George Mason University
Quantitative Chemical Analysis (CHEM 321)
Fall 2006

Instructor: Dr. Abul Hussam
Room: ST1, 337 or 340
Office hours: MW -10:00- 11:30

Goals and requirements of the course

Modern science and technology can not sustain without quantitative chemical analysis. Precise and accurate measurement of chemicals species and analysis of materials are required by all branches of science. This course is designed to introduce you to the process and method of chemical analysis - in theory and practice. Since many of you are going to work as a professional chemist, biologist, doctor, environmental scientist, etc., therefore, it is to your advantage to learn one of the most vital tools of the trade i.e., chemical analysis. Students must have passed and learned the general chemistry (CHEM 211 and CHEM 212) to take this course. Students are expected to know and use word processing and spreadsheet programs to write laboratory reports, process laboratory data and solve assigned computer projects.

Text

Exploring Chemical Analysis (Third Edition) by Daniel C. Harris, W. H. Freeman, 2005 and web materials at *www.whfreeman.com/exploring3e* such as pdf Lab Experiment to accompany the text (LE-Harris). A solution manual for the text is also available.

Course content

The course is designed to solve problems of practical significance. Particular emphasis will be given on error analysis, chemical equilibria, electrochemical techniques, and basic spectrophotometry and separation science. A tentative course schedule is given below:

Lecture	Subject	Chapter	Dates/ Quiz
1-3	Analytical Process, Concentration units, Experimental errors, significant figures, error propagation and math toolkit Tools of the trade (Ch 2: A must lab reading material)	0-3	
4-5	Statistics: Error distribution, t-test, Q-test, calibration curves, linear best fit line. Quality assurance and calibration methods	4-5	
6-7	Volumetric analysis: solubility products, Gravimetric analysis, Relation between K's (part from chapter 1-5)	6,7	
8	Monoprotic acid-base equilibria	8	
9	Buffers and Indicators	9	
10	Acid-base titration	10,11	
11,12	Polyprotic acid base: Speciation analysis, Deeper Look	12	
13	EDTA Titration of Metal ions	13	
18,19	Spectrophotometry	14,15	
14	Electrode Potential	16	
15	Electrode Measurement	17,19	
21,22	Principles of Chromatography	20,21	
23,24	Gas / liquid chromatography, Capillary Electrophoresis	22,23	

Midterm exam: **Wednesday, Oct 4, 12:30-1:20 PM.**
Columbus Day Recess: **Oct 9 (No Tuesday CHEM 321 classes. Reading period)**
Thanksgiving Recess: **Nov 22-26**
Last day of class: **December 9**
Final exam: **Monday, December 18, 10:30-1:00 PM**

Methods of evaluation

Course evaluation and grading are based on homework problems and computer projects (10%), midterm (10%), class quizzes (20%), cumulative course final exam (20%), laboratory grade (35%) and laboratory final exam (5%). Exams quizzes are designed to test your problem solving skills. All exams and quizzes are closed book and closed notes. Quiz dates will be announced in class. Lab grades may include pre-lab quizzes, lab report grade, and lab final exam grade. There will be no makeup exams, quizzes, and labs except under circumstances determined by the instructor.

Methods of instruction
Computerized 'Chalk-Talk' overheads are the primary method of instruction. Laboratory part of the instruction is based on handling wide range of laboratory chemicals, apparatus, and instruments.

Homework Problems: (Class quizzes are based on HW problems)

Chapter	Topics	Problems
1	Chemical measurements	12, 16, 25, 29
3	Math toolkits	13, 17, 20, 23
4	Statistics	9, 12
5	Quality assurance and calibration methods	9, 11, 20
6	Good Titrations: Solubility Products	5, 10, 17, 19
8	Acids and Bases (Calculate concentrations of all species not just pH)	9, 19, 24, 28, 32 Handout problems (Due:)
9	Buffers (Don't' use Henderson)	10, 13, 20
10	Acid Base Titration	8, 14, Handout problems (Due:)
11	Polyprotic acid	6, 14, 23, 25
12	A deeper look at chemical equilibrium	11, 14, 22, 29, 33
13	EDTA Titration	18, 19
14	Electrode Potential	4, 7, 9, 18, Handout problems (Due:)
15	Electrode Measurement	3, 8, 15, 17
18	Let there be light: Spectrophotometry	13, 17, 18, 21
19	Spectrophotometry: Applications	4, 9

Homework problems are not collected for grading except those handout problems. Check the solution manual for details. Problems from chapters on separation chemistry will be assigned later.

Computer Spreadsheet Project Problems

Topics	Chapter, Problems	Due Dates*
Statistics	4-18, 4-20, 4-21	
More Stat Project	Handout, LE-Harris pg 13, and Data from Instructor	
Quality assurance and calibration methods	5-10, 5-15, 5-16	
Acid Base Titration*	10-29, 10-30	
Polyprotic acid*	Handout, Lecture	
Spectrophotometry: Applications*	19-14, 19-16	

Due dates will be announced in class.

GEORGE MASON UNIVERSITY
Quantitative Chemical Analysis Laboratory
CHEM 321 LAB, Fall 2006
M,W: 1:30 - 4:20 (Section 201); M,W: 4:30 - 7:20 (Section 202)
S&T 1, Room 402

Text : *Exploring Chemical Analysis (Third Edition) by Daniel C. Harris, W. H. Freeman, 2004.*
Lab Supplement (LS)*: Quantitative Chemical Analysis Lab Supplement by Abul Hussam, GMU, and* web web materials at *www.whfreeman.com/exploring3e* such as pdf Lab Experiment to accompany the text (**LE-Harris**).

LABORATORY SCHEDULE

Date	Experiment	Due date	Reference	Text Chapter, Pages
August 28	Introduction and Check in		Text	2, 32-48
August 30- Sept 11	Gravimetric Analysis of Iron in Iron Ore*	Week after finish	LE-Harris Text LS	Pg 10 7, 131-143
Sept. 13 – 18	Preparation of standard base and purity of Potassium hydrogen phthalate (KHP)	Sept 25	LE-Harris Text LS	Pg 26 **215,** 192-206
Sept. 20 -27	Determination of carbonate and bicarbonate in a mixture by titration *	Oct 9	LE-Harris Text LS	Pg 26-32 Chapter 10
-Oct 2	Determination of the same mixture by pH titration *	Oct 9	LE-Harris Handout, LS	Pg 32-34
Oct. 4-9	Determination of Chloride	Oct 23	LS Text	Lecture Chapter 6, 123
Oct 11 -18	Redox Titration: Determination of Hydrogen Peroxide	Nov 1	LE-Harris LS	Pg 44 Lecture
Oct 23-Nov 1	Spectrophotometric determination of iron in iron tablet *	Nov 8	LS Text	Lecture Pg 384-386, 397
Nov 6 - Nov 13	pKa of acid-base indicator *	Nov 20	LS	Lecture
Nov 16 - 29	EDTA Titration: Zn by EDTA and by Atomic Absorption Spectroscopy	Dec 4	LS	13, 265-275
Dec 4	Makeup Labs (if any)			
Dec 6	Lab Final Exam			
Dec 6	Cleanup and Checkout**			

LS : Lab supplement
* : Experiments performed with a partner (ask your instructor)
****: Grades are not given without cleanup and checkout.**

Late laboratory reports are penalized 30% per week until the time is submitted.

GEORGE MASON UNIVERSITY
Quantitative Analysis Laboratory (CHEM 321)
Laboratory Policies

In next few weeks you will engage in a series of experiments designed to strengthen your understanding in chemical analysis as applied to analytical chemistry. This course assumes that you have completed the required chemistry courses: General Chemistry (211, 212) and Organic Chemistry (CHEM 314) and have understood the materials. Also, a familiarity with spreadsheet and word-processing programs will be very helpful. Besides following the normal safety regulations we observe the following general guidelines:

- You should come prepared for the laboratory. Bring your safety glass, the laboratory manual, a laboratory notebook, and computer diskettes. Laboratory session starts promptly at class time.

- Read the laboratory manual, the assigned chapters in the textbook and plan ahead. Especially, if the experiment requires the preparation of a large number of solutions then you could do some of the calculations ahead of time.

- Since each group is using a different instrument or setup, it is not possible to give a general lecture. The instructor, in the beginning of the lab period shows you the basic operation of the instrument. Please remember that many of the instruments you are using are research grade and expensive. Therefore, do not venture into doing something that you are not certain about. Ask your instructor for help in such cases. You should also be prepared for situations when the instrument may not function properly and your experiment may be delayed or may be modified by your instructor to obtain meaningful results. You should always note these situations in your notebook.

- Cleanliness is absolutely essential in a good laboratory practice (GLP). Maintain your bench space, the instrument space, and the balance area clean. Do not leave anything on the balance pan and rezero the balance after your use. There may be many sources of errors from sloppy lab practices (SLP). Watch out for these errors. If you are not sure about the proper way of handling apparatus and equipment, ask your instructor for a demonstration.

- Do not throw away large quantities of solutions or chemicals. Think if it could be stored safely or the next group assigned to do the same experiment could use it. In this way you conserve chemicals and time. It also makes a good environmental sense (GES).

- After you finish the day's work examine your notebook and be certain that you have all the data necessary to write a complete lab report. Remember that you only share the raw data. Observations, derived data, graph, results, calculation, and discussion should be your own. **You must checkout with your instructor before you leave the laboratory.**

George Mason University
CHEM 321 Laboratory
General Instructions
Chemistry Department

In next few weeks you will engage in a series of experiments designed to strengthen your understanding in chemical analysis as applied to many branches of science. This course assumes that you have finished the appropriate prerequisites (CHEM 211 and CHEM 212 or equivalent courses) and you are currently enrolled in the CHEM 321 lecture. If you do not have a thorough background in general chemistry then you should revise and reread the CHEM 212 part of the general chemistry. Besides following the normal safety regulations, we observe some general guidelines. Some of these are:

- You should be prepared for the laboratory. Bring your safety glass, the laboratory text book (Quantitative Chemical Analysis, D. C. Harris), the laboratory supplement (Quantitative Chemical Analysis Laboratory Supplement), a laboratory notebook with provision to make copies, and standard graph papers (finely divided, cm-mm type).

- Laboratory session starts promptly at class time. You should come prepared in the laboratory reading the assigned materials and any other basic concepts related to it. In the laboratory, your instructor will discuss the day's lab work for first fifteen minutes or so. During this period he may demonstrate some of the techniques involved in the experiment and related safety precautions. You should listen to this lecture/demonstration carefully.

- Generally, you perform an experiment unless otherwise indicated by the instructor or the schedule. In a group experiment, the instructor assigns the number of students in each group (usually two or three). While experiments are performed in a group each member of the group is responsible for his/her own laboratory notebook keeping. Only raw numerical data and observations are shared. Derived data, graphs, results, calculation and discussion should be your own.

- Cleanliness is absolutely essential in a good laboratory practice (GLP). Maintain your bench space, the instrument space, and the balance area clean. **Do not leave anything on the balance pan unattended and always reset or rezero the balance after your use.** There may be many sources of errors from sloppy lab practices. Watch out for such possible errors. If you are not sure about the proper way of handling a particular apparatus or equipment, ask your instructor for a demonstration. **Proper handling of most used lab equipment is discussed in Tools of the Trade: Chapter 2 of your text.**

- Do not dispose large quantities of solutions or chemicals. Think if it could be stored safely or another group assigned to do the same experiment could use it. In this way you save chemicals and time. It also makes a good environmental sense. Only harmless water-soluble materials should go down the drain. Waste solvents and products should be put in labeled bottles in the hood. Boiling stones should go in the trash and broken glass in the marked box.

- Near the end of the lab period the instructor often reminds you the time left for the class. As a general strategy, first, you should finish the work and record the raw data on your notebook (not on scratch papers!) before you can concentrate on preparing the final report. You should allot at least 15 minutes to clean up and check out. After you finish the day's work examine your notebook and be certain that you have all the data necessary to write a complete lab report. **You must checkout with your instructor before you leave the laboratory.**