

**Chemistry 214, Quantitative Analysis Laboratory
Fall 2015 Syllabus**

Chem 214-001, Quantitative Analysis Laboratory (1 credit hour)

Monday/Wednesday 2:45-5:30 pm, FH-313

Prerequisite: Chem 106/102 and 112; Chem 222/224 and 226 as well as active attendance or completion of lecture Chem 212.

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Course Objectives

- 1) To acquaint students with classical and modern techniques in analytical chemistry
- 2) To teach wet chemical lab skills, efficiency, and planning of experiments
- 3) To teach critical evaluation of experimental results
- 4) To become familiar with conventional data collection in commercial and academic laboratories

Attendance Policy: Students are required to be present for every scheduled lab session. Additional time will not be provided to students who are absent from lab. Students must attend the section in which they are enrolled. Students cannot attend the Monday/Wednesday lab section under any circumstances; this is university policy. Students must have required materials and be properly dressed to perform experiments in the laboratory. Make-up exams and quizzes will not be given unless approved by the Instructor.

Footwear/Clothing: Closed toed, closed heel shoes are required (no slippers, Crocs, perforated shoes, etc). No skin on the foot can be exposed (ballet flats are not allowed unless socks are worn). Long pants are recommended. Shorts and skirts are not allowed as bare skin on the lower extremities is a safety hazard. Be advised that concentrated acids/bases are used in many experiments. Lab coats are required and must be worn at all times during lab experiments. Students will be sent home if proper clothing/footwear is not worn; this counts as an absence. Attendance at the safety lecture given on the 1st day of class is required in order to perform lab experiments. Students must sign a safety sheet acknowledging understanding and a commitment to follow policies.

Required Materials

- One bound (NO SPIRAL) *laboratory notebook* such as a national-brand Composition book.
- An inexpensive *calculator* having logarithm (base 10 and e), exponential, and trig functions.
- A pair of *lab goggles* [safety glasses NOT allowed] which must be worn at all times in the laboratory.
- A long sleeve *Lab coat* which offers an added layer of protection against hazards and must be worn at all times during lab experiments. Lab coats can be purchased from the bookstore or other online retailers.
- Non-erasable pen

Bring all materials to every lab session. For some experiments, it may be advantageous to bring a laptop computer for data entry, analysis, and calculations. If it is deemed to be a distraction/hazard, the TA or instructor may request that it be put away.

Note: Mobile devices (phones, tablets, watches, etc.) are NOT allowed for use during quizzes, the midterm, or final exam.

Laboratory Procedures: The Instructor and/or TA will explain the procedures and goals for each laboratory experiment prior to its execution. Students will be given handouts that are pertinent to each lab experiment beforehand. A semester laboratory schedule, detailing projected start dates for each experiment, pre-lab quiz dates, lab report due dates, and other information will be provided on the first day of class. This schedule will be posted in the laboratory, FH-313.

Experimental Unknowns: In most cases, you will be assigned a standard unknown sample whose composition is known to at least **FOUR** significant figures. **You will determine the concentration of your unknown sample and be graded on how accurately your determinations reflect the true composition.** Make sure to write down the unknown # in your lab notebook, in addition to signing for it on unknown sheets provided by the TA.

For each unknown assignment, you will report the values of your individual unknown determinations, the mean concentration (or percent composition) and the standard deviation associated with the overall determination. You will be permitted to repeat each lab only once as time permits in order to earn a better accuracy grade. However, you will need to analyze a new unknown sample and it must be undertaken in the period established on the laboratory schedule. To accomplish this, **you will need to report your results and calculations as soon as completed.** You will be graded on the accuracy of the results and can thus decide if you want to repeat the experiment. Graded accuracy will determine part of your overall grade.

Good precision (≤ 5 parts per thousand (ppt)) must be maintained throughout all steps within a lab. **Precision** will be a component of the **lab report** grade.

Laboratory Notebook: One bound notebook is required. Notebooks must be completed in PEN. Detailed notebook requirements are listed later in the syllabus. Briefly, the notebook must contain all data and observations assembled during each experiment. It should be organized, but not necessarily perfect and thus can contain strikeouts.

Students must come to lab prepared in order to optimize their lab efficiency. At the start of every NEW experiment* each student must have written in their notebook the following:

- 1) The title of the experiment and the date
- 2) A paragraph introduction to summarize the lab experiment's purpose, background information, and an overview that may include a very brief procedure synopsis to aid in getting started. The first sentence of the introduction should include the purpose of the lab experiment.

*The Instructor and/or TA will review and initial this portion of the lab notebook normally while the pre-lab quiz is being taken and will prevent a student from starting a lab if the notebook is not satisfactorily completed. The student will not be allowed to start the new lab experiment until the notebook is filled out with these requirements.

Laboratory Reports: Lab reports are to be computer generated and must follow the format defined later in the syllabus. All data sets must be included in the final report. The lab report will thus contain the data from the first attempt and experiment 'redo' attempts, a complete analysis of **four** experimental errors, in addition to, but not limited to, content within the guidelines included below. Final accuracy will be determined as the better of the two reported findings. Graded lab reports will determine part of your overall grade (see breakdown below).

Lab report due dates are located on the semester schedule. Lab reports **will not** be accepted via email unless otherwise specified. Reports must be printed and handed in at the beginning of lab on the due date. **Lab reports turned in late will receive a penalty of 10% each day the report is late and result in a grade of 0 if not received within one week of the established due date.** In order to help students better address deficiencies in content within the initial lab report; the first lab report (only) may be resubmitted after grading to receive at most half of the lost points. Please be sure to discuss any questions and concerns about lab report format or grading with the TA or instructor.

Over the course of the semester, eight lab experiments will be performed. You are required to complete all of the lab experiments and turn in unknown sample results for an accuracy grade for each experiment. Writing skills are important to express/explain test results and other important information in the "real world." We realize that completing lab reports is labor intensive. Therefore, you will only write lab reports for four of the labs in this course. **The following list includes the experiments for which a completed lab report is required.***

- 1) Acid-Base Titration: Determination of KHP in Unknown
- 2) Spectrophotometric Determination of Iron
- 3) EDTA Determination of Ca and Mg via Titration and Ion Chromatography
- 4) Assay of SO_3 by Gravimetric Analysis of Sulfate

*At the discretion of the Instructor or TA, this list can be modified at any time over the course of the semester.

Laboratory Exams: Two written exams will be given which cover concepts pertaining to all of the laboratory experiments. The Midterm exam will include **Experiments 1-4** and the Final exam will include **Experiments 5-8**. Exams will cover theory as well as related calculations.

Laboratory Quizzes (Pre-lab Quizzes): Before the start of each new experiment a written pre-lab quiz will be given asking questions in regard to the procedure and calculations to determine preparedness for the lab. **Quizzes will be given during the first 15 minutes of lab. Thus, one MUST be punctual in getting to lab on time! If one arrives late to lab, no extra time will be given to complete the quiz.** Quiz answers must be written in pen or credit will not be given.

Laboratory Safety: In an effort to maintain a safe and clean working environment, students will be allotted 2 safety points per lab session. The loss of these points will be at the discretion of the Instructor and/or TA. Tardiness, dirty work spaces, not cleaning up communal spaces, failure to wear safety goggles and/or lab coat, and general unsafe practices among other things may result in the loss of safety points.

Grading Policy: The established grading policy is subject to change at Instructor and/or TA discretion. Please note that the University uses a +/- grading scale system and it will be implemented in this course.

Grading Category	Points	Percent
Analytical Findings (Accuracy)*	1500	61.2 %
Detailed Laboratory Reports	500	20.4 %
Lab Quizzes	96	3.9 %
Lab Notebook	100	4.1 %
Midterm Exam	100	4.1 %
Final Exam	100	4.1 %
Safety Points	54	2.2%
Total	2450	100 %

Grade Assignment	
Points Range	Letter Grade
2450-2205	A to A-
2204-1960	B+ to B-
1956-1715	C+ to C-
1714-1470	D+ to D-
Below 1470	F

*Seven labs at 200 points per lab (EDTA: Titration – 150 points and IC – 50 points for the IC component), and another worth 100 points. All labs are graded on accuracy.

Lab Report and Notebook Grading Rubrics: The following is a generous guide provided by the Instructor with a rough estimate of systematic grading of lab reports and notebooks. Points can be redistributed at the discretion of the Instructor and TA.

Lab Report	Points
Title, introduction and purpose	10
Materials and methods	20
Results and Discussion	60
Conclusions	20
Report Quality (Grammar, spelling, punctuation, organization, etc.)	15
TOTAL	125

Notebook*	Points
Table of Contents	4
Title, Date and signed Introduction** (1 pt/experiment)	8
Procedures (2 pts/experiment)	16
Results/ Raw Data and Calculations (5 pts/experiment)	40
Conclusions (3 pts/experiment)	24
Organization and format (sections labeled, writing legible)	8
Total	100

*Point breakdown based on 8 experiments completed, this may change based on the progress of the course.

**Unsigned Introduction sections will receive no credit.

Academic Honesty: The Instructor and TA encourage students to consult one another during lab experiments and outside of class. Students may converse, brainstorm, and work through questions together. However copying other students' work and presenting it as one's own is unacceptable. There is a difference between sharing knowledge and cheating. If it is determined that lab reports or other materials in this course are plagiarized or have been shared between students (current or past), no credit will be given for the assignment. Cases of suspected academic dishonesty will be handled according to University policy and guidelines. Please review Loyola University Chicago's policy on Academic Integrity via the following link:

http://www.luc.edu/academics/catalog/undergrad/reg_academicintegrity.shtml

Services for Students with Disabilities (SSWD) Policy: Necessary accommodations will be made for students with disabilities who procure a SSWD letter. Please discuss your academic needs with the

Instructor as soon as possible. However, to receive any accommodations self-disclosure, proper documentation, and registration with the SSWD office at Loyola University Chicago is required. Accommodations cannot be made until the Instructor receives proper documentation. Furthermore, accommodations are not retro-active and begin only once appropriate documentation has been received by the Instructor in a timely manner. Only those accommodations that are specifically listed in the formal SSWD letter will be provided. Policies and procedures for SSWD can be found at <http://www.luc.edu/sswd/>.

General Guidelines for Laboratory Reports

Lab reports for Quantitative Analysis should be more complete, accurate, and detailed than reports done in the past for General Chemistry or Organic Chemistry. This is an upper division level science class, and more thoroughness is expected of the student. Lab reports should be written in a stand-alone format, such that, anyone after reading it, would clearly understand what was done and be able to reproduce it.

It is encouraged that the student looks to the current scientific literature to develop strategies on how to structure the lab report. While the main content areas that must be included are calculations and analysis of experimental error, it is important to structure your lab report into a stand-alone overview of your work. The following elements will aid in structuring a comprehensive lab report. Inclusion of these elements will be considered when grading laboratory reports.

Lab reports should generally consist of the following elements:

1. Title
2. Abstract (not required for this lab)
3. Introduction
4. Materials and Methods
5. Calculations and Results
6. Discussion
7. Conclusions
8. References (include as necessary)

The entirety of the lab report should be written using the student's own words. While it may seem easier to copy certain portions from handouts, such as the methods, this is **plagiarism** and is not acceptable for academic writing, and it is certainly not acceptable for the scientific literature.

When writing the laboratory report it is important to be very clear and concise in your writing. Details do matter and the slightest change in wording may distort the original intent of what was written. It is also important to properly label all tables and figures with descriptive captions as well as making sure the appropriate units are included where necessary. It is suggested that 1 inch margins be used with 1.5 lines spacing for paragraphs. Individual tables and figures should not be split onto separate pages. Laboratory reports should have good spelling, grammar, sentence structure, etc. Use of personal pronouns (I, we, me, etc.) is strongly discouraged. Finally, take the time to check over your work and re-read your report to make sure that what you wrote is clear and makes sense. If necessary have a friend edit your report as well.

The lab report write-up is a **VERY IMPORTANT** part of any laboratory-based work, especially at the junior/senior undergraduate level and, of course, for graduate and even professional level work. It has

been said that a student may do mediocre work and write up an excellent lab report, and the work will be thought of as wonderful. However, a student may do wonderful work and write it up poorly, and the work will be thought of as mediocre.

General Guidelines for Lab Notebooks

First and foremost, lab notebooks **MUST** be completed in pen.

It is strongly encouraged that the first two pages be left blank for the table of contents and labeled as such. Number all pages with the appropriate page number. Then, over the course of the lab, fill in appropriate experiment titles and respective page numbers in the Table of Contents.

The sections of each experiment entry should be appropriately labeled (Introduction, Procedure, Results, Conclusions, etc.).

At the start of each experiment write the title of the experiment and the date. This should be completed prior to coming to lab as well as writing a brief introduction to the lab. The introduction should provide a synopsis of what the point of the experiment is and methods (titration, precipitation, etc.) or instrumentation used in the experiment. Procedures should also be written out prior to coming to lab.

Data, results, and conclusions should clearly include your unknown identifier and all necessary data (tables, graphs, etc.). Calculations for anything prepared in lab should appear in this section as should all masses and volumes used to either make solutions or to complete the experiment. It is also strongly encouraged that any and all observations be recorded. This includes, but is not limited to, color changes (initial solution color and endpoint color in a titration for example), final and initial burette readings for all experimental trials, sample masses, instrument settings, etc. Values that are written down should have units and chemical identity accompanying them (i.e. 15.05 mL of 0.1 M NaOH). Again, everything should be written in pen. Strikeouts are acceptable as no notebook is perfect. Any changes to the procedure should be noted here as well, including the reasons for the change. If data is rejected, reasons **MUST** be recorded for the rejection of the data. Any procedural errors should also be recorded (such as lost samples, contamination, etc.).

Conclusions should be brief. You can simply restate the purpose of the experiment and what was accomplished. Other suggestions, hints, etc. discovered along the way can be included as well.

Every notebook entry **MUST** include a date. This will allow you to better keep track of what was completed and when it was completed. It is not necessary to have an introduction, purpose, and procedure for each day following the start of an experiment that continues over multiple days. If you feel writing out a procedure for everyday is helpful, then please do so. What is outlined above is meant to give you some general idea of what to include in a lab notebook. Feel free to set-up your lab notebook as best fits your needs. However, please keep the grading rubric in mind when setting up your lab notebook.

Finally, lab notebooks will be collected twice during the semester. Grades will be determined based on the number of labs completed up to that point in time. The total value of the lab notebook will be 100 points.

Chem 214-001 Quantitative Analysis Schedule* (Fall 2015)

Assignments	Week #	Class #	Date	Proposed Experiment	Proposed Tasks
Check-in	1	1	Monday, August 24, 2015	Check-in	Discuss syllabus, safety, etc.; Check-in; Prep NaOH
Lab 1 Quiz		2	Wednesday, August 26, 2015	1) Determination of % KHP in an Unknown (200 points)	Prep and standardize NaOH; Begin unknown titrations
	2	3	Monday, August 31, 2015		Complete unknown titrations and calculations; submit results
		4	Wednesday, September 2, 2015		Complete Lab 1 redos; prep HCl for lab 2
Labor Day -- NO CLASS	3	5	Monday, September 7, 2015	-----	NO CLASS
Lab 2 Quiz		6	Wednesday, September 9, 2015	2) Determination of % Carbonate in an Unknown (200 points)	Check NaOH molarity; prep and standardize HCl; titrate unknowns
Lab 1 (KHP) Lab Report Due	4	7	Monday, September 14, 2015		Complete lab 2
Lab 3 Quiz		8	Wednesday, September 16, 2015		Lab 1 and 2 redos
	5	9	Monday, September 21, 2015	3) Spectrophotometric Determination of Iron (200 points)	Complete entire lab; Labs 1 and 2 redos
Lab 4 Quiz		10	Wednesday, September 23, 2015		LAST day to redo Labs 1 and 2; Redo lab 3
	6	12	Monday, September 28, 2015	4) Vitamin C (REDOX) (200 points)	Complete entire lab
		13	Wednesday, September 30, 2015		LAST day to redo Lab 3; redo Lab 4
Mid-Semester Break -- NO CLASS	7	14	Monday, October 5, 2015	-----	NO CLASS
		15	Wednesday, October 7, 2015		LAST day to redo Lab 4; prep for Lab 5
Lab Mid-term Exam; Lab notebooks due; Lab 3 (Iron) Lab Report Due	8	16	Monday, October 12, 2015	Lab Mid-Term Exam / Notebook Check #1	LAST day to submit results for labs 1-4
		17	Wednesday, October 14, 2015	5) Gravimetric Determination of Sulfate (200 points)	Prep unknown samples and begin digestion
	9	18	Monday, October 19, 2015		Complete sample digestion; weigh crucibles; filter samples
		19	Wednesday, October 21, 2015		Complete Lab 5 and submit results
Lab 5 (Sulfate) Lab Report Due	10	20	Monday, October 26, 2015		Redo lab 5
Lab 6 Quiz		21	Wednesday, October 28, 2015	6) EDTA Determination of Ca/Mg via Titration & IC (Titration: 150 points; IC: 50 points)	Prepare EDTA and CaCO ₃ solutions; Standardize EDTA; Redo lab 5
	11	22	Monday, November 2, 2015		Titrate unknowns; make dilution for IC
		23	Wednesday, November 4, 2015		Complete Lab 6 as needed; Redo Labs 5 and 6
	12	24	Monday, November 9, 2015		Lab 5 redos MUST be COMPLETED; redo lab 6
Lab 7 Quiz		25	Wednesday, November 11, 2015	7) To Be Determined (100 points)	TBD
	13	26	Monday, November 16, 2015		TBD
Lab 8 Quiz		27	Wednesday, November 18, 2015	8) Polyprotic Acids (200 points)	Restandardize NaOH if needed; Complete rough titration
Lab 6 (EDTA) Lab Report Due	14	28	Monday, November 23, 2015		Complete careful titration
Thanksgiving -- NO CLASS		29	Wednesday, November 25, 2015		Redo Lab 8
	15	30	Monday, November 30, 2015		Lab 8 redos MUST be COMPLETED
Lab Final; Lab notebooks due; Check-out		31	Wednesday, December 2, 2015	Final Exam / Notebook Check #2 / Check-out	Lab final; Check-out

* This schedule is subject to change at the discretion of the instructor and/or TA at any point during the semester.