

NAME (Block Print) \_\_\_\_\_

# CHEMISTRY 102

FALL 2008

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 am on Wednesday.
- (6) There are a total of 60 questions (33 actual questions) and two bonus points.

## PART 1

**1&2.** The term "exothermic" means that heat \_\_\_\_\_ in a reaction.

- (a) is absorbed                      (b) has a positive value                      (c) equals its entropy  
(d) is released                      (e) is a reactant

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

- (a) V                      (b)  $\text{Sn}^{2+}$                       (c)  $\text{Au}^{3+}$                       (d) Cu                      (e)  $\text{Co}^{2+}$

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

- (1) HCN and NaCN    (2)  $\text{HNO}_3$  and  $\text{NH}_4\text{NO}_3$     (3)  $\text{NH}_3$  and  $\text{NH}_4\text{Cl}$     (4)  $\text{HClO}_3$  and  $\text{NaClO}_3$

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

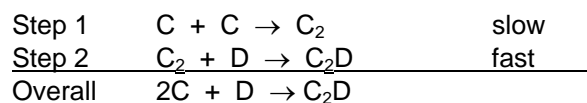
**7&8.** A 0.10 M solution of which one of the following salts has a pH greater than 7?

- (a) KBr                      (b) KClO                      (c)  $\text{Ba}(\text{NO}_3)_2$                       (d)  $\text{CH}_3\text{NH}_3\text{Cl}$                       (e)  $\text{NH}_4\text{Cl}$

**9&10.** Determine the oxidation state of sulfur in the sulfite ion,  $\text{SO}_3^{2-}$ ?

- (a) +4            (b) +6            (c) +1            (d) +3            (e) +5

**11&12.** Consider the gas phase reaction:  $2\text{C} + \text{D} \rightarrow \text{C}_2\text{D}$  that occurs by the following mechanism:



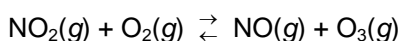
The rate law expression must be Rate = \_\_\_\_\_.

- (a)  $k[\text{D}]$             (b)  $k[\text{C}]^2[\text{D}]$             (c)  $k[\text{C}][\text{D}]$             (d)  $k[\text{C}]^2$             (e)  $k[\text{C}]$

**13&14.** Which is the correct  $K_c$  expression for the equilibrium:  $\text{CH}_4(\text{g}) \rightleftharpoons \text{C}(\text{s}) + 2\text{H}_2(\text{g})$ ?

- (a)  $K_c = \frac{[\text{H}_2]^2}{[\text{CH}_4]}$             (b)  $K_c = \frac{[\text{C}][\text{H}_2]^2}{[\text{CH}_4]}$             (c)  $K_c = \frac{[\text{C}][2\text{H}_2]^2}{[\text{CH}_4]}$
- (d)  $K_c = \frac{2[\text{H}_2]}{[\text{CH}_4]}$             (e)  $K_c = \frac{[\text{C}][2[\text{H}_2]]}{[\text{CH}_4]}$

**15&16.** Consider the gas-phase equilibrium system represented by the equation:



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) adding more oxygen gas  
(b) decreasing the volume of the container at constant temperature  
(c) raising the temperature  
(d) adding a catalyst  
(e) adding more ozone

**17&18.** Which of the following soluble ionic compounds has the largest ideal van't Hoff factor,  $i_{\text{ideal}}$ ?

- (a)  $\text{AlCl}_3$             (b)  $\text{LiHSO}_4$             (c)  $\text{NH}_4\text{NO}_3$             (d)  $\text{NaCN}$             (e)  $\text{KCl}$

**19&20.** Which process is accompanied by an INCREASE in entropy?

- (a)  $\text{Fe}^{2+}(\text{aq}) + \text{S}^{2-}(\text{aq}) \rightarrow \text{FeS}(\text{s})$
- (b)  $3\text{H}_2(\text{g}) + \text{N}_2(\text{g}) \rightarrow 2\text{NH}_3(\text{g})$
- (c) 1 mol  $\text{Ne}(\text{g})$  in a 10 L container  $\rightarrow$  1 mole  $\text{Ne}(\text{g})$  in a 1 L container
- (d)  $\text{KCl}(\text{s}) \rightarrow \text{KCl}(\text{aq})$
- (e)  $\text{H}_2\text{O}(\text{g}) \rightarrow \text{H}_2\text{O}(\text{s})$

**21&22.** For a voltaic cell using  $\text{Ag}^+(1 \text{ M})/\text{Ag}$  and  $\text{Cu}^{2+}(1 \text{ M})/\text{Cu}$  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  $\text{Ag}^+$  will increase as the cell operates.

**23&24.** For a reaction where  $\Delta H$  is  $-345 \text{ kJ/mol rxn}$  and  $\Delta S = -48 \text{ J/K}$ , \_\_\_\_\_.

- (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.

**25&26.** Which of the following statements concerning chemical kinetics is TRUE?

- (a) Catalysts do not participate in a reaction.
- (b) Activation energy for a forward reaction will change with increasing temperature.
- (c) An increase in temperature will change the appearance of a potential energy diagram.
- (d) The rate of a reaction increases with increasing temperature.
- (e) To have an effective collision, the reactants only need to collide with a certain minimum amount of energy.

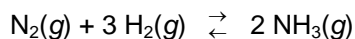
**27&28.** Which of the following salts has the highest molar solubility?

- (a) BaF<sub>2</sub>      (b) CaF<sub>2</sub>      (c) MgF<sub>2</sub>      (d) SnS<sub>2</sub>      (e) PbCl<sub>2</sub>

**29&30.** What is the pH of a 1.9 x 10<sup>-5</sup> M HCl?

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

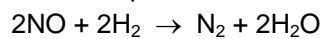
**31&32.** In a 1.0 liter container there are 0.20 mole N<sub>2</sub>, 0.10 mole H<sub>2</sub> and 0.40 mole NH<sub>3</sub> in the system at equilibrium.



What is the value of K<sub>c</sub> for this reaction?

- (a) 0.0012      (b) 20.      (c) 0.050      (d) 8.0 x 10<sup>2</sup>      (e) 8.0

**33&34.** Kinetic studies were done at a particular temperature for the gas phase reaction:



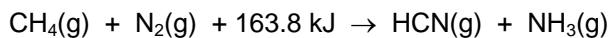
and the following data were obtained:

Trial Run	[NO] <sub>initial</sub>	[H <sub>2</sub> ] <sub>initial</sub>	Initial Rate (M/s)
1	0.10 M	0.20 M	0.0150
2	0.10 M	0.30 M	0.0225
3	0.20 M	0.20 M	0.0600

Based upon these data, the rate-law expression for this reaction is \_\_\_\_\_.

- (a) rate = k[NO][H<sub>2</sub>]      (b) rate = k[NO]<sup>2</sup>[H<sub>2</sub>]      (c) rate = k[NO][H<sub>2</sub>]<sup>2</sup>  
(d) rate = k[NO]<sup>2</sup>[H<sub>2</sub>]<sup>2</sup>      (e) none of the above

**35&36.** Consider the reaction below at 25°C for which  $\Delta G^\circ = +159 \text{ kJ/mol rxn}$ . Calculate  $\Delta S^\circ$  at 25°C.



- (a) +1.54 J/K      (b) +444 J/K      (c) +67.8 J/K      (d) +109 J/K      (e) +16.1 J/K

**37&38.** 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

**39&40.** How many grams of iron can be plated out at the cathode if a solution of  $\text{FeSO}_4$  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

**41&42.** What concentration of  $\text{Sr}^{2+}$  will initiate precipitation in a solution that is  $1.00 \times 10^{-5} \text{ M Na}_3\text{PO}_4$ ?

(a)  $3.0 \times 10^{-5} \text{ M}$

(b)  $5.0 \times 10^{-8} \text{ M}$

(c)  $1.0 \times 10^{-7} \text{ M}$

(d)  $1.0 \times 10^{-6} \text{ M}$

(e)  $1.0 \times 10^{-9} \text{ M}$

**43&44.** Calculate the standard cell potential for the cell:  $\text{Cd}/\text{CdSO}_4 (1 \text{ M}) \parallel \text{CuSO}_4 (1 \text{ M}) / \text{Cu}$

(a) +0.74 V

(b) +0.32 V

(c) +0.06 V

(d) +0.45 V

(e) +0.82 V

**45&46.** If the activation energy in the forward direction of a single step reaction,  $\text{C} \rightarrow \text{D}$ , is 95 kJ and the activation energy in the reverse direction is 60 kJ, what is the energy of reaction  $\Delta E$  for this reaction? (Hint: draw the activation energy diagram.)

(a) +155 kJ

(b) -35 kJ

(c) +35 kJ

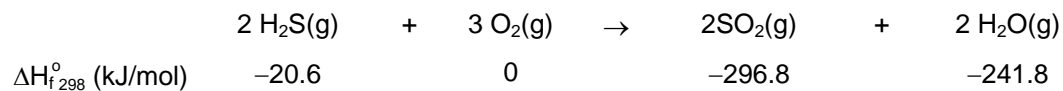
(d) -155 kJ

(e) +83 kJ

**47&48.** The freezing point of a solution of 5.884 g of an unknown nonelectrolyte dissolved in 45.12 g of benzene is 1.51°C. Pure benzene freezes at 5.48°C and its  $K_f$  value is 5.12 °C/m. What is the molecular weight of the compound?

- (a) 154 g/mol      (b) 168 g/mol      (c) 67.1 g/mol      (d) 424 g/mol      (e) 36.2 g/mol

**49&50.** Consider the following reaction and standard free energy of formation data:



Calculate the  $\Delta H^\circ$  for the reaction.

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

**51&52.** Consider the following equilibrium reaction:



If the initial concentrations  $\text{H}_2$  and  $\text{F}_2$  in a closed container are 1.00 M, what will be the concentration of HF after the system finally reaches equilibrium?

- (a) 0.661 M      (b) 0.500 M      (c) 0.252 M      (d) 0.147 M      (e) 0.788 M

**53&54.** A buffer is prepared by mixing 150.0 mL of 0.500 M ammonia, 250.0 mL of 0.200 M ammonium chloride and 600.0 mL of water. To this solution is added 50.0 mL of 0.400 M hydrochloric acid. What is the final pH?

- (a) 4.75      (b) 8.09      (c) 8.73      (d) 9.15      (e) 9.54

**55.** Do the on-line assessment on SurveyMonkey. The directions were sent to your neo account. Completion will give you 5 pts on this final.

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## PART 2

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

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- 56.** Draw the electrolytic cell that results when two inert electrodes are put into an aqueous solution of KCl and connected to a battery. The observations are:
- (1) chlorine gas is evolved at one electrode.
  - (2) H<sub>2</sub> gas is evolved at the other electrode and the solution becomes more basic around the electrode.

- (3 pts) Which is the anode and what is the anodic reaction?  
(3 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.  
(2 pts) What is the overall reaction?

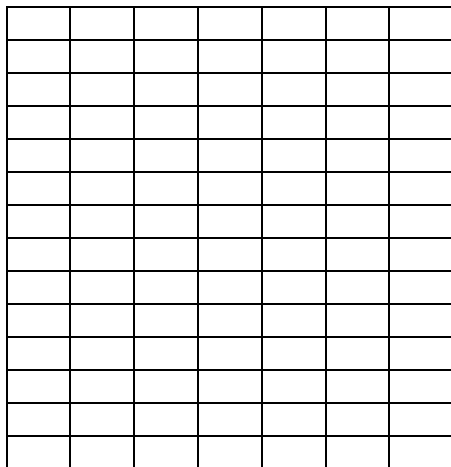
- (5 pts) **57.** Calculate the potential (in volts) for the non-standard voltaic cell when the following two half-cells are connected: Anode: Ag electrode in 0.10 M Ag<sup>+</sup> solution  
Cathode: Au electrode in 1.0 x 10<sup>-5</sup> M Au<sup>3+</sup> solution

**OVER ⇒**

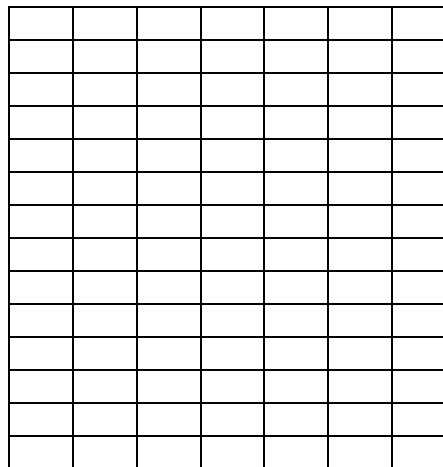
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- (5 pts) **58.** Roughly sketch two graphs with pH on the y axis and volume of titrant added on the x axis for:
- The titration of methylamine with hydrochloric acid
  - The titration of sodium hydroxide with hydrochloric acid.
- Note where pH = 7 on each graph.

(a)



(b)



- (5 pts) **59.** Calculate the molar solubility of  $\text{Ca(OH)}_2$  in a solution that is set at pH = 13.00.

- (5 pts) **60.** Balance the following redox reaction in acidic solution:  $\text{Cu(s)} + \text{NO}_3^-(\text{aq}) \rightarrow \text{Cu}^{2+}(\text{aq}) + \text{NO}_2$

**Please circle**

- 2 Bonus Pts:** (i) How many years of high school chemistry did you take? 0 ½ 1 1½ 2 2½ 3 3½ more  
 (ii) How many years were there between your last chem course in high school and your first university chem course? 0 1 2 3 4 5 more than 5

# SCRAP PAPER OR COMMENTS ON THIS EXAM

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