

C311 – Analytical Chemistry Laboratory, FALL 2005

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Course text: Skoog, West, Holler, Crouch "Fundamentals of Analytical Chemistry",
8th Ed. (2004)

Meetings: Tuesdays

Lecture: Section 2552 Room ET302 4:00 pm – 4:50 pm

Labs: Section 2553 Room LD364 1:00 pm – 3:50 pm

Section 2554 Room LD364 5:45 pm – 8:35 pm

Tentative Schedule

Note: lectures aim to cover experiment theory ahead of experiments. Check *OnCourse* regularly for changes in the schedule. See below for meanings of abbreviations.

Date	Lecture (background chapters)	Lab (# and topic)	Due reports
AUG 30	Overview, errors, statistics (1, 5, 6)	Check in 1 Pipet calibration / Excel / Pasco	-
SEP 06	Volumetric + neutralization titrations (13, 14)	2 NaOH/KHP	R1
SEP 13	Gravimetric + precipitation titrations (13)	2 NaOH/KHP (U1)	-
SEP 20	Statistics, uncertainty (6)	3 AgNO ₃ /HCl or HCl/Na ₂ CO ₃	R2 / U1
SEP 27	Hypothesis testing (7)	3 HCl/Na ₂ CO ₃ or AgNO ₃ /HCl	-
OCT 04	Redox titrations (13, 20)	<i>Redo day 1</i> (U1) / Pasco	Full R3 draft
OCT 11	Coulometric titrations (22)	4 KMnO ₄ /Na ₂ C ₂ O ₄	Full R3 final
OCT 18	Midterm EXAM	4 KMnO ₄ /Na ₂ C ₂ O ₄ (U2)	-
OCT 25	Acid-base titrations (14)	5 Coulo I ₂ /As ₂ O ₃ (U3)	R4 / U2
NOV 01	Advanced acid-base (15,16)	<i>Redo day 2</i> (U2/U3) / Pasco	R5 / U3
NOV 08	EDTA titrations (17)	6 Pasco titrations	-
NOV 15	Electrochemistry (18, 19)	6 Pasco titrations (U4)	-
NOV 22	Potentiometry, electrodes (21)	7 EDTA/MgSO ₄	Full R6 / U4
NOV 29	Sampling, standards (8)	7 EDTA/CaCO ₃ (U5)	
DEC 06	Applications of titrimetry (16, 17, 20, 22)	<i>Redo day 3</i> (U4/U5) Check out	R7 / U5
DEC 16	Final EXAM	-	-

* Pasco = Xplorer GLX and probes as seen at www.pasco.com

Assessment:

C311 is primarily a laboratory-based course, so the bulk of the credit earned will be related to laboratory work. However, an understanding of the principles involved in chemical analysis is essential to successful completion of the experiments, so part of the course assessment is based on pre-lab assignments and examinations. The total points for the course will be 790 points, allocated as follows:

Assessment	Points	Number	Total Points
<i>Lab credit</i>			(570)
Short reports	30	5	150
Full reports	50	2	100
Notebooks	10	7	70
Unknown analyses	50	5	250
<i>Lecture credit</i>			(270)
Pre-lab assignments	10	7	70
Midterm exam	50	1	50
Final exam	100	1	100
Grand Total			790

Pre-lab Assignments (PRE1 to PRE7):

Preparation is key to success in C311. For this reason, each laboratory experiment will have an assignment that must be completed before starting it. The only exception will be the first assignment that is due at the end of the first laboratory session. Otherwise, the assignment is due at the START of each lab session. The assignments will consist of questions and problems targeted to understanding the laboratory procedure.

Late penalty: 2 points if not handed in on entry to your laboratory session. **No credit** if not handed in by the end of the lab period. Note that any time spent finishing the pre-lab assignment will be subtracted from your experiment time.

Examinations:

The examinations are closed book. You are permitted to have scientific calculators (not graphical or programmable), and writing implements. Statistical tables and useful equations will be supplied. The midterm exam will be on Tuesday October 18th during the normal lecture time. The final exam will be on Friday December 16th at 3:30 pm in the lecture room (ET302). You will have 2 hours to complete the final. Make-up exams will only be given for *excused* absences.

Short Laboratory Reports (R1, R2, R4, R5, R7):

These are abbreviated formal reports of completed laboratory assignments. Each report requires the following sections: Purpose; Experimental; Data Tables and Equations; Results and Discussion; References. Reports need a completed cover sheet, and are due with notebook pages at the START of the next laboratory session after completion of the experiment (see the schedule).

Late penalty: 3 points per day late. Reports start being late after the last call for assignments.

Point Distribution for Short Reports (total = 30 points):

Purpose/Experimental/Data: 10 points

Results and Discussion: 15 points

Format, Organization, Clarity: 5 points

Full Laboratory Reports (R3, R6):

These are complete formal laboratory reports. Each report requires the following sections, basically the format of a typical journal article: Abstract; Introduction; Experimental; Results and Discussion; Conclusions; References. Reports need a completed cover sheet, and are due with notebook pages at the START of the laboratory session according to the schedule. You must submit a draft for full report R3 as scheduled in the timetable for feedback from the instructor.

Late penalty: 5 points per day late. Reports start being late after the last call for assignments.

Point Distribution for Full Reports (total = 50 points):

Abstract: 5 points

Introduction: 10 points

Experimental: 5 points

Results and Discussion, Conclusion: 20 points

Format, Organization, Clarity: 10 points

Notebook pages (NB1 to NB7):

A complete set of notebook pages is due with EVERY corresponding experimental report. These may be originals, duplicates, or photocopies, as long as they are *legible*. Make sure you have your own set of notebook records. If sections are too difficult to read, they will not be counted for credit. Credit for notebooks is based on **completion** – having all the required sections, all details, all example calculations and pasted-in tables/graphs.

Late penalty: 1 point per day late. Notebooks start being late after the last call for assignments.

Point Distribution for Notebooks (total = 10 points):

In-lab sections: 4 points

Post-lab sections: 4 points

TA sign: 2 points

Unknown Sample Analyses (U1 to U5):

Most experiments will involve the analysis of the chemical composition of an unknown sample. The grading for the unknown is based on the accuracy of the analysis, so it is in your best interest to know the procedure beforehand, follow instructions, and carry out the analysis as carefully as possible. Results should be clearly given on the cover sheet with unknown number, uncertainty, and the appropriate units. There are 3 “redo days” allocated for the opportunity to repeat one of the available analyses to improve the grade. If you choose to repeat an analysis, the grade you receive will be either the 100% of your first attempt, or 80% of your second attempt. Note that your laboratory report due date does not change if you choose to repeat an unknown analysis.

You will need to record all redo work in your notebook, and submit the notebook pages by the end of the redo day for credit.

Late penalty: 5 points per day late. Unknown analyses start being late after the last call for assignments.

Grading for Unknowns:

The grade scale is based on the *relative error* of your result as follows:

Relative error, U1	Relative error, U2, U4	Relative error, U3, U5	Points
0.00 – 0.19%	0.00 – 0.39%	0.00 – 0.99%	50
0.20 – 0.29%	0.40 – 0.59%	1.00 – 1.49%	48
0.30 – 0.39%	0.60 – 0.79%	1.50 – 1.99%	46
0.40 – 0.49%	0.80 – 0.99%	2.00 – 2.49%	44
0.50 – 0.59%	1.00 – 1.19%	2.50 – 2.99%	42
0.60 – 0.69%	1.20 – 1.39%	3.00 – 3.49%	40
0.70 – 0.79%	1.40 – 1.59%	3.50 – 3.99%	38
0.80 – 0.89%	1.60 – 1.79%	4.00 – 4.49%	36
0.90 – 0.99%	1.80 – 1.99%	4.50 – 4.99%	34
1.00 – 1.09%	2.00 – 2.19%	5.00 – 5.49%	30
1.10 – 1.19%	2.20 – 2.39%	5.50 – 5.99%	26
1.20 – 1.29%	2.40 – 2.59%	6.00 – 6.49%	22
1.30 – 1.39%	2.60 – 2.79%	6.50 – 6.99%	18
> 1.39%	> 2.79%	> 6.99%	15

Pasco Hardware and Software:

C311 will be making use of a modern data-logger, the Xplorer GLX, from Pasco Inc. (www.pasco.com) to obtain titration curves for various chemical systems. The data analysis software, *DataStudio*, may be downloaded for free from the website. Students will be given a site license key that will allow full use of the software, including free upgrades, for life. This will be done during the first lab session so that there will be time to become familiar with the software and its capabilities before the experiment. There will also be opportunities to practice using the hardware during the first two redo days (optional).

Lab Safety:

As with any chemical laboratory, hazards exist. You are expected to dress properly for the laboratory – that is, having closed footwear and eye goggles whilst in room LD364. A lab coat is recommended for protection of your clothes and yourself from chemical hazards, but is not compulsory. Nitrile gloves will be available in the lab. You will not be allowed to work on experiments if you are not properly dressed. **GOGGLES ARE TO BE WORN AT ALL TIMES EXPERIMENTS ARE IN PROGRESS.** Violation of the safety rules may lead to penalties from the instructor.

Missed Labs:

If you are absent (with *accepted* excuse) from a scheduled laboratory session, you will be allowed to make up the missed work on the next scheduled redo day. Unknown analyses will be 100% of the assessed grade but there will not be an opportunity for a redo. Your reports, notebooks and unknowns will be due the next lab session after the redo day.

Course expectations

Objectives of C311:

- To be able to analyze analytical data, and report data appropriately.
- To understand sources of uncertainty and their propagation.
- To develop competence in handling analytical glassware, analytical equipment, and reagents in the laboratory.
- To understand the practice of classical volumetric and gravimetric titration.
- To appreciate the methodology in modern chemical analysis.
- To understand the chemical principles of analysis – acid/base, precipitation, redox, and complex formation.

Expectations of C311:

- Attend all lectures and all required lab sessions.
- Be prepared for lectures by reading textbook chapters, and attempting assigned homework problems.
- Have familiarity with equipment and glassware, as well as basic laboratory techniques (as covered in C125 + C126).
- Have previous experience in using laboratory notebooks and preparing typed laboratory reports.
- Be ready to carry out the assigned experimental work. You should have read the experimental procedure and understand what you need to do. Use the given resources (textbook, lectures, notes) to achieve this.
- Dress properly for the laboratory – change into proper footwear beforehand and have goggles ready and worn when needed.
- Be familiar with safety facilities of the lab and know the hazards in the experiment that you will perform.
- Handle materials and equipment appropriately, clean up any spillage and used glassware, and maintain a tidy workbench during experiments. You are to report breakages or major spillage promptly to the instructor.
- Maintain a bound laboratory notebook and to record ALL primary data and observations there. Notebooks are to be kept up to date.
- Submit pre-labs, reports, notebook pages and unknown analyses in a timely manner and as complete as possible.