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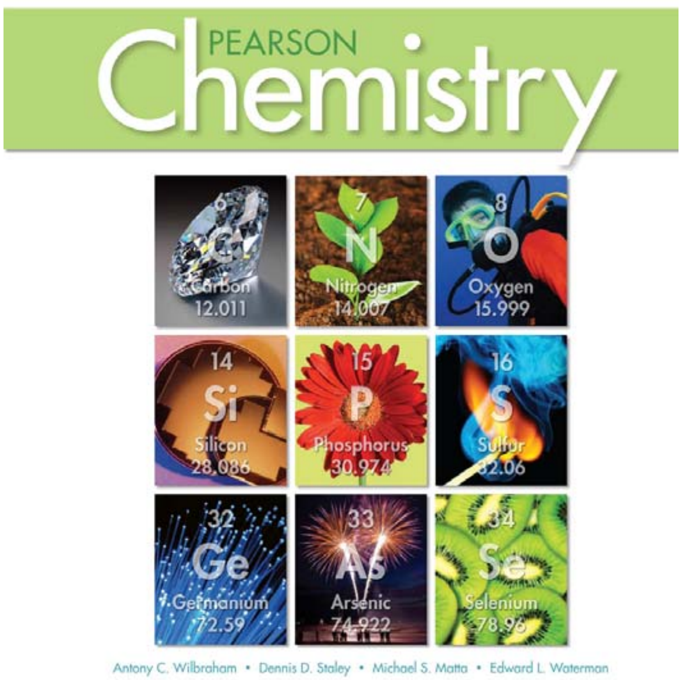

To the

New York
Physical Setting / Chemistry
Core Curriculum

INTRODUCTION

This document demonstrates how ***Pearson Chemistry* ©2012** meets the objectives of the New York Physical Setting/Chemistry Core Curriculum. Correlation page references are to the Student and Teacher's Editions and are cited at the page level.

Pearson Chemistry combines proven and tested content with cutting-edge digital support and hands-on learning opportunities. This program provides you with everything you need to engage and motivate your students, as well as the tools to support the varied types of learners in your classroom.

Built on Grant Wiggins' *Understanding by Design* framework, this learning model connects curriculum, instruction, and assessment to the "Big Ideas" of chemistry that develops deep understanding.

Pearson Chemistry provides all of the problem-solving and math support that students need to be successful in the course, with ample opportunity for practice both in the Student Edition and in the program's digital resources.

Pearson Chemistry helps you meet the unique learning styles of each student in your classroom with a variety of resources. A variety of assessment opportunities helps you monitor student progress ensure student success on high-stakes tests.

Pearsonchem.com integrates key concepts from the text and brings them alive online with complete Student and Teacher eTexts, animations, virtual labs, tutorials, practice problems, and a comprehensive teacher center. Digital references are referenced at point-of-use in the textbook. PearsonChem.com also offers valuable tools you can use to monitor student's progress through your course.

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PROCESS SKILLS - BASED ON STANDARDS 1, 2, 6, AND 7	
STANDARD 1—Analysis, Inquiry, and Design	
Students will use mathematical analysis, scientific inquiry, and engineering design, as appropriate, to pose questions, seek answers, and develop solutions.	
MATHEMATICAL ANALYSIS:	
Key Idea 1: Abstraction and symbolic representation are used to communicate mathematically.	
M1.1 Use algebraic and geometric representations to describe and compare data.	
• organize, graph, and analyze data gathered from laboratory activities or other sources	
identify independent and dependent variables	**SE/TE:** 16
create appropriate axes with labels and scale	**SE/TE:** 180, 238, 467, 887, 896
identify graph points clearly	**SE/TE:** 180, 238, 467, 887, 896
• measure and record experimental data and use data in calculations	
choose appropriate measurement scales and use units in recording	**SE/TE:** 72, 92, 120, 149, 324, 328, 399, 467, 545, 571, 583, 635, 849
show mathematical work, stating formula and steps for solution	**SE/TE:** 72, 92, 120, 149, 324, 328, 399, 467, 545, 571, 583, 635, 670, 849
estimate answers	*Opportunities to address this standard can be found on the following pages:* **SE/TE:** 72, 92, 120, 149, 324, 328, 399, 467, 545, 571, 583, 635, 670, 849
use appropriate equations and significant digits	**SE/TE:** 72, 92, 120, 149, 324, 328, 399, 467, 545, 571, 583, 635, 670, 849
show uncertainty in measurement by the use of significant figures	**SE/TE:** 72
identify relationships within variables from data tables	**SE/TE:** 29, 190, 258, 482, 887
calculate percent error	**SE/TE:** 72, 190, 399 **TE only:** 571
• recognize and convert various scales of measurement	
temperature - Celsius (°C) - Kelvin (K)	**SE/TE:** 78-79, 82, 218, R46 **TE only:** 95

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length - kilometers (km) - meters (m) - centimeters (cm) - millimeters (mm)	**SE/TE:** 88
mass - grams (g) - kilograms (kg)	**SE/TE:** 88, 91, R46
pressure - kilopascal (kPa) - atmosphere (atm)	**SE/TE:** 422, 424, 443, R46
• use knowledge of geometric arrangements to predict particle properties or behavior	**SE/TE:** 204-205, 210, 214, 217, 249-250
Key Idea 2: Deductive and inductive reasoning are used to reach mathematical conclusions.	
M2.1 Use deductive reasoning to construct and evaluate conjectures and arguments, recognizing that patterns and relationships in mathematics assist them in arriving at these conjectures and arguments.	
• interpret a graph constructed from experimentally obtained data	
identify relationships - direct - inverse	**SE/TE:** 467, 482, 485
apply data showing trends to predict information	**SE/TE:** 8, 59, 175, 178, 257, 341, 423, 429, 456, 458, 521, 765, 793
Key Idea 3: Critical thinking skills are used in the solution of mathematical problems.	
M3.1 Apply algebraic and geometric concepts and skills to the solution of problems.	
• state assumptions which apply to the use of a particular mathematical equation and evaluate these assumptions to see if they have been met	**SE/TE:** 138-139, 326, 456, 458, 460, 470, 473, 523, 526, 528, 542-543, 560, 616, 634 **TE only:** 81
• evaluate the appropriateness of an answer, based on given data	**SE/TE:** 326-327, 329, 331, 333, 337, 406, 408, 410, 457, 459, 461-462, 465-466, 471, 474, 479, 500, 524, 526-527, 529-531, 539, 541, 543-544, 547, 561, 564, 567, 570, 573, 575, 581, 585, 606, 617-619, 623, 625, 637, 655, 657-659, 667, 675, 683, 741, 743, 884, 899

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SCIENTIFIC INQUIRY:	
Key Idea 1: The central purpose of scientific inquiry is to develop explanations of natural phenomena in a continuing, creative process.	
S1.1 Elaborate on basic scientific and personal explanations of natural phenomena, and develop extended visual models and mathematical formulations to represent thinking.	
• use theories and/or models to represent and explain observations	**SE/TE:** 184, 238, 778, 787, 856, 887 **TE only:** 36, 121, 130, 133, 179, 192, 195, 197, 201, 209, 211, 213, 221, 224, 242, 255, 268, 275, 312, 350, 401, 423, 452, 470, 763-765, 769, 773, 776-777, 810, 822, 824, 842, 845, 885, 888
• use theories and/or principles to make predictions about natural phenomena	*Opportunities to address this standard can be found on the following pages:* **SE/TE:** 102-103, 107-109, 129-130, 143, 147-148, 240-246, 420
• develop models to explain observations	**SE/TE:** 184, 238, 778, 787, 856, 887 **TE only:** 36, 121, 130, 133, 179, 192, 195, 197, 201, 209, 211, 213, 221, 224, 242, 255, 268, 275, 312, 350, 401, 423, 452, 470, 763-765, 769, 773, 776-777, 810, 822, 824, 842, 845, 885, 888
S1.2 Hone ideas through reasoning, library research, and discussion with others, including experts.	
• locate data from published sources to support/defend/explain patterns observed in natural phenomena	**TE only:** 106
S1.3 Work towards reconciling competing explanations, clarifying points of agreement and disagreement.	
• evaluate the merits of various scientific theories and indicate why one theory was accepted over another	**SE/TE:** 102-104, 105-109, 121, 122-124, 128-130, 133 **TE only:** 131
Key Idea 2: Beyond the use of reasoning and consensus, scientific inquiry involves the testing of proposed explanations involving the use of conventional techniques and procedures and usually requiring considerable ingenuity.	
S2.1 Devise ways of making observations to test proposed explanations.	
• design and/or carry out experiments, using scientific methodology to test proposed calculations	**SE/TE:** 17, 39, 51, 72, 92, 109, 120, 142, 149, 200, 206, 238, 254, 279, 295, 324, 328, 354, 355, 374, 399, 404, 435, 437, 467, 475, 491, 508, 519, 545, 551, 571, 583, 600, 635, 662, 670, 681, 699, 717, 744, 750, 752, 818, 828, 849, 851, 887, 896 **TE only:** 15, 54, 203, 249, 405, 429, 497, 527, 563, 570, 625, 659, 843

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S2.2 Refine research ideas through library investigations, including information retrieval and reviews of the literature, and through peer feedback obtained from review and discussion.	
• use library investigations, retrieved information, and literature reviews to improve the experimental design of an experiment	**TE only:** 39
S2.3 Develop and present proposals including formal hypotheses to test explanations, i.e.; they predict what should be observed under specific conditions if their explanation is true.	
• develop research proposals in the form of “if X is true and a particular test Y is done, then prediction Z will occur”	**SE/TE:** 17 **TE only:** 15, 54, 625
S2.4 Carry out a research plan for testing explanations, including selecting and developing techniques, acquiring and building apparatus, and recording observations as necessary.	
• determine safety procedures to accompany a research plan	**TE only:** 54
Key Idea 3: The observations made while testing proposed explanations, when analyzed using conventional and invented methods, provide new insights into phenomena.	
S3.1 Use various means of representing and organizing observations (e.g., diagrams, tables, charts, graphs, equations, and matrices) and insightfully interpret the organized data.	
• organize observations in a data table, analyze the data for trends or patterns, and interpret the trends or patterns, using scientific concepts	**SE/TE:** 51, 120, 142, 254, 279, 295, 324, 328, 355, 374, 399, 435, 635, 670, 681, 699, 717, 752
S3.2 Apply statistical analysis techniques when appropriate to test if chance alone explains the result.	*Opportunities to address this standard can be found on the following pages:* **SE/TE:** 120, 887
S3.3 Assess correspondence between the predicted result contained in the hypothesis and the actual result, and reach a conclusion as to whether or not the explanation on which the prediction is supported.	
• evaluate experimental methodology for inherent sources of error and analyze the possible effect on the result	**SE/TE:** 92, 120, 571 **TE only:** 17, 563
• compare the experimental result to the expected result; calculate the percent error as appropriate	**SE/TE:** 72, 120, 190, 399, 571 **TE only:** 324
S3.4 Using results of the test and through public discussion, revise the explanation and contemplate additional research.	**SE/TE:** 17, 51, 92, 149, 200, 254, 324, 374, 399, 435, 475, 508, 545, 583, 635, 635, 670, 717, 752, 849 **TE only:** 828
S3.5 Develop a written report for public scrutiny that describes the proposed explanation, including a literature review, the research carried out, its results, and suggestions for further research.	**SE/TE:** 51, 92, 120, 149, 200, 254, 295, 324, 374, 399, 435, 475, 508, 545, 583, 635, 670, 717, 752, 828, 849, 887 **TE only:** 54

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ENGINEERING DESIGN:	
Key Idea 1: Engineering design is an iterative process involving modeling and optimization (finding the best solution within given constraints); this process is used to develop technological solutions to problems within given constraints.	
If students are asked to do a design project, then:	
• Initiate and carry out a thorough investigation of an unfamiliar situation and identify needs and opportunities for technological invention or innovation.	**SE/TE:** 483 **TE only:** 140
• Identify, locate, and use a wide range of information resources, and document through notes and sketches how findings relate to the problem.	**SE/TE:** 483
• Generate creative solutions, break ideas into significant functional elements, and explore possible refinements; predict possible outcomes, using mathematical and functional modeling techniques; choose the optimal solution to the problem, clearly documenting ideas against design criteria and constraints; and explain how human understandings, economics, ergonomics, and environmental considerations have influenced the solution.	**SE/TE:** 483 **TE only:** 140
• Develop work schedules and working plans which include optimal use and cost of materials, processes, time, and expertise; construct a model of the solution, incorporating developmental modifications while working to a high degree of quality (craftsmanship).	*Opportunities to address this standard can be found on the following pages:* **SE/TE:** 483 **TE only:** 140
• Devise a test of the solution according to the design criteria and perform the test; record, portray, and logically evaluate performance test results through quantitative, graphic, and verbal means. Use a variety of creative verbal and graphic techniques effectively and persuasively to present conclusions, predict impact and new problems, and suggest and pursue modifications.	*Opportunities to address this standard can be found on the following pages:* **SE/TE:** 483 **TE only:** 140

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STANDARD 2—Information Systems	
Students will access, generate, process, and transfer information using appropriate technologies.	
Key Idea 1: Information technology is used to retrieve, process, and communicate information as a tool to enhance learning.	
Examples include:	
• use the Internet as a source to retrieve information for classroom use, e.g., Periodic Table, acid rain	**SE/TE:** 217, 603 **TE only:** 18, 106, 114, 205, 266, 309, 432, 438
Key Idea 2: Knowledge of the impacts and limitations of information systems is essential to its effectiveness and ethical use.	
Examples include:	
• critically assess the value of information with or without benefit of scientific backing and supporting data, and evaluate the effect such information could have on public judgment or opinion, e.g., environmental issues	**TE only:** 18
• discuss the use of the peer-review process in the scientific community and explain its value in maintaining the integrity of scientific publication, e.g., "cold fusion"	**SE/TE:** 19
STANDARD 6—Interconnectedness: Common Themes	
Students will understand the relationships and common themes that connect mathematics, science, and technology and apply the themes to these and other areas of learning.	
SYSTEMS THINKING:	
Key Idea 1: Through systems thinking, people can recognize the commonalities that exist among all systems and how parts of a system interrelate and combine to perform specific functions.	
Examples include:	
• use the concept of systems and surroundings to describe heat flow in a chemical or physical change, e.g., dissolving process	**SE/TE:** 557-558, 562-568, 569-575, 576-577, 578-582, 583, 584, 585, 586-589, 591, 642

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MODELS:	
Key Idea 2: Models are simplified representations of objects, structures, or systems used in analysis, explanation, interpretation, or design.	
2.1 Revise a model to create a more complete or improved representation of the system.	
• show how models are revised in response to experimental evidence, e.g., atomic theory, Periodic Table	**SE/TE:** 102-103, 105-109, 122-124, 128-130, 132, 133, 160-162
2.2 Collect information about the behavior of a system and use modeling tools to represent the operation of the system.	
• show how information about a system is used to create a model, e.g., kinetic molecular theory (KMT)	**SE/TE:** 102-103, 107-109, 129-130, 133, 143, 147-148, 240-246, 420 **TE only:** 122
2.3 Find and use mathematical models that behave in the same manner as the processes under investigation.	
• show how mathematical models (equations) describe a process, e.g., combined gas law	**SE/TE:** 79-80, 93, 113, 121, 139, 142, 150, 326-327, 336, 405, 409, 456-460, 462, 465, 470, 473, 478, 498, 509, 523, 526, 528-530, 538, 540, 542-543, 546, 560, 563, 580, 584, 604-605, 616, 622, 634, 636, 654, 656, 667, 682, 737, 753, 849, 883, 898 **TE only:** 81, 143, 406, 463, 884, 889
2.4 Compare predictions to actual observations, using test models.	
• compare experimental results to a predicted value, e.g., percent error	**SE/TE:** 72, 399, 571
MAGNITUDE AND SCALE:	
Key Idea 3: The grouping of magnitudes of size, time, frequency, and pressures or other units of measurement into a series of relative order provides a useful way to deal with the immense range and the changes in scale that affect the behavior and design of systems.	
3.1 Describe the effects of changes in scale on the functioning of physical, biological, or designed information systems.	
• show how microscale processes can resemble or differ from real-world processes, e.g., microscale chemistry	*Opportunities to address this standard can be found on the following pages:* **SE/TE:** 110-111

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3.2 Extend the use of powers of ten notation to understanding the exponential function and performing operations with exponential factors.	
• use powers often to represent a large range of values for a physical quantity, e.g., pH scale	**SE/TE:** 141, 151, 153-155, 308-312, 315, 321, 324, 337, 338-341, 343, 380, 653-659, 662, 667-669, 670, 682, 683, 684-687, 689 **TE only:** 148, 336
EQUILIBRIUM AND STABILITY:	
Key Idea 4: Equilibrium is a state of stability due either to a lack of change (static equilibrium) or a balance between opposing forces (dynamic equilibrium).	
4.1 Describe specific instances of how disturbances might affect a system's equilibrium, from small disturbances that do not upset the equilibrium to larger disturbances (threshold level) that cause the system to become unstable.	
• explain how a small change might not affect a system, e.g., activation energy	**SE/TE:** 596, 601, 638
4.2 Cite specific examples of how dynamic equilibrium is achieved by equality of change in opposing directions.	
• explain how a system returns to equilibrium in response to a stress, e.g., LeChatelier's principle	**SE/TE:** 612-615, 620, 636, 638-640, 688, 794, 834
PATTERNS OF CHANGE:	
Key Idea 5: Identifying patterns of change is necessary for making predictions about future behavior and conditions.	
Examples include:	
• use graphs to make predictions, e.g., half-life, solubility	**SE/TE:** 8, 59, 175, 178, 257, 341, 423, 429, 456, 458, 521, 765, 793
• use graphs to identify patterns and interpret experimental data, e.g., heating and cooling curves	**SE/TE:** 8, 57, 97, 175, 178, 180, 187-188, 257, 339-341, 379, 413, 423, 429, 438, 443-444, 456, 458, 467-468, 482, 485, 511, 521, 542, 549-551, 553, 572, 589, 591, 597, 605, 607, 610, 641, 665, 674, 677, 686-687, 765, 773, 792-793, 832, 881-882, 901-902, 905 **TE only:** 7, 424, 575

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STANDARD 7—Interdisciplinary Problem Solving	
Students will apply the knowledge and thinking skills of mathematics, science, and technology to address real-life problems and make informed decisions.	
CONNECTIONS:	
Key Idea 1: The knowledge and skills of mathematics, science, and technology are used together to make informed decisions and solve problems, especially those relating to issues of science/technology/society, consumer decision making, design, and inquiry into phenomena.	
1.1 Analyze science/technology/society problems and issues on a community, national, or global scale and plan and carry out a remedial course of action.	
• carry out a remedial course of action by communicating the plan to others, e.g., writing and sending “a letter to the editor”	**TE only:** 52, 83, 440, 502, 576, 602, 784
1.2 Analyze and quantify consumer product data, understand environmental and economic impacts, develop a method for judging the value and efficacy of competing products, and discuss cost-benefit and risk-benefit trade-offs made in arriving at the optimal choice.	
• compare and analyze specific consumer products, e.g., antacids, vitamin C	**SE/TE:** 467 **TE only:** 668, 678
1.3 Design solutions to real-world problems on a community, national, or global scale, using a technological design process that integrates scientific investigation and rigorous mathematical analysis of the problem and of the solution.	
• design a potential solution to a regional problem, e.g., suggest a plan to adjust the acidity of a lake in the Adirondacks	**TE only:** 52, 502, 784
1.4 Explain and evaluate phenomena mathematically and scientifically by formulating a testable hypothesis, demonstrating the logical connections between the scientific concepts guiding the hypothesis and the design of an experiment, applying and inquiring into the mathematical ideas relating to investigation of phenomena, and using (and if needed, designing) technological tools and procedures to assist in the investigation and in the communication of results.	
• design an experiment that requires the use of a mathematical concept to solve a scientific problem, e.g., an experiment to compare the density of different types of soda pop	**SE/TE:** 92, 324, 399, 545, 551, 635, 670, 849 **TE only:** 39, 328, 571, 583-584, 887

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STRATEGIES:	
Key Idea 2: Solving interdisciplinary problems involves a variety of skills and strategies, including effective work habits; gathering and processing information; generating and analyzing ideas; realizing ideas; making connections among the common themes of mathematics, science, and technology; and presenting results.	
If students are asked to do a project, then the project would require students to:	
• work effectively	**SE/TE:** 217, 259, 270, 301, 341, 379, 483, 513, 603, 723, 793, 903 **TE only:** 3, 7, 11, 12-13, 18, 27, 43, 46, 52-53, 73, 76, 83, 94, 106, 111, 114, 121, 130, 133, 146-147, 150, 163, 165, 169, 177, 179, 183, 185, 204-205, 213, 223, 231, 236, 239, 245, 255, 266, 272, 283-284, 287, 296, 309, 316, 334-335, 351, 354, 370, 375, 397, 407, 421, 424, 434, 438, 440-441, 442, 455, 476, 478, 490, 502-503, 509, 532-533, 540, 546, 568, 596, 598, 602, 611, 624, 628, 631, 636, 648, 657, 663, 668, 671, 693, 698, 700, 702, 716, 718, 729, 734-735, 740, 744, 751, 752, 753, 764, 776, 780, 783, 784, 785, 800, 803, 806, 809-810, 821, 825-826, 829, 853, 858-859, 867, 890, 897
• gather and process information	**SE/TE:** 217, 259, 270, 301, 341, 379, 483, 513, 603, 723, 793, 903 **TE only:** 3, 7, 11, 12, 18, 27, 43, 46, 52-53, 73, 76, 106, 111, 114, 130, 133, 147, 163, 165, 169, 179, 183, 204-205, 213, 223, 231, 236, 245, 266, 272, 283, 287, 309, 334-335, 351, 354, 370, 375, 397, 407, 421, 424, 434, 438, 441, 478, 490, 503, 509, 533, 540, 568, 577, 584, 596, 598, 611, 624, 628, 631, 636, 648, 657, 663, 668, 671, 693, 698, 700, 702, 716, 718, 729, 734-735, 740, 744, 751, 752, 753, 764, 776, 780, 783, 784, 785, 800, 803, 806, 809-810, 821, 825-826, 829, 853, 858-859, 867, 890, 897
• generate and analyze ideas	**SE/TE:** 217, 259, 270, 301, 341, 379, 483, 513, 603, 723, 793, 903 **TE only:** 3, 7, 11, 12, 18, 27, 43, 46, 52-53, 73, 76, 83, 94, 106, 111, 114, 130, 133, 146-147, 150, 163, 165, 169, 179, 183, 185, 204-205, 213, 223, 231, 236, 245, 255, 266, 272, 283-284, 287, 309, 316, 334-335, 351, 354, 375, 397, 407, 421, 424, 434, 438, 441, 478, 490, 502-503, 509, 533, 540, 568, 576-577, 584, 596, 598, 602, 611, 624, 628, 631, 636, 648, 657, 663, 671, 693, 698, 700, 702, 716, 718, 729, 734-735, 740, 744, 751, 752, 753, 764, 776, 783, 784, 785, 800, 803, 809-810, 821, 825-826, 829, 853, 858, 867, 897

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• observe common themes	**SE/TE:** 270, 301, 379, 483, 513, 603, 793 **TE only:** 52-53, 110-111, 114, 146, 165, 169, 183, 272, 284, 334-335, 351, 397, 424, 434, 478, 490, 502-503, 509, 533, 540, 568, 576-577, 584, 598, 602, 611, 628, 631, 657, 663, 671, 693, 718, 729, 734-735, 764, 784, 803, 806, 809, 823, 826, 840, 848, 858, 897
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PROCESS SKILLS - BASED ON STANDARD 4	
STANDARD 4—The Physical Setting	
Students will understand and apply scientific concepts, principles, and theories pertaining to the physical setting and living environment and recognize the historical development of ideas in science.	
Note: The use of e.g. denotes examples which may be used for in-depth study. The terms for example and such as denote material which is testable. Items in parentheses denote further definition of the word(s) preceding the item and are testable.	
Key Idea 3: Matter is made up of particles whose properties determine the observable characteristics of matter and its reactivity.	
3.1 Explain the properties of materials in terms of the arrangement and properties of the atoms that compose them.	
i. use models to describe the structure of an atom (3.1b, 3.1c)	**TE only:** 107

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ii. relate experimental evidence (given in the introduction of Key Idea 3) to models of the atom (3.1a)	**SE/TE:** 105-109, 122-124
iii. determine the number of protons or electrons in an atom or ion when given one of these values (3.1e)	*Opportunities to address this standard can be found on the following pages:* **SE/TE:** 105-107, 112-113, 195-199
iv. calculate the mass of an atom, the number of neutrons or the number of protons, given the other two values (3.1f)	**SE/TE:** 113-114, 122
v. distinguish between ground state and excited state electron configurations, e.g., 2-8-2 vs. 2-7-3 (3.1j)	**SE/TE:** 154
vi. identify an element by comparing its bright-line spectrum to given spectra (3.1k)	**SE/TE:** 140
vii. distinguish between valence and non-valence electrons, given an electron configuration, e.g., 2-8-2 (3.1l)	**SE/TE:** 196, 198, 201
viii. draw a Lewis electron-dot structure of an atom (3.1l)	**SE/TE:** 195, 199, 214-215, 416, 552, 642
ix. determine decay mode and write nuclear equations showing alpha and beta decay (3.1p, 4.4b)	**SE/TE:** 877-879, 880-881, 886, 900-901
x. interpret and write isotopic notation (3.1g)	**SE/TE:** 115, 122, 125, 156
xi. given an atomic mass, determine the most abundant isotope (3.1n)	**SE/TE:** 117-119
xii. calculate the atomic mass of an element, given the masses and ratios of naturally occurring isotopes (3.1n)	**SE/TE:** 118-119, 121-123
xiii. classify elements as metals, nonmetals, metalloids, or noble gases by their properties (3.1v, 3.1w, 3.1x, 3.1y)	**SE/TE:** 164-166, 170
xiv. compare and contrast properties of elements within a group or a period for Groups 1, 2, 13-18 on the Periodic Table (3.1aa, 3.1)	**SE/TE:** 170-171, 174-175, 177-182, 184, 185-189
xv. determine the group of an element, given the chemical formula of a compound, e.g., XCl or XCl2 (3.1z)	*Opportunities to address this standard can be found on the following pages:* **SE/TE:** 271-279, 280-283
xvi. explain the placement of an unknown element on the Periodic Table based on its properties (3.1v, 3.1w, 3.1x, 3.1y)	*Opportunities to address this standard can be found on the following pages:* **SE/TE:** 162-166, 167-173, 174-175, 177-182

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xvii. classify an organic compound based on its structural or condensed structural formula (i.e., CH3COOH or -C-C-OH) (3.1ff, 3.1gg, 3.1hh)	**SE/TE:** 795, 802, 831, 835
xviii. describe the states of the elements at STP (3.1jj)	*Opportunities to address this standard can be found on the following pages:* **SE/TE:** 36-37, 55
xix. distinguish among ionic, molecular, and metallic substances, given their properties (3.1dd, 3.1w, 5.2g, 5.2h)	**SE/TE:** 204-207, 209-210, 214, 225
xx. draw a structural formula with the functional group(s) on a straight chain hydrocarbon backbone, when given the IUPAC name for the compound (3.1ff, 3.1hh)	**SE/TE:** 766-767, 771, 790
xxi. draw structural formulas for alkanes, alkenes, and alkynes containing a maximum of ten carbon atoms (3.1ff, 3.1gg)	**SE/TE:** 766-767, 771, 790 **TE only:** 773
xxii. use a simple particle model to differentiate among properties of solids, liquids, and gases (3.1jj, 3.1kk)	**SE/TE:** 421, 433 **TE only:** 421
xxiii. compare the entropy of phases of matter (3.1mm)	**SE/TE:** 420, 424, 425, 431, 434, 442 **TE only:** 426, 430
xxiv. describe the processes and uses of filtration, distillation, and chromatography in the separation of a mixture (3.1nn)	**SE/TE:** 40-41, 55, 57, 190
xxv. interpret and construct solubility curves (3.1oo)	**SE/TE:** 521, 549-550
xxvi apply the adage “like dissolves like” to real-world situations (3.1oo)	**SE/TE:** 521
xxvii. interpret solution concentration data (3.1pp)	**SE/TE:** 525, 527, 530-531, 548-550 **TE only:** 528
xxviii. use solubility curves to distinguish among saturated, supersaturated, and unsaturated solutions (3.1oo)	*Opportunities to address this standard can be found on the following page:* **SE/TE:** 520
xxix. calculate solution concentration in molarity (M), percent mass, and parts per million (ppm) (3.1pp)	**SE/TE:** 525-527, 530-531, 546, 548, 550-551, 834
xxx. describe the preparation of a solution, given the molarity (3.1pp)	**SE/TE:** 528-529, 531, 547-548 **TE only:** 527, 530
xxxi. given properties, identify substances as Arrhenius acids or Arrhenius bases (3.1uu)	**SE/TE:** 646-649, 682, 684

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xxxii. identify solutions as acid, base, or neutral based upon the pH (3.1ss)	**SE/TE:** 656, 724
xxxiii. interpret changes in acid-base indicator color (3.1ss)	**SE/TE:** 660, 662
xxxiv. write simple neutralization reactions when given the reactants (3.1xx)	**SE/TE:** 672, 675, 684, 686
xxxv. calculate the concentration or volume of a solution, using titration data (3.1zz)	**SE/TE:** 675
xxxvi. use particle models/diagrams to differentiate among elements, compounds, and mixtures (3.1r)	*Opportunities to address this standard can be found on the following pages:* **SE/TE:** 38-41, 42-44
3.2 Use atomic and molecular models to explain common chemical reactions.	
i. distinguish between chemical and physical changes (3.2a)	**SE/TE:** 37, 42-43, 48, 54, 56-57, 190, 218, 342, 380
ii. identify types of chemical reactions (3.2b, 3.2c)	**SE/TE:** 356-358, 360-367, 375, 377-379, 446, 484, 552
iii. determine a missing reactant or product in a balanced equation (3.2c, 3.2d)	*Opportunities to address this standard can be found on the following page:* **SE/TE:** 379
iv. identify organic reactions (3.2c)	**SE/TE:** 801-802, 807-809, 816-819, 822-827
v. balance equations, given the formulas of reactants and products (3.2a, 3.3a, 3.3c)	**SE/TE:** 350-354, 359, 361, 363, 365, 367, 376-378, 381, 416, 446, 484, 514, 552, 758, 904 **TE only:** 357, 364, 366, 375
vi. write and balance half-reactions for oxidation and reduction of free elements and their monatomic ions (3.2f, 3.2h)	**SE/TE:** 709-715, 717, 720-723
vii. identify and label the parts of a voltaic cell (cathode, anode, salt bridge) and direction of electron flow, given the reaction equation (3.2k)	**SE/TE:** 730-731, 754, 757
viii. identify and label the parts of an electrolytic cell (cathode, anode) and direction of electron flow, given the reaction equation (3.2l)	**SE/TE:** 746-749, 754, 756 **TE only:** 751
ix. compare and contrast voltaic and electrolytic cells (3.2j)	**SE/TE:** 745-746, 751, 753-754, 757
x. use an activity series to determine whether a redox reaction is spontaneous (3.2k)	*Opportunities to address this standard can be found on the following pages:* **SE/TE:** 728-729

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3.3 Apply the principle of conservation of mass to chemical reactions.	
i. balance equations, given the formulas for reactants and products (3.3c)	**SE/TE:** 350-354, 359, 361, 363, 365, 367, 376-378, 381 **TE only:** 357, 364, 366, 375
ii. interpret balanced chemical equations in terms of conservation of matter and energy (3.3a, 3.3c)	**TE only:** 351
iii. create and use models of particles to demonstrate balanced equations (3.3a, 3.3c)	**SE/TE:** 351 **TE only:** 350
iv. calculate simple mole-mole stoichiometry problems, given a balanced equation (3.3c)	**SE/TE:** 387-389, 411, 417 **TE only:** 386
v. determine the empirical formula from a molecular formula (3.3d)	**SE/TE:** 344
vi. determine the mass of a given number of moles of a substance (3.3f)	**SE/TE:** 317-318, 323, 337-338, 552, 642
vii. determine the molecular formula, given the empirical formula and the molecular mass (3.3d)	**SE/TE:** 332-333, 339-340, 484
viii. calculate the formula mass and gram-formula mass (3.3f)	**SE/TE:** 312-315, 336, 338
ix. determine the number of moles of a substance, given its mass (3.3f)	**SE/TE:** 317, 319, 323, 380, 416, 446, 552
3.4 Use kinetic molecular theory (KMT) to explain rates of reactions and the relationships among temperature, pressure, and volume of a substance.	
i. explain the gas laws in terms of KMT (3.4c)	**SE/TE:** 456, 459, 461
ii. solve problems, using the combined gas laws (3.4c)	**SE/TE:** 462-463, 479-481, 642
iii. convert temperatures in Celsius degrees (oC) to kelvins (K), and kelvins to Celsius degrees (3.4e)	**SE/TE:** 78-79, 82, 95-96, 218
iv. describe the concentration of particles and rates of opposing reactions in an equilibrium system (3.4i)	**SE/TE:** 610-611, 620, 638
v. qualitatively describe the effect of stress on equilibrium, using LeChatelier’s principle (3.4j)	**SE/TE:** 612-615, 620, 638-640, 688, 794, 834
vi. use collision theory to explain how various factors, such as temperature, surface area, and concentration, influence the rate of reaction (3.4d)	**SE/TE:** 598-601, 636, 638-639

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vii. identify examples of physical equilibria as solution equilibrium and phase equilibrium, including the concept that a saturated solution is at equilibrium (3.4h)	**SE/TE:** 612-615, 624 **TE only:** 611, 622
Key Idea 4: Energy exists in many forms, and when these forms change, energy is conserved.	
4.1 Observe and describe transmission of various forms of energy.	
i. distinguish between endothermic and exothermic reactions, using energy terms in a reaction equation, ?H, potential energy diagrams, or experimental data (4.1b)	**SE/TE:** 565-568, 585-588
ii. read and interpret potential energy diagrams: PE reactants, PE products, activation energy (with or without a catalyst), heat of reaction (4.1c, 4.1d)	**SE/TE:** 597, 601
4.2 Explain heat in terms of kinetic molecular theory.	
i. distinguish between heat energy and temperature in terms of molecular motion and amount of matter (4.2a, 4.2b)	**SE/TE:** 556
ii. explain phase change in terms of the changes in energy and intermolecular distances (4.2b)	**SE/TE:** 426, 431, 443 **TE only:** 442
iii. qualitatively interpret heating and cooling curves in terms of changes in kinetic and potential energy, heat of vaporization, heat of fusion, and phase changes (4.2a, 4.2c)	**SE/TE:** 572
iv. calculate the heat involved in a phase or temperature change for a given sample of matter (4.2c)	**SE/TE:** 561, 570-571, 573, 575, 577, 585, 586-588, 591, 688, 758
4.4 Explain the benefits and risks of radioactivity.	
i. calculate the initial amount, the fraction remaining, or the halflife of a radioactive isotope, given two of the three variables (4.4a)	**SE/TE:** 883-884, 886, 887, 899-901, 905 **TE only:** 898
ii. compare and contrast fission and fusion reactions (4.4b, 4.4f, 5.3b)	**SE/TE:** 888-889, 891, 898, 900
iii. complete nuclear equations; predict missing particles from nuclear equations (4.4c)	**SE/TE:** 886, 899, 901-902, 905

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iv. identify specific uses of some common radioisotopes, such as I-131 in diagnosing and treating thyroid disorders, C-14 to C-12 ratio in dating once-living organisms, U-238 to Pb-206 ratio in dating geological formations, and Co-60 in treating cancer (4.4d)	**SE/TE:** 896-897, 902-903
Key Idea 5: Energy and matter interact through forces that result in changes in motion.	
5.2 Students will explain chemical bonding in terms of the behavior of electrons.	
i. demonstrate bonding concepts, using Lewis dot structures representing valence electrons: (5.2a, 5.2d) - transferred (ionic bonding) - shared (covalent bonding) - in a stable octet Example: atom ion K. K+ :Cl: :Cl:-	**SE/TE:** 201, 203, 226-235, 238, 256-259, 302, 343
ii. compare the physical properties of substances based on chemical bonds and intermolecular forces, e.g., conductivity, malleability, solubility, hardness, melting point, and boiling point (5.2n)	**SE/TE:** 204, 206-207, 209-210, 214, 216, 252-253, 256
iii. explain vapor pressure, evaporation rate, and phase changes in terms of intermolecular forces (5.2m)	**SE/TE:** 252-253, 257, 426, 428
iv. determine the noble gas configuration an atom will achieve by bonding (5.2b)	**SE/TE:** 201, 214, 226, 228 **TE only:** 227
v. distinguish between nonpolar covalent bonds (two of the same nonmetals) and polar covalent bonds (5.2k)	**SE/TE:** 247-250, 253, 257-258, 261, 302 **TE only:** 247, 249
STANDARD 4 - The Physical Setting	
Students will understand and apply scientific concepts, principles, and theories pertaining to the physical setting and living environment and recognize the historical development of ideas in science.	
Key Idea 3: Matter is made up of particles whose properties determine the observable characteristics of matter and its reactivity.	
PERFORMANCE INDICATOR 3.1 - Explain the properties of materials in terms of the arrangement and properties of the atoms that compose them.	
Major Understandings:	
3.1a The modern model of the atom has evolved over a long period of time through the work of many scientists.	**SE/TE:** 102-104, 105-109, 121, 122-124, 128-132, 133, 150, 152

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3.1b Each atom has a nucleus, with an overall positive charge, surrounded by negatively charged electrons.	**SE/TE:** 107-109, 123
3.1c Subatomic particles contained in the nucleus include protons and neutrons.	**SE/TE:** 109, 121, 590 **TE only:** 107-108
3.1d The proton is positively charged, and the neutron has no charge. The electron is negatively charged.	**SE/TE:** 105, 107, 109, 125, 302, 590 **TE only:** 108
3.1e Protons and electrons have equal but opposite charges. The number of protons equals the number of electrons in an atom.	**SE/TE:** 107, 122, 302, 590 **TE only:** 113
3.1f The mass of each proton and each neutron is approximately equal to one atomic mass unit. An electron is much less massive than a proton or a neutron.	**SE/TE:** 107, 109, 122, 125, 302, 590
3.1g The number of protons in an atom (atomic number) identifies the element. The sum of the protons and neutrons in an atom (mass number) identifies an isotope. Common notations that represent isotopes include: 14C, 14/6C, carbon-14, C-14.	**SE/TE:** 112, 114-115, 119, 121-122
3.1h In the wave-mechanical model (electron cloud model) the electrons are in orbitals, which are defined as the regions of the most probable electron location (ground state).	**SE/TE:** 130-132, 150
3.1i Each electron in an atom has its own distinct amount of energy.	**SE/TE:** 130, 132
3.1j When an electron in an atom gains a specific amount of energy, the electron is at a higher energy state (excited state).	**SE/TE:** 145
3.1k When an electron returns from a higher energy state to a lower energy state, a specific amount of energy is emitted. This emitted energy can be used to identify an element.	**SE/TE:** 144-145, 148, 149, 150, 153
3.1l The outermost electrons in an atom are called the valence electrons. In general, the number of valence electrons affects the chemical properties of an element.	**SE/TE:** 194-195, 214
3.1m Atoms of an element that contain the same number of protons but a different number of neutrons are called isotopes of that element.	**SE/TE:** 114-115, 119, 121-122, 260

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3.1n The average atomic mass of an element is the weighted average of the masses of its naturally occurring isotopes.	**SE/TE:** 116-117, 119, 121-122, 156, 552
3.1o Stability of an isotope is based on the ratio of neutrons and protons in its nucleus. Although most nuclei are stable, some are unstable and spontaneously decay, emitting radiation.	**SE/TE:** 876, 880-881, 900 **TE only:** 115
3.1p Spontaneous decay can involve the release of alpha particles, beta particles, positrons, and/or gamma radiation from the nucleus of an unstable isotope. These emissions differ in mass, charge, ionizing power, and penetrating power.	**SE/TE:** 877-879, 880-881, 898, 900, 902 **TE only:** 886
3.1q Matter is classified as a pure substance or as a mixture of substances.	**SE/TE:** 35, 38, 44, 47
3.1r A pure substance (element or compound) has a constant composition and constant properties throughout a given sample, and from sample to sample.	**SE/TE:** 42, 44, 55
3.1s Mixtures are composed of two or more different substances that can be separated by physical means. When different substances are mixed together, a homogeneous or heterogeneous mixture is formed.	**SE/TE:** 38-41, 54-58
3.1t The proportions of components in a mixture can be varied. Each component in a mixture retains its original properties.	**SE/TE:** 38
3.1u Elements are substances that are composed of atoms that have the same atomic number. Elements cannot be broken down by chemical change.	**SE/TE:** 43, 54, 112
3.1v Elements can be classified by their properties and located on the Periodic Table as metals, nonmetals, metalloids (B, Si, Ge, As, Sb, Te), and noble gases.	**SE/TE:** 162, 164-166, 168-169, 185-187, 191, 260, 302
3.1w Elements can be differentiated by physical properties. Physical properties of substances, such as density, conductivity, malleability, solubility, and hardness, differ among elements.	**SE/TE:** 35, 55-56
3.1x Elements can also be differentiated by chemical properties. Chemical properties describe how an element behaves during a chemical reaction.	**SE/TE:** 48, 56

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3.1y The placement or location of an element on the Periodic Table gives an indication of the physical and chemical properties of that element. The elements on the Periodic Table are arranged in order of increasing atomic number.	**SE/TE:** 46-47, 162, 164-166, 174-175, 177-182, 185, 186-189, 191, 218, 260
3.1z For Groups 1, 2, and 13-18 on the Periodic Table, elements within the same group have the same number of valence electrons (helium is an exception) and therefore similar chemical properties.	**SE/TE:** 170-173, 218, 342
3.1aa The succession of elements within the same group demonstrates characteristic trends: differences in atomic radius, ionic radius, electronegativity, first ionization energy, metallic/nonmetallic properties.	**SE/TE:** 174-175, 177-182, 184, 185-189, 191, 260, 303, 416, 446
3.1bb The succession of elements across the same period demonstrates characteristic trends: differences in atomic radius, ionic radius, electronegativity, first ionization energy, metallic/nonmetallic properties.	**SE/TE:** 174-175, 177-182, 184, 185-189, 191, 260, 303, 380, 416, 446
3.1cc A compound is a substance composed of two or more different elements that are chemically combined in a fixed proportion. A chemical compound can be broken down by chemical means. A chemical compound can be represented by a specific chemical formula and assigned a name based on the IUPAC system.	**SE/TE:** 42-43, 47, 54-55, 271-279, 280-283, 285-288, 289-290, 292-294, 295, 296, 297, 298-300, 303, 342, 380, 416, 446, 484, 590
3.1dd Compounds can be differentiated by their physical and chemical properties.	**SE/TE:** 43
3.1ee Types of chemical formulas include empirical, molecular, and structural.	**SE/TE:** 227, 330, 332-333, 336
3.1ff Organic compounds contain carbon atoms, which bond to one another in chains, rings, and networks to form a variety of structures. Organic compounds can be named using the IUPAC system.	**SE/TE:** 762-771, 772-773, 779-781, 788, 789, 790-793, 795, 800, 802, 804-805, 810-811, 812-813, 815-816, 819-820, 829, 830-832, 835
3.1gg Hydrocarbons are compounds that contain only carbon and hydrogen. Saturated hydrocarbons contain only single carbon-carbon bonds. Unsaturated hydrocarbons contain at least one multiple carbon-carbon bond.	**SE/TE:** 762-771, 772-773, 779-781, 788, 790-793

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3.1hh Organic acids, alcohols, esters, aldehydes, ketones, ethers, halides, amines, amides, and amino acids are categories of organic compounds that differ in their structures. Functional groups impart distinctive physical and chemical properties to organic compounds.	**SE/TE:** 799-800, 802, 804-806, 810-811, 812-816, 819-820, 829-833, 835
3.1ii Isomers of organic compounds have the same molecular formula, but different structures and properties.	**SE/TE:** 775-778, 787, 790-793 **TE only:** 775-778, 787
3.1jj The structure and arrangement of particles and their interactions determine the physical state of a substance at a given temperature and pressure.	**SE/TE:** 420-421, 425, 430, 431, 434, 442 **TE only:** 426
3.1kk The three phases of matter (solids, liquids, and gases) have different properties.	**SE/TE:** 420-421, 424, 425, 430, 431, 434, 442, 443, 447, 484 **TE only:** 426
3.1ll Entropy is a measure of the randomness or disorder of a system. A system with greater disorder has greater entropy.	**SE/TE:** 630-631, 638-639
3.1mm Systems in nature tend to undergo changes toward lower energy and higher entropy.	**SE/TE:** 627, 630-631, 638-639
3.1nn Differences in properties such as density, particle size, molecular polarity, boiling and freezing points, and solubility permit physical separation of the components of the mixture.	**SE/TE:** 40-41, 54, 55, 57
3.1oo A solution is a homogeneous mixture of a solute dissolved in a solvent. The solubility of a solute in a given amount of solvent is dependent on the temperature, the pressure, and the chemical natures of the solute and solvent.	**SE/TE:** 39, 494-495, 501, 509, 510-511, 521-524, 546, 548-550
3.1pp The concentration of a solution may be expressed in molarity (M), percent by volume, percent by mass, or parts per million (ppm).	**SE/TE:** 525-527, 529-531, 546, 548, 550-551
3.1qq The addition of a nonvolatile solute to a solvent causes the boiling point of the solvent to increase and the freezing point of the solvent to decrease. The greater the concentration of solute particles, the greater the effect.	**SE/TE:** 536-537, 548, 553
3.1rr An electrolyte is a substance which, when dissolved in water, forms a solution capable of conducting an electric current. The ability of a solution to conduct an electric current depends on the concentration of ions.	**SE/TE:** 496-497, 501, 509, 510, 512, 515

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3.1ss The acidity or alkalinity of an aqueous solution can be measured by its pH value. The relative level of acidity or alkalinity of these solutions can be shown by using indicators.	**SE/TE:** 656, 660-662, 682
3.1tt On the pH scale, each decrease of one unit of pH represents a tenfold increase in hydronium ion concentration.	**TE only:** 657
3.1uu Behavior of many acids and bases can be explained by the Arrhenius theory. Arrhenius acids and bases are electrolytes.	**SE/TE:** 646-649, 652, 682, 684, 686
3.1vv Arrhenius acids yield H+(aq), hydrogen ion as the only positive ion in an aqueous solution. The hydrogen ion may also be written as H3O+(aq), hydronium ion.	**SE/TE:** 646, 652, 682, 684
3.1ww Arrhenius bases yield OH-(aq), hydroxide ion as the only negative ion in an aqueous solution.	**SE/TE:** 646, 652, 682, 684
3.1xx In the process of neutralization, an Arrhenius acid and an Arrhenius base react to form a salt and water.	**SE/TE:** 672, 675, 682, 684
3.1yy There are alternate acid-base theories. One theory states that an acid is an H+ donor and a base is an H+ acceptor.	**SE/TE:** 649-652, 682, 684-686
3.1zz Titration is a laboratory process in which a volume of a solution of known concentration is used to determine the concentration of another solution.	**SE/TE:** 673-675, 684-686
PERFORMANCE INDICATOR 3.2 - Use atomic and molecular models to explain common chemical reactions.	
Major Understandings:	
3.2a A physical change results in the rearrangement of existing particles in a substance. A chemical change results in the formation of different substances with changed properties.	**SE/TE:** 37, 42, 48, 50, 54, 56-57, 59
3.2b Types of chemical reactions include synthesis, decomposition, single replacement, and double replacement.	**SE/TE:** 356-363, 366-367, 375, 377-379
3.2c Types of organic reactions include addition, substitution, polymerization, esterification, fermentation, saponification, and combustion.	**SE/TE:** 363-364, 367, 801-802, 807-809, 811, 819, 822, 825, 827, 829
3.2d An oxidation-reduction (redox) reaction involves the transfer of electrons (e-).	**SE/TE:** 694-696, 699, 707, 718, 721 **TE only:** 697

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3.2e Reduction is the gain of electrons.	**SE/TE:** 694-695, 699, 718, 795
3.2f A half-reaction can be written to represent reduction.	**SE/TE:** 712, 714-715, 721, 729, 731-733, 735-736, 747-751, 752, 754-755, 757, 759
3.2g Oxidation is the loss of electrons.	**SE/TE:** 694-695, 699, 718, 795
3.2h A half-reaction can be written to represent oxidation.	**SE/TE:** 712, 714-715, 717, 721, 729, 731-733, 735-736, 747-750, 752, 754-755, 757
3.2i Oxidation numbers (states) can be assigned to atoms and ions. Changes in oxidation numbers indicate that oxidation and reduction have occurred.	**SE/TE:** 701-706, 718, 719, 720-723, 725, 795, 834
3.2j An electrochemical cell can be either voltaic or electrolytic. In an electrochemical cell, oxidation occurs at the anode and reduction at the cathode.	**SE/TE:** 730-731, 745-746, 751, 753, 754, 756-757, 834, 872 **TE only:** 734
3.2k A voltaic cell spontaneously converts chemical energy to electrical energy.	**SE/TE:** 730-731, 736, 753 **TE only:** 734
3.2l An electrolytic cell requires electrical energy to produce a chemical change. This process is known as electrolysis.	**SE/TE:** 745-746, 751, 753, 754, 757
PERFORMANCE INDICATOR 3.3 - Apply the principle of conservation of mass to chemical reactions.	
Major Understandings:	
3.3a In all chemical reactions there is a conservation of mass, energy, and charge.	**SE/TE:** 50, 54, 57, 350, 370, 556, 561, 586
3.3b In a redox reaction the number of electrons lost is equal to the number of electrons gained.	**SE/TE:** 694-695
3.3c A balanced chemical equation represents conservation of atoms. The coefficients in a balanced chemical equation can be used to determine mole ratios in the reaction.	**SE/TE:** 350, 375, 390-391
3.3d The empirical formula of a compound is the simplest whole-number ratio of atoms of the elements in a compound. It may be different from the molecular formula, which is the actual ratio of atoms in a molecule of that compound.	**SE/TE:** 330-331, 333, 336, 339-341, 343
3.3e The formula mass of a substance is the sum of the atomic masses of its atoms. The molar mass (gram-formula mass) of a substance equals one mole of that substance.	**SE/TE:** 312-315, 336, 338, 484

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3.3f The percent composition by mass of each element in a compound can be calculated mathematically.	**SE/TE:** 325-327, 333, 336, 337, 338-339, 446, 484 **TE only:** 328
PERFORMANCE INDICATOR 3.4 - Use kinetic molecular theory (KMT) to explain rates of reactions and the relationships among temperature, pressure, and volume of a substance.	
Major Understandings:	
3.4a The concept of an ideal gas is a model to explain the behavior of gases. A real gas is most like an ideal gas when the real gas is at low pressure and high temperature.	**SE/TE:** 467-468, 478, 480, 485, 552, 872
3.4b Kinetic molecular theory (KMT) for an ideal gas states that all gas particles:	
• are in random, constant, straight-line motion.	**SE/TE:** 420, 424, 442
• are separated by great distances relative to their size; the volume of the gas particles is considered negligible.	**SE/TE:** 420, 424, 442
• have no attractive forces between them.	**SE/TE:** 420, 424
• have collisions that may result in a transfer of energy between gas particles, but the total energy of the system remains constant.	**SE/TE:** 420, 424
3.4c Kinetic molecular theory describes the relationships of pressure, volume, temperature, velocity, and frequency and force of collisions among gas molecules.	**SE/TE:** 421, 423-424, 442-443, 451-454, 480-481
3.4d Collision theory states that a reaction is most likely to occur if reactant particles collide with the proper energy and orientation.	**SE/TE:** 596-597, 601
3.4e Equal volumes of gases at the same temperature and pressure contain an equal number of particles.	**SE/TE:** 320
3.4f The rate of a chemical reaction depends on several factors: temperature, concentration, nature of the reactants, surface area, and the presence of a catalyst.	**SE/TE:** 598-601, 636, 638-639, 794
3.4g A catalyst provides an alternate reaction pathway, which has a lower activation energy than an uncatalyzed reaction.	**SE/TE:** 600-601, 638
3.4h Some chemical and physical changes can reach equilibrium.	**SE/TE:** 610-611, 620, 622, 636, 638 **TE only:** 613

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3.4i At equilibrium the rate of the forward reaction equals the rate of the reverse reaction. The measurable quantities of reactants and products remain constant at equilibrium.	**SE/TE:** 610-611, 620, 638
3.4j LeChatelier's principle can be used to predict the effect of stress (change in pressure, volume, concentration, and temperature) on a system at equilibrium.	**SE/TE:** 612-615, 620, 638-640, 688, 794, 834
Key Idea 4: Energy exists in many forms, and when these forms change energy is conserved.	
PERFORMANCE INDICATOR 4.1 - Observe and describe transmission of various forms of energy.	
Major Understandings:	
4.1a Energy can exist in different forms, such as chemical, electrical, electromagnetic, thermal, mechanical, nuclear.	**SE/TE:** 139, 420, 556, 730, 876, 888, 891
4.1b Chemical and physical changes can be exothermic or endothermic.	**SE/TE:** 557-558, 561, 586-588, 688
4.1c Energy released or absorbed during a chemical reaction can be represented by a potential energy diagram.	**SE/TE:** 597
4.1d Energy released or absorbed during a chemical reaction (heat of reaction) is equal to the difference between the potential energy of the products and potential energy of the reactants.	**SE/TE:** 565-566
PERFORMANCE INDICATOR 4.2 - Explain heat in terms of kinetic molecular theory.	
Major Understandings:	
4.2a Heat is a transfer of energy (usually thermal energy) from a body of higher temperature to a body of lower temperature. Thermal energy is the energy associated with the random motion of atoms and molecules.	**SE/TE:** 556
4.2b Temperature is a measurement of the average kinetic energy of the particles in a sample of material. Temperature is not a form of energy.	**SE/TE:** 423-424, 442, 443, 447 **TE only:** 556
4.2c The concepts of kinetic and potential energy can be used to explain physical processes that include: fusion (melting), solidification (freezing), vaporization (boiling, evaporation), condensation, sublimation, and deposition.	**SE/TE:** 426, 428, 430, 442, 443-445 **TE only:** 429

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PERFORMANCE INDICATOR 4.4 - Explain the benefits and risks of radioactivity.	
Major Understandings:	
4.4a Each radioactive isotope has a specific mode and rate of decay (half-life).	**SE/TE:** 882
4.4b Nuclear reactions include natural and artificial transmutation, fission, and fusion.	**SE/TE:** 877-879, 885-886, 888-88, 891
4.4c Nuclear reactions can be represented by equations that include symbols which represent atomic nuclei (with mass number and atomic number), subatomic particles (with mass number and charge), and/or emissions such as gamma radiation.	**SE/TE:** 877-879, 880-881, 885-886, 887, 888, 891, 899-903, 905
4.4d Radioactive isotopes have many beneficial uses. Radioactive isotopes are used in medicine and industrial chemistry for radioactive dating, tracing chemical and biological processes, industrial measurement, nuclear power, and detection and treatment of diseases.	**SE/TE:** 882-883, 896-897, 900, 902-903, 905
4.4e There are inherent risks associated with radioactivity and the use of radioactive isotopes. Risks can include biological exposure, long-term storage and disposal, and nuclear accidents.	**SE/TE:** 877, 879, 890, 902 **TE only:** 892, 894
4.4f There are benefits and risks associated with fission and fusion reactions.	**SE/TE:** 888-891, 892-893, 900
Key Idea 5: Energy and matter interact through forces that result in changes in motion.	
PERFORMANCE INDICATOR 5.2 - Explain chemical bonding in terms of the behavior of electrons.	
Major Understandings:	
5.2a Chemical bonds are formed when valence electrons are:	
• transferred from one atom to another (ionic)	**SE/TE:** 201-202, 214, 256, 302
• shared between atoms (covalent)	**SE/TE:** 223, 255-256, 302
• mobile within a metal (metallic)	**SE/TE:** 209-210, 213
5.2b Atoms attain a stable valence electron configuration by bonding with other atoms. Noble gases have stable valence configurations and tend not to bond.	**SE/TE:** 170, 173, 195, 201, 216, 226-229, 238, 255

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5.2c When an atom gains one or more electrons, it becomes a negative ion and its radius increases. When an atom loses one or more electrons, it becomes a positive ion and its radius decreases.	**SE/TE:** 179, 182, 186, 195-199, 213, 214-215, 217, 260, 265
5.2d Electron-dot diagrams (Lewis structures) can represent the valence electron arrangement in elements, compounds, and ions.	**SE/TE:** 195, 198-199, 201, 203, 215, 226-238, 256-259, 302, 342, 416, 552, 642
5.2e In a multiple covalent bond, more than one pair of electrons are shared between two atoms. Unsaturated organic compounds contain at least one double or triple bond.	**SE/TE:** 230-231, 256, 772, 788, 790 **TE only:** 773
5.2f Some elements exist in two or more forms in the same phase. These forms differ in their molecular or crystal structure, and hence in their properties.	**SE/TE:** 433-434
5.2g Two major categories of compounds are ionic and molecular (covalent) compounds.	**SE/TE:** 201-202, 213, 214, 222-225, 255, 256
5.2h Metals tend to react with nonmetals to form ionic compounds. Nonmetals tend to react with other nonmetals to form molecular (covalent) compounds. Ionic compounds containing polyatomic ions have both ionic and covalent bonding.	**SE/TE:** 202, 226, 233
5.2i When a bond is broken, energy is absorbed. When a bond is formed, energy is released.	*Opportunities to address this standard can be found on the following pages:* **SE/TE:** 556, 565-566
5.2j Electronegativity indicates how strongly an atom of an element attracts electrons in a chemical bond. Electronegativity values are assigned according to arbitrary scales.	**SE/TE:** 181, 248, 253, 255
5.2k The electronegativity difference between two bonded atoms is used to assess the degree of polarity in the bond.	**SE/TE:** 248-249, 253, 257
5.2l Molecular polarity can be determined by the shape of the molecule and distribution of charge. Symmetrical (nonpolar) molecules include CO2, CH4, and diatomic elements. Asymmetrical (polar) molecules include HCl, NH3, and H2O.	**SE/TE:** 247-250, 253, 255, 257-258, 261
5.2m Intermolecular forces created by the unequal distribution of charge result in varying degrees of attraction between molecules. Hydrogen bonding is an example of a strong intermolecular force.	**SE/TE:** 250-251, 253, 257, 261

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5.2n Physical properties of substances can be explained in terms of chemical bonds and intermolecular forces. These properties include conductivity, malleability, solubility, hardness, melting point, and boiling point.	**SE/TE:** 204-207, 209-211, 213, 214-217, 252-253, 255, 257-258
PERFORMANCE INDICATOR 5.3 - Compare energy relationships within an atom's nucleus to those outside the nucleus.	
Major Understandings:	
5.3a A change in the nucleus of an atom that converts it from one element to another is called transmutation. This can occur naturally or can be induced by the bombardment of the nucleus with high-energy particles.	**SE/TE:** 885-886, 898, 900
5.3b Energy released in a nuclear reaction (fission or fusion) comes from the fractional amount of mass that is converted into energy. Nuclear changes convert matter into energy.	**SE/TE:** 888, 891, 898
5.3c Energy released during nuclear reactions is much greater than the energy released during chemical reactions.	**SE/TE:** 888, 891