

09-214 Physical Chemistry Spring 2013

Instructor: Dr. M. Mandal, MI-308 x8-4213, mandal@cmu.edu

Textbook: Physical Chemistry for the Biosciences by Raymond Chang, Publication: 2005
ISBN: 1-891389-33-5

Pre-requisites: (09-106) and (21-122 or 21-124) and (33-106 or 33-111)

Class

Schedule: MWF 10:30-11:20 AM at Wean Hall 5403

Graduate

TA Office Hours: Lea Veras (Mondays, 12:20 – 2:20 PM, DH 2311)
Muwen Kong (Tuesdays, 5:00 – 7:00 PM, MI 308B)

Assignments: Weekly problem sets are posted on Friday in the blackboard. These assignments are for your practice and will not be graded. Additional problem sets will be provided by the TAs in the weekly office hours.

Quizzes: There will be *thirteen* in class quizzes on the days noted in the schedule. Each quiz is worth 10 points. Your best ten quizzes will be considered for final grades.

Exams: There will be *four* in class exams of 100 points each and one final exam worth 200 points. The best three exams will be considered for final grades.

Course Description: Physical chemistry has, as its objective the task of explaining the causes of chemical behavior using quantitative approaches. The topics covered during the semester comprise Chapters 2 through 10 of the textbook, which will be followed quite closely. Some of this material is review from Intro to Modern Chem I, II and Intro to Modern Bio with a broader emphasis on interdisciplinary and biomedical research. Also, wherever relevant to the topics, there will be discussions on various biophysical techniques used in modern day research. Topics covered will be:

- Conservation of Energy and the First Law of Thermodynamics
- The Second and Third Laws, Spontaneous Reactions, Entropy and Free Energy
- Free Energy and Equilibrium
- Physical Equilibrium involving gases, liquids
- Redox reactions
- Kinetics Principles (Rates of Reactions) and Mechanisms of reactions
- Enzyme Kinetics
- Biophysical techniques

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Day	Date	Lecture	Topic	Notes
Mon	January 14	1	Fundamentals of Thermodynamics, work	
Wed	January 16	2	Thermodynamics: The First law, heat and internal energy	
Fri	January 18	3	State functions, thermodynamic paths, Cp & Cv	Quiz 1
Mon	January 21	4	Relation between Cp and Cv continued, Calorimetry	
Wed	January 23	5	Enthalpy of Chemical Reactions	
Fri	January 25	6	Enthalpy of Formation, Bond Enthalpy	Quiz 2
Mon	January 28	7	Second Law; Entropy	Leave "Carnot's Cycle"
Wed	January 30	8	Entropy change in mixing ideal gases, Irreversible process	
Fri	February 1	9	Entropy change in chemical reactions, spontaneous reaction	Quiz 3
Mon	February 4	10	Laws of Thermodynamics	Exam 1
Wed	February 6	11	Temperature dependence of entropy, Concept of Gibbs energy	
Fri	February 8	12	Gibbs and Helmholtz Energy, Various forms	Quiz 4
Mon	February 11	13	Effect of pressure change on free energy	
Wed	February 13	14	Effect of temperature on free energy	
Fri	February 15	15	Chemical Potential, Relationship with free energy	Quiz 5
Mon	February 18	16	Chemical equilibrium constant and free energy	Leave "Real Gases"
Wed	February 20	17	Heterogenous equilibrium	
Fri	February 22	18	Effect of Temperature on equilibrium constant	Quiz 6
Mon	February 25	19	Solutions: Raoult's and Henry's Law	
Wed	February 27	20	Real solutions, Deviations from ideal solutions	
Fri	March 1	21	Colligative Properties	Quiz 7
Mon	March 4	22	Laws of Thermodynamics	Exam 2
Wed	March 6	23	Colligative Properties contd.	
Fri	March 8	24	Water: Structure, chemical and physical properties	
	March 10 th - 16 th		Spring Break	

Mon	March 18	25	Thermodynamics of Ion formation	Quiz 8
Wed	March 20	26	Ionic Activity	
Fri	March 22	27	Redox Reactions, Daniell cell	Quiz 9
Mon	March 25	28	Nernst Equation, Concentrated cells, Solution activity	
Wed	March 27	29	Acids and Bases, Diprotic and polyprotic acids	Quiz 10
Fri	March 29 th	30	<i>Solutions, Electrochemistry, Acids and Bases</i>	<i>Exam 3</i>
Mon	April 1	31	Buffer Solutions, Applications	
Wed	April 3	32	Reaction rates and order of reaction	
Fri	April 5	33	Order of reaction continued	Quiz 11 Leave "Determination of reaction order"
Mon	April 8	34	Molecularity and complex reactions	
Wed	April 10	34	Complex reactions continued	
Fri	April 12	35	Arrhenius equation	Quiz 12
Mon	April 15	36	Transition state theory, Relation with Gibbs free energy	Leave "Collision Theory"
Wed	April 17	37	Continued.	
Fri	April 19	38		<i>Spring Carnival !!</i>
Mon	April 22	39	Ligand Binding continued, standard state of biochemistry	Quiz 13
Wed	April 24	40	Cooperativity of ligand binding, Hill equation	
Fri	April 26	41	Enzyme Kinetics/ Inhibition	
<i>Mon</i>	<i>April 29</i>	<i>42</i>		<i>Exam 4</i>
Wed	May 1	43	Biophysical Techniques: single-molecule optical tweezers hands on experiments	
Fri	May 3	44	single-molecule optical tweezers hands on experiments contd.	