

Science - Frederick County Public Schools

(Revised- Jan 2019)

Graduation Competencies and Performance Standards Overview

Discipline Specific Graduation Competency 1: Asking Questions and Defining Problems

Ask and refine questions in the areas of life, physical and earth/space science that lead to descriptions and explanations of how the natural and designed world works and which can be tested.

1A	Ask, clarify and revise questions from observations of varying phenomena (model, theory or results) to refine a model or explanation to determine testability and relevancy
1B	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

Discipline Specific Graduation Competency 2: Developing and Using Models

Use and construct models to represent ideas and explanations in life, physical and earth/space science.

2A	Evaluate merits and limitations of two different models of the same proposed tool, process, mechanism, or system in order to select or revise a model that best fits the evidence or design criteria
2B	Develop, revise, and/or apply a model or multiple models based on evidence to illustrate and/or predict the relationships between systems or components of a system
2C	Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems

Discipline Specific Graduation Competency 3: Planning and Carrying Out Investigations

Plan and carry out life, physical and earth/space science investigations in the field or laboratory, working collaboratively as well as individually.

3A	Plan, conduct, and evaluate an investigation to produce data for building and revising models, supporting explanations for phenomena, or testing solutions to problems
3B	Identify and manipulate variables and collect data from a complex model of a proposed process or system to identify failure points or improve performance relative to criteria for success

Discipline Specific Graduation Competency 4: Analyzing and Interpreting Data

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Use a range of tools (including tabulation, graphical interpretation, visualization & statistical analysis) to identify significant features & patterns in data in the areas of life, physical & earth/space science.

4A	Analyze data to identify design features or characteristics of the components of a proposed process or system using tools, technologies, and/or models in order to make valid and reliable scientific claims or determine an optimal design solution
4B	Apply concepts of statistics and probability including determining function fits to data, slope, intercept, and correlation coefficient for linear fits to scientific and engineering questions and problems, using digital tools when feasible
4C	Compare and contrast limitations of data analysis (measurement error, sample selection) as well as compare and contrast various types of data sets

Discipline Specific Graduation Competency 5: Using Mathematics and Computational Thinking

Use mathematics and computation to construct simulations, analyze data and recognize, express, and apply quantitative relationships of physical variables in life, physical and earth/space science.

5A	Create, test and/or revise an existing computational model, mathematical expression(s), simulation, or computer program to see if a model “makes sense” by comparing the outcomes with what is known about the real world
5B	Use mathematical, algebraic, computational, or algorithmic representations of phenomena or design solutions to support claims and/or explanations to solve scientific and engineering problems
5C	Apply ratios, rates, percentages, and unit conversions in the context of measurement problems involving quantities with derived or compound units (such as mg/mL, kg/m ³ , acre-feet, etc.)

Discipline Specific Graduation Competency 6: Constructing Explanations and Designing Solutions

Construct explanations in life, physical and earth/space science and design solutions through engineering that are supported by sources of evidence consistent with scientific ideas, and theories.

6A	Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students’ own investigations, models, theories, simulations, peer review)
6B	Design, evaluate, and refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and trade-off considerations

Discipline Specific Graduation Competency 7: Engaging in Argument from Evidence

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Use argumentation (claim, evidence and reasoning) as the process by which explanations and solutions are reached in life, physical and earth/space science.

7A	Compare and evaluate competing arguments or design solutions in light of currently accepted explanations, new evidence, limitations (e.g., trade-offs), constraints, and ethical issues
7B	Construct, use, and present an argument based on data and evidence to support or refute an explanation or a model as well as provide and/or receive critiques
7C	Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and/or logical arguments regarding relevant factors (e.g. economic, societal, environmental, ethical considerations)

Discipline Specific Graduation Competency 8: Obtaining, Evaluating, and Communicating Information

Communicate clearly and persuasively the ideas and methods generated. Critiquing and communicating ideas-is a critical professional activity in the areas of life, physical and earth/space science.

8A	Compare, integrate and evaluate multiple sources of information presented in different media or formats in order to address a scientific question or solve a problem
8B	Gather, read, and evaluate scientific and/or technical information from multiple sources, to determine the validity and reliability of the evidence and usefulness of each source
8C	Critically read and communicate scientific and/or technical information

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Graduation Competencies, Performance Standards and Scoring Criteria

Discipline Specific Graduation Competency 1: Asking Questions and Defining Problems

Ask and refine questions in the areas of life, physical and earth/space science that lead to descriptions and explanations of how the natural and designed world works and which can be tested

1A	Ask, clarify and revise questions from observations of varying phenomena (model, theory or results) to refine a model or explanation to determine testability and relevancy
1B	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

Performance Standards Scoring Criteria for Competency 1

Performance Standards	1 - Emergent	2 - Approaching	3 - Proficient	4 - Exemplary
1A Ask, clarify and revise questions from observations of varying phenomena (model, theory or results) to refine a model or explanation to determine testability and relevancy	I can ask questions based on observation of varying phenomena (model, theory or unexpected results).	I can clarify questions based on observation of varying phenomena (model, theory or unexpected results) to refine a model or explanation.	I can revise questions based on observation of varying phenomena (model, theory or unexpected results) to refine a model or explanation to determine testability and relevancy.	I can evaluate questions based on observation of varying phenomena (model, theory or unexpected results) to refine a model or explanation to determine testability and relevancy.
1B Define a design problem that involves the development of a process or system (with interacting components) and criteria/constraints that may include social, technical and/or environmental considerations	I can define a problem that is part of a process or system.	I can define a design problem that is part of an interdependent process or systems with limited criteria/constraints.	I can define a design problem that involves the development of a process or system (with interacting components) and criteria/constraints that may include social, technical and/or environmental considerations.	I can define a design problem that involves the development of a process or system(with interacting components) and criteria/ constraints to explain social, technical and/or environmental considerations.

Discipline Specific Graduation Competency 2: Developing and Using Models

Use and construct models to represent ideas and explanations in life, physical and earth/space science

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2A	Evaluate merits and limitations of two different models of the same proposed tool, process, mechanism, or system in order to select or revise a model that best fits the evidence or design criteria
2B	Develop, revise, and/or apply a model or multiple models based on evidence to illustrate and/or predict the relationships between systems or components of a system
2C	Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems

Performance Standards Scoring Criteria for Competency 2

Performance Standards	1 - Emergent	2 - Approaching	3 - Proficient	4 - Exemplary
2A Evaluate merits and limitations of two different models of the same proposed tool, process, mechanism, or system in order to select or revise a model that best fits the evidence or design criteria	I can identify the merits and limitations of a model.	I can identify the merits and limitations of two different models of the same proposed tool, process, mechanism, or system.	I can evaluate merits and limitations of two different models of the same proposed tool, process, mechanism, or system in order to select or revise a model that best fits the evidence or design criteria.	I can defend the use of a model that either expands on the previous models or presents the benefits of the approach.
2B Develop, revise, and/or apply a model or multiple models based on evidence to illustrate and/or predict the relationships between systems or components of a system	I can use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system.	I can revise or apply a model or multiple models based on evidence to illustrate and/or predict the relationships between systems or between components of a system.	I can develop, revise, and/or apply a model or multiple models based on evidence to illustrate and/or predict the relationships between systems or between components of a system.	I can justify the use of a model or multiple models based on evidence to illustrate and/or predict the relationships between systems or between components of a system.
2C Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems	I can use a mathematical or computational model to generate data.	I can use a mathematical or computational model to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.	I can develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.	I can analyze the limitations and strengths of the model to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.

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Discipline Specific Graduation Competency 3: Planning and Carrying Out Investigations

Plan and carry out life, physical and earth/space science investigations in the field or laboratory, working collaboratively as well as individually

3A	Plan, conduct, and evaluate an investigation to produce data for building and revising models, supporting explanations for phenomena, or testing solutions to problems
3B	Identify and manipulate variables and collect data from a complex model of a proposed process or system to identify failure points or improve performance relative to criteria for success

Performance Standards Scoring Criteria for Competency 3

Performance Standards	1 - Emergent	2 - Approaching	3 - Proficient	4 - Exemplary
3A Plan, conduct, and evaluate an investigation to produce data for building and revising models, supporting explanations for phenomena, or testing solutions to problems	I can conduct an investigation to produce data to serve as the basis for evidence.	I can plan and conduct an investigation to produce data to serve as the basis for evidence.	I can plan, conduct, and evaluate an investigation to produce data for building and revising models, supporting explanations for phenomena, or testing solutions to problems.	I can defend the plan for the investigation.
3B Identify and manipulate variables and collect data from a complex model of a proposed process or system to identify failure points or improve performance relative to criteria for success	I can identify variables and collect/record data.	I can manipulate a variable and collect the resulting data.	I can identify and manipulate variables and collect data from a complex model of a proposed process or system to identify failure points or improve performance relative to criteria for success.	I can critique and/or revise as necessary the investigation based on the results of the data collection.

Discipline Specific Graduation Competency 4: Analyzing and Interpreting Data

Use a range of tools—including tabulation, graphical interpretation, visualization, and statistical analysis—to identify the significant features and patterns in the data in the areas of life, physical and earth/space science

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4A	Analyze data to identify design features or characteristics of the components of a proposed process or system using tools, technologies, and/or models in order to make valid and reliable scientific claims or determine an optimal design solution
4B	Apply concepts of statistics and probability including determining function fits to data, slope, intercept, and correlation coefficient for linear fits to scientific and engineering questions and problems, using digital tools when feasible
4C	Compare and contrast limitations of data analysis (measurement error, sample selection) as well as compare and contrast various types of data sets

Performance Standards Scoring Criteria for Competency 4

Performance Standards	1 - Emergent	2 - Approaching	3 - Proficient	4 - Exemplary
4A Analyze data to identify design features or characteristics of the components of a proposed process or system using tools, technologies, and/or models in order to make valid and reliable scientific claims or determine an optimal design solution	I can use data to make scientific claims.	I can use data to inform the use of tools, technologies, and/or models to make valid and reliable scientific claims.	I can analyze data to identify design features or characteristics of the components of a proposed process or system using tools, technologies, and/or models in order to make valid and reliable scientific claims or determine an optimal design solution.	I can infer how the use of data can inform a system/model design development.
4B Apply concepts of statistics and probability including determining function fits to data and slope, intercept, and correlation coefficient for linear fits to scientific and engineering questions and problems, using digital tools when feasible	I can identify concepts of statistics and probability.	I can use statistics and probability concepts for analysis of data.	I can apply concepts of statistics and probability, including determining function fits to data and slope, intercept, and correlation coefficient for linear fits to scientific and engineering questions and problems.	I can justify the rationale for choosing a particular statistics and probability tool and its resulting scientific significance.
	e.g.- mean, median, mode, determining function fits to data and slope, intercept, and correlation coefficient for linear fits while using digital tools when feasible			
4C Compare and contrast limitations of data analysis (measurement error, sample selection) as well as compare	I can identify a limitation of data analysis (e.g., measurement error) or identify different types of data sets.	I can identify multiple limitations of data analysis (e.g., measurement error, sample selection) and/or explain appropriate use of	I can compare and contrast limitations of data analysis (measurement error, sample selection) as well as compare	I can develop a logical argument in which the limitations of data analysis are minimized and the most appropriate data set type is

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and contrast various types of data sets		different types of data sets.	and contrast various types of data sets.	utilized.
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Discipline Specific Graduation Competency 5: Using Mathematics and Computational Thinking

Use mathematics and computation to construct simulations, analyze data and recognize, express, and apply quantitative relationships of physical variables in life, physical and earth/space science

5A	Create, test and/or revise an existing computational model, mathematical expression(s), simulation, or computer program to see if a model “makes sense” by comparing the outcomes with what is known about the real world
5B	Use mathematical, algebraic, computational, or algorithmic representations of phenomena or design solutions to support claims and/or explanations to solve scientific and engineering problems
5C	Apply ratios, rates, percentages, and unit conversions in the context of measurement problems involving quantities with derived or compound units (such as mg/mL, kg/m ³ , acre-feet, etc.)

Performance Standards Scoring Criteria for Competency 5

Performance Standards	1 - Emergent	2 - Approaching	3 - Proficient	4 - Exemplary
5A Create, test and/or revise an existing computational model, mathematical expression(s), simulation, or computer program to see if a model “makes sense” by comparing the outcomes with what is known about the real world	I can use a computational model or simulation.	I can explain a computational model or simulation of a phenomenon, designed device, process, or system.	I can create, test and/or revise an existing computational model, mathematical expression(s), simulation, or computer program to see if a model “makes sense” by comparing the outcomes with what is known about the real world.	I can critique the strengths and limitations of a computational model, mathematical expression(s), simulation, or computer program and defend the outcome.
5B Use mathematical, algebraic, computational, or algorithmic representations of phenomena or design solutions to support claims and/or explanations to solve scientific and engineering problems	I can use simple mathematical representations to describe and/or support scientific conclusions and design solutions.	I can use mathematical, algebraic, computational, or algorithmic representations of phenomena or design solutions.	I can use mathematical, algebraic, computational, or algorithmic representations of phenomena or design solutions to support claims and/or explanations to solve scientific and engineering problems.	I can defend the use of mathematical, algebraic, computational, or algorithmic representations of phenomena or design solutions to support a claim and/or explanation to solve scientific and engineering problems.

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5C Apply ratios, rates, percentages, and unit conversions in the context of measurement problems involving quantities with derived or compound units (such as mg/mL, kg/m ³ , acre-feet, etc.)	I can distinguish between measured, derived and compound units when applying mathematical concepts and/or processes.	I can apply mathematical concepts and/or processes (ratio, rates, percent, basic operations, simple algebra) to measurement problems.	I can apply ratios, rates, percentages, and unit conversions in the context of measurement problems involving quantities with derived or compound units (such as mg/mL, kg/m ³ , acre-feet, etc.).	I can connect the results of measurement problems involving quantities to real world situations (medication dosage, stoichiometry, cooking).
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Discipline Specific Graduation Competency 6: Constructing Explanations and Designing Solutions

Construct explanations in life, physical and earth/space science and design solutions through engineering that are supported by multiple sources of evidence consistent with scientific ideas, principles, and theories

6A	Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review)
6B	Design, evaluate, and refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and trade-off considerations

Performance Standards Scoring Criteria for Competency 6

Performance Standards	1 - Emergent	2 - Approaching	3 - Proficient	4 - Exemplary
6A Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review)	I can recognize valid and reliable scientific evidence from a variety of sources (including students' own investigations, models, theories, simulations, peer review).	I can construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review).	I can construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review).	I can defend an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review).

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6B Design, evaluate, and refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and trade-off considerations	I can design a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and trade-off considerations.	I can evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and trade-off considerations.	I can refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and trade-off considerations.	I can critique designs for strengths and weaknesses.
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Discipline Specific Graduation Competency 7: Engaging in Argument from Evidence

Use argumentation as the process by which explanations and solutions are reached in life, physical and earth/space science

7A	Compare and evaluate competing arguments or design solutions in light of currently accepted explanations, new evidence, limitations (e.g., trade-offs), constraints, and ethical issues
7B	Construct, use, and present an argument based on data and evidence to support or refute an explanation or a model as well as provide and/or receive critiques
7C	Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and/or logical arguments regarding relevant factors (e.g. economic, societal, environmental, ethical considerations)

Performance Standards Scoring Criteria for Competency 7

Performance Standards	1 - Emergent	2 - Approaching	3 - Proficient	4 - Exemplary
7A Compare and evaluate competing arguments or design solutions in light of currently accepted explanations, new evidence, limitations (e.g., trade-offs), constraints, and ethical issues	I can formulate an argument using claim, evidence and reasoning.	I can compare and contrast competing arguments or design solutions (using claim, evidence and reasoning) in light of currently accepted explanations, new evidence, limitations (e.g., trade-offs),	I can compare and evaluate competing arguments or design solutions in light of currently accepted explanations, new evidence, limitations (e.g., trade-offs), constraints, and ethical issues.	I can defend my argument in response to counterclaims using claim, evidence and reasoning.

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		constraints, and ethical issues.		
7B Construct, use, and present an argument based on data and evidence to support or refute an explanation or a model as well as provide and/or receive critiques	I can use an argument based on data and evidence to support an explanation or a model as well as provide and/or receive critiques.	I can construct an argument based on data and evidence to support an explanation or a model as well as provide and/or receive critiques.	I can present an argument based on data and evidence to support or refute an explanation or a model as well as provide and/or receive critiques.	I can defend an argument based on data and evidence to support or refute an explanation or a model as well as provide and/or receive critiques.
7C Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and/or logical arguments regarding relevant factors (e.g. economic, societal, environmental, ethical considerations)	I can propose a solution to a real world problem.	I can compare competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and/or logical arguments regarding relevant factors (e.g. economic, societal, environmental, ethical considerations).	I can evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and/or logical arguments regarding relevant factors (e.g. economic, societal, environmental, ethical considerations).	I can modify an existing design solution to a real-world problem based on scientific ideas and principles, empirical evidence, and/or logical arguments regarding relevant factors (e.g. economic, societal, environmental, ethical considerations).

Discipline Specific Graduation Competency 8: Obtaining, Evaluating, and Communicating Information

Communicate clearly and persuasively the ideas and methods generated. Critiquing and communicating ideas individually and in groups is a critical professional activity in the areas of life, physical and earth/space science

8A	Compare, integrate and evaluate multiple sources of information presented in different media or formats in order to address a scientific question or solve a problem
8B	Gather, read, and evaluate scientific and/or technical information from multiple sources, to determine the validity and reliability of the evidence and usefulness of each source
8C	Critically read and communicate scientific and/or technical information

Performance Standards Scoring Criteria for Competency 8

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Performance Standards	1 - Emergent	2 - Approaching	3 - Proficient	4 - Exemplary
8A Compare, integrate and evaluate multiple sources of information presented in different media or formats in order to address a scientific question or solve a problem	I can integrate multiple sources of information presented in different media or formats in order to address a scientific question or solve a problem.	I can compare sources of information presented in different media or formats in order to address a scientific question or solve a problem.	I can evaluate multiple sources of information presented in different media or formats in order to address a scientific question or solve a problem.	I can pose a new scientific question or solution to a problem based on evaluation of scientific literature.
8B Gather, read, and evaluate scientific and/or technical information from multiple sources, to determine the validity and reliability of the evidence and usefulness of each source	I can gather and read scientific and/or technical information from a single source, to gather scientific information related to the topic.	I can gather and read scientific and/or technical information from multiple sources, to gather scientific information related to the topic.	I can evaluate scientific and/or technical information from multiple sources, to determine the validity and reliability of the evidence and usefulness of each source.	I can critique evaluative examples of scientific information and provide feedback to increase the validity and reliability of the evidence.
8C Critically read and communicate scientific and/or technical information	I can recognize and identify scientific and/or technical information.	I can read and describe scientific and/or technical information.	I can critically read and communicate scientific and/or technical information.	I can communicate scientific and/or technical information to a non-scientific audience.