CHE 107 FINAL EXAM - PART A August 1, 2013

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 "5" blank in the J column under IDENTIFICATION NUMBER (to indicate Examination V).
SPECIAL CODES:	Use for course and section number; in positions K-P write in the following: Dr.Blue 107-020
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 **25 questions** in this examination. Your score is the sum of the appropriate credit for each response. On the day following the examination, an examination key will be posted on Blackboard.

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 25 QUESTIONS, A PERIODIC TABLE, AND ONE SHEET OF SCRATCH PAPER. You may NOT use your own scratch paper during this examination. Cell phones, computers, and pagers are to be turned off and out of sight during the exam.

Questions 1 – 13 cover material from Exam 3

1. What is the **conjugate base** of $H_2P_2O_7^{2-}$?

   A. $H_4P_2O_7$
   B. $H_3P_2O_7^-$
   C. $HP_2O_7^{3-}$
   D. $P_2O_7^{4-}$

2. Which one of the following weak acids will have the **lowest** percent ionization?

   A. H_2S, $K_a = 8.9 \times 10^{-8}$
   B. $H_2C_6H_8O_4$, $K_a = 3.9 \times 10^{-5}$
   C. $H_2C_4H_4O_4$, $K_a = 6.2 \times 10^{-5}$
   D. $H_2C_4H_2O_4$, $K_a = 1.2 \times 10^{-2}$

3. Find the pH of a solution formed by mixing 100.0 mL of 0.200 *M* HCl and 100.0 mL of 0.100 *M* HClO. K_a for HClO is 2.9×10^{-8}.

   A. 4.28
   B. 2.39
   C. 1.00
   D. 0.57

4. What is the pH of a 0.235 *M* nitrous acid (HNO_2) solution? K_a for HNO_2 is 4.6×10^{-4}.

   A. 1.00
   B. 1.98
   C. 2.69
   D. 4.08

5. Which of the following aqueous solutions has a pH < 7.0?

   A. CH_3NH_3Br
   B. CaI_2
   C. NaCN
   D. KF

6. Which one of the following has the **stronger acid** listed **first**?

   A. H_2O, H_2Se
   B. HF, HBr
   C. HIO, HClO
   D. $HBrO_4$, HBrO

7. Which of the following is the best example of a **Lewis acid**?

A. NH_3

B. Ni^{2+}

C. H_2O

D. CN^-

8. What is the pH of a solution containing 0.450 *M* $HC_4H_7O_2$ and 0.350 *M* $KC_4H_7O_2$? The pK_a of $HC_4H_7O_2$ is 4.82.

A. 3.86

B. 5.21

C. 4.71

D. 4.82

9. HCl is added to a buffer solution containing CH_3NH_3Cl and CH_3NH_2. Which of the following reactions best explains how the added HCl reacts with the buffer system?

A. $H^+ + CH_3NH_2 \rightarrow CH_3NH_3^+$

B. $H^+ + Cl^- \rightarrow HCl$

C. $CH_3NH_2 + H_2O \rightarrow CH_3NH_3^+ + OH^-$

D. $H^+ + OH^- \rightarrow H_2O$

10. Which of the following combinations is the **best** choice to prepare a buffer with pH = 9.00? All concentrations are 0.250 *M*.

A. $HC_3H_3O_3/NaC_3H_3O_3$, K_a for $HC_3H_3O_3 = 4.1 \times 10^{-3}$

B. $HC_4H_7O_2/NaC_4H_7O_2$, K_a for $HC_4H_7O_2 = 1.5 \times 10^{-5}$

C. HClO/NaClO, K_a for $HClO = 2.9 \times 10^{-8}$

D. HCN/NaCN, K_a for $HCN = 4.9 \times 10^{-10}$

11. A 50.0 mL sample of 0.125 *M* acetic acid ($HC_2H_3O_2$, K_a 1.8×10^{-5}) is titrated with 0.250 *M* NaOH. What is the pH after adding 13.0 mL of NaOH to the $HC_2H_3O_2$ solution?

A. 3.06

B. 4.78

C. 5.42

D. 7.65

12. Which of the following is the correct relationship between the molar solubility, x, and the solubility product constant, K_{sp}, for $Ag_2CO_3(s)$?

A. $K_{sp} = x^2$
C. $K_{sp} = 4x^3$
B. $K_{sp} = 27x^4$
D. $K_{sp} = 9x^2$

13. Which of the following solutions will see a **decrease** in solubility with an **increase** in pH?

A. $Cu(OH)_2$
C. $NaNO_3$
B. $AgCl$
D. K_2SO_4

Questions 14 – 26 cover material after Exam 3

14. Two solutions are mixed together such that:

The final concentration of Pb^{2+} is 5.45×10^{-5} M and CO_3^{2-} is 2.50×10^{-6} M.

The K_{sp} of $PbCO_3$ is 7.40×10^{-14}.

Will a precipitate form?

A. A precipitate will not form because $Q < K_{sp}$.
B. A precipitate will not form because $Q > K_{sp}$.
C. A precipitate will form because $Q < K_{sp}$.
D. A precipitate will form because $Q > K_{sp}$.

15. A solution is prepared that is 2.00×10^{-4} M Fe^{3+} and 0.100 M CN^-. What is the final concentration of Fe^{3+}? K_f of $Fe(CN)_6^{3-} = 2.00 \times 10^{43}$.

A. 3.62×10^{-33} M Fe^{3+}
C. 5.16×10^{-27} M Fe^{3+}
B. 1.08×10^{-41} M Fe^{3+}
D. 2.27×10^{-54} M Fe^{3+}

16. Which one of the following statements is **true**?

A. An endothermic reaction always has a positive ΔS_{surr}.

B. An endothermic reaction always has a positive ΔS_{sys}.

C. An exothermic reaction always has a positive ΔS_{surr}.

D. An exothermic reaction always has a positive ΔS_{sys}.

17. Which of the following systems shows a **decrease** in the entropy of the system?

A. $KNO_3(s) \rightarrow K^+(aq) + NO_3^-(aq)$

B. $4\ PH_3(g) \rightarrow P_4(g) + 6\ H_2(g)$

C. $NH_3(l) \rightarrow NH_3(g)$

D. $U(s) + 3\ F_2(g) \rightarrow UF_6(s)$

18. Consider the decomposition of calcium carbonate below:

$CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g)$ $\quad \Delta S°_{sys} = 160.5$ J/mol·K, $\Delta H°_{sys} = -177.8$ kJ/mol

What is $\Delta S_{universe}$ at 300. K for the reaction?

A. 1,320 J/K

B. 753 J/K

C. 378 J/K

D. 889 J/K

19. Given $\Delta H = 257$ kJ/mol and $\Delta S = 470$ J/mol·K, what is ΔG at 273K?

A. 129 kJ

B. 232 kJ

C. 72 kJ

D. 208 kJ

20. Using the data below, calculate the standard entropy change for the following reaction.

$$N_2H_4(l) + 2\ H_2O_2(l) \rightarrow N_2(g) + 4\ H_2O(l)$$

	S° (J/K·mol)
$N_2H_4(l)$	121.2
$H_2O_2(l)$	109.6
$N_2(g)$	191.6
$H_2O(l)$	188.8

A. 611.2 J/K

B. −149.6 J/K

C. 750.4 J/K

D. 606.4 J/K

21. Predict the spontaneity and temperature dependence of a reaction if the sign of ΔH is negative and the sign of ΔS is negative.

A. The reaction will be nonspontaneous at all temperatures.

B. The reaction will be spontaneous at all temperatures.

C. The reaction will be spontaneous at low temperature, but nonspontaneous at high temperature.

D. The reaction will be nonspontaneous at low temperature, but spontaneous at high temperature.

22. At equilibrium, a 1.0 L reaction vessel contains 0.0200 moles each of hydrogen and chlorine and 1.96 moles of HCl. What is the value of the standard free energy at 298 K?

$$H_2(g) + Cl_2(g) \rightarrow 2\ HCl(g)$$

A. −8.7 kJ/mol

B. −23 kJ/mol

C. −17 kJ/mol

D. −162 kJ/mol

23. What is the coefficient **a** when the reaction below is balanced in acid?

$$\mathbf{a}\ Fe^{2+}(aq) + \mathbf{b}\ MnO_4^-(aq) + \mathbf{c}\ H^+(aq) \rightarrow \mathbf{d}\ Fe^{3+}(aq) + \mathbf{e}\ Mn^{2+}(aq) + \mathbf{f}\ H_2O(l)$$

A. 5
C. 8
B. 1
D. 4

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24. Using the standard reduction potentials listed below, calculate the $E°_{cell}$ at 298 K for

$$3\ Mg(s) + 2\ U^{3+}(aq) \rightarrow 3\ Mg^{2+}(aq) + 2\ U(s)$$

$Mg^{2+}(aq) + 2e^- \rightarrow Mg(s)$ $\quad E^o = -2.37$ V
$U^{3+}(aq) + 3e^- \rightarrow U(s)$ $\quad E^o = -1.80$ V

A. 4.17 V
C. −3.51 V
B. −0.76 V
D. 0.57 V

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25. Calculate the equilibrium constant, K, at 25°C (298 K) for

$$Pb(s) + 2\ Ag^+(aq) \rightarrow Pb^{2+}(aq) + Ag(s) \quad E°_{cell} = 0.93\ V$$

A. 5.2×10^{45}
C. 2.6×10^{31}
B. 3.1×10^{12}
D. 1.8×10^{-2}

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26. A voltaic cell is constructed that uses the following reaction:

$$Zn(s) + Ni^{2+}(aq) \rightarrow Zn^{2+}(aq) + Ni(s) \quad E°_{cell} = 0.53\ V$$

What is E_{cell} when $[Ni^{2+}] = 0.200$ M and $[Zn^{2+}] = 0.900$ M at 25°C (298 K)?

A. 0.49 V
C. 0.53 V
B. 0.51 V
D. 0.57 V

Answer Key:

1. C
2. A
3. C
4. B
5. A
6. D
7. B
8. C
9. A
10. D
11. B
12. C
13. A
14. D
15. B
16. C
17. D
18. B
19. A
20. D
21. C
22. B
23. A
24. D
25. C
26. B