LAB-AIDS CORRELATIONS

ARIZONA ACADEMIC STANDARDS[1]

HIGH SCHOOL CHEMISTRY

A Natural Approach to Chemistry[2] (NAC) is written by Hsu, Chaniotakis, Carlisle, and Damelin. This correlation is intended to show selected locations in NAC programs that support the Arizona Academic Standards for chemistry. 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. This is not an exhaustive document. It is designed to provide a general overview of the alignment of *A Natural Approach to Chemistry* to the Arizona science program standards, grades 9-12, for review and adoption purposes. Support for the state standards may be found at other locations besides those explicitly stated in this document.

For more information about this correlation or for questions about review copies, presentations, or any matters related to sales or service, please contact Ryan Luby, LAB-AIDS Regional Sale Manager, at 480.220.5516, or by email at ryan@lab-aids.com, or visit us on the web at www.lab-aids.com.

[1] http://www.ade.state.az.us/standards/science/articulated.asp
[2] http://www.anaturalapproachtochemistry.com/natc_home.php

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, 11A: 6, 12A: 6, 12B: 1, 6

Means Lab Investigations Manual Chapter 1 Investigation 1A;

Chapter 3 Investigation 3D;

Chapter 11 Investigation 11A Part 6;

Chapter 12 Investigation 12B Part 1 and Part 6

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

SB 1.2 18-30, 51-55

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

LM 9A Pt 4a-c; **9B** Pts 3-5

Means Laboratory Investigations Manual Chapter 9 Investigation 9A Part 4 a-c, Investigation 9B Part 3 – Part 5.

Strand 1: Inquiry Process

AZ Descriptor	*Location in NAC*
Concept 1: Observations, Questions, and Hypotheses Formulate predictions, questions, or hypotheses based on observations. Evaluate appropriate resources.	
PO 1. Evaluate scientific information for relevance to a given problem. (See R09-S3C1, R10-S3C1, R11-S3C1, and R12-S3C1)	SB 1.2 pp. 19-25 LM 1A, 3D, 11A: 6, 12A: 6, 12B: 1, 6
PO 2. Develop questions from observations that transition into testable hypotheses.	
PO 3. Formulate a testable hypothesis.	
PO 4. Predict the outcome of an investigation based on prior evidence, probability, and/or modeling (not guessing or inferring).	
Concept 2: Scientific Testing (Investigating and Modeling) Design and conduct controlled investigations.	
PO 1. Demonstrate safe and ethical procedures (e.g., use and care of technology, materials, organisms) and behavior in all science inquiry.	LM xi-xiv, 1C, 2A, 2C, 3A-D, 4A, 5B, 8A, 9A-C, 10B- C, 11A, 12A, 13A, 15A- D, 17B
PO 2. Identify the resources needed to conduct an investigation.	
PO 3. Design an appropriate protocol (written plan of action) for testing a hypothesis: • Identify dependent and independent variables in a controlled investigation. • Determine an appropriate method for data collection (e.g., using balances, thermometers, microscopes, spectrophotometer, using qualitative changes). • Determine an appropriate method for recording data (e.g., notes, sketches, photographs, videos, journals (logs), charts, computers/calculators).	
PO 4. Conduct a scientific investigation that is based on a research design.	LM 9B, 17B, 21A
PO 5. Record observations, notes, sketches, questions, and ideas using tools such as journals, charts, graphs, and computers.	LM 3C: 1; 4A: 2-3; 5B: 4; 5C: 3; 7A-C; 9A: 2; 9B; 12B: 5; 13A: 8; 14B: 3
Concept 3: Analysis, Conclusions, and Refinements Evaluate experimental design, analyze data to explain results and propose further investigations.	

AZ Descriptor	*Location in NAC*
Design models.	
PO 1. Interpret data that show a variety of possible relationships between variables, including: • *positive relationship* • *negative relationship* • *no relationship*	LM 3B: 6; 8A:3; 9B: 6; 11B: 6; 12B: 6; 13B: 4; 14A: 3
PO 2. Evaluate whether investigational data support or do not support the proposed hypothesis.	
PO 3. Critique reports of scientific studies (e.g., published papers, student reports).	Not addressed
PO 4. Evaluate the design of an investigation to identify possible sources of procedural error, including: • sample size • trials • controls • analyses	LM 3B: 6; 8A:3; 9B: 6; 11B: 6; 12B: 6; 13B: 4; 14A: 3
PO 5. Design models (conceptual or physical) of the following to represent "real world" scenarios: • carbon cycle • water cycle • phase change • collisions	LM 3D (phase change) LM 17 A, B (carbon and hydrocarbons) LM 4A (water cycle)
PO 6. Use descriptive statistics to analyze data, including: • mean • frequency • range (See MHS-S2C1-10)	LM 3A, 3C, 5A*, 9A, 12A
PO 7. Propose further investigations based on the findings of a conducted investigation.	SB 1.2 pp. 19-25 LM 1A, 3D 11A: 6, 12A: 6 12B: 1, 6
Concept 4: Communication Communicate results of investigations.	
PO 1. For a specific investigation, choose an appropriate method for communicating the results. (See W09-S3C2-01 and W10-S3C3-01)	3C: 1; 4A: 2-3; 5B: 4; 5C: 3; 7A-C; 9A: 2; 9B; 12B: 5; 13A: 8; 14B: 3
PO 2. Produce graphs that communicate data. (See MHS-S2C1-02)	

AZ Descriptor	*Location in NAC*
PO 3. Communicate results clearly and logically.	1A, 3D, 11A: 6, 12A: 6; 12B: 1, 6
PO 4. Support conclusions with logical scientific arguments.	

Strand 2: History and Nature of Science

AZ Descriptor	*Location in NAC*
Concept 1: History of Science as a Human Endeavor Identify individual, cultural, and technological contributions to scientific knowledge.	
PO 1. Describe how human curiosity and needs have influenced science, impacting the quality of life worldwide.	SB See for example, 1.3, pp. 30-31; 4.3, pp.126-127; 5.4, pp. 160-161; 6.3, pp. 190- 191; 7.3, pp. 222-223; 10.4, pp. 318-319; 18.4, pp.598-599, etc. LM 17A, 19A, 19B
PO 2. Describe how diverse people and/or cultures, past and present, have made important contributions to scientific innovations.	*Not addressed*
PO 3. Analyze how specific changes in science have affected society.	SB 1.3, pp. 30-31; 4.3, pp.126-127; 5.4, pp. 160-161; 6.3, pp. 190- 191; 7.3, pp. 222-223; 10.4, pp. 318-319; 18.4, pp.598- 599, etc.
PO 4. Analyze how specific cultural and/or societal issues promote or hinder scientific advancements.	*Not addressed*
Concept 2: Nature of Scientific Knowledge Understand how science is a process for generating knowledge.	
PO 1. Specify the requirements of a valid, scientific explanation (theory), including that it be: • logical • subject to peer review • public • respectful of rules of evidence	SB 1.2, 'Scientific inquiry', pp. 19-25
PO 2. Explain the process by which accepted ideas are challenged or extended by scientific innovation.	
PO 3. Distinguish between pure and applied science.	

AZ Descriptor	*Location in NAC*
PO 4. Describe how scientists continue to investigate and critically analyze aspects of theories.	

Strand 3: Science in Personal and Social Perspectives

AZ Descriptor	*Location in NAC*
Concept 1: Changes in Environments Describe the interactions between human populations, natural hazards, and the environment.	
PO 1. Evaluate how the processes of natural ecosystems affect, and are affected by, humans.	SB 1.3 (health effects of lead, air quality) 10.4 (green chemistry, biodegradeable polymers) 15.4 (catalytic converters, cleaning up the environment) 19.3 (carbon sequestering) LM 17B (cleaning up oil spills)
PO 2. Describe the environmental effects of the following natural and/or human-caused hazards: • flooding • drought • earthquakes • fires • pollution • extreme weather	SB 1.3 (health effects of lead, air quality) Other examples not applicable
PO 3. Assess how human activities (e.g., clear cutting, water management, tree thinning) can affect the potential for hazards.	SB 1.3 (health effects of lead, air quality) 10.4 (green chemistry, biodegradeable polymers) 15.4 (catalytic converters, cleaning up the environment) 19.3 (carbon sequestering) LM 17B (cleaning up oil spills)
PO 4. Evaluate the following factors that affect the quality of the environment: • urban development • smoke • volcanic dust	
PO 5. Evaluate the effectiveness of conservation practices and preservation techniques on environmental quality and biodiversity.	
Concept 2: Science and Technology in Society Develop viable solutions to a need or problem.	

AZ Descriptor	*Location in NAC*
PO 1. Analyze the costs, benefits, and risks of various ways of dealing with the following needs or problems: • various forms of alternative energy • storage of nuclear waste • abandoned mines • greenhouse gases • hazardous wastes	SB 1.3 (health effects of lead, air quality) 10.4 (green chemistry, biodegradeable polymers) 15.4 (catalytic converters, cleaning up the environment) 19.3 (carbon sequestering) LM 17B (cleaning up oil spills)
PO 2. Recognize the importance of basing arguments on a thorough understanding of the core concepts and principles of science and technology.	Throughout, see for example 5.1, pp. 135-136; 6.1, pp. 171-175; 14.2: p. 454
PO 3. Support a position on a science or technology issue.	SB 1.3 (health effects of lead, air quality) 10.4 (green chemistry, biodegradeable polymers) 15.4 (catalytic converters, cleaning up the environment) 19.3 (carbon sequestering) LM 17B (cleaning up oil spills)
PO 4. Analyze the use of renewable and nonrenewable resources in Arizona: • water • land • soil • minerals • air	Local standard
PO 5. Evaluate methods used to manage natural resources (e.g., reintroduction of wildlife, fire ecology).	SB 1.3 (health effects of lead, air quality) 10.4 (green chemistry, biodegradeable polymers) 15.4 (catalytic converters, cleaning up the environment) 19.3 (carbon sequestering) LM 17B (cleaning up oil spills)
Concept 3: Human Population Characteristics Analyze factors that affect human populations.	
PO 1. Analyze social factors that limit the growth of a human population, including: • affluence	Not applicable

AZ Descriptor	*Location in NAC*
• education • access to health care • cultural influences	
PO 2. Describe biotic (living) and abiotic (nonliving) factors that affect human populations.	SB 1.3 (health effects of lead, air quality) 6.3 (health effects of group 1, II metal ions) 7.3 (chemistry of trans fats) 15.4 (catalytic converters)
PO 3. Predict the effect of a change in a specific factor on a human population.	

Strand 5: Physical science

AZ Descriptor	*Location in NAC*	*Where assessed*
Concept 1: Structure and Properties of Matter Understand physical, chemical, and atomic properties of matter.		
PO 1. Describe substances based on their physical properties.	2.1, 16.4	**2.1**, 30-37 **16.4**, 66-76
PO 2. Describe substances based on their chemical properties.	2.1	**2.1**, 30-37
PO 3. Predict properties of elements and compounds using trends of the periodic table (e.g., metals, non-metals, bonding – ionic/covalent).	6.2	**6.2**, 21-27
PO 4. Separate mixtures of substances based on their physical properties.	2.3	**2.3**, 48
PO 5. Describe the properties of electric charge and the conservation of electric charge.	5.2, 6.3	**5.2**, 30-31, 36, 40 **6.3**,
PO 6. Describe the following features and components of the atom: • protons • neutrons • electrons • mass • number and type of particles • structure • organization	5.1, 5.2	**5.2**, 30-31, 36, 40
PO 7. Describe the historical development of models of the atom.	5.1	**5.1**, 23-24, 28
PO 8. Explain the details of atomic structure (e.g., electron configuration, energy levels, isotopes).	5.2, 6.3	**5.2**, 30-31, 36, 40 **6.3**, 32-39
Concept 3: Conservation of Energy and Increase in Disorder Understand ways that energy is conserved, stored, and transferred.		
PO 1. Describe the following ways in which energy is stored in a system: • mechanical • electrical	6.2 (electrical) 7.1 (chemical) 20.2 (nuclear)	**6.2**, 21-27 **7.1**, 15-16, 19-20 **20.2**, 43-47

AZ Descriptor	*Location in NAC*	*Where assessed*
• chemical • nuclear		
PO 2. Describe various ways in which energy is transferred from one system to another (e.g., mechanical contact, thermal conduction, electromagnetic radiation.)	3.3 (heat) 6.2 (electrical) 10.4 (chemical) 20.2 (radiation)	**3.3**, 48-53 **6.2**, 32-35 **10.4**, 42-46 **20.2**, 45-47, 50
PO 3. Recognize that energy is conserved in a closed system.	3.2	**3.2**, 40, 43, 47
PO 4. Calculate quantitative relationships associated with the conservation of energy.	3.2, 3.3, 10.4	**3.2**, 40, 43, 47 **3.3**, 48-53 **10.4**, 42-46
PO 5. Analyze the relationship between energy transfer and disorder in the universe (2^{nd} Law of Thermodynamics).	10.4	**10.4**, 42-46
PO 6. Distinguish between heat and temperature.	3.1, 3.2	**3.1**, 36-38 **3.2**, 40, 43, 47
PO 7. Explain how molecular motion is related to temperature and phase changes.	3.3	**3.3**, 48-53
Concept 4: Chemical Reactions Investigate relationships between reactants and products in chemical reactions.		
PO 1. Apply the law of conservation of matter to changes in a system.	4.2	**4.2**, 52
PO 2. Identify the indicators of chemical change, including formation of a precipitate, evolution of a gas, color change, absorption or release of heat energy.	2.1, 10.3	**2.1**, 33-37 **10.3**, 29-30
PO 3. Represent a chemical reaction by using a balanced equation.	4.2	**4.2**, 48, 49, 52
PO 4. Distinguish among the types of bonds (i.e., ionic, covalent, metallic, hydrogen bonding).	7.1, 7.2	**7.1**, 16-20 **7.2**, 17-24
PO 5. Describe the mole concept and its relationship to Avogadro's number.	2.1	**2.1**, 33-37
PO 6. Solve problems involving such quantities as moles, mass, molecules, volume of a gas, and molarity using the mole concept and Avogadro's number.	2.1, 2.2, 14.2	**2.1**, 33-37 **2.2**, 64-67 **14.2**, 17-31
PO 7. Predict the properties (e.g., melting point,	7.1, 8.1, 8.2	**7.1**, 16-24

AZ Descriptor	*Location in NAC*	*Where assessed*
boiling point, conductivity) of substances based upon bond type.		**8.1**, 20-23 **8.2**, 28-32
PO 8. Quantify the relationships between reactants and products in chemical reactions (e.g., stoichiometry, equilibrium, energy transfers).	11.1, 11.2, 12.2	**11.1**, 38-45 **11.2**, 46-53 **12.2**, 63-64
PO 9. Predict the products of a chemical reaction using types of reactions (e.g., synthesis, decomposition, replacement, combustion).	10.3	**10.3**, 39-40
PO 10. Explain the energy transfers within chemical reactions using the law of conservation of energy.	3.2	**3.2**, 40, 43, 47
PO 11. Predict the effect of various factors (e.g., temperature, concentration, pressure, catalyst) on the equilibrium state and on the rates of chemical reaction.	12.2	**12.2**, 36-47
PO 12. Compare the nature, behavior, concentration, and strengths of acids and bases.	13.1	**13.1**, 21-34
PO 13. Determine the transfer of electrons in oxidation/reduction reactions.	15.4	**15.4**, 56-62
Concept 5: Interactions of Energy and Matter Understand the interactions of energy and matter.		
PO 1. Describe various ways in which matter and energy interact (e.g., photosynthesis, phase change).	3.3 (phase change) 4.2 (photosynthesis)	**3.3**, 48-53 **4.2**, 48, 49, 52
PO 2. Describe the following characteristics of waves: • wavelength • frequency • period • amplitude	Not applicable	
PO 3. Quantify the relationships among the frequency, wavelength, and the speed of light.	5.2 (Planck's constant)	**5.2**, 42
PO 4. Describe the basic assumptions of kinetic molecular theory.	14.1	**14.1**, 9-11
PO 5. Apply kinetic molecular theory to the behavior of matter (e.g., gas laws).	14.2	**14.2**, 17-31
PO 6. Analyze calorimetric measurements in simple systems and the energy involved in changes of state.	3.2, 3.3	**3.2**, 40, 43, 47 **3.3**, 48-53

AZ Descriptor	*Location in NAC*	*Where assessed*
PO 7. Explain the relationship between the wavelength of light absorbed or released by an atom or molecule and the transfer of a discrete amount of energy.	5.2, 5.3	**5.3**, 41-49
PO 8. Describe the relationship among electric potential, current, and resistance in an ohmic system.	Not applicable	
PO 9. Quantify the relationships among electric potential, current, and resistance in an ohmic system.	Not applicable	