

# Syllabus for Chemistry 214

## Quantitative Analysis Laboratory

Quantitative Analysis Laboratory (1 credit hour)

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

**Instructor:** Dr. Conrad Naleway  
Flanner Hall Room 200C (773) 508-3115  
Email: [cnalewa@luc.edu](mailto:cnalewa@luc.edu)  
Office Hours: During, Just Prior and After Lab

**Teaching Fellows:** Katrina Binaku  
Email: [KBinaku@luc.edu](mailto:KBinaku@luc.edu) Office: FH-407  
Laboratory Hours: MW 2:45-5:30 in FH-313  
TA Office hours: Mon/Tues 9:30-10:30am and by appt.

**Attendance Policy:** Please be advised that attendance is mandatory for this lab course. There are no “make up” labs in the sense that if one is absent, there is not another section or day to come in to make up work.

### Other Materials:

You will need one bound (NO SPIRAL) laboratory notebook such as a national-brand composition book; available in any bookstore. You also need an inexpensive calculator having logarithm (base 10 and e), exponential, and trig functions. Lab goggles are also required to be worn in the lab at all times. All items must be brought to every lab session. In some instances it may be advantageous to have a laptop computer in lab for data entry, analysis and calculations. If it is deemed to be a distraction or hazard, the TA or Lab Instructor may request that it be put away. Note: Cell phones are not a substitute for a calculator and will NOT be allowed for use during quizzes, the midterm, or final exam.

### Objectives:

- 1) To acquaint students with some of the 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.

### Laboratory Procedures:

The instructor will explain the procedures and goals for each assignment prior to its execution. You will be given handouts that are pertinent to each lab assignment beforehand. Experiment handouts will also be available on the website for the course ([www.conradnaleway.net/chem214](http://www.conradnaleway.net/chem214)). A laboratory schedule for the semester, detailing the projected start dates for each experiment, pre-lab quizzes, lab reports, and other information will also be provided to you on the first day of lab. This schedule will be posted on the course website as well as on Blackboard and in the laboratory, FH-313.

### Lab Notebook:

The instructors will explain during the first lab period how the notebook is to be written. Notebook requirements are detailed in a later section of the syllabus. The notebook must contain all data and calculations assembled during each experiment. It should be organized but not necessarily perfect and thus can contain

strikeouts and must be done in PEN. Students must come prepared to lab to optimize their lab efficiency. At the start of every NEW experiment each student must have written in their notebook:

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

\*The TA and/or Lab Instructors will review and sign off on this portion of the lab notebook (while a 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 experiment until the notebook is filled out with these requirements.

### **Experiment 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 its true composition. Make sure to write down the unknown # in your notebook, in addition to signing for it on unknown sheets provided by the TA.

For each assignment, you will report the values of your individual 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 get a better accuracy grade. However, you will need to analyze a new unknown sample and it must be undertaken in the time frame established on the laboratory schedule. In order to accomplish this, you will need to report your results and calculations on BLACKBOARD as soon as completed. You will then be graded on the accuracy of the results and can thus decide if you want to repeat the experiment. Graded accuracy will determine about 60% of your overall grade (see breakdown below).

### **Lab Reports:**

Laboratory reports are to be computer generated and must follow the format defined later in the syllabus. All (both if a redo was performed) data sets must be included in the final laboratory report. The lab report will thus contain the data from the first attempt and second if repeated. Final accuracy will be determined by the better of the two reported findings. Graded lab reports will determine 22.5% of your overall grade (see breakdown below).

Due dates of lab reports are located on the lab semester schedule. Lab reports **will not** be accepted via email unless otherwise specified. **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.**

Over the course of the semester a total of 8 experiments will be performed. You are required to complete all 8 experiments and will turn in results for accuracy for each. Writing skills are important to express and explain test results and other important information in the "real world," and we realize that completing lab reports is labor intensive. Therefore, you will only be writing lab reports for four (4) of the eight (8) labs in this course.

The following list\* includes the lab experiments for which a completed lab report is required:

- 1) Acid-Base Titration: Determination of Potassium Hydrogen Phthalate and Unknown Sodium Carbonate
- 2) Spectrophotometric Determination of Iron
- 3) Assay of  $\text{SO}_3$  by Gravimetric Analysis of Sulfate
- 4) Weak acid titrations: ID and Quantification of Polyprotic Acids

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

### Laboratory Exams:

There also will be two exams which cover materials in each of the immediately preceding experiments. The midterm exam will include **Experiments 1-3** and the Final Exam will include **Experiments 4-7**. The questions will cover the theory as well as related calculations.

### Lab Quizzes:

Lab Quizzes will also be a part of the overall grade. **Before the start of each experiment a 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 you MUST be punctual in getting to lab on-time, there will be NO excuses! If you arrive late to lab, you will NOT be allowed extra time to complete the quiz. Quizzes must be completed in pen or credit will not be given.**

### In-class Excel Assignment:

Finally, an in-class assignment to familiarize the student with Microsoft Excel and the role it can play in data collection, organization, and analysis will be completed early on in the semester. It is important that the student be familiar with the usage of a program such as Excel if he or she has any intention of further work in the sciences, be it other undergraduate level classes, graduate school, and/or a career in the sciences. The Instructor and TA will dedicate part of a lab period to review Excel in a computer lab; each student will have to generate an Excel spreadsheet during this review, completing the mentioned Excel assignment along the way. The completed Excel spreadsheet must be emailed to the TA at the end of this review and the TA will dismiss you from the computer lab once the assignment is received in her/his Inbox. This exercise is not optional; it is a mandatory portion of the course.

### Grading Policy

The grading policy established here is subject to change at the discretion of the Professor and/or the Teaching Assistant.

Grading Category	Pts	Percent
Analytical Findings (Accuracy)	1200	60 %
Detailed Laboratory Reports	450	22.5 %
Lab Quizzes	90	4.5%
Lab Notebook	60	3%
Midterm exam	100	5%
Final exam	100	5%
Total	2000	100.0%

### Grade Assignment:

Points	
1800 - 2000	A
1600 - 1799	B
1400 - 1599	C
1200 - 1399	D
Below 1200	F

## **Academic Honesty**

Please review Loyola University Chicago policy on Academic Integrity through the following link:

[http://www.luc.edu/academics/catalog/undergrad/reg\\_academicintegrity.shtml](http://www.luc.edu/academics/catalog/undergrad/reg_academicintegrity.shtml)

If it is determined that lab reports or other written materials in this course are plagiarized or have been shared between students (current or past students), no credit will be given for the assignment and all students involved will be reported to the Department Chair and Dean's Office.

Students are encouraged to converse with each other, brainstorm, and work through questions but copying other's work and presenting it as their own is unacceptable.

**SEE THE FOLLOWING PAGES FOR THE LAB REPORT FORMAT & LAB NOTEBOOK REQUIREMENTS**

## Lab Report Format and General Guidelines

### CHEM 214: Quantitative Analysis Laboratory

Lab reports for Quantitative Analysis should be more complete, accurate, and detailed than reports done in the past for General or Organic Chemistry. This is an upper division lab class, and more thoroughness is expected of the student. The report write-up is a **VERY IMPORTANT** part of a laboratory based course, especially at the junior/senior undergraduate level and of course for graduate level work.

#### Lab reports consist of the following elements:

**Title page** – lab experiment name and number centered on the page; your name, lab partners name (for partner labs only), unknown #, and date the report is due should be placed in the lower right hand corner of the title page

**Purpose** – brief statement of the reason for performing this experiment

**Materials** – two separate lists: one for a listing of all equipment (including the balance used) and the second list for chemicals used (including any unknowns, but excluding any solutions the student makes)

- Concentrations of solutions used should be included. Include concentrations of stock solutions, not concentrations of solutions made. Concentrations of solutions made should be given under the results section.

**Procedure** – this is a list of all the steps that you did to perform the lab, including any changes that you may have made to the original printed procedure.

- This can be summarized from that listed in the lab handouts but must be rewritten in your own words! **Do not plagiarize**
- It must be so clear that anyone not familiar with the lab would know exactly what to do.
- It should not contain the actual masses, volumes, etc. used by the student.
- Be careful how you write your prep instructions for solutions. You will dissolve/dilute chemicals in a volume smaller than what the final volume will be and then dilute to the final volume mark. For example: Dissolve 12 g KOH in 300 mL DI water, dilute up to 500 mL mark, and shake to mix well.

**Results** – list data obtained, such as volumes measured, weights, temperatures, in a table format

- Multiple trials must always be done to verify data as having good precision. All data must be shown, including repeat lab data. Teaching assistants will grade lab reports based on precision.
- Data must be represented in table format with appropriate column and row headings and include the individually determined values, averages (for concentrations, percents, unknowns, etc.), standard deviations, and other necessary values. When applicable include units in column headings i.e. "NaOH volume (mL)" or "mL of NaOH." Tables must be labeled with appropriate brief titles describing the contents within a table.
- Statistical analysis of your data should also be put in this section.

- If applicable, graphs should go in this section, and they must be clearly labeled with a title and proper x axis and y axis names as well as units. Graphs should be done in Excel.
- Include calculations in this section labeled appropriately with units, chemical identity and properly identifying what is being calculated and the trial # the calculation is being completed for.
- Include general equations corresponding to each calculation necessary i.e. general equation for **dilutions** (see example below), average, standard deviation, ppt, to name a few.  
(ex.: Calculation for volume of HCl for 0.1M HCl). The calculations may be written, but please write them neatly so they can be read and understood.
  - Show an outline of equation being used and at least one example with your numbers
  - ex.:  $m_1v_1=m_2v_2$        $12M \times (v_1)=0.1M \times (1000mL)$        $v_1=8.33 \text{ mL}$
  - Please utilize leading zeros before the decimal point (0.1mL and not .1mL).
- A paragraph statement of the results must also be present to interpret/summarize the data shown in tables and graphs.
- If graphs/figures are included, such as spectra or chromatograms, they should be accompanied with a proper label i.e. Figure 1, and brief description directly below it.

**Conclusion** – a restatement of your results, and what the results mean

- Include a **detailed** analysis of error (at least 3 errors). This should be done based on the students own data and results. An analysis of error can also be done on theoretical errors as well though the student may not have made these errors.
  - How does the error change the outcome (concentration higher/lower than it should be, etc.)? How does the error affect the subsequent steps in the experiment?
- How can the experiment be improved and/or made simpler?
- How can the student's technique be improved?

#### **Additional Considerations**

- Order is also important for excellent scientific work – the lab report write-up must follow the order listed on these directions.
- Lab reports should have page numbers specifically located in the bottom center of each page. Please staple your lab reports before handing them in.
- Feel free to print double-sided; we are a sustainable university after all!
- All parts of this report must be typed (calculations are an exception). Please use 12 point font, 1.5 lines spacing for paragraphs, and 1 inch margins.
- Please keep entire tables on a single page. If you must split up a table, remember to include column and row headings again on the next page.
- Reports should have good spelling, sentence structure, etc. Do not use run-on sentences, sentence fragments, or misspelled words. Do not use personal pronouns (I, we, me, etc.).
- 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.

#### **The following has been said:**

- A student could do mediocre work and write up an excellent lab report, and the work will be thought of as wonderful. A student could do wonderful work and write it up poorly, and the work will be thought of as mediocre.

# Lab Report Grading Rubric

The following is a rough guideline of how points will be assigned on your lab reports. All lab reports will be out of 50 total points.

<b>Lab Report Categories</b>	<b>Points</b>
Title Page	1
Purpose	3
Materials	5
Procedure	7
Results	13
Conclusion	16
Grammar/Formatting/Spelling	5
<b>TOTAL</b>	<b>50</b>

# Lab Notebook Guidelines and Grading Rubric

NOTEBOOK MUST BE COMPLETED IN PEN

Leave the first 2 pages of the notebook blank. At the top of these two pages please write TABLE OF CONTENTS. Over the course of the lab, label the pages in the lab notebook. Then in the table of contents simply write the name of each experiment. Next to the name, write the page # that the experiment starts on. It doesn't need to be more detailed than that.

On every day of lab work, the date should be written in the notebook at the beginning of class. This will allow you to keep track of what was completed on a particular date, including solutions prepared, experimental work and calculations.

**Each of the sections of the notebook should be labeled as such using roman numerals and the section headings as displayed below.**

At the start of each new experiment the following is required in the notebook at the beginning of lab (i.e. completed before coming to lab):

- I. Title of experiment, date
- II. Introduction: A paragraph synopsis/overview of what the point of the experiment is, methods (titration, precipitation, etc.) or instrumentation (if applicable) utilized in the experiment. From this short paragraph, someone reading your notebook will have a basic idea of what the experiment entails. The FIRST SENTENCE of the introduction should state the purpose/what will be discovered in the particular experiment. This paragraph can be roughly  $\frac{1}{2}$  a page but no more than 1 page long.

Note: The instructor or TA will initial these sections of each experiment. It is the student's responsibility to get their notebook signed as these required initials will count towards the point value of the notebook. If this section is not initialed, 1pt deduction per missing signature.

### III. Procedure (optional)

If students find it helpful to write out the entire experiment's procedure in their own words in detail, they can do so in their notebook in this optional section. It is not a requirement as students will have the printed experimental procedure to reference while completing each experiment.

### IV. Results/Calculations

First and foremost, the unknown number should be clearly written at the beginning of this section. This section, as described earlier in the syllabus, should contain all calculations for solutions you physically prepare in class, all observations and pertinent data that is generated during the experimentation. This includes but is not limited to color changes (initial indicator color and endpoint color), final and initial buret readings for all experimental trials, molarity calculations, unknown calculations,



balance weights, balance #, instrument settings, etc. Values that are written down should have units and chemical identity accompanying them i.e. 15.05mL of NaOH. All data and calculations are REQUIRED to be in this section and written in pen. Strikeouts are acceptable as no notebook is perfect. If alterations or changes in an experimental procedure occur, this is the section to include that information as well.

#### V. Conclusion

Brief. Restate the purpose of the experiment and what was accomplished (one or two sentences that state your unknown number and what you found). If any major errors occurred in the experiment i.e. you accidentally dumped out one of your samples, etc. state that here as well.

Example: The purpose of this experiment was to determine the percent sodium carbonate in an unknown sample. In unknown #12, it was determined that the unknown sample contained 39.57% sodium carbonate.

\*Format Check: IF YOU WOULD LIKE ME TO LOOK AT YOUR NOTEBOOK AFTER THE FIRST EXPERIMENT IS COMPLETED, I WILL DO SO. But I will not actively pursue format checking of notebooks.\*

### Grading Rubric for Lab Notebook

	<b>Points</b>
Table of contents	5
Title of experiment (0.5pt/exp.)	4*
Introduction (signed, 1pt/exp.)	8*
Results/Calculations	25
Conclusion (2pt/exp.)	16
Organization (sections labeled, handwriting legible)	2
<b>TOTAL Notebook Score</b>	<b>60</b>

\*Based on completion of all 8 experiments.