LSC Use Only Proposal No: LSC Action-Date: AP-3/22/12	UWUCC Use Only Proposal No: 11-125d. UWUCC Action-Date: App-4/3/12 Senate Action Date: App-9/11/12

Curriculum Proposal Cover Sheet - University-Wide Undergraduate Curriculum Committee

Contact Person(s) **Wendy Elcesser**	Email Address **endyw@iup.edu**
Proposing Department/Unit **Chemistry**	Phone 72362

Check all appropriate lines and complete all information. Use a separate cover sheet for each course proposal and/or program proposal.

1. Course Proposals (check all that apply)

____ New Course ____ Course Prefix Change ____ Course Deletion

_X_ Course Revision ____ Course Number and/or Title Change _X_ Catalog Description Change

Current course prefix, number and full title: CHEM 111 General Chemistry I

Proposed course prefix, number and full title, if changing:

2. Liberal Studies Course Designations, as appropriate

_x_ This course is also proposed as a Liberal Studies Course (please mark the appropriate categories below)

____ Learning Skills _X_ Knowledge Area ____ Global and Multicultural Awareness ____ Writing Intensive (include W cover sheet)

____ Liberal Studies Elective (please mark the designation(s) that applies – must meet at least one)

____ Global Citizenship ____ Information Literacy ____ Oral Communication

____ Quantitative Reasoning ____ Scientific Literacy ____ Technological Literacy

3. Other Designations, as appropriate

____ Honors College Course ____ Other: (e.g. Women's Studies, Pan African)

4. Program Proposals

____ Catalog Description Change ____ Program Revision ____ Program Title Change ____ New Track

____ New Degree Program ____ New Minor Program ____ Liberal Studies Requirement Changes ____ Other

Current program name:

Proposed program name, if changing:

5. Approvals	Signature	Date
Department Curriculum Committee Chair(s)	[signature]	2/23/12
Department Chairperson(s)	[signature]	2/23/12
College Curriculum Committee Chair	[signature]	3/9/12
College Dean	[signature]	3/12/12
Director of Liberal Studies (as needed)	[signature]	4/2/12
Director of Honors College (as needed)		
Provost (as needed)		
Additional signature (with title) as appropriate		
UWUCC Co-Chairs	Gail S Sechrist	4/3/12

Part II.
New Syllabus of Record
1. Catalog Description

CHEM 111 General Chemistry I (3c-3l-4cr)

Prerequisites: none

Description: Introductory course for science and pre-professional health majors. This course is the first half of a two-semester sequence designed to give students the foundation of knowledge and laboratory techniques required to successfully complete a degree program in the sciences, or gain entry into professional health programs. Topics include atomic theory, an introduction to chemical reactions, stoichiometry, gas laws, thermochemistry, chemical bonding and molecular geometry.

2. Course Outcomes

Objective 1:
Students will be able to demonstrate essential chemical knowledge in the following content areas: atoms, molecules chemical reactions, gases, thermochemistry and chemical bonding.
Expected Student Learning Outcomes 1:
Informed Learners
Rationale:
Course content and activities for this objective require students to learn essential concepts in the indicated areas, as well as to apply these concepts in a variety of chemical systems.

Objective 2:
Students will learn to use mathematical techniques to quantify chemical systems.
Expected Student Learning Outcomes 1 and 3:
Informed Learners and Responsible Learners
Rationale:
Course content and activities for this objective require students to learn the units of measurement and essential calculation principles, as well as the algorithms and formula necessary to calculate chemical data. Additionally, content in this objective also require students to learn significant figures, the concepts of accuracy and precision and the limits of measured values, which are key to understanding the limitations of empirical data.

Objective 3:
Students will use chemical concepts and quantitative skills to solve problems involving chemical systems.
Expected Student Learning Outcomes 1 and 2:
Informed Learners and Empowered Learners
Rationale:
Course content and activities for this objective require students to learn the basic equations and quantitative relationships that govern the chemical systems, such as stoichiometry, gases and

thermochemistry. Additionally, the nature of the problems associated with this objective require a high degree of creative problem-solving and analysis skills.

Objective 4:
Students will be able to apply principles learned in lecture to laboratory experiments, so that they can qualitatively and quantitatively analyze empirical data and explain its significance.
Expected Student Learning Outcomes 1, 2 and 3:
Informed Learners, Empowered Learners, and Responsible Learners
Rationale:
Course content and activities for this objective require students to learn how to apply chemical concepts in a hands-on situation. The nature of the activities associated with this objective require students to solve problems associated with hands-on measurement and data-collection, and to creatively find solutions. Collecting and analyzing data requires students to evaluate the limits of knowledge, and report their imperfect results in an honest manner.

3. **Detailed Course Outline** (1 hour = 50 minutes; allows 3 hours for exams)

1) Measurement (2 hours)
   a) metric system, significant figures
   b) dimensional analysis, accuracy and precision
2) Compounds and Nomenclature (3 hours)
   a) atoms, isotopes, introduction to periodic table
   b) compounds, nomenclature of ionic and molecular compounds
   c) writing and balancing chemical reactions
3) Stoichiometry (5 hours)
   a) atomic mass, Avogadro's number, moles, percent composition
   b) basic stoichiometry calculations
   c) limiting reagents, percent yield
4) Chemical Reactions (5 hours)
   a) precipitation, net ionic reactions
   b) neutralizations reactions, titrations
   c) oxidation-reduction reactions
   d) molarity, solution stoichiometry
5) Gas Laws (5 hours)
   a) development and application of the Ideal Gas Law
   b) Dalton's Law of Partial Pressures
6) Thermochemistry (5 hours)
   a) enthalpy, first law of thermodynamics
   b) phase changes, enthalpies of reaction
   c) standard enthalpy of formation, Hess's Law
7) The Atom and Atomic Orbitals (2 hours)
   a) historical background of the atomic model
   b) quantum theory, modern atomic model
   c) atomic orbitals, quantum numbers, Aufbau principle
8) Periodic Trends (2 hours)
   a) electron configurations, the periodic table

b) periodic trends in physical and chemical properties

9) Lewis Structures (5 hours)
   a) basics of Lewis structures
   b) Lewis structures of molecules and polyatomic ions
   c) advanced structures, formal charge
   d) bond order and resonance

10) Molecular Geometry and Theory (5 hours)
   a) shapes of molecules, VSEPR model
   b) bond energy and length, valence bond theory
   c) basics of molecular orbital theory
   d) applications of molecular orbital theory

11) Final Examination (2 hours, during final examination period)

CHEM 111 Laboratory Schedule (one experiment per session)

Experiment
1. Check-in, Lab Safety, IN-1 Introductory Lab
2. IN-2 Lab Report Tutorial
3. Experiment IN-3: Density, Alcohol Content and the Archimedes Principle
4. Experiment MS-1: How Much Reactant Do I Need?
5. Experiment MS-2: Gravimetric Analysis of Phosphorus in Fertilizer
6. Experiment SS-1: Acid-Base Titrations with Chemical Indicators
7. Experiment SS-2: Analysis of Antacids
8. Experiment SS-3: Analysis of Eggshells for Calcium Carbonate
9. Experiment GS-1: Determination of the Molar Mass of a Metal
10. Experiment GS-2: Design of a Model Airbag
11. Experiment TC-1: Different Causes of Temperature Change
12. Experiment TC-2: Designing Hot and Cold Packs
13. VSEPR Tutorial
14. Check-out and Final Lab Quiz

4. Evaluation Methods:

Exams	37.5%
Quizzes	12.5%
Laboratory	25%
Final Exam	25%

5. Example Grading Scale

A: ≥90% B: 80-89% C: 70-79% D: 60-69% F: <60%

6. Attendance Policy:

The attendance policy for this course will be consistent with the university attendance policy as described in the current undergraduate catalogue.

7. Required Textbook(s), Supplemental Books and Readings:

Principles of Chemistry: A Molecular Approach, Nivaldo J. Tro, Prentice Hall, New York (2010).

General Chemistry I Laboratory Manual, A.E. Kondo, ed, Pro-Packet (2011).

8. Special Resource Requirements:

1. Safety goggles
2. Laboratory notebook

9. Bibliography:

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CHEM 111 SAMPLE ASSIGNMENT

Experiment MS-2: Gravimetric Analysis of Phosphorus in Fertilizer[1]

Background

Gravimetric Analysis

Recall that gravimetric analysis is an important quantitative chemical technique for analyzing "how much?" of a particular element is present in a compound. The typical procedure involves taking a carefully measured amount of a compound or mixture, and reacting it with an excess amount of a particular reagent - one that plucks out the element of interest, and forms a solid precipitate with it. The precipitate is collected by filtration, dried and weighed. Using balanced reactions, the mass of the precipitate can be related back to the mass of the element in the original compound. The mass of the element compared to the mass of the original compound or mixture (times one hundred) tells us percent mass of the element that was present in the original compound. The analyzing reagent is always added in excess to ensure 100% of the element in question is converted to the product precipitate.

Today, we are going to analyze the amount of phosphorus in fertilizer, and compare our results to the labeling on the package.

Fertilizer labeling

The percent mass labeling (x % - y % - z%) convention for fertilizer is % N - % P_2O_5 - % K_2O. However, the phosphorus in fertilizer is present as the phosphate ion, PO_4^{3-}, not P_2O_5. Go figure. (There's actually a historical reason for this labeling method, but we're not going to get into it.) We can circumvent this labeling practice by tracking P, instead of PO_4^{3-} or P_2O_5. We can extract the phosphorus using magnesium cations in the presence of ammonia, NH_3. The balanced chemical reaction that converts the phosphorus P in the fertilizer to product, $MgNH_4PO_4{\cdot}6H_2O(s)$, is:

$$PO_4^{3-}(aq) + MgSO_4(aq) + NH_3(aq) + 7\ H_2O(l) \rightarrow MgNH_4PO_4{\cdot}6H_2O(s) + OH^-(aq) + SO_4^{-2}(aq)$$

We can interpret this balanced equation in a number of ways:

1. By counting units: There is one P for every one $MgNH_4PO_4{\cdot}6H_2O$.
2. By counting moles: There is one mole P for every one mole $MgNH_4PO_4{\cdot}6H_2O$.
3. By conservation of mass and using molar masses: Every 30.97 g of P will produce 245.45 g of $MgNH_4PO_4{\cdot}6H_2O$.

Each one of the three statements above can be used to create a conversion factor for dimensional analysis.

To compare our results with the package labeling on the fertilizer (% P_2O_5), we will need to use the relationship that one P_2O_5 contains two P, or that 141.94 g P_2O_5 contains 61.94 g P, or that P_2O_5 is 61.94x100/141.94 = 43.64 % P by mass. More dimensional analysis!

[1] Adapted from the experiment Wink et al. Working With Chemistry, 2nd edition, W.H. Freeman, 2003

The reaction

Fertilizers contain both water soluble and water insoluble components. The phosphorus component is water soluble, so your first task will be to separate out the insoluble components. Next, you will add magnesium ion in excess to react with 100 % of the phosphorus. Then, to force the precipitate out of solution, you will add ammonia until the solution is very basic (pH = 9; pH is a logarithmic measure of acidity. A solution with pH > 7 is basic.). Finally, you will filter, dry and weigh your product.

Procedure

Part I: Formation of Groups

You will be working in groups of two or three people. Assign tasks such as collecting materials and equipment, cleaning the balance after each use and cleaning up and returning equipment at the end of the experiment. You should work independently, but discuss, the calculations needed to perform the experiment.

Part II: Determining the Phosphorus Content in a Fertilizer

Weigh a five gram sample of fertilizer. Record the mass of the fertilizer to ±0.001 g. As a group, discuss how you will separate the water soluble from the water insoluble components of the fertilizer. Describe your procedure in your report form. Once you have separated the components, you can discard the part that doesn't contain phosphorus.

Following the example in the pre-lab, but adjusting for your particular mass and your particular fertilizer percent composition, calculate the mass of magnesium sulfate you should add to ensure 100% reaction of the phosphorus present in your fertilizer. Each group member should conduct this calculation independently, and then you should check that you all arrive at the same conclusion. Add 50% excess to your answer. Show your sample calculation on the report form. Check your answer with your instructor, and then add the $MgSO_4$ to your dissolved fertilizer sample. Record your observations.

Test the pH of the solution using pH paper and the color guide. Slowly add ammonia until the pH is at least nine. Record your observations. Set the mixture in an ice bath and leave it for at least 30 minutes. While waiting, prepare for vacuum filtration using the diagram below as a guide.

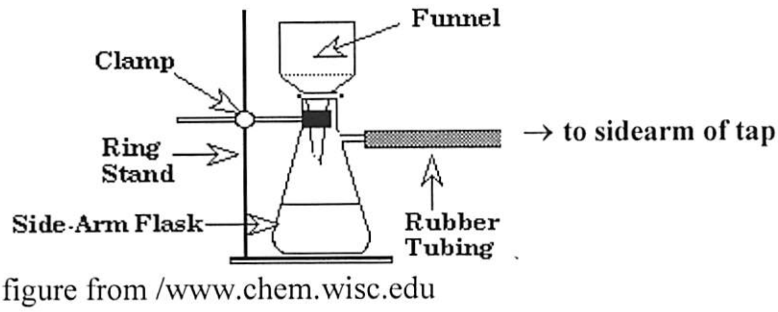

figure from /www.chem.wisc.edu

Weigh a piece of filter paper, place it in the funnel, and use water to dampen it and help it cling to the funnel. Once your mixture has been on the ice bath for 30 minutes, turn on the water tap to create the vacuum, and filter the mixture. Rinse the precipitate with a minimum amount of distilled water. Use a spatula to fluff up the precipitate (be careful not to tear the filter paper) and let it sit on the vacuum to air dry for at least ten minutes. Remove the filter paper and precipitate from the funnel and place it onto a weighed watch glass. Set it aside to air dry.

When your sample is dry, determine the mass of just the precipitate. Calculate the mass of phosphorus present. Calculate the mass of P_2O_5 that contains this mass of phosphorus. Calculate the % mass P in the fertilizer, and the % mass P_2O_5 in the fertilizer. Compare this last result to the label on the fertilizer box.

Report Tutorial for Experiment MS-2:Gravimetric Analysis of Phosphorus in Fertilizer

(JCW/AEK, 5/30/2011)

Write your report in your notebook, including all the headings that appear below in **BOLD**. *Italicized notes in brackets [ ] in this tutorial are guidelines to help you complete the report, so do not include these notes in your report.*

Title of Experiment ______________________________

Report Submitted by ______________________________

Date Submitted ______________________________

Purpose:

[Use the scenario of the experiment group to summarize the purpose of the experiment in 1-2 sentences. Focus on describing the problem your team is expected to solve and how they will solve it.]

Procedure:

Part I: Formation of Group

[Who did what? Be specific about each part of the procedure. Describe the sample type and sizes analyzed by the members of your group.]

Part II: Determining the Phosphorus Content in a Fertilizer

[Use your answers to the pre-lab to help you complete this section.]

(a) Summarize the procedure you used to separate the water-soluble from the water insoluble portions of the fertilizer. Which part did you keep for further analysis?

(b) Show the calculation that you used to determine the mass of $MgSO_4$ you used to react completely with your fertilizer sample.

Data and Results

Part II: Collection and Analysis of Data

Include the:

- *Mass of the fertilizer sample*
- *Percent composition of fertilizer, according to package label*
- *Description of solid fertilizer*
- *Description of fertilizer and water*
- *Description of mixture after addition of $MgSO_4$:*
- *Description of mixture after addition of NH_3:*
- *Description of product*
- *Mass of dried product*

Show sample calculations (word equations, numbers, units, dimensional analysis etc.) for the following:

(a) *Use the mass of dried product, and an appropriate ratio of molar masses of your precipitate, $Mg(NH_4)(PO_4)(H_2O)_6$, and P, to calculate the mass of phosphorus in your precipitate as the element, P.*
(b) *Use an appropriate ratio of molar masses of P_2O_5 and P to convert the mass of phosphorus in your precipitate to mass of P_2O_5.*
(c) *Use the mass of P_2O_5 and the mass of your fertilizer sample to calculate the percent of P_2O_5 in your sample of the fertilizer.*
(d) *Calculate the % difference between your % P_2O_5 and the % P_2O_5 on the fertilizer label.*

Conclusions: Report to the Plants Galore Gardeners

Write your conclusion as if you were explaining your findings in writing to the gardeners of the Plants Galore Nursery. Your opening statement should state the final % P_2O_5, and should note whether result matches that stated on the fertilizer packaging. Answer the question below, being sure to support your conclusion statements by citing specific results from the lab experiment.

Question: Explain the factors that might affect the accuracy and precision of the results by answering these three questions:

(a) What are sources of experimental error in your procedure? Would these errors result in a calculated percentage P_2O_5 that is too high, too low, or unaffected? Explain.
(b) The large amount of potassium that is also present in fertilizers could cause formation of $MgKPO_4(H_2O)_6$, in addition to the desired precipitate. If some of the solid you obtained was actually $MgKPO_4(H_2O)_6$, instead of pure $MgNH_4PO_4(H_2O)_6$, would your calculated percentage be too high, too low, or unaffected? Explain.
(c) Fertilizer companies sometimes overformulate their fertilizers - i.e., they understate the percentages of the key contents on the label. What difference would it make to your analysis if the fertilizer was indeed overformulated in phosphorus?

CHEM 111 SAMPLE ASSESSMENT

GENERAL GRADING CHECKLIST FOR LABORATORY REPORTS

Below is a general grading checklist for laboratory reports. Be sure to include at least the following information in any laboratory report. INCLUDE ALL PARTS IN EACH REPORT.

Laboratory Report Checklist (1 point)

- ☐ Laboratory Report Checklist is completed and attached to the report.

Header for Report and Experiment Objective (2 points)

- ☐ Name, the date and the title of the experiment are at the top of page one.
- ☐ The objective of the experiment was described in no more than one or two sentences and was not copied from the lab manual.

Summary of Procedure (4 points)

- ☐ All aspects of the procedure not in the lab manual have been noted and described clearly.
- ☐ The type and/or precision of each measuring device used is included.
- ☐ A summary of each student's task(s) in collecting group data is included.

Summary of Data (4 points)

- ☐ All data is tabulated, including non-numerical data or observations.
- ☐ Clear headings, with units of measurement are included for all columns and rows. (2 points)
- ☐ The tables include recording the correct precision for all measured values. (2 points)

General Criteria for Calculations and Data Analysis (4 points)

- ☐ Example calculations are shown.
- ☐ All results are tabulated with proper row and column headings.
- ☐ Balanced reaction equations are written for all chemical tests or analyses.
- ☐ Correct significant figures are used for all calculated values.
- ☐ A one sentence conclusion statement that summarizes your answer to the objective of the experiment.

Specific Criteria for Calculations and Data Analysis (10 points)

- ☐ Questions will vary for each lab. Specific suggestions for each lab will be coming.

Experiment MS-2: Specific Criteria for Calculations and Data Analysis (i.e., the last 10 points)

-Calculation of the mass of $MgSO_4$ needed to react completely with your fertilizer sample. (1 pt)
-Calculation of the mass of phosphorus in your precipitate as the element P (1 pt)
-Calculation of the mass of P_2O_5 (1 pt)
-Calculation of the percent of P_2O_5 in your sample of the fertilizer (1 pt)
-Calculation of the % difference in the experimental % P_2O_5 ands that reported on the label (1 pt).
-A conclusion statement (written to the Plants Galore Nursery) that details your final %P2O5 and whether that value matches that stated on the fertilizer packaging (1 pt)

Q (a): Sources of experimental errors in the procedure and how they affect the calculated percentage P2O5 with explanation (1 pt)
Q (b): If some of the product was actually $MgKPO_4(H_2O)_6$, would your calculated percentage be too high, too low, or unaffected? Explain. (1 pt)
Q (c): Fertilizer companies commonly overformulate their fertilizers, that is, the actual content is higher than what is promised on the label. What impact does this have on the results of your analyses? Do your experimental results support the idea that the fertilizer was overformulated (a class average might help you to answer this question so we will collect class data that you may or may not use to answer this question as you could base your answer on your own individual data rather than the class as a whole). (2 pts.)

End of sample assignment/assessment

2. Summary of the proposed revisions.

1. Catalog Description change to better reflect the student audience expected in the course.
2. Change in course objectives to fit expected student learning outcomes
3. Minimum Lab Grade of 70% required for passing course.
4. Updated course text and bibliography
5. Included sample laboratory experiment/report and grading rubric associated with Objectives2&4.

3. Justification/rationale for the revision.

1. CHEM 111 (General Chemistry I) is an existing liberal studies Natural Science course for science majors that does not have any pre-requisites. Students advised into CHEM 111 may lack the chemistry or math background and will spend longer in lecture and lab working on basic concepts and mathematical analysis of chemical problems. Chemistry majors in CHEM 111 will have the opportunity to improve their math skills and still be exposed to chemistry. The separation of the students between CHEM 111 and CHEM 113 (Advanced General Chemistry I) will improve retention of all science majors.
2. **Catalog Description changes** reflect the distinction between General Chemistry I and Advanced General Chemistry I.
3. **Change in course objectives** to fit expected student learning outcomes
4. Updated course text and bibliography - the syllabus of record was last updated in 2003.
5. Minimum Lab Grade of 70% required for passing course was the recommendation of two external evaluators at our last program review. Faculty approved raising the minimum passing lab grade from 65% to 70% to improve student learning and standards.
6. Included sample laboratory experiment/report and grading rubric associated with Objectives2&4.

4. The old syllabus of record.

OLD SYLAABUS OF RECORD FOR CHEM 111 GENERAL CHEMISTRY I

I. CATALOG DESCRIPTION

COURSE NUMBER:	CHEM 111
COURSE TITLE:	General Chemistry I
NUMBER OF CREDITS:	4 cr (3c-3l-4sh)
PREQUISITES:	none
COURSE DESCRIPTION:	A lecture-discussion of principles of chemistry, including theory and applications. The lab illustrates principles discussed. Topics discussed include scientific measurements, simple definitions and concepts, the mole, stoichiometry, gas laws, electronic structure of the atom, bonding, thermochemistry, and descriptive chemistry of the elements. Fulfills Liberal Studies Natural Science Lab Requirement.

II. COURSE OBJECTIVES

The students are expected to understand the basic principles of chemistry and the scientific method of inquiry. They will also gain an appreciation of the significance of chemistry in everyday life.

III. DETAILED COURSE OUTLINE

General Chemistry I is a multi-section course taught by a team of instructors. However, it is always coordinated so that students receive exposure to the same series of lecture topics and the same experiments.

The topics are:

1. <u>Chemistry as a Quantitative Science</u> — 4 lectures
   Development of modern chemistry, experiment-theory, units of measurement.
2. <u>Description of Matter</u> — 3 lectures
   Early atomic theory, symbols, formulas, chemical equations. Atomic mass scale. Periodic table of the elements.
3. <u>Chemical Calculations</u> — 4 lectures
   The mole concept. Molecular weight, formula weight, stoichiometry.

4. Reactions in Aqueous Solution — 4 lectures
Electrolytes, acids, bases, salts. Types of reactions and stoichiometric calculations.
5. The Gaseous State — 4 lectures
The laws of gases: Boyle's, Charles', Avogadro's, and Dalton's laws. The ideal gas, the kinetic molecular theory.
6. Thermochemistry — 4 lectures
Heats of reaction and their measurement. Calorimetry. Hess' law of thermochemistry. Enthalpies of formation.
7. Structure of the Atom — 3 lectures
Discovery of electron and nucleus. Atomic models: Rutherford's model, Bohr's model. Atomic mechanics. Quantum numbers and atomic orbitals
8. Electronic Structure of the Atom — 4 lectures
Electron spin and Pauli principle. Electron configuration. Orbital diagrams. Periodicity of the elements. Brief description of the main group elements.
9. Ionic and Covalent Bonds — 6 lectures
Description of ionic bond. Electron configuration of ions, ionic radii. Description of covalent bond, polar covalent bond, electronegativity. Lewis structures, octet rule, delocalized bonding and resonance.
10. Molecular Geometry and Directional Bonding — 6 lectures
Electron pair repulsion theory and molecular-orbital theory. Dipole moments and molecular geometry.
11. Laboratory Experiments — 13 lab periods
    1. Lab safety, exponential notation of numbers, significant digits, logarithms, graphing of data
    2. Mass and volume measurements, density of solids and liquids
    3. Observation and interpretation of chemical change, chemical formulas and equations
    4. Reactions in aqueous solutions
    5. Acid-base titrations
    6. Boyle's law
    7. Atomic weight of a metal
    8. Molecular weight of a volatile liquid
    9. Thermochemistry I: calorimeter constant determination
    10. Thermochemistry II: enthalpy of hydration
    11. Spectrum of atomic hydrogen
    12. Periodic properties of the elements
    13. Molecular structure and VSEPR Theory

IV. EVALUATION METHODS

The evaluation methods consist of quizzes, hourly exams, grading of weekly lab reports and the final exam. Normally the lecture grade determines three-fourths of the final grade, and the lab grade determines one-fourth. The final exam grade usually contributes 25-30% to the lecture grade and the hourly exams plus quizzes contribute the rest. The lab grade is made up of report and quiz grades.

V. REQUIRED TEXTBOOK(S)

Jones and Atkins. *Chemistry: Molecules, Matter, and Change*. 4th Ed., W.H. Freeman and Co., New York, NY, **2000**.

Wink, Gislason, and Kuehn. *Working with Chemistry: A Laboratory Inquiry Program* W.H. Freeman and Co., New York, NY, **2000**.

With respect to content, general chemistry textbooks usually vary little from each other but the General Chemistry Committee has nevertheless agreed to switch textbooks every three to four years (or sooner, if necessary). This allows for renewal and adjustment to the needs of students.

The laboratory part of the course is made up of about 13 experiments that are intended to provide practical illustrations of the concepts taught in lecture. In order to insure essential flexibility and facilitate broader faculty participation in the construction of the lab program, we have made use of "modular" lab experiments purchased from Chemical Education Resources or especially prepared by some of the teaching faculty. These "modules" contain all of the information necessary to complete a particular lab experiment including background information on the concept under study, pre-lab questions, the experimental procedure, data-analysis and post-lab questions.

VI. SPECIAL RESOURCE REQUIREMENTS

Students are expected to have their own scientific calculators and to purchase acceptable safety goggles, which are available in the Coop Store.

Students are also expected to study from the required textbook and lab "modules". They are also encouraged to use supplementary materials such as books of exercises and occasionally articles in non-specialized journals. There are a number of computer-based programs and web sites that provide drill-and-practice on such topics as chemical nomenclature, balancing chemical reactions, calculation of pH, etc. Students should make sure that they have access to a computer in order to take advantage of these study aids. The department maintains a computer classroom that will be used for some of the laboratory exercises, as well.

VII. BIBLIOGRAPHY

Supplemental bibliography may include journals such as *Journal of Chemical Education, Journal of College Science Teaching, Science, Scientific American, Discover.*

Liberal Studies Course Approval General Information

1. CHEM 111 is a multi-instructor course. In fall 2011, there were four lecture sections (four different instructors) and 16 lab sections (eight different instructors). Basic equivalency between sections is fostered in the following ways: a) all lab sections follow the same experiment schedule; b) lecture instructors use the same textbook; c) lecture instructors are expected to cover the same chapters in this textbook; d) one faculty member acts as the General Chemistry coordinator, and communicates issues concerning the course to all the other instructors; e) lecture and lab instructors are encouraged to join the departmental General Chemistry Teaching Circle, which discusses issues associated with General Chemistry lecture and lab.

2. The content of CHEM 111 is primarily based on essential concepts of chemistry and skills necessary for creative, quantitative problem-solving. Contributions of pioneering female and minority scientists such as Marie Curie, Lise Meitner, George Washington Carver are included.

3. CHEM 111 is a course whose primary purpose is the development of higher level quantitative skills and, thus, has no required supplemental readings. Students (and faculty), however, should be encouraged to examine the primary literature and the items listed in the bibliography. The overarching objective of this course is not the memorization of facts, but the ability to creatively apply the essential concepts of chemistry in a wide variety of contexts. This involves the mastering of a series of both quantitative and non-quantitative problem-solving skills, all of which are contained in the lecture textbook and laboratory instruction package.

4. The chemistry department faculty feels that the type of course envisioned as a Liberal Studies course – an overview of the field of chemistry, with training in the essential problem-solving skills necessary to interpret the chemical world – not only meets the needs of non-majors, but is precisely what is needed for freshmen intending to be chemistry majors. The Committee on Professional Training of the American Chemical Society agrees with this structure. They envision a General Chemistry sequence as a vehicle to get all students to a satisfactory level of knowledge before they take the "foundation" courses of Analytical, Organic, Inorganic, Physical and Biochemistry. Particularly for those students who take the two-semester sequence of General Chemistry I and II, their course work in chemistry will allow them to understand a great deal of the natural world at a non-expert level, or serve as a preliminary for additional learning that will take them to higher knowledge levels.