Advanced Chemistry

Text: Chemistry: An Introduction to General, Organic, & Biological Chemistry (7th Edition)
Author: Timberlake

Instructor: Jeff Christopherson (NCHS)

Philosophy: Reinforce the fundamentals of basic chemistry and integrate the principles of chemistry fundamentals into everyday applications.

Unit 1: Introduction to Chemistry

- Pure science vs. applied science (technology)
- Alchemy vs. Chemistry
- Mathematics of Chemistry
- Areas of Chemistry
- The Scientific Method (politics – thalidomide)
- Controlled Experiments
- Making a Graph
- Units of Measurement (SI and metric prefixes)
- Scientific Notation
- Measured and Exact Numbers
- Significant Figures with calculations
- Conversion Factors
- Safety (MSDS, radon, mercury)

Unit 2: Properties of Matter - (Atoms and Elements)

- Elements and Symbols
- The Periodic Table (essential elements)
- The Atom
- Atomic Number and Mass Number
- Isotopes and Atomic Mass
- Electron arrangement and the Periodic Law
- Radioactivity and its uses

Unit 3: Compounds and Their Bonds

- Nomenclature (structural isomers, representations: ether vs. alcohol)
- Valence Electrons
- Ions and the Octet Rule
- Ionic Compounds
- Naming and Writing Ionic Formulas
- Covalent Bonds
- Covalent Compounds
- Bond Polarity
- Polyatomic Ions
- Free radicals (smog formation)

Unit 4: Chemical Reactions and Quantities

- Chemical Changes
- Chemical Equations
- Balancing a Chemical Equation
- Types of Reactions
- Redox
- The Mole
- Calculations Using Molar Mass
- Mole Relationships in Chemical Equations
- Mass Calculations for Reactions

Unit 5: Energy and States of Matter

- Energy
- Measuring Temperature
- Measuring Heat Energy (latent heat)
- Energy and Nutrition
- States of Matter (steam)
- Melting and Freezing
- Boiling and Condensation
- Heating and Cooling Curves
- Energy in Chemical Reactions
- Chemical Equilibrium

Unit 6: Gases

- Atmospheric Gases/Global warming/CFC's/ acid rain [CO]
- Properties of Gases
- Gas Pressure
- Pressure and Volume
- Temperature and Volume
- Temperature and Pressure
- Combined Gas Law
- Volume and Moles
- Partial Pressures
- Diffusion/Effusion

Unit 7: Solutions

- Properties of Water
- Solutions (supersaturated, hot/cold pack)
- Electrolytes and Non-electrolytes
- Colligative Properties (Rock salt ice cream)
- Solubility (kidney stones) (pesticide runnoff, pfisteria)
- Percent Concentration (w:w; w:v; v:v)
- Colloids and Suspensions
- Osmosis and Dialysis [Clinical Chemistry text]
- Molarity/Normality/Molality (dilutions)
- Titration/Concentration (colorimetrically Spec-20)
- Chromatography

Unit 8: Acids, Bases and Salts

- Acids and Bases nomenclature
- Ionization of Water
- The pH scale
- Strengths of Acids and Bases
- Making Dilutions
- Acid-Base Neutralization
- Buffers
- Acid-Base Titration
- Indicators

Unit 9: Alkanes and Aromatic Hydrocarbons

- Organic Compounds
- Bonding in Hydrocarbons
- Naming Alkanes
- Branched Alkanes
- Stuctural Formulas

Advanced Topics

- Electrochemistry – Re-dox (photography)
- Organic Topics (petroleum)
- Polymers (engineered materials)
- Organic/Biochemistry (esters) (Lab: Aspirin/Oil of Wintergreen)
- Environmental (waste disposal – water)
- Petroleum (soap vs. detergent)
- Nuclear (Fission, Fusion) / Nuclear waste disposal: Medicine (CAT, PET, MRI); smoke detectors
- Radiation (half-life, radioactive dating, radiology)
- Solid Structures

References: Chemistry in the Marketplace
Chem. Matters CD
Laser Disc - demonstrations

General Chemistry

Syllabus (NCHS)

1. Introduction to Chemistry
2. Properties of Matter
3. Atomic Structure
4. Periodicity
5. Nomenclature
6. Chemical Formulas
7. Chemical Equations
8. Stoichiometry
9. Gas Laws
10. Solutions
11. Acids & Bases

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OBJECTIVES

1-1 **Describe** the role of chemists and some of the procedures that chemists use in their studies of matter and energy.
1-2 **Define** matter, energy, and the forms of energy.
1-3 **Explain** the law of conservation of mass-energy and its importance to chemistry.
1-4 **Compare** and **apply** strategies for solving problems in chemistry.
1-5 **Realize** that success in solving chemistry problems lies in knowledge and practice.
1-6 **List** and **use** SI base units for mass, length, time, and temperature.
1-7 **Express** and **convert** quantities using the common SI prefixes.
1-8 **Use** significant digits to express the exactness of measurements.
1-9 **Use** scientific notation to **express** and **evaluate** large and small measurements.
1-9 **Obtain** information from a graph.

2-1 **Perform** calculations using density measurements.
2-2 **Describe** and **distinguish** heterogeneous and homogeneous materials, substances, mixtures, and solutions.
2-3 **Describe** and **give examples** of elements and compounds.
2-4 **Classify** examples of matter.
2-5 **Classify** changes in matter as physical or chemical.
2-6 **Distinguish** among extensive, intensive, physical, and chemical properties.
2-7 **Describe** conditions under which heat is transferred.
2-8 **Convert** between units used to measure energy.
2-9 **Describe** endothermic and exothermic processes and **state** the function of activation energy.
2-10 **Perform** calculations involving specific heat.
2-11 **Discuss** early developments in atomic theory.
2-12 **Explain** the laws of multiple proportions and definite proportions and **give examples.**
2-13 **Determine** the atomic number and mass number of given isotopes of elements.
2-14 **Differentiate** among the major subatomic particles.
2-15 **Discuss** the development of modern atomic theory.
2-16 **Calculate** the average atomic mass of a mixture of isotopes of an element.
2-17 **Describe** the wave-mechanical view of the hydrogen atom.
2-18 **Characterize** the position and velocity of an electron in an atom.
2-19 **Describe** an electron cloud.
2-20 **Characterize** the four quantum numbers.
2-21 **Use** the Pauli exclusion principle and quantum numbers to **describe** an electron in an atom.
2-22 **Determine** the electron configurations of the elements.
2-23 **Write** electron dot diagrams for the elements.
2-24 **Describe** the early attempts at classifying elements.
2-25 **Use** the periodic table to **predict** the electron configurations of elements.
2-26 **Explain** the basis for the arrangement of the modern periodic table.
2-27 **Identify** metals, nonmetals, and metalloids on the periodic table.
2-28 **Give examples** of the relationship between an element's electron configuration and its placement on the periodic table.
2-29 **Predict** the chemical stability of atoms using the octet rule.

3-1 **Demonstrate** proficiency in writing chemical formulas.
3-2 **Define** *oxidation number* and **state** oxidation numbers for common monoatomic ions and charges for common polyatomic ions.
3-3 **Demonstrate** proficiency in naming chemical compounds
3-4 **Distinguish** between molecular and empirical formulas.
3-5 **Demonstrate** the use of coefficients to represent the number of formula units of a substance.
3-6 **Use** the factor-label method (dimensional analysis) in calculations.

- **Use** the Avagadro constant to **define** the mole and to **calculate** molecular and molar mass.
- **Use** the molar mass to **calculate** the molarity of solutions, percentage composition, and empirical formulas.

3-7 **Determine** the formulas of hydrates.

4-1 **Write** chemical equations to represent reactions.
4-2 **Use** coefficients to **balance** chemical equations.
4-3 **Differentiate** among five general types of chemical reactions.
4-4 **Determine** the mass of a reactant or product based on the mass of another reactant or product in a reaction.
4-5 **Calculate** the actual yield of a product as a percentage of the theoretical yield.

- **Determine** the heat of reaction for a chemical reaction in which a specified amount of a substance is involved.
- **Use** examples to **explain** the periodic properties of elements.
- **State** how atomic and ionic sizes change in groups and periods.
- **Predict** oxidation numbers of elements.
- **Define** ionization energy and electron affinity, and **describe** the factors that affect these properties.
- **Use** multiple ionization energies to **predict** oxidation numbers of elements.
- **Define** a family or group and **explain** what members of a chemical family have in common.
- **List** four ways in which hydrogen can bond and **give an example** of each.
- **Define** the shielding effect and **explain** its importance to reactivity of atoms.
- **List** characteristics and **give uses** for representative elements in the alkali metals, alkaline earth metal, and aluminum group.
- **Explain** the importance of nitrogen and phosphorous compounds to living things.
- **State** the relationship between the activities of elements and their locations in the periodic table.
- **List** characteristics and **give uses** for representative main group nonmetals.
- **Define** transition metals and **list** some of their uses.
- **List** representatives and some properties of lanthanoids and actinoids.
- **Identify** the type of bonding between two elements given their electronegativities.
- **List** factors that influence electronegativity and **recognize** it as a periodic property of elements.
- **Differentiate** among properties of ionic, covalent, and metallic bonds.
- **Explain** the use of infrared and microwave spectroscopy to determine the structure of molecules.
- **Differentiate** among atomic radii, ionic radii, covalent radii, and van der Waals raddi.
- **Discuss** factors that affect the values of ionic radii and covalent radii.
- **Use** covalent radii to **calculate** bond lengths.
- **Use** models to explain the structure of a given organic or inorganic molecule.
- **Describe** hydbrid orbitals and **use** hydbridization theory to explain the bond angles in compounds.
- **Differentiate** sigma and pi bonding and saturated and unsaturated carbon compounds.
- **Name** and **write** formulas for simple organic compounds.
- **Define, explain,** and **give examples** of isomerism.
- **Distinguish** between polar and nonpolar covalent bonds.
- **Use** electronegativities to **predict** the comparative polarities of bonds.
- **Define** *dipole* and **compare** the strengths of intermolecular forces based on dipole moments.
- **Define** and **describe** the types of van der Waals forces and **list** the three factors contributing to them.

- **Define** *chromatography, mobile phase,* and *stationary phase*.
- **Define, describe,** and **name** uses for the different types of chromatography.
- **List** and **explain** the basic assumptions of the kinetic theory.
- **Relate** pressure to molecular motion.
- **Differentiate** among an open-arm manometer, a closed-arm manometer, and a barometer.
- **Calculate** the pressure of gases in manometers and barometers using appropriate units.
- **Relate** temperature and energy transfer to molecular motion.
- **Determine** the relative velocities of gas molecules at the same temperature.
- **Differentiate** among the states of matter.
- **Describe** characteristics of substances in each of the three common states of matter in terms of the kinetic theory and bonding in the substances.
- **Describe** between hydrated ions and anhydrous substances.
- **Explain** the properties of liquids and changes of state in terms of the kinetic theory.
- **Use** LeChatelier's principle to explain reversible changes of state in a closed system.
- **Determine** the relationship between energy and change of state and **perform** related calculations.
- **Use** polarity to explain hydrogen bonding.
- **Explain** the uniques properties of water in terms of its molecular structure.
- **Explain** surface tension and capillary rise on the basis of unbalanced surface forces.
- **Explain** the concept of an ideal gas.
- **Describe** the conditions of STP.
- **Relate** the laws of Boyle, Dalton, Charles and **perform** calculations using these laws.
- **Solve** problems involving the change of more than one condition for gases.
- **Explain** Graham's law and **solve** problems using it.
- **Differentiate** between an ideal gas and a real gas.
- **State** Avagadro's principle.
- **Define** molar volume.
- **Explain** and **use** the ideal gas equation.
- **Compute** the molecular mass of a gas from its mass, temperature, pressure, and volume.
- **Solve** gas volume-mass, mass-gas volume, and volume-volume problems.
- **Identify** the limiting reactant and be able to solve problems based upon it.
- **Describe** and **explain** the processes of solvation, dissociation, and dissolving.
- **Discuss** factors affecting the solubility of one substance in another.
- **Differentiate** among and **solve** problems involving molarity, molality, mole fraction, and mass percent.
- **Distinguish** among colloids, solutions, and suspensions.
- **State** Raoult's law and use it to **calculate** the vapor pressure of a solution.
- **Explain** how the process of fractional distillation can be used to separate components of a solution.
- **Identify** the effect of solute particles on the boiling point and freezing point of a solvent.
- **Calculate** the effect of a solute on the boiling point, freezing point, and osmotic pressure of a solution.
- **Determine** the molecular mass of a solute from freezing point, boiling point, or osmotic pressure data.
- **Explain** the concept of osmotic pressure.
- **Determine** an equilibrium constant expression for a system at equilibrium.
- **Use** LeChatelier's principle to **explain** the effects of changes in concentration, pressure, and temperature on an equilibrium system.
- **Relate** relative amounts of product and reactant to the equilibrium constant.
- **Calculate** equilibrium constants and concentrations of reactants and products for a reaction.
- **Distinguish** the definitions of acids and bases as outlined in the theories of Arrhenius, Bronsted-Lowry, and Lewis.
- **Name** acids and bases.
- **Define** acidic and basic anhydrides and **write** formulas for them.
- **Define** and **give examples** of strong and weak acids and bases.
- **Explain** the concept of neutralization and the composition of a salt and be able to **name** salts.
- **Write** net ionic equations.
- **Derive** and **use** ionization constants.
- **Compute** the percent ionization of a weak electrolyte.
- **Explain** the concept of solubility product and **solve** problems using the solubility product constant.

- **Discuss** the auto-ionization of water and **solve** problems using the ion product constant for water.
- **Explain** how the pH scale is used for measuring solution acidity.
- **Describe** the processes of hydrolysis and buffering.
- **State** the principles and uses of indicators.
- **Explain** the process of titration and **perform** calculations using the data from titration.
- **Compare** the process of oxidation with the process of reduction.
- **Explain** what constitutes an oxidizing agent and a reducing agent.
- **Describe** how to assign oxidation numbers to atoms in compounds.
- **State** how to identify oxidation-reduction reactions.
- **Explain** the concept of half-reactions.
- **Determine** how to balance redox equations by the half-reaction method.

Unit 1: Introduction to Chemistry

- *Pure science vs. applied science* (technology)
  - ✓ space exploration - Corning glass; satellite technology; oncology; digital imaging & sound
  - ✓ Edwin Land - Polaroid film from tourmaline crystals
  - ✓ Sodium polyacrylate = waterlock (Proctor & Gamble diapers & anti-erosion compound)
- *Alchemy vs. Chemistry*
  - ✓ Chemist is NOT…
  - ✓ A physical science vs. a life science
  - ✓ Demo: Alchemist Dream
  - ✓ search for the ____ stone
- *Basic Concepts in Chemistry*
  - ✓ Evidence of chemical change
    - Heat, light, gas or precipitate evolved: sound? Or color change?
      - light match
      - blue bottle with ethyl alcohol
      - calcium carbide cannon
      - reaction (sugar + H_2SO_4 → black snake)
  - ✓ Reactants vs. products
    - mercury vs. mercury compound: Dr. Karen Wetterhahn
  - ✓ Conservation of mass
    - baking soda in vinegar with balloon
  - ✓ Conservation of energy
    - Kinetic vs. potential energy
    - Exogonic vs. endogonic
      - NaOH in water
      - Ammonium nitrate + barium octahydrate → cold pack
    - Activation energy
      - Nitrogen triiodide with peacock feather
      - Picric acid story
- *Mathematics of Chemistry* (WS)
  - ✓ Scientific notation
  - ✓ Proper use of calculator (exponent, log, antilog)
  - ✓ Basic algebra - solving equations
- *Areas of Chemistry*
  - ✓ Research, Education, Business, Government
  - ✓ Organic, Inorganic, Analytical, Physical, Biochemistry
- *The Scientific Method*
  - ✓ Drunken Goldfish & Other Irrelevant Scientific Research
  - ✓ politics – thalidomide (only two cases in US {FDA approval denied in US})
  - ✓ Inference vs. observation
  - ✓ Quantitative vs. qualitative analysis
  - ✓ Data vs. variable
  - ✓ Controlled experiment (variables, hypothesis, limitations)
  - ✓ Theory vs. law
  - ✓ Law of Conservation of Matter (mass and energy $E = mc^2$
- *Making a Graph* (bar, line, pie on computer)
- *Measurement*
  - ✓ SI and metric prefixes
  - ✓ Accuracy vs. precision
  - ✓ Measured (inferred uncertainty) and Exact Numbers
  - ✓ Glassware identification
  - ✓ Fermi approximations (estimate final answer: is it reasonable?)
- *Significant Figures with calculations* (statistical significance)
- *Conversion Factors*
  - ✓ Dimensional analysis
- *Safety*
  - ✓ Safety contract
  - ✓ MSDS WS (acetone), LD-50, chronic vs. acute exposure
  - ✓ radon in homes, toxicity of mercury (George Decker - extraction of dental amalgam)

Lab: How does the mass of a penny change with age?

A) Remains constant
B) lighter, cupper wears off
C) heavier; as the penny gets dirty
D) Changes in 1982

MAIN POINTS

- Everything tangible on Earth, as well as everything in the universe, is made of chemicals.
- Chemical reactions in our bodies keep us alive and allow us to move, see, hear, talk, and think.
- Even if we don't realize it, we make chemical choices every day of our lives.
- Chemists and other scientists find out about nature in a systematic way, by asking questions, designing and performing experiments, gathering data, interpreting the data, and checking that their results can be repeated.
- The application of scientific knowledge to solve problems and improve our standard of living is known as technology.
- Modern society relies very heavily on chemical technology.
- The application of chemical knowledge brings both risks and benefits, which can be assessed in a procedure known as risk-benefit analysis.
- It's important for you to keep informed about the latest advances in science and technology. However, be careful about accounts of scientific studies reported in the mass media. Sometimes the reporters oversimplify the details and draw unwarranted conclusions.
- The intimate, unavoidable connection between chemistry, technology and life is the essential reason for our need to understand chemistry.

EXERCISES: Advanced Chemistry

1. The latter part of May brings with it the end of the school year, thoughts of summer (school or work or play?), and, for some fair-skinned students, the desire to fet a golden tan. Some sit in the sun. Others go to tanning salons. List some risks and benefits to consider when judging whether a tan is worth having.

2. Many sciences classes discuss the scientific method as a series of specific steps to be followed. List the steps in the scientific method. After doing so, close the book, take a few moments to have a soda, come back, and without looking at the book, make another list of the steps. Do the lists differ? If so, what can you conclude about the idea of the scientific method as a series of *predetermined*, sequential steps.

3. A recent study examined the effect of the long-term absence of gravity n the bone density of space shuttle astronauts. After finding some calcium loss for one male astronaut (*not* senator John Glenn) after 7 days in Earth orbit, the study concluded, "*long term living in zero-gravity will cause substantial loss of bone density in space travelers.*' Was this conclusion valid? What could have been done to make the experiment more meaningful? Why might such a study not be done?

4. Publish or Perish - Researching the Issue

5. The standard argument against the use of disposable diapers is that the 18 billion plastic-lined disposables that U.S. households use per year take up between 0.8 and 3.3 % of landfill space and therefore exacerbate an already serious landfill problem. Both disposable and reusable diapers have environmental costs, as shown in the accompanying table, which uses data from a 1990 study by consultants at Franklin Associates in Kansas. The data include all costs associated with diaper use, including packaging, disposal, cleaning, pins, and plastic pants. As you can see, there all all kinds of environmental issues involved in the diapering
decision. Cost, convenience, and the comfort of the baby are three more important things to think about. Which type of diaper, disposable of cloth, would you choose for your child? Justify your decision.

Environmental Costs of Diaper Use (per year per child)

Environmental Cost	Cloth Diaper Risk	Disposable Diaper Risk
Energy use equivalent	400 L gasoline	200 L gasoline
Water use	40,000 L	10,000 L
Water pollution	10 kg	2 kg
Combustion products	15 kg	7 kg
Garbage to landfills	minimal	millions of diapers with contents

6. Consider This: *Paradigms*

Thomas Kuhn, a philosopher of science, suggests that because any scientist is a product of society, he or she can be held back by commonly accepted ideas or *paradigms* shared by that society. When evidence mounts against a particular concept and new ideas take its place, that is a *paradigm shift*. It frees a scientist to go forward, to explore other options. Can you think of paradigm shifts, past or present, that represent significant change in the way the natural world is or was viewed?

Unit 2: Properties of Matter - (Atoms and Elements)

- *Matter - How to Classify*
  - ✓ Intensive vs. extensive properties
    - Mass vs. weight
    - Density (Archimedes Principle)
  - ✓ Atoms vs. molecule vs. compound
    - Allotropes vs. isomers
      - Diamond, graphite, buckeyball
      - White & red phosphorous
      - Rhombic sulfur vs. amorphous sulfur
  - ✓ Pure substance vs. mixture
    - Heterogeneous vs. homogeneous
      - Alloy - brass screw vs. bronze (14 karat vs. 24 karat gold)
      - Colloid - Tyndall effect (H_2SO_4 in ammonium thiosulfate) "Artificial Sunset"
      - Suspension - lead iodide (centrifuge)
  - ✓ Methods of Separating Mixtures
    - Chemical properties vs. physical properties
      - Filtration, centrifugation, density, distillation, color, magnetism, solubility
    - Chemical change vs. physical change
      - Glycerin with potassium permanganate
      - Mortar & pestle
      - Distillation apparatus
- *Elements and Symbols* (Fire, Air, Earth, Water ----> Today)
  - ✓ Origin of elements names and where they come from
  - ✓ Chemical Bingo
- *The Periodic Table* (essential elements)
  - ✓ Element autobiography / resume
- *The Atom* (historical development)
  - ✓ Democratus, Dalton, Thomson, Rutheford (Geiger), Bohr, Planck / Einstein
- *Atomic Number and Mass Number*
- *Isotopes and Atomic Mass*
  - ✓ Radioactivity and its uses
- *Electron arrangement and the Periodic Law*
  - ✓ Valence & kernel electrons (shielding effect, & coulombic attraction)
  - ✓ octet rule, isoelectronic species
  - ✓ electron configuration
  - ✓ trends of the periodic table (size, mass, reactivity, melting point)

Unit 3: Compounds and Their Bonds

- *Nomenclature - IUPAC*
  - ✓ (structural isomers, representations: ether vs. alcohol)
- *Valence Electrons*
  - ✓ Lewis dot structures
- *Ions and the Octet Rule*
- *Ionic Compounds*
- *Naming and Writing Ionic Formulas*
- *Covalent Bonds*
- *Covalent Compounds*
- *Bond Polarity*
- *Polyatomic Ions*
- *Free radicals* (smog formation)
  - ➢ Demo: penny in nitric acid ($2NO_2$ <--> N_2O_4)

Unit 4: Chemical Reactions and Quantities

- *Chemical Changes*
  - ✓ Evidence of a chemical reaction
- *Chemical Equations*
  - ✓ Word vs. symbolic with phases
  - ✓ Balancing a Chemical Equation
- *Types of Reactions*
  - ✓ Synthesis, Decomposition, Single & Double Replacement,
  - ✓ Redox, Combustion
    - o Activity Series - SR
    - o Driving Forces - DR (precipitate, gas, water)
- *The Mole Concept* (mass, particles, stoichiometry)
  - ✓ Calculations Using Molar Mass
  - ✓ Mole Relationships in Chemical Equations
- *Mass Calculations for Reactions*
- *Limiting Reagents*

Unit 5: Energy and States of Matter

- *Energy*
  - ✓ Potential vs. kinetic
- *Measuring Temperature*
  - ✓ thermometer
- *Measuring Heat Energy*
  - ✓ Calorimeter
  - ✓ latent heat vs. specific heat
- *Energy and Nutrition*
- *States of Matter*
  - ✓ Solids, liquids, gases, plasma, neutron star
- *Heating and Cooling Curves*
  - ✓ Melting and Freezing
  - ✓ Boiling and Condensation
  - ✓ Colligative Properties
- *Energy in Chemical Reactions*
  - ✓ Hess's law
- *Chemical Equilibrium*
  - ✓ LeChateliers Principle

Unit 6: Gases

- *Atmospheric Gases*
  - ✓ Greenhouse effect = global warming [carbon dioxide]
  - ✓ Ozone depletion CFC's
  - ✓ Acid rain - NO_x + SO_x + CO_x
- *Properties of Gases*
  - ✓ Kinetic Molecular Theory of Gases
    - Temperature
    - Pressure (sublimation)
    - Amount
    - volume
  - ✓ Vapor Pressure
    - Barometer
    - Manometer
    - Cold boil - bell jar; syringe, or rubber stoppered with ice cold water poured on top
    - Pressure cooker
- *Gas Pressure*
  - ✓ Pascals, mm Hg, atmospheres
- *Pressure and Volume*
- *Temperature and Volume*
- *Temperature and Pressure*
- *Combined Gas Law*
- *Volume and Moles*
- *Partial Pressures*
- *Diffusion/Effusion*

Unit 7: Solutions

- *Properties of Water*
- *Solutions*
  - ✓ Concentrated vs. dilute
  - ✓ Solutions guide WS
- *Electrolytes and Non-electrolytes*
  - ✓ Article: Don't Sweat the Small Stuff
- *Colligative Properties*
  - ✓ Freezing point depression; boiling point elevation
    - ➢ Demo: Rock salt ice cream
- *Solubility* (kidney stones) (pesticide runnoff, pfisteria)
  - ✓ Factors that affect rate of solution
    - Particle size
    - Nature of solvent (tincture, amalgam, aqueous, organic)
    - Stirring
    - Temperature
      - ➢ Demo: Sodium silicate garden
      - ➢ Demo: Chromatography (glass plates with silica slurry)
      - ➢ Demo: Supersaturated solution with seed crystal
  - ✓ Solubility Curves
    - Unsaturated
    - Saturated
    - Supersaturated
- *Percent Concentration (w:w; w:v; v:v)*
- *Colloids and Suspensions*
- *Osmosis and Dialysis [Clinical Chemistry text]*
- *Molarity/Normality/Molality (dilutions)*
  - ✓ How to make a standard solution with a volumetric flask
    - ❑ Lab: Titration/Concentration (colorimetrically Spec-20)

Unit 8: Acids, Bases and Salts

- *Acids and Bases nomenclature*
- *Ionization of Water*
- *The pH scale*
- *Strengths of Acids and Bases*
- *Making Dilutions*
- *Acid-Base Neutralization*
- *Buffers*
- *Acid-Base Titration*
- *Indicators*

Unit 9: Alkanes and Aromatic Hydrocarbons

- Organic Compounds
- Bonding in Hydrocarbons
- Naming Alkanes
- Branched Alkanes
- Stuctural Formulas

Advanced Topics - 4th Quarter

- Electrochemistry – Redox (photography)
- Organic Topics (petroleum)
- Polymers (engineered materials)
- Organic/Biochemistry (esters) (Lab: Aspirin/Oil of Wintergreen)
- Environmental (waste disposal – water)
- Petroleum (soap vs. detergent)
- Nuclear (Fission, Fusion) / Nuclear waste disposal: Medicine (CAT, PET, MRI); smoke detectors
- Radiation (half-life, radioactive dating, radiology)
- Solid Structures

Reference: Chemistry in the Marketplace
Chem. Matters CD
Laser Disc - demonstrations

General Chemistry Syllabus: NCHS
Instructors: Jeff Christopherson and John Bergmann

1. Introduction to Chemistry
2. Properties of Matter
3. Atomic Structure
4. Periodicity
5. Nomenclature
6. Chemical Formulas
7. Chemical Equations
8. Stoichiometry
9. Gas Laws
10. Solutions
11. Acids & Bases