

TITLE: The title should be original and should clearly describe the experiment/project.

Author(s) name. (Co-Authors names, if applicable), address and/or email (appropriate public contact information).

Project # Report for CHM343, Semester, Year - Date Submitted, Date Revised, Etc.

ABSTRACT: The abstract is a one paragraph (up to 150 words) overview of the experiment and should summarize the experiment and key (numerical) results including the characterization method(s), the IUPAC name of the compound and pertinent quantitative results, and (importantly) include units and associated errors in all numerical values and all figures of merit.

INTRODUCTION

This template follows the common sections and format of a scientific publication article (manuscript). In general, the introduction section is often 1-5 paragraphs in length. Some examples of the paragraph topics common to scientific laboratory reports: 1) brief introduction to the subject material and its importance; 2) objectives of the study; 3) theory behind the method(s) of analysis. However, because most undergraduate level science labs are based on commonly used and very well-documented methods and materials, students can deviate from a common length introduction and instead provide a one-paragraph introduction that is more in the style of a review or overview statement and provides adequate citations to all the relevant background and introductory topics. In this case, the most critical component to the introduction section is literature references (i.e. journal articles or books), numbered sequentially when cited in the text and placed in the references section (see below). Zotero manages citations, is free (<http://www.zotero.org>) and is recommended (other citation management apps include Mendeley, BibTeX and EndNote). For a given reference, use the same number if it's cited again. It is advised that the student's wrap up the introduction with a sentence or two about the objective of the laboratory exercise/project. It is common that most figures and tables are included in the results and discussion section (and supplemental information). However, it is becoming more common to include an abstract picture or a figure in the introduction to provide a visual introduction to one or more important components of a report (manuscript). An example of a properly included and formatted figure is provided as figure 1 with an associated figure caption.

MATERIAL & METHODS

The materials and methods section (or experimental section) is written as prose (i.e. not point form) and uses the *past tense* and *passive voice* (no personal pronouns) to explicitly and sequentially describe the actual experiment. The goal is to enable other scientists to duplicate your work. This section includes, but is not limited to: a complete description of the reagents,

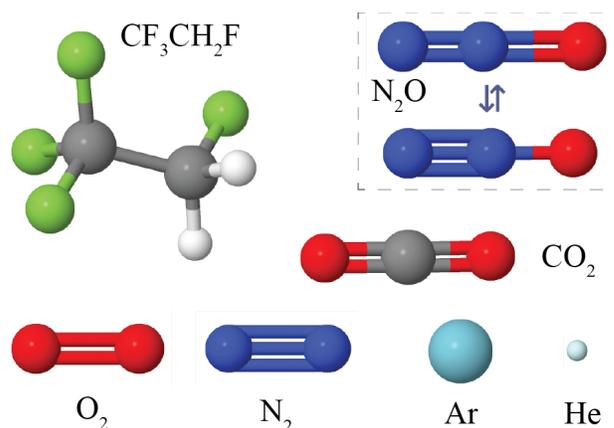


Figure 1 - Atomic or molecular representation of several common gases generated by JSmol using the molcalc.cloud website. These represent the atomic and/or molecular input for thermochemistry calculations.

including the order of addition and quantities; brief description of the experimental apparatus including brand and model numbers; any changes to the procedure of the handout. Subsections are commonly used when there are multiple scientific instruments or techniques being described (for example, subsections for Computational Methods or each major Experimental Instrument, etc.)

RESULTS AND DISCUSSION

The results and discussion section presents the data that was acquired **and interprets the data**. All tables and figures must be properly labeled, sequentially numbered as they appear in the text and have a detailed caption. Figure captions go below the figure, table captions above the table. Spectra and graphs must clearly display axis labels and units with a reasonable number of significant digits. If there are too many zeros then use scientific notation, placing the powers of 10 in the axis label. The figures should be placed near the paragraph to which they're referred. Experimental results are compared with those reported in the literature

whenever possible. Be sure to discuss the figures of merit, the sources of error and the benefits and/or disadvantages of the method.

This section may be broken into two separate sections if preferred. In this case, the results section both displays *and summarizes the data collected* (i.e. it should have prose and refer to the figures), while the discussion section interprets the data.

The majority of figures and tables are included in this section. I like to say that figures should storyboard the entire project being reported on. The concept being that if you just look at the figures, tables and associated captions, a reader should have a very good overview of the entire project and the major findings detailed in the report.

Detailed step-by-step calculations or the detailed statistics for propagation of error and any computational programs or algorithms are commonly put in a separate supplementary information file (or appendix). The material included in a supplementary information section should be references in the primary document and if supplementary tables or figures are used, they are commonly labeled as SI1, SI2, etc (e.g., Fig. SI1, Fig. SI2, Table SI1).

CONCLUSIONS

The conclusions are *not* a simple summary of the experiment or a repetition of the abstract. It should be one paragraph in length and tie together all of the data in a manner that makes some sort of statement as to the relevance of the results. What does it all mean? Other possible topics include future work or the efficacy of the method.

ACKNOWLEDGEMENTS

Acknowledge people who have helped in any way in the preparation of the written document or with the computational, experimental or data science components of data collection and/or analysis.

SUPPLEMENTAL INFORMATION

It is now common for scientific manuscripts, papers and/or reports to include supplementary material associated with the manuscript, paper or report and reference or link in the online version.

REFERENCES

It is advised that laboratory reports use and reference at least ten relevant literature references. Scholarly, peer-reviewed, scientific journals and books should be the primary sources for these references. The format must follow that found in the ACS Style Guide (<http://pubs.acs.org/isbn/9780841239999>).

The best method for finding literature on a desired subject is through scientific search engines to which the university subscribes, namely Scopus or Web of Science. However, public search engines such as Google Scholar or PubMed are also becoming common

alternatives to use. Article type may be further specified such as a review, which are ideal introductions to a topic. Paperpile (or Mendeley or Zetero) allows one to download the citation information, cite the reference in Google Docs or MS-Word and auto-format the reference list into ACS style. As an example, some properly formatted references have been provided below. Besides just being an example of properly included references, it also can serve as some relevant references and information for the following related topics for students in ASU ONLINE CHM 343, physical chemistry laboratory.

The example references provide further information for students on remote/cloud labs¹⁻⁴, writing scientific reports (manuscripts)⁵, peer review of scientific manuscripts⁶⁻⁹ and the most commonly used physical chemistry laboratory resources¹⁰.

REFERENCES (example of formatted references)

- (1) ARNOLD, C. CLOUD LABS: WHERE ROBOTS DO THE RESEARCH. *NATURE* **2022**, *606* (7914), 612–613.
- (2) LOGOTHETIS, T. A.; FLOWERS, C. M. SQUARING THE CIRCLE BY ATTEMPTING TO TEACH A LAB CLASS IN THE CLOUD: REFLECTIONS AFTER A TERM IN LOCKDOWN. *J. CHEM. EDUC.* **2020**, *97* (9), 3018–3022.
- (3) AHLSTRAND, E.; BUETTI-DINH, A.; FRIEDMAN, R. AN INTERACTIVE COMPUTER LAB OF THE GALVANIC CELL FOR STUDENTS IN BIOCHEMISTRY. *BIOCHEM. MOL. BIOL. EDUC.* **2018**, *46* (1), 58–65.
- (4) LEWIS, R. J.; DRYSDALE, T. D. SIMULATION OF RESEARCH-GRADE PHYSICS, CHEMISTRY, AND ENGINEERING EXPERIMENTS IN LABVIEW AS A FLEXIBLE TEMPLATE FOR REMOTE LABORATORIES; 2020; PP 710–725.
- (5) ALLEN, F. H.; BÉRARD, P. M.; BLENDERMANN, S. C.; BOOTH, B. A.; BUEHLER, K. S.; COURTNEY, C. A.; DODD, J. S.; HAMMES, G. G.; HELLER, S. R.; KULAMER, B.; MACLEAN, D.; McNAUGHT, A. D.; MURRAY-RUST, P.; RZEPA, H. S.; SLATER, E. S.; SOLLA, L.; WILLIAMS, A. THE ACS STYLE GUIDE: EFFECTIVE COMMUNICATION OF SCIENTIFIC INFORMATION. *ACS SYMP. SER.* **2006**, 1–444.
- (6) ALEXandrova, A. N.; Hartland, G. V. THE ART OF REVIEWING MANUSCRIPTS. *J. PHYS. CHEM. C* **2021**, *125* (30), 16369–16370.
- (7) BROWN, L. M.; DAVID, E. A.; KARAMLOU, T.; NASON, K. S. REVIEWING SCIENTIFIC MANUSCRIPTS: A COMPREHENSIVE GUIDE FOR PEER REVIEWERS. *J. THORAC. CARDIOVASC. SURG.* **2017**, *153* (6), 1609–1614.
- (8) MAKIN, T. R.; DE XIVRY, J. O. TEN COMMON STATISTICAL MISTAKES TO WATCH OUT FOR WHEN WRITING OR REVIEWING A MANUSCRIPT. *ELIFE* **2019**, *8*. [HTTPS://DOI.ORG/10.7554/E LIFE.48175](https://doi.org/10.7554/eLife.48175).
- (9) SUCATO, G. S.; HOLLAND-HALL, C. REVIEWING MANUSCRIPTS: A SYSTEMATIC APPROACH. *J. PEDIATR. ADOLESC. GYNECOL.* **2018**, *31* (5), 441–445.
- (10) SHOEMAKER, D. P.; GARLAND, C. W.; STEINFELD, J. I. *EXPERIMENTS IN PHYSICAL CHEMISTRY*; McGRAW-HILL, 2018.

Supplemental Information (Appendix)

GENERAL INSTRUCTIONS

If you are using this as a template for your own report in CHM343. First, delete the existing paragraph text for your report! Inserting graphics and tables close to the point at which they are discussed in the text of the manuscript. Save in both .docx and .pdf formats.

A reminder of the common CHM343 breakdown of marks for each section (which should help dictate where students spend the majority of their time and effort). Also, PLEASE consult the syllabus for an up-to-date rubric and current point breakdown. For Prof. Yarger's pchem reports, it is common for a significant portion of the Results and Discussion points to come from a supplemental information (SI) section where detailed calculations associated with data analysis and error analysis are explicitly shown.

Title (Authorship)	5%
Abstract:	5%
Introduction:	5%
Experimental:	10%
Results and Discussion:	60%
Conclusions:	5%
Acknowledgements:	5%
References:	5%
Supplemental Information:	0-50%

Writing skills are a key part of any science education since writing will be required for subsequent careers in science. The ability to effectively communicate ideas and results is crucial whether one goes on to graduate studies, directly into industry or into any area related to chemistry. The ACS Style Guide is an excellent source of information on writing a scientific laboratory report.¹ Use passive voice only, i.e. no personal pronouns. A critical component to laboratory reports figures to illustrate all critical components of the lab and/or project. The figures and figure captions should visually storyboard the entire laboratory project. 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, resize 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)). Ensure that page numbers are present on all pages. Save the file with the graphics in place: select Save As (File menu) and save it as a document file (not a .dot template file).

Equations can be inserted where desired and can only be one column wide. If the artwork needs to be two columns wide, it must be relabeled as a figure, chart, or scheme and mentioned as such in the text.

FIGURE CAPTIONS. Each figure must have a caption that includes the figure number and a brief description, preferably two or more sentences. The caption should be below the figure and follow the format "**Figure 1.** 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. Whenever possible, place the key to symbols in the artwork, not in the caption. To insert the figure into the template, be sure it is already sized appropriately and paste before the figure caption.

TABLE CAPTIONS. Each table must have a caption 'title' that describes its contents, above the table. The title should follow the format "**Table 1.** caption". The caption should be understandable without reference to the text.

Use tables 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. 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.

EXAMPLE of spanning two columns: Now your page is set up so that figures, schemes, charts, and tables can span two columns. These must appear at the top of the page. Be sure to add another section break after the table and change it back to two columns with a spacing of 0.33 in.

Table 1. Example of a Double-Column Table

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8
