I. Resources and Style - Scientific writing is not limited to scientific journal articles. Scientists on every level are more likely to achieve success if they are able to describe their work and explain its significance to others. Technical writing can vary from a brief explanation of how to use a piece of equipment to a lengthy report on the activities in the laboratory. Technical writers produce articles written for the layman explaining technical subjects in understandable terms. Effective technical writing is a job skill that is very much in demand. College-level assignments that involve report writing on technical subjects require the same considerations as professional writing.

First, consider the audience. Will a skilled professional or a layman read the material? In this case it will be your instructor, (consider him/her a skilled professional) but never assume however that your instructor is familiar with the basic principles of the field being covered; you must include some basic background information, with special attention given to explaining technical vocabulary that is specific for the topic being discussed.

Most writing projects begin with a visit to the library or the internet to find appropriate background materials. Again, the level of the project will determine how the information search is conducted. Other information contained in scientific journals can be found through indexes such as those provided in Chemical Abstracts; using the abstract indexes is a skill that must be developed through practice. Many science reports, however, require only limited keyword search using Google Scholar. Some useful links as sources of background information include:

General Chemistry Resources
http://www.chem1.com/acad/webtext/virtualtextbook.html
http://en.wikibooks.org/wiki/General_Chemistry
http://en.wikipedia.org/wiki/Chemical_Science_%28journal%29
http://pubs.acs.org/journal/jceda8

Links for scientific writing:
http://www.lib.berkeley.edu/CHEM/acssstyle.html
http://www.monroec.edu/depts/library/acsc.htm

Dictionaries can be useful in defining technical terms or concepts. Those useful in chemistry include:

Chamber’s Dictionary of Science and Technology (McGraw-Hill)
Chemist’s Dictionary (Van Nostrand)
Hanck’s Chemical Dictionary (McGraw-Hill)
McGraw-Hill Dictionary of Scientific and Technical Terms

Facts and data are found through many scientific handbooks. Some used in chemistry papers include:

CRC Handbook of Chemistry and Physics
CRC Handbook of Environmental Control
Merck index

Review articles in periodicals like Scientific American, Science, and Nature give useful information on a variety of scientific topics. They can be conveniently found through the General Science Index, which provides a comprehensive subject index to English language periodical literature in the sciences. A major resource of the library not to be neglected is the expertise of a good science librarian.

Technical writing depends no less than any other form of writing on the basic language skills of the writer. Incorrect spelling and grammar can mar the effect of the most interesting and original narrative. A good guide to English usage belongs next to a dictionary on the writer’s desk. Good writing style is developed through practice in writing and rewriting. A clear, direct style contains no unnecessary words. For example, consider the following example:

At this point in the experiment the mixture was heated up through the use of a hot plate.

An improved version is:

The mixture was heated with a hot plate.

Some science publications prefer the use of the first person (“I heated the mixture”) be avoided. Use of the passive voice “the mixture was heated” is then indicated. In other uses the more direct form of the active voice may be preferred, as in, ”We decided to heat the mixture” rather than, “It was decided that the mixture should be heated.” When writing instructions the imperative is often a good choice: “Heat the mixture on a hot plate” is more direct than “The mixture should be heated on a hot plate.”

There are many references available to help you develop the valuable skill of communicating information.

General references include:


References pertaining to technical information are:

II. Keeping up with the Laboratory Notebook:

"A laboratory notebook is one of a scientist's most valuable tools. It contains the permanent written record of the researcher's mental and physical activities for experiment and observation, to the ultimate understanding of physical phenomena. The act of writing in the notebook causes the scientist to stop and think about what is being done in the laboratory. It is in this way an essential part of doing good science." "The foremost reason for using a bound notebook rather than a loose-leaf binder or spiral notebook is that the pages are permanently and strongly attached together. The date of a particular entry is less subject to question if notes are recorded in a chronological order with no blank or missing parts. The industrial researcher, whose work may lead to patents, has no choice except to use a bound notebook for all laboratory note taking."

From Writing the Laboratory Notebook by Howard M. Kanare: American Chemical Society 1985

The scientific notebook is the scientist's own record of experiments performed and phenomena observed. Beginning with the first student laboratory report there are special requirements for recording experimental results. The requirements may seem rigid at first, but they are very understandable in light of the purposes of the notebook.

For the professional scientist the claim to original work is found in the scientific notebook. Millions of dollars in patent rights may depend on the existence of a properly dated and authenticated scientific notebook. Many of the rules that are followed in recording data follow from this important function of the notebook. Nothing is ever erased; and incorrect reading is crossed out and the correct one written beside it. Work is recorded in a bound notebook with pages that cannot be removed or added. Every entry is dated, signed, and countersigned by the scientist in charge of the laboratory. All these rules are designed to produce a record that will constitute proof not only of what experiments were performed, but of the exact date. This is important, because if two scientists make the same discovery, the first one to do so will gain all the legal rights and most of the credit for the work. Obviously, it is more important to have a complete and original record than a perfectly neat one. A few crossed-out readings are not uncommon, and a few blots from spilled chemicals are not unheard of either. These are preferable in the laboratory notebook to a perfect page that has been copied over at a later date and no longer constitutes an authentic original record. Under no circumstances is data to be recorded on loose paper rather than directly into the notebook! If you write your data or observations on loose pieces of paper, you automatically will receive zero for that day's lab technique.

Another important function of the notebook is to record the procedure and observations so clearly and completely that the experiment can easily be repeated at a later date. Experiments that cannot be repeated by the same researcher or by other laboratories are soon discredited. For the student in the laboratory, complete notes are important as well. If something goes wrong, it should be possible to find the error in procedure from the lab notebook. At times, the numbers in the crossed-out data entries tell an interesting story. Occasionally an interesting and unexpected phenomenon will be observed that merits further study. Keeping a complete clear record of what has happened in the laboratory is essential.

In order to keep a complete record, each experiment entered into the notebook should include certain features. On each page entry, the scientist's name and the date should be entered. The title of the experiment being performed is an important element that is often neglected. "Chemistry Lab" is an inadequate substitute for the experiment title, which is usually readily available. Often it is useful to begin by writing the objective, or the purpose, of the experiment. Stating the objective clearly helps both the experimenter and the reader of the notebook to understand the experiment. A complete record of experimental procedure is essential, either as a step-by-step description or a pictorial flowchart followed by a complete reference to a standard experimental procedure. If a standard procedure is given, great care must be made to note any deviations from that procedure. A list of materials and equipment used can be a great help in organization if it is included as a part of the experimental procedure. Finally a description of any safety or hazardous guidelines should be included.

Though the laboratory notebook does not have to be perfectly pristine, it is certainly desirable that it should be as organized as possible. Some time and thought spent in planning before the laboratory period begins will result in a better notebook and a more successful experiment. As mentioned above, the date, title, experimenter's name and objective of the experiment should be entered before the experiment begins. If the experimental procedure that has been provided does not already give labeled data tables for an experiment, it is worth some time and thought to set up such tables before entering the laboratory, rather than waste time during the experiment deciding how to do so. Ample space should be provided not only for the expected data, but also for corrections and notes. Unused space can be crossed out later as necessary, though extra pages are never torn out. Sometimes only the right-hand pages of the notebook are used, leaving the other pages free for later notes or calculations. Individual research laboratories or student laboratories may have standard notebooks or forms in which to write laboratory results. All of them share the basic objective of recording in a useful way the scientist's actions, observations, and thoughts while in the laboratory.
Notebook Pages Examples

The following illustrate the proper manner in which a laboratory notebook should be kept. These pages are reproductions of a student’s general laboratory notebook. The style of this notebook conforms to the guidelines presented in the next section of this manual.

Before entering the laboratory, the student had written the complete heading on each page and the objective of the experiment. This is followed by some background information and a pictorial flowchart. A sample data table was sketched and the safety precautions were written.

In another experiment, a student writes up the section of data/results with detailed observations of what happened during the experiment. The second example below shows a student performing several calculations based on the data collected with the step by step calculations.
III. The Chemistry Report (Formal)

When the scientist prepares a formal written report of experiments performed in the laboratory, the report follows a generally accepted outline. Introduction, results and discussion/conclusions follow in order as separate sections and these are clearly labeled. Lists of references and even the title are treated in standard ways. All this is typed in a journal type format.

The Title of a scientific paper is seldom an occasion for creativity. Titles for articles in scientific journals are carefully constructed from words that will be useful key words for information searches by computer. Titles for student laboratory reports are usually indicated in the assignment. As with the laboratory notebook, "Chemistry Laboratory" is unacceptably vague as a laboratory report title. Abbreviations as part of a title should be avoided.

The Introduction section should make clear to the reader the purpose and the background of the experiment. The objective of the work that is being discussed should always be clearly stated. It may be appropriate to discuss the basis of the experimental methods that were used as well as the scientific theory on which the work is based. Usually a well-written introduction makes use of written resources in the form of scientific books and papers, which must be listed in the references cited and footnoted with the appropriate reference.

The Experimental Procedure section explains in detail exactly how the experiment was conducted. It should be possible to reproduce the experiment using the information found in this section. If standard procedures are used and not explained in detail, a reference should be given. A list of materials and equipment is often a useful component in this section. It includes all chemicals used, including the concentrations of solutions and all special equipment.

The Results section includes the data that were obtained in the experiment together with an explanation of the data. Often it is useful to organize the results of the experiment in tables, and sometimes graphs are required as well. All tables and figures should be titled and numbered. All columns in tables and axes of graphs, should be carefully labeled, not omitting units. If calculations have been performed, the equations used should be clearly indicated and enough information about the calculations should be included so that they can be clearly followed. The precision and accuracy of the results should be calculated by standard statistical methods if appropriate to the experiment.

The Discussion / Conclusions section contains the thoughts of the experimenter about the significance of the work performed. Each part of the experiment should be discussed. Numerical results should be evaluated, and the meaning of any statistical calculations explained. The success of the experiment should be evaluated by referring to the objective of the experiment as presented in the introduction. Was the experiment successful? Were the objectives met? What is the overall significance of the experiment?

The Literature Cited section lists all the references used in preparing the report. This section is the most formal in its format. It is important to adhere to the style used. Each scientific journal has a slightly different style that contributors must follow to the letter. Student reports may also be required to follow a certain form. The best way to write this section is with the help of an example. Often college courses use scientific journals as models. The Journal of Chemical Education, Analytical Chemistry and the Journal of the American Chemical Society are examples of chemical journals that have been used in this way; the Journal of Organic Chemistry is often used in organic chemistry courses. When giving references, it is important to notice carefully all words that are set in italics or boldface in the example references. Typesetters use different fonts for italics and boldface that are difficult to reproduce when typing or handwriting, though many word-processing programs are able to reproduce them. Words that are set in italics can be indicated by an underline, Boldface can be represented by a wavy underline.

Typically, a reference to a book appears as follows:

A reference to a scientific journal follows this general form:

An example of a laboratory notebook
http://www.uic.edu/classes/chem/clangrie/CHEM112/syllabus/syllabus.html#example
http://www.dartmouth.edu/~chemlab/info/notebooks/sample.html
http://www.rod.beavon.clara.net/lab_book.htm
http://www.chem.purdue.edu/courses/chm25701/reports.html
ACS (American Chemical Society) Style Guidelines Quick Guide

This web guide is based on the second edition of *The ACS Style Guide: A Manual for Authors and Editors* (1997). For a more thorough discussion refer to *The ACS Style Guide* which is available at the Chemistry and Engineering Libraries (Call number QD8.5.A25 1997 Reference Section).

Citing References in the Body of a Paper

References in the body of a paper can be cited:

- By number (italics)
  The synthesis of the compound has been described previously (1).
- By superscript
  The synthesis of the compound has been described previously.\(^{1}\)
- By author name and date
  The synthesis of the compound has been described previously (Johnson, 1992).

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.

With author name citations, use both names if a reference has two authors (Jones and Smith, 2002). If there are more than two authors, use the first name followed by et al. (Harris et al., 2001).

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.


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.


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.

Encyclopedia Article

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


Handbooks

Basic Format:
Editor, A. A., Editor, B. B., Eds. Handbook Title (italics), Edition number [Online if online]; Publisher: Place of Publication, Year; Pagination or other identifying information.


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.


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.

Newspapers

Basic Format:
Last name, First Name; Last Name, First Name. Article Title. Newspaper Title (italics), Complete Date, Pagination.


Websites

Basic Format:
Author, A. A. (if any). Title of Site. URL (accessed date), other identifying information. (No need to include URL of subscription sites).

IV Grading Rubric for Lab Notebook and Write-up (Garces format for lab notebooks)

Emphasis on the lab this semester is on how you carry out the experiment and the interpretation of the experimental results. The quality of your work as demonstrated by your lab notebook (i.e., how well you record your data in table form, the thoughts in your discussion, and in general the overall quality of your report) accounts for the majority of your grade. Although your report is important, your technique is also part of your grade. Remember that you should always wear your safety glasses during lab. Failure to do so will result in lab technique point deduction. Always wear your safety glasses once your locker is open. You may safely remove your goggles when the last person in class has closed his/her locker.

Timelines and deadlines: All written work MUST be done in the notebook. Your laboratory notebook is YOUR responsibility. If you forget to bring your lab notebook to class you will not be able to work in the lab. The original copies (top page of lab notebook) will be turned in, the carbonless second page copy will remain in your lab notebook. Before beginning each experiment, you must have written an introduction for the experiment in your notebook. If you do not have the pre-lab (introduction and procedure) complete, you will not be allowed to start the experiment. The experimental procedure schedule for the day must be completed before leaving the lab unless otherwise stated, you must turn in the data that you recorded for the day’s work. The original copies of data and the observation section MUST be turned in BEFORE leaving the lab.

The original copies for the calculations-, discussions-, conclusions- and answers to the post-lab questions are due on the due-date of the experiment. The write-up must be turned in at the beginning of class of the due-date (See lab schedule handout). If it is turn in after this time, at best a 20% deduction will be imposed on the grade for the report at worst, you may not receive credit. You will not be allowed to start the lab until the prelab is turned in. In addition for every regular class meeting reports is not turned in an additional 20% will be deducted from the report. After two weeks (one week for summer session) of the due date the report is given a zero.

General Guidelines: All work must be done in block or blue non-erasable ink. The use of correction fluid (such as white-out) is not permitted (5-t penalty). Data may not be photocopied. While discussion and exchanges of ideas is permitted, your lab write-up should be done independently from your lab partner. DO NOT PLAGIARIZE.

The format on keeping a laboratory notebook is given in the next few pages. Please read this and adhere to the regulations. Early in the semester the format will be graded thoroughly so please adhere to the format outlined below. I will follow these guidelines to the letter in grading laboratory reports. Remember that all work should be recorded in the lab book directly, no scratch paper allowed. In the procedural section, don’t just write in your notebook—"refer to page # of the lab manual", a pictorial flowchart is required in this section. This will be discussed in our first experimental meeting.

Start with the table of content. All pages must be referenced in the table of content with the table updated as entries are added to the lab notebook. All entries must be in ink and no data entered is ever erased. The format is provided below and should be adhered to throughout the course. Skip pages only to follow the guidelines above. Depending on the number experiments in the course it might be best to use two lab notebooks for this course since many of the experiments will overlap.

Keeping a Laboratory Notebook: The general guidelines was previously mentioned above. This outlines steps specific to this course. One of the most essential skills a scientist needs is the ability to keep a proper laboratory notebook. This is essential in documenting the work that has been done, whether the information is needed later to write a paper or in order to submit a patent application based on the experiments or simply to act as the archival record of the results. In this course the laboratory notebook you keep should be quite helpful in studying for the quiz and exams. In this course, you are allowed to use your notebook in the exam so be diligent in your notebook upkeep.

One facet of writing the laboratory notebook that is generally difficult for students to decide is, how much information to write in the notebook. The guideline to use is that a competent scientist should be able to reproduce the results of the experiment using only the information in your notebook. It is usually better to err on the side of writing too much information than not enough. It is expected that you will write in proper prose for the narrative portions of the notebook. A second facet is organization and neatness. A portion of your grade on each experiment will be based on how good a job you do in organizing your notebook. If I cannot read what you wrote I will most likely assume that it is incorrect and may ask you to resubmit your report. If you do not have legible penmanship it would be best to slowly print your entry.

Table of Content: The following format for the laboratory notebook will be used in this course. The first five pages of the notebook are for the table of contents. The table of contents should include the experiment number, the title, and the page of which the work for that experiment begins. The table of content should be updated every time an entry is made in the notebook.

Header: Got each project, the top margin of each page in the notebook should have 1) name of person who made the page entry, 2) the title of the experiment, 3) your section number, 4) the date the work on the page was performed, 5) and the names of any lab partners.
Objective, Background Info, Procedure and Safety and Prelab Questions: For each experiment the notebook should include the following sections: Objective, background information, procedure (pictorial form) and SOPs, chemical disposal and safety information. This first section comprises the introduction section.

1. Objective: The objective state why the experiment is being performed, i.e. the goal of the experiment. **ALWAYS START the objective as a complete sentence.** In other words, do not start your prelab discussion with "To determine the concentration of...". The objective should be brief and to the point and should start out as "This experiment is to...".

2. Background: The background information provides the theoretical principles, which form the basis of the experimental method. The background information should be written in your own words and not copied from this lab manual. Any pertinent balanced equations or mathematical equation should also be included in this section. Add any other information you believe is necessary to bring your audience up to date on the experiment.

3. Procedure: Next is the **procedure.** This does not mean that the procedure is copied verbatim into the laboratory notebook; rather a reference to the procedure should be made followed by a pictorial flow-chart showing the steps in the procedure. Sketching an experimental set-up or unusual equipment is very useful in reproducing the experimental procedure. Changes to the published should also be included in this section.

4. Safety: The last section of the introduction section is the **chemical disposal and safety information.** Safety is of paramount importance in the chemical laboratory. In order to raise awareness of any hazards associated with the chemicals or procedures used in the experiments, warnings should be written in the lab notebook. Similarly in order to be environmentally conscious chemical material used should not be released to the environment, i.e. poured down the drain. Whenever possible, Green Chemistry should be practice throughout this course. Review the 12 Principles of Green Chemistry at [http://www.epa.gov/gcc/pubs/principles.html](http://www.epa.gov/gcc/pubs/principles.html). In each experiment, you will be given directed instructions on the proper method to dispose of chemical waste. If you are unsure about the correct disposal procedure, ask your instructor or lab technician for guidance.

5. Prelab Questions: The last part of this section is the prelab questions assigned for the experiment. Do not write the answers for these questions in your background narrative, instead, write out a separate section and answer with the question embedded in your answer. For example if the question is "Why is it necessary to standardize the titrant before the titration experiment?" An appropriate answer would be, "In this experiment, it is necessary to standardize the titrant with KHP in order to know the precise concentration so that the equivalent number of moles of the titrant can be used to analyze the analyte". Notice how the question is embedded in the answer (in italics). Finally, be sure your answer is complete. If you do not fully answer the question, you will not receive credit.

Since the lab notebook are of the carbonless copy type, the original pages containing these sections should be turned in before class begins. Something must be turned at the end of each lab experiment. Not turning in any data or observation means you were absent that day and you will not receive credit for that day’s work.

6. Data and Observations: The data / observations section is completed when carrying out the experimental procedure. The written observation notes should be detailed enough that someone else could repeat the experiment simply by reading the notes. In general it is always a good idea to record more details than too few details. Important items to notice are the color changes, gas evolution, experimental difficulties, etc. that occurred during an experimental procedure. As the experiment is being conducted observations and numerical results (data) should be entered directly in the lab notebook at the moment the data is collected and not a minute later. Raw data should never be written on paper other than the lab notebook. That means the data should not be written on the lab manual or textbook. There is a 5pt penalty for each time this rule is violated. Data should always be entered in the lab notebook. The data should be organized into tables in a logical fashion so that they are easily found when needed for calculations. Numerical data should be recorded with the correct units and precision. Try to keep attachment or computer printout to one page and attach to the notebook via clear tape (no staple). A description of the attachment should be entered in the lab notebook.

The data / observation notebook entry is turned in before leaving class. If the work is continued on another day, the work is still turned in before leaving and the data that is collected on the other day will be turned before leaving the lab on that day. Let me stress again that if you are doing any part of the experiment during class, you need to turn in your notebook page of your data/observations that day. **DO NOT, DO NOT, DO NOT, ever, ever, ever,** write your data in a separate sheet of paper or in the this lab manual. **You will automatically receive a 25% deduction in your lab write-up report if you are caught writing your data and observations other than your lab notebook.** All computer printouts should be properly labeled and a description of the printout should be described in the notebook. In addition, write out the key data from the printout in your notebook. You never know if the computer will crash or some unexpected malfunction occurs with the computer. Do not become too dependent on technology to store your data... a handwritten copy should always be kept in your laboratory notebook, after all, that is the primary function of a lab notebook.

In order for your instructor to check your results, you are required to turn in a data card and result card to your instructor. You might also have to complete this information online via Blackboard. Your instructor will provide you more information on this procedure at the appropriate time. Completion of this data card and result card is important to verify your results and statistical analysis. You should never cut-and-paste the content of the data card and use it as your table of your results. If you want, you can reproduce the table by HANDWRITING the information into your lab notebook directly. It should be always be your handwritten.
7. **Results and Calculations:** After leaving the laboratory the process continues. The next step is to try to make sense of the data that was collected. In this section the data collected are manipulated in order to obtain the answers to the question posed in the objective. First organize your raw data such that all the information you will need to calculate your results are found organized in a data table. In this section, you should go back and organize your raw data that you collected on the day the experiment. You can use the instructor datasheet to help you organize your raw data. Next you should include key equations or provide an example of formulas that will transform the raw data to meaningful results. You should include a complete sample calculation in this section showing how data is used in your calculation. If you are using excel to do the bulk of the calculations, show the layout of the excel spreadsheet and the formulas for important cells in the spreadsheet. Statistical analysis of the results will need to be described and formulas provided. If you are using excel for the statistical analysis, include the statistical function that is used in your description of how the values were obtained. If graphs are generated, be sure to have a title of the graph and the axis properly labeled. A legend should include the meaning of the data points. If LINEST is used for the linear regression, the complete 3x6 matrix (with labels) should be part of the graph and in the result table. Finally, you should take the final results and present it in an organized table, high-lighting the final numbers as requested in the lab write-up directions for that experiment. In other words, the final results should be summarized in very organize "Table of Results". A clear, organized, delineation of raw data to results (including statistics) must be presented in this section.

Computer printouts should only be turned in if the instructor request the printouts, otherwise summarize the results. If you turn in the printouts, organize the data and then attached it as an appendix to your report. A description of the printout should include in this section as well. All printouts should be properly label. Do not confuse the computer printout with results that must be included in this section. Some numerical printouts should not be turned in, especially if it is simply nothing more than pages and pages of numerical values. Talk to your instructor if you are unsure to include it in the appendix. In general if the computer-generated table is greater than 5 pages, you will need to condense it to fewer pages or leave it out.

8. **Discussion and Conclusion:** The next to the last section of the notebook is the discussion /conclusion section. This usually has two parts. The discussion should speculate on the significance of the results that was found in the Results/Calculation section. The discussion should also address if the results are what is expected or if an unexpected results was discovered. Finally the statistical analysis should also be addressed in this section, i.e., state what part of the experimental procedure introduce the greatest error and comment on how the errors (including any errors you made personally) affected the experimental result. The conclusion section should simply state the final result, which pertains to the goal of the experiment.

9. **Post-Lab Questions:** Finally all post-lab questions at the end of your report. This should be written in its own section do not answer these questions as part of the lab discussion. It may be okay to do so, but you will need to write out a Post-Lab question section. As in the prelab question section, you should give an answer that has the question embedded in it. See the pre-lab question section above for more information on how to complete this.

10. **Overall Presentation**

11. **Laboratory Techniques**
Experiment Lab Report Write-up Criteria  
General Chemistry (II) 201

**Required Assignments:** Students are required to perform assigned laboratory experiments, alone or with a partner. Before any lab period and before the class begins, you should have already **read** the lab experiment and have the pre-lab assignment ready to **submit**. Reports consist of observations made during the experiment, calculations and interpretation of your observations. You are required to answer all follow-up questions concerning the concepts studied in each experiment. All work should be recorded in your lab notebook.

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<th><strong>CRITERIA</strong> (Tentative point distribution - may change depending on experiment)</th>
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<tbody>
<tr>
<td>0</td>
<td>Quiz / Homework</td>
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<tr>
<td>1</td>
<td><strong>Objective of Experiment</strong></td>
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<tr>
<td>2</td>
<td>Background information (Math relationship used in study, pertinent chemical reactions, graph to be generated)</td>
<td></td>
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<tr>
<td>3</td>
<td>Procedures</td>
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<td></td>
<td>• Short outline of procedures in Expt.</td>
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<td>• Flow chart pictorial of procedures.</td>
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<td>• Procedural changes.</td>
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<tr>
<td></td>
<td>• Information (data) to be recorded during expt. (Table template form.)</td>
<td></td>
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<tr>
<td>4</td>
<td><strong>Safety</strong> precautions and disposal information.</td>
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<tr>
<td>5</td>
<td><strong>Prelab Questions.</strong> This part may be part of the Homework/Quiz point distribution.</td>
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<td>This portion of the report should be turned in before the start of lab class (prelab discussion).</td>
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<tr>
<td>6</td>
<td><strong>Data and Observation</strong></td>
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<tr>
<td></td>
<td>• Observation</td>
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<td>• Detailed account of what was observed during the experimental procedure.</td>
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<td></td>
<td>• Balance chemical equations; all chemical reaction which occurred during an experiment should be written in this section. Then it should also be written in the discussion portion of the report.</td>
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</tr>
<tr>
<td></td>
<td>• Data</td>
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<td>• Data in table form with correct significant figures, precision and units for each entry. Data should always be recorded in an organize fashion.</td>
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<td>• If you worked for that period, you must have some form of documentation of what you did for that period.</td>
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<td>This portion of the report should be turned in before you leave the laboratory.</td>
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<td>This is true even no matter how little data you collected that day.</td>
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<td>7</td>
<td><strong>Calculations &amp; Results</strong></td>
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<td></td>
<td>• Calculations</td>
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<td></td>
<td>• Sample calculation shown.</td>
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<td></td>
<td>• Statistical analysis of data and result (if applicable)</td>
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<td>• Results</td>
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<td>• Result(s) in table form.</td>
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<td>• Clear delineation of how data is used to get the final results.</td>
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<td>• Data card and result card to the instructor (if necessary)</td>
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<td></td>
<td>In this section accuracy of results are very important as well as detailed calculation showing how the result was obtain. &quot;Unknown&quot; will also be included in this section.</td>
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<td>8</td>
<td><strong>Discussion / Conclusions</strong></td>
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<td>• Discussion</td>
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<td>• A complete discussion should be written in this section. Topics to be discussed can be found at the end of each experimental procedure from the lab manual. Each discussion should include the significance of the result(s) and the meaning of the result of the experiment. All chemical reactions that occurred during the experiment should also be included here.</td>
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<td></td>
<td>• Conclusion</td>
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<td>• Summary of the goal of the experiment and how that goal was achieved in the experiment</td>
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<td>This portion (Calculation and Discussion) is turned in at the beginning of class of the due-date</td>
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<td>9</td>
<td><strong>Post Lab Questions</strong></td>
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<td></td>
<td>• Post-lab questions from manual or class assignment</td>
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<td>• Complete well thought-out answers with an explanation. No explanation, no credit.</td>
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<td>This portion (Post lab question) is turned in at the beginning of class of the due-date</td>
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<td>10</td>
<td><strong>Overall Presentation (of lab notebook)</strong></td>
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<td>• Lab technique during lab e.g., class preparation, safety glasses precautions and leaving the laboratory clean.</td>
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<td>• Lab report e.g., headings of each page of notebook including: name, title, lab partner, date and section #.</td>
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<td>• Legibility of report: ease of readability of written work and clear delineation of calculations.</td>
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<td>The overall impression is important.</td>
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<td>11</td>
<td><strong>Lab Technique</strong></td>
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<td>• Precision of work, sound statistical analysis, conclusion of results</td>
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<td>Total (This total may be adjusted depending on lab technique and student conduct in the experiment)</td>
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100%