Formal Lab Report Guidelines

In general, the goal of a lab report is to document your findings and communicate their significance. A good lab report does more than present data; it demonstrates the writer's comprehension of the concepts behind the data. Merely recording the expected and observed results is not sufficient; you should also identify how and why differences occurred, explain how they affected your experiment, and show your understanding of the principles the experiment was designed to examine. 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.

1. The Title Page needs to contain the name of the experiment, the name of the author, 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: Resistors in Series and Parallel").

2. The Introduction 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:
   Example: The purpose of this experiment was to understand how combinations of resistors act as an equivalent resistance. We will test whether our equations for equivalent resistance in series and in parallel are accurate.

   A good introduction also provides whatever background theory, previous research, or formulas the reader needs to know. Do not repeat the lab manual, but show your own comprehension of the problem. For example, the introduction that followed the example above might explain why resistances in series are added to get the equivalent resistance, etc.

3. Methods and Materials (or Equipment) can usually be a simple list, but make sure it is accurate and complete. You should also explain how equipment is setup. For example, you might say, “In part one of this lab, three resistors are connected in parallel. See the circuit diagram below.”

4. 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 you've done it right, another researcher should be able to duplicate your experiment. For example, you might say, “I then measured the voltage drop across each resistor and the current through the series circuit.”

5. Results are usually dominated by calculations, tables and figures; however, you still need to state all significant results explicitly in verbal form, for example: “The table below shows the resistance of each resistor as measured with the ohmmeter and the resistance as calculated using Ohm’s law.”
<table>
<thead>
<tr>
<th></th>
<th>R (Ohms)</th>
<th>V (mV)</th>
<th>V/I (V/Ohm)</th>
<th>error</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1</td>
<td>1020</td>
<td>45.3</td>
<td>1030</td>
<td></td>
</tr>
<tr>
<td>R2</td>
<td>1036</td>
<td>451</td>
<td>10250</td>
<td></td>
</tr>
<tr>
<td>R3</td>
<td>1156</td>
<td>503</td>
<td>11431</td>
<td></td>
</tr>
</tbody>
</table>

Graphs need to be clear, easily read, and well labeled (e.g. Figure 1: Input Frequency and Capacitor Value). An important strategy for making your results effective is to draw the reader's attention to them with a sentence or two, so the reader has a focus when reading the graph. In most cases, providing a sample calculation is sufficient in the report. Leave the remainder in an appendix. Likewise, your raw data can be placed in an appendix. Refer to appendices as necessary, pointing out trends and identifying special features.

6. **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. Analyze. Interpret. All questions posed in the lab manual should be answered here in paragraph form. You may also include your own analysis of the lab using the following guide:

1. **Analysis**
   What do the results indicate clearly? What have you found? Explain what you know with certainty based on your results and draw conclusions.

2. **Interpretation**
   What is the significance of the results? What ambiguities exist? What questions might we raise? Find logical explanations for problems in the data.

   **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.**
   Was it avoidable? Was it a result of equipment? If an experiment was within the tolerances, you can still account for the difference from the ideal. 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 laws. 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).

7. **Conclusion** can be very short. Simply restate your results along with brief errors. For example, “We have proven that resistors in series combine their resistance according to equation 1 with an accuracy of 1%.” This makes for 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.

8. **Appendices** typically include such elements as raw data, calculations, graphs pictures or tables that have not been included in the report itself. Each kind of item should be contained in a separate appendix. Make sure you refer to each appendix at least once in your report. For example, the results section might begin by noting: "Micrographs printed from the Scanning Electron Microscope are contained in Appendix A." You may not have any appendices as all your data might be included in the lab report itself.