

**New York State Core Curriculum  
Contents Standards Mapping**

CHEMISTRY	Boardworks High School Chemistry Presentation
<b>Key Idea 3. Matter is made up of particles whose properties determine the observable characteristics of matter and its reactivity.</b>	
<b>3.1 Explain the properties of materials in terms of the arrangement and properties of the atoms that compose them.</b>	
3.1a The modern model of the atom has evolved over a long period of time through the work of many scientists.	Introducing Atoms
3.1b Each atom has a nucleus, with an overall positive charge, surrounded by negatively charged electrons.	Atomic Structure
3.1c Subatomic particles contained in the nucleus include protons and neutrons.	Atomic Structure
3.1d The proton is positively charged, and the neutron has no charge. The electron is negatively charged.	Atomic Structure
3.1e Protons and electrons have equal but opposite charges. The number of protons equals the number of electrons in an atom.	Atomic Structure Atomic Number and Mass Number
3.1f The mass of each proton and each neutron is approximately equal to one atomic mass unit. An electron is much less massive than a proton or a neutron.	Atomic Structure Atomic Number and Mass Number
3.1g The number of protons in an atom (atomic number) identifies the element. The sum of the protons and neutrons in an atom (mass number) identifies an isotope. Common notations that represent isotopes include: $^{14}\text{C}$ , $^{14}\text{C}$ , carbon-14, C-14.	Atomic Number and Mass Number Isotopes
3.1h In the wave-mechanical model (electron cloud model) the electrons are in orbitals, which are defined as the regions of the most probable electron location (ground state).	Electron Configuration Orbitals
3.1i Each electron in an atom has its own distinct amount of energy.	Ionization Energy Energy Sublevels
3.1j <i>When an electron in an atom gains a specific amount of energy, the electron is at a higher energy state (excited state).</i>	–
3.1k When an electron returns from a higher energy state to a lower energy state, a specific amount of energy is emitted. This emitted energy can be used to identify an element.	Observing Line Spectra
3.1l The outermost electrons in an atom are called the valence electrons. In general, the number of valence electrons affects the chemical properties of an element.	Patterns of Behavior Electron Structure and the Periodic Table
3.1m Atoms of an element that contain the same number of protons but a different number of neutrons are called isotopes of that element.	Isotopes

3.1n The average atomic mass of an element is the weighted average of the masses of its naturally occurring isotopes.	Isotopes Relative Atomic Mass
3.1o Stability of an isotope is based on the ratio of neutrons and protons in its nucleus. Although most nuclei are stable, some are unstable and spontaneously decay, emitting radiation.	Radioactivity Types of Radiation
3.1p Spontaneous decay can involve the release of alpha particles, beta particles, positrons, and/or gamma radiation from the nucleus of an unstable isotope. These emissions differ in mass, charge, ionizing power, and penetrating power.	Radioactivity Types of Radiation
3.1q Matter is classified as a pure substance or as a mixture of substances.	Introducing Atoms Compounds Separating Mixtures
3.1r A pure substance (element or compound) has a constant composition and constant properties throughout a given sample, and from sample to sample.	Introducing Atoms Compounds
3.1s Mixtures are composed of two or more different substances that can be separated by physical means. When different substances are mixed together, a homogeneous or heterogeneous mixture is formed.	Separating Mixtures
3.1t The proportions of components in a mixture can be varied. Each component in a mixture retains its original properties.	Separating Mixtures
3.1u Elements are substances that are composed of atoms that have the same atomic number. Elements cannot be broken down by chemical change.	Introducing Atoms
3.1v Elements can be classified by their properties and located on the Periodic Table as metals, nonmetals, metalloids (B, Si, Ge, As, Sb, Te), and noble gases.	Patterns of Behavior Electron Structure and the Periodic Table
3.1w <i>Elements can be differentiated by physical properties. Physical properties of substances, such as density, conductivity, malleability, solubility, and hardness, differ among elements.</i>	–
3.1x <i>Elements can also be differentiated by chemical properties. Chemical properties describe how an element behaves during a chemical reaction.</i>	–
3.1y The placement or location of an element on the Periodic Table gives an indication of the physical and chemical properties of that element. The elements on the Periodic Table are arranged in order of increasing atomic number.	The Periodic Table Patterns of Behavior Electron Structure and the Periodic Table
3.1z For Groups 1, 2, and 13-18 on the Periodic Table, elements within the same group have the same number of valence electrons (helium is an exception) and therefore similar chemical properties.	Electron Structure and the Periodic Table
3.1aa The succession of elements within the same group demonstrates characteristic trends: differences in atomic radius, ionic radius, electronegativity, first ionization energy, metallic/nonmetallic properties.	Patterns of Behavior Electron Structure and the Periodic Table Ionization Energy Electronegativity

3.1bb The succession of elements across the same period demonstrates characteristic trends: differences in atomic radius, ionic radius, electronegativity, first ionization energy, metallic/nonmetallic properties.	Patterns of Behavior Electron Structure and the Periodic Table Electronegativity Ionization Energy
3.1cc A compound is a substance composed of two or more different elements that are chemically combined in a fixed proportion. A chemical compound can be broken down by chemical means. A chemical compound can be represented by a specific chemical formula and assigned a name based on the IUPAC system.	Compounds Naming Compounds Thermal Decomposition Types of Formulae
<i>3.1dd Compounds can be differentiated by their physical and chemical properties.</i>	–
3.1ee Types of chemical formulas include empirical, molecular, and structural.	Types of Formulae
3.1ff Organic compounds contain carbon atoms, which bond to one another in chains, rings, and networks to form a variety of structures. Organic compounds can be named using the IUPAC system.	Hydrocarbons
3.1gg Hydrocarbons are compounds that contain only carbon and hydrogen. Saturated hydrocarbons contain only single carbon-carbon bonds. Unsaturated hydrocarbons contain at least one multiple carbon-carbon bond.	Hydrocarbons
3.1hh Organic acids, alcohols, esters, aldehydes, ketones, ethers, halides, amines, amides, and amino acids are categories of organic compounds that differ in their structures. Functional groups impart distinctive physical and chemical properties to organic compounds.	Functional Groups Alcohols Carboxylic Acids Esters
3.1ii Isomers of organic compounds have the same molecular formula, but different structures and properties.	Isomers
3.1jj The structure and arrangement of particles and their interactions determine the physical state of a substance at a given temperature and pressure.	Intermolecular Forces
3.1kk The three phases of matter (solids, liquids, and gases) have different properties.	Changing State Particles in Action
<i>3.1ll Entropy is a measure of the randomness or disorder of a system. A system with greater disorder has greater entropy.</i>	–
<i>3.1mm Systems in nature tend to undergo changes toward lower energy and higher entropy.</i>	–
3.1nn Differences in properties such as density, particle size, molecular polarity, boiling and freezing points, and solubility permit physical separation of the components of the mixture.	Separating Mixtures
3.1oo A solution is a homogeneous mixture of a solute dissolved in a solvent. The solubility of a solute in a given amount of solvent is dependent on the temperature, the pressure, and the chemical natures of the solute and solvent.	Solutions Solubility
3.1pp The concentration of a solution may be expressed in molarity (M), percent by volume, percent by mass, or parts per million (ppm).	Percentage Composition by Mass

3.1qq <i>The addition of a nonvolatile solute to a solvent causes the boiling point of the solvent to increase and the freezing point of the solvent to decrease. The greater the concentration of solute particles, the greater the effect.</i>	–
3.1rr An electrolyte is a substance which, when dissolved in water, forms a solution capable of conducting an electric current. The ability of a solution to conduct an electric current depends on the concentration of ions.	Electrolysis of Dilute Sulfuric Acid Electrolysis of Lead Bromide Electrolysis of NaCl Purification of Copper
3.1ss The acidity or alkalinity of an aqueous solution can be measured by its pH value. The relative level of acidity or alkalinity of these solutions can be shown by using indicators.	pH and Indicators
3.1tt On the pH scale, each decrease of one unit of pH represents a tenfold increase in hydronium ion concentration.	Properties of Acids and Alkalis
3.1uu <i>Behavior of many acids and bases can be explained by the Arrhenius theory. Arrhenius acids and bases are electrolytes.</i>	–
3.1vv Arrhenius acids yield H <sup>+</sup> (aq), hydrogen ion as the only positive ion in an aqueous solution. The hydrogen ion may also be written as H <sub>3</sub> O <sup>+</sup> (aq), hydronium ion.	Electrolysis of Dilute Sulfuric Acid Neutralization Properties of Acids and Alkalis
3.1ww Arrhenius bases yield OH <sup>-</sup> (aq), hydroxide ion as the only negative ion in an aqueous solution.	Neutralization Properties of Acids and Alkalis
3.1xx In the process of neutralization, an Arrhenius acid and an Arrhenius base react to form a salt and water.	Neutralization
3.1yy There are alternate acid-base theories. One theory states that an acid is an H <sup>+</sup> donor and a base is an H <sup>+</sup> acceptor.	Properties of Acids and Alkalis
3.1zz Titration is a laboratory process in which a volume of a solution of known concentration is used to determine the concentration of another solution.	Neutralization
<b>3.2 Use atomic and molecular models to explain common chemical reactions.</b>	
3.2a <i>A physical change results in the rearrangement of existing particles in a substance. A chemical change results in the formation of different substances with changed properties.</i>	–
3.2b Types of chemical reactions include synthesis, decomposition, single replacement, and double replacement.	Thermal Decomposition
3.2c Types of organic reactions include addition, substitution, polymerization, esterification, fermentation, saponification, and combustion.	Combustion Polymers Fermentation Hydrogenation Esters

3.2d An oxidation-reduction (redox) reaction involves the transfer of electrons (e <sup>-</sup> ).	Electrolysis of Dilute Sulfuric Acid Electrolysis of Lead Bromide Extracting Aluminum Purification of Copper
3.2e Reduction is the gain of electrons.	Electrolysis of Dilute Sulfuric Acid Electrolysis of Lead Bromide Extracting Aluminum Purification of Copper
3.2f A half-reaction can be written to represent reduction.	Electrolysis of Dilute Sulfuric Acid Electrolysis of Lead Bromide Extracting Aluminum Purification of Copper
3.2g Oxidation is the loss of electrons.	Electrolysis of Dilute Sulfuric Acid Electrolysis of Lead Bromide Extracting Aluminum Purification of Copper Oxidation Numbers
3.2h A half-reaction can be written to represent oxidation.	Electrolysis of Dilute Sulfuric Acid Electrolysis of Lead Bromide Extracting Aluminum Purification of Copper Oxidation Numbers
3.2i Oxidation numbers (states) can be assigned to atoms and ions. Changes in oxidation numbers indicate that oxidation and reduction have occurred.	Oxidation Numbers
3.2j An electrochemical cell can be either voltaic or electrolytic. In an electrochemical cell, oxidation occurs at the anode and reduction at the cathode.	Electrolysis of Dilute Sulfuric Acid Electrolysis of Lead Bromide Extracting Aluminum Purification of Copper
3.2k <i>A voltaic cell spontaneously converts chemical energy to electrical energy.</i>	–
3.2l An electrolytic cell requires electrical energy to produce a chemical change. This process is known as electrolysis.	Electrolysis of Dilute Sulfuric Acid Electrolysis of Lead Bromide Electrolysis of NaCl Extracting Aluminum Purification of Copper
<b>3.3 Apply the principle of conservation of mass to chemical reactions.</b>	

3.3a In all chemical reactions there is a conservation of mass, energy, and charge.	Conservation of Mass Exothermic Reactions Endothermic Reactions
3.3b In a redox reaction the number of electrons lost is equal to the number of electrons gained.	Electrolysis of Dilute Sulfuric Acid Electrolysis of Lead Bromide Extracting Aluminum Purification of Copper
3.3c A balanced chemical equation represents conservation of atoms. The coefficients in a balanced chemical equation can be used to determine mole ratios in the reaction.	Reacting Masses
3.3d The empirical formula of a compound is the simplest whole-number ratio of atoms of the elements in a compound. It may be different from the molecular formula, which is the actual ratio of atoms in a molecule of that compound.	Types of Formulae
3.3e The formula mass of a substance is the sum of the atomic masses of its atoms. The molar mass (gram-formula mass) of a substance equals one mole of that substance.	Molar Mass Relative Atomic Mass What are Moles?
3.3f The percent composition by mass of each element in a compound can be calculated mathematically.	Percentage Composition by Mass
<b>3.4 Use kinetic molecular theory (KMT) to explain rates of reactions and the relationships among temperature, pressure, and volume of a substance.</b>	
3.4a The concept of an ideal gas is a model to explain the behavior of gases. A real gas is most like an ideal gas when the real gas is at low pressure and high temperature.	Ideal Gas Laws
3.4b Kinetic molecular theory (KMT) for an ideal gas states that all gas particles: <ul style="list-style-type: none"> <li>• are in random, constant, straight-line motion.</li> <li>• are separated by great distances relative to their size; the volume of the gas particles is considered negligible.</li> <li>• have no attractive forces between them.</li> <li>• have collisions that may result in a transfer of energy between gas particles, but the total energy of the system remains constant.</li> </ul>	Particles in Action
3.4c <i>Kinetic molecular theory describes the relationships of pressure, volume, temperature, velocity, and frequency and force of collisions among gas molecules.</i>	–
3.4d Collision theory states that a reaction is most likely to occur if reactant particles collide with the proper energy and orientation.	Rates of Reaction
3.4e Equal volumes of gases at the same temperature and pressure contain an equal number of particles.	Gases and Moles Ideal Gas Laws

3.4f The rate of a chemical reaction depends on several factors: temperature, concentration, nature of the reactants, surface area, and the presence of a catalyst.	Concentration, Pressure and Reaction Rates Surface Area, Catalysts and Reaction Rates Temperature and Reaction Rates
3.4g A catalyst provides an alternate reaction pathway, which has a lower activation energy than an uncatalyzed reaction.	Surface Area, Catalysts and Reaction Rates
3.4h Some chemical and physical changes can reach equilibrium.	Reversible Reactions Dynamic Equilibrium Le Chatelier's Principle
3.4i At equilibrium the rate of the forward reaction equals the rate of the reverse reaction. The measurable quantities of reactants and products remain constant at equilibrium.	Dynamic Equilibrium Le Chatelier's Principle
3.4j Le Chatelier's principle can be used to predict the effect of stress (change in pressure, volume, concentration, and temperature) on a system at equilibrium.	Equilibrium – Changing Conditions Le Chatelier's Principle The Haber Process
<b>Key Idea 4. Energy exists in many forms, and when these forms change energy is conserved.</b>	
<b>4.1 Observe and describe transmission of various forms of energy.</b>	
4.1a <i>Energy can exist in different forms, such as chemical, electrical, electromagnetic, thermal, mechanical, nuclear.</i>	–
4.1b Chemical and physical changes can be exothermic or endothermic.	Endothermic Reactions Exothermic Reactions
4.1c Energy released or absorbed during a chemical reaction can be represented by a potential energy diagram.	Endothermic Reactions Exothermic Reactions
4.1d Energy released or absorbed during a chemical reaction (heat of reaction) is equal to the difference between the potential energy of the products and potential energy of the reactants.	Bonds and Activation Energy Endothermic Reactions Exothermic Reactions
<b>4.2 Explain heat in terms of kinetic molecular theory.</b>	
4.2a Heat is a transfer of energy (usually thermal energy) from a body of higher temperature to a body of lower temperature. Thermal energy is the energy associated with the random motion of atoms and molecules.	Heat Temperature and Reaction Rates
4.2b Temperature is a measurement of the average kinetic energy of the particles in a sample of material. Temperature is not a form of energy.	Heat
4.2c The concepts of kinetic and potential energy can be used to explain physical processes that include: fusion (melting), solidification (freezing), vaporization (boiling, evaporation), condensation, sublimation, and deposition.	Changing State
<b>4.4 Explain the benefits and risks of radioactivity.</b>	
4.4a Each radioactive isotope has a specific mode and rate of decay (half-life).	Half-life

4.4b Nuclear reactions include natural and artificial transmutation, fission, and fusion.	Nuclear Fission Nuclear Fusion
4.4c Nuclear reactions can be represented by equations that include symbols which represent atomic nuclei (with mass number and atomic number), subatomic particles (with mass number and charge), and/or emissions such as gamma radiation.	Nuclear Fission Types of Radiation
4.4d Radioactive isotopes have many beneficial uses. Radioactive isotopes are used in medicine and industrial chemistry for radioactive dating, tracing chemical and biological processes, industrial measurement, nuclear power, and detection and treatment of diseases.	Gamma Rays Nuclear Fission Radioactive Dating Uses of Radiation X-rays
4.4e There are inherent risks associated with radioactivity and the use of radioactive isotopes. Risks can include biological exposure, long-term storage and disposal, and nuclear accidents.	Chain Reactions Dangers of Radiation Gamma Rays Nuclear Waste X-rays
4.4f There are benefits and risks associated with fission and fusion reactions.	Chain Reactions Nuclear Fission Nuclear Fusion Nuclear Waste
<b>Key Idea 5. Energy and matter interact through forces that result in changes in motion.</b>	
<b>5.2 Explain chemical bonding in terms of the behavior of electrons.</b>	
5.2a Chemical bonds are formed when valence electrons are: <ul style="list-style-type: none"> <li>• transferred from one atom to another (ionic)</li> <li>• shared between atoms (covalent)</li> <li>• mobile within a metal (metallic)</li> </ul>	Covalent Bonding Ionic Bonding Metallic Bonding
5.2b Atoms attain a stable valence electron configuration by bonding with other atoms. Noble gases have stable valence configurations and tend not to bond.	The Noble Gases Why do Atoms Form Bonds?
5.2c When an atom gains one or more electrons, it becomes a negative ion and its radius increases. When an atom loses one or more electrons, it becomes a positive ion and its radius decreases.	Formation of Ions Ionization Energy Orbitals
5.2d Electron-dot diagrams (Lewis structures) can represent the valence electron arrangement in elements, compounds, and ions.	Covalent Bonding Formation of Ions Ionic Bonding
5.2e In a multiple covalent bond, more than one pair of electrons are shared between two atoms. Unsaturated organic compounds contain at least one double or triple bond.	Covalent Bonding

5.2f Some elements exist in two or more forms in the same phase. These forms differ in their molecular or crystal structure, and hence in their properties.	Giant Covalent Structures
5.2g Two major categories of compounds are ionic and molecular (covalent) compounds.	Comparing Bonding Covalent Bonding Ionic Bonding Ionic Compounds
5.2h Metals tend to react with nonmetals to form ionic compounds. Nonmetals tend to react with other nonmetals to form molecular (covalent) compounds. Ionic compounds containing polyatomic ions have both ionic and covalent bonding.	Compound Ions Covalent Bonding Ionic Bonding
5.2i When a bond is broken, energy is absorbed. When a bond is formed, energy is released.	Bonds and Activation Energy
5.2j Electronegativity indicates how strongly an atom of an element attracts electrons in a chemical bond. Electronegativity values are assigned according to arbitrary scales.	Electronegativity
5.2k The electronegativity difference between two bonded atoms is used to assess the degree of polarity in the bond.	Electronegativity
5.2l Molecular polarity can be determined by the shape of the molecule and distribution of charge. Symmetrical (nonpolar) molecules include CO <sub>2</sub> , CH <sub>4</sub> , and diatomic elements. Asymmetrical (polar) molecules include HCl, NH <sub>3</sub> , and H <sub>2</sub> O.	Electronegativity
5.2m Intermolecular forces created by the unequal distribution of charge result in varying degrees of attraction between molecules. Hydrogen bonding is an example of a strong intermolecular force.	Intermolecular Forces
5.2n Physical properties of substances can be explained in terms of chemical bonds and intermolecular forces. These properties include conductivity, malleability, solubility, hardness, melting point, and boiling point.	Intermolecular Forces
<b>5.3 Compare energy relationships within an atom's nucleus to those outside the nucleus.</b>	
5.3a <i>A change in the nucleus of an atom that converts it from one element to another is called transmutation. This can occur naturally or can be induced by the bombardment of the nucleus with high-energy particles.</i>	–
5.3b Energy released in a nuclear reaction (fission or fusion) comes from the fractional amount of mass that is converted into energy. Nuclear changes convert matter into energy.	Nuclear Fission Nuclear Fusion
5.3c Energy released during nuclear reactions is much greater than the energy released during chemical reactions.	Nuclear Fission