



CREDIT COURSE OUTLINE

I. COVER PAGE

(1) CHEM 1B

(2) GENERAL CHEMISTRY AND QUALITATIVE ANALYSIS

(3) 5

Number

Title

Units

<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td colspan="2">(4) Lecture / Lab Hours:</td> </tr> <tr> <td colspan="2">Total Course Hours</td> </tr> <tr> <td style="width: 50%;">Total Lec hours:</td> <td style="text-align: right;">3.00</td> </tr> <tr> <td>Total Lab hours:</td> <td style="text-align: right;">6.00</td> </tr> <tr> <td>Total Contact hours:</td> <td style="text-align: right;">162.00</td> </tr> <tr> <td colspan="2">Lec will generate <u>0</u> hour(s) outside work.</td> </tr> <tr> <td colspan="2">Lab will generate <u>0</u> hour(s) outside work.</td> </tr> <tr> <td>(5) Grading Basis:</td> <td>Grading Scale Only</td> </tr> <tr> <td></td> <td>Pass/No Pass option</td> </tr> <tr> <td></td> <td style="text-align: center;">X</td> </tr> <tr> <td></td> <td>Pass/No Pass only</td> </tr> <tr> <td>(6) Advisories:</td> <td>ENGL 1A - READING AND COMPOSITION</td> </tr> <tr> <td>(7) Pre-requisites (requires C grade or better):</td> <td>CHEM 1A MATH 103</td> </tr> <tr> <td>Corequisites:</td> <td></td> </tr> </table>	(4) Lecture / Lab Hours:		Total Course Hours		Total Lec hours:	3.00	Total Lab hours:	6.00	Total Contact hours:	162.00	Lec will generate <u>0</u> hour(s) outside work.		Lab will generate <u>0</u> hour(s) outside work.		(5) Grading Basis:	Grading Scale Only		Pass/No Pass option		X		Pass/No Pass only	(6) Advisories:	ENGL 1A - READING AND COMPOSITION	(7) Pre-requisites (requires C grade or better):	CHEM 1A MATH 103	Corequisites:		<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td colspan="2">(8) Classification:</td> </tr> <tr> <td colspan="2">Degree applicable: X</td> </tr> <tr> <td colspan="2">Non-degree applicable:</td> </tr> <tr> <td colspan="2">Basic skills:</td> </tr> <tr> <td>(9) RC</td> <td>Fulfills AS/AA degree requirement: (area)</td> </tr> <tr> <td></td> <td>General education category:</td> </tr> <tr> <td></td> <td>Area A Natural Sciences</td> </tr> <tr> <td>Major:</td> <td>BIOLOGICAL SCIENCE LIBERAL ARTS & SCIENCES - NATURAL SCIENCES PHYSICAL SCIENCE</td> </tr> <tr> <td>Certificate of:</td> <td></td> </tr> <tr> <td>Certificate in:</td> <td></td> </tr> <tr> <td>(10) CSU</td> <td>Baccalaureate: X</td> </tr> <tr> <td>(11) Repeatable: (A course may be repeated three times)</td> <td style="text-align: center;">0</td> </tr> </table>	(8) Classification:		Degree applicable: X		Non-degree applicable:		Basic skills:		(9) RC	Fulfills AS/AA degree requirement: (area)		General education category:		Area A Natural Sciences	Major:	BIOLOGICAL SCIENCE LIBERAL ARTS & SCIENCES - NATURAL SCIENCES PHYSICAL SCIENCE	Certificate of:		Certificate in:		(10) CSU	Baccalaureate: X	(11) Repeatable: (A course may be repeated three times)	0
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(12) Catalog Description:

This course completes the year long general chemistry sequence (1A-1B) and covers the principles of physical and inorganic chemistry with an emphasis on quantitative, mathematical problem solving. Topics covered include acid-base theory, chemical kinetics, equilibrium (acid-base, hydrolysis, and solubility), chemical thermodynamics, electrochemistry, selected topics in nuclear chemistry, coordination chemistry, and/or chemistry of selected groups. Students will analyze inorganic compounds qualitatively and quantitatively.

II. COURSE OUTCOMES:

(Specify the learning skills the student demonstrates through completing the course and link critical thinking skills to specific course content and objectives.)

Upon completion of this course, students will be able to:

- I. Solve and explain chemical kinetics and mechanisms problems;
- II. Solve and explain chemical equilibrium questions including but not limited to acid/base and pH concepts;
- III. Solve and explain problems on thermodynamic concepts;
- IV. Solve and explain problems on electrochemical concepts;
- V. Explain the fundamental concepts of nuclear chemistry;
- VI. Demonstrate general chemistry skills in the laboratory including qualitative analysis.

III. COURSE OBJECTIVES:

(Specify major objectives in terms of the observable knowledge and/or skills to be attained.)

In the process of completing this course, students will:

- I. use chemical kinetic mathematical operations to determine order and rates of a reaction and understand the effects of temperature;
- II. apply Le Chatelier's Principle to systems displaced from equilibrium, mathematically solve for the equilibrium constant and describe limitations involving the equilibrium constant;
- III. demonstrate the ability to classify acids and bases and then determine equilibrium constant and pH of acids, bases, and buffers;
- IV. solve problems involving the common-ion effect in acid-base and solubility equilibria;
- V. evaluate neutralization reactions and titration curves;
- VI. recognize fractional precipitations and equilibria involving complex ions;
- VII. recognize the concept of qualitative cation analysis and be able to perform related laboratory experiments;
- VIII. solve simple problems involving chemical thermodynamic problems (work, heat, internal energy, enthalpy, entropy, and free energy);

- IX. examine the Second Law of Thermodynamics and apply to the spontaneity of a reaction and the complexity of natural systems;
- X. discuss concepts of an electrochemical cell and mathematically solve for a standard cell potential, change in standard free energy, and equilibrium constants;
- XI. recognize physical and chemical properties of element groups (e.g. alkali metals; alkaline earth metals, transition elements, group 13 metals, group 14 metals, nonmetals including halogens, and noble gases);
- XII. identify and describe the bonding of complex ions and coordination compounds;
- XIII. discuss general concepts of nuclear chemistry (e.g. stability, decay, fission, fusion, radioactivity, and nuclear reactions);
- XIV. perform laboratory procedures and techniques used in semimicro qualitative and quantitative analysis of simple inorganic ions, and the apparatus and measurements used in simple calorimetry and electrochemistry experiments;
- XV. demonstrate skills in the laboratory in the use of the analytical balance, titration, spectroscopy, pH meter, correct use of glassware, melting point apparatus, using safety precautions and general laboratory procedures.

IV. COURSE OUTLINE:

Lecture Content:

A. Chemical Kinetics

- I. rates of a chemical reaction
- II. zero, first, and second order reactions
- III. rate laws, integrated form, half life
- IV. reaction mechanisms

B. Principles of Chemical Equilibrium

- I. dynamic equilibrium
- II. equilibrium constant expression
- III. predicting the direction of net change using Le Châtelier's Principle

C. Acid-base equilibria and hydrolysis

- I. Arrhenius, Lewis, and Brønsted-Lowry theory
- II. strong and weak acids
- III. strong and weak bases
- IV. molecular structure and acid-base behavior
- V. buffer solution
- VI. acid-base indicators
- VII. common-ion effect
- VIII. neutralization reactions
- IX. titration curves
- X. solutions of salts and polyprotic acids

D. Solubility and Complex-Ion Equilibria

- I. solubility product constant K_{sp}
- II. common-ion effect in solubility equilibria
- III. criteria for precipitation and its completeness
- IV. fractional precipitation
- V. solubility and pH
- VI. equilibria involving complex ions
- VII. qualitative cation analysis

E. Thermodynamics, with application to equilibria

- I. spontaneity
- II. evaluating entropy and entropy changes
- III. The Second Law of Thermodynamics
- IV. standard free energy change and equilibrium
- V. Gibbs free energy and K_{eq} as a function of temperature
- VI. coupled reactions

F. Electrochemistry

- I. electrode potentials and their measurements
- II. Ecell, Gibbs free energy, and K_{eq}
- III. Ecell as a function of concentration
- IV. batteries
- V. industrial electrolysis processes

G. Chemistry of select groups

- I. main-group elements I and II
- II. the transition elements

H. Coordination Compounds

- I. ligands
- II. nomenclature
- III. isomerism

- IV. magnetic properties of coordination compounds and Crystal Field Theory
- V. acid base reactions with complex ions

I. Nuclear Chemistry

- I. radioactivity
- II. isotopes
- III. artificially induced radioactivity
- IV. rate of radioactive decay
- V. nuclear reactions
- VI. nuclear stability, nuclear fission, and nuclear fusion

Lab Content:

Laboratory

- A. LeChatelier's Principle in iron thiocyanate equilibrium
- B. A kinetic study of an iodine clock reaction
- C. Determination of an equilibrium constant for ethyl acetate reacting with HCl
- D. Determining pH of weak acids, weak bases, and their salts
- E. Determination of the ionization constant of a weak acid
- F. Investigation of a buffer system
- G. Determination of a solubility product constant for silver acetate
- H. Precipitating and quantifying a product using the Solvay process
- I. Spectrophotometric analysis of commercial aspirin
- J. Paper chromatography: separation of amino acids
- K. Qualitative analysis scheme for anions: groups I, II, III, IV, V
- L. Lab practical on qualitative analysis
- M. (Optional) Melting point characteristics

V. APPROPRIATE READINGS

Reading assignments may include but are not limited to the following:

I. Sample Text Title:

1. Recommended - Tro, Nivaldo *Chemistry A Molecular Approach*, ed. 2 nd Pearson Prentice Hall, Upper Saddle River, New Jersey, 2011,
2. Recommended - Petrucci, Ralph H *General Chemistry Principles and Modern Applications*, ed. 8th Prentice Hall, Upper Saddle River, New Jersey, 2002,
3. Recommended - Chang, Raymond *Chemistry*, ed. 8th McGraw Hill, Boston, Illinois, 2005,
4. Recommended - Dekker/Kimball *General Chemistry Quantitative and Qualitative Laboratory Experiments for Science Majors Book B*, Stipes Publishing, Champaign, Illinois, 2003,
5. Recommended - Weiss, Gerald S *Experiments in General Chemistry: Principles and Modern Applications*, ed. 8th Prentice Hall, Upper Saddle River, New Jersey, 2002,

II. Other Readings

- Global or international materials or concepts are appropriately included in this course
- Multicultural materials and concepts are appropriately included in this course

If either line is checked, write a paragraph indicating specifically how global/international and/or multicultural materials and concepts relate to content outline and/or readings.

VI. METHODS TO MEASURE STUDENT ACHIEVEMENT AND DETERMINE GRADES:

Students in this course will be graded in at least one of the following four categories. Please check those appropriate. A degree applicable course must have a minimum of one response in category A, B, or C.

A. Writing

Check either 1 or 2 below

X	1. Substantial writing assignments are required. Check the appropriate boxes below and provide a written description in the space provided.		
	2. Substantial writing assignments are NOT required. If this box is checked leave this section blank. For degree applicable courses you must complete category B and/or C.		
X	a) essay exam(s)	X	d) written homework
	b) term or other paper(s)		e) reading reports
X	c) laboratory report(s)		f) other (specify)

Required assignments may include but are not limited to the following:

- Exams may include questions where the student would need to explain a concept or theory.
- There are 15 to 18 laboratories performed and all require a written laboratory report.
- All homework is written, some questions require students write definitions or explanations of concepts.

B. Problem Solving			
Computational or non-computational problem-solving demonstrations, including:			
X	a) exam(s)	X	d) laboratory reports
X	b) quizzes		e) field work
X	c) homework problems		f) other (specify):

Required assignments may include but are not limited to the following:

- Exams, quizzes, and homework problems are composed of problem solving questions.
- After each experiment is performed the students are required to write a lab report. The lab report includes a purpose, reactions, reaction mechanisms, data, results, and a conclusion.

C. Skill demonstrations, including:			
X	a) class performance(s)		c) performance exams(s)
	b) field work	X	d) other (specify) Laboratory Practical

Required assignments may include but are not limited to the following:

The students will be required to perform an experiment (laboratory practical) without the assistance of others. Instead they can only refer to a laboratory notebook they have been keeping notes in throughout the semester.

D. Objective examinations including:			
X	a) multiple choice	X	d) completion
X	b) true/false		e) other (specify):
X	c) matching items		

COURSE GRADE DETERMINATION:

Description/Explanation: Based on the categories checked in A-D, it is the recommendation of the department that the instructor's grading methods fall within the following departmental guidelines; however, the final method of grading is still at the discretion of the individual instructor. The instructor's syllabus must reflect the criteria by which the student's grade has been determined. (A minimum of five (5) grades must be recorded on the final roster.)

If several methods to measure student achievement are used, indicate here the approximate weight or percentage each has in determining student final grades.

Item Percentage Exams (3) 10-30% Quizzes (5) 10-20% Final 10-30% Laboratory 10-20% Homework 5-20% Participation 1-10% Total 100%

VII. EDUCATIONAL MATERIALS

For degree applicable courses, the adopted texts, as listed in the college bookstore, or instructor-prepared materials have been certified to contain college-level materials.

Validation Language Level (check where applicable):

College-Level Criteria Met	
YES	NO
<u> X </u>	<u> </u>
<u> </u>	<u> X </u>
<u> X </u>	<u> </u>
<u> X </u>	<u> </u>

Indicate Method of evaluation:

Used readability formulae (grade level 10 or higher)
Text is used in a college-level course X
Used grading provided by publisher
Other: (please explain; relate to Skills Levels)

Computation Level (Eligible for MATH 101 level or higher where applicable)	<u> X </u>	<u> </u>
Content		
Breadth of ideas covered clearly meets college-level learning objectives of this course	<u> X </u>	<u> </u>
Presentation of content and/or exercises/projects:		
Requires a variety of problem-solving strategies including inductive and deductive reasoning.	<u> X </u>	<u> </u>
Requires independent thought and study	<u> X </u>	<u> </u>
Applies transferring knowledge and skills appropriately and efficiently to new situations or problems.	<u> X </u>	<u> </u>

List of Reading/Educational Materials

Recommended - Tro, Nivaldo *Chemistry A Molecular Approach*, ed. 2 nd Pearson Prentice Hall, Upper Saddle River, New Jersey, 2011, ISBN: 0-321-65178-2
 Recommended - Petrucci, Ralph H *General Chemistry Principles and Modern Applications*, ed. 8th Prentice Hall, Upper Saddle River, New Jersey, 2002,
 Recommended - Chang, Raymond *Chemistry*, ed. 8th McGraw Hill, Boston, Illinois, 2005,
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Comments:

 This course requires special or additional library materials (list attached).

 X This course requires special facilities:

Laboratory where students can perform chemistry experiments

Attached Files:

BASIC SKILLS ADVISORIES PAGE The skills listed are those needed for eligibility for English 125, 126, and Math 101. These skills are listed as the outcomes from English 252, 262, and Math 250. In the right hand column, list at least three major basic skills needed at the beginning of the target course and check off the corresponding basic skills listed at the left.

Check the appropriate spaces.

- Eligibility for Math 101 is advisory for the target course.
 Eligibility for English 126 is advisory for the target course.
 Eligibility for English 125 is advisory for the target course.

If the reviewers determine that an advisory or advisories in Basic Skills are all that are necessary for success in the target course, stop here, provide the required signatures, and forward this form to the department chair, the appropriate associate dean, and the curriculum committee.

CONTENT REVIEW

CHEM 1A GENERAL CHEMISTRY

Competent knowledge of the periodic table, molecules, and compounds. Assessed from a pre-test administered at the beginning of the semester and the final exam administered at the end of the semester.

MATH 103 INTERMEDIATE ALGEBRA

Simplify and/or factor mathematical expressions into forms more conducive to analysis.

Solve equations introduced in Intermediate Algebra.

Graph functions and relations introduced in Intermediate Algebra.

Apply Intermediate Algebra topics to solve real-life problems.

REQUISITES

Subject Advisory -- ENGL 1A READING AND COMPOSITION

- Write a documented research paper of at least 1000 words that includes:
- a sophisticated introduction, multiple body paragraphs, and conclusion
- a clearly defined, arguable thesis sentence
- supporting details that exhibit critical thinking and use credible secondary sources

- use chemical kinetic mathematical operations to determine order and rates of a reaction and understand the effects of temperature;
- identify and describe the bonding of complex ions and coordination compounds;
- discuss general concepts of nuclear chemistry (e.g. stability, decay, fission, fusion, radioactivity, and nuclear reactions);

Subject Prerequisite -- CHEM 1A GENERAL CHEMISTRY

- Collect and analyze data and have reasonable conclusions. Assessed by the lab practical.
- Competent knowledge of the periodic table, molecules, and compounds. Assessed from a pre-test administered at the beginning of the semester and the final exam administered at the end of the semester.
- Ability to apply skills to solve chemical problems especially math skills. Assessed from a pre-test administered at the beginning of the semester and the final exam administered at the end of the semester.

- use chemical kinetic mathematical operations to determine order and rates of a reaction and understand the effects of temperature;
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- demonstrate the ability to classify acids and bases and then determine equilibrium constant and pH of acids, bases, and buffers;
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- discuss general concepts of nuclear chemistry (e.g. stability, decay, fission, fusion, radioactivity, and nuclear reactions);
- perform laboratory procedures and techniques used in semimicro qualitative and quantitative analysis of simple inorganic ions, and the apparatus and measurements used in simple calorimetry and electrochemistry experiments;
- demonstrate skills in the laboratory in the use of the analytical balance, titration, spectroscopy, pH meter, correct use of glassware, melting point apparatus, using safety precautions and general laboratory procedures.

Subject Prerequisite -- MATH 103 INTERMEDIATE ALGEBRA

- Simplify and/or factor mathematical expressions into forms more conducive to analysis.
- Solve equations introduced in Intermediate Algebra.
- Graph functions and relations introduced in Intermediate Algebra.
- Apply Intermediate Algebra topics to solve real-life problems.

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- discuss concepts of an electrochemical cell and mathematically solve for a standard cell potential, change in standard free energy, and equilibrium constants;
- discuss general concepts of nuclear chemistry (e.g. stability, decay, fission, fusion, radioactivity, and nuclear reactions);
- demonstrate skills in the laboratory in the use of the analytical balance, titration, spectroscopy, pH meter, correct use of glassware, melting point apparatus, using safety precautions and general laboratory procedures.

ESTABLISHING PREREQUISITES OR COREQUISITES

Every prerequisite or corequisite requires content review plus justification of at least one of the seven kinds below. Prerequisite courses in communication and math outside of their disciplines require justification through statistical evidence. Kinds of justification that may establish a prerequisite are listed below.

Check one of the following that apply. Documentation may be attached.

1. The prerequisite/corequisite is required by law or government regulations.
Explain or cite regulation numbers:
2. The health or safety of the students in this course requires the prerequisite.
Justification: Indicate how this is so.
3. The safety or equipment operation skills learned in the prerequisite course are required for the successful or safe completion of this course.
Justification: Indicate how this is so.
4. The prerequisite is required in order for the course to be accepted for transfer to the UC or CSU systems.
Justification: Indicate how this is so.
5. Significant statistical evidence indicates that the absence of the prerequisite course is related to unsatisfactory performance in the target course.
Justification: Cite the statistical evidence from the research.
6. The prerequisite course is part of a sequence of courses within or across a discipline.
Chem 1B is the second course in the Chem 1A - Chem 1B sequence
7. Three CSU/UC campuses require an equivalent prerequisite or corequisite for a course equivalent to the target course: