NAME (Block Print)_____

CHEMISTRY 102 FALL 2010

FINAL EXAM FORM B 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.

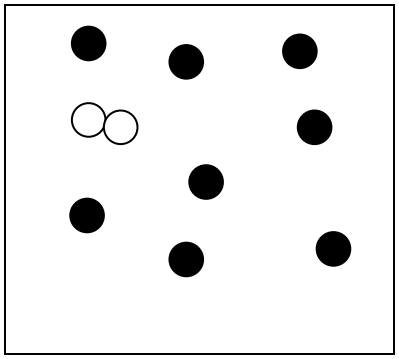
PART 1

1&2. Which is the correct K_c expression for the equilibrium: $CH_4(g) \rightleftarrows C(s) + 2H_2(g)$?

(a) $K_c = \frac{[H_2]^2}{[CH_4]}$ (b) $K_c = \frac{[C][H_2]^2}{[CH_4]}$ (c) $K_c = \frac{[C][2H_2]^2}{[CH_4]}$

(d) $K_c = \frac{2[H_2]}{[CH_4]}$ (e) $\frac{[C]2[H_2]}{[CH_4]}$

3&4. This sketch represents which of the following situations where : ◯ is X and ● is Y?



(a) $Y_2 \rightleftarrows X$ K << 1
(b) $2X \rightleftarrows Y$ K >> 1
(c) $X_2 \rightleftarrows Y$ K << 1
(d) $Y \rightleftarrows X_2$ K << 1
(e) $Y \rightleftarrows 2X$ K >> 1

5&6. When the change in entropy of a system, ΔS is negative, then:

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

7&8. Which of the following soluble ionic compounds has the largest ideal van't Hoff factor, i_{ideal}?

(a) KBr (b) NH_4NO_3 (c) $AlCl_3$ (d) NaBrO (e) $LiHSO_4$

9&10. Which choice includes **ALL** the following processes that are accompanied by an increase in entropy?

(1) $Br_2(s) \rightarrow Br_2(\ell)$ (2) $Mg(OH)_2(s) \rightarrow Mg^{2+}(aq) + 2OH^-(aq)$

(3) $2Br(g) \rightarrow Br_2(g)$ (4) $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$

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

11&12. The hydrolysis constant used when finding the pH of a solution of NaCN is:

(a) $\frac{K_w}{K_a \text{ for } Na^+}$ (b) $\frac{K_a \text{ for } Na^+}{K_w}$ (c) $\frac{K_a \text{ for HCN}}{K_w}$

(d) $\frac{K_w}{K_a \text{ for HCN}}$ (e) $\frac{K_a \text{ for HCN}}{K_b \text{ for } CN^-}$

13&14. A 0.10 M solution of which one of the following salts has a pH less than 7?

(a) $Ba(NO_2)_2$ (b) NaF (c) $KClO_4$ (d) CH_3NH_3Cl (e) KCN

15&16. From the table of thermodynamic data, we see that $\Delta H^\circ_{f\,298}$ (kJ/mol) for $NO_2(g)$ is +33.1 kJ/mol. This value is the ΔH for the following reaction:

(a) $N_2(g) + 2O_2(g) \rightarrow 2NO_2(g)$

(b) $2NO_2(g) \rightarrow N_2(g) + 2O_2(g)$

(c) $2N(g) + O_2(g) \rightarrow NO_2(g)$

(d) $NO_2(g) \rightarrow \frac{1}{2} N_2(g) + O_2(g)$

(e) $\frac{1}{2} N_2(g) + O_2(g) \rightarrow NO_2(g)$

17&18. Which of the following combinations are buffer solutions? All components are present in 0.50 M concentrations.

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

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

19&20. Of the following species, which is the STRONGEST oxidizing agent?

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

21&22. During the electrolysis of aqueous KCl solution using inert electrodes, chlorine gas is evolved at one electrode and hydrogen gas is evolved at the other electrode. The solution around the electrode at which hydrogen gas is evolved becomes basic as the electrolysis proceeds. Which of the following is FALSE?

(a) The electrode where chlorine gas is evolved is the anode.
(b) Faraday's Law says that the longer the cell runs, the more $H_2(g)$ will be produced.
(c) The electrode where the hydrogen gas is evolved is positively charged.
(d) The electrons flow out of the battery into the negatively charged electrode.
(e) The chloride concentration in the cell will decrease.

23&24. Which of the following salts has the lowest molar solubility?

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

25&26. Consider the following gas phase reaction: $A + 2B \rightarrow AB_2$ occurs by the following mechanism:

Step 1	$A + B \rightarrow AB$	slow
Step 2	$AB + B \rightarrow AB_2$	fast
Overall	$A + 2B \rightarrow AB_2$	

The rate law expression must be Rate = _____.

(a) k[A] (b) k[B] (c) k[A][B] (d) $k[B]^2$ (e) $k[A][B]^2$

27&28. For a reaction where ΔH is +255 kJ/mol rxn and ΔS = +52 J/K, _____.

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

29&30. Reduction always occurs at the:

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

(d) cathode (e) anode

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

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

(a) 1,2 (b) 1 only (c) 1,3 (d) 1,2,3 (e) none of these

33&34. Consider the gas-phase equilibrium system represented by the equation:

$$2\ CO(g) + O_2(g) \rightleftarrows 2CO_2(g)$$

given that the conversion of "left-hand" species (the reactants) to "right-hand" species (the products) as written, is exothermic, which of the following changes will INCREASE the equilibrium mass of CO?

(a) decreasing the volume of the system at constant temperature

(b) increasing the temperature

(c) removing CO_2 gas from the system as it is formed

(d) adding a catalyst

(e) adding more oxygen gas

35&36. In a 1.0 liter container there are 0.62 mole N_2, 0.50 mole H_2 and 0.24 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) 0.74 (b) 2.7 (c) 1.3 (d) 0.60 (e) 0.37

37&38. Consider the following reaction and standard free energy of formation data:

	$MnO_2(s)$	+	$2\ CO(g)$	$\rightarrow$	$Mn(s)$	+	$2\ CO_2(g)$
$\Delta H^\circ_{f\,298}$ (kJ/mol)	−520.9		−110.5		0		−393.5

Calculate the ΔH° for the reaction.

(a) −1024.9 kJ (b) +48.3 kJ (c) −45.1 kJ (d) +239.6 kJ (e) −208.9 kJ

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

$$2X(g) + Y(g) \rightarrow Z(g)$$

Experiment	$[X]_{initial}$	$[Y]_{initial}$	Initial Rate of Reaction
1	0.10 M	0.10 M	0.040 M/s
2	0.10 M	0.20 M	0.16 M/s
3	0.30 M	0.20 M	0.48 M/s

(a) Rate = $k[X][Y]$ (b) Rate = $k[X]^2[Y]$ (c) Rate = $k[X]^2[Y]^2$

(d) Rate = $k[X][Y]^2$ (e) Rate = $k[X]^2[Y]^3$

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

$$NH_4NO_3 \rightarrow N_2O(g) + 2\ H_2O(g)$$

at 25°C, $\Delta H_{rxn}^o = -35.9$ kJ and $\Delta S_{rxn}^o = +446$ J/K

(a) +47.1 kJ (b) +97.0 kJ (c) +10.7 kJ (d) −24.8 kJ (e) −169 kJ

43&44. What is the pH of a 1.5×10^{-4} M KOH?

(a) 2.95 (b) 3.80 (c) 10.18 (d) 10.79 (e) 11.52

45&46. What is the pH of a 0.100 *M* nitrous acid solution?

(a) 2.17 (b) 1.58 (c) 1.00 (d) 2.39 (e) 2.04

47&48. Calculate the standard cell potential for the cell: $Cd/CdSO_4$ (1 M) || $NiSO_4$ (1 M) /Ni

(a) +0.65 V (b) +0.15 V (c) +0.06 V (d) +0.32 V (e) +0.48 V

49&50. What concentration of Ca^{2+} will initiate precipitation in a solution that is 1.00×10^{-8} M Na_3PO_4?

(a) 3.0×10^{-2} M (b) 5.0×10^{-3} M (c) 1.0×10^{-5} M
(d) 1.0×10^{-4} M (e) 1.0×10^{-3} M

51&52. How many grams of Al will be deposited from molten $AlCl_3$ by a current of 15.0 amperes flowing for 24.0 hours?

(a) 121 g (b) 92.8 g (c) 50.3 g (d) 84.1 g (e) 78.6 g

53&54. If the activation energy in the forward direction of a single step reaction, A $\rightarrow$ B, is 68 kJ and the activation energy in the reverse direction is 75 kJ, what is the energy of reaction ΔE for the forward reaction? (Hint: draw the activation energy diagram.)

(a) +143 kJ (b) –143 kJ (c) +7 kJ (d) –7 kJ (e) +71 kJ

55&56. Consider the following equilibrium at 200°C: $X + Y \rightleftarrows 2Z$, with a K_c of 0.16. Initially, there is 3.00 M of Z in the container. What is the concentration of Z in the container after the system has reached equilibrium?

(a) 0.10 M (b) 1.20 M (c) 0.50 M (d) 0.30 M (e) 2.80 M

57&58. Calculate the pH that results when 35.0 mL of 1.00 M HCl is added to 500.0 mL of a solution composed of 0.100 M HCOOH and 0.300 M NaCHOO.

(a) 4.74 (b) 4.11 (c) 4.51 (d) 3.39 (e) 3.88

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59&60. What is the boiling point of an aqueous solution prepared by dissolving 45.0 g of $C_6H_{12}O_6$, a non-electrolyte, in 160.0 g of solution?

(a) 101.11°C (b) 1.11°C (c) 100.95°C (d) 100.42°C (e) 0.85°C

PART 2

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

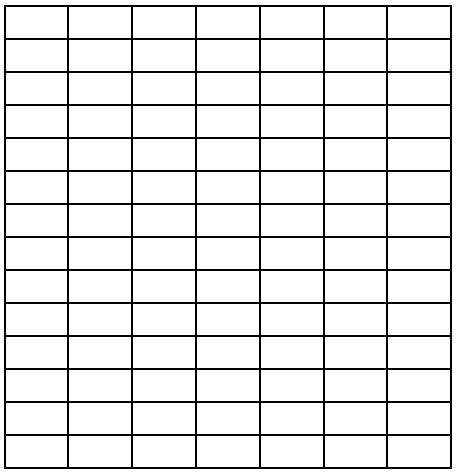
(5 pts) **61.** Roughly sketch two graphs with pH on the y axis and volume of titrant added on the x axis for:

(a) The titration of dimethylamine with hydrochloric acid

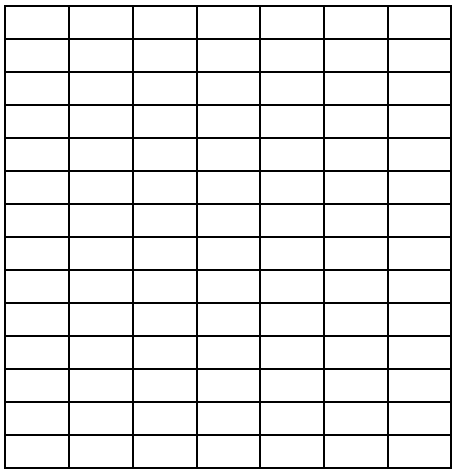
(b) The titration of sodium hydroxide with hydrochloric acid.

Note where pH = 7 on each graph.

(a)



(b)



(5 pts) **62.** Calculate the potential (in volts) for the non-standard voltaic cell when the following two half-cells are connected: Anode: Pb electrode in 0.10 M Pb^{2+} solution
Cathode: Ag electrode in 1.0×10^{-4} M Ag^{+} solution

63. Assign oxidation numbers to all the atoms in the reaction and balance the following redox reaction in acidic solution:

$$SO_3^{2-}(aq) + MnO_4^-(aq) \rightarrow SO_4^{2-}(aq) + Mn^{2+}(aq)$$

64. Draw the voltaic cell that results when the following 2 half cells are connected:

(1) copper electrode is put into a solution of 1.00 M Cu^{2+} solution and

(2) a nickel electrode is put into a solution of 1.00 M Ni^{2+} solution.

Observations:

(1) The copper electrode increases in mass while the $[Cu^{2+}]$ decreases

(2) The nickel electrode decreases in mass while the $[Ni^{2+}]$ increases

(1 pt) Which is the anode and what is the anodic reaction?

(1 pt) 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 pt) What is the overall reaction?

SCRAP PAPER OR COMMENTS ON THIS EXAM