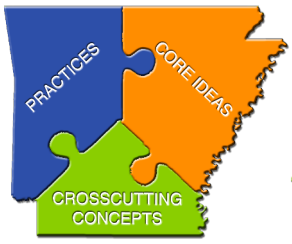


ARKANSAS
K-12 SCIENCE STANDARDS

EDUCATION FOR A NEW GENERATION

Fundamental Science Content

Earth Science

2023

The Arkansas K-12 Science Standards are available here. The standards are three-dimensional, consisting of a Science and Engineering Practice (SEP), a Disciplinary Core Idea (DCI), and a Cross Cutting Concept (CCC). By the end of the grade level, students should be able to demonstrate the full scope of the standard. Example:

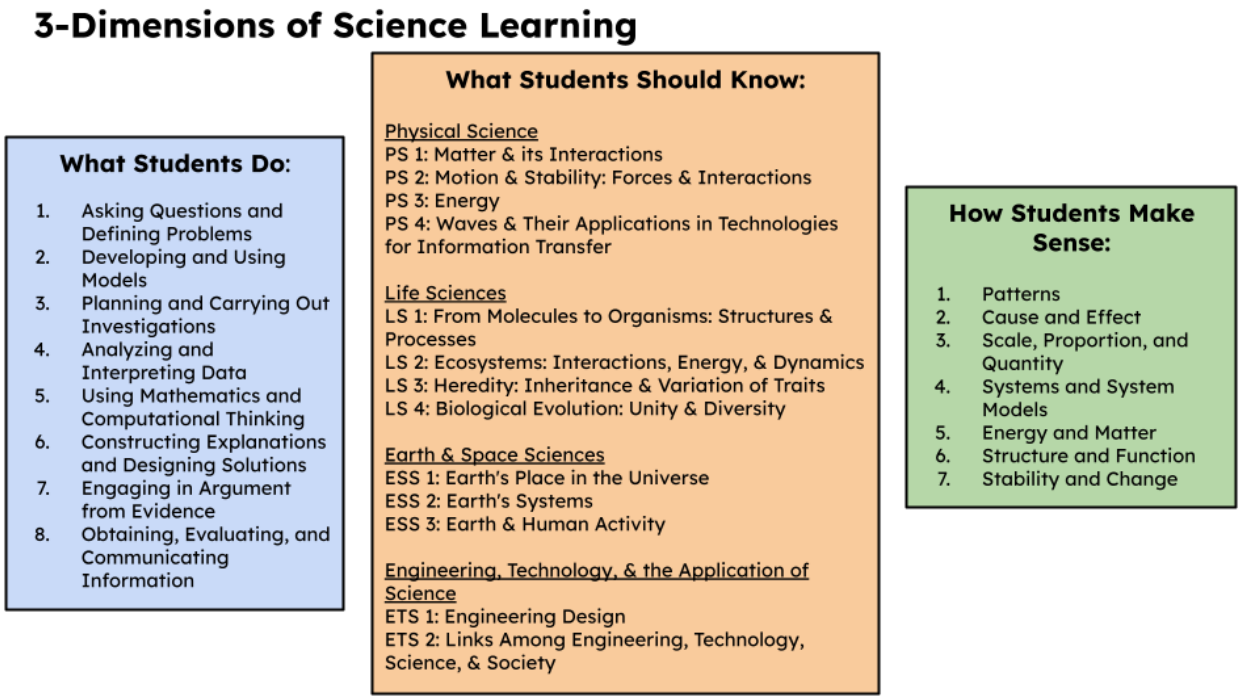
SEP CCC DCI

ES-ESS1-5 Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks.

The focus of this document is specifically on the science core ideas in Earth Science. In Arkansas K-12 Science Standards, science content is found in the DCI portion of each standard. Three-dimensional learning and assessment best prepares students for success so that students have the opportunity to demonstrate both what they know *and* can do in science. Refer to the full standards document to find the corresponding science and engineering practice and cross cutting concept for each standard. The core ideas are organized into the following domains of science:

- Physical Science
- Life Science
- Earth & Space Science
- Engineering Technology & Applications of Science

Each domain contains core ideas organized into component ideas. By the end of Earth Science, students are expected to know the bulleted information under each component idea. Standards that address the bulleted information are included in parentheses and those with an asterisk include an engineering component.



Physical Science

*Asterisks indicate best opportunities to integrate ETS performance expectations into content.

Matter
Nuclear Processes
• Spontaneous radioactive decay follows a characteristic exponential decay law. Nuclear lifetimes allow radiometric dating to be used to determine the ages of rocks and other materials. (ES-ESS1-5, ES-ESS1-6)
Waves
Wave Properties
• Geologists use seismic waves and their reflection at intersections between layers to explore structures deep in the planet. (ES-ESS2-3)

Earth & Space Science

*Asterisks indicate best opportunities to integrate ETS performance expectations into content.

Earth's Place in the Universe
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. (ES-ESS2-4)
The History of Planet Earth
• Continental rocks, which can be older than 4 billion years, are generally much older than the rocks of the ocean floor, which are less than 200 million years old. (ES-ESS1-5)
• 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. (ES-ESS1-6)
Earth's Systems
Earth's Materials
• Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. (ES-ESS2-1, ES-ESS2-2)
• 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. (ES-ESS2-3)
• 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. (ES-ESS2-4)
Plate Tectonics
• Plate tectonics is the unifying theory that explains the past and current movements of the rocks at Earth's surface and provides a framework for understanding its geologic history. (ES-ESS1-5)
• The radioactive decay of unstable isotopes continually generates new energy within Earth's crust and mantle, providing the primary source of the heat that drives mantle convection. Plate tectonics can be viewed as the surface expression of mantle convection. (ES-ESS2-3)
Roles of Water in Earth's 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. (ES-ESS2-5)
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. (ES-ESS2-2) (ES-ESS2-4)
• Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen. (ES-ESS2-6, ES-ESS2-7)
• Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate. (ES-ESS2-4) (ES-ESS2-6)
• 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. (ES-ESS3-6)
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. (ES-ESS2-7)
Earth and Human Activity
Natural Resources
• Resource availability has guided the development of human society. (ES-ESS3-1)

• 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. (ES-ESS3-2*)
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. (ES-ESS3-1)
Human Impacts on Earth Systems
• The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources. (ES-ESS3-3)
• Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that prevent ecosystem degradation. (ES-ESS3-4*)
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. (ES-ESS3-5)
• 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. (ES-ESS3-6)

Engineering, Technology, and Applications of Science

Engineering Design
Defining 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. (ES1-ETS1-1) (ES2-ETS1-1) (ES3-ETS1-1)
• 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. (ES1-ETS1-1) (ES2-ETS1-1) (ES3-ETS1-1)
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. (ES2-ETS1-3) (ES3-ETS1-3, ES-ESS3-2*, ES-ESS3-4*) (ES2-ETS1-3) (ES4-ETS1-3)
• 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. (ES3-ETS1-4)
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. (ES3-ETS1-2)