LAB AIDS CORRELATIONS TO 2009 DCPS SCIENCE STANDARDS

High School Chemistry Standards & Learning Activities[1]

Correlated product: *A Natural Approach to Chemistry* (NAC), written by Hsu, Chaniotakis, Carlisle, and Damelin. This correlation is intended to show selected locations in NAC programs that support the DCPS chemistry standards. It is not an exhaustive document; other citations may exist that are not listed here.

This document was prepared by Mark Koker, Ph D, Director of Curriculum and Training at LAB-AIDS. A *Natural Approach to Chemistry* is published by, and is available exclusively from, LAB-AIDS, Ronkonkoma NY, 800.381.8003.

For more information about this correlation or for questions about review copies, presentations, or any matters related to sales or service, please contact Nicole Young, LAB-AIDS Regional Sales Manager at 609.707.4244, or by email at nyoung@lab-aids.com, or visit us on the web at www.lab-aids.com.

[1] http://dcps.dc.gov/downloads/TEACHING%20&%20LEARNING/Learning%20Standards%202009/DCPS-SCIENCE-CHEMISTRY-STANDARDS.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).

SB 1.2 pp. 19-25

Means Student Book Chapter 1 Section 1.2 pages 19 – 25

LM 1A, 3D

Means Lab Investigations Manual Chapter 1 Investigation 1A;

Chapter 3 Investigation 3D

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

1.2 18-30, 51-55

Means Student Book Chapter 1 Section 1.2 questions 18-30 and questions 51-55

DCPS CHEMISTRY STANDARD	NAC LOCATION	WHERE ASSESSED
SCIENTIFIC INVESTIGATION AND INQUIRY C.1. Broad Concept: Scientific progress is made by asking relevant questions and conducting careful investigations. As a basis for understanding this concept, and to address the content in this grade, students should develop their own questions and perform investigations. Students:		
1. Know the elements of scientific methodology (identification of a problem, hypothesis formulation and prediction, performance of experimental tests, analysis of data, falsification, developing conclusions, reporting results) and be able to use a sequence of those elements to solve a problem or test a hypothesis. Also, understand the limitations of any single scientific method (sequence of elements) in solving problems.	SB 1.2 Scientific inquiry LM, throughout	1.2, 51-55
2. Know that scientists cannot always control all conditions to obtain evidence, and when they are unable to do so for ethical or practical reasons, they try to observe as wide a range of natural occurrences as possible so as to be able to discern patterns.	SB 1.2	1.2, 51-55
3. Recognize the cumulative nature of scientific evidence.	SB 1.2, 5.1, 14.1, 14.2	1.2, 51-55 5.1, 23-24, 27, 39, 31, 33, 37-38
4. Recognize the use and limitations of models and theories as scientific representations of reality.	SB 1.2, 5.2, 6.3, 7.3 LM 1A, 2B, 5A, 6C, 7A, 7B	1.2, 51-55 5.2, 32, 37 7.3, 24, 33, 36, 48, 53-62
5. Distinguish between a conjecture (guess), a hypothesis, and a theory as these terms are used in science.	SB 1.2 LM 1A	1.2, 51-55
6. Plan and conduct scientific investigations to explore new phenomena, to check on previous results, to verify or falsify the	SB 1.2 LM throughout,	1.2, 51-55

DCPS CHEMISTRY STANDARD	NAC LOCATION	WHERE ASSESSED
prediction of a theory, and to use a crucial experiment to discriminate between competing theories.	e.g., 1C, 2A, 2D, 3A-B, 4A, 5B, 8A, 9A-C, 10B-C, 11A, 12A, 13A, 14B, 15A-D, 17B	
7. Use hypotheses to choose what data to pay attention to and what additional data to seek, and to guide the interpretation of the data.	SB 1.2	1.2, 51-55
8. Identify and communicate the sources of error inherent in an experiment.	LM throughout, e.g., 3B: procedure step 6; 8A: step 3; 9B: step 6; 11B: steps 5 & 6; 12B: steps 6; 13B: step 4; 14A: step 3	
9. Identify discrepant results and possible sources of error or uncontrolled conditions.		
10. Select and use appropriate tools and technology to perform tests, collect data, analyze relationships, and display data. (The focus is on manual graphing, interpreting graphs, and mastery of metric measurements and units, with supplementary use of computers and electronic data gathering when appropriate.)	LM throughout, e.g., 1C, 2A, 2D, 3A-B, 4A, 5B, 8A, 9A-C, 10B-C, 11A, 12A, 13A, 14B, 15A-D, 17B	
11. Formulate and revise explanations using logic and evidence.	LM throughout, e.g., 3B: procedure step 6; 8A: step 3; 9B: step 6; 11B: steps 5 & 6; 12B: steps 6; 13B: step 4; 14A: step 3	
12. Analyze situations and solve problems that require combining concepts from more than one topic area of science and applying these concepts.	1.3, health effects of lead 8.4, nanotechnology 15.4, catalytic converters 19.3, carbon sequestration 20.5, nuclear medicine (PET, CAT scans)	
13. Apply mathematical relationships involving linear and quadratic equations, exponential growth and decay laws, and	SB 3.2, 5.2, 12.1, 13.2, 14.2, 20.3	See, for example, 'quantitative' problem sets, all

DCPS CHEMISTRY STANDARD	NAC LOCATION	WHERE ASSESSED
logarithmic relationships to scientific situations.	LM 1D, 2C, 3B, 9B, 13A, 14A, Appendix C	chapters
14. Recognize and deal with the implications of statistical variability in experiments, and explain the need for controls in experiments.	LM 2C, 5B, 12A, 12B, 13B, 14A	
PROPERTIES OF MATTER C.2. Broad Concept: Physical and chemical properties can be used to classify and describe matter. As a basis for understanding this concept, Students:		
1. Investigate and classify properties of matter, including density, melting point, boiling point, and solubility.	SB 1.3, 2.1 LM 2C, 2D, 4A	1.3, 56-58 2.1, 30-37
2. Determine the definitions of and use properties such as mass, volume, temperature, density, melting point, boiling point, conductivity, solubility, and color to differentiate between types of matter.	SB 16.1, 16.4 LM throughout, e.g., 1B, 1C, 2D, 3C, 3D, 9A, 10A	16.1, 41-49 16.4, 66-76
3. Know the concept of a mole in terms of number of particles, mass, and the volume of an ideal gas at specified conditions of temperature and pressure.	SB 2.1, 14.2 LM 14A	2.1, 40-41, 53-62 14.2, 36-72
4. Distinguish between the three familiar states of matter (solid, liquid, and gas) in terms of energy, particle motion, and phase transitions, and describe what a plasma is.	SB 1.3, 21.1 LM 3D, 4A	1.3, 56-58 21.1, 4-5, 9
5. Infer and explain that physical properties of substances, such as melting points, boiling points, and solubility, are due to the strength of their various types of bonds (interatomic, intermolecular, or ionic).	SB 9.1, 16.2, 16.4 LM 3D, 4A	9.1, 31-34 16.2, 55-60 16.4, 66-71
6. Write equations that describe chemical changes and reactions.	SB 10.1, 10.2 LM 10B	10.1, 29-37, 53-63 10.2, 39, 64-65

DCPS CHEMISTRY STANDARD	NAC LOCATION	WHERE ASSESSED
7. Classify substances as metal or nonmetal, ionic or molecular, acid or base, and organic or inorganic, using formulas and laboratory investigations.	SB 8.1, 8.2, 13.1, 17.2 LM 6A, 6B	8.1, 20-27 8.2, 28-33 13.1, 21-26
ACIDS AND BASES C.3. Broad Concept: Acids, bases, and salts are three classes of compounds that form ions in water solutions. As a basis for understanding this concept, Students:		
1. Explain that strong acids (and bases) fully dissociate and that weak acids (and bases) partially dissociate.	SB 13.1, 13.3	13.1, 24, 30 13.3, 46-51
2. Define pH as the negative of the logarithm of the hydrogen (hydronium) ion concentration, and calculate pH from concentration data.	SB 13.2 LM 13A	13.2, 61-65
3. Illustrate and explain the pH scale to characterize acid and base solutions: Neutral solutions have pH 7, acids are less than 7, and bases are greater than 7.	SB 13.2 LM 13A	13.2, 35-44
4. Describe the observable properties of acids, bases, and salt solutions.	SB 13.1, 13.4 LM 13B, 13C	13.1, 21-26 13.4, 52-55
5. Explain the Arrhenius theory of acids and bases: An acid donates hydrogen ions (hydronium) and a base donates hydroxide ions to a water solution.	SB 13.1	13.1, 21-26
6. Explain the Brønsted-Lowry theory of acids and bases: An acid is a hydrogen ion (proton) donor, and a base is a hydrogen ion (proton) acceptor.	SB 13.1	13.1, 21-26
THE ATOM C.4. Broad Concept: An atom is a discrete unit. The atomic model can help us to understand the interaction of elements and compounds observed on a macroscopic scale. As a basis for understanding this concept, Students:		
1. Detail the development of atomic theory	SB 5.1	5.1, 23-28

DCPS CHEMISTRY STANDARD	NAC LOCATION	WHERE ASSESSED
from the ancient Greeks to the present (Democritus, Dalton, Rutherford, Bohr, quantum theory).		
2. Explain Dalton's atomic theory in terms of the laws of conservation of matter, definite composition, and multiple proportions.	SB 5.1	5.1, 23-28
3. Demonstrate and explain how chemical properties depend almost entirely on the configuration of the outer electron shell, which in turn depends on the proton number.	SB 5.3 LM 5A	5.3, 46-51
4. Explain the historical importance of the Bohr model of the atom.	SB 5.2 LM 5A	
5. Construct a diagram and describe the number and arrangement of subatomic particles within an atom or ion.	SB 5.1, 5.2 LM 5A	
6. Describe that spectral lines are the result of transitions of electrons between energy levels.	SB 5.4 LM 5C	5.2, 68 Spectral card set
7. Describe that spectral lines correspond to photons with a frequency related to the energy spacing between levels by using Planck's formula ($E = hv$) in calculations.	SB 5.2, 5.4	Spectral card set
PERIODICITY C.5. Broad Concept: Periodicity of physical and chemical properties relates to atomic structure and led to the development of the periodic table. As a basis for understanding this concept, Students:		
1. Relate an element's position on the periodic table to its atomic number (number of protons).	SB 6.1 LM 5A	6.1, 24, 30
2. Relate the position of an element in the periodic table and its reactivity with other elements to its quantum electron configuration.	SB 6.2 LM 6C	6.2, 34-39

DCPS CHEMISTRY STANDARD	NAC LOCATION	WHERE ASSESSED
3. Use the periodic table to compare trends in periodic properties, such as ionization energy, electronegativity, electron affinity, and relative size of atoms and ions.	SB 6.2 LM 6A, 6B	6.2, 34-39
4. Use an element's location in the periodic table to determine its number of valence electrons, and predict what stable ion or ions an element is likely to form in reacting with other specified elements.	SB 6.3 LM 6C	6.3, 46-52
NUCLEAR PROCESSES C.6. Broad Concept: Nuclear processes are those in which an atomic nucleus changes; they include radioactive decay of naturally occurring and man-made isotopes and nuclear fission and fusion processes. As a basis for understanding this concept, Students:		
1. Explain how protons and neutrons in the nucleus are held together by strong nuclear forces that just balance the electromagnetic repulsion between the protons in a stable nucleus.	SB 20.4	20.4, 59-61
2. Describe that the energy release per gram of material is roughly six orders of magnitude larger in nuclear fusion or fission reactions than in chemical reactions. Know that a small decrease in mass produces a large amount of energy in nuclear reactions as well as in chemical reactions, but the mass change in chemical reactions is negligibly small.	SB 20.4	20.4, 59-61
3. Know that many naturally occurring isotopes of elements are radioactive, as are isotopes formed in nuclear reactions.	SB 20.2	20.2, 6-18
4. Describe the process of radioactive decay as the spontaneous breakdown of certain unstable (radioactive) elements into new elements (radioactive or not) through the spontaneous emission by the nucleus of	SB 20.2, 20.3 LM 20B	20.2, 44-46, 49-53

DCPS CHEMISTRY STANDARD	NAC LOCATION	WHERE ASSESSED
alpha or beta particles, or gamma radiation.		
5. Predict and explain that the alpha, beta, and gamma radiation produced in radioactive decay produce different amounts and kinds of damage in matter and have different ranges of penetration.	SB 20.2	20.2, 44-46, 49-53
6. Explain that the half-life of a radioactive element is the time it takes for the radioactive element to lose one-half its radioactivity, and calculate the amount of radioactive substance remaining after an integral number of half-lives have passed.	SB 20.3 LM 20A	20.3, 54-56, 74-81
CHEMICAL BONDS C.7. Broad Concept: The enormous variety of physical, chemical, and biological properties of matter depends upon the ability of atoms to form bonds. This ability results from the electrostatic forces between electrons and protons and between atoms and molecules. As a basis for understanding this concept, Students:		
1. Explain how Arrhenius' discovery of the nature of ionic solutions contributed to the understanding of a broad class of chemical reactions.	SB 13.1	13.1, 2-31
2. Predict and explain how atoms combine to form molecules by sharing electrons to form covalent or metallic bonds, or by transferring electrons to form ionic bonds.	SB 7.1, 8.1, 8.2 LM 7A	
3. Recognize names and chemical formulas for simple molecular compounds (such as N2O3), ionic compounds, including those with polyatomic ions, simple organic compounds, and acids, including oxyacids (such as HClO4).	SB 8.1, 8.2 L 7B, 8A, 8B	
4. Explain the hydrogen bond as an intermolecular attraction that can exist between a hydrogen atom on one molecule and an electronegative element like fluorine,	SB 9.1	

<table>
<tr><th>DCPS CHEMISTRY STANDARD</th><th>NAC LOCATION</th><th>WHERE ASSESSED</th></tr>
<tr><td>oxygen, or nitrogen on another molecule.</td><td></td><td></td></tr>
<tr><td>5. Demonstrate and explain that chemical bonds between identical or similar atoms in molecules such as H_2, O_2, CH_4, NH_3, C_2H_4, N_2, H_2O and many large biological molecules tend to be covalent; some of these molecules may have hydrogen bonds between them. In addition, molecules have other forms of intermolecular bonds, such as London dispersion forces and/or dipole bonding.</td><td>SB 8.2
LM 7A, 7B</td><td></td></tr>
<tr><td>6. Explain that in solids, particles can only vibrate around fixed positions, but in liquids, they can slide randomly past one another, and in gases, they are free to move between collisions with one another.</td><td>SB 23.3</td><td></td></tr>
<tr><td>7. Draw Lewis dot structures for atoms, molecules, and polyatomic ions.</td><td>SB 7.3
LM 7A, 7B</td><td></td></tr>
<tr><td>8. Predict the geometry and polarity of simple molecules, and explain how these influence the intermolecular attraction between molecules.</td><td>SB 7.2, 8.1, 8.2
LM 7A, 7B</td><td></td></tr>
<tr><td>9. Predict the chemical formulas based on the number of valence electrons.</td><td>SB 7.2
LM 6C</td><td></td></tr>
<tr><td>10. Predict the formulas of ionic compounds based on the charges on the ions.</td><td>SB 8.1
LM 8A</td><td></td></tr>
<tr><td>11. Identify solids held together by London dispersion forces or hydrogen bonding.</td><td>SB 8.3</td><td></td></tr>
<tr><td colspan="3">CONSERVATION OF MATTER
C.8. Broad Concept: The microscopic conservation of atoms in chemical reactions implies the macroscopic principle of conservation of matter and the ability to calculate the mass of products and reactants. As a basis for understanding this concept,
Students:</td></tr>
<tr><td>1. Name substances and describe their reactions based on Lavoisier’s system and</td><td>SB 8.1, 8.2,</td><td></td></tr>
</table>

DCPS CHEMISTRY STANDARD	NAC LOCATION	WHERE ASSESSED
explain how this system contributed to the rapid growth of chemistry by enabling scientists everywhere to share their findings about chemical reactions with one another without ambiguity.	10.3 LM 10B	
2. Describe chemical reactions by writing balanced chemical equations and balancing redox equations.	SB 10.2, 15.3 LM 10B	
3. Classify reactions of various types such as single and double replacement, synthesis, decomposition, and acid/base neutralization.	SB 10.3 LM 10B	
4. Calculate the masses of reactants and products in a chemical reaction from the mass of one of the reactants or products and the relevant atomic or molecular masses.	SB 11.4 LM 10C	
5. Calculate the percent of composition by mass of a compound when given the formula.	SB 11.2 LM 11A	
6. Determine molar mass of a molecule given its chemical formula and a table of atomic masses.	SB 8.4 LM 8A	
7. Convert the mass of a molecular substance to moles, number of particles, or volume of gas at standard temperature and pressure.	SB 8.4, 14.3 LM 14A	
8. Use Avogadro's law to make mass-volume calculations for simple chemical reactions.	SB 11.4	
9. Define oxidation and reduction and oxidizing and reducing agents.	SB 15.2 LM 15C	
10. Use changes in oxidation states to recognize electron transfer reactions, and identify the substance(s) losing and gaining electrons in an electron transfer reaction.	SB 15.2 LM 15C	
11. Describe the effect of changes in reactant concentration, changes in temperature, the surface area of solids, and the presence of	SB 12.1, 12.4 LM 12A, 12B	

DCPS CHEMISTRY STANDARD	NAC LOCATION	WHERE ASSESSED
catalysts on reaction rates.		
GASES AND THEIR PROPERTIES C.9. Broad Concept: The behavior of gases can be explained by the kinetic molecular theory. As a basis for understanding this concept, Students:		
1. Explain the kinetic molecular theory and use it to explain changes in gas volumes, pressure, and temperature.	SB 14.1, 14.2 LM 14A	14.1, 7-16 14.2, 17-22
2. Apply the relationship between pressure and volume at constant temperature (Boyle's law, pV = constant at constant temperature and number of moles), and between volume and temperature (Charles' law or Gay-Lussac's law, V/T = constant at constant pressure and number of moles) and the relationship between pressure and temperature that follows from them.	SB 14.1, 14.2 LM 14A	14.2, 36-72
3. Solve problems using the Ideal Gas law, pV = nRT, and the combined gas law, p1V1/T1= p2V2/T2.	SB 14.3 LM 14A	14.3, 73-81
4. Apply Dalton's Law of Partial Pressures.	SB 14.2 LM 14A	14.2, 32, 38-41
5. Apply Graham's Law of Diffusion.	Not covered	
CHEMICAL EQUILIBRIUM C.10. Broad Concept: Chemical equilibrium is a dynamic process at the molecular level. As a basis for understanding this concept, Students:		
1. Explain how equilibrium is established when forward- and reverse-reaction rates are equal.	SB 12.2 LM 12C	12.2, 36-40
2. Describe the factors that affect the rate of a chemical reaction (temperature, concentration) and the factors that can cause a shift in equilibrium (concentration, pressure, volume, temperature).	SB 12.1, 12.2 LM 12A, 12B	12.1, 21-24, 29-31 12.2, 44-47

DCPS CHEMISTRY STANDARD	NAC LOCATION	WHERE ASSESSED
3. Explain why rates of reaction are dependent on the frequency of collisions, energy of collisions, and orientation of colliding molecules.	SB 12.1, 12.3	12.1, 29-35 12.3, 48
4. Observe and describe the role of activation energy and catalysts in a chemical reaction.	SB 12.1, 12.4	12.1, 31-35 12.4, 53-58
5. Use LeChâtelier's principle to predict the effect of changes in concentration, temperature, volume, and pressure on a system at equilibrium.	SB 12.2 LM 12C	12.2, 44-47
6. Write the equilibrium expression for a given reaction and calculate the equilibrium constant for the reaction from given concentration data.	SB 12.2	12.2, 44-47
CHEMICAL THERMODYNAMICS C.12. Broad Concept: Energy is exchanged or transformed in all chemical reactions and physical changes of matter. As a basis for understanding this concept, Students:		
1. Describe the concepts of temperature and heat flow in terms of the motion and energy of molecules (or atoms).	SB 3.2 LM 3C	3.2, 38, 39-41
2. Determine and explain that chemical processes release (exothermic) or absorb (endothermic) thermal energy.	SB 4.2 LM 4B	4.2, 50-55, 57-58
3. Explain how energy is released when a material condenses or freezes and is absorbed when a material evaporates or melts.	SB 4.2 LM 4B	4.2, 50-55, 57-58
4. Solve problems involving heat flow and temperature changes, using given values of specific heat and latent heat of phase change.	SB 3.2, 3.3	3.2, 64-73 3.3, 74-77
5. Use Hess's law to determine the heat of a reaction and to calculate enthalpy change in a reaction.	SB 10.4 LM 10C	10.4, 66-71

DCPS CHEMISTRY STANDARD	NAC LOCATION	WHERE ASSESSED
ORGANIC CHEMISTRY C.13. Broad Concept: The bonding characteristics of carbon lead to the possibility of many different molecules of many sizes, shapes, and chemical properties. This provides the biochemical basis of life. As a basis for understanding this concept, Students:		
1. Explain how the bonding characteristics of carbon lead to a large variety of structures ranging from simple hydrocarbons to complex polymers and biological molecules.	SB 17.1 LM 17B	17.1, 32-40, 42-54
2. Describe how large molecules (polymers) such as proteins, nucleic acids, and starch are formed by repetitive combinations of simple subunits (monomers).	SB 17.2, 18.1, 18.3 LM 18C	17.2, 51-65 18.1, 37-39 18.3, 80, 84-85
3. Explain that amino acids are the building blocks of proteins.	SB 18.3 LM 18C	18.3, 80, 83-87, 90-92
4. Convert between chemical formulas, structural formulas, and names of simple common organic compounds (hydrocarbons, proteins, fats, carbohydrates).	SB 18.1, 18.3	18.1, 37-39 18.3, 80, 83-87, 90-92