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1. *Catalog Course Description.* 1 credit hour. This is the lab to accompany Chem 3610 - Physical Chemistry. Experiments will involve gases, the thermodynamics of liquids and solids; colligative properties of solutions; phase diagrams; and kinetics.

This course emphasizes the general education core areas of reasoning, numerical understanding, and scientific knowledge and is a part of the university's mission to develop: (1) skills of inquiry, abstract and logical thinking, and critical analysis; (2) the ability to understand and use numbers and statistics; and (3) an understanding of the scientific method.

2. *Prerequisite:*            General Chemistry 1120  
Math 1910, Physics 2010-2020 highly recommended
3. *Lab Time:*                2:20 – 5:20 pm Tuesday/Thursday, D319 lab prep, lab C306 Sundquist
4. *Lab Manual:*            There is no lab manual text. All labs are posted at our class web page, a link from my home page of <http://www.apsu.edu/robertsonr/>. You are responsible for printing these labs before each class. Additional handouts will be given for some experiments in class.
5. *Grading Policy for lab activities:*

2 long reports	50 points each
4 short reports + quizzes	50 points each
Powerpoint presentation	50 points
Daily grades & Notebook	50-100 points
6. My general philosophy is "A grade is an inadequate report of an inaccurate judgment by a biased and variable judge of the extent to which a student has attained an undefined level of mastery of an unknown proportion of an indefinite material" (Paul Dressel) Grades are not perfect or always fair, but I will pledge to be consistent. I want to work with you so that you can do your best within your limitations and opportunities.

Your semester lab grade will be the same as your lecture and will be determined by combining your individual lab and lecture grades in the following manner: 75% lecture and 25% lab. The % cutoffs are as follows: A 84.50%, B 71.50%, C 59.50%, D 49.50%. See the lecture syllabus for lecture details.

Any student who has a disability that may affect his/her academic performance is encouraged to make an appointment with me to discuss this matter, or you may contact Disability Services; telephone 221-6230; tty 221-6278; fax 221-7102.

7. *Goals:* Physical Chemistry is a course in which we experiment in order to determine underlying principles which determine the properties of substances. The experiments are designed to acquaint you with some of the lab skills that are necessary and also the analytical skills that are needed. You will continue your development of lab technique, statistical analysis, and technical writing.
8. *Attendance is required.* "You must be present to win." Your attendance is vital to your progress in this course. It may or may not be possible to make up a lab. It will depend on the lab and on the reason for absence. If at all possible contact me in advance. Usually you will not be able to submit a report for a lab you miss, but you may be allowed to submit a report on a lab you did not attend if you have special circumstances (such as an absence related to official representation of the university – a university excused absence) approved by the instructor.
9. *Drop/Withdrawal Dates:*

Last day to drop without a record	September 9
Last day to drop with an automatic "W"	October 7
Last day to drop before a mandatory "F"	November 8
10. *Safety Protocol:* You must wear approved safety goggles at all times while in the laboratory. Goggles may be purchased at the bookstore. The safety regulations are the same as those in all APSU chemistry courses and are explained on an additional handout. If you have not received a copy previously or have lost your copy, download a copy from the following web page, <http://www.apsu.edu/chemistry/safety>.

Students are expected to conduct themselves appropriately at all times. Academic and classroom misconduct will not be tolerated. Students must read the "Code of Student Conduct" in the new Student Handbook for an understanding of what will be expected of them within the academic setting.

According to APSU policy #3:032, minors (defined as those under the age of 18) are not allowed in classrooms. While I recognize that extenuating circumstances occur and make it difficult for some students to attend without bringing children with them on occasion, I must enforce University policy and thus will deny any request for a child in my classroom. You should also be aware that minors are not allowed in academic labs, computer labs, science labs, or the library. Further, children cannot be left in halls outside classrooms. Please be aware that the policy on unattended minors is for the purpose of ensuring that our classrooms are conducive to learning and for the safety and protection of minors. For additional information on minors on campus, contact the Office of Student Affairs in the Morgan University Center.

11. *Laboratory Notebook.* Each student is required to keep an informal notebook.

The informal notebook must be a bound "composition" notebook and is used to record raw data and observations during the laboratory period. I will check this notebook informally during the semester and at the end of the semester for daily grades. All entries in the informal notebook should be in ink. Draw a single line through a mistake; do not erase or use white-out. Pages may not be torn out of your notebook. If you wish to delete a page, draw one slash line through the page.

Put the date on the first page for each experimental entry. Below the title of the experiment, identify your lab partner or partners. Next give the purpose of the experiment with any necessary and important chemical equations or mathematical equations. Feel free to elaborate on more background information and conclude with an overview for the experimental procedure. For the procedure you can reference the handout as you would in a report. If you deviate from this procedure or if part of the lab is to develop the procedure, this must be explained in detail. Finally record all your data, observations and any brief conclusions. Data must be recorded in a neat, coherent, and concise manner. All data should be recorded in table format which allows easy review of the work performed. The tables may sometimes be constructed before the experiment begins. This will allow you to simply "fill in the blanks" as the experiment is performed. You will be able to sort through your data quickly if it is clearly labeled. Any important details which may affect the data should be recorded.

a. *Cover of the notebook.*

Use a label and write legibly on the cover the following:

Name  
Course Name  
Term/Year

b. *Table of Contents.*

The first page of your notebook should be reserved for a Table of Contents which begins on page one. All experiments must be recorded. Entries should be made in a columnized format as shown in the following example.

Table of Contents		
Experiment	Page	Date
E1 – Heat of Solution	2	

12. *Protocol for the long formal laboratory report.*

Sometimes a long formal lab report will be submitted and graded. The write-up must be word-processed and 1.5 spaced. Chemical structures, equations, and sample calculations in the write-up should also be word processed. Neat hand printing of structures, equations, and calculations can be

submitted but points will be deducted. Data should be reported in table format. All pages must be numbered; do not write on the back pages of the formal write-up.

a. *Experimental Entries.*

Each experiment must include the following items:

Experiment Number, Title, Date

Introduction/Objective

Procedure

Results (tabulated form of all recorded data with calculations)

Discussion

References

Comments

b. *Further information for experimental entries*

i. Example for title, etc:

E1

Heat of Solution – Hot Packs

9-6-11

(experiment 1)

(title of experiment)

(date of experimentation)

ii. The introduction should include the theory and principles pertaining to the experiment. References to previous work (if known) and pertinent chemical information concerning the experiment should also be included. It may be necessary to use chemical equations or structures. The introduction should end by leading into the objective or purpose of the experiment which may be summarized in two or three sentences. An overview of the experimental procedure can either follow the purpose or be in the procedure. Do not discuss results in this section or use pronouns.

iii. The procedure should be written as you performed the experiment. You are telling someone else what you did and why you did it, thus there should be a rationale for your procedure. This is usually referred to as the overview. You have the option of including this overview in the introduction, but the entire procedure must be explained and not just listed. Do not copy the procedure word for word from the handout; it is written in another style. Please write in complete sentences, and do not use pronouns. The procedure should be written in past tense of passive voice. Please include a diagram of the apparatus used other than ordinary lab equipment. Include in your write-up names and model numbers of important instruments used. Ordinary lab equipment such as balances do not require this level of detail.

iv. Results should be presented in table format. All data must be reported because it is unethical to fail to report all scientific data. It is a good idea to separate the raw data from the calculated data in the results section. If you wish to leave out an experimental trial when computing statistical information, a "Q test" or other appropriate statistical test must be performed and recorded in order to legitimately ignore the data. On many experiments you will be asked to compute the propagated error for an analysis. Use the scale errors or random errors for each piece of data to accomplish this. If three or more analyses are attempted the best value (average  $\pm$  standard deviation of the mean) should be reported. Error analysis and the reporting of data will be as explained in detail on the first day of lab.

After a data table, clearly label and explain a sample calculation for each different type of calculation. These sample calculations should flow logically from the data. For statistical replicate analyses, standard errors (the standard deviation of the mean) can be taken from a calculator program or spreadsheet. All other calculations (including propagated error) must be shown. On propagated error calculations show the partial differentiation. *This should include the beginning equation, the equation for the calculation of the error using partial derivatives, the actual partial derivatives, and a substitution of numbers which generates the final propagated error.* Dimensional analysis of units is required when using equations; record numbers to the correct number of significant figures.

- v. The discussion section allows you to reflect on what you did and what you saw during the course of the experiment. This section should be written after the experiment is performed. This section also involves an interpretation of data and discussion of it. Speculation is appropriate as well as types of errors that may have affected your results. This section is often the most difficult to write. In general answer the purpose of the experiment at the beginning of this section. Then proceed to a discussion of errors (design as well as variability of data) and finally conclude with the significance or applications of the results. The discussion of errors should include specific references to the various types of errors (mistakes, scale, replicate, propagated) that are listed in the results section.
- vi. There always should be references for your experimentation. Often I give you a reference in the lab handout, but at other times you may need to search and find references from books in the library or internet sources. Make sure that you reference "true values" in your report as well as any possible text material used. The ACS Style Guide is a lasting source of information about oral and written communication skills and formats. It has an excellent section on referencing. In general there are three ways to reference: (1) by superscript numbers, (2) by italic numbers on the line and in parentheses inside the punctuation, (3) by author name and year of publication in parentheses inside the punctuation. (This is often called the APA style). Any of these styles will be satisfactory for your report. A valuable resource is *The ACS Style Guide: Effective Communication of Scientific Information*, 3<sup>rd</sup> ed. (edited by Anne M. Coghill and Lorrin R. Garson ISBN10-0841239991)
- vii. The last entry for every experiment must contain a comment section. This is your chance to write anything you like, preferably something you learned that day that you did not know before. However, your comments (1-2 sentences) may be of your choosing and should pertain to the lab! You may use pronouns in the comment section.

### 13. Protocol for the short formal laboratory report

The short report will include some or all of the following: selected sections of the long report, an abstract, or a completed worksheet. Exactly what is required will be made clear for each experiment.

The abstract is a:

- brief summary of the principal findings of the experiment.

- stand-alone, self-contained document.

## Contents

The abstract should *briefly* state:

- the purpose of the research or the research problem including a very short background (introduction),
- how the problem was studied (methods),
- the principal findings, including statistical analyses (results), and
- what the findings mean (discussion and conclusions).

While it is difficult to be both concise and descriptive at the same time, that is exactly what you should strive for when writing an abstract. Say only what is essential, using no more words than necessary to convey the meaning. Examine every word carefully.

## Rules

The abstract should be one or two paragraphs and no more than 250 words.

The abstract should:

- *not* include subheadings such as "Purpose" or "Results."
- *not* use first person, e.g., "I."
- *not* emphasize minor details.
- *not* contain bibliographic references, figures, or tables.
- *not* use jargon or abbreviations (*unless* they are commonly used and do not require explanation, e.g., DNA or UV light).
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## 14. Protocol for the oral Powerpoint Presentation

The powerpoint presentation will be given as an oral presentation by the lab group. All members should participate and will receive the same grade unless a group member is found to have not contributed to the work. The presentation will be given in a classroom during the lab period scheduled and should take at least 15 minutes and no more than 20 minutes. Questions will be asked of the group members and the responses will be a part of the presentation grade. Other class members are not allowed to be present. The parts of the presentation should be: Title, Introduction with objective/purpose, Procedure, Results, Discussion, References. Listing is appropriate for the production of the slides.

Reports will be due either one week after completion of the experiment or as indicated by the instructor. Late reports will be penalized at the discretion of the instructor (usually 10% per day late). Plagiarism is completely unacceptable. This includes copying material from previous lab reports or a partner's report.

PHYSICAL CHEMISTRY 3610 LAB  
TENTATIVE LABORATORY SCHEDULE

FALL 2011

Week of	Activity
8/30	Introduction, Statistics, Propagation of Errors, Use of Spreadsheets Problem set due 9/2(Tuesday class) and 9/6 (Thursday class)
9/6	Go over Problem Set, E1 - Heat of Solution: Hot Packs (long report) Statistics Quiz in lecture for both sections on 9/9
9/13	E2 - Molar Mass of a Gas (short report) E1 due
9/20	Quiz over E2, complete E2
9/27	E3 - Heat of Combustion (short report) E2 due
10/4	Quiz over E3, complete E3
10/11	E4 – Heat of Vaporization (long report) E3 due
10/18	Tuesday section - Fall break Thursday section E5 – Liquid/Gas Phase Diagrams (Powerpoint)
10/25	Tuesday section E5 – Liquid/Gas Phase Diagrams (Powerpoint) Thursday section Complete E5 E4 due for both sections
11/1	Tuesday section Complete E5 Thursday section Powerpoint Oral Presentation
11/8	Tuesday section Powerpoint Oral Presentation Thursday section E6 – Solid/Liquid Phase Diagrams (short report)
11/15	Tuesday section E6 – Solid/Liquid Phase Diagrams (short report) Thursday section Complete E6
11/22	Tuesday section Complete E6 Thursday lab section – Thanksgiving holiday
11/29	E6 due for both sections E7 - A Study Of The Rate Of The Reaction Of Chlorine Bleach With Blue Dye (short report), due Wednesday – 12/14
12/6	No lab for Tuesday or Thursday section

*Important – Graded lecture exams may be reviewed/explained in detail during convenient lab times, usually the first lab day after the exam.*

The above schedule and procedures may be changed during the semester due to unforeseen circumstances or coverage speed of material. You will be given at least a week's notice.