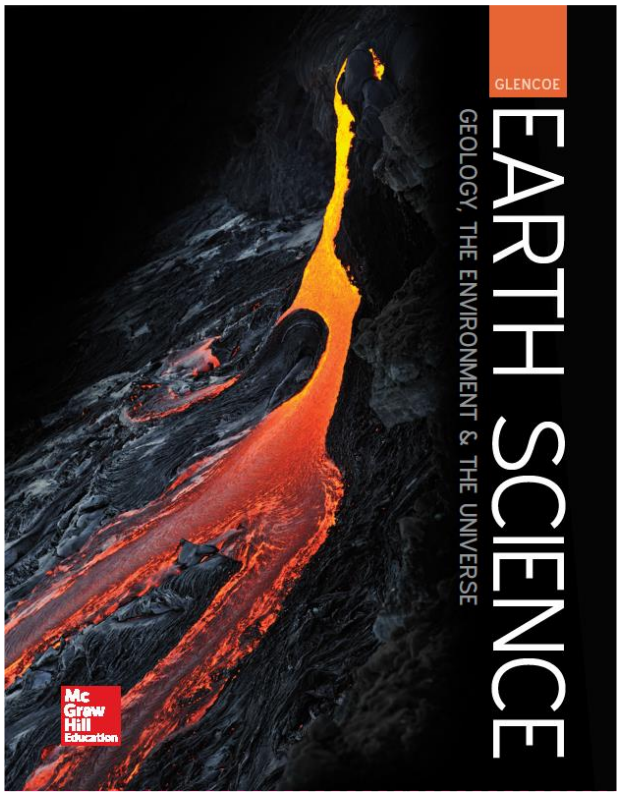
College-and-Career Readiness Standards for Science
Earth and Space Science



STANDARDS	PAGE REFERENCES
Earth and Space Science	
ESS.1 Earth in the Universe **Conceptual Understanding:** The planet Earth is a very small part of a very large universe that has developed over a huge expanse of time.	
ESS.1.A Students will develop an understanding of the universe, its development, immense size, and composition.	
ESS.1A.1 *Describe the Big Bang theory and summarize observations (e.g., cosmic microwave background radiation, Hubble's law, and redshift caused by the Doppler effect) as evidence to support the formation and expansion of the universe.*	**Student Edition:** 873-877, 878-881 *MiniLAB* 873 *Writing in Earth Science* 881 **Teacher Edition:** CFU 881; DI 878, 880; MI 878; P 880; R 881; TCS 880

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

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ESS.1A.2 *Interpret information from the Hertzsprung -Russell diagram to differentiate types of stars, including our sun, according to size, magnitude, and classification.*	**Student Edition:** 843-846, 856#26, 856#41 *Table 2* 844 **Teacher Edition:** A 846; DI 844; DIS 844; ESJ 847; IM 847; R 846
ESS.1A.3 *Organize and interpret data sets for patterns and trends to compare and contrast stellar evolution in order to explain and communicate how a star changes during its life.*	**Student Edition:** 847-851, 856#28 *Section Review #1-3* 851 **Teacher Edition:** A 851; CFU 851; DI 848; ITBI 829; R 851
ESS.1A.4 *Research and explain how nuclear fusion in stars and supernova lead to the formation of all other elements.*	**Student Edition:** 851 *Section Review #4* 851 **Teacher Edition:** MI 847
Conceptual Understanding: The sun, moon, and planets have predictable patterns that are explained by forces and laws. Patterns of motion in the solar system can be described and predicted based on observations and an understanding of gravity.	
ESS.1.B Students will develop an understanding of Earth, the solar system, and the laws that predict the motion of celestial bodies.	
ESS.1B.1 *Read and evaluate scientific information for mechanisms/results (e.g., the solar nebular theory) to explain how the solar system was formed. Cite evidence and develop a logical argument.*	**Student Edition:** 796-799 *Section Review #1* 803 **Teacher Edition:** AC 797
ESS.1B.2 *Compare and contrast celestial bodies (e.g., planets, natural satellites, comets, asteroids, and the Oort cloud) and their motion in our solar system (e.g., revolution and rotation). Build an Analemma calendar.*	**Student Edition:** 804-810, 811-815, 816-819 *GeoLAB* 821 **Teacher Edition:** A 815; CFU 815; CL 804; CON 807, 808; E 806; ESJ 798, 806, 811; R 810, 815
ESS.1B.3 *Design a model (e.g., a gravity simulation using PVC and a neoprene screen) to demonstrate Kepler's laws and the relationships of the orbits of objects in our solar system. Relate them to Newton's law of universal gravitation and laws of motion.*	**Student Edition:** 799-803 *MiniLAB* 801 *Math in Earth Science* 803 *Problem-Solving Lab* 807 **Teacher Edition:** A 801; AC 799; D 802; DI 800; ESJ 801; ITI 800; TCS 800

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ESS.2 Earth Structure and History **Conceptual Understanding:** Earth's interior is divided into a solid inner core, a liquid outer core, a pliable mantle, and a solid crust. Even though the crust is solid, it is always in motion and is recycled through time.	
ESS.2.A Students will develop an understanding of the structure and composition of Earth and tis materials.	
ESS.2A.1 *Analyze and interpret data to explain and communicate the differentiation of Earth's internal chemical structure (e.g., core, mantle, and crust) using the production of internal heat from the radioactive decay of unstable isotopes and gravitational energy.*	**Student Edition:** 486-488, 620-622, 623-624 *Launch Lab* 618 **Teacher Edition:** D 623; R 627; TCS 623
ESS.2A.2 *Analyze and interpret data to explain and communicate the differentiation of Earth's physical divisions (e.g., lithosphere and asthenosphere) using data from seismic waves and Earth's magnetic field.*	**Student Edition:** 536-538 *Figure 11* 537 *Section Review #1* 538 *Writing in Earth Science* 538 **Teacher Edition:** A 538; ACT 537; CFU 538; DI 536; E 536; R 538; TCS 536, 537
ESS.2A.3 *Investigate the physical and/or chemical characteristics of mineral specimens to identify minerals and mineral deposits/groups (e.g., oxides, carbonates, halides, sulfides, sulfates, silicates, and phosphates). Include the relationship between chemical bonds, chemical formulas, mineral use, and mineral properties.*	**Student Edition:** 65, 86-95, 96-101 *Launch Lab* 84 *MiniLAB* 92 *Data Analysis Lab* 94 *GeoLAB* 103 *Reading for Comprehension* 109 **Teacher Edition:** A 95; ACT 90, 93, 94; AES 93; CL 87, 93; CON 86, 97; DI 96; E 95; R 95; TCS 96; UST 99
ESS.2A.4 *Investigate the physical and/or chemical characteristics of rock specimens to identify and categorize igneous, sedimentary, and metamorphic rocks. Include the processes that generate the transformation of rocks.*	**Student Edition:** 112-117, 118-123, 134-140, 141-144, 145-151 *MiniLAB* 115, 136 *Writing in Earth Science* 117 *Problem-Solving Lab* 122, 148 *GeoLAB* 153 **Teacher Edition:** A 123, 144, 151; D 145; DIS 113; E 120; ESJ 114; M 114, 146; R 123

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Conceptual Understanding: Radioactive decay lifetimes and isotopic content in rocks provide a way of dating rock formations and thereby fixing the scale of geological time. Plate tectonics is the unifying theory that explains the movements of rocks on Earth's surface and provides a comprehensive account of its geological history. Physical and chemical weathering is a result of the interactions of Earth's geosphere, hydrosphere, atmosphere, and biosphere.	
ESS.2.B Students will develop an understanding of the history and evolution of the earth.	
ESS.2B.1 *Research, analyze, and evaluate the contributions of William Smith, James Hutton, Nicolaus Steno, Charles Lyell, and others to physical geology.*	**Student Edition:** 595 *Expeditions* 20 **Teacher Edition:** AC 478; ITF 32, 177, 324, 450, 534; TCS 621
ESS.2B.2 *Apply different techniques (e.g., superposition, original horizontality, cross-cutting relationships, lateral continuity, principle of inclusions, fossil succession, and unconformities) to analyze and interpret the relative age of actual sequences, models, or photographs.*	**Student Edition:** 596-600 *MiniLAB* 597 *Problem-Solving Lab* 599 **Teacher Edition:** A 597, 600; CFU 600; D 598, 599; DI 596; M 598; R 600; TCS 598
ESS.2B.3 *Use mathematical concepts to calculate the absolute age of earth materials using actual or simulated isotope ratios.*	**Student Edition:** 62-63, 601-603 *Math in Earth Science* 605 **Teacher Edition:** ACT 603; CFU 605; D 603; DI 602; R 605
ESS.2B.4 *Research, analyze, and explain the origin of geologic features and processes that result from plate tectonics, including sea floor spreading, earthquake activity, volcanic activity, mountain building, and location of natural resources.*	**Student Edition:** 121-123, 451, 473-479, 480-485, 517, 500-507, 543-544, 567-573, 574-576 *MiniLAB* 481 *Earth Science & Environment* 489 *Data Analysis Lab* 501 *Launch Lab* 526 *GeoLAB* 553 *Reading for Comprehension* 585 **Teacher Edition:** AC 480; CL 451; CON 570; DI 543; ITI 477; P 569; TCS 467, 483, 502

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ESS.2B.5 *Use mathematical representations to interpret seismic graphs to triangulate the location of an earthquake's epicenter and magnitude and to correlate the frequency and magnitude of an earthquake.*	**Student Edition:** 534-535, 539-544 *MiniLAB* 541 *Data Analysis Lab* 543 *Math in Earth Science* 544 *GeoLAB* 553 **Teacher Edition:** ACT 542; CFU 544; D 542; ITI 542; R 539, 544; TCS 535, 539, 540
ESS.2B.6 *Plan and conduct a scientific investigation to determine how factors (e.g., wind velocity, water velocity, ice, and temperature) may affect the rate of weathering.* *ESS.2B.7 Enrichment: Use an engineering design process to design a model to simulate the formation of caves and karst topography by groundwater.**	**Student Edition:** 164-170, 259-262 *Launch Lab* 162 *Math in Earth Science* 170 *GeoLAB* 185 *Writing in Earth Science* 262 **Teacher Edition:** AC 166; CFU 17; CL 261; CON 168; D 259; ESJ 168; ITP 169; TCS 259, 261
ESS.3 Earth's Systems and Cycles **Conceptual Understanding:** Earth's surface is comprised of the geosphere, hydrosphere, atmosphere, and biosphere, all of which are interconnected. The complex and dynamic interactions between these systems have shaped Earth, influenced climate, and shaped the evolution of life.	
ESS.3 Students will develop an understanding of Earth's systems and cycles.	
ESS.3.1 *Use mathematical representations (e.g., latitude, longitude, and maps) to calculate the angle of noon solar incidence and relate the value to day length, distribution of sunlight, and seasonal change.*	**Student Edition:** 314-315, 388, 775-778 *MiniLAB* 315, 776 **Teacher Edition:** A 315; D 775; E 388, 778; IM 715; ITBI 281; ITI 777; R 778
ESS.3.2 Enrichment: *Use an engineering design process to explore the concepts of passive solar architecture to design a structure that best utilizes solar incidence.**	**Student Edition:** 714-716 *GeoLAB* 725

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ESS.3.3 *Explain how temperature and density of ocean water influence circulation.*	**Student Edition:** 418-420, 425-427 *GeoLAB* 429 *Apply Your Skill* 429 **Teacher Edition:** A 427; CFU 427; ESJ 426; R 420, 427; TCS 418, 419
ESS.3.4 *Research and communicate information to explain the importance of the transfer of thermal energy among the hydrosphere, geosphere, and atmosphere. Include the unique physical and chemical properties of water, the water cycle, and energy transfer within the rock cycle.*	**Student Edition:** 8-9, 67, 151, 166-167, 224, 303, 316-317, 412, 425-426, 693-694 *Launch Lab* 280 *Writing in Earth Science* 303 *Section Review #1* 427 **Teacher Edition:** CFU 427; D 693; E 166; ESJ 482; R 303; TCS 165, 281; TPK 225
ESS.3.5 *Analyze and interpret weather data using maps and global weather systems to explain and communicate the relationships among air masses, pressure systems, and frontal boundaries.*	**Student Edition:** 314-315, 318-323, 339#39 *Launch Lab* 312 *Problem-Solving Lab* 330 *GeoLAB* 334-335 *Apply Your Skill* 334 **Teacher Edition:** A 323, 332; ACT 322, 330; CL 317; R 317, 323
ESS.3.6 *Construct an explanation from data sets to obtain and evaluate scientific information to construct scientific arguments on changes in climate caused by various natural factors (e.g., plate tectonics and continent location and Milankovitch cycles) versus anthropogenic factors (e.g., fossil fuel use and agricultural factors).*	**Student Edition:** 385-386, 387-392, 393-395, 743-744 *Writing in Earth Science* 395, 396, 401 *Earth Science & Society* 396 *Reading for Comprehension* 403 **Teacher Edition:** A 386, 392; CON 389; D 393; DI 394;EC 395; ESJ 391; IM 387, 390; P 388; TCS 385, 391
ESS.3.7 *Cite evidence and develop logical arguments to identify the cause and effect relationships of the evolutionary milestones (e.g., photosynthesis and the atmosphere, the evolution of multicellular animals, the development of shells, and the colonization of terrestrial environments by plants and animals) that most profoundly shaped Earth's systems.*	**Student Edition:** 408-409, 628-632, 633-637, 648-654, 655-659, 660-665, 687 *Section Review #4* 412 *GeoLAB* 611 *Reading for Comprehension* 673 **Teacher Edition:** A 632, 659; CFU 637; DI 628; R 632, 637; TCS 284, 629

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ESS.3.8 *Analyze and interpret the record of shared ancestry, evolution, and extinction as related to natural selection using fossils.*	**Student Edition:** 594, 606, 652-654, 658-659 *GeoLAB* 667 **Teacher Edition:** A 637; AC 608; AES 593; E 658; ESJ 636; IM 633; ITF 593, 653; TCS 636, 660
ESS.4 Earth's Resources and Human Activity **Conceptual Understanding:** The dynamic Earth impacts human society. Natural hazards and other geologic events have shaped the course of human history. In addition, humans also impact the Earth through resource extraction and land use.	
ESS.4 Students will develop an understanding of Earth's resources and the impact of human activities.	
ESS.4.1 *Research, evaluate, and communicate about how human life on Earth shapes Earth's systems and responds to the interaction of Earth's systems (e.g., geosphere, hydrosphere, atmosphere, and biosphere). Examine how geochemical and ecological processes interact through time to cycle matter and energy and how human activity alters the rates of these processes.*	**Student Edition:** 151, 167, 170-175, 194-200, 202, 238-241, 263-268, 443, 678-681, 682-686, 687-692, 694-697, 734-736, 737-742 *Writing in Earth Science* 175 *GeoLAB* 214-215, 270-271 *Problem-Solving Lab* 264 *Earth Science & Environment* 304 *Figure 11* 689 *Earth Science & Society* 698 *MiniLAB* 740 **Teacher Edition:** CL 202; DIS 204; EC 167, 283, 696; TCS 197, 443
ESS.4.2 *Research, assess, and communicate how Earth's systems influence the distribution of life, including how various natural hazards and geologic events (e.g., volcanic eruptions, earthquakes, landslides, tornadoes, and hurricanes) have shaped the course of human history.*	**Student Edition:** 194-200, 230-231, 350-354, 355-360, 361-365, 512-513, 545-548 *Expeditions* 20 *Earth Science & Technology* 47 *Writing in Earth Science* 47, 213, 513 *Earth Science & Society* 213 *Reading for Comprehension* 249 *Figure 4* 502-503 **Teacher Edition:** A 200, 354; AC 196, 362, 502; AES 199, 230; CON 503; E 199; ESJ 198, 320, 346, 359, 364, 547; P 547; TCS 320, 366

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ESS.4.3 *Analyze earthquake and volcanic data to determine patterns that can lead to predicting such hazards and mitigating impact to humans.*	**Student Edition:** 545-551 *Expeditions* 20, 518 *Writing in Earth Science* 20, 269, 518, 523, 551, 552 *GeoLAB* 519 *Earth Science & Society* 552 *Reading for Comprehension* 559 **Teacher Edition:** ACT 550; TCS 518, 550; TS 20, 518
ESS.4.4 Enrichment: *Use an engineering design process to research, develop, and test models to aid in the responsible management of natural resources (e.g., recycling, composting, and energy usage).**	**Student Edition:** 247#37, 265-268, 720-723 *Section Review #5* 268 *Earth Science & Society* 242 *Earth Science & Environment* 269 *Writing in Earth Science* 269 *GeoLAB* 270-271, 725, 752-753 **Teacher Edition:** CFU 723; EC 683; P 747; TS 269
ESS.4.5 Enrichment: *Research and communicate regarding geoscience career options (e.g., geologist, petroleum engineer, meteorologist, paleontologist, astronomer, and oceanographer.*	**Student Edition:** 6-7, 23#18-19, 156#32 *Careers in Earth Science* 3, 44, 57, 72, 138, 161, 266, 279, 316, 360, 408, 465, 568, 587, 600, 622, 675, 721, 760 *Expeditions* 20, 366, 785 *Writing in Earth Science* 20 *Reading for Comprehension* 191 *Earth Science & Environment* 269 **Teacher Edition:** E 7; ESJ 269; TCS 607