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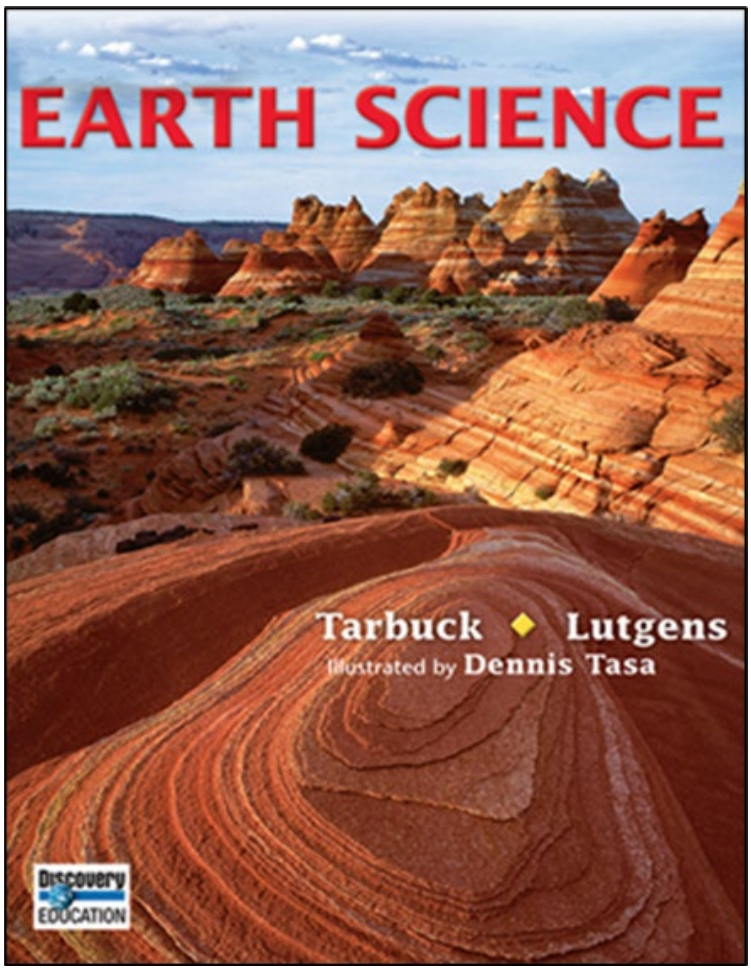

To the

Arkansas
Science Standards 2016
High School Earth Science

Prepared by Savvas Learning Company, formerly Pearson K12 Learning

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High School Earth Science

Introduction

This document demonstrates how ***Earth Science ©2017*** supports the Arkansas Science Standards for Earth Science. Citations include the Student and Teacher Editions, as well as Realize™ digital resources.

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*.

SE = Student Edition **TE = Teacher's Edition**
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ESS1.C: The History of Planet Earth	
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. (Performance Expectation ES-ESS1-6)	**SE/TE:** Formation of Earth, 4-5 Discovering Earth's Composition, 237 Uniformitarianism, 336 Inquiry-Modeling the Geologic Time Scale, 386-387 Asteroids, 660 Comets, 661-663 Meteoroids, 663-664 Earth & Space: Is Earth on a Collision Course?, 665 23.4 Minor Members of the Solar System, 668 **TE Only:** Uniformitarianism vs. Catastrophism, 1C Common Themes, 64C Before You Teach Earth's History, 362C-362D
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New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology. (Performance Expectation ES-ESS2-2, Performance Expectation ES2-ETS1-1, Performance Expectation ES2-ETS1-3)	**SE/TE:** Satellites and Information Technology, 17 Tar Sands and Oil Shale, 97-98 Nuclear Energy, 103-104 14.4 Assessment: Think Critically, 413 Earth & Its Systems: Tracking El Nino from Space, 549 Inquiry Exploration Lab: Teacher Demo: Tracking Sunspots, 693-693 Stem Activity; Earth's Place In The Universe, 730 **TE Only:** Facts and Figures, 323 Integrate Social Studies: Challenger Expedition, 397 Build Science Skills, 578
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Disciplinary Core Ideas	
ESS2.A: Earth Materials and Systems	
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. 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 gravitational movement of denser materials toward the interior. (Performance Expectation ES-ESS2-3)	**SE/TE:** Geosphere, 8-9 Layers Defined by Composition, 233-234 Discovering Earth's Layers, 236 Discovering Earth's Composition, 237 How Earth Works: Effects of Earthquakes, 238-239 Inquiry Exploration Lab: Locating an Earthquake, 240-241 **TE Only:** Address Misconceptions, 9 Facts and Figures: Earth's Fundamental Note, 220 Earth Science Refresher, 278C-278D
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Energy drives the cycling of matter within and between systems. (Performance Expectation ES-ESS2-3)	**SE/TE:** Earth's Changing Surface, 9-10 Energy Sources, 19 The Cause of Earthquakes, 219-221 What Causes Plate Motions?, 270 Plate Motion Mechanisms, 271 Origin of Magma, 280 Batholiths, 297 **TE Only:** Earth Science Refresher: Why do we have plate tectonics?, 246C-246D Review Science Concepts, 246 Earth Science Refresher, 278C-278D Earth Forms, 365 Use Prior Knowledge, 378 Review Science Concepts, 642
Connections to Engineering, Technology, and Applications of Science	
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. (Performance Expectation ES-ESS2-3)	**SE/TE:** Tar Sands and Oil Shale, 97-98 Mapping the Ocean Floor, 396-400 Manganese Nodules, 413 Stem Activity: Earth's Place In The Universe: Plate Tectonics: Measuring Plate Movement, 730 **TE Only:** Integrate Language Arts, 622 Focus on Technology, 730 Career Connections, 731

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Performance Expectation ES-ESS2-5 Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.	**SE/TE:** Inquiry Try It!, 125 Mechanical Weathering, 126–132 Inquiry Exploration Lab: Effect of Temperature on Chemical Weathering, 150 **TE Only:** Build Science Skills, 195 **Realize™ Digital Resources:** >Lab Manual>Chapter 5: Weathering, Soil, and Mass Movements>Investigation 5: Some Factors That Affect Soil Erosion >Lab Manual>Chapter 6: Running Water and Groundwater>Investigation 6A: Rivers Shape the Land >Reading and Study Workbook>Chapter 8: Earthquakes and Earth's Interior>Section 8.2: Measuring Earthquakes >Reading and Study Workbook>Chapter 8: Earthquakes and Earth's Interior>Section 8.3: Earthquake Hazards >Reading and Study Workbook>Chapter 8: Earthquakes and Earth's Interior>Section 8.4: Earth's Layered Structure
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, transmit sunlight, expand upon freezing, dissolve and transport materials, and lower the viscosities and melting points of rocks. (Performance Expectation ES-ESS2-5)	**SE/TE:** Mechanical Weathering, 126–132 Inquiry Exploration Lab: Effect of Temperature on Chemical Weathering, 150 Ocean Density Variation, 425-426 Composition of the Atmosphere: Variable Components, 477 Water's Changes of State, 504-506 **TE Only:** Causes of Chemical Weathering, 124C Water in the Atmosphere, 474C-474D Facts and Figures, 656 **Realize™ Digital Resources:** >Lab Manual>Chapter 5: Weathering, Soil, and Mass Movements>Investigation 5: Some Factors That Affect Soil Erosion >Lab Manual>Chapter 6: Running Water and Groundwater>Investigation 6A: Rivers Shape the Land

Arkansas Science Standards 2016 High School Earth Science	Earth Science ©2017
Science and Engineering Practices	
Planning and Carrying Out Investigations	
Planning and carrying out investigations in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.	
Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (Performance Expectation ES-ESS2-5)	**SE/TE:** Inquiry Exploration Lab: Investigating the Permeability of Soils, 181 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 Exploration Lab: Heating Land and Water, 496-497 Inquiry Try It!: What Causes Condensation?, 503 Inquiry Quick Lab: Observing How Land And Water Absorb And Release Energy, 590 **TE Only:** Build Science Skills: Student Activity: Experiments, 78 Build Science Skills: Student Activity: Design Experiments, 195 Go Further, 441
Crosscutting Concepts	
Structure and Function	
The functions and properties of natural and designed objects and systems can be inferred from their overall structure, the way their components are shaped and used, and the molecular substructures of its various materials. (Performance Expectation ES-ESS2-5)	**SE/TE:** Hydrosphere, 8 Frost Wedging, 127 Inquiry Try It!: How Do Local Bodies of Water Affect Your Community?, 157 Inquiry Try It!: How Does Salinity Affect The Density Of Water?, 421 Inquiry Exploration Lab: How Does Temperature Affect Water Density?, 440-441 Evaporation, 451 Composition of the Atmosphere: Variable Components, 477 Inquiry Exploration Lab: Heating Land and Water, 496-497 Figure 3 Relative Humidity, 507 **TE Only:** Build Science Skills: Student Activity: Design Experiments, 127

Arkansas Science Standards 2016 High School Earth Science	Earth Science ©2017
Performance Expectation ES-ESS2-6 Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.	**SE/TE:** Carbonates, 48 Biochemical Sedimentary Rocks, 78 Earth & Its Systems, 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 Biogenous Sediment, 408–409 Composition of the Atmosphere, 477–478 Human Impact on Climate, 602–603 **TE Only:** Earth Science Refresher, 186C **Realize™ Digital Resources:** >Lab Manual>Chapter 17: Earth's Atmosphere> Investigation 17B: Investigating Factors That Control Temperature >Lab Manual>Chapter 21: Climate>Investigation 21: Modeling the Greenhouse Effect >Reading and Study Workbook >Chapter 3: Rocks>Section 3.4: Metamorphic Rocks >Reading and Study Workbook >Chapter 4: Earth's Resources>Section 4.4: Protecting Resources >Reading and Study Workbook>Chapter 14: The Ocean Floor>Section 14.3: Seafloor Sediments >Reading and Study Workbook>Chapter 17: Earth's Atmosphere> Section 17.1: Atmosphere Characteristics >Reading and Study Workbook>Chapter 21: Climate>Section 21.3: Climate Changes

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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. (Performance Expectation ES-ESS2-6, Performance Expectation ES-ESS2-7)	**SE/TE:** Carbonates, 48 Biochemical Sedimentary Rocks, 78 Earth & Its Systems, 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 Human Impact on Climate, 602–603 **TE Only:** Facts and Figures, 78
Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate. (Performance Expectation ES-ESS2-6)	**SE/TE:** Earth's Blanket of Air, 110 Pollution in the Air, 110 Protecting the Air, 114-115 Composition of the Atmosphere, 477–478 Earth & Its Resources: Atmospheric Stability and Air Pollution, 523 Human Impact on Climate, 602–603 **TE Only:** Earth Science Refresher, 186C-186D **Realize™ Digital Resources:** >Lab Manual>Chapter 17: Earth's Atmosphere> Investigation 17B: Investigating Factors That Control Temperature >Lab Manual>Chapter 21: Climate>Investigation 21: Modeling the Greenhouse Effect Earth's Atmosphere> Section 17.1: Atmosphere Characteristics >Reading and Study Workbook>Chapter 21: Climate>Section 21.3: Climate Changes

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Science and Engineering Practices	
Developing and Using Models	
Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s).	
Develop a model based on evidence to illustrate the relationships between systems or between components of a system. Performance Expectation ES-ESS2-3, Performance Expectation ES-ESS2-6)	**SE/TE:** Figure 3 Nuclei of Isotopes of Carbon, 38 Earth & Its Systems: The Carbon Cycle, 85 Figure 3 Primary Pollutants in the Atmosphere, 478 Figure 15 Change in CO^2 Levels, 602 **TE Only:** Build Science Skills: Student Activity: Use Models, 96 **Realize™ Digital Resources:** >Lab Manual>Chapter 17: Earth's Atmosphere> Investigation 17B: Investigating Factors That Control Temperature >Lab Manual>Chapter 21: Climate>Investigation 21: Modeling the Greenhouse Effect Earth's Atmosphere> Section 17.1: Atmosphere Characteristics >Reading and Study Workbook>Chapter 21: Climate>Section 21.3: Climate Changes
Crosscutting Concepts	
Energy and Matter	
The total amount of energy and matter in closed systems is conserved. (Performance Expectation ES-ESS2-6)	**SE/TE:** Interacting Parts, 18 Open and Closed Systems, 18 Earth as a System, 19-20 Earth & Its Systems, The Carbon Cycle, 85 **TE Only:** Build Science Skills: Use Analogies, 18 Facts and Figures, 20

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Performance Expectation ES-ESS2-7 Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.	**SE/TE:** People and the Environment, 20–21 Soil Formation, 135–137 Discovering Earth's History, 336–341 Types of Fossils, 342–343 The Fossil Record, 344–346 Inquiry-Fossil Occurrence and the Age of Rocks, 356–357 How Earth Works, 438–439 World Soils, 755–757 **Realize™ Digital Resources:** >Lab Manual>Chapter 13: Earth's History>Investigation 13: Determining Geologic Ages >Lab Manual>Chapter 19: Air Pressure and Wind>Investigation 19: Analyzing Pressure Systems >Lab Manual>Chapter 20: Weather Patterns and Severe Storms>Investigation 20A: Analyzing Severe Weather Data >Reading and Study Workbook >Chapter 5: Weathering, Soil, and Mass Movements>Section 5.2: Soil >Reading and Study Workbook>Chapter 12: Geologic Time>Section 12.1: Discovering Earth's History >Reading and Study Workbook>Chapter 12: Geologic Time>Section 12.2: Fossils: Evidence of Past Life >Reading and Study Workbook>Chapter 12: Geologic Time>Section 12.3: Dating With Radioactivity >Reading and Study Workbook>Chapter 12: Geologic Time>Section 12.4: The Geologic Time Scale

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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. (Performance Expectation ES-ESS2-6, Performance Expectation ES-ESS2-7)	**SE/TE:** The Atmosphere Evolves, 365 Precambrian Life, 367-368 13.1 Assessment: Think Critically: Relate Cause and Effect, 368 Chapter 13 Assessment: Think Critically, 390 **TE Only:** Environmental Implications of Resource Use, 92D Facts and Figures: Ozone And Life On Land, 367
ESS2.E: Biogeology	
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. (Performance Expectation ES-ESS2-7)	**SE/TE:** The Fossil Record, 344-346 Precambrian Life, 367-368 The Paleozoic Era, 369-370 The Permian Extinction, 376 The Mesozoic Era, 377-381 The Cenozoic Era, 382-385 **TE Only:** Integrate Biology: Paleontology and Biogeography, 345 The Evolution of Life, 362C-362D Facts and Figures, 367 Evolutionary Survival Techniques, 420C-420D

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Science and Engineering Practices	
Engaging in Argument from Evidence	
Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.	
Construct an oral and written argument or counter-arguments based on data and evidence. (Performance Expectation ES-ESS2-7)	**SE/TE:** Inquiry Try It!: What are Fossils?, 363 Interpret Visuals: About how long ago did the Proterozoic begin?, 365 Reading Checkpoint, 370 Inquiry Apply It!, 383 **TE Only:** Integrate Biology: Origin of Life on Earth, 367 Build Science Skills: Apply Concepts, 367 Using Visuals: Figure 6, 369 Build Reading Literacy: Sequence, 372 Integrate Biology: Evolution of Amphibians, 373 Build Science Skills: Relate Cause and Effect, 383 Integrate Biology: Seed Dispersal, 383
Crosscutting Concepts	
Stability and Change	
Much of science deals with constructing explanations of how things change and how they remain stable. (Performance Expectation ES-ESS2-7)	**SE/TE:** Precambrian Life, 367-368 The Paleozoic Era, 369-370 The Permian Extinction, 376 The Mesozoic Era, 377-381 The Cenozoic Era, 382-385 Marine Life Zones, 430-432 Oceanic Productivity, 433-435 Oceanic Feeding Relationships, 436-437

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Performance Expectation ES2-ETS1-1 Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.	**SE/TE:** Inquiry Exploration Lab: Finding the Product that Best Conserves Resources, 118–119 Inquiry Try It!: Global Climate Change: What Is Causing It?, 587 Inquiry Exploration Lab: Human Impact on Climate and Weather, 606–607 Stem Activity: The Bycatch Problem, 728 **Realize™ Digital Resources:** >Lab Manual>Chapter 4: Earth's Resources>Investigation 4B: Desalinization by Distillation >Lab Manual>Chapter 20: Weather Patterns and Severe Storms>Investigation 20A: Analyzing Severe Weather Data >Reading and Study Workbook >Chapter 4: Earth's Resources>Section 4.4: Protecting Resources >Reading and Study Workbook>Chapter 21: Climate>Section 21.1: Factors That Affect Climate >Reading and Study Workbook>Chapter 21: Climate>Section 21.3: Climate Changes
Disciplinary Core Ideas	
ETS1.A: Defining and Delimiting Engineering Problems	
Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. (Performance Expectation ES2-ETS1-1)	**SE/TE:** Inquiry Exploration Lab, 118–119 Inquiry Try It!, 587 Inquiry Exploration Lab, 606–607 Stem Activity: The Bycatch Problem, 728 Stem Activity: Design to Reduce Waste, 729 **Realize™ Digital Resources:** >Lab Manual>Chapter 4: Earth's Resources>Investigation 4B: Desalinization by Distillation

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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. (Performance Expectation ES2-ETS1-1)	**SE/TE:** Tar Sands, 97 Solar Energy, 102–103 Wind Energy, 104 Hydroelectric Power, 105 Geothermal Energy, 105–106 Tidal Power, 106–107 The Water Planet, 108-109 Keeping Water Clean and Safe, 114 Farming, 115 Disposal of Waste, 116 Reading Checkpoint, 176 **TE Only:** Facts and Figures, 104 Integrate Geography, 105 Facts and Figures, 115
Science and Engineering Practices	
Asking Questions and Defining Problems	
Asking questions and defining problems in 9–12 builds on K–8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations.	
Analyze complex real-world problems by specifying criteria and constraints for successful solutions. (Performance Expectation ES2-ETS1-1)	**SE/TE:** Inquiry—Try It! How Can You Determine the Resources You Use?, 93 Tar Sands and Oil Shale, 97-98 Alternative Energy Solutions, 102-107 Reading Checkpoint, 103 Assessment 4.2, 107 Bingham Canyon, Utah: The Largest Open—Pit Mine, 117 Inquiry—Exploration Lab: Finding the Product that Best Conserves Resources, 118–119 4 Assessment, 122 Stem Activity: Earth and Human Activity: Science and Engineering Practices: Designing Solutions: Design to Reduce Waste, 729

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Crosscutting Concepts	
Connections to Engineering, Technology, and Applications of Science	
Influence of Engineering, Technology, and Science on Society and the Natural World	
New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology. (Performance Expectation ES-ESS2-2, Performance Expectation ES2-ETS1-1, Performance Expectation ES2-ETS1-3)	**SE/TE:** Satellites and Information Technology, 17 Tar Sands and Oil Shale, 97-98 14.4 Assessment: Think Critically, 413 Earth & Its Systems: Tracking El Nino from Space, 549 23.2 Assessment: Communicate, 653 Space Telescopes, 682-683 Stem Activity; Earth's Place In The Universe, 730 **TE Only:** Facts and Figures, 323 Integrate Social Studies: Challenger Expedition, 397 Build Science Skills, 578 Differentiated Instruction, 601
Performance Expectation ES2-ETS1-3 Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.	**SE/TE:** Tar Sands and Oil Shale, 97–98 Alternative Energy Solutions, 102–107 Reading Checkpoint, 103 4.2 Assessment, 107 Stem Activity: The Bycatch Problem, 728 **Realize™ Digital Resources:** >Lab Manual>Chapter 14: The Ocean Floor>Investigation 14: Modeling the Ocean Floor >Lab Manual>Chapter 16: The Dynamic Ocean>Investigation 16: Shoreline Features >Reading and Study Workbook >Chapter 4: Earth's Resources>Section 4.2: Alternate Energy Sources

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Disciplinary Core Ideas	
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. (Performance Expectation ES2-ETS1-3)	**SE/TE:** Tar Sands and Oil Shale, 97–98 Alternative Energy Solutions, 102–107 4.2 Assessment, 107 Stem Activity: The Bycatch Problem, 728 Stem Activity: Design to Reduce Waste, 729 **TE Only:** Build Science Skills: Use Models, 165 **Realize™ Digital Resources:** >Lab Manual>Chapter 14: The Ocean Floor>Investigation 14: Modeling the Ocean Floor >Lab Manual>Chapter 16: The Dynamic Ocean>Investigation 16: Shoreline Features >Reading and Study Workbook >Chapter 4: Earth's Resources>Section 4.2: Alternate Energy Sources
Science and Engineering Practices	
Constructing Explanations and Designing Solutions	
Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles and theories.	
Evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (Performance Expectation ES2-ETS1-3)	**SE/TE:** Tar Sands and Oil Shale, 97–98 Alternative Energy Solutions, 102–107 Reading Checkpoint, 103 4.2 Assessment, 107 Stem Activity: The Bycatch Problem, 728 **Realize™ Digital Resources:** >Lab Manual>Chapter 14: The Ocean Floor>Investigation 14: Modeling the Ocean Floor >Lab Manual>Chapter 16: The Dynamic Ocean>Investigation 16: Shoreline Features >Reading and Study Workbook >Chapter 4: Earth's Resources>Section 4.2: Alternate Energy Sources

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Crosscutting Concepts	
Connections to Engineering, Technology, and Applications of Science	
Influence of Engineering, Technology, and Science on Society and the Natural World	
New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology. (Performance Expectation ES-ESS2-2, Performance Expectation ES2-ETS1-1, Performance Expectation ES2-ETS1-3)	**SE/TE:** Satellites and Information Technology, 17 Tar Sands and Oil Shale, 97-98 14.4 Assessment: Think Critically, 413 Earth & Its Systems: Tracking El Nino from Space, 549 23.2 Assessment: Communicate, 653 **TE Only:** Facts and Figures, 323 Integrate Social Studies: Challenger Expedition, 397 Build Science Skills, 578 Differentiated Instruction, 601

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Topic 3: Human Sustainability	
Students who demonstrate understanding can:	
Performance Expectation ES-ESS3-1 Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.	**SE/TE:** Environmental Problems, 21–22 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 Freshwater Pollution, 108–109 Land Resources, 111–112 Protecting Resources, 113–116 4.4 Assessment, 116 Earth and Its Resources, 117 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 Environmental Problems Associated With Groundwater, 174–176 The Ogallala Aquifer—How Long Will the Water Last?, 180 6 Assessment, 184 Inquiry—Try It! How Can Buildings Be Made Earthquake–Safe?, 217 Earthquake Hazards, 228–232 Tsunamis, 230 Assessment 8.3, 232 Tornado Warnings, 574 How Earth Works, 578–579 Critical Thinking, 584 Concepts in Action, 584 Inquiry—Exploration Lab: Human Impact on Climate and Weather, 606–607 **Realize™ Digital Resources:** >Lab Manual>Chapter 21: Climate>Investigation 21: Modeling the Greenhouse Effect >Reading and Study Workbook>Chapter 17: Earth's Atmosphere> Section 17.3: Temperature Controls >Reading and Study Workbook>Chapter 21: Climate>Section 21.3: Climate Changes

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Disciplinary Core Ideas	
ESS3.A: Natural Resources	
Resource availability has guided the development of human society. (Performance Expectation ES-ESS3-1)	**SE/TE:** People and the Environment, 20-21 Environmental Problems, 21–22 4.1 Assessment, 101 4.2 Assessment, 107 Land Resources, 111–112 Protecting Resources, 113–116 4.4 Assessment, 116 Earth and Its Resources: Bingham Canyon, Utah: The Largest Open-Pit Mine, 117 Inquiry—Try It! How Do Local Bodies of Water Affect Your Community?, 157 6.1 Assessment, 163 Earth & Its Resources: The Ogallala Aquifer—How Long Will the Water Last?, 180 Chapter 6 Assessment, 184 **TE Only:** The History of Climate, 586C–586D **Realize™ Digital Resources:** >Lab Manual>Chapter 4: Earth's Resources>Investigation 4B: Desalinization by Distillation

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ESS3.B: Natural Hazards	
Natural hazards and other geologic events have shaped the course of human history; [they] have significantly altered the sizes of human populations and have driven human migrations. (Performance Expectation ES-ESS3-1)	**SE/TE:** Environmental Problems, 21–22 Figure 21, Mudflow, 144 Reading Checkpoint, 144 5.3 Assessment, 147 Karst Topography, 178-179 The Ogallala Aquifer—How Long Will the Water Last?, 180 6 Assessment, 184 Glaciers of the Ice Age, 197-198 Inquiry—Try It! How Can Buildings Be Made Earthquake–Safe?, 217 Earthquake Hazards, 228–232 Tsunamis, 230 8.3 Assessment, 232 Tornado Intensity 574 How Earth Works: Winds and Storms, 578–579 Critical Thinking, 584 Concepts in Action, 584 **TE Only:** Integrate Biology, 197 Integrate Biology, 317 The History of Climate, 586C–586D
Science and Engineering Practices	
Constructing Explanations and Designing Solutions	
Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific knowledge, principles, and theories.	
Construct 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. (Performance Expectation ES-ESS3-1)	**SE/TE:** Uniformitarianism, 336 Relative Dating, 337 Correlation, 340-341 12.1 Assessment, 341 Fossils and Evolution, 345 Evolution of Birds, 380 The Cretaceous Extinction, 381 Factors Affecting Wind, 534-536 **TE Only:** Facts and Figures, 338 Build Reading Literacy, 534 Use Visuals, 594

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Crosscutting Concepts	
Cause and Effect	
Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (Performance Expectation ES-ESS3-1)	**SE/TE:** Reading Checkpoint, 251 Fossils: Evidence of Past Life, 342-342 Earth & History: Dating With Tree Rings, 352 Resources from the Seafloor, 410-412 Human Impact on Climate, 602-603 21.3 Assessment, 603 Earth & Space: Solar Variability and Climate Change, 691 **TE Only:** Use Visuals, 220 Integrate Biology: East Africa Rift Valley, 317 Facts and Figures, 349
Connections to Engineering, Technology, and Applications of Science	
Influence of Engineering, Technology, and Science on Society and the Natural World	
Modern civilization depends on major technological systems. (HS-ESS3-1),(HS-ESS3-3)	**SE/TE:** Fossil Fuels, 95-98 4.1 Assessment, 101 Figure 15: Accessing Resources, 410 Manganese Nodules, 413 14.4 Assessment, 413 Weather Forecasting, 539 Tornado Warning, 574 Figure 20 Satellite View of a Hurricane, 575 **TE Only:** Facts & Figures, 97 Build Science Skills: Predict, 578

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Performance Expectation ES-ESS3-2 Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.*	**SE/TE:** Inquiry—Try It! How Can You Determine the Resources You Use?, 93 Coal, 95-96 Petroleum and Natural Gas, 96 Tar Sands and Oil Shale, 97 Solar Energy, 103 Nuclear Energy, 104 Wind Energy, 104 Hydroelectric Power, 105 Protecting Resources, 113–116 Bingham Canyon, Utah: The Largest Open-–Pit Mine, 117 Inquiry—Exploration Lab: Finding the Product that Best Conserves Resources, 118–119 4 Assessment, 122 Environmental Problems Associated with Groundwater, 174–176 Gas Hydrates, 411 Manganese Nodules, 413 Earth and Human Activity: Science and Engineering Practices: Designing Solutions: Design to Reduce Waste, 729 **Realize™ Digital Resources:** >Lab Manual>Chapter 4: Earth's Resources>Investigation 4A: Recovering Oil >Reading and Study Workbook >Chapter 4: Earth's Resources>Section 4.1: Energy and Mineral Resources >Reading and Study Workbook >Chapter 4: Earth's Resources>Section 4.3: Water, Air, and Land Resources >Reading and Study Workbook>Chapter 6: Running Water and Groundwater>Section 6.3: Water Beneath the Surface >Reading and Study Workbook>Chapter 14: The Ocean Floor>Section 14.4: Resources From the Seafloor

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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. (Performance Expectation ES-ESS3-2)	Inquiry—Try It! How Can You Determine the Resources You Use?, 93 Coal, 95-96 Petroleum and Natural Gas, 96 Tar Sands and Oil Shale, 97-98 Solar Energy, 102-103 Nuclear Energy, 103-104 Wind Energy, 104 Hydroelectric Power, 105 Geothermal Energy, 105-106 Protecting Resources, 113–116 Bingham Canyon, Utah: The Largest Open—Pit Mine, 117 **Realize™ Digital Resources:** >Lab Manual>Chapter 4: Earth's Resources>Investigation 4A: Recovering Oil >Reading and Study Workbook >Chapter 4: Earth's Resources>Section 4.1: Energy and Mineral Resources
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. (Performance Expectation ES3-ETS1-3, Performance Expectation ES-ESS3-2, Performance Expectation ES-ESS3-4)	**SE/TE:** Bingham Canyon, Utah: The Largest Open—Pit Mine, 117 Inquiry—Exploration Lab: Finding the Product that Best Conserves Resources, 118–119 4 Assessment, 122 Gas Hydrates, 411 Manganese Nodules, 413 Stem Activity: Design to Reduce Waste, 729 **TE Only:** Build Science Skills: Infer, 411 **Realize™ Digital Resources:** >Reading and Study Workbook >Chapter 4: Earth's Resources>Section 4.3: Water, Air, and Land Resources >Reading and Study Workbook>Chapter 6: Running Water and Groundwater>Section 6.3: Water Beneath the Surface >Reading and Study Workbook>Chapter 14: The Ocean Floor>Section 14.4: Resources From the Seafloor

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Science and Engineering Practices	
Engaging in Argument from Evidence	
Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.	
Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and logical arguments regarding relevant factors (e.g. economic, societal, environmental, ethical considerations). (Performance Expectation ES-ESS3-2)	**SE/TE:** Inquiry—Try It! How Can You Determine the Resources You Use?, 93 Coal, 95-96 Tar Sands and Oil Shale, 97 Solar Energy, 103 Nuclear Energy, 104 Wind Energy, 104 Inquiry—Exploration Lab: Finding the Product that Best Conserves Resources, 118–119 **Realize™ Digital Resources:** >Lab Manual>Chapter 4: Earth's Resources>Investigation 4A: Recovering Oil >Reading and Study Workbook >Chapter 4: Earth's Resources>Section 4.1: Energy and Mineral Resources >Reading and Study Workbook >Chapter 4: Earth's Resources>Section 4.3: Water, Air, and Land Resources
Crosscutting Concepts	
Connections to Engineering, Technology, and Applications of Science	
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. (Performance Expectation ES-ESS3-2, Performance Expectation ES-ESS3-4)	**SE/TE:** Solar Energy, 102-103 Wind Energy, 104 Chapter 6 Assessment: Writing in Science, 184 Seismic-Safe Design, 232 **TE Only:** Facts and Figures, 104 The Changing Shapes of Streams, 156D Earthquake Hazards: Resent Everywhere, 216D Differentiated Instruction, 228 Differentiated Instruction, 601

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Analysis of costs and benefits is a critical aspect of decisions about technology. (Performance Expectation ES-ESS3-2, Performance Expectation ES3-ETS1-1, Performance Expectation ES3-ETS1-3)	**SE/TE:** Inquiry—Try It! How Can You Determine the Resources You Use?, 93 Coal, 95-96 Petroleum and Natural Gas, 96 Tar Sands and Oil Shale, 97-98 Solar Energy, 102-103 Nuclear Energy, 103-104 Wind Energy, 104 Hydroelectric Power, 105 Geothermal Energy, 105-106 Protecting Resources, 113–116 Bingham Canyon, Utah: The Largest Open—Pit Mine, 117 **Realize™ Digital Resources:** >Lab Manual>Chapter 4: Earth's Resources>Investigation 4A: Recovering Oil >Reading and Study Workbook >Chapter 4: Earth's Resources>Section 4.1: Energy and Mineral Resources
Connections to Nature of Science	
Science Addresses Questions About the Natural and Material World	
Science and technology may raise ethical issues for which science, by itself, does not provide answers and solutions. (Performance Expectation ES-ESS3-2)	**SE/TE:** Inquiry—Try It! How Can You Determine the Protecting Resources, 113–116
Science knowledge indicates what can happen in natural systems—not what should happen. The latter involves ethics, values, and human decisions about the use of knowledge. (Performance Expectation ES-ESS3-2)	**SE/TE:** Inquiry Apply It!, 174
Many decisions are not made using science alone, but rely on social and cultural contexts to resolve issues. (Performance Expectation ES-ESS3-2)	**SE/TE:** Finding the Product that Best Conserves Resources, 118-119 **TE Only:** Integrate Social Studies: The Dust Bowl, 142

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Performance Expectation ES-ESS3-3 Create a computational simulation to illustrate the relationships among the management of natural resources, the sustainability of human populations, and biodiversity.	**SE/TE:** Inquiry, Apply It, 106 Figure 19, 111 Protecting Resources, 113–116 Environmental Problems Associated with Groundwater, 174–176 **TE Only:** Earth Science Refresher, 92C-92D Map It!, 95 Teacher Demo, 95 **Realize™ Digital Resources:** >Lab Manual>Chapter 4: Earth's Resources>Investigation 4A: Recovering Oil >Lab Manual>Chapter 5: Weathering, Soil, and Mass Movements>Investigation 5: Some Factors That Affect Soil Erosion
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. (Performance Expectation ES-ESS3-3)	**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

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Science and Engineering Practices	
Using Mathematics and Computational Thinking	
Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.	
Create a computational model or simulation of a phenomenon, designed device, process, or system. (Performance Expectation ES-ESS3-3)	**SE/TE:** Inquiry Apply It, 106 Protecting Resources, 113–116 Environmental Problems Associated with Groundwater, 174–176 **Realize™ Digital Resources:** >Lab Manual>Chapter 4: Earth's Resources>Investigation 4A: Recovering Oil >Lab Manual>Chapter 5: Weathering, Soil, and Mass Movements>Investigation 5: Some Factors That Affect Soil Erosion >Lab Manual>Chapter 8: Earthquakes and Earth's Interior>Investigation 8A: Modeling Liquefaction >Lab Manual>Chapter 14: The Ocean Floor>Investigation 14: Modeling the Ocean Floor >Lab Manual>Chapter 21: Climate>Investigation 21: Modeling the Greenhouse Effect
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. (Performance Expectation ES-ESS3-3)	**SE/TE:** Figure 21, Growth of World Population, 21 Chapter 4 Assessment: Analyze Data, 122 Figure 2, Mechanical Weathering And Surface Area, 127 Figure 6 Density and Depth, 426 Figure 6 Thermal Structure of the Atmosphere, 480 Figure 7 Cloud Formation by Adiabatic Cooling, 511 Figure 15 Change in CO_2 Levels, 602 Global Climate Change, 602–603

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Connections to Engineering, Technology, and Applications of Science	
Influence of Engineering, Technology, and Science on Society and the Natural World	
Modern civilization depends on major technological systems. (HS-ESS3-1),(HS-ESS3-3)	**SE/TE:** Fossil Fuels, 95-98 4.1 Assessment, 101 Figure 15: Accessing Resources, 410 Manganese Nodules, 413 14.4 Assessment, 413 Weather Forecasting, 539 Tornado Warning, 574 Figure 20 Satellite View of a Hurricane, 575 Global Climate Change, 603 Inquiry—Exploration Lab: Human Impact on Climate and Weather, 606–607 **TE Only:** Facts & Figures, 97 Build Science Skills: Predict, 578
Connections to Engineering, Technology, and Applications of Science	
Influence of Engineering, Technology, and Science on Society and the Natural World	
New technologies can have deep impacts on society and the environment, including some that were not anticipated. (Performance Expectation ES-ESS3-3, Performance Expectation ES3-ETS1-1, Performance Expectation ES3-ETS1-3)	**SE/TE:** Satellites and Information Technology, 17 Environmental Science, 20 Figure 20, Environmental Impacts, 20 Environmental Problems, 21 Tar Sands and Oil Shale, 97-98 Removal of Vegetation, 145 14.4 Assessment: Think Critically, 413 Earth & Its Systems: Tracking El Nino from Space, 549 The Greenhouse Effect, 602 Global Climate Change, 602 23.2 Assessment: Communicate, 653 Space Telescopes, 682-683 **TE Only:** Use Visuals, 20 Facts and Figures, 323 Integrate Social Studies: Challenger Expedition, 397 Build Science Skills, 578 Differentiated Instruction, 601 Facts and Figures, 602

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Connections to Nature of Science	
Science is a Human Endeavor	
Science is a result of human endeavors, imagination, and creativity. (Performance Expectation ES-ESS3-3)	**SE/TE:** The Continental Puzzle, 248 Earthquake Patterns, 259 Ancient Greeks, 614-616 The Birth of Modern Astronomy, 617-621 **TE Only:** 21st Century Learning: Creativity and Intellectual Curiosity, 28 Facts and Figures, 36 Build Science Skills: Compare and Contrast, 37 Facts and Figures, 338 21st Century Learning: Creativity and Intellectual Curiosity, 470 Procedure Suggestions, 729
Performance Expectation ES-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 Earth and Its Resources, 117 Inquiry—Exploration Lab: Finding the Product that Best Conserves Resources, 118–119 Performance–Based Assessment, 122 Controlling Erosion, 142 Performance–Based Assessment, 154 Artificial Levees, 169 Flood–Control Dam, 169 Limiting Development, 169 Performance–Based Assessment, 418 **Realize™ Digital Resources:** >Lab Manual>Chapter 17: Earth's Atmosphere> Investigation 17B: Investigating Factors That Control Temperature

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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. (Performance Expectation ES-ESS3-4)	**SE/TE:** Environmental Science, 20 Solar Energy, 102–103 Wind Energy, 104 Geothermal Energy, 105–106 Tidal Power, 106–107 Keeping Water Clean and Safe, 114 Protecting the Air, 114–115 Caring for Land Resources, 115–116 Controlling Erosion, 142 Flood-Control Dam, 169
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. (Performance Expectation ES3-ETS1-3, Performance Expectation ES-ESS3-2, Performance Expectation ES-ESS3-4)	**SE/TE:** Environmental Science, 20 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 Land Resources, 111–112 Caring for Land Resources, 115–116 Earth and Its Resources, 117 Controlling Erosion, 142 Artificial Levees, 169 Flood-Control Dam, 169 Limiting Development, 169 Groundwater Contamination, 174-176

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Science and Engineering Practices	
Constructing Explanations and Designing Solutions	
Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific knowledge, principles, and theories.	
Design or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (Performance Expectation ES-ESS3-4)	**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 Inquiry Try It!, 157 Inquiry Try It!, 217 Inquiry Exploration Lab: Human Impact on Climate and Weather, 606–607 Stem Activity: Design to Reduce Waste, 729 **Realize™ Digital Resources:** >Lab Manual>Chapter 8: Earthquakes and Earth's Interior>Investigation 8A: Modeling Liquefaction >Lab Manual>Chapter 8: Earthquakes and Earth's Interior>Investigation 8B: Design and Build a Simple Seismograph >Reading and Study Workbook >Chapter 4: Earth's Resources>Section 4.4: Protecting Resources >Reading and Study Workbook>Chapter 21: Climate>Section 21.3: Climate Changes
Crosscutting Concepts	
Stability and Change	
Feedback (negative or positive) can stabilize or destabilize a system. (Performance Expectation ES-ESS3-4)	**SE/TE:** Environmental Science, 20 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 Beach Nourishment, 467 **TE Only:** Facts and Figures, 20

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Connections to Engineering, Technology, and Applications of Science	
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. (Performance Expectation ES-ESS3-2, Performance Expectation ES-ESS3-4)	**SE/TE:** Solar Energy, 102-103 Wind Energy, 104 Geothermal Energy, 105–106 Tidal Power, 106–107 Keeping Water Clean and Safe, 114 Farming, 115 Chapter 6 Assessment: Writing in Science, 184 Seismic-Safe Design, 232 Stem Activity: The Bycatch Problem, 728 **TE Only:** Facts and Figures, 104 The Changing Shapes of Streams, 156D How Earthquakes Are Located, 216C-216D
Performance Expectation ES-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:** Earth and Its Resources, 117 Inquiry Exploration Lab: Finding Products That Best Conserve Resources, 118-119 Inquiry Exploration Lab, 210–211 How Earth Works, 494–495 Figure 3 Climate Data for Two Cities, 589 Climate Changes, 600 Figure 15 Changes in CO2 Levels, 602 Global Climate Change, 602–603 Inquiry Exploration Lab, 606–607 **Realize™ Digital Resources:** >Lab Manual>Chapter 17: Earth's Atmosphere> Investigation 17A: Determining How Temperature Changes with Altitude >Lab Manual>Chapter 17: Earth's Atmosphere> Investigation 17B: Investigating Factors That Control Temperature >Reading and Study Workbook>Chapter 7: Glaciers, Deserts, and Wind>Section 7.3: Landscapes Shaped by Wind >Reading and Study Workbook>Chapter 17: Earth's Atmosphere> Section 17.3: Temperature Controls >Reading and Study Workbook>Chapter 21: Climate>Section 21.1: Factors That Affect Climate >Reading and Study Workbook>Chapter 21: Climate>Section 21.3: Climate Changes

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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. (Performance Expectation ES-ESS3-6)	**SE/TE:** The Carbon Cycle, 85 Figure 15 Change in CO_2 Levels, 602 The Greenhouse Effect, 602 Global Climate Change, 602–603 21 Assessment: Understand Concepts, 609 **TE Only:** Address Misconceptions, 487 21st Century Learning, 608 Background, 691
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. (Performance Expectation ES-ESS3-6)	For supporting content, please see: **SE/TE:** 1.1 Assessment: Connecting Concepts, 5 The Carbon Cycle, 85 Freshwater Pollution, 108–109 Pollution in the Air, 110 Chapter 13 Assessment: Concepts in Action, 390 How Earth Works, 494–495 Friction, 536 Global Climate Change, 602–603 **TE Only:** Facts and Figures, 137 Deep-Earth Water Cycle, 156C

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Science and Engineering Practices	
Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.	
Use a computational representation of phenomena or design solutions to describe and/or support claims and/or explanations. (Performance Expectation ES-ESS3-6)	**SE/TE:** Inquiry Exploration Lab: Finding the Product that Best Conserve Resources, 118-119 Effect of Temperature on Chemical Weathering, 150-151 Inquiry Exploration Lab: Interpreting a Glacial Landscape, 210-211 Inquiry Exploration Lab: Observing Wind Patterns, 550-551 Inquiry Exploration Lab: Human Impact on Climate and Weather, 606–607 Inquiry Exploration Lab: Modeling the Solar System, 666-667 Stem Activity: The Bycatch Problem, 728 Stem Activity: Design to Reduce Waste, 729 **TE Only:** Build Math Skills, 38
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. (Performance Expectation ES-ESS3-6)	**SE/TE:** Earth & Space: Earth's Place in the Universe, 6 Inquiry Exploration Lab: Human Impact on Climate and Weather, 606–607 Inquiry Exploration Lab: Modeling Synodic and Sidereal Months, 636-637 Inquiry Exploration Lab: Modeling the Solar System, 666-667 **TE Only:** Build Science Skills: Relate Cause and Effect, 19 Use Visuals, 449 Integrate Biology, 594 21st Century Learning, 608 Use Visuals, 616

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Performance Expectation ES3-ETS1-1 Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.	**SE/TE:** Inquiry Exploration Lab, 118–119 Inquiry Try It!, 587 Inquiry Exploration Lab, 606–607 Stem Activity: The Bycatch Problem, 728 **Realize™ Digital Resources:** >Lab Manual>Chapter 4: Earth's Resources>Investigation 4B: Desalinization by Distillation >Lab Manual>Chapter 20: Weather Patterns and Severe Storms>Investigation 20A: Analyzing Severe Weather Data >Reading and Study Workbook >Chapter 4: Earth's Resources>Section 4.4: Protecting Resources >Reading and Study Workbook>Chapter 21: Climate>Section 21.1: Factors That Affect Climate >Reading and Study Workbook>Chapter 21: Climate>Section 21.3: Climate Changes
Disciplinary Core Ideas	
ETS1.A: Defining and Delimiting Engineering Problems	
Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. (Performance Expectation ES3-ETS1-1)	**SE/TE:** Inquiry Exploration Lab, 118–119 Seismic-Safe Design, 232 Stabilizing the Shore, 466-467 Inquiry Try It!, 587 Inquiry Exploration Lab, 606–607 Stem Activity: The Bycatch Problem, 728 Stem Activity: Design to Reduce Waste, 729 **TE Only:** Procedure Suggestions, 729 **Realize™ Digital Resources:** >Lab Manual>Chapter 4: Earth's Resources>Investigation 4B: Desalinization by Distillation

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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. (Performance Expectation ES3-ETS1-1)	**SE/TE:** Tar Sands, 97 Solar Energy, 102–103 Wind Energy, 104 Hydroelectric Power, 105 Geothermal Energy, 105–106 Tidal Power, 106–107 The Water Planet, 108-109 Keeping Water Clean and Safe, 114 Farming, 115 Disposal of Waste, 116 **TE Only:** Integrate Geography, 105 Facts and Figures, 115
Science and Engineering Practices	
Asking Questions and Defining Problems	
Asking questions and defining problems in 9–12 builds on K–8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations.	
Analyze complex real-world problems by specifying criteria and constraints for successful solutions. (Performance Expectation ES3-ETS1-1)	**SE/TE:** Inquiry Exploration Lab, 118–119 Inquiry Try It!, 587 Global Climate Change, 602-603 Inquiry Exploration Lab: Human Impact on Climate and Weather, 606–607 Stem Activity: The Bycatch Problem, 728 Stem Activity: Design to Reduce Waste, 729 **Realize™ Digital Resources:** >Lab Manual>Chapter 4: Earth's Resources>Investigation 4B: Desalinization by Distillation >Lab Manual>Chapter 20: Weather Patterns and Severe Storms>Investigation 20A: Analyzing Severe Weather Data >Reading and Study Workbook >Chapter 4: Earth's Resources>Section 4.4: Protecting Resources >Reading and Study Workbook>Chapter 21: Climate>Section 21.1: Factors That Affect Climate >Reading and Study Workbook>Chapter 21: Climate>Section 21.3: Climate Changes

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Crosscutting Concepts	
Connections to Engineering, Technology, and Applications of Science	
Influence of Engineering, Technology, and Science on Society and the Natural World	
New technologies can have deep impacts on society and the environment, including some that were not anticipated. (Performance Expectation ES-ESS3-3, Performance Expectation ES3-ETS1-1, Performance Expectation ES3-ETS1-3)	**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 **TE Only:** Facts and Figures, 53 Facts and Figures, 146
Analysis of costs and benefits is a critical aspect of decisions about technology. (Performance Expectation ES-ESS3-2, Performance Expectation ES3-ETS1-1, Performance Expectation ES3-ETS1-3)	**SE/TE:** Environmental Science, 20 Figure 20, Environmental Impacts, 20 Environmental Problems, 21-22 Removal of Vegetation, 145 Manganese Nodules, 413 The Greenhouse Effect, 602 Stem Activity: Plate Tectonics: Measuring Plate Movement, 730 **TE Only:** Use Visuals, 20 Build Science Skills, 578 Facts and Figures, 602

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Performance Expectation ES3-ETS1-2 Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.	**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, 118–119 Inquiry Try It!, 157 Inquiry Try It!, 217 Inquiry Exploration Lab, 606–607 Stem Activity: Design to Reduce Waste, 729 **TE Only:** Address Misconceptions, 232 **Realize™ Digital Resources:** >Lab Manual>Chapter 8: Earthquakes and Earth's Interior>Investigation 8A: Modeling Liquefaction >Lab Manual>Chapter 8: Earthquakes and Earth's Interior>Investigation 8B: Design and Build a Simple Seismograph >Reading and Study Workbook >Chapter 4: Earth's Resources>Section 4.4: Protecting Resources >Reading and Study Workbook>Chapter 21: Climate>Section 21.3: Climate Changes
Disciplinary Core Ideas	
ETS1.C: Optimizing the Design Solution	
Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed. (Performance Expectation ES3-ETS1-2)	**SE/TE:** Inquiry Exploration Lab, 118–119 Inquiry Try It!, 157 Inquiry Try It!, 217 Inquiry Exploration Lab, 606–607 Stem Activity: Design to Reduce Waste, 729 **TE Only:** Address Misconceptions, 232 **Realize™ Digital Resources:** >Lab Manual>Chapter 8: Earthquakes and Earth's Interior>Investigation 8A: Modeling Liquefaction >Lab Manual>Chapter 8: Earthquakes and Earth's Interior>Investigation 8B: Design and Build a Simple Seismograph >Reading and Study Workbook >Chapter 4: Earth's Resources>Section 4.4: Protecting Resources >Reading and Study Workbook>Chapter 21: Climate>Section 21.3: Climate Changes

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Science and Engineering Practices	
Constructing Explanations and Designing Solutions	
Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific knowledge, principles, and theories.	
Design a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (Performance Expectation ES3-ETS1-2)	**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, 118–119 Inquiry Try It!, 157 Inquiry Try It!, 217 Inquiry Exploration Lab, 606–607 Stem Activity: Design to Reduce Waste, 729 **TE Only:** Address Misconceptions, 232 **Realize™ Digital Resources:** >Lab Manual>Chapter 8: Earthquakes and Earth's Interior>Investigation 8A: Modeling Liquefaction >Lab Manual>Chapter 8: Earthquakes and Earth's Interior>Investigation 8B: Design and Build a Simple Seismograph >Reading and Study Workbook >Chapter 4: Earth's Resources>Section 4.4: Protecting Resources >Reading and Study Workbook>Chapter 21: Climate>Section 21.3: Climate Changes**:**

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Performance Expectation ES3-ETS1-4 Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.	For supporting content, please see: **SE/TE:** The Inquiry Exploration Lab, 605–606 **Realize™ Digital Resources:** >Reading and Study Workbook>Chapter 21: Climate>Section 21.3: Climate Changes
Disciplinary Core Ideas	
ETS1.B: Developing Possible Solutions	
Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical; and in making a persuasive presentation to a client about how a given design will meet his or her needs. (Performance Expectation ES3-ETS1-4)	**SE/TE:** Inquiry Try It!: How Can Building Be Made Earthquake-Safe, 217 Stem Activity: Plate Tectonics: Measuring Plate Movement, 730 **TE Only:** Facts and Figures, 146 Build Science Skills, Student Activity: Design Experiments, 167 Facts and Figures, 225 Build Science Skills: Use Models, 297 Teacher Demo, 658 21st Century Learning, 668 Background, 691

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Science and Engineering Practices	
Using Mathematics and Computational Thinking	
Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.	
Use mathematical models and/or computer simulations to predict the effects of a design solution on systems and/or the interactions between systems. (Performance Expectation ES3-ETS1-4)	**SE/TE:** The Inquiry Exploration Lab: Human Impact on Climate and Weather , 606–607 Stem Activity: Design to Reduce Waste, 729 **TE Only:** Integrate Math, 161 Use Visuals, 616 **Realize™ Digital Resources:** >Lab Manual>Chapter 23: Touring Our Solar System>Investigation 23: Exploring Orbits >Reading and Study Workbook>Chapter 17: Earth's Atmosphere> Section 17.1: Atmosphere Characteristics >Reading and Study Workbook>Chapter 21: Climate>Section 21.3: Climate Changes >Reading and Study Workbook>Chapter 22: Origin of Modern Astronomy>Section 22.1: Early Astronomy >Reading and Study Workbook>Chapter 22: Origin of Modern Astronomy>Section 22.2: The Earth-Moon-Sun System
Crosscutting Concepts	
Systems and System Models	
Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. (Performance Expectation ES3-ETS1-4)	**SE/TE:** Table 2: Major Types of Water Pollution, 109 Active Art, 138 Figure 20 Deflation, 204 Chapter 14 Assessment: Concepts in Action, 418 Figure 6 Thermal Structure of the Atmosphere, 480 Figure 7 Tilt of Earth's Axis, 481 Figure 8 Processes That Lift Air, 512-513 Figure 3 Isobars, 534 Table 1 Estimated Nationwide Emissions, 606 Figure 11 Stellar Evolution, 710

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Topic 4: Weather and Climate	
Students who demonstrate understanding can:	
Performance Expectation ES-ESS2-4 Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.	**SE/TE:** Ancient Climates, 250–251 Quaternary Period, 384–385 Ocean Currents and Climate, 450 Energy Transfer as Heat, 483–485 Figure 9 Energy Transfer as Heat, 483 Convection, 484 Radiation, 485 What Happens to Solar Radiation? 486–487 How Earth Works: Earth's Atmosphere, 494–495 Inquiry Exploration Lab: Heating Land and Water, 496–497 Performance–Based Assessment, 500 Water's Changes of State, 504–506 Factors Affecting Wind, 534–536 Global Winds, 540 El Nino and La Nina, 546–547 Powered By The Sun, 588 Inquiry Lab: Quick Lab: Observing How Land and Water Absorb and Release Energy, 590 Climate Changes, 600–603 Inquiry—Exploration Lab: Human Impact on Climate and Weather, 606–607 Solar Variability and Climate Change, 691 **Realize™ Digital Resources:** >Reading and Study Workbook>Chapter 9: Plate Tectonics>Section 9.1: Continental Drift >Reading and Study Workbook>Chapter 13: Earth's History>Section 13.3: Mesozoic Era: Age of Reptiles >Reading and Study Workbook>Chapter 17: Earth's Atmosphere> Section 17.2: Heating the Atmosphere >Reading and Study Workbook>Chapter 17: Earth's Atmosphere> Section 17.3: Temperature Controls >Reading and Study Workbook>Chapter 18: Moisture, Clouds, and Precipitation>Section 18.1: Water in the Atmosphere >Reading and Study Workbook>Chapter 19: Air Pressure and Wind>Section 19.2: Pressure Center and Winds

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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 tilt of the planet's axis of rotation, both occurring over hundreds of thousands of years, have altered the intensity and distribution of sunlight falling on the earth. These phenomena cause a cycle of ice ages and other gradual climate changes. (Performance Expectation ES-ESS2-4)	**SE/TE:** Figure 2 Earth's Major Climate Zones, 589 Latitude, 589 Earth's Orbital Motions, 601 Solar Activity, 601 Revolution, 624 Figure 14 The Celestial Sphere, 624 Precession, 625 Figure 15 Precession, 625 Earth & Space: Solar Variability and Climate Change, 691 **TE Only:** Ice Ages of the Past, 186C-186D
ESS2.A: Earth Materials and Systems	
The geological record shows that changes to global and regional climate can be caused by interactions among changes in the sun's energy output or Earth's orbit, tectonic events, ocean circulation, volcanic activity, glaciers, vegetation, and human activities. These changes can occur on a variety of time scales from sudden (e.g., volcanic ash clouds) to intermediate (ice ages) to very long-term tectonic cycles. (Performance Expectation ES-ESS2-4)	**SE/TE:** Plate Tectonics, 600 Earth's Orbital Motions, 601 Ocean Circulation, 601 Solar Activity, 601 Volcanic Eruptions, 601 Human Impact on Climate, 602-603 Revolution, 624 Precession, 625 Earth & Space: Solar Variability and Climate Change, 691 **TE Only:** Ice Ages of the Past, 186C-186D
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. (Performance Expectation ES-ESS2-4)	**SE/TE:** Electromagnetic Waves, 484 Reflection and Scattering, 486 Absorption, 487 Photosynthesis, 487 Land and Water, 489 Cloud Cover and Albedo, 492 World Distribution of Temperature, 492-493 Factors That Affect Climate, 588-591 Natural Processes That Change Climate, 600-602 **TE Only:** Teacher Demo, Earth's Motions and Climate, 601 Facts and Figures, 602

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Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate. (Performance Expectation ES-ESS2-4)	**SE/TE:** Earth & Its Systems, 85 Protecting Resources, 113 Human Influence, 478 Earth & Its Resources: Atmospheric Stability and Air Pollution, 523 Human Impact on Climate, 602-603 Inquiry—Exploration Lab: Human Impact on Climate and Weather, 606–607 **TE Only:** Use Visuals, 478 Facts and Figures, 478 Use Visuals, 602 Facts and Figures, 602
Science and Engineering Practices	
Developing and Using Models	
Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s).	
Use a model to provide mechanistic accounts of phenomena. (Performance Expectation ES-ESS2-4)	**SE/TE:** Figure 7 A More Complete Record, 341 Figure 11 Circulation on a Rotating Earth, 541 Figure 10 Earth's Path Without Gravity, 621 Inquiry Exploration Lab: Modeling the Solar System, 666-667 Stem Activity: Developing and Using Models, 730 **TE Only:** Build Science Skills: Student Activity: Use Models, 103 Build Science Skills, 167 Teacher Demo, 310 Teacher Demo, 484 Build Science Skills: Student Activity: Use Analogies, 719

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Connections to Nature of Science	
Scientific Knowledge is Based on Empirical Evidence	
Science arguments are strengthened by multiple lines of evidence supporting a single explanation. (Performance Expectation ES-ESS2-4)	**SE/TE:** The Continental Puzzle, 248 Evidence for Continental Drift, 249-251 Rejection of Wegener's Hypothesis, 253 Natural Processes That Change Climate, 600-602 Human Impact on Climate, 602-603 Inquiry—Exploration Lab: Human Impact on Climate and Weather, 606–607 The Big Bang, 720-721 **TE Only:** Facts and Figures, 249 Facts and Figures, 250 Teacher Demo: Earth's Motions and Climate, 601
Crosscutting Concepts	
Cause and Effect	
Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (Performance Expectation ES-ESS2-4)	**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

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Performance Expectation ES-ESS3-5 Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth's systems.	**SE/TE:** Temperature Controls, 488–492 Inquiry Exploration Lab, 550 Circulation in the Atmosphere, 591 Natural Processes That Change Climate, 600–601 Human Impact on Climate, 602–603 Inquiry-Human Impact of Climate and Weather, 606–607 21 Assessment, 610 **TE Only:** Integrate Biology, 197 Common Themes & The History of Climate, 586C **Realize™ Digital Resources:** >Lab Manual>Chapter 21: Climate>Investigation 21: Modeling the Greenhouse Effect >Reading and Study Workbook>Chapter 17: Earth's Atmosphere> Section 17.3: Temperature Controls >Reading and Study Workbook>Chapter 19: Air Pressure and Wind>Section 19.3: Regional Wind Systems >Reading and Study Workbook>Chapter 21: Climate>Section 21.3: Climate Changes
Disciplinary Core Ideas	
ESS3.D: Global Climate Change	
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. (Performance Expectation ES-ESS3-5)	**SE/TE:** People and the Environment, 20-21 Environmental Problems, 21-22 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 Inquiry Exploration Lab: Human Impact on Climate and Weather, 606-607 **TE Only:** Biogeosciences, 1D The Start of Seismology, 216C Fact and Figures, 287 Build Science Skills: Predict, 578

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Science and Engineering Practices	
Analyzing and Interpreting Data	
Analyzing data in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.	
Analyze data using computational models in order to make valid and reliable scientific claims. (Performance Expectation ES-ESS3-5)	**SE/TE:** Protecting Resources, 113–116 Environmental Problems Associated with Groundwater, 174–176 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 **Realize™ Digital Resources:** >Lab Manual>Chapter 4: Earth's Resources>Investigation 4A: Recovering Oil >Lab Manual>Chapter 5: Weathering, Soil, and Mass Movements>Investigation 5: Some Factors That Affect Soil Erosion
Connections to Nature of Science	
Scientific Investigations Use a Variety of Methods	
Science investigations use diverse methods and do not always use the same set of procedures to obtain data. (Performance Expectation ES-ESS3-5)	**SE/TE:** Inquiry Exploration Lab: Mineral Identification, 58-59 Inquiry Exploration Lab: Finding the Product that Best Conserves Resources, 118-119 Inquiry Exploration Lab: Investigating the Permeability of Soils, 181 Visual Summary, 220-221 Inquiry Exploration Lab: How Does Temperature Affect Water Density?, 440-441 Inquiry Exploration Lab: Human Impact on Climate and Weather, 606-607 **TE Only:** Use Community Resources, 116 Build Science Skills: Observe, 230 Teacher Demo: Sediment Buildup, 404 Astrobiology, 642C-642D

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New technologies advance scientific knowledge. (Performance Expectation ES-ESS3-5)	**SE/TE:** Controlling Erosion, 142 Earth and Its Systems: Shoes and Toys as Drift Meters, 454 Earth and Its Systems: Tracking El Nino from Space, 549 Earth & History: Foucault's Experiment, 635 Features of Saturn, 656 Space Telescopes, 682-683 Stem Activity: Developing and Using Models, 730 **TE Only:** Matter and Energy, 392C Facts and Figures, 540 Use Visuals, 616
Scientific Knowledge is Based on Empirical Evidence	
Science knowledge is based on empirical evidence. (Performance Expectation ES-ESS3-5)	**SE/TE:** Reading Checkpoint, 251 Fossils: Evidence of Past Life, 342-342 Earth & History: Dating With Tree Rings, 352 Resources from the Seafloor, 410-412 Human Impact on Climate, 602-603 21.3 Assessment, 603 Earth & Space: Solar Variability and Climate Change, 691 **TE Only:** Use Visuals, 220 Integrate Biology: East Africa Rift Valley, 317 Facts and Figures, 349

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Science arguments are strengthened by multiple lines of evidence supporting a single explanation. (Performance Expectation ES-ESS3-5)	**SE/TE:** The Continental Puzzle, 248 Evidence for Continental Drift, 249-251 Rejection of Wegener's Hypothesis, 253 Natural Processes That Change Climate, 600-602 Human Impact on Climate, 602-603 Inquiry—Exploration Lab: Human Impact on Climate and Weather, 606–607 The Big Bang, 720-721 **TE Only:** Facts and Figures, 249 Facts and Figures, 250 Teacher Demo: Earth's Motions and Climate, 601
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. (Performance Expectation ES-ESS3-5)	**SE/TE:** Figure 21 Growth of World Population, 21 Chapter 4 Assessment: Analyze Data, 122 Figure 2, Mechanical Weathering And Surface Area, 127 Figure 15 Modified Mercalli Scale, 226 Figure 11 Paleomagnetism, 258 Figure 6 Density and Depth, 426 Figure 6 Thermal Structure of the Atmosphere, 480 Figure 7 Cloud Formation by Adiabatic Cooling, 511 Figure 15 Change in CO_2 Levels, 602 Global Climate Change, 602–603 Figure 10 Life Cycle of a Sunlike Star, 709

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Performance Expectation ES4-ETS1-3 Evaluate a solution to a complex real-world problem based on prioritized criteria and tradeoffs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.	**SE/TE:** Tar Sands and Oil Shale, 97–98 Alternative Energy Solutions, 102–107 Reading Checkpoint, 103 Assessment 4.2, 107 Stem Activity: The Bycatch Problem, 728 **Realize™ Digital Resources:** >Lab Manual>Chapter 14: The Ocean Floor>Investigation 14: Modeling the Ocean Floor >Lab Manual>Chapter 16: The Dynamic Ocean>Investigation 16: Shoreline Features >Reading and Study Workbook >Chapter 4: Earth's Resources>Section 4.2: Alternate Energy Sources
Disciplinary Core Ideas	
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. (Performance Expectation ES4-ETS1-3)	**SE/TE:** Environmental Science, 20 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 Land Resources, 111–112 Caring for Land Resources, 115–116 Earth and Its Resources, 117 Controlling Erosion, 142 Artificial Levees, 169 Flood-Control Dam, 169 Limiting Development, 169 Groundwater Contamination, 174-176

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Science and Engineering Practices	
Constructing Explanations and Designing Solutions	
Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles and theories.	
Evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (Performance Expectation ES4-ETS1-3)	**SE/TE:** Tar Sands and Oil Shale, 97–98 Alternative Energy Solutions, 102–107 Reading Checkpoint, 103 Assessment 4.2, 107 Stem Activity: The Bycatch Problem, 728 **Realize™ Digital Resources:** >Lab Manual>Chapter 14: The Ocean Floor>Investigation 14: Modeling the Ocean Floor >Lab Manual>Chapter 16: The Dynamic Ocean>Investigation 16: Shoreline Features >Reading and Study Workbook >Chapter 4: Earth's Resources>Section 4.2: Alternate Energy Sources
Crosscutting Concepts	
Connections to Engineering, Technology, and Applications of Science	
Influence of Science, Engineering, and Technology on Society and the Natural World	
New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology. (Performance Expectation ES4-ETS1-3)	**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 **TE Only:** Facts and Figures, 53 Facts and Figures, 146