General Chemistry (First Semester)

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

Curriculum (685 topics)

- Math and Physics (120 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 (10 topics)
  - Understanding that opposite charges attract and like charges repel
  - Understanding net electrical charge
  - 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 (38 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 (10 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
<table>
<thead>
<tr>
<th>Topic</th>
<th>Subtopics</th>
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<tbody>
<tr>
<td>Interconversion of prefixed and base SI units</td>
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<td>Interconversion of prefixed SI units</td>
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<td>Interconverting compound SI units</td>
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<td>Interconverting derived SI units</td>
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<td>Interconverting whole degree temperatures in Celsius and kelvins</td>
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<td>Interconverting temperatures in Celsius and Fahrenheit</td>
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<td>Measurement Math (3 topics)</td>
<td>◊ Addition and subtraction of measurements</td>
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<td>◊ Simplifying unit expressions</td>
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<td>◊ Multiplication and division of measurements</td>
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<td>Measurement Uncertainty (8 topics)</td>
<td>◊ Counting significant digits</td>
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<td>◊ Rounding to a given significant digit</td>
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<td>◊ Counting significant digits when measurements are added or subtracted</td>
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<td>◊ Counting significant digits when measurements are multiplied or divided</td>
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<td>◊ Adding or subtracting and multiplying or dividing measurements</td>
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<td>◊ Reading a measurement from an analog instrument</td>
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<td>◊ Distinguishing accuracy and precision</td>
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<td>◊ Calculating absolute and relative error</td>
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<td>Quantitative Problem Solving (11 topics)</td>
<td>◊ Naming components of the scientific method</td>
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<td>◊ Setting up a one-step unit conversion</td>
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<td>◊ Predicting the units of the solution to a basic quantitative problem</td>
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<td>◊ Deducing the unit missing from the solution to a basic quantitative problem</td>
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<td>◊ Setting up the solution to a basic quantitative problem</td>
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<td>◊ Identifying errors in the solution to a basic quantitative problem</td>
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<td>◊ Setting up the math for a one-step quantitative problem</td>
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<td>◊ Setting up the math for a one-step problem with unit conversion</td>
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<td>◊ Setting up the math for a two-step quantitative problem</td>
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<tr>
<td>Matter (28 topics)</td>
<td>◊ Mass, Volume and Density (9 topics)</td>
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<tr>
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<td>◊ Estimating the volume in liters of a square prism object</td>
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<td>◊ Finding the side length of a cube from its volume in liters</td>
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<td>◊ Estimating the volume in liters of a spherical object</td>
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<td>◊ Estimating the volume in liters of a cylindrical object</td>
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<td>◊ Calculating volume by combining the volume of simple shapes</td>
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<td>◊ Understanding the relationship between mass, volume, and density</td>
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<td>◊ Calculating mass density</td>
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<td>◊ Using mass density to find mass or volume</td>
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<td>◊ Solving applied density problems</td>
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<td>◊ Substances (4 topics)</td>
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<td>◊ Distinguishing mixtures from pure substances through physical properties</td>
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<td>◊ Naming common laboratory separation techniques</td>
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<td>◊ Distinguishing physical and chemical properties by a macroscopic description</td>
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<td>◊ Distinguishing extensive and intensive properties</td>
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<td>◊ Atomic Theory (7 topics)</td>
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<tr>
<td></td>
<td>◊ Distinguishing elements and compounds</td>
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<td>◊ Distinguishing compounds and mixtures</td>
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<td>◊ Classifying substances from a sketch</td>
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<td>◊ Distinguishing chemical and physical change</td>
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◊ Distinguishing solid, liquid and gas phases of a pure substance
◊ Using the Law of Constant Composition
◊ Using the Law of Multiple Proportions
♦ Chemical Elements (8 topics)
  ◊ Names and symbols of important elements
  ◊ Reading a Periodic Table entry
  ◊ Understanding periods and groups of the Periodic Table
  ◊ Recognizing element families
  ◊ Organization 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
• Atoms, Ions and Molecules (34 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 isoprotonic 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 (6 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 difference between a molecular and empirical formula
    ◊ Understanding the prefixes used in naming binary compounds
    ◊ Naming binary covalent compounds
  ♦ Ionic Compounds (15 topics)
    ◊ 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 ions in a binary ionic compound from its empirical formula
    ◊ 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 ionic compounds with common oxoanions
    ◊ Naming hydrates
• Stoichiometry (38 topics)
  ♦ Moles and Molar Mass (8 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

Elemental Analysis (7 topics)
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

Chemical Equations (6 topics)
Stoichiometric coefficients
Balancing chemical equations with noninterfering coefficients
Balancing chemical equations with interfering coefficients
Writing a chemical equation from a description of the reaction
Writing a chemical equation from a molecular movie
Writing the net equation for a sequence of reactions

Reaction Stoichiometry (9 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
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

Solution Stoichiometry (8 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
Calculating ion molarity using solute mass
Dilution
Solving for a reactant in solution
Solving limiting reactant problems in solution

Simple Reactions (26 topics)
Precipitation (4 topics)
Predicting the products of dissolution
Identifying the correct sketch of a compound in aqueous solution
Writing net ionic equations
Predicting precipitation

Acid–Base Reactions (9 topics)
Identifying acids and bases by their chemical formula
Naming inorganic acids
Deducing the formulae of inorganic acids from their names
Naming acid salts
Recognizing common acids and bases
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

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

Predicting Products (6 topics)
- 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
- Predicting products from a general statement about reactivity

Thermochemistry (23 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 (10 topics)
  - Using the general properties of reaction enthalpy
  - 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

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 (35 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

- Chemical Bonds (5 topics)
  ◆ Predicting the relative electronegativities of atoms

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Predicting bond polarity
Predicting relative bond polarity
Predicting the relative ionic character of chemical bonds
Predicting the relative length and energy of chemical bonds

Molecules (11 topics)
- 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 bond angles in a small organic molecule
- Predicting and naming the shape of molecules with a central atom
- 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 (27 topics)
- Gas Laws (11 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
  - Using the ideal equation of state
  - Interconverting molar mass and density of ideal gases
- Mixtures and Reactions of Gases (5 topics)
  - 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
- 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

Advanced Material (278 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 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

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 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

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
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 Kp and Kc
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 (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 (43 topics)
Identifying acids and bases by their reaction with water
Understanding the difference between strong and weak acids
Identifying Bronsted–Lowry acids and bases
Identifying strong or weak acids and bases from a sketch
Finding the conjugate of an acid or base
Predicting acid or base strength from the conjugate
Predicting the products of the reaction of a strong acid with water
Predicting the reactants of a neutralization reaction
Predicting the qualitative acid–base properties of salts
Predicting the qualitative acid–base properties of metal cations
Identifying Lewis acids and bases in reactions
Predicting the acid–base properties of a binary oxide in water
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 Ka of a weak acid from pH
Calculating the pH of a weak acid solution
Writing a base protonation constant expression
Calculating the pH of a weak base solution
Deriving $K_b$ from $K_a$
Interconverting Ka and pKa
Calculating the pH of a salt solution
Calculating percent dissociation of a weak acid
Understanding connections between descriptions of weak acid dissociation
Calculating the pH of a dilute acid solution
Writing the dissociation reactions of a polyprotic acid
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 metallicty
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