Academic English

Section 11: Writing a Laboratory report

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Grading Lab Reports

- the lab report guidelines were followed
- Correct format with each section with title clearly labeled
- Grammar, punctuation and spelling checked
- Sufficient & relevant background information
- In the Procedures/Results sections 3rd person passive voice
- Results thoroughly explained in the Discussion
- Sources of information correctly cited/referenced
Lab report Format

- **Introduction**
  - Background Information
  - Purpose
  - Hypothesis

- **Procedures**

- **Results**
  - Tables and Figures
  - Description of Data

- **Discussion**
  - Conclusions
  - Explanation of Results
  - Future Experiment

- **Literature Citations** (References)
Introduction

Look at the example intro given and evaluate its:

- content
- format
- style
As described in the lab manual: 1. **Record** the barometric pressure.
2. **Measure** about 10 g of ice using the chemical balance and place it into a 100 mL beaker. Heat over a flame until half of the ice has melted. Remove from heat and measure the temperature as accurately as possible using your laboratory thermometer. Repeat with a 10.0 g sample of your unknown. Be sure to record your unknown number. 3. Measure 50 mL of water using your graduated **cylindar** and pour it into a 200 mL beaker. Bring the liquid to a boil over a flame. After the liquid **has been boiling** for approximately 1-2 minutes, measure the temperature of the boiling liquid. Repeat with a 10 g sample of your unknown. Record all data in your lab notebook and clean up.

We followed all the steps above **pretty much** closely and pretty much got the results for water expected, except that the stockroom had cheap thermometers because one of them broke (this was my lab partner’s fault – she used it as a stirring rod which is exactly what you said not to do in your lecture) and the new one was off by a few degrees – but it was close enough for this simple experiment. The pressure in the room was **761.2** and the temperatures measured for our unknown were: **-15** and **17**
Correcting our water results this made our measurements −15.2 and 17.4 after the corrections. Based on these temperatures and the data we looked up in the library, it was certainly “blabber gas.” The error was really small and the experiment worked really good. Other errors include: possible math errors in our calculations and human error. Overall the lab was really good and we learned quite a lot of stuff. I especially liked the part where the blabber gas exploded when heated scaring my partner (I think that may be why she broke the thermometer). The only criticism of the lab is that the equiptment wasn’t really great and that we ran out of time but otherwise it was a really good experinence and I think it taught us a lot of chemistry.

Notes: For references we used our textbook, lab manual, and the Chemical Handbook found on shelf 2 of the library (behind the reference desk).

From: http://homepage.smc.edu/gallogly_ethan/sample_lab_reports.htm
In this site you can also find an improved version of the same report!
Introduction

- Background Information
- Hypothesis
- Purpose
From general to specific

- **First:**
  - Why a non-scientist would be interested in the topic.
  - How the topic relates to human concerns.

- **Later:**
  - What was used in the study and why.
  - Background information on topics the reader should know to understand the basis for the experiment and its results.

- **Near the end:**
  - The variable tested and why it may have an effect.
  - What previous investigations have found.
Identification of a Compound using Melting and Boiling Points

Introduction

One of the primary methods used to characterize a new compound is the physical determination of its normal melting and boiling points. The “normal” melting and boiling point is the temperature at which a substance melts or boils when the barometric pressure is 760 mmHg or 1 atm. In this experiment we will first calibrate our thermometers using ice and water, whose normal melting and boiling points are well characterized as 0.0 °C and 100.0 °C, respectively [1]. Following this, we will measure the normal melting and boiling points of an unknown compound. We will use this data to determine the identity of our unknown from a list of possible unknown samples and physical data from the Chemical Handbook[2].
Procedures

- Experimental set up
- Instrumentation
- Materials (reagents)
- Variables (conditions)
- Calculations
  - calibration of instruments and special features e.g. how well the temperature was controlled
  - barometric pressure
  - concentrations of solutions (with an indication of calculations)
Procedures

- Rewrite the original instructions in a clear, logical and concise sequence.
- The order instructions are given in the lab manual are not always the best for a Procedures section.
Experimental Procedure

As described in the lab manual,[3] ice was placed in a beaker and warmed until approximately 50% had melted. The temperature of the ice/water mixture was then measured with a thermometer. This was followed by a similar measurement of our solid unknown. In part II, water was heated until boiling and the temperature of the liquid/gas mixture measured with a thermometer. This was followed by a similar measurement using our unknown compound. To get the best results possible, the procedure in the manual was modified by repeating each trial three times.

From: http://homepage.smc.edu/gallogly_ethan/sample_lab_reports.htm
“I measured the number of tree rings in cross-sections of 9 spruce trees.”
The number and width of tree rings were measured in cross-sections of 9 spruce trees.
"I obtained 10 grams of NaCl from the front bench and dissolved it in 250 ml of water in a glass beaker. The data were recorded in a table"
Lab Report Procedures section

- “Ten g of NaCl were dissolved in 250 ml of water“

- It is assumed that data are recorded. Note also that a sentence should not begin with an arabic number (i.e., "10").
“The width of the tree rings was measured in millimeters using calipers while viewing the tree sections under a microscope.”
Lab Report Procedures section

- “The width of the tree rings was averaged for a 10 year span for all 9 trees.”

✓
Results

- Tables and figures
- Description of data
Data & Results

The barometric pressure in the lab was measured to be 761.2 mmHg.

### Table One – Experimental Data

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.7 °C *</td>
<td>101.2 °C</td>
<td>80.2 °C</td>
<td>272.7 °C</td>
</tr>
<tr>
<td>2</td>
<td>0.1 °C</td>
<td>101.1 °C</td>
<td>80.7 °C</td>
<td>272.8 °C</td>
</tr>
<tr>
<td>3</td>
<td>0.0 °C</td>
<td>100.9 °C</td>
<td>80.4 °C</td>
<td>273.0 °C</td>
</tr>
<tr>
<td>4</td>
<td>0.1 °C n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Averages:</td>
<td>0.15 °C</td>
<td>101.1 °C</td>
<td>80.4 °C</td>
<td>272.8 °C</td>
</tr>
<tr>
<td>Standard deviation (s):</td>
<td>± 0.06</td>
<td>± 0.15</td>
<td>± 0.15</td>
<td>± 0.06</td>
</tr>
<tr>
<td>95% confidence limits:</td>
<td>± 0.14</td>
<td>± 0.4</td>
<td>± 0.4</td>
<td>± 0.14</td>
</tr>
</tbody>
</table>

* This trial was eliminated because the thermometer was broken (there was a bubble of air in the mercury). A new thermometer was obtained from the stockroom.

**Observations:** The unknown was yellowish-orange in color and had a fruity smell.

As can be seen from our water data the experimental values for the melting and boiling points of water differed from the theoretical values by +0.15 °C and +1.1 °C. These values are used to calibrate the average data for the unknown. Thus the corrected values for the unknown boiling and melting points are given in Table 2.

### Table Two – Corrected Temperatures

<table>
<thead>
<tr>
<th></th>
<th>Unknown 7 Melting Pt. °C</th>
<th>Unknown 7 Boiling Pt. °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measured value</td>
<td>80.4 °C ± 0.4 (95%)</td>
<td>272.80 ± 0.14 °C (95%)</td>
</tr>
<tr>
<td>Correction</td>
<td>+0.15 °C</td>
<td>+1.1 °C</td>
</tr>
<tr>
<td>Corrected value</td>
<td>80.5 °C ± 0.4 (95%)</td>
<td>273.90 ± 0.14 °C (95%)</td>
</tr>
</tbody>
</table>

These values were used to identify our unknown. Table Three below lists possible unknowns and the melting and boiling points for these compounds found in your lab.
Tables and Figures

A correctly prepared table should:

1) be sequentially numbered (Table 1, Table 2, etc.)

2) have a **descriptive** title

3) have rows and columns clearly labeled.
Table 1. Effect of different pollutants on *Chlorella*.

<table>
<thead>
<tr>
<th>Ecosystem</th>
<th># of cells</th>
<th>% of control</th>
</tr>
</thead>
<tbody>
<tr>
<td>control</td>
<td>20</td>
<td>--</td>
</tr>
<tr>
<td>pollutant 1</td>
<td>23</td>
<td>115%</td>
</tr>
<tr>
<td>pollutant 2</td>
<td>3</td>
<td>15%</td>
</tr>
<tr>
<td>pollutant 3</td>
<td>10</td>
<td>50%</td>
</tr>
<tr>
<td>pollutant 4</td>
<td>19</td>
<td>95%</td>
</tr>
</tbody>
</table>

The description of this data might be: The effects of the four pollutants on algal cell growth was also investigated. The number of *Chlorella* cells remaining after twenty days growth with each pollutant is shown in Table 1. The control (grown in spring water only) contained $20 \times 10^6$ cells per ml. Pollutant 2 had the most dramatic effect, reducing the cell count to $3 \times 10^6$ cell/ml (15% of the control). Pollutant 3 reduced the cell count to $10 \times 10^5$ cells/ml (50% of the control). Pollutants 1 and 4 had very little if any effect, yielding 115% and 95% of the control, respectively.
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Experimental Value</th>
<th>Literature Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\omega_e - 2\omega_e$</td>
<td>$2142.2 \pm 0.1 \text{ cm}^{-1}$</td>
<td>$2143.3 \text{ cm}^{-1}$</td>
</tr>
<tr>
<td>$B_e$</td>
<td>$1.933 \pm 0.008 \text{ cm}^{-1}$</td>
<td>$1.9313 \text{ cm}^{-1}$</td>
</tr>
<tr>
<td>$\omega_e$</td>
<td>$0.018 \pm 0.002 \text{ cm}^{-1}$</td>
<td>$0.01748 \text{ cm}^{-1}$</td>
</tr>
<tr>
<td>$R_e$</td>
<td>$0.1128 \pm 0.0007 \text{ nm}$</td>
<td>$0.11281 \text{ nm}$</td>
</tr>
</tbody>
</table>

Examples of a correctly prepared Graph:

![Graph showing oxygen uptake vs temperature](image)

**Figure 1.** Oxygen uptake by barley seeds measured at different temperatures.

The description of this data might be:

Figure 1 presents the uptake of oxygen by barley seeds over a five minute period. Temperatures tested ranged from 0 to 25 degrees Celsius. At the lowest temperature, no oxygen uptake occurred. As the temperature was increased, oxygen uptake by the seeds increased in a linear fashion, to a maximum value of 5 ml O₂ at 25 °C.
Description of Results should:

- Locate your findings. (e.g. Table 1 shows…)

- Use **third person** passive voice.

- Describe the **key features** and trends that you perceive in the data presented in the figures and tables.

- Do **Not interpret** the data. Explaining what the results mean or why the results occurred is done in the Discussion section of the lab report.
Results: Numbers and units

- Numbers should never stand alone—they must be accompanied by appropriate units (e.g. ml, cm, cm/sec, etc.).
- Decimal numbers should always have at least one numeral before the decimal point (0.47g not .47g).
- Superscripts and subscripts should be used when needed: 25°C, 80cm², H₂O
Discussion section

- Conclusions
- Explanation of results
- Future experiment
Discussion
Conclusions

The data did not support the hypothesis that increasing light intensity would cause a decrease in the number of stomata. Instead, between 1000 and 5000 lux, the stomatal density increased proportionally with the light intensity.

Conclusion relative to hypothesis.

Explanation of Results

It was expected that light intensity would cause a decrease in the number of stomata. Instead the opposite relationship was observed (figure 1). It is possible that the increase in the number of stomata was due to an increased rate of photosynthesis.

The function of stomata is closely related to photosynthesis. Mesophyll cells are the most important cells for photosynthesis in the leaf and need a source of CO₂ (Raven et al., 2008, 737). Somata form pores in the leaf to allow exchange of CO₂ and water through the leaf cuticle layer to the underlying mesophyll cells (Buchanan et al., 2000, 651). Photosynthesis also increases as the amount of light increases (Rabinovich and Govingee, 1995, 223), and it is possible that more stomata allow higher rates of photosynthesis to occur.

Other researchers have reported that stomatal density corresponds to other environmental factors, such as humidity and CO₂ concentration (Fraser et al., 2008, 773). Furthermore, mutant plants with abnormally high numbers of stomata were observed to have higher rates of photosynthesis.

Future experiment

If the number of stomata does allow for more photosynthesis, then we should be able to measure this. The increase in photosynthesis could be measured directly, or by comparing the size and weight of the plants.
Experimental Errors

- Human errors
- Measurement errors
- Statistical errors
How to use source information

- Never directly copy or quote sentences from your sources
- Ideas should be conveyed in your own words
- Sources should be cited and referenced
In-text Citations

If the source has a **single author**, then the citation is written as: (Smith, 1992, 97)

If the source has **two authors**, then the citation is written as: (Smith and Jones, 1997, 184)

If the source has **three or more authors**, the abbreviation ‘et al.’ is used after the first author’s name: (Smith et al., 1997, 184)
End-text references

Cover page

- Title of lab experiment performed
- Professor’s name
- Your name
- Team members
- Submission date
Title

- Is relevant, brief but specific
- Includes key research variables, research methodology used, and overall findings
- Written not as a full statement but a phrase describing the experiment (A, An, The)
# Rubric

## Lab Report Rubric (General)

<table>
<thead>
<tr>
<th>Points Awarded</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Introduction</strong></td>
<td>* Includes the question to be answered by the lab</td>
<td>One of the previous conditions is not met satisfactorily</td>
<td>Two of the previous conditions are not met satisfactorily</td>
<td>Three of the previous conditions are not met satisfactorily</td>
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<tr>
<td></td>
<td>* States the hypothesis and provides a justification to support position. Justification is based on sound reasoning and/or research</td>
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<tr>
<td></td>
<td>* Title is relevant, concise, and provides the reader with a clear understanding of what the lab is about</td>
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<tr>
<td></td>
<td>* Hypothesis is testable</td>
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<tr>
<td><strong>Procedure</strong></td>
<td></td>
<td>A description or step-by-step list of how the experiment was performed</td>
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<td>Description is unclear and/or could not be repeated</td>
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<td></td>
<td>* IV and DV are clearly defined, avoiding qualitative statement when possible</td>
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<td>* Control is present and reasonable</td>
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<td>* Constants table is complete and displays a well thought out list</td>
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</tbody>
</table>
## Rubric (continued)

<table>
<thead>
<tr>
<th>Results/Data</th>
<th>Trends not obvious and/or incorrect type of table or chart is used to display data</th>
<th>Results are unclear</th>
<th>Results are present, though too disorganized or poorly recorded to make sense of.</th>
</tr>
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<tbody>
<tr>
<td>* Results and data are clearly recorded, organized so it easy for reader to see trends</td>
<td>* Results and data are clearly recorded, organized so it easy for reader to see trends</td>
<td>* Results and data are clearly recorded, organized so it easy for reader to see trends</td>
<td>* Results and data are clearly recorded, organized so it easy for reader to see trends</td>
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<td>* All appropriate labels and units are included</td>
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<th>Analysis</th>
<th>Analysis is somewhat lacking in insight (more background research may have been needed), there is enough data although additional data would have been more powerful</th>
<th>Analysis is lacking in insight, not enough data was gathered to establish trends OR analysis does not follow data</th>
<th>Analysis poor, not enough data, inaccurate analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>The data and observations are analyzed accurately, trends are noted and explained, enough data was taken to establish conclusion</td>
<td>The data and observations are analyzed accurately, trends are noted and explained, enough data was taken to establish conclusion</td>
<td>The data and observations are analyzed accurately, trends are noted and explained, enough data was taken to establish conclusion</td>
<td>The data and observations are analyzed accurately, trends are noted and explained, enough data was taken to establish conclusion</td>
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</table>

<table>
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<th>Two of the previous conditions are not met satisfactorily</th>
<th>Three of the previous conditions are not met satisfactorily</th>
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<tr>
<td>* Summarizes the essential data used to draw the conclusions</td>
<td>* Summarizes the essential data used to draw the conclusions</td>
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<td>* Conclusions follow data (wild guesses or leaps of logic are not present)</td>
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<td>* Hypothesis is rejected or accepted based on the data</td>
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<td>* Error analysis</td>
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</table>

<table>
<thead>
<tr>
<th>Format</th>
<th>Organized with the correct headers</th>
<th>Somewhat lacking in organization, incorrect headers</th>
<th>Organization is haphazard or organization that is present impedes the ability of the reader to follow the document</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wiki links/link-backs are operational and present</td>
<td>Wiki links/link-backs are operational and present</td>
<td>Wiki links/link-backs are operational and present</td>
<td>Wiki links/link-backs are operational and present</td>
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<tr>
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<td>No spelling errors and/or grammar errors</td>
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<td>Present but not operational or link to incorrect pages</td>
<td>Present but not operational or link to incorrect pages</td>
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<td>Incorrect labeling or non-existent</td>
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<td>Multiple spelling and/or grammar errors present</td>
<td>Multiple spelling and/or grammar errors present</td>
<td>Multiple spelling and/or grammar errors present</td>
</tr>
</tbody>
</table>
References

- http://www.ncsu.edu/labwrite/lc/lc-improvinglaprep.htm
- https://lfcdsscience8.wikispaces.com/Lab+Report+Template
- http://www.udel.edu/pchem/C446/example.pdf
End of Section
Financing

- The present educational material has been developed as part of the educational work of the instructor.

- The project “Open Academic Courses of the University of Crete” has only financed the reform of the educational material.

- The project is implemented under the operational program “Education and Lifelong Learning” and funded by the European Union (European Social Fund) and National Resources.
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