



EARTH SCIENCE

*Geology, the Environment,
and the Universe*

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STANDARDS	PAGE REFERENCES
SCIENTIFIC INVESTIGATION AND INQUIRY	
ES.1. Broad Concept: Scientific progress is made by asking relevant questions and conducting careful investigations. As a basis for understanding this concept, and to address the content in this grade, students should develop their own questions and perform investigations.	
<p>1. Know the elements of scientific methodology (identification of a problem, hypothesis formulation and prediction, performance of experimental tests, analysis of data, falsification, developing conclusions, reporting results) and be able to use a sequence of those elements to solve a problem or test a hypothesis. Also, understand the limitations of any single scientific method (sequence of elements) in solving problems.</p>	<p>Student Edition: 11-16, 17-19 <i>MiniLab</i> 12 <i>GeoDigest</i> 48 <i>GeoLab</i> 70-71, 114-115, 140-141, 174-175, 232-233, 292-293 <i>Design Your Own GeoLab</i> 92-93, 378-379 <i>Skill Handbook</i> 924-931</p> <p>Teacher Wraparound Edition: A 19; P 13</p>
<p>2. Know that scientists cannot always control all conditions to obtain evidence, and when they are unable to do so for ethical or practical reasons, they try to observe as wide a range of natural occurrences as possible so as to be able to discern patterns.</p>	<p>Student Edition: 98-100</p> <p>Teacher Wraparound Edition: CB 98C</p>

STANDARDS	PAGE REFERENCES
<p>3. Recognize the cumulative nature of scientific evidence.</p>	<p>Student Edition: 17-19, 385-387, 443-447, 448-454, 455-459, 589-593, 753-757, 775-779, 847-851 <i>Science & Math</i> 542 Teacher Wraparound Edition: CD 287</p>
<p>4. Recognize the use and limitations of models and theories as scientific representations of reality.</p>	<p>Student Edition: 18-19, 32-33 Teacher Wraparound Edition: CB 33; D 32; DI 32; ITI 33</p>
<p>5. Distinguish between a conjecture (guess), a hypothesis and a theory as these terms are used in science.</p>	<p>Student Edition: 11, 19 <i>Section Assessment</i> 19 <i>GeoDigest</i> 48 Teacher Wraparound Edition: CFU 19; IM 4D; TPK 17</p>
<p>6. Plan and conduct scientific investigations to explore new phenomena, to check on previous results, to verify or falsify the prediction of a theory, and to use a crucial experiment to discriminate between competing theories.</p>	<p>Student Edition: 11-16 <i>GeoLab</i> 70-71, 114-115, 140-141, 174-175, 232-233 <i>Design Your Own GeoLab</i> 92-93, 292-293, 378-379 Teacher Wraparound Edition: A 71, 115, 163; M 170; P 13, 125</p>
<p>7. Use hypotheses to choose what data to pay attention to and what additional data to seek, and to guide the interpretation of the data.</p>	<p>Student Edition: <i>GeoLab</i> 70-71, 114-115, 140-141, 174-175, 232-233, 292-293, 618-619 <i>Design Your Own GeoLab</i> 92-93, 378-379, 406-407, 570-571, 704-705</p>
<p>8. Identify and communicate the sources of error (random and systematic error) inherent in an experiment.</p>	<p>Student Edition: <i>Problem-Solving Lab</i> 110 <i>GeoLab</i> 826-827 Teacher Wraparound Edition: A 21, 110; CB 15; D 15</p>

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<p>9. Identify discrepant results and identify possible sources of error or uncontrolled conditions.</p>	<p>Student Edition: <i>GeoLab</i> 20-21, 174-175, 232-233 <i>Problem-Solving Lab</i> 110 <i>MiniLab</i> 126 <i>Design Your Own GeoLab</i> 798-799</p>
<p>10. Select and use appropriate tools and technology to perform tests, collect data, analyze relationships, and display data. (The focus is on manual graphing, interpreting graphs, and mastery of metric measurements and units, with supplementary use of computers and electronic data gathering when appropriate.)</p>	<p>Student Edition: <i>GeoLab</i> 20-21, 70-71, 114-115, 140-141, 174-175, 406-407, 516-517 <i>Internet GeoLab</i> 352-353, 488-489, 642-643, 852-853 <i>Design Your Own GeoLab</i> 378-379 Teacher Wraparound Edition: A 163</p>
<p>11. Formulate and revise explanations using logic and evidence.</p>	<p>Student Edition: <i>GeoLab</i> 70-71, 114-115, 140-141, 174-175, 232-233, 292-293, 406-407, 618-619, 826-827 <i>Design Your Own GeoLab</i> 92-93, 378-379</p>
<p>12. Analyze situations and solve problems that require combining concepts from more than one topic area of science and applying these concepts.</p>	<p>Student Edition: 37-41, 53-59, 60-66, 153-161, 244-248, 371-374 <i>Science & Technology</i> 22, 72 <i>GeoLab</i> 114-115 <i>Science & Math</i> 206 Teacher Wraparound Edition: AC 314, 388; CB 9, 182; P 371</p>
<p>13. Apply mathematical relationships involving proportionalities, linear relations, quadratic equations, simple trigonometric relationships, exponential growth and decay laws, and logarithmic relationships to scientific situations.</p>	<p>Student Edition: 712-715 <i>GeoLab</i> 20-21, 140-141 <i>Problem-Solving Lab</i> 110, 172 <i>Using Math</i> 748, 778 <i>Science & Math</i> 770 Teacher Wraparound Edition: AC 714; CB 403; DI 749, 777; DIS 713; E 241; P 213</p>
<p>14. Recognize the implications of statistical variability in experiments, and explain the need for controls in experiments.</p>	<p>Student Edition: 11-12, 25 #22 <i>Section Assessment</i> 16 <i>GeoDigest</i> 48 <i>Skill Handbook</i> 930-931</p>

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<p>15. Observe natural phenomena, and analyze their location, sequence, or time intervals (e.g., relative ages of rocks, locations of planets over time, and succession of species in an ecosystem).</p>	<p>Student Edition: 103-106, 121-125, 138-139, 249-257, 273-274, 364-366, 557-561, 564-565 <i>MiniLab</i> 254, 558 <i>Problem-Solving Lab</i> 560 <i>Design Your Own GeoLab</i> 798-799 Teacher Wraparound Edition: ACT 649; CON 103; DI 558</p>
<p>16. Read a topographic map and a geologic map for information provided on the maps.</p>	<p>Student Edition: 32-36 <i>Problem-Solving Lab</i> 35 <i>Mapping GeoLab</i> 42-43, 204-205, 258-259, 430-431, 734-735 Teacher Wraparound Edition: A 27, 36; AC 222; D 32; DI 32, 33; ESJ 35</p>
<p>17. Construct and interpret a simple scale map and topographic cross-section.</p>	<p>Student Edition: 47 #19-#21 <i>Discovery Lab</i> 27 <i>Mapping GeoLab</i> 540-541 Teacher Wraparound Edition: ITI 34; R 49</p>
<p>18. Describe the contributions of key scientists throughout history, including Claudius Ptolemy, Nicholas Copernicus, Johannes Kepler, Tycho Brahe, Galileo Galilei, Nicholas Steno, Sir Charles Lyell, James Hutton, Henrietta Leavitt, Alfred Wegener, and Edwin Powell Hubble.</p>	<p>Student Edition: 364-366, 443-447, 557, 775-779, 839-843, 857 #22 <i>Science & Math</i> 770 Teacher Wraparound Edition: AC 314; CB 437, 442C, 770, 790, 849; CD 287</p>
<p>THE UNIVERSE</p>	
<p>ES.2. Broad Concept: Galaxies are made of billions of stars and form most of the visible mass of the universe. As a basis for understanding this concept,</p>	
<p>1. Recognize that the universe contains many billions of galaxies, and each galaxy contains many billions of stars.</p>	<p>Student Edition: 833, 839-842</p>
<p>2. Describe various instrumentation used to study deep space and the solar system (e.g., telescopes that record in various parts of the electromagnetic spectrum, including visible, infrared, and radio, refracting or reflecting telescopes, and spectrophotometer).</p>	<p>Student Edition: 747-752 <i>Discovery Lab</i> 775 <i>Science in the News</i> 800, 828 <i>National Geographic Expeditions</i> 902-907 Teacher Wraparound Edition: A 753, 775, 861; CB 750; D 749; DI 749; E 749; ESJ 750; R 752; TPK 751</p>

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<p>3. Describe Hubble’s law, and understand the big bang theory and the evidence that supports it (microwave background radiation, relativistic Doppler effect).</p>	<p>Student Edition: 842-843, 850-851, 856 #12 <i>Problem-Solving Lab</i> 843 <i>Using Math</i> 850 Teacher Wraparound Edition: A 843, 850; AC 314; CB 850</p>
<p>4. Explain the basics of the fusion processes that are the source of energy of stars.</p>	<p>Student Edition: 809-810, 822 Teacher Wraparound Edition: AES 810; E 811</p>
<p>5. Explain that the mass of a star and the balance between collapse and fusion determine the color, brightness, lifetime, and evolution of a star.</p>	<p>Student Edition: 822-825, 831 #21, #24 Teacher Wraparound Edition: CFU 825; DIS 822; UAA 822</p>
<p>6. Analyze the life histories of stars and different types of stars found on the Hertzsprung-Russell diagram, including the three outcomes of stellar evolution based on mass (black hole, neutron star, white dwarf).</p>	<p>Student Edition: 819-820, 821-825 <i>GeoDigest</i> 859 Teacher Wraparound Edition: A 825; CB 823; DI 822; R 825, 861</p>
<p>7. Describe how elements with an atomic number greater than helium have been formed by nuclear fusion processes in stars, supernova explosions, or exposure to cosmic rays.</p>	<p>Student Edition: 824-825, 831 #16 Teacher Wraparound Edition: AC 824; E 823</p>
<p>8. Explain that the redshift from distant galaxies and the cosmic microwave background radiation provide evidence for the big bang model that the universe has been expanding for 13 to 14 billion years.</p>	<p>Student Edition: 847-851 <i>MiniLab</i> 845 <i>GeoDigest</i> 860 Teacher Wraparound Edition: ACT 848; CB 850; CFU 851; ITP 849</p>
<p>9. Construct a model and explain the relationships among planetary systems, stars, multiple-star systems, star clusters, galaxies, and galactic groups in the universe.</p>	<p>Student Edition: 402-403, 758-767 <i>MiniLab</i> 761 <i>Problem-Solving Lab</i> 766 <i>Design Your Own GeoLab</i> 798-799 Teacher Wraparound Edition: A 767, 838; D 758, 837; DI 759, 763; M 760, 796, 841</p>

STANDARDS	PAGE REFERENCES
THE SOLAR SYSTEM	
<p>ES.3. Broad Concept: Our solar system is composed of a star, planets, moons, asteroids, comets, and residual material left from the evolution of the solar system over time. The sun is one of billions of stars residing in one of billions of galaxies in a universe that has been changing and evolving over vast amounts of time. As a basis for understanding this concept,</p>	
<p>1. Describe the location of the solar system in an outer edge of the disc-shaped Milky Way galaxy, which spans 100,000 light-years.</p>	<p>Student Edition: 832-838 <i>Discovery Lab</i> 833 Teacher Wraparound Edition: D 837; DI 836; ITI 835</p>
<p>2. Compare and contrast the differences in size, temperature, and age of our sun and other stars.</p>	<p>Student Edition: 805-812, 813-820, 822-825 <i>Earth Science Online</i> 812 <i>GeoDigest</i> 859 Teacher Wraparound Edition: TPK 821</p>
<p>3. Understand and describe the nebular theory concerning the formation of solar systems, including the roles of planetesimals and protoplanets.</p>	<p>Student Edition: 793-795 <i>GeoDigest</i> 858-859 Teacher Wraparound Edition: AC 794; R 838; UAA 794</p>
<p>4. Observe and describe the characteristics and motions of the various kinds of objects in our solar system, including planets, satellites, comets, and asteroids, and the influence of gravity and inertia on these motions.</p>	<p>Student Edition: 753-757, 758-767, 776-779, 780-785, 786-792, 795-797 <i>Mapping GeoLab</i> 768-769 <i>MiniLab</i> 777 Teacher Wraparound Edition: A 785, 792, 797; CB 787; CFU 785; DI 754</p>
<p>5. Explain how Kepler's laws predict the orbits of the planets.</p>	<p>Student Edition: 776-779, 803 #27 <i>Problem-Solving Lab</i> 791 Teacher Wraparound Edition: A 791; ESJ 776; ITI 778</p>

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THE EARTH SYSTEM	
ES.4. Broad Concept: Interactions among the solid Earth, hydrosphere, and atmosphere have resulted in ongoing evolution of the earth system over geologic time. As a basis for understanding this concept,	
<p>1. Examine and describe the structure, composition, and function of Earth's atmosphere, including the role of living organisms in the cycling of atmospheric gases.</p>	<p>Student Edition: 271-277, 278-284, 285-291, 297 #17 <i>Standardized Test Practice</i> 297 <i>GeoDigest</i> 436</p> <p>Teacher Wraparound Edition: A 277; AC 279; CB 272, 279; CON 275; E 65; M 276; R 280</p>
<p>2. Investigate and describe the composition of the Earth's atmosphere as it has evolved over geologic time (outgassing, origin of atmospheric oxygen, variations in carbon dioxide concentration).</p>	<p>Student Edition: 584-588</p> <p>Teacher Wraparound Edition: CB 270C, 576C-576D, 585; CFU 588; R 588; TPK 584</p>
<p>3. Describe the main agents of erosion: water, waves, wind, ice, plants, and gravity.</p>	<p>Student Edition: 162-166, 181-190, 191-197, 198-203, 211-221, 222-227, 244-248</p> <p><i>MiniLab</i> 194</p> <p>Teacher Wraparound Edition: A 166; D 192, 226; DI 202, 223; EC 185; M 225</p>
<p>4. Explain the effects on climate of latitude, elevation, and topography, as well as proximity to large bodies of water and cold or warm ocean currents.</p>	<p>Student Edition: 361-363, 370-371, 405, 411 #23</p> <p><i>MiniLab</i> 302 <i>GeoDigest</i> 437</p> <p>Teacher Wraparound Edition: CFU 363; DI 362; E 370</p>
<p>5. Explain the possible mechanisms and effects of atmospheric changes brought on by things such as acid rain, smoke, volcanic dust, greenhouse gases, and ozone depletion.</p>	<p>Student Edition: 273, 374, 375-377, 664-665, 724-729</p> <p><i>Science in the News</i> 294 <i>Science & the Environment</i> 490</p> <p>Teacher Wraparound Edition: A 374, 377, 729; CB 270C; DI 281; EC 273; M 373; P 727</p>

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<p>6. Determine the origins, life cycles, behavior, and prediction of weather systems.</p>	<p>Student Edition: 299-304, 305-311 <i>Discovery Lab</i> 299 <i>Earth Science Online</i> 309 Teacher Wraparound Edition: A 311; ACT 310; CB 300; CFU 311; CL 308; CON 306; D 309; DI 310; DIS 320; R 303, 311</p>
<p>7. Investigate and identify the causes and effects of severe weather.</p>	<p>Student Edition: 329-333, 334-340, 341-346 <i>Earth Science Online</i> 336 <i>Internet GeoLab</i> 352-353 Teacher Wraparound Edition: CB 328C-328D, 342; CON 330, 343; DI 331; E 336; IM 328D; ITP 341; M 345; TPK 343</p>
<p>8. Explain special properties of water (e.g., high specific and latent heats) and the influence of large bodies of water and the water cycle on heat transport and, therefore, weather and climate.</p>	<p>Student Edition: 285-291 <i>MiniLab</i> 290 Teacher Wraparound Edition: A 290; CB 52D; CFU 291; CL 289; CON 287, 288; D 288; ITU 269; M 303; R 291, 331; UST 288</p>
<p>9. Describe the development and dynamics of climatic changes over time corresponding to changes in the Earth's geography (plate tectonics/continental drift), orbital parameters (the Milankovitch cycles), and atmospheric composition.</p>	<p>Student Edition: 371-374, 444-447, 809 Teacher Wraparound Edition: A 373; AC 372; CB 373; CFU 374</p>
<p>10. Describe the nitrogen and carbon cycles and their roles in the improvement of soils for agriculture.</p>	<p>Student Edition: 172-173, 664, 718-720 Teacher Wraparound Edition: AC 720; CB 720; IM 372</p>
<p>11. Explain that the oceans store carbon dioxide mostly as dissolved HCO_3^- and CaCO_3 as precipitate or biogenic carbonate deposits.</p>	<p>Student Edition: 429 Teacher Wraparound Edition: R 429</p>
<p>12. Use weather maps and other tools to forecast weather conditions.</p>	<p>Student Edition: 312-316, 317-321, 326 #12-#13, 327 #20, 357 #18 <i>Problem-Solving Lab</i> 318 <i>Mapping GeoLab</i> 322-323 <i>Internet GeoLab</i> 352-353 Teacher Wraparound Edition: A 291, 318, 321, 323; ITI 319</p>

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<p>13. Use computer models to predict the effects of increasing greenhouse gases on climate for the planet as a whole and for specific regions.</p>	<p>Student Edition: 375-377*</p> <p>Teacher Wraparound Edition: A 377; CB 320; DI 377</p> <p>*These references discuss increasing greenhouse gases without the use of computer models.</p>
<p>14. Read and interpret space weather data (solar flares, geomagnetic storms, solar wind).</p>	<p>Student Edition: 808-809</p> <p><i>Discovery Lab</i> 805</p> <p>Teacher Wraparound Edition: AC 372; EC 809; UAA 809</p>
<p>THE HYDROLOGIC CYCLE</p>	
<p>ES.5. Broad Concept: Water is continually being recycled by the hydrologic cycle through the watersheds, oceans, and the atmosphere by processes such as evaporation, condensation, precipitation runoff, and infiltration. As a basis for understanding this concept,</p>	
<p>1. Explain how water flows into and through a watershed (e.g., properly use terms precipitation, aquifers, wells, porosity, permeability, water table, capillary water, and runoff).</p>	<p>Student Edition: 211-221, 222-227, 239-243, 249-257</p> <p><i>Discovery Lab</i> 211</p> <p><i>GeoLab</i> 232-233</p> <p>Teacher Wraparound Edition: A 219, 243; ACT 241; CB 212; CL 215; CON 215; E 241; M 214, 240</p>
<p>2. Describe the processes of the hydrologic cycle, including evaporation, condensation, precipitation, surface runoff, and groundwater percolation, infiltration, and transpiration.</p>	<p>Student Edition: 211-221, 228-231, 239-243, 285-291</p> <p><i>Discovery Lab</i> 239</p> <p><i>MiniLab</i> 290</p> <p>Teacher Wraparound Edition: A 240; ACT 285; CB 238C-238D, 240; CL 289; IM 212; R 243, 291; TPK 212</p>
<p>3. Identify and explain the mechanisms that cause and modify the production of tides, such as the gravitational attraction of the moon, the sun, and coastal topography.</p>	<p>Student Edition: 400-403, 410 #13, 764</p> <p><i>Earth Science Online</i> 400</p> <p><i>Problem-Solving Lab</i> 401</p> <p>Teacher Wraparound Edition: AC 401; ACT 403; CB 384D, 403; CON 402; DI 402; E 764; ITI 403</p>

STANDARDS	PAGE REFERENCES
THE ROCK CYCLE	
ES.6. Broad Concept: Rocks and minerals are continually being modified within the rock cycle. As a basis for understanding this concept,	
<p>1. Differentiate among the processes of weathering, erosion, transportation of materials, deposition, and soil formation.</p>	<p>Student Edition: 153-161, 162-166, 167-173, 181-190, 191-197, 198-203 <i>Discovery Lab</i> 153 <i>Earth Science Online</i> 157 <i>MiniLab</i> 163 <i>GeoLab</i> 174-175 Teacher Wraparound Edition: CB 152C-152D, 164; CON 159; DI 155; UAA 170</p>
<p>2. Illustrate the various processes and rock types that are involved in the rock cycle, and describe how the total amount of material stays the same throughout formation, weathering, sedimentation, and reformation.</p>	<p>Student Edition: 99-106, 107-113, 121-127, 128-132, 133-139 <i>MiniLab</i> 108 <i>GeoLab</i> 114-115, 140-141 <i>Discovery Lab</i> 121 Teacher Wraparound Edition: A 113; CB 120C-120D, 147; DIS 135; IM 120D; R 113</p>
<p>3. Explain the absolute and relative dating methods used to measure geologic time.</p>	<p>Student Edition: 557-561, 562-565, 575 #17-#23 <i>MiniLab</i> 558 <i>Problem-Solving Lab</i> 560 <i>Standardized Test Practice</i> 575 Teacher Wraparound Edition: A 558, 560, 561; CB 563; CFU 561; DI 558, 563; M 559; R 561</p>
<p>4. Recognize and explain geologic evidence, including fossils and radioactive dating, that indicates the age of the Earth.</p>	<p>Student Edition: 127, 562-565, 566-569 <i>Using Math</i> 563 <i>Earth Science Online</i> 564 <i>Design Your Own GeoLab</i> 570-571 Teacher Wraparound Edition: A 565; CB 563, 567; CFU 565; R 565</p>

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<p>5. Trace the evolution of the solid Earth in terms of the major geologic eras.</p>	<p>Student Edition: 553-556, 577-579, 580-583, 601-604, 605-608, 612-615, 625-627, 635-638 <i>Design Your Own GeoLab</i> 570-571 <i>Mapping GeoLab</i> 594-595 Teacher Wraparound Edition: A 556, 583; CB 606; ITI 582; R 615</p>
PLATE TECTONICS	
ES.7. Broad Concept: Plate tectonics operating over geologic time has altered the features of land, sea, and mountains on the Earth's surface. As the basis for understanding this concept,	
<p>1. Explain the work of Alfred Wegener, including reintroduction of the idea of moving continents, and the skepticism with which his theories were first received and why.</p>	<p>Student Edition: 443-447 Teacher Wraparound Edition: A 447; CB 442C, 444; CFU 447; CL 446; M 446; R 447</p>
<p>2. Analyze the evidence that supports the hypothesis of movement of the plates (from paleomagnetism, paleontology, paleoclimate, and the continuity of geological structure and stratigraphy across ocean basins).</p>	<p>Student Edition: 443-447, 448-454 <i>Discovery Lab</i> 443 <i>MiniLab</i> 457 <i>Mapping GeoLab</i> 464-465 Teacher Wraparound Edition: A 447; AC 445; CFU 447; D 451; DI 453; IM 444; ITI 445, 450; M 452; R 447</p>
<p>3. Trace the development of a lithospheric plate from its growing margin at a divergent boundary (mid-ocean ridge) to its destructive margin at a convergent boundary (subduction zone).</p>	<p>Student Edition: 455-459 <i>Problem-Solving Lab</i> 458 Teacher Wraparound Edition: A 459; CB 442C-D, 457, 462; CFU 459, 463; DI 457; ITI 455, 462; R 459</p>
<p>4. Explain the relationship between convection currents and the motion of the lithospheric plates.</p>	<p>Student Edition: 460-463 Teacher Wraparound Edition: CB 581; D 460; DI 462; ESJ 462; R 463</p>

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<p>5. Explain why, how, and where earthquakes occur, how they are located and measured, and the ways that they can cause damage (directly by shaking and secondarily by fire, tsunami, landsliding, or liquefaction).</p>	<p>Student Edition: 495-499, 500-504, 505-510, 511-512 <i>Discovery Lab</i> 495 <i>Earth Science Online</i> 507, 509 <i>GeoLab</i> 516-517</p> <p>Teacher Wraparound Edition: CB 494C-494D, 506; CFU 510; DI 512; DIS 507; IM 497; ITI 509</p>
<p>6. Observe and explain how rivers and streams are dynamic systems that erode and transport sediment, change their course, and flood their banks in natural and recurring patterns.</p>	<p>Student Edition: 211-221, 222-227 <i>Problem-Solving Lab</i> 217 <i>Earth Science Online</i> 220 <i>GeoLab</i> 232-233</p> <p>Teacher Wraparound Edition: A 218, 219; CB 210C, 212; CL 215; CON 215; DI 223; IM 210D; M 214; TPK 219</p>