Science and Engineering Practices Progression for Students and Families

Each of the practices is described through questions for teachers, families and students. "Can I" questions can be posed during a lesson as a tool to help students learn how to engage in the practices. "Did I" questions can be used to help students reflect on their use of the practices after a lesson or unit.

PRACTICE 1: 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 works and which can be empirically tested.

	Grades K-2	Grades 3-5	Grades 6-8	Grades 9-12
PRACTICE 1: Asking Questions & Defining Problems	**Can I… ? Did I…?** a) Ask a question about what I noticed to get more information? b) Ask a question that I could answer by doing a science investigation? c) Describe something that was not working right or a problem that could be solved? d) Make a new or improved object or tool to solve a problem?	**Can I… ? Did I…?** a) Ask questions about what would happen if one thing were changed? b) Identify whether or not an experiment is needed to answer a question? c) Ask challenging questions that cannot be answered with a yes or no? d) Make a prediction based on patterns I observed and data I collected? e) Use what I know to describe a problem that can be solved by creating or changing an object, tool or process with the resources that are available?	**Can I… ? Did I…?** a) Ask a question when I observe something that is new or unexpected to clarify or gather more information? b) Ask questions that require evidence to answer? c) Ask a question that helps to identify relationships between variables? d) Ask questions that challenge the logic of an argument or the interpretation of a data set? e) Describe a design problem that can be solved by creating a method or a system and that meets criteria and constraints?	**Can I… ? Did I…?** a) Ask questions based on observations, models, or theory, to clarify or gather more information? b) Ask questions to determine how variables interact? c) Ask questions to improve or clarify a model, explanation, or problem? d) Evaluate if a question is testable or relevant? e) Make reasonable hypotheses based on a model or scientific theory? f) Ask or examine questions that challenge the logic or assumptions of an argument, analysis of a data set, or a design? g) Determine/define a real-world problem that is solved by improving a series of steps or system of interacting parts and criteria and constraints?

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PRACTICE 2: 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.

	Grades K-2	Grades 3-5	Grades 6-8	Grades 9-12
PRACTICE 2: Developing & Using Models	**Can I… ? Did I…?** a) Tell the differences between the model and real life? b) Explain the differences between two models? c) Create something that models what I observed or learned?	**Can I… ? Did I…?** a) Describe what the model explains well? b) Explain how a model might also confuse us? c) Work with others to make or improve a model? d) Make or use my model to test predictions and changes? e) Test cause and effect relationships using a model? f) Make a diagram or prototype to show an idea for a new object, tool, or process?	**Can I… ? Did I…?** a) Evaluate and explain the limitations of a model? b) Make or revise a model based on evidence? c) Develop or use a model to: • make predictions? • describe the natural world? • describe unobservable relationships? • gather data? • test ideas?	**Can I… ? Did I…?** a) Revise a model based on its advantages and limitations? b) Develop, revise, or use a model based on evidence? c) Develop, revise, or use a model to make predictions between systems or with in a system? d) Develop a model to test a proposed process or system?

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PRACTICE 3: 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.

	Grades K-2	Grades 3-5	Grades 6-8	Grades 9-12
PRACTICE 3: Planning & Carrying Out Investigations	**Can I… ? Did I…?** a) Work with others to plan and do a science investigation? b) Make predictions based on what I already know? c) Talk about different ways to observe and/or measure to gather data? d) Collect and compare data? e) Make observations to decide if a tool or solution will solve the problem?	**Can I… ? Did I…?** a) Work with others to plan and do a science investigation where data is collected? b) Plan how to collect data and what tools to use? c) Use an experiment that changes only one thing (fair test) to collect data during an investigation? d) Gather data that can be used as evidence to explain why things happen? e) Make a prediction about what would happen if one thing were changed in an experiment? f) Compare two different models to determine which one works better?	**Can I… ? Did I…?** a) Work alone or in a group to plan an investigation? b) Identify which variable changes and which variable stays the same in an experiment? c) Organize data? d) Decide how much data to collect? e) Collect data as evidence to help answer scientific questions or test a design? f) Collect data about how something works under different conditions?	**Can I… ? Did I…?** a) Plan and conduct an investigation or test a design to produce data that can be used as evidence? b) Think carefully about what data is needed, how much is enough, and how accurate and precise it needs to be to help make the best conclusions? c) Consider other variables, their effects on the data, and control variables as needed? d) Plan and conduct investigations safely, ethically, and with consideration of the environmental impact? e) Select appropriate tools to collect, record, analyze, and evaluate data? f) Describe how the variables in the investigation interact? g) Manipulate variables and collect data about a model, process, or system and use that data to refine it?

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

	Grades K-2	Grades 3-5	Grades 6-8	Grades 9-12
PRACTICE 4: Analyzing & Interpreting Data	**Can I… ? Did I…?** a) Draw or write what I thought or observed? b) Find patterns or connections in what I observed? c) Use a patterns or connections to answer a question or solve a problem? d) Compare what I thought would happen to what I observed? e) Use information to decide if something works the way it is supposed to?	**Can I… ? Did I…?** a) Make a table and/or graph of the data? b) Look for patterns in data that show how things interact (relationships)? c) Look carefully at the data in order to explain something? d) Look for similarities and differences in data collected by different groups? e) Use data to improve a problem or design?	**Can I… ? Did I…?** a) Make graphs that show mathematical relationships? b) Use graphs to identify relationships in large data sets? c) Figure out if a variable is related to or causes a change in the relationship? d) Use data as evidence to explain why something happened? e) Describe the data by calculating the mean, median, or mode and range? f) Evaluate the limitations of our data, tools, or systems? g) Compare and contrast data to look for similarities and differences? h) Find the range in which my object, tool, process or system works best?	**Can I… ? Did I…?** a) Analyze data to make valid and reliable claims or determine the best design solutions? b) Use statistics and probability to make inferences from the data that address scientific and engineering questions and problems? c) Take into account the way I gathered and analyzed my data, while drawing my conclusions? d) Compare and contrast different data sets to look for consistency? e) Determine the effect new data has on existing explanations or models? f) Use data to improve ideas based on the criteria for success for a proposed system or process?

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PRACTICE 5: Using Mathematical 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; statistically analyzing data; and recognizing, expressing, and applying quantitative relationships.

	Grades K-2	Grades 3-5	Grades 6-8	Grades 9-12
PRACTICE 5: Using Mathematical & Computational Thinking	**Can I… ? Did I…?** a) Decide when to use numbers and when to use words to make observations? b) Use counting and numbers to describe a pattern? c) Describe, measure and/or compare properties of objects? d) Make a graph of the data? e) Use number data to compare two solutions?	**Can I… ? Did I…?** a) Decide when it is best to use data in the form of numbers or words? b) Organize data and look for relationships and patterns? c) Describe, measure, estimate and/or graph data to address questions and problems? d) Use math to make a graph or a chart to compare solutions?	**Can I… ? Did I…?** a) Use digital tools to analyze data for patterns and trends? b) Use mathematical models to describe or support a scientific conclusion or a design solution? c) Create a series of ordered steps (algorithm) to solve a problem? d) Apply calculations that are used in math class (ratio, rate, percent, etc.) to scientific questions and engineering problems? e) Use digital tools and/or math to test and compare engineering solutions?	**Can I… ? Did I…?** a) Create or revise a computational model or simulation to better represent something? b) Use math or computer modeling to describe or support claims or explanations? c) Apply algebra and functions to represent and solve science and engineering problems? d) Use simple limit cases to see if a model "makes sense" by comparing the outcomes with what is known in the real world? e) Apply ratios, rates, percentages, and unit conversions to solve complex measurement problems?

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PRACTICE 6: Constructing Explanations and Designing Solutions

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

	Grades K-2	Grades 3-5	Grades 6-8	Grades 9-12
PRACTICE 6: Constructing Explanations & Designing Solutions	**Can I… ? Did I…?** a) Use my five senses to gather information about an object or something that happened? b) Choose the evidence is best to support my claim? c) Think of a way to build something to fix a problem? d) Come up with other ways to fix a problem? e) Compare different ways to fix a problem?	**Can I… ? Did I…?** a) Observe, measure and look for patterns to use as evidence? b) Use evidence and scientific ideas to create an explanation or solve a problem? c) Identify and organize evidence to support an explanation? d) Create more than one solution to a problem and compare them to see which one best meets the design requirements? e) Notice relationships and use evidence to explain why they happen?	**Can I… ? Did I…?** a) Construct an explanation using sufficient and appropriate evidence from valid and reliable sources (including my own experiments)? b) Construct an explanation using evidence and scientific ideas (reasoning) to show how the evidence supports the claim? c) Use scientific ideas to create or test an object, tool, process, or system? d) Use an engineering design process in a project to solve a problem that meets specific requirements? e) Refine how well a design works by prioritizing the design criteria, testing, and making changes to my design?	**Can I… ? Did I…?** a) Make a qualitative and/or quantitative claim regarding the relationship between variables? b) Construct and revise an explanation that includes valid and reliable evidence and sources (including students' own investigations, models, theories, simulations, peer review)? c) Explain phenomena and solve design problems using scientific ideas, principles, and/or evidence and taking into account unexpected effects? d) Use scientific reasoning, theory and/or models to link evidence to the claims and to evaluate the extent to which the data supports the explanation? e) Design, evaluate, and/or refine a solution to a complex, real-life problem using: • scientific knowledge? • student-generated sources of evidence? • prioritized criteria? • tradeoff considerations?

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PRACTICE 7: Engaging in Argument from Evidence

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

	Grades K-2	Grades 3-5	Grades 6-8	Grades 9-12
PRACTICE 7: Engaging in Argument from Evidence	**Can I… ? Did I…?** a) Make a claim and support it with evidence? b) Tell the difference between opinions and evidence? c) Listen carefully to an argument and agree or disagree using the evidence? d) Retell the important parts of an argument? e) Make a claim about how well something works and support it with evidence?	**Can I… ? Did I…?** a) Make a claim and support it with evidence and reasoning? b) Compare and improve arguments based on the evidence? c) Improve an argument by asking classmates questions or listening to their feedback? d) Decide how accurate a claim is about a cause and its effect using data? e) Argue to show which explanation, model, tool, or solution works best?	**Can I… ? Did I…?** a) Examine the evidence in two arguments on the same topic to see how it is used to support the different claims. b) Respectfully provide and receive feedback on an argument by citing evidence, and asking and answering questions? c) Create an argument with a claim, evidence, and reasoning that agrees or disagrees with an existing explanation or model? d) Think about how others might react to the argument being made? e) Work with others to create criteria and choose the design solution that best meets the criteria? f) Make an argument that supports or refutes different designs, processes, or systems based on specific criteria and constraints?	**Can I… ? Did I…?** a) Make and defend a scientific or engineering claim based on evidence that reflects scientific knowledge and student-generated evidence? b) Determine the quality of an argument by evaluating the claim, evidence, and reasoning that is used to make it? c) Respectfully provide and/or receive critiques of arguments by examining the evidence and reasoning? d) Seek additional information and consider diverse perspectives to better understand challenging ideas, conclusions and contradictions? e) Evaluate the quality of competing arguments based on current explanations, new evidence, and ethical issues? f) Evaluate competing design solutions to real-world problems using constraints and criteria (e.g. economic, societal, environmental, ethical)?

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PRACTICE 8: 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.

	Grades K-2	Grades 3-5	Grades 6-8	Grades 9-12
PRACTICE 8: Obtaining, Evaluating, & Communicating Information	**Can I… ? Did I…?** a) Find patterns by listening to or reading books about science or engineering? b) Describe how a picture connects to what I am learning in science or engineering? c) Gather information by reading or looking at pictures to answer questions? d) Tell if the science we read or watch is real or make believe? e) Share science and engineering ideas by talking, writing, drawing, or building something?	**Can I… ? Did I…?** a) Use what I learn from grade level books and websites to explain scientific ideas or the solution to a problem? b) Decide if the source of information is likely to be fictional or real? c) Use different sources of information to support an explanation or argument? d) Gather information from graphs, tables, charts and diagrams to use as evidence? e) Share ideas through speaking and writing in different ways?	**Can I… ? Did I…?** a) Read and identify the main ideas, patterns, and/or evidence within informational texts and reliable media? b) Use observations and measurements from text and reliable media to clarify claims and results? c) Use evidence to critique the quality of the source and of the content? d) Reconsider a scientific claim, explanation or argument when presented with competing evidence? e) Communicate information in writing or oral presentations using various formats?	**Can I… ? Did I…?** a) Critically read, identify central ideas, and paraphrase it in simpler, but accurate terms? b) Compare, integrate, and evaluate sources of information found in media and in writing? c) Gather, read, and assess information from a variety of sources? d) Evaluate the quality of sources, content of the sources, and synthesize information across sources? e) Communicate science and engineering information orally, graphically, textually, and mathematically?