A Caution

Laboratory reports of students who have taken CHEM 446 previously are available, but not from us. **Plagiarism**, among other things, includes taking any other person’s report, whether for years past or this year, and replacing the data with yours, as well as simply paraphrasing the other work. Copying verbatim from any source without appropriate attribution is another example of plagiarism.

Learn what plagiarism is, and avoid it altogether. It is serious and will not be tolerated.

A common ploy is to use information in someone else’s laboratory report. You should know that we keep electronic copies of laboratory reports from several previous semesters. Although it is unlikely that the laboratory instructor will check your report against previous reports, such a check may be made (and has been done in the past). It is not worth the risk to try such a stunt. Besides, it is much better to develop your own way of writing unique reports. This is something everyone must do routinely in science.

Format and Technical Issues

Laboratory reports must be prepared with a word processor and carefully edited and proofread before submission. They are to be submitted electronically as files in PDF to the Laboratory Instructor grading the experiment no later than the beginning of the laboratory period two weeks after the experiment was begun. Many modern word-processing programs, including Microsoft WORD, have a facility to generate files directly in PDF. For those who do not have such a facility or do not have Adobe Acrobat, there is freeware available on the Worldwide Web.1 Because reports are submitted and graded electronically, the email addresses of all authors must appear below their names on the title sheet.

Reports should be written in the following general form. An example report is found at the website; use it.

1. **Title** (5pts) The report should begin with a title that indicates the experiment name and number. On the line below that should appear the laboratory section, the name of the person(s) writing the report (joint or single author), their email addresses, the due date of the report, and the date when the report was submitted.

2. **Introduction (sometimes called Purpose)** (10 pts) There should be brief introductory section in the report, of no more than two short paragraphs. This should start at the top of the second page. Do not copy directly from the laboratory write-up. Importantly, the report is not an article for a journal; it is a report of what you did. Explain what you did and why you did it. No equations should be in this section; this section is also not a tutorial on particular experimental techniques. State the purpose of the experiment clearly, succinctly, and directly.

3. The introduction should be followed by a brief **Experimental Section** (15 pts) that describes the general experimental procedure. It should not be more than about one or two paragraphs. Again, do not reproduce the experimental protocol from the experiment write-up;

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1 If you do not have Adobe Acrobat PDF Maker, there are (at least) two free site to get a PDF maker:
CutePDF:
http://www.cutepdf.com/Products/CutePDF(writer.asp)
PDFCreator:
http://sourceforge.net/projects/pdfcreator/
say in your own words what the procedure was; copying from the laboratory write-up is plagiarism. If you made any significant deviations from the written procedure, mention them in this section.

The Introduction and Experimental Sections combined may not total more than one page.

4. The bulk of the report is the Results and Discussion section (50 pts). In this section you expand on how the work was done, what sorts of analyses were done, etc. Tables, figures, and necessary equations should be given in this section. The methods of presenting data vary from experiment to experiment, but the essential data should be provided as well as the derived quantities from analyzing the data. References to literature data are required if they are available; however, you may not use references to the internet. You must find the appropriate literature (in the library). Be sure to put all references in the proper ACS format.

Pay attention to significant digits in tables, including trailing zeros. The number of decimal places should reflect your experiment, not a standard computer format. With EXCEL, it is necessary to specify the number of decimals in each cell or column. When multiple values of a single quantity are directly measured, give each value in the table independently and use each value in your plot. Use scientific notation, $3.265 \times 10^5$, or simple notation, 0.00156. Do not use computer notation, such as 3.265E5! (Note that EXCEL may do this and you must make sure it is not in that format in the final report.) If quantities have units, those must be included. On tables, this may be done in the heading of the column. For example, if you measured volume of some substances, you may make the heading say “Volume (in cm$^3$)” or “Volume/cm$^3$”. Sometimes it is appropriate to indicate the order of a quantity in the heading, if this is consistent over most measurements. For example, the thermal expansion coefficient of many materials is of the order of $10^{-6}$ K$^{-1}$. In this case, you can write the heading as “$10^6 \alpha$/K$^{-1}$”. So, the entry in the table for a material that has a thermal expansion coefficient of $5.65 \times 10^{-6}$ K$^{-1}$ would be written as 5.65. **Note that the heading, in these cases, indicates what is written in the column, not what the power of exponent in the number is.** This is something that throws lots of students, so think before you write.

Tables and figures should appear in the body of the text near the first reference. All data tables and figures should be discussed briefly; there should be at least one reference to every figure and table. If a figure is derived from a table, the table should precede the figure in the text. Each table and figure should be numbered in order, starting with 1, and have a brief descriptive title that starts with the table or figure number. The title of a figure (called a caption) goes below the figure, not above as EXCEL unfortunately labels figures. Tables should have a brief but descriptive heading that includes the table number (i.e., the title of a table goes above the table). Immediately below the title there should be the headings of the columns of the table. The whole table should be on one page; if that does not happen naturally, you must move the table to make it happen. Move it be as close to its point of first mention, but if you move it, the table should appear after the point of first mention. No data may be discussed that are not presented in the report.

Do not refer to Table 2 before Table 1. Gridlines help in tables. Align the data in columns so that the decimal points are aligned in each column.

Figures should be in Portrait (not Landscape) format. Typical figures should be about 3 inches wide; in WORD, putting the figure in text box along with the figure caption below it in the same text box allows you to move the figure and the caption together; this is not what
WORD normally does, but you can easily do it. For figures, only capitalize the first letter of the first word (and any proper nouns) of the caption.

An EXCEL trend line is often useful to show the general variation of data and to identify obvious outliers. Linear or polynomial fits are may show the trend, but generally don’t use more than a third-order fit. If your trend line has obvious “wiggles” is it probably wrong. Remember that, unless it is some sort of version of a theoretical line, such a trend line is simply to guide the reader’s eye; the coefficients are therefore not particularly meaningful. However, if there is a theoretical relationship that is the trend line, then the coefficients are important parameters of your system.

Do not put the equation of the trend line in the figure (unlike the figures in the example). Write that information in the text, if it is necessary to report it. Axes should be labeled, with units. Do not have EXCEL put a title in the figure, as you are putting a caption below the figure. Adjust the scale of a figure to fit the range of the data: the initial computer values are often not useful: a mole fraction of 1.2 should be embarrassing, as well as an absorbance of – 0.1. Use grid lines to improve the appearance of the figure, if necessary. Sometimes, tick marks look better than grid lines; I generally prefer either figures with both horizontal and vertical grid lines or figures with only tick marks. Data points should be visible in the figure when a line is drawn through them. Do not use the “connect a dot” format for figures. The horizontal axis is the independent variable; the vertical axis is the dependent variable. Backgrounds should be white.

Each table is to be numbered with a brief (not a sentence) descriptive heading above the table. Each figure is numbered with a brief (not a sentence) descriptive title below the figure. The title or caption should be carefully written to describe exactly what is displayed; it takes practice to write an appropriate title or caption. There are two styles one may use for the title of table: (1) the first letter of each major word capitalized, or (2) only the first word of the title capitalized (but capitalize proper nouns). Choose one style and stick to it; do not mix styles in a single document. Here is another trick I use in constructing tables that makes them easy to use: Merge all the cells in the first row of a table, and use that cell as a place to put the title. In the second row write the headings of all the columns. Then start data entry in the third row. This allows you to move the table as a unit around in your report to its proper place, without having to remember to move the heading!

Equations derived from your data that describe relationship between a dependent and an independent variable should be presented in the Results and Discussion section near the point in the text where they are mentioned. Equations can be made in WORD by selecting the “Insert” tab, then click on “Object” and choosing “Microsoft Equation 3.0”. This should produce the box in which you can easily create the equation. Equations must be numbered (at the right edge of the same line) in order through the report, and reference to them should be by number. Explain any symbols used in a subsequent sentence. Numerical parameters in equations must be included with associated uncertainties. Do not type equations in terms of x and y; use appropriate symbols: P, for pressure; T for temperature, d, for density, etc. As an example, here is a report of the temperature dependence of linear dimension of tungsten near room temperature:

\[ L(T) = L_{293K}[1 + (0.000030 \pm 0.000005)(T - 293.0)] \]  

(1)

I usually like to leave one blank line before and one blank line after each equation.

Don’t waste space in your report. Rearrange the presentation to keep from having an empty space on a page. Move tables and figures around, if necessary, to use space.
When possible, comparisons should be made of your data with literature values in a brief paragraph at the end of the Results and Discussion section (10 pts). This section should summarize, in a paragraph or two, the major results of the experiment. The conclusions should include a reasonable assessment of sources of error. Misreading balances or incorrectly standardized solutions are not significant sources of error and should not be seen in the report. You may not be able to explain why your data and the literature data do not agree, but compare the data – numerically when possible.

5. References (10 pts) A list of references should be given at the end of the report in ACS style. They should be referred to numerically in order of appearance in the text. The ACS style guide is available on the Internet, from which you can find the appropriate reference style for each kind of reference. In general, most reports should have several references, many of them found in the literature. Every report must have a minimum of two references. References to Internet sites are not acceptable. Reference to the write-ups for the laboratory are not acceptable. If you reference a paper, you should have read it.

7. Discussion Questions (10 pts) Each experiment has a set of discussion questions which must be answered. Some are simple questions about your work; others ask questions that involve delving into the theory or other reports in the literature. These should be presented in a section at the end of the report (either before the references or after). Write out in bold each question. Answer each question directly below it in your own words. You should expect to spend some time on these answers, as they may be subtle.

General Comments

Some say that reports must be written exclusively in the past tense because it is a report of what you did, not what someone else should do. However, remember that the person reading it is viewing the report at a specific time, which is the present for that person. So, the discussion may, at times, be written in the present tense. As an example, consider the following two examples, one of where past tense is most appropriate because it describes an event in the past, and one where present tense is appropriate because it describes the action happening as the person reads the report:

“Figure 4 shows the development of electrical conductivity as a function of concentration of electrolyte, taken from data that were gathered during the experiment.”

In the first case, the past tense is used because it refers to something that happened before the report is being read. In the second case, however, the present tense is used because it is reporting something to which the reader is being directed at the time he/she is reading the report. The future tense is almost never appropriate in writing a report.

Remove conditional verbs like “can” or “may” or “should” from the report. Be precise in what you say. Be specific and be assertive (but be sure you are right!).

Many people prefer that a report be written in the third person and/or the passive voice. I disagree. At times it is appropriate to use the first person and the active voice in a report. However, using the first person singular in a joint report is always incorrect. Do not blindly follow the suggestions of a word processing program about style; those proscriptions are not always appropriate to scientific writing.