Polymer I

CHEM 381

Welcome to Polymer I. This is a 300 level course, which means that it is expected that you will self-motivate. The workload will be commensurate with the course level. The effort that you put in will reflect what you get out of this course. This syllabus outlines the course requirements and schedule for lecture, laboratory and assignments. This information is also available online in the D2L course module.

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Office Hours:
M 11-12 pm
T/R 2-4 pm

Lecture
6-7:15 pm MW

Laboratory
5-7:50 pm R

Course Goals

1. To identify and name organic polymers
2. To synthesize organic polymers and to perform reactions on organic polymers
3. To interpret simple characterization data for organic polymers
4. To comprehend the uses and applications for organic polymers

Course Materials

1. **Required:** *Polymer Chemistry*, 9th ed., Carraher, CRC Press, 2014, ISBN 978-1-4665-5203-6.
2. **Required:** Lab goggles
3. **Required:** Lab notebook. Hayden McNeil ISBN 9781930882096

Course Evaluation

Course Item	Percentage of Final Grade
Term Paper	20%
Draft 1	*Instructor Reviewed (5%)*
Draft 2	*Peer Reviewed (0%)*
Final Draft	*(15%)*
Homework Packets (2)	10%
Exams	50%
Mid-term 1	*(15%)*
Mid-term 2	*(15%)*
Final	*(20%)*
Laboratory Reports	20%
TOTAL:	100%

Letter Grade	Percent	Letter Grade	Percent
A	≥94.0%	C	74.0-77.9%
A-	90.0-93.9%	C-	70.0-73.9%
B+	88.0-89.9%	D+	68.0-69.9%
B	84.0-87.9%	D	64.0-67.9%
B-	80.0-83.9%	D-	60.0-63.9%
C+	78.0-79.9%	F	Below 60.0%

Dates to note:

January 19 – First day of Classes
January 26 – Drop/Add ends
April 1 – Last day to Withdraw
March 7-March 13-NO CLASS
May 2 – Last day of class
May 3 – Finals week
May 6 –Term Ends

General Course Policies

- Millersville University and its faculty are committed to assuring a safe and productive educational environment for all students. In order to meet this commitment and to comply with Title IX of the Education Amendments of 1972 and guidance from the Office for Civil Rights, the University requires faculty members to report incidents of sexual violence shared by students to the University's Title IX Coordinator. The only exceptions to the faculty member's reporting obligation are when incidents of sexual violence are communicated by a student during a classroom discussion, in a writing assignment for a class, or as part of a University-approved research project.
- Plagiarism is the deliberate or even accidental representation of another's work as your own without proper reference. Although you will work together on some material and experiments, this does not mean that lab reports and assignments should be identical. Each participant uses the collective data and discussion to prepare his or her own individual report. You should be familiar with the University policy on academic honesty and dishonesty. In the event that it is discovered that a student has broken the academic honesty policy, they will receive an F for the course.
- Attendance is expected at all classes. Students are responsible for missed content.
- Make-up policy: Except for academic or involuntary health ailments, which are ***accompanied by a doctor's note***, there is no make-up for the assignments and exams in this course. Please provide any academic excuse to Dr. Allen ahead of time. Provide health excuses to Dr. Allen within one week of make-up.
- All labs are mandatory in order to pass this course. Contact Dr. Allen ASAP in the event that you will miss a lab.
- Arranging academic accommodations are the responsibility of the student.

Cell phone use is not permitted during lab or lecture. Please turn off cell phones!

Tentative Lecture Schedule*

*Subject to change

Week of:	Content	Chapters in Carraher's
Jan. 19th 1 lecture	**Introduction and Nomenclature**	**1**
Jan. 25th 2 lectures	**Introduction and Nomenclature, Morphology: Stereochemistry, Molecular Interactions, Crystallinity/Amorphousity**	**1, 2**
Feb.1st 2 lectures	**Morphology: Stereochemistry, Molecular Interactions, Crystallinity/Amorphousity, Molecular Weight and Solubility**	**2, 3**
Feb. 8th 2 lectures	**Molecular Weight and Solubility, Testing and Characterization: Structure/Property Relationships, Physical tests, Spectral Identification**	**3, 13, 14**
Feb. 15th 2 lectures	**Testing and Characterization: Structure/Property Relationships, Physical tests, Spectral Identification**	**13,14**
Feb. 22nd 2 lectures	**Stepwise polymerizations and condensation polymers**	**4**
Feb. 29th 2 lectures	**Stepwise polymerizations and condensation polymers, chain-reaction polymerizations and addition polymers**	**4, 5, 6**
March 7th	**SPRING BREAK**	
March 14th 2 lectures	**Chain-reaction polymerizations and addition polymers**	**5, 6**
March 21st 2 lectures	**Copolymerization: kinetics, blends, types**	**7**
March 28th 2 lectures	**Copolymerization: kinetics, blends, types, Reactions of Polymers**	**7, 16**
April 4th 2 lectures	**Reactions of Polymers, Polymer Technology**	**16, 19**
April 11th 2 lectures	**Polymer Technology**	**19**
April 18th 2 lectures	**Natural and biomedical Polymers**	**9, 10**
April 25th 2 lectures	**Natural and biomedical Polymers**	**9, 10**
May 2nd 1 lecture	**Room to grow**	

Term Paper

A term paper, rough drafts to be handed in periodically throughout the semester, will make up 20% of your grade. This paper is to be developed based upon lecture material and your own research initiative into polymer science.

You are expected to research a polymer application on your own, propose a target polymer and its synthesis and then suggest the expected characterization and the tests that might be carried out on this polymer for the purposes of this application. You will follow a template for this manuscript, based on ACS guidelines. The template is below as an example but is also accessible electronically on D2L for you to download and type directly into.

Deadlines:

Draft 1 – Due February 19th. You must meet with and discuss your idea with Dr. Allen to develop the concept. Your draft for this meeting must include:

1. Polymer application (i.e. some ideas are: solar cell use [photoactive polymer], elasticity/adhesives, field effect transistor [electrically conductive polymer], plastics)
2. A target polymer – roughly speaking. Your best approach to this is to select a known polymer, already used for your application, and modify it in some way to improve or enhance it. Or even just to see what happens. The difference between these approaches is applied vs. basic research. SciFinder is an excellent resource for this means. Please see the tutorial online for help with how to use SciFinder.
3. An array of tests that will be done on the polymer to prove/disprove your hypothesis of its behavior (dependent on application and target)
4. At least two challenges that may/may not work out or must be overcome synthetically/systematically in order to successfully apply your polymer to the application.

Draft 2 – Due March 25th. You must hand your paper to another student for peer review. A rubric will be provided by which they will critique and make suggestions. Please see below for the rubric. A copy of this is also available on D2L.

Final Paper – Due Finals Week. Must be 5 pages (minimum) with figures, tables, schemes and charts. All figures, tables, schemes and charts must be appropriately sized for the paper (please see published works for an idea about this size scale). Font and margins must follow template guidelines. A minimum of ten references must be used, appropriately.

Template for Manuscript and Laboratory Reports

Using the template – the template is available on D2L. When you open it in Word, you will have access to this in real time. It is strongly recommended you reference it for font, layout and content assistance.

1. Abbreviated instructions for using the template follow.
2. Type your manuscript directly into the template -- select (highlight) the text of the template that you want to replace and begin typing your manuscript (i.e., the select the Title section for typing in your title).
   a. Go to the Word Style list on the formatting toolbar and you will see all the Word Styles from the template that have now been imported into the current document. A Styles toolbar has been generated that will display the different Styles for you to choose from. If this is not present, select **View**, **Toolbars**, and then select **Styles** and it should appear. You can close this at any time and then reopen it when needed.
   b. Click in the sentence or paragraph and then go to the Word Style menu on the toolbar and select the relevant Word Style. This will apply the Word Style to the entire text (sentence or paragraph). Do this for all sections of the manuscript.
3. In ACS publications there are many different components of a manuscript (i.e., title, abstract, main text, figure captions, etc.) that are represented in the template. Be sure to maintain the content as appropriate. Note that you will not use all of the portions of the template.
4. To insert graphics within the text or as a figure, chart, scheme, or table, create a new line and insert the graphic where desired. If your graphic is not visible, ensure that the Word Style is “Normal” with an automatic height adjustment. If the size of the artwork needs to be adjusted, re-size the artwork in your graphics program and re-paste the artwork into the template (maximum width for single-column artwork, 3.3 in. (8.5 cm); maximum width for double-column

artwork, 7 in. (17.8 cm)). **NOTE**: If you are submitting your paper to a journal that requires a Table of Contents graphic, please insert the graphic at the end of the file.

5. Delete all sections from the template that are not needed, including these instructions.
6. Save the file with the graphics in place: select **Save As** (**File** menu) and save it as a document file (.doc).
7. Proof a printout of the manuscript (from a 600 dpi or higher laser printer) to ensure that all parts of the manuscript are present and clearly legible.
8. Ensure that page numbers are present on all pages.

TITLE (Word Style "BA_Title"). The title should accurately, clearly, and concisely reflect the emphasis and content of the paper. The title must be brief and grammatically correct

AUTHOR NAMES (Word Style "BB_Author_Name"). Include in the byline all those who have made substantial contributions to the work, even if the paper was actually written by only one person. Use first names, initials, and surnames (e.g., John R. Smith) or first initials, second names, and surnames (e.g., J. Robert Smith). Do not use only initials with surnames (e.g., J. R. Smith) because this causes indexing and retrieval difficulties and interferes with unique identification of an author. Do not include professional or official titles or academic degrees. At least one author must be designated with an asterisk as the author to whom correspondence should be addressed.

AUTHOR ADDRESS (Word Style "BC_Author_Address"). The affiliation should be the institution where the work was conducted.

AUTHOR EMAIL ADDRESS (Word Style "BI_Email_Address")

ABSTRACT (Word Style "BD_Abstract"). All manuscripts must be accompanied by an abstract. The abstract should briefly state the problem or purpose of the research, indicate the theoretical or experimental plan used, summarize the principal findings, and point out major conclusions. The optimal length is one paragraph.

MANUSCRIPT TEXT (Word Style "TA_Main_Text"). This should include an introduction (background, which should lend structure to the paper and be heavily supported by literature reference), experimental details (sections titled Experimental Methods, Experimental Section, or Materials and Methods), discussion, conclusion.

ACKNOWLEDGMENT (Word Style "TD_Acknowledgments"). Generally the last paragraph of the paper is the place to acknowledge people, organizations, and financing (you may state grant numbers and sponsors here). Avoid use of phrases like "we (I or the authors) would like to thank" and "we (I or the authors) wish to thank", instead use "we (I or the authors) thank". Follow the journal's guidelines on what to include in the Acknowledgments section.

FIGURE CAPTIONS (Word Style "VA_Figure_Caption"). Each figure must have a caption that includes the figure number and a brief description, preferably one or two sentences. The caption should immediately follow the figure with the format "**Figure X.** Figure caption.". All figures must be mentioned in the text consecutively and numbered with Arabic numerals. The caption should be understandable without reference to the text. It is preferable to place the keys to symbols used in the figure in the caption, not in the artwork. Ensure that the symbols and abbreviations in the caption agree with those in the figure itself and in the text and that the figure is already sized appropriately.

SCHEME TITLES (Word Style "VC_Scheme_Title"). Chemical reactions and flow diagrams may be called schemes. Schemes may have brief titles describing their contents. The artwork for each scheme should immediately follow the scheme title. The title should follow the format "**Scheme X.** Scheme Title". All schemes must be mentioned in the text consecutively and numbered with Arabic numerals. Schemes may also have footnotes (use Word Style "FD_Scheme_Footnote"), inserted after the artwork.

CHART TITLES (Word Style "VB_Chart_Title"). Lists of structures may be called charts. Charts may have brief titles describing their contents. The title should follow the format "**Chart X.** Chart Title". Charts may also have footnotes (use Word Style "FC_Chart_Footnote"). To insert the chart into the template, be sure it is already sized appropriately and paste it immediately after the chart title.

TABLES. Each table must have a brief (one phrase or sentence) title that describes its contents. The title should follow the format "**Table X.** Table Title" (Word Style "VD_Table_Title"). The title should be understandable without reference to the text. Put details in footnotes, not in the title (use Word Style "FE_Table_Footnote"). Define nonstandard abbreviations in footnotes.

Use tables (Word Style "TC_Table_Body") when the data cannot be presented clearly as narrative, when many precise numbers must be presented, or when more meaningful interrelationships can be conveyed by the tabular format. **Do not use Word Style "TC_Table_Body" for tables containing artwork.** Tables should supplement, not duplicate, text and figures. Tables should be simple and concise. It is preferable to use the Table Tool in your word-processing package, placing one entry per cell, to generate tables.

REFERENCES (Word Style "TF_References_Section"). In many journals, references are placed at the end of the article, while in others they are treated as footnotes. In any case, place your list of references at the end of the manuscript. In ACS publications, references are cited in three ways: superscript numbers, italic numbers on the line and in parentheses, and by author name and year of publication in parentheses inside the punctuation. Authors are responsible for the accuracy and completeness of all references. Authors should check all parts of each reference listing against the original document. Detailed information on reference style can be found in *The ACS Style Guide,* 2nd ed., available from Oxford Press.

Rubric for Peer Review:

You will be critiquing your peer's paper based on technical writing, content and quality of the chemistry and feasibility of their proposal. Your critique will go a long way to assisting them in improving the paper for the final draft, so please be honest. It is important to maintain a professional demeanor, so please also remain polite. When you receive your own critique(s) back, please remember that a critique on your work is not a personal attack.

Format:

Does the paper follow the ACS guidelines format? Font, font size, margins should all agree with the ACS template

Do the tables/figures/charts/schemes read too large (ridiculously taking up an entire page on their own) or too small (can't read them clearly)?

Are the tables/figures/charts/schemes clearly labeled, without having to reference the text? You should be able to look at the labels under and above each and understand the data.

Abstract

Does the abstract state:

Point of project in context – I.E. What is already known and not known about the subject matter as an introduction to what will be discussed.

The methods used to characterize/define the subject matter, omitting details such as experimental specifics.

Anticipated results – The goal of the project as a means to an end. Is this basic or applied research? You should be able to tell at this point.

Conclusion statement

Introduction:

Does the introduction have at least five references and are they are appropriate? I.E. are they all for the same topic, do they support facts, are any facts left unsupported by a reference?

Does the introduction provide context for the project?

- There should be information about previous work done,
- Rationale as to why you are interested in this project,
- Explanation of the problems with current work that you plan on fixing

Does the introduction succinctly state the point of the project, in a way that you know the goals and reasoning behind the undertaking?

Materials/methods:

Do the materials and methods work for this polymer?

- Are they subject appropriate? (Do they apply to polymers/monomers that you are working with or are they for completely different materials)

- Are anticipated results given and are analogous examples provided for context? (Are you providing DSC/GPC/NMR/IR/UV-Vis/Viscosity/Density data that you expect????) Look up similar examples and use these examples to extrapolate what you expect!

Results/Discussion:

Does the author round out their discussion with a reasoned argument, or are you left able to poke holes easily?

- This will be short, but you should be able to discuss your data in terms of what you expect the material to behave as

- Will the material conduct well if it is a conductor? Will the material stick well if it is an adhesive? How well? How will you tell? Will the material stretch well? Will the material replace any current materials?

Grammar:

Do you find spelling/grammatical problems? Correct them! Mark words and phrases like, 'I think' and 'perhaps' and 'maybe' and 'feel'– these need to be replaced!

Do you avoid the use of 'I'? FORMAL LANGUAGE ONLY!

Laboratory

Lab Rules:

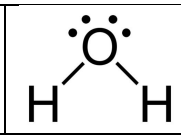
- You must have closed toe shoes
- Long hair must be pulled back
- You must wear safety glasses
- Keep the lab clean
- Abide by OSHA guidelines for proper disposal of waste

- **Lab notebook instructions**
  - Fill in your "Table of Contents" regularly with reaction, page number and date
  - Fill in your experiment with NMR, TLC, reaction times, amounts, reaction data tables, reaction structures…TOO MUCH is better than TOO LITTLE. ALL spectra should be included in the lab notebook!

  - Week #, Title and date of each experiment on each page used at the top of the page. (use these to fill in your table of contents)
  - Reactions & Structures: hand drawn line structures of all organic and inorganic molecules used in lab. If there are no reactions/structures, ignore this section. Follow this format:

For Structures:

Compound Name (Formula)	**Structure**	**Melting Point/Boiling Point**	**Safety Hazards**	**Molecular Weight**

Dihydrogen Monoxide (H_2O)		Mp: 0 C Bp: 100 C	Drowning hazard	18 g/mol

For Reactions:

$$2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(g)}$$

Safety Philosophy:
We enforce safety regulations in the Chemistry Department because safety training is an essential part of becoming a qualified scientist. Good science is safe science. Our safety rules are the same as those widely used in industrial and academic labs. These rules are based on years of experience in hundreds of labs. We also want to keep the risk of injury well within acceptable limits and to minimize both short- and long-range toxicity problems. We would also like to avoid damage to the building and equipment, which often is the result of unsafe practices.

Laboratory Safety Rules

1. **Be slow:** It is dangerous to move too fast while handling toxic and flammable chemicals or breakable glass.
2. **Be thoughtful:** Think your actions through before you do carry them out.
3. **Be inquisitive:** If you are not sure of something...ask me (your instructor).
4. **Be responsible:** Danger associated with spilled chemicals or broken glassware is avoidable. Report accidents.
5. **Be prepared** for the experiment before lab. Think about what you are doing and plan ahead.
6. **Eye protection:** Always wear safety glasses or safety goggles. *No contact lenses in the organic lab.*
7. **Never eat** or drink *anything* in lab.
8. **Never solo.** Never work alone in the lab.
9. **Dress smart.** Always wear proper laboratory attire in lab. Wear older clothing to lab.
    a. Shoes that cover the top of the foot are required. *No Flip-flops, sandals or open top shoes.*
    b. Wear long pants & shirts that cover all of your torso area. *No shorts.*
    c. Laboratory coats or aprons can also be used to protect you and your clothing.
    d. Latex or nitrile gloves are available in the lab.
    e. Confine long hair and loose clothing, such as baggy sleeves, hood strings, etc.
10. **Be neat & tidy.** Keep your work area clean. Keep personal belongings (e.g. backpacks) by the door to the lab. Clean up all spills immediately. Keep the balances clean. Broken glassware should be placed in the designated container - not in the trashcans.
11. **Chemistry in the** Fume **Hood.** Use the fume hoods for experiments as much as possible.
12. **Breathe clean air.** Avoid breathing vapors of any kind. If vapors (gases and/or smells) are being produced by an experiment, move it to a fume hood immediately!
13. **Minimize contact.** Avoid direct contact with chemicals. Many chemicals can be absorbed directly through the skin. If you come into contact with chemicals, rinse chemicals from the affected area with large amounts of running water and *inform your instructor*.
14. **No mouthing.** Always use a pipet bulb to fill a pipet. Never fill or dispense a pipet by mouth.
15. **Acid into water.** No volcano. Always pour concentrated acids into water when diluting.
16. **Point away.** Always point reaction vessels away from you & others.
17. **No fires.** No open flames or excessive heat in lab. Do not heat anything to dryness.
18. **Regulate the electric.** Plug into variable power sources (power mites) when using the heating mantles, not the regular electrical outlet.

19. **No put backs.** Excess reagents obtained, but not used should never be returned to the original bottle. Put chemical leftovers into the proper waste container. Products isolated from an experiment should be placed in a designated collection container or the proper waste container.
20. **Never down the drain.** Excess reagent chemicals, products or waste residue from an experiment should never be washed down the drain - dispose of them in the proper waste container.
21. **No pressure.** No reactions in a closed system. Don't heat a closed apparatus. Glass pressure cooker, no?
22. **Start small.** Whenever a new reaction is attempted, proceed cautiously at first. If feasible, try it on a very small scale first. If one reagent is to be added to another, first add a tiny amount and observe results.
23. **No pranks**. Horseplay, acts of mischief, and startling loud noises are dangerous and not permitted.
24. **Flammable & explosion prone.** Most organic liquids are flammable; many form explosive mixtures with air**.**
25. **You must report** any and all accidents, fire, and injuries to the instructor promptly! **Please report** any dangerous conditions or practices that you observe to the instructor!

Emergency Procedures

Fire extinguishers: Carefully note the location of fire extinguishers, safety shower, and eyewash station so that you can get to them instinctively in an emergency. Note the exits that are provided in the laboratory.

In case of fire or accident, notify the instructor immediately.

Burning reagents: First notify the instructor. If feasible, remove all nearby combustible materials, particularly flammable liquids, to avoid secondary fires. Small amounts of burning liquids usually bum themselves out harmlessly in a few minutes; a panicky overreaction may result in breaking the container and spreading burning liquid over a wide area. It may be feasible to cover the container to smother the fire. Water is ineffective on burning organic liquids, except from a "fog" nozzle as available in fire departments.

Electrical fires: Notify instructor. DO NOT use water. If feasible, unplug the device. Use CO2 extinguisher if available, otherwise a dry-chemical one.

Burning clothing: Prevent the person from running and fanning the flames. Rolling the person on the floor will help extinguish the flames and prevent inhalation of the flames. If a safety shower is nearby, hold the person under the shower until the flames are extinguished and chemicals washed away.

Burns (thermal or chemical): Flush the burned area with cold water (preferably ice water) for at least 15 minutes. Resume if pain returns. Wash the chemicals off with a mild detergent and water. If chemicals are spilled on a person over a large area, remove the contaminated clothing while under the safety shower. Seconds count and time should not be wasted because of modesty. Get prompt medical attention.

Chemicals in the eye(s): Flush the eye with copious amounts of water for 15 minutes using an eyewash fountain or bottle, or by placing the injured person face up on the floor and pouring water in the open eye. Hold the eye open to wash behind the eyelids. After 15 minutes of washing, obtain prompt medical attention, regardless of the severity of the injury.

Minor Cuts: This type of cut is most common in the organic laboratory and usually arises from broken glass. Wash the cut, remove any pieces of glass, and apply pressure to stop the bleeding. Get medical attention.

Major Cuts: Apply firm pressure, wrap the injury, and get immediate medical attention.

Major injury: Avoid moving the patient, unless absolutely necessary to protect him/her from further serious injury. Apply first aid measures to control bleeding, assist respiration, and administer CPR if appropriate. If you are not familiar with the needed first aid measures, try to locate someone nearby to help. *CALL 911***.**

Ingestion of chemicals: Do NOT attempt to give antidotes to induce vomiting. If the victim is conscious, have him/her drink large amounts of water. Seek medical attention. It is extremely useful to the treating physician to know the exact substance(s) that was (were) ingested. If possible, take along the reagent bottle(s).

Medical assistance. Routine cases should be handled by taking the patient to the infirmary. From there they will be referred to a hospital emergency room if necessary. For very serious cases in which time seems crucial, 911 should be called.

Useful Laboratory Resources, & Websites

www.notvoodoo.com

Spectral Database for Organic Compounds SDBS:
http://riodb01.ibase.aist.go.jp/sdbs/cgi-bin/direct_frame_top.cgi
For detailed information on specific chemicals:
The Merck Index
The CRC Handbook of Chemistry and Physics
Aldrich Chemical Catalog in print or online at http://www.sigmaaldrich.com
National Institute of Standards & Technology: http://webbook.nist.gov./chemistry/
For organic chemistry literature searches:
http://www.library.millersville.edu/libguides/chemistry
http://www.accessscience.com/browseTOC.aspx?main=5&sub=544000
Environmental Health & Safety Resources:
EH&S website: http://www.millersville.edu/hr/ehs/workplace-safety.php
Waste labels: http://www.millersville.edu/hr/ehs/hazardous-waste-labels.php
MSDS: http://www.sigmaaldrich.com/safety-center.html
MSDS: http://hazard.com/msds/index.php