# NGSS Scientific and Engineering Practices

## Ask Questions and Define Problems
- I formulate empirically answerable questions.
- I establish what is already known.
- I determine what questions have yet to be answered.
- I define constraints and specifications for a solution.

## Develop and Use Models
- I construct mental and conceptual models to represent and understand phenomena.
- I use models to explain and predict behaviors of systems, or test a design.
- I refine my models in light of new empirical evidence.

## Plan and Carry Out Investigations
- I identify questions to be investigated.
- I identify variables and controls.
- I design and perform experiments to test my hypothesis.
- I decide what data will be collected and how much, and what tools are needed.

## Analyze and Interpret Data
- I use tables, graphs, spreadsheets, etc. to display and analyze data.
- I recognize patterns in data and see relationships between variables.
- I revise my initial hypothesis when the data doesn’t support it.
- I analyze performance of a design under a range of conditions.

## Use Mathematics and Computational Thinking
- I use mathematics and statistics to analyze data.
- I express relationships between variables by writing mathematical models or equations.
- I use technology to collect and analyze data.
- I use mathematical models and computer simulations to test my predictions and designs.

## Construct Explanations and Design Solutions
- I evaluate information and form hypotheses.
- I construct explanations or models of phenomena.
- I design a variety of solutions to a problem.

## Engage in an Argument from Evidence
- I defend my explanation.
- I formulate evidence based on solid data.
- I examine my own understanding in light of the evidence.
- I collaborate with my peers in searching for the best explanation.

## Obtain Evaluate and Communicate Information
- I communicate findings clearly and persuasively.
- I derive meaning from scientific text.
- I engage in discussions with scientific peers.
- I evaluate the validity of the findings of others.
This lesson mentally engages students with an activity or question. It captures their interest, provides an opportunity for them to express what they know about the concept or skill being developed, and helps them to make connections between what they know and the new ideas.

Students carry out hands-on activities in which they can explore the concept or skill. They grapple with the problem or phenomenon and describe it in their own words. This phase allows students to acquire a common set of experiences that they can use to help each other make sense of the new concept or skill.

Only after students have explored the concept or skill does the teacher provide the concepts and terms used by the students to develop explanations for the phenomenon they have experienced. The significant aspect of this phase is that explanation follows experience.

This phase provides opportunities for students to apply what they have learned to new situations and so develop a deeper understanding of the concept or greater use of the skill. It is important for students to discuss and compare their ideas with each other during this phase.

The final phase provides an opportunity for students to review and reflect on their own learning and new understandings and skills. It is also when students provide evidence for changes to their understandings, beliefs and skills.
Crosscutting Concepts

Patterns
Observed patterns of forms and events guide organization and classification, and they prompt questions about relationships and the factors that influence them.

Cause and Effect: Mechanism and Explanation
Events have causes, sometimes simple, sometimes multifaceted. A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts.

Scale, Proportion, and Quantity
In considering phenomena, it is critical to recognize what is relevant at different measures of size, time, and energy and to recognize how changes in scale, proportion, or quantity affect a system’s structure or performance.

Systems and System Models
Defining the system under study – specifying its boundaries and making explicit a model of that system – provides tools for understanding and testing ideas that are applicable throughout science and engineering.

Energy and Matter: Flows, Cycles, and Conservation
Tracking fluxes of energy and matter into, out of, and within systems helps one understand the systems’ possibilities and limitations.

Structure and Function
The way in which an object or living thing is shaped and its substructure determine many of its properties and functions.

Stability and Change
For natural and built systems alike, conditions of stability and determinants of rates of change or evolution of the system are critical elements of study.