General Chemistry (Second Semester)

This course covers material usually taught in the second semester of a two–semester sequence. By default, the topics listed below are all available, **new topics** have been highlighted. However, instructors can customize the course to align with their teaching goals using *any* topics from the complete ALEKS curriculum, which covers a full course sequence.

Curriculum (323 topics + 362 additional topics)

- Math and Physics (33 topics)
  - Mathematics (7 topics)
    ◊ Integer multiplication and division
    ◊ Simplifying a fraction
    ◊ Equivalent fractions
    ◊ Writing expressions using exponents
    ◊ Evaluating expressions with exponents of zero
    ◊ Square root of a perfect square
    ◊ Converting between decimal numbers and numbers written in scientific notation
  - Algebra Expressions (6 topics)
    ◊ Using distribution and combining like terms to simplify: Univariate
    ◊ Quotient rule with negative exponents: Problem type 1
    ◊ Power and quotient rules with positive exponents
    ◊ Multiplying binomials with leading coefficients greater than 1
    ◊ Multiplying rational expressions involving multivariate monomials
    ◊ Square root of a perfect square monomial
  - Linear Equations (6 topics)
    ◊ Additive property of equality with integers
    ◊ Multiplicative property of equality with signed fractions
    ◊ Solving a linear equation with several occurrences of the variable: Fractional forms with monomial numerators
    ◊ Solving a rational equation that simplifies to linear: Denominator x+a
    ◊ Solving for a variable in terms of other variables using addition or subtraction with division
    ◊ Solving for a variable in terms of other variables in a linear equation with fractions
  - Quadratic and Radical Equations (3 topics)
    ◊ Solving a quadratic equation using the square root property: Decimal answers, basic
    ◊ Solving a quadratic equation using the square root property: Decimal answers, advanced
    ◊ Applying the quadratic formula: Decimal answers
  - Graphing Equations (3 topics)
    ◊ Classifying slopes given graphs of lines
    ◊ Graphing a line through a given point with a given slope
    ◊ Finding slope given the graph of a line on a grid
  - Graphing Data (2 topics)
    ◊ Constructing a scatter plot
    ◊ Mean of a data set
  - Logarithms and Exponentials (2 topics)
    ◊ Evaluating a logarithmic expression
    ◊ Solving an equation of the form $\log_b a = c$
  - Electrostatics (4 topics)
• Measurement and Matter (19 topics)
  ♦ Measurement (8 topics)
    ◊ Knowing the value of an SI prefix as a power of 10
    ◊ Interconverting compound SI units
    ◊ Interconverting temperatures in Celsius and Kelvins
    ◊ Counting significant digits
    ◊ Counting significant digits when measurements are added or subtracted
    ◊ Counting significant digits when measurements are multiplied or divided
    ◊ Reading a measurement from an analog instrument
    ◊ Calculating absolute and relative error
  ♦ Quantitative Problem Solving (4 topics)
    ◊ Predicting the units of the solution to a basic quantitative problem
    ◊ Deducing the unit missing from the solution to a basic quantitative problem
    ◊ Setting up the math for a one-step problem with unit conversion
    ◊ Setting up the math for a two-step quantitative problem
  ♦ Elements, Compounds, and Mixtures (2 topics)
    ◊ Recognizing element families
    ◊ Organization of the Periodic Table
  ♦ Atoms, Ions and Molecules (5 topics)
    ◊ Predicting the ions formed by common main-group elements
    ◊ Counting valence electrons in a neutral atom
    ◊ Understanding the prefixes used in naming binary compounds
    ◊ Deducing the ions in a binary ionic compound from its empirical formula
    ◊ Naming ionic compounds with common oxoanions
• Chemical Reactions (19 topics)
  ♦ Stoichiometry (9 topics)
    ◊ Finding molar mass from chemical formulae
    ◊ Balancing chemical equations with interfering coefficients
    ◊ Writing a chemical equation from a molecular movie
    ◊ Writing the net equation for a sequence of reactions
    ◊ Using a chemical equation to find moles of product from moles of reactant
    ◊ Solving for a reactant using a chemical equation
    ◊ Identifying the limiting reactant in a drawing of a mixture
    ◊ Calculating molarity using solute mass
    ◊ Using molarity to find solute mass and solution volume
  ♦ Simple Reactions (7 topics)
    ◊ Identifying the correct sketch of a compound in aqueous solution
    ◊ Writing net ionic equations
    ◊ Predicting the products of a neutralization reaction
    ◊ Determining the volume of base needed to titrate a given mass of acid
    ◊ Assigning oxidation numbers
    ◊ Recognizing reduction and oxidation
    ◊ Predicting products from a general statement about reactivity
  ♦ Thermochemistry (3 topics)
    ◊ Understanding the definitions of heat and work
    ◊ Understanding the definition of enthalpy
    ◊ Using the general properties of reaction enthalpy
• Structure and Bonding (24 topics)
  ♦ Electronic Structure of Atoms (10 topics)
Diamond Recognizing s and p orbitals
◊ Deducing n and l from a subshell label
◊ Drawing a box diagram of the electron configuration of an atom
◊ Writing the electron configuration of an atom using the Periodic Table
◊ Identifying s, p, d and f block elements
◊ Identifying elements with a similar valence electron configuration
◊ Understanding periodic trends in effective nuclear charge
◊ Deducing the block of an element from an electron configuration
◊ Understanding periodic trends in atomic size
◊ Understanding periodic trends in atomic ionizability

♦ Chemical Bonding (14 topics)
◊ Counting valence electrons in a molecule or polyatomic ion
◊ Calculating formal charge
◊ Writing Lewis structures for a molecule with one central atom and no octet–rule exceptions
◊ Writing the Lewis structures for a molecule with resonance
◊ Drawing Lewis structures for simple organic compounds
◊ Predicting the relative electronegativities of atoms
◊ Predicting relative bond polarity
◊ Predicting the relative length and energy of chemical bonds
◊ Predicting bond angles in a small organic molecule
◊ Predicting whether molecules are polar or nonpolar
◊ Naming common chemical groups
◊ Identifying common chemical groups in a Lewis structure
◊ Counting sigma and pi bonds in a small molecule
◊ Identifying carbon hybridization in simple organic molecules

• Gases, Liquids, and Solids (40 topics)
  ♦ Gas Laws (1 topics)
    ◊ Using the ideal equation of state
  ♦ Intermolecular Forces (7 topics)
    ◊ Identifying a molecule from its electrostatic potential map
    ◊ Predicting the strength of intermolecular forces from an electrostatic potential map
    ◊ Identifying hydrogen–bonding interactions between molecules
    ◊ Identifying the intermolecular forces between atoms, ions and molecules
    ◊ Identifying the important intermolecular forces in pure compounds
    ◊ Predicting the relative strength of the dispersion force between molecules
    ◊ Predicting the relative boiling points of pure substances
  ♦ Liquids (4 topics)
    ◊ Identifying important physical properties of liquids
    ◊ Understanding consequences of important physical properties of liquids
    ◊ Relating vapor pressure to vaporization
    ◊ Understanding the connection between vapor pressure, boiling point, and enthalpy of vaporization
  ♦ Solids (7 topics)
    ◊ Predicting the type of solid formed by a compound
    ◊ Predicting the relative stability of ionic crystals from a sketch
    ◊ Predicting the relative lattice energy of binary ionic compounds
    ◊ Drawing the unit cell of a 2D lattice
    ◊ Counting the atoms in a unit cell
    ◊ Recognizing and naming close–packed crystal lattices
    ◊ Recognizing and naming lattices with cubic unit cells
  ♦ Phase Change (7 topics)
    ◊ Using heat of fusion or vaporization to find the heat needed to melt or boil a substance
    ◊ Using a phase diagram to predict phase at a given temperature and pressure
    ◊ Labeling a typical simple phase diagram
Using a phase diagram to find a phase transition temperature or pressure
Sketching a described thermodynamic change on a phase diagram
Identifying phase transitions on a heating curve
Interpreting a heating curve

Solution Composition (5 topics)
Calculating mass percent composition
Calculating molality
Calculating mole fraction
Calculating mass concentration
Solving applied dilution problems

Solubility (2 topics)
Applying like dissolves like
Understanding how solubility varies with temperature and pressure

Ideal Solutions (7 topics)
Predicting relative boiling point elevations and freezing point depressions
Using the Kf and Kb equations
Using the Kf and Kb equations with electrolytes
Using osmotic pressure to find molar mass
Using a solution freezing point to calculate a molar mass
Using Raoult's Law to calculate the vapor pressure of a component
Calculating ideal solution composition after a distillation

Kinetics and Equilibrium (50 topics)
Rates of Reaction (3 topics)
Predicting how reaction rate varies with pressure, concentration and temperature
Calculating the reaction rate of one reactant from that of another
Calculating average and instantaneous reaction rate from a graph of concentration versus time

Rate Laws (11 topics)
Using a rate law
Using reactant reaction order to predict changes in initial rate
Deducing a rate law from initial reaction rate data
Calculating the change in concentration after a whole number of half–lives of a first–order reaction
Using a zero order integrated rate law to find concentration change
Using an integrated rate law for a first–order reaction
Using a second–order integrated rate law to find concentration change
Using first– and second–order integrated rate laws
Deducing a rate law from the change in concentration over time
Finding half life and rate constant from a graph of concentration versus time
Solving applied problems with first–order kinetics

Activation Energy (4 topics)
Interpreting a reaction energy diagram
Relating activation energy to reaction rate
Drawing the reaction energy diagram of a catalyzed reaction
Understanding the qualitative predictions of the Arrhenius equation

Reaction Mechanisms (8 topics)
Identifying the molecularity of an elementary reaction
Identifying intermediates in a reaction mechanism
Writing a plausible missing step for a simple reaction mechanism
Writing the rate law of an elementary reaction
Writing the rate law implied by a simple mechanism with an initial slow step
Expressing the concentration of an intermediate in terms of the concentration of reactants
Writing the rate law implied by a simple mechanism
Deducing information about reaction mechanisms from a reaction energy diagram

Dynamic Equilibrium (4 topics)
Understanding that no reaction goes to 100% completion
Predicting relative forward and reverse rates of reaction in a dynamic equilibrium
Using Le Chatelier's Principle to predict the result of changing concentration
Using Le Chatelier's Principle to predict the result of changing temperature

- **Equilibrium Constants and Expressions (7 topics)**
  - Writing a concentration equilibrium constant expression
  - Writing a pressure equilibrium constant expression
  - Writing the concentration equilibrium expression for a heterogeneous equilibrium
  - Writing the pressure equilibrium expression for a heterogeneous equilibrium
  - Calculating an equilibrium constant from an equilibrium composition
  - Using an equilibrium constant to predict the direction of spontaneous reaction
  - Using the general properties of equilibrium constants

- **Equilibrium Composition (8 topics)**
  - Recognizing equilibrium from a sketch
  - Predicting equilibrium composition from a sketch
  - Setting up a reaction table
  - Calculating equilibrium composition from an equilibrium constant
  - Using the small x approximation to solve equilibrium problems
  - Calculating an equilibrium constant from a partial equilibrium composition
  - Calculating an equilibrium composition after a prior equilibrium determines K
  - Solving problems that mix equilibrium ideas with gas laws

- **Ionic Equilibria (5 topics)**
  - Writing a solubility product (Ksp) expression
  - Using Ksp to calculate the solubility of a compound
  - Using the solubility of a compound to calculate Ksp
  - Calculating the solubility of an ionic compound when a common ion is present
  - Understanding the effect of pH on the solubility of ionic compounds

- **Acids and Bases (46 topics)**
  - **Concepts of Acidity (12 topics)**
    - Identifying acids and bases by their reaction with water
    - Understanding the difference between strong and weak acids
    - Identifying Bronsted−Lowry acids and bases
    - Identifying strong or weak acids and bases from a sketch
    - Finding the conjugate of an acid or base
    - Predicting acid or base strength from the conjugate
    - Predicting the products of the reaction of a strong acid with water
    - Predicting the reactants of a neutralization reaction
    - Predicting the qualitative acid−base properties of salts
    - Predicting the qualitative acid−base properties of metal cations
    - Identifying Lewis acids and bases in reactions
    - Predicting the acid−base properties of a binary oxide in water
  - **Acid−Base Nomenclature (4 topics)**
    - Naming inorganic acids
    - Deducing the formulae of inorganic acids from their names
    - Naming acid salts
    - Recognizing common acids and bases
  - **Acidity and Chemical Structure (2 topics)**
    - Predicting the relative acidity of binary acids
    - Understanding the effect of induction on acidity
  - **pH (8 topics)**
    - Interconverting pH and hydronium ion concentration
    - Interconverting pH and pOH at 25°C
    - Interconverting hydronium and hydroxide concentration at 25°C
Making qualitative estimates of pH change
Calculating the pH of a strong acid solution
Calculating the pH of a strong base solution
Diluting a strong acid solution to a given pH
Preparing a strong base solution with a given pH

Weak Acids and Bases (13 topics)
Writing an acid dissociation constant expression
Determining the strength of acids from a sketch
Calculating the Ka of a weak acid from pH
Calculating the pH of a weak acid solution
Writing a base protonation constant expression
Calculating the pH of a weak base solution
Deriving $K_b$ from $K_a$
Interconverting Ka and pKa
Calculating the pH of a salt solution
Calculating percent dissociation of a weak acid
Understanding connections between descriptions of weak acid dissociation
Calculating the pH of a dilute acid solution
Writing the dissociation reactions of a polyprotic acid

Acid–Base Titrations (3 topics)
Calculating the pH of a weak acid titrated with a strong base
Calculating the pH of a weak base titrated with a strong acid
Calculating the pH at equivalence of a titration

Buffers (4 topics)
Identifying the major species in weak acid or weak base equilibria
Setting up a reaction table for a pH calculation with a common ion
Calculating the pH of a buffer
Calculating the composition of a buffer of a given pH

Entropy and Free Energy (15 topics)

Entropy (8 topics)
Calculating entropy change from reversible heat flow
Calculating absolute entropy using the Boltzmann hypothesis
Calculating entropy change using the Boltzmann hypothesis
Predicting qualitatively how entropy changes with temperature and volume
Predicting qualitatively how entropy changes with mixing and separation
Qualitatively predicting reaction entropy
Using the Second Law to predict spontaneous change
Calculating reaction entropy using the standard molar entropies of reactants

Gibbs Free Energy (7 topics)
Using the general properties of Gibbs free energy
Calculating $dG$ from $dH$ and $dS$
Using the conditions of spontaneity to deduce the signs of $H$ and $S$
Interconverting standard Gibbs free energy and $K$
Using thermodynamic data to calculate $K$
Recognizing consistency between statements about standard Gibbs free energy
Using the maximum work theorem with chemical work

Electrochemistry (17 topics)
Half Reactions (5 topics)
Writing a simple half–reaction from its description
Writing and balancing complex half–reactions in acidic solution
Writing and balancing complex half–reactions in basic solution
Balancing a complex redox equation in acidic or basic solution
Writing the half–reactions of a complex redox reaction in acidic or basic solution
Galvanic Cells (8 topics)
- Designing a galvanic cell from two half-reactions
- Analyzing a galvanic cell
- Picking a reduction or oxidation that will make a galvanic cell work
- Ranking the strength of oxidizing and reducing agents using standard reduction potentials
- Calculating standard reaction free energy from standard reduction potentials
- Recognizing consistency among equilibrium constant, free energy, and cell potential
- Using the Nernst equation to calculate nonstandard cell voltage
- Understanding concentration cells

Electrolysis (4 topics)
- Using the relationship between charge, current and time
- Using the Faraday constant
- Analyzing the electrolysis of molten salt
- Calculating the mass of an electrolysis product from the applied current

The Main–Group Elements (12 topics)

Periodic Trends (7 topics)
- Understanding main–group periodic trends in metallicity
- Predicting the most positive and negative oxidation states of main–group elements
- Predicting the common oxidation states of main–group elements
- Identifying a main–block group from an element oxide
- Identifying a main–block group from an element halide
- Predicting the type of bonding in a main–group element
- Assessing the consistency of statements relating to main–group valence electron configuration

Properties of Groups (5 topics)
- Predicting the products of the reaction of a Group 1A or 2A metal with water
- Predicting the products of the reaction of a Group 1A or 2A metal with oxygen
- Predicting the products of the reaction of elements at either end of the Periodic Table
- Ordering the melting points of elements at either end of the Periodic Table
- Ranking the oxidizing power of halogens

The Transition Metals (18 topics)

Electronic Structure of Transition Metals (4 topics)
- Writing the electron configuration of a first transition series atom
- Interpreting an outer electron box diagram
- Identifying transition metal cations with a given number of d electrons
- Deducing the number of d electrons and unpaired spins in a transition metal cation

Properties of Transition Metals (3 topics)
- Understanding words that describe where transition metals lie in the Periodic Table
- Predicting the highest common oxidation state of a metal in the first transition series
- Predicting the reaction of a transition metal with a strong acid

Metal Complexes and Coordination Compounds (9 topics)
- Writing the formula of a metal complex from its description
- Recognizing typical metal ligands
- Determining the oxidation state of the metal in a complex ion
- Determining the oxidation state of the metal in a coordination compound
- Determining the coordination number of a metal in a complex
- Understanding the connection between geometry and coordination number of a metal complex
- Distinguishing isomers and alternate views of a metal complex
- Drawing an isomer of a metal complex
- Drawing cis and trans isomers of a metal complex

Crystal Field Theory (2 topics)
- Adding electrons to a crystal field theory energy level diagram
- Predicting color and magnetic properties from a crystal field theory energy level diagram

Nuclear and Organic Chemistry (30 topics)
Nuclear Reactions (5 topics)
- Interpreting the symbol for a nuclide
- Writing the symbols in a nuclear chemical equation
- Balancing a nuclear chemical equation
- Writing the equation for a typical radioactive decay
- Calculating the energy change in a nuclear reaction from the mass change

Radioactive Decay (5 topics)
- Knowing the properties of the common types of nuclear radiation
- Understanding the common modes of radioactive decay
- Understanding radioactive half life
- Interconverting amount of radioactive decay and half life
- Calculating radioactive activity from half life

Nuclear Technology (2 topics)
- Using isotope ratios to radiodate
- Using activity to radiodate

Organic Structure (6 topics)
- Identifying organic compounds
- Interpreting condensed chemical structures
- Identifying organic functional groups
- Identifying the main chain of branched alkanes
- Numbering the main chain of branched alkanes
- Interpreting condensed chemical structures with benzene rings

Organic Nomenclature (12 topics)
- Naming normal alkanes
- Using family suffixes to name organic compounds
- Naming the parent hydrocarbon of branched alkanes
- Naming alkyl side chains
- Naming branched alkanes
- Using multiplying affixes in the names of branched alkanes
- Naming unbranched alkenes and alkynes
- Naming alkenes and alkynes
- Naming alkyl halides
- Naming alcohols
- Naming aldehydes and acids
- Naming benzene derivatives

Other Topics Available(*) (362 additional topics)
- Math and Physics (93 topics)
  - Signed fraction addition or subtraction: Basic
  - Signed fraction multiplication: Basic
  - Signed fraction division
  - Exponents and fractions
  - Introduction to inequalities
  - Introduction to exponents
  - Introduction to order of operations
  - Ordering numbers with positive exponents
  - Evaluating an expression with a negative exponent: Whole number base
  - Evaluating an expression with a negative exponent: Positive fraction base
  - Complex fraction without variables: Problem type 1
  - Introduction to square root multiplication
  - Absolute value of a number
  - Multiplication of a decimal by a power of ten
Division of a decimal by a power of ten
Multiplying and dividing numbers written in scientific notation
Calculating positive powers of scientific notation
Finding negative powers of scientific notation
Evaluating a quadratic expression: Integers
Combining like terms: Integer coefficients
Combining like terms in a quadratic expression
Distributive property: Integer coefficients
Introduction to the product rule of exponents
Product rule with positive exponents: Univariate
Introduction to the product rule with negative exponents
Introduction to the quotient rule of exponents
Simplifying a ratio of univariate monomials
Introduction to the power of a product rule of exponents
Rewriting an algebraic expression without a negative exponent
Squaring a binomial: Univariate
Complex fraction involving univariate monomials
Writing a one–step expression for a real–world situation
Writing a multi–step equation for a real–world situation
Identifying solutions to a linear equation in one variable: Two–step equations
Identifying solutions to a linear equation in two variables
Additive property of equality with a negative coefficient
Solving a multi–step equation given in fractional form
Solving a proportion of the form a/(x+b) = c/x
Solving a word problem with two unknowns using a linear equation
Additive property of inequality with integers
Solving a two–step linear inequality: Problem type 2
Discriminant of a quadratic equation
Introduction to solving a radical equation
Solving a radical equation that simplifies to a linear equation: One radical, basic
Graphing a line given its equation in slope–intercept form: Fractional slope
Writing an equation of a line given the y–intercept and another point
Finding slope given two points on the line
Finding the slope and y–intercept of a line given its equation in the form Ax + By = C
Finding x– and y–intercepts given the graph of a line on a grid
Finding x– and y–intercepts of a line given the equation: Advanced
Sketching the line of best fit
Scatter plots and correlation
Approximating the equation of a line of best fit and making predictions
Classifying linear and nonlinear relationships from scatter plots
Linear relationship and the correlation coefficient
Choosing a graph to fit a narrative: Basic
Choosing a graph to fit a narrative: Advanced
Constructing a histogram for numerical data
Finding the mean of a symmetric distribution
Population standard deviation
Word problem involving calculations from a normal distribution
Basic properties of logarithms
Expanding a logarithmic expression: Problem type 1
Expanding a logarithmic expression: Problem type 2
Writing an expression as a single logarithm
Evaluating an exponential function with base e that models a real–world situation
Converting between common logarithmic and exponential equations
Converting between natural logarithmic and exponential equations
Solving a multi-step equation involving natural logarithms
Solving an exponential equation by using logarithms: Decimal answers, basic
Solving an exponential equation by using natural logarithms: Decimal answers
Graphing an exponential function and its asymptote: \( f(x) = a(e)^{x-b} + c \)
Finding an angle measure of a triangle given two angles
Finding an angle measure for a triangle with an extended side
Finding an angle measure for a triangle sharing a side with another triangle
Pythagorean Theorem
Sine, cosine, and tangent ratios: Numbers for side lengths
Using the Pythagorean Theorem to find a trigonometric ratio
Using a trigonometric ratio to find a side length in a right triangle
Using a trigonometric ratio to find an angle measure in a right triangle
Solving a right triangle
Finding the magnitude and direction of a vector given its graph
Finding the components of a vector given its graph
Finding the component of a vector along another vector
Calculating gravitational potential energy
Using conservation of energy with gravitational potential energy
Using conservation of energy with electrostatic potential energy
Understanding how electrostatic force scales with charge and separation
Understanding how electrostatic potential energy scales with charge and separation
Calculating the magnitude of an electrostatic force using Coulomb's Law
Understanding that electrostatic forces add as vectors
Understanding how electrostatic energy scales with charge and separation
Calculating electrostatic energy using Coulomb's Law

Measurement and Matter (75 topics)
Knowing the dimension of common simple SI units
Understanding the purpose of SI prefixes
Interconversion of prefixed and base SI units
Interconversion of prefixed SI units
Interconverting derived SI units
Interconverting whole degree temperatures in Celsius and kelvins
Interconverting temperatures in Celsius and Fahrenheit
Addition and subtraction of measurements
Simplifying unit expressions
Multiplication and division of measurements
Rounding to a given significant digit
Adding or subtracting and multiplying or dividing measurements
Distinguishing accuracy and precision
Naming components of the scientific method
Setting up a one-step unit conversion
Setting up a unit reprefix conversion
Setting up a unit conversion
Setting up the solution to a basic quantitative problem
Identifying errors in the solution to a basic quantitative problem
Setting up the math for a one-step quantitative problem
Estimating the volume in liters of a square prism object
Finding the side length of a cube from its volume in liters
Estimating the volume in liters of a spherical object
Estimating the volume in liters of a cylindrical object
Calculating volume by combining the volume of simple shapes
Understanding the relationship between mass, volume, and density
Chemical Reactions (64 topics)

- Using the Avogadro Number
- Calculating and using the molar mass of elements
- Calculating and using the molar mass of diatomic elements
Calculating and using the molar mass of heterodiatomic compounds
Finding mole ratios from chemical formulae
Finding chemical formulae from a mole ratio
Interconverting number of atoms and mass of compound
Finding mass percent from chemical formulae
Solving applied mass percent problems
Elemental analysis of binary compounds
Elemental analysis
Finding a molecular formula from molar mass and elemental analysis of binary compounds
Finding a molecular formula from molar mass and elemental analysis
Combustion analysis
Stoichiometric coefficients
Balancing chemical equations with noninterfering coefficients
Writing a chemical equation from a description of the reaction
Solving moles-to-moles limiting reactant problems
Limiting reactants
Understanding theoretical, actual, and percent yield
Theoretical yield of chemical reactions
Percent yield of chemical reactions
Reaction sequence stoichiometry
Calculating molarity using solute moles
Using molarity to find solute moles and solution volume
Calculating ion molarity using solute mass
Dilution
Solving for a reactant in solution
Solving limiting reactant problems in solution
Predicting the products of dissolution
Predicting precipitation
Identifying acids and bases by their chemical formula
Determining the molar mass of an acid by titration
Standardizing a base solution by titration
Identifying oxidizing and reducing agents
Identifying oxidized and reduced reactants in a metal-nonmetal reaction
Identifying oxidized and reduced reactants in a single-displacement reaction
Predicting whether simple electrochemical reactions happen
Solving a redox titration problem
Identifying combination, decomposition, single and double displacement reactions
Identifying precipitation, combustion and acid-base reactions
Predicting the products of a combustion reaction
Predicting the products of a single displacement reaction involving hydrogen
Predicting the products of a gas-evolving double displacement reaction
Understanding how kinetic energy scales with mass and speed
Calculating kinetic energy
Using conservation of energy to predict the qualitative exchange of kinetic and potential energy
Calculating pressure-volume work
Interconverting calories and joules
Calculating specific heat capacity
Using specific heat capacity to find heat
Using specific heat capacity to find temperature change
Calculating molar heat capacity
Solving a basic calorimetry problem
Finding the equilibrium temperature when substances at different temperatures mix
Calculating the heat of reaction from molar reaction enthalpy and the mass of a reactant
Calculating heat of reaction from constant-pressure calorimetry data
Calculating heat of reaction from bomb calorimetry data
Using Hess's Law to calculate net reaction enthalpy
Writing a standard formation reaction
Calculating a molar heat of reaction from formation enthalpies
Solving combustion thermochemistry problems
Calculating the heat of reaction from bond energies and Lewis structures
Calculating the heat of reaction from bond energies

Structure and Bonding (49 topics)
Understanding the meaning of a de Broglie wavelength
Finding the minimum uncertainty in a position or velocity measurement
Interpreting the radial probability distribution of an orbital
Interpreting the angular probability distribution of an orbital
Deciding the relative energy of electron subshells
Deducing the allowed quantum numbers of an atomic electron
Calculating the capacity of electron subshells
Knowing the subshells of an electron shell
Interpreting the electron configuration of a neutral atom
Interpreting the electron configuration of a neutral atom in noble-gas notation
Writing the electron configuration of a neutral atom with s and p electrons only
Writing the electron configuration of a neutral atom with a filled d subshell
Interpreting the electron configuration of an atom or atomic ion
Interpreting the electron configuration of an atom or atomic ion in noble-gas notation
Writing the electron configuration of an atom or atomic ion with s and p electrons only
Identifying quantum mechanics errors in electron configurations
Identifying the electron added or removed to form an ion from an s or p block atom
Identifying the electron added or removed to form an ion
Understanding the definitions of ionization energy and electron affinity
Predicting the relative ionization energy of elements
Deducing valence electron configuration from trends in successive ionization energies
Ranking the screening efficacy of atomic orbitals
Understanding the organization of the electromagnetic spectrum
Interconverting the wavelength and frequency of electromagnetic radiation
Interconverting wavelength, frequency and photon energy
Calculating the wavelength of a spectral line from an energy diagram
Predicting the qualitative features of a line spectrum
Calculating the wavelength of a line in the spectrum of hydrogen
Counting bonding and nonbonding electron pairs in a Lewis structure
Counting electron pairs in a Lewis structure with double or triple bonds
Deciding whether a Lewis structure satisfies the octet rule
Writing Lewis structures for diatomic molecules
Predicting the single-bonded molecular compounds formed by two elements
Predicting the compound formed by two main group elements
Recognizing exceptions to the octet rule
Writing Lewis structures for an expanded valence shell central atom
Predicting bond polarity
Predicting the relative ionic character of chemical bonds
Predicting the arrangement of electron groups around the central atom of a molecule
Identifying a molecule with one central atom from its 3D shape
Using the AXE notation to describe a molecule with a central atom
Naming the shape of molecules with one central atom and no octet-rule exceptions
Predicting bond angles in molecules with one central atom and no octet-rule exceptions
Predicting and naming the shape of molecules with a central atom
Predicting deviations from ideal bond angles
Identifying hybridization in a small molecule
Recognizing typical LCAO molecular orbitals
Drawing the MO energy diagram for a Period 2 homodiatom
Using the MO model to predict bond order and paramagnetism

♦ Gases, Liquids, and Solids (43 topics)
  ◊ Interconverting pressure and force
  ◊ Interconverting atmospheres and kilopascals
  ◊ Interconverting atmospheres and torr
  ◊ Understanding pressure equilibrium and atmospheric pressure
  ◊ Understanding Boyle's Law
  ◊ Solving applications of Boyle's Law
  ◊ Using Charles's Law
  ◊ Using the combined gas law
  ◊ Using Avogadro's Law
  ◊ Interconverting molar mass and density of ideal gases
  ◊ Calculating partial pressure of a gas from a sketch
  ◊ Calculating mole fraction in a gas mixture
  ◊ Calculating partial pressure in a gas mixture
  ◊ Calculating the mass of a gas collected over water
  ◊ Solving for a gaseous reactant
  ◊ Understanding how average molecular kinetic energy scales with temperature
  ◊ Understanding how average molecular speed scales with temperature and molar mass
  ◊ Interpreting a graph of molecular speed distribution
  ◊ Predicting how molecular speed distribution changes with temperature and molar mass
  ◊ Calculating average molecular speed
  ◊ Understanding how molecular collision rate scales with temperature and volume
  ◊ Using relative effusion rates to find an unknown molar mass
  ◊ Using thermodynamic state to order the ideality of gases
  ◊ Identifying the origin of nonideality in a gas
  ◊ Understanding the origin of the van der Waals equation of state
  ◊ Using the van der Waals equation of state
  ◊ Calculating vapor pressure from boiling point and enthalpy of vaporization
  ◊ Calculating enthalpy of vaporization from vapor pressure
  ◊ Interpreting a Born–Haber cycle
  ◊ Calculating key distances in the fcc unit cell
  ◊ Calculating key distances in the bcc unit cell
  ◊ Finding an atomic radius from an fcc or bcc lattice constant
  ◊ Finding density from an fcc or bcc lattice constant
  ◊ Drawing a heating curve
  ◊ Using mass percent composition to find solution volume
  ◊ Using mass concentration to find solute mass and solution volume
  ◊ Solving applied mass concentration problems
  ◊ Calculating solubility
  ◊ Using solubility to calculate solute mass or solution volume
  ◊ Understanding conceptual components of the enthalpy of solution
  ◊ Using Henry's Law to calculate the solubility of a gas
  ◊ Predicting the relative heat of hydration of ions
  ◊ Calculating and using the van't Hoff factor for electrolytes

♦ Kinetics and Equilibrium (9 topics)
  ◊ Using the Arrhenius equation to calculate k at one temperature from k at another
  ◊ Using the Arrhenius equation to calculate Ea from k versus T data
  ◊ Calculating an equilibrium constant from a heterogeneous equilibrium composition

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Interconverting Kp and Kc
Writing an equilibrium constant for a reaction sequence
Using the van't Hoff equation to predict K at a different temperature
Writing a complex ion formation constant expression
Using Kf to calculate the equilibrium molarity of a complex
Calculating the solubility of an ionic compound when a complex may form

♦ Acids and Bases (1 topics)
  ◇ Solving a polyprotic acid equilibrium composition problem

♦ Entropy and Free Energy (4 topics)
  ◇ Calculating standard reaction free energy from standard free energies of formation
  ◇ Estimating a phase transition temperature from standard thermodynamic data
  ◇ Calculating reaction free energy under nonstandard conditions
  ◇ Using reaction free energy to predict equilibrium composition

♦ Electrochemistry (3 topics)
  ◇ Writing the half−reactions of a metal−nonmetal reaction
  ◇ Writing the half−reactions of a single−displacement reaction
  ◇ Designing a galvanic cell from a single−displacement redox reaction

♦ The Main−Group Elements (11 topics)
  ◇ Understanding main−group periodic trends in ionization energy
  ◇ Understanding main−group periodic trends in atomic radius
  ◇ Predicting the hydride formed by a main−group element
  ◇ Predicting the oxide formed by a main−group element
  ◇ Identifying a main−block group from its general properties
  ◇ Identifying Group 3A elements
  ◇ Identifying Group 4A elements
  ◇ Identifying Group 5A elements
  ◇ Identifying Group 6A elements
  ◇ Understanding the chemical formulae of interhalogens
  ◇ Understanding how halide bond length varies down a main−block group

♦ The Transition Metals (10 topics)
  ◇ Drawing the outer electron box diagram of a transition metal cation
  ◇ Understanding the exceptional electron configurations in the first transition series
  ◇ Predicting the relative atomic radius of a transition metal atom
  ◇ Predicting the relative density of a transition metal
  ◇ Predicting the relative melting point of a transition metal
  ◇ Naming complex cations with one type of ligand
  ◇ Naming complex anions with one type of ligand
  ◇ Naming complex ions
  ◇ Naming coordination compounds
  ◇ Drawing a crystal field theory energy level diagram

*Other Topics Available* By default, these topics are NOT included in this course because they are usually taught in other terms. However, they can be added using the content editor in the Instructor Module.