

**PTAC: Applied Chemistry**  
**COURSE OUTLINE & OBJECTIVES**  
*ESC Approved –November 19, 2004*

## **INTRODUCTION**

### **A. Introduction to Chemistry Terms**

#### ***Learning Objectives***

1. Define basic terms associated with chemistry:
  - Organic/inorganic/biochemistry/physical chemistry.

## **MEASUREMENT**

#### ***Learning Objectives***

1. Identify and describe Standard English units of measurement.
2. Identify and describe SI (metric) units of measurement.
3. Describe how significant digits impact quality, environmental concerns and economics.
4. Apply units of measurement to practical applications.
5. Perform conversions with factor label method.
6. Use basic math formulas to solve calculations.
7. Use scientific notation calculator correctly.

### **A. Review of Mathematical Calculation**

### **B. Measurements**

- Metric system (SI)
- English system
- Conversions
- Factor Label Method
- Relative sizes
- Concentrations
- Units of measurement (kilo, centi, milli, ppm, ppb)
- Moles (definition)

## C. Uncertainty in measurement and significant digits, precision and accuracy

- Use of Scientific Notation Calculator

### NOTE:

In this section, review, reference and make connections to the sections that follow.

## MATTER

### *Learning Objectives*

1. Define matter.
2. Describe properties of atoms.
3. Define atomic structure.
4. Identify characteristics of metals and non-metals.
5. Locate metals and non-metals on a periodic table.
6. Describe the organization of the periodic table.
7. Identify families and groupings on a periodic table.
8. Use the periodic table to determine atomic weight and atomic number.
9. Describe the physical states of matter.
10. Explain the conservation of matter.
11. Describe the difference between mixtures and pure compounds.
12. Describe the difference between homogeneous and heterogeneous mixtures.
13. Identify and describe the difference between physical and chemical properties.
14. Explain density and specific gravity.
15. Use basic math formulas to solve calculations for density and specific gravity.
16. Identify and describe the difference between physical and chemical changes.

## A. Atoms

- Atomic structure
  - + Protons
  - + Neutrons
  - + Electrons
- Atomic weight
- Atomic number
- Metals and non-metals

- Elements
- Periodic Table
- Compounds

## **B. Matter**

- Physical state of matter
- Changes of states
- Conservation of matter
- Energy

## **C. Mixture vs. pure compounds**

## **D. Homogeneous vs. heterogeneous mixtures**

## **E. Physical and chemical properties**

- Density/Specific gravity

## **F. Physical vs. chemical changes**

# **GENERAL AND INORGANIC CHEMISTRY**

## ***Learning Objectives***

1. Describe valence and its relationship to bonding.
2. Describe the concepts of ionic, covalent and polar covalent bonding.
3. Name ionic and covalent compounds.
4. Given a chemical formula, correctly name the compound and vice versa.
5. Determine the molecular weight of various compounds.
6. Complete chemical equations.
7. Balance chemical equations.
8. Identify and describe reaction types.
9. List typical factors that affect reaction rates.
10. Describe the general properties of acids and bases.
11. Describe an acid/base titration.
12. Describe non-linearity of pH scale.
13. Describe the function of buffers and indicators.

14. Describe a neutralization reaction.
15. List and define factors affecting solubility.
16. Perform simple calculations to determine concentration (%weight, % volume) of solutions.
17. Give an industry-specific example of precipitation, crystallization, and extraction.
18. Describe how polarity and electro negativity affect solubility of different substances.

## **A. Bonding**

- Ions
- Binary compounds
  - + Writing chemical formulas
- Covalent compounds
  - + Writing chemical formulas
- Electro negativity
- Polarity
- Valence
- Electron dots/dot formulas

## **B. Nomenclature of compounds**

- Binary compounds
  - + Ionic and covalent (Most Common)
- Polyatomic ions

## **C. Chemical equations**

- Completing chemical equations
- Balancing equations

## **D. Reactions**

- Types of reactions
- Reaction rates (factors)
- Endothermic and exothermic
- Catalysts

## **E. Acids and Bases**

- Definitions

- Neutralization
- pH scale
- Buffers
- Indicators
- Titration

## **F. Solutions/solubility rules (general basics)**

- Factors affecting solubility
- Concentration (% weight, % volume)
- Precipitation
- Crystallization
- Particle size
- Extraction

# **CHEMICAL CALCULATION**

## ***Learning Objectives***

1. Explain conservation of mass.
2. Describe material balance in relationship to a chemical reaction in a process.
3. Using industrial units of measurement, calculate material balances (lb. to moles to lb.) relating to chemical reactions.
4. Explain the role of a limiting reactant.
5. Perform limiting reactant calculations.
6. Perform calculations that involve acid-based titrations.
7. Perform blending calculations.

## **A. Material balance (chemical equations)**

- Reactants to products and by-products
- Molar weight calculations (use pound moles)
- Limiting reactants
- Acid/Base reactions

## **B. Titration**

## **C. Blending (ppm/concentration%/acid/base)**

# ORGANIC CHEMISTRY

## *Learning Objectives*

1. List and explain the naming systems for organic compounds.
2. Write names and formulas for organic compounds.
3. Describe the difference between saturated, unsaturated and aromatic hydrocarbons.
4. Explain the basic properties of listed functional derivatives/groups.
5. Differentiate between addition, condensation, substitution and combustion reactions.
6. Explain potential outcomes of addition, condensation, substitution and combustion reactions.
7. Draw basic organic structures.
8. Draw functional groups.

## **A. Nomenclature & structures**

- Hydrocarbons
  - + Alkane (paraffin)
  - + Cycloalkanes
  - + Alkene (olefins)
  - + Alkyne
  - + Diene
  - + Aromatics
  - + Isomers
- Hydrocarbon functional groups
  - + Alcohols
  - + Ketones
  - + Organic Acids
  - + Ethers
  - + Esters
  - + Amine
  - + Halides
  - + Aldehydes
  - + Isocyanates

## **B. Reactions**

- Addition reactions
  - + Polymerization reactions
  - + Others
- Condensation reactions
  - + Polymerization reactions
  - + Others
- Substitution
- Combustion

### **NOTE:**

Use processes from crude oil to multiple final products throughout this section.

## **LAB**

### ***Learning Objectives***

1. Use appropriate personal protective equipment.
2. Use safe chemical handling and storage techniques.
3. Explain how teamwork can affect lab and work safety.
4. Use lab measuring devices appropriately.
5. Dispose of chemical waste in an environmentally responsible manner.
6. Follow lab procedures safely and correctly.
7. Report and interpret lab results correctly using experimental data and appropriate supporting information (conversion charts, tables, graphs, etc.).

### **A. General safety and environmental concerns**

### **B. Common process technician lab tests**

- pH analysis and titration
- simple colorimetric analyses
- crystallization
- extraction

- precipitation
- gas chromatograph
- density/specific gravity
- conductivity
- resistivity
- others

### **C. Handling chemicals**

### **D. Reactivity/Compatibility**

### **E. Precision/Accuracy of measuring devices**

- calibration
- significant figures

### **F. Teamwork**

#### **NOTE:**

Weave in safety, environmental, economics, quality, efficiency, etc. throughout this course.