LSC Use Only Proposal No: LSC Action-Date: AP-3/22/12	UWUCC Use Only Proposal No: 11-125e. 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 112 General Chemistry II

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	Anne Kondel [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

Received APR 2 2012 Liberal Studies

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Part II.

New Syllabus of Record

1. Catalog Description

CHEM 112 General Chemistry II (3c-3l-4cr)

Prerequisites: CHEM 111 or 113

Description: Introductory course for science and pre-professional health majors. This course is the second 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 the solid states, solution theory, kinetics, equilibrium, thermodynamics, acids and bases, and electrochemistry.

2. Course Outcomes

Objective 1:
Students will be able to demonstrate essential chemical knowledge in the following content areas: solids, solutions, kinetics, equilibrium, acids & bases, thermodynamics and electrochemistry.
Expected Student Learning Outcome 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.
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 solutions, kinetics,

equilibrium and thermodynamics. 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 hr = 50 minutes; allows three hours for exams):
   1) Organic Chemistry (2 hours)
      a) Essential features of organic molecules
      b) Structural isomers
      c) Functional groups
   2) Solids and Intermolecular Forces (5 hours)
      a) Van der Waals forces and hydrogen bonds
      b) Types of solids
      c) Phase changes
   3) Solutions (4 hours)
      a) Expression of concentration
      b) Mole fraction and Raoult's Law
   4) Kinetics (5 hours)
      a) Measurement of reaction rate
      b) Method of initial rates
      c) First- and second-order rate equations
      d) Determination of reaction order from empirical data
   5) Equilibrium (5 hours)
      a) Concept of chemical equilibrium
      b) Equilibrium calculations
      c) Le Chatelier's Principle
   6) Acid – Base (6 hours)
      a) Physical description of acids and bases
      b) Weak acid and weak base equilibria
      c) Acid-base properties of conjugate salts
      d) Structural effects on acid strength
   7) Aqueous Equilibria (5 hours)
      a) Buffers and buffer calculations
      b) Detailed description of acid-base titrations
      c) Equilibria of slightly soluble salts
   8) Entropy and Gibbs Free Energy (4 hours)

a) Concept of entropy
b) Quantification of entropy
c) Gibbs Free Energy
d) Relationship between ΔG and K_{eq}

9) Electrochemistry (3 hours)
a) Oxidation, reduction and half-reactions
b) Standard reduction potentials
c) Non-spontaneous electrochemical reactions

10) Final Exam (2 hours during final examination period)

CHEM 112 Laboratory Schedule (one experiment per session)
1. Check-in; Safety; Lewis Structures, Line Structures, VSEPR and Functional Groups
2. Experiment CC-1: Using Spartan for Molecular Orbital Calculations
3. Experiment CC-2: Connecting Molecular Structure to Evaporation Rates
4. Experiment CC-3: Synthesis and Purification of Aspirin and Comparison of its Acidity to Salicylic Acid Using Molecular Orbital Calculations
5. Experiment SP-1: Spectrophotometry of Food Dyes
6. Experiment SP-2: The Investigation of the Wreck of the S.S. Crimson Hawk (Spectrophotometric Determination of Solution Concentration)
7. Experiment RS-1: Kinetics of Bisulfite and Iodate (Method of Initial Rates)
8. Experiment RS-2: Removal of Hydrogen Peroxide from Drinking Water
9. Experiment ES-1: Le Châtelier's Principle and Determination of an Equilibrium Constant
10. Experiment: ES-2: Equilibrium Constant of a Chemical Indicator
11. Experiment ES-3: Ka of a Weak Acid
12. Experiment BC-1: Effects of Salt Solutions on pH
13. Experiment BC-2: Andromeda Strain Revisited: pH of Blood
14. Check-out and Course Wrap Up

4. Evaluation Methods:

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

5. Example Grading Scale

A: $\geq$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 II 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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10. *Journal of Chemical Education*
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16. *Women in Chemistry and Physics: A Biographical Sourcebook*, Grimstein, L.S.; Rose, K. R.; Rafailovich, M.H. Eds.; Greenwood Press, 1993.
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CHEM 112 SAMPLE ASSIGNMENT

Experiment BC-1
Concept lab: What makes pH change and by how much?

Background

Our ability to digest food, to breathe properly, to grow plants and to clean our homes is just a sampling of processes that depend on pH, where:

$$pH \equiv -\log([H_3O^+]) = -\log([H^+])$$

From your studies on equilibrium, you know that that any equilibrium that involves H_3O^+ as a product or reactant can be shifted, according to Le Châtelier's Principle, by changing $[H_3O^+]$.

Pure water at 25 ^{0}C has a natural equilibrium that produces $[H_3O^+] = [OH^-] = 1.00x10^{-7}$:

$$H_2O(l) + H_2O(l) \leftrightharpoons H_3O^+(aq) + OH^-(aq) \quad \text{or} \quad H_2O(l) \leftrightharpoons H^+(aq) + OH^-(aq)$$

The equilibrium constant for the autoionization of water at 25 ^{0}C has the value $K_w = [H_3O^+][OH^-] = 1.00x10^{-14}$. Indeed, all aqueous solutions obey the relationship:

$$14.00 = pH + pOH$$

where,

$$pOH = -\log([OH^-])$$

We can alter the pH of an aqueous solution by adding other substances that shift the water equilibrium. For example, adding an acid, HA, to water, causes the reaction:

$$HA(aq) + H_2O(l) \leftrightharpoons H_3O^+(aq) + A^-(aq)$$

Note, however, that the product $[H_3O^+][OH^-]$ will still equal 1.00×10^{-14}, because if $[H_3O^+]$ goes up, then $[OH^-]$ goes down, and vice versa.

So many chemical and biological processes depend upon pH that it is important to understand how we can control, regulate or realign pH when it goes askew. Today, you will explore what happens to the pH of different solutions as strong acid or strong base is added. You should review in your text book the differences between strong and weak acids, and strong and weak bases.

The solutions you will test today have been grouped into four sets:

Set One	Set Two
CH_3COOH	Na_2CO_3
$CaCl_2$	NH_4Cl
Propionic acid/sodium propanoate mixture	Propionic acid/sodium propanoate mixture

Set Three	Set Four
NH_3	$NaCH_3COO$
Distilled water	$NaHCO_3$
Propionic acid/sodium propanoate mixture	Propionic acid/sodium propanoate mixture

Part I: Formation of Groups and Calibration of pH Meter

Work in groups of three, and assign tasks to each member. You will use numerous clear, colorless solutions, so it is important to label them carefully. Your instructor will assign a set of solutions for you to test, but you must obtain class data for the complete list of all chemicals.

Obtain 30 mL each of pH = 4.0 and pH = 7.0 buffer solutions for calibrating the pH probe. Follow the Instrument Guide to calibrate the pH probe.

Your instructor may ask you to divide the work in Parts II and III with another group of three.

Part II: Volumes of Strong Acid needed to Change pH.

Use a 100 mL beaker to obtain 60 mL of 0.050 M HCl. Clean and rinse a 50 mL burette with a small portion of the HCl, and then fill the burette with the HCl, ensuring there are no air bubbles in the tip.

Use a graduated cylinder to measure 30 mL of your first solution of your assigned set, and pour it into a small beaker. (The depth of the solution must be sufficient to cover the tip of the pH probe.) Following the Instrument Guide, measure the initial pH of the solution. Record the initial volume reading of the burette (V_i). You will initially add one or two drops of HCl, swirl, measure the pH, read the burette, and enter the volume ($V-V_i$). If the pH has changed sharply (by more than 0.3), continue the titration one or two drops HCl at a time. If the pH hasn't changed much, continue the titration in about 0.5 mL increments. Stop the titration when the pH reaches 4 (or less, if you accidently overshoot it). Note the volume of HCl needed to reach pH = 4 in Table One of the Report Guide, and record your data on the board to share with the class.

Repeat the procedure in the preceding paragraph for 30 mL samples for the other two solutions listed in your assigned set. Note you do not need to refill the burette to 0.00 mL between each titration. Just subtract the initial volume reading for each different titration. Stop each titration when the pH reaches 4. For each solution, record the volume of HCl needed to reach pH = 4 in Table One of the Report Guide, and record your data on the board to share with the class.

(You will be titrating with the HCl again in Part IV, so do not clean out this burette yet.)

Part III: Volumes of Strong Base needed to Change pH.

Use a 100 mL beaker to obtain 60 mL of 0.050 M NaOH. Clean and rinse a 50 mL burette with a small portion of the NaOH, and then fill the burette with the NaOH, ensuring there are no air bubbles in the tip.

Use a graduated cylinder to measure 30 mL of your first solution of your assigned set, and pour it into a small beaker. (The depth of the solution must be sufficient to cover the tip of the pH probe.) Following the Instrument Guide, measure the initial pH of the solution. Record the initial volume reading of the burette (V_i). You will initially add one or two drops of NaOH, swirl, measure the pH, read the burette, and enter the volume ($V-V_i$). If the pH has changed sharply (by more than 0.3), continue the titration one or two drops NaOH at a time. If the pH hasn't changed much, continue the titration in about 0.5 mL increments. Stop the titration when the pH reaches 10 (or more, if you accidently overshoot it). Note the volume of NaOH needed to reach pH = 10 in Table Two of the Report Guide, and record your data on the board to share with the class.

Repeat the procedure in the preceding paragraph for 30 mL samples for the other two solutions listed in your assigned set. Stop each titration when the pH reaches 10. For each solution, record the volume of NaOH needed to reach pH = 10 in Table Two of the Report Guide, and record your data on the board to share with the class.

(You will be titrating with the NaOH again in Part IV, so do not clean out this burette yet.)

Part IV: Quantitative Analysis of propionic acid/sodium propanoate mixture.

Obtain two more 30 mL samples of the propionic acid/sodium propanoate mixture, measured with a graduated cylinder and poured into two small beakers.

Carefully titrate one sample of the mixture with 0.0500 M HCl to pH 3.0, to generate a titration curve (pH vs. Volume HCl). In contrast to Parts II and III, your increment volume will vary throughout the titration. Here, your initial increment size of HCl should be about 0.5 mL, but as the pH begins to change more sharply, decrease your increment size, down to dropwise addition between measurements. The point where the pH changes the most steeply is called the equivalence point. You want to obtain a precise measure of the volume needed to get to this point, which is why you will decrease increment size as you approach the equivalence point. Print one copy per group of the titration curve , and note the volume of HCl needed to reach the equivalence point.

Titrate the other sample with 0.0500 M NaOH to pH 11, to generate another titration curve (pH vs. Volume NaOH). Print one copy per group of the titration curve , and note the volume of NaOH needed to reach the equivalence point.

When your titrations are complete, wash and rinse your burettes, leaving them upside down, with the stop cocks open, to drain. (If any NaOH is left in the burette, the crystals can clog the tip as the water evaporates.) Wipe down your lab bench with wet paper towels.

Student Guide to Using the Vernier LabPro pH Meter for Titrations.

Calibration

1. Unscrew the cap, carefully remove the pH probe from its storage bottle and stand up the probe in a 250 or 400 mL beaker so it does not tip over.
2. Plug connector of the pH probe into the LabPro Interface. Plug the power adapter for the LabPro into the electrical outlet and its other connector into bottom left corner of the LabPro.
3. Double-click the "Logger Pro" icon to start the program.
4. Use the left mouse button to select the FILE from the main menu and from this select OPEN...
5. When the dialog box appears click to select the "Chemistry With Vernier" folder with the left mouse button and then click the OPEN button. Next select the file "24a Acid-Base Titrations" and then click OPEN or OK. This should display three windows: a meter showing the pH of the solution; a graph of pH versus Volume; and a data table with columns for pH and volume.
6. Click "EXPERIMENT" in the main menu, and "Calibrate" in the submenu.
7. Put the pH probe in the pH 4.01 buffer solution and enter "4.01" under "ENTER VALUE". Click "KEEP". This will display the Reading 2 box.
8. Remove the pH probe from the pH 4.01 buffer solution, rinse it with distilled water and place it in the pH 7 buffer. Enter "7.0" under "ENTER VALUE" and then click "KEEP". Finally click DONE to leave the calibration routine.

Titration: pH and volume measurements

9. Rinse your probe off with distilled water, and place it in the solution being analyzed. Swirl the solution, wait until the pH reading stabilizes and then click "Collect". Click "Keep", and enter the volume "0.00".

10. Add strong acid or strong base in approximately 0.25 mL increments, and swirl. When the pH reading stabilizes, measure the volume added by reading the burette to ±0.01 mL, and calculate $(V - V_i)$, where $V_i = V_{initial}$. Click "Keep", and enter the calculated volume. Repeat step 10 for the duration of the titration. Do not "STOP" the data collection until the titration is complete.
11. When you are finished making measurements, click "STOP".
12. For the quantitative analysis of Part IV, click "ANALYZE", "TANGENT", and slide the tangent line along your titration curve until you find the greatest magnitude of the slope. This point is called the equivalence point. The volume of HCl (or NaOH) at the equivalent point will be used to analyze the contents of the mixture.
13. When you are finished, exit from Logger Pro, return the probe to its storage bottle (make sure cap is screwed down tightly so the O-ring seal around the probe does not leak) and logoff the computer.

Experiment BC-1 Report: What makes pH change and by how much?

(AEK 04/18/09)

Report Submitted by ______________________

Date Submitted ________________________

A. Purpose: *The purpose of this experiment is to determine how strong acids and strong bases affect the pH of different solutions, and to analyze the concentrations of the components of an acid/conjugate base mixture.*

B. Procedure Notes

Part I: Formation of Groups and Calibration of pH Meter

Formation of Groups (Write your and your partner's names and describe in one or two sentences the major roles each one played in collecting the data for this experiment. List your assigned set of solutions. Briefly describe how you calibrated the pH meter.)

C. Experimental Data and Results

Record the exact concentrations of the standardized solutions:

[HCl]:________________ [NaOH]:__________________

Part II: Volumes of Strong Acid needed to Change pH.

In Part II, you and your partners will add strong acid to different solutions and record the volume of HCl needed to drop the pH to 4.0.

Table One: Volume of HCl needed to bring pH = 4

Solution	Initial pH	Volume HCl needed to reach pH = 4
CH_3COOH		
$CaCl_2$		
Na_2CO_3		
NH_4Cl		

NH_3		
Distilled water		
$NaCH_3COO$		
$NaHCO_3$		
Propionic acid/sodium propanoate mixture		

1. What trends do you observe? i.e., which solutions react similarly to each other? Group together solutions that required similar amounts of HCl. Which solutions are distinct?

2. For each solution, write the chemical reaction that the cation or anion might have with water.

   CH_3COOH

   $CaCl_2$

   Na_2CO_3

   NH_4Cl

   NH_3

   $NaCH_3COO$

   $NaHCO_3$

   Propionic acid/sodium propanoate mixture

3. Use the reactions in question 2 above to explain the groupings you created in question # 1.

Part III: Volumes of Strong Base needed to Change pH.

In Part III, you and your partners will add strong base to different solutions and record the volume of NaOH needed to increase the pH to 10.

Table Two: Volume of NaOH needed to bring pH = 10

Solution	Initial pH	Volume HCl needed to reach pH = 4
CH_3COOH		
$CaCl_2$		
Na_2CO_3		
NH_4Cl		
NH_3		
Distilled water		
$NaCH_3COO$		
$NaHCO_3$		
Propionic acid/sodium propanoate mixture		

4. What trends do you observe? i.e., which solutions react similarly to each other? Group together solutions that required similar amounts of NaOH. Which solutions are distinct?

5. Use the reactions in questions 2 above to explain the groupings you created in question # 4.

Part IV: Quantitative Analysis of propionic acid/sodium propanoate mixture ($CH_3CH_2COOH/NaCH_3CH_2COO$).

You and your partners will add strong acid and strong base in small increments to the mixture, and measure the pH. Find the volumes of strong acid and strong base where the slopes are the steepest. Sketch in the space below the pH vs. volume strong acid curve and pH vs. volume strong base added. LABEL your lines! Attach one printout of each graph to the lab report of one group member.

__Analysis of Part IV__

Volume of strong acid corresponding to steepest slope (pH mixture vs. mL strong acid):__________

Volume of strong base corresponding to steepest slope (pH mixture vs. mL strong base):__________

(a) The propionic acid/sodium propionate mixture contains a weak acid, and its conjugate base. Identify which is which:

CH_3CH_2COOH:__________________

$NaCH_3CH_2COO$:______________________

(b) Write the chemical reaction that occurs between the weak acid in the mixture and NaOH:

(c) Write the chemical reaction that occurs between the conjugate base in the mixture and HCl:

(d) What do you notice about the products of these two reactions?

Show your work for the following calculations:

(e) Calculate the moles of strong acid needed to reach the equivalence point, using the volume of strong acid corresponding to the steepest slope, and the concentration of the strong acid:

(f) The strong acid will react with the conjugate base present in the mixture. Using your balanced equation from (c), calculate the number of moles of base in the mixture.

(g) Calculate the original concentration of conjugate base in the mixture, using the moles of conjugate base and the volume of mixture used:

(h) Calculate the moles of strong base needed to reach the equivalence point, using the volume of strong base corresponding to the steepest slope, and the concentration of the strong base:

(i) The strong base will react with the weak acid present in the mixture. Using your balanced equation from (b), calculate the number of moles of weak acid in the mixture.

(j) Calculate the original concentration of weak acid in the mixture, using the moles of weak acid from (i) and the volume of mixture used:

(k) From your instructor, the actual weak acid concentration: ________________ and the actual conjugate base concentration: ______________.

Conclusions

1. In Part II, you added strong acid to CH_3COOH, $CaCl_2$, Na_2CO_3, NH_4Cl, NH_3, Distilled water, $NaCH_3COO$ and $NaHCO_3$. Account for the different volumes of HCl needed to drop the pH to 4.0. Write any chemical reactions that might be occuring between the HCl and the solutions. (Do these reactions account for the differences in volume HCl needed?)

2. In Part III, you added strong base to CH_3COOH, $CaCl_2$, Na_2CO_3, NH_4Cl, NH_3, eistilled water, $NaCH_3COO$ and $NaHCO_3$. Account for the different volumes of NaOH needed to raise the pH to 10.0. Write any chemical reactions that might be occuring between the NaOH and the solutions. (Do the reactions account for the differences in volume NaOH needed?)

3. In general, does the presence of a salt influence the pH of an aqueous solution? Explain.

4. In Parts II and IV, you added strong acid to a mixture of propionic acid and sodium propanoate. Write any chemical reactions that might be occuring between the HCl and this solution.

5. In Parts II and IV, you added strong base to a mixture of propionic acid and sodium propanoate. Write any chemical reactions that might be occuring between the NaOH and these solutions.

6. Using your results for the propionic acid/sodium propionate mixture, explain how a mixture of a weak acid and its conjugate base affects pH differently than an individual solution of just a weak acid or just its conjugate base.

7. Calculate the % error in your weak acid and conjugate base concentrations compared to the given values.

CHEM 112 SAMPLE ASSESSMENT

<u>Experiment BC-1: What makes pH change and by how much?</u>

<u>GRADING CRITERIA FOR EXPERIMENT BC-1</u>

<u>Laboratory Report Checklist (1 point)</u>

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

<u>Header for Report and Experiment Objective (2 points)</u>

- Name, the date submitted, 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. You should relate the objective to the scenario of this series of experiments

<u>Summary of Procedure (4 points)</u>

- 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.

<u>Summary of Data (4 points)</u>

- 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)

<u>General Criteria for Calculations and Data Analysis (4 points)</u>

- Example calculations are shown.
- All results are <u>tabulated</u> 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 Conclusions

(Q1-6 on pp. BC-7-BC-9 and Part IV a-d on pp. BC-9-10 should help you answer the conclusion questions 1-6!)

Q 1-6 1pt each for 6 pts. Total
Calculations Part IV e-k and Conclusion Q7 4 pts total

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 112 (General Chemistry I) is the second in a sequence of courses for science majors, although enrollment is not restricted. It is an existing liberal studies Natural Science course. Students who have successfully completed CHEM 111 or CHEM 113 are prepared for this course. Students may possess less background in chemistry and/or mathematics and thus more time may be spent in class working through relevant problems. Chemistry majors who completed CHEM 113 may opt for this course instead of CHEM 114, depending upon their background or achievement level.
2. **Catalog Description changes** reflect the distinction between General Chemistry II and Advanced General Chemistry II.
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 SYLLABUS OF RECORD FOR CHEM 112, GENERAL CHEMISTRY II

I. CATALOG DESCRIPTION

COURSE NUMBER:	CHEM 112
COURSE TITLE:	General Chemistry II
NUMBER OF CREDITS:	4 cr (3c-3l-4sh)
PREQUISITES:	CHEM 111
COURSE DESCRIPTION:	A continuation of General Chemistry I. Topics covered include the solid and liquid state, solutions, kinetics, equilibria, acids and bases, solubility equilibria, thermodynamics, electrochemistry and descriptive chemistry of the elements. Also 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 II 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. States of Matter: Liquids and Solids — 4 lectures
   Phase transitions. Phase diagrams. Properties of liquids and solids.
2. Solutions — 4 lectures
   Types of solution. The solution process and colligative properties.
3. Reaction Kinetics — 5 lectures
   Reaction rates. Reaction orders. Activation Energy and the Collision Theory.
4. Chemical Equilibrium — 5 lectures
   The description of equilibrium and equilibrium constant. The conditions of chemical reactions and the position of

equilibrium. LeChatelier Principle.

5. <u>Acid-Base Concepts</u> — 4 lectures
Arrhenius, Bronsted-Lowry, and Lewis concepts of acids and bases. Strength of acid-bases and self-ionization of water.

6. <u>Acid-Base Equilibria</u> — 4 lectures
Acid-base ionizations. Equilibrium constants. Titration curves. Hydrolysis of salts.

7. <u>Solubility and Complex-Ion Equilibria</u> — 4 lectures
The solubility product constant. Common ion effect. Precipitation calculations. Complex-ion formation, complex-ion formation and solubility. Qualitative analysis of metal ions.

8. <u>Chemical Thermodynamics</u> — 4 lectures
The law of the conservation of energy (first law). The second law and entropy, free energy and spontaneity. Equilibrium calculations.

9. <u>Electrochemistry</u> — 5 lectures
Electrochemical cells and electrolytic cells, electromotive force, electrode potentials. Equilibrium constants from electromotive forces. The laws of electrolysis.

10. <u>Laboratory Experiments</u> — 13 lab periods
1. Lab safety, preparation of a standard sodium hydroxide solution, titration of a hydrochloric acid solution with sodium hydroxide.
2. Evaluations of commercial antacids.
3. Water hardness
4. Determination of molecular weight by freezing point depression
5. Formaldehyde clock reaction
6. Equilibrium
7. Spectrophotometric analysis of permanganate solutions
8. Determination of the equilibrium constant for $FeSCN^{2+}$
9. Determination of acid dissociation constant by titrimetry. Using the pH meter.
10.A study of pH, dissociation hydrolysis and buffers
11.Introduction to qualitative analysis of cations
12.Electrochemical cells and reduction potentials; electrolysis
13.Practical examination

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 112 is a multi-instructor course. In spring 2011, there were three lecture sections (three different instructors) and 11 lab sections (six 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 112 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. Careers in the sciences and health-science fields are discussed, and the opportunities for female and minority students in these fields are highlighted.

3. CHEM 112 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.