ALEKS®

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 (220 topics + 465 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)

- ◊ Understanding that opposite charges attract and like charges repel
- ◊ Understanding net electrical charge
- ◊ Understanding how electrostatic forces cancel
- ◊ Sketching polarization induced by a nearby charge

- 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)

- ◊ 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 (9 topics)

♦ Gas Laws (1 topics)

- ◊ Using the ideal equation of state

♦ Intermolecular Forces (4 topics)

- ◊ Identifying a molecule from its electrostatic potential map
- ◊ Identifying hydrogen−bonding interactions between molecules
- ◊ Identifying the intermolecular forces between atoms, ions and molecules
- ◊ Predicting the relative strength of the dispersion force between molecules

♦ Phase Change (2 topics)

- ◊ Using a phase diagram to predict phase at a given temperature and pressure
- ◊ Labeling a typical simple phase diagram

♦ Solution Composition (1 topics)

- ◊ Calculating mass concentration

♦ Solubility (1 topics)

- ◊ Applying like dissolves like

• Kinetics and Equilibrium (10 topics)

♦ Rate Laws (2 topics)

- ◊ Using a rate law
- ◊ Solving applied problems with first−order kinetics

♦ Activation Energy (2 topics)

- ◊ Interpreting a reaction energy diagram
- ◊ Drawing the reaction energy diagram of a catalyzed reaction

♦ Dynamic Equilibrium (1 topics)

- ◊ Using Le Chatelier's Principle to predict the result of changing temperature

♦ Equilibrium Constants and Expressions (4 topics)

- ◊ Writing a concentration 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 (1 topics)
  - ◊ Predicting equilibrium composition from a sketch

• Acids and Bases (14 topics)
- ♦ Concepts of Acidity (7 topics)
  - ◊ 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 reactants of a neutralization reaction
  - ◊ Identifying Lewis acids and bases in reactions
  - ◊ Predicting the acid−base properties of a binary oxide in water
- ♦ Acidity and Chemical Structure (1 topics)
  - ◊ Understanding the effect of induction on acidity
- ♦ pH (1 topics)
  - ◊ Interconverting pH and hydronium ion concentration
- ♦ Weak Acids and Bases (3 topics)
  - ◊ Writing an acid dissociation constant expression
  - ◊ Determining the strength of acids from a sketch
  - ◊ Interconverting Ka and pKa
- ♦ Buffers (2 topics)
  - ◊ 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(*) (465 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
- ◊ Calculating mass density
- ◊ Using mass density to find mass or volume
- ◊ Solving applied density problems
- ◊ Distinguishing mixtures from pure substances through physical properties
- ◊ Naming common laboratory separation techniques

- ◊ Distinguishing physical and chemical properties by a macroscopic description
- ◊ Distinguishing extensive and intensive properties
- ◊ Distinguishing elements and compounds
- ◊ Distinguishing compounds and mixtures
- ◊ Classifying substances from a sketch
- ◊ Distinguishing chemical and physical change
- ◊ Distinguishing solid, liquid and gas phases of a pure substance
- ◊ Using the Law of Constant Composition
- ◊ Using the Law of Multiple Proportions
- ◊ 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
- ◊ Distinguishing a metal from a nonmetal by physical properties
- ◊ Identifying the parts of an atom
- ◊ Counting the number of protons and electrons in a neutral atom
- ◊ Counting protons and electrons in atoms and atomic ions
- ◊ 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
- ◊ Understanding the difference between a molecular and empirical formula
- ◊ Naming binary covalent compounds
- ◊ Predicting whether a compound is ionic or molecular
- ◊ Distinguishing an ionic from a molecular compound by physical properties
- ◊ Predicting the formula of binary ionic compounds
- ◊ Naming binary ionic compounds
- ◊ Deducing the empirical formula of a binary ionic compound from its name
- ◊ Predicting ionic compounds formed by two elements
- ◊ Predicting and naming 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 hydrates

♦ 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 (74 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
- ◊ Predicting the strength of intermolecular forces from an electrostatic potential map
- ◊ Identifying the important intermolecular forces in pure compounds
- ◊ 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 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
- ◊ 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
- ◊ 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

- ◊ Drawing a heating curve
  - ◊ Calculating mass percent composition
  - ◊ Using mass percent composition to find solution volume
  - ◊ Calculating molality
  - ◊ Calculating mole fraction
  - ◊ 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
  - ◊ Predicting relative boiling point elevations and freezing point depressions
  - ◊ Using the Kf and Kb equations
  - ◊ Using the Kf and Kb 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 (49 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
  - ◊ 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
  - ◊ Relating activation energy to reaction rate
  - ◊ Understanding the qualitative predictions of the Arrhenius equation
  - ◊ 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
  - ◊ 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
  - ◊ 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
  - ◊ Writing a pressure equilibrium constant expression
  - ◊ 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 Kp and Kc
- ◊ Writing an equilibrium constant for a reaction sequence
- ◊ Recognizing equilibrium 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
- ◊ Using the van't Hoff equation to predict K at a different temperature
- ◊ 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
- ◊ 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 (33 topics)

- ◊ Identifying acids and bases by their reaction with water
- ◊ Understanding the difference between strong and weak acids
- ◊ Predicting the products of the reaction of a strong acid with water
- ◊ Predicting the qualitative acid−base properties of salts
- ◊ Predicting the qualitative acid−base properties of metal cations
- ◊ Naming inorganic acids
- ◊ Deducing the formulae of inorganic acids from their names
- ◊ Naming acid salts
- ◊ Recognizing common acids and bases
- ◊ Predicting the relative acidity of binary acids
- ◊ 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
- ◊ 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
- ◊ 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

- ♦ 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.*

