Science and Engineering Practices

Asking questions and defining problems

A practice of science is to ask and refine questions that lead to descriptions and explanations of how the natural and designed world(s) works and which can be empirically tested.

Developing and using models

A practice of both science and engineering is to use and construct models as helpful tools for representing ideas and explanations. These tools include diagrams, drawings, physical replicas, mathematical representations, analogies, and computer simulations.

Planning and carrying out investigations

Scientists and engineers plan and carry out investigations in the field or laboratory, working collaboratively as well as individually. Their investigations are systematic and require clarifying what counts as data and identifying variables or parameters.

Analyzing and interpreting data

Scientific investigations produce data that must be analyzed in order to derive meaning. Because data patterns and trends are not always obvious, scientists use a range of tools—including tabulation, graphical interpretation, visualization, and statistical analysis—to identify the significant features and patterns in the data. Scientists identify sources of error in the investigations and calculate the degree of certainty in the results.

Using mathematics and computational thinking

In both science and engineering, mathematics and computation are fundamental tools for representing physical variables and their relationships. They are used for a range of tasks such as constructing simulations; solving equations exactly or approximately; and recognizing, expressing, and applying quantitative relationships.

Constructing explanations and designing solutions

The end-products of science are explanations and the end-products of engineering are solutions. The goal of science is the construction of theories that provide explanatory accounts of the world. A theory becomes accepted when it has multiple lines of empirical evidence and greater explanatory power of phenomena than previous theories.

Engaging in argument from evidence

Argumentation is the process by which evidence-based conclusions and solutions are reached. In science and engineering, reasoning and argument based on evidence are essential to identifying the best explanation for a natural phenomenon or the best solution to a design problem.

Obtaining, evaluating, and communicating information

Scientists and engineers must be able to communicate clearly and persuasively the ideas and methods they generate. Critiquing and communicating ideas individually and in groups is a critical professional activity.

Crosscutting Concepts

Patterns

Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them.

Cause and effect

Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering.

Scale, proportion, and quantity

In considering phenomena, it is critical to recognize what is relevant at different size, time, and energy scales, and to recognize proportional relationships between different quantities as scales change.

Systems and system models

A system is an organized group of related objects or components; models can be used for understanding and predicting the behavior of systems.

Energy and matter

Tracking energy and matter flows, into, out of, and within systems helps one understand their system's behavior.

Structure and function

The way an object is shaped or structured determines many of its properties and functions.

Stability and change

For both designed and natural systems, conditions that affect stability and factors that control rates of change are critical elements to consider and understand.

Disciplinary Core Ideas

Life Science	Earth & Space Science	Physical Science
From molecules to organisms: Structures and processes LS1.A: Structure and function LS1.B: Growth and development of organisms LS1.C: Organization for matter and flow in organisms LS1.D: Information processing	**Earth's place in the universe** ESS1.A: The universe and its stars ESS1.B: Earth and the solar system ESS1.C: The history of planet Earth	**Matter and its interactions** PS1.A: Structure and properties of matter PS1.B: Chemical reactions PS1.C: Nuclear processes
Ecosystems: Interactions, energy, and dynamics LS2.A: Interdependent relationships in ecosystems LS2.B: Cycles of matter and energy transfer in ecosystems LS2.C: Ecosystem dynamics, functioning, and resilience LS2.D: Social interactions and group behavior	**Earth's systems** ESS2.A: Earth materials and systems ESS2.B: Plate tectonics and large-scale system interactions ESS2.C: The roles of water in Earth's surface processes ESS2.D: Weather and climate ESS2.E: Biogeology	**Motion and stability: Forces and interactions** PS2.A: Forces and motion PS2.B: Types of interactions PS2.C: Stability and instability in physical systems
Heredity: Inheritance and variation of traits LS3.A: Inheritance of traits LS3.B: Variation of traits	**Earth and human activity** ESS3.A: Natural resources ESS3.B: Natural hazards ESS3.C: Human impacts on Earth systems ESS3.D: Global climate change	**Energy** PS3.A: Definitions of energy PS3.B: Conservation of energy and energy transfer PS3.C: Relationship between energy and forces PS3.D: Energy in chemical processes and everyday life
Biological evolution: Unity and diversity LS4.A: Evidence of common ancestry and diversity LS4.B: Natural selection LS4.C: Adaptation LS4.D: Biodiversity and humans		**Waves and their applications in technologies for information transfer** PS4.A: Wave properties PS4.B: Electromagnetic radiation PS4.C: Information technologies and instrumentation

Engineering, Technology, and the Application of Science

ETS1.A: Defining and delimiting engineering problems
ETS1.B: Developing possible solutions
ETS1.C: Optimizing the design solution