Prerequisites: Physical Chemistry 3910

Instructors:
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Course Format: The course consists of one hour of lecture and one four hour laboratory period per week. Both are mandatory; you will not be allowed to perform the experiment if the pre-lab lecture is missed without a valid excuse.

Goals:
1. To obtain hands-on experience with a number of instruments and techniques commonly used in physical chemistry.
2. To obtain measurements of physical phenomena and to develop an awareness of the influence of experimental errors on data.
3. To develop competence in technical report writing in the form of laboratory reports.

Structure and Grading:
Eight experiments and laboratory reports done according to the attached schedule will constitute the core of the course.

You are expected to perform all laboratory experiments in the time allotted for the course. Your overall grade depends very heavily on the quality of your lab. Approximately 85% of the course grade will be determined from eight formal laboratory reports and 15% from additional assignments/your notebook/your general lab preparation. In this and other handouts you will find the objectives of the course, a list of the experiments, and style guidelines for writing the reports and including references. You are urged to consult The ACS Style Guide to help you with your writing. You can do a competent report with poor laboratory data, but the task of writing the report will be much more difficult. It will be well worth taking the time to carefully collect data.

You must perform every experiment and hand in every laboratory report in order to pass this course. Late reports will be penalized 3% for every day they are late, including weekends. Lab reports more than 2 weeks late will receive a grade of zero. Lab reports must be handed in by 3:00 PM on the due date.

Labs can be made up only for documented reasons. If you know ahead of time that you must miss a lab, you must notify the instructor before the lab, as soon as possible.

Grading will be on the following scale – subject to change by the instructors:

<table>
<thead>
<tr>
<th>Grade</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>88 -100%</td>
</tr>
<tr>
<td>B</td>
<td>78 - 87</td>
</tr>
<tr>
<td>C</td>
<td>68 -77</td>
</tr>
<tr>
<td>D</td>
<td>58- 67</td>
</tr>
<tr>
<td>F</td>
<td>0 - 57</td>
</tr>
</tbody>
</table>

General Comments:
You must thoroughly familiarize yourself with the experiment before you enter the lab. Students coming to lab without adequate preparation will receive a 5% penalty on that lab. Expect to answer questions on the theory or procedure of the lab. A 5% penalty will also be applied to students who arrive more than 10 minutes late for the start of a lab. Read through the lab handout and know what data you will be collecting so you can utilize your time in lab efficiently. Preparing a rough table for data collection before coming to lab will help to ensure that you are well organized. Writing up the Introduction and Theory sections before the lab period will assist you in understanding the requirements for the experiment and will reduce the amount of effort spent on writing up the lab after you complete the experiment. You will need a bound notebook to record the data. This notebook will be collected and checked during the course of the semester for clarity and completeness of data collection.
Laboratory Reports (including a word on plagiarism):

Your report must be prepared by a word processor. Graphs and regression calculations should be prepared with EXCEL or other graphics/spreadsheet software. Equations and unusual symbols may be neatly handwritten to save time or prepared using the Equation Editor function in Microsoft Word. Occasionally an experiment may not function as expected. The fault may lie with the experimenter or with the apparatus. On these occasions when the problems are beyond your control (e.g., the apparatus breaks down) you can still write a satisfactory report. Your write-up should describe the experiment, analyze the difficulty and describe the data. In cases such as these, you should describe where the experiment failed and propose what may have been the cause of the problems. In fact, experiments that do not work according to plan often provide more substance for discussion than those that function as expected.

All laboratory reports should follow the prescribed format (attached). Be sure to give a reference for any data or material that you cite in your lab reports but do not copy out large portions of the handout or text books – this is plagiarism and will be dealt with according to university policy on cheating. Likewise, copying of text, graphs, spreadsheets, diagrams etc. from other students’ lab reports will be regarded as plagiarism and you risk failing this course if you are caught doing this. All cases of plagiarism or cheating of any form will be referred to the Office of Judicial Affairs. Remember that this is a writing intensive course and one of the aims of this laboratory is to give you experience in writing good quality, informative lab reports of the same format as a manuscript that would be submitted to a journal. You should therefore make an effort to improve the quality of your reports with each experiment. Read the comments on your graded lab reports and address these problems in future reports. To give you an opportunity to adjust to the different lab writing styles in this course, you have the option of rewriting the first lab from each instructor – be sure to pay close attention to the comments on the returned lab and you will be guaranteed to improve your grade!

Carefully proofread the final report, check the spelling and grammar, and make sure the report is clear and concise. Spelling, grammar and overall clarity will make up a portion of the grade for each experiment. The report should be written at a level designed to be understood by a chemist who is reasonably experienced, but not familiar with your particular experiment. A report format and checklist is provided below. Points will be lost for each section that is missing or incomplete.

Report Format

General format
Double spaced, 10 or 12 point, 1-1.25 inch margins, numbered pages

Cover Sheet
1. Course and section number.
2. Title and number of experiment as given in handouts.
3. Your name.
4. Your partner's name(s).
5. Date submitted.

Abstract
A short paragraph summary of:
1. Experimental purpose.
2. Experimental technique.
3. Principal experimental results including numbers with uncertainties.
4. Major conclusions.

I. Introduction
1. Purpose of the experiment.
2. Brief description of the theoretical model(s) including equations which relate the data to the results.
3. How information is obtained.
4. How and why the information is useful.

II. Experimental
1. Apparatus.
2. Reagents.
4. Block diagram.

III. Data
1. Instrumental readout/spectra (with descriptive captions and figure numbers).
2. Data tables (again with captions and table numbers).
3. Text describing/introducing the tables, spectra, etc. and referring to these by number.

IV. Calculations, Precision Limits, and Results
1. Sample calculations.
2. Precision limits based on propagation of error or appropriate statistics.
3. Tabulated summaries of redundant calculations.
4. Table of final results with:
   a. precision limits.
   b. correct number of significant figures.
   c. appropriate units.
   d. literature values.
   e. accuracy (as measured by percent deviation from literature values).

V. Discussion
1. Interpretation and comparison of results.
2. Logical implications of results.
3. Results versus goals of the experiment.
4. Comparison of results with literature or expected values.
5. Suggested improvements for the experiment and alternate methods for meeting the goals of the experiment, if appropriate.

VI. References
1. ACS format for journal articles, books, etc.
2. ACS format for private communications and handouts.

"THE ACS STYLE GUIDE—2nd Edition"
SELECTED SECTIONS OF PARTICULAR IMPORTANCE

Grammar, Style and Usage (Chapter 2)
1. Grammar p. 49
2. Punctuation p. 56
3. Spelling p. 67
4. Hyphenation p. 75
5. Capitalization p. 83
6. References*
   Periodicals p. 176
   Books p.186
   Internet sources p. 211

Illustrations and Tables (Chapter 3)
1. Illustrations* pp. 295
2. Tables* pp. 300
3. Lists pp. 135

* Make special note.

SAMPLE TABLE

Note that the table title and column headings should be informative. If necessary define any relevant terms in a footnote to the table. An example is shown below.

Table III. Methyl Cation Affinities (MCAs).\(^a\)

<table>
<thead>
<tr>
<th>Molecule</th>
<th>Basis</th>
<th>HF</th>
<th>MP2</th>
<th>MP3</th>
<th>MP4</th>
<th>Expt.(^b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>H(_2)O</td>
<td>6-31G*</td>
<td>56.2</td>
<td>72.3</td>
<td>69.5</td>
<td>71.1</td>
<td>68.5</td>
</tr>
<tr>
<td></td>
<td>6-31G**</td>
<td>56.2</td>
<td>72.1</td>
<td>69.4</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>6-31+G*</td>
<td>52.7</td>
<td>66.7</td>
<td>64.8</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>6-31+G**</td>
<td>52.0</td>
<td>65.8</td>
<td>64.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>6-311+G**</td>
<td>51.2</td>
<td>66.2</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>6-311++G(2d,2p)</td>
<td>50.3</td>
<td>64.9</td>
<td></td>
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</tr>
<tr>
<td>CH(_3)OH</td>
<td>6-31G*</td>
<td>68.3</td>
<td>85.0</td>
<td>82.2</td>
<td>81.2</td>
<td>84.0</td>
</tr>
<tr>
<td></td>
<td>6-31G**</td>
<td>68.0</td>
<td>84.8</td>
<td>81.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>6-31+G*</td>
<td>63.6</td>
<td>78.5</td>
<td>76.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>6-31+G**</td>
<td>65.1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(CH(_3))(_2)O</td>
<td>6-31G*</td>
<td>74.2</td>
<td>92.1</td>
<td>89.2</td>
<td>91.0</td>
<td>93</td>
</tr>
<tr>
<td></td>
<td>6-31G**</td>
<td>74.1</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>6-31+G*</td>
<td>72.1</td>
<td>89.2</td>
<td>86.9</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^a\)MCAs in kcal/mol, calculated utilizing total electronic energies from this work and references 4, 7 and 25. See text for details. \(^b\)This work or reference 2.