ARKANSAS
K-12 SCIENCE STANDARDS
EDUCATION FOR A NEW GENERATION

Fundamental Science Content
Astronomy

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

A-ESS1-1AR Develop a model using observational evidence that accounts for patterns in the diurnal, seasonal, and annual movements of objects on the celestial sphere.

The focus of this document is specifically on the science core ideas in Astronomy. 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 Astronomy, students are expected to know the bulleted information under each component idea. Standards that address the bulleted information are included in parentheses.

3-Dimensions of Science Learning

What Students Do:

1. Asking Questions and Defining Problems
2. Developing and Using Models
3. Planning and Carrying Out Investigations
4. Analyzing and Interpreting Data
5. Using Mathematics and Computational Thinking
6. Constructing Explanations and Designing Solutions
7. Engaging in Argument from Evidence
8. Obtaining, Evaluating, and Communicating Information

What Students Should Know:

Physical Science
PS 1: Matter & its Interactions
PS 2: Motion & Stability: Forces & Interactions
PS 3: Energy
PS 4: Waves & Their Applications in Technologies for Information Transfer

Life Sciences
LS 1: From Molecules to Organisms: Structures & Processes
LS 2: Ecosystems: Interactions, Energy, & Dynamics
LS 3: Heredity: Inheritance & Variation of Traits
LS 4: Biological Evolution: Unity & Diversity

Earth & Space Sciences
ESS 1: Earth's Place in the Universe
ESS 2: Earth's Systems
ESS 3: Earth & Human Activity

Engineering, Technology, & the Application of Science
ETS 1: Engineering Design
ETS 2: Links Among Engineering, Technology, Science, & Society

How Students Make Sense:

1. Patterns
2. Cause and Effect
3. Scale, Proportion, and Quantity
4. Systems and System Models
5. Energy and Matter
6. Structure and Function
7. Stability and Change

Physical Science

Matter
Structure and Properties of Matter
• A stable molecule has less energy than the same set of atoms separated; one must provide at least this energy in order to take the molecule apart. (A-ESS6-1AR)
Chemical Reactions
• Chemical processes, their rates, and whether or not energy is stored or released can be understood in terms of the collisions of molecules and the rearrangements of atoms into new molecules, with consequent changes in the sum of all bond energies in the set of molecules that are matched by changes in kinetic energy. (A6-ESS1-1)
Motion & Stability
Forces & Motion
• Newton's second law accurately predicts changes in the motion of macroscopic objects. (A-ESS1-4) (A-ESS3-2AR)
• Momentum is defined for a particular frame of reference; it is the mass times the velocity of the object. (A-ESS1-4)
• If a system interacts with objects outside itself, the total momentum of the system can change; however, any such change is balanced by changes in the momentum of objects outside the system. (A-ESS1-4)
Types of Interactions
• Newton's law of universal gravitation and Coulomb's law provide the mathematical models to describe and predict the effects of gravitational and electrostatic forces between distant objects. (A-ESS3-2AR)
• Forces at a distance are explained by fields (gravitational, electric, and magnetic) permeating space that can transfer energy through space. Magnets or electric currents cause magnetic fields; electric charges or changing magnetic fields cause electric fields. (A-ESS3-2AR)
Energy
Definitions of Energy
• Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system's total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms. (A5-ESS1-1) (A-ESS5-2AR) (A-ESS6-1AR)
Conservation & Transfer of Energy
• Conservation of energy means that the total change of energy in any system is always equal to the total energy transferred into or out of the system. (A-ESS4-1AR)
• Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. (A-ESS4-1AR)

• Mathematical expressions, which quantify how the stored energy in a system depends on its configuration (e.g. relative positions of charged particles, compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation of energy to be used to predict and describe system behavior. (A-ESS4-1AR)
Energy & Forces
• When two objects interacting through a field change relative position, the energy stored in the field is changed. (A-ESS3-1AR)
Waves
Electromagnetic Radiation
• Atoms of each element emit and absorb characteristic frequencies of light. These characteristics allow identification of the presence of an element, even in microscopic quantities. (A-ESS6-1AR) (A7-ESS1-1) (A-ESS1-3) (A-ESS7-1AR) (A-ESS1-2)
• Electromagnetic radiation (e.g., radio, microwaves, light) can be modeled as a wave of changing electric and magnetic fields or as particles called photons. The wave model is useful for explaining many features of electromagnetic radiation, and the particle model explains other features. (A-ESS6-1AR)
• When light or longer wavelength electromagnetic radiation is absorbed in matter, it is generally converted into thermal energy (heat). Shorter wavelength electromagnetic radiation (ultraviolet, X-rays, gamma rays) can ionize atoms and cause damage to living cells. (A-ESS6-1AR)
• Photoelectric materials emit electrons when they absorb light of a high-enough frequency. (A-ESS6-1AR)
Waves in Information Technology
• Multiple technologies based on the understanding of waves and their interactions with matter are part of everyday experiences in the modern world (e.g., medical imaging, communications, and scanners) and in scientific research. They are essential tools for producing, transmitting, and capturing signals and for storing and interpreting the information contained in them. (A-ESS1-2AR) (A-ESS2-2AR)

Earth & Space Science

Earth's Place in the Universe
The Universe and its Stars
• The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth. (A-ESS1-1AR) (A-ESS1-2AR) (A-ESS4-2AR) (A6-ESS1-1) (A7-ESS1-1) (A-ESS1-3) (A-ESS7-1AR) (A-ESS1-2)
• The Big Bang theory is supported by observations of distant galaxies receding from our own, of the measured composition of stars and non-stellar gases, and of the maps of spectra of the primordial radiation (cosmic microwave background) that still fills the universe. (A-ESS1-2)
• Other than the hydrogen and helium formed at the time of the Big Bang, nuclear fusion within stars produces all atomic nuclei lighter than and including iron, and the process releases electromagnetic

energy. Heavier elements are produced when certain massive stars achieve a supernova stage and explode. (A-ESS1-2)
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. (A-ESS1-1AR) (A-ESS1-2AR) (A-ESS1-6)(A-ESS5-1AR) (A-ESS5-2AR) (A6-ESS1-1) (A7-ESS1-1) (A-ESS1-3) (A-ESS7-1AR)
• Kepler's laws describe common features of the motions of orbiting objects, including their elliptical paths around the sun. Orbits may change due to the gravitational effects from, or collisions with, other objects in the solar system. (A-ESS3-1AR)
Earth's Systems
Earth's Materials
• 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. (A-ESS5-1AR) (A-ESS5-2AR)
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. (A5-ESS1-1)

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. (A1-ETS1-2) (A3-ETS1-4)
• 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. (A1-ETS1-2) (A3-ETS1-4)
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. (A1-ETS1-2) (A3-ETS1-4) (A6-ETS1-1) (A8-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. (A1-ETS1-2) (A3-ETS1-4) (A-ESS2-1AR) (A-ESS2-2AR)
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. (A1-ETS1-2) (A3-ETS1-4)