LAB-AIDS Correlations to Colorado Academic Standards

High School Chemistry[1]

A Natural Approach to Chemistry (NAC) is written by Hsu, Chaniotakis, Carlisle, and Damelin, This correlation is intended to show selected locations in NAC programs that support the Colorado Academic Standards for high school chemistry. It is not an exhaustive document; other citations for the Colorado chemistry standards 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 NAC to the state 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.

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[1] http://www.cde.state.co.us/scripts/allstandards/COStandards.asp?glid=15&stid2=7&glid2=0

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

CO Academic Standard/21st Century Skills Descriptor	NAC Location	Where assessed
Matter has definite structure that determines characteristic physical and chemical properties		
EVIDENCE OUTCOMES		
• Develop, communicate, and justify an evidence-based scientific explanation supporting the current model of an atom (DOK 1-3)	SB 5.1, LM 5A	SB 5.1, 23-28
• Gather, analyze and interpret data on chemical and physical properties of elements such as density, melting point, boiling point, and conductivity (DOK 1-2)	SB 16.1, LM 16B	16.1, 41-44
• Use characteristic physical and chemical properties to develop predictions and supporting claims about elements' positions on the periodic table (DOK 1-2)	SB 6.1, 6.2, LM 6A, 6B	6.1, 14, 35, 43
• Develop a model that differentiates atoms and molecules, elements and compounds, and pure substances and mixtures (DOK 2-3	SB 2.3, 6.2, LM 2A	2.3, 30-41
21ST CENTURY SKILLS AND READINESS COMPETENCIES		
Inquiry Questions:		
• What patterns can be observed in the properties of elements and families in the periodic table?	SB 6.2, 6.2, LM 6A, 6B	6.1, 14, 35, 43
• What properties do nanoscale particles have that are different than those of macroscopic samples of the same substance?	SB 2.1, 8.3 (p. 254-255)	Not tested
Relevance & Application:		
• The unique properties of various elements make them useful for specific applications. For example, metalloids and semiconductors are useful in electronic applications.	SB 6.2, 6.3	6.2, 26-29 6.3, 39
• Alloys are created by combining metals with other elements to produce materials with useful properties that are not found in nature. For example, iron and carbon make steel.	SB 16.3	16.4, 77-80
• Consumers can make informed decisions regarding the purchase of household chemicals when they understand chemical properties and their implications. For	SB 1.3 (health effects of lead 10.4 (dry cleaning alternatives) 8.4 (food and cosmetic chemistry)	

CO Academic Standard/21st Century Skills Descriptor	NAC Location	Where assessed
example, choosing lead based versus non-lead based paints weighs safety concerns against color and durability in applications.		
• The unique properties of nanoscale particles provide special benefits and dangers.	SB 8.4 Chemistry Connections	
Nature Of:		
• Recognize that the current understanding of molecular structure related to the physical and chemical properties of matter has developed over time and become more sophisticated as new technologies have led to new evidence. (DOK 1)	SB 2.1 Chemistry connections for 2.3, 6.3, 7.3, 8.4, 10.4	Not assessed
• Ask testable questions about the nature of matter, and use an inquiry approach to investigate it. (DOK 1-4)	SB 1.2, LM 1A, 11A: 6, 12A: 6 12B: 1, 6	1.2, 51-55
Matter can change form through chemical or nuclear reactions abiding by the laws of conservation of mass and energy		
EVIDENCE OUTCOMES		
• Recognize, analyze, interpret, and balance chemical equations (synthesis, decomposition, combustion, and replacement) or nuclear equations (fusion and fission) (DOK 1-2)	SB 10.1, 10.3, 20.4, LM 10B	10.1, 29-37, 53-63 10.3, 39-41, 66-71
• Predict reactants and products for different types of chemical and nuclear reactions (DOK 1-2)	SB 10.1, 10.3, 20.4, LM 10B	10.1, 29-37, 53-63 10.3, 39-41, 66-71
• Predict and calculate the amount of products produced in a chemical reaction based on the amount of reactants (DOK 1-2)	SB 11.1, LM 11A, 11B	11.1, 9-21, 38-45
• Examine, evaluate, question, and ethically use information from a variety of sources and media to investigate the conservation of mass and energy (DOK 1-2)	Chemistry connections, SB chapter 11, 19 (carbon cycle, carbon sequestration)	Not assessed
21ST CENTURY SKILL AND READINESS COMPETENCIES		
Inquiry Questions:		
• What patterns of chemical reactions exist?	SB 10.3, 20.4,	10.3, 39-41, 64-

CO Academic Standard/21st Century Skills Descriptor	NAC Location	Where assessed
	LM 10B	65 20.4, 57-64
• How are chemical reactions distinguished from nuclear reactions?	SB 10.3, 20.4	20.4, 57-64
Relevance & Application:		
• Products formed in different types of reactions are useful to people. For example, polymerase reactions making nylon.	17.3 (polymers, hydrogels, Kevlar, polyesters), LM 17B	17.3, 66-83
• The use of chemicals can have both positive and negative environmental effects. For example, the use of lime to make acidic soils more productive or the use of CFCs causing the ozone hole.	SB 10.4 (green chemistry, dry cleaning solvent alternatives), 18.4 (farming and green chemistry)	Not assessed
• When using radioactive substances, there are benefits such as medicine and energy production as well as dangers such as environmental and health concerns.	SB 20.5 (nuclear medicine, CAT scans)	20.5, 65-68, 89-91
Nature Of:		
• Critically evaluate chemical and nuclear change models. (DOK 2-3)	SB 10.3, 20.4	10.3, 39-41, 64-65 20.4, 57-64
• Identify the strengths and weaknesses of a model which represents complex natural phenomenon. (DOK 2-3)	LM 2B, A, 7ABC, 17A, 19A, 20A	
• Use an inquiry approach to test predictions about chemical reactions. (DOK 1-4)	LM 3B: 6; 8A:3; 9B: 6; 11B: 6; 12B: 6; 13B: 4; 14A: 3	
• Share experimental data, and respectfully discuss conflicting results. (DOK 2-		
Atoms bond in different ways to form molecules and compounds that have definite properties.		
EVIDENCE OUTCOMES		
• Develop, communicate, and justify an evidence-based scientific explanation supporting the current models of chemical bonding (DOK 1-3)	SB 7.1, 7.2 7AB, 8B	7.1, 15-20 7.2, 21-29
• Gather, analyze, and interpret data on	SB 7.1, 7.2,	7.1, 15-20

CO Academic Standard/21st Century Skills Descriptor	NAC Location	Where assessed
chemical and physical properties of different compounds such as density, melting point, boiling point, pH, and conductivity (DOK 1-2)	7AB, 8B	7.2, 21-29
• Use characteristic physical and chemical properties to develop predictions and supporting claims about compounds' classification as ionic, polar or covalent (DOK 1-2)	SB 7.1, 7AB, 8B	7.1, 15-20 7.2, 21-29
• Describe the role electrons play in atomic bonding (DOK 1)	SB 7.2, 7AB, 8B	7.1, 15-20 7.2, 21-29
• Predict the type of bonding that will occur among elements based on their position in the periodic table (DOK 1-2)	SB 7.1, 7AB, 8B	7.1, 15-20 7.2, 21-29
21ST CENTURY SKILL AND READINESS COMPETENCIES		
Inquiry Questions:		
• How can various substances be classified as ionic or covalent compounds?	SB 7.1, 7B	7.1, 15-20 7.2, 21-29
• What role do electrons play in different types of chemical bonds?	SB 7.1	7.1, 15-20 7.2, 21-29
Relevance & Application:		
• Related compounds share some properties that help focus chemists when looking for a substance with particular properties for a specific application. For example, finding new super conductors.	SB 6.3 & Chemistry Connections, Ch 6 (cis- and trans-isomers)	6.3, 35, 37, 39, 43, 48
• Carbon atoms bond in ways that provide the foundation for a wide range of applications. For example, forming chains and rings such as sugars and fats that are essential to life and developing synthetic fibers and oils.	SB 17.1, 17AB	17.1, 32-41
• Living systems create and use various chemical compounds such as plants making sugars from photosynthesis and chemicals that can be used as medicine, and endocrine glands producing hormones.	SB 18.1, 18.2, 18.3	18.1, 33-59
Nature Of:		
• Recognize that the current understanding of molecular structure related to the physical and	SB 16.1, 16.2	16.1-16.2, 43-53

CO Academic Standard/21st Century Skills Descriptor	NAC Location	Where assessed
chemical properties of matter has developed over time and become more sophisticated as new technologies have led to new evidence. (DOK 1)		
• Employ data-collection technology to gather, view, analyze, and interpret data about chemical and physical properties of different compounds. (DOK 1-2)	LM 12ABC, 13A, 14A, 15ABCD, 17A,18B	
When energy changes form, it is neither created not destroyed; however, because some is necessarily lost as heat, the amount of energy available to do work decreases		
EVIDENCE OUTCOMES		
• Use direct and indirect evidence to develop and support claims about the conservation of energy in a variety of systems, including transformations to heat (DOK 1-3)	SB 3.1, 3.2 LM 10B	3.2, 13=14
• Evaluate the energy conversion efficiency of a variety of energy transformations (DOK 1-2)	SB 3.2 LM 10B	3.2, 58-73
• Describe energy transformations both quantitatively and qualitatively (DOK 1-2)	SB 3.2, 3.3 LM 10B	3.2, 58-73
• Differentiate among the characteristics of mechanical and electromagnetic waves that determine their energy (DOK 2)	Not covered[2]	
• Examine, evaluate, question, and ethically use information from a variety of sources and media to investigate energy conservation and loss (DOK 1-2)	Not covered[3]	
21ST CENTURY SKILL AND READINESS COMPETENCIES		
Inquiry Questions:		
• Why is 100 percent efficiency impossible in an energy transformation?	SB 3.2, LM 3CD	3.2, 39-40
• How does the law of conservation of energy help us solve problems involving complex systems?	SB 3.2, 3.3 LM 3CD	3.2, 64-73

[2] content typically addressed in physics classes
[3] content typically addressed in physics classes

CO Academic Standard/21st Century Skills Descriptor	NAC Location	Where assessed
• Scientists or engineers often say energy is "lost." Is there a word that might be better than "lost?" Why?	SB 3.2 (in all energy transformations some energy is changed to heat)	3.2, 39-40
Relevance & Application:		
• Incremental strides have been made in improving the efficiency of different forms of energy production and consumption. For example, today's engines are much more efficient than those from 50 years ago, and batteries are more powerful and last longer than those from just a few years ago.	Chemistry connection content: Nanotechnology (8.4) Green chemistry, PERC-free dry cleaning alternatives (10.4) Catalytic converters (15.4) Farming and green chemistry (18.4) Carbon sequestration (19.3)	
• Different technologies such as light-emitting diodes, compact fluorescent lights, and incandescent light bulbs have different efficiencies and environmental impacts.		
Nature Of:		
• Critically evaluate scientific claims made in popular media or by peers regarding the application of energy transformations, and determine if the evidence presented is appropriate and sufficient to support the claims. (DOK 2-3)	Not covered	
• Ask testable questions and make a falsifiable hypothesis about the conservation of energy, and use an inquiry approach to find an answer. (DOK 1-4)	LM 3B: 6; 8A:3; 9B: 6; 11B: 6; 12B: 6; 13B: 4; 14A: 3	
• Share experimental data, and respectfully discuss conflicting results emulating the practice of scientists. (DOK 2-3)		