Program Name: CHEMISTRY

College/School Name: CHS

Academic Year Assessed: F2020/SP2021

Assessment Plan, Data, and Analysis

Assessment Report Requirements:

1. **Program Goals, Student Learning Outcomes (SLO), and Criteria:** At *minimum*, your Program Assessment Plan should have 2 overarching goals and 3 major outcomes derived from the goals that assess the core of your program. Each SLO must have at least 2 criteria and each criterion must have at least one instrument.

2. **Assessment Across Program:**

3. **Instruments Using Direct/Indirect Measures:** Your Program Assessment Plan should include both direct and indirect measures of learning, with direct measures in the majority.

4. **Validation through External Instruments:** ***If possible***, use an external instrument as a direct measure (e.g., ETS/MFT, ACAT, NCLEX, OSAT) to validate your local direct measures.
   - *The Office of Institutional Effectiveness pays for external testing.*

5. **Analysis of Data by Faculty:** All faculty integral to the Program will meet to discuss and analyze the data at the end of the academic year to determine what the collected data says about the program's performance during the current year and how that new knowledge will translate into proposed actions/changes in the coming year(s).

6. **Completion of Template:** *You are required to complete all sections of this report template*. Follow the directions as written. Contact the Assessment Coordinator before modifying the template to match the specific elements of your program assessment plan.

7. **File Name**: Use the following format to name this file before uploading:
   - Program Name Degree Level Asmt Report AY XXXX-XX
   - e.g., Art BFA Asmt Report AY 2020-21
   - e.g., Ed Leadership MEd Asmt Report AY 2020-2021

8. **Upload to Teams:** Complete your plan/report using the template and upload it to your Team channel. Email your Vice President and the Assessment Coordinator to let them know you have finished. *IF you make further changes to your report in Teams, notify your Vice President and the Assessment Coordinator via email.*

See Glossary of Terms for further explanation:
UGRP_ECU Unit Assessment Team >> General channel >> Files.

Assessment Plan, Data, and Analysis

Mission Statements & Goals

EAST CENTRAL UNIVERSITY MISSION STATEMENT:
We educate and empower students to understand and transform our world.

COLLEGE OF HEALTH AND SCIENCES MISSION STATEMENT: The mission of the College of Health and Sciences is to foster a learning environment in which students, faculty, staff, and community interact to educate students in the study of the natural sciences, technology, human-environment interaction, and health care through excellence in teaching, research, creative activities, and service.

CHEMISTRY PROGRAM MISSION STATEMENT: : The mission of the Chemistry Department is to foster a learning environment in which students, faculty, staff, and community interact to educate students in the study of the discipline of chemistry and prepare them for a career in chemistry through excellence in teaching, research, creative activities, and service.
Program Goal(s) Chemistry Goal

PROGRAM GOAL(S): The major program goal of the Chemistry department is to prepare students for entry-level employment in industry, government service, and education, or for entry into graduate or professional schools requiring a bachelor of science degree in Chemistry.

ASSESSMENT ACROSS THE PROGRAM STATEMENT:
Currently assessment data are obtained for nearly every chemistry course required of Chemistry Majors with the exception of CHEM 1114 General Chemistry I and CHEM 1214 General Chemistry II. Since every course in the Chemistry curriculum above CHEM 1214 has CHEM 1214 General Chemistry II as a prerequisite, and relies significantly on the material taught in the Freshman Chemistry Sequence, student learning in the Freshman Chemistry Sequence is effectively assessed in higher level courses.

EXTERNAL INSTRUMENT AVAILABILITY FOR PROGRAM:
If YES, provide name of instrument *and* whether instrument is currently used for assessment.
If NO, state No.
Yes ... American Chemical Society Standardized Examinations are used in several upper division courses.

STUDENT LEARNING OUTCOME 1:
Develop an understanding of Chemical Principles appropriate to a baccalaureate candidate.

Understanding of Chemical principles appropriate for a baccalaureate candidate.
This criterion is directly linked to student's ability to understand underlying causes of

experiments or analyses undertaken in industry, or in graduate research, and is fundamental to student success as a practicing chemist. It is one measure of how students compare to chemistry students nationally.

Criterion 1.1:
Student performance in Organic Chemistry courses on examinations.

Instrument/Measurement 1:
Selected questions (not known to the students) relating theoretical constructs in chemistry on upper-division (3000-4000) courses, specifically CHEM3114 and 4114 the Organic Chemistry Sequence have been evaluated as indicative of knowledge of critical or foundational subjects.

The categories of questions are given below:
Category 1: General reactions including Nucleophilic Aliphatic Substitution (NAS) Reactions
Category 2: Elimination reactions, particularly E2 Reactions
Category 3: Other reactions
Category 4: Synthesis Methods
Category 5: Mechanism of Reactions

Standard:
Standard: Individual instructors set performance goals based on their experience in their discipline, and on their judgment of the relative difficulty of the problems used. These goals are then discussed and agreed upon by the Chemistry Faculty in the Departmental Assessment Meeting. The standards established for the reporting period are summarized below.

Minimum Requirement for Standard to be Met: Organic Chemistry 70% or higher overall 60% of Students to meet or exceed

Table SLO1/Criterion 1.1a:
Data Table (Results) Data for Criterion 1.1, Instrument 1
Summary Table of Results of Organic Chemistry Instrument: Embedded Test Questions

Topic	1	2	3	4	5
AY 2016-2017	44%	52%	46%	75%	62%
AY 2017-2018	45%	40%	74%	65%	64%
AY 2018-2019	62%	53%	70%	66%	56%
AY 2019-2020	34%	32%	46%	73%	61%
AY 2020-2021	62%	78%	72%	71%	78%
Average	49%	51%	62%	70%	64%

Instrument/Measurement 2:
Student Performance on Standardized ACS Examinations in Organic Chemistry

Population: Undergraduate Students in the CHEM 4114 Organic Chemistry Course.

Standard: 70% of students will score 23 or higher. This represents coming within one standard deviation of the national average for the exam.

Table SLO1/Criterion 1.1b:
Data Table (Results) for Instrument/Measurement 2: Student performance on ACS Standardized Examinations

Year	No. Majors	No. Majors with Score 23	Percent
AY 2016-2017	7	4	57%
AY 2017-2018	30	23	77%
AY 2018-2019	27	10	37%
AY 2019-2020*	3	0	0%
AY 2020-2021	7	4	57%
Average	–	–	46%

* Data only available for the Fall 2019 Semester, due to limitations imposed by COVID-19 during the Spring 2020 Semester.

Analysis Table 1.1: Student performance in Organic Chemistry courses on examinations.

Analysis Question	Analysis Response
1. Was your standard met or not met for the year?	MET for Instrument 1; NOT MET for Instrument 2
2. Whether met or not met, explain how your unit performed in relation to the standard (relate the data in the table to the standard).	Instrument 1: With the exception of Category 1 (Nucleophilic Aliphatic Substitution) students exceeded the standard by a significant amount. Instrument 2: Standard was missed by a difference of one student out of seven.
3. Discuss possible reasons why the unit performed as it did this year.	Instrument 1: Student performance was better than in previous years. Instrument 2: With a small number of students taking the test, the difference of one student's performance has an inordinate effect on the results.
4. Look at the 5-year data trends and discuss those. Note if data seem to be increasing/decreasing with time and if so, reasons why.	Instrument 1: NOT MET over LAST 5 YEARS in Categories 1 and 2; MET over LAST FIVE YEARS for Categories 3-5. Instrument 2: Typically this standard is narrowly missed in most years.
5. Using your analysis responses, make specific data-driven decisions about your unit. If no actions or changes are needed, state that. Copy/paste the #5 response to Current Actions and/or Changes	CHEM 3114 Organic Chemistry I: The results show that students continue to struggle most with predicting products of chemical reactions (as in previous years). Weakness in the

	area of epoxide ring opening indicates that students struggle with elimination reactions, which is a major reaction type covered in organic chemistry I. To address these weaknesses, we will continue to place emphasis on predicting products of reactions, with additional homework assignments and classroom activities to reinforce the material. As in previous years, students demonstrate strength in the areas of reaction mechanisms and synthesis. This indicates that coverage of organic mechanisms throughout the course is helpful in teaching students how to represent mechanisms on paper. Additionally, the fact that students did reasonably well in proposing a multistep synthesis shows that students are able to use their knowledge of organic reactions to plan a synthetic scheme. CHEM 4114 Organic Chemistry II: The results show that students struggle more with predicting products of chemical reactions than with synthesis or mechanisms. This mirrors the trends that we've seen in previous years. In future semesters, students could be given more predict the product questions as practice. Students seem to grasp the concept of arrow pushing, as evidenced by their relative performance on the mechanism question. Students also demonstrate an ability to synthesize molecules by utilizing the individual chemical reactions that they've learned throughout the semester.

Criterion 1.2
Student Performance on Physical Chemistry Examinations

Instrument/Measurement 1: Selected questions (not known to the students) relating theoretical constructs in chemistry on upper-division (3000-4000) courses have been evaluated as indicative of knowledge of critical or foundational subjects. Topics of embedded test questions for CHEM4514 are:
#1 Basic Thermodynamics
#2 Phase Equilibria

#3 Chemical Equilibria and Solutions
#4 Electrochemistry

Population: Undergraduate Students in CHEM 4514 Physical Chemistry.

Standard: Individual instructors set performance goals based on their experience in their discipline, and on their judgment of the relative difficulty of the problems used. These goals are then discussed and agreed upon by the Chemistry Faculty in the Departmental Assessment Meeting. The standards established for the reporting period are summarized below.

Minimum Requirement for Standard to be Met Physical Chemistry: 60% for each topic Meet or exceed standard in 3 out of 4 topics
Data Table (Results)

Table SLO1/Criterion 1.2a:
Summary Table of Results: Physical Chemistry Embedded Test Questions

Topic	1	2	3	4
AY 2014-2015	83%	75%	83%	42%
AY 2015-2016	100%	100%	67%	100%
AY 2016-2017	70%	68%	63%	81%
AY 2017-2108*	ND	ND	ND	ND
AY 2018-2019	86%	69%	88%	83%
AY 2019-2020*	ND	ND	ND	ND
AY 2020-2021	100%	88%	75%	62%
Averages	88%	80%	75%	74%

* Class not offered during AY 2017-2018 or 2019-2020

Instrument/Measurement 2: Student Performance on Standardized ACS Examination for Physical Chemistry

Population: Students in CHEM 4514 Physical Chemistry I.

Standard: Prior to 2018, itemized results from the ACS Standardized Physical Chemistry Exam are used to evaluate student understanding in four subtopics of thermodynamics in Physical Chemistry: Basic Thermodynamics, Phase Equilibria, Chemical Equilibria and Solutions, and Electrochemistry. On previous versions of the ACS Standardized Exam (used prior to Fall 2018) some questions were not included in the analysis because they were second semester topics. For the 2018 and present reporting periods, all of the questions were used because the new exam is a modular one covering only CHEM 4514 Physical Chemistry I topics. The present standard is for 50% of students to achieve 50% in each area.

Table SLO1/Criterion 1.2b:

Student Performance by Topic on Standardized ACS Thermodynamics Exam

Year	No. Students	Average Score	No. of Students Scoring ≥ 50%
AY 2016-2017*	8	46%	1t is
AY 2017-2018**	ND	ND	ND
AY 2018-2019	7	44%	3
AY 2019-2020**	ND	ND	ND
AY 2020-2021	8	47%	4
Averages	7.5	46%	3

* Earlier Version of ACS Standardized Test

**Course not offered during AY 2017-2018 or AY 2019-2020

Analysis Table 1.2: Student performance in Physical Chemistry courses on examinations.

Analysis Question	Analysis Response
1. Was your standard met or not met for the year?	MET
2. Whether met or not met, explain how your unit performed in relation to the standard (relate the data in the table to the standard).	Students performed somewhat better on the embedded test questions for this reporting period for categories 2 and 3, but more poorly for 1 and 4. Scores for Category 4 (Electrochemistry) are often lower, possibly because it is at the end of the semester and sometimes does not get as full coverage as topics earlier in the semester.
3. Discuss possible reasons why the unit performed as it did this year.	Instrument 1: Student performance was better than in previous years. Instrument 2: With a small number of students taking the test, the difference of one student's performance has a large effect on results. The results were more or less bimodal for this time period.
4. Look at the 5-year data trends and discuss those. Note if data seem to be increasing/decreasing with time and if so, reasons why.	Instrument 1: MET over LAST 5 YEARS Instrument 2: MET narrowly this reporting period. Typically missed in the past. The new test is more reflective of the content of the ECU curriculum, since it is more specific to the content of CHEM 4514 Physical Chemistry I.
5. Using your analysis responses, make specific data-driven decisions about your unit. If no actions or changes are needed, state that. Copy/paste the #5 response to Current Actions and/or Changes	The recent change to a different standardized exam appears to have a positive result. The standard was met for this reporting period. We will be reviewing the standard. The current exam does not yet have national results available (as of 9/10/21), as it is a new exam. Comparison to national norms would be helpful. Relatively small numbers of students in the course may make statistical inferences less reliable.

Criterion 1.3: Student Performance in Advanced Inorganic Chemistry Examinations

Instrument/Measurement: Selected questions (not known to the students) relating theoretical constructs in inorganic chemistry on examinations in CHEM 4413 (Advanced Inorganic Chemistry Lecture) have been evaluated as indicative of knowledge of critical or foundational subjects.

Population: Undergraduate Students in CHEM 4413 Advanced Inorganic Chemistry.

Standard: Individual instructors set performance goals based on their experience in their discipline, and on their judgment of the relative difficulty of the problems used. These goals are then discussed and agreed upon by the Chemistry Faculty in the Departmental Assessment Meeting. The standards established for the reporting period are summarized below.

Area Standard Minimum Requirement for Standard to be Met IN Advanced Inorganic Chemistry: 70% for each topic to meet or exceed standard.
Summary of Results for Advanced Inorganic Chemistry:

Table SLO1/Criterion 1.3: Advanced Inorganic Chemistry Embedded Test

Year		Area/Percentage Scoring 70%	
	Basic Structure/Bonding	Group Theory/Symmetry	Coordination Chemistry
AY-2015-16*	ND	ND	ND
AY-2016-17	86%	88%	75%
AY-2017-18**	ND	ND	ND
AY-2018-2019	90%	80%	70 %
AY-2019-2020***	ND	ND	ND
AY-2020-2021	80%	60%	80%
Ave.	85%	76 %	52 %

* Course not offered during AY 2015-16
** Course not offered during AY 2018-18
*** Course not offered during AY 2019-20

Analysis Table 1.3: Student performance in Advanced Inorganic Chemistry courses on examinations.

Analysis Question	Analysis Response
1. Was your standard met or not met for the year?	MET

2. Whether met or not met, explain how your unit performed in relation to the standard (relate the data in the table to the standard).	Standard met for Topics 1 and 3; missed for Topic 2. Average for all three topics is 73%.
3. Discuss possible reasons why the unit performed as it did this year.	No definite reason is known as to why Topic 2 results are lower than usual. This is probably an anomaly, as students typically do well in all three areas.
4. Look at the 5-year data trends and discuss those. Note if data seem to be increasing/decreasing with time and if so, reasons why.	MET over LAST 5 YEARS
5. Using your analysis responses, make specific data-driven decisions about your unit. If no actions or changes are needed, state that. Copy/paste the #5 response to Current Actions and/or Changes	With standards being met or exceeded over the past 5 years, no changes are planned for the next reporting period.

Criterion 1.4: Student Performance on Biochemistry Examinations

Instrument/Measurement: Selected questions (not known to the students) relating theoretical constructs in chemistry on upper-division (3000-4000) courses have been evaluated as indicative of knowledge of critical or foundational subjects.

Population: Undergraduate Students in the CHEM 4213-4221 Biochemistry Sequence.

Standard: Individual instructors set performance goals based on their experience in their discipline, and on their judgment of the relative difficulty of the problems used. These goals are then discussed and agreed upon by the Chemistry Faculty in the Departmental Assessment Meeting. The standards established for the reporting period are summarized below.

Minimum Requirement for Standard to be Met in Biochemistry:

70% overall: 70 % of students meet or exceed standards
Data Table (Results)
Summary of Biochemistry Assessment Data
Area 1 Amino acids, proteins, enzymes 3 problems
Area 2 Lipids and membranes 2 problems
Area 3 Sugars and carbohydrates 2 problems
Area 4 DNA and RNA 2 problems
Area 5 Pathways 2 problems
The data were collected and combined for each major area. A performance goal of at least 70% was set for each area. Results for 20162-2021 are summarized in the table below:

Table SLO1/Criterion 1.4: Summary: Student Averages for Each Area by Year for Biochemistry

Year/Area	1	2	3	4	5
AY 2016-2017	100%	100%	100%	100%	50%
AY 2017-2018	80%	83%	79%	74%	61%
AY 2018-2019	85%	87%	87%	78%	82%
AY 2019-2020	86%	83%	85%	89%	86%
AY 2020-2021	86%	80%	77%	86%	86%
Averages	87%	87 %	86%	85%	73 %

Analysis Table 1.4: Student performance in Biochemistry courses on examinations.

Analysis Question	Analysis Response
1. Was your standard met or not met for the year?	MET
2. Whether met or not met, explain how your unit performed in relation to the standard (relate the data in the table to the standard).	Standard met or exceeded for all topics by 7-16% .
3. Discuss possible reasons why the unit performed as it did this year.	These results are typical of data collected over the past 5 years.
4. Look at the 5-year data trends and discuss those. Note if data seem to be increasing/decreasing with time and if so, reasons why.	MET over LAST 5 YEARS. No significant trends are noted.
5. Using your analysis responses, make specific data-driven decisions about your unit. If no actions or changes are needed, state that. Copy/paste the #5 response to Current Actions and/or Changes	With standards being met or exceeded over the past 5 years, no changes are planned for the next reporting period.

Criterion 1.5: Student Performance in the Analytical Chemistry Sequence

Instrument/Measurement: Selected questions (not known to the students) relating theoretical constructs in chemistry on examinations in the CHEM 3214-3484 sequence have been evaluated as indicative of knowledge of critical or foundational topics in Analytical Chemistry.

Population: Undergraduate Students in the CHEM 3214-3484 Analytical Chemistry Sequence.

Standard: Individual instructors set performance goals based on their experience in their discipline, and on their judgment of the relative difficulty of the problems used. These goals are then discussed and agreed upon by the Chemistry Faculty in the Departmental Assessment Meeting. The standards established for the reporting period are summarized below.

Minimum Requirement for Standard to be Met in Analytical Chemistry

80% overall; 70 % of students meet or exceed standards

Table SLO1/1.5: Summary Table of Results: Analytical Chemistry Embedded Test Questions

Year	No. Students	No. Students Scoring 80 %	Percent
AY 2016-2017	5	4	80%
AY 2017-2018	7	5	71%
AY 2018-2019	16	11	69%
AY 2019-2020	19	15	79%
AY 2020-2021	7	6	86%
Average	10.8	8.2	77%

Analysis Table 1.5: Student performance in Biochemistry courses on examinations.

Analysis Question	Analysis Response
1. Was your standard met or not met for the year?	MET
2. Whether met or not met, explain how your unit performed in relation to the standard (relate the data in the table to the standard).	Standard exceeded by 16% .
3. Discuss possible reasons why the unit performed as it did this year.	These results are typical of data collected over the past 5 years.
4. Look at the 5-year data trends and discuss those. Note if data seem to be increasing/decreasing with time and if so, reasons why.	MET over LAST 5 YEARS. No significant trends are noted. The Standard was met for AY 2019-2020. Over the five year period, the standard is clearly and regularly met.
5. Using your analysis responses, make specific data-driven decisions about your unit. If no actions or changes are needed, state that. Copy/paste the #5 response to Current Actions and/or Changes	With standards being met or exceeded over the past 5 years, no changes are planned for the next reporting period.

Student Learning Outcome 2: Be able to communicate chemical principles and subject matter effectively, both in writing and orally.

Criterion 2.1:
Demonstrate an ability to communicate chemical principles in a written format: research papers and written laboratory reports.

Instrument/Measurement:
Laboratory reports or research reports written in Instrumental Analysis and Physical Chemistry

Population:

The population for this measure is those undergraduate students (chemistry majors) in CHEM 4514 Physical Chemistry I, CHEM 3214 Quantitative Analysis, and CHEM 3484 Instrumental Methods of Chemical Analysis.

Standard:
Ninety percent of the students examined should receive a C or higher or their research papers or laboratory reports

Table SLO 2.1: Quality of written reports in Instrumental Analysis, Physical Chemistry, and Advanced Inorganic Chemistry

Year	A	B	C	D	F	Number
AY-2016-2017	1	5	8	1	0	15
AY-2017-2018	3	4	0	0	0	7
AY-2018-2019	4	3	10	4	0	21
AY-2019-2020	2	3	3	0	0	8
AY-2020-2021	7	14	16	2	2	41
Total	17	29	37	7	2	92
Percent	18%	32%	40%	8%	2%	100%

Analysis Table 2.1: Ability to communicate chemical principles in a written format.

Analysis Question	Analysis Response
1. Was your standard met or not met for the year?	MET
2. Whether met or not met, explain how your unit performed in relation to the standard (relate the data in the table to the standard).	The Standard was narrowly met for the AY 2019-2020 period.
3. Discuss possible reasons why the unit performed as it did this year.	This is a fairly typical result for this measure.
4. Look at the 5-year data trends and discuss those. Note if data seem to be increasing/decreasing with time and if so, reasons why.	The Standard was narrowly met for the AY 2019-2020 period and for the five year period. There is no significant trend over time.
5. Using your analysis responses, make specific data-driven decisions about your unit. If no actions or changes are needed, state that. Copy/paste the #5 response to Current Actions and/or Changes	No change to the standard; Writing Skills have been an ongoing area needing continued emphasis.

Criterion 2.2: Demonstrate an ability to communicate chemical principles in oral presentations: in class oral presentations and oral laboratory reports.

Instrument/Measurement: Oral laboratory reports or presentations in Instrumental Analysis and Physical Chemistry courses.

Population: The population for this measure is those undergraduate students (chemistry majors) in CHEM 4514 Physical Chemistry I, CHEM 3214 Quantitative Analysis, and CHEM 3484 Instrumental Methods of Chemical Analysis.

Standard: Ninety percent of the students examined should receive a C or higher or their oral presentations or laboratory reports

Table SLO2.2: Quality of Class Presentations in Instrumental Analysis and Physical Chemistry

Year	A	B	C	D	F	Totals
AY-2016-2017	0	4	2	2	0	8
AY-2017-2018	3	4	0	0	0	7
AY-2018-2019	1	2	4	0	0	7
AY-2019-2020*	ND	ND	ND	ND	ND	ND
AY 2020-2021	3	2	2	0	0	7
Total	7	12	8	2	0	29
Percent	24%	41%	28%	7%	0%	100%

*Due to COVID-19 and the timing of distance learning, this standard was not assessed for the 2019-2020 Reporting Period

Analysis
The standard was not assessed for the reporting period due to COVID-19. It met for the 5 year period including the 2020-2021 reporting period.
Student Learning Outcome Student Learning Outcome 3
Possess the necessary laboratory skills to find employment in chemistry or a related field. Student Learning Outcome 3: Possess the necessary skills to find employment in chemistry or a related field.
Criterion

Analysis Table 2.2 : Ability to communicate chemical principles in oral presentations

Analysis Question	Analysis Response
1. Was your standard met or not met for the year?	MET
2. Whether met or not met, explain how your unit performed in relation to the standard (relate the data in the table to the standard).	The Standard was met with 100% of oral presentations receiving a grade of C or better.
3. Discuss possible reasons why the unit performed as it did this year.	Once students are over their initial nervousness about giving an oral report, they usually do well.
4. Look at the 5-year data trends and discuss those. Note if data seem to be increasing/decreasing with time and if so, reasons why.	STANDARD MET over the last 5 years.
5. Using your analysis responses, make specific data-driven decisions about your unit. If no actions or changes are needed, state that. Copy/paste the #5 response to Current Actions and/or Changes	There are no plans currently to modify this standard.

Student Learning Outcome 3
Possess the necessary laboratory skills to find employment in chemistry or a related field.

Criterion 3.1: Ability to perform laboratory techniques of a quantitative and analytical nature. In particular, student abilities in the areas of analytical chemistry and instrumental analysis are chosen for this criterion because of the precise nature of the results expected in an analytical industrial environment, and because the necessary laboratory technique for analytical chemistry is the most rigorous of all the laboratory techniques required in industry or research.

Instrument/Measurement: Laboratory grades on analytical unknowns as supplied by a nationally recognized manufacturer of student laboratory standards (Thorn Smith Chemist).

Population: Students in CHEM 3214 Quantitative Analysis and CHEM 3484 Instrumental Methods of Chemical Analysis.

Standard: 70 % of students will attain 75% or higher on their laboratory unknowns in Quantitative Analysis Class. Depending on the difficulty of the analysis, this usually requires being within 3-5 % or better of the accepted value of their unknown.
Data Table (Results)

Table SLO3.1: Summary of Data for Unknowns in the Analytical Chemistry Sequence

Year	Total Number of Students	Number with Laboratory Scores ≥ 75%	Percent
AY 2016-2017	5	4	80%
AY 2017-2018	7	6	86%
AY 2018-2019	16	14	88%
AY 2019-2020	19	14	74%
AY 2020-2021	7	5	71%
Averages	54	43	79%

Analysis Table 3.1: Student Performance on Laboratory Unknowns

Analysis Question	Analysis Response
1. Was your standard met or not met for the year?	MET
2. Whether met or not met, explain how your unit performed in relation to the standard (relate the data in the table to the standard).	Students met the standard with 71% achieving scores ≥ 75%
3. Discuss possible reasons why the unit performed as it did this year.	With a relatively small sampling of students, the results may be skewed by only a few students with lower performance.
4. Look at the 5-year data trends and discuss those. Note if data seem to be increasing/decreasing with time and if so, reasons why.	STANDARD MET OVER THE LAST 5 YEARS. This performance has declined slightly over the last two years that this instrument has been used.

5. Using your analysis responses, make specific data-driven decisions about your unit. If no actions or changes are needed, state that. Copy/paste the #5 response to Current Actions and/or Changes	This standard is consistently being met. The standard will be discussed in future faculty meetings with regard to retaining the current standard or raising it.

Criterion 3.2: Ability to successfully perform synthetic laboratory techniques in organic chemistry. Specifically, a multistep synthesis is chosen for this criterion because it demonstrates the student's ability to carry through a sequence of reactions and obtain a significant quantity of the final product. This is a common requirement of an industrial chemist or a graduate student working in the field of organic chemistry.

Instrument/Measurement: Laboratory grades on a multistep synthesis in CHEM 4114 Organic Chemistry II.

Population: Students in CHEM 4114 Organic Chemistry II.

Standard: The standard for the multistep synthesis was that 60% of students would receive a 75% or higher. Of the 26 students 24 received a grade of 75% or higher for a pass rate of 92.3%. All seven of the chemistry majors passed with a 75% or better. We are currently meeting this benchmark and no further action is needed.

Table SLO 3.2: Ability to successfully perform synthetic laboratory techniques in organic chemistry.

Year	Total Number of Students	Number with Scores ≥ 75%	Percent
AY 2016-2017*	ND	ND	ND
AY 2017-2018	32	30	94%
AY 2018-2019	27	25	92%
AY 2019-2020	32	32	100%
AY 2020-2021	26	24	92%
Averages	29	28	97%

* AY 2017-2018 was the first year that this data was collected.

Analysis Table 3.2: Ability to successfully perform synthetic laboratory techniques in organic chemistry.

Analysis Question	Analysis Response
1. Was your standard met or not met for the year?	MET
2. Whether met or not met, explain how your unit performed in relation to the standard (relate the data in the table to the standard).	Students met the standard with 92% achieving scores ≥ 75%
3. Discuss possible reasons why the unit performed as it did this year.	This level of performance is typical of this instrument.

4. Look at the 5-year data trends and discuss those. Note if data seem to be increasing/decreasing with time and if so, reasons why.	STANDARD MET OVER THE LAST 5 YEARS. Success level has been consistently high over the four years that this instrument has been used.
5. Using your analysis responses, make specific data-driven decisions about your unit. If no actions or changes are needed, state that. Copy/paste the #5 response to Current Actions and/or Changes	This standard is consistently being met. The standard will be discussed in future faculty meetings as to retaining the current standard or raising it.

Student Learning Outcome 4
Graduating students will be successful in obtaining employment or placement in graduate school in chemistry or related fields, or placement in professional schools in related areas.

Criterion 4.1
Student Success in gaining admittance to graduate or professional schools in chemistry or related disciplines.

Instrument/Measurement
As an indirect measure of the quality of their chemistry education, personal contact with students via conversation, email, or social media following graduation will be used to learn about their status following graduation.

Population
This population consists of students graduating during the reporting period who attempt to gain admittance to graduate school programs in chemistry or health related professions.

Standard
Seventy percent of students seeking admittance to graduate school will gain admittance.

Table SLO 4.1: Students Seeking Admittance to Graduate School, Pharmacy School, or other Professional Schools

Year	Total No. Students Graduating	No. Seeking Admittance to Professional Schools	No. Accepted to Professional Schools	Percentage
AY 2017- 2018	5	2*	2	100%
AY 2018- 2019	5	2	2	100 %
AY 2019- 2020	2	0	0	N/A
AY 2020-2021	5	4	3	75%
Totals	17	8*	7	92%

* Two graduating students have left the country and their post graduation activities are not known.

Analysis 4.1: Success in gaining admittance to graduate or professional schools in chemistry or related disciplines.

Analysis Question	Analysis Response

1. Was your standard met or not met for the year?	MET
2. Whether met or not met, explain how your unit performed in relation to the standard (relate the data in the table to the standard).	Three students (Seventy five percent of graduating seniors in AY 2020-2021) were admitted to a professional school of their choice. One is applying to graduate schools in Europe and to industrial positions here in the United States and is still trying to determine what they wish to do.
3. Discuss possible reasons why the unit performed as it did this year.	These results are typical of program graduates. It is also not unusual for a few students to be uncertain as to their post-graduation plans. One reality not reflected in the data is that some Pre-Pharmacy students opt out of the undergraduate degree and leave for Pharmacy School after meeting all the requirements at ECU. These students are really a successful product of the program, but no credit is given because they do not graduate with a Chemistry degree.
4. Look at the 5-year data trends and discuss those. Note if data seem to be increasing/decreasing with time and if so, reasons why.	STANDARD MET OVER THE LAST 5 YEARS. Two students from 2017-2018 are unaccounted for at present.
5. Using your analysis responses, make specific data-driven decisions about your unit. If no actions or changes are needed, state that. Copy/paste the #5 response to Current Actions and/or Changes	For the present, no changes are anticipated.

Criterion 4.2
Student success in gaining employment in chemistry or chemistry related fields.

Instrument/Measurement
As an indirect measure of the quality of their chemistry education, personal contact with students via conversation, email, or social media following graduation will be used to learn about their status following graduation.

Population
This population consists of students graduating during the reporting period with a chemistry degree who seek employment in industry or government laboratories.

Standard
Seventy percent of students seeking employment will succeed in obtaining employment in chemistry or a related field.

Table SLO4.2: Student success in gaining employment in chemistry or chemistry related fields

Year	Total No. of Students Graduating	No. Seeking Employment in Chemistry or Related Fields	No. Hired	Percentage

AY 2017-2018	5	1	1	100%
AY 2018-2019	5	2	2	100%
AY 2019-2020	2	Unknown	Unknown	N/A
AY 2020-2021	5	2	1	50%
Totals	17	5	4	90%

Analysis Table 4.2: Criterion 4.2.

Analysis Question	Analysis Response
1. Was your standard met or not met for the year?	MET
2. Whether met or not met, explain how your unit performed in relation to the standard (relate the data in the table to the standard).	The one student who specifically desired employment in industry is employed. This standard is met. Of those students who wish to obtain employment in chemistry or a related field, they are nearly always successful.
3. Discuss possible reasons why the unit performed as it did this year.	One student is exploring both graduate school and employment and is still in the process of applying to both. They were counted in the totals for both Criteria 4.1 and 4.2. The one student who definitely was seeking industrial employment was successful in getting a job.
4. Look at the 5-year data trends and discuss those. Note if data seem to be increasing/decreasing with time and if so, reasons why.	STANDARD WAS MET OVER THE LAST 5 YEARS. This was a new measure in 2017-2018 and therefore there are data for only 4 years as of this reporting period. Over the four years that data has been collected, the standard has been consistently met. Of those students who wish to obtain employment in chemistry or a related field, they are nearly always successful. The post-graduation activities of the 2019-2020 AY graduates are currently unknown.
5. Using your analysis responses, make specific data-driven decisions about your unit. If no actions or changes are needed, state that. Copy/paste the #5 response to Current Actions and/or Changes	Tracking graduates is a challenge at times. Some students remain in contact and some do not. Increase efforts to maintain contact with graduates.

Summary Table of Student Learning Outcomes/Criteria

Summary Table of Student Learning Outcomes/Criteria

Student Learning Outcomes	Criteria/Instrument	Met	Not Met
SLO1:Understanding of Chemical Principles	1.1: Performance on Embedded Questions	x	
	1.2: Performance on Standardized ACS Exams		x

SLO2: Ability to communicate effectively in writing and orally	2.1: Quality of Written Reports in Instrumental Analysis and Physical Chemistry	x	
	2.2: Quality of Class Presentations in Instrumental Analysis and Physical Chemistry	x	
SLO3: Possess necessary skills to find employment	3.1: Unknowns in Analytical Chemistry	x	
	3.2: Organic Chemistry Synthesis Sequence	x	
SLO4: Student Success in obtaining employment or entering graduate or professional school	4.1: Success in entering Graduate or Professional School.	x	
	4.2: Success in obtaining Employment in Chemistry or a related field.	x	

Student Information for this Academic Year	
Total, *unduplicated* number of students assessed this academic year	90
Program census for Fall	28
Program census for Spring	24
Total number of Fall Program graduates	4
Total number of Spring/Summer graduates	2
Mean major GPA of Fall graduates	3.26
Mean major GPA of Spring/Summer graduates	3.97

Faculty Meeting: List meeting date(s) and a roster of those in attendance.
We met in person 9/09/21 from 5:00-6:15 pm.
Present: Dr. Dwight Myers (chair), Dr. Charles Crittell, Dr. Daniel McInnes, Dr. Randall Maples.

Minutes Follow:
Chemistry Assessment Committee Minutes 09 September 2021, 5:00PM.
Members present Dwight Myers, Charles Crittell, Randall Maples, and Dan McInnes.

This year's assessment report covers Fall 2021 and Spring 2021. Instrumental was not taught in this period and will not be included.
Report on Organic Chemistry 1 and 2. The goals were met with respect to the embedded questions. The results were somewhat similar to those of the previous period. It was suggested that the narrative should directly address this fact. After some discussion, was agreed that the narrative would be rewritten to reflect this point.

It was mentioned that the embedded test questions used in Organic 1 and Organic 2 do not correlate well with each other. Question 4, synthesis and question 5, mechanisms mirror one another in the two courses however questions 1-3 do not. Tt was decided that on future assessments, embedded questions 1-3 will be changed as needed to fit the three new categories of elimination, substitution, and addition reactions. This should allow the department to tie these courses together in a more succinct manner.
The ACS standardized test for organic chemistry was discussed next. The department did not meet the goal with respect to the standardized exam. Possible reasons for this were discussed including the concern of the classes being held on-line due to Covid-19. No conclusion as to the cause was reached. The possibility of adjusting the standards were mentioned, but the committee decided the standard was acceptable and did not need to be changed at this point.
The students did well on the multistep synthesis and the department met the established goals. The criteria for this area seems to be working well and it was decided that no changes were needed to be made.
Report on Physical Chemistry The standard set for the ACS exam is that 50% of the students will attain a score of 50% or better. 50% of the students met this benchmark. For the embedded test questions, all students met or exceeded the bench mark of 60%.

Report on Advanced Inorganic Chemistry The students all performed at or above the benchmark of 60% for the embedded questions.

Report on Analytical Chemistry The benchmark for the embedded questions is that 70% of the students will score a 70% or higher. 86% of the students met this benchmark. The department continues to do well in this area.
Report on Effective Communication This is measured in three different courses, Quantitative Analysis, Advanced Inorganic and Physical Chemistry. It is measure both through written reports and oral presentations.

Oral Presentations- The standard for this class is that 90% of the students would receive a C or better. All seven students received a C or higher in Quantitative Analysis. In Advanced Inorganic, all seven of the students received a C or better. Presentations were not given this year in Physical Chemistry. Overall the Students are quite effective in oral communications.
Written Reports The standard for the written report is that 90% of the students would receive a C or better. All seven students received a C or higher in Quantitative Analysis. In Advanced Inorganic, nine of ten students received a C or better and in Physical Chemistry, twenty out of twenty-three students received a C or better. Collectively, 90.2% of the students received a C or better and thus the department is meeting this goal.

The following is the organization of the assessment report.

I. Theory
   A. Organic/Biochemistry
   B. Physical/Analytical/Inorganic
II. Communication
   A. Written
   B. Oral Presentation

III. Lab Practical
   A. Analytical
   B. Synthesis

IV. Successful in Gaining Employment
   A. Graduate or Professional School
   B. Employment in Industry

The meeting was adjourned at 6:24

Sharing with Stakeholders:

1. Stakeholders for this Program include: [Current, Alumni, Faculty,]

2. Current program assessment reports are available on the website of the Office of Institutional Effectiveness: https://myecu.ecok.edu/ICS/Institutional_Reporting/Assessment_Reporting_and_Outcomes.jnz
This link will change Fall 21 since MyECU is being phased out – I will let you know what to change it to.

SUMMARY OF LAST 5 YEARS' ACTIONS/CHANGES/REVIEWS & UPDATES

For instructions see *Glossary of Terms Pgm Asmt* in Teams.

Academic Year	Summary of Actions/Changes from Report
2020-21	**SLO 1.1.** no changes; continue to place emphasis on predicting products of reactions, with additional homework assignments and classroom activities to reinforce the material. **SLO 1.2**. If possible, obtain norms for Physical Chemistry Standardized exam for next offering of CHEM 4514. **SLO 1.3.** Possibly incorporate ACS Standardized Exam for Inorganic Chemistry **SLO 1.4.** With standards being met or exceeded over the past 5 years, no changes are planned for the next reporting period. **SLO 1.5.** With standards being met or exceeded over the past 5 years, no changes are planned for the next reporting period. **SLO 2.1.** No change to the standard; Writing Skills have been an ongoing area needing continued emphasis. **SLO 2.2** There are no plans currently to modify this standard or measurement. **SLO 3.1.** This standard is consistently being met. The standard will be discussed in future faculty meetings with regard to retaining the current standard or raising it. **SLO 3.2.** No changes.

	SLO 4.1 Tracking graduates is a challenge at times. Some students remain in contact and some do not. Increase efforts to maintain contact with graduates. **SLO 4.2** Tracking graduates is a challenge at times. Some students remain in contact and some do not. Increase efforts to maintain contact with graduates.
2019-2020	2019-2020: There are no major changes from the last reporting period. With some data not obtained due to constraints on data collection due to the COVID-19 changes, it was felt that this is not a good year to make any changes.
2018-2019	2018-2019: Principal changes are to a different standardized (modular) Physical Chemistry Exam and the addition of a new Standardized Exam for Advanced Inorganic Chemistry. There are no other major changes from the last reporting period.
2017-2018	Planned changes in Assessment based on UAC Review or findings of this report: 1. For SLO 10: A survey of alumni is planned for next cycle. Data will continue to be gleaned from personal contacts or other forms of alumni feedback as well. 2. A new ACS Standardized test for Physical Chemistry has been acquired. It will be used beginning Fall 2018. 3. A new ACS Standardized test for Inorganic Chemistry has been acquired. It will be used beginning Spring 2019. 4. The possibility of acquiring new ACS Standardized tests for Organic Chemistry and Biochemistry has been discussed informally by the Chemistry Faculty. This point to be raised in the next faculty meeting devoted to assessment. 5. No major changes in curriculum are planned for the next reporting cycle on the basis of assessment results presented in this report. An increased use of ACS Standardized tests is planned. Changes to the report/report format based on UAC Review: 1. An effort was made to present a clear distinction between criteria and instruments to measure the criteria. 2. An effort has been made to clean up the appearance and uniformity of tables. Some tables (in the opinion of this writer should be of a different format due to the difference in material presented. 3. SLO 10 to be be split into Employment and Grad School analyses in order to have necessary two criteria.
2016-2017	Planned changes in Assessment based on UAC Review or findings of this report: 1. For SLO 10: A survey of alumni is planned for next cycle. Data will continue to be gleaned from personal contacts or other forms of alumni feedback as well. 2. A new ACS Standardized test for Physical Chemistry has been acquired. It will be used beginning Fall 2018. 3. A new ACS Standardized test for Inorganic Chemistry has been acquired. It will be used beginning Spring 2019. 4. The possibility of acquiring new ACS Standardized tests for Organic Chemistry and Biochemistry has been discussed informally by the Chemistry Faculty. This point to be raised in the next faculty meeting devoted to assessment.

	5. No major changes in curriculum are planned for the next reporting cycle on the basis of assessment results presented in this report. An increased use of ACS Standardized tests is planned. Changes to the report/report format based on UAC Review: 1. An effort was made to present a clear distinction between criteria and instruments to measure the criteria. 2. An effort has been made to clean up the appearance and uniformity of tables. Some tables (in the opinion of this writer should be of a different format due to the difference in material presented. 3. SLO 10 to be split into Employment and Grad School analyses in order to have necessary two criteria.
2015-2016	**CHANGES** • **CHANGE:** In Organic Chemistry, more practice problems in lecture for synthetic methods. • **CHANGE:** In Physical Chemistry I: A continuation of previous action: emphasis to be placed on chemical equilibria and phase equilibria. Electrochemistry to receive greater emphasis. Continue to emphasize writing and oral reports. • **CHANGE:** In Physical Chemistry, a more recent standardized exam will be sought. • **CHANGE:** In Advanced Inorganic Chemistry, a standardized Exam will be utilized. • **CHANGE:** An indirect measure has been added: Student success at gaining employment or acceptance into graduate or professional school. • **CHANGE:** Future assignments in Physical Chemistry will include problems specifically geared toward conceptual, rather than numerical solutions. • **CHANGE:** In Quantitative Analysis, an increased emphasis on calibration and sampling.

Academic Year	Summary of Annual Reviews of Dean and/or UAC (Reviews found in Teams folder; UAC *does not* review annually)	Updates in Response to Reviews
2019-2020	No Review Found	
2018-2019	NOT FOUND	
2017-2018	Dean's Review -See Appendix	No Issues Mentioned in Review
2016-2017	The outcomes are listed and describe the expectations from the students. These outcomes are not directly linked to the most important purposes of the program.	Effort was made to link outcomes to program purpose in report text.
2015-2016	**Summary of LATEST Dean's/UAC REVIEW & Status Update on feedback** UAC Review of 2012-2013: STRENGTHS: Mission statements and outcomes are aligned and suitable for the needs as set out by this	- Indirect measures were dropped due to concerns about the reliability of the measures that were employed at the time. A

	rubric as determined by the committee. However, the committee did suggest following the recommendations made in the Dean's 2013 memo. Additionally, the committee felt comfortable with the balance of direct and indirect measures in the plan. AREAS OF CONCERN: The committee found ambiguity in the standards used and found numerous inconsistencies in the report, suggesting it needs to be checked for accuracy. SUGGESTIONS: The committee recommends the program faculty closely utilize the resources at their disposal: refer to Dr. Weems' memo for specific areas of concern and schedule more assessment training with Dr. Rothrock. Additionally, the committee recommends clearer articulation of instructor performance goals. Dean's Review of AY 2015-2016 Report: 1. The outcomes are listed and describe the expectations from the students. These outcomes are not directly linked to the most important purposes of the program. However, this linkage is not requested inthe assessment document. The document should be altered to reflect the expectations in the review. 2. Standards need to be outlined for each outcome. For instance, what percent of students taking the ACS organic chemistry exam need to score what level in order to know that the program is meeting the standard? 3. Did not find any indirect measurements. 4. Unclear what AY is being discussed in some parts of the report. For instance, for CHEM 4114 ACS exam, it appears that the 2014-2015 AY is being discussed and no mention of the AY 2015-2016 is made in the analysis information. 5. Actions should be written in terms of what changes will be made instead of what changes could be made.	new indirect measure has been added to this year's assessment. - Greater care and attention to accurate tabulation of the data. - More attention has been paid articulation of standards and goals in the Departmental Assessment meetings and in the report. Response to Dean's Review: 1. - This has been done. 2. - This has been done. 3. - One new indirect measure has been added: employment/graduate school admittance for graduates. 4. - Care has been taken to ensure that descriptions of data are accurate and that data and conclusions are attributed to the proper reporting period. 5. - This has been done.

APPENDIX

Copy/paste screenshots or narrative of blank instruments (rubrics, surveys, data report requests, prepared spread sheets, etc) here.

Rubric: Criterion 2.1 Physical Chemistry Laboratory Reports

Evaluation of Physical Chemistry Laboratory Reports

Abstract: should contain a brief synopsis of the experiment, the results, and the conclusions that can be drawn from the laboratory experiment. 5 pts

Purpose: This section, consisting of a paragraph or two, should briefly state the purpose for doing the experiment - what principles or results are to be expected? 5 pts

Theory: The theory for the experimental procedure should be briefly given, including relevant equations, and any approximations or experimental details relevant to obtaining the final results. The student must convey an understanding of the underlying theory of the experiment. 15 pts

Procedure: should be briefly described, particularly any deviations from the text procedure. 10 pts

Results: The data obtained in the experiment should be given in tabular form, along with sufficient descriptive text to clearly indicate what the various numbers and results are. Sample calculations are to be given in this section as well. The final result from the experiment *e.g.* the enthalpy of formation of a compound, or the heat capacity ratio for a diatomic gas, should be presented along with at least one sample calculation to show how the results were obtained. 20 pts

Discussion: The results should be discussed in terms of the predicted results from theory, and an attempt made to explain agreement or disagreement between the two. A propagation of error analysis should be included in this section, in order to determine whether the results obtained agree within experimental error or not. This section may be combined with the conclusion section so long as the discussion elements are clearly present in the conclusion portion of the report. 25 pts

Conclusion: The final conclusions drawn from the experiment are presented here. Did the experimental results agree with the theoretical predictions? If not, are there possible sources of error to explain the discrepancies? 20 pts

General Comments: In the Theory, Discussion, and Conclusion sections of the report, the student must provide evidence that they understand the theory behind the experiment and what the experimental results prove or fail to prove. Throughout the Report, proper grammar, correct spelling, and an accurate usage of significant figures and units is required. Points are deducted when these standards are not met.

Rubric: Criterion 3.2 Synthesis

Organic Synthesis Rubric

The Multistep Synthesis experiment spans four weeks. Each week, students are graded based on the following scheme, and grades are averaged at the end of the four weeks. The maximum average is 100.

Week 1: Conversion of 1-butanol to 1-bromobutane.

100%: Setting up the reflux apparatus correctly, purifying the crude product using proper technique, and calculating a percent yield for the reaction correctly.
75%: Setting up the reflux apparatus correctly, purifying the crude product using proper technique, but not correctly calculating a percent yield of product.
50%: Setting up the reflux apparatus correctly, but not purifying the crude product using proper technique, and not calculating a percent yield for the reaction correctly.
25%: Not Setting up the reflux apparatus correctly, not purifying the crude product using proper technique, and not calculating a percent yield for the reaction correctly.

Week 2: Preparation of a Grignard Reagent.

100%: Setting up the dry apparatus correctly, demonstrating knowledge of how to use an addition funnel properly.
75%: Setting up an apparatus that is not thoroughly dry, demonstrating knowledge of how to use an addition funnel properly.
50%: Setting up an apparatus that is not thoroughly dry, not using the addition funnel properly.
25%: Not setting up the apparatus properly, not using the addition funnel properly.

Week 3: Isolation of 2-methyl-2-hexanol

100%: Properly employing the techniques of extraction and vacuum distillation, properly drying the product, properly calculating a percent yield of product.
75% Properly employing the techniques of extraction and vacuum distillation, properly drying the product, not properly calculating a percent yield of product.
50%: Properly employing the techniques of extraction and vacuum distillation, not properly drying the product, not properly calculating a percent yield of product.
25%: Not properly employing the techniques of extraction and vacuum distillation, not properly drying the product, not properly calculating a percent yield of product.

Week 4: Preparation of 2-methyl-2-hexene

100%: Properly setting up the apparatus for dehydration, properly drying the product, properly calculating a percent yield of product.
75% Properly setting up the apparatus for dehydration, properly drying the product, not properly calculating a percent yield of product.
50%: Properly setting up the apparatus for dehydration, not properly drying the product, not properly calculating a percent yield of product.
25%: Not properly setting up the apparatus for dehydration, not properly drying the product, not properly calculating a percent yield of product.

Analytical Chemistry Sequence Rubrics: Criterion 1 and 2

The performance goal is that 70% of the students will attain a overall lab grade average of 75% or higher. Analytical technique is gauged by having students analyzing prepared unknowns from Thorn Smith Laboratory. Points were assigned based on students being within 5% of the accepted value. The overall lab average for students 1 through 5 is 90% with 80% of the students having a lab average of 75% or higher. The respective individual averages are listed below:

Student 1	93%
Student 2	94%
Student 3	96%
Student 4	70%
Student 5	98%

Comments for Improvement:

In order to improve performance in lab, a greater emphasis will be placed on preparing for lab and further practice making solutions. This will be accomplished by having students complete problems related to preparing solutions specific to the upcoming lab. The problems will become part of the lab grade. A greater emphasis will also be placed on keeping an organized notebook with a more detailed outlined. This should improve the ability of the students to find and recall exactly what they did when writing the written report. A handout for this will be prepared and discussed in greater detail at the beginning of the semester.

Quantitative Analysis Lab (3214 L)

Consistent with the Assessment of the Chemistry Major, students were required to turn in a formal lab report consisting of seven sections as outlined below and were graded accordingly. The Data Section of the lab report also included points for keeping a notebook and properly recording data.

Introduction 5%
- Describe the purpose and overall goal of the experiment

Background 10%
- Provide a detailed explanation of the reactions and experimental theory.

Experimental 10%
- Include specifically how standard solutions and unknown samples were prepared and analyzed

Data 20%
- Data is neat and organized
- Properly recorded and labeled (ex. significant figures and units)
- Data was properly interpreted (ex. volume used, mass obtained)

Data Analysis 25%
- Calculations were **CLEAR**
- One example per calculation must be shown in detail **including** statistics
- Demonstrated proper use of units and significant figures

Accuracy/Precision 20%
- Results were within an acceptable range of actual values
- For calculated values, the standard deviation and confidence interval are acceptable ranges
  (A scale will be used to assign points for this section)

Conclusion 10%
- Discuss and interpret the overall results of the analysis. Specifically, discuss the accuracy and precision of the standard solution and determination of the unknown. Also discuss sources (atleast three) of error in your experimental determination.

The performance goal is that 75% of the students will score 80% or higher. This semester, 80% of the students met this goal. The respective individual percentages are listed below:

Student 1	76%
Student 2	88%
Student 3	92%
Student 4	92%
Student 5	88%

Comments for Improvement:

In order to improve performance in these areas, a greater emphasis on review of stoichiometry should lead to an improved performance. Less emphasis will be placed on acid base equilibrium allowing for additional time discussing the titration of weak acids. Lastly, this approach will also permit discussion of additional analytical techniques toward the end of the semester.

Quantitative Analysis 3214

In the Quantitative Analysis course, 5 questions from the comprehensive final exam worth 5 points each were chosen in order to assess student learning of determined core concepts. The questions chosen for this assessment were not disclosed to the students and none of the questions were multiple choice. Five questions were chosen and are provided below:

1) A 0.5371 g solid sample containing an unknown amount of Na_2CO_3 was given to you for analysis. You dissolve the sample in 100.0 mL of 0.0731 M HCl. The concentration of the excess HCl (after the reaction) was found to be 0.0312 M. What is the **weight percent** of Na_2CO_3 is in the unknown sample?

   41.3%

2) A 0.1000 M solution of NaOH is used to titrate 25.00 mL of a 0.1000 M solution of an unknown weak acid. You discover that the pH after adding 12.50 mL is 9.30. What is the identity of the unknown weak acid?

   Arsenous acid.

3) Define activity and list two properties of activity coefficients.

   A measure of the effect of the electrolyte on an equilibrium. They are considered to be unity for ideally dilute solutions and are less than unity for solutions of moderate ionic strength.

4) What weight of sodium formate (MM: 67.997 g/mol) must be added to a 500.0 mL solution of 1.20 M formic acid to produce a buffer solution with a pH of 3.48?

   22.4 g

5) 0.1500 M NaOH is used to titrate 25.00 mL of 0.1500 M Acetic Acid. Find the pH initially, after adding 5.00 mL, at the equivalence point and after 27.00 mL of the base has been added.

   2.78, 4.14, 8.81, 11.76

Instrumental Analysis Research Paper (3484)

Students were required to select and instrumental method and discuss the method in detail, the types of samples analyzed, the qualitative and/or quantitative information obtained, the cost and specifications of the instrument available commercially and an overview of at least two peer reviewed research articles that discuss the use of the instrumental method chosen. The presentations were graded according to the following scheme:

Criteria	Points
A topic regarding an instrumental method	5
5-10 pages including a title page, table of contents, and references	5
References must be hardcopy textbooks or published research articles only (NO WEBSITES)	10
Introduce the method and instrument design	10
Discuss each component from source to detector	20
Include advantages and disadvantages this method MAY have over another	5
Choose an instrument from a manufacturer and discuss the specifications (include a printed copy from the website)	5
Be sure to include types of samples that may be analyzed and how they are prepared	10
Discuss what kind of qualitative or quantitative information is obtained	20
Summarize 2-3 published recent research articles that use the instrumental method	10

Instrumental Analysis Presentations (3484)

Students were required to select and instrumental method and discuss the method in detail, the types of samples analyzed, the qualitative and/or quantitative information obtained, the cost and specifications of the instrument available commercially and an overview of at least two peer reviewed research articles that discuss the use of the instrumental method chosen. The presentations were graded according to the following scheme:

Criteria	Points
15-20 minutes	5
Introduce the instrument design	10
Discuss each component from source to detector	20
Include advantages and disadvantages this instrument MAY have over another	5
Choose a commercially available instrument and describe the cost and specifications	10
Be sure to include how a sample is prepared and analyzed	10
Discuss what kind of qualitative and/or quantitative information is obtained	20
Summarize how this instrument is used in one of the articles you selected for the paper	10
Answer 3 questions	10

The performance goal is that 90% of the students will achieve a C or higher on the presentation. All students scored higher than 70%. The respective individual averages are listed below:

Student 1 95%
Student 2 95%
Student 3 100%
Student 4 95%

The performance goal is that 70% of the students will attain an overall lab grade average of 75% or higher. Technique is gauged by having students analyzing prepared unknowns from Thom Smith Laboratory when appropriate. Points were assigned based on students being within 5% of the accepted value. The overall lab average for students 1 through 5 is 93% with all students having a lab average of 75% or higher. The respective individual averages are listed below:

Student 1	95%
Student 2	97%
Student 3	94%
Student 4	95%
Student 5	82%

Comments for Improvement:

These comments are similar to that of Quantitative Analysis lab. A greater emphasis will be placed on preparing for lab and continued practice preparing real samples. This will be accomplished by having students do problems related to the upcoming lab. These will become part of the lab grade. Additionally, analysis of real samples will continue to be emphasized. A greater emphasis will also be placed on keeping an organized notebook. This should improve the ability of the students to find and recall exactly what they did when writing the written report. A handout for this will be prepared and discussed in greater detail at the beginning of the semester.

Instrumental Analysis Lab (3484 L)

Instrumental lab reports were also required and graded in a similar format as Chemistry 3214L. Below is the grading scheme used for Instrumental Analysis Lab:

Introduction 5%
- Describe the purpose and overall goal of the experiment

Background 10%
- Provide a detailed explanation of the reactions and experimental theory. IF also using an instrument, include the theory of the instrument. (ex. source through detector)

Experimental 10%
- Include specifically how standard solutions and unknown samples were prepared and analyzed

Data 20%
- Data is neat and organized
- Properly recorded and labeled (ex. significant figures and units)
- Data was properly interpreted (ex. volume used, mass obtained)

Data Analysis 25%
- Calculations were **CLEAR**
- One example per calculation must be shown in detail **including** statistics
- Demonstrated proper use of units and significant figures

Accuracy/Precision 20%
- Results were within an acceptable range of actual values
- For calculated values, the standard deviation and confidence Interval are acceptable ranges (A scale will be used to assign points for this section)

Conclusion 10%
- Discuss and interpret the overall results of the analysis.
- For determining unknowns, discuss and interpret the overall results related to the accuracy and precision of the standard solution and determination of the unknown.

5. In the flame, it is also possible for the analyte to emit radiation after being excited and relaxing to the ground state. The flame also emits light. How are these interferences eliminated?

   Modulation of the source permits removal of a DC signal caused by the flame and emission.

The performance goal is that 75% of the students will score 80% or higher. This semester, all of the students met this goal. The respective individual averages are listed below:

Student 1	18/20
Student 2	20/20
Student 3	18/20
Student 4	20/20
Student 5	16/20

Comments for Improvement:

In order to improve the performance on these questions, there will be a greater emphasis on methods that the students are not exposed too as much or at all in other courses. For example, less emphasis will be placed on IR allowing more time to reinforce these topics as well as cover additional instrumental techniques.

Instrumental Analysis (Chemistry 3484)

In the Instrumental Analysis course, 5 questions from the comprehensive final exam were chosen in order to assess student learning of determined core concepts. The questions chosen for this assessment were not disclosed to the students and none of the questions were multiple choice. Five questions were chosen and are provided below:

1. The molar absorptivity of $KMnO_4$ is $2.33 \times 10^3\ M^{-1}\ cm^{-1}$. A soil sample contaminated with $KMnO_4$ was given to you for analysis. After totally dissolving 1.3546 g of the soil sample and diluting to 250.0 mL in a volumetric flask, the absorbance is 1.179 using a 1.00 cm cell. What is the weight percent of $KMnO_4$ in the soil sample? (The molar mass of $KMnO_4$ is 158.03 g/mol)

   1.48%

2. Draw a SIMPLE block diagram for an IR instrument. Compare and contrast the block diagram to UV Visible Spectroscopy and identify in which instrument it is possible to place the sample after the source and why this is permissible.

   Source $\rightarrow$ sample $\rightarrow \lambda \rightarrow$ Detector: The sample may be placed after the source as the low energy of IR does not cause photodecomposition.

3. Define ground singlet state, excited singlet state and the excited triplet state. Compare two molecules in which one is in an excited singlet state and the other a excited triplet state, what type of fluorescence will each result in? Which type of fluorescence takes longer and why?

   The ground singlet state is 2 paired electrons in the ground state. The excited singlet state is paired electrons but one electron is excited but the spin of both electrons is still paired. The excited triplet state is one excited electron but now spin is no longer paired. Relaxation from the excited singlet state will result in fluorescence and phosphorescence will result from relaxation from the excited triplet state. Because it takes longer for the spin of the electrons to pair when relaxation occurs from the excited triplet state, phosphorescence lasts longer.

4. Why is ICP typically employed for emission experiments and Flame and Electrothermal methods used for absorption experiments?

   ICP is involved is used in emission experiments because the high temperatures improves ionization efficiency and more atoms are in the excited state. Flame and Electrothermal are used as more atoms are in the ground state.