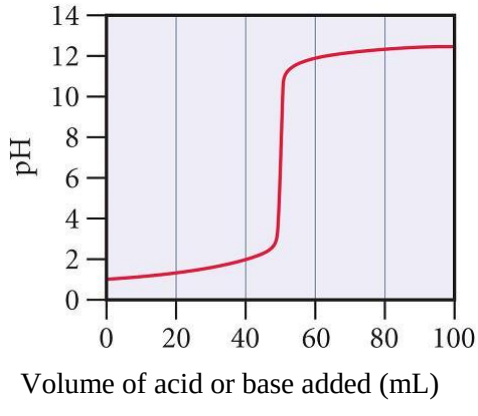
C.



B.



D.



45. Which of the following is the correct relationship between molar solubility, *S*, and the solubility product for Ag_3PO_4 ?

A. $K_{sp} = S^2$
B. $K_{sp} = 4S^3$
C. $K_{sp} = 27S^4$
D. $K_{sp} = 108S^5$

Questions 46 – 60 cover material after Exam III

46. In which aqueous system is $Fe(OH)_2$ least soluble.

A. at pH = 5.0
B. in 0.30 M $NaNO_3$
C. in water only
D. in 0.20 M $Fe(NO_3)_2$

47. What is the solubility of CaF_2 in 0.010 M KF? K_{sp} of $CaF_2 = 1.46 \times 10^{-10}$.

A. 1.46×10^{-8} M
B. 1.46×10^{-14} M
C. 1.46×10^{-6} M
D. 1.46×10^{-12} M

48. What minimum concentration of NaOH is needed to start precipitation of $Ba(OH)_2$ from 0.100 M $Ba(NO_3)_2$? K_{sp} of $Ba(OH)_2$ is 5.0×10^{-3}.

A. 0.0050 M
B. 0.50 M
C. 0.071 M
D. 0.22 M

49. Will a precipitate of MgF_2 form when 200.0 mL of 4.0×10^{-4} M $MgCl_2$ is mixed with 200.0 mL of 4.0×10^{-4} M NaF? K_{sp} of MgF_2 is 5.16×10^{-11}.

A. No, because $Q > K_{sp}$
B. No, because $Q < K_{sp}$
C. Yes, because $Q > K_{sp}$
D. Yes, because $Q < K_{sp}$

50. Which of the following is **not** more soluble in acid than in pure water?

A. AgBr
B. $Mg(OH)_2$
C. CaS
D. PbF_2

51. Which one of the following is **true**?

A. The K_{sp} for $Ca(OH)_2$ is the same in water as it is in 0.10 M NaOH.

B. The K_{sp} and molar solubility of $Ca(OH)_2$ are the same.

C. The addition of $CaCl_2$ to a solution containing $Ca(OH)_2$ does not affect the molar solubility of $Ca(OH)_2$.

D. The molar solubility of $Ca(OH)_2$ is the same in water as it is in the presence of 0.10 M NaOH.

52. Which one of the following has the species with the **larger** entropy value listed **first**? There is one mole of each substance and the temperature is the same for each pair.

A. $Ar(g)$, $F_2(g)$

B. $Na(s)$, $NaCl(s)$

C. $F_2(g)$, $Cl_2(g)$

D. $H_3COCH_3(l)$, $H_3CCH_2OH(l)$

53. What is ΔS^{o}_{rxn} for the following reaction?

$$4\ NH_3(g) + 5\ O_2(g) \rightarrow 4\ NO(g) + 6\ H_2O(g)$$

Use the following S^{o}'s: $NH_3(g) = 192.8$ J/K
$O_2(g) = 205.2$ J/K
$NO(g) = 210.8$ J/K
$H_2O(g) = 188.8$ J/K

A. –336.6 J/K

B. 1.205×10^3 J/K

C. 287.4 J/K

D. 178.8 J/K

54. Which one of the following reactions has the most positive ΔS_{rxn}?

A. $4Fe(s) + 3O_2(g) \leftrightarrows 2Fe_2O_3(s)$

B. $2NH_3(g) \leftrightarrows N_2(g) + 3H_2(g)$

C. $2NO_2(g) \leftrightarrows 2NO(g) + O_2(g)$

D. $2H_2O(l) \leftrightarrows 2H_2(g) + O_2(g)$

55. Sodium carbonate can be made by heating sodium bicarbonate.

$$2\ NaHCO_3(s) \rightarrow Na_2CO_3(s) + CO_2(g) + H_2O(g)$$

The reaction is endothermic. Therefore, the reaction is spontaneous

A. at low temperatures only.
B. at high temperatures only.
C. at all temperatures.
D. at no temperature.

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56. What are the signs of ΔH, ΔS, and ΔG, respectively, for steam condensing at 75°C and 1 atm pressure?

A. -, -, -
B. +, +, -
C. +, -, +
D. -, +, +

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57. Ozone (O_3) in the atmosphere reacts with nitrogen monoxide:

$$O_3(g) + NO(g) \rightarrow NO_2(g) + O_2(g).$$

The ΔG^o for the reaction at 25°C is –198 kJ. What is K_p at this temperature?

A. 1.96×10^{-35}
B. 4.38
C. 5.10×10^{34}
D. 0.228

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58. What are the coefficients a and c when the following reaction is balanced in basic solution according to convention?

$$\mathbf{a}\ Ag(s) + \mathbf{b}\ CN^-(aq) + \mathbf{c}O_2(g) \rightarrow \mathbf{d}\ Ag(CN)_2^-(aq)$$

A. a=4, c=1
B. a=2, c=5
C. a=3, c=2
D. a=5, c=3

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59. Which of the following is true for the following electrochemical cell?

$$Fe(s)\,|\,Fe^{2+}(aq)\,||\,MnO_4^-(aq), H^+(aq), Mn^{2+}(aq)\,|\,Pt(s)$$

A. Fe^{2+} is oxidized at the anode.
B. Pt is reduced at the anode.
C. MnO_4^- is reduced at the cathode.
D. Fe is the oxidizing agent.

60. What is E^o for the reaction $2\ Fe(s) + 3\ Cl_2(g) \rightarrow 6\ Cl^-(aq) + 2\ Fe^{3+}(aq)$? Use the following reduction potentials.

$Cl_2(g) + 2\ e^- \rightarrow 2\ Cl^-(aq)$ $\quad E^o = 1.36$ V
$Fe^{3+}(aq) + 3\ e^- \rightarrow Fe(s)$ $\quad E^o = -0.04$ V

A. –4.16 V
B. 4.16 V
C. 1.40 V
D. 1.32 V

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1. D
2. C
3. B
4. B
5. D
6. B
7. D
8. A
9. C
10. A
11. C
12. A
13. C
14. B
15. B
16. A
17. B
18. C
19. A
20. A
21. B
22. D
23. D
24. B
25. D
26. B
27. D
28. C
29. A
30. C
31. A
32. B
33. A
34. C
35. D
36. B
37. D
38. B
39. C
40. D
41. B
42. A
43. A
44. C
45. C
46. D
47. C
48. D
49. B
50. A

51. A
52. D
53. D
54. D
55. B
56. A
57. C
58. A
59. C
60. C