



Active Chemistry Correlation to the Washington Science Standards, Grades 9-12

Physical Science

Content Standards/Performance Expectations	Location/Page where Standard is found
<p>9-12 SYSA <i>Feedback is a process in which the output of a system provides information used to regulate the operation of the system. Positive feedback increases the disturbance to a system. Negative feedback reduces the disturbance to a system.</i></p>	
<p>Give examples of a positive <i>feedback system</i> and <i>explain</i> its regulatory mechanism (e.g., global warming causes Earth's ice caps to melt, reflecting less energy to space, increasing temperatures).*a</p>	<p>259-261, 308-311, 318-320, 329-332, 353-356, 496-497, 522-535, 575-577, 685-686, 867-869, 877-882, 892-896, 902-904</p>
<p>Give examples of a negative <i>feedback system</i> and <i>explain</i> its regulatory mechanism (e.g., when a human body overheats, it produces sweat that cools the body by evaporation).*a</p>	<p>259-261, 329-332, 353-356, 401-410, 877-882, 892-896, 902-904</p>
<p>9-12 SYSB <i>Systems thinking can be especially useful in analyzing complex situations. To be useful, a system needs to be specified as clearly as possible.</i></p>	
<p>Determine if a <i>systems</i> approach will be helpful in answering a <i>question</i> or solving a problem.*b</p>	<p>5-14, 58-67, 144-150, 193-198, 255-261, 287-295, 329-339, 353-358, 369-377, 401-407, 448-453, 468-474, 477-479, 532-540, 575-583, 621, 641-648, 703-708, 712-721, 857-865, 877-889, 892-900, 902-908, 910-916</p>
<p>Represent the <i>system</i> with a diagram specifying components, boundaries, flows, and <i>feedbacks</i>.*a</p>	<p>5-14, 58-67, 193-198, 287-295, 329-339, 353-358, 369-377, 401-407, 448-453, 468-474, 477-479, 532-540, 575-583, 621, 641-648, 703-708, 712-721, 857-865, 877-889, 892-900, 902-908, 910-916</p>
<p><i>Describe</i> relevant <i>subsystems</i> and the larger <i>system</i> that contains the <i>system</i> being analyzed.*a</p>	<p>5-14, 58-67, 144-150, 193-198, 287-295, 329-339, 353-358, 369-377, 401-407, 448-453, 468-474, 477-479, 532-540, 575-583, 621, 641-648, 703-708, 712-721, 857-865, 877-889, 892-900, 902-908, 910-916</p>

Determine how the <i>system functions</i> with respect to other <i>systems</i> .	5-14, 58-67, 144-150, 193-198, 287-295, 329-339, 353-358, 369-377, 401-407, 448-453, 468-474, 477-479, 532-540, 575-583, 621, 641-648, 703-708, 712-721, 857-865, 877-889, 892-900, 902-908, 910-916
9-12 SYSC In complex systems, entirely new and unpredictable properties may emerge. Consequently, modeling a complex system in sufficient detail to make reliable predictions may not be possible.	
Create a simplified <i>model</i> of a complex <i>system</i> . Trace the possible consequences of a change in one part of the <i>system</i> and <i>explain how</i> the simplified <i>model</i> may not be adequate to reliably <i>predict</i> consequences.	5-14, 32-42, 55, 65, 72-74, 108, 117, 119, 123, 130, 149, 153, 160, 163, 167, 168, 191, 199, 208, 217, 219, 230, 275-278, 295, 304-306, 315, 324-325, 326, 333-335, 340-341, 354, 358-359, 364, 395, 421, 475, 540, 548, 572, 579-581, 615, 621, 638, 652-657, 660-662, 665, 663, 700, 732, 758, 781-783, 796, 824, 855
9-12 SYSD Systems can be changing or in equilibrium.	
Analyze whether or not a <i>system</i> (e.g., population) is changing or in <i>equilibrium</i> . *c	114-116, 194-195, 259-261, 310-313, 324-325, 333-335, 342-343, 358, 370, 373-376, 384, 404-406, 440, 471, 474, 538, 548, 555-558, 580, 621, 696, 716-718, 817-823, 849, 859-863, 877-888, 902-907, 910-916,926
Determine whether a <i>state</i> of equilibrium is <i>static</i> or <i>dynamic</i> (i.e., inflows equal outflows). *c	114-116, 194-195, 259-261, 310-313, 324-325, 342-343, 358, 370, 373-376, 384, 404-406, 440, 471, 474, 538, 548, 555-558, 580, 621, 696, 716-718, 817-823, 849, 859-863, 877-888, 902-907, 910-916,926

EALR 2: Inquiry (INQ)

Core Content: *Conducting Analyses and Thinking Logically*

Content Standards/Performance Expecations	Location/Page where Standard is found
9-12 INQA Question: Scientists generate and evaluate questions to investigate the natural world.	

<p><i>Generate and evaluate a question that can be answered through a scientific investigation. Critique questions generated by others and explain whether or not the questions are scientific.*a</i></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>9-12 INQB Investigate: Scientific progress requires the use of various methods appropriate for answering different kinds of research questions, a thoughtful plan for gathering data needed to answer the question, and care in collecting, analyzing, and displaying the data.</p>	
<p>Plan and conduct a scientific investigation, choosing a method appropriate to the question being asked.</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>Collect, analyze, and display data using calculators, computers, or other technical devices when available.*b</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>
<p>9-12 INQC Explain: Conclusions must be logical, based on evidence, and consistent with prior established knowledge.</p>	
<p>Draw conclusions supported by evidence from the investigation and consistent with established scientific knowledge.*c</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,</p>

	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
Analyze alternative explanations and decide which best fits the data.*d	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
9-12 INQD Communicate Clearly: The methods and procedures that scientists use to obtain <i>evidence</i> must be clearly reported to enhance opportunities for further investigation.	
Write a detailed laboratory report that includes: the <i>question</i> that motivated the study, a justification for the kind of investigation chosen, <i>hypotheses</i> (if any), a description of what was done, a summary of data in tables and graphs, and a conclusion, based on the <i>evidence</i> , that responds to the <i>question</i> .	15-18, 35-38, 46-50, 58-62, 101-103, 110-113, 120-121, 134-137, 144-146, 182-184, 193-195, 201-203, 210-214, 224-230, 233-235, 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, 618-622, 632-634, 641-643, 659-662, 677-679, 685-686, 693-697, 703-704, 712-713, 727-729, 743-744, 779-783, 790-792, 799-804, 812-816, 826-827, 843-848, 857-859, 867-869, 877-882, 892-896, 902-904, 910-912, 919-921
9-12 INQE Model: The essence of scientific investigation involves the development of a <i>theory</i> or conceptual <i>model</i> that can <i>generate</i> testable predictions.	
Formulate one or more <i>hypotheses</i> based on a <i>model</i> or <i>theory</i> of a causal <i>relationship</i> . Demonstrate creativity and critical thinking to formulate and <i>evaluate</i> the <i>hypotheses</i> .	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

9-12 INQF Communicate: <i>Science</i> is a human endeavor that involves logical reasoning and creativity and entails the testing, revision, and occasional discarding of theories as new <i>evidence</i> comes to light.	
<i>Evaluate</i> an investigation to determine if it was a <i>valid</i> means of answering the <i>question</i> , and whether or not the results were <i>reliable</i> . *e	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
<i>Describe</i> the development of a scientific <i>theory</i> that illustrates logical reasoning, creativity, testing, revision, and replacement of prior <i>ideas</i> in light of new <i>evidence</i> .	5-14, 15-22, 26-34, 35-43, 46-56, 58-67, 182-190, 308-315, 416-421, 766-776, 826-832, 910-912
9-12 INQG Intellectual Honesty: Public communication among scientists is an essential aspect of research. Scientists evaluate the validity of one another’s investigations, check the reliability of results, and explain inconsistencies in findings.	
Participate in a scientific discussion about their own investigations and those performed by others.	7-10, 15-18, 26-28, 35-38, 46-50, 58-62, 68-69, 77-79, 101-103, 110-113, 144-146, 179-181, 182-184, 193-195, 201-203, 233-235, 241-242, 255-258, 265-269, 274-278, 287-291, 300-301, 308-311, 361-364, 369-371, 379-382, 390-392, 401-404, 408-410, 416-418, 433-435, 441-444, 448-451, 456-460, 477-479, 485-488, 496-497, 511-513, 522-524, 532-535, 544-545, 551-554, 560-562, 575-577, 593-594, 599-602, 608-610, 618-622, 641-643, 677-679, 685-686, 693-697, 712-713, 743-744, 766-768, 779-783, 790-792, 799-804, 812-816, 826-827, 843-848, 857-859, 867-869, 877-882, 892-896, 902-904, 910-912, 919-921
Respond to <i>questions</i> and criticisms, and if appropriate, revise explanations based on these discussions.	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
9-12 INQH Intellectual Honesty: Scientists carefully evaluate sources of information for reliability before using that information. When referring to the ideas or findings of others, they cite their sources of information.	
Provide appropriate citations for all <i>ideas</i> , findings, and information used in any and all written reports.	N/A
<i>Explain</i> the consequences for failure to provide appropriate citations.	N/A

EALR 3: Application (APP)
Core Content: Science, Technology, and Society

Content Standards/Performance Expectations	Location/Page where Standard is found
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9-12 APPA *Science affects society and cultures by influencing the way many people think about themselves, others, and the environment. Society also affects science by its prevailing views about what is important to study, and by deciding what research will be funded.*

<p>Describe ways that scientific <i>ideas</i> have influenced society or the development of differing cultures.</p>	<p>15-18, 35-38, 46-50, 58-62, 101-103, 110-113, 120-121, 134-137, 144-146, 182-184, 193-195, 201-203, 210-214, 224-230, 233-235, 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, 618-622, 632-634, 641-643, 659-662, 677-679, 685-686, 693-697, 703-704, 712-713, 727-729, 743-744, 779-783, 790-792, 799-804, 812-816, 826-827, 843-848, 857-859, 867-869, 877-882, 892-896, 902-904, 910-912, 919-921</p>
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<p>List <i>questions</i> that scientists <i>investigate</i> that are stimulated by the needs of society (e.g., medical research, <i>global climate change</i>).</p>	<p>5-14, 26-34, 46-56, 77-91, 152-156, 193-198, 241-244, 287-295, 300-306, 353-358, 416-421, 560-566, 575-583, 632-638, 790-796, 826-832, 892-900, 910-916</p>
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9-12 APPB *The technological design process begins by defining a problem in terms of criteria and constraints, conducting research, and generating several different solutions.*

<p>Work collaboratively with other students to <i>generate ideas</i> for solving a problem. Identify <i>criteria</i> and <i>constraints</i>, research the problem, and <i>generate</i> several possible <i>solutions</i>.</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>
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9-12 APPC *Choosing the best solution involves comparing alternatives with respect to criteria and constraints, then building and testing a model or other representation of the final design.*

<p>Choose the best <i>solution</i> for a problem, create a model or drawing of the final design, and devise a way to test it. Redesign the <i>solution</i>, if necessary,</p>	<p>5-14, 32-42, 55, 65, 72-74, 108, 117, 119, 123, 130, 149, 153, 160, 163, 167, 168, 191, 199, 208, 217, 219,</p>
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then present it to peers.*b	230, 275-278, 295, 304-306, 315, 324-325, 326, 333-335, 340-341, 354, 358-359, 364, 395, 421, 475, 540, 548, 572, 579-581, 615, 621, 638, 652-657, 660-662, 665, 663, 700, 732, 758, 781-783, 796, 824, 855
9-12 APPD The ability to solve problems is greatly enhanced by use of mathematics and information technologies.	
Use proportional reasoning, <i>functions</i> , graphing, and estimation to solve problems.*a*b*c	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
Use computers, probes, and software when available to collect, display, and analyze data.	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,
9-12 APPE Perfect <i>solutions</i> do not exist. All technological <i>solutions</i> involve <i>trade-offs</i> in which decisions to include more of one quality means less of another. All solutions involve consequences, some intended others not.	
Analyze a societal issue that may be addressed through <i>science</i> and/or <i>technology</i> . <i>Compare</i> alternative <i>solutions</i> by <i>considering trade-offs</i> and unintended consequences (e.g., removing dams to increase salmon spawning).	5-14, 15-22, 26-34, 35-43, 46-56, 58-67, 182-190, 308-315, 416-421, 766-776, 826-832, 910-912
9-12 APPF - It is important for all citizens to <i>apply science and technology</i> to critical issues that influence society.	
Critically analyze scientific information in current events to make personal choices, or to inform public-policy decisions.*d	182-190, 532-540, 685-692, 727-732, 826-832, 843-854, 910-916, 919-925,

EALR 4: Physical Science

Content Standards/Performance Expecations	Location/Page where Standard is found
Big Idea: Force and Motion (PS1): Core Content: <i>Newton's Laws</i>	
9-11 PS1A <i>Average velocity</i> is defined as a change in position with respect to time. Velocity includes both speed and direction.	
Calculate the <i>average velocity</i> of a moving object, given the object's change in position and time. ($v = \frac{x_2 - x_1}{t_2 - t_1}$) *a	N/A
<i>Explain how</i> two objects moving at the same <i>speed</i> can have different velocities.	N/A
9-11 PS1B <i>Average acceleration</i> is defined as a change in velocity with respect to time. <i>Acceleration</i> indicates a change in <i>speed</i> and/or a change in <i>direction</i>.	
Calculate the <i>average acceleration</i> of an object, given the object's change in velocity with respect to time. ($a = \frac{v_2 - v_1}{t_2 - t_1}$) *a	N/A
<i>Explain how</i> an object moving at constant <i>speed</i> can be accelerating.*b	N/A
9-11 PS1C An object at rest will remain at rest unless acted on by an unbalanced <i>force</i>. An object in <i>motion</i> at constant velocity will continue at the same velocity unless acted on by an unbalanced <i>force</i>. (Newton's 1st <i>Law of Motion</i>, the <i>Law of Inertia</i>)	
Given specific scenarios, <i>compare</i> the <i>motion</i> of an object acted on by balanced <i>forces</i> with the <i>motion</i> of an object acted on by unbalanced <i>forces</i> .	N/A
9-11 PS1D A net <i>force</i> will cause an object to accelerate or change direction. A less massive object will <i>speed up</i> more quickly than a more massive object subjected to the same <i>force</i>. (Newton's 2nd <i>Law of Motion</i>, $F=ma$)	
<i>Predict</i> how objects of different <i>masses</i> will accelerate when subject to the same <i>force</i> . Calculate the <i>acceleration</i> of an object, given the object's <i>mass</i> and the net <i>force</i> on the object, using Newton's 2 nd <i>law of Motion</i> ($F=ma$).*c	N/A
9-11 PS1E Whenever one object exerts a <i>force</i> on another object, a <i>force</i> of equal magnitude is exerted on the first object in the opposite direction. (Newton's 3rd <i>Law of Motion</i>)	
Illustrate with everyday examples that for every action there is an equal and opposite reaction (e.g., a person exerts the same <i>force</i> on the Earth as the Earth exerts on the person).	N/A

<p>9-11 PS1F <i>Gravitation</i> is a universal attractive force by which objects with mass attract one another. The gravitational force between two objects is proportional to their masses and inversely proportional to the square of the distance between the objects. (Newton’s Law of Universal Gravitation)</p>	
<p><i>Predict</i> how the gravitational force between two bodies would differ for bodies of different masses or different distances apart.*d</p>	N/A
<p><i>Explain</i> how the weight of an object can change while its mass remains constant</p>	N/A
<p>9-11 PS1G <i>Electrical force</i> is a force of nature, independent of gravity that exists between charged objects. Opposite charges attract while like charges repel.</p>	
<p><i>Predict</i> whether two charged objects will attract or repel each other, and <i>explain</i> why.</p>	N/A
<p>9-11 PS1H <i>Electricity and magnetism</i> are two aspects of a single electromagnetic force. Moving electric charges produce magnetic forces, and moving magnets produce electric forces.</p>	
<p>Demonstrate and <i>explain that</i> an electric current flowing in a wire will create a magnetic field around the wire (i.e., <i>electromagnetic effect</i>).</p>	26, 27, 33, 193, 195, 198, 200, 287-297, 309, 311, 315-317, 318-327, 348, 353-358, 428, 615, 873,
<p>Demonstrate and <i>explain that</i> moving a magnet near a wire will cause an electric current to flow in the wire (i.e., the generator <i>effect</i>).</p>	N/A
<p>Big Idea: Matter: Properties and Change (PS2): Core Content: <i>Chemical Reactions</i></p>	
<p>9-11 PS2A <i>Atoms</i> are composed of protons, neutrons, and electrons. The nucleus of an atom takes up very little of the atom’s volume but makes up almost all of the mass. The nucleus contains protons and neutrons, which are much more massive than the electrons surrounding the nucleus. Protons have a positive charge, electrons are negative in charge, and neutrons have no net charge</p>	
<p><i>Describe</i> the relative charges, masses, and locations of the protons, neutrons, and electrons in an atom of an element.</p>	11-12, 15-25, 29-31, 33-34, 39-41, 47-49, 51-54, 59-63, 64-65, 71, 73 78, 79-85, 96, 159, 196, 200, 292, 304, 419, 448,499, 611, 646, 763, 838
<p>9-11 PS2B <i>Atoms</i> of the same element have the same number of protons. The number and arrangement of electrons determines how the atom interacts with other atoms to form molecules and ionic compounds.</p>	
<p>Given the number and arrangement of electrons in the outermost shell of an atom, <i>predict</i> the chemical properties of the element.</p>	2, 3, 6, 7, 10-13 19-23, 24, 26-28-34, 36-41, 42-44, 47-56, 58, 59-62, 64-65, 66, 70, 71, 72-74, 77, 78, 79-85, 89-91, 93, 96, 112, 126-128, 141, 146-147, 159-161, 196-197, 199-200, 204, 250, 292, 297, 304, 339, 356, 366, 448, 476, 499, 595-596, 599, 602-604, 606, 611, 641, 643-647, 654, 672, 763, 772-774, 838, 851

<p>9-11 PS2C When <i>elements</i> are listed in order according to the number of <i>protons</i>, repeating <i>patterns</i> of physical and <i>chemical properties</i> identify families of <i>elements</i> with similar <i>properties</i>. This Periodic Table is a consequence of the repeating <i>pattern</i> of outermost <i>electrons</i>.</p>	
<p>Given the number of <i>protons</i>, identify the <i>element</i> using a Periodic Table.</p>	<p>15-25, 29-31, 33-34, 39, 41, 47-49, 54, 59-63, 64-65, 71, 73 78, 79-85, 89-91, 96, 159, 196, 200, 292, 304, 419, 448,499, 611, 646, 763, 838</p>
<p>Explain the arrangement of the <i>elements</i> on the Periodic Table, including the significant <i>relationships</i> among <i>elements</i> in a given column or row.</p>	<p>2, 3, 6, 7, 10-13 19-23, 24, 26-28-34, 36-41, 42-44, 47-56, 58, 59-62, 64-65, 66, 70, 71, 72-74, 77, 78, 79-85, 89-91, 93, 96, 112, 126-128, 141, 146-147, 159-161, 196-197, 199-200, 204, 250, 292, 297, 304, 339, 356, 366, 448, 476, 499, 595-596, 599, 602-604, 606, 611, 641, 643-647, 654, 672, 763, 772-774, 838, 851</p>
<p>9-11 PS2D <i>Ions</i> are produced when <i>atoms</i> or molecules lose or gain <i>electrons</i>, thereby gaining a positive or negative electrical charge. <i>Ions</i> of opposite charge are attracted to each other, forming <i>ionic bonds</i>. Chemical formulas for <i>ionic compounds</i> represent the proportion of <i>ion</i> of each <i>element</i> in the <i>ionic array</i>.</p>	
<p>Explain how <i>ions</i> and <i>ionic bonds</i> are formed (e.g., sodium <i>atoms</i> lose an <i>electron</i> and chlorine <i>atoms</i> gain an <i>electron</i>, then the charged <i>ions</i> are attracted to each other and form bonds).</p>	<p>19, 62, 68-74 105, 106, 153-155, 164, 196, 200, 228, 241-242, 250, 258, 280, 312, 362, 366, 450-453, 463, 452, 596, 643-644, 672, 722, 723, 725, 751-753, 760, 761, 765, 772-774, 758-759, 772-774, 798, 801, 808, 810, 818, 838, 851-852</p>
<p>Explain the meaning of a chemical formula for an <i>ionic array</i> (e.g., NaCl).</p>	<p>71, 76, 228, 448-453, 623, 774, 851-852, 818, 865</p>
<p>9-11 PS2E <i>Compounds</i> are composed of two or more <i>elements</i> bonded together in a fixed proportion by sharing <i>electrons</i> between <i>atoms</i>, forming <i>covalent bonds</i>. Such <i>compounds</i> consist of well-defined <i>molecules</i>. Formulas of <i>covalent compounds</i> represent the types and number of <i>atoms</i> of each <i>element</i> in each <i>molecule</i>.</p>	
<p>Give examples to illustrate that molecules are groups of two or more <i>atoms</i> bonded together (e.g., a molecule of water is formed when one oxygen <i>atom</i> shares <i>electrons</i> with two hydrogen <i>atoms</i>).</p>	<p>152-156, 162-167, 312, 416-421, 448-453, 722-724</p>
<p>Explain the meaning of a chemical formula for a molecule (e.g., CH₄ or H₂O).*a</p>	<p>448-453, 456-464</p>
<p>9-11 PS2F All forms of life are composed of large molecules that contain carbon. Carbon <i>atoms</i> bond to one another and other <i>elements</i> by sharing, forming <i>covalent bonds</i>. Stable molecules of carbon have four <i>covalent bonds</i> per carbon <i>atom</i>.</p>	
<p>Demonstrate how carbon <i>atoms</i> form four <i>covalent bonds</i> to make large molecules. Identify the <i>functions</i> of these molecules (e.g., plant and animal tissue, polymers, sources of food and nutrition, <i>fossil fuels</i>).</p>	<p>72, 79, 164, 165, 751-762, 764, 852, 771-772, 790-798, 799-801, 806-810, 923-924</p>
<p>9-11 PS2G <i>Chemical reactions</i> change the arrangement of <i>atoms</i> in the molecules of substances. <i>Chemical reactions</i> release or acquire energy from their surroundings and result in the formation of new substances.</p>	
<p>Describe at least three <i>chemical reactions</i> of particular importance to humans (e.g., burning of <i>fossil fuels</i>, <i>photosynthesis</i>, rusting of metals)</p>	<p>21, 96, 102, 154, 163, 166, 186-190, 213-218, 222, 228-232, 256-258, 266-273, 276, 325, 356-360,</p>

	392-397, 445, 456-463, 525-526, 608, 613, 616, 619, 626-629, 636, 642-647, 672, 680-682, 725, 738, 761, 838
Use a chemical equation to illustrate how the <i>atoms</i> in molecules are arranged before and after a reaction	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
Give examples of <i>chemical reactions</i> that either release or acquire energy and result in the formation of new substances (e.g., burning of fossil fuels releases large amounts of energy in the form of heat).	86, 166, 262, 270, 318-328, 333-335, 337-338, 470-473, 514-518, 525, 535-536, 560-566, 623, 859, 861
9-11 PS2H Solutions are mixtures in which particles of one substance are evenly distributed through another substance. Liquids are limited in the amount of dissolved solid or gas that they can contain. Aqueous solutions can be described by relative quantities of the dissolved substances and acidity or alkalinity (pH)	
Give examples of <i>common solutions</i> . Explain the differences among the processes of dissolving, melting, and reacting.	122, 405, 436, 437, 440, 463, 476, 480, 490, 617, 624-626, 633, 672, 697-698, 858-865, 867, 821-823, 848, 852, 857-859, 863, 869, 870, 884-888, 902-909, 914, 935
Predict the result of adding increased amounts of a substance to an <i>aqueous solution</i> , in concentration and pH.*b	122, 405, 436, 437, 440, 463, 476, 480, 490, 617, 624-626, 633, 672, 697-698, 858-865, 867, 821-823, 848, 852, 857-859, 863, 869, 870, 884-888, 902-909, 914, 935
9-11 PS2I The rate of a physical or chemical change may be affected by factors such as temperature, surface area, and pressure.	
Predict the effect of a change in temperature, surface area, pressure, on the rate of a given physical or <i>chemical change</i> .*b	110-119, 255-262, 329-339, 361-367, 408-415, 433-439, 468-474, 477-492, 575-583, 857-865
9-11 PS2J The number of neutrons in the nucleus of an atom determines the isotope of the element. Radioactive isotopes are unstable and emit particles and/or radiation. Though the timing of a single nuclear decay is unpredictable, a large group of nuclei decay at a predictable rate, making it possible to estimate the age of materials that contain radioactive isotopes.	
Given the <i>atomic number</i> and <i>atomic mass number</i> of an isotope, students draw and label a <i>model</i> of the <i>isotope's</i> atomic structure (number of <i>protons</i> , <i>neutrons</i> and <i>electrons</i>)	77-91
Given data from a sample, use a decay curve for a radioactive isotope to find the age of the sample. Explain how the decay curve is derived. *c	77-91
9-11 PS2K Nuclear reactions convert matter into energy, releasing large amounts of energy compared with chemical reactions. Fission is the splitting of a large nucleus into smaller pieces. Fusion is the joining of nuclei and is the process that generates energy in the Sun and other stars.	
Distinguish between nuclear <i>fusion</i> and nuclear <i>fission</i> by describing how each process transforms <i>elements</i> present before the reaction into <i>elements</i> present after the reaction.	77-91

Big Idea: Energy: Transfer, Transformation, and Conservation (PS3) Core Content: <i>Transformation and Conservation of Energy</i>	
9-11 PS3A Although energy can be <i>transferred</i> from one object to another and can be <i>transformed</i> from one form of energy to another form, the total energy in a <i>closed system</i> is constant and can neither be created nor destroyed. (<i>Conservation of Energy</i>)	
Describe a situation in which energy is <i>transferred</i> from one place to another, and <i>explain how</i> energy is conserved.*a	114-116, 159, 330-307, 318-328, 373, 383, 384, 411, 468-476, 511-531, 535-536, 555, 563, 588, 696-698, 715-716, 738, 863,
Describe a situation in which energy is <i>transformed</i> from one form to another and <i>explain how</i> energy is conserved.*a	79-91, 165, 259-263, 321-325, 327, 470-476, 472, 514-520, 524-527, 530, 537-538
9-11 PS3B <i>Kinetic energy is the energy of motion. The kinetic energy of an object is defined by the equation: $E_k = \frac{1}{2} mv^2$</i>	
Calculate the <i>kinetic energy</i> of an object, given the object's <i>mass</i> and <i>velocity</i> . *b	114-116, 373, 383, 384, 411, 470, 473, 515-516, 535-536, 555, 696-698, 715-716, 738, 863,
9-11 PS3C <i>Gravitational potential energy is due to the separation of mutually attracting masses. Transformations can occur between gravitational potential energy and kinetic energy, but the total amount of energy remains constant.</i>	
Give an example in which <i>gravitational potential energy</i> and <i>kinetic energy</i> are changed from one to the other (e.g., a child on a swing illustrates the alternating <i>transformation</i> of <i>kinetic</i> and <i>gravitational potential energy</i>).	N/A
9-11 PS3D <i>Waves (including sound, seismic, light, and water waves) transfer energy when they interact with matter. Waves can have different wavelengths, frequencies, amplitudes, and travel at different speeds.</i>	
Demonstrate how energy can be transmitted by sending <i>waves</i> along a spring or rope. Characterize physical <i>waves</i> by <i>frequency</i> , <i>wavelength</i> , <i>amplitude</i> , and <i>speed</i> . <i>Apply these properties</i> to the pitch and volume of sound <i>waves</i> , and to the <i>wavelength</i> and magnitude of water <i>waves</i> .*b	N/A
9-11 PS3E <i>Electromagnetic waves differ from physical waves because they do not require a medium and they all travel at the same speed in a vacuum. This is the maximum speed that any object or wave can travel. Forms of electromagnetic waves include X-rays, ultraviolet, visible light, infrared, and radio.</i>	
Illustrate the <i>electromagnetic spectrum</i> with a labeled diagram, showing how regions of the spectrum differ regarding <i>wavelength</i> , <i>frequency</i> , and <i>energy</i> , and how they are used (e.g., infrared in <i>heat lamps</i> , microwaves for heating foods, X-rays for medical imaging).	35-43, 77, 157-161, 196, 300-306