Course Assessment Report
Washtenaw Community College

Discipline	Course Number	Title
Chemistry	122	CEM 122 04/21/2023-General Chemistry II
College	Division	Department
	Math, Science and Engineering Tech	Chemistry
Faculty Preparer		Eric Schwab
Date of Last Filed Assessment Report		11/10/2021

I. Review previous assessment reports submitted for this course and provide the following information.

1. Was this course previously assessed and if so, when?

   Yes

   Winter 2021

2. Briefly describe the results of previous assessment report(s).

   Outcome 1 was based on a departmental Final Assessment (Exam) consisting of 60 multiple choice questions. 45.8% scored at least 30/40 (75%) which was well below the standard of 75% scoring 75% or greater.

3. Briefly describe the Action Plan/Intended Changes from the previous report(s), when and how changes were implemented.

   In keeping with our course syllabi, we reduced the Outcome 1 metric to 70% of the students scoring 70% or more. To pass the course, students need only attain a score of 70% in both the lecture and laboratory sections of the course.

II. Assessment Results per Student Learning Outcome

Outcome 1: Recognize the concepts and principles of general chemistry relating to chemical kinetics, chemical equilibrium, chemical thermodynamics and electrochemistry.

- Assessment Plan
  - Assessment Tool: Outcome-related departmental exam questions
  - Assessment Date: Winter 2024

- Course section(s)/other population: All sections
- Number students to be assessed: All students
- How the assessment will be scored: Departmental exam multiple-choice questions will be scored against an answer key.
- Standard of success to be used for this assessment: 75% of students will score 70% or higher on the outcome-related questions.
- Who will score and analyze the data: The full-time Chemistry faculty will score the artifacts and analyze the data.

1. Indicate the Semester(s) and year(s) assessment data were collected for this report.

Fall (indicate years below)	Winter (indicate years below)	SP/SU (indicate years below)
2022		

2. Provide assessment sample size data in the table below.

# of students enrolled	# of students assessed
141	62

3. If the number of students assessed differs from the number of students enrolled, please explain why all enrolled students were not assessed, e.g. absence, withdrawal, or did not complete activity.

The number of students enrolled includes the lab sections. Since the lab sections are associated with a particular lecture, the laboratory values are duplicated. The '62' represents the actual number of enrolled students.

4. Describe how students from all populations (day students on campus, DL, MM, evening, extension center sites, etc.) were included in the assessment based on your selection criteria.

All three sections of CEM 122 were assessed. All sections were on campus (i.e. face-to-face). Two of the sections were day sections, and the other was an evening section.

5. Describe the process used to assess this outcome. Include a brief description of this tool and how it was scored.

A Final Assessment exam is given to the students during the last class meeting of the semester. The exam is worth 55 points out of the 555 total lecture points. Part A consists of 40 multiple-choice questions addressing the principles and concepts of the topics presented in CEM122. They are: Chemical Kinetics, Chemical

Equilibrium, Acid-base Equilibrium, Solubility Equilibrium, Chemical Thermodynamics, and Electrochemistry. Five points were used as a bonus.

6. Briefly describe assessment results based on data collected for this outcome and tool during the course assessment. Discuss the extent to which students achieved this learning outcome and indicate whether the standard of success was met for this outcome and tool.

Met Standard of Success: No
All 62 students took the Final Assessment. The average score for Part A was 26.15 (65.4%) and the median score was 26.5 (66.3%). Of the 62 students that took the Final Assessment, 29 (46.8%) scored 28/40 (70%) or higher. This is below our desired standard of 70% of students scoring 70% or higher. Two factors influenced this low percentage. The first is that many of our students who fail, or withdraw, from the class take the Final Assessment. We encourage this, especially if they intend to repeat the course. I was not able to get the number of fails/withdrawals for each section to reanalyze the data. If those students were removed, then it is likely the percentage that met the 70% milestone would have been higher. The second factor was the pandemic shutdown. The Fall 2022 semester was only the second semester in which both the laboratory and lecture sections were taught on campus. From anecdotal evidence, we believe there was an increase in academic dishonesty during the shutdown, which led to CEM111 students not prepared for second semester General Chemistry. All the data for Part A is included in the attached file 'FinalAssessmentStatsW23'.

7. Based on your interpretation of the assessment results, describe the areas of strength in student achievement of this learning outcome.

Looking at the item analysis for Part A, the questions on the Final Assessment are evenly divided by the topics covered. The question breakdown is as follows: Kinetics = 7, Chemical Equilibrium = 5, Acid-Base Equilibrium = 5, Solubility Equilibrium = 3, Thermodynamics = 10, and Electrochemistry 10. The low number for Solubility Equilibrium is a result of it being a minor topic when compared with the other five topics. The cumulative percentages, for each topic, of students answering the questions wrong were: Kinetics = 27.6%, Chemical Equilibrium = 28.6%, Acid-base Equilibrium = 33.8%, Solubility Equilibrium = 34.7%, Thermodynamics = 37.8%, and Electrochemistry 39.8%. Only Kinetics (71.4%) and Chemical Equilibrium (76.2%) met the 70% standard. A more thorough examination into the low performance on Part A revealed that, there were 18 questions that were answered wrong >30% of the time. These questions were numbers 2 (59.7%), 6, (45.2%), 9 (40.3%), 10 (43.6%), 12

(40.3%), 18 (71.0%), 19 (50.0%), 21 (45.2%), 23 (67.7%), 24 (75.8%), 27 (50.0%), 29 (74.2%), 31 (56.4%), 33 (40.3%), 34 (43.6%), 35 (41.9%), 37 (64.5%), and 40 (54.8%). Two questions were in Kinetics, two in Chemical Equilibrium, three in Acid-Base equilibrium, one in Solubility Equilibrium, four in Thermodynamics, and six in Electrochemistry. The low performance on these 18 questions likely contributed to the low percentages on Part A. The CEM122 faculty will review these questions and make changes where we think they are warranted.

The strengths (less than 10% wrong) in student achievement that we noticed are: students were able to determine the effect on rate from a perturbation (Question# 3, 4.84% wrong), apply collision theory to kinetics (Question# 5, 6.0% wrong), write equilibrium constant expressions (Question# 13, 7.0% wrong), identify weak and strong acids/bases (Question# 17, 6.0% wrong), and identify electron flow in an electrochemical cell (Question # 38, 9.0% wrong).

8. Based on your analysis of student performance, discuss the areas in which student achievement of this learning outcome could be improved. If student met standard of success, you may wish to identify your plans for continuous improvement.

Based on the above analysis there are several separate, but related areas, where learning outcomes can be improved.

First, some of the questions with the highest percent wrong (e.g., 18, 19, 23, 24, and 29) were conceptual problems. We will continue to emphasize the conceptual nature of the course curriculum and increase the number of homework problems dedicated to these concepts.

Second, overall there was an inability for students to complete calculations correctly. This may have several causes. Students who pass CEM 111 with a C feel they are prepared for CEM 122. The math required for CEM 122, however, is quite a bit more advanced than that needed for CEM 111 (e.g., logs, exponents, quadratics). Students passing CEM 111 with a C may be conceptually ready for CEM 122, but may lack the math skills required. Ensuring that students leaving CEM 111 have the proper math skills for CEM 122 would increase the success rate.

CEM 122 is conceptually more difficult than CEM 111, and the semester builds on previous material. So, if a student falls behind in Chemical Equilibrium, they will not perform well in the following chapters, since all succeeding chapters require a thorough understanding of chemical equilibrium. This is most evident in performing calculations. Falling behind means they will not have learned the mathematical procedures needed for later chapters. We can check on the classes' overall mastery of the mathematics by giving short, one problem assignments in class and acting on the results. Offering extra problem sets will also give students

more exposure to the types of problems they'll need to master to succeed in CEM 122. Another tactic would be to employ an on-line chemistry homework system, to assess the difficulties students are having with the current subject matter, in a timely fashion.

Outcome 2: Apply the appropriate concepts or principles of chemistry to solve kinetics, equilibrium, thermodynamics and electrochemistry problems.

- Assessment Plan
  - Assessment Tool: Outcome-related departmental exam questions
  - Assessment Date: Winter 2024
  - Course section(s)/other population: All sections
  - Number students to be assessed: All students
  - How the assessment will be scored: Departmental exam multiple-choice questions that require problem-solving with calculations will be scored against an answer key.
  - Standard of success to be used for this assessment: 75% of students will score 70% or higher on the outcome-related questions.
  - Who will score and analyze the data: The full-time Chemistry faculty will score the artifacts and analyze the data.

1. Indicate the Semester(s) and year(s) assessment data were collected for this report.

Fall (indicate years below)	Winter (indicate years below)	SP/SU (indicate years below)
2022		

2. Provide assessment sample size data in the table below.

# of students enrolled	# of students assessed
141	62

3. If the number of students assessed differs from the number of students enrolled, please explain why all enrolled students were not assessed, e.g. absence, withdrawal, or did not complete activity.

The number of students enrolled includes the lab sections. Since the lab sections are associated with a particular lecture, the laboratory values are duplicated. The '62' represents the actual number of enrolled students.

4. Describe how students from all populations (day students on campus, DL, MM, evening, extension center sites, etc.) were included in the assessment based on your selection criteria.

All three sections of CEM122 were assessed. All sections were on campus (i.e. face-to-face). Two of the sections were day sections, and the other was an evening section.

5. Describe the process used to assess this outcome. Include a brief description of this tool and how it was scored.

A Final Assessment exam is given to the students during the last class meeting of the semester. The exam is worth 55 points out of the 555 total lecture points. Part B of this exam is used to assess Outcome 2. Part B consists of 19 multiple-choice questions, and one short answer question. Part B questions assess the ability of the students to apply the formulas and mathematical procedures, presented throughout the semester, to quantitatively solve problems in the topics studied. These topics are: Chemical Kinetics, Chemical Equilibrium, Acid-base Equilibrium, Solubility Equilibrium, Chemical Thermodynamics, and Electrochemistry. Five points were used as a bonus.

6. Briefly describe assessment results based on data collected for this outcome and tool during the course assessment. Discuss the extent to which students achieved this learning outcome and indicate whether the standard of success was met for this outcome and tool.

Met Standard of Success: No
All 62 students enrolled in the Fall 2022 semester took the Final Assessment. The average score for Part B was 13.29 (66.4%) and the median score was 13.0 (65.0%). Of the 62 students that took the Final Assessment, 30 (48.4%) scored 14/20 (70%) or higher. This is below our desired standard of 70% of students scoring 70% or higher. Two factors influenced this low percentage. The first is that many of our students who fail, or withdraw, from the class take the Final Assessment. We encourage this, especially if they intend to repeat the course. I was not able to get the number of fails/withdrawals for each section to reanalyze the data. If those students were removed, then it is likely the percentage that met the 70% milestone would have been higher. The second factor was the pandemic shutdown. The Fall 2022 semester was only the second semester in which both the laboratory and lecture sections were taught on campus. From anecdotal evidence, we believe there was an increase in

academic dishonesty during the shutdown, which led to CEM 111 students not prepared for second semester General Chemistry.

All the data for Part B is included in the attached file 'FinalAssessmentStats23'.

7. Based on your interpretation of the assessment results, describe the areas of strength in student achievement of this learning outcome.

Looking at the item analysis for Part B, the questions on the final assessment are evenly divided by the topics covered. The question breakdown is as follows: Kinetics = 4, Chemical Equilibrium = 2, Acid-Base Equilibrium = 8, Solubility Equilibrium = 1, Thermodynamics = 3, and Electrochemistry = 2. The low number for Solubility Equilibrium is a result of it being a minor topic when compared with the others. The cumulative percentages, for each topic, of students answering the questions wrong were: Kinetics = 31.5%, Chemical Equilibrium = 29.0%, Acid-Base Equilibrium = 29.2%, Solubility Equilibrium = 56.4%, Thermodynamics = 40.3%, and Electrochemistry 35.5%. Only Chemical Equilibrium (71.0%), Acid-base Equilibrium (70.8%) met the 70% standard.

A deeper analysis of the low performance in Part B revealed that, there were 11 questions that were answered wrong >30% of the time. These questions were numbers 42 (32.3%), 43 (38.7%), 45 (33.9%), 46 (56.4%), 51 (41.9%), 52 (30.6%), 54 (35.5%), 55 (54.8%), 57 (46.8%), 59 (62.9%), and 60 (41.9%). Three questions were in Kinetics, one in Chemical Equilibrium, three in Acid-Base equilibrium, one in Solubility Equilibrium, two in Thermodynamics, and one in Electrochemistry. The low performance on these questions contributed to the low percentages on Part B. The CEM 122 faculty will review these questions and make changes where we think it is warranted.

The strengths in student achievement we noticed were:

• Acid-base Equilibrium, students were able to perform all the basic calculations required of this topic. Six of the eight questions had a % wrong metric under 30.

• For Chemical Equilibrium, students were able to determine equilibrium constants from data that was provided.

• For Thermochemistry, students were able to calculate standard thermodynamic quantities of reactions using tabulated values for reactants & products.

• For Electrochemistry, students were able to perform the calculations required of this topic.

8. Based on your analysis of student performance, discuss the areas in which student achievement of this learning outcome could be improved. If student met standard of success, you may wish to identify your plans for continuous improvement.

The high errors on questions 46 (Ksp), 55 (pH of buffer), and 59 (K from thermodynamic values) demonstrate an inability to use the appropriate equations correctly. As discussed in Outcome #1 this may be a result of some students lacking the math skills to perform these calculations. Providing more homework assignments and extra problems from secondary sources may address this issue. We have noticed, however, that students don't always take advantage of these additional resources. Also, stronger emphasis can also be placed on Lab #1. This is essentially a review lab that takes the students through all the mathematical skills they will need for CEM 122. After this lab is graded, we could target specific areas (e.g., calculations with logarithms) that students are having trouble with. This may increase the success rate.

Outcome 2: Apply the appropriate concepts or principles of chemistry to solve kinetics, equilibrium, thermodynamics and electrochemistry problems.

- Assessment Plan
    - Assessment Tool: Problem to be solved requiring that calculations be shown
    - Assessment Date: Winter 2024
    - Course section(s)/other population: All sections
    - Number students to be assessed: All students
    - How the assessment will be scored: A departmentally-developed rubric will be used to score and evaluate the calculations used to solve the posed problem.
    - Standard of success to be used for this assessment: 75% of students will score 70% or higher on the scoring rubric.
    - Who will score and analyze the data: Full-time Chemistry faculty will score and analyze the data.

1. Indicate the Semester(s) and year(s) assessment data were collected for this report.

Fall (indicate years below)	Winter (indicate years below)	SP/SU (indicate years below)

2022		

2. Provide assessment sample size data in the table below.

# of students enrolled	# of students assessed
141	62

3. If the number of students assessed differs from the number of students enrolled, please explain why all enrolled students were not assessed, e.g. absence, withdrawal, or did not complete activity.

All 62 students were assessed.

4. Describe how students from all populations (day students on campus, DL, MM, evening, extension center sites, etc.) were included in the assessment based on your selection criteria.

All three sections were assessed. All the sections were on campus. Two were during the day, the other was an evening section.

5. Describe the process used to assess this outcome. Include a brief description of this tool and how it was scored.

Question# 60 on the Final Assessment required students to calculate the pH of a weak acid solution. Space was given on the test answer form for the students to show all their work.

6. Briefly describe assessment results based on data collected for this outcome and tool during the course assessment. Discuss the extent to which students achieved this learning outcome and indicate whether the standard of success was met for this outcome and tool.

Met Standard of Success: No
Of the 62 students who took the Final Assessment, 26 (41.9%) answered question 60 incorrectly. This is quite a bit below the target success rate of 70%.

7. Based on your interpretation of the assessment results, describe the areas of strength in student achievement of this learning outcome.

Looking at the item analysis for Part B, the questions on the final assessment are evenly divided by the topics covered. The question breakdown is as follows: Kinetics = 4, Chemical Equilibrium = 2, Acid-Base Equilibrium = 8, Solubility Equilibrium = 1, Thermodynamics = 3, and Electrochemistry = 2. The low number for Solubility Equilibrium is a result of it being a minor topic when compared with the others. The cumulative percentages, for each topic, of students answering the questions wrong were: Kinetics = 31.5%, Chemical Equilibrium = 29.0%, Acid-Base Equilibrium = 29.2%, Solubility Equilibrium =

56.4%, Thermodynamics = 40.3%, and Electrochemistry 35.5%. Only Chemical Equilibrium (71.0%), Acid-base Equilibrium (70.8%) met the 70% standard.

A deeper analysis of the low performance in Part B revealed that, there were 11 questions that were answered wrong >30% of the time. These questions were numbers 42 (32.3%), 43 (38.7%), 45 (33.9%), 46 (56.4%), 51 (41.9%), 52 (30.6%), 54 (35.5%), 55 (54.8%), 57 (46.8%), 59 (62.9%), and 60 (41.9%). Three questions were in Kinetics, one in Chemical Equilibrium, three in Acid-Base equilibrium, one in Solubility Equilibrium, two in Thermodynamics, and one in Electrochemistry. The low performance on these questions contributed to the low percentages on Part B. The CEM 122 faculty will review these questions and make changes where we think it is warranted.

The strengths in student achievement we noticed were:

• Acid-base Equilibrium, students were able to perform all the basic calculations required of this topic. Six of the eight questions had a % wrong metric under 30.

• For Chemical Equilibrium, students were able to determine equilibrium constants from data that was provided.

• For Thermochemistry, students were able to calculate standard thermodynamic quantities of reactions using tabulated values for reactants & products.

• For Electrochemistry, students were able to perform the calculations required of this topic.

8. Based on your analysis of student performance, discuss the areas in which student achievement of this learning outcome could be improved. If student met standard of success, you may wish to identify your plans for continuous improvement.

The high errors on questions 46 (Ksp), 55 (pH of buffer), and 59 (K from thermodynamic values) demonstrate an inability to use the appropriate equations correctly.

As discussed in Outcome #1 this may be a result of some students lacking the math skills to perform these calculations. Providing more homework assignments and extra problems from secondary sources may address this issue. We have noticed, however, that students don't always take advantage of these additional resources.

Also, stronger emphasis can also be placed on Lab #1. This is essentially a review lab that takes the students through all the mathematical skills they will need for CEM 122. After this lab is graded, we could target specific areas (e.g., calculations

with logarithms) that students are having trouble with. This may increase the success rate.

Outcome 3: Demonstrate the science processes of collecting and properly recording data, calculating and analyzing results, and drawing conclusions based on results.

- Assessment Plan
    - Assessment Tool: Lab reports
    - Assessment Date: Winter 2024
    - Course section(s)/other population: All sections
    - Number students to be assessed: All students
    - How the assessment will be scored: Lab reports from a selected experiment will be scored against a departmentally-developed lab report rubric.
    - Standard of success to be used for this assessment: 75% of students will score 70% or higher on the lab report rubric.
    - Who will score and analyze the data: The full-time chemistry faculty will score the artifacts and analyze the data.

1. Indicate the Semester(s) and year(s) assessment data were collected for this report.

Fall (indicate years below)	Winter (indicate years below)	SP/SU (indicate years below)
2022		

2. Provide assessment sample size data in the table below.

# of students enrolled	# of students assessed
141	53

3. If the number of students assessed differs from the number of students enrolled, please explain why all enrolled students were not assessed, e.g. absence, withdrawal, or did not complete activity.

The number of students enrolled includes the lab sections. Since the lab sections are associated with a particular lecture, the laboratory values are duplicated. The '62' represents the actual number of enrolled students. Of the 62 students enrolled in the Fall 2022 semester, 53 labs were assessed. This discrepancy is due to several factors. The lab assessed occurs near the end of the semester, by this time, many students have dropped the course. Students who are retaking the course can use their lab grades from a previous semester; so, we wouldn't have their lab report

to assess. Also, lab periods may have students who are absent. If this occurs for the assessed lab, no report would be available.

4. Describe how students from all populations (day students on campus, DL, MM, evening, extension center sites, etc.) were included in the assessment based on your selection criteria.

All three sections of CEM122 were assessed. All sections were on campus (i.e. face-to-face). Two of the sections were day sections, and the other was an evening section.

5. Describe the process used to assess this outcome. Include a brief description of this tool and how it was scored.

To assess this outcome, the author of this report received the graded lab reports from the individual instructors. Using a 10-factor rubric, each lab was assessed using the following categories: Partner, Procedure, Proper significant figures (SF) in the pre-lab, Correct Units in the pre-lab, Completion of Calculations, Proper SF in the results, Correct Units in the results, Conclusion, Answer to Question 1, Answer to all other questions. Each category could receive a maximum score of 1. The assessment rubric is in the attached file 'LabAssessmentW23'.

6. Briefly describe assessment results based on data collected for this outcome and tool during the course assessment. Discuss the extent to which students achieved this learning outcome and indicate whether the standard of success was met for this outcome and tool.

Met Standard of Success: Yes
Of the 53 labs assessed 45 (84.9%) has a score of 7 or greater. This is well above the 70% target for success. The success rate is primarily the result of the training the students receive during the semester, and in previous semesters, in writing a proper lab report. The lab assessed is the second to last lab of the semester, and by this time, most students have learned the proper method for writing a lab report. They can summarize the procedure, perform any pre-lab calculations (e.g., standard curve concentrations, etc.), record and tabulate the experimental data, perform calculations with the collected data, tabulate the results, state their conclusion, and answer questions relevant to the concept being demonstrated by the lab experiment.

7. Based on your interpretation of the assessment results, describe the areas of strength in student achievement of this learning outcome.

Based on the analysis of the assessment data, the students have met the learning outcome for performing laboratory procedures, documenting their data collection,

calculating results from this data, and answering questions pertaining to the overall concept being demonstrated by the lab.

8. Based on your analysis of student performance, discuss the areas in which student achievement of this learning outcome could be improved. If student met standard of success, you may wish to identify your plans for continuous improvement.

While minor, students still forget the 'small' things (e.g., unit labels, and significant figures). Grading early labs slightly harder for these factors will emphasize their importance to the students, and increase the success rate.

III. Course Summary and Intended Changes Based on Assessment Results

1. Based on the previous report's Intended Change(s) identified in Section I above, please discuss how effective the changes were in improving student learning.

The Final Assessment exam was essentially rewritten after the last course assessment. Part of the rewrite was at the suggestion of the Assessment Committee. The new final assessment was structure so the target of 70% correct for both parts A & B could be met.

This assessment is occurring after the pandemic shutdown. Many of the students in the assessed sections had General Chemistry I (CEM111) in a virtual setting. The unit exams were considerably different from those given in face-to-face classes. There were significant indications that academic dishonesty played a role in the success of these students. As such, they were not prepared for CEM122, despite their grade in CEM111.

2. Describe your overall impression of how this course is meeting the needs of students. Did the assessment process bring to light anything about student achievement of learning outcomes that surprised you?

CEM 122 is adequately meeting the needs of our students. This course is a pre-requisite for our organic chemistry course, CEM 211, and many students take this course for that reason. In addition, we have many students taking this course in preparation for admission to professional graduate programs (e.g., medical school, dental school, pharmacy school and physician assistant programs, etc.). Also, a number of U of M engineering students come to WCC to take CEM 122.

The major surprise from the item analysis of the Final Assessment was that the questions with the largest percent wrong dealt with conceptual questions. For example, question 24 (75.8% wrong) asked the students to interpret the Second Law of Thermodynamics. Likewise, question 29 (74.2% wrong) asked the students to choose the strongest reducing agent from a selection of metals. Both questions require a good understanding of the relevant topics. Therefore, it seems

we need to put more emphasis on the conceptual framework that governs the topics in CEM 122.

3. Describe when and how this information, including the action plan, was or will be shared with Departmental Faculty.

The information contained in this assessment and the action plan will be shared with the chemistry faculty at a departmental faculty meeting held in the Fall 2023 semester.

4.

Intended Change(s)

Intended Change	Description of the change	Rationale	Implementation Date
Assessment Tool	The Final Assessment questions that had 70%, or greater, wrong will be rewritten.	The questions alluded to above had roughly the same failure rate across all sections. The may be due to the questions being poorly worded, insufficient data given to solve the problem, or the scope is beyond the course material.	2023
Course Materials (e.g. textbooks, handouts, on-line ancillaries)	Explore using short, one problem assignments or an online chemistry homework system to monitor student understanding of conceptual material. Add emphasis on the conceptual framework governing topics in CEM 122.	CEM 122 is conceptually more difficult than CEM 111, and the course builds on material successively. Students fall behind if they do not have a thorough understanding of previous material. The current assessment also demonstrated students struggled with conceptual questions.	2023

Course Materials (e.g. textbooks, handouts, on-line ancillaries)	Place stronger emphasis on Lab #1, which includes math skills students need for CEM 122. Provide additional assignments and practice problems for needed math skills (e.g. completing calculations, using the appropriate equations correctly).	To identify math skills that may need additional instruction or review to support student learning. To strengthen math skills needed for the course.	2023
Other: grading labs	Grade early labs more strictly for details like unit labels and significant figures.	Emphasizing these details will help students understand their importance and increase the success rate.	2023

5. Is there anything that you would like to mention that was not already captured?

No additional information.

III. Attached Files

Lab Assessment Statistics
Final Assessment Statistics

Faculty/Preparer:	Eric Schwab	**Date:** 04/28/2023
Department Chair:	Breege Concannon	**Date:** 04/28/2023
Dean:	Tracy Schwab	**Date:** 05/08/2023
Assessment Committee Chair:	Jessica Hale	**Date:** 08/22/2023

Course Assessment Report
Washtenaw Community College

Discipline	Course Number	Title
Chemistry	122	CEM 122 08/11/2021-General Chemistry II
College	Division	Department
	Math, Science and Engineering Tech	Chemistry
Faculty Preparer		Eric Schwab
Date of Last Filed Assessment Report		

I. Review previous assessment reports submitted for this course and provide the following information.

1. Was this course previously assessed and if so, when?

   Yes

   The course was last assessed in 2019.

2. Briefly describe the results of previous assessment report(s).

   Outcome 1: Part A – Only 57.8% of the students met the criteria of scoring 70% or higher.

   Outcome 2: Part B – 74.6% of the students met the criteria of scoring 70% or higher.

   Outcome 3: Lab – 96.8% of the students met the criteria of scoring 7/10 on the lab.

3. Briefly describe the Action Plan/Intended Changes from the previous report(s), when and how changes were implemented.

   A new Final Assessment was written.

II. Assessment Results per Student Learning Outcome

Outcome 1: Recognize the concepts and principles of general chemistry relating to chemical kinetics, chemical equilibrium, chemical thermodynamics and electrochemistry.

- Assessment Plan
  - Assessment Tool: Departmental exam

- Assessment Date: Winter 2020
- Course section(s)/other population: All sections
- Number students to be assessed: All students
- How the assessment will be scored: Departmental exam multiple-choice questions will be scored against an answer key.
- Standard of success to be used for this assessment: 70% of the students taking the departmental exam will score 29/41 (70.7%) or higher on the multiple-choice questions.
- Who will score and analyze the data: The full-time chemistry faculty will score the artifacts and analyze the data.

1. Indicate the Semester(s) and year(s) assessment data were collected for this report.

Fall (indicate years below)	Winter (indicate years below)	SP/SU (indicate years below)
	2021	

2. Provide assessment sample size data in the table below.

# of students enrolled	# of students assessed
103	76

3. If the number of students assessed differs from the number of students enrolled, please explain why all enrolled students were not assessed, e.g. absence, withdrawal, or did not complete activity.

The difference between the number of students enrolled in ALL sections, and the number of students assessed is explained by student withdrawals.

4. Describe how students from all populations (day students on campus, DL, MM, evening, extension center sites, etc.) were included in the assessment based on your selection criteria.

All students enrolled in CEM122 for the Winter 2021 semester were included in this assessment. All classes were in virtual mode (i.e., lectures and labs were conducted on-line by way of Zoom meetings). Four classes were 'day' classes, and the remaining was an 'evening' class.

5. Describe the process used to assess this outcome. Include a brief description of this tool and how it was scored.

Outcome 1 was assessed using a Final Assessment (FA) exam given to the students at the end of the semester. The FA was worth 55 points out of 555 total lecture points. Part A of this exam was used to assess Outcome 1. Part A consisted

of 40 multiple choice questions that target the concepts and topics in CEM122 (i.e., chemical kinetics, chemical equilibrium, acid-base equilibrium, solubility equilibrium, chemical thermodynamics, and electrochemistry. Five points were used as a bonus.

6. Briefly describe assessment results based on data collected for this outcome and tool during the course assessment. Discuss the extent to which students achieved this learning outcome and indicate whether the standard of success was met for this outcome and tool.

Met Standard of Success: Yes

Seventy-six students were included in the Part A analysis. The average and median score for Part A was 31.0 (77.6%). Of the 76 students who took the Final Assessment, 59 (77.6%) scored 28/40 (70%) or higher. This is above the desired standard of 75% of students scoring 70% or higher.

One factor influencing this high percentage was the virtual nature of CEM 122 in the Winter 2021 semester. While taking the Final Assessment, students had full access to their notes, the internet, the book, and graphing calculators. All these items are NOT available to students when they take this exam in face-to-face semesters.

All the data for Part A is included in the attached file 'Final AssessmentStatsW21.'.

7. Based on your interpretation of the assessment results, describe the areas of strength in student achievement of this learning outcome.

Parsing the item analysis for Part A of the Final Assessment, the questions are nearly evenly divided by the topics covered. The question breakdown is as follows: Kinetics = 11, Chemical Equilibrium = 7, Acid-base Equilibrium = 13, Solubility Equilibrium = 4, Thermodynamics = 13, and Electrochemistry = 12. The low number for Solubility Equilibrium is a result of it being a minor topic when compared with the other five. The cumulative percentages, by topic, of students answering the questions wrong were: Kinetics = 17.8%, Chemical Equilibrium = 26.7%, Acid-base Equilibrium = 21.9%, Solubility Equilibrium = 32.9%, Thermodynamics = 28.1%, and Electrochemistry = 22.5%. Only Solubility Equilibrium (67.1% answered correctly) did not meet the 70% standard.

A more thorough examination of the performance on Part A revealed 13 questions that were answered wrong by >30% of the students. These questions were numbers 2 (30.3%), 8 (40.8%), 9 (34.2%), 14 (31.6%), 16 (43.4%), 18 (34.2%), 19 (50.0%), 23 (48.7%), 27 (38.2%), 28 (36.8%), 31 (48.7%), 34 (35.5%), and 40 (35.5%). Of these, one was in Kinetics, one in Chemical Equilibrium, 2 in Acid-base Equilibrium, 3 in Solubility Equilibrium, 3 in Thermodynamics, and 3 in Electrochemistry. The low performance on these questions, however, did not prevent students from meeting the 70% standard for Outcome 1. The CEM122 faculty will review these questions and determine if their wording is ambiguous or confusing, which would lead to the poor performance on these questions.

The strengths in student achievement that the item analysis revealed are:

• Kinetics: students were able determine the effect of a catalyst on rate (Question 4, 5.3% wrong), and apply collision theory to kinetics (Question 5, 3.9% wrong).

• Electrochemistry: students were able to determine the properties of a battery based on reduction potentials (Question 35, 6.6% wrong).

8. Based on your analysis of student performance, discuss the areas in which student achievement of this learning outcome could be improved. If student met standard of success, you may wish to identify your plans for continuous improvement.

Based on the analysis above, there are several areas where learning outcomes can be improved.

First, many of the questions 16, 19, 23, and 31 were conceptual in nature. The CEM 122 faculty will be advised to spend more time on these topics to solidify these ideas.

Second, there was some evidence that students had difficulty completing calculations correctly. This may have numerous causes. Students who pass CEM 111 with a C feel they are prepared for CEM 122. The math required for CEM 122, however, is more advanced than that needed for CEMv122 (e.g., logs, exponents, and quadratics). Therefore, students passing CEM 111 with a C may be conceptually prepared for CEM 122, but may lack the math skills needed for success in CEM 122.

Lastly, unlike CEM111, CEM122 is a course that builds on previous material. So, if a student falls behind in Chemical Equilibrium, they will be at a disadvantage for the remainder of the semester, as all the succeeding chapters rely on that material. Most of the difficulties stem from the advance calculations needed to solve equilibrium problems. We can check on the overall mastery of these procedures by increasing the number of problems gone over in lecture, and providing more problem sets for the students to work through on their own. The more exposure the students get to these unique types of problems, the greater their success will be in the course.

Outcome 2: Apply the appropriate concepts or principles of chemistry to solve kinetics, equilibrium, thermodynamics and electrochemistry problems.

- Assessment Plan

- Assessment Tool: Departmental exam
- Assessment Date: Winter 2020
- Course section(s)/other population: All sections
- Number students to be assessed: All students
- How the assessment will be scored: Departmental exam multiple choice questions that require problem-solving with calculations will be scored against an answer key.
- Standard of success to be used for this assessment: 70% of the students taking the departmental exam will score 9/13 (69.2%) or higher on these questions.
- Who will score and analyze the data: The full-time chemistry faculty will score the artifacts and analyze the data.

1. Indicate the Semester(s) and year(s) assessment data were collected for this report.

Fall (indicate years below)	Winter (indicate years below)	SP/SU (indicate years below)
	2021	

2. Provide assessment sample size data in the table below.

# of students enrolled	# of students assessed
103	76

3. If the number of students assessed differs from the number of students enrolled, please explain why all enrolled students were not assessed, e.g. absence, withdrawal, or did not complete activity.

The difference between the number of students enrolled in ALL sections and the number of students assessed can be explained by student withdrawals.

4. Describe how students from all populations (day students on campus, DL, MM, evening, extension center sites, etc.) were included in the assessment based on your selection criteria.

All students enrolled in CEM 122 in the Winter 2021 semester were assessed. Four of these sections were 'day' sections, and the fifth section was an 'evening' section. All section were virtual (i.e., both lecture and lab sessions were conducted via Zoom meetings).

5. Describe the process used to assess this outcome. Include a brief description of this tool and how it was scored.

Outcome 2 is assessed using a Final Assessment exam given to all students at the end of the semester. The exam is worth 55 points out of 555 total lecture points. Part B of this test is used to assess Outcome 2. Part B consists of 20 multiple-choice questions that address calculations covering the topics of CEM122: chemical kinetics, chemical equilibrium, acid-base equilibrium, solubility equilibrium, chemical thermodynamics, and electrochemistry. These 20 questions assess the ability of the students to apply the formulas and mathematical procedures learned throughout the semester to solve problems in the topics studied.

6. Briefly describe assessment results based on data collected for this outcome and tool during the course assessment. Discuss the extent to which students achieved this learning outcome and indicate whether the standard of success was met for this outcome and tool.

Met Standard of Success: Yes
All 76 students were included in the Part B analysis. The average score for Part B was 15.5 (77.3%) and the median score was 16 (77.5%). Of the 76 students who took the Final Assessment 58 (76.3%) scored 14/20 (70%) or higher. This is above our desired standard of 75% of the students scoring 70% or higher. The primary factor influencing this outcome is the virtual format of the course. While taking the Final Assessment, students had full access to their notes, the textbook, the internet, and a graphing calculator. None of these resources are available to the students during a face-to-face class.

7. Based on your interpretation of the assessment results, describe the areas of strength in student achievement of this learning outcome.

Parsing the item analysis for Part B of the Final Assessment, the breakdown of questions by topic are as follows: Kinetics = 4, Chemical Equilibrium = 2, Acid-base Equilibrium = 8, Solubility Equilibrium = 1, Thermodynamics = 3, and Electrochemistry = 2. The low number of questions for Solubility Equilibrium is a result of it being a minor topic when compared to the other five. The cumulative percentages, for each topic, of students answering the questions wrong were: Kinetics = 22.7%, Chemical Equilibrium = 20.4%, Acid-base Equilibrium = 18.3%, Solubility Equilibrium = 25.0%, Thermodynamics = 35.1%, and Electrochemistry = 20.4%. All topics, except Thermodynamics, met the 70% standard. A more critical examination of the Part B results revealed only two questions that were answered wrong more >30% of the time. These questions were number 59 (71.0%) and 60 (52.6%). Question 59 was in Thermodynamics, and question 60 was in Acid-base Equilibrium. The low percentage for both questions can be attributed to two factors. First, they were the last two questions on the exam; so, testing fatigue may play a factor. Also, question 60 required a more complicated

calculation. Since ALL questions are only worth 1 point each, students may elect to simply forego its solution. In previous semesters, many students simply choose not to do question 60.

The students strengths that were noticed are:

• Acid-base Equilibrium: students were able to perform all the basic calculations required of this topic. Only one question, number 60, had a percentage wrong over 30, and that question is often left blank by the students.

• For all other topics, students were able to perform the calculations needed.

8. Based on your analysis of student performance, discuss the areas in which student achievement of this learning outcome could be improved. If student met standard of success, you may wish to identify your plans for continuous improvement.

Based on the above analysis, there is one general area where outcomes could be improved. The students seem to have trouble with more complex calculations. These are calculations that involve logarithms, exponents, multiple equations, or a mix of all three.

As discussed in Outcome 1, this may be a result of some students lacking the mathematical skills to perform these more advanced calculations. Providing more opportunities for students to practice these calculations (e.g., more problem sets, homework assignments, and in class practice) may address this issue.

Finally, at the beginning of the semester, more emphasis can be placed on Lab #1. The lab reviews concepts from CEM 111, and introduces calculations that involve logarithms and exponents. Using the results from the graded lab, specific areas that students are having difficulties with could be targeted by additional problem sets. This should help students become comfortable with these calculations and increase their success rate.

Outcome 2: Apply the appropriate concepts or principles of chemistry to solve kinetics, equilibrium, thermodynamics and electrochemistry problems.

- Assessment Plan
  - Assessment Tool: Problem to be solved requiring that calculations be shown
  - Assessment Date: Winter 2020
  - Course section(s)/other population: All sections
  - Number students to be assessed: All students

- How the assessment will be scored: A departmentally-developed rubric will be used to score and evaluate the calculations used to solve the posed problem.
- Standard of success to be used for this assessment: 70% of students will score 7/9 (77.8%) or higher on the scoring rubric.
- Who will score and analyze the data: Full-time chemistry faculty will score and analyze the data.

1. Indicate the Semester(s) and year(s) assessment data were collected for this report.

Fall (indicate years below)	Winter (indicate years below)	SP/SU (indicate years below)
	2021	

2. Provide assessment sample size data in the table below.

# of students enrolled	# of students assessed
103	76

3. If the number of students assessed differs from the number of students enrolled, please explain why all enrolled students were not assessed, e.g. absence, withdrawal, or did not complete activity.

The difference between the number of students enrolled and the number of students taking the Final Assessment can be explained by student withdrawals.

4. Describe how students from all populations (day students on campus, DL, MM, evening, extension center sites, etc.) were included in the assessment based on your selection criteria.

All five CEM 122 section run during the Winter 2021 semester were assessed. All the section were totally virtual (i.e., both lecture and lab sessions were conducted via Zoom meetings). Four of the sections were 'day' sessions, and the fifth section was an 'evening' section.

5. Describe the process used to assess this outcome. Include a brief description of this tool and how it was scored.

Outcome 2 was assessed using Part B of the Final Assessment. This comprised 20 questions that evaluated the students competence is performing calculations relevant to the topics covered in CEM 122.

6. Briefly describe assessment results based on data collected for this outcome and tool during the course assessment. Discuss the extent to which students achieved this

learning outcome and indicate whether the standard of success was met for this outcome and tool.

Met Standard of Success: <u>Yes</u>
Of the 20 questions from the Final Assessment used to evaluate Outcome 2, only two questions were answered wrong by more than 30% of the students. Overall, 77.6% of the students met the metric of scoring more than 70% on Part B of the Final Assessment.

7. Based on your interpretation of the assessment results, describe the areas of strength in student achievement of this learning outcome.

> Parsing the item analysis for Part B of the Final Assessment, the breakdown of questions by topic are as follows: Kinetics = 4, Chemical Equilibrium = 2, Acid-base Equilibrium = 8, Solubility Equilibrium = 1, Thermodynamics = 3, and Electrochemistry = 2. The low number of questions for Solubility Equilibrium is a result of it being a minor topic when compared to the other five. The cumulative percentages, for each topic, of students answering the questions wrong were: Kinetics = 22.7%, Chemical Equilibrium = 20.4%, Acid-base Equilibrium = 18.3%, Solubility Equilibrium = 25.0%, Thermodynamics = 35.1%, and Electrochemistry = 20.4%. All topics, except Thermodynamics, met the 70% standard.
>
> A more critical examination of the Part B results revealed only two questions that were answered wrong more >30% of the time. These questions were number 59 (71.0%) and 60 (52.6%). Question 59 was in Thermodynamics, and question 60 was in Acid-base Equilibrium. The low percentage for both questions can be attributed to two factors. First, they were the last two questions on the exam; so, testing fatigue may play a factor. Also, question 60 required a more complicated calculation. Since ALL questions are only worth 1 point each, students may elect to simply forego its solution. In previous semesters, many students simply choose not to do question 60.
>
> The students strengths that were noticed are:
>
> • Acid-base Equilibrium: students were able to perform all the basic calculations required of this topic. Only one question, number 60, had a percentage wrong over 30, and that question is often left blank by the students.
>
> • For all other topics, students were able to perform the calculations needed.

8. Based on your analysis of student performance, discuss the areas in which student achievement of this learning outcome could be improved. If student met standard of success, you may wish to identify your plans for continuous improvement.

Based on the above analysis, there is one general area where outcomes could be improved. The students seem to have trouble with more complex calculations. These are calculations that involve logarithms, exponents, multiple equations, or a mix of all three. As discussed in Outcome 1, this may be a result of some students lacking the mathematical skills to perform these more advanced calculations. Providing more opportunities for students to practice these calculations (e.g., more problem sets, homework assignments, and in class practice) may address this issue. Finally, at the beginning of the semester, more emphasis can be placed on Lab #1. The lab reviews concepts from CEM 111, and introduces calculations that involve logarithms and exponents. Using the results from the graded lab, specific areas that students are having difficulties with could be targeted by additional problem sets. This should help students become comfortable with these calculations and increase their success rate.

Outcome 3: Demonstrate the science processes of collecting and properly recording data, calculating and analyzing results, and drawing conclusions based on results.

- Assessment Plan
    - Assessment Tool: Lab reports
    - Assessment Date: Winter 2020
    - Course section(s)/other population: All sections
    - Number students to be assessed: All students
    - How the assessment will be scored: Lab reports from a selected experiment will be scored against a departmentally-developed lab report rubric.
    - Standard of success to be used for this assessment: 75% of students will score 7/10 (70%) or higher on the lab report rubric.
    - Who will score and analyze the data: The full-time chemistry faculty will score the artifacts and analyze the data.

1. Indicate the Semester(s) and year(s) assessment data were collected for this report.

Fall (indicate years below)	Winter (indicate years below)	SP/SU (indicate years below)
	2021	

2. Provide assessment sample size data in the table below.

# of students enrolled	# of students assessed

103	80

3. If the number of students assessed differs from the number of students enrolled, please explain why all enrolled students were not assessed, e.g. absence, withdrawal, or did not complete activity.

The difference between the number of students enrolled and the number of students assessed can be explained through student withdrawals.

4. Describe how students from all populations (day students on campus, DL, MM, evening, extension center sites, etc.) were included in the assessment based on your selection criteria.

All students enrolled in the Winter 2021 semester were assessed. Four sections were 'day' sections, and the fifth was an 'evening' section. All sections were in the virtual format (i.e., both lectures and labs were conducted via Zoom meetings).

5. Describe the process used to assess this outcome. Include a brief description of this tool and how it was scored.

Outcome 3 was assessed by the author of this report. The graded lab reports, for all students, were obtained from the individual section instructors. Using a 10-factor rubric, each lab was assessed using the following categories: Partner, Procedure, Proper significant figures (SF) in the pre-lab, Correct units in the pre-lab, Completion of Calculations, Proper SF in the Results, Correct units in the Results, Conclusion, Answer to Question 1, and Answer to all other questions. Each category was given a maximum score of 1. The assessment rubric is the in attached file 'LabAssessmentW21'.

6. Briefly describe assessment results based on data collected for this outcome and tool during the course assessment. Discuss the extent to which students achieved this learning outcome and indicate whether the standard of success was met for this outcome and tool.

Met Standard of Success: Yes
Of the 80 labs assessed 72 (90%) had a score of 7 or greater. This is well above the target for success. The success rate is primarily due to the training the students receive during the semester in writing a proper lab report. Also, due to the virtual nature of the lab portion of the class, students had access to resources they would not have during face-to-face sessions. The lab assessed is the second to last lab of the semester, therefore the students have had ample time to perfect their lab reporting skills. They can summarize procedures, perform all pre-lab calculations, record and tabulate experimental data, using the collected data to perform calculations, formulate conclusions, and answer questions relevant to the concept being demonstrated by the lab experiment.

7. Based on your interpretation of the assessment results, describe the areas of strength in student achievement of this learning outcome.

90% of the students met the metric of scoring 70% or more on the assessment rubric. Therefore, the students have met the learning outcome for performing laboratory procedures, documenting data collection, calculating results from this data, and answering questions pertaining to the overall concept being demonstrated by the lab.

8. Based on your analysis of student performance, discuss the areas in which student achievement of this learning outcome could be improved. If student met standard of success, you may wish to identify your plans for continuous improvement.

Minor deficiencies were noticed. Students still forget the 'small' things (e.g., unit labels, significant figures, etc.). Grading early labs slightly harder for these factors will emphasize their importance to the students and increase their success rate.

III. Course Summary and Intended Changes Based on Assessment Results

1. Based on the previous report's Intended Change(s) identified in Section I above, please discuss how effective the changes were in improving student learning.

A new Final Assessment was used for Outcomes 1 and 2 for this report. The unusual circumstances under which this assessment was assembled (i.e., the virtual mode of the classes), however, have had an effect on the results. For example, during the course of the semester, the author's three sections had exam scores comparable to face-to-face semesters, or slightly higher. The results of the Final Assessment, however, were well above face-to-face semesters. This is likely due to two factors. First, the unit exams generally involved more complicated calculations than could be easily given on an all on-line exam like the Final Assessment. The unit exams also had a written portion. This portion was generally the one that lowered a student's overall exam score. Second, for the Final Assessment, the students had access to their notes, the textbook, a graphing calculator, and the internet, none of which they could use during a face-to-face exam. Therefore, while it is encouraging that all the outcomes for this assessment were met, it must be understood that the unusual nature of the semester in which this assessment was compiled, may have played a role in the overall success.

2. Describe your overall impression of how this course is meeting the needs of students. Did the assessment process bring to light anything about student achievement of learning outcomes that surprised you?

Overall, CEM 122 is meeting the students' needs very well. Since this course is a prerequisite for our organic chemistry course (CEM 211), and many students take this course for that reason, CEM 122 gives them the advanced concepts, and calculations, they'll need to succeed in subsequent chemistry classes. Also, many students take this class as part of their requirements for admission to medical and dental schools, engineering programs, and other STEM related disciplines.

A somewhat interesting result of this assessment, like the previous one, is that, overall, students had more trouble with conceptual problems than they did with calculations. So again, we need to devise a method to clarify and strengthen the presentation of these topics.

3. Describe when and how this information, including the action plan, was or will be shared with Departmental Faculty.

The information contained in this assessment will be shared with the Chemistry faculty at a department meeting to be held in the Fall 2021 semester.

4.

Intended Change(s)

Intended Change	Description of the change	Rationale	Implementation Date
Course Materials (e.g. textbooks, handouts, on-line ancillaries)	Emphasize the more conceptual topics of the course; increase the number of problems covered in lecture for Outcomes 1-3; provide additional problem sets (including opportunities to practice advanced calculations) for students to work through on their own.	Increasing the amount of time and material (in and out of class) will support students' understanding of difficult topics and strengthen their mathematical skills for advanced calculations.	2022
Other: standard of success	Update the standard of success to read "75% of students will score 70% or higher on the outcome-related questions."	Align the standards of success to the assessment tools.	2022

Other: lab grading	Grade early labs more strictly.	To emphasize the importance of the 'small' things, such as unit labels and significant figures.	2022

5. Is there anything that you would like to mention that was not already captured?

None.

III. Attached Files

Final Assessment Stats 2021
Lab Assessment 2021

Faculty/Preparer:	Eric Schwab	**Date:** 08/21/2021
Department Chair:	Tracy Schwab	**Date:** 08/21/2021
Dean:	Victor Vega	**Date:** 08/26/2021
Assessment Committee Chair:	Shawn Deron	**Date:** 11/10/2021

Course Assessment Report
Washtenaw Community College

Discipline	Course Number	Title
Chemistry	122	CEM 122 08/14/2019-General Chemistry II
Division	Department	Faculty Preparer
Math, Science and Engineering Tech	Physical Sciences	Eric Schwab
Date of Last Filed Assessment Report		

I. Review previous assessment reports submitted for this course and provide the following information.

1. Was this course previously assessed and if so, when?

No

2. Briefly describe the results of previous assessment report(s).

3.

4. Briefly describe the Action Plan/Intended Changes from the previous report(s), when and how changes were implemented.

5.

II. Assessment Results per Student Learning Outcome

Outcome 1: Recognize the concepts and principles of general chemistry relating to chemical kinetics, chemical equilibrium, chemical thermodynamics and electrochemistry.

- Assessment Plan
  - Assessment Tool: Departmental Exam
  - Assessment Date: Winter 2012
  - Course section(s)/other population: all
  - Number students to be assessed: all
  - How the assessment will be scored: Departmental Exam questions will be blind-scored against an answer key.

- Standard of success to be used for this assessment: 75% of the students taking the departmental exam will score 70% or higher on the multiple choice questions
- Who will score and analyze the data: The full-time chemistry faculty will score the artifacts and analyze the data.

1. Indicate the Semester(s) and year(s) assessment data were collected for this report.

Fall (indicate years below)	Winter (indicate years below)	SP/SU (indicate years below)
2018	2019	

2. Provide assessment sample size data in the table below.

# of students enrolled	# of students assessed
188	142

3. If the number of students assessed differs from the number of students enrolled, please explain why all enrolled students were not assessed, e.g. absence, withdrawal, or did not complete activity.

All students who attended the last class of the semester were assessed. Data for the Winter 2019 evening class was not included. Multiple attempts were made to obtain the data from the instructor, to no avail.

4. Describe how students from all populations (day students on campus, DL, MM, evening, extension center sites, etc.) were included in the assessment based on your selection criteria.

This course is only taught face-to-face on the main WCC campus. All sections were assessed, which included both day and evening students.

5. Describe the process used to assess this outcome. Include a brief description of this tool and how it was scored.

A final departmental assessment exam is given to the students during the last class period of the semester and is worth 55 points out of 555 total lecture points. Part A of this test is used to assess learning outcome #1. Part A consists of 40 multiple choice questions that address the principles and concepts of the topics studied in CEM 122: chemical kinetics, chemical equilibrium, acid-base equilibrium, solubility equilibrium, chemical thermodynamics and electrochemistry. Five points were used as a bonus.

6. Briefly describe assessment results based on data collected for this outcome and tool during the course assessment. Discuss the extent to which students achieved this

learning outcome and indicate whether the standard of success was met for this outcome and tool.

Met Standard of Success: <u>No</u>
All 142 students were included in the Part A analysis. The average score for Part A was 28.4 (71.1%) and the median score was 29.0 (72.5%). Of the 142 students taking the final assessment 65 (45.8%) scored 30/40 (75%) or higher. This is well below our desired standard of 75% of students scoring 75% or higher. One factor influencing this low percentage is many of our students who end up failing or withdrawing from this course take this final assessment exam. We encourage them to do this, especially if they intend to repeat the course in a future semester. The larger number of students taking the assessment test, who fit this profile, are likely to score poorly and will decrease the percentage of students scoring 75% or higher. All the data for Part A is included in the attached file 'FinalAssessmentStats_2019'.

7. Based on your interpretation of the assessment results, describe the areas of strength in student achievement of this learning outcome.

Looking at the item analysis for Part A, the questions on the final assessment are evenly divided by the topics covered. The question breakdown is as follows: Kinetics = 7, Chemical Equilibrium = 5, Acid-Base Equilibrium = 5, Solubility Equilibrium = 4, Thermodynamics = 10, and Electrochemistry 10. The low number for Solubility Equilibrium is a result of it being a minor topic when compared with the other five topics. The cumulative percentages, for each topic, of students answering the questions wrong were: Kinetics = 16.6%, Chemical Equilibrium = 23.8%, Acid-Base Equilibrium = 32.5%, Solubility Equilibrium = 35.9%, Thermodynamics = 31.1%, and Electrochemistry 34.3%. Only Kinetics (83.4%) and Chemical Equilibrium (76.2%) met the 75% standard. A deeper dive into the low performance on Part A revealed that, there were 17 questions that were answered wrong >30% of the time. These questions were numbers 2 (52.1%), 8 (31.7%), 9 (50.7%), 10 (35.9%), 12, (35.2%), 18 (62.7%), 19 (42.2%), 23 (57.8%), 24 (62%), 27 (39.4%), 28 (33.8%), 29 (45.1%), 31 (55.6%), 33 (30.3%), 35 (30.3%), 37 (59.9%), and 40 (54.2%). One was in Kinetics, 2 in Chemical Equilibrium, 2 in Acid-Base equilibrium, 2 in Solubility Equilibrium, 5 in Thermodynamics, and 5 in Electrochemistry. The low performance on these 17 questions likely contributed to the low percentages on Part A. The CEM122 faculty will review these questions and make changes where we think it is warranted. The strengths in student achievement that we noticed are:

- For Kinetics, students were able to determine the effect on rate from a perturbation (Question# 3, 1.4% wrong), apply collision theory to kinetics (Question# 5, 5.6% wrong), and identify the correct rate equation given a chemical equation (Question # 7, 7.8% wrong).
- For Thermodynamics, students were able to interpret the effect on entropy given a perturbation (Question #22, 7.0% wrong).

8. Based on your analysis of student performance, discuss the areas in which student achievement of this learning outcome could be improved. If student met standard of success, you may wish to identify your plans for continuous improvement.

Based on the above analysis there are several separate, but related areas, where learning outcomes can be improved.

First, some of the questions with the highest percent wrong (e.g., 23, 24, and 31) were conceptual problems. We will continue to emphasize the conceptual nature of the course curriculum and increase the number of homework problems dedicated to these concepts.

Second, overall there was an inability for students to complete calculations correctly. This may have several causes. Students who pass CEM 111 with a C feel they are prepared for CEM 122. The math required for CEM 122, however, is quite a bit more advanced than that needed for CEM 111 (e.g., logs, exponents, quadratics). Students passing CEM 111 with a C may be conceptually ready for CEM 122, but may lack the math skills required. Ensuring that students leaving CEM 111 have the proper math skills for CEM 122 would increase the success rate.

CEM 122 is conceptually more difficult than CEM 111, and the semester builds on previous material. So, if a student falls behind in Chemical Equilibrium, they will not perform well in the following chapters. This is most evident in performing calculations. Falling behind means they will not have learned the mathematical procedures needed for later chapters. We can check on the classes overall mastery of the mathematics by giving short, one problem assignments in class and acting on the results. Offering extra problem sets will also give students more exposure to the types of problems they'll need to master to succeed in CEM 122.

Outcome 2: Apply the appropriate concepts or principles of chemistry to solve kinetics, equilibrium, thermodynamics and electrochemistry problems.

- Assessment Plan

- Assessment Tool: Departmental Exam
- Assessment Date: Winter 2012
- Course section(s)/other population: all
- Number students to be assessed: all
- How the assessment will be scored: Departmental Exam problems will be blind-scored against a problem- solving rubric.
- Standard of success to be used for this assessment: 75% of the students taking the departmental exam will score 70% or higher on the problems
- Who will score and analyze the data: The full-time chemistry faculty will score the artifacts and analyze the data.

1. Indicate the Semester(s) and year(s) assessment data were collected for this report.

Fall (indicate years below)	Winter (indicate years below)	SP/SU (indicate years below)
2018	2019	

2. Provide assessment sample size data in the table below.

# of students enrolled	# of students assessed
188	142

3. If the number of students assessed differs from the number of students enrolled, please explain why all enrolled students were not assessed, e.g. absence, withdrawal, or did not complete activity.

All students in all sections who attended the last class of the semester were assessed. The Winter 2019 (22 students) evening section was not assessed. Multiple requests for the data were made to the instructor, but no response was received.

4. Describe how students from all populations (day students on campus, DL, MM, evening, extension center sites, etc.) were included in the assessment based on your selection criteria.

This course is only taught face-to-face on the main WCC campus. All sections were assessed, which included both day and evening students. The Winter 2019 evening section was not assessed. Multiple requests for the data were made to the instructor, but no response was received.

5. Describe the process used to assess this outcome. Include a brief description of this tool and how it was scored.

A final departmental assessment exam is given to our students during the last class period of the semester and is worth 55 points out of 555 total lecture points. Part B of this test is used to assess learning outcome #2. Part B consists of 19 multiple choice questions and one short answer question that address the principles and concepts of the topics studied in CEM 122: chemical kinetics, chemical equilibrium, acid-base equilibrium, solubility equilibrium, chemical thermodynamics and electrochemistry. These 19 questions assess the abilities of the students to apply the formulas and mathematical procedures learned throughout the semester to solve problems in the topics studied.

6. Briefly describe assessment results based on data collected for this outcome and tool during the course assessment. Discuss the extent to which students achieved this learning outcome and indicate whether the standard of success was met for this outcome and tool.

Met Standard of Success: <u>No</u>
All 142 students were included in the Part B analysis. The average score for Part B was 15.2 (75.8%) and the median score was 16.0 (80.0%). Of the 142 students taking the final assessment 95 (66.9%) scored 15/20 (75%) or higher. This is below our desired standard of 75% of students scoring 75% or higher. One factor influencing this low percentage is that many of our students, who end up failing or withdrawing from this course, still take the final assessment exam. We actually encourage them to do so, especially if they intend to repeat the course in a future semester. Therefore, the larger number of students taking the assessment test who are likely to score poorly will decrease the percentage of students scoring 75% or higher. If we were to use the common standard of success of 70% of students will score 70% or higher, we would again fall slightly below this standard since 106/142 (74.6%) scored 14/20 (70%) or higher. We do observe a slight bimodal distribution of test scores throughout the semester. There is a small group of students who knows the material and earns high test scores, but also a group of students who has not mastered the material and score rather low on tests. It seems students either know the material well (A's and high B's), or not much at all (low C's and below). There are not many students in between. We also observed that 77/142 (54.2%) students scored 16/20 (80%) or higher on Part B of the assessment exam and that 60/142 (42.2%) scored 17/20 (85%) or higher. This reinforces our sense that the group of students who has learned the course material has retained the information since they perform well on the cumulative final assessment exam. These students are also able to able this knowledge to solving representative problems covering the course material.

All the data for the Part B analysis is in the attached file 'FinalAssessmentStats_2019'.

Question #20 is a short answer problem in which the students must show all their work. This is designed to assess the students proficiency in applying the correct mathematical procedure when solving an acid-base equilibrium problem. The question is scored with a 10-factor rubric (see attached file 'CEM122_2019_Assessment_Problem60'). Of the 142 final assessments, data for problem 60 was available for only 95 students. For Fall 2018, Section 03 we only received a summary of the final assessment data, and for the Winter 2019, Section 04 we did not receive any final assessment data.

Of the 95 students for which we have data, 69 scored above 7.5 on the rubric for a percentage of 72.6, which is slightly below the target of 75%. Since each question on the final assessment is worth one point, some students do not complete question 60. Of the 95 students who took the final assessment, 11 left question 60 blank. This means that 69/84 (82.1%) scored above 7.5 on the rubric, which is above the 75% target.

7. Based on your interpretation of the assessment results, describe the areas of strength in student achievement of this learning outcome.

Looking at the item analysis for Part B, the questions on the final assessment are evenly divided by the topics covered. The question breakdown is as follows: Kinetics = 4, Chemical Equilibrium = 2, Acid-Base Equilibrium = 8, Solubility Equilibrium = 1, Thermodynamics = 3, and Electrochemistry = 2. The low number for Solubility Equilibrium is a result of it being a minor topic when compared with the other five topics. The cumulative percentages, for each topic, of students answering the questions wrong were: Kinetics = 29.6%, Chemical Equilibrium = 18.3%, Acid-Base Equilibrium = 18.3%, Solubility Equilibrium = 52.1%, Thermodynamics = 26.5%, and Electrochemistry 27.1%. Only Chemical Equilibrium (81.7%), Acid-base Equilibrium (81.7%) met the 75% standard.

A deeper dive into the low performance on Part B revealed that, there were four questions that were answered wrong >30% of the time. These questions were numbers 43 (36.6%), 46 (52.1%), 59 (43.7%), and 60 (43.7%). One was in Kinetics, 1 in Acid-Base equilibrium, 1 in Solubility Equilibrium, and 1 in Thermodynamics. The low performance on these four questions may have contributed to the low percentages on Part B. The CEM122 faculty will review these questions and make changes where we think it is warranted.

The strengths in student achievement that we noticed are:

- For Acid-base Equilibrium, students were able to perform all the basic calculations required of this topic. Only one question (#60) had a %wrong metric over 30, and that question is often left blank by students.
- For Chemical Equilibrium, students were able to determine equilibrium constants from data that was provided.
- For Electrochemistry, students were able to perform the calculations required of this topic.

8. Based on your analysis of student performance, discuss the areas in which student achievement of this learning outcome could be improved. If student met standard of success, you may wish to identify your plans for continuous improvement.

Based on the above analysis there is one major area where outcomes can be improved. This applies to all topics. The students seem to have trouble with more complex calculations. These almost always involve the use of Equilibrium Tables to determine either equilibrium concentrations or constants from data provided. The high errors on questions 46 (Ksp) and 60 (pH) demonstrate this inability.

As discussed in Outcome #1 this may be a result of some students lacking the math skills to perform these calculations. Providing more homework assignments and extra problems from secondary sources may address this issue. We have noticed, however, that students don't always take advantage of these additional resources.

A stronger emphasis can also be placed on Lab #1. This is essentially a review lab that takes the students through all the mathematical skills they will need for CEM 122. After this lab is graded, we could target specific areas (e.g., calculations with logarithms) that students are having trouble with. This may increase the success rate.

Outcome 3: Perform laboratory procedures that apply best chemical practices for making measurements, recording data, calculating results and drawing conclusions.

- Assessment Plan
    - Assessment Tool: Sample lab reports
    - Assessment Date: Winter 2012
    - Course section(s)/other population: all
    - Number students to be assessed: random sample of 25%
    - How the assessment will be scored: Lab reports will be blind-scored against a lab report rubric.

- Standard of success to be used for this assessment: 75% of the sample lab reports will have a score of 7 (out of possible 10) or higher
- Who will score and analyze the data: The full-time chemistry faculty will score the artifacts and analyze the data.

1. Indicate the Semester(s) and year(s) assessment data were collected for this report.

Fall (indicate years below)	Winter (indicate years below)	SP/SU (indicate years below)
2018	2019	

2. Provide assessment sample size data in the table below.

# of students enrolled	# of students assessed
188	142

3. If the number of students assessed differs from the number of students enrolled, please explain why all enrolled students were not assessed, e.g. absence, withdrawal, or did not complete activity.

We were not able to obtain the laboratory reports for the Winter 2019 evening section after several requests. Also, a total of 93 lab reports were assessed. Accounting for the 23 from the Winter 2019 evening section, this leaves 16 lab reports not assessed. This number is most likely due to two causes. First, students who are retaking CEM122 do not have to repeat the lab experiments; their grades can be transferred from a previous semester. Second, students know they can miss up to three lab sessions without it severely impacting their final grade. Students have been known to selectively miss labs toward the end of the semester when they know their overall grade (for better or worse) will be unaffected by attending the lab session.

4. Describe how students from all populations (day students on campus, DL, MM, evening, extension center sites, etc.) were included in the assessment based on your selection criteria.

All students in all sections were included in the assessment, with the exceptions noted above.

5. Describe the process used to assess this outcome. Include a brief description of this tool and how it was scored.

To assess this outcome, the author of this report received the graded lab reports from the individual instructors. Using a 10-factor rubric, each lab was assessed using the following categories: Partner, Procedure, Proper significant figures (SF) in the pre-lab, Correct Units in the pre-lab, Completion of Calculations, Proper SF

in the results, Correct Units in the results, Conclusion, Answer to Question 1, Answer to all other questions. Each category could receive a maximum score of 1.

The assessment rubric is in the attached file 'LabAssessment_2019'.

6. Briefly describe assessment results based on data collected for this outcome and tool during the course assessment. Discuss the extent to which students achieved this learning outcome and indicate whether the standard of success was met for this outcome and tool.

Met Standard of Success: Yes
Of the 93 labs assessed 86 (92.5%) has a score of 7 or greater. This is well above the 75% target for success. The success rate is primarily due to the training the students receive during the semester in writing a proper lab report. The lab assessed is the second to last lab of the semester, and by this time, most students have learned the proper method for writing a lab report. They can summarize the procedure, perform any pre-lab calculations (e.g. standard curve concentrations), record and tabulate the experimental data, perform calculations with the collected data, tabulate the results, state their conclusion, and answer questions relevant to the concept being demonstrated by the lab experiment.

7. Based on your interpretation of the assessment results, describe the areas of strength in student achievement of this learning outcome.

Based on the analysis of the assessment data, the students have met the learning outcome for performing laboratory procedures, documenting their data collection, calculating results from this data, and answering questions pertaining to the overall concept being demonstrated by the lab.

8. Based on your analysis of student performance, discuss the areas in which student achievement of this learning outcome could be improved. If student met standard of success, you may wish to identify your plans for continuous improvement.

While minor, students still forget the 'small' things (e.g, unit labels, and significant figures). Grading early labs slightly harder for these factors will emphasize their importance to the students, and increase the success rate.

III. Course Summary and Intended Changes Based on Assessment Results

1. Based on the previous report's Intended Change(s) identified in Section I above, please discuss how effective the changes were in improving student learning.

Since the last assessment the tool used for outcomes 1 & 2 was changed. The Final Assessment was essentially rewritten. Part of the rewrite was at the suggestion of the Assessment Committee. The former final assessment did not allow a clear 75%

metric to be met for either Part A or Part B. The new final assessment accomplishes this with 40 questions in Part A and twenty questions in Part B. Also, based on the last assessment, several questions from the former tool were re-evaluated and found to be confusing. The new tool was rewritten so Part A contains primarily conceptual questions, with minor calculations. Part B contains more involved calculations, and digs deeper into the students understanding of the mathematical processes need to solve problems in CEM122.

2. Describe your overall impression of how this course is meeting the needs of students. Did the assessment process bring to light anything about student achievement of learning outcomes that surprised you?

CEM 122 seems to be meeting the needs of our students very well. This course is a pre-requisite for our organic chemistry course, CEM 211, and many students take this course for that reason. In addition, we have many students taking this course in preparation for admission to professional graduate programs like medical school, dental school, pharmacy school and physician assistant programs. Also, a number of U of M engineering students come to WCC to take CEM 122.

The major surprise from the item analysis of the final assessment was that the questions with the largest %wrong metric dealt were conceptual questions. For example, question 18 (62.7% wrong) asked the students to predict the pH of a solution given the formula of a salt. Likewise, question 24 (62% wrong) asked the students to predict a reactions spontaneity based on the 2nd Law of Thermodynamics. Therefore, it seems we need to put more emphasis on the conceptual framework that governs the topics in CEM122.

3. Describe when and how this information, including the action plan, was or will be shared with Departmental Faculty.

The information contained in this assessment and the action plan will be shared with the chemistry faculty at a faculty meeting held in the Fall 2019 semester.

4.

Intended Change(s)

Intended Change	Description of the change	Rationale	Implementation Date
Assessment Tool	A review will be taken of the Final Assessment used as the tool for Outcomes 1 and 2.	The review will identify potential confusing language that may lead to the low success rates on certain questions.	2020
Other: Lab #1 Review	Place a stronger emphasis on Lab	Reviewing the results of this lab	2020

	#1, which is a lab that reviews all mathematical skills needed for CEM 122. Based on the results of Lab #1, suggestions will be given to students on how to improve their weaker math skills.	can identify specific areas that could be targeted to increase student success.	
Other: Grading standard for early labs	Increase grading standard for early labs.	Grading early labs slightly harder for the "small" things (e.g. unit labels and significant figures) will emphasize their importance to the students and increase the success rate.	2020

5. Is there anything that you would like to mention that was not already captured?

N/A

III. Attached Files

Problem 60 Assessment
Lab Assessment 2019
Final Assessment Stats 2019

Faculty/Preparer:	Eric Schwab	**Date:** 08/18/2019
Department Chair:	Suzanne Albach	**Date:** 08/18/2019
Dean:	Victor Vega	**Date:** 09/26/2019
Assessment Committee Chair:	Shawn Deron	**Date:** 11/11/2019

Course Assessment Report
Washtenaw Community College

Discipline	Course Number	Title
Chemistry	122	CEM 122 06/13/2016-General Chemistry II
Division	Department	Faculty Preparer
Math, Science and Engineering Tech	Physical Sciences	Rosemary Rader
Date of Last Filed Assessment Report		

I. Assessment Results per Student Learning Outcome

Outcome 1: Recognize the concepts and principles of general chemistry relating to chemical kinetics, chemical equilibrium, chemical thermodynamics and electrochemistry.

- Assessment Plan
    - Assessment Tool: Departmental Exam
    - Assessment Date: Fall 2014
    - Course section(s)/other population: all
    - Number students to be assessed: all
    - How the assessment will be scored: Departmental Exam multiple choice questions will be scored against an answer key.
    - Standard of success to be used for this assessment: 75% of the students taking the departmental exam will score 75% or higher on the multiple choice questions.
    - Who will score and analyze the data: The full-time chemistry faculty will score the artifacts and analyze the data.

1. Indicate the Semester(s) and year(s) assessment data were collected for this report.

Fall (indicate years below)	Winter (indicate years below)	SP/SU (indicate years below)
2015	2016, 2015	

2. Provide assessment sample size data in the table below.

# of students enrolled	# of students assessed
258	221

3. If the number of students assessed differs from the number of students enrolled, please explain why all enrolled students were not assessed, e.g. absence, withdrawal, or did not complete activity.

All students in all sections who attended the last class of the semester were assessed.

4. Describe how students from all populations (day students on campus, DL, MM, evening, extension center sites, etc.) were included in the assessment based on your selection criteria.

This course is only taught face-to-face on the main WCC campus. All sections were assessed, which included both day and evening students.

5. Describe the process used to assess this outcome. Include a brief description of this tool and how it was scored.

A final departmental assessment exam is given to our students during the last class period of the semester and is worth 50 points out of 625 total lecture points. Part A of this test is used to assess learning outcome #1. Part A consists of 41 multiple choice questions that address the principles and concepts of the topics studied in CEM 122: chemical kinetics, chemical equilibrium, chemical thermodynamics and electrochemistry.

6. Briefly describe assessment results based on data collected for this outcome and tool during the course assessment. Discuss the extent to which students achieved this learning outcome and indicate whether the standard of success was met for this outcome and tool.

Met Standard of Success: <u>No</u>
One student score on Part A of our departmental exam could not be included in our analysis due to a data entry error that showed a score of 45, when the maximum is only 41. This left 220 student scores in our data set. Both the average score and the median score on Part A were 31.0 (75.6%). However, of these students, only 126/220 (57.3%) scored 31/41 (75.6%) or higher. This is well below our desired standard of 75% of student score 75% or higher. One of the factors that influences this low percentage is the fact that many of our students who end up failing or withdrawing from this course still take this final assessment exam. In fact, we encourage them to do so, especially if they intend to repeat the course in a future semester. The larger number of students taking the assessment test who are likely to score poorly will decrease the percentage of students scoring 75% or higher.

If we were to use the common standard of success of 70% of students will score 70% or higher, we would fall just below this standard since 149/220 (67.7%) scored 29/41 (70.7%) or higher. We do observe a bimodal distribution of test scores throughout the semester. There is a group of students who knows the material and earns high test scores, but also a group of students who has not mastered the material and scores rather low on tests. It seems students either know the material well (A's and high B's), or not much at all (low C's and below). There are not many students in between.

On a positive note, we are pleased to observe that 95/220 (43.2%) students scored 33/41 (80.5%) or higher on Part A of the assessment exam and that 71/220 (32.3%) scored 35/41 (85.4%) or higher. This reinforces our sense that the group of students who has learned the course material has really retained the information since they perform well on the cumulative final assessment exam.

7. Based on your interpretation of the assessment results, describe the areas of strength in student achievement of this learning outcome.

Based on an item analysis, 8 of the 41 questions (3, 4, 5, 7, 13, 16, 23, 40) on Part A of the final assessment exam were missed by 10% or less of the 220 students taking the test. Four of these questions related to the subject of kinetics. Students were very successful at identifying the criteria required for effective collisions to occur and the factors that influence rates of chemical reactions. Two of the eight questions related to chemical equilibrium and showed that students were able to identify correct equilibrium constant expressions and to correctly interpret how the value of an equilibrium constant influences the composition of an equilibrium mixture. The remaining two questions showed that students were able to determine if entropy increases or decreases during given chemical or physical changes, and were able to determine the oxidation number of an element in a compound.

8. Based on your analysis of student performance, discuss the areas in which student achievement of this learning outcome could be improved. If student met standard of success, you may wish to identify your plans for continuous improvement.

Based on an item analysis, 14 of the 41 questions (2, 6, 8, 9, 10, 18, 22, 24, 25, 29, 33, 34, 36, 41) on Part A of the final assessment exam were missed by 30% or more of the 220 students taking the test. Of the 14, three were missed by more than 50% of the class. These questions are always difficult for students. One (#18) is related to salt hydrolysis, the second (#36) involves interpreting the Nernst equation to determine how an electrochemical cell potential will change as reactant concentration changes, and the third (#22) asks students to predict the shift in a solubility equilibrium when strong acid is added. We may want to consider modifying this third question. This question asks how the equilibrium dissolution reaction for AgCl will shift when a "strong acid" is added. The correct answer is that there will be no shift, but if students think of HCl, our most common strong acid, when answering the question, they may consider the chloride ion that is also added and answer that the equilibrium will shift to the left. The question could be re-worded to specify either "If the strong acid HNO_3 is added, which of the following will occur?", or "If the pH of the system is lowered, which of the following will occur?"

Other frequently missed questions involve the following:

1. Determination of rate law from rate data
2. Predicting shifts in equilibrium for changes other than a simple change in concentration of reactant or product
3. Correctly identifying the signs of thermodynamic variables ΔG, ΔH, and ΔS for given processes as well as when a reaction is spontaneous or at equilibrium
4. Identifying the strongest reducing agent in a given list and identifying the reducing agent in a given reaction

The most frequently missed questions continue to be those that require thinking through a number of steps to arrive at the correct answer. We will continue to incorporate more practice answering these types of questions both during lecture class and on the on-line homework assignments.

Outcome 2: Apply the appropriate concepts or principles of chemistry to solve kinetics, equilibrium, thermodynamics and electrochemistry problems.

- Assessment Plan
  - Assessment Tool: Departmental Exam
  - Assessment Date: Fall 2014
  - Course section(s)/other population: all
  - Number students to be assessed: all
  - How the assessment will be scored: Departmental Exam multiple choice questions that require problem-solving with calculations will be scored against an answer key.
  - Standard of success to be used for this assessment: 75% of the students taking the departmental exam will score 75% or higher on these questions,
  - Who will score and analyze the data: The full-time chemistry faculty will score the artifacts and analyze the data.

1. Indicate the Semester(s) and year(s) assessment data were collected for this report.

Fall (indicate years below)	Winter (indicate years below)	SP/SU (indicate years below)
2015	2015, 2016	

2. Provide assessment sample size data in the table below.

# of students enrolled	# of students assessed
258	221

3. If the number of students assessed differs from the number of students enrolled, please explain why all enrolled students were not assessed, e.g. absence, withdrawal, or did not complete activity.

All students in all sections who attended the last class of the semester were assessed.

4. Describe how students from all populations (day students on campus, DL, MM, evening, extension center sites, etc.) were included in the assessment based on your selection criteria.

This course is only taught face-to-face on the main WCC campus. All sections were assessed, which included both day and evening students.

5. Describe the process used to assess this outcome. Include a brief description of this tool and how it was scored.

A final departmental assessment exam is given to our students during the last class period of the semester and is worth 50 points out of 625 total lecture points. Part B of this test is used to assess learning outcome #2. It has a total of 13 questions that require calculations in which students must apply the appropriate concepts or principles of chemistry to solve kinetics, equilibrium, thermodynamics and electrochemistry problems. Of the 13 questions, the first 12 are multiple choice. For the final question, however, students must work out an answer to the posed question, showing all of their work.

6. Briefly describe assessment results based on data collected for this outcome and tool during the course assessment. Discuss the extent to which students achieved this learning outcome and indicate whether the standard of success was met for this outcome and tool.

Met Standard of Success: No
Our students generally score much higher on the problem-solving questions than on the conceptual questions, a trend that continues here. One student score on Part B of our departmental exam could not be included in our analysis due to a data entry error that showed a score of 35, when the maximum is only 13. This left 220

student scores in our data set. The average score on Part B was 10.4 (80.0%) and the median score was 11 (84.6%).

Of the 220 students taking the test, 161 (73.2%) scored 10/13 (76.9%) or higher. This is slightly below our desired standard of 75% of student score 75% or higher.

To achieve a 75% on this outcome, students would have to score 9.75/13, which is not possible since all scores are whole numbers, so we have rounded up to counting the number of students who scored 10/13 or higher. If we used 9/13 (69.2%) or higher as our criterion, then 181/220 (82.3%) would have scored at this level and we would have more than met this standard of success.

One of the factors that influences this lower percentage is the fact that many of our students who end up failing or withdrawing from this course still take this final assessment test. In fact, we encourage them to do so, especially if they intend to repeat the course in a future semester. The larger number of students taking the assessment test who are likely to score poorly will decrease the percentage of students scoring 75% or higher.

We are very pleased that 125/220 (56.8%) students scored 11/13 (84.6%) or higher on Part B of the assessment test.

7. Based on your interpretation of the assessment results, describe the areas of strength in student achievement of this learning outcome.

An item analysis showed there were 4 of 13 Part B questions that were missed by less than 10% of the students, #49, #47, #50, and #48. Students were able to correctly convert between pH and hydronium ion concentration, between hydronium ion concentration and hydroxide concentration, and between NaOH concentration and pH which involved several steps, including recognizing that NaOH is a strong base. Students were also able to use equilibrium concentrations of reactants and products for a given chemical reaction to calculate the value of the equilibrium constant for the reaction.

Students performed reasonably well on questions #51 (missed by 16.7%), #52 (missed by 16.7%), and #53 (missed by 15.4%). These were calculations involving thermodynamics and electrochemistry, topics which were studied at the end of the semester.

Our item analysis also showed that questions #42-#45, related to chemical kinetics, were missed by 24-29% of our students. This is not surprising since kinetics was studied at the beginning of the semester. We are pleased to note that 70-75% of our students could still solve these problems even though they had not been discussed since the first four weeks of the course.

Item analysis showed that 25.8% of our students missed the very last question, #54. This is the question that was not multiple choice. We are pleased that nearly three-quarters of our students could correctly work out the answer to this multi-step problem. We note that since a 9-point scoring rubric is used to score student work on this problem, it is not possible for students to actually score 75% (6.75/9). We observed that 168/218 (77.1%) of our students scored 6/9 (66.7%) on the evaluation of their work.

The strengths in student achievement that we noticed are:

- Of the 57 students who did not calculate a correct numerical answer to question #54, only 19 of these students actually scored zero points on the scoring rubric indicating that they had no idea how to solve the problem.
- Two-thirds of our students who did not arrive at a correct mathematical solution were still able to perform part of the necessary process to determine the answer.
- Overall 87% of the students who showed their work on the last problem correctly recognized the problem as being a weak acid equilibrium problem.
- Of the students who showed their work, 76-81% of them were able to write the proper chemical reaction, set up a correct equilibrium table, and express the equilibrium constant expression correctly in terms of the unknown "x" to solve for pH.
- Finally, 74% of our students made a correct assumption that simplified the mathematics and allowed a solution to be calculated without having to use the quadratic equation.

8. Based on your analysis of student performance, discuss the areas in which student achievement of this learning outcome could be improved. If student met standard of success, you may wish to identify your plans for continuous improvement.

Item analysis showed that 53.8% of our students missed question #46. This is a solubility equilibrium problem and is clearly challenging. It involves a number of steps, including writing a correct equilibrium reaction.

We will continue to spend time in our Lab #1 review of chemical concepts and in lecture practicing how to correctly write dissociation reactions and reviewing the relationships between anion and cation concentrations, as well as writing the correct equilibrium constant expressions. We can also add extra practice to our on-line homework assignments. Dissociation reactions are first discussed in the pre-requisite course, CEM 111, so we will also reiterate to our CEM 111 instructors the importance of these reactions and suggest that more emphasis and practice be given in CEM 111 as well.

As we review the student performance on working out problem #54, item analysis of the scoring rubric showed that 29.4% of our students showed the incorrect number of significant figures in their numerical answer. Significant figures has always been a challenging topic for our chemistry students, but in particular in this course students have been introduced to showing correct significant figures for logarithmic quantities (such as pH) which follow different rules from regular decimal numbers. We will continue to emphasize this topic during our Lab #1 review and in lecture when we work with logarithmic quantities. We can also assign additional on-line homework problems to practice using correct significant figures.

Additionally, the item analysis of the scoring rubric used to evaluate the student performance on solving problem #54, showed that 41.7% of our students failed to check the validity of the assumption they made to simplify the mathematics needed to solve the equation without using the quadratic equation. This is disappointing since we emphasis the importance of doing this as part of these calculations. We will continue to emphasize and practice this during our study of equilibrium. We can also assign additional homework problems in which students must detail all steps of the equilibrium problem-solving process.

Outcome 2: Apply the appropriate concepts or principles of chemistry to solve kinetics, equilibrium, thermodynamics and electrochemistry problems.

- Assessment Plan
  - Assessment Tool: Problem to be solved requiring that calculations be shown.
  - Assessment Date: Fall 2014
  - Course section(s)/other population: All sections
  - Number students to be assessed: All students
  - How the assessment will be scored: A departmentally-developed rubric will be used to score and evaluate the calculations used to solve the posed problem.
  - Standard of success to be used for this assessment: 75% of students will score 75% or higher on the scoring rubric.
  - Who will score and analyze the data: Full time chemistry faculty will score and analyze the data.

1. Indicate the Semester(s) and year(s) assessment data were collected for this report.

Fall (indicate years below)	Winter (indicate years below)	SP/SU (indicate years below)
2015	2016, 2015	

2. Provide assessment sample size data in the table below.

# of students enrolled	# of students assessed
258	221

3. If the number of students assessed differs from the number of students enrolled, please explain why all enrolled students were not assessed, e.g. absence, withdrawal, or did not complete activity.

All students in all sections who attended the last class of the semester were assessed.

4. Describe how students from all populations (day students on campus, DL, MM, evening, extension center sites, etc.) were included in the assessment based on your selection criteria.

This course is only taught face-to-face on the main WCC campus. All sections were assessed, which included both day and evening students.

5. Describe the process used to assess this outcome. Include a brief description of this tool and how it was scored.

A final departmental assessment exam is given to our students during the last class period of the semester and is worth 50 points out of 625 total lecture points. Part B of this test is used to assess learning outcome #2. It has a total of 13 questions that require calculations in which students must apply the appropriate concepts or principles of chemistry to solve kinetics, equilibrium, thermodynamics and electrochemistry problems. Of the 13 questions, the first 12 are multiple choice. For the final question, however, students must work out an answer to the posed question and show all of their work on the back of the answer sheet. The student work is evaluated for the completeness of the problem-solving process used, as well as for the correctness of the answer, using a scoring rubric.

6. Briefly describe assessment results based on data collected for this outcome and tool during the course assessment. Discuss the extent to which students achieved this learning outcome and indicate whether the standard of success was met for this outcome and tool.

Met Standard of Success: No

Of the 221 students assessed, there were 3 students who answered question #54 correctly, but failed to show their work on the back of the answer sheet. The remaining 218 students had their work on problem #54 evaluated using a nine point scoring rubric. The results showed that 158/218 (72.5%) students scored 7/9 (77.8%) or higher on this evaluation of their problem-solving process so the standard of success was not met.

7. Based on your interpretation of the assessment results, describe the areas of strength in student achievement of this learning outcome.

An item analysis showed there were 4 of 13 Part B questions that were missed by less than 10% of the students, #49, #47, #50, and #48. Students were able to correctly convert between pH and hydronium ion concentration, between hydronium ion concentration and hydroxide concentration, and between NaOH concentration and pH which involved several steps, including recognizing that NaOH is a strong base. Students were also able to use equilibrium concentrations of reactants and products for a given chemical reaction to calculate the value of the equilibrium constant for the reaction.

Students performed reasonably well on questions #51 (missed by 16.7%), #52 (missed by 16.7%), and #53 (missed by 15.4%). These were calculations involving thermodynamics and electrochemistry, topics which were studied at the end of the semester.

Our item analysis also showed that questions #42-#45, related to chemical kinetics, were missed by 24-29% of our students. This is not surprising since kinetics was studied at the beginning of the semester. We are pleased to note that 70-75% of our students could still solve these problems even though they had not been discussed since the first four weeks of the course.

Item analysis showed that 25.8% of our students missed the very last question, #54. This is the question that was not multiple choice. We are pleased that nearly three-quarters of our students could correctly work out the answer to this multi-step problem. We note that since a 9-point scoring rubric is used to score student work on this problem, it is not possible for students to actually score 75% (6.75/9). We observed that 168/218 (77.1%) of our students scored 6/9 (66.7%) on the evaluation of their work.

The strengths in student achievement that we noticed are:

- Of the 57 students who did not calculate a correct numerical answer to question #54, only 19 of these students actually scored zero points on the scoring rubric indicating that they had no idea how to solve the problem.

- Two-thirds of our students who did not arrive at a correct mathematical solution were still able to perform part of the necessary process to determine the answer.
- Overall 87% of the students who showed their work on the last problem correctly recognized the problem as being a weak acid equilibrium problem.
- Of the students who showed their work, 76-81% of them were able to write the proper chemical reaction, set up a correct equilibrium table, and express the equilibrium constant expression correctly in terms of the unknown "x" to solve for pH.
- Finally, 74% of our students made a correct assumption that simplified the mathematics and allowed a solution to be calculated without having to use the quadratic equation.

8. Based on your analysis of student performance, discuss the areas in which student achievement of this learning outcome could be improved. If student met standard of success, you may wish to identify your plans for continuous improvement.

Item analysis showed that 53.8% of our students missed question #46. This is a solubility equilibrium problem and is clearly challenging. It involves a number of steps, including writing a correct equilibrium reaction.

We will continue to spend time in our Lab #1 review of chemical concepts and in lecture practicing how to correctly write dissociation reactions and reviewing the relationships between anion and cation concentrations, as well as writing the correct equilibrium constant expressions. We can also add extra practice to our on-line homework assignments. Dissociation reactions are first discussed in the pre-requisite course, CEM 111, so we will also reiterate to our CEM 111 instructors the importance of these reactions and suggest that more emphasis and practice be given in CEM 111 as well.

As we review the student performance on working out problem #54, item analysis of the scoring rubric showed that 29.4% of our students showed the incorrect number of significant figures in their numerical answer. Significant figures has always been a challenging topic for our chemistry students, but in particular in this course students have been introduced to showing correct significant figures for logarithmic quantities (such as pH) which follow different rules from regular decimal numbers. We will continue to emphasize this topic during our Lab #1 review and in lecture when we work with logarithmic quantities. We can also assign additional on-line homework problems to practice using correct significant figures.

Additionally, the item analysis of the scoring rubric used to evaluate the student performance on solving problem #54, showed that 41.7% of our students failed to

check the validity of the assumption they made to simplify the mathematics needed to solve the equation without using the quadratic equation. This is disappointing since we emphasis the importance of doing this as part of these calculations. We will continue to emphasize and practice this during our study of equilibrium. We can also assign additional homework problems in which students must detail all steps of the equilibrium problem-solving process.

Outcome 3: Demonstrate the science processes of collecting and properly recording data, calculating and analyzing results, and drawing conclusions based on results.

- Assessment Plan
  - Assessment Tool: Lab Reports
  - Assessment Date: Fall 2014
  - Course section(s)/other population: All
  - Number students to be assessed: All
  - How the assessment will be scored: Lab reports from a selected experiment will be scored against a departmentally-developed lab report rubric.
  - Standard of success to be used for this assessment: 75% of students will score 7 out of 10 or higher on the lab report.
  - Who will score and analyze the data: The full-time chemistry faculty will score the artifacts and analyze the data.

1. Indicate the Semester(s) and year(s) assessment data were collected for this report.

Fall (indicate years below)	Winter (indicate years below)	SP/SU (indicate years below)
2015	2016, 2015	

2. Provide assessment sample size data in the table below.

# of students enrolled	# of students assessed
258	221

3. If the number of students assessed differs from the number of students enrolled, please explain why all enrolled students were not assessed, e.g. absence, withdrawal, or did not complete activity.

All students in all sections who attended the "Thermochemistry" lab during week 13 of the semester and submitted lab reports were assessed.

4. Describe how students from all populations (day students on campus, DL, MM, evening, extension center sites, etc.) were included in the assessment based on your selection criteria.

This course is only taught face-to-face on campus. All sections were assessed, which included both day and evening students.

5. Describe the process used to assess this outcome. Include a brief description of this tool and how it was scored.

The lab reports for the "Thermochemistry" lab session that ran during week 13 of the semester were collected at the beginning of the week 14 lab session and graded. A lab report scoring rubric was used to evaluate how well students followed the science processes of collecting and properly recording data, calculating and analyzing results, and drawing conclusions based on results, as well as answering a number of related questions.

6. Briefly describe assessment results based on data collected for this outcome and tool during the course assessment. Discuss the extent to which students achieved this learning outcome and indicate whether the standard of success was met for this outcome and tool.

Met Standard of Success: <u>Yes</u>
There were 189 lab reports submitted for the "Thermochemistry" lab that ran during week 13 that were evaluated using a 10-point scoring rubric. Of these, 171/189 (90.5%) scored 7 points or higher out of a possible ten points, which very definitely met the standard of success.

7. Based on your interpretation of the assessment results, describe the areas of strength in student achievement of this learning outcome.

Based on an item analysis of the scoring rubric used to evaluate student lab reports, we find that our students did well in collecting and properly recording data with correct significant figures (95.2% correct) and proper units (92.1% correct), as well as drawing proper conclusions (91.5% correct). They also performed well in showing proper units on their results (93.7% correct). In addition, 98.9% of student showed proper headings in their lab reports and 92.6% recorded the name of their lab partner. We also observed that 76.7% of our students correctly answered question #1 on the lab report, which asked them to predict the effects of a given experimental error on the data collected and how this error would affect their experimental results.

8. Based on your analysis of student performance, discuss the areas in which student achievement of this learning outcome could be improved. If student met standard of success, you may wish to identify your plans for continuous improvement.

The item analysis of the scoring rubric used to evaluate student lab reports showed that while 95.2% of students reported measured data to the correct number of significant figures, only 76.7% of them used correct significant figures when reporting their experimental results. They have more difficulty determining the correct number of significant figures for calculated values. We do discuss this in our Lab #1 review but need to continue to emphasize the rules for determining significant figures for calculated answers.

We also note that only 67.7% of students correctly answered most of questions 2-6. We would like to see this number increase. Some students still struggle with identifying the driving forces operating in the three chemical processes investigated in this lab session. This is discussed in lecture but we can include more examples in the future.

The weakest area in the lab report is the calculations. In the Winter 2015 semester we find that 16/77 students (20.8%) had calculation errors, either in determining the amount of heat exchanged during any part of the experiment or the amount of product formed in Part C, a limiting reaction problem. In an attempt to get more specific data about student performance on the calculations, we adjusted the rubric for the Fall 2015 and Winter 2016 semesters, changing from 1 pt. for correct calculations to 0.5 pts. for correct heat calculations and 0.5 pts. for correct limiting reaction calculations. We found that 20/112 (17.9%) of our students made heat calculation errors, and 31/112 (27.7%) of our students made errors in the limiting reactant problem needed to determine the amount of product formed in Part C.

Since our last assessment report, we re-wrote the laboratory handout to clarify what is needed to calculate the heat exchanged during all three parts of the lab and this appears to have improved our students' success in this area. However, over a quarter of our students are still not recognizing that a limiting reactant problem has to be solved to correctly determine the amount of product formed in Part C. In addition, many students try to use mass, instead of volume and concentration, to solve this problem.

Solution stoichiometry and limiting reactant problems are always difficult for students. The topic is introduced in the prerequisite course, CEM 111, but is not widely used until this course. We currently offer three extra credit problems of this type to our students at the end of each of Labs 3-5. We will remind our CEM 111 instructors of the importance of this topic to students moving on to CEM 122 and ask them to put more emphasis on problems of this type. One thing we don't want to do is to rewrite our Thermochemistry lab handout to prompt our students that they will need to do a limiting reactant calculation for Part C of the lab. The

goal is to have them recognize the necessity of doing a limiting reactant calculation on their own.

II. Course Summary and Action Plans Based on Assessment Results

1. Describe your overall impression of how this course is meeting the needs of students. Did the assessment process bring to light anything about student achievement of learning outcomes that surprised you?

CEM 122 seems to be meeting the needs of our students very well. This course is a pre-requisite for our organic chemistry course, CEM 211, and many students take this course for that reason. In addition, we have many students taking this course in preparation for admission to professional graduate programs like medical school, dental school, pharmacy school and physician assistant programs. Also a number of U of M engineering students come to WCC to take CEM 122. One of the main surprises was the large number of students (53.8%) that missed question #46 that is related to solubility equilibrium, even though this was covered later in the semester during weeks 10 and 11. Our students definitely need more practice writing dissociation reactions for ionic substances and recognizing the concentration relationships between the anions and cations.

2. Describe when and how this information, including the action plan, was or will be shared with Departmental Faculty.

This assessment will be shared with the chemistry faculty during a faculty meeting held in the Fall 2016 semester.

3.

Intended Change(s)

Intended Change	Description of the change	Rationale	Implementation Date
Assessment Tool	As discussed earlier we may want to re-word part of question #22 from "If a strong acid is added to this system, which of the folloiwing will occur"? to "If the pH of the system is lowered, which of the following will	The most common example of a strong acid used in CEM 122 is HCl. Since the effect of specifically adding HCl to the equilibrium reaction system given in the question would be different from just adding strong acid	2016

	occur"? or to "If the pH of the system is lowered by adding the strong acid HNO_3, which of the following will occur"?	in general, we should re-write the question to make certain that there is only one correct answer to the question by either omitting the reference to "a strong acid" that would suggest HCl to some students or specifying HNO_3 as the strong acid.	
Other: Standard of Success	We are very happy with our assessment tools and scoring rubrics. However, we should update our standard of success to be based on the scores and percentages that our students can actually earn, rather than on the usual 75% or 70%. Outcome #1. Suggest using standard of success as 70% of students will score 29/41 (70.7%) or higher on Part A of the final assessment test. Outcome #2, tool 1. Suggest using standard of success as 70% of students will score 9/13 (69.2%) or higher on Part B of the	As discussed earlier, a number of students take the final assessment exam who have not been attending class regularly, are failing, and intend to repeat the course. We encourage these students to take the final assessment exam, but recognize that this lowers the overall performance of our students and decreases the mean and median scores of the test so it seems appropriate to lower the standard of success from 75% of student will score at a given level to 70% of students will score at a given level on the final assessment exam.	2016

	final assessment test. Outcome #2, tool 2. Suggest using standard of success as 70% of students will score 7/9 (77.8%) or higher on the rubric used to evaluate student work on problem #54 which is not multiple choice. Outcome #3. Since students performed very well on the lab report evaluation suggest using standard of success as 75% of students will score 7/10 (70.0%) on the rubric used to evaluate student lab reports.		

4. Is there anything that you would like to mention that was not already captured?

5.

III. Attached Files

Lab Report Scoring Rubric
Assessment Data File
Final Assessment Part B Q54 Scoring Rubric

Faculty/Preparer:	Rosemary Rader	**Date:** 11/02/2016
Department Chair:	Kathleen Butcher	**Date:** 11/03/2016
Dean:	Kristin Good	**Date:** 11/04/2016
Assessment Committee Chair:	Michelle Garey	**Date:** 12/06/2016

COURSE ASSESSMENT REPORT

I. Background Information

1. Course assessed:
   Course Discipline Code and Number: CEM 122
   Course Title: General Chemistry II
   Division/Department Codes: MSH/PHYD

2. Semester assessment was conducted (check one):
   ☒ Fall 2011
   ☐ Winter 20__
   ☐ Spring/Summer 20__

3. Assessment tool(s) used: check all that apply.
   ☐ Portfolio
   ☐ Standardized test
   ☐ Other external certification/licensure exam (specify):
   ☐ Survey
   ☐ Prompt
   ☒ Departmental exam
   ☐ Capstone experience (specify):
   ☒ Other (specify): Lab Report

4. Have these tools been used before?
   ☐ Yes
   ☒ No

   If yes, have the tools been altered since its last administration? If so, briefly describe changes made.
   NA

5. Indicate the number of students assessed and the total number of students enrolled in the course.
   58 students out of 65 still enrolled in the course took the departmental final assessment test.
   Lab reports from 25 students (25/58 = 43%) were assessed.

6. If all students were not assessed, describe how students were selected for the assessment. *(Include your sampling method and rationale.)*
   All students still attending class on the last day of the semester took the final departmental assessment test.
   At least 25% of the lab reports submitted in each section for Lab #13 were randomly selected for assessment.

II. Results

1. Briefly describe the changes that were implemented in the course as a result of the previous assessment.
   The initial assessment tool for this course was a portion of the American Chemical Society standardized exam for general chemistry. The tool was changed to a departmental final exam to better reflect the course outcomes and objectives. In addition the test was split into two parts, part A to assess outcome 1 (conceptual questions) and part B to assess outcome 2 (problem-solving and calculations).

   Since the previous assessment a third outcome was added to the course to include student laboratory work.

2. List each outcome that was assessed for this report exactly as it is stated on the course master syllabus. *(You can copy and paste these from CurricUNET's WR report.)*
   Outcome 1. Recognize the concepts and principles of general chemistry relating to chemical kinetics, chemical equilibrium, chemical thermodynamics and electrochemistry.
   Outcome 2. Apply the appropriate concepts or principles of chemistry to solve kinetics, equilibrium, thermodynamics and electrochemistry problems.
   Outcome 3. Perform laboratory procedures that apply best chemical practices for making measurements, recording data, calculating results and drawing conclusions.

logged 6/25/12 sjr

3. For each outcome that was assessed, indicate the standard of success exactly as it is stated on the course master syllabus. *(You can copy and paste these from CurricUNET's WR report.)*
   Outcome 1. 75% of the students taking the departmental exam will score 70% or higher on the (conceptual) multiple choice questions.
   Outcome #2. 75% of the students taking the departmental exam will score 70% or higher on the problems.
   Outcome #3. 75% of the sample lab reports will have a score of 7 (out of possible 10) or higher.

4. Briefly describe assessment results based on data collected during the course assessment. Indicate the extent to which students are achieving each of the learning outcomes listed above and state whether the standard of success was met for each outcome. ***In a separate document, include a summary of the data collected and any rubrics or scoring guides used for the assessment.***
   Outcome 1. In part A of the final departmental assessment exam which had 41 questions, 43/58 (74.1%) students scored 29 (70.7%) or higher. This is just under the standard of success of 75% or more of students scoring 70% or higher. Further analysis shows that 27/58 students (46.6%) scored 80% (33/41) or higher and 50% of the students assessed scored 78% or higher.

   Outcome 2. Part B of the final departmental assessment exam had 13 questions which were scored as either correct or incorrect. It was not possible for students to score exactly 75% (9.75/13). Of those taking the assessment test, 54/58 (93.1%) students scored 9 (69.2%) or higher and 42/58 (72.4%) students scored a 10 (76.9%) or higher. This is close to meeting the standard of success of 75% or more of students scoring 70% or higher.

   The last question on the departmental final assessment exam was not multiple choice but one in which students had to perform a calculation. This question was initially scored as either correct or not correct and was included in the total score for part B that was discussed above. While not part of the assessment plan shown on the master syllabus, we decided to further assess student problem-solving ability by requiring students to show how they obtained the answer to this question. The work shown was scored against a rubric that had a possible 8 points. When this data was analyzed, one student's answer sheet was misplaced. This is indicated on the results that are attached as "unavailable". Of the 57 students whose work was shown, 47 (82.5%) scored 6 (75%) or higher. We think this is quite successful!

   Outcome 3. When the lab reports were scored against the departmental rubric, which had 10 possible points, 20/25 (80.0%) students scored 7 points (70.0%) or higher. This meets the standard of success of 75% or more of students scoring 70% or higher.

5. Describe the areas of strength and weakness in students' achievement of the learning outcomes shown in the assessment results. *(This should be an interpretation of the assessment results described above and a thoughtful analysis of student performance.)*
   Strengths: The median for outcome #1 was 78% so even though the standard of success was not met, we know that in general, students were able to correctly answer basic questions about each topic studied in the course.

   Students performed well on the outcome #2 questions (Part B of the assessment exam) that required calculations.

   In regards to outcome #3, by the end of the semester when the assessment occurred, nearly all students followed the proper format for writing a lab report.

   Weaknesses:
   In the outcome #1 conceptual questions (Part A on the assessment exam) the topics that were most frequently missed were: determining a rate law from data, applying Le Chatelier's Principle, salt hydrolysis, buffers, interpreting the Nernst equation, and identifying oxidizing and reducing agents.

   In the outcome #2 calculation questions (Part B on the assessment exam) the most commonly missed questions required students to initially write balanced chemical reactions, which it appears they were unable to do.

For outcome #3, students continue to have difficulty analyzing sources of error and writing a proper conclusion. In addition, a number of students made errors in recording their data and results to the correct number of significant figures. Finally, many students did not show all of the results we expected to see in the results table.

III. Changes influenced by assessment results

1. If weaknesses were found (see above) or students did not meet expectations, describe the action that will be taken to address these weaknesses. *(If students met all expectations, describe your plan for continuous improvement.)*

   Outcome #1. In lecture more emphasis will be placed on applying concepts. For example, more class time will be spent on interpretation of pictorial information, diagrams and graphs. In addition, more of these types of questions will be added to quizzes and tests.

   Outcome #2. Based on the questions most commonly missed in Part B of the assessment exam, more review of writing correct chemical formulas and balanced chemical reactions will be done at the beginning of the semester. Discussion will be on going with the instructors of the pre-requisite course (CEM 111) to be certain that these topics are emphasized throughout CEM 111.

   Outcome #3. We realized that our assessment of outcome #3 does not actually measure student performance in the laboratory, but rather assesses the ability of students to follow the science processes of collecting and properly recording data, calculating and analyzing results, and drawing conclusions based on their analysis. Since following these science processes is our intended course goal, we will rewrite outcome #3 to reflect this.

   Proper use of significant figures is challenging for nearly all chemistry students. This topic is taught in both CEM 090 and CEM 111 and reviewed in Lab #1 of this course. Significant figures will continue to be emphasized in both the lab and lecture. Revisions will be made to the first labs done in the semester to lead students through the process of analyzing sources of experimental error. The hope is that later in the semester, students will be able to write a proper source of error section in their lab report on their own.

   A number of the Lab #13 reports that were assessed did not show all of the results we expected to see in the results table. Consequently the handout for this laboratory will be modified to clarify the directions for reporting results.

2. Identify intended changes that will be instituted based on results of this assessment activity (check all that apply). Please describe changes and give rationale for change.

   a. ☒ Outcomes/Assessments on the Master Syllabus
   Change/rationale: The outcome language of outcome #3 will be revised on the Master Syllabus to read: **Demonstrate the science processes of collecting and properly recording data, calculating and analyzing results, and drawing conclusions based on results.** We realized that we do not want to measure student performance in the laboratory, but rather assesses the ability of students to follow the science processes of collecting and properly recording data, calculating and analyzing results, and drawing conclusions based on their analysis. We will rewrite outcome #3 to reflect this.

   b. ☒ Objectives/Evaluation on the Master Syllabus
   Change/rationale: **More questions that involve interpretation of pictorial information, diagrams and graphs will be added to quizzes and tests since students continue to have difficulty in this area.**

   c. ☐ Course pre-requisites on the Master Syllabus
   Change/rationale:

   d. ☐ 1st Day Handouts
   Change/rationale:

   e. ☐ Course assignments
   Change/rationale:.

f. ☒ Course materials (check all that apply)
☐ Textbook
☒ Handouts
☐ Other:

Because students continue to have a difficult time writing a proper source of error section, revisions will be made to the handouts for a number of the first labs done in the semester to lead students through the process of analyzing sources of experimental error.

The handout for Lab #1 will be revised to include a review of writing correct chemical formulas and balanced chemical reactions since students' inability to do this affects their performance on many questions that require calculations.

The handout for Lab #13, Thermochemistry, will be modified to clarify the directions for reporting results since on the assessment many students did not include answers to all calculations in the results table.

g. ☐ Instructional methods
Change/rationale:

h. ☒ Individual lessons & activities
Change/rationale: **More class time will be spent on interpretation of pictorial information, diagrams and graphs since students continue to have difficulty in this area.**

3. What is the timeline for implementing these actions?
Implementation of these changes will occur in the Fall 2012 semester.

IV. Future plans

1. Describe the extent to which the assessment tools used were effective in measuring student achievement of learning outcomes for this course.
The departmental final assessment exam is effective in measuring student achievement of learning outcomes #1 and #2. Separating the test into two sections, part A for outcome #1 and part B for outcome #2 has made the assessment of each outcome much more straightforward and will be used again in future assessments.

2. If the assessment tools were not effective, describe the changes that will be made for future assessments.
The scoring rubric used to assess student work on the last calculation problem in part B of the assessment exam will be modified to include checking for the correct number of significant figures in the answer.

3. Which outcomes from the master syllabus have been addressed in this report?
All **XXX** Selected _____
If "All", provide the report date for the next full review: **Fall 2014** __________.
If "Selected", provide the report date for remaining outcomes: ____________________.

Submitted by: Rosemary Rader 6/13/12

Print: Rosemary Rader/Tracy Schwab **Signature** Tracy Schwab **Date:** 6/13/12
Faculty/Preparer

Print: Kathleen Butcher **Signature** Kathleen Butcher **Date:** 6/19/12
Department Chair

Print: Martha Showalter **Signature** Martha Showalter **Date:** 6/21/12
Dean/Administrator

COURSE ASSESSMENT REPORT

Background Information

1. Course assessed:
   Course Discipline Code and Number: CEM-122
   Course Title: General Chemistry II
   Division/Department Codes: MNBS/CEM

2. Semester assessment was conducted (check one):
   ☐ Fall 20__
   ☒ Winter 2006
   ☐ Spring/Summer 20__

3. Assessment tool(s) used: check all that apply.
   ☐ Portfolio
   ☒ Standardized test
   ☐ Other external certification/licensure exam (specify):
   ☐ Survey
   ☐ Prompt
   ☐ Departmental exam
   ☐ Capstone experience (specify):
   ☐ Other (specify):

4. Have these tools been used before?
   ☒ Yes
   ☐ No

   If yes, have the tools been altered since its last administration? If so, briefly describe changes made.
   The standarized test from the Americal Chemical Society was re-typed from its original form. Questions not germane to this course were removed and one question was slightly modified for clarity.

5. Indicate the number of students assessed/total number of students enrolled in the course.
   All students from all sections of the course, 52 in total, were assessed.

6. Describe how students were selected for the assessment.
   All students were assessed.

Results

1. Briefly describe the changes that were implemented in the course as a result of the previous assessment.
   Previous use of this test focused on estabilishing a baseline for WCC students.

2. State each outcome from the master syllabus that was assessed.
   Outcome #1. Define, explain and recognize the physical principles related to chemical kinetics, equilibrium, thermodynamics, electrochemistry and nuclear chemistry.
   Outcome #2. Apply appropriate physical principles in problem situations.

3. Briefly describe assessment results based on data collected during the course assessment, demonstrating the extent to which students are achieving each of the learning outcomes listed above. Please attach a summary of the data collected.
   The test consisted of 30 mulitple choice questions. Raw scores and item analysis were obtained. The item analysis was used to determine which questions were most frequently missed. Raw scores were converted to a percentage. Because national norms for this test were not available, raw scores were adjusted by scaling the percentages.

4. For each outcome assessed, indicate the standard of success used, and the percentage of students who achieved that level of success.

Please return completed form to the Office of Curriculum & Assessment, SC 247.

To be successful, 75% of students taking the test should earn an adjusted score of 70% or higher. Of the 52 students taking the test, 24 (46%) met this criternion of success. Ten other students (19%) nearly met the criterion by scoring 68-62%. The remaining 35% were not successful.

5. Describe the areas of strength and weakness in students' achievement of the learning outcomes shown in assessment results.

   Strengths: Based on the item analysis, there were 8 questions that more than 70% of the students answered correctly. These questions involved basic calculations (outcome #2) and recognition of concepts in conjunction with interpretation of chemical symbols, notation or diagrams.

   Weaknesses: Based on the item analysis, there were 7 questions that more than 70% of the students answered incoreectly. These questions covered topic areas of solution chemistry, electrochemistry and thermodynamics. Many of the most frequently missed problems involved 2 or more steps.

Changes influenced by assessment results

1. If weaknesses were found (see above) or students did not meet expectations, describe the action that will be taken to address these weaknesses, along with a timeline for these actions.
   During the Fall 2006 semester we will try to locate the national test norms for this exam from the American Chemical Society to determine if our adjustment of raw percentage is correct and in line with national norms. A number of the test questions can be described as "tricky" and difficult to read, especially for ESL students.

2. Identify any other intended changes that will be instituted based on results of this assessment activity (check all that apply). Please describe changes and give rationale for change.

   ☒ Master syllabus
   Change/rationale: Add a unit on solutions that includes a laboratory exercise.

   ☐ Curriculum
   Change/rationale:

   ☐ Course syllabus
   Change/rationale:

   ☒ Course assignments
   Change/rationale: Add additional questions to laboratory exercises to reinforce thermodynamic and electrochemical concepts.

   ☐ Course materials (check all that apply)
   - ☐ Textbook
   - ☐ Handouts
   - ☐ Other:

   Change/rationale:

   ☒ Instructional methods
   Change/rationale: Reinforce solution concepts when discusssing acid ionization.

   ☐ Other:
   Change/rationale:

Future plans

1. Describe the extent to which the assessment tools used were effective in measuring student achievement of learning outcomes for this course.
   The standardized test used clearly showed some areas of the course that need improvement.
2. If the assessment tools were not effective, describe the changes that will be made for future assessments.

Please return completed form to the Office of Curriculum & Assessment, SC 247.

We are going to look for a more appropriate standardized test that will better serve our students, especially the ESL students.

Submitted by:

Name: Gary Van Houten Rosemary Rader Date: 6/28/06 28 June 2006

Department Chair: Date: 6/29/06

Dean: M. Sherer Date: 7/13/06

Please return completed form to the Office of Curriculum & Assessment, SC 247.