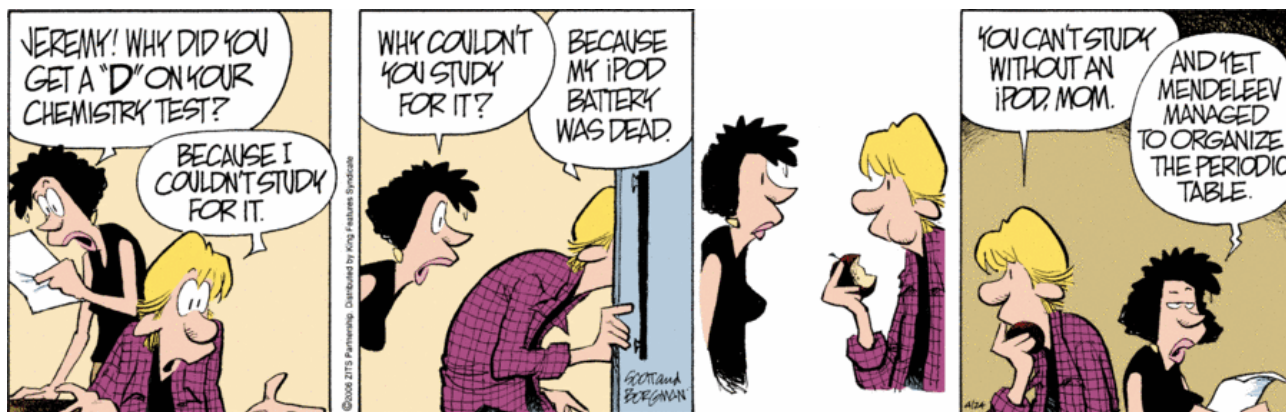


Name: _____

EXAM 3

CHEM 1412

April 29, 2010



Total:		100
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Instructions:

1. There are **8 pages** in this exam. Put your initials on every page.
2. You have 1 hour to complete the exam.
3. You may use calculators.
4. **Write only in ink!** Exams taken in pencil will not be accepted for regrades.
5. *Show all work*; answers must include the correct units and be to the correct number of significant figures.
6. *Partial credit will be given on many problems*, so it is to your advantage to write at least something for every question.

DON'T PANIC

CHAPTER 15: Acid-Base Equilibria

1. Choose the stronger acid in each of the following pairs: (5 pts)
- a. HClO_3 or HClO_2 _____
 - b. HOBr or HOI _____
 - c. HBr or HI _____
 - d. H_2S or H_3P _____
 - e. H_2SO_3 or HClO_3 _____
2. A 0.100 M solution of veritaserum, a weakly basic drug used in lie detection, has a pH of 12.25. What is the value of K_b for veritaserum? (5 pts)
3. Predict whether the following salts will form **acidic**, **basic**, or **neutral** solutions. (5 pts)
- a. KCN _____
 - b. AlCl_3 _____
 - c. NaBr _____
 - d. NH_4Br _____
 - e. NaNO_2 _____
4. What is the pH of a 0.10 M solution of NaClO_2 ? For the acid form, HClO_2 , $K_a = 1.1 \times 10^{-2}$ (5 pts)

CHAPTER 16: Applications of Aqueous Equilibria.

5. A buffer solution is prepared which contains 0.500 M HC₂H₃O₂ and 0.400 M NaC₂H₃O₂. (5 pts)
- What is the pH of the buffer solution? (The K_a of HC₂H₃O₂ is 1.8×10^{-5} .)

 - What will the pH of the buffer solution be if 100. mL of 1.00 M NaOH is added to one liter of the solution?
6. Calculate the pH during the titration of 25.00 mL of 0.500 M HCl after 35.00 mL of 0.500 M NaOH solution has been added. (5 pts)
7. Calculate the pH during the titration of 50.00 mL of 0.1000 M ammonia, NH₃ ($K_b = 1.8 \times 10^{-5}$), with 0.1000 M HCl solution after 15.00 mL of the HCl solution has been added. (5 pts)

8. Which **TWO** of the following mixtures will **NOT** result in a buffer solution: (5 pts)

- a. 150.0 mL of 0.10 M NaCl and 135.0 mL of 0.175 M HCl
- b. 75.0 mL of 0.25 M NH₃ and 50.0 mL of 0.25 M HCl
- c. 50.0 mL of 0.10 M NH₃ and 60.0 mL of 0.10 M NH₄Cl
- d. 50.0 mL of 0.20 M HF and 60.0 mL of 0.20 M KOH
- e. 75.0 mL of 0.10 M HF and 75.0 mL of 0.10 M NaF

(a) **b and d**

_____ (b) **a and d**

(c) **c and e**

(d) **b and c**

(e) **a and c**

9. When 100.0 mL of 1.00 M acetic acid, HC₂H₃O₂, is titrated with 1.00 M NaOH, what is the pH at the equivalence point? (The K_b of NH₃ is 1.8×10^{-5} .) (5 pts)

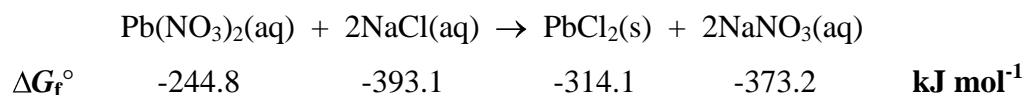
10. Silver phosphate, Ag₃PO₄, has a molar solubility of 1.76×10^{-5} mol/L. What is the value of K_{sp} for Ag₃PO₄? (5 pts)

11. Calculate the molar solubility of PbCl₂ in pure water. (The K_{sp} for PbCl₂ is 1.7×10^{-5} .) (5 pts)

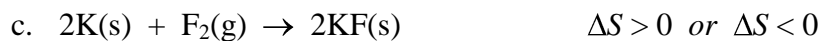
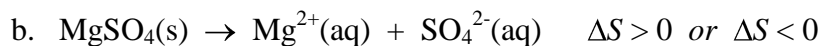
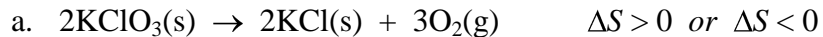
12. Calculate the molar solubility of PbCl_2 in 0.200 M CaCl_2 solution. (The K_{sp} for PbCl_2 is 1.7×10^{-5} .) (5 pts)
13. A solution is prepared which has a 0.020 M Ca^{2+} concentration and a 0.030 M CrO_4^{2-} concentration. Calculate the Q_{sp} of the solution. Will a precipitate of calcium chromate form under these conditions if the K_{sp} of CaCrO_4 is 7.1×10^{-4} ? (5 pts)

CHAPTER 17: Thermodynamics: Entropy, Free Energy, and Equilibrium.

14. Which ONE of the following statements is **TRUE**? (5 pts)
- _____ (a) The entropy of a pure crystalline material at 25°C is zero.
- _____ (b) The free energy change of a system is positive for a spontaneous process.
- _____ (c) The entropy change for the system does not determine whether a process is spontaneous.
- _____ (d) Exothermic reactions are always spontaneous.
- _____ (e) The entropy of the universe decreases for a spontaneous process.
15. (a) Use the data given below to calculate ΔG° for the following reaction. (b) Is this reaction *spontaneous* or *nonspontaneous*? (5 pts)



16. Predict the algebraic sign of the entropy change for the following reactions: (5 pts)



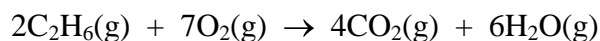
17. For a particular reaction, ΔH° is -335.5 kJ, and ΔS° is -325.8 J/K. (a) Use the Gibbs equation to calculate ΔG° for the reaction at 298. K. (b) At what temperature will the reaction become nonspontaneous? (c) What is the value of K for the reaction? (5 pts)

a. ΔG° _____

b. T _____

c. K _____

18. Calculate ΔH° and ΔS° for the following reaction from the given thermodynamic data, and then calculate ΔG° for the reaction using the Gibbs equation. (Use standard conditions for the temperature in the Gibbs equation.) (5 pts)



ΔH_f°	-84.667	0	-393.5	-241.826	kJ / mol
S°	229.5	205.0	213.7	188.72	J / K mol

a. ΔH° _____

b. ΔS° _____

c. ΔG° _____

19. Consider the following reaction:



- (a) Calculate ΔG° (in kJ) for the reaction at standard thermodynamic conditions (298K) ($R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$)
- (b) Calculate ΔG for the reaction at 298K when $P_{\text{ICl}} = 2.00 \text{ atm}$, $P_{\text{I}_2} = 0.20 \text{ atm}$, and $P_{\text{Cl}_2} = 0.20 \text{ atm}$. (5 pts)

CHAPTER 18: Electrochemistry.

20. Balance the following redox skeleton reaction: (5 pts)



21. What was either the name or subject of this year's Moon Lecture speaker? (+ 2 pts.)

22. **Bonus.** From an analysis of the Gibbs equation, what must be true about the signs of ΔH° and ΔS° for a reaction to be **nonspontaneous** at **all** temperatures? (+2 pts)

 **Physical Constants** 

Avogadro's number	6.022×10^{23} units/mol
Planck's Constant	$h = 6.626 \times 10^{-34}$ J s
Speed of light	$c = 3.00 \times 10^8$ m/s
Universal gas constant	$R = 0.0821$ L atm K ⁻¹ mol ⁻¹ $R = 8.314$ J K ⁻¹ mol ⁻¹
Ion-product of water	$K_w = 1.0 \times 10^{-14}$
Faraday Constant	$F = 9.65 \times 10^4$ C/mol e ⁻ = 9.65×10^4 J / V mol e ⁻

Conversion Factors

(Conversion factors are exact except where indicated.)

1 in = 2.54 cm	$^{\circ}\text{C} = \frac{5}{9} (^{\circ}\text{F} - 32)$	1 mmHg = 1 torr
3.281 ft = 1 m (not exact)	$^{\circ}\text{F} = \frac{9}{5} ^{\circ}\text{C} + 32$	1 atm = 1.01325×10^5 Pa
1.609 km = 1 mi	$\text{K} = ^{\circ}\text{C} + 273.15$	1 atm = 760 mmHg
5280 ft = 1 mi	1 atm = 101 kPa (not exact)	1 atm = 760 torr
		1 atm = 14.7 lb / in ² (psi)

Equations

For a quadratic equation of the form $ax^2 + bx + c = 0$,

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$