

## Practice 1: Asking Questions and Defining Problems

*Use a highlighter or pen to mark up and underline; think about what is clear and what is confusing and make a note of it.*

*“Students at any grade level should be able to ask questions of each other about the texts they read, the features of the phenomena they observe, and the conclusions they draw from their models or scientific investigations. For engineering, they should ask questions to define the problem to be solved and to elicit ideas that lead to the constraints and specifications for its solution.” (NRC Framework 2012, p. 56)*

Scientific questions arise in a variety of ways. They can be driven by curiosity about the world, inspired by the predictions of a model, theory, or findings from previous investigations, or they can be stimulated by the need to solve a problem. Scientific questions are distinguished from other types of questions in that the answers lie in explanations supported by empirical evidence, including evidence gathered by others or through investigation.

While science begins with questions, engineering begins with defining a problem to solve. However, engineering may also involve asking questions to define a problem, such as: What is the need or desire that underlies the problem? What are the criteria for a successful solution? Other questions arise when generating ideas, or testing possible solutions, such as: What are the possible trade-offs? What evidence is necessary to determine which solution is best?

Asking questions and defining problems also involves asking questions about data, claims that are made, and proposed designs. It is important to realize that asking a question also leads to involvement in another practice. A student can ask a question about data that will lead to further analysis and interpretation. Or a student might ask a question that leads to planning and design, an investigation, or the refinement of a design.

Whether engaged in science or engineering, the ability to ask good questions and clearly define problems is essential for everyone. The following progression of Practice 1 summarizes what students should be able to do by the end of each grade band. Each of the examples of asking questions below leads to students engaging in other scientific practices.

From **APPENDIX F – Science and Engineering Practices in the NGSS**  
*A Science Framework for K-12 Science Education*

# Science & Engineering Practices in *Next Generation Science Standards*

**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. Engineering questions clarify problems to determine criteria for successful solutions and identify constraints to solve problems about the designed world. Both scientists and engineers also ask questions to clarify ideas.

K–2 Condensed Practices	3–5 Condensed Practices	6–8 Condensed Practices	9–12 Condensed Practices
Asking questions and defining problems in K–2 builds on prior experiences and progresses to simple descriptive questions that can be tested.	Asking questions and defining problems in 3–5 builds on K–2 experiences and progresses to specifying qualitative relationships.	Asking questions and defining problems in 6–8 builds on K–5 experiences and progresses to specifying relationships between variables, clarify arguments and models.	Asking questions and defining problems in 9–12 builds on K–8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations.
<ul style="list-style-type: none"> <li>Ask questions based on observations to find more information about the natural and/or designed world(s).</li> </ul>	<ul style="list-style-type: none"> <li>Ask questions about what would happen if a variable is changed.</li> </ul>	<ul style="list-style-type: none"> <li>Ask questions that arise from careful observation of phenomena, models, or unexpected results, to clarify and/or seek additional information.</li> <li>Ask questions to identify and/or clarify evidence and/or the premise(s) of an argument.</li> <li>Ask questions to determine relationships between independent and dependent variables and relationships in models.</li> <li>Ask questions to clarify and/or refine a model, an explanation, or an engineering problem.</li> </ul>	<ul style="list-style-type: none"> <li>Ask questions that arise from careful observation of phenomena, or unexpected results, to clarify and/or seek additional information.</li> <li>Ask questions that arise from examining models or a theory, to clarify and/or seek additional information and relationships.</li> <li>Ask questions to determine relationships, including quantitative relationships, between independent and dependent variables.</li> <li>Ask questions to clarify and refine a model, an explanation, or an engineering problem.</li> </ul>
<ul style="list-style-type: none"> <li>Ask and/or identify questions that can be answered by an investigation.</li> </ul>	<ul style="list-style-type: none"> <li>Identify scientific (testable) and non-scientific (non-testable) questions.</li> <li>Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships.</li> </ul>	<ul style="list-style-type: none"> <li>Ask questions that require sufficient and appropriate empirical evidence to answer.</li> <li>Ask questions that can be investigated within the scope of the classroom, outdoor environment, and museums and other public facilities with available resources and, when appropriate, frame a hypothesis based on observations and scientific principles.</li> </ul>	<ul style="list-style-type: none"> <li>Evaluate a question to determine if it is testable and relevant.</li> <li>Ask questions that can be investigated within the scope of the school laboratory, research facilities, or field (e.g., outdoor environment) with available resources and, when appropriate, frame a hypothesis based on a model or theory.</li> </ul>
		<ul style="list-style-type: none"> <li>Ask questions that challenge the premise(s) of an argument or the interpretation of a data set.</li> </ul>	<ul style="list-style-type: none"> <li>Ask and/or evaluate questions that challenge the premise(s) of an argument, the interpretation of a data set, or the suitability of the design.</li> </ul>
<ul style="list-style-type: none"> <li>Define a simple problem that can be solved through the development of a new or improved object or tool.</li> </ul>	<ul style="list-style-type: none"> <li>Use prior knowledge to describe problems that can be solved.</li> <li>Define a simple design problem that can be solved through the development of an object, tool, process, or system and includes several criteria for success and constraints on materials, time, or cost.</li> </ul>	<ul style="list-style-type: none"> <li>Define a design problem that can be solved through the development of an object, tool, process or system and includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions.</li> </ul>	<ul style="list-style-type: none"> <li>Define a design problem that involves the development of a process or system with interacting components and criteria and constraints that may include social, technical and/or environmental considerations.</li> </ul>