Writing Chemistry at University

GUIDES FOR WRITING IN SPECIFIC DISCIPLINES

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1 What is chemistry and what do chemists write about?

Chemistry is the study of the composition, structure and properties of matter. It studies how and why substances combine or separate to form other substances and how they interact with energy. It is sometimes called the central science because it is crucial to understanding matter at the molecular level.

The field of chemistry is divided into five main branches: (1) analytical chemistry identifies and measures the physical and chemical properties of substances; (2) physical chemistry combines chemistry and physics to study how matter and energy interact; (3) organic chemistry studies compounds made of carbon found in living tissue; (4) inorganic chemistry deals with the synthesis and behaviour of all chemical compounds except carbon-based compounds containing C–H bonds; and (5) biochemistry studies the chemical processes within living organisms.

2 General characteristics of writing in chemistry

Scientific discovery in chemistry depends on obtaining new data, developing innovative ideas and communicating them to both the scientific community and the general public. In addition to presenting research results, chemistry papers often detail the scientific process that produced them: formulation of scientific questions; background research; research objectives or hypotheses; data analysis or hypothesis testing; and conclusions drawn from the results.

Good writing in chemistry is characterized by clear expression and no unnecessary detail. It is simple and direct, and avoids vague, ambiguous language and complicated sentences. In the interest of precision, technical terms are used, but only as needed. Chemical compounds should be properly named, and have their international labels specified (e.g., Chemical Abstracts Service Registry Numbers). The International System of Units should be used throughout.

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In chemistry writing, the publication of formulas, schemes, equations, diagrams and other items requires high typographical quality. That explains why more and more chemistry texts are produced in LaTeX, a document preparation system that allows writers to focus more on content and less on formatting issues.

Chemistry texts are impartial and objective, and logically organized into sections with clear headings. They detail how and where data were collected, support conclusions with evidence, and acknowledge the work of others. To achieve these goals, writers must make crucial decisions about several issues.

One of the most important issues is the appropriate use of past, present and future tenses. Generally speaking, use the present tense to state facts (general truths) and analyse data. Write lab reports and research papers mainly in this tense. Use the past tense to describe specific experimental methods and observations and to cite published results, and the future tense to refer to future issues.

The use of active and passive voice is also an issue of debate. The passive voice and its more formal and depersonalized style has been the traditional preference, especially when the agents are unknown or information about them is obvious or unimportant. Now, more and more scientists and journal editors prefer the clearer, more direct and easier-to-read style of the active voice over clumsy, complicated passive sentences voice structures. That said, however, the passive voice is still more appropriate in many situations. Writers need to know how to combine both voices to achieve their communicative purposes. (In the case of a text for publication, it is always advisable to be familiar with the stylistic preferences of the journal before submitting the manuscript).

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Closely related to the question of voice is that of first-person pronouns. For decades, in the interest of impartiality, science writers avoided personal expressions or statements. They believed scientific texts should not include first-person pronouns (*I, me, my, we, our,* or *us*) because the focus is on facts, not researchers. This belief, like the preference for passive voice, has recently been scrutinized.

Compare the following two sentences. The first is impersonal; the second uses first-person pronouns.

1. *The explanation for this behaviour may be found in…*
2. *We/I believe that the explanation for this behaviour may be found in...*

The personal pronouns (we or I) and the verb (believe) do not add important information to sentence 2 and could be avoided.

However, impersonal writing often requires the passive voice "may be found", which can result in hard-to-understand or ambiguous sentences when used excessively.

As a result, using first-person pronouns (and writing in the active voice) is often recommended to keep meaning clearer. Sentences 3 and 4 demonstrate this. The first (impersonal and passive) is slightly vague (who made the decision?), while the second (personal and active) is more direct and less ambiguous.

3. It was decided that the temperature should be adjusted.

4. We decided that the temperature should be adjusted.

A much less common (and very formal) way to be more direct and less ambiguous is with an impersonal and active sentence in which the first-person pronoun (we) is replaced by a third-person subject (the research team), and the focus on facts over researchers is maintained.

5. The research team decided that the temperature should be adjusted.

In reference to one's own results or conclusions, a third-person subject like the one in sentence 5 can be simpler and clearer.

6. While Smith and Jones report a cell dimension, c, of 26.4(1), the authors' own data yield a value of 26.7(1).

But the authors' own data is an awkward phrase. Using a first-person pronoun "our data" is simpler and clearer.

7. While Smith and Jones report a cell dimension, c, of 26.4(1), our data yield a value of 26.7(1).

Another source of potential partiality is subjective language that is open to question or interpretation and implies personal thought or belief. For example, the information in sentence 8 is not accurately measured or explained, making the sentence too subjective.

8. The mixture was subjected to a high temperature and turned a beautiful blue colour.

Language that is concrete and specific is always preferable to abstract and vague expressions.

3 Typical text types in chemistry

Chemists typically write reports, literature reviews, research proposals, and original papers or articles for publication. Literature reviews summarize research published by other authors but focussed on a common topic or problem. Because the data in these published reports have been carefully documented, experimental data are not included in literature reviews. Research proposals are usually written to apply for

funding. They may include a literature review to support the proposal, but they mainly focus on the original research proposed and the benefits to be gained by carrying it out.

Most of the literature in chemistry consists of original research papers that include careful descriptions of the problem to be addressed, of related work and of the experimental methods employed. The research results must be carefully documented and the conclusions drawn after close analysis and interpretation of those results.

The introduction in a paper formulates a research question and provides background information to establish the importance of the research conducted. To highlight that relevance, it should also contain a short, rigorously cited literature review of work that has already been done. This background research allows the paper's central question to be stated more explicitly. Finally, the introduction should also indicate the objectives of the research or a hypothesis supported or refuted by data in the remainder of the text.

The materials and methods 'or experimental' section lists all items (resources or equipment) used in the research and details the experimental procedures in a way that allows other researchers to replicate them as closely as possible. For the same

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reason, this section should also include relevant suppliers and/or model or version numbers. Raw data and in-depth procedures that support the experimental results are sometimes included in a separate section called *Supplemental Information*.

A paper's results and discussion section describes the work the author has done and the results obtained. This section is not simply a technical description of procedures; it continues the introduction by explaining the research progress that eventually leads to the final results. When results and discussion sections are combined, after each result is presented, its relevance is explained. A results section on its own should only present, not interpret, results.

In the conclusion, the author summarizes the main objectives, confirms or rejects any hypotheses, re-emphasizes the importance of the work presented, and describes future work.

A final reference section lists all non-original sources used in the text in the order in

which they appear with the appropriate number. Citations should be made according to the format of the journal to which you will submit your paper. Unlike other disciplines, citations in a chemistry paper are usually not in-text or parenthetical, but incorporated using superscripts as at the end of this sentence.[1]

Students of chemistry are typically required to write laboratory reports and keep laboratory notebooks. Laboratory reports are less formal than research papers but more formal than notebooks. They are written to explain experimental results and share them with others. Lab reports typically include the same features as research papers.

The introduction provides background information related to the experiment, including theory and past research, the relevance of the research, an explanation of any unusual experimental approaches, and the thesis statement.

The experimental section states the goal of the experiment, explaining why it is being performed. Include enough details so that others might repeat the experiment and obtain similar results, including information about the treatment of data and the instruments and materials used.

The section with results reports and organizes the data. Include in it any figures, graphs and tables that summarize the data, which should mirror information provided in written form in the text. Specifically reference tables or figures included in the report in the text, as done at the end of the sentence (*Table 1*).

The discussion section analyses this experimental results. You should discuss the accuracy and precision of the data, any possible sources of error, the relationship between the data and theories or scientific principles, past research in the field relevant to the results and the potential for future research. As this section addresses the significance of the data overall, be sure to include the actual numbers obtained throughout the experiment.

The conclusion usually relates back to the purpose and goals of the experiment. In it, you should briefly summarize the report, state important results and assess the research with respect to the purpose. If you combine this section with the discussion section, the last paragraph of the discussion section may serve as a conclusion.

Laboratory notebooks are informal records of experiments and data. Use them to validate experimental procedures and the resulting data, and to communicate results to colleagues. Keep them well organized and include the purpose of the lab work, the procedures followed, any data, calculations or observations, a discussion of the experimental results, and some kind of conclusion.

4 Writing conventions in chemistry

The point of writing in chemistry is to present results and prove conclusions based on those results. Therefore, evidence should be provided in support of arguments and communicated effectively in figures, graphs, tables, diagrams or other visual materials.

All figures, graphs and tables in the text should be titled and referenced.

References are usually cited consecutively with superscript numbers corresponding to each one in the reference section of the paper. It is less common to cite by placing the name of the author(s) and the date of publication in parentheses.

Abbreviations and acronyms save time and avoid repetition, but they can be confusing. Use standard abbreviations only when needed, reduce the use of others to a minimum, and explain each one the first time it appears in the text.

Keep your descriptions of chemical processes and phenomena as succinct as possible. Avoid flowery language in favour of clear analysis, and omit exhaustive descriptions of techniques that are considered standard practice.

Do not start sentences with a numerical digit unless it is part of a chemical name; instead, spell the number out.

Do not capitalize the names of chemicals unless they begin a sentence.

Do not include statements of opinion. Saying that the experiment was difficult or tedious is an opinion and does not belong in a report of the results.

5 Selected works and websites

1. *Study and Communication Skills for the Chemical Sciences* by Overton et al. (2015)
   http://www.rsc.org/learn-chemistry/resource/res00002088/study-communication-skills-for-chemistry-book?cmpid=CMP00007022

   In this book, written specifically for undergraduate students, several chapters are dedicated to writing.

2. *Writing Guide for Chemistry*
   http://chemistry.oregonstate.edu/content/writing-guide-chemistry

   Written to provide a short introduction to writing for chemistry students at Oregon State University, this guide is not a comprehensive writing reference. However, it introduces some major issues in writing, gives a great deal of information on both

chemistry-specific writing guidelines and general writing recommendations, and provides some excellent resources.

3. *Guide for Writing in Chemistry*
http://www.southwestern.edu/live/files/4169-guide-for-writing-in-chemistry.pdf

This guide from Southwestern University in Texas has been designed to provide an introduction to the conventions, or rules, of writing in chemistry for students to use to complete assignments. It contains information about writing in chemistry: common types, research papers, conventions, citations and formatting, and common errors to avoid.

4. *Chemistry Writing Guide*
http://www.swarthmore.edu/writing/chemistry-writing-guide

The Swarthmore College guide offers very detailed information about writing in chemistry. It includes a basic explanation of the nature of a chemistry paper, descriptions of two types of written assignments in chemistry (lab reports and abstracts), an outline of discipline-specific strategies and some advice about avoiding common mistakes.

5. *Guide to Writing a Lab Report – For Chemistry and Biochemistry Students*
https://www.concordia.ca/content/dam/concordia/offices/cdev/docs/writing/types-of-writing/writing_lab_report.pdf

In addition to advice about style, formatting and referencing, this two-page guide provides an overview of the purpose of each section of a lab report: the abstract, the introduction (or theory), the experimental (or procedure), the results, the discussion and the conclusion.

6. *The ACS Style Guide*
http://pubs.acs.org/isbn/9780841239999

The definitive source for all information needed to write, review, submit and edit scholarly and scientific manuscripts, the ACS Style Guide teaches how to effectively communicate scientific information. The entire guide is available in PDF format in 21 separate links on this web page.

7. *American Chemical Society Publications*
http://www.jlakes.org/config/hpkx/news_category/2017-02-14/ACS-StyleGuide.pdf

This ACS site provides links to journals in the field of chemistry (such as Chemical Reviews and Journal of the American Chemical Society) that allow users to browse through recent issues or search for information on a particular topic.

Servei de Llengües (UAB) and Servei de Llengües Modernes (UdG)

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