

**CHEMISTRY 102****FALL 2008****FINAL EXAM****FORM D****Section 502****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).

**PART 1**

**1&2.** Determine the oxidation state of nitrogen in the nitrate ion,  $\text{NO}_3^-$ ?

- (a) +2                      (b) +6                      (c) +4                      (d) +5                      (e) +3

**3&4.** Consider 0.1 M solutions of these weak acids. The weakest of these weak acids is:

- (a)  $\text{HNO}_2$                       (b)  $\text{CH}_3\text{COOH}$                       (c)  $\text{CHOOH}$                       (d)  $\text{HClO}$                       (e)  $\text{HBrO}$

**5&6.** Which statement(s) list(s) the substance with the lower entropy first and the higher entropy second?

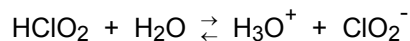
- (1) 1 mole of  $\text{N}_2$  in a 20 L container < 1 mole of  $\text{N}_2$  in a 10 L container  
 (2)  $\text{H}_2\text{O}(\text{s})$  at  $0^\circ\text{C}$  <  $\text{H}_2\text{O}(\ell)$  at  $0^\circ\text{C}$   
 (3)  $\text{CHOOH}$  <  $\text{CH}_3\text{COOH}$

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

**7&8.** Which is the correct  $K_c$  expression for the equilibrium:  $[\text{Co}(\text{CO})_4]_2(\text{s}) \rightleftharpoons 2\text{Co}(\text{s}) + 8\text{CO}(\text{g})$  ?

- (a)  $K_c = \frac{[\text{Co}]^2[\text{CO}]^8}{[[\text{Co}(\text{CO})_4]_2]}$                       (b)  $K_c = \frac{[[\text{Co}(\text{CO})_4]_2]}{[\text{Co}]^2[\text{CO}]^8}$                       (c)  $K_c = \frac{[\text{CO}]^8}{[[\text{Co}(\text{CO})_4]_2]}$
- (d)  $K_c = \frac{2[\text{Co}] + 8[\text{CO}]}{[[\text{Co}(\text{CO})_4]_2]}$                       (e)  $K_c = [\text{CO}]^8$

**9&10.** For the system given below, Bronsted would classify acidic species as:



- (a)  $\text{HClO}_2$  and  $\text{H}_2\text{O}$                       (b)  $\text{H}_3\text{O}^+$  and  $\text{ClO}_2^-$                       (c)  $\text{HClO}_2$  and  $\text{H}_3\text{O}^+$   
(d)  $\text{H}_2\text{O}$  and  $\text{ClO}_2^-$                       (e)  $\text{HClO}_2$  and  $\text{ClO}_2^-$

**11&12.** The following solutions are mixed in equal volumes. Which will give (a) buffer solution(s)?

- (1) 0.1 M HCl and 0.1 M NaCl  
(2) 0.1 M HClO and 0.1 M NaCl  
(3) 0.1 M HClO and 0.1 M NaClO  
(4) 0.1 M HCl and 0.1 M NaClO

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

**13&14.** Which of the following species is the BEST reducing agent?

- (a)  $\text{Cu}^+$                       (b) Al                      (c)  $\text{Br}^-$                       (d)  $\text{Co}^{2+}$                       (e)  $\text{F}_2$

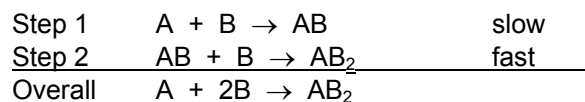
**15&16.** Consider the following gaseous phase system at equilibrium:



Which of the following changes will DECREASE the amount of ICl at equilibrium?

- (a) decreasing the volume of the container  
(b) adding  $\text{I}_2(\text{g})$   
(c) raising the temperature  
(d) adding a catalyst  
(e) adding  $\text{N}_2(\text{g})$

**17&18.** Consider the following gas phase reaction:  $\text{A} + 2\text{B} \rightarrow \text{AB}_2$ , which occurs by the following mechanism:



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

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

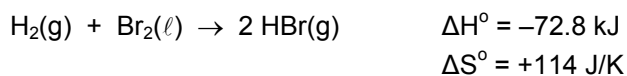
**19&20.** The relationship between  $K_{sp}$  and  $s$ , the molar solubility in mol/L, for  $\text{Co}(\text{OH})_2$  is:

- (a)  $K_{sp} = s^2$                       (b)  $K_{sp} = s^{1/3}$                       (c)  $K_{sp} = 4s^3$   
(d)  $K_{sp} = 4s^2$                       (e)  $K_{sp} = s^3$

**21&22.** A 0.10 M solution of a substance has  $\text{pH} = 10$ . That substance is most likely a:

- (a) weak acid    (b) strong acid    (c) strong base    (d) weak base    (e) sugar

**23&24.** Consider the following reaction and choose the correct statement:



- (a) The reaction is nonspontaneous at all temperatures.  
(b) The reaction is spontaneous at all temperatures.  
(c) The reaction becomes spontaneous as the temperature increases.  
(d) The reaction becomes nonspontaneous as the temperature increases.  
(e) The temperature does not influence the spontaneity of any reaction.

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

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

**27&28.** Which of the following statements is FALSE?

- (a)  $\Delta S_{\text{universe}} = \Delta S_{\text{surroundings}} + \Delta S_{\text{system}}$   
(b) A reaction is spontaneous if  $\Delta S_{\text{surroundings}}$  increases.  
(c) Hess' Law allows you to calculate the entropy involved in a reaction.  
(d) Exothermic processes are those with  $\Delta H < 0$ .  
(e) If a reaction is endothermic, heat is being absorbed.

**29&30.** During the electrolysis of aqueous KBr solution using inert electrodes, bromine liquid 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 bromide concentration in the cell will decrease.
- (b) The electrode where bromine liquid is evolved is the anode.
- (c) Faraday's Law says that the longer the cell runs, the more H<sub>2</sub>(g) will be produced.
- (d) The electrode where the hydrogen gas is evolved is positively charged.
- (e) The electrons flow out of the battery into the negatively charged electrode.

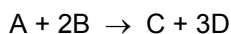
**31&32.** Which of the following pairs of liquids are NOT miscible?

- (a) CH<sub>3</sub>CH<sub>2</sub>OH / CH<sub>3</sub>OH
- (b) C<sub>6</sub>H<sub>6</sub> / CCl<sub>4</sub>
- (c) CCl<sub>4</sub> / CHCl<sub>3</sub>
- (d) CH<sub>3</sub>CH<sub>2</sub>OH / H<sub>2</sub>O
- (e) H<sub>2</sub>O / CCl<sub>4</sub>

**33&34.** What is the pH of a 1.5 x 10<sup>-4</sup> M KOH?

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

**35&36.** Rate data were collected for the following reaction at a particular temperature. What is the correct rate law expression?



Experiment	[A] <sub>initial</sub>	[B] <sub>initial</sub>	Initial Rate of Reaction
1	0.10 M	0.40 M	0.0090 M/min
2	0.20 M	0.40 M	0.036 M/min
3	0.10 M	0.20 M	0.0045 M/min

- (a) Rate = k[A][B]
- (b) Rate = k[A]<sup>2</sup>[B]
- (c) Rate = k[A][B]<sup>2</sup>
- (d) Rate = k[A]<sup>2</sup>[B]<sup>2</sup>
- (e) Rate = k[A]<sup>2</sup>

**37&38.** What will happen when equal volumes of 0.20 M of  $\text{Pb}(\text{NO}_3)_2$  and 0.0020 M of  $\text{Na}_2\text{SO}_4$  are mixed?

- (a) a precipitate will occur because  $Q_{\text{sp}} > K_{\text{sp}}$
- (b) a precipitate will occur because  $Q_{\text{sp}} < K_{\text{sp}}$
- (c) no precipitate will occur because  $Q_{\text{sp}} > K_{\text{sp}}$
- (d) no precipitate will occur because  $Q_{\text{sp}} < K_{\text{sp}}$
- (e) the mixture will explode

**39&40.** Calculate the standard cell potential for the cell:  $\text{Fe}/\text{FeSO}_4 (1 \text{ M}) \parallel \text{CuSO}_4 (1 \text{ M}) / \text{Cu}$

- (a) +0.65 V
- (b) +0.15 V
- (c) +0.06 V
- (d) +0.32 V
- (e) +0.78 V

**41&42.** If 4.27 grams of sucrose,  $\text{C}_{12}\text{H}_{22}\text{O}_{11}$  are dissolved in 16.2 grams of water, what will be the boiling point of the resulting solution?  $K_b$  for water =  $0.512 \text{ }^\circ\text{C}/m$

- (a)  $101.64^\circ\text{C}$
- (b)  $100.39^\circ\text{C}$
- (c)  $99.626^\circ\text{C}$
- (d)  $100.73^\circ\text{C}$
- (e)  $101.42^\circ\text{C}$

**43&44.** What is the enthalpy change of the reaction below at 298 K and 1 atm pressure?

	SiH <sub>4</sub> (s)	+	2O <sub>2</sub> (g)	→	SiO <sub>2</sub> (s)	+	2H <sub>2</sub> O(g)
$\Delta H_f^\circ$ (kJ/mol)	+34		0		-910.9		-285.8

- (a) -955 kJ                      (b) -1159 kJ                      (c) -1230 kJ  
(d) -1517 kJ                      (e) -1250 kJ

**45&46.** What concentration of Pb<sup>2+</sup> will initiate precipitation in a solution that is 0.010 M NaBr?

- (a)  $6.3 \times 10^{-1}$  M                      (b)  $6.3 \times 10^{-4}$  M                      (c)  $6.3 \times 10^{-6}$  M  
(d)  $6.3 \times 10^{-2}$  M                      (e)  $6.3 \times 10^{-5}$  M

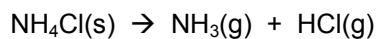
**47&48.** What is the pH of a 0.70 M formic acid solution?

- (a) 4.19                      (b) 3.27                      (c) 2.32                      (d) 4.85                      (e) 1.95

- 49&50.** Consider the equilibrium at a certain temperature:  $\text{H}_2(\text{g}) + \text{I}_2(\text{g}) \rightleftharpoons 2\text{HI}(\text{g})$   $K_c = 63.0$   
If 2.00 mol of HI are placed in a 1.00 L container, what is the concentration of HI at equilibrium?
- (a) 1.60 M      (b) 1.86 M      (c) 0.85 M      (d) 0.27 M      (e) 0.51 M

- 51&52.** At the equivalence point in the titration of nitrous acid with sodium hydroxide, the salt concentration was 0.250 M. What was the pH at the equivalence point?
- (a) 5.13      (b) 8.37      (c) 9.14      (d) 10.79      (e) 11.52

**53&54.** At what temperature (in K) will the following system be at equilibrium?



$$\Delta H = +176 \text{ kJ}$$

$$\Delta S = +284.5 \text{ J/K}$$

(a) 619 K

(b) 634 K

(c) 467 K

(d) 582 K

(e) 680 K

**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. Deadline is **11:45pm** tonight.

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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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(5 pts) **56.** Calculate the potential (in volts) for the non-standard voltaic cell when the following two half-cells are connected: Anode: Ni electrode in  $1.0 \times 10^{-4}$  M  $\text{Ni}^{2+}$  solution  
Cathode: Ag electrode in 0.10 M  $\text{Ag}^{+}$  solution

(5 pts) **57.** What average current (in amperes) must be maintained to electroplate 12.4 grams of tin per hour from a solution of tin(IV) ions?

(5 pts) **58.** Balance the following redox reaction in acidic solution:  $\text{Sn}(s) + \text{NO}_3^-(aq) \rightarrow \text{SnO}_2(s) + \text{NO}_2$

(5 pts) **59.** A buffer is prepared by mixing 100 mL of 0.200 M formic acid and 300 mL of 0.100 M sodium formate. What is the pH of the final solution after 20.0 mL of 0.400 M  $\text{HNO}_3$  is added?

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

- (1) iron electrode is put into a solution of 1.00 M  $\text{Fe}^{2+}$  solution and
- (2) a lead electrode is put into a solution of 1.00 M  $\text{Pb}^{2+}$  solution.

Observations:

- (1) The iron electrode decreases in mass while the  $[\text{Fe}^{2+}]$  increases
- (2) The lead electrode increases in mass while the  $[\text{Pb}^{2+}]$  decreases

(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?

**Please circle**

**2 Bonus Pts:** (i) How many years of high school chemistry did you take? 0  $\frac{1}{2}$  1  $1\frac{1}{2}$  2  $2\frac{1}{2}$  3  $3\frac{1}{2}$  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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