Manhattan Center for Science and Math High School

Science Department Curriculum

Discipline: Chemistry

Unit 1: Matter and Energy

Essential Question: What is the “stuff” that makes up the world around us and how do we describe it?

Topics

- Scientific method
- Significant figures in measurements
- Defining matter
- Identifying the physical and chemical properties of matter
- Classifying matter: substances and mixtures
- Forms of energy
- Defining temperature and unit conversions
- Defining heat and heat flow

Objectives

- Define and identify independent and dependent variable
- Identify the number of significant figures in a measurement and from a mathematical operation
- Draw particle diagrams for each phase of matter
- Solve density problems
- Identify changes or properties as physical or chemical from either description or particle diagram
- Classify matter as homogeneous or heterogeneous
- Identify matter as an element, compound, or mixture
- Describe how energy is converted from one form to another but not created nor destroyed
- Convert between Celsius and Kelvin temperatures
- Relate temperature to particle motion
- Predict heat flow direction
- Identify change as exothermic or endothermic

Vocabulary

Scientific method; independent variable; dependent variable; significant figures; mass; density; conservation of matter; physical and chemical properties and changes; homogeneous; heterogeneous; substance; temperature; heat; endothermic; exothermic

Assessments

Measurements lab report; Density lab report; Properties of Matter lab report; Conservation of Mass lab report; Composition of Hydrate lab report; in-class worksheets; homework assignments; end of unit exam

NYS Core Standards

- Standard 1-Scientific Inquiry & Mathematical Analysis
- Key Idea #3: Matter is made of particles whose properties determine the observable characteristics of matter and its reactivity
- Three phases of matter (solids, liquids and gases (3.1kk)
- Matter is classified as pure substance(3.1q)
- A pure substance (element or compound) has a constant composition and constant properties throughout a given sample, and from sample to sample (3.1r)
- Elements can also be differentiated by chemical properties. Chemical properties describe how an element behaves during a chemical reaction(3.1x)
- These properties include conductivity, malleability, solubility, hardness, melting point, and boiling point(5.2n)

	• The three phases of matter (solids, liquids and gases) have different properties.(3.1kk). • 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. (3.2a) • Elements cannot be broken down by chemical change (3.1u) • Elements can be differentiated by physical properties. Physical properties of substances, such as density, conductivity, malleability, solubility, and hardness, differ among elements.(3.1w) • 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. (3.1cc) • Energy can exist in different forms, such as chemical, electrical, electromagnetic, thermal, mechanical and nuclear (4.1a) • Chemical and physical changes can be exothermic or endothermic. (4.1b) • Heat is a transfer of energy (i.e. 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. (4.2a)
Differentiation **ELL**	Chemistry vocabulary contains many cognates which helps ELL students easily assimilate the technical vocabulary. Language glossaries pertinent to chemistry are made available to students who request them. Additional time is given on assessments to those students who need it. Written work emphasizes common question and answer stems, e.g. “describe change”, “compare strength of; “explain in terms of “
SWDs	Appropriate modifications and accommodations are made to instruction based on needs of students elucidated in their IEPs.
High-Achievers	Chemistry is classified as a course indicative of college-readiness. High-achieving students will be made aware of this categorization, and the course and regents exam grades expected of student of their abilities.
Resources	NYS Chemistry Reference Tables; Chemistry Glencore “Matter & Change” or Pearson NYS Chemistry; NYS Chemistry Core Curriculum; Pupil Path; Class Websites

Manhattan Center for Science and Math High School

Science Department Curriculum	
Discipline: CHEMISTRY	
Unit 2: Atomic Structure	
Essential Question: What is the structure of the atom?	
Topics	• History of the development of our understanding of the atom • Important results of the Rutherford gold foil experiment • Subatomic particles • Difference between atoms of the same element and isotopes • Arrangement of electrons in an atom • Energy changes of electrons • Valence electrons and Lewis Dot Diagrams • Modern model of the atom
Objectives	• Describe the Dalton and Thompson models of the atom • Describe the results of the Rutherford gold foil experiement and changes to the atomic model • Identify subatomic particles and know the charge and mass of each • Determine the number of protons, electrons and neutrons in an atom • Define an isotope and determine the number of subatomic particles in an isotope • Define and calculate atomic mass • Describe energy changes and electron transitions in an atom • Describe the production of spectral lines • Describe an electron orbital • Define and identify valence electrons and draw Lewis Dot Diagrams
Vocabulary	Models of the atom (Dalton, Thompson, Rutherford, Bohr, Wave Mechanical); proton; electron; neutron; charge; atomic mass; mass number; isotope notation; ground vs. excited states; spectral lines; valence electron
Assessments	Isotopes lab report; Flame Test and Spectral Lines lab report; in-class worksheets; homework assignments; end of unit exam
NYS Core Standards	• Modern model of the atom evolved over a long period of time (3.1a) • Each atom has a nucleus, with an overall positive charge, surrounded by negatively charged electrons. (3.1b) • The mass of each proton and each neutron is approximately equal to one atomic mass unit. An electron is much less massive that a proton or a neutron. (3.1f) • Each atom has a nucleus, overall positive charge, surrounded by one or more negatively charged electrons (3.1b) • Each electron in an atom has its own distinct amount of energy (3.1i) • When an electron in an atom gains a specific amount of energy , the electron is at a higher energy state (excited state) (3.1j) • Nucleus includes protons and neutrons (3.1c) • The proton is positively charged, and the neutron has no charge. The electron is negatively charged. (3.1d)

	• Protons and electrons have equal but opposite charges. The number of protons equals the number of electrons in an atom. (3.1e) • Atoms of an element that contain the same number of protons but different number of neutrons are called isotopes of that element. (3.1m) • 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. (3.1k) • The average atomic mass of an element is the weighted average of the masses of its naturally occurring isotopes. (3.1n) • In the wave-mechanical model (electron cloud model), the electrons are in orbitals, which are defined as the regions of the most probable electron (3.1h) • 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. (3.1l) • Electron-dot diagrams (Lewis structures) can represent the valence electron arrangement in elements, compounds, and ions. (5.2d)
Differentiation **ELLs**	Chemistry vocabulary contains many cognates which helps ELL students easily assimilate the technical vocabulary. Language glossaries pertinent to chemistry are made available to students who request them. Additional time is given on assessments to those students who need it. Written work emphasizes common question and answer stems, e.g. "describe change", "compare strength of; "explain in terms of "
SWDs	Appropriate modifications and accommodations are made to instruction based on needs of students elucidated in their IEPs.
High-Achievers	Chemistry is classified as a course indicative of college-readiness. High-achieving students will be made aware of this categorization, and the course and regents exam grades expected of student of their abilities.
Resources	NYS Chemistry Reference Tables; Chemistry Glencore "Matter & Change" or Pearson NYS Chemistry; NYS Chemistry Core Curriculum; Pupil Path; Class Websites

Science Department Curriculum

Discipline: CHEMISTRY

Unit 3: Periodic Table of Elements	
Essential Question: How is the Periodic Table organized to determine and understand the properties of elements?	
Topics	• Organization of the Periodic Table and the Periodic Law • Formation of positive and negative ions • Factors that affect the size of the atom • Ionization energy and trends of ionization energy in the Periodic Table • Electronegativity and trends of electronegativety in the Periodic Table • Properties of metals and nonmetals • Properties of alkali and alkaline metals Groups • General properties of transition metals, halogens and noble gases
Objectives	• State the Periodic Law and recognize its importance in the Periodic Table • Relate Groups and Periods to electron configuration • Given an ion, provide the number of protons and electrons • Predict the type of ion that an element will form • Explain trends in the atomic radius within a Group and Period as the atomic number increases. • Predict relative change in atomic radius when forming positive and negative ions. • Define ionization energy and explain trends in ionization energy within a Group and Period as the atomic number increases. • Explain electronegativity and trends in the Periodic Table • Explain why Noble Gases have no electronegativity • Classify an element as a metal, nonmetal and metalloid. • Given the properties of an element, classify as metal, nonmetal or metalloid. • Predict reactivity of metals within a Group and the relative reactivity of halogens • Explain why Noble Gases are non-reactive
Vocabulary	Period; Group; Octet Rule; Ion; Atomic Radius; Ionic Radius; Ionization Energy; Electronegativity; Metallic Character; Alkali Metals; Alkaline Metals; Transition Metals; Noble Gases
Assessments	Metals lab report; in-class worksheets; homework assignments; end of unit exam
NYS Core Standards	• The succession of elements within the same group demonstrates characteristic trends: differences in atomic radius, ionic radius, electronegativity, first ionization energy, metallic/nonmetallic properties (3.1aa) • The succession of elements across the same period demonstrates characteristic trends: differences in atomic radius, ionic radius, electronegativity, first ionization energy, metallic/nonmetallic properties(3.1bb) • 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(3.1y) • 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.(3.1v) • Elements can be differentiated by physical properties. Physical properties of substances, such as density, conductivity, malleability, solubility, and hardness, differ among elements.(3.1w) • Elements can also be differentiated by chemical properties. Chemical properties describe how an element behaves during a chemical reaction(3.1x) • 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.(3.1z) • Atoms attain a stable valence electron configuration by bonding with other atoms. Noble gases have stable valence configurations and tend not to bond.(5.2b) • 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.(5.2c)
Differentiation	
ELLs	Chemistry vocabulary contains many cognates which helps ELL students easily assimilate the technical vocabulary. Language glossaries pertinent to chemistry are made available to students who request them. Additional time is given on assessments to those students who need it. Written work emphasizes common question and answer stems, e.g. “describe change”, “compare strength of; “explain in terms of “
SWDs	Appropriate modifications and accommodations are made to instruction based on needs of students elucidated in their IEPs.
High-Achievers	Chemistry is classified as a course indicative of college-readiness. High-achieving students will be made aware of this categorization, and the course and regents exam grades expected of student of their abilities.
Resources	NYS Chemistry Reference Tables; Chemistry Glencore “Matter & Change” or Pearson NYS Chemistry; NYS Chemistry Core Curriculum; Pupil Path; Class Websites

Manhattan Center for Science and Math High School

Science Department Curriculum	
Discipline: CHEMISTRY	
Unit 4: Bonding	
Essential Question: How are atoms and molecules attracted to each other to form new substances and phases?	
Topics	• Attractive forces between atoms • Bonding and energy changes • Stable electron configuration and bonding between atoms • Formation of ionic bonds • Formation of metallic bonds • Formation of polar and non-polar covalent bonds • Molecular polarity and molecular shapes • Polyatomic ions • Properties of solids influenced by type of bonding
Objectives	• Describe energy flow in bond forming, breaking • Explain, attractions, repulsions between two atoms • Show ion formation using electron dot structures • Write formulas for ionic substances • Explain conductivity, melting point of metals • Compare and contrast ionic, metallic bonds • Draw electron dot structures for diatomic molecules • Distinguish between nonpolar and polar covalent • Predict bond type based on electronegativity difference • Draw dot structures of simple molecules • Determine molecular polarity based on dot structure • Predict the strength of attraction based on boiling point and/or molecular polarity • Write formulas for compounds with polyatomic ions • Draw structures of simple polyatomic ions • Explain/predict melting points and conductivity of metallic, molecular, and ionic solids
Vocabulary	Bond; Octet Rule; Formula; Electrongegativity Difference; Ionic Bond; Covalent Bond; Molecule; Bond Polarity; Molecular Polarity; Symmetrical; Asymmetrical; Intermolecular Force; Ionic Compound; Molecular Compound
Assessments	Molecular modeling lab report; in-class worksheets; homework assignments; end of unit exam
NYS Core Standards	• Chemical bonds are formed when valence electrons are: a) transferred from one atom to another (ionic); shared between atoms (covalent); mobile within a metal (metallic) (5.2a)

	• Atoms attain a stable valence electron configuration by bonding with other atoms. Noble gases have stable valence configurations and tend not to bond (5.2b) • Two major categories of compounds are ionic and molecular (covalent) compounds (5.2g) • When a bond is broken, energy is absorbed. When a bond is formed, energy is released. (5.2i) • Electron dot diagrams (Lewis structures) can represent the valence electron arrangement in elements, compounds and ions (5.2d) • Electronegativity indicates how strongly an atom of an element attracts electrons in a chemical bond (5.2j) • The difference in electonegativity between two bonded atoms is used to assess the degree of polarity in the bond (5.2k) • Metals tend to react with nonmetals to form ionic compounds (5.2h) • 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. (5.2e) Electron-dot diagrams (Lewis structures) can represent the valence electron arrangement in elements, compounds, and ions. (5.2d) • 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. (5.2h) • The electronegativity difference between two bonded atoms is used to assess the degree of polarity in the bond. (5.2k) • Molecular polarity can be determined by the shape of the molecule and distribution of charge. Symmetrical (nonpolar) molecules include CO2, CH4, and diatomic elements. Asymmetrical (polar) molecules include HCl, NH3, and H2O. (5.2l)
Differentiation **ELL**	Chemistry vocabulary contains many cognates which helps ELL students easily assimilate the technical vocabulary. Language glossaries pertinent to chemistry are made available to students who request them. Additional time is given on assessments to those students who need it. Written work emphasizes common question and answer stems, e.g. "describe change", "compare strength of; "explain in terms of "
SWDs	Appropriate modifications and accommodations are made to instruction based on needs of students elucidated in their IEPs.
High-Achievers	Chemistry is classified as a course indicative of college-readiness. High-achieving students will be made aware of this categorization, and the course and regents exam grades expected of student of their abilities.
Resources	NYS Chemistry Reference Tables; Chemistry Glencore "Matter & Change" or Pearson NYS Chemistry; NYS Chemistry Core Curriculum; Pupil Path; Class Websites

Science Department Curriculum

Discipline: Chemistry

Unit 5: Phases of Matter

Essential Question: What are the characteristic properties and behaviors of the solid, liquid, and gas phases?

Topics	• Particle diagrams of phase and phase change • Intermolecular forces – types and strengths • Properties of ionic, metallic, and molecular solids • Vapor pressure and boiling point of liquids • Heating and cooling curves • Kinetic molecular theory and the ideal gas model • Pressure, volume, and temperature relationships in the ideal gas model • Combined gas law
Objectives	• Draw particle diagrams to represent the solid, liquid, or gas phases • Draw particle diagrams to represent phase changes • Compare the strength of a covalent bond to that of an intermolecular force • Label the location and type of intermolecular force in a particle diagram • Determine the relative strength an intermolecular force, given boiling points or phase • Identify the particles and forces present in ionic, metallic and molecular solids • Predict the melting point and conductivities of ionic, metallic, and molecular solids • Determine the vapor pressure of a liquid at a given temperature • Determine the boiling point of a liquid from a vapor pressure curve • Label the phases of matter present on a heating or cooling curve • Label the melting point and boiling point on a heating or cooling curve • Label kinetic and potential energy changes on a heating or cooling curve • Describe the behavior and arrangement of particles in the ideal gas model • Describe the conditions of temperature and pressure that lead to ideal gas behavior • Describe the qualitative relationships between pressure, volume and temperature of an ideal gas • Solve problems using the combined gas law
Vocabulary	Solid, liquid, gas, melt, freeze, vaporize, condense, sublime, depose, intermolecular, dispersion, dipole-dipole, hydrogen bond, covalent, ionic, molecular, melting point, boiling point, heat, cool, kinetic energy, potential energy, temperature, ideal gas, pressure, volume, STP
Assessments	Heating curve lab report, volume and temperature of a gas lab report, types of solids lab report, in-class worksheets, homework assignments, end-of-unit exam
NYS Core Standards	• The three phases of matter (solids, liquids, and gases) have different properties. (3.1kk) • 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. (4.2a)

	• Temperature is a measurement of the average kinetic energy of the particles in a sample of material. Temperature is not a form of energy. (4.2b) • 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. (3.4a) • Kinetic molecular theory (KMT) for an ideal gas states that all gas particles (3.4b): 1. are in random, constant, straight-line motion. 2. are separated by great distances relative to their size; the volume of the gas particles is considered negligible. 3. have no attractive forces between them. 4. have collisions that may result in the transfer of energy between gas particles, but the total energy of the system remains constant. • Kinetic molecular theory describes the relationships of pressure, volume, temperature, velocity, and frequency and force of collisions among gas molecules. (3.4c) • Equal volumes of different gases at the same temperature and pressure contain an equal number of particles. (3.4e) • 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. (4.2c) • The structure and arrangement of particles and their interactions determine the physical state of a substance at a given temperature and pressure. (3.1jj) • 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. (5.2m) • 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. (5.2n)
ELL Differentiation	• Chemistry vocabulary contains many cognates which helps ELL students easily assimilate the technical vocabulary. Language glossaries pertinent to chemistry are made available to students who request them. Additional time is given on assessments to those students who need it. Written work emphasizes common question and answer stems, e.g. “describe change”, “compare strength of”.
SWD Differentiation	• Appropriate modifications and accommodations are made to instruction based on needs of students elucidated in their IEPs.
High Achiever Differentiation	• Chemistry is classified as a course indicative of college-readiness. High-achieving students will be made aware of this categorization, and the course and regents exam grades expected of student of their abilities.
Resources	NYS Chemistry Reference Tables, Chemistry Pearson NY Textbook, NYS Chemistry Core Curriculum, PupilPath, Class Websites

Manhattan Center for Science and Math High School

Science Department Curriculum

Discipline: Chemistry

Unit 6: Chemical Formulas and Equations

Essential Question: What do chemical formulas and equations tell us about the composition and changes of matter?

Topics	• Formulas and charges of polyatomic ions • IUPAC naming of ionic and molecular compounds • Definition of mole and molar interpretation of chemical formulas • Definition and determination of molar mass (gram-formula mass) • Conversions mass to moles and moles to mass • Percent composition of compounds • Empirical and molecular formula • Structure and interpretation of chemical equations • Balancing of chemical equations to represent conservation of mass • Mole ratios in chemical equations • Classification of equations by type
Objectives	• Write the chemical formula of a compound containing a polyatomic ion • Determine the chemical formula or name of a given ionic or molecular compound • Determine the mole ratios of elements in a chemical formula • Determine the molar mass of a given element or compound • Use the molar mass to convert mass of a substance to moles or moles to mass • Calculate the percent by mass of each component of a given compound • Define the empirical formula and convert a molecular formula into an empirical formula • Identify the reactants and products in an equation • Add smallest-whole-number coefficient to make a balanced chemical equation • Determine the missing mass in an equation using the conservation of mass law • Use mole ratios in an equation to predict the moles of a substance used or made in a reaction • Classify an equation as representing synthesis, decomposition, single replacement, or double replacement
Vocabulary	Atom, molecule, ion, polyatomic ion, formula, equation, mole, molar mass, gram-formula mass, composition, empirical, conservation, coefficient, subscript, reactant, product, synthesis, decomposition, single, replacement, double replacement
Assessments	Composition of hydrate lab report, types of reactions lab report, mole and mass lab report, in-class worksheets, homework assignments, mid and end-of-unit exam
NYS Core Standards	• 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. (3.1cc) • Types of chemical formulas include empirical, molecular, and structural. (3.1ee)

	• 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. (3.3d) • In all chemical reactions there is a conservation of mass, energy, and charge. (3.3a) • 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. (3.3c) • 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. (3.3e) • The percent composition by mass of each element in a compound can be calculated mathematically. (3.3f) • Types of chemical reactions include synthesis, decomposition, single replacement, and double replacement. (3.2b)
ELL Differentiation	• Chemistry vocabulary contains many cognates which helps ELL students easily assimilate the technical vocabulary. Language glossaries pertinent to chemistry are made available to students who request them. Additional time is given on assessments to those students who need it. Written work emphasizes common question and answer stems, e.g. "determine the", "show numerical set-up".
SWD Differentiation	• Appropriate modifications and accommodations are made to instruction based on needs of students elucidated in their IEPs.
High Achiever Differentiation	• Chemistry is classified as a course indicative of college-readiness. High-achieving students will be made aware of this categorization, and the course and regents exam grades expected of student of their abilities.
Resources	NYS Chemistry Reference Tables, Chemistry Pearson NY Textbook, NYS Chemistry Core Curriculum

Manhattan Center for Science and Math High School

Science Department Curriculum

Discipline: Chemistry

Unit 7: Solution Chemistry

Essential Question: What are the characteristic properties and behaviors of chemical solutions?

Topics	• Solution definition, composition, and notation • Solution concentration – percent by mass, parts per million, molarity • Electrolyte and non-electrolyte solutions • Saturated and unsaturated solutions • Solubility of ionic solutes • Solubility of molecular solutes • Solubility and temperature relationship • Solubility and pressure relationship • Solute effects on freezing and boiling points • Separation of solutions by distillation and chromatography
Objectives	• Identify the solute and solvent in a given solution • Use the aqueous notation to represent a solution • Calculate the percent by mass of solute in a given solution • Calculate the parts per million of solute in a given solution • Calculate the molarity of solute in a given solution • Predict whether a given solute is an electrolyte or not, and explain why • Describe the difference between a saturated and unsaturated solution • Using Table F to predict whether an ionic compound is soluble in water • Use molecular polarity to predict if a given substance is soluble in water • Use Table G to determine saturation points at different temperatures • Describe temperature and pressure conditions that maximize the solubility of gaseous solutes • Describe the effect of additional solute on the freezing point and the boiling point of a solution • Identify a chromatography apparatus and describe how it separates a solution
Vocabulary	Solute, solvent, solution, aqueous, homogeneous, mixture, concentration, molarity, saturate, soluble, insoluble, ionic, molecular, electrolyte, temperature, pressure, freezing point, boiling point, precipitate
Assessments	Solubility and precipitation lab report, solubility and temperature lab report, in-class worksheets, homework assignments, mid and end-of-unit exam
NYS Core Standards	• 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. (3.1s) • The proportions of components in a mixture can be varied. Each component in a mixture retains its original properties. (3.1t) • Differences in properties such as density, particle size, molecular polarity, boiling point and freezing

	point, and solubility permit physical separation of the components of the mixture. (3.1nn) • 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. (3.1oo) • The concentration of a solution may be expressed as molarity (M), percent by volume, percent by mass, or parts per million (ppm). (3.1pp) • 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 particles, the greater the effect. (3.1qq)
ELL Differentiation	• Chemistry vocabulary contains many cognates which helps ELL students easily assimilate the technical vocabulary. Language glossaries pertinent to chemistry are made available to students who request them. Additional time is given on assessments to those students who need it. Written work emphasizes common question and answer stems, e.g. "determine the concentration of", "describe the effect of".
SWD Differentiation	• Appropriate modifications and accommodations are made to instruction based on needs of students elucidated in their IEPs.
High Achiever Differentiation	• Chemistry is classified as a course indicative of college-readiness. High-achieving students will be made aware of this categorization, and the course and regents exam grades expected of student of their abilities.
Resources	NYS Chemistry Reference Tables, Chemistry Pearson NY Textbook, NYS Chemistry Core Curriculum

Manhattan Center for Science and Math High School

Science Department Curriculum

Discipline: Chemistry

Unit 8: Acids and Bases

Essential Question: What are the characteristic properties of acids and bases?

Topics	• What are the properties of acids and bases? • What is another way to describe acids and bases? • What is the pH scale? • How do acids and bases react with each other? • How are acid, base indicators used? • How can we find concentration of an unknown acid or base?
Objectives	• Identify acid/ bases given chemical formula • Identify H+ (H3O+) as acid and OH- as base • Describe why acids and bases are electrolytes • Identify acids and bases in a chemical equation • Describe relationships between [H+], [OH-], pH • Predict order of magnitude of [H+] based on pH change • Predict products of acid, base neutralizations • Predict pH shift of neutralization reaction • Identify suitable indicators for pH ranges • Predict indicator color given a pH • Find molarity of unknown acid or base • Read and interpret a titration data table
Vocabulary	Arrhenius acid/base definitions, Electrolytes, Bitter vs. sour, Bronsted-Lowry acid/base definitions, [H+] vs. [OH-], pH scale, Neutralization, Effect on pH, Table M, Titration
Assessments	Acids and Bases lab report, Titration lab report, in-class worksheets, homework assignments, end-of-unit exam
NYS Core Standards	• 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.(3.1ss) • On the pH scale, each decrease of one unit of pH represents a tenfold increase in hydronium ion concentration.(3.1tt) • Behavior of many acids and bases can be explained by the Arrhenius theory. Arrhenius acids and bases are electrolytes. (3.1uu) • Arrhenius acids yield H+(aq), hydrogen ion as the only positive ion in an aqueous solution. The hydrogen ion may also be written as H3O+(aq), hydronium ion. (3.1 vv) • Arrhenius bases yield OH-(aq), hydroxide ion as the only negative ion in an aqueous solution. (3.1 ww) • In the process of neutralization, an Arrhenius acid and an Arrhenius base react to form a salt and water. (3.1xx) • There are alternate acid-base theories. One theory states that an acid is an H+ donor and a base is an H+ acceptor. (3.1yy) • Titration is a laboratory process in which a volume of a solution of known concentration is used to determine the concentration of another solution. (3.1zz)

ELL Differentiation	• Chemistry vocabulary contains many cognates which helps ELL students easily assimilate the technical vocabulary. Language glossaries pertinent to chemistry are made available to students who request them. Additional time is given on assessments to those students who need it. Written work emphasizes common question and answer stems, e.g. “describe change”, “compare strength of”.
SWD Differentiation	• Appropriate modifications and accommodations are made to instruction based on needs of students elucidated in their IEPs.
High Achiever Differentiation	• Chemistry is classified as a course indicative of college-readiness. High-achieving students will be made aware of this categorization, and the course and regents exam grades expected of student of their abilities.
Resources	NYS Chemistry Reference Tables; Chemistry Glencore “Matter & Change” or Pearson NYS Chemistry; NYS Chemistry Core Curriculum; Pupil Path; Class Websites

Manhattan Center for Science and Math High School

Science Department Curriculum

Discipline: Chemistry

Unit 9: Kinetics and Thermodynamics

Essential Question: How can the rate of a chemical reaction be manipulated and what energy changes occur?

Topics	• What is collision theory? • What factors affect the rate of a chemical reaction? • How do we identify endothermic and exothermic changes? • How does potential energy change during a reaction? • What is entropy? • How do we predict if reactions are spontaneous?
Objectives	• Describe conditions for effective collisions • Draw molecular models to show reaction • Identify strategies to increase rate of reaction • Determine activation energy from a PE diagram • Show catalyst effect on activation energy • Describe endothermic and exothermic reactions based on heat flow • Identify location of heat in a chemical equation • Calculate energy changes from mole changes • Label reactants, products, activation energy, and heat of reaction on diagram • Recognize endothermic and exothermic diagrams • Show catalyst effect on diagram • Identify if reaction results in increased or decreased entropy • Rank relative entropies of phases of matter • Describe nature's tendencies for energy and entropy
Vocabulary	Effective vs. ineffective collisions, Temperature, Surface area, Concentration, Catalysts, Activation Energy, Heat flow, Enthalpy, sign of ΔH, Table I, PE Diagrams, Dispersal, disorder of particles, Low energy, high entropy tendencies
Assessments	Reaction Rates lab report, calorimetry lab report, in-class worksheets, homework assignments, end-of-unit exam
NYS Core Standards	• Collision theory states that a reaction is most likely to occur if reactant particles collide with the proper energy and orientation.(3.4d) • The rate of a chemical reaction depends on several factors: temperature, concentration, nature of the reactants, surface area, and the presence of a catalyst.(3.4f) • A catalyst provides an alternate reaction pathway, which has a lower activation energy than an uncatalyzed reaction (3.4g) • Energy released or absorbed during a chemical reaction can be represented by a potential energy diagram.(4.1c) • 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.(4.1d)

	• Entropy is a measure of the randomness or disorder of a system. A system with greater disorder has greater entropy.(3.1ll) • Systems in nature tend to undergo changes toward lower energy and higher entropy.(3.1mm)
ELL Differentiation	• Chemistry vocabulary contains many cognates which helps ELL students easily assimilate the technical vocabulary. Language glossaries pertinent to chemistry are made available to students who request them. Additional time is given on assessments to those students who need it. Written work emphasizes common question and answer stems, e.g. “describe change”, “compare strength of”.
SWD Differentiation	• Appropriate modifications and accommodations are made to instruction based on needs of students elucidated in their IEPs.
High Achiever Differentiation	• Chemistry is classified as a course indicative of college-readiness. High-achieving students will be made aware of this categorization, and the course and regents exam grades expected of student of their abilities.
Resources	NYS Chemistry Reference Tables; Chemistry Glencore “Matter & Change” or Pearson NYS Chemistry; NYS Chemistry Core Curriculum; Pupil Path; Class Websites

Manhattan Center for Science and Math High School

Science Department Curriculum

Discipline: Chemistry

Unit 10: Equilibrium

Essential Question: What are the characteristic properties of chemical reactions in equilibrium?

Topics	• How is physical equilibrium described? • How is chemical equilibrium described? • How do systems at equilibrium respond to stress? • How does a catalyst affect equilibrium? • What is the Haber process?
Objectives	• Qualitatively describe equilibrium between solid-liquid, gas-liquid, and saturated solution. • Qualitatively describe characteristics of chemical equilibrium. • Given a stress, predict shift direction • Describe effect of shift on concentrations • Give stresses that result in desired shift • Predict the effects of a catalyst on equilibrium reaction rates • Apply Le Chatelier's principle to ammonia synthesis
Vocabulary	Phase equilibrium, Solution equilibrium, Reversibility, Equal rates, Constant concentration, Le Chatelier, Concentration, Temperature, Pressure, Forward and reverse reactions increase equally, Integrate kinetics, equilibrium in a real-world application
Assessments	Le Chatelier's Principle lab report, in-class worksheets, homework assignments, end-of-unit exam
NYS Core Standards	• A catalyst provides an alternate reaction pathway, which has a lower activation energy than an uncatalyzed reaction.(3.4g) • Some chemical and physical changes can reach equilibrium.(3.4h) • 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.(3.4i) • LeChatelier's principle can be used to predict the effect of stress (change in pressure, volume, concentration, and temperature) on a system at equilibrium.(3.4j)
ELL Differentiation	• Chemistry vocabulary contains many cognates which helps ELL students easily assimilate the technical vocabulary. Language glossaries pertinent to chemistry are made available to students who request them. Additional time is given on assessments to those students who need it. Written work emphasizes common question and answer stems, e.g. "describe change", "compare strength of".

SWD Differentiation **High Achiever Differentiation**	• Appropriate modifications and accommodations are made to instruction based on needs of students elucidated in their IEPs. • Chemistry is classified as a course indicative of college-readiness. High-achieving students will be made aware of this categorization, and the course and regents exam grades expected of student of their abilities.
Resources	NYS Chemistry Reference Tables; Chemistry Glencore "Matter & Change" or Pearson NYS Chemistry; NYS Chemistry Core Curriculum; Pupil Path; Class Websites

Manhattan Center for Science and Math High School

Science Department Curriculum

Discipline: Chemistry	
Unit 11: Electrochemistry	
Essential Question: What are oxidation and reduction reactions and what are their applications?	
Topics	• Oxidation states / numbers • Oxidation and reduction • Half-reactions • Conservation of mass and charge • Oxidation and reduction activity series (Table J) • Voltaic cells • Electrolytic cell or electrolysis • Electroplating
Objectives	• Assign oxidation numbers to each species in a chemical formula • Define oxidation and reduction • Identify species oxidized and reduced in a reaction based on oxidation numbers • Identify oxidation-reduction reactions • Write balanced oxidation and reduction half-reactions • Properly balance an oxidation-reduction reaction • Predict spontaneity of a given redox reaction • Describe function of a salt bridge and a power source/battery • Describe e-flow • Define and identify anode and cathode • Write half reactions and redox reaction for the cell • Compare and contrast voltaic and electrolytic cells
Vocabulary	Oxidation state/number, oxidation, reduction, species, half-reaction, spontaneous, conserve, charge, conservation of charge, activity series, more/less active, electrochemical cell, voltaic cell, anode, cathode, salt bridge, power source, e-flow, chemical energy, electrical energy, convert, electrolytic cell, electrolysis, electroplating
Assessments	Oxidation-reduction reactions lab report, voltaic cells lab report, in-class worksheets, homework assignments, end-of-unit exam
NYS Core Standards	• An oxidation-reduction (redox) reaction involves the transfer of electrons (e-). (3.2d) • Reduction is the gain of electrons. (3.2e) • A half-reaction can be written to represent reduction. (3.2f) • Oxidation is the loss of electrons. (3.2g) • A half-reaction can be written to represent oxidation. (3.2h) • In a redox reaction the number of electrons lost is equal to the number of electrons gained. (3.3b) • Oxidation numbers (states) can be assigned to atoms and ions. Changes in oxidation numbers indicate that oxidation and reduction have occurred. (3.2i)

	• An electrochemical cell can be either voltaic or electrolytic. In an electrochemical cell, oxidation occurs at the anode and reduction at the cathode. (3.2j) • A voltaic cell spontaneously converts chemical energy to electrical energy. (3.2k) • An electrolytic cell requires electrical energy to produce chemical change. This process is known as electrolysis. (3.2l)
ELL Differentiation	• Chemistry vocabulary contains many cognates which helps ELL students easily assimilate the technical vocabulary. Language glossaries pertinent to chemistry are made available to students who request them. Additional time is given on assessments to those students who need it. Written work emphasizes common question and answer stems, e.g. "explain in terms of", "compare in terms of".
SWD Differentiation	• Appropriate modifications and accommodations are made to instruction based on needs of students elucidated in their IEPs.
High Achiever Differentiation	• Chemistry is classified as a course indicative of college-readiness. High-achieving students will be made aware of this categorization, and the course and regents exam grades expected of student of their abilities.
Resources	NYS Chemistry Reference Tables, Chemistry Pearson NY Textbook, NYS Chemistry Core Curriculum

Manhattan Center for Science and Math High School

Science Department Curriculum

Discipline: Chemistry	
Unit 12: Organic Chemistry	
Essential Question: What are the composition, structure, and properties of organic compounds?	
Topics	• Bonding of carbon • Hydrocarbons: Alkanes, alkenes, and alkynes • Isomers • Functional Groups • Organic reactions
Objectives	• Draw the structural formula for alkanes, alkenes, and alkynes given a name • Name alkanes, alkenes, and alkynes given a structural formula • Identify hydrocarbon series given the chemical formula or name • Distinguish between saturated and unsaturated hydrocarbons based on bond type • Define isomer • Draw an isomer of a given structure • Name and draw structures of branched hydrocarbons • Given a structure, identify the functional group • Given a name, draw the structure of the organic compound containing functional group and vice versa • Given a structure, draw an isomer with a different functional group • Given the reaction, identify the type of reaction • Predict reaction product(s)
Vocabulary	Hydrocarbon, multiple, covalent bond, homologous series, alkane, alkene, alkyne, isomer, functional group, alcohol, organic acid, aldehyde, ether, ester, ketone, halide or halocarbon, amine, amide, amino acid, saturated, unsaturated, straight-chain hydrocarbon, branched hydrocarbon, structural formula, halogenation, addition, substitution, fermentation, combustion, esterification, saponification, polymerization
Assessments	Molecular models of organic molecules lab report, in-class worksheets, homework assignments, end-of-unit exam
NYS Core Standards	• 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. (3.1ff) • 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. (3.1gg) • Organic acids, alcohols, esters, aldehydes, ketones, ethers, halides, amines, amides, and amino acids are categories of organic molecules that differ in their structures. Functional groups impart distinctive physical and chemical properties to organic compounds. (3.1hh) • Isomers of organic compounds have the same molecular formula but different structures and properties. (3.1ii) • 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. (5.2e) • Types of organic reactions include: addition, substitution, polymerization, esterification, fermentation, saponification, and

	combustion. (3.2c)
ELL Differentiation	• Chemistry vocabulary contains many cognates which helps ELL students easily assimilate the technical vocabulary. Language glossaries pertinent to chemistry are made available to students who request them. Additional time is given on assessments to those students who need it. Written work emphasizes common question and answer stems, e.g. “explain in terms of”, “compare in terms of”.
SWD Differentiation	• Appropriate modifications and accommodations are made to instruction based on needs of students elucidated in their IEPs.
High Achiever Differentiation	• Chemistry is classified as a course indicative of college-readiness. High-achieving students will be made aware of this categorization, and the course and regents exam grades expected of student of their abilities.
Resources	NYS Chemistry Reference Tables, Chemistry Pearson NY Textbook, NYS Chemistry Core Curriculum

Manhattan Center for Science and Math High School

Science Department Curriculum

Discipline: Chemistry

Unit 13: Nuclear Chemistry

Essential Question: What are the characteristics of nuclear reactions?

Topics	• Structure of the Nucleus • Isotopes • Radioactive decay: Alpha, beta, positron, and gamma radiation • Half-Life • Artificial or Induced transmutation: Alpha and neutron bombardment • Fusion and fission • Benefits and risks of nuclear reactions
Objectives	• Write balanced nuclear equations showing alpha, beta, and positron decay • Differentiate decay particles in terms of charge, mass, and penetrating power • Calculate # of half-lives or remaining mass given time period • Calculate # of half-lives or time period given mass ratios or fraction remaining • Identify uses of C-14, U-238, I-131, and Co-60 • Fill in missing particle in radioactive decay equations • Identify transmutations as natural or artificial • Identify fission and fusion reactions • Compare and contrast fission and fusion • Fill in a missing term in fission and fusion equations
Vocabulary	Nucleus, neutron-to-proton ratio, stable, unstable, stability, mass, charge, conservation of mass, conservation of charge, isotopes, transmutation, spontaneous, natural transmutation, radioactive decay, alpha, beta, positron, gamma, artificial or induced transmutation, charge, ionizing power, penetrating power, emission, subatomic particle(s), atomic number, mass number, bombardment, half-life, fusion, fission, radioisotopes
Assessments	Radioactive decay and half-life lab report, in-class worksheets, homework assignments, end-of-unit exam
NYS Core Standards	• Stability of isotopes 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. (3.1o) • Each radioactive isotope has a specific mode and rate of decay (half-life). (4.4a) • 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 by high-energy particles. (5.3a) • 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, and ionizing power, and penetrating power. (3.1p) • Nuclear reactions include natural and artificial transmutation, fission, and fusion. (4.4b) • There are benefits and risks associated with fission and fusion reactions. (4.4f) • Nuclear reactions can be represented by equations that include symbols which represent atomic nuclei (with the mass number and atomic number), subatomic particles (with mass number and charge), and/or emissions such as gamma radiation. (4.4c).

ELL Differentiation	• Chemistry vocabulary contains many cognates which helps ELL students easily assimilate the technical vocabulary. Language glossaries pertinent to chemistry are made available to students who request them. Additional time is given on assessments to those students who need it. Written work emphasizes common question and answer stems, e.g. “explain in terms of”, “compare in terms of”.
SWD Differentiation	• Appropriate modifications and accommodations are made to instruction based on needs of students elucidated in their IEPs.
High Achiever Differentiation	• Chemistry is classified as a course indicative of college-readiness. High-achieving students will be made aware of this categorization, and the course and regents exam grades expected of student of their abilities.
Resources	NYS Chemistry Reference Tables, Chemistry Pearson NY Textbook, NYS Chemistry Core Curriculum

Manhattan Center for Science and Math High School

Science Department Curriculum

Discipline: Chemistry	
Unit 13: Nuclear Chemistry	
Essential Question: What are the characteristics of nuclear reactions?	
Topics	• Structure of the Nucleus • Isotopes • Radioactive decay: Alpha, beta, positron, and gamma radiation • Half-Life • Artificial or Induced transmutation: Alpha and neutron bombardment • Fusion and fission • Benefits and risks of nuclear reactions
Objectives	• Write balanced nuclear equations showing alpha, beta, and positron decay • Differentiate decay particles in terms of charge, mass, and penetrating power • Calculate # of half-lives or remaining mass given time period • Calculate # of half-lives or time period given mass ratios or fraction remaining • Identify uses of C-14, U-238, I-131, and Co-60 • Fill in missing particle in radioactive decay equations • Identify transmutations as natural or artificial • Identify fission and fusion reactions • Compare and contrast fission and fusion • Fill in a missing term in fission and fusion equations
Vocabulary	Nucleus, neutron-to-proton ratio, stable, unstable, stability, mass, charge, conservation of mass, conservation of charge, isotopes, transmutation, spontaneous, natural transmutation, radioactive decay, alpha, beta, positron, gamma, artificial or induced transmutation, charge, ionizing power, penetrating power, emission, subatomic particle(s), atomic number, mass number, bombardment, half-life, fusion, fission, radioisotopes
Assessments	Radioactive decay and half-life lab report, in-class worksheets, homework assignments, end-of-unit exam
NYS Core Standards	• Stability of isotopes 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. (3.1o)

	• Each radioactive isotope has a specific mode and rate of decay (half-life). (4.4a) • 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 by high-energy particles. (5.3a) • 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, and ionizing power, and penetrating power. (3.1p) • Nuclear reactions include natural and artificial transmutation, fission, and fusion. (4.4b) • There are benefits and risks associated with fission and fusion reactions. (4.4f) • Nuclear reactions can be represented by equations that include symbols which represent atomic nuclei (with the mass number and atomic number), subatomic particles (with mass number and charge), and/or emissions such as gamma radiation. (4.4c).
ELL Differentiation	• Chemistry vocabulary contains many cognates which helps ELL students easily assimilate the technical vocabulary. Language glossaries pertinent to chemistry are made available to students who request them. Additional time is given on assessments to those students who need it. Written work emphasizes common question and answer stems, e.g. “explain in terms of”, “compare in terms of”.
SWD Differentiation	• Appropriate modifications and accommodations are made to instruction based on needs of students elucidated in their IEPs.
High Achiever Differentiation	• Chemistry is classified as a course indicative of college-readiness. High-achieving students will be made aware of this categorization, and the course and regents exam grades expected of student of their abilities.
Resources	NYS Chemistry Reference Tables, Chemistry Pearson NY Textbook, NYS Chemistry Core Curriculum