

**CHEMISTRY | Curriculum Map and Pacing Guide**

<p><b>COURSE DESCRIPTION:</b>                  This course is organized around a central theme: Properties of matter are a consequence of its structure. A working chemistry vocabulary is developed early through quantitative lab work. Students evaluate the function of chemistry in society and in their lives. They learn basic measurement principles and mathematical techniques used in problem solving and lab work. Study of structure includes the atom and subatomic particles. The periodic system of classification is explored. Students learn about chemical bonds and resulting molecular geometries and study the states of matter, reaction rates, equilibrium, acid/base chemistry, nuclear chemistry, and organic chemistry.</p>	<p><b>Course SCI340</b>  <b>1 year, 1 credit</b>  <b>Grades 10-12</b>  <b>Prerequisite:</b> Physical Science and Geometry, Honors Biology or comparable course; teacher recommendation</p>
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QUARTER 1		
<b>Topic:</b> Introduction to Chemistry and Matter		
<b>Key Terms:</b> fact, law, theory, precision, accuracy, element, compound, mixture, matter, energy, conservation laws		
<b>Measurable Skills:</b> Calculate: Percent error, K to C temperatures, C to K temperatures, density		
Ohio Science Standards (2018)	Student Learning Targets	Learning Activities/Investigations
C.PM.1: Atomic structure	Explain why mass is used as a quantity of matter and differentiate between mass and weight.	Eureka Video Weight vs. Mass Activity
	Explain density qualitatively and solve density problems by applying an understanding of the concept of density.	Density Sheet Density of Al lab
	Calculate percent error and analyze experimental errors that affect percent error.	Lab Calculations Error Sheet
	Explain the basis and importance of the absolute temperature scale and convert between the Kelvin and Celsius scales.	Temperature Conversion Sheet Measurement Challenge
	Compare the characteristics of elements, compounds, and mixtures.	Vocabulary Journals CO2 Extinguisher Demo
	Compare the definition of matter and energy and the laws of conservation of matter and energy.	Vocabulary Journals Change in Mass Lab
	Describe how matter is classified by state of matter and by composition.	Lecture Fire Writing Demo

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### QUARTER 1

**Topic:** Introduction to Chemistry and Matter

**Key Terms:** fact, law, theory, precision, accuracy, element, compound, mixture, matter, energy, conservation laws

**Measurable Skills:** Calculate: Percent error, K to C temperatures, C to K temperatures, density

Ohio Science Standards (2018)	Student Learning Targets	Learning Activities/Investigations
	Explain the difference between chemical and physical changes and demonstrate how these changes can be used to separate mixtures and compounds into their components.	Lecture Chemical and Physical Properties Demo
	Define chemical and physical properties and compare them by providing examples.	Chem. vs. Phys. Prop. Activity
	Describe differences between solids, liquids, and gases at the atomic and molecular levels.	Video State of Matter Activity
	Describe and perform common separation techniques (e.g., filtration, distillation, and chromatography).	Quantitative Separation Lab Qualitative Separation Lab Paper Chromatography Lab

### QUARTER 1

**Topic:** Structure of the Atom

**Key Terms:** Wave, Wavelength, Frequency, Wave energy, Wave speed, Orbitals

**Measurable Skills:** Use Periodic table, Calculate Avg. Atomic Mass, Determine Elemental Electron Configurations

Ohio Science Standards (2018)	Student Learning Targets	Learning Activities/Investigations
C.PM.1: Atomic structure	Compare characteristics of isotopes of the same element.	Isotopes Sheet Isotopes and Ropes Demo Bermanium Lab
	Describe the importance of models for the study of atomic structure.	World of Chemistry Model Video Sheet
	Describe the crucial contributions of scientists and the critical experiments that led to the development of the modern atomic model.	Timeline Activity Cathode Ray Tube demo Rutherford Scattering Lab
	Use the periodic table to determine the atomic number; atomic mass; mass number; and number of protons, electrons, and neutrons in isotopes of elements.	Isotopes Sheet

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### QUARTER 1

**Topic:** Structure of the Atom

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**Measurable Skills:** Use Periodic table, Calculate Avg. Atomic Mass, Determine Elemental Electron Configurations

Ohio Science Standards (2018)	Student Learning Targets	Learning Activities/Investigations
	Calculate the weighted average atomic mass of an element from isotopic abundance, given the atomic mass of each contributor.	Avg. Atomic Mass Sheet
	Describe characteristics of a wave, such as wavelength, frequency, energy, and speed.	Vocabulary Journals Flame Test Demo Gas Tubes and Spectroscopes demo
	Describe the role of probability in orbital theory.	Lecture Quantum Mechanical Lab
	Describe atomic orbitals (s, p, d, f) and their basic shapes.	Vocabulary Journals
	Apply Hund's rule and the Aufbau process to specify the electron configurations of the elements.	Electron Configuration Sheets Paramagnetism Demo

### QUARTER 1

**Topic:** Periodic Table and Ionic Bonding

**Key Terms:** period, group, family, series, ionic compound, ionic bond

**Measurable Skills:** Draw Ionic Lewis Structures, Convert Ionic Compound Names to formulas and vice versa

Ohio Science Standards (2018)	Student Learning Targets	Learning Activities/Investigations
C.PM.2: Periodic Table	Describe the historical development of the modern periodic table, including work by Mendeleev and then Moseley.	Video/Lecture
	Describe and explain the organization of elements into periods and groups in the periodic table.	P.T. Trend Activity
	Identify regions (e.g., groups, families, and series) of the periodic table and describe the chemical characteristics of each.	P.T. Trend Activity Reactivity of Metals Demo
	Compare the periodic properties of the elements (e.g., metal/nonmetal/metalloid behavior, electrical/heat conductivity, electronegativity and electron affinity, ionization energy, atomic/covalent/ionic radius) and how they relate to position in the periodic table.	P.T. Trend Activity Reactivity of Halogens Demo

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### QUARTER 1

<b>Topic:</b> Periodic Table and Ionic Bonding		
<b>Key Terms:</b> period, group, family, series, ionic compound, ionic bond		
<b>Measurable Skills:</b> Draw Ionic Lewis Structures, Convert Ionic Compound Names to formulas and vice versa		
Ohio Science Standards (2018)	Student Learning Targets	Learning Activities/Investigations
	Use the periodic table to predict and explain the valence electron configurations of the elements, to identify members of configuration families, and to predict the common valences of the elements.	P.T. Trend Activity
C.PM.4: Representing compounds	Use the names, formulas, and charges of commonly referenced polyatomic ions AND common acids.	Ion/Acid Quizzes Cation Test Lab
	Provide the interconversion of ionic formulas, and names, translation: write names for formulas and formulas from names).	Naming Compounds Sheet
	Use Lewis dot diagrams to represent bonding in ionic compounds.	Ionic Lewis structures and Elec. Configs. Sheet
C.PM.3: Chemical bonding	Describe the characteristics of ionic bonding.	Lecture
	Explain ionic stability, recognize typical ionic configurations, and predict ionic configurations for elements (e.g., electron configurations, Lewis dot models).	Ionic Lewis structures and Elec. Configs. Sheet
	Describe the nature of the chemical bond with respect to valence electrons in ionic bonding atoms.	Lecture Chemical Change Lab

### QUARTER 1

<b>Topic:</b> Covalent Bonding and Intermolecular Forces		
<b>Key Terms:</b> Covalent compound, Covalent bond, dipole moment, polarity, hydrogen bonding		
<b>Measurable Skills:</b> Draw covalent Lewis Structures, Convert covalent Compound Names to formulas and vice versa, identify molecular geometries from Lewis structures		
Ohio Science Standards (2018)	Student Learning Targets	Learning Activities/Investigations
C.PM.3 Chemical Bonding C.PM.6 Intermolecular Forces	Provide the interconversion of molecular formulas, structural formulas, and names, (translation: write names for formulas and formulas from names).	Naming Compounds Sheet

**QUARTER 1**

**Topic:** Covalent Bonding and Intermolecular Forces

**Key Terms:** Covalent compound, Covalent bond, dipole moment, polarity, hydrogen bonding

**Measurable Skills:** Draw covalent Lewis Structures, Convert covalent Compound Names to formulas and vice versa, identify molecular geometries from Lewis structures

Ohio Science Standards (2018)	Student Learning Targets	Learning Activities/Investigations
	Describe the characteristics of covalent bonding.	Vocabulary Journal
	Describe the nature of the chemical bond with respect to valence electrons in covalent bonding atoms.	Lecture
	Explain how ionic and covalent compounds differ.	World of Chemistry Bonds Video Sheet
	Explain and provide examples for dipole moments, bond polarity, and hydrogen bonding.	Video/Lecture Viscosity of Liquids Demo Evaporation Lab
	Use Lewis dot diagrams to represent bonding in covalent compounds.	Covalent Lewis structures Sheet
	Draw Lewis structures for molecules and polyatomic ions, including those that must be represented by a set of resonance structures.	Covalent Lewis structures Sheet
	Use VSEPR theory to explain geometries of molecules and polyatomic ions.	Molecular Geometry activity Bubble Molecule Demo
	Describe how orbital hybridization models relate to molecular geometry.	Lecture
	Describe the molecular orbital models for double bonds, triple bonds, and delocalized pi electrons	Lecture
	Describe the relationship between molecular polarity and bond polarity.	Vocabulary Journal Polar vs. Nonpolar Liquids Demo Graphite Dots Demo Water on a String Demo

**QUARTER 2**

**Topic:** Chemical Reactions

**Key Terms:** solution, solute, solvent

**Measurable Skills:** Write and balance equations, classify chemical reactions, predict products of reactions

Ohio Science Standards (2018)	Student Learning Targets	Learning Activities/Investigations
C.IM.1	Explain how conservation laws form the basis for balancing chemical reactions and know what quantities are conserved in physical, chemical, and nuclear changes.	Lecture
	Write and balance chemical equations, given the names of reactants and products.	Balancing Sheet
	Describe what is represented, on a molecular and molar level, by chemical equations.	Lecture Balloon to make H <sub>2</sub> O
	Use the appropriate symbols for state (i.e., solid, liquid, gaseous, aqueous) and reaction direction when writing chemical equations.	Balancing Sheet
	Classify chemical reactions as being synthesis, decomposition, single replacement, or double replacement reactions.	Balancing Sheet Elephant Toothpaste demo Types of Reactions Lab
	Predict the products of synthesis, combustion, and decomposition reactions and write balanced equations for these reactions.	Predict Product Sheet Steel Balls SR Demo
	Predict products of single replacement reactions, using the activity series, and write balanced equations for these reactions.	Predict Product Sheet Carbon Soufflé Demo
	Predict the products of double replacement reactions, using solubility charts to identify precipitates, and write balanced equations for these reactions.	Predict Product Sheet
	Write ionic equations, identifying spectator ions and the net ionic equation.	Ionic equation Sheet
	Define solution, solute, and solvent.	Vocabulary Journals

QUARTER 2

**Topic:** Mole and Stoichiometry

**Key Terms:** chemical symbols, empirical formulas, molecular formulas, structural formulas, mole, Avogadro's number, formula mass, empirical mass, molecular mass, gram molecular mass, and gram formula mass

**Measurable Skills:** calculate the percent composition, conversions from mass, moles, to particles, do stoichiometry, finding limiting reagents, and do percent yield

Ohio Science Standards (2018)	Student Learning Targets	Learning Activities/Investigations
C.IM.3: Stoichiometry C.PM.5 Quantifying Matter	Distinguish between chemical symbols, empirical formulas, molecular formulas, and structural formulas.	Vocabulary Journal
	Interpret the information conveyed by chemical formulas for numbers of atoms of each element represented.	Counting atoms and Molar mass worksheet
	Calculate the percent composition of a substance, given its formula or masses of each component element in a sample.	Percent composition worksheet Hydrate Lab
	Determine the empirical formulas and molecular formulas of compounds, given percent composition data or mass composition data.	Empirical Formula Worksheet MgO Lab Baking Soda Lab
	Explain the meaning of mole and Avogadro's number.	Vocabulary Journal
	Interconvert between mass, moles, and number of particles.	Conversion Worksheet
	Distinguish between formula mass, empirical mass, molecular mass, gram molecular mass, and gram formula mass.	Vocabulary Journal
	Use chemical equations to perform basic mole-mole, mass-mass, and mass-mole computations for chemical reactions.	Stoichiometry Worksheet
	Identify limiting reagents and use this information when solving reaction stoichiometry problems.	Limiting Reagent worksheet S'mores Activity
	Compute theoretical yield, actual (experimental) yield, and percent yield.	Percent Yield worksheet Nail Lab Al and CuCl <sub>2</sub> Lab

**QUARTER 2**

**Topic:** States of Matter

**Key Terms:** gas pressure, torr, kilopascals, mm Hg, atmospheres, van der Waals, dispersion, ionic, molecular, metallic, and network

**Measurable Skills:** Classify solids as ionic, molecular, metallic or network

Ohio Science Standards (2018)	Student Learning Targets	Learning Activities/Investigations
C.PM.6: Intermolecular Forces	Describe the phase and energy changes associated with boiling/condensing, melting/freezing, sublimation, and crystallization (deposition).	Video Black blocks melting Demo
	Define gas pressure and the various pressure units (e.g., torr, kilopascals, mm Hg, and atmospheres).	Vocabulary Journal Pressure mat Demo
	Describe the use and operation of mercury barometers and manometers to find atmospheric pressure or relative gas pressures.	Vocabulary Journal Candle under glass demo Jelly Jars demo
	Explain the basis for gaseous diffusion and effusion.	Effusion/Diffusion Demo
	Use the kinetic molecular theory to explain the states and properties (i.e., microscopic and macroscopic) of matter and phase changes.	World of Chemistry Matter of State video Super-heated steam demo
	Use the kinetic-molecular theory as a basis for explaining gas pressure, Avogadro's hypothesis, and Boyle's/Charles's laws.	Reading with Questions
	Compare the different types of intermolecular forces (e.g., van der Waals, dispersion).	Vocabulary Journal Pop Can skating rink demo
	Describe the unique physical and chemical properties of water resulting from hydrogen bonding.	World of chemistry video Water How ice skates work demo
	Explain the relationship between evaporation, vapor pressure, molecular kinetic energy, and boiling point for a single pure substance.	Reading with questions
	Explain the relationship between intermolecular forces, boiling points, and vapor pressure when comparing differences in the properties of pure substances.	Worksheet
Classify solids as ionic, molecular, metallic, or network.	Worksheet	

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### QUARTER 3

<b>Topic:</b> Gases		
<b>Key Terms:</b> Avogadro's hypothesis, ideal gas, real gas, Boyle's law, Charles' law, Gay-Lussac's law, and Dalton's law		
<b>Measurable Skills:</b> Solve problems using gas stoichiometry, ideal gas law, Boyle's law, Charles' law, Gay-Lussac's law, and Dalton's law		
Ohio Science Standards (2018)	Student Learning Targets	Learning Activities/Investigations
C.IM.2: Gas Laws	Predict boiling point changes based on changes in atmospheric pressure.	Syringe Demo
	Describe Avogadro's hypothesis and use it to solve stoichiometric problems.	Worksheet
	Explain the difference between an ideal and real gas, the assumptions made about an ideal gas, and what conditions favor ideal behavior for a real gas.	Notes Cartesian Diver Demo
	Apply the mathematical relationships that exist among the volume, temperature, pressure, and number of particles in an ideal gas.	Worksheet Calculating R with Water Displacement Lab
	Compute gas density when given molar mass, temperature, and pressure.	Worksheet Can Crush Demo
	Apply the ideal gas law to determine the molar mass of a volatile compound.	Worksheet Molar Mass of Air Lab
	Solve gas stoichiometry problems at standard and nonstandard conditions.	Worksheet CO2 Cannon Demo
	Define the gas laws given by Boyle, Charles, Gay-Lussac, and Dalton and solve problems based on these laws.	Vocabulary Journal Gas Laws Lab

### QUARTER 3

<b>Topic:</b> Solutions		
<b>Key Terms:</b> saturated, unsaturated, supersaturated, dilute, concentrated, molality, mole fraction, suspensions, colloids, and true solutions		
<b>Measurable Skills:</b> Calculate changes in the boiling point and freezing point		
Ohio Science Standards (2018)	Student Learning Targets	Learning Activities/Investigations
C.IM.3: Stoichiometry	Define the terms saturated, unsaturated, supersaturated, dilute, and concentrated as they pertain to solutions.	Vocabulary Activity Super Saturated Demo
	Define and calculate the molarity of a solution.	Worksheet Composition of Acetic Acid Lab

## BEXLEY CITY SCHOOLS

### QUARTER 3

**Topic:** Solutions

**Key Terms:** saturated, unsaturated, supersaturated, dilute, concentrated, molality, mole fraction, suspensions, colloids, and true solutions

**Measurable Skills:** Calculate changes in the boiling point and freezing point

Ohio Science Standards (2018)	Student Learning Targets	Learning Activities/Investigations
	Define and calculate the percent composition of a solution.	Worksheet
	Describe the preparation and properties of solutions.	Book questions Acid Base Titration Lab
	Describe the relationship between temperature or pressure and the solubility of gases in liquids.	Notes Hand Boiler
	Describe the relationship between solvent character and solute character and explain miscibility.	Notes Bubble Speed Demo
	Apply the general rules of solubility to aqueous salt solutions.	Lab activity
	Describe the factors affecting the solubility of a solute in a given solvent and its rate of solution.	Notes
	Describe qualitatively the effect of adding solute on freezing point, boiling point, and vapor pressure of a solvent.	Notes
	Define molality and mole fraction.	Vocabulary Activity
	Compare properties of suspensions, colloids, and true solutions.	Vocabulary Activity
	Calculate changes in the boiling point and freezing point when nonvolatile, nonelectrolyte solutes are added to solvents.	Worksheet Problems

### QUARTER 3

**Topic:** Thermal Energy and Heat

**Key Terms:** law of conservation of energy, heat, heat energy, temperature, enthalpy, endothermic, exothermic, entropy, chemical changes, and physical changes

**Measurable Skills:** Calculate heat capacity, heat of fusion, heat of vaporization, heat of reaction, Hess' Law, and heat of reaction forward and reverse

Ohio Science Standards (2018)	Student Learning Targets	Learning Activities/Investigations
C.IM.1: Chemical reactions	Explain the law of conservation of energy in chemical reactions.	Notes Boiling water in cup Demo

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Ohio Science Standards (2018)	Student Learning Targets	Learning Activities/Investigations
	Describe the concept of heat, and explain the difference between heat energy and temperature.	Vocabulary Activity
	Explain physical and chemical changes as endothermic or exothermic energy changes.	Notes/Book problems Cold Pack Demo Hot Pack demo
	Solve heat capacity and heat transfer problems involving specific heat, heat of fusion, and heat of vaporization.	Worksheet Specific heat of unknown solid Enthalpy of fusion of water
	Calculate the heat of reaction for a given chemical reaction when given calorimetric data.	Worksheet Cheeto Calorimetry
	Define enthalpy and explain how changes in enthalpy determine whether a reaction is endothermic or exothermic.	Vocabulary Activity Fire Syringe demo Drinky Bird demo
	Compute $\Delta H_{rxn}$ from $\Delta H_f^\circ$ values and explain why the $\Delta H_f^\circ$ values for elements are zero.	Worksheet
	Explain and apply, mathematically, the relationship between $\Delta H_{rxn}^\circ$ (forward) and $\Delta H_{rxn}^\circ$ .	Worksheet
	Define entropy and explain the role of entropy in chemical and physical changes, and explain the changes that favor increases in entropy.	Vocabulary Activity

QUARTER 4

**Topic:** Reaction Rates

**Key Terms:** collision theory, reaction rates, kinetic theory, reaction mechanism, rate-determining step, activated complex, heat of reaction, activation energy, reaction kinetics, catalysts, and potential energy diagrams

**Measurable Skills:** Interpret and label a plot of energy versus reaction coordinate

Ohio Science Standards (2018)	Student Learning Targets	Learning Activities/Investigations
C.IM.1: Chemical reactions	Explain the collision theory of reactions	Vocabulary Activity
	Analyze factors (e.g., temperature, nature of reactants) affecting reaction rates in relation to the kinetic theory	Notes Alka Seltzer Lab
	Relate reaction mechanism, rate-determining step, activated complex, heat of reaction, and activation energy to reaction kinetics	Vocabulary Activity
	Interpret potential energy diagrams for chemical reactions	Notes
	Relate the rate of a chemical reaction to the appearance of products and the disappearance of reactants	Book Problems
	Describe the meaning of reaction mechanism and rate-determining step	Vocabulary Activity
	Relate collision theory to the factors that affect the rate of reaction.	Vocabulary Activity Reaction Rates Book lab Inhibition of H <sub>2</sub> O <sub>2</sub> Demo
	Describe the meaning of activation energy and activated complex.	Vocabulary Activity
	Interpret and label a plot of energy versus reaction coordinate.	Worksheet
	Explain the effects of catalysts on reaction rates (e.g., mechanism, activation energy/activated complex).	Notes Catalytic Oxidation of acetone demo
C.IM.1: Chemical reactions	Describe the unique features of bonding in carbon compounds.	Notes
	Describe the conditions that define equilibrium systems on a dynamic molecular level and on a static macroscopic scale.	Characteristics of Equilibrium Lab N <sub>2</sub> gas oscillator Demo
	Apply Le Châtelier's principle to explain a variety of changes in physical and chemical equilibria.	Worksheet Cobalt Chloride Demo Copper Chloride Demo

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### QUARTER 4

**Topic:** Reaction Rates

**Key Terms:** collision theory, reaction rates, kinetic theory, reaction mechanism, rate-determining step, activated complex, heat of reaction, activation energy, reaction kinetics, catalysts, and potential energy diagrams

**Measurable Skills:** Interpret and label a plot of energy versus reaction coordinate

Ohio Science Standards (2018)	Student Learning Targets	Learning Activities/Investigations
	Define $K_{sp}$ and manipulate $K_{sp}$ to predict solubility.	Worksheet
	Explain the law of concentration (mass) action and write equilibrium law expressions for chemical equilibria.	Worksheet
	Determine solubility product constants from solubilities (and vice versa) for a given solubility equilibrium system.	Notes and Problems

### QUARTER 4

**Topic:** Acids and Bases

**Key Terms:** acid, base, hydronium ion, amphoterism, Arrhenius and Brønsted-Lowry acids and bases, conjugate acids and bases,  $K_w$ , pH scale, percent ionization,  $K_a$ ,  $K_b$ , buffer

**Measurable Skills:** Solve stoichiometry calculations based on reactions involving aqueous solutions, identify conjugate acids and bases in reactions, Write and balance a simple equation for a neutralization reaction, calculate hydrogen ion concentration, hydroxide ion concentration, pH, and pOH

Ohio Science Standards (2018)	Student Learning Targets	Learning Activities/Investigations
C.IM.1: Chemical reactions	Solve stoichiometry calculations based on reactions involving aqueous solutions.	Notes and Problems How to blow out a light bulb demo
	Describe the nature and interactions of acids and bases.	Notes
	Describe the hydronium ion and the concept of amphoterism.	Vocabulary activity
	Describe Arrhenius and Brønsted-Lowry acids and bases; identify conjugate acids and bases in reactions.	Notes and worksheet
	Define the water constant, $K_w$ , and the pH scale.	Vocabulary activity
	Describe characteristics of strong and weak acids and bases, and identify common examples of both.	Vocabulary Activity Acid Strength demo
	Write and balance a simple equation for a neutralization reaction.	Notes and problems
	Calculate hydrogen ion concentration, hydroxide ion concentration, pH, and pOH for acidic or basic solutions.	Notes and problems Std. of NaOH lab

**QUARTER 4**

**Topic:** Acids and Bases

**Key Terms:** acid, base, hydronium ion, amphoterism, Arrhenius and Brønsted-Lowry acids and bases, conjugate acids and bases, Kw, pH scale, percent ionization, Ka, Kb, buffer

**Measurable Skills:** Solve stoichiometry calculations based on reactions involving aqueous solutions, identify conjugate acids and bases in reactions, Write and balance a simple equation for a neutralization reaction, calculate hydrogen ion concentration, hydroxide ion concentration, pH, and pOH

Ohio Science Standards (2018)	Student Learning Targets	Learning Activities/Investigations
	Explain how the acid-base indicators work.	Notes Rainbow reaction demo
	Define percent ionization, Ka, and Kb and explain how they relate to acid/base strength.	Vocabulary Activity
	Qualitatively understand the behavior of a buffer and explain why buffer solutions maintain pH upon dilution.	Vocabulary Activity Buffer Lab

**District Instructional Resource:**

*World of Chemistry* (2013) / Cengage (6-year online subscription: 2019-2020 to 2024-2025)

**Standards Alignment:**

Ohio Learning Standards (2018) – retrieved Jan. 2, 2019

<http://education.ohio.gov/getattachment/Topics/Learning-in-Ohio/Science/Ohios-Learning-Standards-and-MC/SciFinalStandards121018.pdf.aspx?lang=en-US>