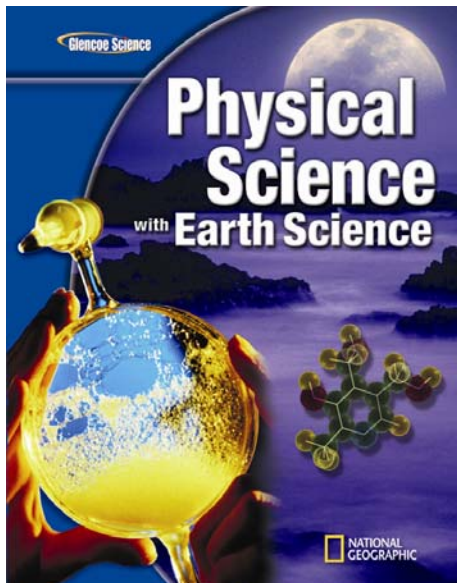




High School Science Content
Expectations
Physics/Earth Science/Chemistry
Core Skills



Physical Science with Earth Science

© 2009

STANDARDS

PAGE REFERENCES

PHYSICS

STANDARD P1: INQUIRY, REFLECTION, AND SOCIAL IMPLICATIONS

Students will understand the nature of science and demonstrate an ability to practice scientific reasoning by applying it to the design, execution, and evaluation of scientific investigations. Students will demonstrate their understanding that scientific knowledge is gathered through various forms of direct and indirect observations and the testing of this information by methods including, but not limited to, experimentation. They will be able to distinguish between types of scientific knowledge (e.g., hypotheses, laws, theories) and become aware of areas of active research in contrast to conclusions that are part of established scientific consensus. They will use their scientific knowledge to assess the costs, risks, and benefits of technological systems as they make personal choices and participate in public policy decisions. These insights will help them analyze the role science plays in society, technology, and potential career opportunities.

STANDARDS

PAGE REFERENCES

P1.1 Scientific Inquiry

Science is a way of understanding nature. Scientific research may begin by generating new scientific questions that can be answered through replicable scientific investigations that are logically developed and conducted systematically. Scientific conclusions and explanations result from careful analysis of empirical evidence and the use of logical reasoning. Some questions in science are addressed through indirect rather than direct observation, evaluating the consistency of new evidence with results predicted by models of natural processes. Results from investigations are communicated in reports that are scrutinized through a peer review process.

<p>P1.1f Predict what would happen if the variables, methods, or timing of an investigation were changed.</p>	<p>Student Edition: 8-10, 54-57 <i>Accidents in Science</i> 60, 210, 744 <i>Design Your Own Physics Lab</i> 88-89, 144-145, 540-541 <i>Model and Invent LAB</i> 176-177 <i>Science Skill Handbook</i> 854-858 Teacher Wraparound Edition: A 9; AIL 28, 88, 144</p>
<p>P1.1g Based on empirical evidence, explain and critique the reasoning used to draw a scientific conclusion or explanation.</p>	<p>Student Edition: 6-10, 12-13 <i>Design Your Own LAB</i> 414-415, 568-569 <i>LAB</i> 196, 406 <i>Model and Invent LAB</i> 840-841 <i>Science and History</i> 146, 478 <i>Science and Society</i> 778 <i>Science Skill Handbook</i> 858 Teacher Wraparound Edition: DI 553; FYI 404; QD 10</p>
<p>P1.1h Design and conduct a systematic scientific investigation that tests a hypothesis. Draw conclusions from data presented in charts or tables.</p>	<p>Student Edition: 8-10 <i>Design Your Own Physics Lab</i> 28-29, 88-89, 144-145, 242-243, 344-345, 414-415, 540-541, 568-569 <i>Science Skill Handbook</i> 853-858 Teacher Wraparound Edition: A 9; FF 8</p>

STANDARDS	PAGE REFERENCES
<p>P1.1i Distinguish between scientific explanations that are regarded as current scientific consensus and the emerging questions that active researchers investigate.</p>	<p>Student Edition: 823-825 <i>Applying Science</i> 49, 499 <i>National Geographic</i> 2-3, 548-549 <i>Science and History</i> 146, 600 <i>Science and Society</i> 178, 778 Teacher Wraparound Edition: IM 827; FYI 82</p>
<p>P1.2 Scientific Reflection and Social Implications The integrity of the scientific process depends on scientists and citizens understanding and respecting the “Nature of Science.” Openness to new ideas, skepticism, and honesty are attributes required for good scientific practice. Scientists must use logical reasoning during investigation design, analysis, conclusion, and communication. Science can produce critical insights on societal problems from a personal and local scale to a global scale. Science both aids in the development of technology and provides tools for assessing the costs, risks, and benefits of technological systems. Scientific conclusions and arguments play a role in personal choice and public policy decisions. New technology and scientific discoveries have had a major influence in shaping human history. Science and technology continue to offer diverse and significant career opportunities.</p>	
<p>P1.2f Critique solutions to problems, given criteria and scientific constraints.</p>	<p>Student Edition: 10, 54-57 <i>Design Your Own LAB</i> 88-89 <i>LAB</i> 51, 112, 118-119, 134 <i>Model and Invent LAB</i> 58-59 <i>Science Skill Handbook</i> 857-858 Teacher Wraparound Edition: A 48; CYD 59</p>
<p>P1.2g Identify scientific tradeoffs in design decisions and choose among alternative solutions.</p>	<p>Student Edition: 10, 54-57 <i>Accidents in Science</i> 210 <i>Science Skill Handbook</i> 858 Teacher Wraparound Edition: DI 10; SJ 11</p>
<p>P1.2h Describe the distinctions between scientific theories, laws, hypotheses, and observations.</p>	<p>Student Edition: 8-10, 12, 98-103, 105, 113-117, 199-202, 721-722 <i>Science and History</i> 120 <i>Science Skill Handbook</i> 853-854 Teacher Wraparound Edition: IL 12; QD 102; SJ 11, 114</p>

STANDARDS	PAGE REFERENCES
<p>P1.2i Explain the progression of ideas and explanations that lead to science theories that are part of the current scientific consensus or core knowledge.</p>	<p>Student Edition: 400-405, 438-440, 581-583, 592-594, 721-722, 823-825, 836-839 <i>National Geographic</i> 441, 582 <i>Science and History</i> 120, 478, 810 Teacher Wraparound Edition: DI 592; FYI 787; QD 440; SJ 824; UA 722</p>
<p>P1.2j Apply science principles or scientific data to anticipate effects of technological design decisions.</p>	<p>Student Edition: 42-45, 46-50, 54-57, 162-165, 275-277, 409-413 <i>Design Your Own Physics Lab</i> 414-415 <i>Integrate Physics</i> 416 <i>MiniLAB</i> 47 <i>Model and Invent LAB</i> 176-177 <i>National Geographic</i> 44 Teacher Wraparound Edition: FYI 48, 164; IL 54; LD 170; TC 36</p>
<p>P1.2k Analyze how science and society interact from a historical, political, economic, or social perspective.</p>	<p>Student Edition: 11-13, 38-45, 46-50, 497-499 <i>Accidents in Science</i> 210 <i>LAB</i> 51 <i>National Geographic</i> 44 <i>Science and History</i> 120, 478, 810 <i>Science and Society</i> 510, 778 Teacher Wraparound Edition: CD 8; D 53; FYI 48; TC 36</p>

STANDARDS	PAGE REFERENCES
<p>STANDARD P2: MOTION OF OBJECTS</p>	
<p><i>The universe is in a state of constant change. From small particles (electrons) to the large systems (galaxies) all things are in motion. Therefore, for students to understand the universe they must describe and represent various types of motion. Kinematics, the description of motion, always involves measurements of position and time. Students must describe the relationships between these quantities using mathematical statements, graphs, and motion maps. They use these representations as powerful tools to not only describe past motions but also predict future events.</i></p>	
<p>P2.1 Position – Time An object's position can be measured and graphed as a function of time. An object's speed can be calculated and graphed as a function of time.</p>	
<p>P2.1g Solve problems involving average speed and constant acceleration in one dimension.</p>	<p>Student Edition: 71-72 <i>Applying Math</i> 72 <i>Design Your Own LAB</i> 88-89 <i>Launch Lab</i> 69 <i>MiniLAB</i> 71 <i>National Geographic</i> 78 Teacher Wraparound Edition: DI 72; IM 74</p>
<p>P2.1h Identify the changes in speed and direction in everyday examples of circular (rotation and revolution), periodic, and projectile motions.</p>	<p>Student Edition: 73, 77, 108-111, 289-291, 294-299 <i>Integrate Earth Science</i> 293 <i>LAB</i> 300, 310-311 Teacher Wraparound Edition: DI 110; LD 289</p>
<p>P2.2 Velocity — Time The motion of an object can be described by its position and velocity as functions of time and by its average speed and average acceleration during intervals of time.</p>	
<p>P2.2e Use the area under a velocity-time graph to calculate the distance traveled and the slope to calculate the acceleration.</p>	<p>Student Edition: 77-79 <i>National Geographic</i> 78 Teacher Wraparound Edition: DI 78</p>
<p>P2.2f Describe the relationship between changes in position, velocity, and acceleration during periodic motion.</p>	<p>Student Edition: 288-291, 295-296 <i>LAB</i> 300, 310-311 <i>Science and History</i> 312 Teacher Wraparound Edition: CU 293; FYI 325</p>

STANDARDS		PAGE REFERENCES
P2.2g	Apply the independence of the vertical and horizontal initial velocities to solve projectile motion problems.	Student Edition: 108-109 Teacher Wraparound Edition: CU 111; VL 109
P2.3x Frames of Reference All motion is relative to whatever frame of reference is chosen, for there is no motionless frame from which to judge all motion.		
P2.3a	Describe and compare the motion of an object using different reference frames.	Student Edition: 70-72, 76-77 <i>Integrate Astronomy</i> 74 Teacher Wraparound Edition: CC 73; CU 75; UA 72; USW 71; VL 74
STANDARD P3: FORCES AND MOTION <i>Students identify interactions between objects either as being by direct contact (e.g., pushes or pulls, friction) or at a distance (e.g., gravity, electromagnetism), and to use forces to describe interactions between objects. They recognize that non-zero net forces always cause changes in motion (Newton's first law). These changes can be changes in speed, direction, or both. Students use Newton's second law to summarize relationships among and solve problems involving net forces, masses, and changes in motion (using standard metric units). They explain that whenever one object exerts a force on another, a force equal in magnitude and opposite in direction is exerted back on it (Newton's third law).</i>		
P3.1 Basic Forces in Nature Objects can interact with each other by "direct contact" (e.g., pushes or pulls, friction) or at a distance (e.g., gravity, electromagnetism, nuclear).		
P3.1x Forces There are four basic forces (gravitational, electromagnetic, strong, and weak nuclear) that differ greatly in magnitude and range. Between any two charged particles, electric force is vastly greater than the gravitational force. Most observable forces (e.g., those exerted by a coiled spring or friction) may be traced to electric forces acting between atoms and molecules.		
P3.1b	Explain why scientists can ignore the gravitational force when measuring the net force between two electrons.	Student Edition: 104, 394 Teacher Wraparound Edition: FYI 787
P3.1c	Provide examples that illustrate the importance of the electric force in everyday life.	Student Edition: 394, 401-403, 409-411, 431-437 <i>National Geographic</i> 388-389, 397 Teacher Wraparound Edition: CD 410; TPK 431; VL 398

STANDARDS		PAGE REFERENCES	
P3.1d	Identify the basic forces in everyday interactions.	Student Edition: 82-86, 98-103, 106-111; 162-164, 166-174 <i>LAB</i> 87, 112 <i>Model and Invent LAB</i> 176-177 <i>National Geographic</i> 115, 168 <i>Science and History</i> 312 Teacher Wraparound Edition: A 85, 108; DI 109; IM 82; LD 102	
P3.2 Net Forces		Forces have magnitude and direction. The net force on an object is the sum of all the forces acting on the object. Objects change their speed and/or direction only when a net force is applied. If the net force on an object is zero, there is no change in motion (Newton's First Law).	
P3.2d	Calculate all the forces on an object on an inclined plane and describe the object's motion based on the forces using free-body diagrams.	Student Edition: 161 <i>Design Your Own Physics Lab</i> 88-89 <i>MiniLAB</i> 99 <i>Model and Invent LAB</i> 176-177 Teacher Wraparound Edition: A 172, 173; DI 100	
P3.3 Newton's Third Law		Whenever one object exerts a force on another object, a force equal in magnitude and opposite in direction is exerted back on the first object.	
P3.3b	Predict how the change in velocity of a small mass compares to the change in velocity of a large mass when the objects interact (e.g., collide).	Student Edition: 116-117 <i>LAB</i> 118-119 Teacher Wraparound Edition: CU 117; D 116	
P3.3c	Explain the recoil of a projectile launcher in terms of forces and masses.	Student Edition: 113-114 <i>National Geographic</i> 115 Teacher Wraparound Edition: FF 115	
P3.3d	Analyze why seat belts may be more important in autos than in buses.	Student Edition: 100-101, 116 Teacher Wraparound Edition: D 101	

STANDARDS		PAGE REFERENCES
<p>P3.4 Forces and Acceleration</p> <p>The change of speed and/or direction (acceleration) of an object is proportional to the net force and inversely proportional to the mass of the object. The acceleration and net force are always in the same direction.</p>		
P3.4e	Solve problems involving force, mass, and acceleration in two-dimensional projectile motion restricted to an initial horizontal velocity with no initial vertical velocity (e.g., ball rolling off a table).	<p>Student Edition: 108-109</p> <p>Teacher Wraparound Edition: DI 109</p>
P3.4f	Calculate the changes in velocity of a thrown or hit object during and after the time it is acted on by the force.	<p>Student Edition: 108-109</p> <p>Teacher Wraparound Edition: DI 109</p>
P3.4g	Explain how the time of impact can affect the net force (e.g., air bags in cars, catching a ball).	<p>Student Edition: 100-101, 109</p> <p>Teacher Wraparound Edition: D 101</p>
<p>P3.5x Momentum</p> <p>A moving object has a quantity of motion (momentum) that depends on its velocity and mass. In interactions between objects, the total momentum of the objects does not change.</p>		
P3.5a	Apply conservation of momentum to solve simple collision problems.	<p>Student Edition: 116-117 LAB 118-119</p> <p>Teacher Wraparound Edition: DI 116</p>
<p>P3.6 Gravitational Interactions</p> <p>Gravitation is a universal attractive force that a mass exerts on every other mass. The strength of the gravitational force between two masses is proportional to the masses and inversely proportional to the square of the distance between them.</p>		
P3.6d	Calculate force, masses, or distance, given any three of these quantities, by applying the Law of Universal Gravitation, given the value of G .	<p>Student Edition: 104-107</p> <p>Teacher Wraparound Edition: A 107; FF 105; QD 106</p>
P3.6e	Draw arrows (vectors) to represent how the direction and magnitude of a force changes on an object in an elliptical orbit.	See <i>Glencoe's Physics Principles and Problems</i> © 2005.

STANDARDS		PAGE REFERENCES
P3.7 Electric Charges		
Electric force exists between any two charged objects. Oppositely charged objects attract, while objects with like charge repel. The strength of the electric force between two charged objects is proportional to the magnitudes of the charges and inversely proportional to the square of the distance between them (Coulomb's Law).		
P3.7x Electric Charges — Interactions		
Charged objects can attract electrically neutral objects by induction.		
P3.7c	Draw the redistribution of electric charges on a neutral object when a charged object is brought near.	Student Edition: 396, 398-399 <i>National Geographic</i> 397 Teacher Wraparound Edition: VL 398
P3.7d	Identify examples of induced static charges.	Student Edition: 392-393 <i>National Geographic</i> 397 Teacher Wraparound Edition: FF 395; QD 394; SJ 393
P3.7e	Explain why an attractive force results from bringing a charged object near a neutral object.	Student Edition: 393 <i>MiniLAB</i> 398 Teacher Wraparound Edition: VL 398
P3.7f	Determine the new electric force on charged objects after they touch and are then separated.	Student Edition: 398-399 <i>MiniLAB</i> 398 Teacher Wraparound Edition: R 399
P3.7g	Propose a mechanism based on electric forces to explain current flow in an electric circuit.	Student Edition: 400-405, 407-408 Teacher Wraparound Edition: IM 401

STANDARDS		PAGE REFERENCES
P3.p8 Magnetic Force (prerequisite)		
Magnets exert forces on all objects made of ferromagnetic materials (e.g., iron, cobalt, and nickel) as well as other magnets. This force acts at a distance. Magnetic fields accompany magnets and are related to the strength and direction of the magnetic force. (<i>prerequisite</i>)		
P3.8x Electromagnetic Force		
Magnetic and electric forces are two aspects of a single electromagnetic force. Moving electric charges produce magnetic forces and moving magnets produce electric forces (e.g., electric current in a conductor).		
P3.8b	Explain how the interaction of electric and magnetic forces is the basis for electric motors, generators, and the production of electromagnetic waves.	Student Edition: 431-437, 438-440, 456-460 <i>LAB 445</i> <i>National Geographic 441</i> Teacher Wraparound Edition: DI 436; IL 434; VL 458
STANDARD P4: FORMS OF ENERGY AND ENERGY TRANSFORMATIONS		
<i>Energy is a useful conceptual system for explaining how the universe works and accounting for changes in matter. Energy is not a “thing.” Students develop several energy-related ideas: First, they keep track of energy during transfers and transformations, and account for changes using energy conservation. Second, they identify places where energy is apparently lost during a transformation process, but is actually spread around to the environment as thermal energy and therefore not easily recoverable. Third, they identify the means of energy transfers: collisions between particles, or waves.</i>		
P4.1 Energy Transfer		
Moving objects and waves transfer energy from one location to another. They also transfer energy to objects during interactions (e.g., sunlight transfers energy to the ground when it warms the ground; sunlight also transfers energy from the Sun to the Earth).		
P4.1x Energy Transfer — Work		
Work is the amount of energy transferred during an interaction. In mechanical systems, work is the amount of energy transferred as an object is moved through a distance, $W = Fd$, where d is in the same direction as F . The total work done on an object depends on the net force acting on the object and the object's displacement.		
P4.1c	Explain why work has a more precise scientific meaning than the meaning of work in everyday language.	Student Edition: 154-157 Teacher Wraparound Edition: TPK 154
P4.1d	Calculate the amount of work done on an object that is moved from one position to another.	Student Edition: 156 <i>Applying Math 156</i> <i>MiniLAB 157</i> Teacher Wraparound Edition: QD 156

STANDARDS		PAGE REFERENCES	
P4.1e	Using the formula for work, derive a formula for change in potential energy of an object lifted a distance h .	Student Edition: 132-133, 156 Teacher Wraparound Edition: SJ 155	
P4.2 Energy Transformation Energy is often transformed from one form to another. The amount of energy before a transformation is equal to the amount of energy after the transformation. In most energy transformations, some energy is converted to thermal energy.			
P4.2e	Explain the energy transformation as an object (e.g., skydiver) falls at a steady velocity.	Student Edition: 85-86, 137 Teacher Wraparound Edition: A 85; FYI 137	
P4.2f	Identify and label the energy inputs, transformations, and outputs using qualitative or quantitative representations in simple technological systems (e.g., toaster, motor, hair dryer) to show energy conservation.	Student Edition: 139-140, 163, 274, 734 <i>Design Your Own LAB</i> 144-145 <i>Integrate Environment</i> 139 <i>National Geographic</i> 138 Teacher Wraparound Edition: LD 138	
P4.3 Kinetic and Potential Energy Moving objects have kinetic energy. Objects experiencing a force may have potential energy due to their relative positions (e.g., lifting an object or stretching a spring, energy stored in chemical bonds). Conversions between kinetic and gravitational potential energy are common in moving objects. In frictionless systems, the decrease in gravitational potential energy is equal to the increase in kinetic energy or vice versa.			
P4.3x Kinetic and Potential Energy — Calculations The kinetic energy of an object is related to the mass of an object and its speed: $KE = \frac{1}{2}mv^2$.			
P4.3d	Rank the amount of kinetic energy from highest to lowest of everyday examples of moving objects.	Student Edition: 130-131 Teacher Wraparound Edition: IM 137; QD 130	
P4.3e	Calculate the changes in kinetic and potential energy in simple mechanical systems (e.g., pendulums, roller coasters, ski lifts) using the formulas for kinetic energy and potential energy.	Student Edition: 130-133; 135-140 <i>LAB</i> 134 <i>National Geographic</i> 138 Teacher Wraparound Edition: IM 137; VL 136	

STANDARDS	PAGE REFERENCES
<p>P4.3f Calculate the impact speed (ignoring air resistance) of an object dropped from a specific height or the maximum height reached by an object (ignoring air resistance), given the initial vertical velocity.</p>	<p>Student Edition: 106-109</p> <p>Teacher Wraparound Edition: QD 106</p>
<p>P4.4 Wave Characteristics Waves (mechanical and electromagnetic) are described by their wavelength, amplitude, frequency, and speed.</p>	
<p>P4.4x Wave Characteristics — Calculations Wave velocity, wavelength, and frequency are related by $v = \lambda f$. The energy transferred by a wave is proportional to the square of the amplitude of vibration and its frequency.</p>	
<p>P4.4d Demonstrate that frequency and wavelength of a wave are inversely proportional in a given medium.</p>	<p>Student Edition: 296-297 LAB 310-311</p> <p>Teacher Wraparound Edition: QD 296</p>
<p>P4.4e Calculate the amount of energy transferred by transverse or compression waves of different amplitudes and frequencies (e.g., seismic waves).</p>	<p>Student Edition: 298-299</p> <p>Teacher Wraparound Edition: MM 298</p>
<p>P4.5 Mechanical Wave Propagation Vibrations in matter initiate mechanical waves (e.g., water waves, sound waves, seismic waves), which may propagate in all directions and decrease in intensity in proportion to the distance squared for a point source. Waves transfer energy from one place to another without transferring mass.</p>	

STANDARDS	PAGE REFERENCES
<p>P4.6 Electromagnetic Waves Electromagnetic waves (e.g., radio, microwave, infrared, visible light, ultraviolet, x-ray) are produced by changing the motion (acceleration) of charges or by changing magnetic fields. Electromagnetic waves can travel through matter, but they do not require a material medium. (That is, they also travel through empty space.) All electromagnetic waves move in a vacuum at the speed of light. Types of electromagnetic radiation are distinguished from each other by their wavelength and energy.</p>	
<p>P4.6x Electromagnetic Propagation Modulated electromagnetic waves can transfer information from one place to another (e.g., televisions, radios, telephones, computers and other information technology devices). Digital communication makes more efficient use of the limited electromagnetic spectrum, is more accurate than analog transmission, and can be encrypted to provide privacy and security.</p>	
<p>P4.6e Explain why antennas are needed for radio, television, and cell phone transmission and reception.</p>	<p>Student Edition: 469 <i>National Geographic</i> 471 Teacher Wraparound Edition: D 473; UA 470</p>
<p>P4.6f Explain how radio waves are modified to send information in radio and television programs, radio-control cars, cell phone conversations, and GPS systems.</p>	<p>Student Edition: 469-470, 472-475 <i>National Geographic</i> 471 Teacher Wraparound Edition: QD 470</p>
<p>P4.6g Explain how different electromagnetic signals (e.g., radio station broadcasts or cell phone conversations) can take place without interfering with each other.</p>	<p>Student Edition: 469-470 <i>National Geographic</i> 471 <i>Use the Internet LAB</i> 476-477 Teacher Wraparound Edition: D 473; DI 471; QD 470</p>
<p>P4.6h Explain the relationship between the frequency of an electromagnetic wave and its technological uses.</p>	<p>Student Edition: 462-467, 469-470 Teacher Wraparound Edition: CC 470; IC 472; IL 464</p>
<p>P4.r7x Quantum Theory of Waves (recommended) Electromagnetic energy is transferred on the atomic scale in discrete amounts called quanta. The equation $E = hf$ quantifies the relationship between the energy transferred and the frequency, where h is Planck's constant. (recommended)</p>	

STANDARDS		PAGE REFERENCES
<p>P4.8 Wave Behavior — Reflection and Refraction The laws of reflection and refraction describe the relationships between incident and reflected/refracted waves.</p>		
<p>P4.8x Wave Behavior — Diffraction, Interference, and Refraction Waves can bend around objects (diffraction). They also superimpose on each other and continue their propagation without a change in their original properties (interference). When refracted, light follows a defined path.</p>		
P4.8c	Describe how two wave pulses propagated from opposite ends of a demonstration spring interact as they meet.	<p>Student Edition: 306-309</p> <p>Teacher Wraparound Edition: A 307; IL 306; VL 308</p>
P4.8d	List and analyze everyday examples that demonstrate the interference characteristics of waves (e.g., dead spots in an auditorium, whispering galleries, colors in a CD, beetle wings).	<p>Student Edition: 306-309</p> <p>Teacher Wraparound Edition: CD 306</p>
P4.8e	Given an angle of incidence and indices of refraction of two materials, calculate the path of a light ray incident on the boundary (Snell's Law).	<p>Student Edition: 329</p> <p>Teacher Wraparound Edition: FYI 328</p>
P4.8f	Explain how Snell's Law is used to design lenses (e.g., eye glasses, microscopes, telescopes, binoculars).	<p>Student Edition: 331-335, 336-337</p> <p>Teacher Wraparound Edition: CC 336</p>
<p>P4.9 Nature of Light Light interacts with matter by reflection, absorption, or transmission.</p>		
<p>P4.r9x Nature of Light — Wave-Particle Nature (recommended) The dual wave-particle nature of matter and light is the foundation for modern physics. (recommended)</p>		

STANDARDS	PAGE REFERENCES
<p>P4.10 Current Electricity — Circuits</p> <p>Current electricity is described as movement of charges. It is a particularly useful form of energy because it can be easily transferred from place to place and readily transformed by various devices into other forms of energy (e.g., light, heat, sound, and motion). Electrical current (amperage) in a circuit is determined by the potential difference (voltage) of the power source and the resistance of the loads in the circuit.</p>	
<p>P4.10x Current Electricity — Ohm’s Law, Work, and Power</p> <p>In circuits, the relationship between electric current, I, electric potential difference, V, and resistance, R, is quantified by $V = IR$ (Ohm’s Law). Work is the amount of energy transferred during an interaction. In electrical systems, work is done when charges are moved through the circuit. Electric power is the amount of work done by an electric current in a unit of time, which can be calculated using $P = IV$.</p>	
<p>P4.10e Explain energy transfer in a circuit, using an electrical charge model.</p>	<p>Student Edition: 400-401, 403-405, 407, 409, 412</p> <p>Teacher Wraparound Edition: D 403</p>
<p>P4.10f Calculate the amount of work done when a charge moves through a potential difference, V.</p>	<p>Student Edition: 158-159</p> <p>Teacher Wraparound Edition: R 159</p> <p>See also Glencoe’s <i>Physics: Principles and Problems</i> © 2005.</p>
<p>P4.10g Compare the currents, voltages, and power in parallel and series circuits.</p>	<p>Student Edition: 407-408</p> <p><i>Design Your Own Physics Lab</i> 414-415</p> <p>Teacher Wraparound Edition: LD 408; QD 409; TPK 407</p>
<p>P4.10h Explain how circuit breakers and fuses protect household appliances.</p>	<p>Student Edition: 409-410</p> <p>Teacher Wraparound Edition: MM 410</p>
<p>P4.10i Compare the energy used in one day by common household appliances (e.g., refrigerator, lamps, hair dryer, toaster, televisions, music players).</p>	<p>Student Edition: 135, 410, 412</p> <p><i>Applying Math</i> 411, 412</p> <p>Teacher Wraparound Edition: R 413</p>

STANDARDS	PAGE REFERENCES
<p>P4.10j Explain the difference between electric power and electric energy as used in bills from an electric company.</p>	<p>Student Edition: 410-413</p> <p>Teacher Wraparound Edition: R 413</p>
<p>P4.11x Heat, Temperature, and Efficiency</p> <p>Heat is often produced as a by-product during energy transformations. This energy is transferred into the surroundings and is not usually recoverable as a useful form of energy. The efficiency of systems is defined as the ratio of the useful energy output to the total energy input. The efficiency of natural and human-made systems varies due to the amount of heat that is not recovered as useful work.</p>	
<p>P4.11a Calculate the energy lost to surroundings when water in a home water heater is heated from room temperature to the temperature necessary to use in a dishwasher, given the efficiency of the home hot water heater.</p>	<p>Student Edition: 266-267, 275-277</p> <p>Teacher Wraparound Edition: FF 275</p>
<p>P4.11b Calculate the final temperature of two liquids (same or different materials) at the same or different temperatures and masses that are combined.</p>	<p>Student Edition: 259</p> <p>Teacher Wraparound Edition: CC 257</p>
<p>P4.12 Nuclear Reactions</p> <p>Changes in atomic nuclei can occur through three processes: fission, fusion, and radioactive decay. Fission and fusion can convert small amounts of matter into large amounts of energy. Fission is the splitting of a large nucleus into smaller nuclei at extremely high temperature and pressure. Fusion is the combination of smaller nuclei into a large nucleus and is responsible for the energy of the Sun and other stars. Radioactive decay occurs naturally in the Earth's crust (rocks, minerals) and can be used in technological applications (e.g., medical diagnosis and treatment).</p>	
<p>P4.12x Mass and Energy</p> <p>In nuclear reactions, a small amount of mass is converted to a large amount of energy, $E = mc^2$, where c is the speed of light in a vacuum. The amount of energy before and after nuclear reactions must consider mass changes as part of the energy transformation.</p>	
<p>P4.12d Identify the source of energy in fission and fusion nuclear reactions.</p>	<p>Student Edition: 801-802, 803</p> <p><i>Science and History</i> 810</p> <p>Teacher Wraparound Edition: FYI 803</p>

STANDARDS	PAGE REFERENCES
EARTH SCIENCE	
STANDARD E1: INQUIRY, REFLECTION, AND SOCIAL IMPLICATIONS	
<p><i>Students will understand the nature of science and demonstrate an ability to practice scientific reasoning by applying it to the design, execution, and evaluation of scientific investigations. Students will demonstrate their understanding that scientific knowledge is gathered through various forms of direct and indirect observations and the testing of this information by methods including, but not limited to, experimentation. They will be able to distinguish between types of scientific knowledge (e.g., hypotheses, laws, theories) and become aware of areas of active research in contrast to conclusions that are part of established scientific consensus. They will use their scientific knowledge to assess the costs, risks, and benefits of technological systems as they make personal choices and participate in public policy decisions. These insights will help them analyze the role science plays in society, technology, and potential career opportunities.</i></p>	
E1.1 Scientific Inquiry	
<p>Science is a way of understanding nature. Scientific research may begin by generating new scientific questions that can be answered through replicable scientific investigations that are logically developed and conducted systematically. Scientific conclusions and explanations result from careful analysis of empirical evidence and the use of logical reasoning. Some questions in science are addressed through indirect rather than direct observation, evaluating the consistency of new evidence with results predicted by models of natural processes. Results from investigations are communicated in reports that are scrutinized through a peer review process.</p>	
<p>E1.1f Predict what would happen if the variables, methods, or timing of an investigation were changed.</p>	<p>Student Edition: 6-10 <i>Communicating Your Data</i> 89 <i>Design Your Own Lab</i> 144-145, 344-345, 414-415, 540-541 <i>Lab</i> 300, 338, 445 Teacher Wraparound Edition: A 87, 523; AIL 118, 310, 541, 568</p>
<p>E1.1g Based on empirical evidence, explain and critique the reasoning used to draw a scientific conclusion or explanation.</p>	<p>Student Edition: <i>Design Your Own Lab</i> 28-29, 88-89, 144-145, 242-243, 344-345, 414-415, 446-447, 540-541, 568-569 <i>Lab</i> 87, 118-119, 134, 278-279, 507, 742-743</p>
<p>E1.1h Design and conduct a systematic scientific investigation that tests a hypothesis. Draw conclusions from data presented in charts or tables.</p>	<p>Student Edition: <i>Design Your Own Lab</i> 28-29, 88-89, 144-145, 242-243, 344-345, 414-415, 446-447, 540-541, 568-569 <i>Lab</i> 87, 278-279, 507 Teacher Wraparound Edition: A 13; ACT 9; R 13</p>

STANDARDS	PAGE REFERENCES
<p>E1.1i Distinguish between scientific explanations that are regarded as current scientific consensus and the emerging questions that active researchers investigate.</p>	<p>Student Edition: 218-222, 226-229, 238-241, 354-361, 500, 836-839 <i>Integrate Chemistry</i> 228 <i>Science and Society</i> 178 Teacher Wraparound Edition: SCB 816E; VL 227</p>
<p>E1.2 Scientific Reflection and Social Implications The integrity of the scientific process depends on scientists and citizens understanding and respecting the “Nature of Science.” Openness to new ideas, skepticism, and honesty are attributes required for good scientific practice. Scientists must use logical reasoning during investigation design, analysis, conclusion, and communication. Science can produce critical insights on societal problems from a personal and local scale to a global scale. Science both aids in the development of technology and provides tools for assessing the costs, risks, and benefits of technological systems. Scientific conclusions and arguments play a role in personal choice and public policy decisions. New technology and scientific discoveries have had a major influence in shaping human history. Science and technology continue to offer diverse and significant career opportunities.</p>	
<p>E1.2f Critique solutions to problems, given criteria and scientific constraints.</p>	<p>Student Edition: <i>Design Your Own Lab</i> 344-345 <i>Model and Invent Lab</i> 58-59, 176-177 Teacher Wraparound Edition: IL 274; MM 56; UP 67, 389</p>
<p>E1.2g Identify scientific tradeoffs in design decisions and choose among alternative solutions.</p>	<p>Student Edition: 46-50 <i>Model and Invent Lab</i> 58-59 Teacher Wraparound Edition: AIL 508</p>
<p>E1.2h Describe the distinctions between scientific theories, laws, hypotheses, and observations.</p>	<p>Student Edition: 8-12 <i>Science Online</i> 12 <i>Science Skill Handbook</i> 850-855 Teacher Wraparound Edition: FF 8; TT 4F</p>
<p>E1.2i Explain the progression of ideas and explanations that lead to science theories that are part of the current scientific consensus or core knowledge.</p>	<p>Student Edition: 7-12, 204-207, 218-221, 836-839 <i>National Geographic</i> 582 Teacher Wraparound Edition: CFU 839; DIS 8; IL 12</p>

STANDARDS	PAGE REFERENCES
<p>E1.2j Apply science principles or scientific data to anticipate effects of technological design decisions.</p>	<p>Student Edition: <i>Applying Science</i> 49 <i>Integrate Environment</i> 667 <i>MiniLAB</i> 47 <i>Science Online</i> 45 <i>Use the Internet Lab</i> 508-509 Teacher Wraparound Edition: A 45; DI 44; PR 50, 500</p>
<p>E1.2k Analyze how science and society interact from a historical, political, economic, or social perspective.</p>	<p>Student Edition: 38-45, 46-50, 52-57, 63 #25, #27, 65 #12 <i>National Geographic</i> 44 <i>Science and History</i> 120, 312, 448 <i>Science and Society</i> 178, 510 Teacher Wraparound Edition: CD 187; TFYI 53</p>
<p>STANDARD E2: EARTH SYSTEMS</p>	
<p><i>Students describe the interactions within and between Earth systems. Students will explain how both fluids (water cycle) and solids (rock cycle) move within Earth systems and how these movements form and change their environment. They will describe the relationship between physical process and human activities and use this understanding to demonstrate an ability to make wise decisions about land use.</i></p>	
<p>E2.1 Earth Systems Overview</p> <p>The Earth is a system consisting of four major interacting components: geosphere (crust, mantle, and core), atmosphere (air), hydrosphere (water), and biosphere (the living part of Earth). Physical, chemical, and biological processes act within and among the four components on a wide range of time scales to continuously change Earth's crust, oceans, atmosphere, and living organisms. Earth elements move within and between the lithosphere, atmosphere, hydrosphere, and biosphere as part of geochemical cycles.</p>	

STANDARDS	PAGE REFERENCES
<p>E2.2 Energy in Earth Systems</p> <p>Energy in Earth systems can exist in a number of forms (e.g., thermal energy as heat in the Earth, chemical energy stored as fossil fuels, mechanical energy as delivered by tides) and can be transformed from one state to another and move from one reservoir to another. Movement of matter and its component elements, through and between Earth's systems, is driven by Earth's internal (radioactive decay and gravity) and external (Sun as primary) sources of energy. Thermal energy is transferred by radiation, convection, and conduction. Fossil fuels are derived from plants and animals of the past, are nonrenewable, and, therefore, are limited in availability. All sources of energy for human consumption (e.g., solar, wind, nuclear, ethanol, hydrogen, geothermal, hydroelectric) have advantages and disadvantages.</p>	
<p>E2.2e Explain how energy changes form through Earth systems.</p>	<p>Student Edition: 269, 288-293, 361, 362-366, 486-493, 501-506 <i>Lab 507</i> <i>Launch Lab 485</i> <i>MiniLAB 502</i> <i>National Geographic 268</i></p> <p>Teacher Wraparound Edition: AIL 278; CB 280; IL 274; SCB 516E; SJ 139</p>
<p>E2.2f Explain how elements exist in different compounds and states as they move from one reservoir to another.</p>	<p>Student Edition: 373-378, 521-522, 536-538, 608-615, 617-623, 630-635 <i>Integrate Life Science 522</i> <i>MiniLAB 628</i> <i>National Geographic 633</i></p> <p>Teacher Wraparound Edition: ACT 570; CFU 522; DIS 570, 634; SCB 606E; VL 536</p>
<p>E2.3 Biogeochemical Cycles</p> <p>The Earth is a system containing essentially a fixed amount of each stable chemical atom or element. Most elements can exist in several different states and chemical forms; they move within and between the geosphere, atmosphere, hydrosphere, and biosphere as part of the Earth system. The movements can be slow or rapid. Elements and compounds have significant impacts on the biosphere and have important impacts on human health.</p>	
<p>E2.3b Explain why small amounts of some chemical forms may be beneficial for life but are poisonous in large quantities (e.g., dead zone in the Gulf of Mexico, Lake Nyos in Africa, fluoride in drinking water).</p>	<p>Teacher Wraparound Edition: IE 466</p>
<p>E2.3c Explain how the nitrogen cycle is part of the Earth system.</p>	<p>Teacher Wraparound Edition: ACT 570</p>

STANDARDS	PAGE REFERENCES
<p>E2.3d Explain how carbon moves through the Earth system (including the geosphere) and how it may benefit (e.g., improve soils for agriculture) or harm (e.g., act as a pollutant) society.</p>	<p>Student Edition: 492, 518-519, 536-538, 545 #28 <i>Applying Math</i> 537 <i>Lab</i> 51</p> <p>Teacher Wraparound Edition: A 51, 539; FF 538; LD 537; PR 539; VL 536</p>
<p>E2.4 Resources and Human Impacts on Earth Systems</p> <p>The Earth provides resources (including minerals) that are used to sustain human affairs. The supply of nonrenewable natural resources is limited and their extraction and use can release elements and compounds into Earth systems. They affect air and water quality, ecosystems, landscapes, and may have effects on long-term climate. Plans for land use and long-term development must include an understanding of the interactions between Earth systems and human activities.</p>	
<p>E2.4c Explain ozone depletion in the stratosphere and methods to slow human activities to reduce ozone depletion.</p>	<p>Student Edition 466, 538, 545 #23</p> <p>Teacher Wraparound Edition: PR 467, 539; RS 466; VL 538</p>
<p>E2.4d Describe the life cycle of a product, including the resources, production, packaging, transportation, disposal, and pollution.</p>	<p>See Glencoe's <i>Earth Science</i> © 2005.</p>
<p>STANDARD E3: THE SOLID EARTH</p> <p><i>Students explain how scientists study and model the interior of the Earth and its dynamic nature. They use the theory of plate tectonics, the unifying theory of geology, to explain a wide variety of Earth features and processes and how hazards resulting from these processes impact society.</i></p>	
<p>E3.p1 Landforms and Soils (prerequisite)</p> <p>Landforms are the result of a combination of constructive and destructive forces. Constructive forces include crustal deformation, volcanic eruptions, and deposition of sediments transported in rivers, streams, and lakes through watersheds. Destructive forces include weathering and erosion. The weathering of rocks and decomposed organic matter result in the formation of soils. (prerequisite)</p>	
<p>E3.p2 Rocks and Minerals (prerequisite)</p> <p>Igneous, metamorphic, and sedimentary rocks are constantly forming and changing through various processes. As they do so, elements move through the geosphere. In addition to other geologic features, rocks and minerals are indicators of geologic and environmental conditions that existed in the past. (prerequisite)</p>	
<p>E3.p3 Basic Plate Tectonics (prerequisite)</p> <p>Early evidence for the movement of continents was based on the similarities of coastlines, geology, faunal distributions, and paleoclimatological data across the Atlantic and Indian Oceans. In the 1960s, additional evidence from marine geophysical surveys, seismology, volcanology, and paleomagnetism resulted in the development of the theory of plate tectonics. (prerequisite)</p>	

STANDARDS	PAGE REFERENCES
<p>E3.1 Advanced Rock Cycle</p> <p>Igneous, metamorphic, and sedimentary rocks are indicators of geologic and environmental conditions and processes that existed in the past. These include cooling and crystallization, weathering and erosion, sedimentation and lithification, and metamorphism. In some way, all of these processes are influenced by plate tectonics, and some are influenced by climate.</p>	
<p>E3.1c Explain how the size and shape of grains in a sedimentary rock indicate the environment of formation (including climate) and deposition.</p>	<p>Student Edition: 624-629 <i>Integrate Chemistry</i> 627 <i>Lab</i> 636-637 <i>MiniLAB</i> 628</p> <p>Teacher Wraparound Edition: ACT 626; DI 626; LD 627; PR 629; QD 625, 626; R 629; RS 628; SCB 606F</p>
<p>E3.1d Explain how the crystal sizes of igneous rocks indicate the rate of cooling and whether the rock is extrusive or intrusive.</p>	<p>Student Edition: 617-623 <i>Applying Math</i> 621 <i>Lab</i> 636-637 <i>Science Online</i> 622</p> <p>Teacher Wraparound Edition: CFU 623; PR 623; QD 619, 621; R 623; SCB 606E; SJ 622</p>
<p>E3.1e Explain how the texture (foliated, nonfoliated) of metamorphic rock can indicate whether it has experienced regional or contact metamorphism.</p>	<p>Student Edition: 630-635 <i>National Geographic</i> 633 <i>Lab</i> 636-637</p> <p>Teacher Wraparound Edition: DI 631; DIS 631; QD 631; SCB 606E; TFYI 632</p>
<p>E3.2 Interior of the Earth</p> <p>The Earth can also be subdivided into concentric layers based on their physical characteristics: (lithosphere, asthenosphere, lower mantle, outer core, and inner core). The crust and upper mantle compose the rigid lithosphere (plates) that moves over a “softer” asthenosphere (part of the upper mantle). The magnetic field of the Earth is generated in the outer core. The interior of the Earth cannot be directly sampled and must be modeled using data from seismology.</p>	
<p>E3.2d Explain the uncertainties associated with models of the interior of the Earth and how these models are validated.</p>	<p>Student Edition: 370-372 <i>Science Online</i> 293</p> <p>Teacher Wraparound Edition: DIS 371; PR 372; QD 371; SCB 352F</p>

STANDARDS	PAGE REFERENCES
<p>E3.3 Plate Tectonics Theory</p> <p>The Earth's crust and upper mantle make up the lithosphere, which is broken into large mobile pieces called tectonic plates. The plates move at velocities in units of centimeters per year as measured using the global positioning system (GPS). Motion histories are determined with calculations that relate rate, time, and distance of offset geologic features. Oceanic plates are created at mid-ocean ridges by magmatic activity and cooled until they sink back into the Earth at subduction zones. At some localities, plates slide by each other. Mountain belts are formed both by continental collision and as a result of subduction. The outward flow of heat from Earth's interior provides the driving energy for plate tectonics.</p>	
<p>E3.3d Distinguish plate boundaries by the pattern of depth and magnitude of earthquakes.</p>	<p>Student Edition: 293, 362-369, 385 #17, 387 #18 <i>Lab</i> 380-381 <i>Science Online</i> 359</p> <p>Teacher Wraparound Edition: A 293; IES 292; PR 369; SCB 352E</p>
<p>E3.4 Earthquakes and Volcanoes</p> <p>Plate motions result in potentially catastrophic events (earthquakes, volcanoes, tsunamis, mass wasting) that affect humanity. The intensity of volcanic eruptions is controlled by the chemistry and properties of the magma. Earthquakes are the result of abrupt movements of the Earth. They generate energy in the form of body and surface waves.</p>	
<p>E3.4d Explain how the chemical composition of magmas relates to plate tectonics and affects the geometry, structure, and explosivity of volcanoes.</p>	<p>Student Edition: 373-378 <i>MiniLAB</i> 375 <i>Science Online</i> 374</p> <p>Teacher Wraparound Edition: LD 376; PR 377; QD 374; R 378; RS 376; SCB 352F; TFYI 374</p>
<p>E3.4e Explain how volcanoes change the atmosphere, hydrosphere, and other Earth systems.</p>	<p>Student Edition: 373-378, 536 <i>Integrate History</i> 377 <i>Science and History</i> 382 <i>Science Online</i> 376</p> <p>Teacher Wraparound Edition: CB 382; CC 130; DIS 375; HS 382; UP 251</p>
<p>E3.4f Explain why fences are offset after an earthquake, using the elastic rebound theory.</p>	<p>Student Edition: 364-366*</p> <p>*These page references show offset electric poles following an earthquake, not fences; elastic rebound theory is implied without being mentioned by name.</p>

STANDARDS

PAGE REFERENCES

STANDARD E4: THE FLUID EARTH

Students explain how the ocean and atmosphere move and transfer energy around the planet. They also explain how these movements affect climate and weather and how severe weather impacts society. Students explain how long term climatic changes (glaciers) have shaped the Michigan landscape. They also explain features and processes related to surface and ground-water and describe the sustainability of systems in terms of water quality and quantity.

E4.p1 Water Cycle (prerequisite)

Water circulates through the crust and atmosphere and in oceans, rivers, glaciers, and ice caps and connects all of the Earth systems. Groundwater is a significant reservoir and source of freshwater on Earth. The recharge and movement of groundwater depends on porosity, permeability, and the shape of the water table. The movement of groundwater occurs over a long period time. Groundwater and surface water are often interconnected. *(prerequisite)*

E4.p2 Weather and the Atmosphere (prerequisite)

The atmosphere is divided into layers defined by temperature. Clouds are indicators of weather. *(prerequisite)*

E4.p3 Glaciers (prerequisite)

Glaciers are large bodies of ice that move under the influence of gravity. They form part of both the rock and water cycles. Glaciers and ice sheets have shaped the landscape of the Great Lakes region. Areas that have been occupied by ice sheets are depressed. When the ice sheet is removed, the region rebounds (see also climate change). *(prerequisite)*

E4.1 Hydrogeology

Fresh water moves over time between the atmosphere, hydrosphere (surface water, wetlands, rivers, and glaciers), and geosphere (groundwater). Water resources are both critical to and greatly impacted by humans. Changes in water systems will impact quality, quantity, and movement of water. Natural surface water processes shape the landscape everywhere and are affected by human land use decisions.

E4.2 Oceans and Climate

Energy from the sun and the rotation of the Earth control global atmospheric circulation. Oceans redistribute matter and energy around the Earth through currents, waves, and interaction with other Earth systems. Ocean currents are controlled by prevailing winds, changes in water density, ocean topography, and the shape and location of landmasses. Oceans and large lakes (e.g., Great Lakes) have a major effect on climate and weather because they are a source of moisture and a large reservoir of heat. Interactions between oceanic circulation and the atmosphere can affect regional climates throughout the world.

E4.2c Explain the dynamics (including ocean-atmosphere interactions) of the El Niño-Southern Oscillation (ENSO) and its effect on continental climates.

Student Edition:
539, 545 #31

E4.2d Identify factors affecting seawater density and salinity and describe how density affects oceanic layering and currents.

See Glencoe's *Earth Science* © 2005.

STANDARDS		PAGE REFERENCES
E4.2e	Explain the differences between maritime and continental climates with regard to oceanic currents.	Student Edition: 532-534 <i>Integrate Earth Science</i> 258 <i>National Geographic</i> 531 Teacher Wraparound Edition: AIL 278; DIS 532; RS 532; SCB 516E
E4.2f	Explain how the Coriolis effect controls oceanic circulation.	Student Edition: 525* <i>MiniLAB</i> 525 *This page reference explains how the Coriolis effect controls the movement of wind. Also see Glencoe's <i>Earth Science</i> © 2005 for discussion of the Coriolis effect and ocean circulation.
E4.3 Severe Weather Tornadoes, hurricanes, blizzards, and thunderstorms are severe weather phenomena that impact society and ecosystems. Hazards include downbursts (wind shear), strong winds, hail, lightning, heavy rain, and flooding. The movement of air in the atmosphere is due to differences in air density resulting from variations in temperature. Many weather conditions can be explained by fronts that occur when air masses meet.		
E4.3g	Explain the process of adiabatic cooling and adiabatic temperature changes to the formation of clouds.	Student Edition: 520-521* *These page references meet the standard without using the term <i>adiabatic</i> . Teacher Wraparound Edition: AIL 278
STANDARD E5: THE EARTH IN SPACE AND TIME <i>Students explain theories about how the Earth and universe formed and evolved over a long period of time. Students predict how human activities may influence the climate of the future.</i>		
E5.p1 Sky Observations (prerequisite) Common sky observations (such as lunar phases) can be explained by the motion of solar system objects in regular and predictable patterns. Our galaxy, observable as the Milky Way, is composed of billions of stars, some of which have planetary systems. Seasons are a result of the tilt of the rotation axis of the Earth. The motions of the moon and sun affect the phases of the moon and ocean tides. (<i>prerequisite</i>)		

STANDARDS	PAGE REFERENCES
<p>E5.1 The Earth in Space</p> <p>Scientific evidence indicates the universe is orderly in structure, finite, and contains all matter and energy. Information from the entire light spectrum tells us about the composition and motion of objects in the universe. Early in the history of the universe, matter clumped together by gravitational attraction to form stars and galaxies. According to the Big Bang theory, the universe has been continually expanding at an increasing rate since its formation about 13.7 billion years ago.</p>	
<p>E5.1b Describe how the Big Bang theory accounts for the formation of the universe.</p>	<p>Student Edition: 836-839</p>
<p>E5.1c Explain how observations of the cosmic microwave background have helped determine the age of the universe.</p>	<p>Student Edition: 837</p>
<p>E5.1d Differentiate between the cosmological and Doppler red shift.</p>	<p>Student Edition: 323-324, 836-839 <i>Integrate Astronomy</i> 324 <i>Model and Invent Lab</i> 840-841 Teacher Wraparound Edition: A 839; FF 837; PR 326; QD 324, 838; R 839; RS 837</p>
<p>E5.2 The Sun</p> <p>Stars, including the Sun, transform matter into energy in nuclear reactions. When hydrogen nuclei fuse to form helium, a small amount of matter is converted to energy. Solar energy is responsible for life processes and weather as well as phenomena on Earth. These and other processes in stars have led to the formation of all the other chemical elements.</p>	
<p>E5.2x Stellar Evolution</p> <p>Stars, including the Sun, transform matter into energy in nuclear reactions. When hydrogen nuclei fuse to form helium, a small amount of matter is converted to energy. These and other processes in stars have led to the formation of all the other chemical elements. There is a wide range of stellar objects of different sizes and temperatures. Stars have varying life histories based on these parameters.</p>	
<p>E5.2e Explain how the Hertzsprung-Russell (H-R) diagram can be used to deduce other parameters (distance).</p>	<p>Student Edition: 823-829 <i>Lab</i> 830 <i>National Geographic</i> 826 Teacher Wraparound Edition: SJ 824; V 826; VL 824</p>
<p>E5.2f Explain how you can infer the temperature, life span, and mass of a star from its color. Use the H-R diagram to explain the life cycles of stars.</p>	<p>Student Edition: 823-829 <i>National Geographic</i> 826 Teacher Wraparound Edition: CFU 829; SJ 824; TPK 823; V 826</p>

STANDARDS		PAGE REFERENCES	
E5.2g	Explain how the balance between fusion and gravity controls the evolution of a star (equilibrium).	Student Edition: 824-825	Teacher Wraparound Edition: PR 839
E5.2h	Compare the evolution paths of low-, moderate-, and high-mass stars using the H-R diagram.	Student Edition: 823-829, 847 #17	Teacher Wraparound Edition: DI 826; DIS 825; RS 825; SJ 824
<p>E5.3 Earth History and Geologic Time</p> <p>The solar system formed from a nebular cloud of dust and gas 4.6 Ga (billion years ago). The Earth has changed through time and has been affected by both catastrophic (e.g., earthquakes, meteorite impacts, volcanoes) and gradual geologic events (e.g., plate movements, mountain building) as well as the effects of biological evolution (formation of an oxygen atmosphere). Geologic time can be determined through both relative and absolute dating.</p>			
<p>E5.3x Geologic Dating</p> <p>Early methods of determining geologic time, such as the use of index fossils and stratigraphic principles, allowed for the relative dating of geological events. However, absolute dating was impossible until the discovery that certain radioactive isotopes in rocks have known decay rates, making it possible to determine how many years ago a given mineral or rock formed. Different kinds of radiometric dating techniques exist. Technique selection depends on the composition of the material to be dated, the age of the material, and the type of geologic event that affected the material.</p>			
E5.3e	Determine the approximate age of a sample, when given the half-life of a radioactive substance (in graph or tabular form) along with the ratio of daughter to parent substances present in the sample.	Student Edition: 672-673, 683 #10, 794, 815 #9 <i>Applying Math</i> 681, 795, 798, 813 <i>Applying Science</i> 586, 675	Teacher Wraparound Edition: DI 794
E5.3f	Explain why C-14 can be used to date a 40,000 year old tree, but U-Pb cannot.	Student Edition: 673, 681 #25, 794-795 <i>Applying Science</i> 586 <i>Integrate Life Science</i> 586	
E5.3g	Identify a sequence of geologic events using relative-age dating principles.	Student Edition: 669-675 <i>Lab</i> 676-677	Teacher Wraparound Edition: A 677; AIL 677; MM 674; SCB 644F; VL 671, 674

STANDARDS	PAGE REFERENCES
<p>E5.4 Climate Change</p> <p>Atmospheric gases trap solar energy that has been reradiated from the Earth's surface (the greenhouse effect). The Earth's climate has changed both gradually and catastrophically over geological and historical time frames due to complex interactions between many natural variables and events. The concentration of greenhouse gases (especially carbon dioxide) has increased due to human industrialization, which has contributed to a rise in average global atmospheric temperatures and changes in the biosphere, atmosphere, and hydrosphere. Climates of the past are researched, usually using indirect indicators, to better understand and predict climate change.</p>	
<p>E5.4e Based on evidence from historical climate research (e.g. fossils, varves, ice core data) and climate change models, explain how the current melting of polar ice caps can impact the climatic system.</p>	<p>Student Edition: <i>Research Report</i> 600</p> <p>Teacher Wraparound Edition: SCB 561F</p>
<p>E5.4f Describe geologic evidence that implies climates were significantly colder at times in the geologic record (e.g., geomorphology, striations, and fossils).</p>	<p>Student Edition: 535 <i>Science and History</i> 600</p> <p>Teacher Wraparound Edition: CC 658; SCB 516F</p>
<p>E5.4g Compare and contrast the heat-trapping mechanisms of the major greenhouse gases resulting from emissions (carbon dioxide, methane, nitrous oxide, fluorocarbons) as well as their abundance and heat-trapping capacity.</p>	<p>Student Edition: 536-538 <i>Applying Math</i> 537 <i>Lab</i> 51</p> <p>Teacher Wraparound Edition: A 51; LD 537</p>

STANDARDS	PAGE REFERENCES
CHEMISTRY	
STANDARD B1: INQUIRY, REFLECTION, AND SOCIAL IMPLICATIONS	
<p>Students will understand the nature of science and demonstrate an ability to practice scientific reasoning by applying it to the design, execution, and evaluation of scientific investigations. Students will demonstrate their understanding that scientific knowledge is gathered through various forms of direct and indirect observations and the testing of this information by methods including, but not limited to, experimentation. They will be able to distinguish between types of scientific knowledge (e.g., hypotheses, laws, theories) and become aware of areas of active research in contrast to conclusions that are part of established scientific consensus. They will use their scientific knowledge to assess the costs, risks, and benefits of technological systems as they make personal choices and participate in public policy decisions. These insights will help them analyze the role science plays in society, technology, and potential career opportunities.</p>	
C1.1 Scientific Inquiry	
<p>Science is a way of understanding nature. Scientific research may begin by generating new scientific questions that can be answered through replicable scientific investigations that are logically developed and conducted systematically. Scientific conclusions and explanations result from careful analysis of empirical evidence and the use of logical reasoning. Some questions in science are addressed through indirect rather than direct observation, evaluating the consistency of new evidence with results predicted by models of natural processes. Results from investigations are communicated in reports that are scrutinized through a peer review process.</p>	
<p>C1.1f Predict what would happen if the variables, methods, or timing of an investigation were changed.</p>	<p>Student Edition: 8-10, 54-57 <i>Accidents in Science</i> 60, 210, 744 <i>Design Your Own Physics Lab</i> 88-89, 144-145, 540-541 <i>Model and Invent LAB</i> 176-177 <i>Science Skill Handbook</i> 854-858 Teacher Wraparound Edition: A 9; AIL 28, 88, 144</p>
<p>C1.1g Based on empirical evidence, explain and critique the reasoning used to draw a scientific conclusion or explanation</p>	<p>Student Edition: 6-10, 12-13 <i>Design Your Own LAB</i> 414-415, 568-569 <i>LAB</i> 196, 406 <i>Model and Invent LAB</i> 840-841 <i>Science and History</i> 146, 478 <i>Science and Society</i> 778 <i>Science Skill Handbook</i> 858 Teacher Wraparound Edition: DI 553; FYI 404; QD 10</p>

STANDARDS	PAGE REFERENCES
<p>C1.1h Design and conduct a systematic scientific investigation that tests a hypothesis. Draw conclusions from data presented in charts or tables.</p>	<p>Student Edition: 8-10 <i>Design Your Own Physics Lab</i> 28-29, 88-89, 144-145, 242-243, 344-345, 414-415, 540-541, 568-569 <i>Science Skill Handbook</i> 853-858</p> <p>Teacher Wraparound Edition: A 9; FF 8</p>
<p>C1.1i Distinguish between scientific explanations that are regarded as current scientific consensus and the emerging questions that active researchers investigate.</p>	<p>Student Edition: 823-825 <i>Applying Science</i> 49, 499 <i>National Geographic</i> 2-3, 548-549 <i>Science and History</i> 146, 600 <i>Science and Society</i> 178, 778</p> <p>Teacher Wraparound Edition: IM 827; FYI 82</p>
<p>C1.2 Scientific Reflection and Social Implications</p> <p>The integrity of the scientific process depends on scientists and citizens understanding and respecting the “Nature of Science.” Openness to new ideas, skepticism, and honesty are attributes required for good scientific practice. Scientists must use logical reasoning during investigation design, analysis, conclusion, and communication. Science can produce critical insights on societal problems from a personal and local scale to a global scale. Science both aids in the development of technology and provides tools for assessing the costs, risks, and benefits of technological systems. Scientific conclusions and arguments play a role in personal choice and public policy decisions. New technology and scientific discoveries have had a major influence in shaping human history. Science and technology continue to offer diverse and significant career opportunities.</p>	
<p>C1.2f Critique solutions to problems, given criteria and scientific constraints.</p>	<p>Student Edition: 10, 54-57 <i>Design Your Own LAB</i> 88-89 <i>LAB</i> 51, 112, 118-119, 134 <i>Model and Invent LAB</i> 58-59 <i>Science Skill Handbook</i> 857-858</p> <p>Teacher Wraparound Edition: A 48; CYD 59</p>
<p>C1.2g Identify scientific tradeoffs in design decisions and choose among alternative solutions.</p>	<p>Student Edition: 10, 54-57 <i>Accidents in Science</i> 210 <i>Science Skill Handbook</i> 858</p> <p>Teacher Wraparound Edition: DI 10; SJ 11</p>

STANDARDS	PAGE REFERENCES
<p>C1.2h Describe the distinctions between scientific theories, laws, hypotheses, and observations.</p>	<p>Student Edition: 8-10, 12, 98-103, 105, 113-117, 199-202, 721-722 <i>Science and History</i> 120 <i>Science Skill Handbook</i> 853-854 Teacher Wraparound Edition: IL 12; QD 102; SJ 11, 114</p>
<p>C1.2i Explain the progression of ideas and explanations that lead to science theories that are part of the current scientific consensus or core knowledge.</p>	<p>Student Edition: 400-405, 438-440, 581-583, 592-594, 721-722, 823-825, 836-839 <i>National Geographic</i> 441, 582 <i>Science and History</i> 120, 478, 810 Teacher Wraparound Edition: DI 592; FYI 787; QD 440; SJ 824; UA 722</p>
<p>C1.2j Apply science principles or scientific data to anticipate effects of technological design decisions.</p>	<p>Student Edition: 42-45, 46-50, 54-57, 162-165, 275-277, 409-413 <i>Design Your Own Physics Lab</i> 414-415 <i>Integrate Physics</i> 416 <i>MiniLAB</i> 47 <i>Model and Invent LAB</i> 176-177 <i>National Geographic</i> 44 Teacher Wraparound Edition: FYI 48, 164; IL 54; LD 170; TC 36</p>
<p>C1.2k Analyze how science and society interact from a historical, political, economic, or social perspective.</p>	<p>Student Edition: 11-13, 38-45, 46-50, 497-499 <i>Accidents in Science</i> 210 <i>LAB</i> 51 <i>National Geographic</i> 44 <i>Science and History</i> 120, 478, 810 <i>Science and Society</i> 510, 778 Teacher Wraparound Edition: CD 8; D 53; FYI 48; TC 36</p>

STANDARDS	PAGE REFERENCES
<p>STANDARD C2: FORMS OF ENERGY</p>	
<p><i>Students recognize the many forms of energy and understand that energy is central to predicting and explaining how and why chemical reactions occur. The chemical topics of bonding, gas behavior, kinetics, enthalpy, entropy, free energy, and nuclear stability are addressed in this standard.</i></p>	
<p><i>Chemistry students relate temperature to the average kinetic energy of the molecules and use the kinetic molecular theory to describe and explain the behavior of gases and the rates of chemical reactions. They understand nuclear stability in terms of reaching a state of minimum potential energy.</i></p>	
<p>P2.p1 Potential Energy (prerequisite)</p>	
<p>Three forms of potential energy are gravitational, elastic, and chemical. Objects can have elastic potential energy due to their compression or chemical potential energy due to the arrangement of the atoms. (prerequisite)</p>	
<p>C2.1x Chemical Potential Energy</p>	
<p>Potential energy is stored whenever work must be done to change the distance between two objects. The attraction between the two objects may be gravitational, electrostatic, magnetic, or strong force. Chemical potential energy is the result of electrostatic attractions between atoms.</p>	
<p>C2.1a Explain the changes in potential energy (due to electrostatic interactions) as a chemical bond forms and use this to explain why bond breaking always requires energy.</p>	<p>Student Edition: 690-692, 694-702 <i>MiniLAB</i> 698 Teacher Wraparound Edition: DI 698; FF 691; FYI 696; UA 690</p>
<p>C2.1b Describe energy changes associated with chemical reactions in terms of bonds broken and formed (including intermolecular forces).</p>	<p>Student Edition: 720-722, 723-725, 734-740 Teacher Wraparound Edition: D 739; FYI 736</p>
<p>C2.1c Compare qualitatively the energy changes associated with melting various types of solids in terms of the types of forces between the particles in the solid.</p>	<p>Student Edition: 262-263, 696-702 Teacher Wraparound Edition: DI 698; FYI 696</p>
<p>C2.2 Molecules in Motion</p>	
<p>Molecules that compose matter are in constant motion (translational, rotational, vibrational). Energy may be transferred from one object to another during collisions between molecules.</p>	
<p>C2.2x Molecular Entropy</p>	
<p>As temperature increases, the average kinetic energy and the entropy of the molecules in a sample increases.</p>	
<p>C2.2c Explain changes in pressure, volume, and temperature for gases using the kinetic molecular model.</p>	<p>Student Edition: 260-262, 265 Teacher Wraparound Edition: AS 265; LD 261</p>

STANDARDS		PAGE REFERENCES	
C2.2d	Explain convection and the difference in transfer of thermal energy for solids, liquids, and gases using evidence that molecules are in constant motion.	Student Edition: 260-261, 267 <i>LAB 271</i> <i>National Geographic 268</i>	Teacher Wraparound Edition: LD 261; QD 268
C2.2e	Compare the entropy of solids, liquids, and gases.	Student Edition: 276-277	Teacher Wraparound Edition: FF 275; IH 273
C2.2f	Compare the average kinetic energy of the molecules in a metal object and a wood object at room temperature.	Student Edition: 257-258 <i>Applying Math 258</i>	Teacher Wraparound Edition: QD 258; TPK 254
<p>C2.3x Breaking Chemical Bonds For molecules to react, they must collide with enough energy (activation energy) to break old chemical bonds before their atoms can be rearranged to form new substances.</p>			
C2.3a	Explain how the rate of a given chemical reaction is dependent on the temperature and the activation energy.	Student Edition: 738-739 <i>LAB 742-743</i>	Teacher Wraparound Edition: RS 738
C2.3b	Draw and analyze a diagram to show the activation energy for an exothermic reaction that is very slow at room temperature.	Student Edition: 736-738	Teacher Wraparound Edition: LD 736

STANDARDS	PAGE REFERENCES
<p>C2.4x Electron Movement</p> <p>For each element, the arrangement of electrons surrounding the nucleus is unique. These electrons are found in different energy levels and can only move from a lower energy level (closer to nucleus) to a higher energy level (farther from nucleus) by absorbing energy in discrete packets. The energy content of the packets is directly proportional to the frequency of the radiation. These electron transitions will produce unique absorption spectra for each element. When the electron returns from an excited (high energy state) to a lower energy state, energy is emitted in only certain wavelengths of light, producing an emission spectra.</p>	
<p>C2.4a Describe energy changes in flame tests of common elements in terms of the (characteristic) electron transitions.</p>	<p>Student Edition: 592-593, 690-691</p> <p>Teacher Wraparound Edition: FF 691; IL 697</p> <p>This text does not extend to emission or absorption spectra. See Glencoe's <i>Physics: Principles and Problems</i> © 2005.</p>
<p>C2.4b Contrast the mechanism of energy changes and the appearance of absorption and emission spectra.</p>	<p>Student Edition: 592-593, 690-691</p> <p>Teacher Wraparound Edition: FF 691; IL 697</p> <p>This text does not describe emission or absorption spectra. See Glencoe's <i>Physics: Principles and Problems</i> © 2005.</p>
<p>C2.4c Explain why an atom can absorb only certain wavelengths of light.</p>	<p>Student Edition: 592-593, 690-691</p> <p>Teacher Wraparound Edition: FF 691; IL 697</p> <p>This text does not describe such absorption directly. See Glencoe's <i>Physics: Principles and Problems</i> © 2005.</p>
<p>C2.4d Compare various wavelengths of light (visible and nonvisible) in terms of frequency and relative energy.</p>	<p>Student Edition: 462-467</p> <p><i>MiniLAB</i> 463</p> <p>Teacher Wraparound Edition: QD 470; SJ 464</p>

STANDARDS	PAGE REFERENCES
<p>C2.5x Nuclear Stability</p> <p>Nuclear stability is related to a decrease in potential energy when the nucleus forms from protons and neutrons. If the neutron/proton ratio is unstable, the element will undergo radioactive decay. The rate of decay is characteristic of each isotope; the time for half the parent nuclei to decay is called the half-life. Comparison of the parent/daughter nuclei can be used to determine the age of a sample. Heavier elements are formed from the fusion of lighter elements in the stars.</p>	
<p>C2.5a Determine the age of materials using the ratio of stable and unstable isotopes of a particular type.</p>	<p>Student Edition: 672-673 <i>Applying Science</i> 586 <i>Integrate Life Science</i> 586</p> <p>Teacher Wraparound Edition: CB 673</p>
<p>STANDARD C3: ENERGY TRANSFER AND CONSERVATION</p> <p><i>Students apply the First and Second Laws of Thermodynamics to explain and predict most chemical phenomena.</i></p> <p><i>Chemistry students use the term enthalpy to describe the transfer of energy between reactants and products in simple calorimetry experiments performed in class and will recognize Hess's Law as an application of the conservation of energy.</i></p> <p><i>Students understand the tremendous energy released in nuclear reactions is a result of small amounts of matter being converted to energy.</i></p>	
<p>P3.p1 Conservation of Energy (prerequisite)</p> <p>When energy is transferred from one system to another, the quantity of energy before transfer equals the quantity of energy after transfer. (prerequisite)</p>	
<p>C3.1x Hess's Law</p> <p>For chemical reactions where the state and amounts of reactants and products are known, the amount of energy transferred will be the same regardless of the chemical pathway. This relationship is called Hess's law.</p>	
<p>C3.1a Calculate the ΔH for a given reaction using Hess's Law.</p>	<p>Student Edition: 734-738 This text does not discuss enthalpy, H. See Glencoe's <i>Chemistry: Matter and Change</i> © 2005.</p>
<p>C3.1b Draw enthalpy diagrams for exothermic and endothermic reactions.</p>	<p>Student Edition: 734-738 This text does not discuss enthalpy, H. See Glencoe's <i>Chemistry: Matter and Change</i> © 2005.</p>
<p>C3.1c Calculate the ΔH for a chemical reaction using simple coffee cup calorimetry.</p>	<p>Student Edition: 734-738 This text does not discuss enthalpy, H. See Glencoe's <i>Chemistry: Matter and Change</i> © 2005.</p>
<p>C3.1d Calculate the amount of heat produced for a given mass of reactant from a balanced chemical equation.</p>	<p>See Glencoe's <i>Chemistry: Matter and Change</i> © 2005.</p>

STANDARDS		PAGE REFERENCES
P3.p2 Energy Transfer (prerequisite)		
Nuclear reactions take place in the sun. In plants, light from the sun is transferred to oxygen and carbon compounds, which, in combination, have chemical potential energy (photosynthesis). (prerequisite)		
C3.2x Enthalpy		
Chemical reactions involve breaking bonds in reactants (endothermic) and forming new bonds in the products (exothermic). The enthalpy change for a chemical reaction will depend on the relative strengths of the bonds in the reactants and products.		
C3.2a	Describe the energy changes in photosynthesis and in the combustion of sugar in terms of bond breaking and bond making.	Teacher Wraparound Edition: TPK 734 Also see Glencoe's <i>Chemistry: Matter and Change</i> © 2005.
C3.2b	Describe the relative strength of single, double, and triple covalent bonds between nitrogen atoms.	Student Edition: 697 Also see Glencoe's <i>Chemistry: Matter and Change</i> © 2005.
C3.3 Heating Impacts		
Heating increases the kinetic (translational, rotational, and vibrational) energy of the atoms composing elements and the molecules or ions composing compounds. As the kinetic (translational) energy of the atoms, molecules, or ions increases, the temperature of the matter increases. Heating a sample of a crystalline solid increases the kinetic (vibrational) energy of the atoms, molecules, or ions. When the kinetic (vibrational) energy becomes great enough, the crystalline structure breaks down, and the solid melts.		
C3.3x Bond Energy		
Chemical bonds possess potential (vibrational and rotational) energy.		
C3.3c	Explain why it is necessary for a molecule to absorb energy in order to break a chemical bond.	Student Edition: 734-735 Teacher Wraparound Edition: D 739
C3.4 Endothermic and Exothermic Reactions		
Chemical interactions either release energy to the environment (exothermic) or absorb energy from the environment (endothermic).		
C3.4x Enthalpy and Entropy		
All chemical reactions involve rearrangement of the atoms. In an exothermic reaction, the products have less energy than the reactants. There are two natural driving forces: (1) toward minimum energy (enthalpy) and (2) toward maximum disorder (entropy).		
C3.4c	Write chemical equations including the heat term as a part of equation or using ΔH notation.	See Glencoe's <i>Chemistry: Matter and Change</i> © 2005.

STANDARDS		PAGE REFERENCES
C3.4d	Draw enthalpy diagrams for reactants and products in endothermic and exothermic reactions.	See Glencoe's <i>Chemistry: Matter and Change</i> © 2005.
C3.4e	Predict if a chemical reaction is spontaneous given the enthalpy (ΔH) and entropy (ΔS) changes for the reaction using Gibb's Free Energy, $\Delta G = \Delta H - T\Delta S$ (Note: mathematical computation of ΔG is not required.)	See Glencoe's <i>Chemistry: Matter and Change</i> © 2005.
C3.4f	Explain why some endothermic reactions are spontaneous at room temperature.	See Glencoe's <i>Chemistry: Matter and Change</i> © 2005.
C3.4g	Explain why gases are less soluble in warm water than cold water.	Student Edition: 763
	<p>C3.5x Mass Defect</p> <p>Nuclear reactions involve energy changes many times the magnitude of chemical changes. In chemical reactions matter is conserved, but in nuclear reactions a small loss in mass (mass defect) will account for the tremendous release of energy. The energy released in nuclear reactions can be calculated from the mass defect using $E = mc^2$.</p>	
C3.5a	Explain why matter is not conserved in nuclear reactions.	Student Edition: 141, 801-803 Teacher Wraparound Edition: CU 806
	<p>STANDARD C4: PROPERTIES OF MATTER</p> <p><i>Compounds, elements, and mixtures are categories used to organize matter. Students organize materials into these categories based on their chemical and physical behavior. Students understand the structure of the atom to make predictions about the physical and chemical properties of various elements and the types of compounds those elements will form. An understanding of the organization the Periodic Table in terms of the outer electron configuration is one of the most important tools for the chemist and student to use in prediction and explanation of the structure and behavior of atoms.</i></p> <p>P4.p1 Kinetic Molecular Theory (prerequisite)</p> <p>Properties of solids, liquids, and gases are explained by a model of matter that is composed of tiny particles in motion. (prerequisite)</p> <p>P4.p2 Elements, Compounds, and Mixtures (prerequisite)</p> <p>Elements are a class of substances composed of a single kind of atom. Compounds are composed of two or more different elements chemically combined. Mixtures are composed of two or more different elements and/or compounds physically combined. Each element and compound has physical and chemical properties, such as boiling point, density, color, and conductivity, which are independent of the amount of the sample. (prerequisite)</p>	

STANDARDS		PAGE REFERENCES
<p>C4.1x Molecular and Empirical Formulae Compounds have a fixed percent elemental composition. For a compound, the empirical formula can be calculated from the percent composition or the mass of each element. To determine the molecular formula from the empirical formula, the molar mass of the substance must also be known.</p>		
C4.1a	Calculate the percent by weight of each element in a compound based on the compound formula.	See Glencoe's <i>Chemistry: Matter and Change</i> © 2005.
C4.1b	Calculate the empirical formula of a compound based on the percent by weight of each element in the compound.	See Glencoe's <i>Chemistry: Matter and Change</i> © 2005.
C4.1c	Use the empirical formula and molecular weight of a compound to determine the molecular formula.	See Glencoe's <i>Chemistry: Matter and Change</i> © 2005.
<p>C4.2 Nomenclature All compounds have unique names that are determined systematically.</p>		
<p>C4.2x Nomenclature All molecular and ionic compounds have unique names that are determined systematically.</p>		
C4.2c	Given a formula, name the compound.	<p>Student Edition: 706-709 <i>Applying Science 706</i></p> <p>Teacher Wraparound Edition: A 706; DI 707; IM 704</p>
C4.2d	Given the name, write the formula of ionic and molecular compounds.	<p>Student Edition: 703-705 <i>Applying Math 705</i></p> <p>Teacher Wraparound Edition: A 705, 706; CU 709</p>
C4.2e	Given the formula for a simple hydrocarbon, draw and name the isomers.	See Glencoe's <i>Chemistry: Matter and Change</i> © 2005.
<p>C4.3 Properties of Substances Differences in the physical and chemical properties of substances are explained by the arrangement of the atoms, ions, or molecules of the substances and by the strength of the forces of attraction between the atoms, ions, or molecules.</p>		

STANDARDS		PAGE REFERENCES
C4.3x Solids		
Solids can be classified as metallic, ionic, covalent, or network covalent. These different types of solids have different properties that depend on the particles and forces found in the solid.		
C4.3c	Compare the relative strengths of forces between molecules based on the melting point and boiling point of the substances.	Student Edition: 700-702 Teacher Wraparound Edition: CU 702
C4.3d	Compare the strength of the forces of attraction between molecules of different elements. (For example, at room temperature, chlorine is a gas and iodine is a solid.)	Student Edition: 592-593, 595-596 Teacher Wraparound Edition: DI 593
C4.3e	Predict whether the forces of attraction in a solid are primarily metallic, covalent, network covalent, or ionic based upon the elements' location on the periodic table.	Student Edition: 590-591, 595-596, 703-704 Teacher Wraparound Edition: FYI 590
C4.3f	Identify the elements necessary for hydrogen bonding (N, O, F).	See Glencoe's <i>Chemistry: Matter and Change</i> © 2005.
C4.3g	Given the structural formula of a compound, indicate all the intermolecular forces present (dispersion, dipolar, hydrogen bonding).	Student Edition: 697-700 <i>National Geographic</i> 699 Teacher Wraparound Edition: FYI 696
C4.3h	Explain properties of various solids such as malleability, conductivity, and melting point in terms of the solid's structure and bonding.	Student Edition: 610-611 Teacher Wraparound Edition: A 610
C4.3i	Explain why ionic solids have higher melting points than covalent solids. (For example, NaF has a melting point of 995°C, while water has a melting point of 0° C.)	Student Edition: 700-702 Teacher Wraparound Edition: CU 702
C4.4x Molecular Polarity		
The forces between molecules depend on the net polarity of the molecule as determined by shape of the molecule and the polarity of the bonds.		
C4.4a	Explain why at room temperature different compounds can exist in different phases.	Student Edition: 700-701 Teacher Wraparound Edition: CU 702

STANDARDS		PAGE REFERENCES
C4.4b	Identify if a molecule is polar or nonpolar given a structural formula for the compound.	Student Edition: 697-700 Teacher Wraparound Edition: UA 700
C4.5x Ideal Gas Law The forces in gases are explained by the ideal gas law.		
C4.5a	Provide macroscopic examples, atomic and molecular explanations, and mathematical representations (graphs and equations) for the pressure-volume relationship in gases.	See Glencoe's <i>Chemistry: Matter and Change</i> © 2005.
C4.5b	Provide macroscopic examples, atomic and molecular explanations, and mathematical representations (graphs and equations) for the pressure-temperature relationship in gases.	See Glencoe's <i>Chemistry: Matter and Change</i> © 2005.
C4.5c	Provide macroscopic examples, atomic and molecular explanations, and mathematical representations (graphs and equations) for the temperature-volume relationship in gases.	Student Edition: 265 Also see Glencoe's <i>Chemistry: Matter and Change</i> © 2005.
C4.6x Moles The mole is the standard unit for counting atomic and molecular particles in terms of common mass units.		
C4.6a	Calculate the number of moles of any compound or element given the mass of the substance.	See Glencoe's <i>Chemistry: Matter and Change</i> © 2005.
C4.6b	Calculate the number of particles of any compound or element given the mass of the substance.	See Glencoe's <i>Chemistry: Matter and Change</i> © 2005.
C4.7x Solutions The physical properties of a solution are determined by the concentration of solute.		
C4.7a	Investigate the difference in the boiling point or freezing point of pure water and a salt solution.	See Glencoe's <i>Chemistry: Matter and Change</i> © 2005.
C4.7b	Compare the density of pure water to that of a sugar solution.	Student Edition: 19-20 Also see Glencoe's <i>Chemistry: Matter and Change</i> © 2005.

STANDARDS		PAGE REFERENCES
<p>C4.8 Atomic Structure</p> <p>Electrons, protons, and neutrons are parts of the atom and have measurable properties, including mass and, in the case of protons and electrons, charge. The nuclei of atoms are composed of protons and neutrons. A kind of force that is only evident at nuclear distances holds the particles of the nucleus together against the electrical repulsion between the protons.</p>		
<p>C4.8x Electron Configuration</p> <p>Electrons are arranged in main energy levels with sublevels that specify particular shapes and geometry. Orbitals represent a region of space in which an electron may be found with a high level of probability. Each defined orbital can hold two electrons, each with a specific spin orientation. The specific assignment of an electron to an orbital is determined by a set of 4 quantum numbers. Each element and, therefore, each position in the periodic table is defined by a unique set of quantum numbers.</p>		
C4.8e	Write the complete electron configuration of elements in the first four rows of the periodic table.	<p>Student Edition: 590-591, 592-594</p> <p>Teacher Wraparound Edition: DI 592; FF 593</p>
C4.8f	Write kernel structures for main group elements.	<p>Student Edition: 592-594</p> <p>Teacher Wraparound Edition: DI 592</p>
C4.8g	Predict oxidation states and bonding capacity for main group elements using their electron structure.	<p>Student Edition: 592-594</p> <p>Teacher Wraparound Edition: DI 592</p>
C4.8h	Describe the shape and orientation of s and p orbitals.	See Glencoe's <i>Chemistry: Matter and Change</i> © 2005.
C4.8i	Describe the fact that the electron location cannot be exactly determined at any given time.	See Glencoe's <i>Chemistry: Matter and Change</i> © 2005.
<p>C4.9 Periodic Table</p> <p>In the periodic table, elements are arranged in order of increasing number of protons (called the atomic number). Vertical groups in the periodic table (families) have similar physical and chemical properties due to the same outer electron structures.</p>		
<p>C4.9x Electron Energy Levels</p> <p>The rows in the periodic table represent the main electron energy levels of the atom. Within each main energy level are sublevels that represent an orbital shape and orientation.</p>		
C4.9b	Identify metals, non-metals, and metalloids using the periodic table.	<p>Student Edition: 590-591, 595</p> <p>Teacher Wraparound Edition: FYI 590; R 596</p>

STANDARDS	PAGE REFERENCES
<p>C4.9c Predict general trends in atomic radius, first ionization energy, and electronegativity of the elements using the periodic table.</p>	<p>Teacher Wraparound Edition: FF 691 Also see Glencoe's <i>Chemistry: Matter and Change</i> © 2005.</p>
<p>C4.10 Neutral Atoms, Ions, and Isotopes A neutral atom of any element will contain the same number of protons and electrons. Ions are charged particles with an unequal number of protons and electrons. Isotopes are atoms of the same element with different numbers of neutrons and essentially the same chemical and physical properties.</p>	
<p>C4.10x Average Atomic Mass The atomic mass listed on the periodic table is an average mass for all the different isotopes that exist, taking into account the percent and mass of each different isotope.</p>	
<p>C4.10c Calculate the average atomic mass of an element given the percent abundance and mass of the individual isotopes.</p>	<p>Student Edition: 586-587 Teacher Wraparound Edition: FYI 585</p>
<p>C4.10d Predict which isotope will have the greatest abundance given the possible isotopes for an element and the average atomic mass in the periodic table.</p>	<p>Student Edition: 587, 590-591 Teacher Wraparound Edition: A 590</p>
<p>C4.10e Write the symbol for an isotope, X_Z^A, where Z is the atomic number, A is the mass number, and X is the symbol for the element.</p>	<p>Student Edition: 789, 794</p>
<p>STANDARD C5: CHANGES IN MATTER <i>Students will analyze a chemical change phenomenon from the point of view of what is the same and what is not the same.</i></p>	
<p>P5.p1 Conservation of Matter (prerequisite) Changes of state are explained by a model of matter composed of tiny particles that are in motion. When substances undergo changes of state, neither atoms nor molecules themselves are changed in structure. Mass is conserved when substances undergo changes of state. (prerequisite)</p>	

STANDARDS	PAGE REFERENCES
<p>C5.r1x Rates of Reactions (recommended) The rate of a chemical reaction will depend upon (1) concentration of reacting species, (2) temperature of reaction, (3) pressure if reactants are gases, and (4) nature of the reactants. A model of matter composed of tiny particles that are in constant motion is used to explain rates of chemical reactions. (recommended)</p>	
<p>C5.r1a Predict how the rate of a chemical reaction will be influenced by changes in concentration, and temperature, pressure. (recommended)</p>	<p>Student Edition: 738-740 LAB 741, 742-743 Teacher Wraparound Edition: D 739</p>
<p>C5.r1b Explain how the rate of a reaction will depend on concentration, temperature, pressure, and nature of reactant. (recommended)</p>	<p>Student Edition: 738-740 LAB 741, 742-743 Teacher Wraparound Edition: D 739</p>
<p>C5.2 Chemical Changes Chemical changes can occur when two substances, elements, or compounds interact and produce one or more different substances whose physical and chemical properties are different from the interacting substances. When substances undergo chemical change, the number of atoms in the reactants is the same as the number of atoms in the products. This can be shown through simple balancing of chemical equations. Mass is conserved when substances undergo chemical change. The total mass of the interacting substances (reactants) is the same as the total mass of the substances produced (products).</p>	
<p>C5.2x Balancing Equations A balanced chemical equation will allow one to predict the amount of product formed.</p>	
<p>C5.2d Calculate the mass of a particular compound formed from the masses of starting materials.</p>	<p>Student Edition: 726-729 Teacher Wraparound Edition: SS 727</p>
<p>C5.2e Identify the limiting reagent when given the masses of more than one reactant.</p>	<p>See Glencoe's <i>Chemistry: Matter and Change</i> © 2005.</p>
<p>C5.2f Predict volumes of product gases using initial volumes of gases at the same temperature and pressure.</p>	<p>See Glencoe's <i>Chemistry: Matter and Change</i> © 2005.</p>
<p>C5.2g Calculate the number of atoms present in a given mass of element.</p>	<p>See Glencoe's <i>Chemistry: Matter and Change</i> © 2005.</p>

STANDARDS		PAGE REFERENCES
<p>C5.3x Equilibrium <i>Most chemical reactions reach a state of dynamic equilibrium where the rates of the forward and reverse reactions are equal.</i></p>		
C5.3a	Describe equilibrium shifts in a chemical system caused by changing conditions (Le Chatelier's Principle).	See Glencoe's <i>Chemistry: Matter and Change</i> © 2005.
C5.3b	Predict shifts in a chemical system caused by changing conditions (Le Chatelier's Principle).	See Glencoe's <i>Chemistry: Matter and Change</i> © 2005.
C5.3c	Predict the extent reactants are converted to products using the value of the equilibrium constant.	See Glencoe's <i>Chemistry: Matter and Change</i> © 2005.
<p>C5.4 Phase Change/Diagrams <i>Changes of state require a transfer of energy. Water has unusually high-energy changes associated with its changes of state.</i></p>		
<p>C5.4x Changes of State <i>All changes of state require energy. Changes in state that require energy involve breaking forces holding the particles together. The amount of energy will depend on the type of forces.</i></p>		
C5.4c	Explain why both the melting point and boiling points for water are significantly higher than other small molecules of comparable mass (e.g., ammonia and methane).	See Glencoe's <i>Chemistry: Matter and Change</i> © 2005.
C5.4d	Explain why freezing is an exothermic change of state.	Student Edition: 262 Also see Glencoe's <i>Chemistry: Matter and Change</i> © 2005.
C5.4e	Compare the melting point of covalent compounds based on the strength of IMFs (intermolecular forces).	See Glencoe's <i>Chemistry: Matter and Change</i> © 2005.
<p>C5.5 Chemical Bonds — Trends <i>An atom's electron configuration, particularly of the outermost electrons, determines how the atom can interact with other atoms. The interactions between atoms that hold them together in molecules or between oppositely charged ions are called chemical bonds.</i></p>		
<p>C5.5x Chemical Bonds <i>Chemical bonds can be classified as ionic, covalent, and metallic. The properties of a compound depend on the types of bonds holding the atoms together.</i></p>		
C5.5c	Draw Lewis structures for simple compounds.	Student Edition: 594, 689-690, 697 Teacher Wraparound Edition: SJ 697

STANDARDS		PAGE REFERENCES
C5.5d	Compare the relative melting point, electrical and thermal conductivity and hardness for ionic, metallic, and covalent compounds.	Student Edition: 696-702 Teacher Wraparound Edition: CU 702
C5.5e	Relate the melting point, hardness, and electrical and thermal conductivity of a substance to its structure.	Student Edition: 696-702 Teacher Wraparound Edition: CU 702
<p>C5.6x Reduction/Oxidation Reactions Chemical reactions are classified according to the fundamental molecular or submolecular changes that occur. Reactions that involve electron transfer are known as oxidation/reduction (or “redox”).</p>		
C5.6a	Balance half-reactions and describe them as oxidations or reductions.	See Glencoe’s <i>Chemistry: Matter and Change</i> © 2005.
C5.6b	Predict single replacement reactions.	Student Edition: 731-732 Teacher Wraparound Edition: DI 732
C5.6c	Explain oxidation occurring when two different metals are in contact.	See Glencoe’s <i>Chemistry: Matter and Change</i> © 2005.
C5.6d	Calculate the voltage for spontaneous redox reactions from the standard reduction potentials.	See Glencoe’s <i>Chemistry: Matter and Change</i> © 2005.
C5.6e	Identify the reactions occurring at the anode and cathode in an electrochemical cell.	See Glencoe’s <i>Chemistry: Matter and Change</i> © 2005.
<p>C5.7 Acids and Bases Acids and bases are important classes of chemicals that are recognized by easily observed properties in the laboratory. Acids and bases will neutralize each other. Acid formulas usually begin with hydrogen, and base formulas are a metal with a hydroxide ion. As the pH decreases, a solution becomes more acidic. A difference of one pH unit is a factor of 10 in hydrogen ion concentration.</p>		
<p>C5.7x Brønsted-Lowry Chemical reactions are classified according to the fundamental molecular or submolecular changes that occur. Reactions that involve proton transfer are known as acid/base reactions.</p>		
C5.7f	Write balanced chemical equations for reactions between acids and bases and perform calculations with balanced equations.	Student Edition: 769-770, 772 Teacher Wraparound Edition: AS 770; DI 773

STANDARDS	PAGE REFERENCES
C5.7g Calculate the pH from the hydronium ion or hydroxide ion concentration.	Student Edition: 773-774 <i>LAB 775</i> Teacher Wraparound Edition: A 773
C5.7h Explain why sulfur oxides and nitrogen oxides contribute to acid rain.	Student Edition: 765 <i>Science and Society 778</i> Teacher Wraparound Edition: A 765
C5.8 Carbon Chemistry The chemistry of carbon is important. Carbon atoms can bond to one another in chains, rings, and branching networks to form a variety of structures, including synthetic polymers, oils, and the large molecules essential to life.	