NGSS Science & Engineering Practices Grades 9-12

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Practice / Indicator	1	2	3	4	NOTES
Asking questions and defining problems in grades 9–12 builds from grades K–8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and explanatory models and simulations					
Ask questions that arise from phenomena, models, theory, or unexpected results.					
Ask questions that require relevant empirical evidence.					
Ask questions to determine quantitative relationships between independent and dependent variables.					
Ask questions that challenge the premise of an argument, the interpretation of a data set, or the suitability of a design.					
Modeling in 9–12 builds on K–8 and progresses to using, synthesizing, and constructing models to predict and explain relationships between systems and their components in the natural and designed world.					
Use multiple types of models to represent and explain phenomena, and move flexibly between model types based on merits and limitations.					
Construct, revise, and use models to predict and explain relationships between systems and their components.					
Use models (including mathematical and computational) to generate data to explain and predict phenomena, analyze systems, and solve problems.					
Design a test of a model to ascertain its reliability.					
Examine merits and limitations of various models in order to select or revise a model that best fits the evidence or the design criteria.					
Planning and carrying out investigations to answer questions or test solutions to problems in 9–12 builds on K–8 experiences and progresses to include investigations that build, test, and revise conceptual, mathematical, physical, and empirical models. ***Planning and carrying out investigations may include elements of all of the other practices.***					
Plan and carry out investigations individually and collaboratively and test designs as part of building and revising models, explaining phenomena, or testing solutions to problems. Consider possible confounding variables or effects and ensure the investigation's design has controlled for them.					
Evaluate various methods of collecting data (e.g., field study, experimental design, simulations) and analyze components of the design in terms of various aspects of the study. Decide types, how much, and accuracy of data needed to produce reliable measurement and consider any limitations on the precision of the data (e.g., number of trials, cost, risk, time).					
Select appropriate tools to collect, record, analyze, and evaluate data.					
Plan and carry out investigations and test design solutions in a safe and ethical manner including considerations of environmental, social, and personal impacts.					
Analyzing data in 9–12 builds on K–8 and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.					
Use tools, technologies, and/or models (e.g., computational, mathematical) to generate and analyze data in order to make valid and reliable scientific claims or determine an optimal design solution.					
Consider limitations (e.g., measurement error, sample selection) when analyzing and interpreting data.					
Determine function fits to data, including slope, intercept, and correlation coefficient for linear fits.					
Compare and contrast various types of data sets (e.g., self-generated,					

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archival) to examine consistency of measurements and observations.					
Evaluate the impact of new data on a working explanation of a phenomenon or design solution.					
Mathematical and computational thinking at the 9–12 level builds on K–8 and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.					
Use mathematical or algorithmic representations of phenomena or design solutions to create explanations, computational models, or simulations.					
Use mathematical expressions to represent phenomena or design solutions in order to solve algebraically for desired quantities.					
Use simple limit cases to test mathematical expressions, computer programs or algorithms, or simulations to see if a model "makes sense" by comparing the outcomes with what is known about the real world.					
Use statistical and mathematical techniques and structure data (e.g., displays, tables, graphs) to (e.g., displays, tables, graphs) to find regularities, patterns (e.g., fitting mathematical curves to data), and relationships in data.					
Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific knowledge, principles, and theories.					
Make quantitative claims regarding the relationship between dependent and independent variables.					
Apply scientific reasoning, theory, and models to link evidence to claims and show why the data are adequate for the explanation or conclusion.					
Construct and revise explanations and arguments based on evidence obtained from a variety of sources (e.g., scientific principles, models, theories) and peer review.					
Base casual explanations on valid and reliable empirical evidence from multiple sources and the assumption that natural laws operate today as they did in the past and will continue to do so in the future.					
Apply scientific knowledge to solve design problems by taking into account possible unanticipated effects.					
Engaging in argument from evidence in 9–12 builds from K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world. Arguments may also come from current scientific or historical episodes in science.					
Criticize and evaluate arguments and design solutions in light of new evidence, limitations (e.g., trade-offs), constraints, and ethical issues.					
Evaluate the merits of competing arguments, design solutions, and/or models					
Evaluate the claims, evidence, and reasoning of currently accepted explanations or solutions as a basis for the merits of the arguments.					
Construct a counter-argument that is based in data and evidence that challenges another proposed argument					
Obtaining, evaluating, and communicating information in 9–12 builds on K–8 and progresses to evaluating the validity and reliability of the claims, methods, and designs.					
Critically read scientific literature adapted for classroom use to identify key ideas and major points and to evaluate the validity and reliability of the claims, methods, and designs.					
Generate, synthesize, communicate, and critique claims, methods, and designs that appear in scientific and technical texts or media reports.					
Recognize the major features of scientific and technical writing and					

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speaking and produce written and illustrated texts or oral presentations that communicate ideas and accomplishments.					

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