

Writing the Laboratory Notebook

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University Relations and Fellowship Programs



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What makes a good Research Notebook?

"Faraday's handwritten notebooks...have long been of interest to historians and philosophers of science because of the extraordinarily direct insight they give into the way his thinking developed.... They are also remarkable in the amount of detail that they give about the design and setting up of experiments, interspersed with comments about their outcome and thoughts of a more philosophical kind. All are couched in plain language, with many vivid phrases of delightful spontaneity...."

— Peter Day, "The Philosopher's Tree: A Selection of Michael Faraday's Writings"

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What's the point of a Research Notebook?

- It tells exactly what was done, and when
- It makes it clear who did it
- It enables someone else to reproduce the work
- It is durable and verifiable

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Why keep a Research Notebook?

- Record for yourself
- Record for those who follow
- Regulatory audits
- Patent protection

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U.S. Patent Law is unique

- Other countries: first to file wins
- U.S.: first to invent wins
 - BUT you must be able to prove it!
 - Notebooks must be clear, easy to authenticate, and obviously original.

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The Equipment needed

- Bound notebook(s) with numbered pages
- Good pen (never pencil!)
- Don't be stingy with the paper, make sure what you write is legible and easy to follow

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What do I put in it?

Basics:

- You must sign and date each entry/page
- You may need a witness to sign/date as well
 - Patent protection
- Never leave large blank space on a page – put an "X" over that portion – *never* go back and make new entries on a previously signed/dated/witnessed page.
- Make sure there is a Table of Contents

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What do I put in it?

- Introduction
 - Discuss the broad basis for what you will study and why
- Experimental design
 - Use lists of steps for clarity
 - Make clear drawings of unique equipment
 - Sectional
 - Large enough to allow labels
 - Simple, to the point

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Sample Page

Clear statement of next steps

Note the "plain language" discussing results

Credit where it is due

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9/26/96

Build sample for OF. See copy of 9/26/96

Then sample put in for analysis
re 116 A - 500 24818557 5000
re 200 A - communication 13760 2000
vrt 02/02

Can sample put in for analysis
re 116 A - 500 24818557 5000
re 200 A - communication 13760 2000
re 117 vrt 02/02

more data, especially with frequency for both
very important

9/26/96

With spectrum not just needed - 9/26/96
but covering the run schedule for the report
(and 1/28 again before it goes in) - call
for more information - 1/28/96 (1/28/96)

Testing will consist of by doing a run - job
of 1 unit 1165 A - another 1/28/96 +
the one on 200 A again - (1/28/96)

The book 116 had on 200 A the next morning - 200
consistency of all read to get some more
to see if it is there

Call 116... make it 1/28/96 - 1/28/96
then repeat for the (2 the second job done 2/28/96)
The next morning

1/28/96

What do I put in it?

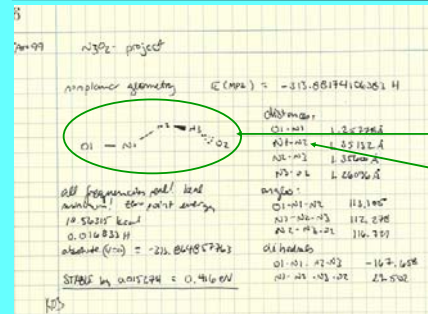
■ Data/results

- Record data *as you take it* – don't trust memory
- Do not write on scrap paper – put it in your notebook
- Put in your observations and thoughts
- Do not put in stray marks without explanation
- If data is computer printed, permanently affix it into the notebook and sign over the seam
- Tables should be properly formatted!
- Graphs should be properly labeled!

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Clearly indicating your "language" is critical!



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What do I put in it?

■ Analysis/Conclusions

- Make sure your calculations are clear and *use units*
- Use words to explain the steps of calculations
- Discuss interpretation of data in plain language
- Postulate any further experiments needed to clarify your conclusions

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Clear Calculations

Confidence limits are important

Note the use of units!

024

Geometric Determination of Chloride in a Soluble Sample

Run #	% Cl
1	65.72 ± 0.11
2	65.78 ± 0.10
3	66.19 ± 0.10

Mean % Cl = 65.95 ± 0.54
 Relative Mean Deviation = 2.3 ppt
 Relative Error = -8.0 ppt

Sample Calculations from Run # 2

$QCl = 0.9182 \text{ g AgCl} \times \frac{1 \text{ mol AgCl}}{143.32 \text{ g/mol}} \times \frac{1 \text{ mol Cl}}{1 \text{ mol AgCl}} = 0.1282 \text{ mol Cl}$

$\% Cl = \frac{0.1282 \text{ mol Cl}}{0.1975 \text{ g sample}} = 64.19$

Standard deviation = $\sqrt{\frac{(65.95-65.72)^2 + (65.95-65.78)^2 + (65.95-66.19)^2}{2}}$

$= 0.2120$

Confidence 95%

$ME \pm 1.96 \sigma$ $ME \pm 95.95 \pm \frac{(1.96)(0.2120)}{\sqrt{3}}$

$ME \pm 65.95 \pm 0.4820$ $ME \pm 65.95 \pm 0.53$

KJL 3/18/17

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Discussion of your results includes your ideas

Data: The filtrate of the 1st decolorization of brown sugar was almost perfectly clear. The filtrate of the 2nd decolorization of brown sugar was tinted amber.

In the purification of naphthalene, 0.960 g were recovered. They appeared (the crystals) in plate form and were very white.

Conclusion: If more decolorizing charcoal is used, a better decolorization occurs, but this can reduce yield; the carbon can also absorb the desired product also.

In the purification of naphthalene, a distinct color change and loss of visible impurities indicate that recrystallization is a valid method of purification.

Kelli Sudd
3/20/16

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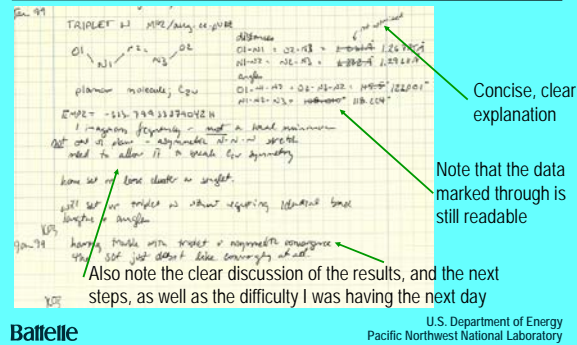
What if I make a mistake?

- Never erase or obliterate an entry! Don't use liquid paper or bleach or any other method to cover or remove the ink.
- Use a single line to mark through the entry, making sure it is still readable – you may still need it!
- Write a short explanation of the error
- Put in the new information

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Example of error correction



The image shows a handwritten page from a lab notebook. The text is written in black ink on lined paper. There are several lines of text, some of which are crossed out with a single horizontal line. Green arrows point from text annotations to specific parts of the handwriting. The annotations include: 'Concise, clear explanation' pointing to a line of text; 'Note that the data marked through is still readable' pointing to a line of text that has been crossed out; and 'Also note the clear discussion of the results, and the next steps, as well as the difficulty I was having the next day' pointing to a paragraph of text. The handwriting is legible despite the corrections.

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What if I find a mistake from days ago?

- It is best not to go back and "edit" a previous page
- Make a note on the current entry, referencing the previous page, and enter the corrected information
- On the previous page, draw a line through the error, and reference the new page. Make sure to date and initial this entry.
- If the previous page had been witnessed, make sure the witness sees the correction and "re-witnesses"

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This all seems rather tedious... BUT!

- It's for your protection!
- It will help tremendously when you write the paper about the study
- It will be of great use to your lab after you leave

Remember, this is a research laboratory, and not an academic setting! It is very important for the success of the work that you respect the guidelines set by your mentor.

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A Final Thought...

"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 science."

—Howard M. Keesom, "Writing the Laboratory Notebook"

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