LAS
Embedded Assessment Action Report

For

Program Review

Degree Program(s): BA/BS

Course # / Title: Ch 334-336 Organic Chemistry

Faculty name: Arlene Courtney

Date: Academic Year 2010-2011

A) State the program **learning outcome** or **general education goal** this assessment is linked to:

This course is a full year sequence covering organic chemistry. The audience for this course is chemistry majors, chemistry minors, and pre-professional students (pre-med, dent, vet, etc). Ch 334 covers the chemistry alkanes and alkyl halides emphasizing their structures, properties and reactions. Ch 335 covers the structure and properties of alkenes, alkynes; elimination, addition, oxidation-reduction and radical reactions and the functional groups that participate in these reactions; and the use of spectroscopy for structure determination. Ch 336 covers the chemistry of carbonyl containing compounds, carboxylic acids, carboxylic acid derivatives and amines emphasizing their structures, properties, reactions, syntheses and spectroscopic properties.

List of objectives:

1. Recognize the functional group associated with each class of organic compound.
    - Be able to name organic compounds based on functional groups present
    - Recognize electron density distributions within a functional group and predict reactivity
    - Predict structural differences due to functional groups
    - Predict physical properties due to functional groups
2. Predict reaction products from reactions of all functional groups.
3. Draw potential energy diagrams for the pathways of the reactions of all functional groups.

4. Draw step-by-step mechanisms for reactions of all functional groups.
5. Determine structure of an unknown compound from H-nmr, C-13-nmr, ir, and mass spectral data.
6. Draw 3-D representations of organic molecules.

B) Check the embedded assessment tool(s) used :

- ☐X Exam question
- ☐X Essay
- ☐ Oral presentation
- ☐ Thesis
- ☐ Portfolios
- ☐ Practicum / Service Learning
- ☐ Capstone paper / project
- ☐ X Other

  Administration of nationally-normed comprehensive American Chemical Society Organic Chemistry Exam

For Ch 334: two midterms and a final exam each worth 100 points were administered.
Course Data for exams:
Mean: 75
Median: 77
For Ch 335: two midterms and a final exam each worth 100 points were administered.
Course Data for exams:
Mean: 76
Median: 79
For Ch 336: two midterms each worth 100 points and the Comprehensive ACS exam were administered.
Mean: 73
Median: 66

The entire Ch 334-336 sequence was assessed through the administration of the American Chemical Society standardized organic chemistry examination, and the results compared to national norms. Within the OUS system, performances at the 50th percentile or above are considered to show successful mastery of organic chemistry at the upper division level. The results for the WOU students in Spring 2011 showed that 61% the students in the class scored at or above this level and 33% of the class scored above the 65th percentile with two students scoring at or above the 90th percentile (90th and 95th percentile).

Degree Program(s): BA/BS

Course # / Title: Ch 350W Chemical Literature

Faculty name: Arlene Courtney

Date: Winter 2011

A) State the program **learning outcome** or **general education goal** this assessment is linked to:

In this course students learn to distinguish the various types of chemical information sources and to choose appropriate sources to solve specific chemical information problems.

List of Objectives:

1. Demonstrate the ability to perform efficient searches for subjects, authors and substances using computer-based databases and Chemical Abstracts On-line.
2. Locate chemical and physical properties for specific substances using reference books and online techniques.
3. Identify a particular literature source as primary, secondary or tertiary.
4. Write an annotated bibliography.
5. Format references as delineated in the ACS Handbook for Authors.
6. Be able to read and extract information from U.S. patents.
7. Demonstrate the ability to write using chemical style with good sentence structure, spelling and punctuation.

B) Check the embedded assessment tool(s) used :

- ☐X Exam question
- ☐ Essay
- ☐X Oral presentation
- ☐ Thesis
- ☐ Portfolios
- ☐ Practicum / Service Learning
- ☐ X Capstone paper / project
- ☐ X Other

  Students complete a literature searches

Sample Literature search:

Chemical Abstracts On-Line

The following problems are arranged in order of increasing difficulty so you should work them in the order given. Your search is to be conducted in the LCA file (the learning databae). Since LCA is a static file, the number of answers that shouldbe found are indicated in parentheses. Provide bibliographic information for each question. Submit your answers via Moodle.

1. Find papers by O. Leslie Dutton on photosynthesis. (6 answers)
2. What type of compounds are being used as hydrosulfuriation catalysts? Hint: Don't forget to search the abstract index. (14 answers) How many of these articles are patents?
3. Find the composition of stick antiperspirant or deodorant. (1 answer)
4. Making fibers waterproof or water repellant is a big business. Locate articles on this topic. (23 answers) How many patents does 3M hold in this area?
5. Wine-making is an old science, but it has yielded to modern ways. Find applications of chromatography to monitor wine quality.

Sample Writing Assignment:

In this exercise you will use both the paper and electronic resources available through the Hamersley Library to build a bibliography for the topic "insect control using hormones and pheromones."

The Literature Search

Begin your search by defining, with the aid of a chemical dictionary, the terms hormone and pheromone. In parentheses, footnote the dictionary you utilized and indicate the page where the definition appears. Next, consult the McGraw-Hill Encyclopedia of Science and Technology that is found in the Referenece Room of the Library. Use the index of the encyclopedia to locate topics concerning insect control which are relevant to your search. Use the Library's online catalog to develop a list of relevant treatises, monographs and books to add to your bibliography. Complete your search using the Library's periodical indices or databases to find recent journal articles relevant to this topic.

The Written Assignment

Write a short discussion of how hormones and pheromones are used in insect control (1 page summary). Append your bibliography to this summary. The bibliography you generate will be an annotated bibliography. In addition to the standard bibliographical information, for works available in the Hamersley Library (either in hard copy or via electronic form such as html or PDF), you should include a description of what is found in each work that relates to the topic (~150 words or less per annotation). For each entry in your bibliography, indicate if it is an example of primary, secondary or tertiary literature. Choose one of the journal articles that you included in your annotated bibliography to do the following part of the assignment. Underline and annotate a copy of the article as described in the handout about reading scientific articles. Write a summary (no more than one page) of this article. Chemistry has its own conventions for writing bibliographic citations. The ACS Style Guide presents these style conventions. These are the conventions that you are to use in your annotated bibliography.

This assignment is to be submitted as a Microsoft Word .doc via Moodle. The underlined and annotated journal article is to be turned in as a hard copy.

Term Project

Overview: Your mission is to choose a chemical topic of current scientific interest, do a complete literature search on that topic, prepare a document detailing what you learned about the topic and present the information orally to the class. Your topic must be approved by the instructor.

Project Requirements:
You must carry out an extensive literature search on your topic. You must use Chemical Abstracts in your literature search. You must utilize the primary chemical literature in developing your project and have references that include papers published in the last 15 years in peer-reviewed journals. You may use information from the World Wide Web as long as you can determine if the source is scientifically sound using the techniques learned in this class.

Presentation of Research:

1. Your written presentation will be in the form of a web site that you will design.
2. The class will view your web site as you give a short formal presentation of your topic
3. You will prepare a written abstract and outline of your presentation for the class.

Excerpts fro Final Exam:

Identify the following as examples of primary literature, secondary literature or tertiary literature.

a. A paper in the Journal of Organic Chemistry which details the synthesis of arthritigon, an new anti-inflammatory drug.
b. A Chemical Abstracts entry about arthritigon.
c. A patent for arthritigon.
d. An annual review article discussing research on anti-inflammatory drugs.
e. The laboratory notebook of the chemist who developed the synthesisarthritigon.
f. An article about arthritigon in Chemical and Engineering News, the weekly news magazine of the American Chemical Society.

Use the LCA or LReg file to answer the following questions:

a. Find publications from Upjohn on drugs for the treatment of herpes. Give the CA abstract number and title of any publications that you find.
b. Locate patents on the disposal of radioactive waste. You need to think like someone working in this area would think to do your search. (Hint: can radioactive waste be destroyed or must you do something else with it?) There are four answers in LCA. Give the title of each article.

c. Find the registry number for 5-(trifluoromethyl)-1-idodperfluorohexane.

Answer the following questions using the patent included with this exam.

a. Is this a design patent, utility patent or plant patent?
b. On what date will this patent expire?
c. Would an ester prepared by esterification of a guerbet alcohol having a structure where a and b are 6 with meadowfoam oil at 160 ^{o}C be covered by this patent? Document your answer from the patent.

Using the attached journal article and page of CASSI abbreviations, write a correct citation for this journal article that does not include the title of the article.

Using the attached copy that contains the cover of a book, the page containing copyright information and an exerpt from the Table of Contents, write a correct citation for Chapter 4 including the title of the chapter.

Degree Program(s): BA/BS

Course # / Title: Ch 337 Organic Chemistry lab (2 sections; one lab period each per week)

Faculty name: Arlene Courtney

Date: Winter 2011

A) State the program **learning outcome** or **general education goal** this assessment is linked to:

This laboratory experience concerns itself with methods of purifying organic compounds and introduces methods of determining sample purity. Taken concurrently with Ch 335.

List of Objectives:

1. Use a handbook to find physical properties for organic compounds.
2. Determine the melting points of solid compounds and interpret the results to determine the purity of a sample or determine the identity of the unknown compound.
3. Be able to carry out a Thin Layer Chromotography and determine the purity and identity of the components of a mixture with this technique.
4. Be able to recrystallize an impure solid to obtain it in pure form.
5. Separate components in a mixture via extraction.
6. Purify components of a mixture via simple or fractional distillation.
7. Be able to determine whether to use simple or fractional distillation for a particular separation.

B) Check the embedded assessment tool(s) used :

- ☐X Exam question
- ☐ Essay
- ☐ Oral presentation
- ☐ Thesis
- ☐ Portfolios
- ☐ Practicum / Service Learning
- ☐ Capstone paper / project
- ☐ X Other

  Identification of unknown samples

  Written laboratory notebook

Sample Final Exam Scenario and Questions:

1. You have been given a drug tablet to analyze that is thought to contain a mixture of the anti-inflammatory agent ibuprofen and the stimulant caffeine. Your job is to separate and identify the components of the tablet. In answering this question, you may use any of the handbooks on the book shelf but no other resources.

Since caffeine and methamphetamine are organic bases while ibuprofen is an organic acid, you decide to try to separate the components by extraction. The tablet weighs 1 gram. After grinding up the tablet, you dissolve it in 50 mL of MTBE. Not all of the powder dissolves because the active ingredients are mixed with inert binders to make the tablet. You separate the ninders from the sample by gracity filtration, put the resulting solution into a separatory funnel and extract it withtree 15 mL portions of 5% aqueous HCl. After removing the aqueous layer, you extract the MTBE layer with three 15-mL portions f 5% NaOH.

2. In these extractions, is the aqueous layer the top or bottom layer?
3. Circle the functional group in the structures of methamphetamine and ibuprofen drawn below that makes each compound behave as an acid or base.
4. Fill in the flowchart below to show how the extraction separates the components of the mixture, caffeine/methamphetamine (I) and ibuprofen (II). Place the appropriate Roman Numerals in the boxes provided.
5. Briefly explain how you would recover the ibuprofen from the aqueous solution in which it is dissolved after the extraction.
6. The product you obtain from extracting the MTBE solution with 5% HCl has a melting point of 234-236.5^{0}C, and the product extracted with 5% NaOH has a melting point of 49-52^{o}C. What does this information indicate to you about the possible identity of the components of the mixture?

Degree Program(s): BA/BS

Course # / Title: Ch 462W Experimental Chemistry

Faculty name: Arlene Courtney

Date: Winter 2011

A) State the program **learning outcome** or **general education goal** this assessment is linked to:

This course utilizes the laboratory skills students have developed in their general, organic, analytical and instrumental analysis courses; learn new advanced laboratory techniques; analyze data and design an investigation of their own. It is one of the capstones for all chemistry majors. This is also a writing intensive offering in which students are exposed to a number of the different types of written communication used by professional chemist.

List of Objectives:

1. Demonstrate the ability to carry out literature searches.
2. Demonstrate the ability to design an investigation and write a research proposal for that investigation.
3. Demonstrate the ability to analyze samples using various instrumental techniques.
4. Carry out environmental testing using DNA analysis.
5. Write documents such as a literature review, letters, memos, press releases, academic laboratory reports, client report, resumes, job applications and proposals.
6. Collaboratively write and edit a report document
7. Generate a Power Point slide presentation of the results of an investigation.

B) Check the embedded assessment tool(s) used :

- ☐X Exam question
- ☐ Essay
- ☐X Oral presentation
- ☐ Thesis
- ☐ Portfolios
- ☐ Practicum / Service Learning
- ☐ X Capstone paper / project
- ☐ X Other
  Series of writing assignments
  Written laboratory notebook

Project Sample: Analysis of “Fiestaware” Pottery (includes individual proposal writing assignment, collaborative client report preparation, cover letter and group oral presentation)

Scenario:

Ima Cheapskate, owner of Pottery For Less, got a really good deal on glazed pottery bowls (actually some bowls “Fiestaware” style bowls we have). She is worried about her liability if the bowls are glazed with a uranium based glaze which would contain lead as a decay product of the uranium and has requested that you laboratory analyze samples of the bowls. Your job is to determine if lead is present and, if so, how much leaches into a commercial vinegar solution over a 24 hour period. Ms. Cheapskate would like to know if the bowls should be sold with a warning label indicating that they should be used for non-consumptive applications only.

Writing Assignments (actual description too long for inclusion here):

- Proposal – you will research methods for measuring the lead content of aqueous solutions, select a method appropriate for the equipment and/or instrumentation that we have in the laboratory and write a proposal requesting approval of your method. Members of the class and the instructor will review the proposal using a scoring rubric and select one or more of the methods proposed for use in the analysis.
- Collaboratively Generated Letter of Transmittal – introducing the report to the client stating how and why the report originated and who requested it; the scope and subject matter of the report and highlight any important conclusions and recommendations for the client
- Collaboratively Generated Client Report – a formal report giving the details of the analysis incorporating a Cover and Title Page; Abstract; Table of Contents; List of Tables, Illustrations and Figures; Body of Text (written according to background of client); References
- Log of student participation in group activities
- Group Power Point presentation of results

Degree Program(s): BA/BS

Course # / Title: Ch 338 Organic Chemistry Lab II (2 sections; two lab periods each per week)

Faculty name: Arlene Courtney

Date: Spring 2011

B) State the program **learning outcome** or **general education goal** this assessment is linked to:

Students apply the techniques mastered in Ch 337 to a series of synthetic preparations including nucleophilic substitution reations, dehydration oxidation-reduction, Diels-Alder and electrophilic aromatic substitution. A significant portion of the term is spent learning how to identify unknown organic substances During the second half of the term students are given three vials containing unknown organic compounds that they must identify using qualitative organic testing. This exercise requires the interpretation of experimental results, decision making and demonstration of critical thinking skills. Each student is given their own individual set of unknown different from other students.

B) Check the embedded assessment tool(s) used :

- ☐X Exam question
- ☐ Essay
- ☐X Oral presentation
- ☐ Thesis
- ☐ Portfolios
- ☐ Practicum / Service Learning
- ☐ Capstone paper / project
- ☐ X Other
  Identification of unknown samples
  Written laboratory notebook

The Oral Presentation:
You will deliver a poster presentation of the identification of one of your unknown to the class during the last laboratory period. Your poster should outline all the steps that you carried out to determine the identity of your unknown and the conclusions that you were able to draw from each procedure. Sample posters from a previous class are located in the display case in the hall outside the organic lab room. You will be graded on the quality of your oral presentation as well as the visual and content quality of your poster.

Sample from Final Exam:

General instructions for the exam: For each of the following questions, indicate what each of the procedural observations tells you about the unknown compound. A table of possible compounds is attached to this exam.

One of the Exam Questions:

Answer (a-e). For (a-d) indicate what the observation tells you about the unknown. Compound W is a liquid with an experimentally determined boiling point of 116-117 ^{o}C.

a) When added to water, it appears that a very small amount may dissolve. It does not dissolve in 1M NaOH or 1 M HCl but does react with concentrated sulfuric acid as evidenced by a color change and the test tube getting hot.
b) When treated with acetyl chloride, there is an evolution of a large amount of heat and hydrogen chloride. On dilution with water no precipitation occurs.
c) When treated with a red sooution of CrO_3 in sulfuric acid, the solution turns blue-green.
d) Treatment with a solution of zinc chloride in hydrochloric acid (Lucas Test) yielded an insoluble material in three minutes.
e) What is the probable identity of Compound W, and how would you definitively identify it from other similar possibilities in the table attached to this exam?

Degree Program(s): BA/BS

Course # / Title: Ch 407W Seminar

Faculty name: Arlene Courtney

Date: Spring 2011

A) State the program **learning outcome** or **general education goal** this assessment is linked to:

To prepare and deliver a public seminar on a current topic in chemistry or forensic chemistry. This is a program capstone assessment tool.

List of Objectives:

1. Conduct a formal literature search on a topic of current interest.
2. Lean to prepare Power Point lecture slides
3. Demonstrate the ability to generate an Annotated Bibliography about the topic
4. Learn to write a presentation abstract for publication in a meeting's Proceedings volume.
5. Demonstrate the ability to present a seminar of at least 30 minutes to a public audience
6. Demonstrate the ability to answer questions about the topic of the presentation

Seminar Requirements as presented to students:

- The main objective of this class is for you to develop a topic of current interest, do a complete literature search, prepare and deliver a public seminar on this topic. All seminars will be delivered during the Academic Excellence Showcase.
- The seminar must be 30 minutes in length to pass this course. You will have 30-35 minutes for your presentation followed by a 5-10 minute question period.
- Your literature search must involve a Chemical Abstracts and on-line database search. You will prepare an annotated bibliography of all the sources that you use in preparing your seminar. You must have journal articles among your references. More details about the annotated bibliography will be available via the Moodle class site. The annotated bibliography is to be printed and copies distributed during your seminar.
- If you do not have at east two references from primary literature surces such as peer reviewed scientific journals, you topic is not acceptable for use as a seminar topic. You may use internet resources, but they may not comprise the bulk of your references.

- Your seminar will be presented using Power Point as your visual aid tool. You may do a demonstration if it is appropriate to your topic. You may also insert video into your presentation if it is directly needed to clarify some point you need to make during your seminar. Video clips in which someone else is delivering the spoken content must be limited to 2 minutes or less. A clip may be longer if you are doing a voice over during the showing of the video.
- This seminar is a formal presentation. You will dress in a professional manner to present your seminar such as a dress, skirt or suit for women and a tie and sport coat or suit for men. You might as well get used to this type of attire as it is what is expected of you when you go to a job interview!
- Everyone will give a draft presentation of their seminars. Your draft presentation will likely not be during the normal class period. Please make time in your schedule for the dress rehersals. You must attend at least two dress rehearsals other than your own. From past experience, the more you support each other, the better your seminars will be.
- The abstract is the description of your seminar that will be published in the Academic Excellence Showcase Proceedings volume. You will prepare and submit this abstract electronically.

Ch 440 **Physical Chemistry (I)** Fall 2010
Levine 5^{th} Ed.

The assessment form in this course was based upon a selected number of learning outcomes (see below) and students' performance on midterms and final exam.

- Graded on a 100-point scale, for this assessment students scoring 70 or higher on the midterms demonstrated competence on the learning outcomes.
- The average score on the first exam was 68.8 while the highest score was 79.5.
- The average score on the second midterm was 77.5 while the highest score was 88.
- The average score on the final was 59.0 while the highest score was 82.

Ch 440 **Physical Chemistry (I)**

Some of the following items were used on the midterms and the final exam as the **LEARNIG OUTCOMES** for this course.

1. Name the four branches of physical chemistry.
2. Be able to use differentiation or partial differentiation of various functions.
3. Apply indefinite and definite integrals in solving problems throughout the course.
4. Apply the First Law of Thermodynamics.
5. Understand terminologies such open, closed, isolated, homogeneous, heterogeneous systems, surroundings, adiabatic, thermodynamic equilibrium, extensive versus intensive properties, phase, and equation of state.
6. Calculate P (V or T) of an ideal gas or an ideal gas mixture using PV = nRT.
7. Calculate molar mass, density, and partial pressures.
8. Use thermal expansivity coefficient (α) and isothermal compressibility (κ) to find volume changes produced by T or P changes.
9. Calculate ΔH, ΔU, q, w, for various processes, namely, phase change, heating at constant pressure (or volume), isothermal reversible, adiabatic reversible expansion (or compression).
10. Apply the Second Law of Thermodynamics.
11. Calculation of ΔS for various processes involving perfect gases. This includes mixing of gases, constant-pressure heating, reversible phase change, etc.
12. Calculate q, w, ΔU, and ΔH for adiabatic expansion of a perfect gas in vacuum.
13. Understand the line integral, specifically, $\int$.
14. Understand the Joule and Thomson experiments and be able to apply the results in solving various problems such as cooling.
15. Understand Carnot cycle and calculation of the efficiency of a heat engine.
16. Understand the Gibbs energy, G, and the Helmholtz energy, A, and Calculation of ΔG and ΔA under various conditions like isothermal, adiabatic,
17. Apply Euler reciprocity relation to the Gibbs equations and be able to use the Maxwell relations to derive formulas in terms of measurable properties such as α, κ T, V, and P.
18. Calculation of $C_p - C_v$, $(\partial U/\partial V)_T$, $(\partial H/\partial P)_T$, etc.
19. Conditions for material equilibrium.
20. Understand the Kirchhoff's law and the temperature dependence of reaction heats.

21. Be able to estimate $\Delta H°$ using bond energies.
22. Use numerical integration to calculate the absolute entropies for substances.
23. Understand the Third Law of Thermodynamics.
24. Calculation of ΔU for a reaction from adiabatic bomb calorimeter.
25. Understand the Nernst-Simon entropy statement and the unattainability of absolute zero.
26. Calculation of ΔH from ΔU and vice versa for a chemical reaction.

Ch 441 **Physical Chemistry (II)** Winter 2011

The assessment form in this course was based upon a selected number of learning outcomes (see below) and students' performance on midterms as well as the final exam.

Graded on a 100-point scale, for this assessment students scoring 70 or higher on the midterms demonstrated competence on the learning outcomes.

- The average score on the first exam was 69.7 while the highest score was 79.5.
- The average score on the second midterm was 64.3 while the highest score was 79.5.
- The average score on the final exam was 71.8 while the highest score was 82.

Ch 441 **Physical Chemistry (II)**

Some of the following items were used on the midterms and the final exam as the **LEARNIG OUTCOMES** for this course.

Having read chapters 6, 7, 8, 9, 10, 12, and 15, you should be able to:

1. Calculate $K_P°$ and $\Delta G°$ from observed equilibrium composition.
2. Calculate $K_P°$ and $\Delta G°$ using $\Delta G° = -RT\ln K_P°$.
3. Calculate the equilibrium composition from $K_P°$ and the initial composition for constant-T and -P or constant-T and V-conditions.
4. Calculate $K_P°$ at T_2 from $K_P°$ at T_1 using $d\ln K_P°/dT = \Delta H°/RT^2$.
5. Calculate $\Delta H°$, $\Delta G°$, and $\Delta S°$ from $K_P°$ versus T data using $\Delta G° = -RT\ln K_P°$.
6. Understand the chemical potential and their role in determining the thermodynamic properties.
7. Predict the shifts in Ideal-Gas Reaction equilibria.
8. Understand the Phase-Rule and its application.
9. Understand the Clapeyron equation.
10. Understand the phase diagrams involving pure substances.
11. Understand higher-order phase transitions.
12. Understand Real-Gas equation of state such as van der Waals, Redlich-kwong, etc.

13. Understand the compressibility factor, condensation, the critical state.
14. Understand the liquid- vapor equilibria.
15. Understand, ideal solutions, partial molar quantities, mixing quantities, solution composition, thermodynamic properties of ideal solutions.
16. Understand ideally dilute solutions and their properties.
17. Understand Raoult's law, Henry's law and its application such as solubility of gases.
18. Understand nonideal solutions, activities and activity coefficients.
19. Understand solutions of electrolytes.
20. Understand colligative properties.
21. Calculate the osmotic pressure, vapor-pressure lowering, boiling point elevation and freezing point depression and molecular weight determination.
22. Interpret the multicomponent phase diagrams.
23. Understand the Kinetic-Molecular theory of gases.

24. Understand the Distribution of Molecular Speed and application of Maxwell Theory.
25. Understand molecular collisions and mean free path.
26. Understand the Boltzmann Distribution Law.
27. Understand the barometric formula.
28. Understand the heat capacities of ideal polyatomic gases.

Ch 411 **Advanced Inorganic Chemistry** Winter 2011
Text: J. Bowser

The assessment form in this course was based upon a selected number of learning outcomes (see below) and students' performance on midterms as well as the final exam.

> Graded on a 100-point scale, for this assessment students scoring 70 or higher on the midterms demonstrated competence on the learning outcomes.

- The average score on the first exam was 89.7 while the highest score was 90.
- The average score on the second midterm was 81.3 while the highest score was 91.
- The average score on the final exam was 78.3 while the highest score was 85.

Some of the following items were used on midterms and the final exam as the **LEARNIG OUTCOMES** for this course.

Having read chapters 1, 2, 3, 4, 5, and 6, you should be able to:

1. Recognize the atomic number, mass number and isotopes.
2. Understand orbitals of the hydrogen atom and quantum numbers.
3. Understand the multi-electron atom, the *aufbau* principle and electronic configurations
4. Recognize the excited state electron configurations.
5. Understand the periodic table.
6. Understand the atomic size, ionic size, ionization energies and electron affinities.

7. Rank the elements (or ions) according to their atomic size, ionization energy, etc.
8. Draw the Lewis structures, the octet rule.
9. Understand the Valence Bond theory and the fundamentals of Molecular Orbital theory.
10. Understand the electronegativity, dipole moments, formal charge rules, and polarity.
11. Apply the MO theory to heteronuclear diatomic and triatomic molecules.
12. Apply the VSEPR theory to predict the molecular shape.
13. Use the Slater rules to calculate the effective nuclear charge (Z^*).
14. Understand symmetry operators and symmetry elements, point groups and be able to recognize them.
15. Understand the character tables for various point groups.
16. Understand the application of group theory in vibrational spectroscopy (IR and Raman)
17. Understand the different interactions among various orbital, specifically, formation of sigma (σ), pi (π) , and delta (δ) bonds.
18. Determine the number of irreducible representations in a given reproducible representation.
19. Understand bonding in polyatomic molecules, hybridization of atomic orbital.
20. Distinguish the difference between polymorphism and allotropy.
21. Understand ionic solids, lattice energy and Born-Haber cycle.
22. Understand the defects, namely, Schottky and Frenkel defects in solid state lattices.
23. Understand ionic lattices, types of cubic lattices, radius ratio.
24. Distinguish among covalent radius, van derWaals radius, metallic radius and ionic radius.
25. Estimate the lattice energy based upon the electrostatic model (i.e. coulombic attraction).
26. Understand the introduction of the Madelung constant (A) and the Born exponent (forces) into the electrostatic model.
27. Use the Kapustinskii equation to estimate the lattice energy.
28. Understand the meaning of the terms like band theory, band gap, intrinsic and extrinsic semiconductors, n- and p-type semiconductors, doping (a semiconductor), insulator, and interstitial hole.

Ch 442 **Physical Chemistry (III)** Spring 2011

The assessment form in this course was based upon a selected number of learning outcomes (see below) and students' performance on the midterms and the final exam.

Graded on a 100-point scale, for this assessment students scoring 70 or higher on the midterms demonstrated competence on the learning outcomes.

- The average score on the first exam was 65.1 while the highest score was 82.
- The average score on the second midterm was 64.7 while the highest score was 79.
- The average score on the final was 61.2 while the highest score was 81.5.

Some of the following items were used on the midterms and the final exam as the **LEARNIG OUTCOMES** for this course.

Having read chapters 17, 18, 19, and 20, you should be able to:

1. Understand the measurement of reaction rates.
2. Understand the integration of the rate laws.
3. Determine the rate law.
4. Understand the rate laws and the equilibrium constants for an elementary reaction.
5. Understand temperature dependence of the rate constant.
6. Understand relation between the rate constant and the equilibrium constant for composite reactions.
7. Understand the molecularity.
8. Understand the relaxation techniques and fast reactions.
9. Understand the catalysis, both homogeneous and the heterogeneous.
10. Understand the nuclear decay.
11. Calculate the activity of a radioactive sample at time t from its half-life and initial activity.
12. Determine the reaction orders from kinetic data.
13. Use the Arrhenius equation to calculate A and E_a from k versus T data.
14. Understand Blackbody radiation and energy quantization.
15. Understand the Photoelectric Effect and photons.
16. Understand the Bohr Theory of the H-atom.
17. Understand the de Broglie Hypothesis and be able to solve problems involving the de Broglie equation.
18. Understand the Uncertainty Principle.
19. Understand the Classical Mechanics versus the Quantum Mechanics.
20. Understand the physical meaning of the state function Ψ used in the time-independent Schrödinger equation.
21. Understand the meaning associated with the stationary states and their properties.
22. Understand the meaning of a “well-behaved” function.
23. Understand the “Particle in a One-Dimensional Box”.
24. Understand the “Particle in a Three-Dimensional Box” and its application in real chemical systems.
25. Understand the terms such as degeneracy, operators, eigenfuction, eigenvalue, Laplacian operator, linear operator, average (expectation) value.
26. Understand the One-Dimensional Harmonic Oscillator, Energies wavefuctions , nodes.
27. Understand the tunneling phenomenon, and the meaning of the *classically forbidden* regions.
28. Understand the Two Particle Rigid Rotor, rotational energy levels.
29. Understand the approximation methods, namely, the variation method.
30. Understand the orthogonality of eigenfunctions, Hermitian operators and an orthonormal set.
31. Understand the atomic structure, the H-atom, angular momentum, quantum numbers real wavefunction, spherical harmonics, probability density, electron spin.
32. The helium atom and the Pauli principle.
33. Understand the symmetric versus antisymmetric functions, fermions, bosons.
34. Distinguish the symmetric from antisymmetric wavefunctions.

35. Calculate the total orbital and spin angular momenta for multielectron atom.

Ch 221 **General Chemistry** Winter 2011

The following items were used on the quizzes, midterms and the final exam as the learning outcomes for this course.

The assessment form in this course was based upon a selected number of **LEARNING OUTCOMES** (see below) and students' performance on midterms as well as the final exam. Graded on a 100-point scale, for this assessment students scoring 70 or higher on the midterms demonstrated competence on the learning outcomes.

- The average score on the first exam was 66.5 while the highest score was 95.
- The average score on the second midterm was 60.6 while the highest score was 94.
- The average score on the final exam was 61.8 while the highest score was 86.

Having read chapters 1, 2, 3, 4, 6, 7, and 8 you should be able to:

1. Distinguish between the chemical change, physical change or physical versus chemical property.
2. Recognize the mixtures versus compounds, homogeneous versus heterogeneous solution.
3. Classify matter as an element, substance or a compound.
4. Give the (derived) SI base units, some common SI prefixes with their associated decimal multipliers.
5. Convert between the metric and the British systems.
6. Convert from Fahrenheit, to Celsius and Kelvin temperatures or vice versa.
7. Solve problems involving the density, mass and volume.
8. Recognize the intensive from the extensive properties.
9. Perform mathematical operations with the correct number of significant figures.
10. Understand the difference between accuracy and precision. Uncertainty in a measured quantity.
11. Provide the statements of Dalton's atomic theory and the fundamental chemical laws.
12. Show the validity of the law of conservation of matter, the law of constant composition and the law of multiple proportions from the experimental data.
13. Define radioactivity, characteristic properties of alpha, beta and gamma radiations.
14. Understand and distinguish atomic number, atomic mass, mass number, isotopic mass, amu.
15. Give the number of neutrons, protons and electrons for a given isotopic species (e.g. ^{14}C, ..).
16. Calculate the atomic weight of an element from its isotopic abundance and the isotopic mass or find the isotopic abundance from the atomic weight and its isotopic mass.
17. Identify the periodic table location of *groups, periods, metals, metalloids, nonmetals, alkali metals, alkaline earth metals, halogens, noble gases and transition elements.*
18. Name compounds (both ionic and covalent) or given the name, be able to write the formulas

as practiced in the lab.

19. Understand the mole concept and use mole to solve chemical problems. Namely, given the mass of a reactant, calculate the mass of a product from a balanced equation.
20. Convert grams to moles to number of atoms (or molecules) and vice versa.
21. Understand the empirical, molecular and structural formulas.
22. Understand molar mass of an element or a compound and calculate the molar mass from the atomic mass.
23. Calculate the percent composition from molecular formula.
24. Use experimental data to calculate the number of water molecules in a hydrated compound.
25. Calculate the empirical formula from percentage. Also, given the molecular weight, find the molecular formula.
26. Use the nomenclature to name a compound or given the name, be able to write its formula.
27. Balance chemical reactions by inspection such as combustion reactions.
28. Complete and balance combustion reactions.
29. Relate reactant mass to the product mass, simple stoichiometry.
30. Solve problems involving, limiting reagent, % yield calculations, empirical/molecular formula.
31. Name and distinguish an electrolyte from a nonelectrolyte, strong from weak.
32. Name strong acids and bases.
33. Write the net ionic equations by applying the solubility rules to these reactions.
34. Distinguish the soluble from insoluble compounds.
35. Recognize the monoprotic, diprotic and triprotic acids and give examples for these acids.
36. Define acids or bases according to Arrhennius's or Brønsted.
37. Complete and balance chemical reactions and their classifications.
38. Classify different types of reactions and be able to recognize the redox reactions, assign the oxidation number, identify the element reduced/oxidized , reducing/oxidizing agents.
39. Balance the redox equations in acidic solutions.
40. Solve problems involving molarity(M) including dilution, preparation of solution with a specified concentration.
41. Solve titration problems involving redox, acid-base or gravimetric analysis.
42. Distinguish various forms of kinetic/potential energy, their classification and the units.
43. Use the first law of thermodynamic.
44. Solve calorimetry problems involving specific heat, heat capacity, q, and the temperature.
45. Use Hess's law to calculate)H for a specified reaction.
46. Identify the state functions.
47. Use the heat of formations,)H_f°, to calculate the heat of a reaction.
48. Use the first law of thermodynamics to calculate the internal energy change.
49. Understand the difference between the endothermic and exothermic reactions.
50. Understand the heat of solution ()H_{soln}), lattice energy (U) and heat of dilution.
51. Define node, frequency, and wavelength.
52. Calculate frequency, wavelength and energy of electromagnetic radiation, Planck's equation.
53. Explain the photoelectric effect and the wave-particle duality and de Broglie equation.
54. Explain terminologies such as: ground state, excited state and line spectrum .
55. Calculate the energy of an electron in any orbit (level) according to the Bohr's model.
56. Explain the uncertainty principle.
57. Use quantum numbers; give possible allowed values associated with each. See the

homework.

58. Sketch and identify the shapes of s, p, and d orbitals and give the number of spherical nodes.
59. Choose the paramagnetic/diamagnetic atoms.

60. Write out the electron configurations ($1s^22s^2$....) and/or give the orbital box diagram designations for both atoms and ions.
61. Explain the Hund's rule and the Pauli Exclusion Principle.
62. Tell the number of valence electron(s) associated with the **main groups** elements (1A through 8A).
63. Apply the restriction imposed on each quantum number (allowed values) in deciding which set of quantum numbers are acceptable.
64. Understand the shielding effect in many-electron atoms.
65. Arrangement of the element in the periodic table and their classification.
66. Understand the effective nuclear charge and its role in predicting the atomic size and the ionic size.
67. Understand the trends in atomic size, ionization energies, and electron affinities.
68. Rank elements or ions according to their size, and the their ionization energies.
69. Choose the isoelectronic ions from a given list.
70. Explain the variation in chemical properties of the representative elements. Group 1A & 2A.

Ch 222 **General Chemistry** **Spring 2011**

The assessment form in this course was based upon a selected number of **LEARNING OUTCOMES** (see below) and students' performance on quizzes, midterms as well as the final exam. Graded on a 100-point scale, for this assessment students scoring 70 or higher on the midterms demonstrated competence on the learning outcomes.

- The average score on the first exam was 76.2 while the highest score was 94.
- The average score on the second midterm was 69.2 while the highest score was 94.
- The average score on the final exam was 68.2 while the highest score was 88.

Having read chapters 8,9,10, 5, 12, and 13 you should be able to:

1. Give the number of valence electrons associated with each element (only the main groups).
2. Define free radical, isoelectronic species and give examples of each.
3. Rank the polarity of chemical bonds.
4. Use the atomic or ionic trends to rank them according to their size and their ionization energies.
5. Answer question regarding the chemical properties, completing chemical reactions associated with the elements, oxides, etc. (descriptive chemistry).
6. Give examples of various oxides and their reaction with water.
7. Draw the Lewis electron (dot) structures for atoms, ions and molecules.
8. Identify polar or nonpolar species.
9. Define lattice energy , choose ionic compound with higher lattice energy, higher melting point or/and greater solubility
10. Use the Born– Haber cycle to calculate the electron affinity, ionization energy, lattice energy, sublimation energy, ... and the heat of formation.
11. Tell the difference between electronegativity and electron affinity.
12. Calculate the formal charge and be able to choose the most important Lewis or resonance structure.
13. draw the resonance structures for a given ion or molecule.
14. Use bond energies to calculate the heat of a reaction (ΔH) or given the heat of a reaction find the bond energy.
15. Use the VSEPR theory to assign electron geometry and the molecular geometry (shape).
16. Use the valence bond theory to describe bonding or assign the hybridization to the central atom.
17. Use the MO theory to explain molecular properties such as paramagnetic, diamagnetic species, bond order, bond length, and stability.
18. Understand the delocalized molecular orbitals.
19. Use Valence Bond Theory to describe bonding in molecules containing multiple bonds.
20. Use Molecular Orbital Theory to explain the molecular properties such as bond order, magnetic property, bond length, and bond energy in diatomic molecules or ions.
21. Understand gas laws and use the related equations to solve problems involving pressure, volume, temperature, density, molecular weight, and the gas stoichiometry.
22. Understand Dalton's Law of partial pressures and mole fractions, specifically collection of a gas over water.
23. Understand the Kinetic Molecular Theory of gases, distribution of molecular speed, root-mean-square speed (u_{rms}), diffusion rate and its relation to molecular weight and associated calculations.
24. Intermolecular forces and their strength in liquids. Name the strongest intermolecular force in a given liquid.
25. Choose compound with higher boiling point based upon the strength of their intermolecular forces.

26. Draw H–bonds for molecules capable of forming hydrogen bonds.
27. Explain the properties of liquids, namely surface tension, viscosity, vapor pressure, boiling point and their relationship with the intermolecular forces.
28. Interpret the phase diagrams. Cooling curves and their interpretations.
29. Relate ΔH_{vap}, with ΔH_{fus} and ΔH_{sub}, ...
30. Solve problems involving the Clausius – Clapeyron equation.
31. Understand crystals forming the cubic unit cells and be able to solve problems involving density, edge length, radius, number of atoms per unit cell, atomic weight, ...
32. Understand different types of crystals and their general properties. Be able to give an example. See table 11.4.
33. Use Henry's law in order to determine the solubility of gases in a solvent.
34. Use colligative properties (vapor pressure lowering , Raoult's law, freezing point depression) to solve the related problems. This includes determination of molar mass, boiling point and the freezing point, mass of the solute, ...
35. Determine the van't Hoff factor, *i*, or to apply this factor to a solution of an electrolyte.
36. Understand collision theory, activation energy, temperature effect and the Arrhenius equation.
37. Understand catalysis, homogeneous and heterogeneous catalysts
38. Understand the reaction mechanisms, molecularity, elementary steps, rate determining step and the intermediate(s).
39. Determine the rate law from the proposed mechanism(s).
40. Determine a plausible mechanism.

Ch 463 **Experimental Chemistry** Spring 2011

Chemistry 463 – Learning Outcomes

This laboratory course focuses on the experimental aspects of Physical Chemistry and allows students to apply their knowledge based upon theoretical principles studied throughout the year. Completion of the final lab examination will also be required.

The assessment form in this course was based upon a selected number of experiments (see below) and students' performance on the final exam.

- Graded on a 20-points per lab report and a 40 points final exam, students scoring 140 points or greater demonstrated competence on the learning outcomes.
- The average score on formal lab reports was 15.2 out of 40.

- The average score on the final was 62.8 (%) while the highest score was 70(%).

Having completed this laboratory course, students are able to

1. Determine the Heat and Entropy of a reaction from temperature dependence of its equilibrium constant.
2. Determine the entropy of dissolution of a substance involved in an endothermic process.
3. Investigate the internal energy and the enthalpy using bomb calorimeter.
4. Determine the equilibrium constant for a homogeneous reaction.
5. Investigate the thermodynamics of a gas phase equilibrium reaction: Reversible dissociation of N_2O_4.
6. Determine the PK_a of an organic acid in the first excited singlet state as compare to the ground state.
7. Investigate the spectrum of a particle in a box using some conjugated organic molecules.
8. Determine the molecular properties of some diatomic molecules using classical mechanics, quantum mechanics and statistical mechanics.
9. Determine the Heat and Entropy of a reaction from temperature dependence of its equilibrium constant.
10. Determine the entropy of dissolution of a substance involved in an endothermic process.
11. Investigate the internal energy and the enthalpy using bomb calorimeter.
12. Determine the equilibrium constant for a homogeneous reaction.
13. Investigate the thermodynamics of a gas phase equilibrium reaction: Reversible dissociation of N_2O_4.
14. Determine the PK_a of an organic acid in the first excited singlet state as compare to the ground state.
15. Investigate the spectrum of a particle in a box using several conjugated organic molecules.
16. Determine the molecular properties of some diatomic molecules using classical mechanics, quantum mechanics and statistical mechanics.

LAS
Embedded Assessment Action Report

For

Program Review

Degree Program(s): BA/BS

Course # / Title: Ch 334-336 Organic Chemistry

Faculty name: Arlene Courtney

Date: Academic Year 2010-2011

A) State the program **learning outcome** or **general education goal** this assessment is linked to:

This course is a full year sequence covering organic chemistry. The audience for this course is chemistry majors, chemistry minors, and pre-professional students (pre-med, dent, vet, etc). Ch 334 covers the chemistry alkanes and alkyl halides emphasizing their structures, properties and reactions. Ch 335 covers the structure and properties of alkenes, alkynes; elimination, addition, oxidation-reduction and radical reactions and the functional groups that participate in these reactions; and the use of spectroscopy for structure determination. Ch 336 covers the chemistry of carbonyl containing compounds, carboxylic acids, carboxylic acid derivatives and amines emphasizing their structures, properties, reactions, syntheses and spectroscopic properties.

List of objectives:

1. Recognize the functional group associated with each class of organic compound.
    - Be able to name organic compounds based on functional groups present
    - Recognize electron density distributions within a functional group and predict reactivity
    - Predict structural differences due to functional groups
    - Predict physical properties due to functional groups
2. Predict reaction products from reactions of all functional groups.
3. Draw potential energy diagrams for the pathways of the reactions of all functional groups.

4. Draw step-by-step mechanisms for reactions of all functional groups.
5. Determine structure of an unknown compound from H-nmr, C-13-nmr, ir, and mass spectral data.
6. Draw 3-D representations of organic molecules.

B) Check the embedded assessment tool(s) used :

- ☐X Exam question
- ☐X Essay
- ☐ Oral presentation
- ☐ Thesis
- ☐ Portfolios
- ☐ Practicum / Service Learning
- ☐ Capstone paper / project
- ☐ X Other

  Administration of nationally-normed comprehensive American Chemical Society Organic Chemistry Exam

For Ch 334: two midterms and a final exam each worth 100 points were administered.
Course Data for exams:
Mean: 75
Median: 77
For Ch 335: two midterms and a final exam each worth 100 points were administered.
Course Data for exams:
Mean: 76
Median: 79
For Ch 336: two midterms each worth 100 points and the Comprehensive ACS exam were administered.
Mean: 73
Median: 66

The entire Ch 334-336 sequence was assessed through the administration of the American Chemical Society standardized organic chemistry examination, and the results compared to national norms. Within the OUS system, performances at the 50^{th} percentile or above are considered to show successful mastery of organic chemistry at the upper division level. The results for the WOU students in Spring 2011 showed that 61% the students in the class scored at or above this level and 33% of the class scored above the 65^{th} percentile with two students scoring at or above the 90^{th} percentile (90^{th} and 95^{th} percentile).

Degree Program(s): BA/BS

Course # / Title: Ch 350W Chemical Literature

Faculty name: Arlene Courtney

Date: Winter 2011

A) State the program **learning outcome** or **general education goal** this assessment is linked to:

In this course students learn to distinguish the various types of chemical information sources and to choose appropriate sources to solve specific chemical information problems.

List of Objectives:

1. Demonstrate the ability to perform efficient searches for subjects, authors and substances using computer-based databases and Chemical Abstracts On-line.
2. Locate chemical and physical properties for specific substances using reference books and online techniques.
3. Identify a particular literature source as primary, secondary or tertiary.
4. Write an annotated bibliography.
5. Format references as delineated in the ACS Handbook for Authors.
6. Be able to read and extract information from U.S. patents.
7. Demonstrate the ability to write using chemical style with good sentence structure, spelling and punctuation.

B) Check the embedded assessment tool(s) used :

- ☐X Exam question
- ☐ Essay
- ☐X Oral presentation
- ☐ Thesis
- ☐ Portfolios
- ☐ Practicum / Service Learning
- ☐ X Capstone paper / project
- ☐ X Other
  Students complete a literature searches

Sample Literature search:

Chemical Abstracts On-Line

The following problems are arranged in order of increasing difficulty so you should work them in the order given. Your search is to be conducted in the LCA file (the learning databae). Since LCA is a static file, the number of answers that shouldbe found are indicated in parentheses. Provide bibliographic information for each question. Submit your answers via Moodle.

1. Find papers by O. Leslie Dutton on photosynthesis. (6 answers)
2. What type of compounds are being used as hydrosulfuriation catalysts? Hint: Don't forget to search the abstract index. (14 answers) How many of these articles are patents?
3. Find the composition of stick antiperspirant or deodorant. (1 answer)
4. Making fibers waterproof or water repellant is a big business. Locate articles on this topic. (23 answers) How many patents does 3M hold in this area?
5. Wine-making is an old science, but it has yielded to modern ways. Find applications of chromatography to monitor wine quality.

Sample Writing Assignment:

In this exercise you will use both the paper and electronic resources available through the Hamersley Library to build a bibliography for the topic "insect control using hormones and pheromones."

The Literature Search

Begin your search by defining, with the aid of a chemical dictionary, the terms hormone and pheromone. In parentheses, footnote the dictionary you utilized and indicate the page where the definition appears. Next, consult the McGraw-Hill Encyclopedia of Science and Technology that is found in the Referenece Room of the Library. Use the index of the encyclopedia to locate topics concerning insect control which are relevant to your search. Use the Library's online catalog to develop a list of relevant treatises, monographs and books to add to your bibliography. Complete your search using the Library's periodical indices or databases to find recent journal articles relevant to this topic.

The Written Assignment

Write a short discussion of how hormones and pheromones are used in insect control (1 page summary). Append your bibliography to this summary. The bibliography you generate will be an annotated bibliography. In addition to the standard bibliographical information, for works available in the Hamersley Library (either in hard copy or via electronic form such as html or PDF), you should include a description of what is found in each work that relates to the topic (~150 words or less per annotation). For each entry in your bibliography, indicate if it is an example of primary, secondary or tertiary literature. Choose one of the journal articles that you included in your annotated bibliography to do the following part of the assignment. Underline and annotate a copy of the article as described in the handout about reading scientific articles. Write a summary (no more than one page) of this article. Chemistry has its own conventions for writing bibliographic citations. The ACS Style Guide presents these style conventions. These are the conventions that you are to use in your annotated bibliography.

This assignment is to be submitted as a Microsoft Word .doc via Moodle. The underlined and annotated journal article is to be turned in as a hard copy.

Term Project

Overview: Your mission is to choose a chemical topic of current scientific interest, do a complete literature search on that topic, prepare a document detailing what you learned about the topic and present the information orally to the class. Your topic must be approved by the instructor.

Project Requirements:
You must carry out an extensive literature search on your topic. You must use Chemical Abstracts in your literature search. You must utilize the primary chemical literature in developing your project and have references that include papers published in the last 15 years in peer-reviewed journals. You may use information from the World Wide Web as long as you can determine if the source is scientifically sound using the techniques learned in this class.

Presentation of Research:

1. Your written presentation will be in the form of a web site that you will design.
2. The class will view your web site as you give a short formal presentation of your topic
3. You will prepare a written abstract and outline of your presentation for the class.

Excerpts fro Final Exam:

Identify the following as examples of primary literature, secondary literature or tertiary literature.

a. A paper in the Journal of Organic Chemistry which details the synthesis of arthritigon, an new anti-inflammatory drug.
b. A Chemical Abstracts entry about arthritigon.
c. A patent for arthritigon.
d. An annual review article discussing research on anti-inflammatory drugs.
e. The laboratory notebook of the chemist who developed the synthesisarthritigon.
f. An article about arthritigon in Chemical and Engineering News, the weekly news magazine of the American Chemical Society.

Use the LCA or LReg file to answer the following questions:

a. Find publications from Upjohn on drugs for the treatment of herpes. Give the CA abstract number and title of any publications that you find.
b. Locate patents on the disposal of radioactive waste. You need to think like someone working in this area would think to do your search. (Hint: can radioactive waste be destroyed or must you do something else with it?) There are four answers in LCA. Give the title of each article.

c. Find the registry number for 5-(trifluoromethyl)-1-idodperfluorohexane.

Answer the following questions using the patent included with this exam.

a. Is this a design patent, utility patent or plant patent?
b. On what date will this patent expire?
c. Would an ester prepared by esterification of a guerbet alcohol having a structure where a and b are 6 with meadowfoam oil at 160 ^{o}C be covered by this patent? Document your answer from the patent.

Using the attached journal article and page of CASSI abbreviations, write a correct citation for this journal article that does not include the title of the article.

Using the attached copy that contains the cover of a book, the page containing copyright information and an exerpt from the Table of Contents, write a correct citation for Chapter 4 including the title of the chapter.

Degree Program(s): BA/BS

Course # / Title: Ch 337 Organic Chemistry lab (2 sections; one lab period each per week)

Faculty name: Arlene Courtney

Date: Winter 2011

A) State the program **learning outcome** or **general education goal** this assessment is linked to:

This laboratory experience concerns itself with methods of purifying organic compounds and introduces methods of determining sample purity. Taken concurrently with Ch 335.

List of Objectives:

1. Use a handbook to find physical properties for organic compounds.
2. Determine the melting points of solid compounds and interpret the results to determine the purity of a sample or determine the identity of the unknown compound.
3. Be able to carry out a Thin Layer Chromotography and determine the purity and identity of the components of a mixture with this technique.
4. Be able to recrystallize an impure solid to obtain it in pure form.
5. Separate components in a mixture via extraction.
6. Purify components of a mixture via simple or fractional distillation.
7. Be able to determine whether to use simple or fractional distillation for a particular separation.

B) Check the embedded assessment tool(s) used :

☐X Exam question
☐ Essay
☐ Oral presentation
☐ Thesis
☐ Portfolios
☐ Practicum / Service Learning
☐ Capstone paper / project
☐ X Other
Identification of unknown samples
Written laboratory notebook

Sample Final Exam Scenario and Questions:

1. You have been given a drug tablet to analyze that is thought to contain a mixture of the anti-inflammatory agent ibuprofen and the stimulant caffeine. Your job is to separate and identify the components of the tablet. In answering this question, you may use any of the handbooks on the book shelf but no other resources.

Since caffeine and methamphetamine are organic bases while ibuprofen is an organic acid, you decide to try to separate the components by extraction. The tablet weighs 1 gram. After grinding up the tablet, you dissolve it in 50 mL of MTBE. Not all of the powder dissolves because the active ingredients are mixed with inert binders to make the tablet. You separate the ninders from the sample by gracity filtration, put the resulting solution into a separatory funnel and extract it withtree 15 mL portions of 5% aqueous HCl. After removing the aqueous layer, you extract the MTBE layer with three 15-mL portions f 5% NaOH.

2. In these extractions, is the aqueous layer the top or bottom layer?
3. Circle the functional group in the structures of methamphetamine and ibuprofen drawn below that makes each compound behave as an acid or base.
4. Fill in the flowchart below to show how the extraction separates the components of the mixture, caffeine/methamphetamine (I) and ibuprofen (II). Place the appropriate Roman Numerals in the boxes provided.
5. Briefly explain how you would recover the ibuprofen from the aqueous solution in which it is dissolved after the extraction.
6. The product you obtain from extracting the MTBE solution with 5% HCl has a melting point of 234-236.5^{0}C, and the product extracted with 5% NaOH has a melting point of 49-52^{o}C. What does this information indicate to you about the possible identity of the components of the mixture?

Degree Program(s): BA/BS

Course # / Title: Ch 462W Experimental Chemistry

Faculty name: Arlene Courtney

Date: Winter 2011

A) State the program **learning outcome** or **general education goal** this assessment is linked to:

This course utilizes the laboratory skills students have developed in their general, organic, analytical and instrumental analysis courses; learn new advanced laboratory techniques; analyze data and design an investigation of their own. It is one of the capstones for all chemistry majors. This is also a writing intensive offering in which students are exposed to a number of the different types of written communication used by professional chemist.

List of Objectives:

1. Demonstrate the ability to carry out literature searches.
2. Demonstrate the ability to design an investigation and write a research proposal for that investigation.
3. Demonstrate the ability to analyze samples using various instrumental techniques.
4. Carry out environmental testing using DNA analysis.
5. Write documents such as a literature review, letters, memos, press releases, academic laboratory reports, client report, resumes, job applications and proposals.
6. Collaboratively write and edit a report document
7. Generate a Power Point slide presentation of the results of an investigation.

B) Check the embedded assessment tool(s) used :

- ☐X Exam question
- ☐ Essay
- ☐X Oral presentation
- ☐ Thesis
- ☐ Portfolios
- ☐ Practicum / Service Learning
- ☐ X Capstone paper / project
- ☐ X Other

  Series of writing assignments
  Written laboratory notebook

Project Sample: Analysis of “Fiestaware” Pottery (includes individual proposal writing assignment, collaborative client report preparation, cover letter and group oral presentation)

Scenario:

Ima Cheapskate, owner of Pottery For Less, got a really good deal on glazed pottery bowls (actually some bowls “Fiestaware” style bowls we have). She is worried about her liability if the bowls are glazed with a uranium based glaze which would contain lead as a decay product of the uranium and has requested that you laboratory analyze samples of the bowls. Your job is to determine if lead is present and, if so, how much leaches into a commercial vinegar solution over a 24 hour period. Ms. Cheapskate would like to know if the bowls should be sold with a warning label indicating that they should be used for non-consumptive applications only.

Writing Assignments (actual description too long for inclusion here):

- Proposal – you will research methods for measuring the lead content of aqueous solutions, select a method appropriate for the equipment and/or instrumentation that we have in the laboratory and write a proposal requesting approval of your method. Members of the class and the instructor will review the proposal using a scoring rubric and select one or more of the methods proposed for use in the analysis.
- Collaboratively Generated Letter of Transmittal – introducing the report to the client stating how and why the report originated and who requested it; the scope and subject matter of the report and highlight any important conclusions and recommendations for the client
- Collaboratively Generated Client Report – a formal report giving the details of the analysis incorporating a Cover and Title Page; Abstract; Table of Contents; List of Tables, Illustrations and Figures; Body of Text (written according to background of client); References
- Log of student participation in group activities
- Group Power Point presentation of results

Degree Program(s): BA/BS

Course # / Title: Ch 338 Organic Chemistry Lab II (2 sections; two lab periods each per week)

Faculty name: Arlene Courtney

Date: Spring 2011

B) State the program **learning outcome** or **general education goal** this assessment is linked to:

Students apply the techniques mastered in Ch 337 to a series of synthetic preparations including nucleophilic substitution reations, dehydration oxidation-reduction, Diels-Alder and electrophilic aromatic substitution. A significant portion of the term is spent learning how to identify unknown organic substances During the second half of the term students are given three vials containing unknown organic compounds that they must identify using qualitative organic testing. This exercise requires the interpretation of experimental results, decision making and demonstration of critical thinking skills. Each student is given their own individual set of unknown different from other students.

B) Check the embedded assessment tool(s) used :

- ☐X Exam question
- ☐ Essay
- ☐X Oral presentation
- ☐ Thesis
- ☐ Portfolios
- ☐ Practicum / Service Learning
- ☐ Capstone paper / project
- ☐ X Other
  Identification of unknown samples
  Written laboratory notebook

The Oral Presentation:
You will deliver a poster presentation of the identification of one of your unknown to the class during the last laboratory period. Your poster should outline all the steps that you carried out to determine the identity of your unknown and the conclusions that you were able to draw from each procedure. Sample posters from a previous class are located in the display case in the hall outside the organic lab room. You will be graded on the quality of your oral presentation as well as the visual and content quality of your poster.

Sample from Final Exam:

General instructions for the exam: For each of the following questions, indicate what each of the procedural observations tells you about the unknown compound. A table of possible compounds is attached to this exam.

One of the Exam Questions:

Answer (a-e). For (a-d) indicate what the observation tells you about the unknown. Compound W is a liquid with an experimentally determined boiling point of 116-117 ^{o}C.

a) When added to water, it appears that a very small amount may dissolve. It does not dissolve in 1M NaOH or 1 M HCl but does react with concentrated sulfuric acid as evidenced by a color change and the test tube getting hot.
b) When treated with acetyl chloride, there is an evolution of a large amount of heat and hydrogen chloride. On dilution with water no precipitation occurs.
c) When treated with a red sooution of CrO_3 in sulfuric acid, the solution turns blue-green.
d) Treatment with a solution of zinc chloride in hydrochloric acid (Lucas Test) yielded an insoluble material in three minutes.
e) What is the probable identity of Compound W, and how would you definitively identify it from other similar possibilities in the table attached to this exam?

Degree Program(s): BA/BS

Course # / Title: Ch 407W Seminar

Faculty name: Arlene Courtney

Date: Spring 2011

A) State the program **learning outcome** or **general education goal** this assessment is linked to:

To prepare and deliver a public seminar on a current topic in chemistry or forensic chemistry. This is a program capstone assessment tool.

List of Objectives:

1. Conduct a formal literature search on a topic of current interest.
2. Lean to prepare Power Point lecture slides
3. Demonstrate the ability to generate an Annotated Bibliography about the topic
4. Learn to write a presentation abstract for publication in a meeting's Proceedings volume.
5. Demonstrate the ability to present a seminar of at least 30 minutes to a public audience
6. Demonstrate the ability to answer questions about the topic of the presentation

Seminar Requirements as presented to students:

- The main objective of this class is for you to develop a topic of current interest, do a complete literature search, prepare and deliver a public seminar on this topic. All seminars will be delivered during the Academic Excellence Showcase.
- The seminar must be 30 minutes in length to pass this course. You will have 30-35 minutes for your presentation followed by a 5-10 minute question period.
- Your literature search must involve a Chemical Abstracts and on-line database search. You will prepare an annotated bibliography of all the sources that you use in preparing your seminar. You must have journal articles among your references. More details about the annotated bibliography will be available via the Moodle class site. The annotated bibliography is to be printed and copies distributed during your seminar.
- If you do not have at east two references from primary literature surces such as peer reviewed scientific journals, you topic is not acceptable for use as a seminar topic. You may use internet resources, but they may not comprise the bulk of your references.

- Your seminar will be presented using Power Point as your visual aid tool. You may do a demonstration if it is appropriate to your topic. You may also insert video into your presentation if it is directly needed to clarify some point you need to make during your seminar. Video clips in which someone else is delivering the spoken content must be limited to 2 minutes or less. A clip may be longer if you are doing a voice over during the showing of the video.
- This seminar is a formal presentation. You will dress in a professional manner to present your seminar such as a dress, skirt or suit for women and a tie and sport coat or suit for men. You might as well get used to this type of attire as it is what is expected of you when you go to a job interview!
- Everyone will give a draft presentation of their seminars. Your draft presentation will likely not be during the normal class period. Please make time in your schedule for the dress rehersals. You must attend at least two dress rehearsals other than your own. From past experience, the more you support each other, the better your seminars will be.
- The abstract is the description of your seminar that will be published in the Academic Excellence Showcase Proceedings volume. You will prepare and submit this abstract electronically.

Ch 440 **Physical Chemistry (I)** Fall 2010
Levine 5^{th} Ed.

The assessment form in this course was based upon a selected number of learning outcomes (see below) and students' performance on midterms and final exam.

- Graded on a 100-point scale, for this assessment students scoring 70 or higher on the midterms demonstrated competence on the learning outcomes.
- The average score on the first exam was 68.8 while the highest score was 79.5.
- The average score on the second midterm was 77.5 while the highest score was 88.
- The average score on the final was 59.0 while the highest score was 82.

Ch 440 **Physical Chemistry (I)**

Some of the following items were used on the midterms and the final exam as the **LEARNIG OUTCOMES** for this course.

1. Name the four branches of physical chemistry.
2. Be able to use differentiation or partial differentiation of various functions.
3. Apply indefinite and definite integrals in solving problems throughout the course.
4. Apply the First Law of Thermodynamics.
5. Understand terminologies such open, closed, isolated, homogeneous, heterogeneous systems, surroundings, adiabatic, thermodynamic equilibrium, extensive versus intensive properties, phase, and equation of state.
6. Calculate P (V or T) of an ideal gas or an ideal gas mixture using PV = nRT.
7. Calculate molar mass, density, and partial pressures.
8. Use thermal expansivity coefficient (α) and isothermal compressibility (κ) to find volume changes produced by T or P changes.
9. Calculate ΔH, ΔU, q, w, for various processes, namely, phase change, heating at constant pressure (or volume), isothermal reversible, adiabatic reversible expansion (or compression).
10. Apply the Second Law of Thermodynamics.
11. Calculation of ΔS for various processes involving perfect gases. This includes mixing of gases, constant-pressure heating, reversible phase change, etc.
12. Calculate q, w, ΔU, and ΔH for adiabatic expansion of a perfect gas in vacuum.
13. Understand the line integral, specifically, $\int$.
14. Understand the Joule and Thomson experiments and be able to apply the results in solving various problems such as cooling.
15. Understand Carnot cycle and calculation of the efficiency of a heat engine.
16. Understand the Gibbs energy, G, and the Helmholtz energy, A, and Calculation of ΔG and ΔA under various conditions like isothermal, adiabatic,
17. Apply Euler reciprocity relation to the Gibbs equations and be able to use the Maxwell relations to derive formulas in terms of measurable properties such as α, κ T, V, and P.
18. Calculation of $C_p - C_v$, $(\partial U/\partial V)_T$, $(\partial H/\partial P)_T$, etc.
19. Conditions for material equilibrium.
20. Understand the Kirchhoff's law and the temperature dependence of reaction heats.

21. Be able to estimate $\Delta H°$ using bond energies.
22. Use numerical integration to calculate the absolute entropies for substances.
23. Understand the Third Law of Thermodynamics.
24. Calculation of ΔU for a reaction from adiabatic bomb calorimeter.
25. Understand the Nernst-Simon entropy statement and the unattainability of absolute zero.
26. Calculation of ΔH from ΔU and vice versa for a chemical reaction.

Ch 441 **Physical Chemistry (II)** Winter 2011

The assessment form in this course was based upon a selected number of learning outcomes (see below) and students' performance on midterms as well as the final exam.

Graded on a 100-point scale, for this assessment students scoring 70 or higher on the midterms demonstrated competence on the learning outcomes.

- The average score on the first exam was 69.7 while the highest score was 79.5.
- The average score on the second midterm was 64.3 while the highest score was 79.5.
- The average score on the final exam was 71.8 while the highest score was 82.

Ch 441 **Physical Chemistry (II)**

Some of the following items were used on the midterms and the final exam as the **LEARNIG OUTCOMES** for this course.

Having read chapters 6, 7, 8, 9, 10, 12, and 15, you should be able to:

1. Calculate $K_P°$ and $\Delta G°$ from observed equilibrium composition.
2. Calculate $K_P°$ and $\Delta G°$ using $\Delta G° = - RT\ln K_P°$.
3. Calculate the equilibrium composition from $K_P°$ and the initial composition for constant-T and -P or constant-T and V-conditions.
4. Calculate $K_P°$ at T_2 from $K_P°$ at T_1 using $d\ln K_P°/dT = \Delta H°/RT^2$.

5. Calculate $\Delta H°$, $\Delta G°$, and $\Delta S°$ from $K_P°$ versus T data using $\Delta G° = - RT\ln K_P°$.
6. Understand the chemical potential and their role in determining the thermodynamic properties.
7. Predict the shifts in Ideal-Gas Reaction equilibria.
8. Understand the Phase-Rule and its application.
9. Understand the Clapeyron equation.
10. Understand the phase diagrams involving pure substances.
11. Understand higher-order phase transitions.
12. Understand Real-Gas equation of state such as van der Waals, Redlich-kwong, etc.

13. Understand the compressibility factor, condensation, the critical state.
14. Understand the liquid- vapor equilibria.
15. Understand, ideal solutions, partial molar quantities, mixing quantities, solution composition, thermodynamic properties of ideal solutions.
16. Understand ideally dilute solutions and their properties.
17. Understand Raoult's law, Henry's law and its application such as solubility of gases.
18. Understand nonideal solutions, activities and activity coefficients.
19. Understand solutions of electrolytes.
20. Understand colligative properties.
21. Calculate the osmotic pressure, vapor-pressure lowering, boiling point elevation and freezing point depression and molecular weight determination.
22. Interpret the multicomponent phase diagrams.
23. Understand the Kinetic-Molecular theory of gases.

24. Understand the Distribution of Molecular Speed and application of Maxwell Theory.
25. Understand molecular collisions and mean free path.
26. Understand the Boltzmann Distribution Law.
27. Understand the barometric formula.
28. Understand the heat capacities of ideal polyatomic gases.

Ch 411 **Advanced Inorganic Chemistry** Winter 2011
Text: J. Bowser

The assessment form in this course was based upon a selected number of learning outcomes (see below) and students' performance on midterms as well as the final exam.

> Graded on a 100-point scale, for this assessment students scoring 70 or higher on the midterms demonstrated competence on the learning outcomes.

- The average score on the first exam was 89.7 while the highest score was 90.
- The average score on the second midterm was 81.3 while the highest score was 91.
- The average score on the final exam was 78.3 while the highest score was 85.

Some of the following items were used on midterms and the final exam as the **LEARNIG OUTCOMES** for this course.

Having read chapters 1, 2, 3, 4, 5, and 6, you should be able to:

1. Recognize the atomic number, mass number and isotopes.
2. Understand orbitals of the hydrogen atom and quantum numbers.
3. Understand the multi-electron atom, the *aufbau* principle and electronic configurations
4. Recognize the excited state electron configurations.
5. Understand the periodic table.
6. Understand the atomic size, ionic size, ionization energies and electron affinities.

7. Rank the elements (or ions) according to their atomic size, ionization energy, etc.
8. Draw the Lewis structures, the octet rule.
9. Understand the Valence Bond theory and the fundamentals of Molecular Orbital theory.
10. Understand the electronegativity, dipole moments, formal charge rules, and polarity.
11. Apply the MO theory to heteronuclear diatomic and triatomic molecules.
12. Apply the VSEPR theory to predict the molecular shape.
13. Use the Slater rules to calculate the effective nuclear charge (Z^*).
14. Understand symmetry operators and symmetry elements, point groups and be able to recognize them.
15. Understand the character tables for various point groups.
16. Understand the application of group theory in vibrational spectroscopy (IR and Raman)
17. Understand the different interactions among various orbital, specifically, formation of sigma (σ), pi (π) , and delta (δ) bonds.
18. Determine the number of irreducible representations in a given reproducible representation.
19. Understand bonding in polyatomic molecules, hybridization of atomic orbital.
20. Distinguish the difference between polymorphism and allotropy.
21. Understand ionic solids, lattice energy and Born-Haber cycle.
22. Understand the defects, namely, Schottky and Frenkel defects in solid state lattices.
23. Understand ionic lattices, types of cubic lattices, radius ratio.
24. Distinguish among covalent radius, van derWaals radius, metallic radius and ionic radius.
25. Estimate the lattice energy based upon the electrostatic model (i.e. coulombic attraction).
26. Understand the introduction of the Madelung constant (A) and the Born exponent (forces) into the electrostatic model.
27. Use the Kapustinskii equation to estimate the lattice energy.
28. Understand the meaning of the terms like band theory, band gap, intrinsic and extrinsic semiconductors, n- and p-type semiconductors, doping (a semiconductor), insulator, and interstitial hole.

Ch 442 **Physical Chemistry (III)** Spring 2011

The assessment form in this course was based upon a selected number of learning outcomes (see below) and students' performance on the midterms and the final exam.

Graded on a 100-point scale, for this assessment students scoring 70 or higher on the midterms demonstrated competence on the learning outcomes.

- The average score on the first exam was 65.1 while the highest score was 82.
- The average score on the second midterm was 64.7 while the highest score was 79.
- The average score on the final was 61.2 while the highest score was 81.5.

Some of the following items were used on the midterms and the final exam as the **LEARNIG OUTCOMES** for this course.

Having read chapters 17, 18, 19, and 20, you should be able to:

1. Understand the measurement of reaction rates.
2. Understand the integration of the rate laws.
3. Determine the rate law.
4. Understand the rate laws and the equilibrium constants for an elementary reaction.
5. Understand temperature dependence of the rate constant.
6. Understand relation between the rate constant and the equilibrium constant for composite reactions.
7. Understand the molecularity.
8. Understand the relaxation techniques and fast reactions.
9. Understand the catalysis, both homogeneous and the heterogeneous.
10. Understand the nuclear decay.
11. Calculate the activity of a radioactive sample at time t from its half-life and initial activity.
12. Determine the reaction orders from kinetic data.
13. Use the Arrhenius equation to calculate A and E_a from k versus T data.
14. Understand Blackbody radiation and energy quantization.
15. Understand the Photoelectric Effect and photons.
16. Understand the Bohr Theory of the H-atom.
17. Understand the de Broglie Hypothesis and be able to solve problems involving the de Broglie equation.
18. Understand the Uncertainty Principle.
19. Understand the Classical Mechanics versus the Quantum Mechanics.
20. Understand the physical meaning of the state function Ψ used in the time-independent Schrödinger equation.
21. Understand the meaning associated with the stationary states and their properties.
22. Understand the meaning of a “well-behaved” function.
23. Understand the “Particle in a One-Dimensional Box”.
24. Understand the “Particle in a Three-Dimensional Box” and its application in real chemical systems.
25. Understand the terms such as degeneracy, operators, eigenfuction, eigenvalue, Laplacian operator, linear operator, average (expectation) value.
26. Understand the One-Dimensional Harmonic Oscillator, Energies wavefuctions , nodes.
27. Understand the tunneling phenomenon, and the meaning of the *classically forbidden* regions.
28. Understand the Two Particle Rigid Rotor, rotational energy levels.
29. Understand the approximation methods, namely, the variation method.
30. Understand the orthogonality of eigenfunctions, Hermitian operators and an orthonormal set.
31. Understand the atomic structure, the H-atom, angular momentum, quantum numbers real wavefunction, spherical harmonics, probability density, electron spin.
32. The helium atom and the Pauli principle.
33. Understand the symmetric versus antisymmetric functions, fermions, bosons.
34. Distinguish the symmetric from antisymmetric wavefunctions.

35. Calculate the total orbital and spin angular momenta for multielectron atom.

Ch 221 **General Chemistry** Winter 2011

The following items were used on the quizzes, midterms and the final exam as the learning outcomes for this course.

The assessment form in this course was based upon a selected number of **LEARNING OUTCOMES** (see below) and students' performance on midterms as well as the final exam. Graded on a 100-point scale, for this assessment students scoring 70 or higher on the midterms demonstrated competence on the learning outcomes.

- The average score on the first exam was 66.5 while the highest score was 95.
- The average score on the second midterm was 60.6 while the highest score was 94.
- The average score on the final exam was 61.8 while the highest score was 86.

Having read chapters 1, 2, 3, 4, 6, 7, and 8 you should be able to:

1. Distinguish between the chemical change, physical change or physical versus chemical property.
2. Recognize the mixtures versus compounds, homogeneous versus heterogeneous solution.
3. Classify matter as an element, substance or a compound.
4. Give the (derived) SI base units, some common SI prefixes with their associated decimal multipliers.
5. Convert between the metric and the British systems.
6. Convert from Fahrenheit, to Celsius and Kelvin temperatures or vice versa.
7. Solve problems involving the density, mass and volume.
8. Recognize the intensive from the extensive properties.
9. Perform mathematical operations with the correct number of significant figures.
10. Understand the difference between accuracy and precision. Uncertainty in a measured quantity.
11. Provide the statements of Dalton's atomic theory and the fundamental chemical laws.
12. Show the validity of the law of conservation of matter, the law of constant composition and the law of multiple proportions from the experimental data.
13. Define radioactivity, characteristic properties of alpha, beta and gamma radiations.
14. Understand and distinguish atomic number, atomic mass, mass number, isotopic mass, amu.
15. Give the number of neutrons, protons and electrons for a given isotopic species (e.g. ^{14}C, ..).
16. Calculate the atomic weight of an element from its isotopic abundance and the isotopic mass or find the isotopic abundance from the atomic weight and its isotopic mass.
17. Identify the periodic table location of *groups, periods, metals, metalloids, nonmetals, alkali metals, alkaline earth metals, halogens, noble gases and transition elements.*
18. Name compounds (both ionic and covalent) or given the name, be able to write the formulas

as practiced in the lab.

19. Understand the mole concept and use mole to solve chemical problems. Namely, given the mass of a reactant, calculate the mass of a product from a balanced equation.
20. Convert grams to moles to number of atoms (or molecules) and vice versa.
21. Understand the empirical, molecular and structural formulas.
22. Understand molar mass of an element or a compound and calculate the molar mass from the atomic mass.
23. Calculate the percent composition from molecular formula.
24. Use experimental data to calculate the number of water molecules in a hydrated compound.
25. Calculate the empirical formula from percentage. Also, given the molecular weight, find the molecular formula.
26. Use the nomenclature to name a compound or given the name, be able to write its formula.
27. Balance chemical reactions by inspection such as combustion reactions.
28. Complete and balance combustion reactions.
29. Relate reactant mass to the product mass, simple stoichiometry.
30. Solve problems involving, limiting reagent, % yield calculations, empirical/molecular formula.
31. Name and distinguish an electrolyte from a nonelectrolyte, strong from weak.
32. Name strong acids and bases.
33. Write the net ionic equations by applying the solubility rules to these reactions.
34. Distinguish the soluble from insoluble compounds.
35. Recognize the monoprotic, diprotic and triprotic acids and give examples for these acids.
36. Define acids or bases according to Arrhennius's or Brønsted.
37. Complete and balance chemical reactions and their classifications.
38. Classify different types of reactions and be able to recognize the redox reactions, assign the oxidation number, identify the element reduced/oxidized , reducing/oxidizing agents.
39. Balance the redox equations in acidic solutions.
40. Solve problems involving molarity(M) including dilution, preparation of solution with a specified concentration.
41. Solve titration problems involving redox, acid-base or gravimetric analysis.
42. Distinguish various forms of kinetic/potential energy, their classification and the units.
43. Use the first law of thermodynamic.
44. Solve calorimetry problems involving specific heat, heat capacity, q, and the temperature.
45. Use Hess's law to calculate)H for a specified reaction.
46. Identify the state functions.
47. Use the heat of formations,)H_f°, to calculate the heat of a reaction.
48. Use the first law of thermodynamics to calculate the internal energy change.
49. Understand the difference between the endothermic and exothermic reactions.
50. Understand the heat of solution ()H_{soln}), lattice energy (U) and heat of dilution.
51. Define node, frequency, and wavelength.
52. Calculate frequency, wavelength and energy of electromagnetic radiation, Planck's equation.
53. Explain the photoelectric effect and the wave-particle duality and de Broglie equation.
54. Explain terminologies such as: ground state, excited state and line spectrum .
55. Calculate the energy of an electron in any orbit (level) according to the Bohr's model.
56. Explain the uncertainty principle.
57. Use quantum numbers; give possible allowed values associated with each. See the

homework.

58. Sketch and identify the shapes of s, p, and d orbitals and give the number of spherical nodes.
59. Choose the paramagnetic/diamagnetic atoms.

60. Write out the electron configurations ($1s^2 2s^2$....) and/or give the orbital box diagram designations for both atoms and ions.
61. Explain the Hund's rule and the Pauli Exclusion Principle.
62. Tell the number of valence electron(s) associated with the **main groups** elements (1A through 8A).
63. Apply the restriction imposed on each quantum number (allowed values) in deciding which set of quantum numbers are acceptable.
64. Understand the shielding effect in many-electron atoms.
65. Arrangement of the element in the periodic table and their classification.
66. Understand the effective nuclear charge and its role in predicting the atomic size and the ionic size.
67. Understand the trends in atomic size, ionization energies, and electron affinities.
68. Rank elements or ions according to their size, and the their ionization energies.
69. Choose the isoelectronic ions from a given list.
70. Explain the variation in chemical properties of the representative elements. Group 1A & 2A.

Ch 222 **General Chemistry** **Spring 2011**

The assessment form in this course was based upon a selected number of **LEARNING OUTCOMES** (see below) and students' performance on quizzes, midterms as well as the final exam. Graded on a 100-point scale, for this assessment students scoring 70 or higher on the midterms demonstrated competence on the learning outcomes.

- The average score on the first exam was 76.2 while the highest score was 94.
- The average score on the second midterm was 69.2 while the highest score was 94.
- The average score on the final exam was 68.2 while the highest score was 88.

Having read chapters 8,9,10, 5, 12, and 13 you should be able to:

1. Give the number of valence electrons associated with each element (only the main groups).
2. Define free radical, isoelectronic species and give examples of each.
3. Rank the polarity of chemical bonds.
4. Use the atomic or ionic trends to rank them according to their size and their ionization energies.
5. Answer question regarding the chemical properties, completing chemical reactions associated with the elements, oxides, etc. (descriptive chemistry).
6. Give examples of various oxides and their reaction with water.
7. Draw the Lewis electron (dot) structures for atoms, ions and molecules.
8. Identify polar or nonpolar species.
9. Define lattice energy , choose ionic compound with higher lattice energy, higher melting point or/and greater solubility
10. Use the Born– Haber cycle to calculate the electron affinity, ionization energy, lattice energy, sublimation energy, ... and the heat of formation.
11. Tell the difference between electronegativity and electron affinity.
12. Calculate the formal charge and be able to choose the most important Lewis or resonance structure.
13. draw the resonance structures for a given ion or molecule.
14. Use bond energies to calculate the heat of a reaction (ΔH) or given the heat of a reaction find the bond energy.
15. Use the VSEPR theory to assign electron geometry and the molecular geometry (shape).
16. Use the valence bond theory to describe bonding or assign the hybridization to the central atom.
17. Use the MO theory to explain molecular properties such as paramagnetic, diamagnetic species, bond order, bond length, and stability.
18. Understand the delocalized molecular orbitals.
19. Use Valence Bond Theory to describe bonding in molecules containing multiple bonds.
20. Use Molecular Orbital Theory to explain the molecular properties such as bond order, magnetic property, bond length, and bond energy in diatomic molecules or ions.
21. Understand gas laws and use the related equations to solve problems involving pressure, volume, temperature, density, molecular weight, and the gas stoichiometry.
22. Understand Dalton's Law of partial pressures and mole fractions, specifically collection of a gas over water.
23. Understand the Kinetic Molecular Theory of gases, distribution of molecular speed, root-mean-square speed (u_{rms}), diffusion rate and its relation to molecular weight and associated calculations.
24. Intermolecular forces and their strength in liquids. Name the strongest intermolecular force in a given liquid.
25. Choose compound with higher boiling point based upon the strength of their intermolecular forces.

26. Draw H–bonds for molecules capable of forming hydrogen bonds.
27. Explain the properties of liquids, namely surface tension, viscosity, vapor pressure, boiling point and their relationship with the intermolecular forces.
28. Interpret the phase diagrams. Cooling curves and their interpretations.
29. Relate ΔH_{vap}, with ΔH_{fus} and ΔH_{sub}, ...
30. Solve problems involving the Clausius – Clapeyron equation.
31. Understand crystals forming the cubic unit cells and be able to solve problems involving density, edge length, radius, number of atoms per unit cell, atomic weight, ...
32. Understand different types of crystals and their general properties. Be able to give an example. See table 11.4.
33. Use Henry's law in order to determine the solubility of gases in a solvent.
34. Use colligative properties (vapor pressure lowering , Raoult's law, freezing point depression) to solve the related problems. This includes determination of molar mass, boiling point and the freezing point, mass of the solute, ...
35. Determine the van't Hoff factor, *i*, or to apply this factor to a solution of an electrolyte.
36. Understand collision theory, activation energy, temperature effect and the Arrhenius equation.
37. Understand catalysis, homogeneous and heterogeneous catalysts
38. Understand the reaction mechanisms, molecularity, elementary steps, rate determining step and the intermediate(s).
39. Determine the rate law from the proposed mechanism(s).
40. Determine a plausible mechanism.

Ch 463 **Experimental Chemistry** Spring 2011

Chemistry 463 – Learning Outcomes

This laboratory course focuses on the experimental aspects of Physical Chemistry and allows students to apply their knowledge based upon theoretical principles studied throughout the year. Completion of the final lab examination will also be required.

The assessment form in this course was based upon a selected number of experiments (see below) and students' performance on the final exam.

- Graded on a 20-points per lab report and a 40 points final exam, students scoring 140 points or greater demonstrated competence on the learning outcomes.
- The average score on formal lab reports was 15.2 out of 40.

- The average score on the final was 62.8 (%) while the highest score was 70(%).

Having completed this laboratory course, students are able to

1. Determine the Heat and Entropy of a reaction from temperature dependence of its equilibrium constant.
2. Determine the entropy of dissolution of a substance involved in an endothermic process.
3. Investigate the internal energy and the enthalpy using bomb calorimeter.
4. Determine the equilibrium constant for a homogeneous reaction.
5. Investigate the thermodynamics of a gas phase equilibrium reaction: Reversible dissociation of N_2O_4.
6. Determine the PK_a of an organic acid in the first excited singlet state as compare to the ground state.
7. Investigate the spectrum of a particle in a box using some conjugated organic molecules.
8. Determine the molecular properties of some diatomic molecules using classical mechanics, quantum mechanics and statistical mechanics.
9. Determine the Heat and Entropy of a reaction from temperature dependence of its equilibrium constant.
10. Determine the entropy of dissolution of a substance involved in an endothermic process.
11. Investigate the internal energy and the enthalpy using bomb calorimeter.
12. Determine the equilibrium constant for a homogeneous reaction.
13. Investigate the thermodynamics of a gas phase equilibrium reaction: Reversible dissociation of N_2O_4.
14. Determine the PK_a of an organic acid in the first excited singlet state as compare to the ground state.
15. Investigate the spectrum of a particle in a box using several conjugated organic molecules.
16. Determine the molecular properties of some diatomic molecules using classical mechanics, quantum mechanics and statistical mechanics.

LAS
Embedded Assessment Action Report

For

Program Review

Degree Program(s): __________BS Chemistry________________________________

(BA, BS, BFA, MA, MS, LACC, etc.)

Course # / Title: ___Ch221 General Chemistry, F 2010______________________

Faculty name: _____Pete Poston____

Date: ______________________________________

A) State the program **learning outcome** or **general education goal** this assessment is linked to:

The following items were used on the quizzes, midterms, and final exams (both lecture and lab) as the **LEARNING OUTCOMES** for this course.

- # be able to apply the scientific method
- # classification of matter
- # Metric System
- # Scientific calculations following significant figure conventions
- # Chemical Nomenclature
- # Atomic Theory
- # The Periodic Table
- # Molecules and Ions
- # molecular vs. empirical formulas
- # predicting formulas of ionic compounds
- # definition of atomic mass and molecular masses
- # The mole, molar mass, and Avogadro's number
- # Conversions between grams, moles, and atoms
- # Determining empirical formula from % composition
- # Combustion analysis
- # Stoichiometry calculations and limiting reagents
- # strong, weak, and non-electrolytes
- # Precipitation Reactions and Solubility Rules
- # Net Ionic Equations
- # Arrhenius versus Bronsted definition of acids/bases
- # Acid-Base Neutralization Reactions
- # Oxidation-Reduction (Redox) reactions and Oxidizing and Reducing agents
- # Half reactions
- # Molarity and the Dilution Equation
- # Stoichiometry problems using molarity

Titrations
Law of Conservation of Energy, Potential and Kinetic Energy
Units of heat energy
Thermochemistry - Exothermic versus endothermic reactions
Thermodynamics – state and state functions
Enthalpy
Stoichiometry calculations involving heat
Calorimetry – constant volume and constant pressure
Using $\Delta H^o_{rxn} = \Sigma\, n_p \times \Delta H_f^o$(products) - $\Sigma\, n_r \times \Delta H_f^o$(reactants)
Hess' Law Calculations
Properties of waves: $u = \lambda\nu$ (memorize)
Electromagnetic radiation and the Electromagnetic Spectrum
Atomic Line Spectra
The Bohr Model of Hydrogen

B) Check the embedded assessment tool(s) used :

x Exam question
☐ Essay
☐ Oral presentation
☐ Thesis
☐ Portfolios
☐ Practicum / Service Learning
☐ Capstone paper / project
☐ Other ____

Attach a copy of the actual question / assignment as it is presented to the student or a description of the embedded process.

Copies of the midterms, final, or quizzes are available if needed.

The assessment form in this course was based upon a selected number of ***learning outcomes*** and students' performance on two midterms, eight quizzes, a lecture final exam, lab experiments (handouts), and a lab final.

- Students demonstrated competence on the learning outcomes by scoring 70% (considered a "C") or higher overall in the class. The course grade was based on the following lecture and lab components:

200 pts (36%) 2 hour exams

200 pts (36%) comprehensive final

100 pts (18%) 25 pts from lab final, 75 points from lab exercises (drop lowest score)

50 pts (9%) quizzes (drop the lowest and scale total to 50 pts)

550 pts total

- The average score on the first midterm was 71%
- The average score on the second midterm was 71%
- The overall quiz average was 84%
- The average score on the lecture final exam was 62%
- The average overall score in the class was 72%

LAS
Embedded Assessment Action Report

For

Program Review

Degree Program(s): __________BS Chemistry_________________________________

(BA, BS, BFA, MA, MS, LACC, etc.)

Course # / Title: ___Ch222 General Chemistry, W 2011_____________________

Faculty name: _____Pete Poston____

Date: ______________________________________

A) State the program **learning outcome** or **general education goal** this assessment is linked to:

The following items were used on the quizzes, midterms, and final exams (both lecture and lab) as the **LEARNING OUTCOMES** for this course.

- Quantum Mechanics – basic principles
- energy of orbitals in Hydrogen and multielectron atoms
- splitting of subshell energies in multielectron atoms due to greater penetration of s-electrons compared to p and d.
- energy level filling order diagram (memorize)
- the Pauli Exclusion Principle, the Aufbau Principle, and Hund's rule
- electron configurations through Z= 36 including Cr and Cu exception
- orbital box diagrams
- know where the s, p, d, and f-blocks are in the periodic table, and use them to determne electron configurations
- electron spin and cause of magnetism
- diamagnetism and paramagnetism
- Mendeleev and the Periodic Law
- Representative elements, Noble gases, Transition elements, f-block transition elements
- valence electrons – representative vs. transition metals
- electron configurations of cations and anions (transition metals s-electrons removed first)
- shielding and effective nuclear charge (nuclear charge effect)
- periodicity in atomic radius, ionic radius, ionization energy, and electron affinity
- Lewis dot symbols
- Lewis structures for ionic compounds
- Lattice energies, Coulomb's Law, and Born-Haber cycles
- Lewis structures for covalent compounds, single, double, and triple bonds
- Bond lengths

- properties of covalent vs. ionic compounds
- polar covalent compounds
- trends in electronegativity
- predicting polar covalent vs. ionic bonds
- Lewis structures for charges species
- formal charge
- guidelines for drawing Lewis structures including (1) selecting a central atom with the lowest electronegativity, (2) choosing a structure with the least formal charge on each atom, (3) choosing a structure where the lowest formal charge is on the most electronegative atom
- drawing resonance structures (hybrids)
- Exceptions to the Octet Rule: (1) less than 8 valence electrons for Group 3A, (2) expanded octets when the central atom is in the 3^{rd} period or higher (exccpt for charged polyatomic ions mentioned in the major exception above), (3) odd-electron species (free radicals)
- bond energies and calculation of ΔH^{o}_{rxn}
- VSEPR Geometry (A = central atom, B = terminal atom, E = lone pair)
- Applying VSEPR theory - (1) Lewis structure, (2) count electron clouds around central atom, (3) determine appropriate VSEPR electron cloud geometry first, (4) then determine molecular geometry based on the position of atoms in space
- Remember: Multiple bonds count as one cloud in VSEPR theory
- Molecular geometries of more complicated molecules with more than one central atom (apply VSEPR theory to each central atom)
- Dipole moments and polar molecules
- Valence Bond Theory – hybrid orbitals
- σ and π bonds
- Be able to illustrate hybridization for simple molecules using orbital diagrams, showing σ and π bonds
- Molecular Orbital Theory – bonding and antibonding orbitals, given MO energy diagrams (be able to fill in the MO's, determine stability based on bond order, predict magnetism, and identify as σ vs π-bonding
- Gas phase elements - H_2, N_2, F_2, O_2, Cl_2 and the Noble Gases
- Properties of gases – indefinite shape and volume, compressible, mix together evenly and completely, low densities (g/L)
- Pressure = force/area, units: atm, mmHg (Torr), Pa; converting between units
- Mercury barometer
- Simple Gas Laws:
- Avogadro's Law and Stoichiometery: equal volumes of any two gases contain the same number of moles
- Ideal Gas Law: PV = nRT
- Deriving simple gas laws from Ideal Gas Law
- STP: standard temperature and pressure = 1 atm and 273K; 1 mole of any gas occupies 22.4 L @ STP
- Situations where many variables change simultaneously: $P_1V_1/n_1T_1 = P_2V_2/n_2T_2$
- Calculating densities and molecular weights from the Ideal Gas Law: d = PM/RT, rearranging then M = dRT/P, if don't know density then M = gRT/PV
- Gas Stoichiometry Problems
- Dalton's Law of Partial Pressures
- Collecting a gas over water: $P_{total} = P_{gas} + P_{H2O}$
- Kinetic Molecular Theory: $\langle KE \rangle \,\alpha\, T$, molecular speeds as a function of temperature and molar mass
- intermolecular forces:
- Properties of liquids: surface tension, cohesion and adhesion, viscosity,
- Unique properties of water: 3-D hexagonal structure of ice (unusual because the solid is less dense than the liquid), maximum density at 4 ^{o}C (why?)
- Kinetic Molecular Theory of liquids
- Liquid-vapor equilibrium – evaporation and condensation, equilibrium vapor pressure, boiling

point, ΔH_{vap}, trends in boiling point and ΔH_{vap} and dependence on intermolecular forces (Table 11.6)

- Clausius-Clapeyron equation (given)
- Vapor pressure vs. temperature curves and effect of intermolecular forces
- Liquid-solid equilibrium – melting and freezing point, ΔH_{fus}, trends in melting point and ΔH_{fus} and dependence on intermolecular forces
- Heating curves – qualitatively understand what happens as you heat a substance through phase boundaries
- Solid-vapor equilibrium – sublimation and deposition, $\Delta H_{sub} = \Delta H_{fus} + \Delta H_{vap}$
- Be able to use ΔH_{vap}, ΔH_{fus}, and ΔH_{sub} to calculate heat changes across phase boundaries
- Phase diagrams – boundaries, positive vs. negative slope for solid-liquid boundary, triple point, critical T and P, supercritical fluids
- saturated, unsaturated, supersaturated
- concentration units – mole fraction (χ), molarity (M), molality (*m*)
- Colligative Properties of Nonelectrolyte Solutions – vapor pressure lowering and Raoult's Law, boiling point elevation and freezing point elevation calculations
- Using colligative properties to determine molar mass
- Colligative Properties of Electrolyte Solutions – van't Hoff factor
- A molecular view of the solution process – miscible vs. immiscible, Like dissolves Like
- The effect of temperature on solubility – solubility of solids and fractional crystallization, gas solubilities
- The effect of pressure on the solubility of gases – Henry's Law
- factors controlling reaction kinetics
- definition of a rate and determining graphically by measuring slope
- average vs. instantaneous rate
- reaction rates and stoichiometry
- The Rate Law: rate = $k[A]^a[B]^b[C]^c$...
- Order of a reaction in terms of a given reactant and overall
- The Method of Initial Rates
- First Order kinetics

B) Check the embedded assessment tool(s) used :

x Exam question
☐ Essay
☐ Oral presentation
☐ Thesis
☐ Portfolios
☐ Practicum / Service Learning
☐ Capstone paper / project
☐ Other ____

Attach a copy of the actual question / assignment as it is presented to the student or a description of the embedded process.

Copies of the midterms, final, or quizzes are available if needed.

The assessment form in this course was based upon a selected number of ***learning outcomes*** and students' performance on two midterms, eight quizzes, a lecture final exam, lab experiments (handouts), and a lab final.

- Students demonstrated competence on the learning outcomes by scoring 70% (considered a "C") or higher overall in the class. The course grade was based on the following lecture and lab components:

200 pts (36%) 2 hour exams

200 pts (36%) comprehensive final

100 pts (18%) 25 pts from lab final, 75 points from lab exercises (drop lowest score)

50 pts (9%) quizzes (drop the lowest and scale total to 50 pts)

550 pts total

- The average score on the first midterm was 72%
- The average score on the second midterm was 71%
- The overall quiz average was 84%
- The average score on the lecture final exam was 62%
- The average overall score in the class was 72%

LAS
Embedded Assessment Action Report

For

Program Review

Degree Program(s): __________BS Chemistry________________________________

(BA, BS, BFA, MA, MS, LACC, etc.)

Course # / Title: ___Ch223 General Chemistry, S 2011______________________

Faculty name: _____Pete Poston____

Date: ______________________________________

A) State the program **learning outcome** or **general education goal** this assessment is linked to:

The following items were used on the quizzes, midterms, and final exams (both lecture and lab) as the **LEARNING OUTCOMES** for this course.

1. Understand collision theory, activation energy, temperature effect and the Arrhenius equation.
2. Understand catalysis, homogeneous and heterogeneous catalysts.
3. Understand the reaction mechanisms, molecularity, elementary steps, rate determining step and identify the intermediate(s), and the catalyst.
4. Determine the rate law from the proposed mechanism(s).
5. Calculate the activation energy from rate constants and temperature changes.
6. Determine a plausible mechanism consistent with the observed rate law.
7. Solve problems involving the first and the second order reactions.
8. Relate the rate of formation of a product to the rate of consumption of a reactant or vice versa.
9. Determine the rate law using the initial rate method.
10. Write the equilibrium constant expression for all chemical reactions involving solid, liquid and gas.
11. Tell the relationship between the chemical reaction (as written) and its equilibrium constant (K_p or K_c)
12. Understand the significance of the magnitude of the equilibrium constant, too large or too small.
13. Understand the reaction quotient, Q, and its relationship to the equilibrium constant (K_c or K_p).
14. Perform the equilibrium calculations. See the separate hand out given in class.
15. Understand the ***Le Châtelier's Principle*** and its application in chemical equilibria. Specifically, predict the direction of shift in equilibrium as we change the conditions such as concentration, temperature, pressure, etc.
16. Tell the various definitions of acids and bases.

17. Give examples of a monoprotic, diprotic and triprotic and amphiprotic substances.
18. Give the conjugate acid given the conjugate base and vice versa.
19. Understand the relationship between the strength of an acid and its ionization (dissociation) constant (K_a).
20. Rank both the binary acids and oxoacids according to their strength.
21. Use relative acid-base strengths to predict the direction of acid - base equilibrium reactions.
22. Use K_w, K_a, K_b and the pH scale in various chemical calculations involving weak acids or bases. Specifically, finding K_a from pH or pH from K_a. Also learn the examples worked out in class. See the note below.
23. Understand ***hydrolysis*** and be able to write hydrolysis reactions for different species.
24. Understand the role of the molecular structure and the acid - base strength (inductive effect).
25. Identify Lewis acid or a Lewis base in an acid-base reaction.
26. Identify buffer solutions and understand their properties such as the capacity.
27. Tell the buffer range for a buffer system.
28. Calculate the pH of any buffer solution.
29. Prepare a buffer solution with a specific pH.
30. Calculate the new pH of a buffer solution after a small amount of acid (or base) has been added.
31. Choose an appropriate indicator from a table for a given acid-base titration reaction.
32. Calculate the pH at any point in an acid-base titration. This includes strong acid-strong base, weak acid-strong base and weak base-strong acid only.
33. Write the K_{sp} expression for all slightly soluble salts (used to be insoluble salt).
34. Calculate the K_{sp} from the solubility data or the solubility from the K_{sp} values.
35. Calculate the solubility of a salt in the presence of the common ion.
36. Recognize the solubility of slightly soluble salts containing basic anions in acidic or basic solutions. That is, the dependency of the solubility upon pH.
37. Decide whether a precipitate forms when the two respective aqueous solutions are mixed.
38. Estimate the relative solubilities from K_{sp}'s of similar salts. No calculation required here.
39. Predict the sign of the entropy change without calculation for simple reactions.
40. Explain the Second Law and the Third Law of thermodynamics.
41. Calculate the entropy change for a chemical reaction from the known molar entropies, S°.
42. Calculate the entropy change for phase transition from the available data.
43. Understand the principle concept of "coupled *reactions"*.
44. Calculate the free energy change for a chemical reaction from □G_f°.
45. Calculate the (minimum) temperature at which the reaction becomes product favored (i.e. spontaneous)
46. Associate the equilibrium constant (K) with the free energy of the reaction, □G°.
47. Understand the difference between□G° and □G and their association with the equilibrium condition.
48. Identify the anode, cathode, oxidation, reduction, electrolyte solutions, polarity, and direction of current (electron flow) in a voltaic or an electrolytic cell.
49. Balance the redox equations both in acidic or basic solutions.
50. Relate E°of the cell to □G°.
51. Calculate the cell potential (cell voltage) using the Nernst equation.
52. Use the table of standard reduction potentials; decide the strongest (or weakest) reducing agent, strongest (or weakest) oxidizing agent.
53. Tell whether or not the reaction is product-favored.
54. Calculate the equilibrium constant from electrochemical information such as E°.
55. Recognize and appreciate the difference between primary and secondary batteries, their advantages or disadvantages.
56. Understand the fuel cells, their benefits and their principal mode of operations.
57. Recognize the corrosion process, in particular, cathodic protection.
58. Identify the reactions that occur during the electrolysis of molten salt versus aqueous salt solution.
59. Apply the Faraday's law to chemical problems involving electrolysis. See the class hand-out.
60. Define the terminologies or words such as isotopes, alpha(□), beta(□), positron etc.

61. Complete and balance a nuclear reaction.
62. Decide whether a given radioactive isotope decays by□, □, □ or an electron capture.
63. Calculate the binding energy of a particular isotope.
64. Calculate the half-life, or be able to apply the equation $\ln[(A)/(A_0)] =$ □kt in problems involving radioactive decay. This also includes radiocarbon dating.
65. Recognize the difference between nuclear fusion and nuclear fission.

B) Check the embedded assessment tool(s) used :

x Exam question
☐ Essay
☐ Oral presentation
☐ Thesis
☐ Portfolios
☐ Practicum / Service Learning
☐ Capstone paper / project
☐ Other ____

Attach a copy of the actual question / assignment as it is presented to the student or a description of the embedded process.

Copies of the midterms, final, or quizzes are available if needed.

The assessment form in this course was based upon a selected number of ***learning outcomes*** and students' performance on two midterms, eight quizzes, a lecture final exam, lab experiments (handouts), and a lab final.

- Students demonstrated competence on the learning outcomes by scoring 70% (considered a "C") or higher overall in the class. The course grade was based on the following lecture and lab components:

200 pts (33%) 2 hour exams
200 pts (33%) comprehensive final
100 pts (17%) 25 pts from lab final, 75 points from lab exercises (drop lowest score)
100 pts (17%) quizzes (drop the lowest and scale total to 100 pts)
600 pts total

- The average score on the first midterm was 67%
- The average score on the second midterm (including bonus points) was 71%
- The overall quiz average was 58%
- The average score on the lecture final exam was 63%
- The average score in the lab was 78%
- The average overall score in the class was 67%

LAS
Embedded Assessment Action Report

For

Program Review

Degree Program(s): __________BS Chemistry________________________________

(BA, BS, BFA, MA, MS, LACC, etc.)

Course # / Title: ___Ch223 General Chemistry, F 2010______________________

Faculty name: _____Pete Poston____

Date: ____

The following items were used on the quizzes, midterms, and final exams (both lecture and lab) as the **LEARNING OUTCOMES** for this course.

B) Check the embedded assessment tool(s) used :

x Exam question
☐ Essay
☐ Oral presentation
☐ Thesis
☐ Portfolios
☐ Practicum / Service Learning
☐ Capstone paper / project
☐ Other ____

Attach a copy of the actual question / assignment as it is presented to the student or a description of the embedded process.

Copies of the midterms, final, or quizzes are available if needed.

The assessment form in this course was based upon a selected number of ***learning outcomes*** and students' performance on two midterms, eight quizzes, a lecture final exam, lab experiments (handouts), and a lab final.

- Students demonstrated competence on the learning outcomes by scoring 70% (considered a "C") or higher overall in the class. The course grade was based on the following lecture and lab components:

200 pts (33%) 2 hour exams

200 pts (33%) comprehensive final
100 pts (17%) 25 pts from lab final, 75 points from lab exercises (drop lowest score)
100 pts (17%) quizzes (drop the lowest and scale total to 100 pts)
600 pts total

- The average score on the first midterm was 76%
- The average score on the second midterm (including bonus points) was 72%
- The overall quiz average was 79%
- The average score on the lecture final exam was 72%
- The average overall score in the class was 77%

LAS
Embedded Assessment Action Report

For

Program Review

Degree Program(s): __________BS Chemistry_________________________________

(BA, BS, BFA, MA, MS, LACC, etc.)

Course # / Title: ___Ch310 Geochemistry__________________________________

Faculty name: _____Pete Poston____

Date: ______________________________________

A) State the program **learning outcome** or **general education goal** this assessment is linked to:

The following items were used on the quizzes, midterms, and final exams (both lecture and lab) as the **LEARNING OUTCOMES** for this course.

- be able to use the exponential decay equation (given) $P(t) = P_o e^{-\lambda t}$
- be able to use the isochron equation (given) $D = D_o + P(t)[e^{\lambda t}-1]$
- Rb/Sr, U/Pb, K/Ar, Ar/Ar, and ^{14}C dating
- Petrogenesis
- Age of the Earth
- Stable Isotopes of Low Atomic Number including Oxygen geothermometry and Global Warming
- Goldschmidt's Classification
- Bowen's Reaction Series
- General rules for Ionic substitution
- Chemical Weathering
- The Carbonate Cycle
- Oxidation
- Hydrolysis of Silicates
- Weathering of K-feldspar to Kaolinite
- Chemistry of H_4SiO_4 and cryptocrystalline quartz
- Clay Mineralogy
- kaolinite and montmorillonite structures
- isomorphous substitution
- interpreting the clay minerals and geologic examples
- The Phase Rule
- Example phase diagrams with a eutectic, solid solution, double eutectic, incongruent melting, and solvus

- Nonequilibrium Effects
- Ternary Phase Diagrams
- Crystallization Of Magmas And Magmatic Differentiation
- Origin Of Basaltic And Granitic Magmas
- Characteristics of Hydrothermal Ore Deposits
- Sunnyside Mine: geologic setting, general mineralization, age, fluid inclusions, pH, source of water, sulfur isotopes & geothermometry, Pb source, mineralization model
- limits of Eh and pH in nature
- H_2O boundaries on Eh/pH diagrams
- Eh/pH diagram for iron and iron minerals, weathering of sulfide minerals, gold. copper
- Supergene Sulfide Enrichment and Porphyry Copper Deposits
- Colorado Plateau Uranium deposits

B) Check the embedded assessment tool(s) used :

x Exam question
☐ Essay
☐ Oral presentation
☐ Thesis
☐ Portfolios
☐ Practicum / Service Learning
☐ Capstone paper / project
☐ Other ____

Attach a copy of the actual question / assignment as it is presented to the student or a description of the embedded process.

Copies of the midterms, final, or quizzes are available if needed.

The assessment form in this course was based upon a selected number of ***learning outcomes*** and students' performance on two midterms, 5 homework sets, and a final exam.

- Students demonstrated competence on the learning outcomes by scoring 70% (considered a "C") or higher overall in the class. The course grade was based on the following lecture and lab components:

200 pts (50%) 2 hour exams

150 pts (38%) comprehensive final

50 pts (12%) 5 homework sets (10 pts each)

400 pts total

- The average score on the first midterm was 81%
- The average score on the second midterm was 95%
- The average score on the final exam was 85%
- The average score on the homework sets was 81%
- The average overall score in the class was 87%

LAS
Embedded Assessment Action Report

For

Program Review

Degree Program(s): ___________BS Chemistry_________________________________

(BA, BS, BFA, MA, MS, LACC, etc.)

Course # / Title: ___Ch312 Quantitative Methods____________________________

Faculty name: ______Pete Poston____

Date: ____

A) State the program **learning outcome** or **general education goal** this assessment is linked to:

The following items were used on the quizzes, midterms, and final exams (both lecture and lab) as the **LEARNING OUTCOMES** for this course.

- propagation of errors - addition/subtraction and mult/div formulas
- frequency distributions and histograms
- Normal Gaussian distributions
- confidence intervals, Student's t-distribution, and the confidence interval of the mean
- Q-testing data
- general titration setup, standard solutions, primary standards, indicators
- endpoint vs. equivalence point
- Equivalence point calculations, percent purity
- back titrations
- Ksp - the solubility product
- solubility calculations:
- The common ion effect
- Will a precipitate form ($Q > K_{sp}$)?
- Stoichiometry review, percent purity calculations, gravimetric factors
- organic precipitating agents
- Properties of precipitates, colloids
- relative supersaturation
- colloid growth and coagulation
- coprecipitation with colloids, digestion
- practical treatment of colloids
- ignition of precipitat
- Bronsted-Lowry theory, conjugate acids and bases
- self-ionization of water and K_w

- strengths of acids and bases - table of strong acids and bases
- classes of weak acids and bases
- hydrolysis reactions
- pH of solutions containing strong acids or bases (given formula if M acid or base very small)
- pH of solutions containing weak acids or bases - approximate, exact, and method of successive approximations
- Henderson-Hasselbach equation
- A buffer in action
- How to practically prepare a buffer solution
- The Effect of Ionic Strength on Solubility of Salts
- Ionic Atmospheres and Increased Solubility
- Activities and activity coefficients
- Charge Effect – equation for calculating ionic strength
- Extended Huckel-Debye equation (given)
- example activity coefficient calculations
- the real definition of pH
- Systematic Treatment of Equilibria: mass balance, charge balance
- indicators and titration errors
- strong acid-strong base titration curve – with either acid <u>or</u> base as analyte
- weak acid- strong base titration curve – with either acid <u>or</u> base as analyte
- amino acids - acidic form (H_2L^+), intermediate (zwitterion - HL), and basic forms (L^-)
- polyprotic acid titration curves - be able to <u>**generally**</u> graph the titration curve using first half eq. pt. = pK_{a1}, first eq. pt. = (pK_{a1} + pK_{a2})/2, etc.
- complex ions, EDTA, stepwise formation constants
- EDTA lab calcs: standardization, percent purity of unknown, water hardnessmasking problems
- pH dependence of EDTA titrations
- Fractional composition diagrams – know general shape for a given acid or base
- Buffers of polyprotic acids/bases
- effective equilibrium constant (Conditional Formation Constant)
- example of using the Conditional Formation Constant in an equilibrium calculation
- titration curves - be able to calculate pM **at the eq. pt.**
- indicators - Calgamite, addition of Mg to the EDTA to sharpen the Ca endpoint
- effect of formation constant and pH on shape of titration curve
- titrations of a mixture – which ion precipitates first
- titration curves of a mixture, be able to calculate concentration of ions in a mixture given the curve and eq. pt. volumes
- Mohr, Volhard, and Fajans methods (including indicators)
- galvanic (voltaic) cells
- standard reduction potentials
- Nernst equation, equilibrium constant formula
- reference electrodes Ag/AgCl and calomel
- converting between scales using different references
- potentiometric titrations - 2^{nd} derivative plots - be able to calculate eq. pt. numerically
- How ion-selective electrodes work – A. liquid-based, glass membrane (e.g.Ca^{2+} ion and pH), B. Solid State (e.g. F^-)
- potentials: 59.2 mV/n voltage change per factor of 10 change in concentration where n = charge on ion
- detection limits and interferences
- sample treatment: tin(II) chloride, $HgCl_2$, Zimmerman-Reinhard reagent
- Fe ore titration calculations – standardization and percent purity
- Theory of redox titration curves – half eq. pt. and endpoint potentials versus the Saturated Calomel Electrode calculation, formal potentials, choice of indicator
- properties of light, $c= \lambda\nu$, $E = h\nu$
- electromagnetic spectrum (know qualitatively) and know what kind of excitation process is occurring: e.g UV-Vis = electronic excitation, IR = vibration etc

- ground states vs excited states, calculating photon energies
- radiant power, Po and P, transmittance and absorbance
- Beer's Law and finding concentration from absorbance
- using Beer's Law – preparing and using calibration curves
- Beer's Law of a Mixture – know how it was applied in the UV-Vis lab
- What Is Atomic Spectroscopy? – know basic instrumental configuration
- flame atomization – aspiration, nebulization, etc
- complete atomization and detection limits
- fuels and flame temperatures as pertains to previous bullet
- What is chromatography?
- mobile phase, stationary phase, elution
- different types of chromatography – adsorption, partition, ion-exchange, molecular exclusion, affinity
- the chromatogram
- internal standard calculations
- basic description of process (stationary phase, mobile phase, match sample polarity to stationary phase, separate by boiling points, etc)
- basic instrumentation
- injection port basics
- capillary columns – we use WCOT
- stationary phases and their effect on separation – be able to draw structure of a polysiloxane
- temperature programming

B) Check the embedded assessment tool(s) used :

x Exam question
☐ Essay
☐ Oral presentation
☐ Thesis
☐ Portfolios
☐ Practicum / Service Learning
☐ Capstone paper / project
☐ Other ____

Attach a copy of the actual question / assignment as it is presented to the student or a description of the embedded process.

Copies of the midterms, final, or quizzes are available if needed.

The assessment form in this course was based upon a selected number of ***learning outcomes*** and students' performance on two midterms, nine labs, a lab notebook, and a final exam.

- Students demonstrated competence on the learning outcomes by scoring 70% (considered a "C") or higher overall in the class. The course grade was based on the following lecture and lab components:

2 midterms	200	points (35 %)
Final - weighted towards final chapters	200	points (35 %)
Lab: first 6 labs at 20 pts; last 3 labs at 10 pts	150	points (26 %)
Lab notebook	25	points (4 %)
Total	575	points

- The average score on the first midterm was 72%
- The average score on the second midterm was 76%
- The average score on the lecture final exam was 72%
- The average score on the lab handouts was 83%
- The average overall score in the class was 71%

LAS
Embedded Assessment Action Report

For

Program Review

Degree Program(s): __________BS Chemistry________________________________

(BA, BS, BFA, MA, MS, LACC, etc.)

Course # / Title: ___Ch313 Instrumental Methods___________________________

Faculty name: ______Pete Poston____

Date: ____

A) State the program **learning outcome** or **general education goal** this assessment is linked to:

The following items were used on the quizzes, midterms, and final exams (both lecture and lab) as the **LEARNING OUTCOMES** for this course.

- Basic statistics review
- Calibration Curves - sensitivity, detection limits (LOD)
- EM radiation – wavelength, frequency, photons
- EM spectrum (know qualitatively) - calculations of □ and □
- Superposition of waves – constructive and destructive interference
- Fraunhofer Diffraction – order, intensity, widths of color bands, blue diffracted smaller angle than red
- Refraction of Light - refractive index, dispersion, unequal widths of color bands, blue refracted larger angle than red
- Interactions of Radiation and Matter – absorption, emission, luminescence, scattering
- Atomic vs. Molecular transitions
- Spectroscopy, Optical Instruments, Optical Spectroscopic Methods
- % basic elements of optical instruments
- Sources of Radiation
- Optical materials – visible, UV, IR
- Filters – FWHM, bandwidth
- Grating monochromator design and components
- Echellette grating and the grating equation, holographic gratins
- Reciprocal Linear Dispersion
- Resolving Power of Monochromators
- Light Gathering Power of Monochromators
- Effect of slit width on resolution
- Resolution
- Radiation Transducers - vacuum phototube, photomultiplier tube, photodiodes, photodiode

arrays, CCD’s, spectral response

- Transmittance and absorbance
- Beer's Law – wavelength dependence of molar absorptivity
- Absorbance spectrum – molar absorptivity is wavelength dependent
- Limitations to Beer’s Law - concentration effect, chemical deviations (equilibrium), polychromatic radiation, stray light
- Light sources – UV and Vis, blackbody radiation and continuum sources
- Single vs. Double Beam Instruments – how double beam instruments remove the background
- Double Dispersing Instruments - How stray light controls the LOD
- Multichannel Instruments
- Absorption by Organic Molecules - types of electronic transitions, e.g. □→ □*, allowed vs. forbidden transitions
- General Absorbance Spectrum
- Spectral details are lost in the liquid phase - fine structure from vibrational sublevels
- Qualitative Analysis - Solvent shifts, effect of ring substituents on aromatic rings, effect of pH (indicators)
- Quantitative Analysis - mixtures, sample matrix and standard addition methods, derivative spectroscopy, enzyme kinetics
- Fluorescence, Phosphorescence and Nonradiative Decay - Singlet vs. triplet states, Jablonski Diagrams
- Quantum Yields
- Vibrational relaxation, internal conversion, intersystem crossing
- Luminescence lifetimes
- Fluorescence and structure
- Illustration of the Heavy Atom Effect
- Emission and excitation spectra
- Instruments for Measuring Fluorescence and Phosphorescence
- Xe-arc lamps
- Spectrofluorometers - corrected spectra
- Phosphorimeters
- Selectivity
- Effect of Concentration on Fluorescence Intensity
- Absorbance vs. Fluorescence Signals
- Comparing UV-Vis to Fluorescence LOD's
- Applications – Inorganic, Organic, Forensics, Imaging
- atomic spectra - emission, absorption, fluorescence
- line broadening
- flame atomization - common fuel mixtures
- flame populations
- flame structure and T profile
- sample positioning and flow rates
- atomization and nebulization
- burners
- electrothermal atomization - graphite furnace
- Atomic Absorption Spectroscopy - hollow cathode lamps
- interferences - releasing & protecting agents, ionization in flames
- LOD's as a function of atomization method
- Inductively Coupled Plasma (ICP) Spectroscopy
- Emission of X-Rays – Electron Beam Source
- Continuum and Line Sources
- Line Spectra (K, L, M...)
- Origin of X-Ray Line Spectra
- Radioactive Sources
- X-Ray Fluorescence
- Diffraction and Bragg’s Law

- Photon Counting
- Wavelength Dispersive versus Energy Dispersive Instruments
- Theory - wavenumbers
- vibrational frequency
- absorption process and selection rules
- types of vibrations (normal modes)
- calculating wavenumber of a peak
- frequency-mass and force constant-bond strength correlations
- Definition of the Fourier Transform – know what it does qualitatively
- FTIR
- Applications of IR
- Qualitative IR - peak identification from a correlation chart
- Quantitative IR - reasons why IR less sensitive and why FTIR has improved sensitivity
- Diffuse Reflectance
- ATR Spectrometry
- IR Microscopy
- Rayleigh scattering (from Ch 6 – section 6B-10)
- Raman Scattering – Stokes and anti-Stokes
- Excitation and Mechanism of Raman Spectra
- Comparison of Raman & IR Spectra
- Instrumentation
- Process Analytical Chemistry
- Theory of NMR – nuclear spin states, spin quantum number (I), number of spin states 2I+1, energy levels in an external magnetic field, ΔE and absorption of radiofrequency radiation
- Classical Description of NMR – precession, circularly polarized radiation, Larmor Frequency
- FT-NMR – pulsed excitation, free induction decay (FID)
- Origin of the Chemical Shift, Shielding
- General Correlation Chart
- Theory of the Chemical Shift – electronegativity, hybridization, acidic protons, magnetic anisotropy
- 1^{st} Order Interpretation of NMR Spectra – spin-spin splitting (N+1 rule), simple interpretation of an NMR spectrum, signal integration
- FT-NMR Spectrometers
- Resolution of FT-NMR Spectrometers
- Carbon-13 NMR
- outline of technique (sample → fragments etc), ion sources
- hard vs. soft ionization
- electron impact (EI) ionization
- electron impact ion source
- McLafferty rearrangement
- example electron impact spectra – alkanes and aromatics
- chemical ionization (CI) – methane as reagent gas
- electrospray ionization and spectra
- Instrumentation outline
- Mass analyzers - magnetic sector, quadrupole, time of flight
- electron multiplier detector
- General Description of Chromatography
- Classification of Chromatographic Methods
- Elution in Column Chromatography
- Plate Theory – band broadening, experimental evaluation of H and N from the chromatogram
- Rate Theory - longitudinal diffusion, stationary phase-mass transfer term, eddy diffusion, Van Deemter equation, optimal flow rate
- Practical Control of Separation
- Resolution
- Retention (Capacity) Factor – optimal value
- Selectivity Factor

- Resolution, capacity factor, and selectivity combined expression
- basic description of process (stationary phase, mobile phase, match sample polarity to stationary phase, separate by boiling points, etc)
- Basic Instrumentation
- injection port – know split vs. splitless
- packed columns, solid support, bonded phases, liquid-coated stationary phases
- capillary columns – we use WCOT
- common stationary phases in capillary GC – be able to draw structure of a polysiloxane, know cross-linking and column bleed (max column temperature)
- Effect of particle size on the Eddy Diffusion term
- temperature programming
- detectors – thermal conductivity, FID, ECD
- Gas Chromatography-Mass Spectrometry – TIC vs. SIC
- example separations
- HPLC, scope of LC, partition chromatography
- LC van Deemter plots – understand effect of particle size and lack of B-term
- Instrumentation
- normal vs. reversed phase separations
- mobile phase

B) Check the embedded assessment tool(s) used :

x Exam question
☐ Essay
☐ Oral presentation
☐ Thesis
☐ Portfolios
☐ Practicum / Service Learning
☐ Capstone paper / project
☐ Other ____

Attach a copy of the actual question / assignment as it is presented to the student or a description of the embedded process.

Copies of the midterms, final, or quizzes are available if needed.

The assessment form in this course was based upon a selected number of ***learning outcomes*** and students' performance on two midterms, an informal writing component, lab handouts, a formal writing component (lab reports), and a comprehensive final exam.

- Students demonstrated competence on the learning outcomes by scoring 70% (considered a "C") or higher overall in the class. The course grade was based on the following lecture and lab components:

200 pts	(36%) two 100 pt hour exams
200 pts	(36%) 200 pt comprehensive final
50 pts	(9%) 8 quizzes @ 10 pts each - score scaled to 50 pts total
100	(18%) labs and written reports (100 pts), writing exercise (10 pts), total scaled to 100 pts.

pts	
550 pts	total

- The average score on the first midterm was 78%
- The average score on the second midterm was 73%
- The average score on the quizzes was 65%
- The average score on the lecture final exam was 67%
- The average score in the lab was 86%
- The average overall score in the class was 78%
-

LAS
Embedded Assessment Action Report

For

Program Review

Degree Program(s): __________BS Chemistry________________________________

(BA, BS, BFA, MA, MS, LACC, etc.)

Course # / Title: ___Ch461 Experimental Chemistry__________________________

Faculty name: _____Pete Poston____

Date: ______________________________________

A) State the program **learning outcome** or **general education goal** this assessment is linked to:

The following items were used on the quizzes, midterms, and final exams (both lecture and lab) as the **LEARNING OUTCOMES** for this course.

- # In addition to a series of standard laboratory exercises, students will be given chemical problems to solve apply their problem-solving skills to the analysis of "real-world" samples in a team environment
- # Much of the emphasis will be environmental and forensic in nature
- # after researching the problems by consulting the literature, they will submit a plan of action to the instructor for approval
- # Since extraction and sampling techniques have not been covered in detail in other courses, students will be taught the basics of solvent extraction, Solid Phase Extraction (SPE), Solid Phase Microextraction (SPME), Soxhlet extraction, and Supercritical Fluid extraction techniques
- # Since this class is a writing-intensive course, there will be a research proposal (PAH's in creosote) and formal lab report required (Au-nanoparticles).
- # Students will become familiar with Quality Assurance-Quality Control (QA-QC) Techniques commonly used in Science and Industry
- # Students will use cutting-edge technology in Raman Spectroscopy and Nanotechnology to design a chemical sensor sensitive to methamphetamine
- # Students will measure photolytic degradation rates of toxic chemicals in the environment, and learn about the role of photocatalysts.
- # A series of 4 quizzes are given to assess lecture material (this is a "lab" course in nature, but new concepts are still taught and tested)

B) Check the embedded assessment tool(s) used :

x Exam question
☐ Essay
☐ Oral presentation
☐ Thesis
☐ Portfolios
☐ Practicum / Service Learning
☐ Capstone paper / project
☐ Other ____

Attach a copy of the actual question / assignment as it is presented to the student or a description of the embedded process.

Copies of the midterms, final, or quizzes are available if needed.

The assessment form in this course was based upon a selected number of ***learning outcomes*** and students' performance on formal lab writing, four quizzes, a lab notebook, and lab experiments (handouts).

- Students demonstrated competence on the learning outcomes by scoring 70% (considered a "C") or higher overall in the class. The course grade was based on the following lecture and lab components:

200 pts	(50%) <u>Writing exercises/Research Results:</u> PAH proposal (60 pts), Nanoparticle formal lab report (100 pts), Lab notebook (40 pts)
100 pts	(25%) <u>Lab Handouts:</u> 5 Lab handouts (20 pts each)
100 pts	(25%) 4 Quizzes (25 pts each)
400 pts	Total

- The overall quiz average was 82%
- The average score on the formal lab writing was 85%
- The average score on the lab handouts was 98%
- The average overall score in the class was 87%

LAS
Embedded Assessment Action Report

For

Program Review

Degree Program(s): __________BS Chemistry________________________________

(BA, BS, BFA, MA, MS, LACC, etc.)

Course # / Title: ___Ch221 General Chemistry, F 2010______________________

Faculty name: ______Pete Poston____

Date: ____

A) State the program **learning outcome** or **general education goal** this assessment is linked to:

The following items were used on the quizzes, midterms, and final exams (both lecture and lab) as the **LEARNING OUTCOMES** for this course.

be able to apply the scientific method
classification of matter
Metric System
Scientific calculations following significant figure conventions
Chemical Nomenclature
Atomic Theory
The Periodic Table
Molecules and Ions
molecular vs. empirical formulas
predicting formulas of ionic compounds
definition of atomic mass and molecular masses
The mole, molar mass, and Avogadro's number
Conversions between grams, moles, and atoms
Determining empirical formula from % composition
Combustion analysis
Stoichiometry calculations and limiting reagents
strong, weak, and non-electrolytes
Precipitation Reactions and Solubility Rules
Net Ionic Equations
Arrhenius versus Bronsted definition of acids/bases
Acid-Base Neutralization Reactions
Oxidation-Reduction (Redox) reactions and Oxidizing and Reducing agents
Half reactions
Molarity and the Dilution Equation
Stoichiometry problems using molarity

- # Titrations
- # Law of Conservation of Energy, Potential and Kinetic Energy
- # Units of heat energy
- # Thermochemistry - Exothermic versus endothermic reactions
- # Thermodynamics – state and state functions
- # Enthalpy
- # Stoichiometry calculations involving heat
- # Calorimetry – constant volume and constant pressure
- # Using $\Delta H^{o}_{rxn} = \Sigma\ n_p \times \Delta H_f^{o}(\text{products}) - \Sigma\ n_r \times \Delta H_f^{o}(\text{reactants})$
- # Hess' Law Calculations
- # Properties of waves: $u = \lambda\nu$ (memorize)
- # Electromagnetic radiation and the Electromagnetic Spectrum
- # Atomic Line Spectra
- # The Bohr Model of Hydrogen

B) Check the embedded assessment tool(s) used :

x Exam question
☐ Essay
☐ Oral presentation
☐ Thesis
☐ Portfolios
☐ Practicum / Service Learning
☐ Capstone paper / project
☐ Other ____

Attach a copy of the actual question / assignment as it is presented to the student or a description of the embedded process.

Copies of the midterms, final, or quizzes are available if needed.

The assessment form in this course was based upon a selected number of ***learning outcomes*** and students' performance on two midterms, eight quizzes, a lecture final exam, lab experiments (handouts), and a lab final.

- Students demonstrated competence on the learning outcomes by scoring 70% (considered a "C") or higher overall in the class. The course grade was based on the following lecture and lab components:

200 pts (36%) 2 hour exams
200 pts (36%) comprehensive final
100 pts (18%) 25 pts from lab final, 75 points from lab exercises (drop lowest score)
50 pts (9%) quizzes (drop the lowest and scale total to 50 pts)
550 pts total

- The average score on the first midterm was 71%
- The average score on the second midterm was 71%
- The overall quiz average was 84%
- The average score on the lecture final exam was 62%
- The average overall score in the class was 72%

LAS
Embedded Assessment Action Report

For

Program Review

Degree Program(s): __________BS Chemistry________________________________

(BA, BS, BFA, MA, MS, LACC, etc.)

Course # / Title: ___Ch222 General Chemistry, W 2011_____________________

Faculty name: ______Pete Poston____

Date: _______________________________________

A) State the program **learning outcome** or **general education goal** this assessment is linked to:

The following items were used on the quizzes, midterms, and final exams (both lecture and lab) as the **LEARNING OUTCOMES** for this course.

- Quantum Mechanics – basic principles
- energy of orbitals in Hydrogen and multielectron atoms
- splitting of subshell energies in multielectron atoms due to greater penetration of s-electrons compared to p and d.
- energy level filling order diagram (memorize)
- the Pauli Exclusion Principle, the Aufbau Principle, and Hund's rule
- electron configurations through Z= 36 including Cr and Cu exception
- orbital box diagrams
- know where the s, p, d, and f-blocks are in the periodic table, and use them to determne electron configurations
- electron spin and cause of magnetism
- diamagnetism and paramagnetism
- Mendeleev and the Periodic Law
- Representative elements, Noble gases, Transition elements, f-block transition elements
- valence electrons – representative vs. transition metals
- electron configurations of cations and anions (transition metals s-electrons removed first)
- shielding and effective nuclear charge (nuclear charge effect)
- periodicity in atomic radius, ionic radius, ionization energy, and electron affinity
- Lewis dot symbols
- Lewis structures for ionic compounds
- Lattice energies, Coulomb's Law, and Born-Haber cycles
- Lewis structures for covalent compounds, single, double, and triple bonds
- Bond lengths

- properties of covalent vs. ionic compounds
- polar covalent compounds
- trends in electronegativity
- predicting polar covalent vs. ionic bonds
- Lewis structures for charges species
- formal charge
- guidelines for drawing Lewis structures including (1) selecting a central atom with the lowest electronegativity, (2) choosing a structure with the least formal charge on each atom, (3) choosing a structure where the lowest formal charge is on the most electronegative atom
- drawing resonance structures (hybrids)
- Exceptions to the Octet Rule: (1) less than 8 valence electrons for Group 3A, (2) expanded octets when the central atom is in the 3rd period or higher (exccpt for charged polyatomic ions mentioned in the major exception above), (3) odd-electron species (free radicals)
- bond energies and calculation of ΔH^{o}_{rxn}
- VSEPR Geometry (A = central atom, B = terminal atom, E = lone pair)
- Applying VSEPR theory - (1) Lewis structure, (2) count electron clouds around central atom, (3) determine appropriate VSEPR electron cloud geometry first, (4) then determine molecular geometry based on the position of atoms in space
- Remember: Multiple bonds count as one cloud in VSEPR theory
- Molecular geometries of more complicated molecules with more than one central atom (apply VSEPR theory to each central atom)
- Dipole moments and polar molecules
- Valence Bond Theory – hybrid orbitals
- σ and π bonds
- Be able to illustrate hybridization for simple molecules using orbital diagrams, showing σ and π bonds
- Molecular Orbital Theory – bonding and antibonding orbitals, given MO energy diagrams (be able to fill in the MO's, determine stability based on bond order, predict magnetism, and identify as σ vs π-bonding
- Gas phase elements - H_2, N_2, F_2, O_2, Cl_2 and the Noble Gases
- Properties of gases – indefinite shape and volume, compressible, mix together evenly and completely, low densities (g/L)
- Pressure = force/area, units: atm, mmHg (Torr), Pa; converting between units
- Mercury barometer
- Simple Gas Laws:
- Avogadro's Law and Stoichiometery: equal volumes of any two gases contain the same number of moles
- Ideal Gas Law: $PV = nRT$
- Deriving simple gas laws from Ideal Gas Law
- STP: standard temperature and pressure = 1 atm and 273K; 1 mole of any gas occupies 22.4 L @ STP
- Situations where many variables change simultaneously: $P_1V_1/n_1T_1 = P_2V_2/n_2T_2$
- Calculating densities and molecular weights from the Ideal Gas Law: d = PM/RT, rearranging then M = dRT/P, if don't know density then M = gRT/PV
- Gas Stoichiometry Problems
- Dalton's Law of Partial Pressures
- Collecting a gas over water: $P_{total} = P_{gas} + P_{H2O}$
- Kinetic Molecular Theory: $\langle KE \rangle \propto T$, molecular speeds as a function of temperature and molar mass
- intermolecular forces:
- Properties of liquids: surface tension, cohesion and adhesion, viscosity,
- Unique properties of water: 3-D hexagonal structure of ice (unusual because the solid is less dense than the liquid), maximum density at 4 ^{o}C (why?)
- Kinetic Molecular Theory of liquids
- Liquid-vapor equilibrium – evaporation and condensation, equilibrium vapor pressure, boiling

point, ΔH_{vap}, trends in boiling point and ΔH_{vap} and dependence on intermolecular forces (Table 11.6)

- Clausius-Clapeyron equation (given)
- Vapor pressure vs. temperature curves and effect of intermolecular forces
- Liquid-solid equilibrium – melting and freezing point, ΔH_{fus}, trends in melting point and ΔH_{fus} and dependence on intermolecular forces
- Heating curves – qualitatively understand what happens as you heat a substance through phase boundaries
- Solid-vapor equilibrium – sublimation and deposition, $\Delta H_{sub} = \Delta H_{fus} + \Delta H_{vap}$
- Be able to use ΔH_{vap}, ΔH_{fus}, and ΔH_{sub} to calculate heat changes across phase boundaries
- Phase diagrams – boundaries, positive vs. negative slope for solid-liquid boundary, triple point, critical T and P, supercritical fluids
- saturated, unsaturated, supersaturated
- concentration units – mole fraction (χ), molarity (M), molality (*m*)
- Colligative Properties of Nonelectrolyte Solutions – vapor pressure lowering and Raoult's Law, boiling point elevation and freezing point elevation calculations
- Using colligative properties to determine molar mass
- Colligative Properties of Electrolyte Solutions – van't Hoff factor
- A molecular view of the solution process – miscible vs. immiscible, Like dissolves Like
- The effect of temperature on solubility – solubility of solids and fractional crystallization, gas solubilities
- The effect of pressure on the solubility of gases – Henry's Law
- factors controlling reaction kinetics
- definition of a rate and determining graphically by measuring slope
- average vs. instantaneous rate
- reaction rates and stoichiometry
- The Rate Law: rate = $k[A]^a[B]^b[C]^c$...
- Order of a reaction in terms of a given reactant and overall
- The Method of Initial Rates
- First Order kinetics

B) Check the embedded assessment tool(s) used :

x Exam question
☐ Essay
☐ Oral presentation
☐ Thesis
☐ Portfolios
☐ Practicum / Service Learning
☐ Capstone paper / project
☐ Other ____

Attach a copy of the actual question / assignment as it is presented to the student or a description of the embedded process.

Copies of the midterms, final, or quizzes are available if needed.

The assessment form in this course was based upon a selected number of ***learning outcomes*** and students' performance on two midterms, eight quizzes, a lecture final exam, lab experiments (handouts), and a lab final.

- Students demonstrated competence on the learning outcomes by scoring 70% (considered a "C") or higher overall in the class. The course grade was based on the following lecture and lab components:

200 pts (36%) 2 hour exams

200 pts (36%) comprehensive final

100 pts (18%) 25 pts from lab final, 75 points from lab exercises (drop lowest score)

50 pts (9%) quizzes (drop the lowest and scale total to 50 pts)

550 pts total

- The average score on the first midterm was 72%
- The average score on the second midterm was 71%
- The overall quiz average was 84%
- The average score on the lecture final exam was 62%
- The average overall score in the class was 72%

LAS
Embedded Assessment Action Report

For

Program Review

Degree Program(s): __________BS Chemistry________________________________

(BA, BS, BFA, MA, MS, LACC, etc.)

Course # / Title: ___Ch223 General Chemistry, S 2011_______________________

Faculty name: ______Pete Poston____

Date: ____

A) State the program **learning outcome** or **general education goal** this assessment is linked to:

The following items were used on the quizzes, midterms, and final exams (both lecture and lab) as the **LEARNING OUTCOMES** for this course.

1. Understand collision theory, activation energy, temperature effect and the Arrhenius equation.
2. Understand catalysis, homogeneous and heterogeneous catalysts.
3. Understand the reaction mechanisms, molecularity, elementary steps, rate determining step and identify the intermediate(s), and the catalyst.
4. Determine the rate law from the proposed mechanism(s).
5. Calculate the activation energy from rate constants and temperature changes.
6. Determine a plausible mechanism consistent with the observed rate law.
7. Solve problems involving the first and the second order reactions.
8. Relate the rate of formation of a product to the rate of consumption of a reactant or vice versa.
9. Determine the rate law using the initial rate method.
10. Write the equilibrium constant expression for all chemical reactions involving solid, liquid and gas.
11. Tell the relationship between the chemical reaction (as written) and its equilibrium constant (K_p or K_c)
12. Understand the significance of the magnitude of the equilibrium constant, too large or too small.
13. Understand the reaction quotient, Q, and its relationship to the equilibrium constant (K_c or K_p).
14. Perform the equilibrium calculations. See the separate hand out given in class.
15. Understand the ***Le Châtelier's Principle*** and its application in chemical equilibria. Specifically, predict the direction of shift in equilibrium as we change the conditions such as concentration, temperature, pressure, etc.
16. Tell the various definitions of acids and bases.

17. Give examples of a monoprotic, diprotic and triprotic and amphiprotic substances.
18. Give the conjugate acid given the conjugate base and vice versa.
19. Understand the relationship between the strength of an acid and its ionization (dissociation) constant (K_a).
20. Rank both the binary acids and oxoacids according to their strength.
21. Use relative acid-base strengths to predict the direction of acid - base equilibrium reactions.
22. Use K_w, K_a, K_b and the pH scale in various chemical calculations involving weak acids or bases. Specifically, finding K_a from pH or pH from K_a. Also learn the examples worked out in class. See the note below.
23. Understand ***hydrolysis*** and be able to write hydrolysis reactions for different species.
24. Understand the role of the molecular structure and the acid - base strength (inductive effect).
25. Identify Lewis acid or a Lewis base in an acid-base reaction.
26. Identify buffer solutions and understand their properties such as the capacity.
27. Tell the buffer range for a buffer system.
28. Calculate the pH of any buffer solution.
29. Prepare a buffer solution with a specific pH.
30. Calculate the new pH of a buffer solution after a small amount of acid (or base) has been added.
31. Choose an appropriate indicator from a table for a given acid-base titration reaction.
32. Calculate the pH at any point in an acid-base titration. This includes strong acid-strong base, weak acid-strong base and weak base-strong acid only.
33. Write the K_{sp} expression for all slightly soluble salts (used to be insoluble salt).
34. Calculate the K_{sp} from the solubility data or the solubility from the K_{sp} values.
35. Calculate the solubility of a salt in the presence of the common ion.
36. Recognize the solubility of slightly soluble salts containing basic anions in acidic or basic solutions. That is, the dependency of the solubility upon pH.
37. Decide whether a precipitate forms when the two respective aqueous solutions are mixed.
38. Estimate the relative solubilities from K_{sp}'s of similar salts. No calculation required here.
39. Predict the sign of the entropy change without calculation for simple reactions.
40. Explain the Second Law and the Third Law of thermodynamics.
41. Calculate the entropy change for a chemical reaction from the known molar entropies, S°.
42. Calculate the entropy change for phase transition from the available data.
43. Understand the principle concept of "coupled *reactions"*.
44. Calculate the free energy change for a chemical reaction from □G_f°.
45. Calculate the (minimum) temperature at which the reaction becomes product favored (i.e. spontaneous)
46. Associate the equilibrium constant (K) with the free energy of the reaction, □G°.
47. Understand the difference between □G° and □G and their association with the equilibrium condition.
48. Identify the anode, cathode, oxidation, reduction, electrolyte solutions, polarity, and direction of current (electron flow) in a voltaic or an electrolytic cell.
49. Balance the redox equations both in acidic or basic solutions.
50. Relate E°of the cell to □G°.
51. Calculate the cell potential (cell voltage) using the Nernst equation.
52. Use the table of standard reduction potentials; decide the strongest (or weakest) reducing agent, strongest (or weakest) oxidizing agent.
53. Tell whether or not the reaction is product-favored.
54. Calculate the equilibrium constant from electrochemical information such as E°.
55. Recognize and appreciate the difference between primary and secondary batteries, their advantages or disadvantages.
56. Understand the fuel cells, their benefits and their principal mode of operations.
57. Recognize the corrosion process, in particular, cathodic protection.
58. Identify the reactions that occur during the electrolysis of molten salt versus aqueous salt solution.
59. Apply the Faraday's law to chemical problems involving electrolysis. See the class hand-out.
60. Define the terminologies or words such as isotopes, alpha(□), beta(□), positron etc.

61. Complete and balance a nuclear reaction.
62. Decide whether a given radioactive isotope decays by☐, ☐, ☐ or an electron capture.
63. Calculate the binding energy of a particular isotope.
64. Calculate the half-life, or be able to apply the equation $\ln[(A)/(A_0)]$ =☐kt in problems involving radioactive decay. This also includes radiocarbon dating.
65. Recognize the difference between nuclear fusion and nuclear fission.

B) Check the embedded assessment tool(s) used :

x Exam question
☐ Essay
☐ Oral presentation
☐ Thesis
☐ Portfolios
☐ Practicum / Service Learning
☐ Capstone paper / project
☐ Other ____

Attach a copy of the actual question / assignment as it is presented to the student or a description of the embedded process.

Copies of the midterms, final, or quizzes are available if needed.

The assessment form in this course was based upon a selected number of ***learning outcomes*** and students' performance on two midterms, eight quizzes, a lecture final exam, lab experiments (handouts), and a lab final.

- Students demonstrated competence on the learning outcomes by scoring 70% (considered a "C") or higher overall in the class. The course grade was based on the following lecture and lab components:

200 pts (33%) 2 hour exams
200 pts (33%) comprehensive final
100 pts (17%) 25 pts from lab final, 75 points from lab exercises (drop lowest score)
100 pts (17%) quizzes (drop the lowest and scale total to 100 pts)
600 pts total

- The average score on the first midterm was 67%
- The average score on the second midterm (including bonus points) was 71%
- The overall quiz average was 58%
- The average score on the lecture final exam was 63%
- The average score in the lab was 78%
- The average overall score in the class was 67%

LAS
Embedded Assessment Action Report

For

Program Review

Degree Program(s): __________BS Chemistry________________________________

(BA, BS, BFA, MA, MS, LACC, etc.)

Course # / Title: ___Ch223 General Chemistry, F 2010_______________________

Faculty name: _____Pete Poston____

Date: ______________________________________

The following items were used on the quizzes, midterms, and final exams (both lecture and lab) as the **LEARNING OUTCOMES** for this course.

B) Check the embedded assessment tool(s) used :

x Exam question
☐ Essay
☐ Oral presentation
☐ Thesis
☐ Portfolios
☐ Practicum / Service Learning
☐ Capstone paper / project
☐ Other ____

Attach a copy of the actual question / assignment as it is presented to the student or a description of the embedded process.

Copies of the midterms, final, or quizzes are available if needed.

The assessment form in this course was based upon a selected number of ***learning outcomes*** and students' performance on two midterms, eight quizzes, a lecture final exam, lab experiments (handouts), and a lab final.

- Students demonstrated competence on the learning outcomes by scoring 70% (considered a "C") or higher overall in the class. The course grade was based on the following lecture and lab components:

200 pts (33%) 2 hour exams

200 pts (33%) comprehensive final
100 pts (17%) 25 pts from lab final, 75 points from lab exercises (drop lowest score)
<u>100 pts</u> (17%) quizzes (drop the lowest and scale total to 100 pts)
600 pts total

- The average score on the first midterm was 76%
- The average score on the second midterm (including bonus points) was 72%
- The overall quiz average was 79%
- The average score on the lecture final exam was 72%
- The average overall score in the class was 77%

LAS
Embedded Assessment Action Report

For

Program Review

Degree Program(s): __________BS Chemistry_________________________________

(BA, BS, BFA, MA, MS, LACC, etc.)

Course # / Title: ___Ch310 Geochemistry___________________________________

Faculty name: _____Pete Poston____

Date: ______________________________________

A) State the program **learning outcome** or **general education goal** this assessment is linked to:

The following items were used on the quizzes, midterms, and final exams (both lecture and lab) as the **LEARNING OUTCOMES** for this course.

- be able to use the exponential decay equation (given) $P(t) = P_o e^{-\lambda t}$
- be able to use the isochron equation (given) $D = D_o + P(t)[e^{\lambda t}-1]$
- Rb/Sr, U/Pb, K/Ar, Ar/Ar, and ^{14}C dating
- Petrogenesis
- Age of the Earth
- Stable Isotopes of Low Atomic Number including Oxygen geothermometry and Global Warming
- Goldschmidt's Classification
- Bowen's Reaction Series
- General rules for Ionic substitution
- Chemical Weathering
- The Carbonate Cycle
- Oxidation
- Hydrolysis of Silicates
- Weathering of K-feldspar to Kaolinite
- Chemistry of H_4SiO_4 and cryptocrystalline quartz
- Clay Mineralogy
- kaolinite and montmorillonite structures
- isomorphous substitution
- interpreting the clay minerals and geologic examples
- The Phase Rule
- Example phase diagrams with a eutectic, solid solution, double eutectic, incongruent melting, and solvus

- Nonequilibrium Effects
- Ternary Phase Diagrams
- Crystallization Of Magmas And Magmatic Differentiation
- Origin Of Basaltic And Granitic Magmas
- Characteristics of Hydrothermal Ore Deposits
- Sunnyside Mine: geologic setting, general mineralization, age, fluid inclusions, pH, source of water, sulfur isotopes & geothermometry, Pb source, mineralization model
- limits of Eh and pH in nature
- H_2O boundaries on Eh/pH diagrams
- Eh/pH diagram for iron and iron minerals, weathering of sulfide minerals, gold. copper
- Supergene Sulfide Enrichment and Porphyry Copper Deposits
- Colorado Plateau Uranium deposits

B) Check the embedded assessment tool(s) used :

x Exam question
☐ Essay
☐ Oral presentation
☐ Thesis
☐ Portfolios
☐ Practicum / Service Learning
☐ Capstone paper / project
☐ Other ____

Attach a copy of the actual question / assignment as it is presented to the student or a description of the embedded process.

Copies of the midterms, final, or quizzes are available if needed.

The assessment form in this course was based upon a selected number of ***learning outcomes*** and students' performance on two midterms, 5 homework sets, and a final exam.

- Students demonstrated competence on the learning outcomes by scoring 70% (considered a "C") or higher overall in the class. The course grade was based on the following lecture and lab components:

200 pts (50%) 2 hour exams

150 pts (38%) comprehensive final

50 pts (12%) 5 homework sets (10 pts each)

400 pts total

- The average score on the first midterm was 81%
- The average score on the second midterm was 95%
- The average score on the final exam was 85%
- The average score on the homework sets was 81%
- The average overall score in the class was 87%

LAS
Embedded Assessment Action Report

For

Program Review

Degree Program(s): __________BS Chemistry________________________________

(BA, BS, BFA, MA, MS, LACC, etc.)

Course # / Title: ___Ch312 Quantitative Methods____________________________

Faculty name: _____Pete Poston_______________________________________

Date: ______________________________________

A) State the program **learning outcome** or **general education goal** this assessment is linked to:

The following items were used on the quizzes, midterms, and final exams (both lecture and lab) as the **LEARNING OUTCOMES** for this course.

- propagation of errors - addition/subtraction and mult/div formulas
- frequency distributions and histograms
- Normal Gaussian distributions
- confidence intervals, Student's t-distribution, and the confidence interval of the mean
- Q-testing data
- general titration setup, standard solutions, primary standards, indicators
- endpoint vs. equivalence point
- Equivalence point calculations, percent purity
- back titrations
- Ksp - the solubility product
- solubility calculations:
- The common ion effect
- Will a precipitate form ($Q > K_{sp}$)?
- Stoichiometry review, percent purity calculations, gravimetric factors
- organic precipitating agents
- Properties of precipitates, colloids
- relative supersaturation
- colloid growth and coagulation
- coprecipitation with colloids, digestion
- practical treatment of colloids
- ignition of precipitat
- Bronsted-Lowry theory, conjugate acids and bases
- self-ionization of water and K_w

- strengths of acids and bases - table of strong acids and bases
- classes of weak acids and bases
- hydrolysis reactions
- pH of solutions containing strong acids or bases (given formula if M acid or base very small)
- pH of solutions containing weak acids or bases - approximate, exact, and method of successive approximations
- Henderson-Hasselbach equation
- A buffer in action
- How to practically prepare a buffer solution
- The Effect of Ionic Strength on Solubility of Salts
- Ionic Atmospheres and Increased Solubility
- Activities and activity coefficients
- Charge Effect – equation for calculating ionic strength
- Extended Huckel-Debye equation (given)
- example activity coefficient calculations
- the real definition of pH
- Systematic Treatment of Equilibria: mass balance, charge balance
- indicators and titration errors
- strong acid-strong base titration curve – with either acid <u>or</u> base as analyte
- weak acid- strong base titration curve – with either acid <u>or</u> base as analyte
- amino acids - acidic form (H_2L^+), intermediate (zwitterion - HL), and basic forms (L^-)
- polyprotic acid titration curves - be able to **<u>generally</u>** graph the titration curve using first half eq. pt. = pK_{a1}, first eq. pt. = (pK_{a1} + pK_{a2})/2, etc.
- complex ions, EDTA, stepwise formation constants
- EDTA lab calcs: standardization, percent purity of unknown, water hardnessmasking problems
- pH dependence of EDTA titrations
- Fractional composition diagrams – know general shape for a given acid or base
- Buffers of polyprotic acids/bases
- effective equilibrium constant (Conditional Formation Constant)
- example of using the Conditional Formation Constant in an equilibrium calculation
- titration curves - be able to calculate pM **at the eq. pt.**
- indicators - Calgamite, addition of Mg to the EDTA to sharpen the Ca endpoint
- effect of formation constant and pH on shape of titration curve
- titrations of a mixture – which ion precipitates first
- titration curves of a mixture, be able to calculate concentration of ions in a mixture given the curve and eq. pt. volumes
- Mohr, Volhard, and Fajans methods (including indicators)
- galvanic (voltaic) cells
- standard reduction potentials
- Nernst equation, equilibrium constant formula
- reference electrodes Ag/AgCl and calomel
- converting between scales using different references
- potentiometric titrations - 2nd derivative plots - be able to calculate eq. pt. numerically
- How ion-selective electrodes work – A. liquid-based, glass membrane (e.g.Ca^{2+} ion and pH), B. Solid State (e.g. F^-)
- potentials: 59.2 mV/n voltage change per factor of 10 change in concentration where n = charge on ion
- detection limits and interferences
- sample treatment: tin(II) chloride, $HgCl_2$, Zimmerman-Reinhard reagent
- Fe ore titration calculations – standardization and percent purity
- Theory of redox titration curves – half eq. pt. and endpoint potentials versus the Saturated Calomel Electrode calculation, formal potentials, choice of indicator
- properties of light, $c= \lambda\nu$, $E = h\nu$
- electromagnetic spectrum (know qualitatively) and know what kind of excitation process is occurring: e.g UV-Vis = electronic excitation, IR = vibration etc

- ground states vs excited states, calculating photon energies
- radiant power, Po and P, transmittance and absorbance
- Beer's Law and finding concentration from absorbance
- using Beer's Law – preparing and using calibration curves
- Beer's Law of a Mixture – know how it was applied in the UV-Vis lab
- What Is Atomic Spectroscopy? – know basic instrumental configuration
- flame atomization – aspiration, nebulization, etc
- complete atomization and detection limits
- fuels and flame temperatures as pertains to previous bullet
- What is chromatography?
- mobile phase, stationary phase, elution
- different types of chromatography – adsorption, partition, ion-exchange, molecular exclusion, affinity
- the chromatogram
- internal standard calculations
- basic description of process (stationary phase, mobile phase, match sample polarity to stationary phase, separate by boiling points, etc)
- basic instrumentation
- injection port basics
- capillary columns – we use WCOT
- stationary phases and their effect on separation – be able to draw structure of a polysiloxane
- temperature programming

B) Check the embedded assessment tool(s) used :

x Exam question
☐ Essay
☐ Oral presentation
☐ Thesis
☐ Portfolios
☐ Practicum / Service Learning
☐ Capstone paper / project
☐ Other ____

Attach a copy of the actual question / assignment as it is presented to the student or a description of the embedded process.

Copies of the midterms, final, or quizzes are available if needed.

The assessment form in this course was based upon a selected number of ***learning outcomes*** and students' performance on two midterms, nine labs, a lab notebook, and a final exam.

- Students demonstrated competence on the learning outcomes by scoring 70% (considered a "C") or higher overall in the class. The course grade was based on the following lecture and lab components:

2 midterms	200	points (35 %)
Final - weighted towards final chapters	200	points (35 %)
Lab: first 6 labs at 20 pts; last 3 labs at 10 pts	150	points (26 %)
Lab notebook	25	points (4 %)
Total	575	points

- The average score on the first midterm was 72%
- The average score on the second midterm was 76%
- The average score on the lecture final exam was 72%
- The average score on the lab handouts was 83%
- The average overall score in the class was 71%

LAS
Embedded Assessment Action Report

For

Program Review

Degree Program(s): __________BS Chemistry________________________________

(BA, BS, BFA, MA, MS, LACC, etc.)

Course # / Title: ___Ch313 Instrumental Methods___________________________

Faculty name: ______Pete Poston____

Date: ____

A) State the program **learning outcome** or **general education goal** this assessment is linked to:

The following items were used on the quizzes, midterms, and final exams (both lecture and lab) as the **LEARNING OUTCOMES** for this course.

- Basic statistics review
- Calibration Curves - sensitivity, detection limits (LOD)
- EM radiation – wavelength, frequency, photons
- EM spectrum (know qualitatively) - calculations of □ and □
- Superposition of waves – constructive and destructive interference
- Fraunhofer Diffraction – order, intensity, widths of color bands, blue diffracted <u>smaller</u> angle than red
- Refraction of Light - refractive index, dispersion, unequal widths of color bands, blue refracted <u>larger</u> angle than red
- Interactions of Radiation and Matter – absorption, emission, luminescence, scattering
- Atomic vs. Molecular transitions
- Spectroscopy, Optical Instruments, Optical Spectroscopic Methods
- % basic elements of optical instruments
- Sources of Radiation
- Optical materials – visible, UV, IR
- Filters – FWHM, bandwidth
- Grating monochromator design and components
- Echellette grating and the grating equation, holographic gratins
- Reciprocal Linear Dispersion
- Resolving Power of Monochromators
- Light Gathering Power of Monochromators
- Effect of slit width on resolution
- Resolution
- Radiation Transducers - vacuum phototube, photomultiplier tube, photodiodes, photodiode

arrays, CCD's, spectral response
- Transmittance and absorbance
- Beer's Law – wavelength dependence of molar absorptivity
- Absorbance spectrum – molar absorptivity is wavelength dependent
- Limitations to Beer's Law - concentration effect, chemical deviations (equilibrium), polychromatic radiation, stray light
- Light sources – UV and Vis, blackbody radiation and continuum sources
- Single vs. Double Beam Instruments – how double beam instruments remove the background
- Double Dispersing Instruments - How stray light controls the LOD
- Multichannel Instruments
- Absorption by Organic Molecules - types of electronic transitions, e.g. $□ \rightarrow □^*$, allowed vs. forbidden transitions
- General Absorbance Spectrum
- Spectral details are lost in the liquid phase - fine structure from vibrational sublevels
- Qualitative Analysis - Solvent shifts, effect of ring substituents on aromatic rings, effect of pH (indicators)
- Quantitative Analysis - mixtures, sample matrix and standard addition methods, derivative spectroscopy, enzyme kinetics
- Fluorescence, Phosphorescence and Nonradiative Decay - Singlet vs. triplet states, Jablonski Diagrams
- Quantum Yields
- Vibrational relaxation, internal conversion, intersystem crossing
- Luminescence lifetimes
- Fluorescence and structure
- Illustration of the Heavy Atom Effect
- Emission and excitation spectra
- Instruments for Measuring Fluorescence and Phosphorescence
- Xe-arc lamps
- Spectrofluorometers - corrected spectra
- Phosphorimeters
- Selectivity
- Effect of Concentration on Fluorescence Intensity
- Absorbance vs. Fluorescence Signals
- Comparing UV-Vis to Fluorescence LOD's
- Applications – Inorganic, Organic, Forensics, Imaging
- atomic spectra - emission, absorption, fluorescence
- line broadening
- flame atomization - common fuel mixtures
- flame populations
- flame structure and T profile
- sample positioning and flow rates
- atomization and nebulization
- burners
- electrothermal atomization - graphite furnace
- Atomic Absorption Spectroscopy - hollow cathode lamps
- interferences - releasing & protecting agents, ionization in flames
- LOD's as a function of atomization method
- Inductively Coupled Plasma (ICP) Spectroscopy
- Emission of X-Rays – Electron Beam Source
- Continuum and Line Sources
- Line Spectra (K, L, M...)
- Origin of X-Ray Line Spectra
- Radioactive Sources
- X-Ray Fluorescence
- Diffraction and Bragg's Law

- Photon Counting
- Wavelength Dispersive versus Energy Dispersive Instruments
- Theory - wavenumbers
- vibrational frequency
- absorption process and selection rules
- types of vibrations (normal modes)
- calculating wavenumber of a peak
- frequency-mass and force constant-bond strength correlations
- Definition of the Fourier Transform – know what it does qualitatively
- FTIR
- Applications of IR
- Qualitative IR - peak identification from a correlation chart
- Quantitative IR - reasons why IR less sensitive and why FTIR has improved sensitivity
- Diffuse Reflectance
- ATR Spectrometry
- IR Microscopy
- Rayleigh scattering (from Ch 6 – section 6B-10)
- Raman Scattering – Stokes and anti-Stokes
- Excitation and Mechanism of Raman Spectra
- Comparison of Raman & IR Spectra
- Instrumentation
- Process Analytical Chemistry
- Theory of NMR – nuclear spin states, spin quantum number (I), number of spin states 2I+1, energy levels in an external magnetic field, ΔE and absorption of radiofrequency radiation
- Classical Description of NMR – precession, circularly polarized radiation, Larmor Frequency
- FT-NMR – pulsed excitation, free induction decay (FID)
- Origin of the Chemical Shift, Shielding
- General Correlation Chart
- Theory of the Chemical Shift – electronegativity, hybridization, acidic protons, magnetic anisotropy
- 1^{st} Order Interpretation of NMR Spectra – spin-spin splitting (N+1 rule), simple interpretation of an NMR spectrum, signal integration
- FT-NMR Spectrometers
- Resolution of FT-NMR Spectrometers
- Carbon-13 NMR
- outline of technique (sample → fragments etc), ion sources
- hard vs. soft ionization
- electron impact (EI) ionization
- electron impact ion source
- McLafferty rearrangement
- example electron impact spectra – alkanes and aromatics
- chemical ionization (CI) – methane as reagent gas
- electrospray ionization and spectra
- Instrumentation outline
- Mass analyzers - magnetic sector, quadrupole, time of flight
- electron multiplier detector
- General Description of Chromatography
- Classification of Chromatographic Methods
- Elution in Column Chromatography
- Plate Theory – band broadening, experimental evaluation of H and N from the chromatogram
- Rate Theory - longitudinal diffusion, stationary phase-mass transfer term, eddy diffusion, Van Deemter equation, optimal flow rate
- Practical Control of Separation
- Resolution
- Retention (Capacity) Factor – optimal value
- Selectivity Factor

- Resolution, capacity factor, and selectivity combined expression
- basic description of process (stationary phase, mobile phase, match sample polarity to stationary phase, separate by boiling points, etc)
- Basic Instrumentation
- injection port – know split vs. splitless
- packed columns, solid support, bonded phases, liquid-coated stationary phases
- capillary columns – we use WCOT
- common stationary phases in capillary GC – be able to draw structure of a polysiloxane, know cross-linking and column bleed (max column temperature)
- Effect of particle size on the Eddy Diffusion term
- temperature programming
- detectors – thermal conductivity, FID, ECD
- Gas Chromatography-Mass Spectrometry – TIC vs. SIC
- example separations
- HPLC, scope of LC, partition chromatography
- LC van Deemter plots – understand effect of particle size and lack of B-term
- Instrumentation
- normal vs. reversed phase separations
- mobile phase

B) Check the embedded assessment tool(s) used :

x Exam question
☐ Essay
☐ Oral presentation
☐ Thesis
☐ Portfolios
☐ Practicum / Service Learning
☐ Capstone paper / project
☐ Other ____

Attach a copy of the actual question / assignment as it is presented to the student or a description of the embedded process.

Copies of the midterms, final, or quizzes are available if needed.

The assessment form in this course was based upon a selected number of ***learning outcomes*** and students' performance on two midterms, an informal writing component, lab handouts, a formal writing component (lab reports), and a comprehensive final exam.

- Students demonstrated competence on the learning outcomes by scoring 70% (considered a "C") or higher overall in the class. The course grade was based on the following lecture and lab components:

200 pts	(36%) two 100 pt hour exams
200 pts	(36%) 200 pt comprehensive final
50 pts	(9%) 8 quizzes @ 10 pts each - score scaled to 50 pts total
100	(18%) labs and written reports (100 pts), writing exercise (10 pts), total scaled to 100 pts.

pts	
550 pts	total

- The average score on the first midterm was 78%
- The average score on the second midterm was 73%
- The average score on the quizzes was 65%
- The average score on the lecture final exam was 67%
- The average score in the lab was 86%
- The average overall score in the class was 78%
-

LAS
Embedded Assessment Action Report

For

Program Review

Degree Program(s): __________BS Chemistry________________________________

(BA, BS, BFA, MA, MS, LACC, etc.)

Course # / Title: ___Ch461 Experimental Chemistry_________________________

Faculty name: _____Pete Poston____

Date: ______________________________________

A) State the program **learning outcome** or **general education goal** this assessment is linked to:

The following items were used on the quizzes, midterms, and final exams (both lecture and lab) as the **LEARNING OUTCOMES** for this course.

- # In addition to a series of standard laboratory exercises, students will be given chemical problems to solve apply their problem-solving skills to the analysis of "real-world" samples in a team environment
- # Much of the emphasis will be environmental and forensic in nature
- # after researching the problems by consulting the literature, they will submit a plan of action to the instructor for approval
- # Since extraction and sampling techniques have not been covered in detail in other courses, students will be taught the basics of solvent extraction, Solid Phase Extraction (SPE), Solid Phase Microextraction (SPME), Soxhlet extraction, and Supercritical Fluid extraction techniques
- # Since this class is a writing-intensive course, there will be a research proposal (PAH's in creosote) and formal lab report required (Au-nanoparticles).
- # Students will become familiar with Quality Assurance-Quality Control (QA-QC) Techniques commonly used in Science and Industry
- # Students will use cutting-edge technology in Raman Spectroscopy and Nanotechnology to design a chemical sensor sensitive to methamphetamine
- # Students will measure photolytic degradation rates of toxic chemicals in the environment, and learn about the role of photocatalysts.
- # A series of 4 quizzes are given to assess lecture material (this is a "lab" course in nature, but new concepts are still taught and tested)

B) Check the embedded assessment tool(s) used :

x Exam question
☐ Essay
☐ Oral presentation
☐ Thesis
☐ Portfolios
☐ Practicum / Service Learning
☐ Capstone paper / project
☐ Other ____

Attach a copy of the actual question / assignment as it is presented to the student or a description of the embedded process.

Copies of the midterms, final, or quizzes are available if needed.

The assessment form in this course was based upon a selected number of ***learning outcomes*** and students' performance on formal lab writing, four quizzes, a lab notebook, and lab experiments (handouts).

- Students demonstrated competence on the learning outcomes by scoring 70% (considered a "C") or higher overall in the class. The course grade was based on the following lecture and lab components:

200 pts	(50%) Writing exercises/Research Results: PAH proposal (60 pts), Nanoparticle formal lab report (100 pts), Lab notebook (40 pts)
100 pts	(25%) Lab Handouts: 5 Lab handouts (20 pts each)
100 pts	(25%) 4 Quizzes (25 pts each)
400 pts	Total

- The overall quiz average was 82%
- The average score on the formal lab writing was 85%
- The average score on the lab handouts was 98%
- The average overall score in the class was 87%