Chemistry Curriculum Map

	September	October
Content	Defines the field of chemistry and distinguishes between different branches of chemistry Defines matter and contrasts major physical and chemical changes that matter can undergo Outlines the basic form of a chemical equation and describes how matter is classified Introduces the periodic table as a classification scheme for the elements with descriptions of metals, nonmetals, and metalloids Covers the scientific method and its component activities, such as observing, collecting data, formulating and testing hypotheses, and theorizing Presents Sl units of measurement, the concepts of mass and density, and the use of conversion factors Describes accuracy and precision, percent error, the use of significant figures and scientific notation, and steps to use in solving problems The history and development of atomic theory, from Democritus to Dalton to the modern era The experiments that led to the discovery of the electron and the nucleus as well as the principal properties of these subatomic particles The manner in which the number of atoms of an element and the number of subatomic particles inside atoms can be expressed and measured	The principles of electromagnetic radiation and the development of the Bohr model of the atom The location of electrons around the nucleus from a wave-mechanical, or quantum, perspective using quantum numbers The rules used to determine the electron configurations of the elements and introduces electron configuration notations Mendeleev and other chemists in developing the periodic table and how the periodic law is used to predict elements' physical and chemical properties The relationship between electron configuration and the arrangement of elements in groups, blocks, and periods of the periodic table, as well as the elements' general properties Explores the relationship between the periodic law and electron configuration, including trends in the properties of electron affinity, electronegativity, ionization energy, atomic radii and ionic radii Chemical bonding and uses electronegativity values to contrast polar- covalent, nonpolar- covalent and ionic bonding
Skills	Define chemistry List examples of the branches of chemistry Compare and contrast basic research, applied research, and technological development Distinguish between the physical properties and chemical properties of matter Classify changes of matter as physical or chemical Explain the gas, liquid, and solid states in terms of particles Distinguish between a mixture and a pure	Explain the mathematical relationship among the speed, wavelength, and frequency of electromagnetic radiation Discuss the dual wave- particle nature of light Discuss the significance of the photoelectric effect and the line-emission spectrum of hydrogen to the development of the atomic model Describe the Bohr model of the hydrogen atom Discuss Louis de Broglie's role in the development of the quantum model of the atom Compare and contrast the Bohr model and the quantum model of

	substance Use a periodic table to name elements, given their symbols Use a periodic table to write the symbols of elements, given their names Describe the arrangement of the periodic table List the characteristics that distinguish metals, nonmetals, and metalloids Describe the purpose of the scientific method Distinguish between qualitative and quantitative observations Describe the differences between hypotheses, theories, and models Distinguish between a quantity, a unit, and a measurement standard Name SI units for length, mass, time, volume, and density Distinguish between mass and weight Perform density calculations Transform a statement of equality to a conversion Distinguish between accuracy and precision Determine the number of significant figures in measurements Perform mathematical operations involving significant figures Convert measurements into scientific notation Distinguish between inversely and directly proportional relationships Explain the law of conservation of mass, the law of definite proportions, and the law of multiple proportions Summarize the five essential points of Dalton's atomic theory Explain the relationship between Dalton's atomic theory and the law of conservation of mass, the law of definite proportions, and the law of multiple proportions Summarize the observed properties of cathode rays that led to the discovery of the electron Summarize the experiment carried out by Rutherford and his coworkers that led to the discovery of the nucleus	the atom Explain how the Heisenberg uncertainty principle and the Schroedinger wave equation led to the idea of atomic orbitals List the four quantum numbers, and describe their significance Relate the number of sublevels corresponding to each of an atom's main energy levels, the number of orbitals per sublevel, and the number of orbitals per main energy level List the total number of electrons needed to fully occupy each main energy level State the Aufbau principle, the Pauli exclusion principle, and Hund's rule Describe the electron configurations for the atoms of any element using orbital notation, electron configuration notation, and, when appropriate, noble-gas notation Explain the roles of Mendeleev and Moseley in the development of the periodic table Describe the modern periodic table Explain how the periodic law can be used to predict the physical and chemical properties of elements Describe how the elements belonging to a group of the periodic table are interrelated in terms of atomic number Describe the relationship between electrons in sublevels and the length of each period of the periodic table Locate and name the four blocks of the periodic table and explain the reasons for these names Discuss the relationship between group configurations and group numbers Describe the locations in the periodic table and the general properties of the alkali metals, the alkaline earth metals, the halogens, and the noble gases Define atomic and ionic radii, *ionization energy, electron* affinity, and *electronegativity* Compare the periodic trends of atomic radii, ionization energy, and electronegativity, and state the reasons for these variations Define *valence electrons,* and state how many are present in atoms of each main-group element Compare the atomic radii, ionization energies, and electronegativities of the d-block elements with those of the main-group elements Define *chemical bond* Explain why most atoms form chemical bonds Describe ionic and covalent bonding

	List the properties of protons, neutrons, and electrons Define the atom Explain what isotopes are Define *atomic number* and *mass number,* and describe how they apply to isotopes Given the identity of a nuclide, determine its number of protons, neutrons, and electrons Define *mole* in terms of Avogadro's number, and define *molar mass* Solve problems involving mass in grams, amount in moles, and number of atoms of an element	Explain why most chemical bonding is neither purely ionic nor purely covalent Classify bonding type according to electronegativity differences
Assessment	Class Participation; Objective Evaluation [Quizzes, Tests, Worksheets] Laboratory Results Attitude	Class Participation; Objective Evaluation [Quizzes, Tests, Worksheets] Laboratory Results Attitude
NJ Standards	**Science** 5.1 Scientific Processes 5.2 Science and Society 5.3 Mathematical Applications 5.4 Nature and Process of Technology 5.6 Physical Science - Chemistry CCRWR: **All Students Will**: S1. develop career planning and workplace readiness skills. S2. use technology, information and other tools. S3. use critical thinking, decision-making, and problem-solving skills. S4. demonstrate self-management skills. S5. apply safety principles**.**	**Science** 5.1 Scientific Processes 5.2 Science and Society 5.3 Mathematical Applications 5.4 Nature and Process of Technology 5.6 Physical Science - Chemistry : CCRWR: **All Students Will**: S1. develop career planning and workplace readiness skills. S2. use technology, information and other tools. S3. use critical thinking, decision-making, and problem-solving skills. S4. demonstrate self-management skills. S5. apply safety principles**.**

	November	December
Content	The characteristics of covalent bonding, including the relationship between bond length and bond strength and the use of Lewis structures The characteristics of ionic bonding The characteristics of metallic bonding and the resulting properties of metals Theories of molecular geometry, including VSEPR theory and hybridization theory How intermolecular attraction is affected by molecular geometry The naming of binary ionic and molecular compounds How oxidation numbers are assigned and the Stock system of naming compounds How to calculate formula masses, molar masses, and percentage compositions	How to determine chemical formulas from percentage compositions and empirical data Description of Chemical Reactions Types of Chemical Reactions Activity Series of the Elements Definition of mole ratio and introduction to molar mass as a conversion factor in solving stoichiometry problems
Skills	Explain why most chemical bonding is neither purely ionic nor purely covalent Classify bonding type according to electronegativity differences Define *molecule* and *molecular formula* Explain the relationships between potential energy, distance between approaching atoms, bond length, and bond energy State the octet rule List the six basic steps used in writing Lewis structures Explain how to determine Lewis structures for molecules containing single bonds, multiple bonds, or both Explain why scientists use resonance structures to represent some molecules Compare and contrast a chemical formula for a molecular compound with one for an ionic compound Discuss the arrangements: of ions in crystals Define *lattice energy* and explain its significance List and compare the distinctive properties of ionic and molecular compounds Write the Lewis structure for a polyatomic ion given the identity of the atoms combined and other appropriate information Describe the electron-sea model of metallic bonding, and explain why metals are good electrical conductors Explain why metal surfaces are shiny Explain why metals are malleable and ductile but ionic-crystal line compounds are not Explain VSEPR theory	Define empirical formula, and explain how the term applies to ionic and molecular compounds Determine an empirical formula from either a percentage or a mass composition Explain the relationship between the empirical formula and the molecular formula of a given compound Determine a molecular formula from an empirical formula List three observations that suggest that a chemical reaction has taken place List three requirements for a correctly written chemical equation Write a word equation and a formula equation for a given chemical reaction Balance a formula equation by inspection Define and give general equations for *synthesis, decomposition, single-replacement,* and *double replacement* reactions Classify a reaction as synthesis, decomposition, single replacement, double replacement, or combustion List three types of synthesis reactions and six types of decomposition reactions List four types of single replacement reactions and three types of double replacement reactions Predict the products of simple reactions given the reactants Explain the significance of an activity series Use an activity series to predict whether a given reaction will occur and what the products will be Define *stoichiometry* Describe the importance of the *mole ratio* in stoichiometric calculations Write a mole ratio relating two substances in a chemical equation

	Predict the shapes of molecules or polyatomic ions using VSEPR theory Explain how the shapes of molecules are accounted for by hybridization theory Describe dipole-dipole forces, hydrogen bonding, induced dipoles, and London dispersion forces Explain what determines molecular polarity Explain the significance of a chemical formula Determine the formula of an ionic compound formed between two given ions Name an ionic compound given its formula Using prefixes, name a binary molecular compound from its formula Write the formula of a binary molecular compound given its name List the rules for assigning oxidation numbers Give the oxidation number for each element in the formula of a chemical compound Name binary molecular compounds using oxidation numbers and the Stock system Calculate the formula mass or molar mass of any given compound Use molar mass to convert between mass in grams and amount in moles of a chemical compound Calculate the number of molecules, formula units, or ions in a given molar amount of a chemical compound Calculate the percentage composition of a given chemical compound	
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	readiness skills. S2. use technology, information and other tools. S3. use critical thinking, decision-making, and problem-solving skills. S4. demonstrate self-management skills. S5. apply safety principles**.**	S2. use technology, information and other tools. S3. use critical thinking, decision-making, and problem-solving skills. S4. demonstrate self-management skills. S5. apply safety principles**.**

	January	February
Content	Demonstration of solutions to problems involving conversions from moles of given to moles of *unknown,* from moles to mass, from mass to moles, and from mass to mass Explains the concepts of limiting reactant and percent yield and provides strategies for solving problems based on these concepts Introduces the kinetic molecular theory of matter Explain how the theory accounts for certain physical properties of ideal gases, which differ from real gases Define pressure and standard pressure in terms of force Explain how pressure is measured Define and convert units of pressure State gas laws that express simple mathematical relationships between pressure, temperature, volume, and quantity of gases Develop the relationships between the volume, mass, and number of particles of a gas State the Avogadro's law that leads to the concept of molar volume of a gas Derive the ideal gas law, which is put to practical use in calculations	Shows students how to use the relationship between the volume and moles of a gas to carry out stoichiometric calculations from chemical reactions Demonstrates the relationship between the mass of gas particles and their rate of effusion Uses the kinetic-molecular theory to describe properties of liquids and explain changes of state involving liquids Describes the properties of solids, contrasts them with liquid properties, and explains them of the basis of the kinetic-molecular theory Describe changes of state and the factors that determine them Introduces the concept of equilibrium in terms of changes of state Explain the structure, physical properties, and changes of state of water
Skills	Calculate the amount in moles of a reactant or product from the amount in moles of a different reactant or product Calculate the mass of a reactant or product from the amount in moles of a different reactant or product Calculate the amount in moles of a reactant or product from the mass of a different reactant or product Calculate the mass of a reactant or product from the mass of a different reactant or product Describe a method for determining which of two reactants is a limiting reactant Calculate the amount in moles or mass in grams of a product, given the amounts in moles or masses in grams of two reactants, one of which is in excess Distinguish between theoretical yield, actual yield, and percent yield Calculate percent yield, given the actual yield and	Explain how Gay-Lussac's law and Avogadro's law apply to the volumes of gases in chemical reactions Use a chemical equation to specify volume ratios for gaseous reactants or products, or both Use volume ratios and the gas laws to calculate volumes, masses, or molar amounts of gaseous reactants or products State Graham's law of effusion Determine the relative rates of effusion of two gases of known molar masses State the relationship between the molecular velocities of two gases and their molar masses Describe the motion of particles in liquids and the properties of liquids according to the kinetic-molecular theory Discuss the process by which liquids can change into a gas. Define vaporization Discuss the process by which liquids can change into a solid. Define freezing

	quantity of a reactant State the kinetic-molecular theory of matter, and describe how it explains certain properties of matter List the five assumptions of the kinetic-molecular theory of gases. Define the terms ideal gas and real gas Describe each of the following characteristic properties of gases: expansion, density, fluidity, compressibility, diffusion, and effusion Describe the conditions under which a real gas deviates from " ideal" behavior Define pressure and relate it to force Describe how pressure is measured Convert units of pressure State the standard conditions of temperature and pressure Use the kinetic-molecular theory to explain the relationships between gas volume, temperature, and pressure Use Boyle's law to calculate volume-pressure changes at constant temperature Use Charles's law to calculate volume-temperature changes at constant pressure Use Gay-Lussac's law to calculate pressure-temperature changes at constant volume Use the combined gas law to calculate volume-temperature-pressure changes Use Dalton's law of partial pressures to calculate partial pressures and total pressures State the law of combining volumes State Avogadro's law and explain its significance Define standard molar volume of a gas, and use it to calculate gas masses and volumes Use standard molar volume to calculate the molar mass of a gas State the ideal gas law Derive the ideal gas constant and discuss its units Using the ideal gas law, calculate pressure, volume, temperature, or amount of gas when the other three quantities are known Using the ideal gas law, calculate the molar mass or density of a gas	Describe the motion of particles in solids and the properties of solids according to the kinetic-molecular theory Distinguish between the two types of solids Describe the different types of crystal symmetry. Define crystal structure and unit cell Explain the relationship between equilibrium and changes of state Predict changes in equilibrium using Le Chatelier's principle Explain what is mean by equilibrium vapor pressure Describe the processes of boiling, condensation, freezing, melting, deposition and sublimation Interpret phase diagrams Describe the structure of a water molecule Discuss the physical properties of water. Explain how they are determined by the structure of water Calculate the amount of heat energy absorbed or released when a quantity of water changes state

	Reduce the ideal gas law to Boyle's law, Charles's law, and Avogadro's law. Describe the conditions under which each applies	
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	March	April
Content	Characteristics that distinguish solutions from suspensions and colloids The physical and chemical factors that affect solubility Concentration expressed as molarity and molality with calculations The dissociation of ionic compounds and the ionization of some molecular compounds when they dissolve in water Strong and weak electrolytes How precipitation reactions occur Methods of writing ionic equations for precipitation reactions Description and mathematics of boiling-point elevation and freezing-point depression The mechanism of osmosis and the cause of osmotic pressure Description of acids and bases Arrhenius acids and bases Acid-base nomenclature and strong and weak acids and bases The Bronsted-Lowry and Lewis theories Explain acid-base reactions in aqueous solutions	Acid-base reactions in aqueous solutions The ionization of water and the equilibrium concentrations of H_30^+ and OH^- in water and in aqueous solutions of acids and bases The mathematical concept of pH How acid-base indicators work and how indicators, pH meters, and titrations are used to determine the pH of a solution Defines heat; temperature; heats of reaction, formation, and combustion; and enthalpy change. Explains how to use enthalpy, entropy, and free energy to predict whether a reaction will occur. Uses collision theory and activation energy to describe the mechanisms by which chemical reactions take place. Reviews the factors that influence the rate of a chemical reaction and shows how to calculate the reaction rate from experimental data.
Skills	Distinguish between heterogeneous and homogeneous mixtures List three different solute solvent combinations Compare the properties of suspensions, colloids, and solutions Distinguish between electrolytes and nonelectrolytes List and explain three factors that affect the rate at which a solid solute dissolves in a liquid solvent Explain solution equilibrium, and distinguish among saturated, unsaturated, and supersaturated solutions Explain the meaning of "like dissolves like" in terms of polar and nonpolar substances List the three interactions that contribute to the heat of solution, and explain what causes dissolution to be exothermic or endothermic Compare the effects of temperature and pressure on solubility Given the mass of solute and volume of solvent,	Describe the self-ionization of water Define pH, and give the pH of a neutral solution at 25'C Explain and use the pH scale Given $[H_30^+1$ or $[OH^-]$, find pH Given pH, find $[H_30^+1$ or $[OH^-]$ Describe how an acid- base indicator functions Explain how to carry out an acid-base titration Calculate the molality of a solution from titration data Define temperature and state the units in which it is measured Define heat and state its units Perform specific-heat calculations Explain heat of reaction, heat of formation, heat of combustion, and enthalpy change Solve problems involving heats of reaction, heats of formation, and heats of combustion Explain the relationship between enthalpy change and the tendency of a reaction to occur Explain the relationship between entropy change and the

	calculate the concentration of a solution Given the concentration of a solution, determine the amount of solute in a given amount of solution Given the concentration of a solution, determine the amount of solution that contains a given amount of solute Write equations for the dissolution of soluble ionic compounds in water Predict whether a precipitate will form when solutions of soluble ionic compounds are combined, and write net ionic equations for precipitation reactions Compare dissociation of ionic compounds with ionization of molecular compounds Draw the structure of the hydronium ion, and explain why it is used to represent the hydrogen ion in solution Distinguish between strong electrolytes and weak electrolytes List four colligative properties, and explain why they are classified as colligative properties Calculate freezing-point depression, boiling-point elevation, and solution molality of nonelectrolytic solutions Calculate the expected changes in freezing point and boiling point of an electrolytic solution Discuss causes of the differences between expected and experimentally observed colligative properties of electrolytic solutions List five general properties of aqueous acids and bases Name common binary acids and oxyacids, given their chemical formulas List five acids commonly used in industry and the laboratory, and give two properties of each Define acid and *base* according to Arrhenius's theory of ionization Explain the differences between strong and weak acids and bases Define and recognize *Bronsted-Lowry acids* and *bases* Define a *Lewis acid* and a *Lewis base* Name compounds that are acids under the Lewis	tendency of a reaction to occur Discuss the concept of free energy, and explain how the value of this quantity is calculated and interpreted Describe the use of free energy change to determine the tendency of a reaction to occur Explain the concept of reaction mechanism Use the collision theory to interpret chemical reactions Define activated complex Relate activation energy to heat of reaction Define chemical kinetics, and explain the two conditions necessary for chemical reactions to occur Discuss the five factors that influence reaction rate Define catalyst, and discuss two different types Explain and write rate laws for chemical reactions

	definition but are not acids under the Bronsted-Lowry definition Describe a conjugate acid, a conjugate base, and an amphoteric compound Explain the process of neutralization Explain how acid rain damages marble structures	
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	May	June
Content	Defines reversible reactions, the state of equilibrium, and K, the equilibrium constant. Describes the equilibria will shift in response to changes in concentration, pressure. and temperature and discusses the common-ion effect Describes the equilibria of acids, bases, and salts; explains the acid-ionization constant, K_a; and discusses buffering and hydrolysis. Discusses solubility equilibria and explains calculations involving the solubility-product constant, $K_{sp,}$ and precipitate formation. Defines oxidation and reduction reactions and provides rules for determining oxidation numbers. Presents guidelines for balancing redox equations by using the half-reaction method. Describes the roles of the oxidizing agent and the reducing agent in a redox reaction. Explains the operation of electrochemical cells and distinguishes between voltaic cells and electrolytic cells.	Identifies the forces that affect the stability of the nucleus Write balanced nuclear equations Outlines the different types of radioactive decay and demonstrates calculations involving the half-life of an isotope Surveys the penetrating ability of nuclear radiation and methods for detecting radiation Describes some common applications of nuclear radiation Explains the difference between fission and fusion and discusses their uses and potential uses as energy sources
Skills	Define chemical equilibrium Explain the nature of the equilibrium constant Write chemical equilibrium expressions and carry out calculations involving them Discuss the factors that disturb equilibrium Discuss conditions under which reactions go to completion Describe the common-ion effect Explain the concept of acid-ionization constants, and write acid-ionization equilibrium expressions Review the ionization constant of water Explain buffering Compare cation and anion hydrolysis Explain what is meant by solubility-product constants, and calculate their values Calculate solubilities using solubility-product constants Carry out calculations to predict whether precipitates will form when solutions are combined	Explain what a nuclide is, and describe the different ways nuclides can be represented Define and relate the terms mass defect and nuclear binding energy Explain the relationship between nucleon number and stability of nuclei Explain why nuclear reactions occur, and know how to balance a nuclear equation Define and relate the terms radioactive decay and nuclear radiation Describe the different types of radioactive decay and their effects on the nucleus Define the term half-life, and explain how it relates to the stability of a nucleus Define and relate the terms decay series, parent nuclide, and daughter nuclide Explain how artificial radioactive nuclides are made, and discuss their significance

	Assign oxidation numbers to reactant and product species Define oxidation and reduction Explain what an oxidation-reduction reaction (redox reaction) is Explain what must be conserved in redox equations Balance redox equations by using the half-reaction method Relate chemical activity to oxidizing and reducing strength Explain the concept of auto-oxidation Explain what is required for an electrochemical cell Describe the nature of voltaic cells Describe the nature of electrolytic cells Explain the process of electroplating Describe the chemistry of a rechargeable cell Calculate cell potentials from a table of standard electrode potentials	Compare the penetrating ability and shielding requirements of alpha particles, beta particles, and gamma rays Define the terms roentgen and rem, and distinguish between them Describe the devices used in radiation detection Discuss applications of radioactive nuclides Define nuclear fission, chain reaction, and nuclear fusion, and distinguish between them Explain how a fission reaction is used to generate power Discuss the possible benefits and the current difficulty of controlling fusion reactions
Assessment	Class Participation; Objective Evaluation [Quizzes, Tests, Worksheets] Laboratory Results Attitude	Class Participation; Objective Evaluation [Quizzes, Tests, Worksheets] Laboratory Results Attitude
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