These are excerpts from a series of documents on ‘Writing at the University of Toronto’, specifically “How to write a lab report”: http://www.writing.utoronto.ca/advice/specific-types-of-writing/lab-report

A good lab report does more than present data; it demonstrates the writer's comprehension of the concepts behind the data. Bear in mind that a format, however helpful, cannot replace clear thinking and organized writing. You still need to organize your ideas carefully and express them coherently.

We emphasize that the hints below constitute a complete description on how to write a formal lab report. The day-to-day lab reports you will write will be informal, therefore, you will reduce Abstract, Introduction to a minimum and will not include References, Appendices and Further Reading unless you feel that they are absolutely necessary.

Keep it short!

Typical Components (complete list)

- Title
- Abstract
- Introduction
- Methods and Materials (or Equipment)
- Experimental Procedure
- Results
- Discussion
- Conclusion
- References
- Appendices
- Further Reading

1. The Title needs to contain the name of the experiment, the names of lab partners, and the date. Titles should be straightforward, informative, and less than ten words (i.e. Not "Lab #4" but "Lab #4: Sample Analysis using the Debye-Sherrer Method").

2. The Abstract summarizes four essential aspects of the report: the purpose of the experiment (sometimes expressed as the purpose of the report), key findings, significance and major conclusions. The abstract often also includes a brief reference to theory or methodology. The

information should clearly enable readers to decide whether they need to read your whole report. The abstract should be one very short paragraph.

Quick Abstract Reference

Must have:

1. Purpose
2. Key result(s)
3. Most significant point of discussion
4. Major conclusion

May Include:

1. Brief method
2. Brief theory

3. The introduction is more narrowly focussed than the abstract. It states the objective of the experiment and provides the reader with background to the experiment. State the topic of your report clearly and concisely, in one or two sentences:

Quick Intro Reference

Must Have:

1. Purpose of the experiment
2. Important background and/or theory

May include:

1. Description of specialized equipment
2. Justification of experiment's importance

Example: The purpose of this experiment was to identify the specific element in a metal powder sample by determining its crystal structure and atomic radius. These were determined using the Debye-Sherrer (powder camera) method of X-ray diffraction.

A good introduction also provides whatever background theory, previous research, or formulas the reader needs to know. Usually, an instructor does not want you to repeat the lab manual, but to show your own comprehension of the problem. For example, the introduction that followed the example above might describe the Debye-Sherrer method, and explain that from the diffraction angles the crystal structure can be found by applying Bragg's law. If the amount of introductory material seems to be a lot, consider adding subheadings such as: Theoretical Principles or Background.

Note on Verb Tense

Introductions often create difficulties for students who struggle with keeping verb tenses straight. These two points should help you navigate the introduction:

- The experiment is already finished. Use the past tense when talking about the experiment.

  "The objective of the experiment was..."

- The report, the theory and permanent equipment still exist; therefore, these get the present tense:

  "The purpose of this report is..."

  "Bragg's Law for diffraction is ..."

  "The scanning electron microscope produces micrographs ..."

4. Methods and Materials (or Equipment) can usually be a simple list, but make sure it is accurate and complete. In some cases, you can simply direct the reader to a lab manual or standard procedure: "Equipment was set up as in CHE 276 manual."

5. Experimental Procedure describes the process in chronological order. Using clear paragraph structure, explain all steps in the order **they actually happened**, not as they were supposed to happen. If your professor says you can simply state that you followed the procedure in the manual, be sure you still document occasions when you did not follow that exactly (e.g. "At step 4 we performed four repetitions instead of three, and ignored the data from the second repetition"). If you've done it right, another researcher should be able to duplicate your experiment.

6. Results are usually dominated by calculations, tables and figures; however, you still need to state all significant results explicitly in verbal form.

Quick Results Reference

1. Number and Title tables and graphs
2. Use a sentence or two to draw attention to key points in tables or graphs
3. Provide sample calculation only
4. State key result in sentence form

Results have to be quoted with error and with the appropriate number of significant figures.

Graphs need to be clear, easily read, and well labeled.

In most cases, providing a sample calculation is sufficient in the report.

7. Discussion is the most important part of your report, because here, you show that you understand the experiment beyond the simple level of completing it. Explain. Analyse. Interpret. Some people like to think of this as the "subjective" part of the report. By that, they mean this is what is not readily observable. This part of the lab focuses on a question of understanding "What is the significance or meaning of the results?" To answer this question, use both aspects of discussion:

Analysis	Interpretation
What do the results indicate clearly? What have you found? Explain what you know with certainty based on your results and draw conclusions:	What is the significance of the results? What ambiguities exist? What questions might we raise? Find logical explanations for problems in the data:
Since none of the samples reacted to the Silver foil test, therefore sulfide, if present at all, does not exceed a concentration of approximately 0.025 g/l. It is therefore unlikely that the water main pipe break was the result of sulfide-induced corrosion.	Although the water samples were received on 14 August 2000, testing could not be started until 10 September 2000. It is normally desirably to test as quickly as possible after sampling in order to avoid potential sample contamination. The effect of the delay is unknown.

More particularly, focus your discussion with strategies like these:

Compare expected results with those obtained.

If there were differences, how can you account for them? Saying "human error" implies you're incompetent. Be specific; for example, the instruments could not measure precisely, the sample was not pure or was contaminated, or calculated values did not take account of friction.

Analyze experimental error.

What kind of error dominated the experiment? Was it avoidable? Was it a result of equipment? If the flaws result from the experimental design explain how the design might be improved.

Explain your results in terms of theoretical issues.

Often undergraduate labs are intended to illustrate important physical laws, such as Kirchhoff's voltage law. Usually you will have discussed these in the introduction. In this section move from the results to the theory. How well has the theory been illustrated?

Relate results to your experimental objective(s).

If you set out to identify an unknown metal by finding its lattice parameter and its atomic structure, you'd better know the metal and its attributes.

Compare your results to similar investigations.

In some cases, it is legitimate to compare outcomes with classmates, not to change your answer, but to look for any anomalies between the groups and discuss those.

Analyze the strengths and limitations of your experimental design.

This is particularly useful if you designed the thing you're testing (e.g. a circuit).

8. Conclusion can be very short in most undergraduate laboratories. Simply state what you know now for sure, as a result of the lab:

Quick Conclusion Reference

Must do:

1. State what's known

    Justify statement

Might do:

1. State significance
2. Suggest further research

Example: The Debye-Sherrer method identified the sample material as nickel due to the measured crystal structure (fcc) and atomic radius (approximately 0.124nm).

Notice that, after the material is identified in the example above, the writer provides a justification. We know it is nickel because of its structure and size. This makes a sound and sufficient conclusion. Generally, this is enough; however, the conclusion might also be a place to discuss weaknesses of experimental design, what future work needs to be done to extend your conclusions, or what the implications of your conclusion are.

9. References include your lab manual and any outside reading you have done.

To learn more about writing science papers, visit our handout on writing in the sciences.