

CHEMISTRY 102**FALL 2008****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 am on Wednesday.
- (6) There are a total of 60 questions (33 actual questions) plus 2 bonus points.
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PART 1

1&2. Which is the correct K_c expression for the equilibrium: $\text{N}_2\text{H}_4(l) \rightleftharpoons \text{N}_2(g) + 2\text{H}_2(g)$?

(a) $K_c = \frac{[\text{N}_2] \cdot 2[\text{H}_2]}{[\text{N}_2\text{H}_4]}$

(b) $K_c = \frac{[\text{N}_2][2\text{H}_2]^2}{[\text{N}_2\text{H}_4]}$

(c) $K_c = \frac{[\text{N}_2][\text{H}_2]^2}{[\text{N}_2\text{H}_4]}$

(d) $K_c = [\text{N}_2][2\text{H}_2]^2$

(e) $K_c = [\text{N}_2][\text{H}_2]^2$

3&4. Determine the oxidation state of phosphorus in the phosphite ion, PO_3^{3-} ?

(a) +1

(b) +6

(c) +4

(d) +5

(e) +3

5&6. The term "endothermic" means that heat _____ in a reaction.

(a) is absorbed

(b) has a negative value

(c) is released

(d) equals its entropy

(e) is a product

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

(a) NH_4NO_3 (b) NaCl (c) AlCl_3 (d) KCN (e) LiHSO_4

9&10. Which process is accompanied by a DECREASE in entropy?

- (a) $2\text{NH}_3(\text{g}) \rightarrow 3\text{H}_2(\text{g}) + \text{N}_2(\text{g})$
- (b) $\text{KCl}(\text{s}) \rightarrow \text{KCl}(\text{aq})$
- (c) $\text{Al}^{3+}(\text{aq}) + \text{PO}_4^{3-}(\text{aq}) \rightarrow \text{AlPO}_4(\text{s})$
- (d) $\text{H}_2\text{O}(\text{s}) \rightarrow \text{H}_2\text{O}(\text{g})$
- (e) 1 mol $\text{SO}_2(\text{g})$ in a 1 L container \rightarrow 1 mole $\text{SO}_2(\text{g})$ in a 10 L container

11&12. A 0.10 M solution of which one of the following salts has a pH less than 7?

- (a) KClO_4
- (b) $\text{CH}_3\text{NH}_3\text{Cl}$
- (c) $\text{Ba}(\text{NO}_2)_2$
- (d) NaF
- (e) KCN

13&14. Which of the following combinations are buffer solutions? All components are present in 0.50 M concentrations.

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

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

15&16. Of the following species, which is the STRONGEST oxidizing agent?

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

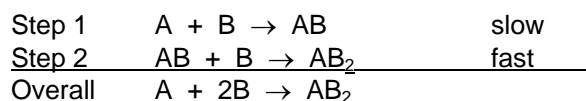
17&18. During the electrolysis of aqueous KCl solution using inert electrodes, chlorine gas is evolved at one electrode and hydrogen gas is evolved at the other electrode. The solution around the electrode at which hydrogen gas is evolved becomes basic as the electrolysis proceeds. Which of the following is FALSE?

- (a) The electrode where chlorine gas is evolved is the anode.
- (b) The electrode where the hydrogen gas is evolved is positively charged.
- (c) Faraday's Law says that the longer the cell runs, the more $\text{H}_2(\text{g})$ will be produced.
- (d) The electrons flow out of the battery into the negatively charged electrode.
- (e) The chloride concentration in the cell will decrease.

19&20. 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

21&22. Consider the following gas phase reaction: $\text{A} + 2\text{B} \rightarrow \text{AB}_2$
occurs by the following mechanism:



The rate law expression must be Rate = _____.

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

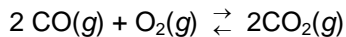
23&24. For a reaction where ΔH is +255 kJ/mol rxn and $\Delta S = +52 \text{ J/K}$, _____.

- (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.

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.

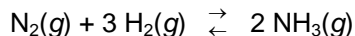
27&28. Consider the gas-phase equilibrium system represented by the equation:



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

- (a) decreasing the volume of the system at constant temperature
- (b) removing CO₂ gas from the system as it is formed
- (c) decreasing the temperature
- (d) adding a catalyst
- (e) removing more oxygen gas

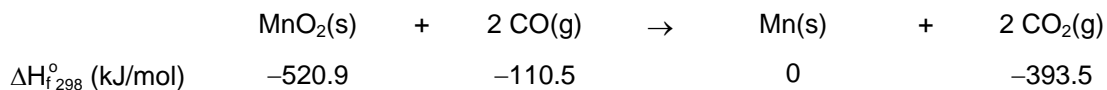
29&30. In a 1.0 liter container there are 0.62 mole N₂, 0.50 mole H₂ and 0.24 mole NH₃ in the system at equilibrium.



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

31&32. Consider the following reaction and standard free energy of formation data:



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

33&34. Kinetic studies were done on the reaction:



and the following data were obtained:

Experiment	[A] _{initial}	[B] _{initial}	Rate (M/s)
1	$2.0 \times 10^{-3} \text{ M}$	$4.0 \times 10^{-3} \text{ M}$	5.7×10^{-7}
2	$4.0 \times 10^{-3} \text{ M}$	$4.0 \times 10^{-3} \text{ M}$	22.8×10^{-7}
3	$2.0 \times 10^{-3} \text{ M}$	$8.0 \times 10^{-3} \text{ M}$	11.4×10^{-7}

Determine the rate law for this reaction.

(a) $\text{rate} = k[A][B]$

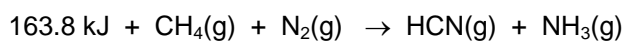
(b) $\text{rate} = k[A] / [B]$

(c) $\text{rate} = k[A][B]^2$

(d) $\text{rate} = k[A]^2[B]$

(e) none of the above

35&36. Calculate the change in entropy, ΔS° at 25°C , for the following reaction for which $\Delta G^\circ = +159 \text{ kJ/mol rxn}$.



(a) $+1.54 \text{ J/K}$

(b) $+16.1 \text{ J/K}$

(c) $+67.8 \text{ J/K}$

(d) $+109 \text{ J/K}$

(e) $+444 \text{ J/K}$

37&38. What is the pH of a $1.5 \times 10^{-4} \text{ M KOH}$?

(a) 2.95

(b) 3.80

(c) 10.18

(d) 10.79

(e) 11.52

39&40. What is the pH of a 0.100 M nitrous solution?

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

41&42. Calculate the standard cell potential for the cell: Cd/CdSO₄ (1 M) || NiSO₄ (1 M) /Ni

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

43&44. What concentration of Ca²⁺ will initiate precipitation in a solution that is 1.00 x 10⁻⁸ M Na₃PO₄?

- (a) 3.0 x 10⁻² M (b) 5.0 x 10⁻³ M (c) 1.0 x 10⁻⁵ M
(d) 1.0 x 10⁻⁴ M (e) 1.0 x 10⁻³ M

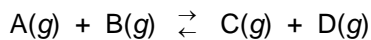
45&46. How many grams of Al will be deposited from molten AlCl_3 by a current of 15.0 amperes flowing for 24.0 hours?

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

47&48. If the activation energy in the forward direction of a single step reaction, $\text{A} \rightarrow \text{B}$, is 68 kJ and the activation energy in the reverse direction is 75 kJ, what is the energy of reaction ΔE for this reaction? (Hint: draw the activation energy diagram.)

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

49&50. The equilibrium constant for the following gas phase reaction is 144 at a 200°C . If 0.400 mol of both C and D are placed in a 2.00 liter container at that temperature, what will the concentration of A be at that same temperature?



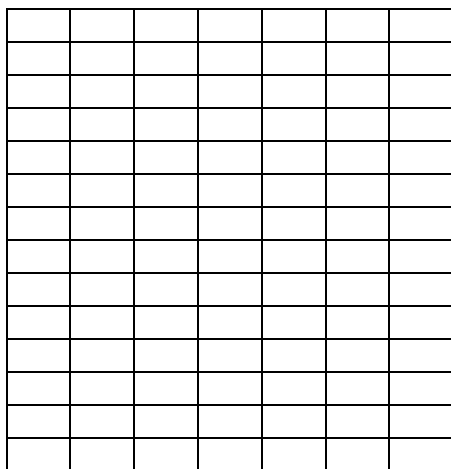
- (a) 0.0020 M (b) 0.075 M (c) 0.13 M (d) 0.067 M (e) 0.015 M

PART 2

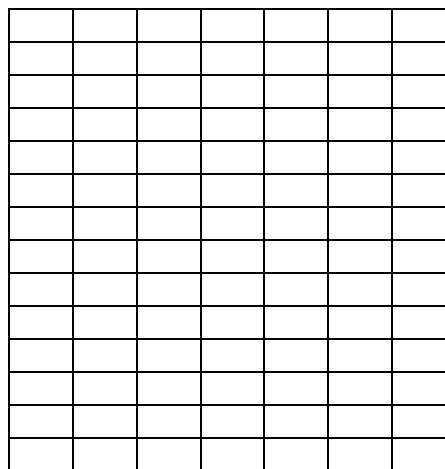
Please read and sign: "On my honor, as an Aggie, I have neither given nor received unauthorized aid on this exam." _____

- (5 pts) **56.** Roughly sketch two graphs with pH on the y axis and volume of titrant added on the x axis for:
- (a) The titration of nitrous acid with sodium hydroxide
 - (b) The titration of nitric acid with sodium hydroxide.
- Note where pH = 7 on each graph.

(a)



(b)



- (5 pts) **57.** Calculate the potential (in volts) for the non-standard voltaic cell when the following two half-cells are connected:
- Anode: Al electrode in 0.10 M Al^{3+} solution
Cathode: Ag electrode in 1.0×10^{-4} M Ag^{+} solution

58. Calculate the molar solubility of $\text{Mg}(\text{OH})_2$ in a solution that is set at $\text{pH} = 12.00$. (5 pts).

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

60. 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 $[\text{Cu}^{2+}]$ decreases

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

(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 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
