LAB-AIDS CORRELATIONS TO NEW YORK SCIENCE STANDARDS

HIGH SCHOOL CHEMISTRY[1]

A Natural Approach to Chemistry (NAC) is written by Hsu, Chaniotakis, Carlisle, and Damelin, and is published by, and available exclusively from, LAB-AIDS, Ronkonkoma NY.

This correlation was prepared by Mark Koker, Ph D, Director of Curriculum and Training at LAB-AIDS, and is intended to show selected locations in *NAC* programs that support the New York State Core Curriculum Standards for chemistry.

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[1] http://www.p12.nysed.gov/ciai/mst/pub/chemist.pdf

The Natural Approach to Chemistry		
THEMES		
Energy is a unifying theme that explains why chemistry occurs		
The atomic model of matter is consistently woven through every chapter		
Understanding of 'why' chemistry occurs is emphasized		
Principles are illustrated with examples from the human body and the environment		
ORGANIZATION OF CONTENT		
Fundamentals	Chapters 1 -4	Present comprehensive overview of all main ideas in chemistry such as the atomic nature of matter, systems, temperature, and energy. *"Big Picture"*
Core Concepts	Chapters 5 -14	Present in-depth coverage of all major topic areas. They developed usable understanding of the big ideas laid out in the first four chapters. The treatment includes strong conceptual development as well as algebra-based quantitative problem solving. *All academic content and instruction standards for chemistry have been met by the end of Chapter 14.*
Applications	Chapter 15 - 21	Provide deeper exploration of significant areas of interest in chemistry. *Examples include rechargeable batteries, materials science, planetary atmospheres, etc.*
COMPLETE LEARNING SYSTEM		
Coordinated student textbook		
Integrated laboratory investigations manual containing 58 labs to choose from		
New laboratory control, data collection and probe system		
Evaluation elements throughout the curriculum (student book and lab investigation manual) through which student knowledge or skills are assessed or applied		

Correlation Citation Reference Key:

Locations are given in the student book (SB) and/or laboratory manual (LM).

1.2

Means Student Book Chapter 1 Section 1.2 pages 19 – 25

LM 1A, 3D, 11A

Means Lab Investigations Manual Chapter 1 Investigation 1A;

Chapter 3 Investigation 3D;

Chapter 11 Investigation 11A

Relevant questions from the student book (SB) and lab manual (LM) problem sets and questions are indicated, e.g.,

2: 2-4, 31, 47-48

Means Student Book Chapter 2 questions 2-4, question 31 and questions 47-48

STANDARD 4: The Physical Setting

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 Idea 3: Matter is made up of particles whose properties determine the observable characteristics of matter and its reactivity.

NEW YORK CHEMISTRY PERFORMANCE INDICATOR	NAC LOCATION	WHERE ASSESSED
3.1 Explain the properties of materials in terms of the arrangement and properties of the atoms that compose them. Major Understandings:		
3.1a The modern model of the atom has evolved over a long period of time through the work of many scientists.	5.1 LM 5A	5: 23-24, 28, 29-33, 52
3.1b Each atom has a nucleus, with an overall positive charge, surrounded by negatively charged electrons.	5.1 LM 5A	5: 17, 19, 29, 31, 32, 37-40, 71-72, 74
3.1c Subatomic particles contained in the nucleus include protons and neutrons.	5.1 LM 5A	
3.1d The proton is positively charged, and the neutron has no charge. The electron is negatively charged.	5.1 LM 5A	
3.1e Protons and electrons have equal but opposite charges. The number of protons equals the number of electrons in an atom.	5.1 LM 5A	5: 32, 38-40
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.	5.1	5: 71-72,
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: 14C, 14C, carbon-14, C-14. 6	5.1 LM 5A	5: 32, 38-40, 73, 76
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).	5.2	5: 42-51, 68
3.1i Each electron in an atom has its own distinct amount of energy.	5.2 LM 5A	5: 42-51, 68
3.1j When an electron in an atom gains a specific amount of energy, the electron is at a higher energy	5.2	5: 68-70

NEW YORK CHEMISTRY PERFORMANCE INDICATOR	NAC LOCATION	WHERE ASSESSED
state (excited state).		
3.1k When an electron returns from a higher energy state to a lower energy state, a specific amount of energy is emitted. This emitted energy can be used to identify an element.	5.2 LM 5B, 5C	5: 68-70
3.1l The outermost electrons in an atom are called the valence electrons. In general, the number of valence electrons affects the chemical properties of an element.	6.3 LM 6C	6: 31-39
3.1m Atoms of an element that contain the same number of protons but a different number of neutrons are called isotopes of that element.	5.1 LM 5A	5: 73-74
3.1n The average atomic mass of an element is the weighted average of the masses of its naturally occurring isotopes.	5.1 LM 5A	5: 22, 73, 74, 76
3.1o Stability of an isotope is based on the ratio of neutrons and protons in its nucleus. Although most nuclei are stable, some are unstable and spontaneously decay, emitting radiation.	5.1, 20.2 LM 20B	20: 2-23, 44-46, 51-53
3.1p Spontaneous decay can involve the release of alpha particles, beta particles, positrons, and/or gamma radiation from the nucleus of an unstable isotope. These emissions differ in mass, charge, ionizing power, and penetrating power.	20.2 LM 20B	20: 2-23, 44-46, 51-53
3.1q Matter is classified as a pure substance or as a mixture of substances.	2.1 LM 2A	2: 2-4, 31, 47-48
3.1r A pure substance (element or compound) has a constant composition and constant properties throughout a given sample, and from sample to sample.	2.1, 2.3 LM 2A	2: 2, 4, 12-14, 42, 43, 44, 46
3.1s Mixtures are composed of two or more different substances that can be separated by physical means. When different substances are mixed together, a homogeneous or heterogeneous mixture is formed.	2.3 LM 2A	2: 2-4, 31, 47-48
3.1t The proportions of components in a mixture can be varied. Each component in a mixture retains its original properties.	2.3 LM 2A	2: 2-4, 31, 47-48
3.1u Elements are substances that are composed of atoms that have the same atomic number. Elements cannot be broken down by chemical change.	2.1	2: 2, 4, 12
3.1v Elements can be classified by their properties and located on the Periodic Table as metals,	6.1 LM 6A, 6B	6: 14, 29, 37, 43, 44

NEW YORK CHEMISTRY PERFORMANCE INDICATOR	NAC LOCATION	WHERE ASSESSED
nonmetals, metalloids (B, Si, Ge, As, Sb, Te), and noble gases.		
3.1w Elements can be differentiated by physical properties. Physical properties of substances, such as density, conductivity, malleability, solubility, and hardness, differ among elements.	2.1 LM 6A, 6B	2: 26, 30
3.1x Elements can also be differentiated by chemical properties. Chemical properties describe how an element behaves during a chemical reaction.	2.1	2: 5, 32-37
3.1y The placement or location of an element on the Periodic Table gives an indication of the physical and chemical properties of that element. The elements on the Periodic Table are arranged in order of increasing atomic number.	2.1, 6.2	2: 38, 39 6: 48, 49
3.1z For Groups 1, 2, and 13-18 on the Periodic Table, elements within the same group have the same number of valence electrons (helium is an exception) and therefore similar chemical properties.	6.2, 6.3 LM 6C	6: 37, 42, 43
3.1aa The succession of elements within the same group demonstrates characteristic trends: differences in atomic radius, ionic radius, electronegativity, first ionization energy, metallic/nonmetallic properties.	6.2	6: 25-29, 35, 37, 38, 42, 43
3.1bb The succession of elements across the same period demonstrates characteristic trends: differences in atomic radius, ionic radius, electronegativity, first ionization energy, metallic/nonmetallic properties.	6.2	6: 25-29, 35, 37, 38, 42, 43
3.1cc A compound is a substance composed of two or more different elements that are chemically combined in a fixed proportion. A chemical compound can be broken down by chemical means. A chemical compound can be represented by a specific chemical formula and assigned a name based on the IUPAC system.	2.2 LM 2B	2: 12, 13, 42, 44, 46, 64-67
3.1dd Compounds can be differentiated by their physical and chemical properties.	2.2	2: 12, 13, 42, 44, 46, 64-67
3.1ee Types of chemical formulas include empirical, molecular, and structural.	2.2 LM 2B	2: 42, 44, 46, 64-67
3.1ff Organic compounds contain carbon atoms, which bond to one another in chains, rings, and	17.1, 17.2	17: 32-36, 39, 40, 47

NEW YORK CHEMISTRY PERFORMANCE INDICATOR	NAC LOCATION	WHERE ASSESSED
networks to form a variety of structures. Organic compounds can be named using the IUPAC system.		
3.1gg Hydrocarbons are compounds that contain only carbon and hydrogen. Saturated hydrocarbons contain only single carbon-carbon bonds. Unsaturated hydrocarbons contain at least one multiple carbon-carbon bond.	17.1	17: 32-36
3.1hh Organic acids, alcohols, esters, aldehydes, ketones, ethers, halides, amines, amides, and amino acids are categories of organic compounds that differ in their structures. Functional groups impart distinctive physical and chemical properties to organic compounds.	17.2	17: 55-60
3.1ii Isomers of organic compounds have the same molecular formula, but different structures and properties.	17.1	17: 48-51
3.1jj The structure and arrangement of particles and their interactions determine the physical state of a substance at a given temperature and pressure.	3.3 LM 3A	3: 22, 24, 31, 33, 48
3.1kk The three phases of matter (solids, liquids, and gases) have different properties.	3.3 LM 3A	3: 22, 24, 31, 33, 48
3.1ll Entropy is a measure of the randomness or disorder of a system. A system with greater disorder has greater entropy.	9.3	9: 26, 67
3.1mm Systems in nature tend to undergo changes toward lower energy and higher entropy.	9.3	9: 26, 67
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.	2.3, 9.3 LM 2D, 9A	2: 30-31
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.	9.1 LM 9A, 9B	9: 1, 4, 28, 20, 46, 47-50, 56-59
3.1pp The concentration of a solution may be expressed in molarity (M), percent by volume, percent by mass, or parts per million (ppm).	9.2 LM 9A	9: 76-81
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.	9.2	9: 82-87

NEW YORK CHEMISTRY PERFORMANCE INDICATOR	NAC LOCATION	WHERE ASSESSED
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.	15.5	15: 32, 65, 67-68
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.	13.2 LM 13A	13: 35-44
3.1tt On the pH scale, each decrease of one unit of pH represents a ten-fold increase in hydronium ion concentration.	13.2 LM 13A	13: 35-39
3.1uu Behavior of many acids and bases can be explained by the Arrhenius theory. Arrhenius acids and bases are electrolytes.	13.1	13: 1, 4, 7, 26, 27
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 H3O+(aq), hydronium ion.	13.1	13: 1, 4, 26, 27
3.1ww Arrhenius bases yield OH-(aq), hydroxide ion as the only negative ion in an aqueous solution.	13.1	13: 26-30
3.1xx In the process of neutralization, an Arrhenius acid and an Arrhenius base react to form a salt and water.	13.4 LM 13B, 13C	13: 15, 52-57
3.1yy There are alternate acid-base theories. One theory states that an acid is an H+ donor and a base is an H+ acceptor.	13.1	13: 7, 27
3.1zz Titration is a laboratory process in which a volume of a solution of known concentration is used to determine the concentration of another solution.	13.3, 13.4 LM 13B, 13C	13: 14, 75-81

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

Major Understandings:

NEW YORK CHEMISTRY PERFORMANCE INDICATOR	NAC LOCATION	WHERE ASSESSED
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.	2.2	2: 5, 32-37
3.2b Types of chemical reactions include synthesis, decomposition, single replacement, and double replacement.	10.3 LM 10B	10: 7-14, 39
3.2c Types of organic reactions include addition, substitution, polymerization, esterification, fermentation, saponification, and combustion.	17.3	17: 20-31
3.2d An oxidation-reduction (redox) reaction involves the transfer of electrons (e-).	15.2 LM 15C	15: 19, 24-26
3.2e Reduction is the gain of electrons.	15.2 LM 15C	15: 18, 19, 20, 56-57
3.2f A half-reaction can be written to represent reduction.	15.2 LM 15C, 15D	15: 24-26
3.2g Oxidation is the loss of electrons.	15.2	25: 17, 22, 56-57
3.2h A half-reaction can be written to represent oxidation.	15.2 LM 15C, 15D	15: 24-26
3.2i Oxidation numbers (states) can be assigned to atoms and ions. Changes in oxidation numbers indicate that oxidation and reduction have occurred.	15.2	15: 56-62
3.2j An electrochemical cell can be either voltaic or electrolytic. In an electrochemical cell, oxidation occurs at the anode and reduction at the cathode.	15.1 LM 15B	15: 65-74
3.2k A voltaic cell spontaneously converts chemical energy to electrical energy.	15.1 LM 15A	15: 50-55
3.2l An electrolytic cell requires electrical energy to produce a chemical change. This process is known as electrolysis	15.1 LM 15D	15: 44, 65-74

3.3 Apply the principle of conservation of mass to chemical reactions. Major Understandings:

NEW YORK CHEMISTRY PERFORMANCE INDICATOR	NAC LOCATION	WHERE ASSESSED
3.3a In all chemical reactions there is a conservation of mass, energy, and charge.	3.2, 10.2, 15.2 LM 3C, 10B, 15C	3: 14 10: 4 15: 20, 24
3.3b In a redox reaction the number of electrons lost is equal to the number of electrons gained.	15.2	15: 24, 61-64, 84-87
3.3c A balanced chemical equation represents conservation of atoms. The coefficients in a balanced chemical equation can be used to determine mole ratios in the reaction.	10.2	10: 39, 56-63
3.3d The empirical formula of a compound is the simplest whole-number ratio of atoms of the elements in a compound. It may be different from the molecular formula, which is the actual ratio of atoms in a molecule of that compound.	8.4 LM 8A	8: 10, 48-50
3.3e The formula mass of a substance is the sum of the atomic masses of its atoms. The molar mass (gram-formula mass) of a substance equals one mole of that substance.	2.2	2: 13, 43, 44, 46, 64-65
3.3f The percent composition by mass of each element in a compound can be calculated mathematically.	8.4 LM 8A	8: 65-67

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:

NEW YORK CHEMISTRY PERFORMANCE INDICATOR	NAC LOCATION	WHERE ASSESSED
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.	14.2 LM 14A	14: 6, 28-31
3.4b Kinetic molecular theory (KMT) for an ideal gas states that all gas particles:	14.1, 14.2	14: 6, 9-10, 28-31
• are in random, constant, straight-line motion.		
• are separated by great distances relative to their size; the volume of the gas particles is considered negligible.		

• have no attractive forces between them. • have collisions that may result in a transfer of energy between gas particles, but the total energy of the system remains constant.		
3.4c Kinetic molecular theory describes the relationships of pressure, volume, temperature, velocity, and frequency and force of collisions among gas molecules.	14.1	14: 4, 9, 10
3.4d Collision theory states that a reaction is most likely to occur if reactant particles collide with the proper energy and orientation.	12.1	12: 29-30
3.4e Equal volumes of gases at the same temperature and pressure contain an equal number of particles.	14.2, 14.3	14: 5, 27-31
3.4f The rate of a chemical reaction depends on several factors: temperature, concentration, nature of the reactants, surface area, and the presence of a catalyst.	12.1 LM 12A	12: 21-24, 26
3.4g A catalyst provides an alternate reaction pathway, which has a lower activation energy than an uncatalyzed reaction.	12.4 LM 12B	12: 53-58
3.4h Some chemical and physical changes can reach equilibrium.	12.2 LM 12C	12: 26-40
3.4i At equilibrium the rate of the forward reaction equals the rate of the reverse reaction. The measurable quantities of reactants and products remain constant at equilibrium.	12.2 LM 12C	12: 26-40
3.4j LeChatelier's principle can be used to predict the effect of stress (change in pressure, volume, concentration, and temperature) on a system at equilibrium.	12.2, 12.3 LM 12C	12: 43-47

Key Idea 4: Energy exists in many forms, and when these forms change energy is conserved.

4.1 Observe and describe transmission of various forms of energy. Major Understandings:

NEW YORK CHEMISTRY PERFORMANCE INDICATOR	NAC LOCATION	WHERE ASSESSED
4.1a Energy can exist in different forms, such as chemical, electrical, electromagnetic, thermal, mechanical, nuclear.	3.2, 15.1 LM 3B, 15B	3: 2, 4
4.1b Chemical and physical changes can be exothermic or endothermic.	4.2 LM 4C	4: 21-22
4.1c Energy released or absorbed during a chemical reaction can be represented by a potential energy diagram.	12.1	12: 32, 35
4.1d Energy released or absorbed during a chemical reaction (heat of reaction) is equal to the difference between the potential energy of the products and potential energy of the reactants.	12.1	12: 32, 35

4.2 Explain heat in terms of kinetic molecular theory. Major Understandings:

NEW YORK CHEMISTRY PERFORMANCE INDICATOR	NAC LOCATION	WHERE ASSESSED
4.2a Heat is a transfer of energy (usually thermal energy) from a body of higher temperature to a body of lower temperature. Thermal energy is the energy associated with the random motion of atoms and molecules.	3.2 LM 3C	3: 11, 39-44
4.2b Temperature is a measurement of the average kinetic energy of the particles in a sample of material. Temperature is not a form of energy.	3.1 LM 3A	3: 2, 37-38
4.2c The concepts of kinetic and potential energy can be used to explain physical processes that include: fusion (melting), solidification (freezing), vaporization (boiling, evaporation), condensation, sublimation, and deposition.	3.3 LM 3D	3: 22-33

4.4 Explain the benefits and risks of radioactivity. Major Understandings:

NEW YORK CHEMISTRY PERFORMANCE INDICATOR	NAC LOCATION	WHERE ASSESSED
4.4a Each radioactive isotope has a specific mode and rate of decay (half-life).	20.2 LM 20B	20: 43-53, 72-81
4.4b Nuclear reactions include natural and artificial transmutation, fission, and fusion.	20.2	20: 57-64
4.4c Nuclear reactions can be represented by equations that include symbols, which represent atomic nuclei (with mass number and atomic number), subatomic particles (with mass number and charge), and/or emissions such as gamma radiation.	20.1	20: 69, 72-73
4.4d Radioactive isotopes have many beneficial uses. Radioactive isotopes are used in medicine and industrial chemistry for radioactive dating, tracing chemical and biological processes, industrial measurement, nuclear power, and detection and treatment of diseases.	20.5	20: 55, 65-68
4.4e There are inherent risks associated with radioactivity and the use of radioactive isotopes. Risks can include biological exposure, long-term storage and disposal, and nuclear accidents.	20.4, 20.5	
4.4f There are benefits and risks associated with fission and fusion reactions.	20.4	20: 62-65

Key Idea 5: Energy and matter interact through forces that result in changes in motion.

5.2 Explain chemical bonding in terms of the behavior of electrons. Major Understandings:

NEW YORK CHEMISTRY PERFORMANCE INDICATOR	NAC LOCATION	WHERE ASSESSED
5.2a Chemical bonds are formed when valence electrons are:	7.1 LM 7A	7: 3-5, 16-25
• transferred from one atom to another (ionic)		
• shared between atoms (covalent)		
• mobile within a metal (metallic)		
5.2b Atoms attain a stable valence electron configuration by bonding with other atoms. Noble gases have stable valence configurations and tend not to bond.	7.2 LM 7A	6: 10
5.2c When an atom gains one or more electrons, it	7.2	7: 21-26

NEW YORK CHEMISTRY PERFORMANCE INDICATOR	NAC LOCATION	WHERE ASSESSED
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.		
5.2d Electron-dot diagrams (Lewis structures) can represent the valence electron arrangement in elements, compounds, and ions.	7.3 LM 7A	7: 53-62
5.2e In a multiple covalent bond, more than one pair of electrons are shared between two atoms. Unsaturated organic compounds contain at least one double or triple bond.	7.3 LM 7B	7: 48, 58, 61, 62
5.2f Some elements exist in two or more forms in the same phase. These forms differ in their molecular or crystal structure, and hence in their properties.	7.3	7: 11, 33-36
5.2g Two major categories of compounds are ionic and molecular (covalent) compounds.	7.1	7: 3-5, 18, 21-27
5.2h Metals tend to react with nonmetals to form ionic compounds. Nonmetals tend to react with other nonmetals to form molecular (covalent) compounds. Ionic compounds containing polyatomic ions have both ionic and covalent bonding.	7.1	
5.2i When a bond is broken, energy is absorbed. When a bond is formed, energy is released.	4.1 LM 4C	4: 21-22
5.2j Electronegativity indicates how strongly an atom of an element attracts electrons in a chemical bond. Electronegativity values are assigned according to arbitrary scales.	6.1, 7.1	6: 7 7: 5, 21-22, 26, 32
5.2k The electronegativity difference between two bonded atoms is used to assess the degree of polarity in the bond.	7.1	7: 21-25, 32
5.2l Molecular polarity can be determined by the shape of the molecule and distribution of charge. Symmetrical (nonpolar) molecules include CO_2, CH_4, and diatomic elements. Asymmetrical (polar) molecules include HCl, NH_3, and H_2O.	7.2, 7.3 LM 7B	7: 21-25, 29
5.2m Intermolecular forces created by the unequal distribution of charge result in varying degrees of attraction between molecules. Hydrogen bonding is an example of a strong intermolecular force.	7.2, 7.3	7: 3-5, 21-25
5.2n Physical properties of substances can be explained in terms of chemical bonds and intermolecular forces. These properties include	16.1	16: 10-16, 32-26, 55-60, 66-70

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conductivity, malleability, solubility, hardness, melting point, and boiling point.		

5.3 Compare energy relationships within an atom's nucleus to those outside the nucleus. Major Understandings:

NEW YORK CHEMISTRY PERFORMANCE INDICATOR	NAC LOCATION	WHERE ASSESSED
5.3a A change in the nucleus of an atom that converts it from one element to another is called transmutation. This can occur naturally or can be induced by the bombardment of the nucleus with high-energy particles.	20.2, 'transmutation' not mentioned by name	Not assessed
5.3b Energy released in a nuclear reaction (fission or fusion) comes from the fractional amount of mass that is converted into energy. Nuclear changes convert matter into energy.	20.4	20: 57-64
5.3c Energy released during nuclear reactions is much greater than the energy released during chemical reactions.	20.4	20: 57-64