San Bernardino Valley College
Curriculum Approved: November 18, 2002
Last Updated: November 15, 2002
Honors Course enhancements are indicated in **bold**.

I. CATALOG DESCRIPTION:

A. Division: Science and Math
Department: Chemistry
Course ID: CHEM 151**H**
Course Title: General Chemistry II **- Honors**
Units: 5
Lecture: 3 Hours
Laboratory: 6 Hours
Prerequisite: CHEM 150 and CHEM 150H

B. Catalog and Schedule Description:
The second half of a two-part sequence in chemistry with an emphasis on thermodynamics, equilibrium calculations, kinetics, and electro chemistry. **Enrollment is limited to students eligible for the Honors Program.**

II. NUMBER OF TIMES COURSE MAY BE TAKEN FOR CREDIT: One

III. EXPECTED OUTCOMES FOR STUDENTS

Upon completion of the course, the student should be able to:

A. **Analyze** the equilibrium expression to predict which way a chemical reaction shifts with external stresses.
B. Use the equilibrium expression to calculate the amounts of material left at equilibrium for any gas phase's reactions.
C. **Analyze** thermodynamic tables to calculate free energy change for reactions.
D. **Evaluate** thermodynamic tables to calculate equilibrium constants for reactions.
E. Use solubility rules to predict simple precipitation reactions and write net ionic equations for the reaction.
F. **Compare** Ksp values and the rules to manipulate reactions to get K values for competing precipitation reactions
G. Use Ksp tables to calculate the solubility of a salt in water and in water with a common Ion.
H. **Evaluate** Ksp tables to calculate the conditions needed to separate two Ions of different concentrations.
I. Calculate Ksp values from Lattice, Hydration and Entropy values.
J. **Predict** reactions for the different ways acid solutions can arise.
K. Calculate the pH of strong acids and weak acids.
L. Predict relative acid strengths.
M. Write reactions for the different ways basic solutions can arise.
N. Calculate the pH in weak and strong bases.
O. Relate Ka and Kb for conjugate acid base pairs.
P. Write reactions for acid base reactions and calculate K values for the reaction.
Q. Calculate the pH of an acid base mixture after the reaction has occurred.
R. **Derive** the correct indicators for a titration using titration curve shape.
S. Calculate the ratio of the two colored forms of and indicator.
T. **Select** what acid and salt should be used to prepare a buffer of a given pH and calculate the amounts of acid and salt to use.
U. Calculate pH changes in buffers.
V. Write reactions, get K values, do solubility calculations in systems containing acids and insoluble salts.
W. **Predict** condition needed for sulfide separations.
X. **Solve for** shape of a transition metal couple using magnetic data.

Y. Write reactions, get K values and calculate the solubility of an insoluble salt when a complexing agent is present.
Z. **Determine** the number of unpaired electrons on a metal using crystal field splitting.
AA. Get relative visible absorption spectra of complexes using crystal field.
BB. Balance redox reactions using tables of half reactions
CC. Be able to draw a picture of an electrochemical cell and show the direction of electron flow using the Nernst equation.
DD. Perform calculations on electrolytic cells.
EE. Calculate equilibrium constants and equilibrium calculations for redox reactions.
FF. Use experimental values of time and concentration to get at the rate law for a reaction.
GG. Do calculations using the integrated rate equations.
HH. Explain the effect of concentration, activation energy, catalysts and temperature on reaction speeds.
II. Draw an activation energy diagram and the picture of a possible intermediate for a reaction.
JJ. Calculate the activation energy from experimental data.
KK. Rule out mechanisms that are not consistent with the experimental rate law.
LL. Given a mechanism, be able to derive the experimental rate law.
MM. **Write an acceptable college-level research paper on a topic in general chemistry.**
1. **Use both Internet and standard sources to gather information.**
2. **Evaluate the validity of the sources.**
3. **Organize information into an outline of the paper.**
4. **Integrate researched information into their proposed experimental design.**
5. **Utilize calculations where needed.**
6. **Critically analyze the methodology and the results.**

NN. **Prepare an oral presentation on the research topic.**

IV. COURSE CONTENT:

Lecture

A. Chemistry Equilibrium
General properties of chemical equilibrium, equilibrium constants external stresses on an equilibrium state, manipulations of K values.
B. Equilibrium Calculations in Gas Phase Systems
C. Thermodynamics
Review of first law, the second law and entropy, relation between enthalpy, wntropy and free energy and their use of predicting spontaneous chemical reactions, relation of K values to thermodynamics.
D. Precipitation Reaction
Thermodynamics of solubility, general solubility trends, use of K_{sp} for solubility calculations.
E. Acids and Bases
Ways to get acidic solutions and pH scales, weak acids and K use of K to calculate pH acidic solutions. Thermodynamics molecular structures and acidity. Ways to get basic solution and calculations involving K_b, conjucate acid-base pairs.
F. Acids Base Systems
Acid-base reactions. Titrations and titration curves, indicators, buffers, reactions of insoluble salt and acids using K_{sp} and K.
G. Coordination compounds
Oxidation numbers, complex ions, their bonding, geometries, magnetic, and spectral properties. Kinetic and thermodynamic calculations also included.
H. Oxidation reduction reactions, Electrochemical cells.

I Thermo dynamics of electro chemistry and E^o values, Nernst equation and K values.

J. Chemical Kinetics
Experimental treatment of rate data, temperature effects on rates, theoretical treatment of Kinetics, chemical equilibrium and kinetics.

V. METHODS OF INSTRUCTION:

A. Multimedia lectures
B. Laboratory
C. Discussion
E. Examination
F. Demonstration
G. **Field trips to universities or scientific meetings relevant to course research and topics.**
H. **Guest speakers on research techniques, oral presentations, or other pertinent topics.**
I. **Small interactive groups for developing topics, comparing resources, and evaluating progress.**

VI. TYPICAL ASSIGNMENTS:

A. Lecture: Read textbook chapters assigned and answer all problems
Sample Problem: A factory releases $3.2X10^{7}$ g of SO_2 into 10^7 liters of air. The (H_2O) =0.1M and the (O_2)=0.04M. Air density is 1.2g/L. Calculate the parts per million H_2SO_4 produced in the air. Use the following reaction: 2 $H_2O(g)$ + SO_2 (g) + $O_2(g)$ → $2H_2SO_4(g)$ $K_e = 10^{-8}$

B. Lab: Do the laboratory experiment "Getting the Rate Law for a Chemical Reaction"
Sample Lab: Based on the mass of your unknown salt, MX_2, and your titration data from the ion exchange resin, determine the K_{sp} of your unknown salt.

C. **Research Paper Project: The students will develop their research paper and oral presentation based on a variety of acceptable topics in general chemistry. Topics are approved or suggested by the faculty for the section of general chemistry. The paper will be evaluated before the preparation of the poster and oral presentation. An example of a topic for research is: Calculate the energy fuel efficiency of a gasoline driven car compared to an electric car, using the rules of thermodynamics. Evaluate the efficiency and provide data that would support your recommendation of a more fuel-efficient vehicle. The research paper is expected to be 8-10 pages. Information from this paper can be reformatted for a poster presentation. An oral presentation will also be given based on the paper or the poster.**

VII. EVALUATION(S):

A. Method of evaluation
1. Examination and quizzes:
a) Typical multiple-choice type of question: "Which substance would be best to use to approximate the entropy of CSe_2(L)":
i. CO_2(s)
ii. CO_2 (g)
iii. UF_6 (g)
iv. CS_2 (L)
v. CSe_2(g)

b) Typical problem solving question "calculate the parts per million lead in a water supply (D= 1.1 gm/ml) that contains $PbCl_2$ (s) In 0.1M chloride Ion

2. Laboratory performance criteria
   a) Attendance
   b) Lab reports
   c) Typical questions "Get the solubility of Ca $(IO_3)_2$ at different hydrogen Ion Concentrations by experiment. Using the appropriate expression, plot the data to get a straight line. From the graph get K_a of $HI0_3$ and K_{sp} of Ca $(IO_3)_2$

B. Frequency of Evaluations
   1. Exams are given every couple of weeks. 4 to 5 exams are given during the semester, and a comprehensive final is given during "Final Week".
   2. Quizzes are typically given every few weeks.
   3. Lab work is on a weekly basis.
   4. **The research paper is expected to be 8-10 pages. Information from this paper can be reformatted for a poster presentation. An oral presentation will also be given based on the paper or the poster.**

VIII. TYPICAL TEXT(S):

Scott, Chemistry, 5th ed., Harpers printing, 1997
Chang, Chemistry, 6th ed., Mc Graw Hill, 1997
Scott, Multimedia Chemistry, 3rd ed.,
These are tapes that were custom made by the instructor. They are on reserve in the Learning Center.
Laboratory: The students use customized labs that have been created by the instructor. These are equivalent to commercial lab manuals such as: General Chemistry in the Laboratory 3rd ed., 1991 Roberts, Hollenberg, and Pistma, W.H. Freeman and Co.

IX. OTHER SUPPLIES REQUIRED OF STUDENTS: Scientific calculator