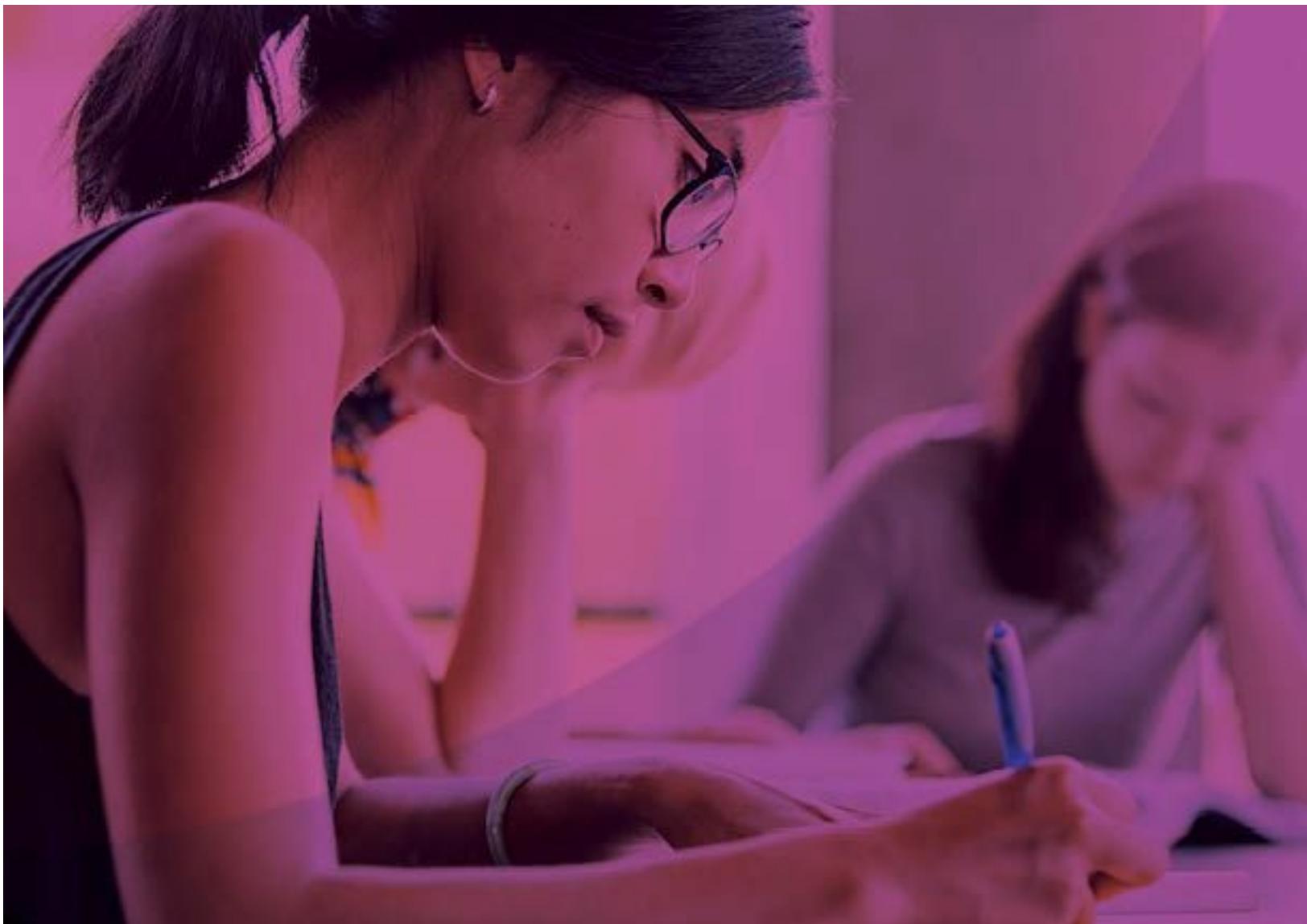




# Principles of General Chemistry

978-1-63545-004-0



To learn more about all our offerings  
Visit [Knewton.com/highered](https://www.knewton.com/highered)

---

<b>Source</b>	<b>Author(s) (Text or Video)</b>	<b>Title(s)</b>	<b>Link (where applicable)</b>
OpenStax (Text)	Senior Contributing Authors: Paul Flowers - University of North Carolina at Pembroke Klaus Theopold - University of Delaware Richard Landley - Stephen F. Austin State University	Chemistry	<a href="#">OpenStax</a>
Professor Dave Explains	Dave Farina	Professor Dave Explains	<a href="#">YouTube Channel</a>

Knewton Principles of General Chemistry was developed to meet the scope and sequence of a typical two-semester introduction to chemistry course. To develop the course, Knewton used three main sources of content: Openstax, videos created by a Chemistry Professor with a graduate degree from Cal State Northridge who has taught in various undergraduate settings but specializes in organic chemistry, and a team of Subject Matter Experts (SMEs). The SMEs come from diverse backgrounds and are all accomplished academics in the field of Chemistry.

Knewton Principles of General Chemistry has at least two instructional sequences for every learning objective, giving students multiple opportunities to learn new concepts. Between our instructional texts, videos, and SMEs, we were able to solicit ideas from chemistry instructors and students. Knewton Principles of General Chemistry covers the typical breadth of introductory chemistry topics and also provides the necessary depth to ensure the course is manageable and engaging for instructors and students alike.

---

## Principles of General Chemistry | Table of Contents

### Chapter 1: Essential Ideas

- Chemistry in Context
  - the importance of chemistry
  - the scientific method
  - the domains of chemistry
- Matter, Mass, and Weight
  - matter and its states
  - mass and weight
  - law of conservation of matter
- Atoms, Molecules, Compounds, Mixtures
  - atoms and molecules
  - elements and compounds
  - mixtures and solutions
- Physical and Chemical Properties
  - physical properties and changes
  - chemical properties and changes
  - extensive and intensive properties
- Measurements
  - general measurement and units
  - length, volume, mass
  - density
  - temperature, time
- Measurement Uncertainty
  - accuracy and precision
  - significant figures general
  - significant figures in calculations
- Dimensional Analysis
  - dimensional analysis general
  - computing quantities and dimensional analysis
  - conversion of temperature units

### Chapter 2: Atoms Molecules and Ions

- Atomic Theory
    - dalton's atomic theory
    - laws of definite and multiple proportions
    - modern atomic theory
  - Atomic Structure
    - subatomic particles
    - atomic mass unit (amu)
    - atomic number and mass number
-

- Chemical Formulas
  - empirical and molecular formulas
  - structural formulas
  - chemical symbols
- The Periodic Table
  - history of the periodic table
  - organization of the periodic table
  - reading elements blocks
  - groups on the periodic table
- Molecular and Ionic Compounds
  - ions general
  - ionic compounds
  - molecular compounds
- Chemical Nomenclature
  - nomenclature: monatomic ions
  - nomenclature: polyatomic ions
  - nomenclature: metal ion with a variable charge
  - nomenclature: binary molecular compounds
  - nomenclature: binary acids
  - nomenclature: oxyacids

### Chapter 3: Substances and Solutions

- Formula Mass
    - determine formula mass for covalent substances
    - determine formula mass for ionic compounds
  - The Mole
    - the mole
    - converting moles to grams and grams to moles for an element and a compound
    - deriving number of atoms from mass for an element
    - deriving the Number of Atoms and Molecules from the Mass of a Compound
  - Empirical and Molecular Formulas
    - calculate percent composition
    - calculate percent composition from formula mass
    - determining a compound's empirical formula from the masses of its elements
    - determining empirical formula from percent composition
    - deriving molecular formulas
  - Molarity
    - calculating molar concentrations
    - deriving moles and volumes from molar concentrations
    - calculating molar concentrations from mass of a solute
    - determining mass of a solute given volume of a solution
    - determining volume of a solution given mass of a solute
-

- Dilutions
  - dilution and related equations
  - determining the concentration of diluted solution
  - volume of a diluted solution
  - volume of a concentrated solution needed for dilution
- Concentrations of Solutions
  - mass percentage
  - volume percentage
  - mass-volume percentage
  - ppm and ppb

#### **Chapter 4: Stoichiometry of Chemical Reactions**

- Writing and Balancing Chemical Equations
  - chemical equations general
  - balancing chemical equations
  - equations for ionic reactions
- Classifying Chemical Reactions
  - precipitation reactions and solubility rules
  - acid-base reactions
  - oxidation-reduction reactions general
  - balancing redox reactions
- Reaction Stoichiometry
  - stoichiometry general
  - stoichiometry- moles of reactant required in a reaction
  - stoichiometry- number of product molecules generated by a reaction
  - stoichiometry- relating masses of reactants and products
- Reaction Yields
  - limiting reactant
  - percent yield

#### **Chapter 5: Thermochemistry**

- Energy Basics and Heat
    - energy general
    - thermal energy, temperature, and heat
    - heat capacity
    - specific heat capacity
  - Calorimetry
    - calorimetry techniques
    - heat transfer
    - bomb calorimeter
-

- Enthalpy
  - first law of thermodynamics
  - defining and calculating enthalpy
  - enthalpy of combustion
  - enthalpy of formation
  - hess's law

## **Chapter 6: Electron Configuration and Properties of Elements**

- Classic Electromagnetic Theory and Waves
    - electromagnetic radiation and waves
    - electromagnetic spectrum and determining the wavelength and frequency of radiation
    - standing waves
  - The Bohr Model
    - bohr's model general
    - calculating the energy of an electron in a bohr orbit
    - energy in one-electron bohr system
  - Quantum Theory
    - calculating the wavelength of a particle
    - heisenberg uncertainty principle
    - quantum-mechanical model of an atom
    - various quantum numbers
    - pauli exclusion principle
  - Electron Configurations
    - orbital energies and atomic structure
    - the aufbau principle
    - orbital diagrams
    - valence and core electrons
  - Variations in Element Properties
    - variations in covalent radius
    - variation in ionic radii
    - variation in ionization energies
    - variation in electron affinities
  - Paradoxes within the Classic Electromagnetic Theory
    - blackbody radiation
    - the photoelectric effect
    - line spectra
  - Extensions of Electron Configurations
    - electron configurations and the periodic table
    - electron configurations of ions
-

## Chapter 7: Chemical Bonding and Molecular Geometry

- Ionic Bonding
  - formation of ionic compounds
  - cations
  - anions
  - ionic bond strength
  - the born-haber cycle
- Covalent Bonding
  - formation of covalent bonds
  - pure vs. polar covalent bonds
  - electronegativity
  - covalent bond strength
- Lewis Symbols and Structures
  - lewis symbols and structures
  - the octet rule, triple and double bonds
  - writing lewis structures with the octet rule
  - exceptions to the octet rule
  - writing lewis diagrams with octet rule exceptions
- Formal Charges and Resonance
  - calculating formal charge
  - using formal charge to predict molecular structure
  - resonance
- Molecular Structure and Polarity
  - vsepr theory
  - electron-pair geometry vs. molecular structure
  - predicting electron-pair geometry and molecular structure
  - structure for multi-center molecules
  - molecular polarity and dipole moment

## Chapter 8: Advanced Theories of Covalent Bonding

- Valence Bond Theory
    - atomic orbital overlap
    - sigma and pi bonds
  - Hybrid Atomic Orbitals
    - hybridization
    - sp (1, 2, 3) hybridization
    - sp<sup>3</sup>d and sp<sup>3</sup>d<sup>2</sup> hybridization
    - assignment of hybrid orbitals to central atoms
  - Molecular Orbital Theory
    - molecular orbital theory general
    - molecular orbital energy diagrams
    - bond order
    - bonding in diatomic molecules
-

## Chapter 9: Gases

- Gas Pressure
  - pressure definition and calculation
  - pressure units
  - barometric pressure
  - manometer
- Gas Laws
  - pressure and temperature: amontons's law
  - volume and temperature: charles's law
  - volume and pressure: boyle's law
  - the ideal gas law
- Stoichiometry with Gases
  - density of a gas
  - molar mass of a gas
  - the pressure of a mixture of gases: dalton's law
  - collection of gases over water
- Effusion and Diffusion of Gases
  - diffusion and rate of diffusion
  - effusion and graham's law of effusion
  - determining molar mass using graham's law
- The Kinetic Molecular Theory
  - the kinetic molecular theory general
  - the kinetic molecular theory and the gas laws
  - molecular velocities and kinetic energy
- Non Ideal Gas Behavior
  - non-ideal gas behavior
  - van der waals equation
  - comparing ideal gas behavior and van der waals equation

## Chapter 10: Liquids

- Intermolecular Forces
    - intermolecular forces general
    - dispersion forces
    - dipole-dipole attractions
    - hydrogen bonding
  - Properties of Liquids
    - viscosity
    - cohesive forces and adhesive forces
    - surface tension
    - capillary action and capillary rise
-

- Phase Transitions and Changes
  - vaporization and condensation
  - boiling points
  - enthalpy of vaporization
  - melting and freezing
  - sublimation and deposition
- Phase Diagrams
  - heating and cooling curves
  - reading a phase diagram
  - supercritical fluids and critical point

### **Chapter 11: Solids**

- Types and Properties of Solids
  - crystalline vs. amorphous solids
  - types of solids- ionic solids, metallic solids, covalent network solid, molecular solid
  - properties of solids
- The Structures of Metals
  - types of unit cells
  - calculate atomic radius and density for metals
- The Structures of Ionic Crystals
  - structures of ionic crystals
  - unit cells of ionic compounds
  - calculate ionic radii in ionic crystals
  - x-ray crystallography

### **Chapter 12: Solutions and Colloids**

- The Solution Process and General Solubility
    - describe the traits of a solution
    - describe the formation of solutions
    - explain solubility and the differences between saturated, unsaturated and supersaturated
  - Electrolytes
    - understand the basics of electrolytes
    - describe the qualities of ionic electrolytes
    - describe the qualities of covalent electrolytes
  - Gas Solubility
    - describe the properties of solutions of gases in liquids
    - apply Henry's law
  - Basics of Colligative Properties
    - identify colligative properties
    - calculate mole fraction and molality
-

- Calculations of Colligative Properties
  - determine vapor pressure
  - determine boiling point
  - determine freezing point
  - determine osmotic pressure
- Colloids
  - identify the general properties of colloids
  - describe the preparation of colloidal systems
  - explain the electrical properties of colloidal particles
- Solids and Liquids in Solution
  - describe the properties of solutions of liquids in liquids
  - describe the properties of solutions of solids in liquids

### Chapter 13: Kinetics

- Chemical Reaction Rates
    - define rate of reaction
    - derive rate expressions for relative reactions
    - calculate reaction rates from experimental data
  - Factors Affecting Reaction Rates
    - explain how intensive properties of participating reactants affects the rate of reaction
    - explain how temperature and concentration of reactant affects the rate of reaction
  - Rate Laws
    - explain rate laws
    - determine rate laws from initial rates
    - identify reaction order and rate constant units
  - Integrated Rate Laws
    - perform calculations for first order reactions
    - perform calculations for second order reactions
    - perform calculations for zero order reactions
    - perform rate calculations using half life
  - Theories of Chemical Kinetics
    - define collision theory and its postulates
    - calculate activation energy and the arrhenius equation
  - Reaction Mechanisms
    - explain the reaction mechanism process
    - identify the molecularity of elementary reactions
    - relate reaction mechanisms to rate laws
  - Catalysis
    - define catalysts
    - describe homogeneous catalysts
    - describe heterogeneous catalysts
-

### Chapter 14: Equilibrium Concepts

- Chemical Equilibria
  - describe the nature of chemical equilibria
  - understand reaction quotient expressions
  - derive equilibrium constants
  - compare homogeneous and heterogeneous equilibria
- Shifting Equilibria: Le Châtelier's Principle
  - understand the effect of change in concentration on equilibrium
  - understand the effect of change in pressure on equilibrium
  - understand the effect of change in temperature on equilibrium
  - understand how catalysts affect equilibrium
- Equilibrium Calculations
  - determine relative changes in concentrations
  - calculate an equilibrium constant
  - calculate a missing equilibrium concentration
  - calculate changes in concentration

### Chapter 15: Acid Base Equilibria

- Bronsted Lowry Acids and Bases
    - identify acids, bases, and conjugate acid-base pairs according to the Bronsted-Lowry definition
    - write equations for acid and base ionization reactions
    - describe the acid-base behavior of amphiprotic substances
  - pH and pOH
    - calculate hydronium and hydroxide ion concentrations
    - compare acidic, basic and neutral aqueous solution
    - identify hydronium and hydroxide ion concentrations on the pH and pOH scales
    - perform calculations relating pH and pOH
  - Strength of Acids and Bases
    - explain acid strength and  $K_a$
    - explain base strength and  $K_b$
    - describe acid-base conjugate pairs
    - explain the ionization of weak acids and bases
  - Calculations of Acids and Bases
    - determine  $K_a$  and  $K_b$  from equilibrium concentrations
    - determine  $K_a$  and  $K_b$  from pH
    - calculate the pH of a weak acid
  - Hydrolysis of Salt Solutions
    - describe how salts form from weak bases and strong acids
    - describe how salts form from weak acids and strong bases
    - describe how salts form from weak acids and weak bases
-

- Polyprotic Acids
  - calculate pH of a hydrated metal ion
  - describe monoprotic and diprotic acids
  - describe triprotic and polyprotic acids
  - perform calculations for polyprotic acids
- Buffers
  - explain how buffers work
  - describe buffer capacity
  - explain how to select a suitable buffer mixture
  - calculate the pH of a buffer solution using the henderson hasselbalch equation
- Acid Base Titrations
  - interpret titration curves
  - calculate pH during acid base titration
  - understand and interpret acid base indicator data

#### **Chapter 16: Equilibria of Other Reaction Classes**

- Dissolution
  - write equations and solubility products
  - calculate  $K_{sp}$
  - perform calculations using  $K_{sp}$
  - calculate the solubility of a molecule using  $K_{sp}$
- Precipitation
  - predict precipitation
  - calculate concentration needed for precipitation
  - describe and predict selective precipitation
  - describe and apply the common ion effect
- Lewis Acids and Bases
  - explain Lewis acids, Lewis bases and their reactions
  - explain complex ions
  - explain formation constants
  - describe the relationship between molecular structure and acid-base strength
- Multiple Equilibria
  - explain what is meant by multiple equilibria
  - perform calculations using multiple equilibria
  - explain the effects of dissolution on equilibria

#### **Chapter 17: Thermodynamics**

- Spontaneity
    - describe spontaneous and nonspontaneous processes
    - explain how the dispersal of matter and energy affect spontaneity
-

- Entropy
  - explain and calculate entropy
  - define microstate and its relationship to entropy
  - predict the sign of entropy
- The Second and Third Laws of Thermodynamics
  - explain the second law of thermodynamics
  - explain the third law of thermodynamics
- Free Energy
  - define standard free energy change
  - calculate free energy change
  - explain how spontaneity is affected by temperature
  - describe the relationship between free energy changes and equilibrium constants

### Chapter 18: Electrochemistry

- Electrochemistry General and Oxidation Reduction Reactions
    - explain the basics of electrochemistry
    - balance acidic oxidation-reduction reactions
    - balance basic oxidation-reduction reactions
  - Galvanic Cells
    - explain galvanic cells and cell potential
    - interpret cell notation to describe a reaction
  - Standard Reduction Potentials
    - define standard reduction potential
    - calculate standard reduction potential
  - The Nernst Equation
    - explain the relationship between free energy, equilibrium constant and standard cell potential
    - calculate free energy and equilibrium constant using standard cell potential
    - calculate cell potential of a concentration cell
  - Batteries and Fuel Cells
    - explain how primary batteries work
    - explain how secondary batteries work
    - explain how fuel cells work
  - Corrosion and Electrolysis
    - describe corrosion
    - describe electrolysis
    - describe electrolysis of various solutions
    - perform various calculations related to electrolysis
-

### Chapter 19: Organic Chemistry

- Hydrocarbons
  - identify the characteristics of alkanes
  - name alkanes
  - identify the characteristics of alkenes
  - identify the characteristics of alkynes
- Alcohols and Ethers
  - identify the characteristics of alcohols
  - identify the characteristics of ethers
- Aldehydes, Ketones, Carboxylic Acids, and Esters
  - identify the characteristics of aldehydes and ketones
  - identify the characteristics of carboxylic acids and esters
- Amines and Amides
  - identify the characteristics of amines
  - identify the characteristics of amides

### Chapter 20: Nuclear Chemistry

- Nuclear Structure and Stability
    - understand the basics of nuclear chemistry
    - describe and calculate nuclear binding energy
    - explain nuclear stability
  - Nuclear Equations
    - compare types of particles in nuclear reactions
    - balance nuclear reactions
  - Radioactive Decay
    - compare types of radioactive decay
    - calculate half-lives of radioactive elements
    - explain radiometric dating
  - Transmutation and Nuclear Energy
    - explain the synthesis of nuclides
    - describe the process of nuclear fission
    - understand the importance of nuclear reactors and fuels
    - describe the process of nuclear fusion
-