Fundamentals of Macroscopic Chemical Analysis (CHEM 255)
Spring 2013
Course Syllabus, Policies, and Procedures

Prerequisites: Completed CHEM 125

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Text: Fundamentals of Macroscopic Chemical Analysis, Freeman Custom Publishing (requird)

Web resources: Chemistry 255: Fundamentals of Macroscopic Chemical Analysis [Course moodle site: https://moodle.csbsju.edu/course/view.php?id=2834

Course Description/Meeting Time:
Three meetings each cycle
9:40 am – 10:50 am (Days: 1, 3, 5), Ardolf Science Center 105

Office Hours:
11:00 am -12:00 pm (Days: 1, 2, 3)
By appointment

Objectives:
The chemical analysis process often begins with a question that is not phrased in terms of the chemical analysis. The question could be; "Is this water safe to drink?" or "Does emission testing of automobiles reduce air pollution?" The analytical chemist then has to translate these questions into the need for a particular measurement. The chemist must then choose or invent a procedure to carry out those measurements.

When the analysis is complete, the analyst must translate the results into terms that can be understood by others – often the general public. One of the most important features of any result is its limitations. What is the uncertainty in the reported results? If you took samples in a different manner, would you obtain the same results? Is a tiny amount of analyte found in a sample really there or is it contamination. Only after understanding all of these aspects of an analysis can we begin to draw conclusions and make decisions.

The general steps in the analytical process involves formulating the question, selecting analytical procedures, sampling, sample preparation, analysis, data interpretation, drawing conclusions and

reporting. We will try to develop a complete understanding of this process by an in-depth study of the foundations of "analytical analysis" with the following goals:

- The students should integrate knowledge obtained in previous courses and apply this knowledge to the analysis of chemical problems.
- The students will develop laboratory skills that will allow them to make careful chemical analyses of complex systems. By the end of the semester, the students should be able to design and develop experiments that give meaningful and useful results, using systematic methods and documentation in the development of these experiments.
- The students should develop the problem solving skills to take a complex chemical system (especially equilibria systems), break it into smaller solvable units, and develop a mathematical model for these systems.
- The students should develop confidence in their chemical knowledge and be able to show these skills in oral and written presentations.

Attendance, Late submission and Missed Exam/Class policies:

Attendance at class is expected, as are preparation and participation. Group work is very important in this class and you are expected to actively participate.

There are always times when you must miss class for a legitimate reason (weddings, funerals, illness, athletics, etc.). This always creates tension with regards to making-up missed assignments, exams, etc. To help reduce this tension, **the policy in this course is that missed assignments (quiz, exam, homework) need not be made up or handed in late**. If you miss a class, please find out the notes and assignments you missed and come prepared for the next class. If you miss a quiz, you will receive the average of your last two quiz scores. If you miss one of the chapter exams your final will be counted twice. You will get zero points for a missed homework. You will lose points for late submission (less than 24 hours: 20%, less than 72 hours: 50%). If you are late for more than 3 days, you will get zero.

Academic Ethics:

Original work performed in good faith is assumed on all exams /homework/ laboratories. It is presumed that the data you record and report in laboratory is your work. Scientific and scholarly misconduct includes the following forms of inappropriate activities:

- Plagiarism (e.g., copying from other students, past reports, or writing of others etc.)
- Intentional misrepresentation of credentials
- Falsification of data

Failure to adhere to this code of ethics will result in prosecution to the fullest extent (**http://www.csbsju.edu/catalog/2007_2009/programs/rights/001.htm**). ***If you have not done something yourself, do not attempt to pass it as original work.***

Evaluation Procedures:

Your overall grad in this course is based on total points. These points are acquired through Exams, Quizzes, Homework and Project work.

Exams: There will be three 60-minute exams along with a Final Exam. The 60-minute exams will cover the most recently covered material in class. The final exam will be comprehensive (ACS Standardized Exam).

Quizzes: A series of short, 20-minute, quizzes will be given during the semester. These quizzes are designed to give timely assessment of the classes understanding of the concepts being covered. Quizzes will be announced in advance in class.

Homework: Homework is very central to the way the course will be conducted. In order to get the most from this course, you need to be an active participant in your own learning. You will work in a group to solve the homework assignments.

Project work: Students (in groups) will work on projects related to the latest advancements in the field of analytical/bioanalytical chemistry. Students will review current literature on selected topics and submit written reports.

Grading:
The course is graded based on the percent of total points earned (rather than based on a curve). This means that any number of students may earn an "A" or any other grade. The minimum requirements for each grade are:

Total points (%)	**Assigned grade**
90% and up	A
85% - 89.99%	AB
80% - 84.99%	B
75% - 79.99%	BC
70% - 74.99%	C
65% - 64.99%	CD
60% - 64.99%	D

Exam types	**Comments**	**Percent (%) contribution**
Chapter exams	3 Exams	40%
Quizzes	6 quizzes	20%
Homework	homework assignments	10%
Project work	group assignment	10%
Final exam	ACS standardized exam	20% (may count double)*

*The final exam score may be used to replace a missed exam

Classroom etiquettes

- No cell phones/Blackberries/Palms are to be ON/used in class
- No laptops are to be ON/used in class
- Do not have conversations with your neighbor during class (<u>except group work</u>)
- Bring a scientific calculator to class

Keys to success in Chemistry 255:

Chemistry is a fairly difficult subject and requires hard work from you. Always remember **I want you to succeed**. I believe in providing academic challenge in a supportive environment so that all the students can bring out their best. Here are some keys to doing great in this course:

- Attend all classes, pay close attention, and actively participate
- Chemistry is sequential and hierarchical. Do not fall behind.
- Read the assigned chapters in the book so you are prepared for class
- Practice problem solving as much as you can. This will give you a chance to apply the concepts you have learned.
- Learn from your mistakes on problem sets and tests.
- Make daily, weekly and monthly plans and follow it.

Tentative Class Schedule

Cycle	Chapter	Topics	Suggested Problem Set
1	01/14: Fundamentals	Matter and energy (A.1-A.3) Moles and molar mass (E.1-E.2) Concentration and dilution (G.3, G.4) Chemical equations (H.1-H.2) Reaction stoichiometry (L.1-L.3) Limiting reagents (M.1, M.2)	E.25, G.9, G.12, L.2, L.5, M.7, M.8
	01/16:Experimental errors (Ch 3)	Significant figures (3-1, 3-2) Types of errors (3-3) Propagation of uncertainty (3-3, 3-4)	3-1, 3-5, 3-12, 3-15
	01/18: Statistics (Ch 4)	Gaussian distribution (4-1) Confidence intervals (4-2) Student's t-test (4-3)	4-4, 4-11, 4-13, 4-14, 4-21, 4-23, 4-29
2	01/22: Statistics (Ch 4)	F-test (4-4) Grubs test (4-6) The method of least square (4-7) Calibration curves (4-8)	
	01/24: quality assurance (Ch 5)	Basic (5-1) Method validation (5-2) Standard addition (5-3) Internal standard (5-4)	5-5, 5-7, 5-9, 5-13, 5-19, 5-21, 5-23, 5-29
	01/28: **Quiz #1** introduction	States of matter (0.1) Energy (0.4) Temperature (0.6)	
	01/30: First law of thermodynamics (Ch 2)	System and surroundings (2.1) Work and heat (2.2) The measurement of work (2.3) The measurement of heat (2.4)	2-4, 2-11, 2-14, 2-17

3	02/01: First law of thermodynamics (Ch 2)	The internal energy (2.6) State function (2.7) The enthalpy (2.8) The temperature variation of enthalpy (2.9)	
	02/05: Thermodynamics: application of first law (Ch 3)	Enthalpy of phase transition (3.1) Atomic and molecular changes (3.2) Enthalpy of combustion (3.3) Combination of reaction enthalpies (3.4) Standard enthalpy of formation (3.5) Variation of enthalpy with temperature (3.7)	3-3, 3-13, 3-20, 3-26, 3-34
4	02/07: Thermodynamics: the second law (Ch 4)	Spontaneous change (4.1 Entropy and second law (4.2) Entropy change for expansion (4.3) Entropy change for heating (4.4)	4-1, 4-8, 4-11, 4-20, 4-26, 4-28
	02/11: Thermodynamics: the second law (Ch 4)	Entropy change for phase transition (4.5) Entropy change in surroundings (4.6) Third law of thermodynamics (4.7) The statistical entropy (4.8)	
	02/13: **Quiz #2** Thermodynamics: the second law (Ch 4)	Residual entropy (4.9) Standard reaction enthalpy (4.10) Spontaneity of chemical reaction (4.11) Gibbs free energy (4.12, 4.13)	
5	02/15: Physical equilibria (Ch 5) Properties of mixtures (Ch 6)	Phase diagrams (5.3) Phase boundaries (5.4) Characteristic points (5.6) The phase rule (5.7) Ideal solutions (6.3) Colligative properties (6.6)	5-14, 5-16, 5-18 6-20, 6-22
	02/19: CHAPTER EXAM I		
	02/25: Chemical equilibrium (power point)	The equilibrium constant Calculation of equilibrium concentrations Effects of variables on systems in equilibrium	
	02/27: Systematic treatment of equilibrium	Effect of ionic strength (7.1)	7-12, 7-20, 7-23

6	(Ch7)	Activity coefficients (7-2) pH revisited (7-3) Systematic treatment (7-4) Applying systematic treatment (7-5)	
	03/01: Monoprotic acid-base equilibrium (Ch 8)	Strong acids and bases (8-1) Weak acids and bases (8-2) Weak acid equilibria (8-3)	8-6, 8-20, 8-23, 8-32, 8-34, 8-34
	03/05: Monoprotic acid-base equilibrium (Ch 8)	Weak base equilibria (8-4) Buffers (8-5)	
7	03/07: **Quiz #3** Polyprotic acid-base equilibria (Ch 9)	Diprotic acids and bases (9-1)	9-5, 9-13, 9-26
	03/11: Polyprotic acid-base equilibria (Ch 9)	Diprotic buffers (9-2) Polyprotic acids and bases (9-3) Principal species (9-4) Fractional composition, monoprotic system (9-5) Isoelectric point and pH (9-6)	
	03/13: Acid-base titration (Ch 10)	Titration of strong acid with strong base (10-1) Titration of weak acid with strong base (10-2)	10-8, 10-14, 10-23
8	03/15: **Quiz #4** Acid-base titration (Ch 10)	Titration of weak base with strong acid (10-3) Titration of diprotic systems (10-4)	
	03/19: Acid-base titration (Ch 10)	Finding end point with pH electrode (10-5) Finding end point with indicators (10-6) The leveling effect (10-9) Evaluation of titration method	
	03/21: CHAPTER EXAM II		
9	04/02: EDTA titrations (Ch 11)	Metal chelate complexes (11-1) EDTA (11-2) EDTA titration curves (11-3)	11-3, 11-8, 11-16, 11-33
	04/04: EDTA titrations (Ch 11)	Auxiliary complexing agents (11-5) Metal ion indicators (11-6) EDTA titration techniques (11-7)	
	04/08: Fundamentals of Electrochemistry (Ch	Basic concepts (13-1)	13-5, 13-9, 13-16

	13)	Galvanic cells (13-2) Standard potential (13-3)	
10	04/10: **Quiz #5** Fundamentals of Electrochemistry (Ch 13)	Nernst Equation (13-4) E^0 and equilibrium constant (13-5) Cells as chemical probes (13-6)	
	04/12: Electrodes and Potentiomatry (Ch 14)	Reference electrodes (14-1) Indicator electrodes (14-2) Ion selective electrodes (14-4)	14-25, 14-39
	04/16: Electrodes and Potentiometry (Ch 14)	pH measurement (14-5) Ion selective electrodes (14-6) using ion selective electrodes (14-7)	
11	04/18: Redox titration (Ch 15)	Shape of redox titrations (15-1) Finding the end point (15-2)	
	04/22: Redox titrations (Ch 15)	Analyte oxidation states (15-3) Oxidation with potassium permanganate (15-4) Oxidation with potassium dichromate (15-6) Methods with iodine (15-7)	15-5, 15-25
	04/25: **Quiz #6** Fundamentals of spectroscopy (power point)	Properties of light Absorption of light Beers law Spectrophotometric titrations	
12	04/29: Redox titration (Ch 15)	Energy diagram Fluorescence and phosphorescence Evaluation Analysis of mixture	
	05/01: CHAPTER EXAM III		
	05/03: Review		
	FINAL EXAM: ACS Standardized Test		