CHE 255 LAB REPORTS WRITING WORKSHOP MANUAL

Description

The sharing of research methods, results and ideas is fundamental to the development of the chemical engineering profession. Due to the importance of contribution and publication, researchers need to be confident about their writing and the presentation of their findings and ideas. Producing a functioning lab report is one of the most essential parts of this process. A lab report requires careful planning if it is to appropriately fulfill its purposes: (1) to summarize the lab work, methods, and results (2) to contribute to the ongoing discussions of research in your field. For these purposes, this workshop overviews the methods and strategies most common to the construction of a lab report and suggests how to evaluate its writing. At the conclusion of this workshop, students will have acquired a set of skills necessary to write their own chemical engineering lab reports and to evaluate them in terms of both strengths and weaknesses. This workshop will last approximately 75 minutes, and will be hosted by the **College Writing Center**, currently located on the 4th floor of Dewey Hall, at the University of Rochester. The Writing Center offers free, individualized tutoring both on-line and person for UR students. Please refer to http://writing.rochester.edu/ for more information.

1. OVERVIEW

1.1 The Functions of the Lab Report

- To shed light on previously unexplained phenomena
- To prove or disprove others' work on a subject
- To improve on the efficiency or precision of others' work
- To show others how to duplicate your work for verifying results
- To ponder the meaning of your results within the context of others' work

1.2 Structure of the Lab Report

Title Page	Includes the name of the university, department, and course number. The title of the lab experiment is printed in bold in the center of the page. The student's name appears below the title. Group members are listed in alphabetical order and its leader is identified. The date of experiment, submitted date, and name of the instructor are shown near the bottom.
Executive Summary	An abbreviated form of the most important parts of the report. Usually the summary addresses: purpose of the experiment, given facts and data, assumptions, measured data, and results or conclusions. Details are not included.
Objective, Purpose, or Introduction	Discusses what the experiment hoped to accomplish. Typical aims include: (1) To shed light on previously unexplained phenomena, (2) To prove or disprove others' work on a subject, (3) To improve on the efficiency or precision of others' work, (4) To show others how to duplicate your work for verifying results, (5) To ponder the meaning of your results within the context of others' work.
Equipment and Apparatus	A list of Apparatus used in the experiments is frequently included in student laboratory reports. However, descriptions are usually not included. Common lab equipment, like stopwatches and scales, are typically excluded from the list.
Sample Calculations	Calculations clearly present the equations used with the data. Each section is labeled for easy identification. Results are underlined and indicated with an arrow drawn from the right margin. Explanations are not included in these calculations since the steps are self-explanatory. References are included for uncommon equations.
Laboratory Procedure or Methods	This section discusses the operation that is performed rather than listing the steps for performing the operation.

Data and Calculations	Data often includes sketches to identify the symbols that are used. The tables include column headings with units. The data is presented in the same sequence that it was collected and each section is clearly identified. An original data sheet may be included in the Appendix.
Discussion of Results	The discussion often begins with a brief summary of the results. All results are clearly identified. The discussion then compares the results from the different methods of determination. It also discusses the possible causes of irregularities with the anticipated results.
Conclusions	This section discusses the results with respect to the objectives stated at the beginning of the report. Sometimes, suggestions for further study or improvements may be suggested.
References	Lists sources of material for further research by the reader. The citations are alphanumeric and may include page numbers after the name of the publisher.
Figures and Tables	Graphs, charts, and other visuals are clearly titled and axes are clearly labeled with units that can be plotted from the data already presented without further calculation or conversion.
Appendices	Includes supplementary material used to reinforce the material, for example, original data sheet or extensive theory.

2. SAMPLE CHE 255 LAB EXECUTIVE SUMMARY

2.1 Task #1. Read the following summary and answer the questions that follow in small groups.

Vapor pressure of palladium from 1473 K to 1973 K

Summary:

(1) Most of the available vapor pressure data for palladium has been taken below the fusion temperature. (2) In fact, only a few experimental studies exist on the vapor pressure of liquid palladium. In this current study, vapor pressures were measured from 1473 K to 1973 K (from well above and well below the melting point). (3) In addition, the range in temperature covered in the current study represents one of the largest continuous investigations of palladium vapor pressure to date. (4) The vapor pressure of palladium was studied using a Knudsen effusion cell and a commercial thermogravimetric balance. (5) Vapor pressures were measured using four Knudsen cells of different effusion areas with consistent results. (6) The standard enthalpy of sublimation calculated via a third-law analysis of the vapor pressure data is (377.7 ± 0.2) $kJ \cdot mol^{-1}$, in excellent agreement with the recommended value of (377 ± 5) $kJ \cdot mol^{-1}$ from the most recent review of available palladium vapor pressure data.

1. What is the title? Does it clearly and succinctly suggest the paper's main objective?
2. What general field is the author(s) investigating, and why is this study important in relation to the general field?
3. What is the specific objective/purpose of this project? Is it clearly stated in the summary?
4. What methods does the author use in this lab? Would the intended reader be able to clearly understand the research process?
5. How did the author(s) address this specific research question?
6. What were the author(s) specific results? Did the author list too many, too few, or just right?
7. What does the author(s) contribute to the general conversation or similar areas of research?
8. The author does not italicize measurements (e.g., K, kJ). Does this matter? Why is the term "vapor pressure" repeated so often?
9. Provide 1 additional suggestion to revise this summary. Be specific!

3. OBJECTIVE/PURPOSE

3.1 Lab Objective/Purpose Outline

Move 1 **Establishing a Territory**

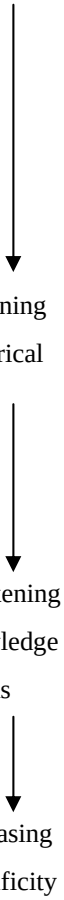
- Step 1 Claiming Centrality and/or
- Step 2 Making Topic Generalization(s) and/or
- Step 3 Reviewing Items of Previous Research

Move 2 **Establishing a Niche**

- Step 1A Counter-claiming
- Step 1B Indicating a Gap
- Step 1C Question-raising
- Step 1D Continuing a Tradition

Move 3 **Occupying the Niche**

- Step 1A Outlining Purposes and/or
- Step 1B Announcing Present Research
- Step 2 Announcing Principal Findings



3.2 Task #2. Read the following lab report introduction. Try to label the three moves and then the various steps within each move. Remember not all steps may be used!

(1) Metallic bonds comprise one of the most common sources of industrial refinement. (2) These bonds enable us to increase the concentrations of certain chemicals from their raw solutions. (3) They are widely used in the petroleum industry as well as many other industries. (4) In particular, Cu2+ and Zn2+ typically form more stable complexes than Mn2+. (5) Recent research has sought to clarify the unclear cellular mechanisms that manage Mn2+ acquisition by most nascent proteins. (6) To investigate this question, we identified the most abundant Cu2+-protein, CucA (Cu2+-cupin A), and the most abundant Mn2+-protein, MncA (Mn2+-cupin A), in the periplasm of the cyanobacterium *Synechocystis* PCC 6803. (7) Each of these newly identified proteins binds its respective metal via identical ligands. (8) MncA only binds Mn2+ after folding in solutions containing at least a 104 times molar excess of Mn2+ over Cu2+ or Zn2+. (9) However, once MncA has bound Mn2+, the metal does not exchange with Cu2+. (10) Export by the Tat pathway allows MncA to fold in the cytoplasm. (11) In contrast, CucA folds in the periplasm. (12) These findings reveal a mechanism whereby the compartment in which a protein folds overrides its binding preference to control its metal content. (13) These findings also explain why the cytoplasm must contain only tightly bound and buffered copper and Zn2+.

3.3 The Language of Introductions

A. Move 1 – Establishing a Territory ; Step 1 - Claiming Centrality

- The increasing interest in … has heightened the need for …
- Of particular interest and complexity are …
- Recently, there has been a spate of interest in how to …
- In recent years, applied researchers have become increasingly interested in …
- The possibility … has generated interest in …
- Recently, there has been wide interest in …
- The time development … is a classic problem in fluid mechanics.
- The explication of the relationship between … is a classic problem of …
- The well-known … phenomena … has been favorite topics for analysis both in …
- Knowledge of … has a great importance for …
- The study of … has become an important aspect of …
- The theory that … has led to the hope that …
- The effect of … has been studied extensively in recent years.
- Many investigators have recently turned to …
- The relationship between … has been studied by many authors.
- A central issue in … is the validity of …

B. Move 1 – Establishing a Territory; Step 3 – Reviewing Items of Previous Research

	Integral		**Non-Integral**	
1a	Brie (1988) showed that the moon is made of cheese.	Na	Previous research has shown that the moon is made of cheese (Brie, 1988).	Reporting Verbs
1b	The moon's cheesy composition was established by Brie (1988).	Nb	It has been shown that the moon is made of cheese (Brie, 1988).	
1c	Brie's theory (1988) claims that the moon is made of cheese.	Nc	It has been established that the moon is made of cheese [1-3].	
1d	Brie's (1988) theory of lunar composition has general support.	Nd	The moon is probably made of cheese (Brie, 1988).	Non-Reporting Verbs
1e	According to Brie (1988), the moon is made of cheese.	Ne	The moon may be made of cheese [1-3].	
		Nf	The moon may be made of cheese (but cf. Rock, 1989).	

C. Move 2 – Establishing a Niche

Step 1 A While some have argued that …… our study suggests the opposite.

(Counter-claim) While previous studies suffer from … and are limited to …. our study may provide alternatives that improve on the previous limitations.

Step 1 B The previous studies focused on adults, ages 21-45, but failed to consider children, ages 8-16 …

(Gap) While many have researched this growing trend in the United States, our study examines whether a similar situation exists in South Korea.

Step 1 C However, it is not clear whether the use of … can be modified for children, ages 8-16.

(Question) A question still remains whether these studies are applicable to other countries and cultures, such as South Korea.

Step 1 D This study continues the research of Dr. A and applies the same methods to children, ages 8-16.

(Continuation) The previous research suggested the direction for this study in ….

More examples:

S8 *However*, the previously mentioned methods *suffer from some limitations* …

S9 The first group … *cannot* treat … and is *limited to* …

S10 The second group … is *time consuming* and *therefore expensive*, and its … is *not sufficiently accurate*.

S11 Both … suffer from the dependency on …

S12 The … method, upon which the present method is based, eliminates many of these limitations by …, *but* it can treat *only* …

Language for Creating a Niche:

a) Negative or Quasi-negative Quantifiers

no little none (of) few / very few neither … nor

b) Lexical Negation

Verbs	fail, lack, overlook
Adjectives	inconclusive, complex, misleading, elusive, scarce, limited, questionable
Nouns	failure, limitation
Other	without regard for

c) Negation in the Verb Phrase

not rarely ill

d) Questions

Direct (e.g. How can this problem be solved?)

Indirect (e.g. “A question remains whether …”)

e) Expressed Needs/ Desires/Interests

The differences need to be analyzed …

It is desirable to perform test calculations …

It is of interest to compare …

f) Logical conclusions

Must (e.g. “This must represent …”)

Seem/Appear (e.g. “One would intuitively expect …”)

g) Contrastive Comment

The research has tended to focus on …, rather than …

They center mainly on …, rather than on …

Studies most often contrast …, rather than …

Researchers have focused primarily on …, as opposed to …

Emphasis has been on …, with scant attention given to …

Although considerable research has been done on …, much less is known as to …

h) Problem-raising

The application presents a problem …

A key problem in many … is …

D. Move 3 - Occupying the Niche; Step 1 – Outlining Purposes or Announcing Present Research

This paper reports on the results obtained …

The aim of the present paper is to give …

In this paper we give preliminary results of …

The main purpose of the experiment reported her was to …

This study was designed to evaluate …

The present work extends the use of the last model …

The purpose of this investigation is/was to …

3.4 Task #3: One More Introduction

Read the following introduction with your group and discuss whether or not it is an effective introduction. Each member of the group should propose ONE suggestion to improve the writing.

Distillation is one of the most common forms of industrial refinement. This process enables us to increase the concentrations of certain chemicals from their raw solutions. It is widely used in the petroleum industry as well as many other industries. Here we characterized the efficiency and heat loss of an experimental distillation column. All relative concentrations were evaluated using a gas chromatograph.

An ethanol-water mixture was purified through a five stage column under a reboiler power of 1200 to 1800 watts; it should be noted that the data from the high power points is susceptible to error as a result of inter-stage contamination. Our analysis encompassed both the Murphree efficiency from the column as well as heat losses. This characterization process would need to be re-preformed if a different mixture needed to be purified.

4. RESULTS AND DATA COMMENTARIES

4.1 Starting a Data Commentary

It is not easy to predict precisely what you might need to do in the results section of your writing, but here are some of the more common steps.

- Provide sufficient background
- Introduce the table and locate it for the reader.
- Highlight the key results.
- Explain the significance and/or implications of those key results.
- Conclude with a strong or weak claim stating how these results support your thesis. (Normally this part appears in the CONCLUSION section)

Look over Table 5, read the data commentary that follows, and then answer the questions.

TABLE 5 Source of Computer Virus Infections

Source of Virus	*Percentage*
E-mail attachments	87%
Disks from home	4%
Disks (other)	2%
Unknown	2%
Download (from internal or external sources)	2%

Distribution CD	1%
Disk (sales demo)	<1%
Automated software distribution	<1%
Disk (shrink-wrapped)	<1%
Disk (from LAN manager)	<1%
Malicious person	<1%
Browsing WWW	0%
Disk (from repair person)	0%
Total survey respondents	299

Source: Data from ICSA Labs Computer Virus Prevalence Study.

Note: Because respondents to the survey may have indicated more than one means of infection, the totals exceed 100%.

(1) A computer virus is a program that is specifically and maliciously designed to attack a computer system, destroying data. (2) As businesses have become increasingly dependent on computers, e-mail, and the Internet, concern over the potential destructiveness of such viruses has also grown. (3) Table 5, above, shows the most common sources of infection for U.S. businesses. (4) As can be seen from the first row, in a great majority of cases, the entry point of the virus infection can be detected, with e-mail attachments being responsible for nearly 9 out of 10 viruses. (5) This very high percentage is increasingly alarming, especially since with a certain amount of caution such infections are largely preventable. (6) In consequence, e-mail users should be wary of all attachments, even those from trusted colleagues or known senders. (7) In addition, all computers used for e-mail need to have a current version of a good antivirus program whose virus definitions are updated regularly. (8) While it may be possible to lessen the likelihood of downloading an infected file, businesses are still vulnerable to computer virus problems because of human error and the threat of new, quickly spreading viruses that cannot be identified by antivirus software.

1. Where does the data commentary actually start?
2. What are the purposes of sentences 1 and 2?
3. Which sentence contains the author’s key point?
4. The author has chosen to comment only on e-mail attachments. Why? Do you think this is enough? If not, what else should be discussed?
5. E-mail attachments constitute 87% of the total. In sentence 4, this is expressed as “nearly 9 out of 10.” What do you think about this and about the following alternatives?
    a. about 90%
    b. just under 90%
    c. as much as 87% of all
    d. nearly all

4.2 Structure of Data Commentary

Data commentaries usually have the following elements in the following order.

1. Location elements and/or summary statements
2. Highlighting statements
3. Discussions of implications, problems, exceptions, recommendations, etc.

Linking *as*-clause

Location + indicative summary **+ highlight**

(3) Table 5, above, shows the most common sources of infection for U.S. businesses. (4) As can be seen from the first row, in a great majority of cases, the entry point of the virus infection can be detected, with e-mail attachments being responsible for nearly 9 out of 10 viruses. (5) This very high percentage is increasingly alarming, especially since with a certain amount of caution such infections are largely preventable. (6) In consequence, e-mail users should be wary of all attachments, even those from trusted colleagues or known senders. (7) In addition, all computers used for e-mail need to have a current version of a good antivirus program whose virus definitions are updated regularly. (8) While it may be possible to lessen the likelihood of downloading an infected file, businesses are still vulnerable to computer virus problems because of human error and the threat of new, quickly spreading viruses that cannot be identified by antivirus software.

Implications

4.3 Location Elements and Summaries

Many data commentary sections begin with a sentence containing a location element and a brief summary. Location elements refer readers to important information in a table, chart, graph, or other figure.

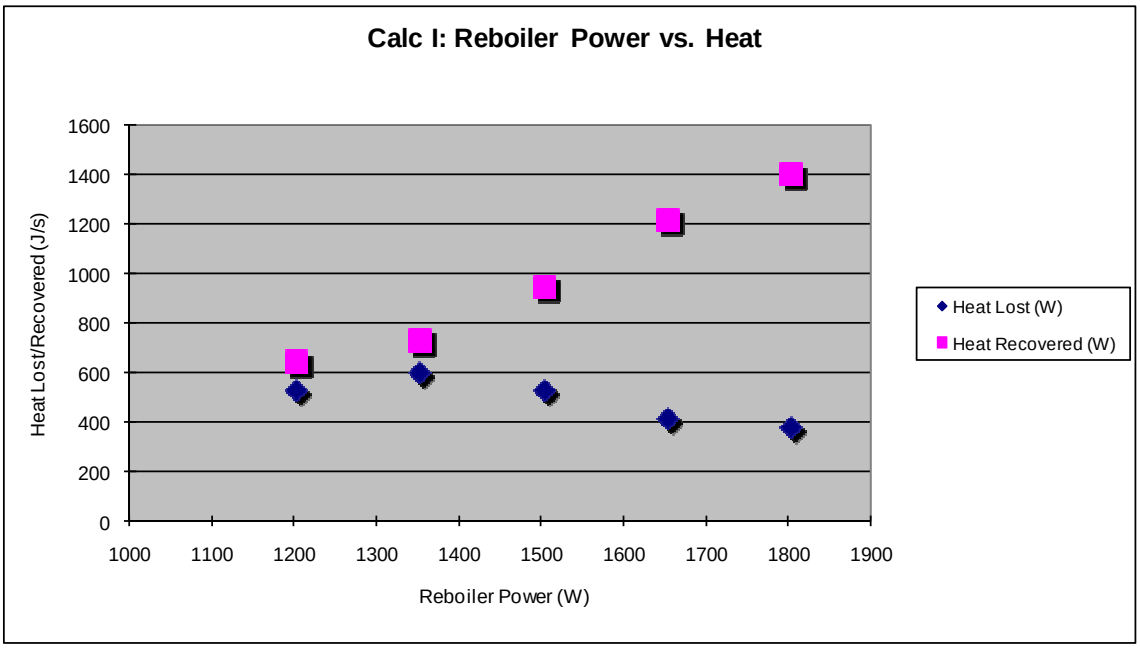
Location Element	*Summary*
a. Table 5 shows	the points of entry of computer viruses for U.S. businesses.
b. Table 2 provides	details of the fertilizer used.
c. Figure 2 plots	the two series for the last five years.
d. Figure 4.2 gives	the results of the second experiment.

The passive voice can also be used.

Summary	*Location Element*
a. The most common modes of computer infection for U.S. businesses	are shown in Table 5.
b. The details of the fertilizer used	are provided in Table 2.
c. The two series for the last five years	are plotted in Figure 2.
d. The results of the second experiment	are given in Figure 4.2.

4.4 Data Commentary Task

Table 6 provides some data related to chemical engineering. Individually, consider what data you might highlight and what your discussion will contain. Then, write one data commentary and compare with the other members of your group. Don't forget to include a short background then a location + indicative summary at the beginning.



5. LANGUAGE FOCUS: CONNECTING IDEAS

5.1 *this* + noun phrase (NP)

This device links the current sentence with the previous one putting "old" or "given" information before "new" information at the beginning of a sentence.

Consider the following statement:

The first experiment yielded significantly higher results than expected.

This surprised our research team.

It surprised our research team.

This surprised our research team.

This yield surprised our research team.

This unexpectedly high yield surprised our research team.

This unexpectedly high yield from the first experiment surprised our research team.

5.2 Connecting Words

	Subordinators	Sentence Connectors	Phrase Linkers
	(DC <> IC)	(→ IC)	(IC <>NP)
Addition		furthermore, plus, in addition, moreover	In addition to
Adversativity	although, even though, while, whereas	despite the fact, however, nevertheless, in contrast, on the other hand, conversely	despite, in spite of, in contrast to, unlike
Cause and Effect	because, since	therefore, as a result, consequently, hence, thus*	because of, due to, as a result of, thus*
Clarification		in other words, that is, to explain further	
Illustration		for example, for instance, to illustrate	especially, particularly
Intensification		On the contrary, as a matter of fact, in fact	

5.3 A Quick Grammar Note – Punctuation

A sentence, also known as an independent clause (IC), contains a subject, a verb, and one complete idea. For example: I like chocolate. Or She took a vacation. A dependent clause (DC), also contains a subject, a verb, but is not a complete idea. For example: I like Or When she took a vacation.

There are several ways to link two ICs. Take for example the following two sentences:
I like chocolate. She likes vanilla.

1) I like chocolate; she likes vanilla. (IC ; IC)
2) I like chocolate, and/but she likes vanilla. (IC , conjunction IC)
3) Whereas I like chocolate, she likes vanilla. (DC, IC)
4) I like chocolate whereas she likes vanilla. (IC DC) *note no comma
5) I like chocolate; however, she likes vanilla. (IC ; connecting word, DC)

5.4 High-Frequency Reporting Verbs

Discipline	Verbs and Frequency					
Rank	1	2	3	4	5	6
Biology	describe	find	report	show	suggest	observe
Physics	develop	report	study	find	expand	
Epidemiology	find	describe	suggest	report	examine	show
Nursing	show	report	demonstrate	observe	find	suggest
Education	find	suggest	note	report	demonstrate	provide

Source: Data for biology and physics from Hyland 1999, 341-67. Other data thanks to Carson Maynard.

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The material for this workshop was compiled and modified using the following sources:

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