

TWO CLASS LABORATORIES LISTED HERE – SEE PAGE 11 FOR OTHER LAB
ChE 451: Senior Laboratory
Thursday 12:30 – 16:20
Spring 2011

Course Instructor: Edwin L. Kugler
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Recommended Texts: J. C. Smith and P. Harriott, *Unit Operations of Chemical Engineering, 5th Edition*, W. L. McCabe, McGraw-Hill 1993

J. M. Haile, *Technical Style*, Macatea 2002

This Outline must be read in conjunction with the Laboratory Manual for the course.

Course Goal: To consolidate and solidify the concepts and knowledge you have acquired during the undergraduate program, in a hands-on and communications framework.

1. Learning Outcomes

In partial fulfillment of *ChE Educational Outcomes 2, 3, 4, 5 and 7* (see “Undergraduate Program Mission, Outcomes and Objectives” statement), at the conclusion of this course, you will:

- develop the ability to design and to perform laboratory experiments from a general problem statement and relevant literature suggested;
- become familiar with process equipment and instrumentation similar to that found in actual plant environments;
- integrate the principles learned in classes with laboratory operation and practice;
- learn how to document data and ideas appropriately in a laboratory notebook;
- analyze experimental data using basic chemical-engineering principles;
- communicate effectively in both written and oral formats;
- improve technical-writing skills by receiving written feedback and revising written reports;
- develop interpersonal skills necessary for team performance;
- practice standard laboratory safety procedures and follow good environmental practice.

2. Summary of Important Course Policies

- a) Labs must be done on the scheduled dates with all members present. Please try to schedule interviews accordingly.
- b) The team is responsible for reading and understanding the laboratory manual and any reference material provided.

- c) An approved Pre-laboratory Report must be given to the GTA before the experiment can be initiated. Any revisions must be submitted to the GTA at least one day before the experiment is scheduled.
- d) All reports must be neatly printed double-spaced using word processor software in the format described in the manual.
- e) Each team member must participate in every Oral Report.
- f) You may examine equipment during normal working hours but under no circumstances are you to work on or to operate an experiment alone or without proper supervision.
- g) Laboratory safety procedures are of paramount importance and will be strictly enforced. If you are not sure about something, please ask!!

3. Course Schedule

The three laboratory cycles for this course are shown in Table 1. Each cycle represents a different experiment which will be identified later in this document. Three different reports and an oral presentation are associated with each cycle. The due dates and grade weighting of each of these are shown in Table 2.

Table 1. Course Schedule

Week #	Cycle #	Activity	Date	Location
1		Introduction and Laboratory Overview	13-Jan	201
2	1	Pre-laboratory Report	20-Jan	Galli Lab
3		Experiment & Preliminary Report	27-Jan	Galli Lab
4		Experiment & Appendix	3-Feb	Galli Lab
5		Oral & Written Report	10-Feb	201
6	2	Pre-laboratory Report	17-Feb	Galli Lab
7		Experiment & Preliminary Report	24-Feb	Galli Lab
8		Experiment & Appendix	3-Mar	Galli Lab
9		Oral & Written Report	10-Mar	201
10	3	Pre-laboratory Report	17-Mar	Galli Lab
11		Experiment & Preliminary Report	31-Mar	Galli Lab
12		Experiment & Appendix	7-Apr	Galli Lab
13		Oral & Written Report	14-Apr	201

Table 2. Laboratory Report Grade Weighting

Cycle Activity	Due Date	Points
Pre-laboratory Report	Cycle Week 1	50
Preliminary Report	Cycle Week 2	50
Oral Presentation	Cycle Week 4	50
Final Report	Cycle Week 4	100

4. Student and Team Performance

At the beginning of the semester, each student will be assigned to a student team. In a given cycle, the student team will perform the assigned laboratory experiment. The experiments and team assignments are given in Tables 3 and 4, respectively. The team members will plan and

perform the experiment together. but they will submit individually written reports to the instructor or graduate teaching assistant (GTA).

CHE 450 is designated as a writing course and meets Objective 1 in the General Education Curriculum. As such, students are expected to receive feedback on their writing and to revise reports to improve their writing skills. Each student is expected to produce at least 30-60 pages of original writing over the course of the semester.

Table 3. List of Experiments

Experiment #	Name of Experiment
1	Process Control Simulation
2	Convective Heat Transfer
3	Distillation Column
4	Cross-Flow Filtration
5	Fuel Cell
6	Residence Time Distribution
7	Enzyme Kinetics
8	Tank Drainage
9	Fluidized Bed
10	Heat Transfer Coefficients in Spheres

Table 4. Student Team and Experiment Assignments

Team #	Team Members	Lab No. 1	Lab No. 2	Lab No. 3
1	Jamie A. Barr Alan S. Campbell Kristen C. Carpenter	6	7	8
2	Jordan Z. Beilhart Owen J. McGrath Zachary D. Mayes	1	2	3
3	Michael P. Gramlich Andrew R. Graves Cory M. Hinerman	3	1	2
4	Kevin R. Gross Paul A. Kast Thomas E. Sobray	8	6	7
5	Alexandria L. Harris Kristen D. Kief Jennifer R. Weigand	2	3	1

4. Cycle Sequence and Report Preparation

A short memorandum to each student team will initiate each laboratory cycle. This memo will provide a brief description of a problem (experiment) and will describe the task assigned. Each team needs to discuss this memorandum and to do the background work necessary to start the project. Each cycle consists of the following activities.

A. Pre-laboratory Report (Cycle Week 1)

A neatly written experimental plan (Pre-laboratory Report, “Pre-lab”) must be submitted to the GTA or instructor at the Pre-laboratory meeting one week before the experiment is performed. The Pre-laboratory schedule is given in Table 5. The Pre-laboratory Report consists of a brief

(2-5 page) written description of the theory and experimental procedures planned, important variables and ranges of parameters to be measured, and a discussion of important safety aspects. Pre-laboratory Reports will be graded for content, and the writing will be critiqued. See Appendix I for grading criteria.

Table 5. Pre-laboratory Schedule (1st Thursday)

Team #	Lab #1 Time	Lab #2 Time	Lab #3 Time
Team 1	1:00	1:40	2:20
Team 2	1:20	2:00	2:40
Team 3	1:40	2:20	1:00
Team 4	2:00	2:40	1:20
Team 5	2:20	1.00	1:40

The Pre-laboratory meeting with the instructor or GTA should clearly reflect the level of planning the team has done for the experiment. No experiment can be performed until the Pre-laboratory Report is approved.

B. Preliminary Report and Lab Day (Cycle Week 2)

A Preliminary Report must be submitted at the start of the experiment. It should consist of as complete a body of the report as possible, understanding that the experiment has not yet been done. The instructor will evaluate this report for technical content and writing style. It will be returned within one week so that comments can be integrated into the Final Report. See Appendix II for grading criteria. The team will carry out the experiment in the Senior Laboratory at this time.

C. Data Review with GTA and Another Lab Day (Cycle Week 3)

The team will meet with the GTA at the designated time slot on Wednesday of the third cycle week in the Senior Laboratory. The team will show the experimental results to the GTA. At that time it will be determined if the experiment needs to be repeated. The schedule for GTA review of experimental data is given in Table 6.

Table 6. Schedule for Data Review by Graduate Teaching Assistant (3rd Wednesday)

Team #	Lab #1 Time	Lab #2 Time	Lab #3 Time
Team 1	2:00	2:40	3:20
Team 2	2:20	3:00	3:40
Team 3	2:40	3:20	2:00
Team 4	3:00	3:40	2:20
Team 5	3:20	2.00	2:40

Any team that did not finish the experiment during Cycle Week 2 is allowed to repeat the experiment in the third week of the cycle, Second Laboratory Day. Even if the team finished the experiment, there may be “bad data” because, e.g., correct conditions and/or procedures were not used. In many cases, it is possible to improve the data collection technique. In these cases, team members are allowed to repeat the experiment. See Appendix III for additional comments.

D. Final Report (Cycle Week 4)

The Final Written Report must be submitted at the beginning of the class when Oral Presentations are given. Late reports will be penalized. Reports will be corrected for writing and technical content, and returned by the instructor within one week. You should carefully read the instructor's remarks to determine how you can improve reports. Make corrections and submit a revised report to the instructor for grading. See Appendix IV for grading criteria.

E. Oral Presentation (Cycle Week 4)

Oral Presentations with visual aids (PowerPoint format for projection system) will be made by all team members on the fourth week of the cycle. See Appendix V for grading criteria.

5. Social-Justice Statement

“WVU is committed to social justice. I concur with that commitment and expect to maintain a positive learning environment based upon open communication, mutual respect, and nondiscrimination. WVU does not discriminate on the basis of race, sex, age, disability, veteran status, religion, sexual orientation, color or national origin. Any suggestions as to how to further such a positive and open environment in this class will be appreciated and given serious consideration. If you are a person with a disability and anticipate needing any type of accommodation in order to participate in this class, please advise me and make appropriate arrangements with the Office of Disability Services (304-293-6700)”

Appendix I: Pre-Laboratory Report (0-50 points)

Pre-laboratory planning requires a review of literature and an inspection of the apparatus in the laboratory. All aspects of the experiment must be planned. The pre-laboratory report should include, but is not necessarily limited to, the number of data points, range of data points, experimental procedure, and variables to be measured and/or fixed. Remember these estimates may need to be revised as you perform the experiment.

One key to success in experimental work is to ask continually: *What am I looking for? Why am I measuring this? Does the measurement really answer any of my questions? What does the measurement tell me?* These questions may seem rather elementary, but they should be asked frequently throughout the progress of any experimental program. Some particular points, which should be addressed in experimental planning, are shown below. Also see the Laboratory Manual.

Note that an experiment will not be permitted to be run until an acceptable pre-laboratory plan is approved.

Pre-Laboratory Report Grading

A. Overall Objectives (20%)

Summarize the goals of the experiment, and your proposed approach to those goals.

B. Details of Experimental Work (60%)

1. Outline the experiment and identify important process variables and measurements. Relate them briefly to important theoretical concepts.
2. Speculate on the more difficult aspects of the experiment.
3. Quantify the range of the more important process variables that you intend to cover in the experiment.
4. Summarize the safety considerations and outline emergency procedures.

C. Appearance and Exposition (20%)

Report should have neat appearance and be free of grammatical errors.

Appendix II: Written Preliminary Report (0-50 points)

In addition to addressing the three items in your pre-laboratory report, the Preliminary Report should contain a draft of the Introduction, Theory and Experimental sections to be included in your final report. The instructor will check this report for both technical accuracy as well as writing style. For specific details regarding these portions of a report, refer to the section explaining the information needed.

Introduction: You should be able to write this section based upon your preliminary research into the experiment being performed.

Theory: If you have researched the experiment fully, you should be able to write a draft of this section before performing the experiment.

Experimental: If you familiarize yourself with the equipment, you should be able to write a draft of this section before performing the experiment.

Preliminary Report Grading

The instructor will review the Preliminary Report as a draft of the Final Written Report. It is due on the day the experiment is performed. The report will be edited, commented on and returned by the instructor within one week, when the Appendix is due to the GTA. The grade will be based upon the technical content and the research to be performed on the experiment, the degree and thoroughness of the experimental plan, and the writing style and mechanics. While it is recognized that this draft is incomplete at the time of submission, the student is expected to do a thorough job in preparation. If a Preliminary Report needs revision, it will be returned to the student to be rewritten. The Preliminary Report will be used to prepare the Final Written Report, which will address all instructor comments.

Appendix III: Meeting with Graduate Teaching Assistant (not graded)

Data and hand calculations will be checked by the GTA and will be initialed by him/her. Initialed hand-calculations must be included in the appendix of the final report. The person making the calculations should use the initialed original; other team members should use a photocopy.

If the instructor or GTA feels that experiment needs to be repeated, the third week in the cycle will be used as a Second Laboratory Day. Students should not repeat experiments alone, but must arrange for supervision by the GTA or instructor.

Appendix IV. Written Final Reports (100 points)

Grading will be assigned based on an overall review of the report using the following criteria.

A. Presentation: (30%)

1. Organization: the assembly of information and facts into a logical and understandable sequence of statements leading to definite objectives and conclusions.
2. Completeness and conciseness: inclusion of absolute essentials as a minimum. Omission of irrelevant, nonessential, and trivial material.
3. Judgment: selection of material to be discussed, order of presentation, direct statements of importance, length of presentation, etc.
4. Neatness.

B. Exposition: (30%)

1. Clarity
2. Good choice of words
3. Economy of words (including absence of typographical errors)
4. Correct spelling
5. Precision
6. Correct interpretation of the meaning of words
7. Correct grammar
8. Correct punctuation
9. Freedom from use of jargon or slang
10. Freedom from awkward expressions

C. Technical Competence: (40%)

1. Correctness and clarity of thought: explanation of the relevant physical and chemical phenomena and economic factors at play.
2. Quality of results: a reflection on the quality of experimental design of the experiment, treatment of data, and analysis of the design problem.
3. Discussion and conclusions: the recognition and interpretation of the significance of the information presented; judgment in stating technically sound conclusions; and judgment in the omission of trivia.

Appendix V: Oral Presentation (50 points)

An overall grade will be given on orals using the following general criteria. Percentages are approximate.

A. Presentation: (40%)

1. Organization: presentation of the major segments of the project in an easily understandable and logically connected way.
2. Clarity: transmission of ideas and information in clear, uncomplicated sentences; absence of obscure and ambiguous statements.
3. Figures and Tables: properly sized; readable; conveying important information.
4. Poise: self-assurance; non-frivolous and natural demeanor; adequate voice volume.

B. Technical Content: (40%)

1. Completeness: coverage of the important technical matters relevant to the experiment.
2. Correctness: use of appropriate principles, factual information, and technically sound reasoning.

C. Response to Questions: (20%)

1. Knowledge of the project: knowledge of all aspects of the project and the ability to give a technically sound answer.
2. Defense of methods and procedures: ability to argue soundness and appropriateness of methods and procedures when challenged.

NOTE. You are encouraged to prepare simple visual aids (PowerPoint slides) that will help make your presentation more effective and "professional."

Appendix VI: Sample Cover Page for Reports

For Pre-laboratory Report:

CHE 450 - Pre-laboratory Report
Cycle #, Experiment #, Experiment Name
Written by Name
Lab Partners: Names
Submitted to Dr. E. L. Kugler
Date Submitted

For Preliminary Report:

CHE 450 - Preliminary Report
Cycle #, Experiment #, Experiment Name
Written by Name
Lab Partners: Names
Submitted to Dr. E. L. Kugler
Date Submitted

For Final Report:

CHE 450 - Final Report
Cycle #, Experiment #, Experiment Name
Written by Name
Lab Partners: Names
Submitted to Dr. E. L. Kugler
Date Submitted

For Revised Report:

CHE 450 - Final Report (Revision #)
Cycle #, Experiment #, Experiment Name
Written by Name
Lab Partners: Names
Submitted to Dr. E. L. Kugler
Date Submitted

ChE 451: Senior Laboratory
Tuesday 13:00 – 16:50
Spring 2011

Course Instructor: J.Zondlo
Office Location: 415 Engineering Sciences Building
Office Hours: TTh 10 – 11 AM
Email: john.zondlo@mail.wvu.edu
Phone: 304-293-9366

Graduate Teaching Assist: Jason Peluchette
Office Location: G55A ESB
Phone: 304-293-9367
Email: jpeluche@mix.wvu.edu

Recommended Texts: J. C. Smith and P. Harriott, *Unit Operations of Chemical Engineering, 5th Edition*, W. L. McCabe, McGraw-Hill 1993

J. M. Haile, *Technical Style*, Macatea 2002

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1. Learning Outcomes

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- develop the ability to design and to perform laboratory experiments from a general problem statement and relevant literature suggested;
- become familiar with process equipment and instrumentation similar to that found in actual plant environments;
- integrate the principles learned in classes with laboratory operation and practice;
- learn how to document data and ideas appropriately in a laboratory notebook;
- analyze experimental data using basic chemical-engineering principles;
- communicate effectively in both written and oral formats;
- improve technical-writing skills by receiving written feedback and revising written reports;
- develop interpersonal skills necessary for team performance;
- practice standard laboratory safety procedures and follow good environmental practice.

2. Summary of Important Course Policies

- a) Laboratory work must be carried out on the scheduled dates with all members present. Please try to schedule job interviews accordingly.
- b) The team is responsible for reading and understanding the laboratory manual and any reference material provided.

- c) An approved Pre-laboratory Report must be given to the GTA before the experiment can be initiated. Any revisions must be submitted to the GTA at least one day before the experiment is scheduled.
- d) All reports must be neatly printed double-spaced using word processor software in the format described in the manual.
- e) Each team member must participate in every Oral Report.
- f) You may examine equipment during normal working hours but under no circumstances are you to work on or to operate an experiment alone or without proper supervision.
- g) Laboratory safety procedures are of paramount importance and will be strictly enforced. If you are not sure about something, please ask!!

3. Course Schedule

The three laboratory cycles for this course are shown in Table 1. Each cycle represents a different experiment which will be identified later in this document. Three different reports and an oral presentation are associated with each cycle. The due dates and grade weighting of each of these are shown in Table 2.

Table 1. Course Schedule

Week #	Cycle #	Activity	Date	Location
1		Introduction and Laboratory Overview	11-Jan	249A
2	1	Pre-laboratory Report	18-Jan	Galli Lab
3		Experiment & Preliminary Report	25-Jan	Galli Lab
4		Experiment & Appendix	1-Feb	Galli Lab
5		Oral & Written Report	8-Feb	249A
6	2	Pre-laboratory Report	15-Feb	Galli Lab
7		Experiment & Preliminary Report	22-Feb	Galli Lab
8		Experiment & Appendix	1-Mar	Galli Lab
9		Oral & Written Report	8-Mar	249A
10	3	Pre-laboratory Report	15-Mar	Galli Lab
11		Experiment & Preliminary Report	29-Mar	Galli Lab
12		Experiment & Appendix	5-Apr	Galli Lab
13		Oral & Written Report (then on to Damons)	12-Apr	249A

Table 2. Laboratory Report Grade Weighting

Cycle Activity	Due Date	Points
Pre-laboratory Report	Cycle Week 1	50
Preliminary Report	Cycle Week 2	50
Oral Presentation	Cycle Week 4	50
Final Report	Cycle Week 4	100

4. Student and Team Performance

Each student has been assigned to a student team last semester. We'll keep the same teams this semester. In a given cycle, the student team will perform the assigned laboratory experiment.

The experiments and team assignments are given in Tables 3 and 4, respectively. The team members will plan and perform the experiment together. but they will submit individually written reports to the instructor or graduate teaching assistant (GTA).

CHE 451 is designated as a writing course and meets Objective 1 in the General Education Curriculum. As such, students are expected to receive feedback on their writing and to revise reports to improve their writing skills. Each student is expected to produce at least 30-60 pages of original writing over the course of the semester.

Table 3. List of Experiments

Experiment #	Name of Experiment
1	Process Control Simulation
2	Convective Heat Transfer
3	Distillation Column
4	Cross-Flow Filtration
5	Dye Fading Kinetics
6	Residence Time Distribution
7	Enzyme Kinetics
8	Tank Drainage
9	Fluidized Bed
10	Heat Transfer Coefficients in Spheres
11	Pressure drop in pipes

Table 4. Student Team and Experiment Assignments

Team #	Team Members	Lab No. 1	Lab No. 2	Lab No. 3
1	Z. Baker S. Bruce M. Nagowski	1	11	5
2	J. Caldwell N. Guy M. Thompson	3	2	11
3	M. Payne E. Rasky J. Wiedman	2	3	1
4	A. Defusco W. Kistler J. Maxim	5	1	4
5	N. Carr A. Miller D. Walls	11	5	3

4. Cycle Sequence and Report Preparation

A short memorandum to each student team will initiate each laboratory cycle. A packet of all the pertinent memos will be supplied to you on the first day. This memo will provide a brief description of a problem (experiment) and will describe the task assigned. Each team needs to discuss this memorandum and to do the background work necessary to start the project. Each cycle consists of the following activities.

A. Pre-laboratory Report (Cycle Week 1)

A neatly written experimental plan (Pre-laboratory Report, “Pre-lab”) must be submitted to the GTA or instructor at the Pre-laboratory meeting one week before the experiment is performed. The Pre-laboratory schedule is given in Table 5. The Pre-laboratory Report consists of a brief (2-5 page) written description of the theory and experimental procedures planned, important variables and ranges of parameters to be measured, and a discussion of important safety aspects. Pre-laboratory Reports will be graded for content, and the writing will be critiqued. See Appendix I for grading criteria.

Table 5. Pre-laboratory Schedule

Team #	Lab #1 Time	Lab #2 Time	Lab #3 Time
Team 1	1:00	1:40	2:20
Team 2	1:20	2:00	2:00
Team 3	1:40	2:20	1:00
Team 4	2:00	1:20	1:20
Team 5	2:20	1:00	1:40

The Pre-laboratory meeting with the instructor or GTA should clearly reflect the level of planning the team has done for the experiment. No experiment can be performed until the Pre-laboratory Report is approved.

B. Preliminary Report and Lab Day (Cycle Week 2)

A Preliminary Report must be submitted at the start of the experiment. It should consist of as complete a body of the report as possible, understanding that the experiment has not yet been done. The instructor will evaluate this report for technical content and writing style. It will be returned within one week so that comments can be integrated into the Final Report. See Appendix II for grading criteria. The team will carry out the experiment in the Galli Laboratory at this time.

C. Data Review with GTA and Another Lab Day (Cycle Week 3)

The team will meet with the GTA at the designated time slot on Tuesday of Cycle Week 3 in the Galli Laboratory. The team will show the experimental results to the GTA. At that time it will be determined if the experiment needs to be repeated. The schedule for GTA review of experimental data is given in Table 6.

Table 6. Schedule for Data Review by Graduate Teaching Assistant (3rd Wednesday)

Team #	Lab #1 Time	Lab #2 Time	Lab #3 Time
Team 1	2:00	2:40	3:20
Team 2	2:20	3:00	3:40
Team 3	2:40	3:20	2:00
Team 4	3:00	3:40	2:20
Team 5	3:20	2:00	2:40

Any team that did not finish the experiment during Cycle Week 2 is allowed to repeat the experiment in the third week of the cycle, Second Laboratory Day. Even if the team finished the experiment, there may be “bad data” because, e.g., correct conditions and/or procedures were not

used. In many cases, it is possible to improve the data collection technique. In these cases, team members are allowed to repeat the experiment. Unless the data from the previous week are exceptional, all experiments should be repeated either duplicating the previous runs or covering a wider range of variables. This will allow some estimation of the uncertainty in the data. See Appendix III for additional comments.

D. Final Report (Cycle Week 4)

The Final Written Report must be submitted at the beginning of the class when Oral Presentations are given. Late reports will be penalized. Reports will be corrected for writing and technical content, and returned by the instructor within one week. You should carefully read the instructor's remarks to determine how you can improve reports. Make corrections and submit a revised report to the instructor for grading. See Appendix IV for grading criteria.

E. Oral Presentation (Cycle Week 4)

Oral Presentations with visual aids (PowerPoint format for projection system) will be made by all team members on the fourth week of the cycle. See Appendix V for grading criteria.

5. Social-Justice Statement

“WVU is committed to social justice. I concur with that commitment and expect to maintain a positive learning environment based upon open communication, mutual respect, and nondiscrimination. WVU does not discriminate on the basis of race, sex, age, disability, veteran status, religion, sexual orientation, color or national origin. Any suggestions as to how to further such a positive and open environment in this class will be appreciated and given serious consideration. If you are a person with a disability and anticipate needing any type of accommodation in order to participate in this class, please advise me and make appropriate arrangements with the Office of Disability Services (304-293-6700)”

Appendix I: Pre-Laboratory Report (0-50 points)

Pre-laboratory planning requires a review of literature and an inspection of the apparatus in the laboratory. All aspects of the experiment must be planned. The pre-laboratory report should include, but is not necessarily limited to, the number of data points, range of data points, experimental procedure, and variables to be measured and/or fixed. Pertinent equations necessary for data analysis should be included. Remember these estimates may need to be revised as you perform the experiment.

One key to success in experimental work is to ask continually: *What am I looking for? Why am I measuring this? Does the measurement really answer any of my questions? What does the measurement tell me?* These questions may seem rather elementary, but they should be asked frequently throughout the progress of any experimental program. Some particular points, which should be addressed in experimental planning, are shown below. Also see the Laboratory Manual.

Note that an experiment will not be permitted to be run until an acceptable pre-laboratory plan is approved.

Pre-Laboratory Report Grading

A. Overall Objectives (20%)

Summarize the goals of the experiment, and your proposed approach to those goals.

B. Details of Experimental Work (60%)

1. Outline the experiment and identify important process variables and measurements. Relate them briefly to important theoretical concepts.
2. Speculate on the more difficult aspects of the experiment.
3. Quantify the range of the more important process variables that you intend to cover in the experiment.
4. Summarize the safety considerations and outline emergency procedures.

C. Appearance and Exposition (20%)

Report should have neat appearance and be free of grammatical errors.

Appendix II: Written Preliminary Report (0-50 points)

In addition to addressing the three items in your pre-laboratory report, the Preliminary Report should contain a draft of the Introduction, Theory and Experimental sections to be included in your final report. The instructor will check this report for both technical accuracy as well as writing style. For specific details regarding these portions of a report, refer to the section explaining the information needed.

Introduction: You should be able to write this section based upon your preliminary research into the experiment being performed.

Theory: If you have researched the experiment fully, you should be able to write a draft of this section before performing the experiment.

Experimental: If you familiarize yourself with the equipment, you should be able to write a draft of this section before performing the experiment.

Preliminary Report Grading

The instructor will review the Preliminary Report as a draft of the Final Written Report. It is due on the day the experiment is performed. The report will be edited, commented on and returned by the instructor within one week, when the Appendix is due to the GTA. The grade will be based upon the technical content and the research to be performed on the experiment, the degree and thoroughness of the experimental plan, and the writing style and mechanics. While it is recognized that this draft is incomplete at the time of submission, the student is expected to do a thorough job in preparation. If a Preliminary Report needs revision, it will be returned to the student to be rewritten. The Preliminary Report will be used to prepare the Final Written Report, which will address all instructor comments. Try to keep these reports brief and concise!!

Appendix III: Meeting with Graduate Teaching Assistant (not graded)

Data and hand calculations will be checked by the GTA and will be initialed by him/her. Initialed hand-calculations must be included in the appendix of the final report. The person making the calculations should use the initialed original; other team members should use a photocopy.

The feedback from this meeting will guide you in repeating some or all the of the experiment in the third week in the cycle. Students should not repeat experiments alone, but must arrange for supervision by the GTA or instructor.

Appendix IV. Written Final Reports (100 points)

Grading will be assigned based on an overall review of the report using the following criteria. Try to keep your reports as brief as possible by using a concise writing style.

A. Presentation: (30%)

1. Organization: the assembly of information and facts into a logical and understandable sequence of statements leading to definite objectives and conclusions.
2. Completeness and conciseness: inclusion of absolute essentials as a minimum. Omission of irrelevant, nonessential, and trivial material.
3. Judgment: selection of material to be discussed, order of presentation, direct statements of importance, length of presentation, etc.
4. Neatness.

B. Exposition: (30%)

1. Clarity
2. Good choice of words
3. Economy of words (including absence of typographical errors)
4. Correct spelling
5. Precision
6. Correct interpretation of the meaning of words
7. Correct grammar
8. Correct punctuation
9. Freedom from use of jargon or slang
10. Freedom from awkward expressions

C. Technical Competence: (40%)

1. Correctness and clarity of thought: explanation of the relevant physical and chemical phenomena and economic factors at play.
2. Quality of results: a reflection on the quality of experimental design of the experiment, treatment of data, and analysis of the design problem.
3. Discussion and conclusions: the recognition and interpretation of the significance of the information presented; judgment in stating technically sound conclusions; and judgment in the omission of trivia. Address specifically the uncertainty of the data and how it affects your calculated results.
4. Be sure to include a section on how the experiment can be improved or operated in a way to yield better data/results. This section will be passed along to the next group doing the experiment as a help to them.

Appendix V: Oral Presentation (50 points)

An overall grade will be given on orals using the following general criteria. Percentages are approximate.

A. Presentation: (40%)

1. Organization: presentation of the major segments of the project in an easily understandable and logically connected way.
2. Clarity: transmission of ideas and information in clear, uncomplicated sentences; absence of obscure and ambiguous statements.
3. Figures and Tables: properly sized; readable; conveying important information.
4. Poise: self-assurance; non-frivolous and natural demeanor; adequate voice volume.

B. Technical Content: (40%)

1. Completeness: coverage of the important technical matters relevant to the experiment.
2. Correctness: use of appropriate principles, factual information, and technically sound reasoning.

C. Response to Questions: (20%)

1. Knowledge of the project: knowledge of all aspects of the project and the ability to give a technically sound answer.
2. Defense of methods and procedures: ability to argue soundness and appropriateness of methods and procedures when challenged.

NOTE. You are encouraged to prepare simple visual aids (PowerPoint slides) that will help make your presentation more effective and "professional."

Appendix VI: Sample Cover Page for Reports

For Pre-laboratory Report:

CHE 451 - Pre-laboratory Report
Cycle #, Experiment #, Experiment Name
Written by Name
Lab Partners: Names
Submitted to J Zondlo
Date Submitted

For Preliminary Report:

CHE 451 - Preliminary Report
Cycle #, Experiment #, Experiment Name
Written by Name
Lab Partners: Names
Submitted to J Zondlo
Date Submitted

For Final Report:

CHE 451 - Final Report
Cycle #, Experiment #, Experiment Name
Written by Name
Lab Partners: Names
Submitted to J Zondlo
Date Submitted

For Revised Report:

CHE 451 - Final Report (Revision #)
Cycle #, Experiment #, Experiment Name
Written by Name
Lab Partners: Names
Submitted to J Zondlo
Date Submitted