Objective

Be familiar while reporting experimental data in a formal laboratory report and formal presentation.

General comments:

- **Be concise.** In scientific writing, it is very important to say as much as is needed while using as few words as possible. Lab reports should be thorough, but repetition should be avoided. The entire report should be clear and straightforward.
- Write in the third person. Avoid using the words "I" or "we" when referring to the experimental procedure. For example, instead of "I boiled 50 mL of water for 10 minutes," the report should read, "50 mL of water was boiled for 10 minutes." This can be a bit difficult to get used to, so it is important to pay close attention to the wording in the report.
- Use correct verb tenses. Many students become confused when trying to decide whether to use past or present tense in their reports. The general rules for verb tenses are as follows:
- The experimental procedure has already been conducted, so use the past tense of the verb when referring to it:
 - <u>Ex</u>: The purpose of the experiment was...
 - The compound was weighed to 5 g...
- The report, equipment, and theory still exist, so use the present tense of the verb for them:
 - <u>Ex</u>: The purpose of this report is... Bunsen burners are used...

This is a group project; ALL TEAM MEMBERS SHOULD PARTICIPATE IN EVERY STEP OF THE PROCESS.

Remember

- Spell check

- Proofread your work; have a friend read it-spell check!
- Do NOT paste your structures or mechanisms from any website
- Avoid chit-chat
- This is a group project.
- Make sure to review your lab and to reference properly!

- *References should be included in the document (internal) and at the end in a "References" section.*

- Do not use Wikipedia!
- Make sure each figure or mechanism has a caption.

Format

1. Cover page team data

- Title of the experiment. Please use a title that give the main idea of your experiment • <u>Ex</u>: Determination of unknown ions by flame test and precipitation reactions.
- Name of each one of the member
- Course Number-Section number
- Due date
- All information should be centered

2. Abstract

- The report abstract is a short summary of the report. It should be no more than one paragraph (100-200 words) and should include about one or two sentences on each of the following main points:
 - Purpose of the experiment
 - Key results
 - Major points of discussion
 - o Main conclusions
- It may help to complete the other sections of the report before writing the abstract, as these four main points can be drawn from them.

3. Introduction

- This introduction is also often referred to as the 'purpose' or 'plan' section. It should include two main categories:
 - **Purpose or objective** of the experiment expressed clearly in only one or two sentences, including the main method used to accomplish the purpose.
 - **Ex**: The purpose of the experiment was to determine the unknown ions presented in an unknown solution by using precipitation reactions and the method of flame test.

The purpose is also sometimes written as a separate section from the introduction.

Background and theory pertaining to the experiment. This can include information from previous research, explanations of theories, methods or equations used, etc.; for the example above, you might want to explain the theory behind acid/base titration and a brief description of the setup and process you will use in the experiment. If research is done for this section, be sure to cite any sources used according to the reference section. Be careful to include only the information that a reader would need to know in order to understand the purpose and methods; the report should still be as straightforward as possible. Regardless of the specific information required from the instructor, the main focus of the introduction should be on helping the reader to understand the purpose, methods, and reasons these particular methods are being used.

4. Materials and Methods

• This is usually a simple listing of the equipment used in the form of a bulleted list, but it should be complete and accurate. Graphics of more complex setups may also be included if they would be helpful. Take as an example your lab manual.

5. Experimental procedure

• This section includes the process of the experiment exactly as it was done in the laboratory. Usually the procedure is written out in paragraph form, but it may also be written out step by-step in the form of a numbered list.

- There should **not be any results** (things that happened when the procedure was being carried out) included in this section; only include the procedures carried out. A good rule of thumb for writing complete but concise experimental procedures is to include enough information so that others who read the report would be able to duplicate the experiment at a later date.
- Read the lab manual to provide you an idea of how a **procedure** is made.

6. Results

- This section contains all the results of the experiment, including:
 - **Raw data** (weights, temperatures, etc.) organized into graphs or tables. Each graph, table, or figure should be labeled and titled properly. The key to making tables and figures effective is to refer to and explain each one in the body of the paper. (COMBINE ALL YOUR DATA. Ex. 1 graph, 1 table, etc.)
 - **Important results** in verbal form. For the main results that will be expanded upon in the discussion section, use complete sentences (i.e. "The ions present in the unknown solution where Na⁺, K⁺ and SO₄²⁻"). This will help the key results to stand out from all the calculations, tables, and figures that normally dominate the results section.
 - **Calculations.** Usually, only a sample of each calculation is needed. For example, if the percentage of acetic acid in 10 samples of vinegar has to be calculated and then averaged, write out the calculation for only one of them, then mention that the calculation was repeated for 10 samples and give the average of all 10. Correct significant figures should be used in all calculations (see our "Significant Figure Rules" handout for help with significant figures). Make sure units (cm, mL, etc.) are included in all calculations, and that major results of each calculation stand out from the rest of the numbers. This can be accomplished by typing the key numbers in boldface and by including them in a complete sentence as shown above.

7. Discussion

- The discussion section is the most important part of the report. This is the section where the results are explained, and a student can show the instructor that he or she has a thorough understanding of the concept of the experiment and the results obtained. The main question to be addressed in this section is "What is the significance of the results?"
- Here are some strategies to help focus your discussion:
 - **Compare expected results with actual results.** If the experiment did not turn out exactly as expected, think about why the results might have been different and try to explain why you got the results you did.
 - **Analyze experimental error.** There is a degree of error in every experiment, so every lab report should mention potential causes of error. Be specific about what caused the error. Was it due to the equipment? Impurity of the sample? Errors in calculations?
 - **Explain how the methods could be improved.** Once you have decided what might have caused error, you should explain how the error might have been avoided. How could the setup be made more effective? Should you have been more careful with measurements? How could contamination have been prevented more effectively? Should more precise equipment be used?
 - **Explain the results in terms of the purpose.** If the original purpose of the experiment was achieved, explain how the results show that the purpose was accomplished. For example, if the purpose was to determine the percentage of acetic acid in vinegar, you could research the real percentage of acetic acid in most commercial vinegars and compare that to the calculated result from the experiment. A small difference would indicate that the percentage calculated was very close to

the actual percentage and the purpose was accomplished. If the purpose was not achieved, prove this by the results in a similar fashion.

• **Relate the results to those of other, similar experiments.** Depending on the nature of the experiment and the instructor's preferences, you may want to compare your results to those of the rest of the class. If your results were similar to the others', this can be an indication that they were reasonably accurate. If they were very different, explain why they may have been different.

8. Conclusion

• This section includes only one or two sentences that summarize definitive conclusions from the results. Here is an example of a conclusion for the unknown ions in an unknown solution experiment used in earlier examples:

From a comparison of the results obtained experimentally by performing a flame test and precipitation test with the unknown solution and the reference solutions, it can be concluded that the ions present in the unknown solution used in this experiment were Na+, yellow flame color, K+, violet/purple flame color, and, SO_4^{2-} by a precipitation reaction.

Notice how the conclusion relates directly to the main objective of finding the ions in a given unknown solution. The conclusion also justifies itself based on the results; the actual results were comparable to the expected results. The degree of confidence the writer has in the conclusion is also shown; the ions were determined by flame test and precipitation reaction.

9. References

• (See below).

Remember there is only one report per team The minimum pages per report is 10 and max 15 Manuscript format: 12-point Times New Roman font. Margins are 1" all around. Text is 1.5 spaced.

References

ACS (American Chemical Society) Style Guidelines Quick Guide

This guide is based on the second edition of *The ACS Style Guide: A Manual for Authors and Editors* (1997).

Citing References in the Body of a Paper

References in the body of a paper can be cited:

- By superscript
 - \circ <u>Ex</u>: The synthesis of the compound has been described previously.¹

With numerical citations, references should be numbered sequentially. If a reference is repeated, do not give it another number; rather, use the original reference number.

Creating a Bibliography

• Arrange the references in your bibliography based on the method used for in-text citations. If numerical citations were used, then arrange references at the end of the paper numerically. If author names were used, arrange alphabetically.

- All references end with a period.
- Do not leave blank lines between references.
- Journal article titles and book chapter titles are not essential, but they are considered desirable.
- If a book as a whole is used, pagination is not necessary.

Book with Author(s)

Basic Format:

Author, A. A.; Author, B. B. *Book Title (italics)*, Edition (if any); Publisher: Place of Publication, Year; Pagination.

Dill, K. A.; Bromberg, S. *Molecular Driving Forces: Statistical Thermodynamics in Chemistry and Biology*; Garland Science: New York, 2003.

Book with Editor(s), and Entire Book is Referenced

Basic Format:

Editor, A. A., Editor, B. B., Editor, C. C., Eds. *Book Title (italics)*; Series Information (if any, including series number); Publisher: Place of Publication, Year.

Lin, Q., Pearson, R. A., Hedrick, J. C., Eds. *Polymers for Microelectronics and Nanoelectronics*; ACS Symposium Series 874; American Chemical Society: Washington, DC, 2004.

Authored Chapters in a Book with Editor(s)

Basic Format:

Author, A. A.; Author, B. B. Chapter Title. In *Book Title (italics)*; Editor, A. A., Editor, B. B., Eds.; Series Information (if any, including series number); Publisher: Place of Publication, Year; Volume number (if any), Pagination.

Downs, G. M.; Barnard, J. M. Clustering Methods and Their Uses in Computational Chemistry. In *Reviews in Computational Chemistry*; Wiley: Hoboken, NJ, 2002; Vol. 18, p 11.

Encyclopedia Article

Basic Format:

Article Title. *Encyclopedia Name (italics)*, Edition number; Publisher: Place of Publication, Year; Volume Number, Pagination.

Psychopharmacological Agents. *Kirk-Othmer Encyclopedia of Chemical Technology*, 4th ed.; Wiley: New York, 1996; Vol. 20, pp 455-457.

Journal Articles

Basic Format:

Author, A. A; Author, B. B; Author, C. C. Title of Article. *Journal Abbreviation (italics)* [Online if online] **Year (boldface)**, *Volume (italics)*, Pagination.

Borman, S. Protein Sequencing for the Masses. Chem. Eng. News [Online] 2004, 82, pp 22-23.

Slunt, K. M.; Giancarlo, L. C. Student-Centered Learning: A Comparison of Two Different Methods of Instruction. *J. Chem. Educ.* **2004**, *81*, pp 985-988.

Takahaski, T. The Fate of Industrial Carbon Dioxide. Science [Online] 2004, 305, 352-353.

The standard list of journal abbreviations is published in *CASSI*, the *Chemical Abstracts Service Source Index*. A copy is kept at the Chemistry Library circulation/reference desk.

Web site

Basic Format:

National Institute for Occupational Safety and Health, International Chemical Safety Cards (ICSCs) Database (U.S. National Version). http://www.cdc.gov/niosh/ipcs/nicstart.html (accessed January 2014).

Date	 	
Section	 	
Topic		

CHEM 1412 Lab Reports will be scored based upon the following system.

Component / %	Basis of Evaluation	
Organization / 10%	The report should be in the standard format of Cover Sheet, Abstract, Introduction, Materials and Methods,	
	Experimental, Results, Discussion, Conclusion, and References	
Style / 10%	The report should be written using correct sentence structure and free of errors in grammar, spelling, and	
	The report must clearly describe the theory of the	
Content / 40%	determination, including all relevant chemical reactions,	
	equations, and any other major factors which would affect	
	the analysis.	
Line of Data / 200/	I ne report must include a conclusion based upon a	
Use of Data / 20%	nust be shown and observations and deductions must be	
	clearly explained.	
	All sections of the report should coordinate in such a	
Cohesion / 20%	manner that the overall report demonstrates efficient	
	teamwork.	
	Each student will submit a confidential evaluation of the	
Teamwork / 20%	contribution of each team member (including his/herself)	
	to the project based upon a scoring rubric. This peer	
	evaluation will include contributions to both the data	
	collection portion and report preparation portion of the	
	project.	
Other feature	Points will be deducted for lateness at a rate of 10	
Other factors	Plagioriam will reput in a grade of 0 on the report and	
	may result in other senctions enpropriate to the soverity	
	of the offence.	

Scoring System for CHEM 1412 Lab Reports

CHEM 1412 Lab Report Team Assignments and Contact information

Section:	Experiment:			
Team Members	:			
<u>Name</u>		Phone	<u>Email</u>	

Date	 	
Section_	 	
Topic		

	Level of Achievement			Total
	1 Below expectations	2 Meets expectations	3 Exceeds expectations	
Organization	Material not well organized with paragraphs combining multiple thoughts or section / subsections are not identified clearly; prescribed format is not followed.	Organizes material in a logical sequence to enhance reader's comprehension (paragraph structure, subheadings, etc.) with minor errors; prescribed format is followed.	Organizes material in a logical sequence to enhance reader's comprehension (paragraph structure, subheadings, etc.) and conforms to prescribed format.	
Style	Text rambles, key points are not organized; spelling or grammar errors present throughout more than 1/3 of paper; style is inappropriate for audience	Articulates ideas; one or two grammar or spelling errors per page.	Articulates ideas clearly and concisely; presented neatly and professionally; grammar and spelling are correct; uses good professional style;.	
Use of data	Fails to use graphs, tables, diagrams to support, explain, or interpret information; figures presented are flawed: axes mislabeled, no data points, etc.	Uses graphs, tables, diagrams used to support, explain, or interpret information with minor errors.	Uses graphs, tables, diagrams to support points; to explain, interpret, and assess information; figures are all in proper format.	

Rubric to Assess Written Communication

Overall Points:

Overall %: _____

	I	Level of Achievement	Total	
	1 Below expectations	2 Meets expectations	3 Exceeds expectations	
Contributions & Problem- solving	Rarely provides useful ideas when participating in the group and in classroom discussion. May refuse to participate. Does not try to solve problems or help others solve problems. Lets others do the work.	Sometimes provides useful ideas when participating in the group and in classroom discussion. A satisfactory group member who does what is required. Refines solutions suggested by others.	Routinely provides useful ideas when participating in the group and in classroom discussion. Actively looks for and suggests solutions to problems.	
Attitude & focus	Is often publicly critical of the project or the work of other members of the group. Is often negative about the task(s). Rarely focuses on the task and what needs to be done. Lets others do the work.	Is rarely publicly critical of the project or the work of others. Often has a positive attitude about the task(s). Focuses on the task and what needs to be done most of the time. Other group members can count on this person.	Is never publicly critical of the project or the work of others. Always has a positive attitude about the task(s). Consistently stays focused on the task and what needs to be done. Very self- directed	
Working with Others	Rarely listens to, shares with, and supports the efforts of others. Often is not a good team player.	Usually listens to, shares, with, and supports the efforts of others.	Almost always listens to, shares with, and supports the efforts of others. Tries to keep people working well together.	

Rubric to Assess Teamwork

Overall Points:_____

Overall %: _____