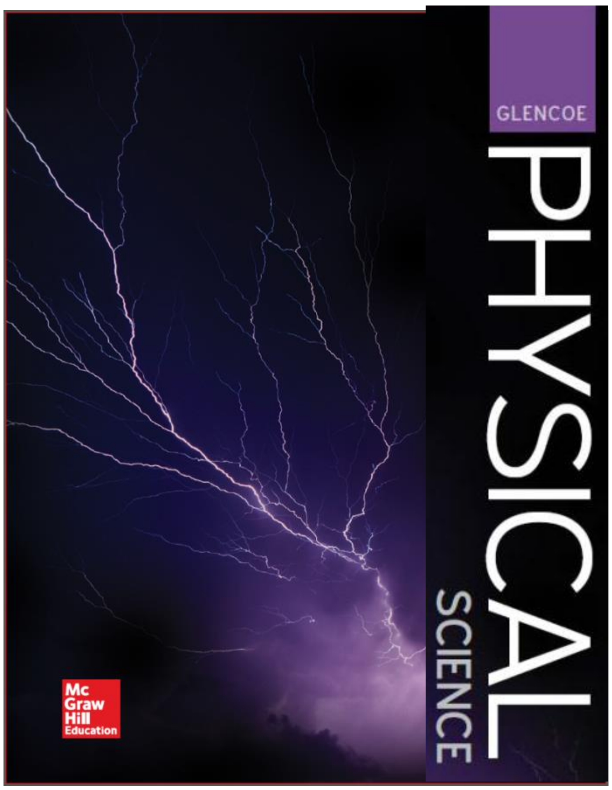
College- and Career-Readiness
Standards for Science
Physical Science



STANDARDS	PAGE REFERENCES
PHS.1 Nature of Matter **Conceptual Understanding:** To actively develop scientific investigation, reasoning, and logic skills, this standard develops basic ideas about the characteristics and structure of matter. Matter is anything that has mass and occupies space. All matter is made up of small particles called atoms. Matter can exist as a solid, liquid, gas, or plasma.	

Codes used for Teacher Edition pages are the initial caps of headings on that page.

STANDARDS	PAGE REFERENCES
PHS.1 Students will demonstrate an understanding of the nature of matter.	
PHS.1.1 *Use contextual evidence to describe particle theory of matter. Examine the particle properties of solids, liquids, and gases.*	**Student Edition:** 432-434, 438-439, 450 *Figure 2* 433 *Section 1 Review* 439 #1-#2 **Teacher Wraparound Edition:** BI 431; BP 434; D 434; DI 439; IC 431; PR 438; QD 433; SJ 438; VLe 433
PHS.1.2 *Use scientific research to generate models to compare physical and chemical properties of elements, compounds, and mixtures.*	**Student Edition:** *Figure 11* 468 *LAB* 477, 508-509 *Mini Lab* 503 **Teacher Wraparound Edition:** A 466, 472; As 477, 503; DI 464, 503; PC 428
PHS.1.3 *Conduct an investigation to determine the identity of unknown substances by comparing properties to known substances.*	**Teacher Wraparound Edition:** VLa 465
PHS.1.4 *Design and conduct investigations to explore techniques in measurements of mass, volume, length, and temperature.*	Students can design and conduct investigations on mass, volume, length, and temperature. **Student Edition:** Standards of Measurement in Chapter 1, Section 2
PHS.1.5 *Design and conduct an investigation using graphical analysis (e.g., line graph) to determine the density of liquids and/or solids.*	Using the following investigation, the students can compare densities. **Student Edition:** *Mini Lab* 18 **Teacher Wraparound Edition:** As 18
PHS.1.6 *Use mathematical and computational analysis to solve density problems. Manipulate the density formula to determine density, volume, or mass or use dimensional analysis to solve problems.*	**Student Edition:** *Apply Math* 20 #11, 39 #49 *Mini Lab* 18 *Short Response* 41 #13 **Teacher Wraparound Edition:** As 18; VL 18

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PHS.2 Atomic Theory **Conceptual Understanding:** Many scientists have contributed to our understanding of atomic structure. The atom is the basic building block of matter and consists of subatomic particles (proton, neutron, electron, and quark) that differ in their location, charge, and relative mass.	
PHS.2 Students will demonstrate an understanding of both modern and historical theories of atomic structure.	
PHS.2.1 *Research and develop models (e.g., 3-D models, online simulations, or ball and stick) to investigate both modern and historical theories of atomic structure. Compare models and contributions of Dalton, Thomson, Rutherford, Bohr, and of modern atomic theory.*	**Student Edition:** 488-491, 493 *Figure 4* 492 *Table 2* 491 **Teacher Wraparound Edition:** A 492; BP 491; DI 488; QD 495; VEAM 492
PHS.3 Periodic Table **Conceptual Understanding:** The organization of the periodic table allows scientists to obtain information and develop an understanding of concepts of atomic interactions. Developing scientific investigations increases logical reasoning and deduction skills to present the nature of science in the context of key scientific concepts.	
PHS.3 Students will analyze the organization of the periodic table of elements to predict atomic interactions.	
PHS.3.1 *Use contextual evidence to determine the organization of the periodic table, including metals, metalloids, and nonmetals; symbols; atomic number; atomic mass; chemical families/groups; and periods/series.*	**Student Edition:** 502-505, 520-524, 526-530, 532-536 *Applying Practices* 505 *Figure 9* 500-501 *Figure 12* 503 *LAB* 531 **Teacher Wraparound Edition:** A 500, 504; As 531, 539; BI 517; DI 539; IL 523; MI 532; Re 506; SUP 429; TFYI 500; VLa 518
PHS.3.2 *Using the periodic table and scientific methods, investigate the formation of compounds through ionic and covalent bonding.*	**Student Edition:** *Chapter 18 Review* 577 #44 *Figure 3* 554 *Figure 5* 555 *LAB* 557 **Teacher Wraparound Edition:** A 555, 560, 561; As 556, 557, 564; CU 556; DI 530; DiI 555, 562; Di 533, 559; IL 505; QD 555; Re 564; TFYI 521; VLe 554, 559

STANDARDS	PAGE REFERENCES
PHS.3.3 *Using naming conventions for binary compounds, write the compound name from the formula, and write balanced formulas from the name (e.g., carbon dioxide -CO_2, sodium chloride -NaCl, iron III oxide-Fe2O3, and calcium bromide -$CaBr_2$).*	**Student Edition:** 566-568, 570-571 *Example Problem* 567, 568 *Practice Problem* 567, 568 *Section 3 Review* 571 #20 **Teacher Wraparound Edition:** A 567, 568; CU 571; VLe 568
PHS.3.4 *Use naming conventions to name common acids and common compounds used in classroom labs (e.g., sodium bicarbonate (baking soda), $NaHCO_3$; hydrochloric acid, HCl; sulfuric acid, H_2SO_4 ; acetic acid (vinegar), $HC_2H_3O_2$; and nitric acid, HNO_3).*	**Student Edition:** *Thinking Critically* 577 #47 *Table 1* 679 & *Table 2* 681 give names for common acids and bases.
PHS.3.5 *Use mathematical and computational analysis to determine the atomic mass of binary compounds.*	**Student Edition:** 588-589 *Table 2* 588
PHS.4 The Law of Conservation of Matter and Energy **Conceptual Understanding:** The law of conservation of matter and energy states that matter and energy can be transformed in different ways, but the total amount of mass and energy will be conserved. These concepts should be investigated and further developed in the classroom.	
PHS.4 Students will analyze changes in matter and the relationship of these changes to the law of conservation of matter and energy.	
PHS.4.1 *Design and conduct experiments to investigate physical and chemical changes of various household products (e.g., rusting, sour milk, crushing, grinding, tearing, boiling, and freezing) and reactions of common chemicals that produce color changes or gases.*	**Student Edition:** *Launch Lab* 580 investigates changes
PHS.4.2 *Design and conduct investigations to produce evidence that mass is conserved in chemical reactions (e.g., vinegar and baking soda in a Ziploc© bag).*	**Student Edition:** *LAB* 478-479 **Teacher Wraparound Edition:** AIL 478
PHS.4.3 *Apply the concept of conservation of matter to balancing simple chemical equations.*	**Student Edition:** 585-586 *Apply Math* 589 #9 *Apply Practices* 583 *Example Problem* 587 *Mini Lab* 584 *Practice Problems* 587 **Teacher Wraparound Edition:** As 584; Re 589

STANDARDS	PAGE REFERENCES
PHS.4.4 *Use mathematical and computational analysis to examine evidence that mass is conserved in chemical reactions using simple stoichiometry problems (1:1 mole ratio) or atomic masses to demonstrate the conservation of mass with a balanced equation.*	**Student Edition:** 588-589 *Applying Practices* 583 *Table 2* 588
PHS.4.5 *Research nuclear reactions and their uses in the modern world, exploring concepts such as fusion, fission, stars as reactors, nuclear energy, and chain reactions.*	**Student Edition:** 624-626 *LAB* 628 *Science & History* 636 **Teacher Wraparound Edition:** BP 624; Re 627; SH 636; SJ 624; TFYI 625; VI 628
PHS.4.6 *Analyze and debate the advantages and disadvantages of nuclear reactions as energy sources.*	**Teacher Wraparound Edition:** SJ 625

PHS.5 Newton's Laws of Motion

Conceptual Understanding: Kinematics (contact forces) describe the motion of objects using words, diagrams, numbers, graphs, and equations. The goal of any study of kinematics is to develop scientific models to describe and explain the motion of real-world objects. Newton's laws of motion are an example of a tool that can aid in the explanation of motion.

PHS.5 Students will analyze the scientific principles of motion, force, and work.

PHS.5.1 *Research the scientific contributions of Newton, and use models to communicate Newton's principles.*	**Student Edition:** 80-85 *Mini Lab* 81 **Teacher Wraparound Edition:** As 81; BP 80; CU 85; MM 80; PR 85; QD 83, 84; VLa 81
PHS.5.2 *Design and conduct an investigation to study the motion of an object using properties such as displacement, time of motion, velocity, and acceleration.*	**Student Edition:** *LAB* 94-95
PHS.5.3 *Collect, organize, and interpret graphical data using correct metric units to determine the average speed of an object.*	**Student Edition:** *LAB* 94-95
PHS.5.4 *Use mathematical and computational analyses to show the relationships among force, mass, and acceleration (i.e., Newton's second law).*	**Student Edition:** *Apply Math* 85 *Applying Practices* 82 *Example Problem* 83 *Practice Problems* 83

STANDARDS	PAGE REFERENCES
PHS.5.5 *Design and construct an investigation using probe systems and/or online simulations to observe relationships between force, mass, and acceleration (F=ma).*	**Student Edition:** *LAB* 94-95
PHS.5.6 *Use an engineering design process and mathematical analysis to design and construct models to demonstrate the law of conservation of momentum (e.g., roller coasters, bicycle helmets, bumper systems).*	**Teacher Wraparound Edition:** PR 92; VLa 91
PHS.5.7 *Use mathematical and computational representations to create graphs and formulas that describe the relationships between force, work, and energy (i.e., W=Fd, KE=½ mv^2, PE=mgh, W=KE).*	Information and computations for these equations are in the following page references: **Student Edition:** *Example Problem* 107, 116, 119 *Figure 2* 108 (shows graph of work on object) *Practice Problems* 107, 116, 119 **Teacher Wraparound Edition:** TFYI 107
PHS.5.8 *Research the efficiency of everyday machines, and debate ways to improve their economic impact on society (e.g., electrical appliances, transportation vehicles).*	Machines and efficiency are discussed in the following pages: **Student Edition:** 109-110
PHS.6 Waves **Conceptual Understanding:** Waves are everywhere in nature. Understanding of the physical world is not complete until we understand the nature, properties, and behaviors of waves. Students have experienced transverse and horizontal waves in their everyday lives. The exploration of waves in greater depth will allow students to conceptualize these waves. The goal is to develop various models of waves and apply those models to understanding wave interactions.	
PHS.6 Students will explore the characteristics of waves.	
PHS.6.1 *Use models to analyze and describe examples of mechanical waves' properties (e.g., wavelength, frequency, speed, amplitude, rarefaction, and compression).*	**Student Edition:** *Figure 6* 311 *Figure 7* 279 *Figure 8* 280 *Figure 9* 281 *Figure 10* 283 *Figure 11* 284 *LAB* 285, 296-297 *Launch Lab* 304 *Mini Lab* 280 **Teacher Wraparound Edition:** A 277; As 280, 284, 297, 304, 310; CU 278; DI 276; MM 283; Re 284; VLa 281; VLe 280, 283

STANDARDS	PAGE REFERENCES
PHS.6.2 *Analyze examples and evidence of transverse and longitudinal waves found in nature (e.g., earthquakes, ocean waves, and sound waves).*	**Student Edition:** *Chapter 9 Review* 301 #46 *Figure 4* 276 *Figure 6* 278 **Teacher Wraparound Edition:** As 278; Di 276; SJ 277; VLe 276
PHS.6.3 *Generate wave models to explore energy transference.*	**Student Edition:** *Launch Lab* 272 **Teacher Wraparound Edition:** BI 273; LL 272
PHS.6.4 ***Enrichment:*** *Use an engineering design process to design and build a musical instrument to demonstrate the influence of resonance on music.**	**Teacher Wraparound Edition:** WQ 271
PHS.6.5 *Design and conduct experiments to investigate technological applications of sound (e.g., medical uses, music, acoustics, Doppler effects, and influences of mathematical theory on music).*	**Teacher Wraparound Edition:** IL 314
PHS.6.6 *Research real-world applications to create models or visible representations of the electromagnetic spectrum, including visible light, infrared radiation, and ultraviolet radiation.*	**Teacher Wraparound Edition:** Re 351
PHS.6.7 ***Enrichment:*** *Use an engineering design process to design and construct an apparatus that forms images to project on a screen or magnify images using lenses and/or mirrors.**	**Teacher Wraparound Edition:** AIL 420
PHS.6.8 ***Enrichment:*** *Debate the particle/wave behavior of light.*	**Student Edition:** *Applying Practices* 343
PHS.7 Energy **Conceptual Understanding:** Concepts about different energy forms and energy transformations continue to be expanded and explored in greater depth, leading to the development of more mathematical applications. Focus should be on students actively developing scientific investigations, reasoning, and logic skills.	
PHS.7 Students will examine different forms of energy and energy transformations.	
PHS.7.1 *Using digital resources, explore forms of energy (e.g., potential and kinetic energy, mechanical, chemical, electrical, thermal, radiant, and nuclear energy).*	The following page references explore the forms of energy. **Student Edition:** 115-119, 139-140, 212-215, 241, 248-253 **Teacher Wraparound Edition:** BP 241; SJ 115, 125; VLa 235, 248

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PHS.7.2 *Use scientific investigations to explore the transformation of energy from one type to another (e.g., potential to kinetic energy, and mechanical, chemical, electrical, thermal, radiant, and nuclear energy interactions).*	**Student Edition:** *Applying Practices* 157 *LAB* 128-129, 254 *Mini Lab* 156 **Teacher Wraparound Edition:** A 123, 129, 153; AIL 128; As 159; De 124; IH 212, 213; MM 122, 158; QD 124; SJ 125; VLa 121
PHS.7.3 *Using mathematical and computational analysis, calculate potential and kinetic energy based on given data. Use equations such as PE=mgh and KE=½ mv²*.	**Student Edition:** 116, 118 *Apply Math* 119 *Chapter 4 Review* 133 #49 *Example Problem* 116, 119 *Practice Problem* 116, 119 **Teacher Wraparound Edition:** As 119; DI 125
PHS.7.4 *Conduct investigations to provide evidence of the conservation of energy as energy is converted from one form of energy to another (e.g., wind to electric, chemical to thermal, mechanical to thermal, and potential to kinetic).*	**Student Edition:** *Applying Practices* 124, 142 *LAB* 128-129 **Teacher Wraparound Edition:** AIL 128; As 129; De 124; MM 122; QD 124; VLa 121
PHS.8 Thermal Energy **Conceptual Understanding:** Thermal energy is transferred in the form of heat. Heat is always transferred from an area of high heat to low heat. More complex concepts and terminology related to phase changes are developed, including the distinction between heat and temperature.	
PHS.8 Students will demonstrate an understanding of temperature scales, heat, and thermal energy transfer.	
PHS.8.1 *Compare and contrast temperature scales by converting between Celsius, Fahrenheit, and Kelvin.*	**Student Edition:** 20, 139 *Apply Math* 20 #10 *Figure 12* 20
PHS.8.2 *Apply particle theory to phase change and analyze freezing point, melting point, boiling point, vaporization, and condensation of different substances.*	**Student Edition:** 434-436 *Figure 4* 434 *Figure 5* 435 *Section 1 Review* 439 #3, #4 **Teacher Wraparound Edition:** VLe 436

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PHS.8.3 *Relate thermal energy transfer to real world applications of conduction (e.g., quenching metals), convection (e.g., movement of air masses/weather/plate tectonics), and radiation (e.g., electromagnetic).*	**Student Edition:** 152-153 *Figure 7* 145 *Figure 9* 146 *Figure 14* 152 *LAB* 160-161 *Science & History* 162 **Teacher Wraparound Edition:** AIL 160; As 150, 161; CD 154; ISS 147; MI 144; QD 153; TFYI 139
PHS.8.4 Enrichment: *Use an engineering design process to construct a simulation of heat energy transfer between systems. Calculate the calories/joules of energy generated by burning food products. Communicate conclusions based on evidence from the simulation.**	The following page references allow the student to construct an investigation of heat energy transfer. **Teacher Wraparound Edition:** A 153; IL 154
PHS.9 Electricity **Conceptual Understanding:** Electrical energy (both battery and circuit energy) is transformed into other forms of energy. Charged particles and magnetic fields are similar because they both store energy. Magnetic fields exert forces on moving charged particles. Students investigate practical uses of these concepts and develop a working understanding of the basic concepts of magnetism and electricity.	
PHS.9 Students will explore basic principles of magnetism and electricity (e.g., static electricity, current electricity, and circuits).	
PHS.9.1 *Use digital resources and online simulations to investigate the basic principles of electricity, including static electricity, current electricity, and circuits. Use digital resources (e.g., online simulations) to build a model showing the relationship between magnetic fields and electric currents.*	**Student Edition:** *Animation* 173, 177 **Teacher Wraparound Edition:** BP 178; VLa 209; VLe 173, 177
PHS.9.2 *Distinguish between magnets, motors, and generators, and evaluate modern industrial uses of each.*	**Student Edition:** 203-205, 209-215, 217-222 *Figure 15* 214 *Figure 19* 217 *Figure 21* 219 *LAB* 223, 224-225 **Teacher Wraparound Edition:** A 219; AIL 224; IL 214; MM 214; VLa 217; VMG 219

STANDARDS	PAGE REFERENCES
PHS.9.3 ***Enrichment:*** *Use an engineering design process to construct a working electric motor to perform a task. Communicate the design process and comparisons of task performance efficiencies.**	The following references allow students to construct a motor without the motor constructing a task. **Student Edition:** *LAB* 223 **Teacher Wraparound Edition:** As 223
PHS.9.4 *Use an engineering design process to construct and test conductors, semiconductors, and insulators using various materials to optimize efficiency.**	The following reference is an introductory lab on conductors and insulators. **Student Edition:** *LAB* 184