Science and Engineering Practices

Asking Questions and Defining Problems

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

Developing and Using Models

2 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

3 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

4 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. Modern technology makes the collection of large data sets much easier, providing secondary sources for analysis.

Using Mathematics and Computational Thinking

5 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; statistically analyzing data; and recognizing, expressing, and applying quantitative relationships.

Constructing Explanations and Designing Solutions

6 The products of science are explanations and the products of engineering are solutions.

Engaging in Argument from Evidence

7 Argumentation is the process by which explanations and solutions are reached.

Obtaining, Evaluating, and Communicating Information

8 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.

Cross Cutting Concepts

Patterns

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

Cause and Effect

2 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

3 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

4 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

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

Structure and Function

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

Stability and Change

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