Course Structure

Welcome! We're excited that you're interested in using and remixing our Chemistry 1 and 2 Course. Some quick notes to get you started:

These courses are built around the OpenStax Chemistry 2e Online Textbook. You can browse the learning objectives for each unit below. For each unit the following resources are provided to support and supplement in-class instruction:

- **OpenStax Enhanced PowerPoint Slides**. These slides have been slightly reorganized to match the unit structure given below.

- **Pre-Lecture Reading Assignments**. These assignments are designed to be used prior to class meetings. Students will read the relevant portions of the OpenStax textbook and answer 5-10 comprehension questions on their reading. Assignments are provided as QTI files for importing into a LMS and as printable pdfs.

- **End of Unit Problem Assignments.** These assignments are designed to be used after class meetings. Students will be given 15-25 problems focused on applying concepts and performing calculations based on the unit's learning objectives. Assignments are provided as QTI files (for importing into an LMS) and as printable pdfs.

- **Homework Help Videos.** These 2-5 minute videos are designed to be used concurrently with the End of Unit Problem Assignments. Each video focuses on a particular type of problem, providing a step-by-step explanation for how to solve it. Videos are provided for particularly difficult problems. These videos will be linked for the relevant problems in the End of Unit Problems QTI files and PDFs, but MP4s and transcript files are also provided.

QuickStart:
If you're just looking to grab some LMS assignments, importing the QTI package into your LMS is a great place to start! The assignments along with embedded textbook and video links should be ready to go, plug and play style. These assignments were originally built in Canvas, so if you're using another LMS you may want to check to make sure everything imports.

Deep Dive:
If you're looking to get a better understanding of the nitty gritty of the assignments, start by reviewing the word documents--these should give you a pretty comprehensive view of the types of problems used and how they're programmed within the learning management system.

Units & Learning Objectives

Course: Chemistry 1

Unit 1: The Scientific Method

- Recognize uncertainty in measurements, use significant figures in dimensional analysis problem solving, and understand the difference between accuracy and precision
- Convert between units, including units which are squared or cubed. Use metric prefixes to convert between units.

Unit 2: Elements & Compounds

- Distinguish elements from compounds, pure substances from mixtures, homogeneous from heterogeneous mixtures (solutions), and physical from chemical properties
- Write formulas and names for elements, cations and anions, oxoacids; and ionic and covalent compounds
- Describe the properties of protons, neutrons, electrons, atoms, ions and isotopes

Unit 3: Quantifying Compounds & Moles

- Perform calculations using Avogadro's number and use the concept of the mole to convert between atomic/molecular and macroscopic quantities
- Determine the empirical and molecular formulas of compounds from elemental analysis data
- Calculate molarity for solutions and molarity of diluted solutions

Unit 4: Chemical Reactions

- Categorize and predict the products for metathesis, combination, decomposition, acid/base, oxidation, and precipitation reactions
- Balance chemical reactions
- Define and distinguish between Arrhenius and Brønsted-Lowry acids and bases
- Perform calculations relating quantities in chemical reactions, including limiting reactant, theoretical yield, and percent yield calculations
- Perform calculations solving for an unknown analyte in a titration.

Unit 5: Thermochemistry

- Identify various forms of energy, interconversion between these forms, and its role in physical processes and chemical reactions
- Perform calculations using standard enthalpies of formation, standard enthalpy of reaction, standard enthalpy of combustion and Hess's Law
- Conduct simple calorimetry experiments and perform calculations to determine if a process or chemical reaction is endothermic or exothermic

Unit 6: Quantum Atomic Theory

- Describe the implications of wave mechanics and the quantization of electron energies and spin, including quantum numbers, atomic orbital energies, and the shapes of s, p and d orbitals
- Write full and condensed electron configurations, differentiate between core and valence electrons, draw orbital diagrams
- Explain the organization of the periodic table, group names, trends in metallic character, atomic radius, ionization energy, electron affinity, and electronegativity
- Convert between frequency, wavelength, and energy for electromagnetic radiation
- Perform calculations for energy changes in the Bohr Model of the atom.

Unit 7: Bonding and Molecular Shape

- Describe the difference between ionic and covalent bonding and differentiate between ionic and covalent compounds
- Use the concept of electronegativity to predict bond covalency, bond polarity, and the dipole moment of molecules
- Draw Lewis symbols, structures and resonance structures; use formal charge to rank likely Lewis structure
- Use VSEPR to determine atomic orbital hybridization, predict electron pair and molecular geometry for molecules and ions
- Describe sigma (σ) and pi (π) bonding in hybrid and molecular orbitals. Understand the differences between valence bond and molecular orbital theory

Unit 8: Gases

- Describe the kinetic molecular theory of gases and how it predicts the macroscopic behavior of gases
- Qualitatively predict the behavior of gases based on the simple gas laws, and perform quantitative calculations using the Ideal Gas Law
- Perform calculations for mixtures of gases using Dalton's Law and the concept of a mole fraction

Course: Chemistry 2

Unit 9: Molecular Interactions

- Prepare solutions and calculate solution concentration using molarity, molality, weight percent, mole fraction
- Identify molecular/ion interactions based upon structures – hydrogen bonding, dipole-dipole and London Dispersion forces
- Sketch and interpret phase diagrams- normal boiling point, critical triple, triple point

Unit 10: Solutions

- Describe the steps and energetics of forming a solution
- Describe and calculate the impact of colligative properties (freezing point depression, boiling point elevation, osmotic pressure, vapor pressure) of solutions
- Calculate the partial pressure of solution components and the vapor pressure of a solution using Raoult's Law

Unit 11: Kinetics

- Distinguish between initial, average and instantaneous rates of reaction
- Perform kinetics calculations to determine reaction and reactant order, and half-life
- Perform calculations using integrated rate laws, predict the linearity of concentration vs. time graphs based on integrated rate laws, define and calculate the half-life for a chemical reaction
- Analyze and interpret reaction coordinate diagrams - identify reactants, intermediates, reaction mechanisms, transition states, catalysts and products
- Solve steady state kinetics reaction problems; choose between two possible mechanism given an experimental rate law

Unit 12: Equilibrium

- Describe the implications of reaction reversibility for chemical equilibrium
- Calculate, manipulate, and interpret equilibrium constants (K_f, Kc, Kp, Ksp, Kw, Kf)
- Predict the direction of an equilibrium by comparing the equilibrium constant and the reaction quotient
- Define the differences between kinetics, thermodynamics and equilibrium

Unit 13: Acid Base Chemistry

- Identify weak acids and bases, conjugate pairs, rank them in terms of acidity using Kas and/or molecular structure
- Identify which species are acting as Lewis Acids or Lewis Bases in a chemical reaction
- Describe and define the autoionization of water, pH, pOH, and acid/base dissociation constants

Unit 14: Buffers & Titrations

- Calculate pH and/or pOH for a weak acid and weak base solutions, weak acid titrations, and buffer solutions
- Describe how to create a buffer with a target pH, calculate how the pH of a buffer will change with the addition of acid/base
- Calculate the unknown analyte for an acid base titration. Calculate the pH during a strong acid or weak acid titration.

Unit 15: Thermodynamics

- Predict the spontaneity of a chemical reaction based on thermodynamic quantities
- Define entropy and use standard molar entropies to calculate standard entropies of a reaction
- Calculate Standard Free Energy of a reaction using Standard Free Energy of formation or standard enthalpy and standard entropy
- Perform calculations relating Free Energy to temperature and equilibrium constants

Unit 16: Electrochemistry

- Balance RedOx reactions using the half-reaction method in both acidic and basic media
- Identify the components of a galvanic cell: anode, cathode, salt-bridge, solutions, reductant, and oxidant.
- Predict the cell potential for galvanic cells using standard reduction potentials
- Use the Nernst equation to calculate the cell potential at non-standard conditions
- Relate cell potential to spontaneity, equilibrium constants, and Free Energy
- Calculate the stoichiometry of electrolysis reactions; predict the products of electrolysis reactions