Chemistry 29A Fall 2017 Syllabus

Course and Instructor Information:

Course Info: Tues/Thurs 8:00-10:50am, PHY-77 (Course# 56670)
Instructor: Kurtis Thiesen
Office: ANX 5 (Faculty Annex)
Office Hours: Mon 8:30-10:30am; Wed 8:30-10:30am; Fri 8:30-9:30am (virtual)
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Required Course Materials:

1. Textbook: *Pavia, Donald L., et al., A Microscale Approach to Organic Laboratory Techniques, 6th edition; *Other options are available including older versions of the textbook (for purchase online) or the ebook (also available online).
2. Approved (chemical resistant - Z-87 rated) lab safety goggles and a lab coat
3. Bound laboratory notebook (pages must be bound; no binders or spiral notebooks; duplicate pages are not necessary).
4. Scientific calculator: Any scientific calculator is acceptable, but graphing/programmable calculators and cell phone calculators are not allowed during quizzes.

Course Prerequisites: CHEM 1B

Introduction and Course Description:

Chemistry 29A is the first of two laboratory courses in organic chemistry, and as such it is primarily concerned with introducing the tools and techniques that chemists use to investigate the nature of organic compounds. Students will learn a variety of isolation and purification techniques such as recrystallization, liquid-liquid extraction, distillation (simple, fractional, steam), and chromatography (solid and gas phase). Students will also synthesize organic compounds and characterize their purified products using using melting point determination and FTIR analysis. Gas chromatography, boiling point, refractometry, polarimetry, and NMR will also be utilized in this course.

Student Learning Outcomes:

Upon completion of this course, students will be able to:

1. Work safely in the laboratory, including being able to properly dispose of chemical waste
2. Prepare a protocol for an experiment based upon a typical text write-up, and carry out the experiment independently
3. Maintain accurate and informative laboratory records that would allow another person of similar ability level to repeat the experiment with similar results
4. Synthesize organic compounds and use new techniques to isolate those compounds. Relevant isolation and purification techniques include: recrystallization, liquid-liquid extraction, distillation (simple, fractional, steam), and chromatography (solid and gas phase). Students will also characterize their purified products using basic characterization techniques, including melting and boiling point determinations, FTIR analysis, gas chromatography, refractometry, polarimetry, and/or NMR analysis.

Course Objectives:

In the process of completing this course, students will:

1. Identify and safely use organic chemistry glassware (including that containing ground glass joints)
2. Synthesize organic compounds and subsequently purify/isolate these compounds using appropriate techniques such as recrystallization, liquid-liquid extraction, distillation, and chromatography
3. Analyze organic compounds and measure their physical properties using a variety of techniques including melting point, solubility, boiling point, density, chromatography (solid and gas phase), optical properties (index of refraction, optical rotation), optical spectroscopy (UV-VIS, IR, NMR), and mass spectroscopy
4. Interpret data and draw meaningful conclusions about experimental work; clearly communicate findings both orally and in writing

Important Dates:

Friday, Sept. 1 – Last day to drop a full-term class without receiving a "W" on your transcript.
Friday, Oct. 13 – Last day to drop a full-term class.

Course Format:
You are responsible for reading the relevant experiment and doing the pre-lab write-up before coming to class. Pre-lab lectures for each experiment will be given that cover the basic techniques, theory, experimental design and purpose of the week's experiment, but these are not a substitute for you coming to class prepared. The relevant "Technique" chapter(s) for each experiment are noted in the introductory reading at the beginning of each experiment and you are responsible for reading these…they will help you understand what you are doing in lab and how best to accomplish it.

Post-labs (including lab results): Post-labs will be due on a weekly basis, and they will include a summary and analysis of your experimental results (as outlined in the post-lab handouts) as well as some additional theory-related questions; grades for post-labs will be based on the accuracy of your results, the quality of your data analysis and responses to theory-related questions, as well as product yield and purity (when applicable). Note: At the instructor's discretion experiments may be weighted differently based on the time required to obtain products/results—e.g., an experiment that requires more time to complete, or requires significantly more time out-of-class will normally be weighted more heavily than one that requires less time and effort.

Formal Lab Report: As noted in the course schedule, one of your experiments will be written as a formal lab report using the observations and data collected in the experiment. This lab report will be written in the format of a research paper with an abstract (1 paragraph summary), additional background information (at least 600 words), results and conclusions and references. Background information should be gathered from a minimum of 4 different references (examples are your lab manual, textbook, other books, reputable internet sites etc.) but only 2 of these may be internet references; your references must be cited (ACS) at the end of your lab report. Relevant reaction mechanisms must be drawn using "Chemdraw" (or the free "Chemsketch" or "Chemdoodle" found on the internet) or a similar professional chemical drawing program. You will submit an electronic copy of your abstract and background in Microsoft Word or another compatible word processor (without the diagrams) to the instructor, as well as a printed copy of the entire report to the instructor by the beginning of class on the report's due date. Lab reports will be checked for plagiarism using "Turnitin."

Lab Notebook: You are required to write Pre-Lab and In-Lab notes for each experiment that you do. The instructions for writing these notes in your laboratory notebook are provided in the Mandatory Formatting for Laboratory Notebooks section of this syllabus. Pre-labs will be evaluated at the beginning of each lab period (in which a new experiment is started) and in-lab notes are subject to evaluation throughout the term (see lab schedule for lab book collection dates). The post-lab portion of your experiments will be completed on separate paper (though you have the option to write post-labs into your notebook) and submitted weekly. You will not be allowed to begin an experiment unless your pre-lab is completed. All data for all experiments must be recorded in your lab notebook. Use tables where appropriate to summarize data. Include all printouts, such as IR spectra, gas chromatograms, and representative TLC plates. These printouts must be stapled or pasted into your notebook (no loose paper). For a given experiment, products, results and lab write-ups should be ready for submission/grading no later than one week after the experiment is completed (based on the lab schedule). If necessary, samples should be submitted in a labeled sample vial or glassine envelope. Make sure that the vial/envelope is labeled properly so that the chemistry department can properly (legally) dispose of its contents at the end of the semester. Vial/envelope labels should include the compound's name, the date it was prepared and your name; do not write directly on glass vials (use a label), but you can write directly on glassine envelopes if you'd like.

Quizzes: There will be four (4) lab quizzes—dates are listed in the lab schedule. Three of these quizzes will be approximately 45 minutes in length and the fourth will be cumulative (and longer). The quizzes will examine your understanding of lab techniques, theory and results as well as material discussed in pre-lab lectures and assigned post-lab questions.

Lab Practicals: The lab practicals are the last two experiments of the semester (see Lab Schedule). You will be given a procedure (handout) at the beginning of each lab practical session and you will have the entire lab session to complete it. Your grade for these lab practicals will be based on the time required for completion of each procedure, the yield and purity of your products, your performance in the lab, and your lab write-ups.

Instructor's Evaluation: The instructor's evaluation can make a significant difference in your final course grade. This evaluation will be based on the following factors: arriving to lab on time, being prepared for lab, observance of lab safety rules, laboratory technique, efficient use of lab time (completing labs on time), working independently, initiative and work-ethic.

Additional Note: Some experiments will be carried out in pairs or small groups. In such cases each student is expected to participate fully in the project. Although each student is responsible for their own laboratory work, notes and reports, it is permissible to compare results and discuss the significance of these results with other students.

Grading:

Post-labs (including lab results)..	26% of course grade
Formal lab report ……..….	5%
Lab Notebook (PL + IL)……..	26%
Quizzes 1-3……..	18%
Quiz 4 (cumulative)…….	12%
Lab Practicals……..	8%
Instructor Evaluation……...	5%
Total ……	100%

Your grades will be based on the weighting of assignments listed above, and final course grades will be based on the following grading scale.

A 90-100
B 80-89
C 70-79
D 60-69
F < 60

Attendance: Since this is a lab course, attendance is mandatory; you must complete all experiments in order to obtain a passing grade in the course. Since important information about each experiment (including safety information) is provided at the beginning of the lab period it is important to be on-time. *Being late for lab will contribute to lowering your final point total which is the basis of your final grade.* You may not be allowed to begin an experiment if you miss the pre-lab lecture. **Important Attendance Note:** If you cannot make it to lab you must notify your instructor before the lab period explaining why you're missing the lab…in case of an emergency, contact your instructor as soon as possible. If you miss lab you are still required to document the reason for missing the lab and you will still be expected to make the lab up and complete the assigned work.

Additional Course Policies:

Students with Disabilities: It is our policy not to discriminate against any student. If you suspect that you have any type of physical disability or learning disability that is relevant to your performance in the course, I'd encourage you to come talk to me about it right away (though you're not required to). Additionally, it may be helpful for you to stop by the disabled student services office and talk with staff members there to determine what kinds of services and support are available to you to help you succeed in this and other courses. SCCCD policy: *If you have a verified need for an academic accommodation or materials in alternate media (i.e., Braille, large print, electronic text, etc.) per the Americans with Disabilities Act (ADA) or Section 504 of the Rehabilitation Act, please contact the Disabled Student Services as soon as possible.*

Cheating and Plagiarism: Cheating is the actual or attempted practice of fraudulent or deceptive acts for the purpose of improving one's grade or obtaining course credit; such acts also include assisting another student to do so. Typically, such acts occur in relation to examinations. However, it is the intent of this definition that the term 'cheating' not be limited to examination situations only, but that it includes any and all actions by a student that are intended to gain an unearned academic advantage by fraudulent or deceptive means. Plagiarism is a specific form of cheating which consists of the misuse of the published and/or unpublished works of others by misrepresenting the material (i.e., their intellectual property) so used as one's own work. Penalties for cheating and plagiarism will be strictly enforced (to the fullest extent) in accordance with SCCCD policy.

Disruptive Classroom Behavior: Student conduct which disrupts the learning process shall not be tolerated and may lead to disciplinary action and/or removal from class. Penalties for disruptive classroom behavior will be assessed based on relevant SCCCD policy.

Chem 29A, Fall 2017 Schedule

This schedule is a tentative one, and is subject to change by the instructor. In addition to the assigned reading in the schedule, students are responsible for reading the "Technique" chapters related to each experiment (which are listed in the introductory readings of each experiment). In some cases, your instructor may modify these readings to focus on the most relevant part(s) of each experiment, but in general you should assume that you are responsible for all of the content in the relevant technique chapters. **Note: All experiments will be performed individually unless otherwise specified**.

Month & Day	Topic
Aug 15	Introduction, class policies, lab books, safety *Note: Assigned reading for Safety Orientation (Pavia): Technique 1 - Laboratory safety*
Aug 17	***Safety Quiz** + Expt 1: Exercises 1A-C + Exercise 2 (pipette calibration)
Aug 22	Expt 2: Solubility (parts A-D)
Aug 24	Finish Expt 2
Aug 29	Expt 3: Crystallization (parts A-D)
Aug 31	Finish Expt 3
Sept 5	Expt 4: Extraction (parts A, C & D)
Sept 7	Finish Expt 4
Sept 12	Expt 6: Chromatography (parts A,B and D)
Sept 14	Finish Expt 6
Sept 19	Expt 7: Distillation (simple distillation + GC analysis) **Note: Students will work in pairs**
Sept 21	**Quiz #1 (Expts 2-5)** + Finish Expt 7 (fractional distillation + GC analysis)
Sept 26	Expt 17: Chlorophyll/Carotenoids from Spinach (parts A-C) *Note: Expt 17 will be the subject of your formal report*
Sept 28	Finish Expt 17
Oct 3	Expt 8: IR Spectroscopy + BP Determination (parts A-C) *Assigned Reading: Technique 25: IR Spectroscopy (part A reading is optional)*
Oct 5	Expt 8 Add-on: Refractive Index + Polarimetry Analyses *Assigned Reading: Techniques 23 and 24: Polarimetry and Refractometry*
Oct 10	Expt 15: Isolation of Eugenol via Steam Distillation (part B)
Oct 12	**Quiz #2 (Expts 6, 17, 8)**; Finish Expt 15
Oct 17	Expt 11: Acetaminophen Synthesis (part B)
Oct 19	Finish Expt 11
Oct 24	Expt 14: Isopentyl Acetate Synthesis (part B)
Oct 26	Finish Expt 14
Oct 31	Expt 23: n-butyl bromide Synthesis (part B)
Nov 2	Finish 23B
Nov 7	Expt 23: t-pentyl chloride Synthesis (part D)
Nov 9	**Quiz #3 (Expts 15, 11, 14, 23)**; Expt 19: Molecular Modeling **Note: Students will work in pairs**
Nov 14	Expt 33: Synthesis of Benzoic Acid via Grignard Reaction (Initial Grignard Reagent Prep. + part B)
Nov 16	Finish Expt 33
Nov 21	Expt 30: Resolution of α-phenylethylamine (part A)
Nov 23	**Thanksgiving (No Lab on Thursday)**
Nov 28	Finish Expt 30
Nov 30	Lab Practical #1: Synthesis of a Solid
Dec 5	Lab Practical #2: Synthesis of a Liquid
Dec 7	**Quiz #4 (Cumulative)**; Lab kit and drawer check-out
Dec 11-15	**Chem 29A doesn't meet during finals week**

*Although the safety quiz score does not affect your final lab grade, you must pass the safety quiz in order to continue to work in the Chem 29A lab. The quiz is based on the Technique 1 reading (Pavia) and our in-class discussion (1st day of class); the safety quiz may be taken up to three times.

Additional Resources:

MSDS sheets and other physical and safety data are available here (and other sites on the web).

- http://www.chemspider.com
- http://www.chem.ualberta.ca/~iip/safety_info/msds.htm
- In many cases it works to just do a google search like this one: "Name of Compound" + MSDS and often your search results will contain links to pdf documents of MSDSs for your compound of interest. An example of a website/database that provides MSDSs for many different compounds is ScienceLab.

Online Collection of Spectra

- http://www.lib.utexas.edu/chem/info/spectra.html (contains a large collection of IR, NMR and Mass spectra—this is an excellent source)
- http:///www.sigmaaldrich.com

Mandatory Format for Laboratory Notebook

I. YOUR LABORATORY NOTEBOOK

A. Since your lab notebook is the primary record of your experimental work, it has to be written in a hard-bound notebook. Spiral and three-ring binders are NOT acceptable.

B. All entries must be made DIRECTLY in your lab notebook, i.e. data recorded on scraps of paper and written in pencil are not acceptable. Note: entries must be handwritten in pen or pencil (**not** typed). No credit for typed content.

C. The notebook should begin with a "Table of Contents" (leave 1-2 pages for this at the beginning), and the remaining pages should be numbered sequentially (front and back of each page); The Table of Contents should list the name and number of the experiment, such as "Synthesis of Acetaminophen," and not just the number of the experiment.

D. Your lab notebook should be written with accuracy and completeness. It must be organized and legible, but does not need to be a work of art.

E. Your lab notebook should be an ongoing written record of what you do and have done in lab. Note: experiments should **not** be rewritten afterwards to improve neatness. No credit for rewritten work.

F. Your lab notebook needs to be written in three steps: Pre-Lab, In-lab, and Post-Lab. It should contain the following categories for each experiment that you perform in the lab.

PRE-LAB: TO BE DONE IN YOUR NOTEBOOK BEFORE YOU COME TO THE LAB

NOTE: You will not be allowed to begin an experiment if you have not prepared the Pre-Lab properly. Also, your primary source of instructions/procedural steps will be your Pre-Lab notes. You will not be allowed to use your lab text unless otherwise instructed. So, spend the time to write sufficient Pre-Lab notes in order to perform a given experiment in the allotted lab time. Follow the format given below.

1) Date

2) Experiment's Number & Title

3) **Introduction**
Provide a brief introduction about the "reason or purpose" for performing the experiment. You may include a brief summary of the reaction mechanism and/or techniques that you will be learning by performing the experiment. If you are making (synthesizing) a new compound, you must also include a BALANCED CHEMICAL EQUATION somewhere in this introductory section which describes the synthesis (you can find the balanced equations in the introductory material to the experiment in the lab textbook). The rest of your discussion (and this will be the bulk of it) should focus on relevant lab theory.

4) **Table of Necessary Chemicals & Equipment**
Include the names and formulas (if available) of all reagents and solvents, as many physical properties as available (MW, mp of a solid, bp and density of a liquid, etc.) for each, and any pertinent safety warnings/precautions. You can get this information via the text, Handbooks (CRC, Merck, etc), or online at www.aldrich.com or www.acros.com, MSDS sheets are available from the online resources noted above, under "Additional Resources.

Safety Notes: Summarize any important information you find in Hazard Codes, Risk Statements and Safety Statements for the chemicals that you will be handling in the experiment.

5) **Experimental Procedure & Observations**
Write an experimental outline (with numbered steps) in sufficient detail so that the experiment could be done without reference to your lab manual. Here is a format that has worked well in the past. Divide the "Procedure" page into two columns. The first column is for the Procedure Outline that you take from the lab manual, and the second column is for writing your Observations as you perform the experiment in the lab - that is, the "In-Lab" part. For example:

	Procedure Outline (Pre-Lab)	Observations (In-Lab)
1.	Carefully mix 2 mL of conc. sulfuric acid with 2 mL of nitric acid in a small flask	1. White smoke observed as the two acids were mixed
2.	Add 1.5 mL of chlorobenzene dropwise to the mixture and shake the reaction flask gently	2. After the addition was complete, two distinct layers were noticeable
3.	etc.	3. etc.

As you have noticed, numbering the steps in both columns provides for an easy way of cross-indexing a given procedural item with its corresponding observation. It should be obvious that if no special observations are made, you should place a "check mark" or write "done" in the "Observations" column.

IN-LAB: TO BE DONE IN YOUR NOTEBOOK DURING THE LAB SESSION

The actual quantities of all reagents must be recorded in the "Observations" column. For example, if the procedure calls for adding between 5 to 7 grams of a solid, you should write in the "Observations" column the actual amount that you weighed and added (for example 6.35 g). Also, the actual amount of a product, as well as its color and physical appearance, reaction time, percent yield, sources of experimental error or product loss, etc. should also be recorded in this column.

Remember: organic chemistry is an experimental science. Therefore, all the minute details that you might think of as unimportant in any given experiment, may actually be significant to your understanding of that experiment, and, later, in your explanation of the results. That is why your observations, and proper recording of them, are crucial in having a successful learning and lab experience.

This was taken care of above in the "Observations" column and does not require further explanation.

Note: If there is a change in the procedure when you arrive in lab, that change(s) should be noted in your lab notebook. You can write “omit” and cross out a part(s) that you did not have to do, and/or add a procedure(s) if you did something in lab that you did not plan on in your pre-lab write-up.

6) **Calculation of Percent Yield (for synthesis experiments only)**
Show your calculation of the theoretical (expected) yield as follows:
First, you need to figure out what the limiting reagent (reactant) is in your experiment based on the stoichiometric ratios among the reactants. You can obtain this ratio using the coefficients of the reactants in the balanced chemical equation which you wrote in the Introduction section (Pre-Lab Item #3).

Second, you must CLEARLY show the following conversions: grams limiting reactant → moles limiting reactant → moles product → grams product

Third, calculate percent yield as:

$$\% \text{ Yield} = \frac{\text{Actual yield of product}}{\text{Theoretical yield}} \times 100$$

POST-LAB: TO BE DONE ON A SEPARATE SHEET OF PAPER AND/OR IN YOUR LAB NOTEBOOK AFTER COMPLETING THE EXPERIMENT

In this section of your lab notebook you will evaluate and interpret your experimental results. Note: You will be given weekly post-lab handouts that clearly indicate what data needs to be reported and how that data should be analyzed.

7) **Post-lab Handouts (summary of lab results and conclusions)**
Post-lab handouts will be posted on Canvas at the end of each experiment and you will generally be given one week to complete these. You will be asked to attach copies of any printouts, chromatograms, or graphs that you obtained (e.g. IR or NMR spectra) to your post-lab write-up, but the originals should always be added (stapled or pasted) to your lab notebook soon after you've obtained them.

Note: Make sure to cite any books or reference sources (other than the textbook) that you may have used during the experiment.