Institutional Effectiveness Report

Name of Program/Department:	**Chemistry**
Year:	**2018-2019**
Name of Preparer:	**Pete Peterson, Chemistry IE and Gen Ed Coordinator, and Department Chair**

Program Mission Statement

The mission of the chemistry department is to provide a dynamic and inquiry based curriculum in chemistry that provides knowledge and skills needed for students to be successful in their professional and life-long endeavors. Accordingly, the department offers introductory, foundation, and in-depth chemistry courses that satisfy requirements in liberal arts, pre-professional programs, the basic chemistry degree, and the American Chemical Society approved degree program. The department strongly encourages students to engage in undergraduate research, service, and networking within the scientific community.

Program Learning Outcomes (PLOs)

Senior chemistry majors at Francis Marion University will be characterized with the following qualities or attitudes:

Direct Assessments:

PLO #1 – Chemistry majors will demonstrate that they have the knowledge and skills needed that will allow them to communicate chemistry effectively in both oral and written form.

PLO #2 – Chemistry majors will demonstrate that they can apply critical thinking skills in chemistry.

PLO #3 – Chemistry majors will demonstrate an understanding of core concepts, methods and limits of scientific inquiry that will allow them to successfully solve integrated problems in chemistry.

PLO #4 – Chemistry majors will demonstrate that they can adequately apply their knowledge of chemistry.

PLO #5 – Chemistry majors will demonstrate that they can adequately use the scientific literature.

PLO #6 – Chemistry majors will demonstrate an understanding of safe laboratory skills and procedures for laboratory experiments that they perform.

PLO #7 – Chemistry majors will have accrued over the period of their undergraduate studies, an overall favorable view of the Department of Chemistry's quality of instruction, advising, and facilities.

Executive Summary of Report

Presented in this report are the Chemistry Department's Mission, Program and Student Learning Outcomes, the assessment and results of each, and action items for the academic year 2018-2019. Achievement and attitudes of our senior chemistry majors on their chemistry concept knowledge and critical thinking skills, and on communication skills were assessed with (1) Capstone writing assignments, (2) the standardized American Chemical Society (ACS) *Diagnostic of Undergraduate Chemical Knowledge* (**DUCK**) Exam, (3) an oral presentation, (4) a written chemistry term paper, (5) a chemical safety exam, and (6) an exit questionnaire and interview.

Students in the Chemistry 499 Senior Capstone course performed at a 68.00% pass rate on five capstone writing assignments that assessed their understanding of key chemical concepts SLO (# 1). The 68.00% fell below our target goal of 80.00% for SLO # 1.

Students in the Chemistry 499 Senior Capstone course scored on average at the 20.75 percentile with a range of 38.00-8.00 percentile for the 8 students taking the standardized the ACS (American Chemical Society) Diagnostic of Undergraduate Chemical Knowledge (DUCK) exam (SLO # 2). The 20.75 percentile is well below the national percentile of 31.37 (Sts error = 3.70%), and was also well below the Department's very optimistic goal for the 50th Percentile for SLO # 2.

Students in Chemistry 499 Senior Capstone, on average, performed at the 91.00% level or above when demonstrating competency in presenting technical information through their written communication skills on a chemistry topic of their choosing that was approved by the chemistry faculty (SLO # 3). Our goal for SLO # 3 was 80.00%. Therefore, our target was achieved.

Students taking the Chemistry 499 Senior Capstone, on average, performed at the 82.93% level when demonstrating competency in presenting technical information through their oral communication skills on the same chemistry topic in as in SLO # 3 of their choosing that was approved by the chemistry faculty (SLO # 4). Our goal for SLO # 4 was 80.00%. Therefore, our target was achieved.

All students (100%) enrolled in Chemistry 201 demonstrated an adequate level of understanding of laboratory safety procedures at or above the 70% level (SLO # 5). Our goal for SLO # 5 was 70%. Therefore, our target was achieved.

A Gen Ed Assessment Exam was also administered to Students enrolled in the Spring 2019 Chemistry 101 course. 30.8% of the 51 students taking the exam scored 60% or better.

And finally pertaining to students' attitudes about the Department of Chemistry, their overwhelming opinion is that the Department of Chemistry's instruction, advising, and facilities are at or above the level considered to be favorable.

Student Learning Outcomes (SLOs)

SLO# 1.0: Students in the Chemistry Senior Capstone course, on average, will perform at or above the 80.00% level, on a pass/fail basis, on capstone writing assignments that assess their understanding of key chemical concepts.

SLO# 2.0: 80% of graduating Chemistry students will, on average, perform at or above the 50^{th} percentile on their understanding of integrated chemical concepts based on their performance on a nationally standardize chemistry exam.

SLO #3.0: Students in the Chemistry Senior Capstone course, on average, will perform at or above the 80.00% level on their ability to present technical information through written communication.

SLO #4.0: Students in the Chemistry Senior Capstone course, on average, will perform at or above the 80.00% level on their ability to present technical information through oral communication.

SLO #5.0: 100% of students enrolled in Chemistry 201 will demonstrate at least an adequate level of 70.00% on their understanding of laboratory safety procedures.

SLO #6.0: 95% of chemistry majors will have accrued over the period of their undergraduate studies, an overall favorable view of the Department of Chemistry's quality of instruction, programs, and facilities.

SLO #7.0: 80% of students tested who are enrolled in General Chemistry 101 will demonstrate an adequate level or above in at least one of the Gen Ed STEM assessment goals.

Assessment Methods

SLO# 1.0: Students in the Chemistry Senior Capstone course, on average, will perform at or above the 80.00% level, on a pass/fail basis, on capstone writing assignments that assess their understanding of key chemical concepts.

Assessment Method for SLO# 1.0: Five writing assignments (Appendix 1) were administered to eight students during the course of the senior Chem 499 Capstone course for the spring of 2019 semester. The assignments were graded on a pass/fail basis. A passing (P) grade was assigned if the student presented an adequate knowledge or above on the chemical concepts tested as determined by Capstone instructor Pete Peterson. Otherwise a grade of fail (F) was assign.

SLO# 2.0: 80% of graduating Chemistry students will, on average, perform at or above the 50th percentile on their understanding of integrated chemical concepts based on their performance on a nationally standardize chemistry exam.

Assessment Method for SLO# 2.0: Eight graduating chemistry senior chemistry majors were administered the *Diagnostic of Undergraduate Chemical Knowledge* (**DUCK**) (Appendix 2 for Description) exam near the end of the spring of 2019. The DUCK is a standardized exam produced by the American Chemical Society (ACS).

SLO #3.0: Students in the Chemistry Senior Capstone course, on average, will perform at or above the 80.00% level on their ability to present technical information through written communication

Assessment Method for SLO# 3.0: To assess their written communications skills, eight students enrolled in the Chemistry Senior Capstone course wrote a term paper near the end of the spring semester of 2019, based on a technical chemistry topic they select and then was faculty approved. Each paper was graded by Capstone instructor Pete Peterson using a standard, department generated grading rubric for scientific term papers.

SLO #4.0: Students in the Chemistry Senior Capstone course, on average, will perform at or above the 80.00% level on their ability to present technical information through oral communication

Assessment Method for SLO# 4.0: To assess their oral communications skills, eight students enrolled in the Chemistry Senior Capstone course delivered an oral presentation near the end of the spring of 2019 on the same chemistry topic as their written topic, which is described in SLO 3.0. Each presentation was graded by all of the available chemistry instructors using a standard, department generated grading rubric for scientific term papers.

SLO #5.0: 100% of students enrolled in Chemistry 201 will demonstrate at least an adequate level of 70.00% on their understanding of laboratory safety procedures.

Assessment Method for SLO# 5.0: All of the approximately 60 students enrolled in Organic Chemistry 201, a foundation course that is required for all chemistry majors, are taught a lab module on chemical safety during the first two weeks of the course at the beginning of the Fall 2018 semester. This was followed by their taking a comprehensive and cumulative lab safety exam that is produced and administered by the Chemistry Department. They must score at least 70% on the safety exam to remain in the course.

SLO #6: 95% of chemistry majors will have accrued over the period of their undergraduate studies, an overall favorable view of the Department of Chemistry's quality of instruction, programs, and facilities.

Assessment Method for SLO# 6.0: To help access the quality of its instruction, advising, and facilities, the Department of Chemistry administers an associated questionnaire (Appendix 1) and also an exit interview (Appendix 2) to its senior chemistry majors enrolled in the senior capstone course.

Assessment Results

SLO# 1.0: Students in the Chemistry Senior Capstone course, on average, will perform at the 80% level, on a pass/fail basis or above, on capstone writing assignments that assess their understanding of key chemical concepts.

Assessment Results for SLO# 1.0: Students in 499 Chemistry Senior Capstone on average, performed at a 68.00% pass rate for the 2018-2019 academic year for SLO # 1. Therefore, the pass rate of 68.00% for SLO # 1 did not reach our target goal of 80.00%.

SLO# 2.0: 80% of graduating Chemistry students will, on average, perform at the 50th percentile or above when demonstrating their understanding of integrated chemical concepts based on their performance on a nationally standardize chemistry exam. The exam, which is the ACS (American Chemical Society) Diagnostic of Undergraduate Chemical Knowledge (DUCK) exam, consisted of several chemistry scenarios testing integrated chemical concepts, each of which was followed by several multiple choice questions based on it. There are a total of 60 questions in all.

Assessment Results for SLO# 2.0: Senior FMU chemistry majors scored an average at the 20.75 percentile with a range of 38.00-8.00 percentile for the 8 students taking the DUCK exam. Therefore, this 20.75 percentile of students scoring at or above the 50th percentile for SLO # 2.0 did not reach our target goal of 80.00%.

SLO #3.0: Students in the Chemistry Senior Capstone course, on average, will perform at the 80% level or above when demonstrating competency in presenting technical information through written communication in the form of a chemistry term paper.

Assessment Results for SLO# 3.0: Students in 499 Chemistry Senior Capstone, on average, performed at the 91.00% level % level on their chemistry term paper as graded by the Chemistry 499 Capstone instructor using a standard scientific term paper rubric (Appendix 3). Our target for SLO # 3 was 80.00%. Therefore, our target was achieved.

SLO #4.0: Students in the Chemistry Senior Capstone course, on average, will perform at the 80% level or above when demonstrating competency in presenting technical information through oral communication.

Assessment Results for SLO# 4.0: Students in 499 Chemistry Senior Capstone, on average, performed at the 81.88% % level on their chemistry oral presentation as graded by the chemistry faculty using a standard scientific, department generated rubric (Appendix 4). Our target for SLO # 4 was 80.00%. Therefore, our target was achieved.

SLO #5.0: 100% of students enrolled in Chemistry 201 will demonstrate an adequate or above understanding of laboratory safety procedures at or above the 70% level.

Assessment Results for SLO# 5.0: 100% of students enrolled in Chemistry 201 demonstrated an understanding of laboratory safety procedures at the 70% level or above based on a comprehensive and cumulative lab safety exam that was produced and administered by the Chemistry Department. Respective lab instructors graded the lab safety exams. Our target for SLO # 5 was 100.00%. Therefore, our target was achieved.

PLO #7 – Chemistry majors will have accrued over the period of their undergraduate studies, an overall favorable view of the Department of Chemistry's quality of instruction, programs, and facilities.

Assessment Results for SLO# 6.0: To help access the quality of its instruction, advising, and facilities, the Department of Chemistry administers an associated questionnaire and also an exit interview (Appendix 5) to its senior chemistry majors enrolled in the senior capstone course. The questionnaire is grouped into questions pertaining to the quality of its programs, resources, and instructions. This assessment instrument revealed the following for the 8 students enrolled in the Chemistry Capstone course: 98.1% of responses to the 12 questions pertaining to instruction were viewed as favorable, 95.5% of responses to the 9 questions pertaining to advising were viewed as favorable, and 79.2% of responses to the 13 questions pertaining to facilities were viewed as favorable.

These findings were supported by the exit interviews of the capstone students conducted by the Department Chair near the end of the 2019 spring semester.

Gen Ed Assessment (SLO 7)

The assessment procedure involved a quiz (Appendix 6) based on a description of a laboratory experiment. The quiz began with a brief description of the experimental procedure, followed by five multiple choice questions designed to assess Goals 6 and 9 on the Gen Ed Matrix of Assessment Sheet (Appendix 6).

Overall, 30.8% of the 51 students taking the exam scored at the target of 60.0% or above.

Action Items

To better prepare students for the high level thinking problems given on exams like the DUCK (SLO 2) all chemistry instructors will be given a quick reference guide to Bloom's Taxonomy and they will be encouraged to continue with creating such higher order problems in their courses.

Pertaining to students' attitudes about the Department of Chemistry that based on the Department Exit interview and questionnaire, the overwhelming majority of the responses that eight students enrolled in the Chemistry 499 Capstone course felt that the Department of Chemistry's instruction, programs, and facilities are adequate or better.

Based on the Department Exit interview and questionnaire, the major finding is for a need to change the Math requirement for chemistry majors to make it more flexible for the upper level courses. Specifically, students believe that the required Math 203 is of lesser importance than any of the other optional courses such as Math 303, 304, or 305.

To address matters associated with improving all SLO's that were identified in the evaluation of data from the 2018-2019 academic year, the Chemistry Department will continue to review and modify its current action plan from previous years and its IE Feedback Report (Appendix 7), and these will be incorporated for the 2019-2020 academic year.

Based on the IE assessment data from 2018-2019 and looking toward the 2019-2020 academic year, the Chemistry Department faculty will continue to look for ways to improve the writing and oral presentation rubrics. These rubrics will be made available to all chemistry majors starting at the freshman level, with goal that they will be better prepared at the senior level. Next, the Department will continue to develop its online component of the Chemistry 499 Capstone course on the Blackboard platform that will enable students to access review materials and practice tests earlier during the 2019-2020 Academic year in order for them to have more time to review and prepare for the DUCK exam.

All department efforts dedicated toward improving PLO's, SLO's, and our Gen Ed Assessment, will be discussed and decided upon at our Department's regular meetings.

Appendix 1

Capstone Writing Assignment 1 **Due Date: By 5:00 pm on 22/Jan/19**

Name_____

Title: Production of Table Salt from the Reaction of Baking Soda with Hydrochloric Acid

Lab Setup:

A lab experiment was performed to produce table salt (sodium chloride, NaCl) by reacting a quantity of baking soda (sodium bicarbonate, $NaHCO_3$) with a stoichiometric amount of hydrochloric acid (HCl) according to the reaction:

$NaHCO_3$ (s) + HCl (aq) → NaCl (s) + CO_2 (g) + H_2O (l)

The experiment begins by weighing a clean, dry, empty test tube. The baking soda was then placed in the test tube and the mass of the tube plus the baking soda was determined. Stoichiometric amounts of hydrochloric acid was then slowly and carefully added to the tube, whereupon the reaction occurred to completion as described above, until all the baking soda reacts.

The resulting solution was then carefully heated to dryness, leaving behind only the table salt, a white solid. The test tube with the table salt product were allowed to cool to room temperature and then weighed again. The mass of the table salt produced was then determined by subtraction.

Circle the correct answer for the questions below and give a brief justification for your answer directly below it. Use additional sheets for the justification if needed.

1. If the baking soda was unknowingly added to a wet test tube and then weighed, the calculated mass of table salt at the end of the experiment in comparison to the mass calculated using the dry test tube would be

(a) too high (b) too low (c) the same (d) equal to the excess water

Justification:

2. The formula NaCl tells us that there is

(a) 1 gram of sodium per 1 gram of chlorine. (b) 1 atom of sodium per 1 atom of chlorine.

(c) 1 mole of sodium per 1 gram of chlorine. (d) 1 atom of sodium per 1 mol of chlorine.

Justification:

3. When the procedure is carried out correctly using stoichiometric amounts of baking soda and hydrochloric acid, the mass of table salt formed is less than the mass of the baking soda reacted. Why is this?

(a) The mass of sodium in the table salt is less than the mass of sodium in the baking soda.
(b) The mass of chlorine in the table salt is less than the mass of bicarbonate in the baking soda.
(c) The mass of bicarbonate in the baking soda is less than the mass of chlorine in the table salt.
(d) Much of the baking soda is lost due to splashing.

Justification:

4. After the conversion of baking soda to table salt is complete, and the tube and sodium chloride is weighed, a student then adds more hydrochloric acid to the table salt in the tube, again heated to dryness, and then weighs the tube and its contents a second time. The mass of the tube and its contents should be _____ .

(a) the same as its mass before adding more hydrochloric acid.
(b) more than its mass before adding more hydrochloric acid.
(c) less than its mass before adding more hydrochloric acid.
(d) the same as the mass of the hydrochloric acid added.

Justification:

5. A student wishes to prove that the conversion of baking soda to table salt is complete. Which of the following observations would most likely indicate that the conversion was completed?

(a) The solid remaining in the test tube was white.
(b) The solid remaining in the test tube gives a positive test for chloride ion.
(c) Addition of HCl to the solid remaining in the test tube yields no evolution of gas
(d) Litmus paper shows that the white solid is basic.

Justification:

6. Student A uses twice as much HCl in the procedure as student B. Which of the following statements is true?

(a) Both students will obtain the same amount of NaCl.
(b) Student A will obtain twice as much NaCl.
(c) Student A will obtain $NaCl_2$.
(d) Student A's reaction will not work, and the solid remaining in the test tube will be baking soda.

Justification:

Capstone Writing Assignment 2 **Due Date: By 5:00 pm on 5/Feb/19**

Name_____

For the compound with the molecular formula $C_5 H_{10} O$, determine the correct structure from its corresponding proton nmr spectrum, C-13 nmr spectrum, IR spectrum, and its mass spectrum, all of which are given below. Draw your structure using a molecular drawing software program such as ChemDraw or Accelrys Draw and attach it to this report. For each of the spectra, provide a reasonable explanation below on what specific piece of information it provided to allow you to ascertain the structure.

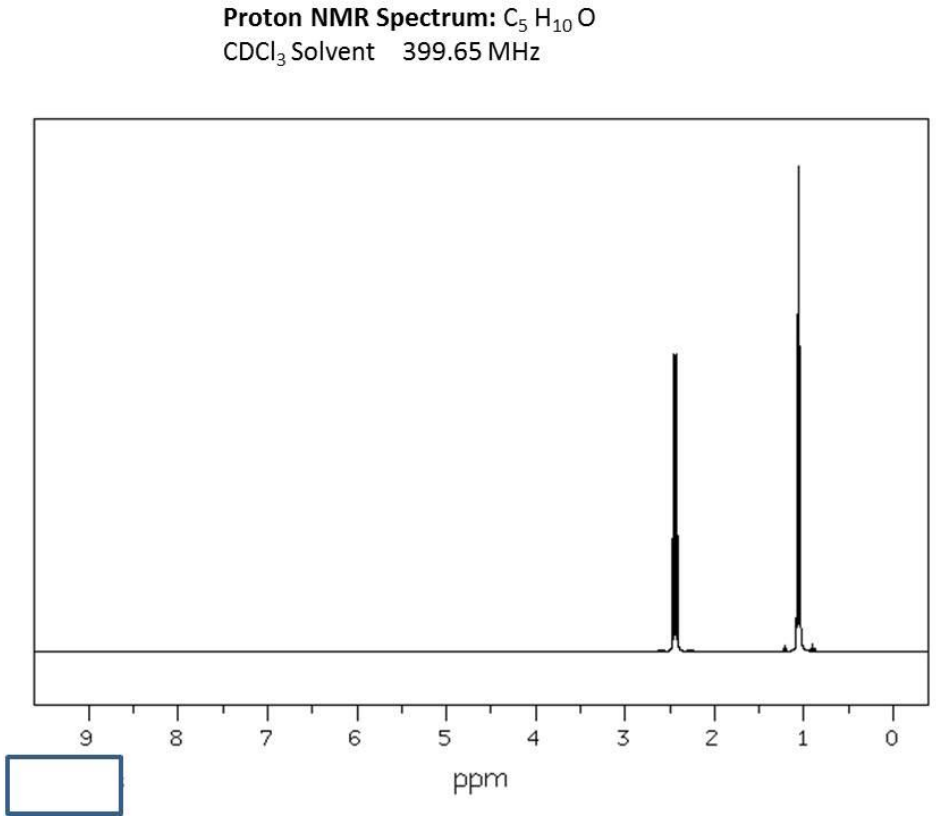
Correct structure of $C_5 H_{10} O$ (Draw by hand here):

Proton NMR spectrum:

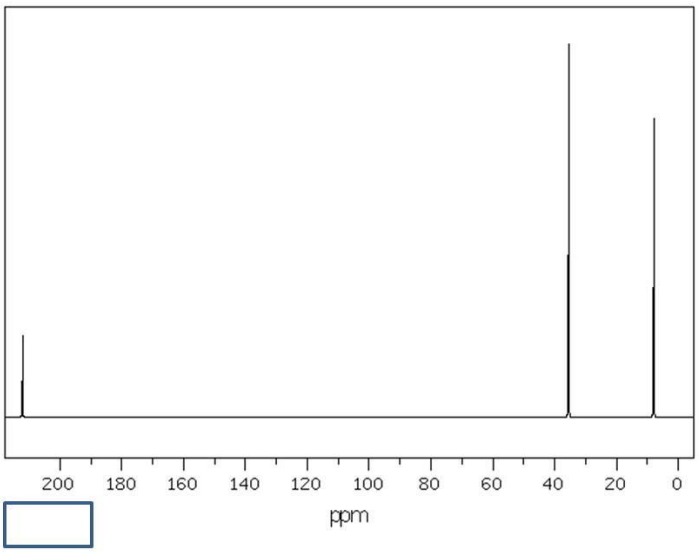
^{13}C NMR spectrum:

IR Spectrum:

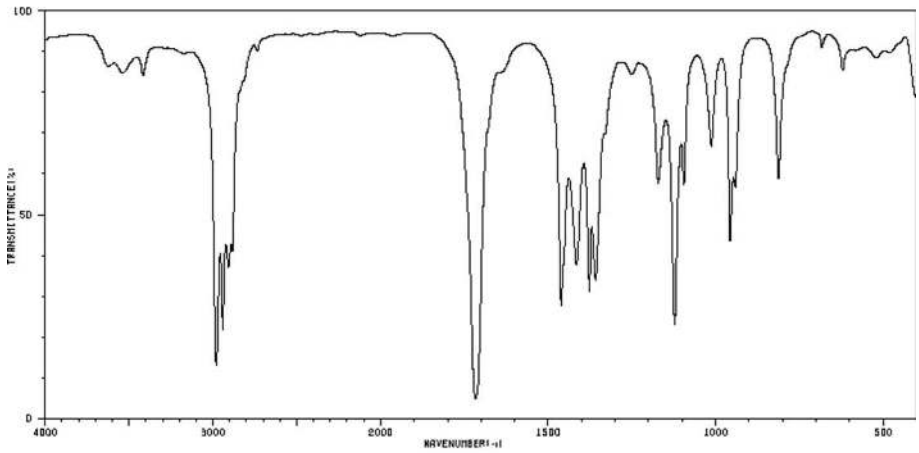
Mass Spectrum:

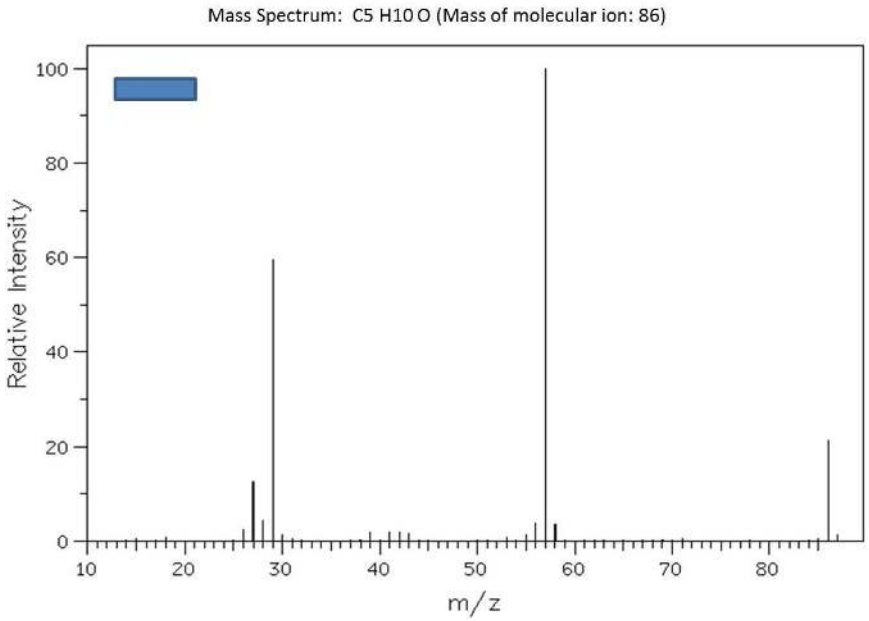


^{13}C NMR Spectrum: $C_5H_{10}O$
$CDCl_3$ Solvent 15.09 MHz



Infrared Spectrum : $C_5H_{10}O$
Liquid Film





Chemistry Capstone Assignment 3
Date: By 5:00 pm on

Writing Due 20/Feb/19

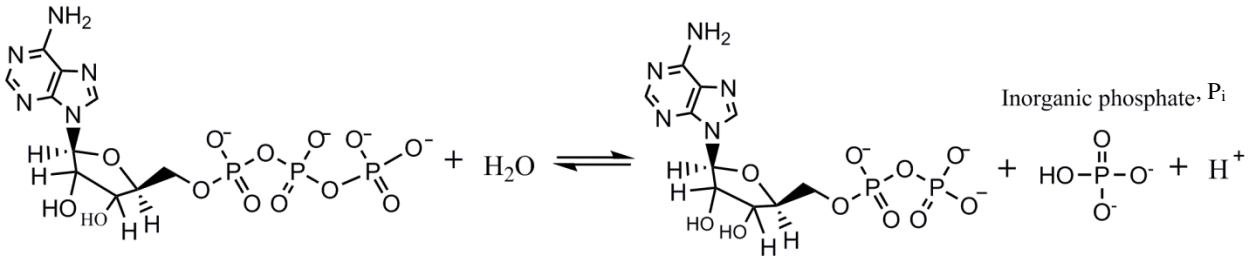
Name_____

The hydrolysis of adenosine triphosphate (ATP) to yield adenosine diphosphate (ADP) plus an inorganic phosphate (HPO_4^{2-} or p_i) is a crucial biochemical reaction:

Adenosine triphosphate, ATP

Adenosine diphosphate, ADP

Inorganic phosphate, P_i



$$ATP^{4-} + H_2O \rightleftharpoons ADP^{3-} + HPO_4^{2-} + H^+ \qquad \Delta G^{o'} = -30.5 \text{ kJ/mol}$$

Write a short paper of about 250 words or less that discusses both the importance of this reaction and addresses the following topics:

(a) Describe the basic structural components of ATP, and tell why the reaction above is classified as a hydrolysis?

(b) The value of $\Delta G^{o'}$ is -30.5 kJ/mol. Determine and then justify whether or not the reaction is spontaneous under standard state conditions at 25°C.

(c) The standard enthalpy change (ΔH^o) for the ATP hydrolysis reaction above is -16.7 kJ/mol at 25°C. Determine the corresponding value for ΔS^o, and decide if this value makes sense based on the number of reactants and products species given in the ATP-to-ADP hydrolysis reaction above? Justify your response.

(d) ATP is a major energy transporter for many biochemical reactions in the cell to make nonspontaneous reactions spontaneous. Describe how ATP performs this task, and give a specific example of this.

(e) ADP must constantly be converted back to ADP to meet the steady energy requirements of cells. Give a very brief and general overview of where the energy comes from to convert ADP back to ATP?

Your paper will be graded on the degree to which it addresses the points above, on basic grammar and punctuation, and on its organization and structure. You are free to order the topics in any way to produce an effective, well written paper. You may also discuss additional topics for continuity and support.

Capstone Writing Assignment 4 Due Date: By 5:00 pm on 26/Mar/19

Name_____

Answer the following four questions and provide adequate justification.

1. Which gas, He or Xe, would you expect to deviate more from ideal behavior at a given temperature and pressure? Explain and justify your answer.

2. A supersaturated solution of sodium acetate trihydrate, which exist in a metastable state, will spontaneously crystallize if a seed crystal is added to it, and the process releases heat at room temperature as is evidenced by the container getting warmer to the touch.
   Based on this information, discuss what the signs of)G,)H, and)S should be, and then justify your choices.

3. Discuss the Arrhenius equation and its use to describe the temperature dependence of chemical reactions.

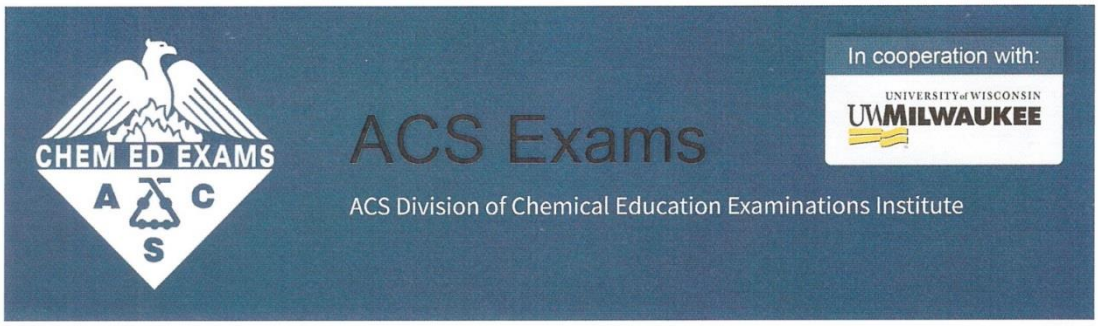
4. The energy levels for the one-dimensional particle in a box have been used to approximate the energies of the B electrons in linear conjugated molecules. Draw structures for the conjugated molecules butadiene and hexatriene, and predict using the particle in a box approximation which molecule requires more energy to excite an electron from its HOMO to its LUMO. Justify your answer.

Chemistry Capstone Writing Assignment 5 Due Date: By 5:00 pm on 16/April/2019

Name_____

For the coordination compounds $K_3[Fe(CN)_6]$ and $[Fe(H_2O)_6](NO_3)_3$: (a) Make a line-dash-wedge drawing of $K_3[Fe(CN)_6]$ and $[Fe(H_2O)_6](NO_3)_3$. Both have octahedral geometries. (b) Construct a d orbital splitting diagram with d electrons shown for each. (c) Which of the two complexes is more likely to to be paramagnetic? (d) Which complex is more likely to absorb light at the shorter wavelength? Justify your choice for each.

Appendix 2



2013 Diagnostic of Undergraduate Chemistry Knowledge Exam

Stock Code	Title	Norms
DUCK13	2013 Diagnostic of Undergraduate Chemistry Knowledge Exam	View PDF

The Diagnostic of Undergraduate Chemistry Knowledge (DUCK) exam is designed to be taken at or near the end of a four-year undergraduate curriculum. All items on the exam are part of scenarios that require knowledge from more than one traditional area of chemistry, so students are less likely to segment their knowledge into such areas and be successful on this exam.

Pricing & Shipping

Ordering Information

Appendix 3

Chemistry 499 Capstone Course 2019

Chemistry Term Paper Rubric

Student's Name _____ Faculty Reviewer _____

	Category	Scoring Criteria	Score Range	Reviewer's Score

1	**Abstract**	(a) Main points are briefly presented, (b) keywords accurately describe information in report, (c) abstract is less than 200 words long	**0-5** 5 being the highest	
2	**Introduction**	(a) effectively communicates the purpose and importance of the research topic in the context of chemistry, (b) supplies and demonstrates understanding and proper use of needed information and terms, (e) lays out the framework for the rest of the paper (f) includes visual aids such as graphs, tables, equations, and schemes, etc, (g) each type of visual aid must be cited in text and in consecutive numerical order, (h) each table or graph must have an appropriate descriptive caption or title	**0-15** 15 being the highest	
3	**Body**	(a) shows command of topic, (b) chemistry content is sufficient (c) describes experimental procedures and results and makes valid interpretation of results, (d) contains accurate information, (e) draws on multiple areas, (f) content backed up by multiple, refereed, and credible sources, (g) includes visual aids such as graphs, tables, equations, and schemes, etc, (h) each type of visual aid must be cited in text and in consecutive numerical order, (i) each table or graph must have an appropriate descriptive caption or title	**0-25** 25 being the highest	
4	**Conclusion**	(a) Communicates a logical conclusion that follows from the body, (b) summarizes and evaluates the major points, strengths and possible weaknesses of the research, (c) discusses further research needed in the area	**0-20** 20 being the highest	
5	**References and Appendices**	(a) Cite at least six references from at least three different peer review journals, (b) references are complete and numbered, (c) references follow acceptable format (see ACS Style Guide or the reference style of one of the journals cited, (d) supplementary materials are located at the back of report, (e) sources of information including tables, graphics, and other visual aids are appropriately cited and referenced	**0-10** 10 being the highest	
6	**Appearance and Format**	(a) makes effective use of headings and subheadings, (b) pages are numbered and bound in a folder, (c) uses appropriate font sizes, the height of the letters must not be smaller than 10 point type density, including characters and spaces, must be no more than 15 characters per 2.5 cm, for proportional spacing, the average for any representative section of text must not exceed 15 characters per 2.5 Cm, (d) no more than 6 lines of type within in a vertical space of 2.5 cm, left and right margins are justified and must be at least 2.5 cm	**0-5** 5 being the highest	
7	**Writing Style and Grammar**	(a) writing is coherent, clear, concise, engaging, and gets point across (b) no sentence fragments, comma splices, or fused sentences, (c) no errors in punctuation , spelling, and/or in the placement of words, (d) makes good use of strong nouns and action verbs	**0-10** 10 being the highest	
8	**Other Relevant Factors**	(a) term paper should be around 5-10 pages including visual aids, (b) Title is sufficiently narrowed down and reflects the content of the paper (c) shows some understanding of other relevant areas outside of chemistry, (d) engaging, (e) good choice of topic, (e) new and interesting ideas	**0-10** 10 being the highest	
9	**Faculty Comments and Recommendations for Rubric Improvements**		**100 Pts maximum**	**Reviewer's Total Score** _____

Appendix 4

Chemistry 499 Capstone Course 2019
Chemistry Oral Presentation Rubric

Student's Name _____ Faculty Reviewer _____

	Category	Scoring Criteria	Score Range	Reviewer's Score
1	**Introduction**	(a) Good opening statement, (b) effectively communicates the purpose and importance of the talk and research in the context of chemistry, (c) supplies and demonstrates understanding of background information, (d) lays out the framework for the rest of talk	**0-10** 10 being the highest	
2	**Chemistry Content**	(a) Describes experimental procedures and results relating to chemistry, (b) contains accurate information, (c) draws on multiple areas, (d) good use and explanation of visual aids (e.g., data charts, illustrations, and drawings), (e) content backed up by multiple, refereed, and credible sources	**0-30** 30 being the highest	
3	**Knowledge of Topic**	(a) Understands basic chemical terms and principles relevant to the research for the level of senior chemistry majors, (b) evaluates the research (e.g., strong and weak points) at the level of senior chemistry majors, (c) answers questions adequately without a distractive use of notes, internet, or other persons	**0-30** 30 being the highest	
4	**Conclusion**	(a) Communicates a logical conclusion, (b) summarizes the major points, strengths and possible weaknesses of the research, (c) discusses further research needed in the area	**0-10** 10 being the highest	
5	**Delivery**	(a) Speaks clearly and presentation does not seem to be read from a scripted text, (b) well organized, (c) effective and smooth transitions, (d) dresses appropriately, (e) good body language, (f) delivers presentation adequately and generally not reading from prepared notes (g) does not go to internet to answer questions from the audience, (h) presentation done within the 15 minute (not counting Q&A's) allotted time	**0-10** 10 being the highest	
6	**Other Relevant Factors**	(a) Adequately understands other relevant areas outside of chemistry, (b) engaging; (c) creativity; (d) topic choice; (e) new and interesting ideas; (f) answers questions adequately without the use of note cards, internet, or other persons	**0-10** 10 being the highest	
7	**Faculty Comments and Recommendations for Rubric Improvements**		**100 Pts maximum**	**Reviewer's Total Score** _____

Appendix 5

CHEMISTRY DEPARTMENT EXIT QUESTIONNAIRE 2019

FRANCIS MARION UNIVERSITY

Chemistry Department

This is an exit questionnaire to determine your response to the department's programs, resources, and quality of instruction. You will also have a personal exit interview in which you will have another opportunity to help us improve. Your cooperation is appreciated. Thank you!

Date _____
First Enrolled at FMU _____

Name _____
Major(s) _____
Minor/Collaterals _____

ANSWER THOSE QUESTIONS WHICH ARE APPROPRIATE FOR YOU.

CHEMISTRY

1. Which Chemistry courses have you taken at FMU? (Check appropriate box.)
   - ~ Chem 150 (Chemistry for Everyday Life)
   - ~ Chem 101 (Gen Chem I)
   - ~ Chem 102 (Gen Chem II)
   - ~ Chem 201 (Organic Chem I)
   - ~ Chem 202 (Organic Chem II)
   - ~ Chem 203 (Quant)
   - ~ Chem 301 (P-Chem I)
   - ~ Chem 302 (P-Chem II)
   - ~ Chem 303 (Intrumental)
   - ~ Chem 313 (Environmental)
   - ~ Chem 402 (Inorganic Chem)
   - ~ Chem 404 (Biochem I)
   - ~ Chem 408 (Biochem II)
   - ~ Chem 405 (Adv Meth Org Syn & Char)
   - ~ Chem 407 (Intro to Polymer Sci)
   - ~ Chem 297 (Intro the Research)
   - ~ Chem 497 (Special Studies)
   - ~ Chem 498 (Chem Internship)
   - ~ Chem 499 (Capstone)
2. Does the department offer a sufficient variety of courses?
   Yes Comments
   No Comments
3. Do you find that the lab exercises improved your understanding of Chemistry?
   Yes Comments
   No Comments
4. Do you get enough "hands-on" experience in the lab?
   Yes Comments
   No Comments
5. Do you find the lower level Chemistry courses to be a good foundation for the upper level courses?
   Yes Comments
   No Comments
6. Were you able to take chemistry courses or labs at acceptable times of the day or week?
   Yes Comments
   No Comments
7. Did your chemistry classes have an appropriate number of students?
   Yes Comments

No Comments

8. Were the chemistry courses offered on an appropriate semester basis?
   Yes Comments
   No Comments
9. Should a senior research project be required of all Chemistry majors?
   Yes Comments
   No Comments
10. After graduation, do you intend to:
    Teach High School Go to Graduate School
    Take a Job Other
11. Do you feel adequately prepared for your career after graduation?
    Yes Comments
    No Comments
12. In comparison with other courses in other departments, how challenging did you find your chemistry courses?
    Too demanding Not challenging enough Appropriate in difficulty
    Comments:

ADVISING AND INSTRUCTION QUALITY

1. Was your advisor knowledgeable about the Chemistry program (i.e., sequence, prerequisite)?
   Yes Comments
   No Comments
2. Did your advisor assist you in long-range planning?
   Yes Comments
   No Comments
3. How effective overall were the instructors in your Chemistry classes?
   Excellent Good Acceptable Poor Inadequate
   Comments:
4. Were your instructors appropriately available for help outside the class?
   Yes Comments
   No Comments
5. Did your instructors use a variety of teaching styles? (i.e. demonstrations, problem assignments, library assignments, class discussions)
   Yes Comments
   No Comments
6. Were the instructors explicit in stating the course objectives and the evaluation methods to be used?
   Yes Comments
   No Comments
7. Were lab manuals appropriate for the courses (detailed instructions, appropriate background, etc.)?
   Yes Comments
   No Comments

8. Do you feel that your professors cared about you and your progress in learning?
   Yes Comments
   No Comments
9. Did your chemistry classes prepare you to think independently and apply this knowledge to new situations?
   Yes Comments
   No Comments

FACILITIES AND EQUIPMENT

1. Overall, how would you rate the department's facilities (i.e. classroom space, desks, lighting, temperature control, readable screens and chalkboards, etc)?
   Excellent Good Acceptable Poor Inadequate
   Comments:
2. How would you rate the effectiveness of the use of equipment in lecture demonstrations in terms of helping you master the course material?
   Excellent Good Acceptable Poor Inadequate
   Comments:
3. How would you rate multimedia and online integration in your chemistry lectures/labs?
   Excellent Good Acceptable Poor Inadequate
   Comments:
4. How would you rate the department's laboratory equipment in terms of operating condition?
   Excellent Good Acceptable Poor Inadequate
   Comments:
5. Would you say the department's laboratory equipment is sufficiently up-to-date?
   Yes Comments
   No Comments
6. Would you say the department's laboratory equipment is sufficiently maintained?
   Yes Comments
   No Comments
7. Are instruments available in sufficient number for the labs?
   Yes Comments
   No Comments
8. How would you rate the department in terms of access to computers and various types of software (i.e. internet access, Office)
   Excellent Good Acceptable Poor Inadequate
   Comments:
9. Would you say the department's computer facilities/software are sufficiently up-to-date?
   Yes Comments
   No Comments
10. Would you say the department's computer facilities are sufficiently maintained?
    Yes Comments
    No Comments
11. If you were involved in a research project, how would you rate the department in terms of obtaining any equipment necessary for your project?
    Excellent Good Acceptable Poor Inadequate
    Comments:
12. How would you rate the department in terms of availability and proper use of safety related equipment?
    Excellent Good Acceptable Poor Inadequate
    Comments:
13. How would you rate the James A. Rogers Library for book holding, facilities, and reference materials?
    Excellent Good Acceptable Poor Inadequate

Comments:

FINAL COMMENTS:

CHEMISTRY DEPARTMENT EXIT INTERVIEW 2019

Date _____

Interviewer _____

Student Name _____

Major _____

Minor/Collaterals _____

Your Chemistry Degree is the Basic or ACS-Approved?

Why did you choose your chemistry degree track and not the other one?

CIRCLE ANSWERS WHERE APPROPRIATE

1. If you are going to graduate school, do you feel adequately prepared in your major subject?

   Yes Comments No Comments

If you are going to work in industry, do you feel competent in your technical skills and knowledge of your major subject?

   Yes Comments No Comments

   If you are going to teach, do you feel prepared to teach your major subject?

   Yes Comments

   No Comments

2. Which Chemistry courses would you like to have removed or modified in the curriculum?

3. Which Physics courses would you like to have removed or modified in the curriculum?

4. What changes would you like to recommend for the required mathematics courses?

5. What recommendations would you make concerning computers and their uses at FMU?

6. What changes would you like to see in the Chemistry major at FMU?

7. What other suggestions for improvement in your Chemistry program would you like to make?

8. The best thing about the Chemistry program is:

9. The worst thing about the Chemistry program is:

10. Any other comments?

Appendix 6

IE Gen Ed Chemistry Assessment Exam 2018-2019

Title: Production of Table Salt from the Reaction of Baking Soda with Hydrochloric Acid

Lab Setup:

A lab experiment was performed to produce table salt (sodium chloride, NaCl) by reacting a quantity of baking soda (sodium bicarbonate, $NaHCO_3$) with a stoichiometric amount of aqueous hydrochloric acid [HCl (aq)] according to the reaction:

$NaHCO_3$ (s) + HCl (aq) → NaCl (s) + CO_2 (g) + H_2O (l)

The experiment begins by weighing a clean, dry, empty test tube. A 0.4000-gram sample of baking soda was then placed in the test tube and the combined mass of the tube plus the baking soda was determined. Stoichiometric amounts of HCl(aq) was then slowly and carefully added to the tube, whereupon the reaction occurred to completion as described above, until all the baking soda reacted to form table salt.

The resulting solution was then carefully heated several times to dryness and constant mass, and all the solvent was driven off completely. Only the table salt in the form of a white solid remained in the test tube. The test tube with the table salt product were allowed to cool to room temperature and then weighed one last time. The mass of the table salt produced was then determined by subtracting the mass of the test tube from the combined mass of the test tube plus the table salt (NaCl) that was produced.

Circle the correct answer for each of the questions.

1. The formula NaCl tells us that there is

(a) 1 gram of sodium per 1 gram of chlorine.

(b) 1 atom of sodium per 1 atom of chlorine.

(c) 1 mole of sodium per 1 gram of chlorine.

(d) 1 atom of sodium per 1 mol of chlorine.

2. When the procedure is carried out correctly using stoichiometric amounts of baking soda and HCl(aq), the mass of table salt formed is less than the mass of the baking soda reacted. Why is this?

(a) The mass of sodium in the table salt is less than the mass of sodium in the baking soda.

(b) The mass of chlorine in the table salt is less than the mass of bicarbonate in the baking soda.

(c) The mass of bicarbonate in the baking soda is less than the mass of chlorine in the table salt.

(d) Much of the baking soda is lost due to splashing.

3. After the conversion of baking soda to table salt is complete and the tube and the table salt product is weighed, a student then adds more HCl(aq) to the table salt in the tube, again heating it to dryness, and then weighs the tube and its contents a second time. The mass of the tube and its contents should be _____

(a) the same as its mass before adding more HCl (aq).

(b) more than its mass before adding more HCl (aq).

(c) less than its mass before adding more HCl (aq).

(d) the same as the mass of the HCl (aq) added.

4. A student wishes to prove that the conversion of baking soda to table salt is complete. Which of the following observations would most likely indicate that the conversion was completed?

(a) The solid remaining in the test tube was white.

(b) The solid remaining in the test tube gives a positive test for chloride ion.

(c) Addition of HCl (aq) to the solid remaining in the test tube yields no evolution of gas

(d) Litmus paper shows that the white solid is basic.

5. Student A uses twice as much HCl (aq) in the procedure as student B, both using 0.4000 g of baking soda. Which of the following statements is true?

(a) Both students will obtain the same amount of NaCl.

(b) Student A will obtain twice as much NaCl.

(c) Student A will obtain $NaCl_2$.

(d) Student A's reaction will not work, and the solid remaining in the test tube will be baking soda.

General Education Goals
Matrix of Assessment

	Goal	Course	Assessment
1	The ability to write and speak English clearly, logically, creatively, and effectively.		
	Write English clearly		
	Write English logically		
	Write English creatively		

	Write English effectively		
2	Ability to read and listen with understanding and comprehension.		
	Read with understanding		
	Read with comprehension		
	Listen with understanding		
	Listen with comprehension		
3	Ability to use technology to locate, organize, document, present, and analyze information and ideas.		
	Use technology to locate information		
	Use technology to locate ideas		
	Use technology to organize information		
	Use technology to organize ideas		
	Use technology to document information		
	Use technology to document ideas		
	Use technology to present information		
	Use technology to present ideas		
	Use technology to analyze information		
	Use technology to analyze ideas		
4	Ability to explain artistic processes and evaluate artistic product.		
	Explain artistic processes		
	Evaluate artistic product		
5	Ability to use fundamental mathematical skills and principles in various applications.		
	Use fundamental mathematical skills in various applications		
	Use fundamental mathematical principles in various applications		
6	**Ability to demonstrate an understanding of the natural world and apply scientific principles to reach conclusions.**		
	Demonstrate an understanding of the natural world		
	Apply scientific principles to reach conclusions		
7	Ability to recognize the diverse cultural heritages and other influences which have shaped civilization and how they affect individual and collective human behavior.		
	Recognize the diverse cultural heritages which have shaped civilization		
	Recognize how diverse cultural heritages affect individual behavior		
	Recognize how diverse cultural heritages affect collective human behavior		
	Recognize how other influences have shaped civilization		
	Recognize how other influences affect individual behavior		
	Recognize how other influences affect collective human behavior		
8	Ability to describe the governing structures and operations of the United States, including the rights and responsibilities of its citizens.		
	Describe the governing structures of the United States		
	Describe the operations of the United States		
	Describe the rights of US citizens		
	Describe the responsibilities of US citizens		
9	**Ability to reason logically and think critically in order to develop problem-solving skills and to make informed and responsible choices.**		
	Ability to reason logically		
	Ability to think critically		

	Develop problem-solving skills		
	Make informed choices		
	Make responsible choices		

Appendix 7

Institutional Effectiveness
Francis Marion University
Feedback - IE Reports
2017-2018

Chemistry

#	Evaluation Components	Comments	
1	Organization		
2	Program Learning Outcomes		
3	Student Learning Outcomes		Rubric for SLO1. Scale used for
4	Assessment Methods	Specify the number of students assessed and number of students in program. Identify baseline, benchmark and target.	scientific term papers. Who are assessing the papers and does it occur during the semester?
5	Assessment Results	Is it 60% or 70% on the safety exam?	
6	Action Items	What are some possible recommendations.	
7	Appendix		
8	Readability		

2/27/2019
2:00p.m.
Chemistry LSF 303C