BEXLEY CITY SCHOOLS

HONORS CHEMISTRY | Curriculum Map and Pacing Guide

COURSE DESCRIPTION: This course is recommend for students interested in taking AP Chemistry. This course is designed to prepare students for college chemistry. Topics are introduced and reinforced by a mixture of experiments, demonstrations, lecture, group work, and problem solving. The course blends theory, practical lab skills, and everyday applications. Activities are designed to promote critical thinking, questioning techniques, and an awareness of the environment. Topics of study include data analysis, atomic structure, periodic table, ionic compounds, covalent bonding, chemical reqctions, mole concept, stoichiometry, kinetic theory, bases, solutions, thermochemistry, reaction rate, chmical equilibrium, acids and bases, and electrochemistry.	**Course SCI345** **1 credit** **Grades 10-12** **Prerequisite:** Physical Science or Honors Biology, completion of Algebra 2, teacher recommendation

QUARTER 1

Topic: Safety, Scientific Methods, and Introduction to Periodic Table

Key Terms: chemistry, matter, models, particle diagram, scientific methods, observation, inference, hypothesis, prediction, fact, claim, experiment, experimental group, control group, independent variable, dependent variable, constants, qualitative data, quantitative data, continuous data, discrete data (categorical), theory, scientific law, peer review, element, periodic table, periodic law, group, period, metal, nonmetal, metalloid, transition metal, representative element, alkali metal, alkaline metal, halogens, noble gas, lanthanides, actinides

Measurable Skills: identify, design, conduct, use, formulate, revise, recognize, analyze, communicate, explain, apply, contrast, describe, graph, evaluate, support, improve

Ohio Science Standards (2018)	Student Learning Targets	Learning Activities/Investigations
SIA 1-6	Identify questions and concepts that guide chemical investigations.	UCB website https://undsci.berkeley.edu/
	Design and conduct chemical investigations.	Lab: Chemistry of Paint, Demo: Safety, Safety Video: American Chemical Society
	Use technology and mathematics to improve investigations and communications.	Vernier probes, lab quest minis, Logger Pro Software, and laptops
	Formulate and revise chemical explanations and models using logic and evidence.	Demo: Paint can
	Recognize and analyze chemistry explanations and models.	Particle diagrams
	Communicate and support chemical arguments.	Lab reports

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Ohio Science Standards (2018)	**Student Learning Targets**	**Learning Activities/Investigations**
	Explain and apply criteria to evaluate claims, predictions, hypotheses, and explanations.	Demo: Candle
	Explain why all scientific knowledge is subject to change and the role of peer review.	
	Contrast the scientific definitions of observation, qualitative data, quantitative data, discrete data, continuous data, inference, fact, law, theory, hypothesis, and prediction and give examples of each in chemistry.	Video clip: Continuous vs. Discrete Data
PM-2	Describe the historical development of the modern periodic table, including work by Lavoisier, Priestly, Meyer, Mendeleev, Newland's, and then Moseley.	Timeline
	Explain the organization of elements into periods and groups in the periodic table.	
	Use the IUPAC symbols of the most commonly referenced elements.	Elements quizzes, element song
	Identify if an element is representative or transitional; metallic, metalloid, or nonmetal; the name of selected groups.	Lab: Metal, nonmetal or metalloid

QUARTER 1		
Measurable Skills: explain, use, recognize, solve, express, distinguish, interconert, differentiate, apply, manipulate, graph, represent, report, predict, infer, conduct, model		
Ohio Science Standards (2018)	**Student Learning Targets**	**Learning Activities/Investigations**
PM-5	Explain why mass is used as a quantity of matter and differentiate mass versus weight.	Demo: mass vs. weight
	Explain density qualitatively and solve density problems by applying an understanding of the concept of density.	Lab: mass vs. volume for aluminum
	Explain the basis and importance of the absolute temperature scale and convert between the Kelvin and Celsius scales.	
	Use appropriate SI units for length, mass, time, temperature, quantity of matter, area, volume, and density; describe the relationships among SI unit prefixes and recognize commonly used non-SI units.	
	Solve for unknown quantities by manipulating variables.	Lab: Salt sense
	Express measurements and numbers in scientific notation when appropriate.	
	Distinguish between precision and accuracy with respect to experimental data .	
	Use the correct number of significant figures in reporting measurements and the results of calculations .	
	Use appropriate statistical methods to represent the results of investigations – central tendancy (mean, mode, median), frequency distribution (percentage, histograms), dispersion (range).	Lab: Measuring mass changes
	Use graphical and mathematical models to express patterns, relationships, and make predictions inferred from sets of scientific data – histograms, line graphs, linear functions.	
	Correctly use laboratory equipment and techniques when conducting scientific investigations.	Lab: Measurement challenge
	Explain the meaning of mole and Avogadro's number.	Lab: Model of the mole concept

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Ohio Science Standards (2018)	**Student Learning Targets**	**Learning Activities/Investigations**
	Interconvert between mass, moles, and number of particles for elements.	Demo: Mole blocks

QUARTER 1		
Topic: Classifying, Describing and Quantifying Pure Substances and Mixtures with Properties and Changes		
Key Terms: states of matter, solid, liquid, gas, aqueous, vapor, solution, atom, element, compound, mixture, heterogenous mixture, homogenous mixture, physical property, extensive property, intensive property, chemical property, physical change, chemical change, phase change, law of conservation of mass, filtration, chromatography, distillation, decant, crystalization, sublimation, law of definite proportions, law of multiple proportions, electrolysis, percent composition, solute, solvent, alloy, molarity, percent by mass, percent by volume, concentrated, dilute, supersaturated, soluble, insoluble, suspension, colloid, miscibility, Tyndall effect, mallability, conductivity, magnetisim, viscosity, endothermic, exothermic, endergonic, exergonic		
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Ohio Science Standards (2018)	**Student Learning Targets**	**Learning Activities/Investigations**
PM-1	Describe the early ideas about matter, including Aristotle, Democritus, and Dalton.	Activity: Dalton's Playhouse Website https://web.visionlearning.com/dalton_playhouse/ad_loader.html
PM-5	Describe how matter is classified: by state of matter and composition at macroscopic and atomic levels; with characteristics and properties for elements, compounds, suspensions, colloids, and solutions; and draw/interpret particle diagrams to represent them.	Activity: Elements, atoms, ions, and isotopes Demo: Heated water
	Define chemical and physical properties and compare them by providing examples with explanations.	Activity: Elements, compounds and mixtures Demo: Dollar bill
	Compare the definitions and laws of conservation for matter (mass, definite composition, and multiple proportions) and energy and apply them.	
	Use mass ratios to deduce formula of a compound and reason if different samples are the same compound.	

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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 (physical changes) and compounds (chemical changes) into their components.	Video Clip: Iron and Sulfur Lab: Observing and identifying physical vs. chemical changes
	Describe and perform common separation techniques for mixtures (e.g., filtration, distillation, and chromatography).	Lab: Qualitative separation of mixture Lab: Paper chromatography
	Describe how electrolysis is used to classify pure substances into elements or compounds.	Demo: Electrolysis
	Calculate the percent composition of a substance, given its formula or masses of each component element in a sample.	Lab: Quantitative separation
	Define, identify, and create a particle diagram for a solution using solute and solvent particles, and explain miscibility.	Demo: Miscibility of alcohol and water
	Define and calculate the molarity of a solution when given moles of solute and volume of solution or calculate moles of solute when given molarity and volume of solution.	
	Define and calculate the percent composition of a solution by mass and volume.	Activity: Supersaturated solution
	Describe the preparation of solutions when given mass and moles of solute and volume of solution, or molarity when given a concentrated solution to dilute.	Lab: Molarity of tricherry kooloxide
PM-1	Describe the specific contribution(s) of each scientist who contributed to the development of the modern atomic model (atomic theory), including the details of their	Demos: CRT, oil prop pHet, gold foil Demos: Heated solids vs. heated gases

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	experimental design, the results observed, the conclusions they made, and how the atomic model was modified. (Dalton, Thomson, Millikan, Rutherford, Bohr, Chadwick, Plank, Einstein, De Broglie, Heisenberg, and Schrodinger)	
	Describe the importance of models in the study of atomic and electronic structure.	Demo: Paraffin paradox
	Calculate the weighted average atomic mass of an element from isotopic abundance, given the atomic mass of each isotope when given tabulated, graphical, or mass spectrum data and identify the element/compound	Lab: Beanium Demo: Mass spectroscopy
	Measure wavelength using emmision and absortion spectroscopy and use to calculate frequency and energy.	Demo: Flame tests (emission) and absorption spectroscopy Demo: ZnS
	Describe, calculate, and compare characteristics of a wave generated by an electron, as wavelength, frequency, energy, and speed	Lab: Absorption spectroscopy for dye Demo: Microwaves Infrared Images
	Describe atomic orbitals (s, p, d, f), their basic shapes, the role of probability, and use the periodic table to determine the level, sublevel, orientation in space and spin in orbital diagrams in order to explain how the quantum model replaced the shell model.	Lab: Atomic target practice

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	Apply Hund's rule, Pauli exclusion principle, and the Aufbau principle to specify the electron configurations of the elements in ground, excited, and ionic states.	Lab: Quantum leap
	Interpret photoelectron spectroscopy data to infer the identity of elements and support the shell and quantum model of the electron.	Activity: PES spectrographs
PM-2	Use the periodic table to determine the atomic number; atomic mass; mass number; and number of protons, electrons, and neutrons in isotopes of elements.	
	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.	
	Identify regions (e.g., groups, families, series) of the periodic table and describe the chemical characteristics of each.	Demo: Alkali and alkaline Earth metals Reactivity vs. Activity
	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 the periodic table and electron conf.	Lab: Periodic trends Demo: Paramagnetism and diamagnetisim
PM-3	Describe the nature of chemical bonds using valence electrons in bonding atoms.	

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Ohio Science Standards (2018)	**Student Learning Targets**	**Learning Activities/Investigations**
	Describe the characteristics of metallic, ionic and covalent bonding.	
	Classify solids as ionic, molecular, metallic, or network and explain how they differ.	Demo: Conductivity and melting points
	Explain how the electron sea model for metallic bonding accounts for the physical properties of metals and compare/contrast these properties with ionic and covalent bond properties.	Demo: Mallability
	Identify two types of metallic solutions (alloys) when given particle diagrams and justify your classification using structural features.	Particle diagrams
	Use and predict multiple representations to represent bonding in ionic and covalent compounds including, chemical equations, chemical formulas, electron configurations, orbital notation, Lewis dot structures, and atomic models.	
	Recognize typical ionic configurations and explain stability using energy.	
PM-4	Interpret the information conveyed by chemical formulas for numbers of atoms of each element.	Lab: Analyses of ions in solution
	Write chemical names (nomenclature) for ionic and covalent compounds.	

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	Use the names, formulas, and charges of commonly referenced polyatomic ions.	
	Draw Lewis structures for molecules and polyatomic ions, including and resonance structures.	Video Clip: Tacoma Narrows Bridge
	Describe the unique features of bonding in carbon compounds using multiple bonds.	Lab: Molecular compounds

QUARTER 2

Topic: Molecular Structure, Shape, Polarity, and Quantifying Compounds

Key Terms: bond polarity, molecular polarity, molecular structure, molecular geometry, dipole moment, bond angle, hydrogen bonding, hydrocarbon, organic chemistry, biochemistry, molar mass, percent composition, empirical formula, molecula formula, mass composition, hydrate, molarity

Measurable Skills: Use, Determine, Describe, Apply, Relate, Explain, Provide, Interconvert, Distinguish, Calculate, Derive

Ohio Science Standards (2018)	Student Learning Targets	Learning Activities/Investigations
PM-4	Use VSEPR theory to explain and determine geometries of molecules and polyatomic ions, including shape and bond angle.	Lab: Molecular structure and geometry
	Describe and apply how orbital hybridization models relate to molecular geometry.	Demo: Balloon geometry
	Describe and apply the relationship between molecular polarity and bond polarity.	Demo: Polarity of water vs. benzene

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Ohio Science Standards (2018)	**Student Learning Targets**	**Learning Activities/Investigations**
	Explain and provide examples for dipole moments, bond polarity, and hydrogen bonding.	
	Use multiple representations to name simple hydrocarbons (no branches or functional groups) using prefixes and suffixes.	
PM-5	Interconvert between mass, moles, and number of particles in compounds.	
	Distinguish between chemical symbols, empirical formulas, molecular formulas, and structural formulas .	
	Calculate the percent composition of a substance, given its formula or masses of each component element in a sample.	
	Determine the empirical formulas and molecular formulas of compounds, given percent composition data or mass composition data .	Lab: Empirical formula for ionic compound
	Determine percent composition experimentally and derive empirical formulas from the data (including hydrates).	Lab: Empirical formula for hydrate
	Interconvert between molarity, mass, moles, and number of particles in solutions.	
	Describe the preparation and properties of solutions using mass, mols, or molarity.	

QUARTER 3

Topic: Chemical Reactions

Key Terms: chemical reaction, reactants, products, chemical equations, chemical symbol, coefficient, subscripts, synthesis, decomposition, combustion, single replacement, activity series, double replacement, solubility chart, precipitate, reduction-oxidation, reduction potential table, neutralization, balancing, total ionic equations, net ionic equations, spectator ion, acid-base indicator, titration, pH, hydrogen ion, titrant, equivalence point, end point, reduction, oxidation, oxidation number, oxidizing agent, reducing agent, electrochemical cell, voltaic cell, electrolytic cell, species, half reaction, hydroxide ion, voltage, net voltage, salt bridge, electrode, cathode, anode, half cell, reduction potential, standard hydrogen electrode

Measurable Skills: apply, know, write, balance, describe, use, classify, predict, identify, explain, conduct, assign, diagram, create, design, determine

Ohio Science Standards (2018)	Student Learning Targets	Learning Activities/Investigations
IM-1	Apply conservation laws and know what quantities are conserved. (mass, atoms, energy, and electrons).	
	Write and balance chemical equations, given the names of reactants and products.	
	Describe what is represented, on a molecular and molar level, by chemical equations .	
	Use the appropriate symbols for state (i.e., solid, liquid, gaseous, aqueous) and reaction direction when writing chemical equations.	
	Classify chemical reactions as being synthesis, decomposition, combustion, single replacement, double replacement, neutralization, or redox reactions.	Lab: Chemical reactions suite
	Predict the products of synthesis, combustion, and decomposition and balance.	
	Predict products in single replacement reactions with an activity series and balance.	
	Predict products of double replacement reactions with solubility chart to identify precipitates, and write balanced equations for these reactions.	
	Write ionic equations, identifying spectator ions and the net ionic equation.	

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Ohio Science Standards (2018)	Student Learning Targets	Learning Activities/Investigations
	Apply the general rules of solubility to aqueous salt solutions.	
	Write and balance a simple equation for a neutralization reaction.	Activity: RSC Acid-Base Titration Simulation
	Explain how the acid-base indicators work.	Demo: Acid-Base Indicators Lab: Titration and Acid-Base Indicators
	Conduct an acid base titration experiment in order to determine concentration.	Lab: Acid-Base Titration
	Assign oxidation numbers (states) to reaction species; identify the species oxidized and reduced, and the oxidizing agent and reducing agent, in a REDOX reaction.	
	Balance REDOX equations by the ion-electron and half-reaction methods.	
	Diagram and explain the operation of a voltaic cell.	Demo: Potato Clock
	Use the table of standard reduction potentials to determine the net voltage obtained when standard half-cells are paired to form a voltaic cell, and use this voltage to conduct a spontaneous electrochemistry experiment.	Lab: Metal Electrodes and Voltaic Cells
IM-3	Use chemical equations to perform basic mole-mole, mass-mass, and mass-mole computations for chemical reactions.	BCA Charts
	Identify limiting reagents and use this information when solving reaction stoichiometry problems.	Activity: Smore Stoichiometry

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Ohio Science Standards (2018)	Student Learning Targets	Learning Activities/Investigations
	Compute theoretical yield, actual (experimental) yield, and percent yield.	Lab: Stoichiometry of Baking Soda
	Solve stoichiometry calculations based on reactions involving aqueous solutions.	Lab - Stoichiometry of Al and CuCl2
	Solve gas stoichiometry problems at standard and nonstandard conditions.	
IM-2	Define gas pressure and the various pressure units (e.g., torr, kilopascals, mm Hg, atmospheres, psi, bar).	
	Describe the use and operation of mercury barometers and manometers to find atmospheric pressure or relative gas pressures.	
	Define the gas laws given by Boyle, Charles, Gay-Lussac, and Dalton and solve problems based on these laws.	Lab: Gas Laws
	Describe Avogadro's hypothesis and use it to solve stoichiometric problems.	Demo: Hydrogen Balloon
	Apply the mathematical relationships that exist among the volume, temperature, pressure, and number of particles in an ideal gas .	Lab: Determining "R" in ideal gas law
	Compute gas density when given molar mass, temperature, and pressure.	Lab: Molar Mass and Density Using Ideal Gas Law
	Apply the ideal gas law to determine the molar mass of a volatile compound.	

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PM-6	Explain the basis for gaseous diffusion and effusion.	Demo: Orange Diffusion Demo: CO2 and sulfur hexafluoride gasses
	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.	
	Use the kinetic molecular theory to explain the states and properties (i.e., microscopic and macroscopic) of matter and phase change.	Demo: Can crush
	Use the kinetic-molecular theory as a basis for explaining gas pressure, Avogadro's hypothesis, and Boyle's/Charles's laws.	Demo: Burning candle and water level
	Compare the different types of intermolecular forces.	Demo: Magic Sand, Popcan skating rink Lab: Column Chromotography
	Describe the physical and chemical properties of water from hydrogen bonding.	Demo: Jelly Jar
	Explain the relationship between evaporation, vapor pressure, molecular kinetic energy, and boiling point for a single pure substance.	Lab: Intermolecular Forces Demo: Boiling Water in Syringe Demo: Drinking Bird
	Explain the relationship between IMF, boiling points, and vapor pressure when comparing differences in the properties of pure substances.	Demo: Love Meter
	Predict phase changes, bp, mp, using phase diagram, heating/cooling curves.	Demo: Triple point and Critical Point for N2

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	Describe the relationship between temperature, pressure and solubility of gases in liquids.	
	Describe the relationship between solvent character and solute character in terms of interparticle forces and polarity.	
	Describe the factors affecting the solubility of a solute in a given solvent and its rate of solution.	
	Describe qualitatively the effect of adding solute on freezing point, boiling point, and vapor pressure of a solvent.	
PM-5	Define and calculate molality.	
	Calculate changes in the boiling point and freezing point when nonvolatile, nonelectrolyte or electrolyte solutes are added to solvents.	
IM-1	Describe and represent the phase and energy changes associated with boiling/condensing, melting/freezing, sublimation, and crystallization (deposition).	Energy bar charts
IM-1	Explain and apply the law of conservation of energy in chemical reactions.	
	Describe heat, and explain the difference between heat, thermal energy, and temperature.	Activity: H2 bubbles and methane bubbles
	Define enthalpy and explain how changes in enthalpy in physical and chemical changes determine whether a reaction is endothermic or exothermic.	

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Ohio Science Standards (2018)	Student Learning Targets	Learning Activities/Investigations
	Solve heat capacity and transfer problems using specific heat, heat of fusion, and heat of vaporization.	Demo: Boiling water in paper and melting blocks Lab: Enthalpy of fusion for water Lab: Heat capacity of aluminum
	Calculate the heat of reaction for a given chemical reaction when given calorimetric data.	Lab: Enthalpy of neutralization
	Compute ΔHrxn from ΔHfº values and explain why the ΔHfº values for elements are zero.	
	Explain and apply, mathematically, the relationship between ΔHrxnº (forward) and ΔHrxnº (reverse).	
	Define entropy and explain the role of entropy in chemical and physical changes, and identify the changes that favor increases in entropy.	Lab: Enthalpy of solutions
	Define and calculate free energy.	
	Determine whether enthalpy, entropy, or free energy is negative or positive for a system and predict spontanaiety.	
	Explain the collision theory of reactions.	
	Describe the meaning of activation energy and activated complex.	Demo: Activation energy and thermit reaction with rusted steel balls
	Interpret potential energy diagrams for chemical reactions.	
	Relate the rate to the appearance of products and the disappearance of reactants.	

QUARTER 3

Topic: Chemical Reactions

Key Terms: chemical reaction, reactants, products, chemical equations, chemical symbol, coefficient, subscripts, synthesis, decomposition, combustion, single replacement, activity series, double replacement, solubility chart, precipitate, reduction-oxidation, reduction potential table, neutralization, balancing, total ionic equations, net ionic equations, spectator ion, acid-base indicator, titration, pH, hydrogen ion, titrant, equivalence point, end point, reduction, oxidation, oxidation number, oxidizing agent, reducing agent, electrochemical cell, voltaic cell, electrolytic cell, species, half reaction, hydroxide ion, voltage, net voltage, salt bridge, electrode, cathode, anode, half cell, reduction potential, standard hydrogen electrode

Measurable Skills: apply, know, write, balance, describe, use, classify, predict, identify, explain, conduct, assign, diagram, create, design, determine

Ohio Science Standards (2018)	Student Learning Targets	Learning Activities/Investigations
	Interpret and label a plot of energy versus reaction coordinate.	
	Relate collision theory to the factors that affect the rate of reaction and analyze those factors.	Lab - Alka Seltzer kinetics and thermodynamics
	Explain and sketch the effects of catalysts on reaction rates using energy profiles and mechanisms.	
	Calculate rate order, reaction order, and rate constant from given information or tabulated data.	Lab: Iodine clock kinetics
	Describe the meaning of reaction mechanism and rate-determining step and apply when given a reaction mechanism.	
	Relate reaction mechanism, rate-determining step, activated complex, heat of reaction, and activation energy to reaction kinetics	

QUARTER 4

Topic: Equilibrium and Acids and Bases

Key Terms: dynamic equilibrium, reversible reaction, law of chemical equilibrium (mass action), equilibrium constant, equilibrium expression, LeChatelier's principle, stress, hydronium ion, autoionization, acidic solution, basic solution, neutral solution, strong acid, strong base, weak acid, weak base, acid ionization constant, base ionization constant, Arrhenius model, Lewis model, Bronsted-Lowry model, conjugate acid, conjugate base, conjugate acid-base pair, amphoteric, ion product constant for water, power of hydrogen ion (pH), power of hydroxide ioin (pOH)

Measurable Skills: Describe, Explain, Write, Calculate, Apply, Relate, Identify, Define

Ohio Science Standards (2018)	Student Learning Targets	Learning Activities/Investigations
IM-1	Describe the conditions that define equilibrium systems on a dynamic molecular level and on a static macroscopic scale.	
	Explain the law of concentration (mass) action and write equilibrium law expressions for chemical equilibria.	
	Calculate equilibrium concentrations and constants.	
	Apply Le Châtelier's principle to explain a variety of changes in physical and chemical equilibria.	Lab: Le Chatelier's Principle
	Describe the nature and interactions of acids and bases.	Lab: Titrate weak acid with strong base
	Describe the hydronium ion and the concept of amphoterism.	
	Describe Arrhenius and Brønsted-Lowry acids and bases; identify conjugate acids and bases in reactions.	
	Relate solvent interaction to the formation of acidic and basic solutions.	Lab: Make NaOH solution
	Describe characteristics of strong and weak acids and bases, and identify common examples of both.	
	Define percent ionization, Ka, and Kb and explain how they relate to acid/base strength.	
	Define the water constant, Kw, and the pH scale.	
	Calculate hydrogen ion concentration, hydroxide ion concentration, pH, and pOH for acidic or basic solutions.	Lab: Standardize strong base with weak acid

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