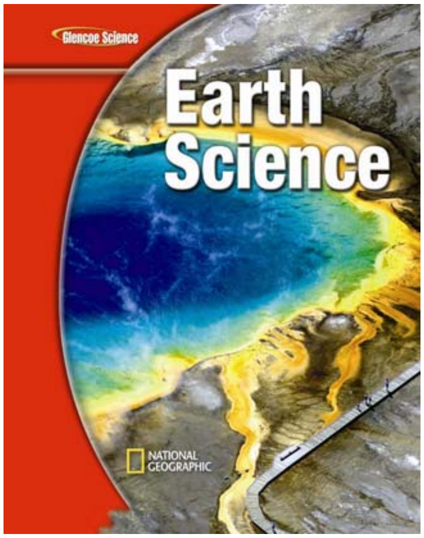
Glencoe

High School Science Content
Expectations
Earth Science
Core Skills



Earth Science

STANDARDS		PAGE REFERENCES
	EARTH SCIENCE	
	STANDARD E1: INQUIRY, REFLECTION, AND SOCIAL IMPLICATIONS *Students will understand the nature of science and demonstrate an ability to practice scientific reasoning by applying it to the design, execution, and evaluation of scientific investigations. Students will demonstrate their understanding that scientific knowledge is gathered through various forms of direct and indirect observations and the testing of this information by methods including, but not limited to, experimentation. They will be able to distinguish between types of scientific knowledge (e.g., hypotheses, laws, theories) and become aware of areas of active research in contrast to conclusions that are part of established scientific consensus. They will use their scientific knowledge to assess the costs, risks, and benefits of technological systems as they make personal choices and participate in public policy decisions. These insights will help them analyze the role science plays in society, technology, and potential career opportunities.*	
	E1.1 Scientific Inquiry Science is a way of understanding nature. Scientific research may begin by generating new scientific questions that can be answered through replicable scientific investigations that are logically developed and conducted systematically. Scientific conclusions and explanations result from careful analysis of empirical evidence and the use of logical reasoning. Some questions in science are addressed through indirect rather than direct observation, evaluating the consistency of new evidence with results predicted by models of natural processes. Results from investigations are communicated in reports that are scrutinized through a peer review process.	
E1.1f	Predict what would happen if the variables, methods, or timing of an investigation were changed.	**Student Edition:** *Lab* 52-53 **Teacher Wraparound Edition:** A 45, 53, 136, 139, 171, 261, 634; AIL 110, 229, 562, 590, 650, 680

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

STANDARDS		PAGE REFERENCES
E1.1g	Based on empirical evidence, explain and critique the reasoning used to draw a scientific conclusion or explanation.	**Student Edition:** *Lab* 23, 24-25, 52-53, 67, 80-81, 200-201, 228-229, 350-351, 444-445, 503, 532-533, 585 *Communicating Your Data* 98 **Teacher Wraparound Edition:** A 23; AIL 110
E1.1h	Design and conduct a systematic scientific investigation that tests a hypothesis. Draw conclusions from data presented in charts or tables.	**Student Edition:** 8-11 *Lab* 24-25, 52-53, 136, 200-201, 228-229, 260-261, 350-351, 444-445, 504-505, 532-533, 616-617 **Teacher Wraparound Edition:** A 221; IL 9, 193
E1.1i	Distinguish between scientific explanations that are regarded as current scientific consensus and the emerging questions that active researchers investigate.	**Student Edition:** 273-275, 276-278, 280-289, 643-649, 673-674 *Science Online* 409, 647, 700 *Science and Society* 476 **Teacher Wraparound Edition:** DI 409, 647; R 502
	E1.2 Scientific Reflection and Social Implications The integrity of the scientific process depends on scientists and citizens understanding and respecting the "Nature of Science." Openness to new ideas, skepticism, and honesty are attributes required for good scientific practice. Scientists must use logical reasoning during investigation design, analysis, conclusion, and communication. Science can produce critical insights on societal problems from a personal and local scale to a global scale. Science both aids in the development of technology and provides tools for assessing the costs, risks, and benefits of technological systems. Scientific conclusions and arguments play a role in personal choice and public policy decisions. New technology and scientific discoveries have had a major influence in shaping human history. Science and technology continue to offer diverse and significant career opportunities.	
E1.2f	Critique solutions to problems, given criteria and scientific constraints.	**Student Edition:** *Lab* 142-143, 172-173, 474-475 *Debate* 262 *MiniLAB* 318 *Science and Society* 652 **Teacher Wraparound Edition:** ACT 133; IL 101, 133, 515, 575; R 319; UP 269
E1.2g	Identify scientific tradeoffs in design decisions and choose among alternative solutions.	**Student Edition:** *Lab* 142-143, 474-475 *Debate* 262 *Science and Society* 652 **Teacher Wraparound Edition:** ACT 133; IL 101, 464, 515, 575; UP 269

STANDARDS		PAGE REFERENCES
E1.2h	Describe the distinctions between scientific theories, laws, hypotheses, and observations.	**Student Edition:** 7, 18, 31 #19 *MiniLAB* 19 *Section Review* 22 **Teacher Wraparound Edition:** A 22; DIS 18; USW 394
E1.2i	Explain the progression of ideas and explanations that lead to science theories that are part of the current scientific consensus or core knowledge.	**Student Edition:** 15-20, 273-275, 276-278, 280-289, 394-399, 676-679, 690-694, 742-745 *Science Online* 273 *Lab* 279 **Teacher Wraparound Edition:** DI 277, 394; SJ 281, 395; TBI 270
E1.2j	Apply science principles or scientific data to anticipate effects of technological design decisions.	**Student Edition:** 196-199 *Lab* 142-143, 474-475 *Debate* 262 **Teacher Wraparound Edition:** ACT 133; DI 225; IL 101, 133, 464, 515, 575; MM 132; UP 269
E1.2k	Analyze how science and society interact from a historical, political, economic, or social perspective.	**Student Edition:** 12-14 *Integrate Health* 37 *Science and History* 82, 174 *Science and Society* 112, 262, 476, 592, 618 *Accidents in Science* 144, 352, 384 **Teacher Wraparound Edition:** CD 580; CFU 14; R 199

STANDARDS		PAGE REFERENCES
	STANDARD E2: EARTH SYSTEMS *Students describe the interactions within and between Earth systems. Students will explain how both fluids (water cycle) and solids (rock cycle) move within Earth systems and how these movements form and change their environment. They will describe the relationship between physical process and human activities and use this understanding to demonstrate an ability to make wise decisions about land use.*	
	E2.1 Earth Systems Overview The Earth is a system consisting of four major interacting components: geosphere (crust, mantle, and core), atmosphere (air), hydrosphere (water), and biosphere (the living part of Earth). Physical, chemical, and biological processes act within and among the four components on a wide range of time scales to continuously change Earth's crust, oceans, atmosphere, and living organisms. Earth elements move within and between the lithosphere, atmosphere, hydrosphere, and biosphere as part of geochemical cycles.	
	E2.2 Energy in Earth Systems Energy in Earth systems can exist in a number of forms (e.g., thermal energy as heat in the Earth, chemical energy stored as fossil fuels, mechanical energy as delivered by tides) and can be transformed from one state to another and move from one reservoir to another. Movement of matter and its component elements, through and between Earth's systems, is driven by Earth's internal (radioactive decay and gravity) and external (Sun as primary) sources of energy. Thermal energy is transferred by radiation, convection, and conduction. Fossil fuels are derived from plants and animals of the past, are nonrenewable, and, therefore, are limited in availability. All sources of energy for human consumption (e.g., solar, wind, nuclear, ethanol, hydrogen, geothermal, hydroelectric) have advantages and disadvantages.	
E2.2e	Explain how energy changes form through Earth systems.	**Student Edition:** 120-129, 130-135, 149 #21 *Science Online* 133 *Integrate Physics* 213 **Teacher Wraparound Edition:** FF 132; IL 133; LD 132; MM 132; QD 131; SCB 118E; TPK 130; VL 134
E2.2f	Explain how elements exist in different compounds and states as they move from one reservoir to another.	**Student Edition:** 39-44, 46-51, 65-66, 94-97, 185-186, 437-438, 451 #15-#17, 458-461 *Launch Lab* 33, 453 **Teacher Wraparound Edition:** ACT 50; DI 43; R 438; SCB 32F, 118F

	STANDARDS	PAGE REFERENCES
	E2.3 Biogeochemical Cycles The Earth is a system containing essentially a fixed amount of each stable chemical atom or element. Most elements can exist in several different states and chemical forms; they move within and between the geosphere, atmosphere, hydrosphere, and biosphere as part of the Earth system. The movements can be slow or rapid. Elements and compounds have significant impacts on the biosphere and have important impacts on human health.	
E2.3b	Explain why small amounts of some chemical forms may be beneficial for life but are poisonous in large quantities (e.g., dead zone in the Gulf of Mexico, Lake Nyos in Africa, fluoride in drinking water).	**Student Edition:** 600-601, 610
E2.3c	Explain how the nitrogen cycle is part of the Earth system.	**Student Edition:** 427, 601 **Teacher Wraparound Edition:** VL 427
E2.3d	Explain how carbon moves through the Earth system (including the geosphere) and how it may benefit (e.g., improve soils for agriculture) or harm (e.g., act as a pollutant) society.	**Student Edition:** 121-122, 185, 253-254, 379, 427, 449 #22, 499-502, 511 #13-#15 *Applying Skills* 433 **Teacher Wraparound Edition:** CFU 502; DIS 499, 501; LD 500; SCB 236F; VL 427
	E2.4 Resources and Human Impacts on Earth Systems The Earth provides resources (including minerals) that are used to sustain human affairs. The supply of nonrenewable natural resources is limited and their extraction and use can release elements and compounds into Earth systems. They affect air and water quality, ecosystems, landscapes, and may have effects on long-term climate. Plans for land use and long-term development must include an understanding of the interactions between Earth systems and human activities.	
E2.4c	Explain ozone depletion in the stratosphere and methods to slow human activities to reduce ozone depletion.	**Student Edition:** 428, 432-433, 451 #20, 611, 623 #15 *Science Online* 429 **Teacher Wraparound Edition:** A 433; CD 432; DI 432; IES 446
E2.4d	Describe the life cycle of a product, including the resources, production, packaging, transportation, disposal, and pollution.	**Student Edition:** 137-141, 576-577, 586-589 *Applying Science* 140 *Lab* 562-563, 585 **Teacher Wraparound Edition:** AIL 562; DI 576; DIS 432; IL 575; MM 432; SCB 572F; VL 577

STANDARDS		PAGE REFERENCES
STANDARD E3: THE SOLID EARTH *Students explain how scientists study and model the interior of the Earth and its dynamic nature. They use the theory of plate tectonics, the unifying theory of geology, to explain a wide variety of Earth features and processes and how hazards resulting from these processes impact society.*		
E3.p1 Landforms and Soils *(prerequisite)* Landforms are the result of a combination of constructive and destructive forces. Constructive forces include crustal deformation, volcanic eruptions, and deposition of sediments transported in rivers, streams, and lakes through watersheds. Destructive forces include weathering and erosion. The weathering of rocks and decomposed organic matter result in the formation of soils. *(prerequisite)*		
E3.p2 Rocks and Minerals *(prerequisite)* Igneous, metamorphic, and sedimentary rocks are constantly forming and changing through various processes. As they do so, elements move through the geosphere. In addition to other geologic features, rocks and minerals are indicators of geologic and environmental conditions that existed in the past. *(prerequisite)*		
E3.p3 Basic Plate Tectonics *(prerequisite)* Early evidence for the movement of continents was based on the similarities of coastlines, geology, faunal distributions, and paleoclimatelogical data across the Atlantic and Indian Oceans. In the 1960s, additional evidence from marine geophysical surveys, seismology, volcanology, and paleomagnetism resulted in the development of the theory of plate tectonics. *(prerequisite)*		
E3.1 Advanced Rock Cycle Igneous, metamorphic, and sedimentary rocks are indicators of geologic and environmental conditions and processes that existed in the past. These include cooling and crystallization, weathering and erosion, sedimentation and lithification, and metamorphism. In some way, all of these processes are influenced by plate tectonics, and some are influenced by climate.		
E3.1c	Explain how the size and shape of grains in a sedimentary rock indicate the environment of formation (including climate) and deposition.	**Student Edition:** 103-109, 115 #24 *MiniLAB* 104 *Lab* 110-111 **Teacher Wraparound Edition:** ACT 106; AIL 110; DIS 105; IM 360F; QD 107; R 109; SCB 88F; SJ 105
E3.1d	Explain how the crystal sizes of igneous rocks indicate the rate of cooling and whether the rock is extrusive or intrusive.	**Student Edition:** 94-97, 117 #11 *Science Online* 96 *Lab* 98 **Teacher Wraparound Edition:** CFU 97; DI 95; R 97; SCB 88E-F

STANDARDS		PAGE REFERENCES
E3.1e	Explain how the texture (foliated, nonfoliated) of metamorphic rock can indicate whether it has experienced regional or contact metamorphism.	**Student Edition:** 99-102, 117 #12 *Science Online* 100 **Teacher Wraparound Edition:** ACT 101; DIS 92, 100; SCB 88F; UAA 100
	E3.2 Interior of the Earth The Earth can also be subdivided into concentric layers based on their physical characteristics: (lithosphere, asthenosphere, lower mantle, outer core, and inner core). The crust and upper mantle compose the rigid lithosphere (plates) that moves over a "softer" asthenosphere (part of the upper mantle). The magnetic field of the Earth is generated in the outer core. The interior of the Earth cannot be directly sampled and must be modeled using data from seismology.	
E3.2d	Explain the uncertainties associated with models of the interior of the Earth and how these models are validated.	**Student Edition:** 309-311, 327 #21 **Teacher Wraparound Edition:** CFU 311; DI 310; QD 310; UAA 310
	E3.3 Plate Tectonics Theory The Earth's crust and upper mantle make up the lithosphere, which is broken into large mobile pieces called tectonic plates. The plates move at velocities in units of centimeters per year as measured using the global positioning system (GPS). Motion histories are determined with calculations that relate rate, time, and distance of offset geologic features. Oceanic plates are created at mid-ocean ridges by magmatic activity and cooled until they sink back into the Earth at subduction zones. At some localities, plates slide by each other. Mountain belts are formed both by continental collision and as a result of subduction. The outward flow of heat from Earth's interior provides the driving energy for plate tectonics.	
E3.3d	Distinguish plate boundaries by the pattern of depth and magnitude of earthquakes.	**Student Edition:** 280-288, 300-303 *Science Online* 282 *Lab* 290-291, 320-321 **Teacher Wraparound Edition:** A 291; AIL 290; CC 287; DI 288, 302; SCB 298E; TPK 280

	STANDARDS	PAGE REFERENCES
	E3.4 Earthquakes and Volcanoes Plate motions result in potentially catastrophic events (earthquakes, volcanoes, tsunamis, mass wasting) that affect humanity. The intensity of volcanic eruptions is controlled by the chemistry and properties of the magma. Earthquakes are the result of abrupt movements of the Earth. They generate energy in the form of body and surface waves.	
E3.4d	Explain how the chemical composition of magmas relates to plate tectonics and affects the geometry, structure, and explosivity of volcanoes.	**Student Edition:** 330-335, 336-343 *Science Online* 282 *National Geographic* 338 *MiniLAB* 340 *Lab* 344, 350-351 **Teacher Wraparound Edition:** MM 341; R 343; SCB 328E-F; VL 342
E3.4e	Explain how volcanoes change the atmosphere, hydrosphere, and other Earth systems.	**Student Edition:** 330-331, 336-343, 406, 497 *Accidents in Science* 352 *Science and History* 506 **Teacher Wraparound Edition:** A 502; CB 506; DI 338; DIS 506; IL 337
E3.4f	Explain why fences are offset after an earthquake, using the elastic rebound theory.	**Student Edition:** 288, 300-303* **Teacher Wraparound Edition:** A 303; VL 284 *These references explain why features are offset without mentioning elastic rebound theory.
	STANDARD E4: THE FLUID EARTH *Students explain how the ocean and atmosphere move and transfer energy around the planet. They also explain how these movements affect climate and weather and how severe weather impacts society. Students explain how long term climatic changes (glaciers) have shaped the Michigan landscape. They also explain features and processes related to surface and ground-water and describe the sustainability of systems in terms of water quality and quantity.*	
	E4.p1 Water Cycle *(prerequisite)* Water circulates through the crust and atmosphere and in oceans, rivers, glaciers, and ice caps and connects all of the Earth systems. Groundwater is a significant reservoir and source of freshwater on Earth. The recharge and movement of groundwater depends on porosity, permeability, and the shape of the water table. The movement of groundwater occurs over a long period time. Groundwater and surface water are often interconnected. *(prerequisite)*	
	E4.p2 Weather and the Atmosphere *(prerequisite)* The atmosphere is divided into layers defined by temperature. Clouds are indicators of weather. *(prerequisite)*	

STANDARDS		PAGE REFERENCES
E4.p3 Glaciers *(prerequisite)* Glaciers are large bodies of ice that move under the influence of gravity. They form part of both the rock and water cycles. Glaciers and ice sheets have shaped the landscape of the Great Lakes region. Areas that have been occupied by ice sheets are depressed. When the ice sheet is removed, the region rebounds (see also climate change). *(prerequisite)*		
E4.1 Hydrogeology Fresh water moves over time between the atmosphere, hydrosphere (surface water, wetlands, rivers, and glaciers), and geosphere (groundwater). Water resources are both critical to and greatly impacted by humans. Changes in water systems will impact quality, quantity, and movement of water. Natural surface water processes shape the landscape everywhere and are affected by human land use decisions.		
E4.2 Oceans and Climate Energy from the sun and the rotation of the Earth control global atmospheric circulation. Oceans redistribute matter and energy around the Earth through currents, waves, and interaction with other Earth systems. Ocean currents are controlled by prevailing winds, changes in water density, ocean topography, and the shape and location of landmasses. Oceans and large lakes (e.g., Great Lakes) have a major effect on climate and weather because they are a source of moisture and a large reservoir of heat. Interactions between oceanic circulation and the atmosphere can affect regional climates throughout the world.		
E4.2c	Explain the dynamics (including ocean-atmosphere interactions) of the El Niño-Southern Oscillation (ENSO) and its effect on continental climates.	**Student Edition:** 493 *MiniLAB* 493 *National Geographic* 494-495 **Teacher Wraparound Edition:** ACT 494; CB 495; CC 494; CD 521; DI 494; V 494
E4.2d	Identify factors affecting seawater density and salinity and describe how density affects oceanic layering and currents.	**Student Edition:** 514-517, 518-523, 537 #20-#21 *Launch Lab* 513 *Science Online* 519 *MiniLAB* 521 **Teacher Wraparound Edition:** LD 522; MM 516; SCB 512E-F
E4.2e	Explain the differences between maritime and continental climates with regard to oceanic currents.	**Student Edition:** 484-487, 488-489, 520 *Integrate Earth Science* 534 **Teacher Wraparound Edition:** DIS 520; FF 486
E4.2f	Explain how the Coriolis effect controls oceanic circulation.	**Student Edition:** 518-519, 559 #18 *Section Review* 523 **Teacher Wraparound Edition:** DI 519; R 523; VL 519

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	E4.3 Severe Weather Tornadoes, hurricanes, blizzards, and thunderstorms are severe weather phenomena that impact society and ecosystems. Hazards include downbursts (wind shear), strong winds, hail, lightning, heavy rain, and flooding. The movement of air in the atmosphere is due to differences in air density resulting from variations in temperature. Many weather conditions can be explained by fronts that occur when air masses meet.	
E4.3g	Explain the process of adiabatic cooling and adiabatic temperature changes to the formation of clouds.	**Student Edition:** 458-461* *Integrate Physics* 486 **Teacher Wraparound Edition:** SCB 452E *These references discuss the process of adiabatic cooling and adiabatic temperature changes in relation to cloud formation without using the term *adiabatic.*
	STANDARD E5: THE EARTH IN SPACE AND TIME *Students explain theories about how the Earth and universe formed and evolved over a long period of time. Students predict how human activities may influence the climate of the future.*	
	E5.p1 Sky Observations *(prerequisite)* Common sky observations (such as lunar phases) can be explained by the motion of solar system objects in regular and predictable patterns. Our galaxy, observable as the Milky Way, is composed of billions of stars, some of which have planetary systems. Seasons are a result of the tilt of the rotation axis of the Earth. The motions of the moon and sun affect the phases of the moon and ocean tides. *(prerequisite)*	
	E5.1 The Earth in Space Scientific evidence indicates the universe is orderly in structure, finite, and contains all matter and energy. Information from the entire light spectrum tells us about the composition and motion of objects in the universe. Early in the history of the universe, matter clumped together by gravitational attraction to form stars and galaxies. According to the Big Bang theory, the universe has been continually expanding at an increasing rate since its formation about 13.7 billion years ago.	
E5.1b	Describe how the Big Bang theory accounts for the formation of the universe.	**Student Edition:** 745, 753 #26 *National Geographic* 744 **Teacher Wraparound Edition:** ACT 744; SJ 744

STANDARDS		PAGE REFERENCES
E5.1c	Explain how observations of the cosmic microwave background have helped determine the age of the universe.	**Teacher Wraparound Edition:** ACT 744* *This reference directs students to research the work of Penzias and Wilson (the scientists who discovered cosmic microwave background) and to analyze the significance of the discovery.
E5.1d	Differentiate between the cosmological and Doppler red shift.	**Student Edition:** 742-743, 753 #10 *Section Review* 745 **Teacher Wraparound Edition:** IL 743; QD 743; R 745
	E5.2 The Sun Stars, including the Sun, transform matter into energy in nuclear reactions. When hydrogen nuclei fuse to form helium, a small amount of matter is converted to energy. Solar energy is responsible for life processes and weather as well as phenomena on Earth. These and other processes in stars have led to the formation of all the other chemical elements.	
	E5.2x Stellar Evolution Stars, including the Sun, transform matter into energy in nuclear reactions. When hydrogen nuclei fuse to form helium, a small amount of matter is converted to energy. These and other processes in stars have led to the formation of all the other chemical elements. There is a wide range of stellar objects of different sizes and temperatures. Stars have varying life histories based on these parameters.	
E5.2e	Explain how the Hertzsprung-Russell (H-R) diagram can be used to deduce other parameters (distance).	**Student Edition:** 734-736
E5.2f	Explain how you can infer the temperature, life span, and mass of a star from its color. Use the H-R diagram to explain the life cycles of stars.	**Student Edition:** 734-739 **Teacher Wraparound Edition:** CFU 739; DI 735
E5.2g	Explain how the balance between fusion and gravity controls the evolution of a star (equilibrium).	**Student Edition:** 736-739
E5.2h	Compare the evolution paths of low-, moderate-, and high-mass stars using the H-R diagram.	**Student Edition:** 734-739 *Science Online* 736 **Teacher Wraparound Edition:** R 739; VL 737

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	E5.3 Earth History and Geologic Time The solar system formed from a nebular cloud of dust and gas 4.6 Ga (billion years ago). The Earth has changed through time and has been affected by both catastrophic (e.g., earthquakes, meteorite impacts, volcanoes) and gradual geologic events (e.g., plate movements, mountain building) as well as the effects of biological evolution (formation of an oxygen atmosphere). Geologic time can be determined through both relative and absolute dating.	
	E5.3x Geologic Dating Early methods of determining geologic time, such as the use of index fossils and stratigraphic principles, allowed for the relative dating of geological events. However, absolute dating was impossible until the discovery that certain radioactive isotopes in rocks have known decay rates, making it possible to determine how many years ago a given mineral or rock formed. Different kinds of radiometric dating techniques exist. Technique selection depends on the composition of the material to be dated, the age of the material, and the type of geologic event that affected the material.	
E5.3e	Determine the approximate age of a sample, when given the half-life of a radioactive substance (in graph or tabular form) along with the ratio of daughter to parent substances present in the sample.	**Student Edition:** 377-381, 389 #18-#20 *MiniLAB* 378 *Applying Science* 380 *Applying Math* 387 **Teacher Wraparound Edition:** A 381; ACT 379; CFU 381; DI 380; DIS 378; LD 378; QD 379; R 381; VL 379
E5.3f	Explain why C-14 can be used to date a 40,000 year old tree, but U-Pb cannot.	**Student Edition:** 379 *MiniLAB* 378 *Applying Science* 380 **Teacher Wraparound Edition:** CC 36; TFYI 379
E5.3g	Identify a sequence of geologic events using relative-age dating principles.	**Student Edition:** 370-375 *Science Online* 371 *National Geographic* 373 *Lab* 376 **Teacher Wraparound Edition:** A 375; ACT 373; CFU 375; DI 371, 372; DIS 372; IL 374; R 375; SCB 88F; V 373; VL 372

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	E5.4 Climate Change Atmospheric gases trap solar energy that has been reradiated from the Earth's surface (the greenhouse effect). The Earth's climate has changed both gradually and catastrophically over geological and historical time frames due to complex interactions between many natural variables and events. The concentration of greenhouse gases (especially carbon dioxide) has increased due to human industrialization, which has contributed to a rise in average global atmospheric temperatures and changes in the biosphere, atmosphere, and hydrosphere. Climates of the past are researched, usually using indirect indicators, to better understand and predict climate change.	
E5.4e	Based on evidence from historical climate research (e.g. fossils, varves, ice core data) and climate change models, explain how the current melting of polar ice caps can impact the climatic system.	**Student Edition:** 500 **Teacher Wraparound Edition:** VL 500
E5.4f	Describe geologic evidence that implies climates were significantly colder at times in the geologic record (e.g., geomorphology, striations, and fossils).	**Student Edition:** 218, 274, 295 #16, 496 *Science Online* 380 **Teacher Wraparound Edition:** CC 219; DI 218; FF 496; SCB 270E; 482E
E5.4g	Compare and contrast the heat-trapping mechanisms of the major greenhouse gases resulting from emissions (carbon dioxide, methane, nitrous oxide, fluorocarbons) as well as their abundance and heat-trapping capacity.	**Student Edition:** 499 *Science Online* 499 *Lab* 503 **Teacher Wraparound Edition:** A 502; SCB 390E
E5.4h	Use oxygen isotope data to estimate paleotemperature. *(recommended)*	**Student Edition:** *Science Online* 380* *This reference directs students to report on isotopes in ice cores in relation to paleoclimatology; oxygen isotopes are commonly analyzed in ice cores.
E5.4i	Explain the causes of short-term climate changes such as catastrophic volcanic eruptions and impact of solar system objects. *(recommended)*	**Student Edition:** 331, 406, 411, 492-497, 509 #22 *National Geographic* 494-495 *Science and History* 506 **Teacher Wraparound Edition:** CB 495; DI 338; DIS 496; SCB 390E; TFYI 411, 427
E5.4j	Predict the global temperature increase by 2100, given data on the annual trends of CO_2 concentration increase. *(recommended)*	**Teacher Wraparound Edition:** DIS 5011