4. **Required Courses and Course Correlations**

Almost every chemistry course that you will take will have one or more pre-requisites. Pre-requisites are requirements that must be met before you can register for the course. When you attend an upper level course it is assumed that you have mastered certain concepts and techniques that have been taught in a pre-requisite course. For example, the prerequisite for General Chemistry is either high-school chemistry or Introduction to Chemistry (CHE 110) or an equivalent to either of these. These pre-requisite courses cover topics such as nomenclature and stoichiometry. Therefore, the General Chemistry faculty assume that you have mastered these concepts. If you have not, then it will be very difficult for you to be successful in the General Chemistry course. It is imperative that you keep this in mind as you progress through your program of study. In this section each of the required courses are described with regard to major concepts and techniques that are taught and concepts and techniques that you should have mastered beforehand in order to be successful in the course.

A) General Chemistry

Lecture Background

Name ionic and simple covalent compounds
Write chemical formulas
Balance chemical equations
Identify compounds as ionic or covalent
Use factor label method
Calculate molar masses
Understand and use the mole concept
Carry out stoichiometric calculations
Acid-base theory, especially Arrhenius definition

Laboratory Background

Familiarity with carrying out reactions
Familiarity with quantitative techniques
Ability to measure mass, volume, and temperature

Lecture Objectives

Convert between metric and English units
Predict charges on ions
Classify chemical reactions
Classify compounds as acids or bases
Understand and discuss acid-base theories
Complete and balance chemical equations
Carry out stoichiometric calculations
Calculate theoretical and percent yields
Determine empirical formulas from data
Carry out solution calculations
Carry out calculations involving colligative properties
Calculate stoichiometric changes involving heat
Identify reactions as exothermic or endothermic
Understand the kinetic molecular theory of gases
Work gas law problems
Discuss the Bohr and Quantum atom
Write electron configurations
Relate atomic structure to properties
Understand ionic bond theory
Understand VSEPR Theory
Understand Valence Bond Theory (VBT)
Relate bonding, shapes and properties
Describe hybridization and hybrid orbitals
Describe multiple bonds in terms of VBT forms
Describe resonance and write resonance
Understand basics of Molecular Orbital Theory
Construct molecular and hybrid orbitals
Discuss states of matter and phase changes
Relate states of matter to properties
Discuss colligative properties of matter
Understand and discuss redox reactions
Understand kinetic theory of reactions
Understand principles of reaction equilibria
Carry out equilibria calculations
Understand entropy, enthalpy, and free energy
Calculate entropy, enthalpy, and free energy
Discuss electrochemical cells
Calculate cell potentials
Discuss nuclear reactions, nuclear reactors
Discuss reactions of main group elements
Discuss the production of metals from ores

Laboratory Objectives

Measure mass, volume, and temperature
Measure pH
Learn basics of chromatographic separations
Learn basics of synthetic methods
Quantitatively transfer materials
Learn basics of gravimetric analyses
Measure heat exchanges
Carry out titrations
Carry out distillations
Acquire IR spectra of liquids
Acquire uv-visible absorption spectra
Carry out qualitative analyses
Determine solution concentration from uv-visible spectra

Filter and wash compounds
Calculate theoretical and percent yields
Properly dispose of laboratory wastes
Use word processing software
Use spreadsheet software
Recrystallize compounds
Use safe laboratory techniques
Learn the use of computers
Use graphing software
Write formal laboratory reports

B) Organic Chemistry

Lecture Background

Understand and discuss acid-base theories
Understand Valence Bond Theory (VBT)
Describe hybridization and hybrid orbitals
VBT Describe resonance and write resonance forms
Theory Construct molecular and hybrid orbitals
Understand principles of reaction equilibria
Understand ionic bond theory
Relate bonding, shapes, and properties
Describe multiple bonds in terms of
Understand basics of Molecular Orbital
Understand kinetic theory of reactions

Laboratory Background

Measure mass and volume
Filter and wash compounds
Use safe laboratory techniques
Quantitatively transfer materials
Calculate theoretical and percent yields
Properly dispose of laboratory wastes

Lecture Objectives

Classify organic functional groups
Understand and apply reaction mechanisms
reaction results
Describe stereochemical structure of substances
Describe the stereochemistry of reactions
substances
Name organic compounds
Classify organic reactions
Give theoretical explanations for
Draw quasi 3D structures of molecules
Use spectroscopic data to identify

Laboratory Objectives

Learn methods for synthesis of organic compounds
Carry out organic reactions
compounds
Isolate and purify organic compounds
Elucidate structures of organic

C) Analytical Chemistry

Lecture Background

Understand and discuss acid-base theories
Understand and discuss redox reactions
equilibria Carry out equilibrium calculation
Carry out stoichiometric calculations
Understand principles of reaction

Laboratory Background

Measure mass, volume, and temperature
Know basics of gravimetric analyses
Use safe laboratory techniques
Use word processing software
Use spreadsheet software
Measure pH
Carry out titrations
Properly dispose laboratory wastes
Use graphing software
Write formal laboratory reports

Lecture and Laboratory Objectives

Prepare samples for quantitative analysis
concentration
Learn basics of chromatographic methods
Use titrimetric methods of quantitative analysis
analysis
Use redox methods of quantitative analysis
Carry out methods of error analysis
Learn additional uses of computers
software
Prepare solutions of a given
Learn the use of ion specific electrodes
Use spectrophotometric methods of
Learn calibration methods
Carry out methods of statistical analysis
Learn additional uses of computer

D) Instrumental Chemistry

Lecture Background

An understanding of principles of analytical chemistry
An understanding of principles of organic chemistry
An understanding of principles of physics
An understanding of electricity and magnetism

Lab Background

Analytical techniques
Be able to use computers and computer software

Lecture and Laboratory Objectives

Learn additional chromatographic techniques
Learn additional spectroscopic methods of analysis
Learn additional calibration methods
Learn the basics of electronics
Learn the basics of computers
Learn the basics of computer interfacing
Learn the principles behind instrument-task relationship

E) Inorganic Chemistry

Lecture Background

- Convert between metric and English units
- Classify chemical reactions
- Understand and discuss acid-base theories
- Calculate theoretical and percent yields
- Write electron configurations
- Understand ionic bond theory
- Understand Valence Bond Theory
- Describe hybridization and hybrid orbitals
- Describe resonance, write resonance forms
- Relate states of matter to properties
- Understand kinetic theory of reactions
- Discuss entropy, enthalpy, and free energy
- Discuss electrochemical cells
- Discuss nuclear reactions, nuclear reactors
- Discuss the production of metals from ores
- Classify organic reactions
- Describe the stereochemical structure of substances
- Describe the stereochemistry of reactions
- Predict charges on ions
- Classify compounds as acids or bases
- Complete and balance chemical equations
- Discuss the Bohr and Quantum atom
- Relate atomic structure to properties
- Understand VSEPR Theory
- Relate bonding, shapes and properties
- Describe multiple bonds in terms of VBT
- Understand basics of Molecular Orbital Theory
- Understand and discuss redox reactions
- Understand principles of reaction equilibria
- Calculate entropy, enthalpy, and free energy
- Calculate cell potentials
- Discuss reactions of main group elements
- Classify organic functional groups
- Understand and apply reaction mechanisms
- Draw quasi 3D structures of molecules
- Name organic compounds

Laboratory Background

- Measure mass and volume
- Quantitatively transfer materials
- Acquire IR spectra of liquids
- Filter and wash compounds
- Calculate theoretical and percent yields
- Properly dispose of laboratory wastes
- Write formal lab reports
- Know basics of chromatographic separations
- Carry out distillations
- Acquire uv-visible absorption spectra
- Recrystallize compounds
- Use safe laboratory techniques
- Use word processing software

Lecture Objectives

Learn Valence Bond Theory in depth
Apply VSEPR Theory
Relate bonding, shape, and properties
Learn use of Molecular Orbital Theory
Understand relationship between atomic structure and properties
Relate thermodynamic properties to reaction equilibrium
Learn properties and reactions of hydrogen
Classify compounds according to different acid-base theories
Balance redox reactions and the use Latimer and Frost diagrams
Learn reactions of main group elements
Learn syntheses of compounds of main group elements
Learn industrial synthetic methods for key industrial compounds
Name and write formulas for inorganic and coordination compounds
Use Group Theory to classify molecules according to point group
Use Group Theory to predict IR spectral characteristics of certain compounds
Learn basics of Ligand Field Theory (LFT) and Crystal Field Theory (CFT)
Use LFT and CFT to explain properties of coordination compounds
Learn basic reactions of transition metals and their compounds
Learn basic methods used in the synthesis of organometallic compounds
Learn the Effective Atomic Number Rule and its applications to predicting formulas of compounds

Laboratory Objectives

Learn basic inorganic synthetic techniques
Use IR spectra to identify inorganic compounds
Use NMR spectra to identify inorganic compounds
Learn microscale synthetic techniques
Learn basic use of STN ON-LINE
Learn basic glassblowing techniques
Learn the use of an inert gas - vacuum manifold
Learn basic methods for synthesizing air-sensitive compounds

F) Biochemistry

Lecture Background

Understand and discuss acid-base reactions
Understand and discuss redox reactions
Understand kinetic theory of reactions
Understand principles of reaction equilibria
Carry out equilibria calculations
Understand entropy, enthalpy, free energy
Calculate free energy
Classify organic functional groups
Describe stereochemical structure of substances
Understand and apply reaction mechanisms
Give theoretical explanations for reactions results
Understand basic cellular structure

Laboratory Background

Measure mass, volume, and temperature
Measure pH
Know basics of chromatographic techniques
Quantitatively transfer materials
Acquire uv-visible absorption spectra
Use safe laboratory techniques
Properly dispose of laboratory wastes
Use word processing software
Use spreadsheet software
Use graphing software
Write formal lab reports

Lecture Objectives

Apply pH theories to concepts of biochemical buffers
Learn detailed aspects of protein structure
Learn protein chemistry
Study strategies of protein purification
Relate structure to function of proteins
Learn chemical characteristics of lipids and carbohydrates
Apply theories of thermodynamics to enzyme reactions
Apply theories of kinetics to enzyme reactions
Learn enzyme mechanism strategies
Use thermodynamics, kinetics, and mechanisms to learn key metabolic pathways
Learn to interpret biochemical experimental results
Learn to search the internet for biochemical information
Learn how to approach reading scientific journal articles
Write a paper on a chosen enzyme, integrating class theories into the paper

Laboratory Objectives

Learn to make hypotheses and design experiments to test those hypotheses
Apply pH principles to make buffers
Learn and apply dilution principles for making solutions
Learn to transfer accurately micro-volumes of solutions
Learn and apply principles of Beer's Law
Learn to critically keep a laboratory notebook
Apply strategies of purification to purify an enzyme
Learn biochemical techniques to determine the size of a protein
Learn to conduct enzyme assays
Prepare poster for presentation of experimental results

G) Physical Chemistry

Lecture Background

Carry out stoichiometric calculations of gases
Understand the kinetic molecular theory
Carry out calculations involving colligative properties
Carry out gas law calculations
Carry out solution calculations
Understand principles of chemical equilibria
Carry out equilibria calculations
Discuss states of matter and phase changes
Discuss bonding theories (MO and VBT)
Work problems involving calculus and physics

Lab Background

Prepare solutions of a given concentration
Use titrimetric methods of quantitative analysis
Use word processing software
Use graphing software
Use spreadsheet software
Carry out error analysis
Use statistical analysis
Write formal laboratory reports
Use safe laboratory techniques
Properly dispose of laboratory wastes

Lecture Objectives

Apply calculus and physics to chemical problems
Discuss the three laws of thermodynamics
Apply laws of thermodynamics to physical changes
Apply laws of thermodynamics to chemical reactions
Apply laws of thermodynamics to phase equilibria
Apply laws of thermodynamics to chemical equilibria
Apply kinetics to transport processes such as fluid flow, heat flow, diffusion, and solution conductivity
Determine rate laws, rate constants, and energies of activation from experimental data
Critically analyze reaction mechanisms
Discuss basic postulates of quantum mechanics
Apply principles of quantum mechanics to simple systems
Apply principles of quantum mechanics to atoms and molecule
Apply principles of quantum mechanics to spectroscopic analysis

Laboratory Objectives

Carry out calorimetric experiments to obtain thermodynamic data
Construct phase diagrams from data
Determine equilibrium constants and activity coefficients from data
Carry out kinetic experiments to determine rate laws, rate constants, and energies of activation
Use molecular modeling software
Use spectroscopic methods to determine molecular constants