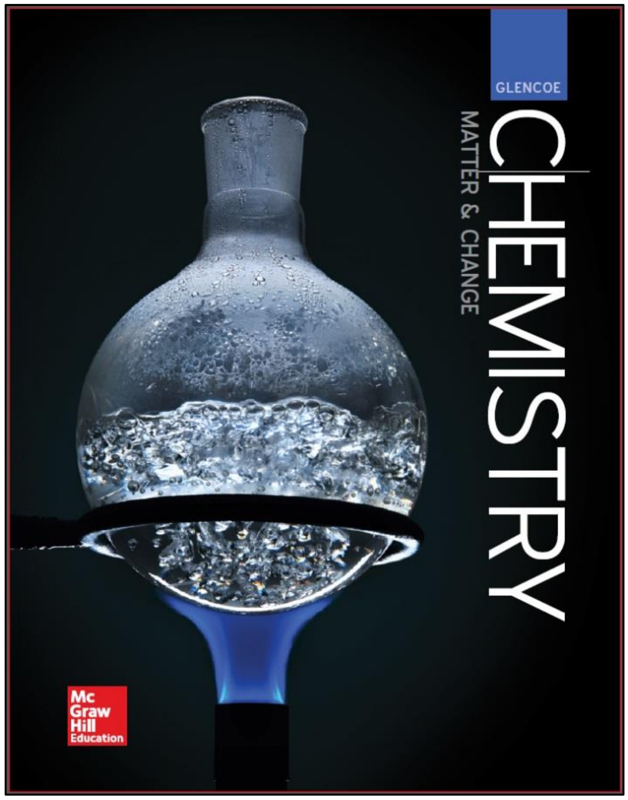
Louisiana STUDENT STANDARDS SCIENCE



Online references found at www.connected.mcgraw-hill.com

STANDARDS	PAGE REFERENCES
MATTER AND ITS INTERACTIONS	**HS-PS1-1**
Performance Expectation Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level and the composition of the nucleus of atoms **Clarification Statement** **Physical Science:** Examples of properties that could be predicted from patterns could include metals, nonmetals, metalloids, number of valence electrons, types of bonds formed, or atomic mass. Emphasis is on main group elements. **Chemistry:** Examples of properties that could be predicted from patterns could include reactivity of metals, types of bonds formed, numbers of bonds formed, atomic radius, atomic mass, or reactions with oxygen. Emphasis is on main group elements and qualitative understanding of the relative trends of ionization energy and electronegativity.	**Activity:** Electron Patterns in Atoms, Chapter 6 Section 3

STANDARDS	PAGE REFERENCES
Science and Engineering Practices	
Developing and Using Models Modeling in 9–12 builds on K–8 and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds. • Use a model to predict the relationships between systems or between components of a system.	**Science and Engineering Practices Handbook:** Practice 2
Disciplinary Core Ideas	
STRUCTURE AND PROPERTIES OF MATTER Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons. (HS.PS1A.a)	**Student Edition:** 106–114,115–121, 128, 129, 130, 131, 146–155, 156–162, 167, 168, 169
The periodic table orders elements horizontally by the number of protons in the atom's nucleus and places those with similar chemical properties in columns. The repeating patterns of this table reflect patterns of outer electron states.(HS.PS1A.b)	**Student Edition:** 174–181, 182–186, 187–194, 196, 198, 199, 200, 201
TYPES OF INTERACTIONS Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects.(HS.PS2B.c)	**Student Edition:** 206–209, 210–217, 225–228, 232, 233, 234, 235, 240–241, 242, 246–247, 265–270, 271, 274, 275, 276, 411–414, 417–419, 422–424, 432, 434, 435, 436, 477, 489–491, 497
Crosscutting Concepts	
PATTERNS Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.	**Student Edition:** 182-185, 187-194, 210-212, 493 *Applying Practices* 191 *ChemLAB* 196 *Figure 7 & 8* 183 *Figure 11 & 12* 188 *Figure 14* 190 *Figure 15* 191, 493 *Figure 17* 193 *Figure 18* 194 *Practice Problem* 212 *Problem-Solving LAB* 180 *Section 3 Review* 194 *Table 4* 211

STANDARDS	PAGE REFERENCES
MATTER AND ITS INTERACTIONS	**HS-PS1-2**
Performance Expectation Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties. **Clarification Statement** **Physical Science:** Examples of chemical reactions could include the reaction of sodium and chlorine, carbon and oxygen, or hydrogen and oxygen. Reaction classification includes synthesis, decomposition, single displacement, double displacement, and acid-base. **Chemistry:** Examples of chemical reactions could include the reaction of sodium and chlorine, carbon and oxygen, or carbon and hydrogen. Reaction classification aids in the prediction of products (e.g. synthesis, decomposition, single displacement, double displacement, and acid-base).	**Activity:** Electron States and Simple Chemical Reactions, Chapter 8 Section 1
Science and Engineering Practices	
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. • Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.	**Science and Engineering Practices Handbook:** Practice 6
Disciplinary Core Ideas	
STRUCTURE AND PROPERTIES OF MATTER The periodic table orders elements horizontally by the number of protons in the atom's nucleus and places those with similar chemical properties in columns. The repeating patterns of this table reflect patterns of outer electron states. (HS.PS1A.b)	**Student Edition:** 174–181,182–186, 187–194, 196, 198, 199, 200, 201

STANDARDS	PAGE REFERENCES
CHEMICAL REACTIONS The fact that atoms are conserved, together with knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions. (HS.PS1B.c)	**Student Edition:** 77–79, 105, 128, 285–288, 289–298, 299–308, 310, 312, 313, 314, 315, 368–372, 373–378, 379–384, 385–388, 390, 392, 393, 394, 395, 396, 397
Crosscutting Concepts	
PATTERNS Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.	**Student Edition:** 182-185, 187-194, 210-212, 493 *Applying Practices* 191 *ChemLAB* 196 *Figure 7 & 8* 183 *Figure 11 & 12* 188 *Figure 14* 190 *Figure 15* 191, 493 *Figure 17* 193 *Figure 18* 194 *Practice Problem* 212 *Problem-Solving LAB* 180 *Section 3 Review* 194 *Table 4* 211
MATTER AND ITS INTERACTIONS	**HS-PS1-3**
Performance Expectation Plan and conduct an investigation to gather evidence to compare the structure of substances at the macroscale to infer the strength of electrical forces between particles. **Clarification Statement** Emphasis is on understanding the strengths of forces between particles, not on naming specific intermolecular forces (such as dipole-dipole). Examples of particles could include ions, atoms, molecules, and network solids (such as graphite). Examples of macro-properties of substances could include the melting point and boiling point, vapor pressure, and surface tension.	**Activity:** Investigate Interparticle Forces, Chapter 12 Section 4

STANDARDS	PAGE REFERENCES
Science and Engineering Practices	
Planning and Carrying Out Investigations Planning and carrying out investigations in 9–12 builds on K–8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models. • Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly.	**Science and Engineering Practices Handbook:** Practice 3
Disciplinary Core Ideas	
STRUCTURE AND PROPERTIES OF MATTER The structure and interactions of matter at the macro scale are determined by electrical forces within and between atoms. (HS.PS1A.c)	**Student Edition:** 191–194, 199, 200, 201, 212–217, 226, 227, 228, 242, 246–247, 269–270, 411–414, 417, 418–419, 434, 435, 436, 437
TYPES OF INTERACTIONS Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects. (secondary) (HS.PS2B.c)	**Student Edition:** 206–209, 210–217, 225–228, 232, 233, 234, 235, 240–241, 242, 246–247, 265–270, 271, 274, 275, 276, 411–414, 417–419, 422–424, 432, 434, 435, 436, 477, 489–491, 497

STANDARDS	PAGE REFERENCES
Crosscutting Concepts	
PATTERNS Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.	**Student Edition:** 206-209, 210-217, 225-228, 240-247, 265-270, 411-414, 417-419, 489-491 *ChemLAB* 230 *Data-Analysis LAB* 216 *Figure 2* 207, 241 *Figure 4* 209 *Figure 5* 243 *Figure 8* 245 *Figure 9* 246, 412, 489 *Figure 10* 413, 490 *Figure 11* 225, 413 *Figure 15* 417 *Figure 17* 419 *Figure 21* 266 *Figure 23* 268 *Practice Problems* 212 *Section 2 Review* 217 *Table 2* 208 *Table 3* 209 *Table 4* 211 *Table 5* 422
MATTER AND ITS INTERACTIONS	**HS-PS1-4**
Performance Expectation Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy. **Clarification Statement** Emphasis is on the idea that a chemical reaction is a system that affects the energy change. Examples of models could include molecular-level drawings and diagrams of reactions, graphs showing the relative energies of reactants and products, and representations showing energy is conserved.	**Activity:** Modeling Energy in Chemical Reactions, Chapter 15 Section 1

STANDARDS	PAGE REFERENCES
Science and Engineering Practices	
Developing and Using Models Modeling in 9–12 builds on K–8 and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds. • Develop a model based on evidence to illustrate the relationships between systems or between components of a system.	**Science and Engineering Practices Handbook:** Practice 2
Disciplinary Core Ideas	
STRUCTURE AND PROPERTIES OF MATTER A stable molecule has less energy than the same set of atoms separated; one must provide at least this energy in order to take the molecule apart. (HS.PS1A.d)	**Student Edition:** 159, 193, 216–217, 240–241, 246–247
CHEMICAL REACTIONS Chemical processes, their rates, and whether or not energy is stored or released can be understood in terms of the collisions of molecules and the rearrangements of atoms into new molecules, with consequent changes in the sum of all bond energies in the set of molecules that are matched by changes in kinetic energy. (HS.PS1B.a)	**Student Edition:** 516–522, 522–528, 529–533, 535–541, 550, 552, 553, 554, 555, 560–567, 568–573, 580–582, 584, 586, 587, 588
Crosscutting Concepts	
ENERGY AND MATTER Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system.	**Student Edition:** 216-217, 516-520, 523-524, 526-528, 529-533, 534-540, 563-565, 580-582 *Chapter 15 Assessment* 552-554 *Example Problem* 521, 525, 532, 536, 540 *Figure 5 & 6* 565 *Figure 9* 528 *Figure 10* 530 *Figure 13* 535 *Figure 15* 538 *Figure 20* 582 *MiniLAB* 526 *Practice Problem* 521, 525, 532, 537, 541 *Section 2 Review* 528 *Section 3 Review* 533 *Section 4 Review* 541 *Table 5* 538

STANDARDS	PAGE REFERENCES
MATTER AND ITS INTERACTIONS	**HS-PS1-5**
Performance Expectation Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs. **Clarification Statement** Student reasoning should focus on the number and energy of collisions between molecules. Emphasis is on simple reactions in which there are only two reactants; evidence from temperature, concentration, and rate data; and qualitative relationships between rate and temperature.	**Activity**: Concentration, Temperature, and Reaction Rates, Chapter 16, Section 2
Science and Engineering Practices	
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. • Apply scientific principles and evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects.	**Science and Engineering Practices Handbook:** Practice 6
Disciplinary Core Ideas	
CHEMICAL REACTIONS Chemical processes, their rates, and whether or not energy is stored or released can be understood in terms of the collisions of molecules and the rearrangements of atoms into new molecules, with consequent changes in the sum of all bond energies in the set of molecules that are matched by changes in kinetic energy. (HS.PS1B.a)	**Student Edition:** 516–522, 522–528, 529–533, 535–541, 550, 552, 553, 554, 555, 560–567, 568–573, 580–582, 584, 586, 587, 588
Crosscutting Concepts	
PATTERNS Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.	**Student Edition:** 517-520, 525-528, 529-533, 534-540, 568-573, 578-582 *Applying Practices* 569 *ChemLAB* 584 *Figure 11* 510 *Figure 12* 572 *Figure 13* 535 *Figure 17* 578 *Figure 20* 582

STANDARDS	PAGE REFERENCES
MATTER AND ITS INTERACTIONS	**HS-PS1-6**
Performance Expectation Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium. **Clarification Statement** Emphasis is on the application of Le Chatelier's Principle and on refining designs of chemical reaction systems, including descriptions of the connection between changes made at the macroscopic level and what happens at the molecular level. Examples of designs could include different ways to increase product formation including adding reactants or removing products.	**Activity:** Food for Thought, Chapter 17 Section 2
Science and Engineering Practices	
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. • Refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.	**Science and Engineering Practices Handbook:** Practice 6
Disciplinary Core Ideas	
CHEMICAL REACTIONS In many situations, a dynamic and condition-dependent balance between a reaction and the reverse reaction determines the numbers of all types of molecules present. (HS.PS1B.b)	**Student Edition:** 594–605, 606–611, 612–622, 623, 624, 626, 627, 628, 629
OPTIMIZING THE DESIGN SOLUTION Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed. (secondary) (HS.ETS1C.a)	**Science and Engineering Practices Handbook:** Practice 1, Practice 6

STANDARDS	PAGE REFERENCES
Crosscutting Concepts	
STABILITY AND CHANGE Much of science deals with constructing explanations of how things change and how they remain stable.	**Student Edition:** 594-600, 602, 604, 606-611 *Chemistry and Health* 623 *Document-Based Questions* 629 *Example Problem* 601, 603, 605 *Figure 2* 595 *Figure 3* 596 *Figure 8* 602 *Figure 12* 608 *Figure 13* 609 *Figure 15* 610 *Practice Problem* 601, 603, 605 *Problem-Solving LAB* 622 *Section 2 Review* 611
MATTER AND ITS INTERACTIONS	**HS-PS1-7**
Performance Expectation Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction. **Clarification Statement** **Physical Science:** Emphasis is on using mathematical ideas to communicate the relationship between masses of reactants and products as well as balancing chemical equations. **Chemistry:** Emphasis is on using mathematical ideas as they relate to stoichiometry to communicate the proportional relationships between masses of atoms in the reactants and the products, and the translation of these relationships to the macroscopic scale using the mole as the conversion from the atomic to the macroscopic scale. Emphasis is on assessing students' use of mathematical thinking and not on memorization and rote application of problem-solving techniques.	**Activity:** Conservation of Mass, Chapter 11 Section 3

STANDARDS	PAGE REFERENCES
Science and Engineering Practices	
Using Mathematics and Computational Thinking Mathematical and computational thinking at the 9–12 level builds on K–8 and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions. • Use mathematical representations of phenomena to support claims.	**Science and Engineering Practices Handbook:** Practice 5
Disciplinary Core Ideas	
CHEMICAL REACTIONS The fact that atoms are conserved, together with knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions. (HS.PS1B.c)	**Student Edition:** 77–79, 105, 128, 285–288, 289–298, 299–308, 310, 312, 313, 314, 315, 368–372, 373–378, 379–384, 385–388, 390, 392, 393, 394, 395, 396, 397
Crosscutting Concepts	
ENERGY AND MATTER The total amount of energy and matter in closed systems is conserved.	**Student Edition:** 77, 105, 285, 288, 368-369, 517-518, 525-528 *Applying Practices* 381, 517 *Example Problem* 78, 287, 370 *Figure 3* 105 *Figure 5* 285 *Figure 8* 527 *Figure 9* 528 *Practice Problems* 78, 287, 371 *Problem-Solving Strategy* 374 *Section 1 Review* 372 *Table 2* 286

STANDARDS	PAGE REFERENCES
MATTER AND ITS INTERACTIONS	HS-PS1-8
Performance Expectation Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay. **Clarification Statement** **Physical Science:** Emphasis is only on simple qualitative models, such as pictures or diagrams, and on the scale of energy released in nuclear processes relative to other kinds of transformations. Radioactive decay focus is on its relationship to half-life. **Chemistry:** Emphasis is on simple qualitative models, such as pictures or diagrams, and on the scale of energy released in nuclear processes relative to other kinds of transformations. Emphasis is on alpha, beta, and gamma radioactive decays.	**Activity:** Modeling Fission, Fusion, and Radioactive Decay, Chapter 24 Section 3
Science and Engineering Practices	
Developing and Using Models Modeling in 9–12 builds on K–8 and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds. • Develop a model based on evidence to illustrate the relationships between systems or between components of a system.	**Science and Engineering Practices Handbook:** Practice 2
Disciplinary Core Ideas	
NUCLEAR PROCESSES Nuclear processes, including fusion, fission, and radioactive decays of unstable nuclei, involve release or absorption of energy. The total number of neutrons plus protons does not change in any nuclear process. (HS.PS1C.a)	**Student Edition:** 122–124, 129, 130, 860–864, 865–869, 875–884, 894, 895, 896, 897

STANDARDS	PAGE REFERENCES
Crosscutting Concepts	
ENERGY AND MATTER In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved.	**Student Edition:** 861-863, 866-868, 870-871, 875-879 *Applying Practices* 879 *Example Problem* 869, 876 *Figure 3* 862 *Figure 4* 863 *Figure 8* 867 *Figure 9* 868 *Figure 13* 875 *Figure 15 & 16* 879 *Practice Problems* 869, 876
MOTION AND STABILITY: FORCES AND INTERACTIONS HS-PS2-6	
Performance Expectation Communicate scientific and technical information about why the atomic-level, subatomic-level, and/or molecular level structure is important in the functioning of designed materials. **Clarification Statement** Emphasis is on the attractive and repulsive forces that determine the functioning of the material. Examples could include why electrically conductive materials are often made of metal, fireworks and neon signs are made of certain elements, flexible but durable materials are made up of long chained molecules, and pharmaceuticals are designed to interact with specific receptors.	**Activity:** Touching the Future, Chapter 12 Section 3
Science and Engineering Practices	
Obtaining, Evaluating, and Communicating Information Obtaining, evaluating, and communicating information in 9–12 builds on K–8 and progresses to evaluating the validity and reliability of the claims, methods, and designs. • Communicate scientific and technical information (e.g. about the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically).	**Science and Engineering Practices Handbook**: Practice 8

STANDARDS	PAGE REFERENCES
Disciplinary Core Ideas	
STRUCTURE AND PROPERTIES OF MATTER The structure and interactions of matter at the macro scale are determined by electrical forces within and between atoms. (HS.PS1A.c)	**Student Edition:** 191–194, 199, 200, 201, 212–217, 226, 227, 228, 242, 246–247, 269–270, 411–414, 417, 418–419, 434, 435, 436, 437
TYPES OF INTERACTIONS Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects. (HS.PS2B.c)	**Student Edition:** 206–209, 210–217, 225–228, 232, 233, 234, 235, 240–241, 242, 246–247, 265–270, 271, 274, 275, 276, 411–414, 417–419, 422–424, 432, 434, 435, 436, 477, 489–491, 497
ELECTROMAGNETIC RADIATION Photoelectric materials emit electrons when they absorb light of a high-enough frequency. (HS.PS4B.c)	**Student Edition:** 142, 144 *Connection to Astronomy* 145 *Figure 7* 142 *Figure 8* 144
Atoms of each element emit and absorb characteristic frequencies of light. These characteristics allow identification of the presence of an element, even in microscopic quantities. (HS.PS4B.d)	**Student Edition:** 144 *ChemLAB* 164 *Connection to Astronomy* 145 *Document-Based Questions* 169 *Figure 8* 144 *Figure 9* 145 *MiniLAB* 144
Crosscutting Concepts	
STRUCTURE AND FUNCTION Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem.	**Student Edition:** *LaunchLAB* 514

STANDARDS	PAGE REFERENCES
ENERGY	**HS-PS3-1**
Performance Expectation Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known. **Clarification Statement** **Chemistry:** Emphasis is on explaining the meaning of mathematical expressions used in the model. Focus is on basic algebraic expression or computations, systems of two or three components, and thermal energy. **Physics:** Emphasis is on explaining the meaning of mathematical expressions used in the model. Focus is on basic algebraic expression or computations; systems of two or three components; and thermal energy, kinetic energy, and/or the energies in gravitational, magnetic, or electric fields.	**Student Edition:** 529-533, 534-540, 544-545 *Applying* Practices 517 *Example Problem* 532, 536, 540 *Practice Problem* 532, 537, 541, 545 *Section 4 Review* 541 *Writing in Chemistry* 549
Science & Engineering Practices	
Using mathematics and computational thinking: Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions. including, computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions. • Create and/or revise a computational model or simulation of a phenomenon, designed device, process, or system.	**Student Edition:** *Applying* Practices 517 *Example Problem* 532, 536, 540, 548 *Practice Problem* 532, 537, 541, 548 *Writing in Chemistry* 549
Disciplinary Core Ideas	
DEFINITIONS OF ENERGY Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system's total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms. (HS.PS3A.a)	**Student Edition:** 516-518, 525-528, 534-540, 543-547, 863-864 *Applying* Practices 517 *Example Problem* 536, 540, 548 *Figure 4* 710 *Figure 8* 527 *Figure 9* 528 *Figure 13* 535 *Figure 15* 538 *Practice Problems* 537, 541, 548

STANDARDS	PAGE REFERENCES
CONSERVATION OF ENERGY AND ENERGY TRANSFER Conservation of energy means that the total change of energy in any system is always equal to the total energy transferred into or out of the system. (HS.PS3B.a)	**Student Edition:** 517-518, 525-528, 534-540, 543-547 *Applying* Practices 517 *Example Problem* 536, 540, 548 *Figure 4* 710 *Figure 8* 527 *Figure 9* 528 *Figure 13* 535 *Figure 15* 538 *Practice Problems* 537, 541, 548
Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. (HS.PC3B.b)	**Student Edition:** 516–517, 525–528, 552, 554
Mathematical expressions allow the concept of conservation of energy to be used to predict and describe system behavior. These expressions quantify how the stored energy in a system depends on its configuration (e.g. relative positions of charged particles, compression of a spring) and how kinetic energy depends on mass and velocity. (HS.PC3B.c)	**Student Edition:** 527-528, 529-533, 534-540, 543-547 *Example Problem* 532, 536, 540, 548 *Figure 8* 527 *Figure 9* 528 *Figure 13* 535 *Figure 15* 538 *Practice Problems* 532, 537, 541, 548 *Section 4 Review* 541
The availability of energy limits what can occur in any system. (HS.PC3B.d)	**Student Edition:** 517-518, 525-528, 534-540, 543-547 *Applying* Practices 517 *Example Problem* 536, 540, 548 *Figure 4* 710 *Figure 8* 527 *Figure 9* 528 *Figure 13* 535 *Figure 15* 538 *Practice Problems* 537, 541, 548

STANDARDS	PAGE REFERENCES
Crosscutting Concepts	
SYSTEMS AND MODELS Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models.	**Student Edition:** 10 *Applying* Practices 517 *ChemLAB* 126, 272 *Concepts in Motion* 15, 114, 161, 564 *Figure 2* 561 *Figure 4* 379, 564 *LaunchLAB* 134 *MiniLAB* 120 *Problem-Solving Strategy* 374 *Section 1 Review* 209 #6 *Section 2 Review* 114
ENERGY	**HS-PS3-3**
Performance Expectation Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy. **Clarification Statement** **Physical Science:** Emphasis is on qualitative evaluations of devices. Constraints could include use of renewable energy forms and efficiency. Emphasis is on devices constructed with teacher approved materials. Examples of devices can be drawn from chemistry or physics clarification statements below. **Chemistry:** Emphasis is on both qualitative and quantitative evaluations of devices. Constraints could include use of renewable energy forms and efficiency. Focus of quantitative evaluations is limited to total output for a given input. Emphasis is on devices constructed with teacher approved materials. Examples of devices in chemistry could include hot/cold packs and batteries. **Physics:** Emphasis is on both qualitative and quantitative evaluations of devices. Constraints could include use of renewable energy forms and efficiency. Focus of quantitative evaluations is limited to total output for a given input. Emphasis is on devices constructed with teacher approved materials. Examples of devices in physics could include Rube Goldberg devices, wind turbines, solar cells, solar ovens, and electric motors.	**Student Edition:** *LaunchLAB* 514

STANDARDS	PAGE REFERENCES
Science & Engineering Practices	
Constructing explanations and designing solutions: Constructing explanations (science) and designing solutions (engineering) in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. • Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.	**Student Edition:** *Writing in Chemistry* 271
Disciplinary Core Ideas	
DEFINITIONS OF ENERGY At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy. (HS.PS3A.b)	**Student Edition:** 137-139, 516-518 *Applying Practices* 517 *Chemistry & Health* 163 *Connection to Astronomy* 145 *Figure 2* 517 *Figure 4* 710
ENERGY IN CHEMICAL PROCESSES Although energy cannot be destroyed, it can be converted to other forms—for example, to thermal energy in the surrounding environment. (HS.PS3D.a)	**Student Edition:** 516–517
DEFINING AND DELIMITING ENGINEERING PROBLEMS Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. (HS.ETS1A.a)	**Science and Engineering Practices Handbook:** Practice 1, Practice 6

STANDARDS	PAGE REFERENCES
Crosscutting Concepts	
ENERGY AND MATTER Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system.	**Student Edition:** 216-217, 516-520, 523-524, 526-528, 529-533, 534-540, 563-565, 580-582 *Chapter 15 Assessment* 552-554 *Example Problem* 521, 525, 532, 536, 540 *Figure 5 & 6* 565 *Figure 9* 528 *Figure 10* 530 *Figure 13* 535 *Figure 15* 538 *Figure 20* 582 *MiniLAB* 526 *Practice Problem* 521, 525, 532, 537, 541 *Section 2 Review* 528 *Section 3 Review* 533 *Section 4 Review* 541 *Table 5* 538
ENERGY	HS-PS3-4
Performance Expectation Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics). **Clarification Statement** **Physical Science, Physics and Chemistry:** Emphasis is on analyzing data from student investigations and using mathematical thinking appropriate to the subject to describe the energy changes quantitatively and conceptually. Examples of investigations could include mixing liquids at different initial temperatures or adding objects at different temperatures to water.	**Activity:** Coffee Cup Calorimetry, Chapter 15 Section 2

STANDARDS	PAGE REFERENCES
Science and Engineering Practices	
Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in 9–12 builds on K–8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models. • Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly.	**Science and Engineering Practices Handbook:** Practice 3
Disciplinary Core Ideas	
CONSERVATION OF ENERGY AND ENERGY TRANSFER Energy cannot be created or destroyed, but it can be transported from one place to another, transformed into other forms, and transferred between systems. (HS.PS3B.b)	**Student Edition:** 516–517, 525–528, 552, 554
Uncontrolled systems always evolve toward more stable states--that is, toward more uniform energy distribution (e.g., water flows downhill, objects hotter than their surrounding environment cool down). (HS.PS3B.e)	**Student Edition:** 240–241, 542–548, 554, 865–866, 874, 894
ENERGY IN CHEMICAL PROCESSES AND EVERYDAY LIFE Although energy cannot be destroyed, it can be converted to less useful other forms—for example, to thermal energy in the surrounding environment. (HS.PS3D.a)	**Student Edition:** 516–517

STANDARDS	PAGE REFERENCES
Crosscutting Concepts	
SYSTEMS AND MODELS When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models.	**Student Edition:** 525-528, 534-540, 543-547, 607-611 *ChemLAB* 550 *Concepts in Motion* 523 *Example Problem* 536, 540, 548 *Figure 12* 608 *Figure 15* 610 *MiniLAB* 526, 611 *Practice Problem* 537, 541, 548 *Section 2 Review* 611 *Section 5 Review* 548 *Virtual Investigations* 524 *Writing in Chemistry* 549
ENERGY	**HS-PS3-6**
Performance Expectation Evaluate the validity and reliability of claims in published materials about the viability of nuclear power as a source of alternative energy relative to other forms of energy (e.g., fossil fuels, wind, solar, geothermal). **Clarification Statement** Emphasis is on the trade-offs existing between the amount of energy produced, the types and amounts of pollution produced, safety, and cost . Examples of published materials could include trade books, magazines, web resources, videos, and other passages that may reflect bias.	**Activity:** Human Health and Radiation Frequency, Chapter 24 Section 4
Science & Engineering Practices	
Obtaining, evaluating, and communicating information: Obtaining, evaluating, and communicating information in 9–12 builds on K–8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs. • Evaluate the validity and reliability of and/or synthesize multiple claims, methods, and/or designs that appear in scientific and technical texts or media reports, verifying the data when possible.	*The Chemistry: Matter & Change 2017 text in its entirety can meet this standard with classroom discussion and the information in the text.*

STANDARDS	PAGE REFERENCES
Disciplinary Core Ideas	
NUCLEAR PROCESSES Nuclear processes, including fusion, fission, and radioactive decays of unstable nuclei, involve release or absorption of energy. The total number of neutrons plus protons does not change in any nuclear process. (HS.PS1C.a)	**Activity:** *Modeling Fission, Fusion, and Radioactive Decay,* Chapter 24 Section 3 **Optimizing the Design Solution** **Student Edition:** 122–124, 129, 130, 860–864, 865–869, 875–884, 894, 895, 896, 897
DEVELOPING POSSIBLE SOLUTIONS When evaluating solutions it is important to take into account a range of constraints including cost, safety, reliability and aesthetics and to consider social, cultural and environmental impacts. (HS.ETS1B.a)	**Student Edition:** *How It Works* 775 *Writing in Chemistry* 733, 775
NATURAL RESOURCES All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors. (HS.ESS3A.b)	**Student Edition:** 880-882 *Section 3 Review* 884 #25 **Teacher Edition:** CJ 882; CP 879, 883; DI 880; E 883
Crosscutting Concepts	
ENERGY AND MATTER In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved.	**Student Edition:** 861-863, 866-868, 870-871, 875-879 *Applying Practices* 879 *Example Problem* 869, 876 *Figure 3* 862 *Figure 4* 863 *Figure 8* 867 *Figure 9* 868 *Figure 13* 875 *Figure 15 & 16* 879 *Practice Problems* 869, 876