

Topic 4: Writing an Organic Chemistry Lab Report

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General Information

Unless otherwise indicated, always write your report as if you are submitting a paper to the Journal of Organic Chemistry (view *J. Org. Chem.* **2012**, *77*, 11296-11301 or any other recent Journal of Organic Chemistry article for a good example). This means that you must adhere to the American Chemical Society (ACS) standards for formatting, including citations and references.

General Lab Report Guidelines

1. ***Title all sections of your lab report.*** There should be no question as to which section is which. Your lab report should include all of the following sections: Abstract, Introduction, Results and Discussion, Conclusions, Experimental Section, and References.
2. ***Use formal, professional prose.*** Do not use contractions or colloquialisms.
3. ***Never use “I” or “my”.*** While the occasional “we” is acceptable, you should never refer to yourself or other individuals. Also avoid “the student”, “the experimenter”, or “one”.
4. ***Be clear and concise.*** Try to state what you need to as understandable as possible and in as few words as possible.
5. ***Do not use quotes.*** If you are explaining information from a reference, restate it in your own words, and then use an in-text citation in the style of the American Chemical Society.
6. ***Proofread your work.*** Spelling and grammar errors are unacceptable. It is recommended that you add chemistry words to your word processor’s dictionary so that they can easily be detected.
7. ***Assume the reader is an organic chemist, but knows nothing about your experiment.*** For example, write your report as if you are explaining your results to an organic chemistry student at a different university. Do not make assumptions that they know what the melting point is supposed to be, or why you used the techniques you did. Explain everything.

Every Lab Report Must Include...

1. ***Title.*** Your title should be clear and accurate. It does not have to be the title of the experiment as listed in your lab manual. Feel free to get creative.
2. ***Authors.*** If you are writing the report with a partner or a team, be sure to include everyone’s name.
3. ***Abstract (1 paragraph):*** Your abstract should summarize the purpose of your study, the main results, and your major conclusions. Abstracts are typically 2-5 sentences in length (200 word

maximum) and are usually published separately from the article in order to attract readers. As such, they should not contain any references or undefined abbreviations.

4. **Introduction (1-3 paragraphs):** Here is where you explain why you are conducting the experiment. Technically, this section can be written BEFORE you actually conduct the experiment and thus your approach should reflect that. Include applicable background information, and clearly state the purpose and objectives of the study (what is the scientific problem that you are addressing?). If applicable, state your initial hypothesis. Also outline your experimental strategy (don't include experimental details; just explain your general plan of attack in a sentence or two). Use present tense, and lots of in-text citations. Do not include any experimental results or conclusions.
5. **Results and Discussion (2 or more paragraphs):** Note that organic chemistry journals typically combine the results and discussion in the same section (many other journals separate these sections). This is where you explain your experiment, how it worked, the results you got, and what those results mean. While you should talk about (and explain) your experiment here, remember to save the details (like amounts of reagents used, etc.) for the experimental section. Explain how your experiment worked, and the purpose of each step and/or component. Then describe each result and what information it gave you (i.e., discuss your hypothesis, then how and why your results support or contradict your hypothesis). When discussing a product, be sure to address issues such as product identification, purity, and percent yield. Compare your results to those in the literature (and be sure to include in-text citations when citing information from the literature). If your results are inconclusive or inconsistent, mention that here and suggest possible sources of error.

Don't forget to include any applicable figures, schemes, and/or tables. All schemes must contain skeletal structures and be drawn in ChemDraw or a similar chemistry drawing program (photos, hand drawn schemes, and materials that are not your own is unacceptable). Be sure to include all reagents in your scheme and a percent yield. Additionally, every figure, scheme, and table must contain a title and a number. (You may also opt to number the structures in your scheme, which makes referring to the structures in the text of your report much easier.)

6. **Conclusions (1 paragraph):** Summarize your main findings and explain why they are significant. Suggest studies you might conduct to confirm your results or build on your results if you had more time and/or resources.
7. **Experimental Section (1 or more paragraphs):** Yes, this section comes after the conclusions. Include enough detail so that a peer could reproduce your results (if you keep a good lab notebook, you will just have to type up what you wrote in it). Don't forget to include any important observations such as colors of solution, appearance of crystals, yields (grams and percent yield), melting points (for melting points, report uncorrected mp, apparatus number, calibration curve, and corrected mp), R_f values, and/or spectroscopic data (any IR and ^1H NMR values must be reported in ACS format). Be sure to use past tense to describe what you did, and use passive voice (e.g., instead of saying "I put HCl in the flask" or "Add HCl to the flask", say "HCl was added to the flask").
8. **References:** Helpful in case someone wants to reproduce your study and/or confirm your findings. You should be sure to cite your references in text and list them in the style of the American Chemical Society (ACS). Don't forget to include obvious references like the lab manual and/or textbook.

The ACS Format for Citing and Listing References

For formal lab reports, you must use the American Chemical Society (ACS) style for citation and referencing. You must use superscript numbers in the text when you refer to information from a reference. The numbers should be listed in order as they appear in your paper, and the list should be included at the end of your report. If you refer to a reference twice, you can just use the same number both times. View *J. Org. Chem.* **2012**, *77*, 11296-11301 or any other recent Journal of Organic Chemistry article for an example of how to correctly format in-text citations.

For the proper format of your references, see the examples below. If you don't see the example you need, refer to the ACS Style Guide.

Journal Article Example

Kawano, R.; Osaki, T.; Sasaki, H.; Takinoue, M.; Yoshizawa, S.; Takeuchi, S. *J. Am. Chem. Soc.* **2011**, *133*, 8474-8477.

Here's a breakdown of the information contained in the example above:

1. Authors (in normal font) → Kawano, R.; Osaki, T.; Sasaki, H.; Takinoue, M.; Yoshizawa, S.; Takeuchi, S.
2. Journal (in italics) → *J. Am. Chem. Soc.*
3. Year published (in bold) → **2011**
4. Volume of the Journal (in italics) → *133*
5. Page numbers (in normal font) → 8474-8477

Book Example

Lehman, J. W. *The Student's Lab Companion: Laboratory Techniques for Organic Chemistry*, 2nd ed.; Prentice Hall: Upper Saddle River, NJ, 2008; pp 120-132.

Here's a breakdown of the information contained in the example above:

1. Authors (in normal font) → Lehman, J. W.
2. Book title (in italics) → *The Student's Lab Companion: Laboratory Techniques for Organic Chemistry*
3. Edition (in normal font) → 2nd ed.
4. Name of publisher & place of publication (in normal font) → Prentice Hall: Upper Saddle River, NJ
5. Publication year (in normal font) → 2008
6. Pages referenced (in normal font...note that for books you must include a "pp" whereas you do not for journals) → pp 120-132

General Website Example

Hunt, I. Halogenation of Alkenes. <http://www.chem.ucalgary.ca/courses/350/Carey5th/Ch06/ch6-7.html> (accessed Aug 14, 2013).

Here's a breakdown of the information contained in the example above:

1. Authors, if any (in normal font) → Hunt, I.
2. Title of Site (in normal font) → Halogenation of Alkenes
3. URL (in normal font) → <http://www.chem.ucalgary.ca/courses/350/Carey5th/Ch06/ch6-7.html>
4. Date accessed (in normal font) → Aug 14, 2013

Documents Retrieved from Institutional or Agency Website Example

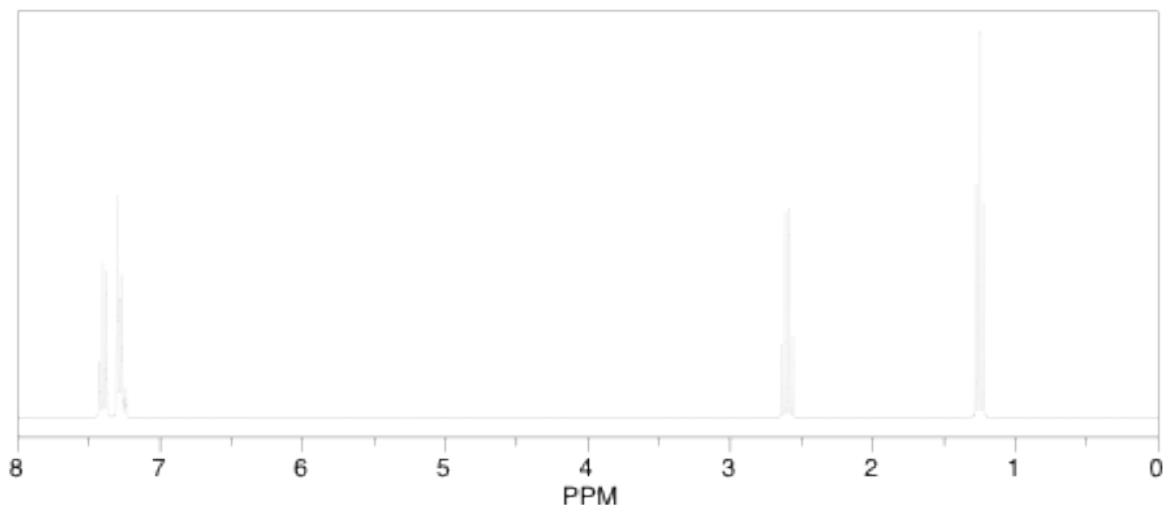
Solano, D. M. Topic 4: Writing an Organic Chemistry Lab Report, 2015. Department of Chemistry & Biochemistry - Organic Chemistry Lab Manual | California State University, Bakersfield. http://www.csub.edu/chemistry/organic/manual/Topic4_report.pdf (accessed Aug 17, 2015).

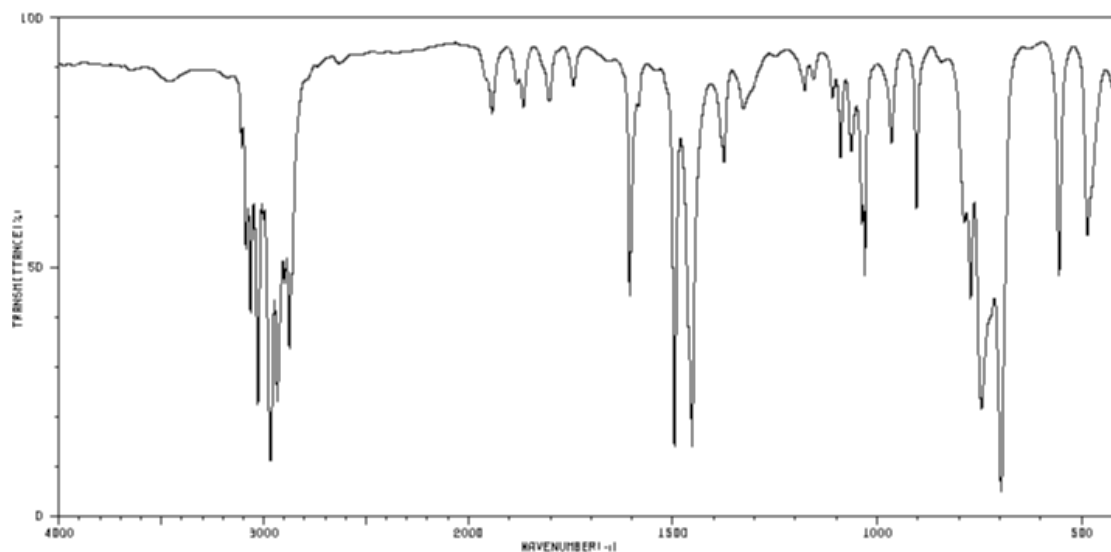
Here's a breakdown of the information contained in the example above:

1. Authors, if any (in normal font) → Solano, D. M.
2. Title of Document (in normal font) → Topic 4: Writing an Organic Chemistry Lab Report
3. Year (in normal font) → 2015
4. Title of Site (in normal font) → Department of Chemistry & Biochemistry - Organic Chemistry Lab Manual | California State University, Bakersfield
5. URL (in normal font) → http://www.csub.edu/chemistry/organic/manual/Topic4_Report.pdf
6. Date accessed (in normal font) → Aug 17, 2015

The ACS Format for Reporting a Compound's Spectral and Other Data

Pretend you are reporting data for ethylbenzene. Your IR and NMR are shown below:





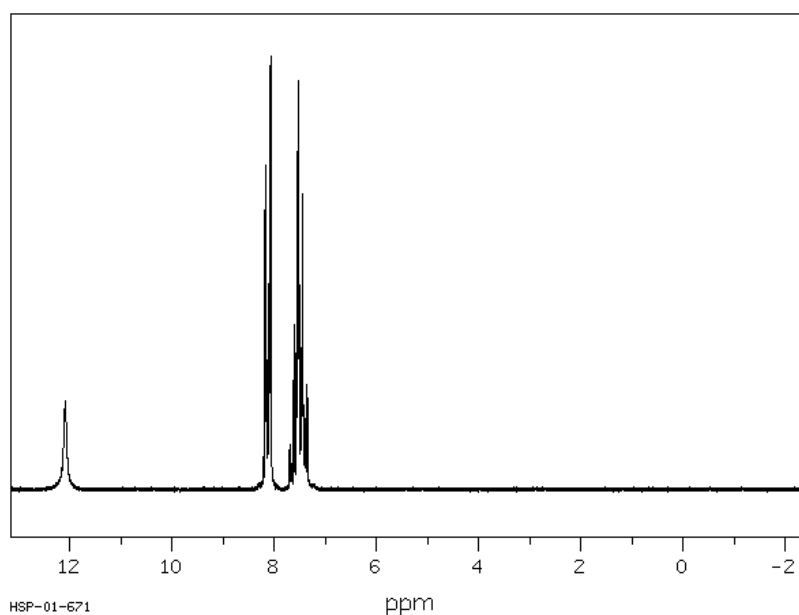
So at the end of your experimental section, you would include the experimental data like this:

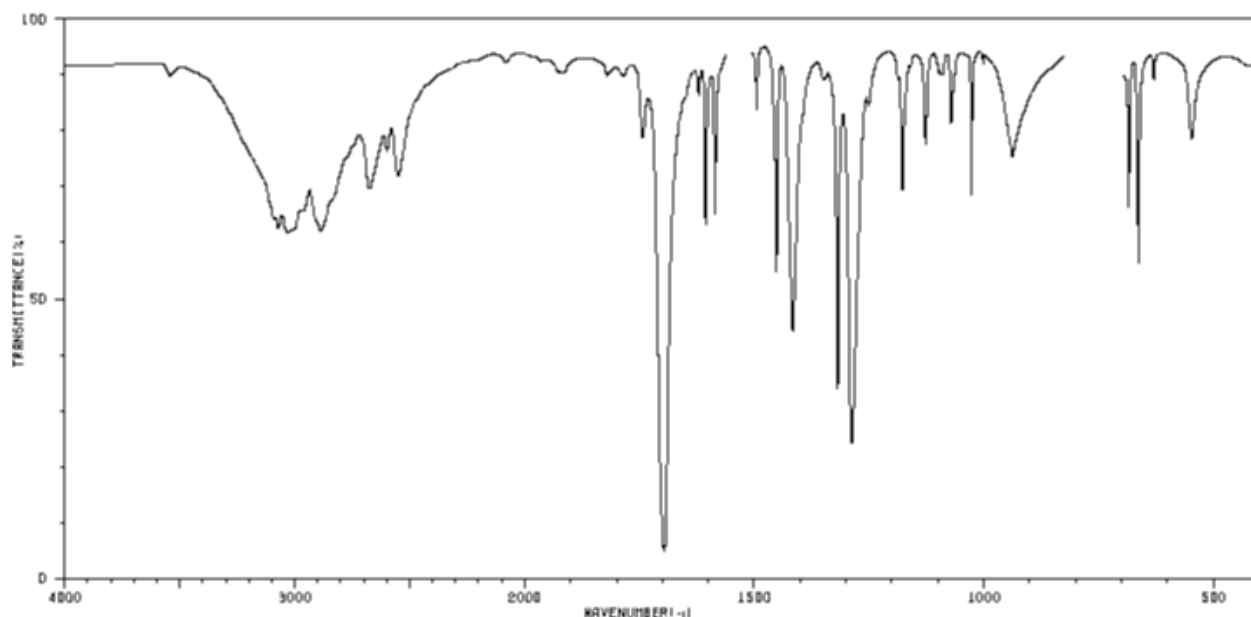
Clear, colorless liquid: bp 137-138 °C; IR (neat) λ_{max} 3028, 2967, 1806, 1496, 1453, 1030, 746, 697 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3) δ 7.44-7.36 (m, 2H), 7.33-7.23 (m, 3H), 2.60 (q, 2H), 1.25 (t, 3H).

A couple important points:

- You don't have to report every single IR peak, just a few of the big and/or important ones.
- If you took your ^1H NMR in DMSO rather than chloroform, replace the " CDCl_3 " with " $\text{DMSO-}d_6$ ".
- Be sure to note the frequency of the NMR machine that you used (for example, 60 MHz or 400 MHz). Also note that the frequency is different for ^{13}C NMR.

Here's one more example. This includes the IR and ^1H NMR of benzoic acid:





White crystalline solid: mp 120-122 °C (corrected); IR (neat) λ_{max} 3071 (br), 1696, 1417, 1319, 1288 cm^{-1} ; $^1\text{H NMR}$ (60 MHz, CDCl_3) δ 12.09 (br s, 1H), 8.27-7.97 (m, 2H), 7.77-7.30 (m, 3H).

Note that the broad carboxylic acid O-H stretch on the IR has a "br" next to it to indicate how broad it is. Also, the proton from the CO_2H (at 12 ppm) is broader than normal, and this is also indicated.

Plagiarism (and How to Avoid It)

When you use someone else's words, ideas, and/or other material (such as images) without identifying them as a source, you are committing a form of academic dishonesty known as plagiarism. If you are caught committing plagiarism, you will be reported to the Office of Student Rights and Responsibilities and receive a grade penalty (which could be as severe as an 'F' for the entire course), so it is in your best interest to avoid plagiarism.

The first step to avoiding plagiarism is to make sure to cite all sources used whether they be a textbook, journal article, website, or other source (see the previous section on "The ACS Format for Citing and Listing References" for the proper way to do this). Keep in mind that even if the words are your own, but the idea is not, you must cite the source where the idea came from. Next, always be sure to explain what you read from the source in your own words. In the rare event that you must quote the source directly, be sure to use quotations. (Keep in mind that quotes are generally not considered acceptable in scientific papers and you will usually get marked down if you do this in a lab report.) Further, do not use any images that you can make yourself in ChemDraw. You do not have to cite ChemDraw if you make an image in ChemDraw. (You wouldn't cite Microsoft Word just because you used it to write your report.) If you find an image you need to use that is impossible to duplicate on your own, be sure to make it clear that the image is not your own.

Finally, take care that you do not plagiarize from other students. This means that if you work together, you must make sure that you both use your own words and ChemDraw images (i.e., do not copy).

References & Additional Resources

1. Lehman, J. W. *The Student's Lab Companion: Laboratory Techniques for Organic Chemistry*, 2nd ed.; Prentice Hall: Upper Saddle River, NJ, 2008; pp 36-37.
2. *The ACS Style Guide* [Online]; Coghill, A. M, Garson, L. R., Eds.; American Chemical Society: Washington, DC, 2006. <http://pubs.acs.org/isbn/9780841239999> (accessed Aug 18, 2015).
3. Spectral Database for Organic Compounds SDBS. National Institute of Advanced Industrial Science and Technology (AIST). <http://sdb.sdb.aist.go.jp> (accessed Sept 13, 2015).