

Introductory College Chemistry

This course covers material usually taught in a one-term, introductory chemistry course. 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.

Curriculum (645 topics)

- Math and Physics (119 topics)
 - ◆ Mathematics (19 topics)
 - ◇ Integer multiplication and division
 - ◇ Simplifying a fraction
 - ◇ Equivalent fractions
 - ◇ Signed fraction addition or subtraction: Basic
 - ◇ Signed fraction multiplication: Basic
 - ◇ Signed fraction division
 - ◇ Exponents and fractions
 - ◇ Introduction to inequalities
 - ◇ Writing expressions using exponents
 - ◇ Introduction to exponents
 - ◇ Introduction to order of operations
 - ◇ Ordering numbers with positive exponents
 - ◇ Evaluating expressions with exponents of zero
 - ◇ 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
 - ◇ Square root of a perfect square
 - ◇ Introduction to square root multiplication
 - ◇ Absolute value of a number
 - ◆ Algebra Expressions (21 topics)
 - ◇ Evaluating a quadratic expression: Integers
 - ◇ Combining like terms: Integer coefficients
 - ◇ Combining like terms in a quadratic expression
 - ◇ Distributive property: Integer coefficients
 - ◇ Using distribution and combining like terms to simplify: Univariate
 - ◇ 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
 - ◇ Quotient rule with negative exponents: Problem type 1
 - ◇ Introduction to the power of a product rule of exponents
 - ◇ Power and quotient rules with positive exponents
 - ◇ Rewriting an algebraic expression without a negative exponent
 - ◇ Squaring a binomial: Univariate
 - ◇ Multiplying binomials with leading coefficients greater than 1
 - ◇ Multiplying rational expressions involving multivariate monomials

- ◇ Complex fraction involving univariate monomials
- ◇ Square root of a perfect square monomial
- ◇ Writing a one–step expression for a real–world situation
- ◇ Writing a multi–step equation for a real–world situation
- ◆ Linear Equations (14 topics)
 - ◇ 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 integers
 - ◇ Additive property of equality with a negative coefficient
 - ◇ Multiplicative property of equality with signed fractions
 - ◇ Solving a multi–step equation given in fractional form
 - ◇ 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
 - ◇ 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
- ◆ Quadratic and Radical Equations (6 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
 - ◇ 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 Equations (9 topics)
 - ◇ Classifying slopes given graphs of lines
 - ◇ 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
 - ◇ Graphing a line through a given point with a given slope
 - ◇ Finding slope given the graph of a line on a grid
 - ◇ 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
- ◆ Graphing Data (13 topics)
 - ◇ 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
- ◆ Logarithms and Exponentials (13 topics)
 - ◇ Evaluating a logarithmic expression

- ◇ Solving an equation of the form $\log_b a = c$
- ◇ 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: $f(x) = a(e)^{x-b} + c$
- ◆ Trigonometry (9 topics)
 - ◇ 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
- ◆ Vectors (3 topics)
 - ◇ 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
- ◆ Force and Energy (3 topics)
 - ◇ Calculating gravitational potential energy
 - ◇ Using conservation of energy with gravitational potential energy
 - ◇ Using conservation of energy with electrostatic potential energy
- ◆ Electrostatics (9 topics)
 - ◇ Understanding that opposite charges attract and like charges repel
 - ◇ 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 how electrostatic forces cancel
 - ◇ Understanding that electrostatic forces add as vectors
 - ◇ Understanding how electrostatic energy scales with charge and separation
 - ◇ Calculating electrostatic energy using Coulomb's Law
 - ◇ Sketching polarization induced by a nearby charge
- Measurement (33 topics)
 - ◆ Scientific Notation (6 topics)
 - ◇ Multiplication of a decimal by a power of ten
 - ◇ Division of a decimal by a power of ten
 - ◇ Converting between decimal numbers and numbers written in scientific notation
 - ◇ Multiplying and dividing numbers written in scientific notation
 - ◇ Calculating positive powers of scientific notation
 - ◇ Finding negative powers of scientific notation
 - ◆ SI Units (9 topics)
 - ◇ Knowing the dimension of common simple SI units
 - ◇ Understanding the purpose of SI prefixes
 - ◇ Knowing the value of an SI prefix as a power of 10
 - ◇ Interconversion of prefixed and base SI units

- ◇ Interconversion of prefixed SI units
- ◇ Interconverting compound SI units
- ◇ Interconverting derived SI units
- ◇ Interconverting temperatures in Celsius and Kelvins
- ◇ Interconverting temperatures in Celsius and Fahrenheit
- ◆ Measurement Math (3 topics)
 - ◇ Addition and subtraction of measurements
 - ◇ Simplifying unit expressions
 - ◇ Multiplication and division of measurements
- ◆ Measurement Uncertainty (5 topics)
 - ◇ Counting significant digits
 - ◇ Rounding to a given significant digit
 - ◇ Counting significant digits when measurements are added or subtracted
 - ◇ Counting significant digits when measurements are multiplied or divided
 - ◇ Adding or subtracting and multiplying or dividing measurements
- ◆ Quantitative Problem Solving (10 topics)
 - ◇ Setting up a one-step unit conversion
 - ◇ Setting up a unit reprefix conversion
 - ◇ Setting up a unit conversion
 - ◇ 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 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
 - ◇ Setting up the math for a one-step problem with unit conversion
 - ◇ Setting up the math for a two-step quantitative problem
- Matter (17 topics)
 - ◆ Mass, Volume and Density (7 topics)
 - ◇ 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
 - ◆ Atomic Theory (4 topics)
 - ◇ Distinguishing elements and compounds
 - ◇ Distinguishing compounds and mixtures
 - ◇ Distinguishing chemical and physical change
 - ◇ Distinguishing solid, liquid and gas phases of a pure substance
 - ◆ Chemical Elements (6 topics)
 - ◇ Names and symbols of important elements
 - ◇ Reading a Periodic Table entry
 - ◇ Understanding periods and groups of the Periodic Table
 - ◇ Organization of the Periodic Table
 - ◇ Standard chemical and physical states of the elements
 - ◇ Using the Periodic Table to identify similar elements
- Atoms, Ions and Molecules (31 topics)
 - ◆ Atomic Structure (13 topics)
 - ◇ 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 isotopic atoms

- ◇ Finding isoelectronic atoms
- ◇ Predicting the ions formed by common main-group elements
- ◇ Isotopes
- ◇ Finding atomic mass from isotope mass and natural abundance
- ◇ **Finding isotope mass or natural abundance from atomic mass**
- ◇ Counting valence electrons in a neutral atom
- ◇ 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
- ◆ Chemical Compounds (5 topics)
 - ◇ 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 prefixes used in naming binary compounds
 - ◇ Naming binary covalent compounds
- ◆ Ionic Compounds (13 topics)
 - ◇ Predicting whether a compound is ionic or molecular
 - ◇ Predicting the formula of binary ionic compounds
 - ◇ Naming binary ionic compounds
 - ◇ Deducing the ions in a binary ionic compound from its empirical formula
 - ◇ 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 ionic compounds with common oxoanions
 - ◇ **Naming hydrates**
- Stoichiometry (34 topics)
 - ◆ Moles and Molar Mass (14 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
 - ◇ Finding molar mass from chemical formulae
 - ◇ **Interconverting number of atoms and mass of compound**
 - ◇ 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**
 - ◆ Chemical Equations (6 topics)
 - ◇ Stoichiometric coefficients
 - ◇ Balancing chemical equations with noninterfering coefficients
 - ◇ Balancing chemical equations with interfering coefficients
 - ◇ Identifying combination, decomposition, single and double displacement reactions
 - ◇ Writing a chemical equation from a description of the reaction
 - ◇ Writing the net equation for a sequence of reactions
 - ◆ Reaction Stoichiometry (7 topics)

- ◇ **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
- ◇ Limiting reactants
- ◇ Theoretical yield of chemical reactions
- ◇ Percent yield of chemical reactions
- ◇ **Reaction sequence stoichiometry**
- ◆ Solution Stoichiometry (7 topics)
 - ◇ Calculating molarity using solute moles
 - ◇ Using molarity to find solute moles and solution volume
 - ◇ 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 (20 topics)
 - ◆ Precipitation (3 topics)
 - ◇ Predicting the products of dissolution
 - ◇ Writing net ionic equations
 - ◇ Predicting precipitation
 - ◆ Acid–Base Reactions (10 topics)
 - ◇ Identifying precipitation, combustion and acid–base reactions
 - ◇ Identifying acids and bases by their chemical formula
 - ◇ Predicting the products of a neutralization reaction
 - ◇ Naming inorganic acids
 - ◇ Deducing the formulae of inorganic acids from their names
 - ◇ Naming acid salts
 - ◇ Recognizing common acids and bases
 - ◇ 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
 - ◆ Oxidation–Reduction Reactions (7 topics)
 - ◇ Assigning oxidation numbers
 - ◇ 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
 - ◇ **Solving a redox titration problem**
- Thermochemistry (21 topics)
 - ◆ Energy (6 topics)
 - ◇ 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
 - ◆ Calorimetry (7 topics)
 - ◇ 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**
- ◆ Reaction Enthalpy (8 topics)
 - ◇ Using the general properties of reaction enthalpy
 - ◇ Calculating the heat of reaction from molar reaction enthalpy and the mass of a reactant
 - ◇ 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
- Electronic Structure (38 topics)
 - ◆ Quantum Mechanics (5 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
 - ◇ Recognizing s and p orbitals
 - ◆ Electron Configuration (17 topics)
 - ◇ Deducing n and l from a subshell label
 - ◇ Deciding the relative energy of electron subshells
 - ◇ Drawing a box diagram of the electron configuration of an atom
 - ◇ 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
 - ◇ Writing the electron configuration of an atom using the Periodic Table
 - ◇ 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
 - ◆ Electronic Properties of The Elements (10 topics)
 - ◇ 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
 - ◇ 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 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
 - ◆ Atomic Spectroscopy (6 topics)
 - ◇ 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
- Chemical Bonding (31 topics)
 - ◆ Lewis Structures (13 topics)
 - ◇ Counting bonding and nonbonding electron pairs in a Lewis structure
 - ◇ Counting electron pairs in a Lewis structure with double or triple bonds
 - ◇ Counting valence electrons in a molecule or polyatomic ion
 - ◇ 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
 - ◇ Calculating formal charge
 - ◇ Writing Lewis structures for a molecule with one central atom and no octet-rule exceptions
 - ◇ Recognizing exceptions to the octet rule
 - ◇ Writing Lewis structures for an expanded valence shell central atom
 - ◇ Writing the Lewis structures for a molecule with resonance
 - ◇ Drawing Lewis structures for simple organic compounds
 - ◆ Molecules (12 topics)
 - ◇ Predicting the relative electronegativities of atoms
 - ◇ Predicting bond polarity
 - ◇ 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 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
 - ◇ Predicting the relative length and energy of chemical bonds
 - ◇ Predicting whether molecules are polar or nonpolar
 - ◇ Naming common chemical groups
 - ◇ Identifying common chemical groups in a Lewis structure
 - ◆ VB and MO Theory (6 topics)
 - ◇ Identifying hybridization in a small molecule
 - ◇ Counting sigma and pi bonds in a small molecule
 - ◇ Identifying carbon hybridization in simple organic molecules
 - ◇ 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 (24 topics)
 - ◆ Gas Laws (10 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 Avogadro's Law**
 - ◇ Using the ideal equation of state
 - ◇ Interconverting molar mass and density of ideal gases
 - ◆ Gas Mixtures (3 topics)
 - ◇ Calculating mole fraction in a gas mixture
 - ◇ Calculating partial pressure in a gas mixture
 - ◇ Solving for a gaseous reactant
 - ◆ Kinetic Theory (7 topics)

- ◇ 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
- ◆ Real Gases (4 topics)
 - ◇ **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**
- Advanced Material (277 topics)
 - ◆ Liquids and Solids (25 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
 - ◇ 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
 - ◆ Phase Change (8 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
 - ◇ Drawing a heating curve
 - ◆ Solutions (23 topics)
 - ◇ 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**
- ◇ Applying like dissolves like
- ◇ 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 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**
- ◆ Chemical Kinetics (28 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 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**
 - ◇ 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
 - ◇ 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
 - ◇ Deducing information about reaction mechanisms from a reaction energy diagram
- ◆ Chemical Equilibrium (31 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

- ◇ 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
- ◇ Calculating an equilibrium constant from a heterogeneous equilibrium composition
- ◇ Using an equilibrium constant to predict the direction of spontaneous reaction
- ◇ Using the general properties of equilibrium constants
- ◇ **Interconverting K_p and K_c**
- ◇ **Writing an equilibrium constant for a reaction sequence**
- ◇ **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**
- ◇ **Using the van't Hoff equation to predict K at a different temperature**
- ◇ Writing a solubility product (K_{sp}) expression
- ◇ 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
- ◇ Understanding the effect of pH on the solubility of ionic compounds
- ◇ **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 (42 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
 - ◇ Predicting the relative acidity of binary acids
 - ◇ Understanding the effect of induction on acidity
 - ◇ 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
 - ◇ Writing an acid dissociation constant expression
 - ◇ **Determining the strength of acids from a sketch**
 - ◇ Calculating the K_a 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 K_a and pK_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
- ◇ Calculating the pH of a buffer
- ◇ Calculating the composition of a buffer of a given pH
- ◆ Entropy and Free Energy (19 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
 - ◇ 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)
 - ◇ 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
 - ◇ 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**
- ◇ 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)**
 - ◇ **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**
 - ◇ **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)**
 - ◇ 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
 - ◇ 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
 - ◇ 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
- ◇ 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 Chemistry (12 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
 - ◇ 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
 - ◇ Using isotope ratios to radiodate
 - ◇ Using activity to radiodate
- ◆ Organic Chemistry (18 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
 - ◇ 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