NAME (Block Print)_____

CHEMISTRY 102 FALL 2010

FINAL EXAM FORM A Section 501 DR. KEENEY-KENNICUTT

Directions: (1) Put your name on PART 1 and your name and signature on PART 2 of the exam where indicated.
(2) Sign the Aggie Code on PART 2 of this exam.
(3) Each multiple choice question is actually 2 questions on your scanning sheet. If you are sure of an answer, **put the same answer down for both questions** for 5 pts. If you cannot decide between two answers, put your best answer down for the first (odd) question and the other answer down for the second (even) question. If you get the first one correct you'll get 3 pts; if you get the second one correct you'll get 2 pts. If there is an ambiguous multiple choice question, use the last page to explain your answer.
(4) Do NOT write on the envelope.
(5) When finished, put everything in the envelope and wait to be excused. At the table, take everything out of the envelope. You can pick up the multiple choice part with the answers outside my office after 10:30 am on Wednesday.
(6) There are a total of 60 multiple choice questions (30 actual questions) plus 20 pts free response.

PART 1

1&2. When the change in entropy of a system, ΔS is positive, then:

(a) the reaction is spontaneous (b) the reaction is non-spontaneous (c) ΔG must be negative
(d) disorder is increasing (e) order is increasing

3&4. Of the following species, which is the STRONGEST reducing agent?

(a) Mg (b) Sn^{4+} (c) Ag^{+} (d) Cu (e) Co^{2+}

5&6. Which of the following combinations are buffer solutions? All components are present in 0.10 M concentrations.

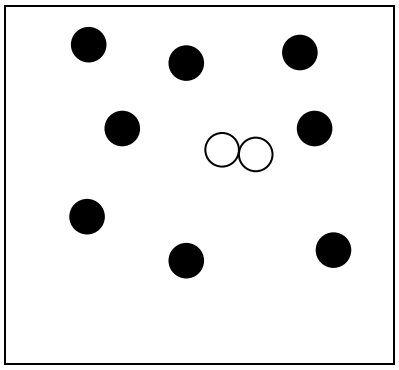
(1) NH_3 and NH_4Cl (2) HNO_3 and NH_4NO_3 (3) HCN and NaCN (4) $HClO_3$ and $NaClO_3$

(a) 1, 3, 4 (b) 1, 2 (c) 2, 3, 4 (d) 3, 4 (e) 1, 3

7&8. A 0.10 M solution of which one of the following salts has a pH greater than 7?

(a) CH_3NH_3Cl (b) NaBrO (c) $Ca(NO_3)_2$ (d) KBr (e) NH_4Cl

9&10. This sketch represents which of the following situations where : ● is A and ○ is B.



(a) $2A \rightleftarrows B$ K >> 1

(b) $B_2 \rightleftarrows A$ K << 1

(c) $B \rightleftarrows A_2$ K >> 1

(d) $A_2 \rightleftarrows B$ K << 1

(e) $A \rightleftarrows B_2$ K << 1

11&12. From the table of thermodynamic data, we see that $\Delta H^{\circ}_{f\,298}$ (kJ/mol) for MgO(s) is –601 kJ/mol. This value is the ΔH for the following reaction:

(a) $Mg(s) + O(g) \rightarrow MgO(s)$

(b) $MgO(s) \rightarrow Mg(s) + ½\ O_2(g)$

(c) $2MgO(s) \rightarrow Mg(s) + O_2(g)$

(d) $Mg(s) + ½\ O_2(g) \rightarrow MgO(s)$

(e) $2Mg(s) + O_2(g) \rightarrow 2MgO(s)$

13&14. Oxidation always occurs at the:

(a) platinum electrode (b) positive electrode (c) negative electrode

(d) cathode (e) anode

15&16. Consider the gas phase reaction: $2C + D \rightarrow C_2D$ that occurs by the following mechanism:

Step 1	$C + C \rightarrow C_2$	slow
Step 2	$C_2 + D \rightarrow C_2D$	fast
Overall	$2C + D \rightarrow C_2D$	

The rate law expression must be Rate = _____.

(a) k[D] (b) $k[C]^2[D]$ (c) k[C][D] (d) $k[C]^2$ (e) k[C]

17&18. Which is the correct K_c expression for the equilibrium: $N_2H_4(\ell) \rightleftarrows N_2(g) + 2H_2(g)$?

(a) $K_c = \frac{[N_2]\cdot 2[H_2]}{[N_2H_4]}$ (b) $K_c = \frac{[N_2][2H_2]^2}{[N_2H_4]}$ (c) $K_c = \frac{[N_2][H_2]^2}{[N_2H_4]}$

(d) $K_c = [N_2][2H_2]^2$ (e) $K_c = [N_2][H_2]^2$

19&20. Consider the gas-phase equilibrium system represented by the equation:

$$NO_2(g) + O_2(g) \rightleftarrows NO(g) + O_3(g)$$

given that the conversion of "left-hand" species (the reactants) to "right-hand" species (the products) as written, is endothermic, which of the following changes will DECREASE the equilibrium amount of NO?

(a) lower the temperature

(b) decreasing the volume of the container at constant temperature

(c) removing more ozone

(d) adding more oxygen gas

(e) adding a catalyst

21&22. Which of the following soluble ionic compounds has the largest ideal van't Hoff factor, i_{ideal}?

(a) $AlCl_3$ (b) $LiHSO_4$ (c) NH_4NO_3 (d) NaCN (e) KCl

23&24. The hydrolysis constant used when finding the pH of a solution of NaCN is:

(a) $\frac{K_a \text{ for HCN}}{K_b \text{ for } CN^-}$ (b) $\frac{K_a \text{ for HCN}}{K_w}$ (c) $\frac{K_w}{K_a \text{ for HCN}}$

(d) $\frac{K_a \text{ for } Na^+}{K_w}$ (e) $\frac{K_w}{K_a \text{ for } Na^+}$

25&26. Which choice includes **ALL** the following processes that are accompanied by an increase in entropy?

(1) $I_2(s) \rightarrow I_2(g)$ (2) $2I(g) \rightarrow I_2(g)$

(3) $2NH_3(g) \rightarrow N_2(g) + 3H_2(g)$ (4) $Mg^{2+}(aq) + 2OH^-(aq) \rightarrow Mg(OH)_2(s)$

(a) 1,2 (b) 1,3 (c) 3,4 (d) 3 (e) 2,4

27&28. For a voltaic cell using Ag^+(1 M)/Ag and Cu^{2+}(1 M)/Cu half cells, which of the following statements is **incorrect**?

(a) The copper electrode is the anode.
(b) Electrons will flow through the external circuit from the copper electrode to the silver electrode.
(c) Reduction occurs at the silver electrode as the cell operates.
(d) The mass of the copper electrode will decrease as the cell operates.
(e) The concentration of Ag^+ will increase as the cell operates.

29&30. For a reaction where ΔH is –345 kJ/mol rxn and ΔS = –48 J/K, _____.

(a) the reaction is spontaneous only at temperatures above a certain value.
(b) the reaction is spontaneous only at temperatures below a certain value.
(c) the reaction is spontaneous at all temperatures.
(d) the reaction is nonspontaneous at all temperatures
(e) It is impossible to tell if the reaction is or is not spontaneous.

31&32. Which of the following statements is/are TRUE concerning the action of catalysts?

(1) Their presence always changes the mechanism of the reaction.
(2) Catalysts do not participate in the reaction.
(3) The activation energy of the rate-determining step is lowered and the reaction speeds up.

(a) 1, 3 only (b) 2, 3 only (c) 2 only (d) 1, 2, 3 (e) 1, 2 only

33&34. Which of the following salts has the highest molar solubility?

(a) BaF_2 (b) CaF_2 (c) MgF_2 (d) SnS_2 (e) $PbCl_2$

35&36. What is the pH of a 1.9×10^{-5} M HCl?

(a) 2.35 (b) 4.51 (c) 4.72 (d) 3.09 (e) 3.17

37&38. In a 1.0 liter container there are 0.20 mole N_2, 0.10 mole H_2 and 0.40 mole NH_3 in the system at equilibrium.

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

What is the value of K_c for this reaction?

(a) 0.0012 (b) 20. (c) 0.050 (d) 8.0×10^2 (e) 8.0

39&40. Rate data were collected for the following reaction at a particular temperature. What is rate law expression?

$$A(g) + 2B(g) \rightarrow C(g) + 2D(g)$$

Experiment	$[A]_{initial}$	$[B]_{initial}$	Initial Rate of Reaction
1	0.10 M	0.10 M	0.020 M/s
2	0.20 M	0.10 M	0.080 M/s
3	0.20 M	0.20 M	0.160 M/s

(a) Rate = $k[A][B]$ (b) Rate = $k[A]^2[B]^2$ (c) Rate = $k[A][B]^2$

(d) Rate = $k[A]^2[B]^3$ (e) Rate = $k[A]^2[B]$

41&42. Calculate ΔG^o for the following reaction at 25°C in kJ:

$$N_2\,(g) + O_2(g) \rightarrow 2\,NO(g)$$

at 25°C, ΔH_{rxn}^o = +180.5 kJ and ΔS_{rxn}^o = +24.9 J/K

(a) −173.1 kJ (b) +173.1 kJ (c) +155.3 kJ (d) −78.3 kJ (e) +30.4 kJ

43&44. What is the pH of a 0.200 *M* ammonia solution?

(a) 11.45 (b) 12.00 (c) 11.28 (d) 12.59 (e) 13.00

45&46. How many grams of iron can be plated out at the cathode if a solution of $FeSO_4$ is electrolyzed by a current of 1.00 amp for 30.0 minutes?

(a) 0.391 g (b) 0.521 g (c) 1.04 g (d) 838 g (e) 16.6 g

47&48. What concentration of Sr^{2+} will initiate precipitation in a solution that is 1.00×10^{-5} M Na_3PO_4?

(a) 3.0×10^{-5} M (b) 5.0×10^{-8} M (c) 1.0×10^{-7} M
(d) 1.0×10^{-6} M (e) 1.0×10^{-9} M

49&50. Calculate the standard cell potential for the cell: $Cd/CdSO_4$ (1 M) || $CuSO_4$ (1 M) /Cu

(a) +0.74 V (b) +0.32 V (c) +0.06 V (d) +0.45 V (e) +0.82 V

51&52. If the activation energy in the forward direction of a single step reaction, C $\rightarrow$ D, is 95 kJ and the activation energy in the reverse direction is 60 kJ, what is the energy of reaction ΔE for the forward reaction? (Hint: draw the activation energy diagram.)

(a) +155 kJ (b) -35 kJ (c) +35 kJ (d) -155 kJ (e) +83 kJ

53&54. What is the boiling point of an aqueous solution prepared by dissolving 55.0 g of $C_{12}H_{22}O_{11}$, a non-electrolyte, in enough water to make 260.0 g of solution?

(a) 100.11°C (b) 0.40°C (c) 100.95°C (d) 100.40°C (e) 0.85°C

55&56. Consider the following reaction and standard free energy of formation data:

	$2\ H_2S(g)$	+	$3\ O_2(g)$	$\rightarrow$	$2SO_2(g)$	+	$2\ H_2O(g)$
$\Delta H^o_{f\,298}$ (kJ/mol)	−20.6		0		−296.8		−241.8

Calculate the ΔH^o for the reaction.

(a) −1036 kJ (b) −558.8 kJ (c) −48.3 kJ (d) +208.9 kJ (e) −518.0 kJ

OVER →

57&58. Consider the following equilibrium at 300°C: A + B $\rightleftarrows$ 2C, with a K_c of 64.0.
Initially, there is 3.00 M of C in the container. What is the concentration of C in the container after the system has reached equilibrium?

(a) 1.6 M (b) 2.4 M (c) 2.8 M (d) 0.35 M (e) 0.70 M

59&60. Calculate the pH that results when 30.0 mL of 1.00 M NaOH is added to 500.0 mL of a solution composed of 0.200 M dimethylamine and 0.100 M dimethylammonium chloride.

(a) 10.98 (b) 10.84 (c) 10.01 (d) 11.68 (e) 2.35

PART 2

Please read and sign: "On my honor, as an Aggie, I have neither given nor received unauthorized aid on this exam." _____

61. Draw the electrolytic cell that results when two inert electrodes are put into an aqueous solution of KBr and connected to a battery. The observations are:

(1) bromine gas is evolved at one electrode.
(2) H_2 gas is evolved at the other electrode and the solution becomes more basic around the electrode.

(1 pts) Which is the anode and what is the anodic reaction?
(1 pts) Which is the cathode and what is the cathodic reaction?
(1 pt) What is the sign on each electrode?
(1 pt) Show the direction of the electron flow.
(1 pts) What is the overall reaction?

(5 pts) **62.** Calculate the potential (in volts) for the non-standard voltaic cell when the following two half-cells are connected: Cathode: Ag electrode in 0.10 M Ag^+ solution
Anode: Cu electrode in 1.0×10^{-3} M Cu^{2+} solution

OVER ⇒

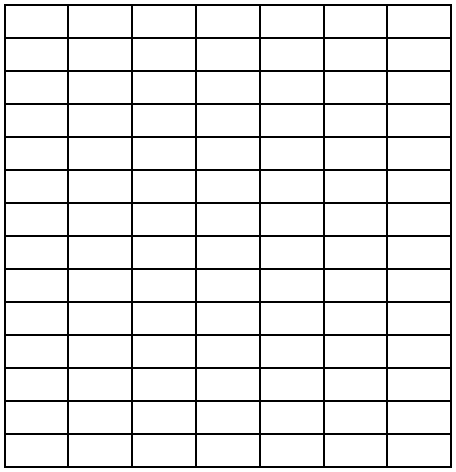
(5 pts) **63.** Roughly sketch two graphs with pH on the y axis and volume of titrant added on the x axis for:

(a) The titration of hypochlorous acid with sodium hydroxide

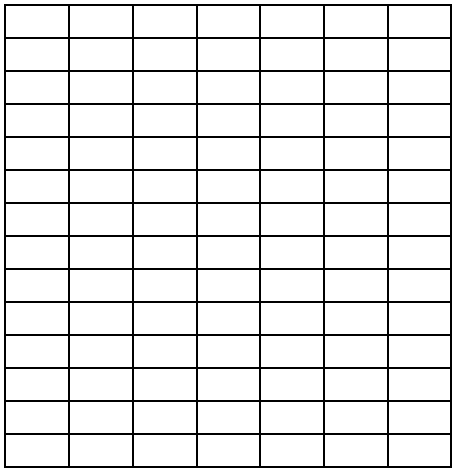
(b) The titration of hydrochloric acid with sodium hydroxide.

Note where pH = 7 on each graph.

(a)



(b)



(5 pts) **64.** Assign oxidation numbers to each atom in the reaction and balance the following redox reaction in acidic solution:

$$Cr_2O_7^{2-}(aq) + Fe^{2+}(aq) \rightarrow Cr^{3+}(aq) + Fe^{3+}(aq)$$

SCRAP PAPER OR COMMENTS ON THIS EXAM