

# E3 STEM ACADEMY

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## PreAP Chemistry - Course Outline

### **Unit 1: Introduction to Chemistry**

- Metric System and Units of Measurement
- Density (mass/volume)
- How to make measurements
- Dimensional Analysis/Sig Figs

### **Unit 2: Atomic Theory**

- Atomic Structure (protons, neutrons, electrons)
- Atomic Numbers and Defining Elements
- Isotopes and Atomic Mass
- Introduction to the Mole
- Measuring Molecular Mass

### **Unit 3: Nuclear Chemistry**

- Fission & Fusion
- Transmutations
- Radioactivity ( $\alpha$ ,  $\beta^-$ ,  $\beta^+$ ,  $\gamma$ )
- Half-lives & Radioactive Decay
- Carbon-14 and Radiometric Dating Techniques

### **Unit 4: Electron Structure**

- Electron Orbitals
- Electron Configuration
- Aufbau Principal, Hund's Rule,
- Electron spin and Pauli Exclusion Principal
- Energy Levels (s, p, d, and f orbitals)
- Valence Elections
- Lewis Dot Structures
- Octet Rule
- Spectral Analysis

### **Unit 5: The Periodic Table**

- Periodic Relationships, Groups/Families
- Atomic Radii/Ionic Radii
- Electron Affinity
- Ionization Energy

### **Unit 6: Chemical Bonding**

- Electronegativity
- Ionic Bonds
- Effects of Periodic Trends on Reactivity

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- Metallic Bonds and Metallic Character
- Covalent Bonds
- Hybridization (sp, sp<sup>2</sup>, sp<sup>3</sup>)
- Resonance and Formal Charge

## **Unit 7: Naming and Writing Compounds**

- Ionic Compounds and Polyatomic Ions
- Covalent Compounds
- Acids and Bases
- Naming Organic Compounds

## **Unit 8: Molecular Geometry**

- Drawing Molecules and Lewis structures
- VSEPR
- Geometry of Polyatomic Ions
- Intermolecular Forces
- Electronegativity
- Polarity and Asymmetry
- Dipole-dipole and Ion-dipole Interactions
- Hydrogen Bonding
- Dipole-induced Dipole
- London Dispersion Forces
- Phase Changes
- Surface Tension and Capillary Action
- Colligative Properties (Viscosity, freezing point depression, and boiling point elevation)

## **Unit 9: Solubility and Solutions**

- Factors Affecting Solubility of Ions
- Solubility Curves
- Gas Solubility
- Solubility Rules
- Precipitation Reactions

## **Unit 10: Types of Chemical Reactions**

- Synthesis Reactions
- Decomposition Reactions
- Single Replacement Reactions
- The Reactivity Series and Electronegativity
- Double Replacement Reaction
- Combustion Reactions
- Oxidation Numbers
- Redox Reactions

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- Half-reactions and Balancing Electrons
- Transition Metal Chemistry
- Intro to Electrochemistry

## **Unit 11: Stoichiometry**

- Law of Conservation of Mass
- Balancing Equations
- The Mole and Avogadro's Number
- Chemical Reactivity and Products
- Percent Composition
- Empirical Formulas
- Hydrate Crystals
- Limiting Reagents and Excess
- Percent Yield and Percent Error

## **Unit 12: Solution Chemistry**

- % Solution by Mass
- Parts per Million (ppm)
- Molarity
- Solution Stoichiometry

## **Unit 13: Gas Laws**

- Kinetic Theory
- Pressure/Temperature/Volume measurements
- Boyles' law, Charles' law, Gay-Lussac's law
- Combined Gas Law
- Ideal Gas Law
- Dalton's Law of Partial Pressures
- Gas Density and Buoyancy
- Molar Mass of Gases
- Gas Stoichiometry

## **Unit 14: Thermochemistry**

- Specific Heat Capacity
- Heats of Fusion and Vaporization
- Heats of Hydration, Solvation, and Dilution
- Enthalpy and Calorimetry
- Endothermic/Exothermic reactions
- Bond Enthalpy
- Heats of Formation
- Equilibrium and Reversible Reactions
- Hess's Law

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- Entropy
- Introduction to Kinetics and Collision Theory
- Reaction Spontaneity and Gibbs Free Energy

### **Unit 15: Acids and Bases**

- Arrhenius Acids/bases
- pH Scale
- Strong Acids & Bases (complete disassociation)
- Weak Acids & Bases (partial disassociation)
- Bronsted-Lowry Acid/bases
- Acidic and Basic Salts
- Acid/Base Titration