Chemistry 342

Physical Chemistry I

Spring 2005

MWF 2:00 PM in 309 BH + F 3:00 PM in 309 BH

Prerequisites: Phys. 141, 142 (or one year of College Physics) and Chem. 222 (or Chem. 118 or CheE 201) and Math. 180, 181 (Calculus I and II).

Textbook: L. M. Raff, "Principles of Physical Chemistry".

Lecturer: **Prof. Cynthia J. Jameson**, 4240 SES

Office Hours: Mon. Wed. 3-4 PM {You may look for me also at other times and in 4378SES}

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Office Hours: Tues 9-10 AM, Fri 11-12 AM

Course Outline

Textbook Raff

1. Empirical Properties of Gases **Chap 1**
   - 1.1 The Ideal Gas
   - 1.2 Real Gases
2. The First Law of Thermodynamics; Thermochemistry **Chap 2-3**
   - 2.1 Definitions (system, surroundings, isolated system, open system, state of a system, change in state, path, process, state variable)
   - 2.2 Work (w) and Heat (q)
   - 2.3 Work of expansion, work of compression, maximum and minimum quantities of work
   - 2.4 Reversible and Irreversible Transformations, a cyclical transformation
   - 2.5 Energy, $\mathbf{U}$; the First Law of Thermodynamics
   - 2.6 Exact and Inexact Differentials
   - 2.7 Examples of Changes in State (at Constant Volume, at Constant Pressure); Definition of $\mathbf{H}$
   - 2.8 Relation between C_p and C_V
   - 2.9 The Measurement of $(\partial\mathbf{U}/\partial V)_T$ - Joule's Expt.; the Measurement of $(\partial\mathbf{H}/\partial p)_T$ - Joule-Thomson Expt.
   - 2.10 Adiabatic Changes in State
   - 2.11 Application of the First Law of Thermodynamics to Chemical Reactions, Standard Enthalpy Changes
   - 2.12 Temperature Dependence of Enthalpy
3. Introduction to the Second Law of Thermodynamics **Chap 4**
   - 3.1 The Carnot Cycle
   - 3.2 The Thermodynamic Definition of Entropy, $d\mathbf{S} \equiv dq_{rev}/T$
   - 3.3 The Clausius Inequality

4. Entropy Changes Accompanying Specific Processes, the Third Law of Thermodynamics **Chap 4**
   - 4.1 Entropy Changes in Isothermal Transformations, Trouton's rule
   - 4.2 Entropy as a Function of Temperature and Volume
   - 4.3 Entropy as a Function of Temperature and Pressure
   - 4.4 The Third Law of Thermodynamics
   - 4.5 Standard Entropy Values ("Third Law Entropies), $\mathbf{S^\circ}$ (T)

5. Spontaneity and Equilibrium **Chap 5**
   - 5.1 The General Conditions for Equilibrium and Spontaneity
   - 5.2 Define Helmholtz Free Energy, **A** ; Define Gibbs Free Energy, **G**
   - 5.3 The Maxwell Relations
   - 5.4 The Properties of **A**, the Properties of **G**, The Gibbs Helmholtz Eqn.
   - 5.5 The Chemical Potential, μ of a Pure Substance, fugacity

6. Phase Equilibrium in Simple Systems; The Phase Rule **Chap 6**
   - 6.1 The Equilibrium Condition
   - 6.2 The Clapeyron Equation; solid-liquid, liquid gas, solid-gas equilibria
   - 6.3 The Phase Diagram, the Phase Rule

7. Solutions **Chap 8**
   - 7.1 The Ideal Solution, Raoult's law
   - 7.2 The Gibbs-Duhem Equation, the Gibbs Energy of Mixing, the Chemical Potential in Ideal Solutions
   - 7.3 Vapor Pressure of Binary Solutions
   - 7.4 The Chemical Potential in the Ideal Dilute Solution, Henry's law
   - 7.5 Colligative Properties, Freezing Point Depression, Boiling Point Elevation, Osmotic Pressure
   - 7.6 Equilibria in Non-Ideal Systems: The Concept of Activity $\boldsymbol{a}_i$, the Rational System, or the Practical System, or in terms of Molalities

8. Phase Diagrams of Two-Component Systems **Chap 8**
   - 8.1 Vapor Pressure Diagrams; the Lever Rule
   - 8.2 Temperature Composition Diagrams; Fractional Distillation, Azeotropes
   - 8.3 Liquid-Liquid Equilibria, Partially Miscible Liquids, Critical Solution Temperature
   - 8.4 Solid-Liquid Equilibria, Eutectics, Incongruent Melting

9. Chemical Equilibrium **Chap 5**
   - 9.1 Chemical Equilibrium in a Mixture of Ideal Gases
   - 9.2 Chemical Equilibrium in a Mixture of Real Gases
   - 9.3 The Temperature Dependence of an Equilibrium Constant
   - 9.4 LeChatelier's Principle
   - 9.5 Activities in Solutions of Electrolytes,Mean Activity Coefficients **Chap 9**

9.6 Equilibria in ionic solutions

9.7 Debye Hückel limiting law

10. Equilibria in Electrochemical Cells **Chap 9**

10.1 Definitions (electrochemical cell, electrical potential, electrical potential difference, electrode potential, electromotive force of the cell)

10.2 Gibbs Free Energy of Formation of an Ion in Solution

10.3 Thermodynamic Functions from Cell Measurements: $\Delta \mathbf{G^\circ}$, Equilibrium Constants, $\Delta \mathbf{S^\circ}$, Activities and Activity Coefficients

SCHEDULE

Lect slides Part#	Topic in outline	Text book	Prob session slides	Prob lem Set#	Exam	Review sheet for exam
1	1. Empirical Properties of Gases	Chap 1	Sample Probs for Part 1	Set 1		
2	2. The First Law of Thermodynamics; Thermochemistry	Chap 2,3	Sample Probs for Part 2	Set 2 Set 3	Exam I covering Parts 1&2	Review Sheet for Parts 1&2
3	3. Introduction to the Second Law of Thermodynamics	Chap 4	Sample Probs for Parts 3&4	Set 4		
4	4. Entropy Changes Accompanying Specific Processes, the Third Law of Thermodynamics	Chap 4	Sample Probs for Parts 3&4	Set 4 Set 5 Set 6		
5	5. Spontaneity and Equilibrium	Chap 5	Sample Probs for Parts 1-5	Set 6	Exam II covering Parts 1-5 (esp 3-5)	Review Sheet for Parts 3-5
6	6. Phase Equilibrium in Simple Systems; The Phase Rule	Chap 6	Sample Probs for Parts 6&7	Set 7		
7	7. Solutions	Chap 8	Sample Probs for Parts 6&7	Set 7 Set 8		
8	8. Phase Diagrams of Two-Component Systems	Chap 8	Sample Probs for Part 8	Set 8 Set 9 Set 10	Exam III covering Parts 1-8 (esp 6-8)	Review Sheet for Parts 1-8
9	9. Chemical Equilibrium	Chap 5	Sample Probs for Part 9	Set 9		
	9.5 Activities in Solutions of Electrolytes, Mean Activity Coefficients;	Chap 9		Set 9 Set 11		
10	10. Equilibria in Electrochemical cells	Chap 9	Sample Probs for Part 10	Set 11	Final Exam covering Parts 1-10	

Exams are pre-scheduled; no make-up exams are given for absences for any reason.

EXAMS:

First Hour Exam: **Friday, February 4, 2005**
Second Hour Exam: **Friday, March 18, 2005**
Third Hour Exam: **Friday, April 22, 2005**
FINAL Exam: **Tuesday, May 3, 2005 1:00-4:00 PM (three hours)**

Problem Sets: will be graded and included in determining the final course grade.
Collected one week after they are assigned (late penalties).
NOT ACCEPTED after answers are posted on the Chemistry 342 web site.

Chemistry 342 web site for this semester:

http://www.chem.uic.edu/chem342

Starting from the second week of the semester, we will no longer provide paper copies in class. This Syllabus, Physical Chemistry Survival Guide, and Problem Sets will be posted on this site. You may download your own copy. Solutions to problem sets, hand-outs, and solutions to Exams will also be available in the same way.

Hand-outs are posted as : hand1.pdf, …., hand9.pdf ; these include previews of problems to be discussed during the Problem Session periods on Fridays and review sheets for exams (hand3, hand4, hand8)

Problem Sets are posted as set1.pdf, …, set10.pdf

Solutions to problem sets are posted as ans1.pdf, ….., ans10.pdf

Answers/solutions of exams are posted as exam-ans1.pdf, …., exam-ans3.pdf