Introduction to Chemical Research  
CHEM 488; Spring 2015

Course Name: CHEM 488: Undergraduate Research in Chemistry and Biochemistry  
CRN: 34566  
Pre/Co-requisites: CHEM 314, CHEM 324, or CHEM 434

Location: REIC 138  
Meeting Time: Thursday 2-3pm

Instructor: Dr. Sarah Hayes  
Office: Reichardt 188  
Phone: 907-474-7118  
Email: s.hayes@alaska.edu

Safety officer: Emily Reiter  
Office: Reichardt 192  
Phone: 907-474-6748  
Email: e.reiter@alaska.edu

Office Hours: Just drop by when our doors are open or by appointment

Blackboard Link: http://classes.uaf.edu

Required materials: none

Catalogue Course Description: Advanced research topics from outside the usual undergraduate laboratory offerings. The student will be required to make a presentation and turn in a final report. Research areas range from atmospheric chemistry to molecular biology. A substantial level of chemistry or biochemistry background is assumed.

Course Goals: Students will become involved with contemporary research ongoing in the department, which will enhance and expand technical laboratory skills. Research projects will be shared through periodic research updates, a formal technical report in journal format, and public poster presentation.

Student Learning Outcomes: Students will be prepared to plan and execute their future research projects. Upon successful completion of this course, students will:

• Design of experiments (background, rationale, techniques/materials, expected outcomes/alternatives, logistics/time line)
• Analysis of multiple data sets with appropriate statistical methods
• Written comprehensive report adherent to ACS standards (see below)

American Chemical Society Definition of Undergraduate Research:  
The ACS Committee on Professional Training (CPT) approves our programs and defines undergraduate research in their guidelines as:  
The research project should be envisioned as a component of a publication in a peer-reviewed journal. It should be well-defined, stand a reasonable chance of completion in the available time, apply and develop an understanding of in-depth concepts, use a variety of instrumentation, promote awareness of advanced safety practices, and be grounded in the primary chemical literature. Research can satisfy up to four semester credit hours or six quarter credit hours of the in-depth course requirement for student certification and can account for up to 180 of the required 400 laboratory hours. A student using research to meet the ACS certification requirements must prepare a well-written, comprehensive, and well-documented research report including safety considerations. Although oral presentations, poster presentations, and journal article coauthorship are valuable, they do not substitute for the student writing a comprehensive report.  
To complete by Jan 29:
1. Attend organization meeting at first class, or by arrangement with instructor
2. Visit three profs and discuss their possible projects (Due Jan 22)
3. Choose one project with the approval of the professor.
4. Write up a half-page description of the project and a description of potential hazards.
5. Get signatures from your new research mentor, and Emily Reiter
6. Make copies for yourself, and hand in the two pages in Hayes’ mailbox, room 194
7. Pick up a lab book from 194, and start to work!
8. Check with Emily Reiter regarding safety training

Finding a Project: If you are a new 488 student, or working with a different professor, meet with at least three faculty members (see attached signature form due January 22) to discuss possible projects. The signatures of the three faculty members must be obtained on the attached form. Select a research mentor and write up a half-page statement outlining the proposed research project, including one reference, and a description of possible hazards associated with the project. Submit statement to your mentor and the instructor (shayes@alaska.edu) by Jan 29 during class (see attached form). Faculty research: see http://www.uaf.edu/chem/faculty.

Continuing students hand in a half-page statement outlining that semester’s proposed research. If the procedures or materials of your ongoing project are different this semester than last, also note that at the bottom of the page, and get the signatures of your research professor and Emily Reiter (include potential hazards).

Before you begin working in a research lab you must complete lab safety training.

Contact Emily Reiter (e.reiter@alaska.edu or 474-6748) for more information.

Required safety trainings include:
1. General online lab safety trainings (power point training presentations and quizzes to be passed) or attend special training on Monday, January 26 from 2:15-5:15 in Spencer Library (REIC 306).
2. Individual project-specific training session with the safety officer (Emily Reiter) tailored to your project and the lab(s) in which you will be working. Before scheduling with her, you must have completed the written project statement, with emphasis on the safety and environmental aspects of the project.

Research Safety: Always carry out research with all due caution; do not work alone; wear safety glasses at all times; no food/beverages in the lab; do not rush; do not attempt a procedure without proper training; familiarize yourself with the potential hazards. Most of all Use common sense!

Research Expectations & Number of Credits: Credits are assigned at the beginning of the semester when students enroll, but may be subject to change as the result of consultation between the student and professor. One credit of 488 is reserved generally for library or small computational projects. In general, 2 credits provide the absolute minimum amount of time to accomplish a laboratory project; the usual lab-based project will require about 3 credits per semester. Each credit of 488 corresponds to an average weekly minimum of 3 hours working productively in the lab, plus one to two hours planning, interpretation, notebook writing, and reading outside of lab. Expectations for a student taking the course for three credits are higher compared to a student taking the course for two credits.
**Integrating into a Research Group:** Research progress strongly depends on a regular schedule of preparation for lab, attendance in the lab, and consultation with your mentor. As part of your immersion in a research group, you may also be asked to attend a regular research discussion with your mentor, and/or group meetings, which are informal research or literature discussion sessions held every so often during the semester. In addition to our class's weekly meetings (described above), regular attendance in the research lab, and at research meetings or group meetings, is required.

**End of semester Lab Inspection Checklist:** At the end of each semester, all students must complete Lab Inspection Checklist with the research mentor or Emily Reiter. The checklist will emphasize checking that all chemicals are properly stored, glassware has been washed and put away, and the lab space is generally neat.

**Course Evaluation**
Course grade is assigned in consultation with your research mentor based on the quality of the research executed, the comprehensive report, and the poster. There are **200 total points available** in this class. Grades are assigned as follows: 200-180 A, 180-160 B, 160-140 C, etc. The instructor reserves the right to adjust the grading scheme at any time in a manner that is beneficial to students. Discuss grading with your research mentor early in the semester to understand “satisfactory progress.”

<table>
<thead>
<tr>
<th>Graded Element</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research updates (7 required @ 10 pts each)</td>
<td>70</td>
</tr>
<tr>
<td>Poster and presentation at department potluck</td>
<td>30</td>
</tr>
<tr>
<td>Research report</td>
<td>100</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>200</strong></td>
</tr>
</tbody>
</table>

**Weekly meetings & Research Updates:** There will be at least 12 meetings throughout the semester to discuss research progress (Thursday 2-3pm). You are expected to present an update on your research in at least seven of these meetings for full credit. Presentations will be graded promptly as "acceptable" or "insufficient", with acceptable being 10 points, and insufficient as 0 points. Because seven such reports are required, you can get 70 points for this grading component. Absences due to travel, illness etc will be reasonably accommodated, but **attendance is required regardless of if you are presenting.**

**Laboratory Notebook:** Research-style notebooks **must** be obtained from the Department of Chemistry and Biochemistry. Keep complete handwritten notes (data, procedures, and results) and have your notebook signed on a weekly basis by your mentor!!!

Digital data collections require cross-references to pages in the notebook (include file names). Provide a copy of all digital data (spectra files, hyperchem, excel, word) on a CD, labeled, and at the end of each semester to your research mentor! The lab notebook ultimately remains with your research mentor.

**Poster & Presentation:** Each semester, research students must present a poster at the end-of-the-semester departmental potluck/poster session (April 30, 4-5pm). The usual size is 36” x 36”, which will be printed with departmental funds.

**Required semester report:** Each semester a final written report in journal format (as agreed upon with your mentor) is required. Submit copies of your final report both to the instructor (Hayes) and your mentor no later than 5 PM on Monday, May 4. **Your report is a public document, and we plan on showing it as examples of the work done in the class and posting it to the department's website.**
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Report components:
Journal guide for authors due April 2
Annotated figures (20 points) due April 9
Lab notebook and digital data to instructor (10 points) due April 23
Report (50 points) due April 23
Peer review in class on April 30
Final report (20 points) due May 4

Course Policies:
Classroom Behavior and Late Work: Students are expected to conduct themselves in a professional manner at all times. Disrespect of the classroom learning environment, instructors or mentors, and fellow students will not be tolerated! Late work is accepted at a 10% per day reduction of the points possible. This is in an effort to keep the entire class moving though the projects efficiently. Continued attendance to class indicates each student agrees to the policies set forth in this syllabus.

Honor Code and Academic integrity: Students are expected to conduct themselves in accordance with the UAF Honor code. The Chemistry Department policy states: Any student caught cheating will be assigned a course grade of F. The students’ academic advisor will be notified of this failing grade and the student will not be allowed to drop the course.

Ethical Considerations: Plagiarism is defined as the use of “other” intellectual property without proper reference to the original author. Intellectual property includes all electronic, spoken or print media thus any information taken of the web is included under this statement. Students are expected to cite all sources used in oral and written presentations. Cases of plagiarism will be taken seriously with a grade 0 for the particular assignment. Severe cases may be referred to the Department Chair or Dean or class failing considered.

Disability Services: I will work with the Office of Disabilities Services (208 Whitaker Bldg, 474-5655) to provide reasonable accommodation to students with disabilities. It is the student’s responsibility to make an appointment with me to discuss appropriate accommodations within the first two weeks of the first class meeting. A letter from disabilities services must be provided for discussion at that time.

Veteran Support Services: Walter Crary (wecrary@alaska.edu)is the Veterans Service Officer at the Veterans Resource Center (111 Eielson Building, 474-2475). Fairbanks Vet Center 456-4238. VA Community Based Outpatient Clinic at Ft. Wainwright is 361-6370.
### Tentative Schedule

Below find a tentative time schedule to complete your research project.

<table>
<thead>
<tr>
<th>Date</th>
<th>Week</th>
<th>Task(s)</th>
<th>Research</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan 16</td>
<td>1</td>
<td>Course Details - To Do List</td>
<td>On line search&lt;br&gt;Meeting time w mentors</td>
</tr>
<tr>
<td>Jan 22</td>
<td>2</td>
<td>Talk to 3 Mentors&lt;br&gt;Decide on research project &lt;br&gt;<strong>Due: Signature page</strong></td>
<td>Familiarize with mentor research program&lt;br&gt;Write project summary</td>
</tr>
<tr>
<td><em>Jan 26</em></td>
<td></td>
<td><strong>Optional safety training:</strong> M 2:15-5:15pm in REIC 245</td>
<td></td>
</tr>
<tr>
<td>Jan 29</td>
<td>3</td>
<td>Pick up lab note book &lt;br&gt;<strong>Due: Safety training with E. Reiter</strong></td>
<td>Learn techniques&lt;br&gt;Read background information pertinent to your project</td>
</tr>
<tr>
<td>Feb 5</td>
<td>4</td>
<td>Gather references database&lt;br&gt;Write summary of papers for intro</td>
<td>Experimentation</td>
</tr>
<tr>
<td>Feb 12</td>
<td>5</td>
<td>Gather references database&lt;br&gt;Write summary of papers for intro</td>
<td>Experimentation</td>
</tr>
<tr>
<td>Feb 19</td>
<td>6</td>
<td>Write Introduction and Method section</td>
<td>Experimentation</td>
</tr>
<tr>
<td>Feb 26</td>
<td>7</td>
<td>Write Introduction and Method section</td>
<td>Experimentation/Analysis</td>
</tr>
<tr>
<td>Mar 5</td>
<td>8</td>
<td>Draft Figures, Tables etc&lt;br&gt;Write Result section</td>
<td>Experimentation/Analysis</td>
</tr>
<tr>
<td>Mar 12</td>
<td>9</td>
<td>Draft Figures, Tables etc&lt;br&gt;Write Result section</td>
<td>Experimentation/Analysis</td>
</tr>
<tr>
<td>Mar 16-20</td>
<td></td>
<td><strong>Spring Break</strong></td>
<td></td>
</tr>
<tr>
<td>Mar 26</td>
<td>10</td>
<td>Draft Figures, Tables etc&lt;br&gt;Write Result section</td>
<td>Experimentation/Analysis</td>
</tr>
<tr>
<td>Apr 2</td>
<td>11</td>
<td>Draft Figures, Tables etc&lt;br&gt;Write Result section&lt;br&gt;Write Discussion &lt;br&gt;<strong>Due: Journal style guide for report</strong></td>
<td>Experimentation/Analysis</td>
</tr>
<tr>
<td>Apr 9</td>
<td>12</td>
<td>Write discussion&lt;br&gt;Write abstract &lt;br&gt;<strong>Due: Annotated Figures and Tables</strong></td>
<td>Analysis</td>
</tr>
<tr>
<td>Apr 16</td>
<td>13</td>
<td>Format reference list and citations &lt;br&gt;<strong>Due: Draft of poster</strong></td>
<td>Analysis</td>
</tr>
<tr>
<td>Apr 23</td>
<td>14</td>
<td><strong>Due: Report, Lab notebook&lt;br&gt;Due: Final draft of poster</strong></td>
<td>Dissemination</td>
</tr>
<tr>
<td>Apr 30</td>
<td>15</td>
<td><strong>In class: Peer review</strong></td>
<td>Dissemination</td>
</tr>
<tr>
<td><em>Apr 30</em></td>
<td></td>
<td>4-5pm Departmental poster session and potluck</td>
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<tr>
<td><em>May 4</em></td>
<td></td>
<td><strong>Due 5pm: Final Report to Instructor and Mentor</strong></td>
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</tbody>
</table>
Student Name________________________________________
UAF email address__________________________@alaska.edu

Return this page with three or more signatures to Simpson’s mailbox in Reichardt 194 no later than the 3rd Friday of the semester. Include a half-page description of the proposed research project.

Cathy Cahill ..........._______________________________Date:__________
Kelly Drew ..........._______________________________Date:__________
Lawrence Duffy .. _________________________________Date:__________
Kriya Dunlap ...... _________________________________Date:__________
Brian Edmonds .. _________________________________Date:__________
Thomas Green .... _________________________________Date:__________
Sarah Hayes .......... ________________________________Date:__________
Jennifer Guerard._______________________________Date:__________
William Howard._______________________________Date:__________
Chris Iceman....... _________________________________Date:__________
Thomas Kuhn .... _________________________________Date:__________
Brian Rasley ...... _________________________________Date:__________
William Simpson _________________________________Date:__________
Thomas Trainor . _________________________________Date:__________

I have agreed to serve as research mentor for the above student. A brief description of the proposed research, along with a statement of possible laboratory hazards associated with the project, is attached.

_____________________________Date:________________________
Mentor Signature

_____________________________Number of Credit hours_____
Mentor Print name

The above student has completed his or her safety training and is approved for working on this project

_____________________________Date________________________
Emily Reiter
Write neatly on this, or type up your own.

Name_______________________________  Semester_______________________
Mentor____________________________

Description of proposed research (300 words):

Lead-in literature reference:

Overview of planned laboratory procedures and materials, including descriptions of potentially hazardous procedures or materials.
488 LABORATORY CHECK-OUT LIST

Name ________________________
Advisor ____________________________                     Lab Space(s) Used _________________

Check out performed by ________________________________ on__/___/_____
Approved by PI? ________________________________ on__/___/_____

<table>
<thead>
<tr>
<th>Description</th>
<th>Checked</th>
</tr>
</thead>
<tbody>
<tr>
<td>Desk/office area cleared: books, files, personal materials</td>
<td></td>
</tr>
<tr>
<td>Comments:</td>
<td></td>
</tr>
<tr>
<td>Turned in your lab notebook/copies of data/data files</td>
<td></td>
</tr>
<tr>
<td>Benchtop/work area cleared</td>
<td></td>
</tr>
<tr>
<td>Comments:</td>
<td></td>
</tr>
<tr>
<td>Chemicals or solutions remaining—clearly labeled</td>
<td></td>
</tr>
<tr>
<td>Comments:</td>
<td></td>
</tr>
<tr>
<td>Samples or items in refrigerator or freezer in lab and/or in department</td>
<td></td>
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<tr>
<td>Comments:</td>
<td></td>
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<tr>
<td>Waste bottles remaining</td>
<td></td>
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<tr>
<td>Comments:</td>
<td></td>
</tr>
<tr>
<td>Dishes cleaned and returned</td>
<td></td>
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<tr>
<td>Comments:</td>
<td></td>
</tr>
<tr>
<td>Fume hoods empty and clean</td>
<td></td>
</tr>
<tr>
<td>Comments:</td>
<td></td>
</tr>
<tr>
<td>Equipment borrowed from stockroom or other labs? Returned?</td>
<td></td>
</tr>
<tr>
<td>Comments:</td>
<td></td>
</tr>
<tr>
<td>Chemicals borrowed or used up from stockroom or other labs?</td>
<td></td>
</tr>
<tr>
<td>Comments:</td>
<td></td>
</tr>
<tr>
<td>Gas cylinders returned stockroom?</td>
<td></td>
</tr>
<tr>
<td>Comments:</td>
<td></td>
</tr>
<tr>
<td>Instruments cleaned and in good working order, no samples or waste remaining.</td>
<td></td>
</tr>
<tr>
<td>Comments:</td>
<td></td>
</tr>
<tr>
<td>Notice any damaged/defective/non-working equipment? List below.</td>
<td></td>
</tr>
<tr>
<td>Notice any potential problems? Do you have comments or concerns? List below.</td>
<td></td>
</tr>
</tbody>
</table>
Poster Preparation Guidelines
(adapted from the Division of Chemical Education*)

These remarks are intended to supplement the guidelines for preparation posters found on standard ACS Abstract Forms. Please consider them as thoughtful suggestions designed to enhance your presentation and the enjoyment and understanding of your audience.

Poster size should be 36”x 36”. After approval of your poster either by your mentor and by the instructor, get a “ticket” from Lori (CHEM 194) to print out the poster. You need to also give a PDF version and a reduced-size (8.5”x11”) version of the poster to Lori for archival.

• Consider the visual impact your presentation has to achieve. You need to attract the reader(s). Everything should be legible from three feet. Use colored mounting paper behind panels to increase to increase contrast and impact, but avoid fluorescent papers which will make things hard to read when someone gets closer.
• Divide your presentation is clear sections (2-3 columns, or 2-3 rows, quadrants etc)
• Choose a simple font such as Times, Helvetica or Prestige Elite and stick with it. Avoid overuse of outlining and shadowing, it can be distracting. To make something stand out, use a larger font size, bold or underline instead.
• The title should be in very large type, 84 pt or larger. Your name and school should also be noted in large type, consider 72 pt. Headings and sub-headings should be at least 36 pt. You need not use all capitals for titles and headings, it can sometimes make them harder to read.
• Text on panels should be between 18 and 24 pt to be legible. Use double or 1.5 spacing between lines of text. Keep each panel relatively short and to the point. More than 25 lines won’t get read, but 15 to 18 usually will. Framing the text by putting a box around it will also help readers to focus.
• Whenever possible, use graphs, charts, tables, figures, pictures or lists instead of text to get your points across.
• Make sure your presentation flows in a logical sequence. It should have an introduction, body and conclusion, just like any other presentation. Arrange it ahead of time to make sure it fits the space provided. It will take longer than you think to put things together.

*http://www.acscinf.org/content/guidelines-acs-speakers-and-poster-presenters

CHEM 488 Poster Rubric

___ /5 Motivation and Introduction- Clear, interesting motivation for work, overarching and specific aims listed
___ /5 Materials and Methods- Methods and procedures listed, instruments and structures given as needed
___ /5 Results and Observations- publication quality figures and tables, observations and interpretations clearly follow data presented
___ /5 Professional Layout- appearance supports science presented, not distracting
___/10 pts Concise, logical, interesting presentation
___/30 pts total
Research Report Guidelines

Your research report has to adhere to the specific format provided in the guidelines outlines below or to a standard journal format within your field. If you never had a writing intensive course in the field of chemistry/biochemistry, please contact the instructor (Hayes) and your mentor for additional supporting material/instructions.

For an efficient managing of your references and all the literature related to your research, EndNote is an excellent tool freely available to you.

**General Formatting Guidelines:** Your research report should include the text, references, figure legends, tables, and figures in this particular order. The text (Microsoft Word format) consists of Title Page, Abstract, Introduction, Materials and Methods, Results, and Discussion (in this order).

It is your responsibility to print two copies (PDF format) and hand one in to your mentor and the other to the instructor. This final printed version is a significant component of your grade in the course. In addition, you must provide a PDF file of the report to the course instructor. All electronic files and notebook(s) should be archived as described in the syllabus.

All text should be types 12-point Times New Roman, double-spaced with one-inch margins, and all pages should be numbered consecutively.

**Title Page:** The title page should provide the following information:
- An appropriate title not to exceed two lines
- Full name of author (student)
- Full name of mentor
- Complete institutional affiliation
- Number of credits (total), semester, and date of submission
- Journal format being used (e.g., Formatted for submission to Environmental Science and Technology)
- Up to six key words
- Word counts: abstract, intro, main text (methods and materials, results, discussion, legends)
- Number of Tables and Figures

**Abstract:** Provide a single paragraph with no more than 250 words summarizing the rationale, hypothesis tested, experimental design, major findings, and conclusions. Do not cite references and avoid abbreviations.

**Main Text Body:** This section consists of Introduction, Materials and Methods, Results, Discussion, and Conclusions.
- Abbreviations are often necessary and should be introduced clearly when used the first time.
- Element names (Iron) are spelled out only if they are the first word in a sentence and when they are part of a name (iron oxides). Otherwise, the symbol is used (Fe).
- Succinct description and clear reference in text to all figures and tables in the text.
- Do not duplicate data between the text and figures or tables.
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- Use SI units or the standard units in the field for all laboratory data. Appropriate formatting is used to indicate units. For example, mg kg\(^{-1}\) is correct, while mg/kg or ppm is not. Pay attention to these details in the literature you are reviewing.
- Use bold font to indicate references to figures, tables, and equations in the text. This helps during the proofreading process. Reference to Figure 1 in the middle of a sentence and at the end of the sentence (Fig. 1). The word is always spelled out in entirety (Table 1).
- All figures and tables must have a descriptive caption clearly explaining the figure. Explain all abbreviations and symbols used in the figure and provide sufficient experimental and statistical detail.
- Provide sufficient experimental detail to allow reproducibility by a person with a similar skill level as yourself.
- Provide details on the origin of chemicals you use. Example: sodium chloride (JT Baker, lot 324)
- If instrumentation is used, report the make and model number of the instruments and location of manufacture. Example: 7500 series High Performance Liquid Chromatography (Agilent; Ames, IA)
- If non-standard software is used, report the version of the software and reference the developer. Example: Sixpack (version 1.57; Webb, 2006).
- Pay attention to significant figures. All measurements should have an uncertainty associated with them. Error only has one significant figure, and this often limits the number of significant figures in a measurement. Example: 3.45 \(\pm\) 0.3 should be reported as 3.4\(\pm\)0.3. If you have questions about this, see your instructor.
- Pay attention to consistent formatting for both in-text citations and in the reference list. Be sure to manually double check that the reference list and text (including figure and tables) have the exact same references.

Acknowledgments: Although the report is single-authored, we do realize (and strongly encourage) the collaborative nature of research. Any person that significantly contributed to your work should be mentioned (mentor, other undergraduate and/or graduate students, postdocs, technicians etc) and her/his type of contribution.

References: Please use the following guidelines or other appropriate format for your references.

Journal Articles

Chapter/article in edited book

Books

Figures and Tables: Figures are attached at the end of the complete text with each table and figure on a separate page with a brief figure or table caption. Do not forget to number these pages too.
All figures should be of journal quality, i.e. not default excel plots. Export excel files into photoshop or powerpoint and make sure your resolution is sufficient for all details. Make sure each axis is clearly labeled including units. Clearly labeled peaks, bars etc and ensure sufficient size of symbols. For line art TIFF format is commonly used for simple black and white illustrations (photoshop). Power point files are also acceptable. Ensure a resolution of at least 600 dpi. For grayscale illustrations use TIFF or JPEG format (photoshop, power point) and at least 300 dpi resolution.

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CHEM 488 Report Rubric

___/20 pts Annotated figures
Appropriate, complete, publication quality figures and tables. Pertinent observations and interpretations that logically follow from the data presented.

___/10 pts Lab notebook and digital archive
Neat, careful record of experiments performed. Digital files referenced in lab notebook. Digital copy of data provided in reasonable form to mentor.

___/50 pts Report
___ /2 Title page- complete and appropriate
___ /5 Abstract- summarize all major points lab writeup in ~250 words
Concise summary of experiment, results, and conclusions
___ /5 Introduction- Importance explained to a broad audience. Sufficient yet targeted background, defining concepts / terms used later.
___ /5 Materials and Methods- Experiments reproducible from text. Instrument parameters, statistical analysis, etc clearly explained.
___ /10 Results- Showcase your processed data- describe what you found
No raw data.
___ /10 Discussion- What do your results mean? Organization, clarity, figures referenced properly. Good explanation of all figures and tables or data, clear summary of key finding.
___ /5 Conclusions- Sum it up. Clearly enumerated and logical conclusions follow from discussion.
Reasonable future directions mentioned, as needed.
___ /2 Acknowledgements
___ /2 References- proper formatting
___ /4 Figures and Tables- referenced in text, appropriate presentation and captions

___/10 pts Revisions- suggestions incorporated

___/100 pts total