



## Active Chemistry Correlation to the Minnesota Academic Standards, Grades 9-12

### The Nature of Science and Engineering

Standard/Benchmark	Location/Page where Standard is found
<b>1. The Practice of Science</b>	
<b>1. Science is a way of knowing about the natural world and is characterized by empirical criteria, logical argument and skeptical review.</b>	
9.1.1.1.1 Explain the implications of the assumption that the rules of the universe are the same everywhere and these rules can be discovered by careful and systematic investigation	119, 125, 131, 143, 151, 156, 240, 286, 297, 307, 317, 328, 343, 360, 400, 440, 476, 484, 541, 574, 617, 640, 649, 658, 667, 709, 778, 833, 901, 909
9.1.1.1.2 Understand that scientists conduct investigations for a variety of reasons, including: to discover new aspects of the natural world, to explain observed phenomena, to test the conclusions of prior investigations, or to test the predictions of current theories.	15-18, 35-37, 19-20, 24, 29-30, 33, 34, 39-41, 43, 46-50, 54, 58-62, 82, 101-103, 182-184, 703-704, 712-713
9.1.1.1.3 Explain how the traditions and norms of science define the bounds of professional scientific practice and reveal instances of scientific error or misconduct.	
9.1.1.1.4 Explain how societal and scientific ethics impact research practices.	
9.1.1.1.5 Identify sources of bias and explain how bias might influence the direction of research and the interpretation of data.	111, 121, 135, 370, 391, 402, 442, 468, 477, 533, 545, 553, 576, 600, 609, 618, 633, 642, 660, 679, 686, 694, 712, 727, 802, 845, 858, 868, 878, 893, 903, 910, 920,

<p>9.1.1.1.6 Describe how changes in scientific knowledge generally occur in incremental steps that include and build on earlier knowledge.</p>	<p>15-18, 19-22, 29-32, 34, 35-37, 39-40, 54, 63-64, 82, 101-103, 152-153, 182-184, 416-418, 568-569, 608-610, 618-620, 703-704, 712-713, 919-921</p>
<p>9.1.1.1.7 Explain how scientific and technological innovations—as well as new evidence— can challenge portions of, or entire accepted theories and models including, but not limited to: cell theory, atomic theory, theory of evolution, plate tectonic theory, germ theory of disease, and the big bang theory.</p>	<p>15-18, 35-37, 19-20, 24, 29-30, 33, 34, 39-41, 43, 46-50, 54, 58-62, 82, 101-103, 182-184, 703-704, 712-713</p>
<p><b>2. Scientific inquiry uses multiple interrelated processes to investigate and explain the natural world.</b></p>	
<p>9.1.1.2.1 Formulate a testable hypothesis, design and conduct an experiment to test the hypothesis, analyze the data, consider alternative explanations and draw conclusions supported by evidence from the investigation.</p>	<p>7-10, 15-18, 35-37, 101-103, 113-113, 120-121, 126-127, 134-137, 144-146, 152-153, 157-158, 162-164, 182-184, 193-195, 201-203, 210-214, 224-227, 233-236, 241-242, 255-258, 287-291, 300-301, 308-311, 318-320, 329-332, 353-356, 369-371, 379-382, 390-392, 401-404, 408-410, 416-418, 433-435, 441-444, 448-451, 456-460, 468-469, 477-479, 485-488, 496-497, 511-513, 522-524, 532-535, 544-545, 551-554, 560-562, 568-569, 575-577, 599-602, 608-610, 618-520, 632-634, 641-643, 659-661, 677-679, 685-686, 693-697, 703-704, 712-713, 727-728, 743-745, 766-768, 779-783, 790-792, 799-803, 812-816, 843-848, 857-858, 867-869, 877-882, 892-896, 902-904, 910-912, 919-921</p>
<p>9.1.1.2.2 Evaluate the explanations proposed by others by examining and comparing evidence, identifying faulty reasoning, pointing out statements that go beyond the scientifically acceptable evidence, and suggesting alternative scientific explanations</p>	<p>15-18, 19-22, 29-32, 34, 35-37, 39-40, 54, 63-64, 82, 101-103, 152-153, 182-184, 416-418, 568-569, 608-610, 618-620, 703-704, 712-713, 919-921</p>

9.1.1.2.3 Identify the critical assumptions and logic used in a line of reasoning to judge the validity of a claim.	15-18, 35-37, 19-20, 24, 29-30, 33, 34, 39-41, 43, 46-50, 54, 58-62, 82, 101-103, 182-184, 703-704, 712-713
9.1.1.2.4 Use primary sources or scientific writings to identify and explain how different types of questions and their associated methodologies are used by scientists for investigations in different disciplines.	
<b>2. The Practice of Engineering</b>	
<b>1. Engineering is a way of addressing human needs by applying science concepts and mathematical techniques to develop new products, tools, processes and systems.</b>	
9.1.2.1.1 Understand that engineering designs and products are often continually checked and critiqued for alternatives, risks, costs and benefits, so that subsequent designs are refined and improved.	95, 119,131- 133, 173, 249, 299, 347, 376, 389, 392, 400, 418, 427, 467, 505, 543, 583, 587, 607, 631, 711, 737, 789, 837, 891,
9.1.2.1.2 Recognize that risk analysis is used to determine the potential positive and negative consequences of using a new technology or design, including the evaluation of causes and effects of failures.	95, 119,131- 133, 173, 249, 299, 347, 376, 389, 392, 400, 418, 427, 467, 505, 543, 583, 587, 607, 631, 711, 737, 789, 837, 891
9.1.2.1.3 Explain and give examples of how, in the design of a device, engineers consider how it is to be manufactured, operated, maintained, replaced and disposed of	95, 119,131- 133, 173, 249, 299, 347, 376, 389, 392, 400, 418, 427, 467, 505, 543, 583, 587, 607, 631, 711, 737, 789, 837, 891,
<b>2. Engineering design is an analytical and creative process of devising a solution to meet a need or solve a specific problem.</b>	
9.1.2.2.1 Identify a problem and the associated constraints on possible design solutions.	95, 119,131- 133, 173, 249, 299, 347, 376, 389, 392, 400, 418, 427, 467, 505, 543, 583, 587, 607, 631, 711, 737, 789, 837, 891,
9.1.2.2.2 Develop possible solutions to an engineering problem and evaluate them using conceptual, physical and mathematical models to determine the extent to which the solutions meet the design specifications.	95, 119,131- 133, 173, 249, 299, 347, 376, 389, 392, 400, 418, 427, 467, 505, 543, 583, 587, 607, 631, 711, 737, 789, 837, 891,

**3. Interactions Among Science, Technology, Engineering, Mathematics, and Society**

**1. Natural and designed systems are made up of components that act within a system and interact with other systems.**

9.1.3.1.1 Describe a system, including specifications of boundaries and subsystems, relationships to other systems, and identification of inputs and expected outputs.	95, 119, 131- 133, 173, 249, 299, 347, 376, 389, 392, 400, 418, 427, 467, 505, 543, 583, 587, 607, 631, 711, 737, 789, 837, 891,
9.1.3.1.2 Identify properties of a system that are different from those of its parts but appear because of the interaction of those parts.	
9.1.3.1.3 Describe how positive and/or negative feedback occur in systems.	308-315, 318-327, 369-377, 468-474, 477-492

**2. Men and women throughout the history of all cultures, including Minnesota American Indian tribes and communities, have been involved in scientific inquiry and engineering design.**

9.1.3.2.1 Provide examples of how diverse cultures, including natives from all of the Americas, have contributed scientific and mathematical ideas and technological inventions.	92, 170, 246, 344, 424, 502, 584, 668, 734, 834, 928
9.1.3.2.2 Analyze possible careers in science and engineering in terms of education requirements, working practices and rewards.	92, 170, 246, 344, 424, 502, 584, 668, 734, 834, 928

**3. Science and engineering operate in the context of society and both influence and are influenced by this context.**

9.1.3.3.1 Describe how values and constraints affect science and engineering.	162-164, 179-181, 193-195, 201-203, 233-235, 353-356, 416-418, 532-535, 560-562, 575-577, 607, 685-686, 743-744, 766-768, 812-816, 826-827, 902-904
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<p>9.1.3.3.2 Communicate, justify and defend the procedures and results of a scientific inquiry or engineering design project using verbal, graphic, quantitative, virtual or written means.</p>	<p>7-10, 26-28, 46-50, 58-62, 101-103, 113-113, 120-121, 134-137, 144-146, 182-184, 193-195, 201-203, 210-214, 224-227, 233-236, 241-242, 255-258, 287-291, 300-301, 308-311, 329-332, 353-356, 361-364, 369-371, 379-382, 390-392, 401-404, 416-418, 433-435, 441-444, 448-451, 456-460, 468-469, 477-479, 485-488, 496-497, 511-513, 522-524, 532-535, 544-545, 560-562, 575-577, 599-602, 608-610, 618-520, 632-634, 641-643, 659-661, 677-679, 685-686, 693-697, 703-704, 712-713, 727-728, 743-745, 779-783, 790-792, 799—803, 812-816, 843-848, 857-858, 867-869, 877-882, 892-896, 902-904, 910-912, 919-921</p>
<p>9.1.3.3.3 Describe how scientific investigations and engineering processes require multi-disciplinary contributions and efforts.</p>	<p>15-18, 19-22, 29-32, 34, 35-37, 39-40, 54, 63-64, 82, 101-103, 152-153, 182-184, 416-418, 568-569, 608-610, 618-620, 703-704, 712-713, 919-921</p>
<p><b>4. Science, technology, engineering and mathematics rely on each other to enhance knowledge and understanding.</b></p>	
<p>9.1.3.4.1 Describe how technological problems and advances often create a demand for new scientific knowledge, improved mathematics and new technologies.</p>	<p>119, 125, 131, 143, 151,156, 240, 286, 297, 307,317,328, 343,360, 400, 440, 476, 484, 541, 574, 617, 640, 649, 658, 667, 709, 778, 833, 901, 909</p>
<p>9.1.3.4.2 Determine and use appropriate safety procedures, tools, computers and measurement instruments in science and engineering contexts.</p>	<p>102, 111, 121, 135, 145, 158, 163, 194-5, 202, 211, 225, 234, 242, 256, 288, 309, 311, 330, 354, 370, 391, 402, 434,442, 450, 459, 468, 477, 486, 512, 523,533, 545, 553, 576, 600, 609, 618, 633, 642, 651, 660, 679, 686, 694, 703, 712, 727, 766, 802, 845, 858, 868, 878, 893, 903, 910, 920,</p>

9.1.3.4.3 Select and use appropriate numeric, symbolic, pictorial, or graphical representation to communicate scientific ideas, procedures and experimental results.	47, 111, 115, 141, 259, 278-281, 324-325, 337, 364, 376, 382, 383, 471-475, 490, 538, 553, 556-558, 567, 601, 605, 615, 708, 773, 813, 816, 845, 847, 859, 862-863, 914-915
9.1.3.4.4 Relate the reliability of data to consistency of results, identify sources of error, and suggest ways to improve data collection and analysis.	19, 135, 139, 140, 174, 213, 278, 385, 405, 600, 604, 713, 868, 893,
9.1.3.4.5 Demonstrate how unit consistency and dimensional analysis can guide the calculation of quantitative solutions and verification of results.	31, 36. 40-42, 54, 83, 91, 96, 137-138, 142-143, 215-218, 284-285, 289-291, 296-297, 302-304, 372-375, 382-383, 385, 403-407, 411-412, 492, 494, 517, 534-536, 548, 554, 562-563, 579-580, 604-605, 607, 664, 699-701, 717-718, 821-823, 860-863, 865, 871, 878-887, 903, 912, 917, 927,
9.1.3.4.6 Analyze the strengths and limitations of physical, conceptual, mathematical and computer models used by scientists and engineers.	

## Chemistry

Standard/Benchmark	Location/Page where Standard is found
<b>1. The Nature of Science and Engineering</b>	
<b>3. Interactions Among Science, Technology, Engineering, Mathematics, and Society</b>	
<b>3. Developments in chemistry affect society and societal concerns affect the field of chemistry.</b>	
9C.1.3.3.1 Explain the political, societal, economic and environmental impact of chemical products and technologies.	224-230, 233-238, 287-295, 308-315, 353-358, 416-421, 560-566, 575-583, 743-748, 790-796, 826-832, 910-916, 919-925
<b>4. Physical and mathematical models are used to describe physical systems.</b>	

9C.1.3.4.1 Use significant figures and an understanding of accuracy and precision in scientific measurements to determine and express the uncertainty of a result.	15-18, 35-37, 19-20, 24, 29-30, 33, 34, 39-41, 43, 46-50, 54, 58-62, 82, 101-103, 182-184, 703-704, 712-713
<b>2. Physical Science</b>	
<b>1. Matter</b>	
<b>1. The periodic table illustrates how patterns in the physical and chemical properties of elements are related to atomic structure.</b>	
9C.2.1.1.1 Explain the relationship of an element's position on the periodic table to its atomic number and electron configuration.	15-22, 2634, 46-56, 58-67, 68-76, 77-91, 212, 276, 419
9C.2.1.1.2 Identify and compare trends on the periodic table, including reactivity and relative sizes of atoms and ions; use the trends to explain the properties of subgroups, including metals, non-metals, alkali metals, alkaline earth metals, halogens and noble gases.	29-33, 39, 47, 49, 50-51, 54, 58-67, 77, 78, 79-85, 89-91, 96, 159, 196, 200, 287-297, 304, 366, 448, 499, 611, 646, 763, 772-774, 851,
<b>2. Chemical and physical properties of matter result from the ability of atoms to form bonds.</b>	
9C.2.1.2.1 Explain how elements combine to form compounds through ionic and covalent bonding.	163, 166, 186-190, 213-218, 222, 228-232, 256-258, 266-273, 276, 325, 356-360, 364-368, 392-397, 445, 456-463, 496-497, 525-526, 608, 613, 616, 619, 622-629, 626-629, 636, 642-647, 672, 680-682, 725, 738, 757-765, 761, 769-777, 838, 850-853
9C.2.1.2.2 Compare and contrast the structure, properties and uses of organic compounds, such as hydrocarbons, alcohols, sugars, fats and proteins.	152-156, 162-167, 416-421, 532-540, 790-792, 799-807
9C.2.1.2.3 Use IUPAC (International Union of Pure and Applied Chemistry) nomenclature to write chemical formulas and name molecular and ionic compounds, including those that contain polyatomic ions.	13, 83, 65, 69, 104-106, 109, 164, 215, 595, 760
9C.2.1.2.4 Determine the molar mass of a compound from its chemical formula and a table of atomic masses; convert the mass of a molecular substance to moles, number of particles, or volume of gas at standard temperature and pressure.	19-21, 78, 82, 96, 111-116, 212, 215-216, 278-279, 280-283, 286, 373, 383-387, 394, 403-405, 411-415, 428, 437, 570, 577-580, 698-700, 715-

	721, 885
9C.2.1.2.5 Determine percent composition, empirical formulas and molecular formulas of simple compounds.	13, 83, 65, 69, 104-106, 109, 164, 212-217, 279, 411-412, 570, 595, 760
9C.2.1.2.6 Describe the dynamic process by which solutes dissolve in solvents, and calculate concentrations, including percent concentration, molarity and parts per million.	405, 436-437, 480, 490, 633, 822, 823, 848, 870, 884, 914
9C.2.1.2.7 Explain the role of solubility of solids, liquids and gases in natural and designed systems.	120-126, 224-230, 233-238, 241-244, 287-295, 308-315, 353-358, 408-415, 659-665, 685-692, 703-708, 779-786, 857-865, 867-874, 877-889, 892-900, 902-908, 910-916
<b>3. Chemical reactions describe a chemical change in which one or more reactants are transformed into one or more products.</b>	
9C.2.1.3.1 Classify chemical reactions as double replacement, single replacement, synthesis, decomposition or combustion	21, 96, 102, 154, 163, 166, 186-190, 213-218, 222, 228-232, 256-258, 266-273, 276, 325, 356-360, 392-397, 445, 456-463, 525-526, 608, 613, 616, 619, 626-629, 636, 642-647, 672, 680-682, 725, 738, 761, 838
9C.2.1.3.2 Use solubility and activity of ions to determine whether a double replacement or single replacement reaction will occur.	10, 13, 182, 184-190, 210, 213, 215, 233-234, 250, 257, 424, 445, 488-490, 491, 539, 570, 588, 625, 641-648, 687-689, 703, 706, 754, 817, 820-824, 828-829, 868, 870-871,
9C.2.1.3.3 Relate the properties of acids and bases to the ions they contain and predict the products of an acid-base reaction.	10, 13, 182, 184-190, 210, 213, 215, 233-234, 250, 257, 424, 445, 488-490, 491, 539, 570, 588, 625, 687-689, 703, 706, 754, 817, 820-824, 828-829, 868, 870-871,
9C.2.1.3.4 Balance chemical equations by applying the laws of conservation of mass and constant composition.	21, 96, 102, 154, 163, 166, 186-190, 213-218, 222, 228-232, 256-258, 266-273, 276, 325, 356-360, 392-397, 445,

	456-463, 525-526, 608, 613, 616, 619, 626-629, 636, 642-647, 672, 680-682, 725, 738, 761, 838
9C.2.1.3.5 Use the law of conservation of mass to describe and calculate relationships in a chemical reaction, including molarity, mole/mass relationships, mass/volume relations, limiting reactants and percent yield.	19-21, 78, 82, 96, 102, 154, 163, 166, 186-190, 213-218, 222, 228-232, 256-258, 266-273-283, 286, 325, 356-360, 392-397, 408-415, 437, 445, 456-463, 525-526, 570, 608, 613, 616, 619, 626-629, 636, 642-647, 672, 680-682, 725, 738, 761, 838, 885
9C.2.1.3.6 Describe the factors that affect the rate of a chemical reaction, including temperature, pressure, mixing, concentration, particle size, surface area and catalyst.	170, 324-325, 341, 470, 480-481, 528, 538-539, 613-614, 706
9C.2.1.3.7 Recognize that some chemical reactions are reversible and that not all chemical reactions go to completion	478-480, 877, 880-884, 886-888, 932
<b>4. States of matter can be described in terms of motion of molecules. The properties and behavior of gases can be explained using the kinetic molecular theory.</b>	
9C.2.1.4.1 Use kinetic molecular theory to explain how changes in energy content affect the state of matter (solid, liquid and gaseous phases).	114-119, 260, 364, 404-406, 410-413, 546-550, 555-558, 714-719
9C.2.1.4.2 Use the kinetic molecular theory to explain the behavior of gases and the relationship among temperature, pressure, volume and the number of particles.	15, 20, 24, 54, 111-116, 373, 383-387, 403-405, 410-415, 428, 470-472, 515, 577, 578, 580, 698-700, 714-721, 738