CHEM 1C: GENERAL CHEMISTRY & QUALITATIVE ANALYSIS

Foothill College Course Outline of Record

Heading	Value
Units:	5
Hours:	3 lecture, 6 laboratory per week (108 total per quarter)
Prerequisite:	CHEM 1B or 1BH.
Degree & Credit Status:	Degree-Applicable Credit Course
Foothill GE:	Non-GE
Transferable:	CSU/UC
Grade Type:	Letter Grade (Request for Pass/No Pass)
Repeatability:	Not Repeatable

Student Learning Outcomes

- A successful student must be able to recognize the types of salts presented as strong or non-electrolytes. Secondly, perform the required critical thinking/mathematical analysis of the experimental data to select the one salt that satisfies the conditions given.
- A successful student will demonstrate the ability to think critically and employ computational skills in the analysis of redox reactions and chemistry.
- The successful student will demonstrate an understanding of the impact of science on society.
- Successful students will illustrate separation and identification schemes using flow diagrams and apply principles of aqueous solubility equilibria to separate and identify the ions in a solution.
- Students will demonstrate an understanding of how to execute common laboratory techniques.
- A successful student will demonstrate an understanding of the impact of science on society in the area of nuclear chemsitry.
- A successful student will demonstrate the ability to make connections between concepts across several areas of General Chemistry as applied to salt solutions.

Description

Aqueous ionic equilibria of buffers, solubility product constants and formation constants; properties of solutions, including factors affecting solubility, energy changes in the solution process and colligative properties; electrochemistry, including the thermodynamics of voltaic cells; introduction to coordination chemistry and bonding theory; nuclear chemistry with emphasis on applications; and, time permitting, an introduction to modern materials. Laboratory parallels lecture topics with an introduction to qualitative inorganic analysis.

Course Objectives

The student will be able to:
A. demonstrate an understanding of buffer solutions
B. classify various aqueous solution equilibria
C. calculate the equilibrium constant for various aqueous solution ionic reactions
D. demonstrate an understanding of factors that effect solubility of slightly soluble salts
E. describe the process of solution formation and the energetics involved
F. describe and explain factors that effect solubility
G. calculate concentrations of solutions using various units of concentration
H. describe and explain colligative properties and apply the mathematical equations that describe these properties
I. diagram an electrochemical cell
J. define the anode and cathode in an electrochemical cell
K. contrast and compare an electrolytic cell and a voltaic cell
L. calculate the EMF of an electrochemical cell under standard and non-standard conditions
M. calculate *d*G and equilibrium constants from standard cell potentials
N. perform quantitative electrolysis calculations involving current and time
O. describe factors that effect corrosion of iron
P. describe the different types of radioactive decay
Q. describe the difference between fission and fusion
R. calculate the energy involved in a nuclear reaction
S. use half-life to calculate the age of an object
T. describe health and safety issues involving radioactivity
U. describe various uses of radioactive nuclides
V. identify a coordination compound
W. describe the structures and bonding for coordination compounds
X. explain color and magnetism of coordination compounds in term of electronic structure
Y. apply principles of aqueous solubility equilibria to separate and identify the ions in a solution
Z. summarize a separation and identification scheme for various aqueous solutions
AA. illustrate separation and identification schemes using flow diagrams
BB. describe some modern materials, such as semiconductors, polymers and/or materials for nanotechnology (time permitting)

Course Content

A. Aqueous equilibria
1. Common ion effect
2. Acid/base equilibria: buffers
a. How buffers work
b. Calculating buffer pH
c. Preparing buffers
3. Analysis of acid/base titration curves
4. Solubility equilibria
a. Definition of solubility product constant (Ksp)
c. Using Ksp to predict relative solubilities
d. Determining Ksp from solubility, determining solubility from Ksp
e. Factors effecting solubility of slightly soluble salts: common-ion effect, pH and formation of complex ions
e. Calculating solubility in the presence of a common ion
f. Selective precipitation (separation) of ions
g. Simultaneous equilibria involving slightly soluble compounds
5. Complex ion equilibria
a. Definition of formation constant (Kf)
b. Complex ion equilibria and calculations involving Kf values
c. Amphoterism
B. Solutions
1. Calculation of concentrations
a. ppm, mole fraction, molarity, molality
2. Energy changes upon solution formation
3. Factors effecting solubility

a. Nature of solute and solvent
b. Temperature
c. Pressure
4. Colligative properties: vapor pressure lowering, boiling point elevation, freezing point depression and osmotic pressure
5. Colligative properties of electrolyte solutions: the van't Hoff factor
C. Electrochemistry
1. Balancing redox reactions using half reaction method
2. Definitions: oxidation, reduction, oxidizing agent, reducing agent
3. Standard reduction potentials: strengths of reducing and oxidizing agents
4. Voltaic and electrolytic cells
a. Determining cell emf under standard conditions (Ecell-std)
b. Sign of Ecell-std, sign of *d*G-std (Gibbs Free Energy), and spontaneity
c. Calculating *d*G and equilibrium constants (K)
5. Voltaic and electrolytic cell diagrams
a. Reduction occurs at the cathode, oxidation at the anode
b. The function of the electrolyte and the salt bridge
c. Direction of electron flow
6. Cell emf under nonstandard conditions
a. Using the Nernst equation to calculate cell emf
b. Using cell emf and the Nernst equation to calculate ion concentrations (pH, Ksp)
c. Concentration cells
7. Batteries
a. Primary batteries, secondary batteries and fuel cells
8. Corrosion of iron
a. Sacrificial anodes
9. Electrolysis
a. Molten salts and aqueous solutions
b. Quantitative calculations: relationships/conversions between current, time and amount of a substance oxidized/reduced
D. Nuclear chemistry
1. Different types of radioactivity
a. Detection of radiation
b. Disintegration series
2. Writing balanced nuclear reactions
3. Energy changes in nuclear reactions
a. Nuclear stability and binding energy
4. Kinetics of radioactive decay and half-life
a. Radioactive dating
6. Uses of radioactive nuclides
7. Nuclear fission and fusion
8. Health and safety issues involving radioactivity
a. Units of radiation exposure: rad, rem, gray
E. Coordination compounds
1. Basic terms
a. Complex ions, ligands, coordination numbers
2. Structures
3. Bonding
4. Electronic structure
a. Color and magnetism
F. Modern materials (time permitting)
1. Metals, semiconductors and insulators
2. Polymers
3. Materials for electronics
4. Materials for nanotechnology
G. Qualitative analysis
1. Separation and identification of various ions in aqueous solutions

Lab Content

Laboratory develops experimental techniques, critical thinking and data analysis skills, and includes the use of a laboratory notebook. Graphical techniques using Graphical Analysis software are employed for data analysis. Laboratory parallels lecture topics and includes an introduction to qualitative inorganic analysis.
A. Buffers
1. use of a pH electrode
2. determination of suitable weak acid/conjugate base pairs for a given pH
3. calculating amounts of reactants needed to prepare a buffer
4. preparing buffers and measuring buffer pH before and after addition of strong acid and base to the buffer
5. investigating buffer range and capacity
B. Titration Curves
1. using a pH electrode to record titration curve data
2. graphing of titration curves
3. analysis of titration curves for strong and weak acids and bases
C. Solubility Equilibria
1. experimental determination, via titration, of a solubility product constant
2. quantitative investigation of the common ion effect on solubility of a slightly soluble salt
D. Aqueous Equilibria
1. investigation of Le Chatelier's Principle; shifting equilibria via temperature changes, pH changes and complex ion formation
2. writing net-ionic equations for observed reactions
E. Voltaic Cells
1. use of a voltmeter
2. constructing standard voltaic cells
a. measurement of the cell voltage
b. identification of the cathode, anode and overall reaction for voltaic cells
c. comparison of measured cell voltage to literature values
2. constructing non-standard voltaic cells
a. measurement of cell under non-standard conditions
b. calculation of ion concentrations using the non-standard cell voltage
c. determination of a solubility product constant
F. Electrolytic Cells
1. use of a DC power supply
2. construction of a electrolytic cell
3. experimental determination of the equivalent mass of a metal
G. Qualitative Analysis: identification of the cations contained in an unknown solution. Concepts learned in lecture are applied to the separation and identification of the cations
1. solubility product constants and selective precipitate
2. complex ion formation
3. dependence of solubility on pH
4. flame tests

Special Facilities and/or Equipment

Chemistry laboratory, safety glasses, Texas Instruments calculators (83, 84, 86 or 89), specialized hardware for digital data acquisition (Vernier LabPro system) and computers for data analysis.

Method(s) of Evaluation

A. Written lecture examinations on fundamental chemical principles: problem solving skills, conceptual understanding of the material and ability to integrate concepts.

B. Laboratory activities, worksheets and reports that parallel lecture topics and include: detailed analysis of buffer systems, titration curves, solubility equilibria, colligative properties, redox chemistry (voltaic and electrochemical cells) and qualitative analysis of unknowns.
C. Written lab exams emphasizing chemical equations, problems, calculations, details of experimental techniques, flow diagrams, and graphs.
D. Laboratory notebook.
E. Online homework focusing on topics covered in lecture.

Method(s) of Instruction

Lecture, laboratory.

Representative Text(s) and Other Materials

Tro, Nivaldo J. Chemistry: Structure and Properties. 2nd ed. Pearson, 2018.

Types and/or Examples of Required Reading, Writing, and Outside of Class Assignments

A. Lecture: Three hours per week of lecture covering subject matter from text and related material.

1. Reading and study of the textbook, related materials and notes.

B. Homework problems: Homework problems covering subject matter from text and related material, ranging from 20-40 problems per week.

C. Lab: Two hours lab lecture and four hours lab.

1. Reading and studying experimental background, theory and procedure.

2. Lab notebook containing the purpose, background, procedure, data, analysis and conclusions for each experiment.

3. Computer graphing and graphical analysis of experimental data.

4. Lab reports: Analysis of data involving quantitative reasoning and calculations, drawing conclusions, critical analysis of results and integration of concepts.

D. Worksheets: Problems and activities covering the subject matter. Such worksheets may be completed inside and/or outside of lecture and/or lab.

Discipline(s)

Chemistry