

Chemistry 2810
Quantitative Analysis
Spring 2016

Instructor: Dr. Christopher L. Klug

Office: SCI E-3019

Phone: 706-667-4867

Course Hours: Tu/Th 1130-1245 E 1047; T/W 1430-1715 E 3031

Final Exam: May 4, 1100-1300

Office Hours: M-F 0900-1000, M 1430-1530, or by appointment

Objectives: There is not a substantial amount of new material in this course, rather it's an extension of stoichiometry and equilibria and their application to lab. You should become very comfortable with the topics covered and learn to use this material to make decisions in lab. In addition to making solutions and practicing standard instrumental and classical lab techniques, this course should help you to learn to vary written procedures to fit your experimental situation, interpret experimental results, and make efficient use of your time in lab. Thus, anything in lab is fair game in class and vice versa.

Prerequisites: CHEM 1212 (C or better)

Required Materials: *Quantitative Chemical Analysis, 8th edition* by Daniel C. Harris.; a scientific, nonprogrammable calculator (recommended TI-30X IIs); a lab notebook with pre-numbered duplicate pages; a pair of safety glasses or goggles; a lab coat; a permanent (Sharpie) marker. All lab instructions and handouts can be found on my own website, <http://spots.gru.edu/cklug/Chem2810.html> or on D2L

Grading: Your grade for the class will include a combination of class and lab work. There are usually 1000-1200 available points for the class; about half of the total points are from exams and about half are from lab. Your grade will be based on a percentage of the points earned out of the total points possible, where A= 90% or more; 89-80% is a "B"; 79-70% is a "C"; 69-60% is a "D" and less than 60% is an "F." Points will be available in the following ways:

Exams: There will be 3 in-class exams worth 100 points each. The final exam is worth 150 points.

Prelabs: The top portion of a ditto will contain questions pertaining to a lab. These prelab questions *must* be answered and turned in to me before you may begin each lab. These will be worth 10 points and will be graded and turned back to you immediately for feedback. The bottom half will have a 3" x 5" section for reporting actual lab results.

Notebook grading: For each day you are in lab, you are expected to turn in the duplicate pages of your lab notebook, documenting your progress for the day *before you leave lab*. Each page must be labeled with your name, the experiment the data refers to and contain the date (or dates) when information was recorded. If this information is not provided, the page will not count. Do not put two different experiments on the same page. Do not staple the pages together. All pages referring to a particular experiment must be turned in before the final results are turned in. These pages contain your experimental data. For each experiment, several students will be selected at random for grading. Each student will be graded at least three times over the course of the semester. The grade (worth 20 points) will be based on the ability of the instructor to obtain your final results from the data recorded in your notebook pages. This will require a particular emphasis on labeling of data and recording of data (with significant figures, units, etc.). If your notebook is selected for grading and pages for that experiment have not been turned in (although results have), the notebook will be graded as if those pages do not exist. If you have also shown work on the notebook pages, that could help me to find any mistakes and give you feedback, lessening the impact on your grade of any differences between my answer and your own.

Results: Results must be turned in on the prelab sheet which includes *your name, unknown number (or other sample identifier), the result in the requested units with absolute error.* If these features are not included, the results will be returned and late penalties will apply. Results will be graded on (1) accuracy and (2) precision in the form of significant figures and absolute error. Points will be subtracted for incorrect or incomplete information. The degree of accuracy and precision required for full credit will depend on the experiment. You will not be told these requirements, nor the correct value, only that your result is higher or lower than the true value. Labs will be worth at least 30 points, with multiple results increasing the value of the lab. The minimum score (before penalties for precision or lateness) will be half the value of the experiment. If no prelab was used for the experiment, use a 3"x 5" index card for your results instead, which can be attached to any remaining notebook pages or calculations.

Reports: Your final experiment will ask you to design an acid/base titration. There will be no prelab, instead you will provide a word-processed report (no longer than 2 pages, double spaced) *and* titration curve (according to the format specified

in the Figure section of the Style Guide, published on the web) using proper American English and scientific grammar and spelling. This report is worth 50 points based on accuracy (concentration and identity) and explanation of results (how did you use your data to determine answer), including indicator used and reason for the choice.

Other assignments: If I get creative and invent any other assignments, they will be given a point value when assigned.

Policies:

Attendance: You are expected to attend lecture and lab sessions regularly. If you miss a lecture session, it is your responsibility to find out what material was covered and what announcements were made. If you are absent from six *lectures or labs*, you will be dropped from the course. This instructor will only withdraw a student after midterm (3/7) with the accompanying WF grade, regardless of when your absences occurred. Midterm is the last day that a student may withdraw from a course with a grade of W.

Exam Make-ups: If you are aware of an upcoming absence (e.g., Regent's test, athletics) you must schedule to take the exam early. If pre-notification is not possible, you must contact me within 1 hour after the end of the exam, and you may make it up provided you can do so before the exam is returned to students. You must provide authoritative documentation before taking a makeup exam. The grade will remain officially a zero until I receive the agreed upon, written documentation of your excuse. Makeup exams may be more difficult than the original exam if exams have been returned to the class.

Late Penalties: There will be a 5 point late penalty on the total assignment for each lecture (*or any part thereof*) past the deadline. Computer problems are not considered a legitimate excuse for late assignments. Early assignments are gratefully accepted (and you may even get some helpful hints).

Help: The lab manual used might be ambiguous or inappropriate to your specific situation. The purpose of this lab course is to give you an opportunity to learn to consider how things apply to your specific situation rather than blindly following directions. This does not mean that you can't ask for help or further explanation. I want you to think through an experiment *before you attempt it and before the last minute*. Consequently, there are a few limitations. *No questions about an assignment (including exams!) will be answered on the day that assignment is due and only reluctantly afterwards; any question is cheerfully (although perhaps not directly) answered/discussed before this time.*

Quant Lab Policies

Students are expected to have good laboratory practices at all times. These are detailed in Chapter 2 of the text. Also, see department safety rules on the course website, including closed-toe shoes, clothes covering from your *shoulders to your ankles*, lab coats, and safety glasses/goggles. Students consistently having unsafe practices will be asked to leave the lab and may be withdrawn from the course.

You are expected to attend all lab sessions until you have completed all assignments. If you finish your experiments before the end of the term...and notify the instructor...you will not be counted as absent from further lab periods. There are no makeup lab times available (unless inclement weather forces us to use 3/26). Under extreme circumstances, you may receive an extension on a due date provided (1) you notify the instructor of the problem within 24 hours of missing a lab and (2) you provide authoritative documentation (I decide who is an authority) of your excuse as soon as possible. An extension would be agreed upon at the time of notification as well as what documentation would be most appropriate for the absence and when that would be due. All late penalties will apply unless and until documentation is received.

No students will be allowed to work in the lab outside of the scheduled times. Attempting to do so will result in immediate withdrawal from the course. Any student who is late leaving lab will have 1 point deducted from their lab score *per minute late*.

Only a calculator and laboratory notebooks are allowed for use inside the lab. Scrap paper, textbooks, etc. will be confiscated for the lab period. Record all measurements and observations directly into your lab notebook.

Students are responsible for returning all materials in the same condition as they were received (or better). Students who break expensive items or many things through carelessness may be charged to replace them. If a student does not check out before the end of the term a hold will be placed on their registration until they check out and return drawer keys.

Students must label **all** their chemicals with content (including concentration), NFPA code, date, and name. Solutions should not be stored in volumetric flasks between lab periods. Any inappropriately stored material may be dumped at any time (including unlabeled or mislabeled items). Lab drawers will be randomly inspected. Do not put labeling tape on items in the oven. You may label glassware with a permanent marker, and remove the writing with acetone. This is the **ONLY** use for acetone in this lab.

Drying Ovens may only be opened during the following times: 2:30-2:45, 3:45-4, 5-5:15.

Calendar for Quantitative Analysis (CHEM 2810) Spring 2016
(tentative)

- 1/12 Introduction to class and analytical chemistry
Read Chapter 0
Lab meets as extra class in SCI-E1047, 2:30-3:45
Review of units with conversions
Read Chapter 1
Homework: Chap 1 problems: A-D, 14-20, 28-32A
- 1/13 Lab meets as extra class in SCI-E1049, 2:30-3:45
Finish chapter 1; start Chapter 3 (with references to Chapter 2)
Read Chapters 2 and 3
Error, especially significant figures as applied to lab equipment
Homework: Chapter 3: A, 1-7, 42, 43
- 1/14 Propagation of Error
Finish Chapter 3
Homework: Chapter 3—B, C, 10-16e, 21
- 1/19 Statistics
Read Chapter 4.1-6
Homework: Chapter 4--A, C, E, F, 3, 11, 12, 13, 17, 19, 23 and unit problems
Lab meets as extra class in SCI-E1047, 2:30-3:45
Statistics continued???
Lab Check-in and orientation: SCI-E3031, 3:45-5:15 (or earlier if stat finished)
- 1/20 Lab meets at 2:30 pm sharp.
- 1/21 Planning your lab time efficiently **Pre-read labs:** standardization of acid, standardization of base, direct titration, gravimetric analysis of calcium
- 1/26 Titrations
Read Chapter 1-5&6
Homework: Chapter 1: E, 44-46
Lab as usual
Note: lab continues from here as scheduled unless noted otherwise
- 1/28 Normality and equivalents
Homework: Normality problems
Calibration of Glassware Lab due
- 2/2 Gravimetric analyses
Read Chapter 26
Standardization of Acid or Base due
- 2/4 More on Gravimetric analyses
Homework: Chapter 26-- A-D, 10-14, 16-19 (for the brave: 20, 23)
Standardization of Acid or Base due (the other one)
- 2/9 Review Statistics and Stoichiometric Analysis (or finish)
Direct Titration due
- 2/11 **Exam One**
Salad Dressing Analysis due

- 2/16 Calibration Methods
Read Chapter 4.7-9 and 5.1-3
Homework: Chapter 4--G, 30, 31,33,35,36
- 2/18 More Calibration Methods
See “[Graphing in Excel](#)” from website; use these directions for all homework graphs
Homework: Chapter 5—B, 23, 24 and [calibration problems](#)
[Antacid Analysis due](#)
- 2/23 Basic Spectroscopy & light
Read Chapter 17
[Equivalent Weight due](#)
- 2/25 Beer’s Law
Read Chapter 18.1-2
Homework: Chapter 17-- A, B, C, D, 16, 18, 19
- 3/1 Potentiometry
Read Chapter 14
Homework: Chapter 14—C, E, 34, 38 and [potentiometry problems](#)
[Redox Titration of Oxalate due](#)
- 3/3 Chromatography
Read Chapter 22-1&2
Homework: [chromatography problems](#)
[Gravimetric Analysis of calcium due](#)
- 3/7 Midterm!
- 3/8 [Exam Two](#)
- 3/10 Qualitative Equilibria
Homework: [qual problems](#)
[Copper in Brass due](#)
- 3/15 General Quantitative Equilibria relationships.
Solubility Calculations
Read Chapter 6
Homework: Chapter 6-- A, C, D, E, H, I, 14-17
- 3/17 Acid/Base reactions
More Chapter 6
Homework: Chapter 6—37, 40, 46, 48-51, 53
- 3/22 Monoprotic Acid/base Equilibria
Read Chapter 8
Homework: Chapter 8-- B-I, 2, 3, 5- 8, 11, 12, 19-24, 32-35
[Spectrophotometric Analysis of Fe due](#)
[AAS Analysis of Fe due](#)
- 3/24 Polyprotic Acid/Base equilibria
Read Chapter 9
Homework: Chapter 9—A, C, D, 4, 5, 6, 13, 14, and [AB Practice](#)
[Ka of an indicator due](#)
- 3/26 LAB MAKEUP DAY IF NEEDED

- 3/29 Activity (only really new topic, don't miss this day!!)
Read Chapter 7
Homework: Chapter 7-- A-E, 3, 4, 9-12, Chapter 8—A, 14
- 3/31 Qualitative Titration Curves
Water Hardness Analysis due
- 4/4-4/8 SPRING BREAK
- 4/12 Strong Acid/Base Titration curves
Read Chapter 10.1
Homework: Chapter 10--A, 2
- 4/14 Titrations of weak acids and bases
Read Chapter 10.2-3
Homework: Chapter 10—B, C, F, I,4-8, 12, 14, 17, 18
ISE of Fluoride due
- 4/19 Polyprotic titration curves
Read Chapter 10.4
Homework: Chapter 10—D, E, 19, 23, 24, 26
- 4/21 Titration curves continued
Precipitation Titrations
Read Chapter 26.5-8
Homework: Chapter 26—E, F, 40, 41,43
Gas Chromatography due
- 4/26 **Exam Three**
Last day to do experimental work in lab
- 4/27 *Last day to check out of lab*
- 4/28 EDTA titrations
Read Chapter 12.1-3, 6,7
Homework: A-C, 3, 5-8
Acid/Base Design Lab due
- 5/4 **Final Exam 1100-1300**

Lab Calendar

Spring 2016

| Experiment | theory found in 8 th ed Harris | estimated # labs required | Report as | due date† |
|-----------------------------------|--|--|---|-----------|
| Calibration of Glassware | 2.3-6,9; fig 3.3 ref procedure after chap 2 problems | 1 | mL pipet delivers; for buret: average correction in any 10 mL region beyond tolerance | 1/28 |
| Standardization of Acid and Base | 1.5,6;10.6,7; ref procedure chap 10 | 2 | M HCl & M NaOH (one 2/2 other 2/4) | 2/2 & 2/4 |
| Direct Titration of Acid or Base | 1.5,6;10.6,7; ref procedure chap 10 | 1 | % KHP or % Na ₂ CO ₃ | 2/9 |
| Salad Dressing Analysis | 1.5,6;10.6,7 | 1 | %(w/v) acetic acid | 2/11 |
| Antacid Analysis | 1.5,6;10.5 including fig 10.5,7,8; normality notes | 2 | meq/g and % (w/w) Mg(OH) ₂ | 2/18 |
| Equivalent weight | Normality notes | 1 | eq wt of acid or base | 2/23 |
| Redox Titration of Oxalate | 15.4; tab 15.3 | 2 | % oxalate | 3/1 |
| Gravimetric Analysis of Ca | 1.4; 26.1,2,3; tab 26.1 | 9 (1 entire lab and <10 min of 4-8 more) | % CaO | 3/3 |
| Determination of Cu in Brass | 15.2,7; tab 15.4 | 2 | % Cu | 3/10 |
| Spectrophotometric Analysis of Fe | 4.7,8; 17.2-4 | 2 | ppm Fe in powder and mg Fe/tablet | 3/22 |
| AAS analysis of Fe* | 4.7,8; 20.1-5 | 1 | ppm Fe in powder and mg Fe/tablet | 3/22 |
| Ka of an Indicator* | 6.6,7; 17.3,4;18.1 | 2 | Ka (no error) | 3/24 |
| Water Hardness | 11.1,2; box 11-3 | 2 | ppm CaCO ₃ and ppm Ca & ppm Mg | 3/31 |
| ISE Fluoride* | 4.7-8; 14.4 | 2 | ppm F in each sample | 4/14 |
| Gas Chromatography* | chap 23, notes | 1 | % analyte (no error) submit calculations too | 4/21 |
| Acid/Base Design | chapter 10 | 3 | M & identity | 4/28 |

†All labs are due at or before 11:30 am.

*Limited instrumentation is available. You may have to wait to use it. Consider that in your planning. Let the instructor know at least one week ahead of the time you expect to need the instrument.