



**COLORADO**  
**Science Content Standards Grades 9-12**  
***Chemistry: Concepts and Applications* © 2005**

STANDARDS	PAGE REFERENCES
<b>STANDARD 1:</b> <b>Students understand the processes of scientific investigation and design, conduct, communicate about, and evaluate such investigations.</b> <b>As students in grades 9-12 extend their knowledge, what they know and are able to do includes</b>	
<ul style="list-style-type: none"> <li>asking questions and stating hypotheses, using prior scientific knowledge to help guide their development;</li> </ul>	SE: 6, 58, 61-64, 69-70, 88-91 <i>Chemistry &amp; Technology</i> 326-327, 573 <i>ChemLab</i> 136-137, 236-237, 328-329
<ul style="list-style-type: none"> <li>creating and defending a written plan of action for a scientific investigation;</li> </ul>	TWE: P 38, 56, 172, 328, 422, 560, 651, 722
<ul style="list-style-type: none"> <li>selecting and using appropriate technologies to gather, process, and analyze data and to report information related to an investigation;</li> </ul>	SE: <i>Art Connection</i> 759 <i>Biology Connection</i> 487, 772 <i>Chemistry &amp; Technology</i> 573 <i>Chemistry Skill Handbook</i> 799-801 <i>ChemLab</i> 136-137 <i>How It Works</i> 410, 569 <i>MiniLab</i> 22, 30
<ul style="list-style-type: none"> <li>identifying major sources of error or uncertainty within an investigation (<i>for example, particular measuring devices and experimental procedures</i>);</li> </ul>	SE: <i>Chemistry Skill Handbook</i> 791-795 <i>ChemLab</i> 38-39, 56-57, 422-423, 542-543, 722-723 <i>MiniLab</i> 63
<ul style="list-style-type: none"> <li>constructing and revising scientific explanations and models, using evidence, logic, and experiments that include identifying and controlling variables;</li> </ul>	SE: 10-11, 65, 77-79, 86-94 <i>ChemLab</i> 136-137, 752-753 <i>Everyday Chemistry</i> 76, 417 TWE: IS 246
<ul style="list-style-type: none"> <li>communicating and evaluating scientific thinking that leads to particular conclusions;</li> </ul>	SE: 86-95, 143-147, 238-242 <i>Everyday Chemistry</i> 248-249, 275 <i>History Connection</i> 271 <i>How It Works</i> 519 <i>Literature Connection</i> 26
<ul style="list-style-type: none"> <li>recognizing and analyzing alternative explanations and models; and</li> </ul>	SE: 65, 77-79 <i>Art Connection</i> 759 <i>Biology Connection</i> 772 <i>Earth Science Connection</i> 727 TWE: AC 309 DE 6-7 IS 128, 246
<ul style="list-style-type: none"> <li>explaining the difference between a scientific theory and a scientific hypothesis.</li> </ul>	SE: 53-55, 59, 86-94, 230-233, 342-345 <i>ChemLab</i> 136-137 <i>MiniLab</i> 245 TWE: DIN 75

STANDARDS	PAGE REFERENCES
For students continuing their science education beyond the standards, what they know and are able to do <b>may</b> include	
<ul style="list-style-type: none"> <li>designing and completing an advanced scientific investigation—either individually or as part of a student team—that extends over several days or weeks; and</li> </ul>	SE: <i>Try at Home Labs</i> 869(2), 870(1), 872(1)
<ul style="list-style-type: none"> <li>continuing to practice and apply inquiry skills as they extend their understanding of science content through further study.</li> </ul>	SE: 292-295, 531-536, 648-661, 692-700 <i>Chemistry &amp; Technology</i> 176-178, 326-327, 573, 728-729
<b>STANDARD 2:</b> <b>Physical Science: Students know and understand common properties, forms, and changes in matter and energy. (Focus: Physics and Chemistry)</b>	
<b>2.1 Students know that matter has characteristic properties, which are related to its composition and structure.</b>	
<b>As students in grades 9-12 extend their knowledge, what they know and are able to do includes</b>	
<ul style="list-style-type: none"> <li>examining, describing, measuring, classifying, and predicting common properties of substances (<i>for example, electrical charge, chemical reactivity, acidity, electrical conductivity, radioactivity, relationships in the periodic table</i>);</li> </ul>	SE: 36-37, 91, 498-500, 601-605, 756 <i>ChemLab</i> 38-39, 100-101, 172-173, 504-505 <i>MiniLab</i> 89
<ul style="list-style-type: none"> <li>describing and explaining properties and composition of samples of matter using models (<i>for example, atomic and molecular structure, the periodic table</i>);</li> </ul>	SE: 74-75, 111-113, 138-142, 315-333 <i>Chemistry &amp; Technology</i> 176-178 <i>ChemLab</i> 752-753 <i>MiniLab</i> 63, 89, 97, 262
<ul style="list-style-type: none"> <li>separating substances based on their chemical and physical properties (<i>for example, color, solubility, chemical reactivity, melting point, boiling point</i>); and</li> </ul>	SE: 20, 170-171, 467, 638 <i>Chemistry &amp; Technology</i> 326-327, 354-355 <i>ChemLab</i> 422-423 <i>MiniLab</i> 22, 30, 312
<ul style="list-style-type: none"> <li>using word and chemical equations to relate observed changes in matter to its composition and structure.</li> </ul>	SE: 129, 132-139, 193-196, 198-199, 203-209, 486, 555-559, 655-658 TWE: EX 200 VL 192
<b>2.2 Students know that energy appears in different forms, and can move (be transferred) and change (be transformed).</b>	
<b>As students in grades 9-12 extend their knowledge, what they know and are able to do includes</b>	
<ul style="list-style-type: none"> <li>identifying, measuring, calculating, and analyzing quantitative relationships involved with energy forms (<i>for example, heat transfer in a system involving mass, specific heat, and change in temperature of matter</i>); and</li> </ul>	SE: 599-605, 719-720, 726, 730-731, 736-737, 764-765 <i>Chemistry &amp; Technology</i> 728-729 <i>ChemLab</i> 362-363, 606-607 <i>How It Works</i> 614
<ul style="list-style-type: none"> <li>identifying, measuring, calculating, and analyzing qualitative and quantitative relationships associated with energy transfer or energy transformation (<i>for example, changes in temperature, velocity, potential energy, kinetic energy, conduction, convection, radiation, voltage, current</i>).</li> </ul>	SE: 348-350, 374-375, 391-392, 719-720, 730-731 <i>ChemLab</i> 362-363, 606-607 <i>MiniLab</i> 726 TWE: DE 602-603

STANDARDS	PAGE REFERENCES
<b>2.3 Students understand that interactions can produce changes in a system, although the total quantities of matter and energy remain unchanged.</b>	
As students in grades 9-12 extend their knowledge, what they know and are able to do includes	
<ul style="list-style-type: none"> <li>identifying, describing, and explaining physical and chemical changes involving the conservation of matter and energy (<i>for example, oscillating pendulum/spring, chemical reactions, nuclear reactions</i>);</li> </ul>	SE: 42-43, 391-393, 585-588, 599-605, 708-712, 736-737 <i>ChemLab</i> 56-57, 422-423 <i>MiniLab</i> 726 TWE: DI 44
<ul style="list-style-type: none"> <li>observing, measuring, and calculating quantities to demonstrate conservation of matter and energy in chemical changes (<i>for example, acid-base, precipitation, oxidation-reduction reactions</i>), and physical interactions of matter (<i>for example, force, work, power</i>);</li> </ul>	SE: 41-42, 53, 55, 198, 414-419 <i>ChemLab</i> 56-57 TWE: CD 54 CM 59 DE 426-427 DI 44
<ul style="list-style-type: none"> <li>describing and predicting chemical changes (<i>for example, combustion, simple chemical reactions</i>), and physical interactions of matter (<i>for example, velocity, force, work, power</i>), using word or symbolic equations; and</li> </ul>	SE: 40-43, 55, 138-142, 193-196, 570, 588-589 <i>Chemistry &amp; Technology</i> 216-217 <i>ChemLab</i> 136-137 <i>How It Works</i> 614 TWE: DE 198-199
<ul style="list-style-type: none"> <li>describing and explaining physical interactions of matter using conceptual models (<i>for example, conservation laws of matter and energy, particle model for gaseous behavior</i>).</li> </ul>	SE: 65, 74-75, 342-347, 351, 372-375, 386, 392, 451-453 <i>Everyday Chemistry</i> 320 TWE: QD 459
For students continuing their science education beyond the standards, what they know and are able to do <b>may</b> include	
<ul style="list-style-type: none"> <li>relating their prior knowledge and understanding of properties of matter to observable characteristics of materials and emerging technologies (<i>for example, semiconductors, superconductors, photovoltaics, ceramics</i>);</li> </ul>	SE: 105-107, 111-113, 144-147, 613, 648-661 <i>Chemistry &amp; Technology</i> 176-178 <i>Everyday Chemistry</i> 248-249, 417 <i>How It Works</i> 468, 569, 614
<ul style="list-style-type: none"> <li>modeling quantitative aspects of chemical and physical interactions (<i>for example, rates of reactions, stoichiometry, electromagnetic phenomena, statics and dynamics, electrochemistry</i>);</li> </ul>	SE: 382-383, 386-392, 404-409, 414-421, 502-507, 539-541, 601-605 <i>ChemLab</i> 328-329, 384-385, 542-543
<ul style="list-style-type: none"> <li>applying knowledge and understanding of chemical and physical interactions to explore factors that influence or govern change (<i>for example, equilibrium constants, kinetics, thermodynamics</i>); and</li> </ul>	SE: 74-75, 218-223, 396-398, 601-605, 713-714, 716-718 <i>ChemLab</i> 674-675 <i>Everyday Chemistry</i> 397, 571 <i>MiniLab</i> 557
<ul style="list-style-type: none"> <li>distinguishing among different types of constancy (<i>for example, static and dynamic equilibrium, symmetry, uniform/accelerated motion</i>) and different types of change (<i>for example, qualitative and quantitative trends, cyclic change, chaotic systems</i>).</li> </ul>	SE: 40-44, 55, 74-75, 138-142, 190-196, 198-199, 382-383, 601-605, 711-714, 719-720, 756

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<p><b>STANDARD 5:</b>  <b>Students know and understand interrelationships among science, technology, and human activity and how they can affect the world.</b>            As students in grades 9-12 extend their knowledge, what they know and are able to do includes</p>	
<ul style="list-style-type: none"> <li>analyzing benefits, limitations, costs, and consequences involved in using technology or resources (<i>for example, X-rays, agricultural chemicals, natural gas reserves</i>);</li> </ul>	SE: <i>Chemistry and Society</i> 32, 146, 495, 659 <i>Chemistry &amp; Technology</i> 216-217, 424-425, 728-729 <i>Everyday Chemistry</i> 221, 715 <i>How It Works</i> 614
<ul style="list-style-type: none"> <li>analyzing how the introduction of a new technology has affected or could affect human activity (<i>for example, invention of the telescope, applications of modern telecommunications</i>);</li> </ul>	SE: 111-113, 637-639 <i>Chemistry &amp; Technology</i> 216-217, 288-291 <i>Everyday Chemistry</i> 466, 594 <i>How It Works</i> 569, 612, 614 <i>Physics Connection</i> 566
<ul style="list-style-type: none"> <li>demonstrating the interrelationships between science and technology (<i>for example, building a bridge, designing a better running shoe</i>); and</li> </ul>	SE: <i>Biology Connection</i> 203, 772 <i>Chemistry &amp; Technology</i> 216-217, 240-241, 326-327, 590-592, 754-755 <i>Physics Connection</i> 566
<ul style="list-style-type: none"> <li>explaining the use of technology in an occupation.</li> </ul>	SE: <i>People in Chemistry</i> 12-13, 212-213, 316-317, 448-449, 490-491, 596-597, 654-655, 678-679
<p>For students continuing their science education beyond the standards, what they know and are able to do <b>may</b> include</p>	
<ul style="list-style-type: none"> <li>applying their knowledge and understanding of chemical and physical interactions to explain present and anticipated technologies (<i>for example, lasers, ultrasound, superconducting materials, photocopy machines</i>); and</li> </ul>	SE: <i>Chemistry and Society</i> 537 <i>Chemistry &amp; Technology</i> 108-109, 390, 573, 754-755 <i>How It Works</i> 167, 468, 569, 612, 614
<ul style="list-style-type: none"> <li>exploring the scientific and technological aspects of contemporary problems (<i>for example, issues related to nutrition, air quality, natural resources</i>).</li> </ul>	SE: <i>Biology Connection</i> 280 <i>Chemistry and Society</i> 60, 447, 495, 659 <i>Everyday Chemistry</i> 777 <i>MiniLab</i> 452, 775
<p><b>STANDARD 6:</b>  <b>Students understand that science involves a particular way of knowing and understand common connections among scientific disciplines.</b>            As students in grades 9-12 extend their knowledge, what they know and are able to do includes</p>	
<ul style="list-style-type: none"> <li>evaluating print and visual media for scientific evidence, bias, or opinion;</li> </ul>	SE: <i>Art Connection</i> 759 <i>Chemistry and Society</i> 32, 495 <i>History Connection</i> 307 <i>Literature Connection</i> 96 <i>Physics Connection</i> 232 TWE: DE 6-7
<ul style="list-style-type: none"> <li>explaining that the scientific way of knowing uses a critique and consensus process (<i>for example, peer review, openness to criticism, logical arguments, skepticism</i>);</li> </ul>	SE: 53-55, 59, 63-65, 94 <i>History Connection</i> 58 TWE: CJ 78 CM 70 DE 6-7
<ul style="list-style-type: none"> <li>using graphs, equations, or other models to analyze systems involving change and constancy (<i>for example, comparing the geologic time scale to shorter time frames</i>);</li> </ul>	SE: 74-75, 383, 386, 601-605, 713-714, 756 <i>Chemistry Skill Handbook</i> 805-808 <i>ChemLab</i> 362-363, 674-675

STANDARDS	PAGE REFERENCES
<ul style="list-style-type: none"> <li>analyzing and comparing models of cyclic change as used within and among scientific disciplines (<i>for example, water cycle, circular motion, sound waves, weather cycles</i>);</li> </ul>	SE: 55, 690, 696-700, 734-737 TWE: CD 233
<ul style="list-style-type: none"> <li>identifying and predicting cause-effect relationships within a system (<i>for example, the effect of temperature on gas volume, effect of carbon dioxide level on the greenhouse effect, effects of changing nutrients at the base of a food pyramid</i>);</li> </ul>	SE: <i>Biology Connection</i> 280 <i>Chemistry and Society</i> 495 <i>Chemistry &amp; Technology</i> 216-217, 424-425 <i>ChemLab</i> 384-385, 674-675 <i>Everyday Chemistry</i> 76, 248-249 <i>MiniLab</i> 122, 166
<ul style="list-style-type: none"> <li>identifying and describing the dynamics of natural systems (<i>for example, weather systems, ecological systems, body systems, systems at dynamic equilibrium</i>);</li> </ul>	SE: 696-700, 734-735 <i>Biology Connection</i> 487 <i>Chemistry and Society</i> 146, 495 <i>Chemistry &amp; Technology</i> 754-755 <i>Earth Science Connection</i> 524 TWE: IS 276
<ul style="list-style-type: none"> <li>identifying and testing a model to analyze systems involving change and constancy (<i>for example, a mathematical expression for gas behavior; constructing a closed ecosystem such as an aquarium</i>);</li> </ul>	SE: 383, 386, 392, 713-714, 756 <i>Chemistry &amp; Technology</i> 424-425 <i>Chemistry Skill Handbook</i> 805-808 <i>ChemLab</i> 362-363, 384-385, 674-675 TWE: DE 212-213
<ul style="list-style-type: none"> <li>explaining an exponential model (<i>for example, pH scale, population growth, Richter scale</i>); and</li> </ul>	SE: 500-502, 506-508, 540-541, 756-758 <i>ChemLab</i> 752-753 TWE: DIN 503
<ul style="list-style-type: none"> <li>refining a hypothesis based on an accumulation of data over time (<i>for example, Alvarez's theory on dinosaur extinction</i>).</li> </ul>	SE: 59, 61-65, 94, 111-113 <i>Biology Connection</i> 772 <i>History Connection</i> 58, 271 <i>MiniLab</i> 775
For students continuing their science education beyond the standards, what they know and are able to do <b>may</b> include	
<ul style="list-style-type: none"> <li>relating small-scale phenomena to large-scale properties (<i>for example, intermolecular forces related to physical properties</i>); and</li> </ul>	SE: 144-147, 342-347, 351-352, 438-443, 483-485, 531-533 <i>Physics Connection</i> 566
<ul style="list-style-type: none"> <li>tracing the development of an invention, theory, or discovery to demonstrate the dynamic nature of science.</li> </ul>	SE: 52-55, 62-65, 74-77, 86-94, 111-113, 611-615 <i>Chemistry &amp; Technology</i> 216-217, 424-425 <i>History Connection</i> 58

## Codes Used for TWE pages

AC	Across the Curriculum
CD	Concept Development
CJ	Chemistry Journal
CM	Correcting Misconceptions
DE	Demonstration
DI	Discussion
DIN	Differentiated Instruction
EX	Extension
IS	Integrating the Sciences
P	Procedure
QD	Quick Demo
VL	Visual Learning