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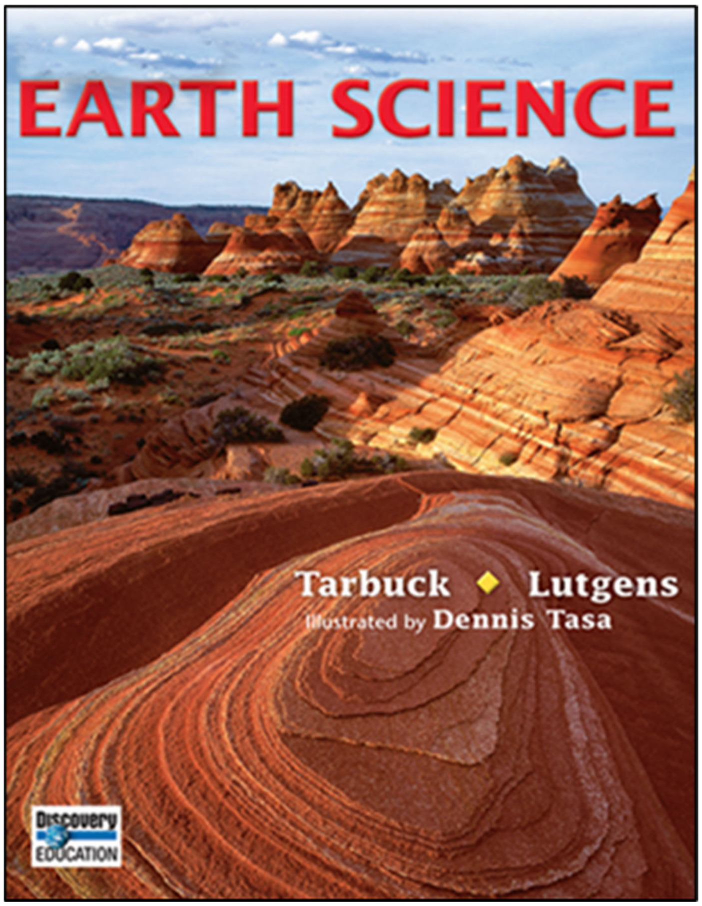

To the

South Carolina
College- and Career-Ready Standards for Science 2021
Earth and Space Science

Prepared by Savvas Learning Company, formerly Pearson K12 Learning

Introduction

This document demonstrates how ***Earth Science ©2017*** supports the South Carolina College- and Career-Ready Standards for Science: Earth and Space Science, High School. Correlation page references are to the Student and Teacher Editions and cited at the page level.

Engage in a journey of observation, explanation, and participation with ***Earth Science***!

Renowned authors Edward Tarbuck and Frederick Lutgens invite students on a journey of observation, explanation, and participation in the study of Earth's processes. An accessible writing style combined with digital support create a fresh new program that leads your diverse classroom on a path to discovery. Detailed illustrations by Dennis Tasa provide students with a comprehensive and immersive look at the science behind our planet.

The ©2017 edition of Earth Science features support for the **Next Generation Science Standards** and STEM activities, as well as enhanced resources for both students and teachers:

21st Century Skills: Each chapter of Earth Science an activity geared toward developing one or 21st Century skills. All of these activities task students to capture what they are learning in the science classroom and apply their knowledge to solving real-life problems in order to encourage productive, thoughtful members of the 21st century world.

STEM Activities: STEM activities support the implementation of the engineering process in an engaging and hands-on way. Excite students with real-world engineering design problem and hands-on inquiry. These activities promote higher-order critical thinking skills and result in improved student performance. Teachers are provided with point-of-use STEM activities and teaching strategies.

Savvas Realize: On savvasrealize.com, you can go digital with online Student Editions and online Teacher Editions, as well as access to editable worksheets.

In addition, Earth Science ©2017 supports the today's diverse classroom with key Spanish resources, including the *Spanish Guided Reading and Study Workbook* and the *Spanish Chapter Tests*.

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Science and Engineering Practices	
Constructing Explanations and Designing Solutions Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.	**SE/TE:** Solar Variability and Climate Change, 691 Inquiry—Exploration Lab Teacher Demo: Tracking Sun Spots, 692–693 Death of Massive Stars, 711 Supernovae, 713 **TE ONLY:** Teacher Demo, Modeling a Pulsar, 713
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Radioactive decay lifetimes and isotopic content in rocks provide a way of dating rock formations and thereby fixing the scale of geological time. Although active geologic processes, such as plate tectonics and erosion, have destroyed or altered most of the very early rock record on Earth, other objects in the Solar System, such as lunar rocks, asteroids, and meteorites, have changed little over billions of years. Studying these objects can provide information about Earth's formation and early history. Study of other planets and their moons, many of which exhibit features such as volcanism and meteor impacts similar to those found on Earth, also help illuminate aspects of Earth's history and changes.	**SE/TE:** Radiometric Dating, 348 Limitations of Radiometric Dating, 349 Age of Earth, 349 Radiometric Dating of Sedimentary Rock, 350 What Is the Geologic Time Scale?, 353 The Lunar Surface, 631 Craters, 631 Lunar History, 633 Figure 8, Sapas Mons and Maat Mons, 651 Structure, 652 **TE ONLY:** Facts and Figures, 652
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Evidence from deep probes and seismic waves, reconstructions of historical changes in Earth's surface and its magnetic field, and an understanding of physical and chemical processes lead to a model of Earth with a hot but solid inner core, a liquid outer core, a solid mantle, and crust. All of Earth's processes are the result of energy flowing and matter cycling within and among Earth systems. Motions of the mantle and its plates occur primarily through thermal convection, which involves the cycling of matter due to the outward flow of energy from Earth's interior and the gravitational movement of denser materials toward the interior.	**SE/TE:** Layers Form on Earth, 5 Destructive and Constructive Forces, 9 Theory of Plate Tectonics, 10 Layers Defined by Composition, 233 Figure 15, Paths of Seismic Waves, 233 Figure 16, Earth's Layered Structure, 234–235 Layers Defined by Physical Properties, 234–235 Figure 17, Earth's Magnetic Field, 235 Discovering Earth's Layers, 236 Figure 18, Earth's Interior Showing P and S Waves Paths, 236 Discovering Earth's Composition, 237 Visual Summary, Figure 5, Breakup of Pangaea, 252
ESS2.B: Plate Tectonics and Large-Scale System Interactions	
The radioactive decay of unstable isotopes continually generates new energy within Earth's crust and mantle providing the primary source of the heat that drives mantle convection. Plate tectonics can be viewed as the surface expression of mantle convection. The top part of the mantle, along with the crust, make up the moving tectonic plates of the lithosphere. Tectonic plates ride above giant convection cells that bring matter from the hot inner mantle up to the cool surface. The plates move across Earth's surface, carrying the continents, creating and destroying ocean basins, producing earthquakes and volcanoes, and forming mountain ranges and plateaus.	**SE/TE:** The Process of Sea–Floor Spreading, 256 Eruptions Along Mid–Ocean Ridges, 256 Movement of the Ocean Floor, 256 Subduction at Deep Ocean Trenches, 257 Earthquake Patterns, 259 Causes of Plate Motions, 261 Effects of Plate Motions, 261 What Causes Plate Motions?, 270 Plate Motion Mechanisms, 271

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PS4.A: Wave Properties	
Geologists use seismic waves and their reflection at interfaces between layers to probe structures deep in the planet.	**SE/TE:** P Waves, 222 S Waves, 222 Earth's Layered Structure, 233 Figure 15, Paths of Seismic Waves, 233 Discovering Earth's Layers, 236 Figure 18, Earth's Interior Showing P and S Wave Paths, 236 **TE ONLY:** Facts and Figures, 233
ETS2.A: Interdependence of Science, Engineering, and Technology	
Science and engineering complement each other in the cycle known as research and development (R&D). Many R&D projects may involve scientists, engineers, and others with wide ranges of expertise. (secondary)	**SE/TE:** Assessing Earthquake Risk, 231 Seismic–Safe Design, 232 **TE ONLY:** Facts and Figures, 236
Science and Engineering Practices	
Developing and Using Models Develop a model based on evidence to illustrate and/or predict the relationships between systems or between components.	**SE/TE:** Inquiry—Try It! How Can Buildings Be Made Earthquake–Safe?, 217 Visual Summary, Figure 4, Seismic Waves, 223 Seismic–Safe Design, 232 **TE ONLY:** Teacher Demo, Sweet Stress, 219 Teacher Demo, Seismic Waves, 223 Build Science Skills: Use Models, 229
Crosscutting Concepts	
Energy and Matter Energy and matter cannot be created nor destroyed - only moved between one place and another place between objects and/or fields, or between systems. The total amount of energy and matter in closed systems is conserved.	**SE/TE:** Causes of Plate Motion, 261 Types of Plate Boundaries, 263 Divergent Boundaries, 264 Convergent Boundaries, 265–266 Transform Fault Boundaries, 268 Plate Motion Mechanisms, 271

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Performance Expectation	
E-ESS2-4 Use a model to describe how causes of short and long-term variations in the flow of energy into and out of Earth's systems result in changes to climate.	**SE/TE:** Inquiry—Try It! Modeling the Angle of the Sun, 475 Conduction, 483 Convection, 484 Radiation, 485 What Happens to Solar Radiation?, 486 Reflection and Scattering, 486 Absorption, 487 Earth's Atmosphere, 494–495 Inquiry—Exploration Lab: Heating Land and Water, 496–497 Performance–Based Assessment, 500 Global Winds, 540 Rotating Earth Model, 540–541 Influence of Continents, 542 Inquiry—Quick Lab, Observing How Land and Water Absorb and Release Energy, 590 Inquiry—Exploration Lab: Human Impact on Climate and Weather, 606–607
Disciplinary Core Ideas	
ESS1.B: Earth and the Solar System	
Cyclical changes in the shape of Earth's orbit around the sun, together with changes in the orientation of the planet's axis of rotation, both occurring over tens to hundreds of thousands of years, have altered the intensity and distribution of sunlight falling on Earth. These phenomena cause cycles of ice ages and other gradual climate changes. (secondary)	**SE/TE:** Figure 2, Earth's Major Climate Zones, 589 Latitude, 589 Earth's Orbital Motions, 601 Solar Activity, 601 Global Climate Change, 602–603 Revolution, 624 Figure 14, The Celestial Sphere, 624 Precession, 625 Figure 15, Precession, 625

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ESS2.D: Weather and Climate	
The foundation for Earth's global climate systems is the electromagnetic radiation from the Sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy's re-radiation into space. Climate changes, which are defined as significant and persistent changes in an area's average or extreme weather conditions can occur if any of Earth's systems change. Scientists can infer these changes from geological evidence. Some climate changes in Earth's history were rapid shifts (caused by natural events, such as volcanic eruptions and meteoric impacts, which suddenly put a large amount of particulate matter into the atmosphere or by abrupt changes in ocean currents, or variations in solar output). Other climate changes were gradual and longer term--due, for example, to solar output variations, or atmospheric changes due to the rise of plants and other life forms that modified the atmosphere via photosynthesis. The timescale of these changes varies from a few to millions of years. Cumulative increases in the atmospheric concentrations of carbon dioxide and other greenhouse gases, whether arising from natural sources or human industrial activity, increase the capacity of Earth to retain energy. Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate.	**SE/TE:** The Carbon Cycle, 85 Dating with Tree Rings, 352 Reflection and Scattering, 486 Absorption, 487 Land and Water, 489 Cloud Cover and Albedo, 492 Factors That Affect Climate, 588 Latitude, 589 Elevation, 589 Topography, 590 Bodies of Water, 590 Circulation in the Atmosphere, 591 Vegetation, 591 Plate Tectonics, 600 Earth's Orbital Motions, 601 Ocean Circulation, 601 Solar Activity, 601 Volcanic Eruptions, 601 Figure 15, Change in CO_2 Levels, 602 The Greenhouse Effect, 602 Global Climate Change, 602–603 The Atmosphere Evolves, 365 Photosynthetic Organisms, 367 Silurian Life, 372 Devonian Period, 372 Seafloor Sediment and Climate Data, 409 **TE ONLY:** Teacher Demo, Heating and Angles, 589 Address Misconceptions, 600 Teacher Demo, Earth's Motions and Climate, 601 Facts and Figures, 602 Integrate Biology, 367
Science and Engineering Practices	
Developing and Using Models Use a model based on evidence to illustrate and/or predict the relationships between systems or between components.	**SE/TE:** Inquiry—Try It! Modeling the Angle of the Sun, 475 Inquiry—Exploration Lab: Heating Land and Water, 496–497 Inquiry—Exploration Lab: Human Impact on Climate and Weather, 606–607 Performance–Based Assessment, 500 Inquiry—Quick Lab, Observing How Land and Water Absorb and Release Energy, 590

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Crosscutting Concepts	
Cause and Effect Empirical evidence is required to differentiate between cause and correlations and make claims about specific causes and effects.	**SE/TE:** Inquiry—Try It! Modeling the Angle of the Sun, 475 Inquiry—Exploration Lab: Heating Land and Water, 496–497 Inquiry—Exploration Lab: Human Impact on Climate and Weather, 606–607 Performance–Based Assessment, 500 Inquiry—Quick Lab, Observing How Land and Water Absorb and Release Energy, 590 **TE ONLY:** Teacher Demo, Angles and Seasons, 481 Teacher Demo, Heating of Land and Water, 490 Teacher Demo, Heating and Angles, 589 Teacher Demo, Modeling Humid Climates, 596 Teacher Demo, Earth's Motions and Climate, 601
Performance Expectation	
E-ESS2-5 Investigate the ways that water (given its unique physical and chemical properties) impacts various Earth systems.	**SE/TE:** Inquiry—Try It! What Causes Weathering?, 125 Inquiry—Exploration Lab: Effect of Temperature on Chemical Weathering, 150–151 Inquiry—Exploration Lab: Investigating the Permeability of Soils, 181 Inquiry—Try It! How Does Pressure Affect Ice Crystals?, 187 Inquiry—Try It! How Does Particle Size Affect Settling Rates?, 393 Inquiry—Try It! How Does Salinity Affect the Density of Water?, 421 Inquiry—Exploration Lab: How Does Temperature Affect Water Density?, 440–441 Inquiry—Exploration Lab: Heating Land and Water, 496–497 Inquiry—Quick Lab, Observing How Land and Water Absorb and Release Energy, 590

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Disciplinary Core Ideas	
ESS2.C: The Roles of Water in Earth's Surface Processes	
The abundance of liquid water on Earth's surface and its unique combination of physical and chemical properties are central to the planet's dynamics. These properties include water's exceptional capacity to absorb, store, and release large amounts of energy as it changes state; transmit sunlight; expand upon freezing; dissolve and transport materials; and lower the viscosities and melting points of the material when mixed with fluid rocks within the mantle. Each of these properties plays a role in how water affects other Earth systems (e.g., ice expansion contributes to rock erosion, or ocean thermal capacity contributes to moderating temperature variations).	**SE/TE:** Hydrosphere, 8 Frost Wedging, 127 Water, 129 The Water Cycle, 158–159 Erosion, 164 Sediment Transport, 164 Dissolved Load, 164 Suspended Load, 165 Bed Load, 165 Deposition, 166 Glacial Erosion, 192 Glacial Deposition, 194 Water Content, 281 Inquiry—Exploration Lab: Melting Temperatures of Rocks, 300–301 Temperature Variation With Depth, 424 Hydrothermal Vents, 430 Figure 12, Marine Life Zones, 431 How Earth Works, 438–439 Inquiry—Exploration Lab: How Does Temperature Affect Water Density?, 440–441 Surface Currents, 448–449 Ocean Currents and Climate, 450 Deep Ocean Circulation, 451 Evaporation, 451 Sea Ice, 452 A Conveyor Belt, 453 Figure 8, A Continuous Current, 453 Wave Impact, 461 Abrasion, 462 Longshore Transport, 463 Inquiry—Exploration Lab: Heating Land and Water, 496–497
Science and Engineering Practices	
Planning and Carrying Out Investigations Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence.	**SE/TE:** Inquiry—Exploration Lab: Effect of Temperature on Chemical Weathering, 150–151 Inquiry—Try It! How Does Pressure Affect Ice Crystals?, 187 Inquiry—Try It! How Does Salinity Affect the Density of Water?, 421 Inquiry—Exploration Lab: How Does Temperature Affect Water Density?, 440–441 Inquiry—Exploration Lab: Heating Land and Water, 496–497 Inquiry—Quick Lab, Observing How Land and Water Absorb and Release Energy, 590

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Crosscutting Concepts	
Cause and Effect Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system. Systems can be designed to cause a desired effect.	**SE/TE:** Visual Summary, Figure 2, Mechanical Weathering and Surface Data, 127 Inquiry—Exploration Lab: Effect of Temperature on Chemical Weathering, 150–151 Inquiry—Try It! How Does Pressure Affect Ice Crystals?, 187 Inquiry—Quick Lab, Evaporative Salts, 412 Inquiry—Try It! How Does Salinity Affect the Density of Water?, 421 Inquiry—Exploration Lab: How Does Temperature Affect Water Density?, 440–441 Inquiry—Try It! How Do Ocean Waves Form?, 447 Inquiry—Exploration Lab: Heating Land and Water, 496–497 Inquiry—Quick Lab, Observing How Land and Water Absorb and Release Energy, 590 Inquiry—Exploration Lab: Measuring Humidity, 524–525
Performance Expectation	
E-ESS2-6 Develop a quantitative model to describe the cycling of carbon through the hydrosphere, atmosphere, geosphere, and biosphere.	**SE/TE:** Isotopes, 38 Carbonates, 48 Biochemical Sedimentary Rocks, 78 The Carbon Cycle, 85 Coal, 95–96 Petroleum and Natural Gas, 96 Tar Sands, 97 Oil Shales, 97 Earth's Blanket of Air, 110 Pollution in the Air, 110
Disciplinary Core Ideas	
ESS2.D: Weather and Climate	
Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen. Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate.	**SE/TE:** The Atmosphere Evolves, 365 The Oceans Form, 365 Photosynthetic Organisms, 367 Ordovician Period, 371 Silurian Life, 372 Figure 3, Primary Pollutants in the Atmosphere, 478 Human Impact on Climate, 602 The Greenhouse Effect, 602 Figure 15, Change in CO_2 Levels, 602 Global Climate Change, 602–603 Inquiry—Exploration Lab: Human Impact on Climate and Weather, 606–607

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Science and Engineering Practices	
Developing and Using Models Develop a model based on evidence to illustrate and/or predict the relationships between systems or between components.	**SE/TE:** The Carbon Cycle, 85 Earth's Atmosphere, 495–496 Global Climate Change, 602–603 **TE ONLY:** Teaching Tips, 3rd bullet, 85
Crosscutting Concepts	
Energy and Matter The total amount of energy and matter in closed systems is conserved.	**SE/TE:** Open and Closed Systems, 18 **TE ONLY:** Build Reading Literacy, 19
Performance Expectation	
E-ESS2-7 Communicate scientific information that illustrates how Earth's systems and life on Earth change and influence each other over time.	**SE/TE:** Inquiry—Try It! What Are Fossils?, 363 The Atmosphere Evolves, 365 Photosynthetic Organisms, 367 Precambrian Life, 367 The Earliest Life, 367 Photosynthetic Organisms, 367 13.1 Assessment, 368 Figure 6, Paleozoic Era, 369 Reading Strategy, 369 Figure 17, Mesozoic Era, 377 Figure 24, Cenozoic Era, 382 Quaternary Earth, 384 Quaternary Life, 384 Quaternary Extinction, 385
Disciplinary Core Ideas	
ESS2.D: Weather and Climate	
Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen. The time scales of these changes varied from a few to millions of years.	**SE/TE:** The Atmosphere Evolves, 365 The Oceans Form, 365 Photosynthetic Organisms, 367 Cambrian Life, 370 Ordovician Life, 371 Silurian Period, 372 **TE ONLY:** Integrate Biology, 367

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ESS2.E: Biogeology	
As Earth changes, life on Earth adapts and evolves to those changes, so just as life influences other Earth systems, other Earth systems influence life. Life and the planet's nonliving systems can be said to co-evolve. The many dynamic and delicate feedbacks between the biosphere and other Earth systems cause a continual co-evolution of Earth's surface and the life that exists on it.	**SE/TE:** The Atmosphere Evolves, 365 Precambrian Life, 367 The Earliest Life, 367 Photosynthetic Organisms, 367 Prokaryotes and Eukaryotes, 368 Multicellular Life, 368 The Paleozoic Era, 369 Figure 6, Paleozoic Era, 369 Cambrian Earth, 370 Cambrian Period, 370 Ordovician Earth, 371 Ordovician Life, 371 Silurian Earth, 372 Silurian Life, 372 Devonian Earth, 372 Devonian Life, 373 Carboniferous Earth, 374 Carboniferous Life, 374 Permian Earth, 375 Permian Life, 375 The Permian Extinction, 376 Figure 6, Mesozoic Era, 377 Triassic Earth, 378 Triassic Life, 378 Jurassic Earth, 379 Jurassic Life, 379 Evolution of Birds, 380 Cretaceous Earth, 380 Cretaceous Life, 380 The Cretaceous Extinction, 381 Figure 6, Cenozoic Era, 382 Tertiary Earth, 383 Tertiary Life, 383 Quaternary Earth, 384 Quaternary Life, 384 Quaternary Extinction, 385

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Science and Engineering Practices	
Obtaining, Evaluating, and Communicating Information	
Communicate scientific and/or technical information or ideas (e.g. about phenomena) in multiple formats (i.e., orally, graphically, textually, mathematically).	**SE/TE:** Inquiry—Exploration Lab: Fossil Occurrence and the Age of Rocks, 356–357 Performance–Based Assessment, 360 **TE ONLY:** Build Science Skills: Use Analogies, 336 Use Community Resources, 337 Build Science Skills: Use Models, 344 Build Reading Literacy, 365 Build Reading Literacy, 372 Build Science Skills: Use Models, 375 21st Century Learning, 388
Use words, tables, diagrams, and graphs, as well as mathematical expressions to communicate their understanding or to ask questions about a system under study.	**SE/TE:** The Carbon Cycle, 85 Inquiry—Try It! What Are Fossils?, 363 13.1 Assessment, 368 Reading Strategy, 369 13.2 Assessment, 376 Reading Strategy, 377 13.3 Assessment, 381 Reading Strategy, 382 Figure 26, Ice Age Cycles, 384 13,4 Assessment, 385 13 Assessment, 389–390
Crosscutting Concepts	
Stability and Change Much of science deals with constructing explanations of how things change and how they remain stable.	**SE/TE:** 13.1 Assessment, 368 Reading Strategy, 369 13.2 Assessment, 376 Reading Strategy, 377 13.3 Assessment, 381 Reading Strategy, 382 13.4 Assessment, 385 13 Assessment, 389–390

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Earth and Human Activity (ESS3)	
Performance Expectation	
E-ESS3-1 Construct an explanation based on evidence for how the availability of natural resources and occurrence of natural hazards have influenced human activity.	**SE/TE:** 1.4 Assessment, 22 Figure 5, Distribution of Oil Shale in the Green River Formation, 98 4.1 Assessment, 101 Figure 10, Photovoltaic Cells, 103 Figure 11, Diablo Canyon Nuclear Power Plant Near San Luis Obispo, California, 103 4.2 Assessment, 107 4.3 Assessment, 112 Reading Checkpoint, 141 5.2 Assessment, 142 Figure 21, Mudflow, 144 Reading Checkpoint, 144 5.3 Assessment, 147 Inquiry—Try It! How Do Local Bodies of Water Affect Your Community?, 157 6.1 Assessment, 163 6.2 Assessment, 170 The Ogallala Aquifer—How Long Will the Water Last?, 180 6 Assessment, 184 Inquiry—Try It! How Can Buildings Be Made Earthquake–Safe?, 217 8.3 Assessment, 232 20 Assessment, 584 Inquiry—Exploration Lab: Human Impact on Climate and Weather, 606–607
Disciplinary Core Ideas	
Resource availability has guided the development of human society.	**SE/TE:** Earth's Resources, 20 Population Effects on Resources, 21 Energy and Mineral Resources, 94 Renewable ad Nonrenewable Resources, 94–95 Coal, 93 Tar Sands and Oil Shale, 97 Placer Deposits, 100 Nonmetallic Mineral Resources, 100 Alternative Energy Sources, 102 Protecting Resources, 113 Bingham Canyon, Utah: The Largest Open–Pit Mine, 117 4 Assessment, 122

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ESS3.B: Natural Hazards	
Natural hazards and other geologic events have shaped the course of human history by destroying buildings and cities, eroding land, changing the course of rivers, and reducing the amount of arable land. These have significantly altered the sizes of human populations and have driven human migrations. Natural hazards can be local, regional, or global in origin, and their risks increase as populations grow.	**SE/TE:** Nuclear Energy, 104 Damage to Land Resources, 111–112 Figure 21, Mudflow, 144 Removal of Vegetation, 145 Map It! Activity, 166 Map It! Activity, 168 Floods and Flood Control, 168–169 Artificial Levees, 169 Flood–Control Dam, 169 Limiting Development, 169 Figure 24, Sinkhole, 179 Photograph, 216–217 Figure 7, Modified Mercalli Scale, 226 Figure 9, Earthquake Damage, 228 Figure 10, Liquefaction and Landslides, 229 Liquefaction, 229 Landslides and Mudflows, 229 Figure 11, Indian Ocean Tsunami, 2004, 230 Tsunamis, 230 Volcanic Hazards, 294 How Earth Works, 298–299
ETS2.B: Influence of Engineering, Technology, and Science on Society and the Natural World	
World Modern civilization depends on major technological systems. (secondary)	**SE/TE:** Satellites and Information Technology, 17 Solar Energy, 102–103 Nuclear Energy, 103 Wind Energy, 104 Hydroelectric Power, 105 Geothermal Energy, 105–106 Tidal Power, 106–107 Floods and Flood Control, 168–169 Recording Seismic Waves, 224 Tsunamis, 230 Reducing Earthquake Damage, 231 Assessing Earthquake Risk, 231 Seismic–Safe Design, 232 Evaporative Salts, 412 Sand and Gravel, 412 Manganese Nodules, 413 Tornado Warning, 574

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Science and Engineering Practices	
Constructing Explanations and Designing Solutions Apply scientific ideas, principles, and/or evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects.	**SE/TE:** 4.2 Assessment, 107 6.1 Assessment, 163 6.2 Assessment, 170 Inquiry—Try It! How Can Buildings Be Made Earthquake–Safe?, 217 8.2 Assessment, 227 8.3 Assessment, 232 Figure 15, Assessing Resources, 410 14.4 Assessment, 413 How Earth Works, 578–579
Crosscutting Concepts	
Cause and Effect Empirical evidence is required to differentiate between cause and correlations and make claims about specific causes and effects.	**SE/TE:** Inquiry—Try It! How Can Buildings Be Made Earthquake–Safe?, 217 Inquiry—Quick Lab, Why Are Some Volcanoes Explosive?, 287
Performance Expectation	
E-ESS3-2 Evaluate competing design solutions that address the impacts of developing, managing, and using Earth's energy and mineral resources.	**SE/TE:** Inquiry—Try It! How Can You Determine the Resources You Use?, 93 Coal, 96 Tar Sands, 97 Oil Shale, 97–98 Solar Energy, 103 Nuclear Energy, 104 Wind Energy, 104 Hydroelectric Power, 105 Bingham Canyon, Utah: The Largest Open-–Pit Mine, 117 Inquiry—Exploration Lab: Finding the Product that Best Conserves Resources, 118–119 4 Assessment, 122 Earth and Human Activity: Science and Engineering Practices: Designing Solutions: Design to Reduce Waste, 729

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Disciplinary Core Ideas	
ESS3.A: Natural Resources	
All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors.	**SE/TE:** Coal, 96 Tar Sands, 97 Oil Shale, 97–98 Figure 5, Distribution of Oil Shale in the Green River Formation, 98 Nonmetallic Mineral Resources, 100 4.2 Alternative Energy Sources, 102 Solar Energy, 102–103 Figure 11, Diablo Canyon Nuclear Power Plant Near San Luis Obispo, California, 103 Nuclear Energy, 103–104 Wind Energy, 104 Hydroelectric Power, 105 Geothermal Energy, 105–106 Tidal Power, 106–107 Figure 15, Tidal Dam, 107 Freshwater Pollution, 108–109 Pollution in the Air, 110 Damage to Land Resources, 111–112 Protecting Resources, 113 Keeping Water Clean and Safe, 114 Protecting the Air, 114–115 Farming, 115 Forests, 115 Disposal of Waste, 116 Recycling, 116 Bingham Canyon, Utah: The Largest Open–Pit Mine, 117 Oil and Gas, 410 Figure 15, Accessing Resources, 410 Gas Hydrates, 411 Evaporative Salts, 412 Sand and Gravel, 412 Manganese Nodules, 413 **TE ONLY:** Integrate Economics, 94 Differentiated Instruction, 95 Build Reading Literacy, 97 Facts and Figures, 97 Build Science Skills: Apply Concepts, 109 Build Reading Literacy, 115 Facts and Figures, 115

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ETS1.A: Defining and Delimiting an Engineering Problem	
Humanity faces major global challenges today, such as the need for supplies of clean water and food or for energy sources that minimize pollution, which can be addressed through engineering. These global challenges also may have manifestations in local communities.	**SE/TE:** Tar Sands, 97 Solar Energy, 102–103 Wind Energy, 104 Hydroelectric Power, 105 Geothermal Energy, 105–106 Tidal Power, 106–107 Keeping Water Clean and Safe, 114 Farming, 115 **TE ONLY:** Facts and Figures, 104 Integrate Geography, 105 Facts and Figures, 115
ETS1.B: Developing Possible Solutions	
When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. Testing should lead to improvements in the design through an iterative procedure. (secondary)	**SE/TE:** Design to Reduce Waste, 729 Design Solutions, 729
ETS2.B: Influence of Engineering, Technology, and Science on Society and the Natural World	
Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks. Analysis of costs and benefits is a critical aspect of decisions about technology. (secondary)	**SE/TE:** Wind Energy, 104 Hydroelectric Power, 105 Geothermal Energy, 105–106 Tidal Power, 106–107 Keeping Water Clean and Safe, 114 Farming, 115 Design to Reduce Waste, 729 Design Solutions, 729
Science and Engineering Practices	
Constructing Explanations and Designing Solutions Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student generated sources of evidence, prioritized criteria, and trade off considerations.	**SE/TE:** Inquiry—Try It! How Can You Determine the Resources You Use?, 93 Bingham Canyon, Utah: The Largest Open-—Pit Mine, 117 Inquiry—Exploration Lab: Finding the Product that Best Conserves Resources, 118–119 4 Assessment, 122 Earth and Human Activity: Science and Engineering Practices: Designing Solutions: Design to Reduce Waste, 729

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Crosscutting Concepts	
Cause and Effect Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system.	**SE/TE:** Figure 10, Photovoltaic Cells, 103 Figure 11, Diablo Canyon Nuclear Power Plant Near San Luis Obispo, California, 103 Table 2 Major Types of Water Pollution,109 **TE ONLY:** Build Science Skills: Apply Concepts, 104 Teacher Demo: Modeling Hydroelectric Power, 105 Teacher Demo: Making a Geyser, 106 Build Reading Literacy, 111
Performance Expectation	
E-ESS3-3 Use computational representation to illustrate the relationships among the management of Earth's resources, the sustainability of human populations, and biodiversity.	**SE/TE:** Population Effect on Resources, 21 Environmental Problems, 21–22 Renewable and Nonrenewable Resources, 94–95 Coal, 95–96 Petroleum and Natural Gas, 96–97 Tar Sands, 97 Oil Shale, 97–98 Mineral Resources and igneous Processes, 98 Hydrothermal Solutions, 99 Placer Deposits, 99–100 Nonmetallic Mineral Resources, 100–101 Solar Energy, 102–103 Nuclear Energy, 104 Wind Energy, 104 Hydroelectric Power, 105 Geothermal Energy, 105–106 Tidal Power, 106–107 The Water Planet, 108 Freshwater Pollution, 108–109 Pollution in the Air, 110 Damage to Land Resources, 111–112 Protecting Resources, 113 Keeping Water Clean and Safe, 114 Protecting the Air, 114–115 Farming, 115 Forests, 115 Disposal of Waste, 116 Recycling, 116

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Disciplinary Core Ideas	
ESS3.C: Human Impacts on Earth Systems	
The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources. When the source of an environmental problem is understood and international agreement can be reached, human activities can be regulated to mitigate global impacts (e.g., acid rain and the ozone hole near Antarctica).	**SE/TE:** Environmental Problems, 21 1.4 Assessment, 22 Coal, 96 Oil Shale, 97 Nonmetallic Mineral Resources, 100 Alternative Energy Sources, 102 Solar Energy, 103 Nuclear Energy, 104 Wind Energy, 104 Hydroelectric Power, 105 Table 2, Major Types of Water Pollution, 109 Pollution in the Air, 110 Damage to Land Resources, 111–112 4.3 Assessment, 112 How Earth Works, 494–495
ETS2.B: Influence of Engineering, Technology, and Science on Society and the Natural World:	
Modern civilization depends on major technological systems.	**SE/TE:** Satellites and Information Technology, 17 Solar Energy, 102–103 Nuclear Energy, 103–104 Wind Energy, 104 Hydroelectric Power, 105 Geothermal Energy, 105–106 Tidal Power, 106–107 Floods and Flood Control, 168–169
New technologies can have deep impacts on society and the environment, including some that were not anticipated.	**SE/TE:** Satellites and Information Technology, 17 Solar Energy, 102–103 Nuclear Energy, 103–104 Wind Energy, 104 Hydroelectric Power, 105 Geothermal Energy, 105–106 Tidal Power, 106–107 Floods and Flood Control, 168–169
Science and Engineering Practices	
Using Mathematics and Computational Thinking Use a computational representation of phenomena or design solutions to describe and/or support claims and/or explanations.	**SE/TE:** The Bycatch Problem, 728 Use Mathematical and Computational Thinking, 728

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Crosscutting Concepts	
Stability and Change Feedback (negative or positive) can stabilize or destabilize a system.	**SE/TE:** Nuclear Energy, 103–104 Wind Energy, 104 Hydroelectric Power, 105 Floods and Flood Control, 169 Artificial Levees, 169 Flood–Control Dam, 169 Limiting Development, 169 **TE ONLY:** Facts and Figures, 20
Performance Expectation	
E-ESS3-4 Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.	**SE/TE:** Protecting Resources, 113 Keeping Water Clean and Safe, 114 Protecting the Air, 114–115 Caring for Land Resources, 115–116 Inquiry—Exploration Lab: Finding the Product that Best Conserves Resources, 118–119 Performance–Based Assessment, 122 Controlling Erosion, 142 Artificial Levees, 169 Flood–Control Dam, 169 Limiting Development, 169 Performance–Based Assessment, 154 Performance–Based Assessment, 418
Disciplinary Core Ideas	
ESS3.C: Human Impacts on Earth Systems	
Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation.	**SE/TE:** Solar Energy, 102–103 Wind Energy, 104 Geothermal Energy, 105–106 Tidal Power, 106–107
ETS1.B: Developing Possible Solutions	
When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. Testing should lead to improvements in the design through an iterative procedure.	**SE/TE:** Coal, 96 Tar Sands, 97 Oil Shale, 97–98 Solar Energy, 102–103 Nuclear Energy, 103–104 Wind Energy, 104 Hydroelectric Power, 105 Geothermal Energy, 105–106 Tidal Power, 106–107

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EST2.B: Influence of Engineering, Technology, and Science on Society and the Natural World	
Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks.	**SE/TE:** Design to Reduce Waste, 729 Design Solutions, 729
Science and Engineering Practices	
Constructing Explanations and Designing Solutions Design or refine a solution to a complex real- world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and trade off considerations.	**SE/TE:** Inquiry—Exploration Lab: Finding the Product that Best Conserves Resources, 118–119 Design to Reduce Waste, 729 Build Science Skills: Use Models, 103
Crosscutting Concepts	
Stability and Change Feedback (negative or positive) can stabilize or destabilize a system.	**SE/TE:** Figure 10, Photovoltaic Cells, 103 Figure 11, Diablo Canyon Nuclear Power Plant Near San Luis Obispo, California, 103 Nuclear Energy, 103–104 Wind Energy, 104 Hydroelectric Power, 105 Floods and Flood Control, 169 Artificial Levees, 169 Flood–Control Dam, 169 Limiting Development, 169
Performance Expectation	
E-ESS3-5 Analyze data and the results from global climate models to make an evidence-based forecast of the current rate of regional or global climate change and associated future impacts to Earth's systems..	**SE/TE:** Figure 15, Change in CO_2 Levels, 602 21.3 Assessment, 603 Inquiry—Exploration Lab: Human Impact on Climate and Weather, 606–607 21 Assessment, 610
Disciplinary Core Ideas	
ESS3.D: Global Climate Change	
Global climate models are often used to understand the process of climate change because these changes are complex and can occur slowly over Earth's history.	**SE/TE:** Inquiry—Try It! Global Climate Change: What Is Causing It?, 587 Plate Tectonics, 600 Earth's Orbital Motions, 601 Ocean Circulation, 601 Solar Activity, 601 Volcanic Eruptions, 601 Figure 15, Change in CO_2 Levels, 602 The Greenhouse Effect, 602 Global Climate Change, 602–603

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Though the magnitudes of human impacts are greater than they have ever been, so too are human abilities to model, predict, and manage current and future impacts.	**SE/TE:** Inquiry—Try It! Global Climate Change: What Is Causing It?, 587 Figure 15, Change in CO_2 Levels, 602 The Greenhouse Effect, 602 Global Climate Change, 602–603
Science and Engineering Practices	
Analyzing and Interpreting Data Analyze data using computational models in order to make valid and reliable scientific claims.	**SE/TE:** Inquiry—Try It! Global Climate Change: What Is Causing It?, 587 The Greenhouse Effect, 602 Figure 15, Change in CO_2 Levels, 602 Global Climate Change, 602–603 Inquiry—Exploration Lab: Human Impact on Climate and Weather, 606–607
Crosscutting Concepts	
Stability and Change Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible.	**SE/TE:** Figure 15, Change in CO_2 Levels, 602 Global Climate Change, 602–603
Performance Expectation	
E-ESS3-6 Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.	**SE/TE:** How Earth Works, 494–495 Climate Changes, 600 Figure 15, Change in CO_2 Levels, 602 Human Impact on Climate, 602 Global Climate Change, 602–603 Inquiry—Exploration Lab: Human Impact on Climate and Weather, 606–607
Disciplinary Core Ideas	
ESS2.D: Weather and Climate	
Current models predict that, although future regional climate changes will be complex and varied, average global temperatures will continue to rise. The outcomes predicted by global climate models strongly depend on the amounts of human-generated greenhouse gases added to the atmosphere each year and by the ways in which these gases are absorbed by the ocean and biosphere. Hence the outcomes depend on human behaviors as well as on natural factors that involve complex feedback among Earth's systems. (secondary)	**SE/TE:** The Carbon Cycle, 85 Figure 15, Change in CO_2 Levels, 602 The Greenhouse Effect, 602 Global Climate Change, 602–603 **TE ONLY:** 21st Century Learning, 608

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ESS3.D: Global Climate Change	
Through computer simulations and other studies, important discoveries are still being made about how the ocean, the atmosphere, and the biosphere interact and are modified in response to human activities.	**SE/TE:** The Carbon Cycle, 85 Freshwater Pollution, 108–109 Pollution in the Air, 110 How Earth Works, 494–495 Global Climate Change, 602–603
ESS3.B: Natural Hazards	
Human activities can contribute to the frequency and intensity of some natural hazards.	**SE/TE:** Floods and Flood Control, 168–169 Limiting Development, 169 The Greenhouse Effect, 602 Global Climate Change, 602–603 Inquiry—Exploration Lab: Human Impact on Climate and Weather, 606–607
Science and Engineering Practices	
Using Mathematics and Computational Thinking Use a computational representation of phenomena or design solutions to describe and/or support claims and/or explanations.	**SE/TE:** Inquiry—Exploration Lab: Human Impact on Climate and Weather, 606–607
Crosscutting Concepts	
Systems and System Models When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models.	**SE/TE:** Inquiry—Exploration Lab: Human Impact on Climate and Weather, 606–607
Performance Expectation	
E-ESS3-7 Create an argument, based on evidence, that describes how changes in climate on Earth have affected human activity.	**SE/TE:** Global Climate Change, 602–603 21.3 Assessment, 603 Inquiry—Exploration Lab: Human Impact on Climate and Weather, 606–607

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Disciplinary Core Ideas	
ESS3.D: Global Climate Change	
Impacts of climate change--for example, increased frequency of severe storms due to ocean warming--have begun to influence human activities. Through computer simulations and other studies, important discoveries are still being made about how the ocean, the atmosphere, and the biosphere interact and are modified in response to human activities, as well as to changes in human activities. Thus, science and engineering will be essential both to understanding the possible impacts of global climate change and to informing decisions about how to slow its rate and consequences for humanity as well as for the rest of the planet. The impacts of climate change are uneven and may affect some regions, species, of human populations more severely than others. By using science-based predictive models, humans can anticipate long-term change more effectively than ever and plan accordingly.	**SE/TE:** El Niño and La Niña, 546 Figure 16, Normal Conditions, 546 El Niño, 546–547 Figure 17, El Niño, 547 La Niña, 547 Tracking El Niño from Space, 549 Global Climate Change, 602–603
ETS2.B: Influence of Engineering, Technology, and Science on Society and the Natural World	
Modern civilization depends on major technological systems. (secondary)	For supporting content, please see: **SE/TE:** Global Climate Change, 603 Inquiry—Exploration Lab: Human Impact on Climate and Weather, 606–607
Science and Engineering Practices	
Engaging in Argument from Evidence Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments; Construct a scientific argument based on data and evidence.	**SE/TE:** Inquiry, Try It!, p. 587 Global Climate Change, 603 21.3 Assessment, 603 Inquiry—Exploration Lab: Human Impact on Climate and Weather, 606–607 Writing in Science, 611
Crosscutting Concepts	
Cause and Effect Empirical evidence is required to differentiate between cause and correlations and make claims about specific causes and effects.	**SE/TE:** Figure 15, Change in CO_2 Levels, 602 Inquiry—Exploration Lab: Human Impact on Climate and Weather, 606–607