

## *General Chemistry (Third Quarter)*

This course covers material usually taught in the third quarter of a three-quarter 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 (277 topics + 368 additional topics)

- Math and Physics (36 topics)
  - ◆ Mathematics (9 topics)
    - ◇ Integer multiplication and division
    - ◇ Equivalent fractions
    - ◇ Signed fraction addition or subtraction: Basic
    - ◇ Signed fraction multiplication: Basic
    - ◇ Signed fraction division
    - ◇ 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 (8 topics)
    - ◇ Using distribution and combining like terms to simplify: Univariate
    - ◇ Product rule with positive exponents: Univariate
    - ◇ Introduction to the product rule with negative exponents
    - ◇ 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 (7 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 a proportion of the form  $a/(x+b) = c/x$
    - ◇ 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
  - ◆ Logarithms and Exponentials (2 topics)
    - ◇ Evaluating a logarithmic expression

- ◇ Solving an equation of the form  $\log_b a = c$
- ◆ Electrostatics (4 topics)
  - ◇ Understanding that opposite charges attract and like charges repel
  - ◇ Understanding how electrostatic forces cancel
  - ◇ Understanding how electrostatic energy scales with charge and separation
  - ◇ Sketching polarization induced by a nearby charge
- Measurement and Matter (19 topics)
  - ◆ Measurement (7 topics)
    - ◇ Knowing the value of an SI prefix as a power of 10
    - ◇ Interconverting compound SI units
    - ◇ Interconverting temperatures in Celsius and Kelvins
    - ◇ Simplifying unit expressions
    - ◇ Counting significant digits
    - ◇ Counting significant digits when measurements are added or subtracted
    - ◇ Counting significant digits when measurements are multiplied or divided
  - ◆ Quantitative Problem Solving (4 topics)
    - ◇ Predicting the units of the solution to a basic quantitative problem
    - ◇ 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
  - ◆ Mass, Volume and Density (2 topics)
    - ◇ Distinguishing solid, liquid and gas phases of a pure substance
    - ◇ Organization of the Periodic Table
  - ◆ Atoms, Ions and Molecules (6 topics)
    - ◇ Counting protons and electrons in atoms and atomic ions
    - ◇ 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
    - ◇ Predicting and naming ionic compounds formed by two elements
- Chemical Reactions (22 topics)
  - ◆ Stoichiometry (12 topics)
    - ◇ Finding molar mass from chemical formulae
    - ◇ Interconverting number of atoms and mass of compound
    - ◇ Balancing chemical equations with interfering coefficients
    - ◇ 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
    - ◇ Dilution
    - ◇ Solving for a reactant in solution
    - ◇ Solving limiting reactant problems in solution
  - ◆ Simple Reactions (7 topics)
    - ◇ Writing net ionic equations
    - ◇ Predicting the products of a neutralization reaction
    - ◇ Determining the volume of base needed to titrate a given mass of acid
    - ◇ Determining the molar mass of an acid by titration
    - ◇ Standardizing a base solution by titration
    - ◇ Assigning oxidation numbers
    - ◇ Solving a redox titration problem
  - ◆ Thermochemistry (3 topics)

- ◇ Finding the equilibrium temperature when substances at different temperatures mix
- ◇ Using the general properties of reaction enthalpy
- ◇ Calculating the heat of reaction from molar reaction enthalpy and the mass of a reactant
- Structure and Bonding (24 topics)
  - ◆ Electronic Structure of Atoms (10 topics)
    - ◇ 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 or atomic ion with s and p electrons only
    - ◇ 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 the definitions of ionization energy and electron affinity
    - ◇ Understanding periodic trends in effective nuclear charge
    - ◇ Deducing the block of an element from an electron configuration
  - ◆ 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 bond polarity
    - ◇ Predicting bond angles in molecules with one central atom and no octet–rule exceptions
    - ◇ Predicting the relative length and energy of chemical bonds
    - ◇ Predicting whether molecules are polar or nonpolar
    - ◇ Identifying common chemical groups in a Lewis structure
    - ◇ Identifying hybridization in a small molecule
    - ◇ Counting sigma and pi bonds in a small molecule
    - ◇ Identifying carbon hybridization in simple organic molecules
- Gases, Liquids and Solids (14 topics)
  - ◆ Gas Laws (2 topics)
    - ◇ Interconverting atmospheres and kilopascals
    - ◇ Using the ideal equation of state
  - ◆ Kinetic Theory (3 topics)
    - ◇ Interpreting a graph of molecular speed distribution
    - ◇ Predicting how molecular speed distribution changes with temperature and molar mass
    - ◇ Understanding how molecular collision rate scales with temperature and volume
  - ◆ Intermolecular Forces (3 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
  - ◆ Solids (1 topics)
    - ◇ Predicting the type of solid formed by a compound
  - ◆ Phase Change (3 topics)
    - ◇ 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
  - ◆ Solubility (1 topics)
    - ◇ Applying like dissolves like
  - ◆ Ideal Solutions (1 topics)
    - ◇ Predicting relative boiling point elevations and freezing point depressions
- Kinetics and Equilibrium (21 topics)

- ◆ Rates of Reaction (1 topics)
  - ◇ Predicting how reaction rate varies with pressure, concentration and temperature
- ◆ Rate Laws (2 topics)
  - ◇ Calculating the change in concentration after a whole number of half-lives of a first-order reaction
  - ◇ Using an integrated rate law for a first-order reaction
- ◆ 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 (1 topics)
  - ◇ 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 or volume
  - ◇ Using Le Chatelier's Principle to predict the result of changing temperature
- ◆ Equilibrium Constants and Expressions (5 topics)
  - ◇ Writing a concentration equilibrium constant expression
  - ◇ Writing a pressure equilibrium constant expression
  - ◇ Writing the concentration equilibrium expression for a heterogeneous equilibrium
  - ◇ Using an equilibrium constant to predict the direction of spontaneous reaction
  - ◇ Using the general properties of equilibrium constants
- ◆ Equilibrium Composition (2 topics)
  - ◇ Recognizing equilibrium from a sketch
  - ◇ Predicting equilibrium composition from a sketch
- ◆ Ionic Equilibria (2 topics)
  - ◇ Writing a solubility product ( $K_{sp}$ ) expression
  - ◇ Understanding the effect of pH on the solubility of ionic compounds
- Acids and Bases (21 topics)
  - ◆ Concepts of Acidity (11 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 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 (1 topics)
    - ◇ Recognizing common acids and bases
  - ◆ Acidity and Chemical Structure (1 topics)
    - ◇ Understanding the effect of induction on acidity
  - ◆ pH (3 topics)
    - ◇ Interconverting pH and hydronium ion concentration
    - ◇ Making qualitative estimates of pH change
    - ◇ Calculating the pH of a strong acid solution
  - ◆ Weak Acids and Bases (5 topics)
    - ◇ Writing an acid dissociation constant expression
    - ◇ Determining the strength of acids from a sketch

- ◇ Writing a base protonation constant expression
- ◇ Deriving  $K_b$  from  $K_a$
- ◇ Interconverting  $K_a$  and  $pK_a$
- Entropy and Free Energy (19 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 (11 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  $S$
    - ◇ Calculating standard reaction free energy from standard free energies of formation
    - ◇ Estimating a phase transition temperature from standard thermodynamic data
    - ◇ 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
    - ◇ Calculating reaction free energy under nonstandard conditions
    - ◇ Using reaction free energy to predict equilibrium composition
- Electrochemistry (20 topics)
  - ◆ Half Reactions (7 topics)
    - ◇ Writing a simple half-reaction from its description
    - ◇ Writing the half-reactions of a metal-nonmetal reaction
    - ◇ Writing the half-reactions of a single-displacement reaction
    - ◇ 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 (9 topics)
    - ◇ Designing a galvanic cell from a single-displacement redox reaction
    - ◇ 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 (23 topics)
  - ◆ Periodic Trends (12 topics)
    - ◇ Understanding main-group periodic trends in ionization energy
    - ◇ Understanding main-group periodic trends in atomic radius

- ◇ 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
- ◇ 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 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 (11 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
  - ◇ 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
  - ◇ Ordering the melting points of elements at either end of the Periodic Table
  - ◇ Ranking the oxidizing power of halogens
- The Transition Metals (28 topics)
  - ◆ Electronic Structure of Transition Metals (6 topics)
    - ◇ Writing the electron configuration of a first transition series atom
    - ◇ Interpreting an outer electron box diagram
    - ◇ Drawing the outer electron box diagram of a transition metal cation
    - ◇ 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
    - ◇ Understanding the exceptional electron configurations in the first transition series
  - ◆ Properties of Transition Metals (6 topics)
    - ◇ Understanding words that describe where transition metals lie in the Periodic Table
    - ◇ 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
    - ◇ 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 (13 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
    - ◇ Naming complex cations with one type of ligand
    - ◇ Naming complex anions with one type of ligand
    - ◇ Naming complex ions
    - ◇ Determining the oxidation state of the metal in a coordination compound
    - ◇ Naming coordination compounds
    - ◇ 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 (3 topics)
    - ◇ Adding electrons to a crystal field theory energy level diagram

- ◇ Predicting color and magnetic properties from a crystal field theory energy level diagram
- ◇ Drawing 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(\*) (368 additional topics)
  - ◆ Math and Physics (89 topics)
    - ◇ Simplifying a fraction
    - ◇ 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
- ◇ 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 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
- ◇ Constructing a scatter plot
- ◇ 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
- ◇ Mean of a data set
- ◇ 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
- ◇ Calculating electrostatic energy using Coulomb's Law
- ◆ Measurement and Matter (56 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 temperatures in Celsius and Fahrenheit
  - ◇ Addition and subtraction of measurements
  - ◇ Multiplication and division of measurements
  - ◇ Rounding to a given significant digit
  - ◇ Adding or subtracting and multiplying or dividing measurements
  - ◇ Setting up a one-step unit conversion
  - ◇ Setting up a unit reprefix conversion
  - ◇ Setting up a unit conversion
  - ◇ 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
  - ◇ 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
  - ◇ Calculating mass density
  - ◇ Using mass density to find mass or volume
  - ◇ Distinguishing elements and compounds
  - ◇ Distinguishing compounds and mixtures
  - ◇ Distinguishing chemical and physical change
  - ◇ Names and symbols of important elements

- ◇ Reading a Periodic Table entry
- ◇ Understanding periods and groups of the Periodic Table
- ◇ Standard chemical and physical states of the elements
- ◇ Using the Periodic Table to identify similar elements
- ◇ Identifying the parts of an atom
- ◇ Counting the number of protons and electrons in a neutral atom
- ◇ Finding isoprotonic atoms
- ◇ Finding isoelectronic atoms
- ◇ Isotopes
- ◇ Finding atomic mass from isotope mass and natural abundance
- ◇ Finding isotope mass or natural abundance from atomic mass
- ◇ Counting valence electrons in an atomic ion
- ◇ Drawing the Lewis dot diagram of a main group atom or common atomic ion
- ◇ Counting the electron shells in a neutral atom
- ◇ Counting the number of atoms in a formula unit
- ◇ Writing a chemical formula given a molecular model
- ◇ Writing a chemical formula given a chemical structure
- ◇ Naming binary covalent compounds
- ◇ Predicting whether a compound is ionic or molecular
- ◇ Predicting the formula of binary ionic compounds
- ◇ Naming binary ionic compounds
- ◇ Predicting ionic compounds formed by two elements
- ◇ Identifying common polyatomic ions
- ◇ Predicting the formula of ionic compounds with common polyatomic ions
- ◇ Naming ionic compounds with common polyatomic ions
- ◇ Deducing the ions in a polyatomic ionic compound from its empirical formula
- ◇ Identifying oxoanions
- ◇ Naming ionic compounds with common oxoanions
- ◇ Naming hydrates
- ◆ Chemical Reactions (49 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 heterodiatomc compounds
  - ◇ Finding mole ratios from chemical formulae
  - ◇ Finding chemical formulae from a mole ratio
  - ◇ Finding mass percent from chemical formulae
  - ◇ 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
  - ◇ Identifying combination, decomposition, single and double displacement reactions
  - ◇ Writing a chemical equation from a description of the reaction
  - ◇ Limiting reactants
  - ◇ 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
  - ◇ Predicting the products of dissolution

- ◇ Predicting precipitation
- ◇ Identifying precipitation, combustion and acid–base reactions
- ◇ Identifying acids and bases by their chemical formula
- ◇ Recognizing reduction and oxidation
- ◇ 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
- ◇ 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
- ◇ Understanding the definitions of heat and work
- ◇ Understanding the definition of enthalpy
- ◇ 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
- ◇ 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 (45 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
  - ◇ 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
  - ◇ 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 periodic trends in atomic size
  - ◇ Understanding periodic trends in atomic ionizability
  - ◇ 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 the arrangement of electron groups around the central atom of a molecule
- ◇ 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 and naming the shape of molecules with a central atom
- ◇ Predicting deviations from ideal bond angles
- ◇ Naming common chemical groups
- ◇ 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 (66 topics)
  - ◇ Interconverting pressure and force
  - ◇ 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 Avogadro's Law
  - ◇ Interconverting molar mass and density of ideal gases
  - ◇ Calculating mole fraction in a gas mixture
  - ◇ Calculating partial pressure in a gas mixture
  - ◇ 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
  - ◇ Calculating average molecular speed
  - ◇ 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
  - ◇ 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
  - ◇ 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
  - ◇ Calculating vapor pressure from boiling point and enthalpy of vaporization
  - ◇ Calculating enthalpy of vaporization from vapor pressure
  - ◇ Predicting the relative stability of ionic crystals from a sketch
  - ◇ Predicting the relative lattice energy of binary ionic compounds
  - ◇ Interpreting a Born-Haber cycle
  - ◇ 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
- ◇ 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
- ◇ Using heat of fusion or vaporization to find the heat needed to melt or boil a substance
- ◇ Sketching a described thermodynamic change on a phase diagram
- ◇ Identifying phase transitions on a heating curve
- ◇ Interpreting a heating curve
- ◇ Drawing a heating curve
- ◇ Calculating mass percent composition
- ◇ Using mass percent composition to find solution volume
- ◇ Calculating molality
- ◇ Calculating mole fraction
- ◇ Calculating mass concentration
- ◇ Using mass concentration to find solute mass and solution volume
- ◇ Solving applied mass concentration problems
- ◇ Solving applied dilution problems
- ◇ Calculating solubility
- ◇ Using solubility to calculate solute mass or solution volume
- ◇ Understanding how solubility varies with temperature and pressure
- ◇ 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
- ◇ Using the  $K_f$  and  $K_b$  equations
- ◇ Using the  $K_f$  and  $K_b$  equations with electrolytes
- ◇ Calculating and using the van't Hoff factor for 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 (38 topics)
  - ◇ Calculating the reaction rate of one reactant from that of another
  - ◇ Calculating average and instantaneous reaction rate from a graph of concentration versus time
  - ◇ Using a rate law
  - ◇ Using reactant reaction order to predict changes in initial rate
  - ◇ Deducing a rate law from initial reaction rate data
  - ◇ Using a zero order integrated rate law to find concentration change
  - ◇ 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
  - ◇ Using the Arrhenius equation to calculate  $k$  at one temperature from  $k$  at another
  - ◇ Using the Arrhenius equation to calculate  $E_a$  from  $k$  versus  $T$  data
  - ◇ 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
- ◇ Writing the pressure equilibrium expression for a heterogeneous equilibrium
- ◇ Calculating an equilibrium constant from an equilibrium composition
- ◇ Calculating an equilibrium constant from a heterogeneous equilibrium composition
- ◇ Interconverting  $K_p$  and  $K_c$
- ◇ Writing an equilibrium constant for a reaction sequence
- ◇ 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
- ◇ Using the van't Hoff equation to predict  $K$  at a different temperature
- ◇ Using  $K_{sp}$  to calculate the solubility of a compound
- ◇ Using the solubility of a compound to calculate  $K_{sp}$
- ◇ Calculating the solubility of an ionic compound when a common ion is present
- ◇ Writing a complex ion formation constant expression
- ◇ Using  $K_f$  to calculate the equilibrium molarity of a complex
- ◇ Calculating the solubility of an ionic compound when a complex may form
- ◆ Acids and Bases (25 topics)
  - ◇ Naming inorganic acids
  - ◇ Deducing the formulae of inorganic acids from their names
  - ◇ Naming acid salts
  - ◇ Predicting the relative acidity of binary acids
  - ◇ Interconverting pH and pOH at 25°C
  - ◇ Interconverting hydronium and hydroxide concentration at 25°C
  - ◇ 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
  - ◇ Calculating the  $K_a$  of a weak acid from pH
  - ◇ Calculating the pH of a weak acid solution
  - ◇ Calculating the pH of a weak base solution
  - ◇ 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
  - ◇ Solving a polyprotic acid equilibrium composition problem
  - ◇ 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
  - ◇ 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

**\*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.*