CONTENTS

ACKNOWLEDGMENTS

The State Education Department acknowledges the assistance of teachers and school administrators from across New York State and the New York State Chemistry Mentors. In particular, the State Education Department would

Table, and Amedeo Avogadro had provided keen insights into the relationships of gaseous molecules. Ernest Rutherford discovered the nucleus, and soon afterward Henry Moseley identified the atomic number as the identifying factor of the elements. Soon after, Albert Einstein proposed the insight into the interrelationship of matter and energy. Marie Curie worked with radioactive substances showing natural transmutations. Linus Pauling provided insights into the nature of the chemical bond in the 1930s, and introduced electronegativity values, an important tool in understanding bonding.

To successfully teach chemistry, teachers can interweave both the concepts and the scientists who were responsible for discovering them. Chemistry will be far more interesting when the human element can be incorporated into the lessons.

Scientific Thinking and a Scientific Method
Modern science began around the late 16th century with a new way of thinking about the world. Few scientists will disagree with Carl Sagan's assertion that "science is a way of thinking much more than it is a body of knowledge" (*Broca's Brain*, 1979). Thus science is a process of inquiry and investigation. It is a way of thinking and acting, not just a body of knowledge to be acquired by memorizing facts and principles. This way of thinking, the scientific method, is based on the idea that scientists begin their investigations with observations. From these observations they develop a hypothesis, which is extended in the form of a predication, and challenge the hypothesis through experimentation and thus further observations. Science has progressed in its understanding of nature through careful observation, a lively imagination, and increasing sophisticated instrumentation. Science is distinguished from other fields of study in that it provides guidelines or methods for conducting research, and the research findings must be reproducible by other scientists for those findings to be valid.

It is important to recognize that scientific practice is not always this systematic. Discoveries have been made that are serendipitous and others have not started with the observation of data. Einstein's theory of relativity started not with the observation of data but with a kind of intellectual puzzle.

Laboratory Requirements
Critical to understanding science concepts is the use of scientific inquiry to develop explanations of natural phenomena. Therefore, as a prerequisite for admission to the Physical Setting / Chemistry Regents Examination, students must have successfully completed 1200 minutes of laboratory experience with satisfactory reports on file. Because of the strong emphasis on student development of laboratory skills, a minimum of 280 minutes per week of class and laboratory time is recommended.

Prior to the written portion of the Regents examination, students will be required to complete a laboratory performance test during which concepts and skills from Standards 1, 2, 4, 6, and 7 will be assessed.

The Laboratory Setting
Laboratory safety dictates that a minimum amount of space be provided for each individual student. According to the National Science Teachers Association, recommended space considerations include:

- A minimum of 60 ft^2 / pupil (5.6m^2) which is equivalent to 1440 ft^2 (134m^2) to accommodate a class of 24 safely in a combination laboratory / classroom.

Science process skills should be based on a series of discoveries. Students learn most effectively when they have a central role in the discovery process. To that end, Standards 1, 2, 6, and 7 incorporate in the Chemistry Core Curriculum *a student-centered, problem-solving approach to chemistry. This list is not intended to be an all-inclusive list of the content or skills that teachers are expected to incorporate into their curriculum. It should be a goal of the instructor to encourage science process skills that will provide students with background and curiosity to investigate important issues in the world around them.*

Note: The use of e.g. *denotes examples which may be used for in-depth study. The terms* for example *and* such as *denote material which is testable. Items in parentheses denote further definition of the word(s) preceding the item and are testable.*

STANDARD 1
Analysis, Inquiry, and Design

MATHEMATICAL

STANDARD 1 Analysis, Inquiry, and Design	
	• Devise a test of the solution according to the design criteria and perform the test; record, portray, and logically evaluate performance test results through quantitative, graphic, and verbal means. Use a variety of creative verbal and graphic techniques effectively and persuasively to present conclusions, predict impact and new problems, and suggest and pursue modifications.

STANDARD 6 Interconnectedness: Common Themes MODELS:	*Key Idea 2:* Models are simplified representations of objects, structures, or systems used in analysis, explanation, interpretation, or design. 2.1 Revise a model to create a more complete or improved representation of the system. • show how models are revised in response to experimental evidence, e.g., atomic theory, Periodic Table 2.2 Collect information about the behavior of a system and use modeling tools to represent the operation of the system. • show how information about a system is used to create a model, e.g., kinetic molecular theory (KMT) 2.3 Find and use mathematical models that behave in the same manner as the processes under investigation. • show how mathematical models (equations) describe a process, e.g., combined gas law 2.4 Compare predictions to actual observations, using test models. • compare experimental results to a predicted value, e.g., percent error

STANDARD 6 Interconnectedness: Common Themes MAGNITUDE AND SCALE:	*Key Idea 3:* The grouping of magnitudes of size, time, frequency, and pressures or other units of measurement into a series of relative order provides a useful way to deal with the immense range and the changes in scale that affect the behavior and design of systems. 3.1 Describe the effects of changes in scale on the functioning of physical, biological, or designed information systems. • show how microscale processes can resemble or differ from real-world processes, e.g., microscale chemistry 3.2 Extend the use of powers of ten notation to understanding the exponential function and performing operations with exponential factors. • use powers often to represent a large range of values for a physical quantity, e.g., pH scale

STANDARD 6 Interconnectedness: Common Themes EQUILIBRIUM AND STABILITY:	*Key Idea 4:* Equilibrium is a state of stability due either to a lack of change (static equilibrium) or a balance between opposing forces (dynamic equilibrium). 4.1 Describe specific instances of how disturbances might affect a system's equilibrium, from small disturbances that do not upset the equilibrium to larger disturbances (threshold level) that cause the system to become unstable. • explain how a small change might not affect a system, e.g., activation energy 4.2 Cite specific examples of how dynamic equilibrium is achieved by equality of change in opposing directions. • explain how a system returns to equilibrium in response to a stress, e.g., LeChatelier's principle

STANDARD 6 **Interconnectedness: Common Themes** **PATTERNS OF**	*Key Idea 5:* Identifying patterns of change is necessary for making predictions about future behavior and conditions. Examples include: • use graphs to make predictions, e.g., half-life, solubility

STANDARD 7 Interdisciplinary Problem Solving STRATEGIES:	*Key Idea 2:* Solving interdisciplinary problems involves a variety of skills and strategies, including effective work habits; gathering and processing information; generating and analyzing ideas; realizing ideas; making connections among the common themes of mathematics, science, and technology; and presenting results. If students are asked to do a project, then the project would require students to: • work effectively • gather and process information • generate and analyze ideas • observe common themes • realize ideas • present results

STANDARD 4
The Physical Setting

continued

- xxi draw structural formulas for alkanes, alkenes, and alkynes containing a maximum of ten carbon atoms
- xxii use a simple particle model to differentiate among properties of solids, liquids, and gases
- xxiii compare the entropy of phases of matter
- xxiv describe the processes and uses of filtration, distillation, and chromatography in the separation of a mixture
- xxv interpret and construct solubility curves
- xxvi apply the adage “like dissolves like” to real-world situations
- xxvii interpret solution concentration data
- xxviii use solubility curves to distinguish among saturated, supersaturated, and unsaturated solutions
- xxix calculate solution concentration in molarity (M), percent mass, and parts per million (ppm)
- xxx describe the preparation of a solution, given the molarity
- xxxi given properties, identify substances as Arrhenius acids or Arrhenius bases
- xxxii identify solutions as acid, base, or neutral based upon the pH
- xxxiii interpret changes in acid-base indicator color
- xxxiv write simple neutralization reactions when given the reactants
- xxxv calculate the concentration or volume of a solution, using titration data
- xxxvi use particle models / diagrams to differentiate among elements, compounds, and mixtures

3.2 Use atomic and molecular models to explain common chemical reactions.

- i distinguish between chemical and physical changes
- ii identify types of chemical reactions
- iii determine a missing reactant or product in a balanced equation
- iv identify organic reactions
- v balance equations, given the formulas of reactants and products
- vi write and balance half-reactions for oxidation and reduction of free elements and their monatomic ions
- vii identify and label the parts of a voltaic cell (cathode, anode, salt bridge) and direction of electron flow, given the reaction equation
- viii identify and label the parts of an electrolytic cell (cathode, anode) and direction of electron flow, given the reaction equation
- ix compare and contrast voltaic and electrolytic cells
- x use an activity series to determine whether a redox reaction is spontaneous

3.3

STANDARD 4 The Physical Setting continued		
	4.4 Explain the benefits and risks of radioactivity.	
	i calculate the initial amount, the fraction remaining, or the half-life of a radioactive isotope, given two of the three variables	4.4a
	ii compare and contrast fission and fusion reactions	4.4b, 4.4f, 5.3b
	iii complete nuclear equations; predict missing particles from nuclear equations	4.4c
	iv identify specific uses of some common radioisotopes, such as I-131 in diagnosing and treating thyroid disorders, C-14 to C-12 ratio in dating once-living organisms, U-238 to Pb-206 ratio in dating geological formations, and Co-60 in treating cancer	4.4d
	Key Idea 5: Energy and matter interact through forces that result in changes in motion.	
	5.2 Students will explain chemical bonding in terms of the behavior of electrons.	
	i demonstrate bonding concepts, using Lewis dot structures rep-	5.2a, 5.2d

PERFORMANCE INDICATOR 3.1

continued

3.1d The proton is positively charged, and the neutron has no charge. The electron is negatively charged.

3.1e Protons and electrons have equal but opposite charges. The number of protons equals the number of electrons in an atom.

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.

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}C, $^{14}_{6}C$, carbon-14, C-14.

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).

PERFORMANCE INDICATOR 3.1

continued

3.1jj The structure and arrangement of particles and their interactions determine the physical state of a substance at a given temperature and pressure.

3.1kk The three phases of matter (solids, liquids, and gases) have different properties.

3.1ll Entropy is a measure of the randomness or disorder of a system. A system with greater disorder has greater entropy.

3.1mm Systems in nature tend to undergo changes toward lower energy and higher entropy.

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.

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.

3.1pp The concentration of a solution may be expressed in molarity (M), percent by volume, percent by mass, or parts per million (ppm).

3.1qq 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.

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.

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.

3.1tt On the pH scale, each decrease of one unit of pH represents a tenfold increase in hydronium ion concentration.

3.1uu Behavior of many acids and bases can be explained by the Arrhenius theory. Arrhenius acids and bases are electrolytes.

3.1vv Arrhenius acids yield $H^+(aq)$, hydrogen ion as the only positive ion in an aqueous solution. The hydrogen ion may also be written as $H_3O^+(aq)$, hydronium ion.

3.1ww Arrhenius bases yield $OH^-(aq)$, hydroxide ion as the only negative ion in an

PERFORMANCE INDICATOR 3.2

Use atomic and molecular models to explain common chemical reactions.

Major Understandings:

3.2a 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.

3.2b Types of chemical reactions include synthesis, decomposition, single replacement, and double replacement.

3.2c Types of organic reactions include addition, substitution, polymerization, esterification, fermentation, saponification, and combustion.

3.2d An oxidation-reduction (redox) reaction involves the transfer of electrons (e^-).

3.2e Reduction is the gain of electrons.

3.2f

PERFORMANCE INDICATOR 3.3

PERFORMANCE INDICATOR 3.4 Use kinetic molecular theory (KMT) to explain rates of reactions and the relationships among temperature, pressure, and volume of a substance.

Major Understandings:

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.

3.4b Kinetic molecular theory (KMT) for an ideal gas states that all gas particles:

•

PERFORMANCE

CHEMISTRY CORE TOPICS

This section contains ten topic areas in which the major understandings found in the core are sorted by content topic. These ten topic areas may be used for ease in curriculum writing; however, they do not connote a suggested scope and sequence.

II.

III.7 The percent composition by mass of each element in a compound can be calculated mathematically. (3.3f)

III.8 Types of chemical reactions include synthesis, decomposition, single replacement, and double replacement. (3.2b)

IV. Chemical Bonding

IV.1

V.1 Matter is classified as a pure substance or as a mixture of substances. (3.1q)

V.2 The three phases of matter (solids, liquids, and gases) have different properties. (3.1kk)

V.3 A pure substance (element or compound) has a constant composition and constant properties throughout a given sample, and from sample to sample. (3.1r)

V.4 Elements are substances that are composed of atoms that have the same atomic number. Elements cannot be broken down by chemical change. (3.1u)

V.5 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)

V.6 The proportions of components in a mixture can be varied. Each component in a mixture retains its original properties. (3.1t)

V.7 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)

V.8 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)

V.9 The concentration of a solution may be expressed as molarity (M), percent by volume, percent by mass, or parts per million (ppm). (3.1pp)

V.10 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)

V.11 Energy can exist in different forms, such as chemical, electrical, electromagnetic, thermal, mechanical, and nuclear. (4.1a)

V.12 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)

V.13 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)

V.14 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)

V.15 Kinetic molecular theory (KMT) for an ideal gas states that all gas particles (3.4b):

1. are in random, constant, straight-line motion.
2.

V.16 Collision theory states that a reaction is most likely to occur if reactant particles collide with the proper energy and orientation. (3.4d)

V.17 Kinetic molecular theory describes the relationships of pressure, volume, temperature, velocity, and frequency and force of collisions among gas molecules. (3.4c)

V.18 Equal volumes of different gases at the same temperature and pressure contain an equal number of particles. (3.4e)

V.19 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)

V.20 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)

V.21 Chemical and physical changes can be exothermic or endothermic. (4.1b)

V.22 The structure and arrangement of particles and their interactions determine the physical state of a substance at a given temperature and pressure. (3.1jj)

V.23 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)

V.24 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)

VI. Kinetics/Equilibrium

VI.1 Collision theory states that a reaction is most likely to occur if reactant particles collide with the proper energy and orientation. (3.4d)

VI.2 The rate of a chemical reaction depends on several factors: temperature, concentration, nature of reactants, surface area, and the presence of a catalyst. (3.4f)

VI.3 Some chemical and physical changes can reach equilibrium. (3.4h)

VI.4 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)

VI.5 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)

VI.6 Energy released or absorbed by a chemical reaction can be represented by a potential energy diagram. (4.1c)

VI.7 Energy released or absorbed during a chemical reaction (heat of reaction) is equal to the difference between the potential energy of the products and the potential energy of the reactants. (4.1d)

VI.8 A catalyst provides an alternate reaction pathway, which has a lower activation energy than an uncatalyzed reaction. (3.4g)

VI.9 Entropy is a measure of the randomness or disorder of a system. A system with greater disorder has greater entropy. (3.1ll)

VI.10 Systems in nature tend to undergo changes toward lower energy and higher entropy. (3.1mm)

VII. Organic Chemistry

VII.1 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)

VII.2 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)

VII.3 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)

VII.4 Isomers of organic compounds have the same molecular formula but different structures and properties. (3.1ii)

VII.5 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)

VII.6 Types of organic reactions include: addition, substitution, polymerization, esterification, fermentation, saponification, and combustion. (3.2c)

VIII. Oxidation-Reduction

VIII.1 An oxidation-reduction (redox) reaction involves the transfer of electrons (e^-). (3.2d)

VIII.2 Reduction is the gain of electrons. (3.2e)

VIII.3 A half-reaction can be written to represent reduction. (3.2f)

VIII.4 Oxidation is the loss of electrons. (3.2g)

VIII.5 A half-reaction can be written to represent oxidation. (3.2h)

VIII.6 In a redox reaction the number of electrons lost is equal to the number of electrons gained. (3.3b)

VIII.7 Oxidation numbers (states) can be assigned to atoms and ions. Changes in oxidation numbers indicate that oxidation and reduction have occurred. (3.2i)

VIII.8 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)

VIII.9 A voltaic cell spontaneously converts chemical energy to electrical energy. (3.2k)

VIII.10 An electrolytic cell requires electrical energy to produce chemical change. This process is known as

IX. Acids, Bases, and Salts

IX.1

X.8 Energy released in a nuclear reaction (fission or fusion) comes from the fractional amount of mass converted into energy. Nuclear changes convert matter into energy. (5.3b)

X.9 Energy released during nuclear reactions is much greater than the energy released during chemical reactions. (5.3c)

X.10 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. (4.4e)

X.11 Radioactive isotopes have many beneficial uses. Radioactive isotopes are used in medicine and industrial chemistry, e.g., radioactive dating, tracing chemical and biological processes, industrial measurement, nuclear power, and detection and treatment of disease. (4.4d)

PHYSICAL SETTING/CHEMISTRY CONTENT CONNECTIONS TABLE

The Content Connections Table has been designed to assist teachers in curriculum writing and lesson planning. Some of the listed major understandings have a related skill and / or real-world connection to a specific content focus area. The scope of the content connections and skills is not meant to be limited; i.e., a skill may be connected to more than one major understanding.

Additionally, real-world connections have been identified only to assist teachers in planning and are not meant to link these connections to any assessment.

Students will understand and apply scientific concepts, principles, and theories pertaining to the physical setting and living environment and recognize the historical development of ideas in science.

KEY			SKILLS The student should be able to:	REAL-WORLD CONNECTIONS
3.1a			relate experimental evidence (given in the introduction of Key Idea 3) to models of the atom (3.1ii)	
3.1b			use models to describe the structure of an atom (3.1i)	
3.1c				
3.1d				
3.1e			determine the number of protons or electrons in an atom or ion when given one of these values (3.1iii)	
3.1f			calculate the mass of an atom, the number of neutrons or the number of protons, given the other two values (3.1iv)	◆ lasers

KEY	LINK TO APPENDIX A	MAJOR UNDERSTANDINGS	SKILLS The student should be able to:	REAL-WORLD CONNECTIONS
3.1z	II.7	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.	determine the group of an element, given the chemical formula of a compound, e.g., XCl or XCl_2 (3.1xv)	
3.1aa	II.8	The succession of elements within the same group demonstrates characteristic trends: differences in atomic radius, ionic radius, electronegativity, first ionization energy, metallic / nonmetallic properties.	compare and contrast properties of elements within a group or a period for Groups 1, 2, 13-18 on the Periodic Table (3.1xiv)	
3.1bb	II.9	The succession of elements across the same period demonstrates characteristic trends: differences in atomic radius, ionic radius, electronegativity, first ionization energy, metallic / nonmetallic properties.		
3.1cc	III.1	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.		◆ reading food and beverage labels (consumer Chemistry)
3.1ee	III.2	Types of chemical formulas include: empirical, molecular, and structural.		

KEY	LINK TO APPENDIX A	MAJOR UNDERSTANDINGS	SKILLS The student should be able to:	REAL-WORLD CONNECTIONS
3.3d	III.3	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.	determine the molecular formula, given the empirical formula and molecular mass (3.3vii) determine the empirical formula from a molecular formula (3.3v)	
3.3a	III.4	In all chemical reactions there is a conservation of mass, energy, and charge.	interpret balanced chemical equations in terms of conservation of matter and energy (3.3ii)	
3.3c	III.5	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.	balance equations, given the formulas for reactants and products (3.3i) interpret balanced chemical equations in terms of conservation of matter and energy (3.3ii) create and use models of particles to demonstrate balanced equations (3.3iii) calculate simple mole-mole stoichiometry problems, given a balanced equation (3.3iv)	
3.3e	III.6	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.	calculate the formula mass and the gram-formula mass (3.3viii)	
3.3f	III.7	The percent composition by mass of each element in a compound can be calculated mathematically.	determine the number of moles of a substance, given its mass (3.3ix) determine the mass of a given number of moles of a substance (3.3vi)	

KEY	LINK TO	MAJOR	SKILLS	REAL-WORLD
	III.8			

KEY	LINK TO APPENDIX A	MAJOR UNDERSTANDINGS	SKILLS The student should be able to:	REAL-WORLD CONNECTIONS
5.2c	IV.6	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.		
5.2i	IV.7	When a bond is broken, energy is absorbed. When a bond is formed, energy is released.		
5.2b	IV.8			
5.2n	IV.9			
5.2d	IV.10			
5.2j	IV.11			

KEY	LINK TO APPENDIX A	MAJOR UNDERSTANDINGS	SKILLS The student should be able to:	REAL-WORLD CONNECTIONS
5.2k	IV.12	The electronegativity difference between two bonded atoms is used to assess the degree of polarity in the bond.	distinguish between nonpolar covalent bonds (two of the same nonmetals) and polar covalent bonds (5.2v)	
5.2h	IV.13	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.		
3.1q	V.1	Matter is classified as a pure substance or as a mixture of substances.		
3.1kk	V.2	The three phases of matter (solids, liquids, and gases) have different properties.	use a simple particle model to differentiate among properties of a solid, a liquid, and a gas (3.1xxii)	◆ common everyday examples of solids, liquids, and gases ◆ nature of H_2O in our environment ◆ solids " metallic " crystalline " amorphous (quartz glass, opals) " solid state ◆ liquids " surface tension " capillary " viscosity ◆ gases " real and ideal gases
		compound) has a constant	use particle models / diagrams	

	LINK TO		SKILLS	

KEY	LINK TO APPENDIX A	MAJOR UNDERSTANDINGS	SKILLS The student should be able to:	REAL-WORLD CONNECTIONS
3.1pp	V.9			
3.1qq	V.10			
	V.11			

KEY	LINK TO APPENDIX A	MAJOR UNDERSTANDINGS	SKILLS The student should be able to:	REAL-WORLD CONNECTIONS
3.4b	V.15	Kinetic molecular theory (KMT) for an ideal gas states all gas particles: ◆ are in random, constant, straight-line motion ◆ are separated by great distances relative to their size; the volume of gas particles is considered negligible ◆ have no attractive forces between them ◆ have collisions that may result in a transfer of energy between particles, but the total energy of the system remains constant.		
3.4d	V.16	Collision theory states that a reaction is most likely to occur if reactant particles collide with the proper energy and orientation.		
3.4c	V.17	Kinetic molecular theory describes the relationships of pressure, volume, temperature, velocity, and frequency and force of collisions among gas molecules.	explain the gas laws in terms of KMT (3.4i) solve problems, using the combined gas law (3.4ii)	
3.4e	V.18	Equal volumes of gases at the same temperature and pressure contain an equal number	convert temperatures in Celsius degrees (^{o}C) to kelvins (K), and kelvins to Celsius degrees	
(3.4iii)82 25TJETEMC øftparticles.(3. / P ≮Mt h632iles. (3.4iii)ation. 3.4i) changeKMT ky and force of c(h632))fut a(3.4iii8.4iTJET(c sdescte0001 h632invsingd0 Tw TjEith the pr)17.(eph2 T)or pres-				
4.2c	V.19			

[illegible]				

KEY	LINK TO APPENDIX A	MAJOR UNDERSTANDINGS	SKILLS The student should be able to:	REAL-WORLD CONNECTIONS
3.4d	VI.1	Collision theory states that a reaction is most likely to occur if reactant particles collide with the proper energy and orientation.	use collision theory to explain how various factors, such as temperature, surface area, and concentration, influence the rate of reaction (3.4vi)	◆ synthesis of compounds
3.4f	VI.2	The rate of a chemical reaction depends on several factors: temperature, concentration, nature of reactants, surface area, and the presence of a catalyst.		◆ catalysts and inhibitors
3.4h	VI.3	Some chemical and physical changes can reach equilibrium.	identify examples of physical equilibria as solution equilibrium and phase equilibrium, including the concept that a saturated solution is at equilibrium (3.4 vii)	◆ balloons
3.4i	VI.4	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.	describe the concentration of particles and rates of opposing reactions in an equilibrium system (3.4iv)	
3.4j	VI.5	LeChatelier's principle can be used to predict the effect of stress (change in pressure, volume, concentration, and temperature) on a system at equilibrium.	qualitatively describe the effect of stress on equilibrium, using LeChatelier's principle (3.4v)	◆ Haber process
4.1c	VI.6	Energy released or absorbed by a chemical reaction can be represented by a potential energy diagram.	read and interpret potential energy diagrams: PE of reactants and products, activation energy (with or without a catalyst), heat of reaction (4.1ii)	
4.1d	VI.7	Energy released or absorbed by a chemical reaction (heat of reaction) is equal to the difference between the potential energy of the products and the potential energy of the reactants.		◆ burning fossil fuels ◆ photosynthesis ◆ production of photochemical smog

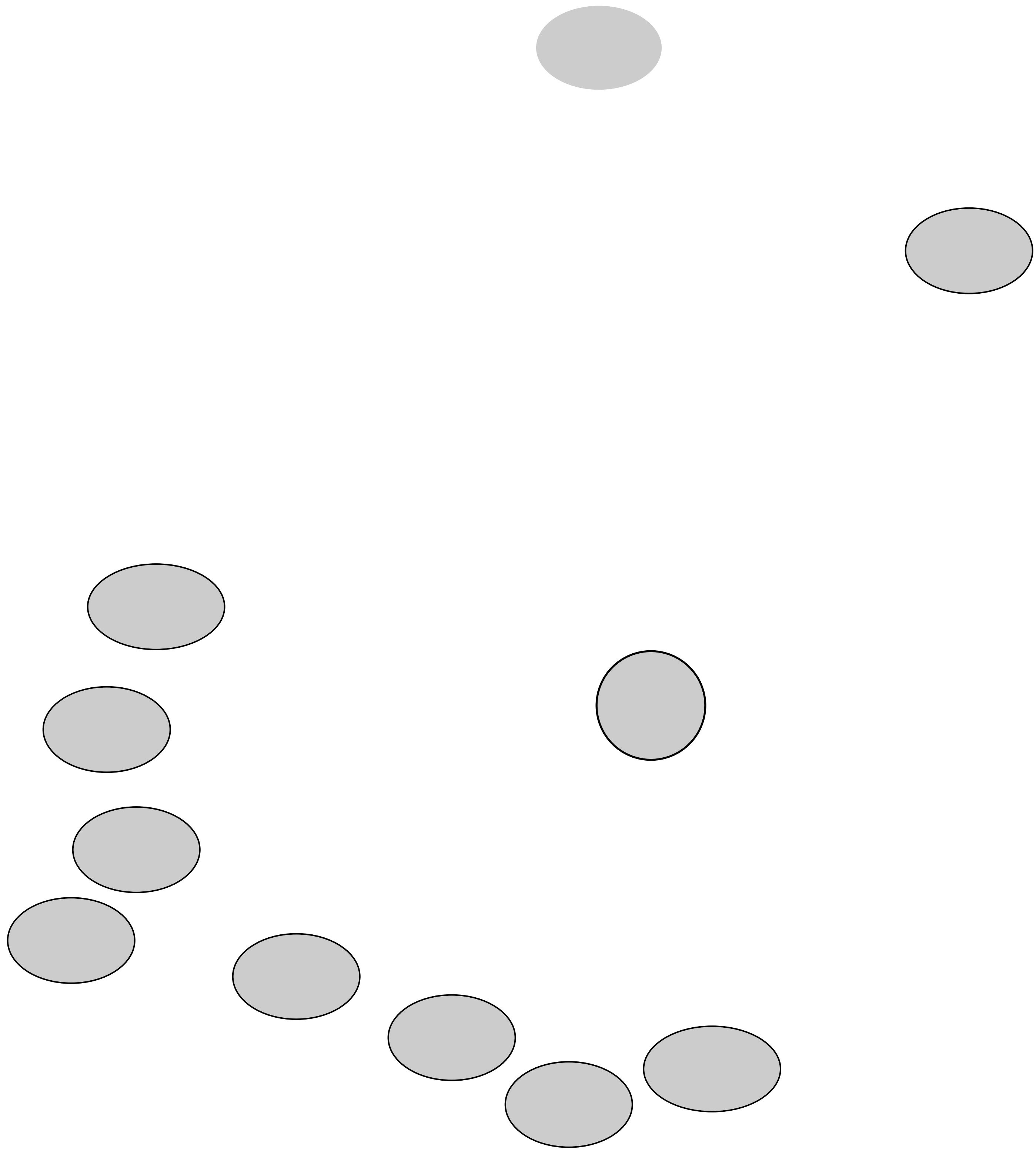
KEY	LINK TO APPENDIX A	MAJOR UNDERSTANDINGS	SKILLS The student should be able to:	

KEY	LINK TO APPENDIX A	MAJOR UNDERSTANDINGS	SKILLS The student should be able to:	REAL-WORLD CONNECTIONS
3.2h	VIII.5	A half-reaction can be written to represent oxidation.		
3.3b	VIII.6	In a redox reaction the number of electrons lost is equal to the number of electrons gained.		
3.2i	VIII.7	Oxidation numbers (states) can be assigned to atoms and ions. Changes in oxidation numbers indicate that oxidation and reduction have occurred.		
3.2j	VIII.8	An electrochemical cell can be either voltaic or electrolytic. In an electrochemical cell, oxidation occurs at the anode and reduction at the cathode.	compare and contrast voltaic and electrolytic cells (3.2ix)	◆ patina (copper—Statue of Liberty)
3.2k	VIII.9	A voltaic cell spontaneously converts chemical energy to electrical energy.	identify and label the parts of a voltaic cell (cathode, anode, salt bridge) and direction of electron flow, given the reaction equation (3.2vii) use an activity series to determine whether a redox reaction is spontaneous (3.2x)	
3.2l	VIII.10	An electrolytic cell requires electrical energy to produce chemical change. This process is known as electrolysis.	identify and label the parts of an electrolytic cell (anode, cathode) and direction of electron flow, given the reaction equation (3.2viii)	◆ metallurgy of iron and steel ◆ electroplating

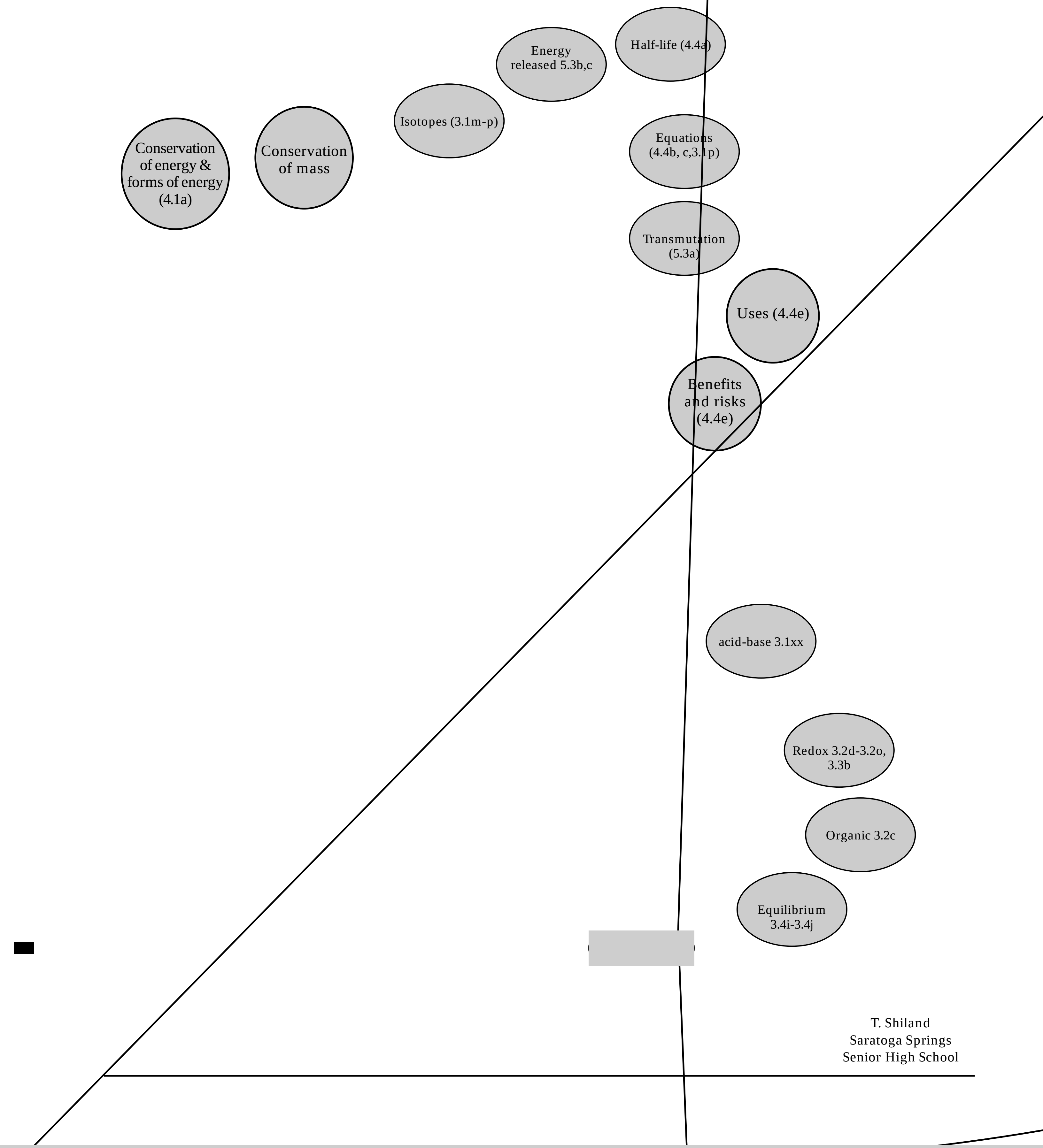
KEY	LINK TO APPENDIX A	MAJOR UNDERSTANDINGS	SKILLS The student should be able to:	REAL-WORLD CONNECTIONS
	IX.1	Behavior of many acids and bases can be explained by the		

	LINK TO		SKILLS	
	IX.8			

KEY	LINK TO APPENDIX A	MAJOR UNDERSTANDINGS	SKILLS The student should be able to:	REAL-WORLD CONNECTIONS
4.4b 4				



This is an example of how the chemistry core might be presented during the year. It is a suggested format from the New York State Education Department.



T. Shiland
Saratoga Springs
Senior High School