PLTW Engineering Standards Connection
Engineering Design and Development

Connections to Standards in Engineering

PLTW curriculum is designed to empower students to thrive in an evolving world. As a part of the design process when developing and updating our curriculum, we focus on connections to a variety of standards. PLTW Engineering Design and Development connects to standards in the following:

Table of Contents

Common Core State Standards for English Language Arts Anchor Standards

Reading

Key Ideas and Details

CCSS.ELA-LITERACY.CCRA.R.1

Read closely to determine what the text says explicitly and to make logical inferences from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text.

- [x] Component 0
- [x] Component 1
- [x] Component 2
- [x] Component 3
- [x] Component 4
- [x] Component 5

CCSS.ELA-LITERACY.CCRA.R.2

Determine central ideas or themes of a text and analyze their development; summarize the key supporting details and ideas.

- [x] Component 0
- [x] Component 1
- [x] Component 2
- [ ] Component 3
- [x] Component 4
- [x] Component 5

Craft and Structure

CCSS.ELA-LITERACY.CCRA.R.4

Interpret words and phrases as they are used in a text, including determining technical, connotative, and figurative meanings, and analyze how specific word choices shape meaning or tone.

- [x] Component 0
- [x] Component 1
- [x] Component 2
- [x] Component 3
- [x] Component 4
- [x] Component 5

CCSS.ELA-LITERACY.CCRA.R.6

Assess how point of view or purpose shapes the content and style of a text.

- [ ] Component 0
- [x] Component 1
- [x] Component 2
- [ ] Component 3
- [x] Component 4
- [x] Component 5

Integration of Knowledge and Ideas

CCSS.ELA-LITERACY.CCRA.R.7

Integrate and evaluate content presented in diverse formats and media, including visually and quantitatively, as well as in words.

- [ ] Component 0
- [x] Component 1
- [x] Component 2
- [x] Component 3
- [x] Component 4
- [x] Component 5

CCSS.ELA-LITERACY.CCRA.R.8

Delineate and evaluate the argument and specific claims in a text, including the validity of the reasoning as well as the relevance and sufficiency of the evidence.

- [ ] Component 0
- [x] Component 1
- [x] Component 2
- [ ] Component 3
- [x] Component 4
- [x] Component 5

CCSS.ELA-LITERACY.CCRA.R.9

Analyze how two or more texts address similar themes or topics in order to build knowledge or to compare the approaches the authors take.

- [ ] Component 0 - [x] Component 1 - [x] Component 2
- [ ] Component 3 - [x] Component 4 - [x] Component 5

Range of Reading and Level of Text Complexity

CCSS.ELA-LITERACY.CCRA.R.10

Read and comprehend complex literary and informational texts independently and proficiently.

- [x] Component 0 - [x] Component 1 - [x] Component 2
- [x] Component 3 - [x] Component 4 - [x] Component 5

Writing

Text Types and Purposes

CCSS.ELA-LITERACY.CCRA.W.1

Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.

- [x] Component 0 - [x] Component 1 - [x] Component 2
- [x] Component 3 - [x] Component 4 - [x] Component 5

CCSS.ELA-LITERACY.CCRA.W.2

Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content.

- [x] Component 0 - [x] Component 1 - [x] Component 2
- [x] Component 3 - [x] Component 4 - [x] Component 5

CCSS.ELA-LITERACY.CCRA.W.3

Write narratives to develop real or imagined experiences or events using effective technique, well-chosen details, and well-structured event sequences.

- [ ] Component 0 - [x] Component 1 - [x] Component 2
- [x] Component 3 - [x] Component 4 - [x] Component 5

Production and Distribution of Writing

CCSS.ELA-LITERACY.CCRA.W.4

Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

- [x] Component 0 - [x] Component 1 - [x] Component 2
- [x] Component 3 - [x] Component 4 - [x] Component 5

Common Core State Standards for English Language Arts Anchor Standards

CCSS.ELA-LITERACY.CCRA.W.5

Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach.

- ☑ Component 0 ☑ Component 1 ☑ Component 2
- ☑ Component 3 ☑ Component 4 ☑ Component 5

CCSS.ELA-LITERACY.CCRA.W.6

Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others.

- ☑ Component 0 ☑ Component 1 ☑ Component 2
- ☑ Component 3 ☑ Component 4 ☑ Component 5

Research to Build and Present Knowledge

CCSS.ELA-LITERACY.CCRA.W.7

Conduct short as well as more sustained research projects based on focused questions, demonstrating understanding of the subject under investigation.

- ☑ Component 0 ☑ Component 1 ☑ Component 2
- ☑ Component 3 ☑ Component 4 ☑ Component 5

CCSS.ELA-LITERACY.CCRA.W.8

Gather relevant information from multiple print and digital sources, assess the credibility and accuracy of each source, and integrate the information while avoiding plagiarism.

- ☑ Component 0 ☑ Component 1 ☑ Component 2
- ☑ Component 3 ☑ Component 4 ☑ Component 5

CCSS.ELA-LITERACY.CCRA.W.9

Draw evidence from literary or informational texts to support analysis, reflection, and research.

- ☑ Component 0 ☑ Component 1 ☑ Component 2
- ☑ Component 3 ☑ Component 4 ☑ Component 5

Range of Writing

CCSS.ELA-LITERACY.CCRA.W.10

Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audiences.

- ☑ Component 0 ☑ Component 1 ☑ Component 2
- ☑ Component 3 ☑ Component 4 ☑ Component 5

Speaking and Listening

Comprehension and Collaboration

CCSS.ELA-LITERACY.CCRA.SL.1

Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively.

- ☑ Component 0 ☑ Component 1 ☑ Component 2
- ☑ Component 3 ☑ Component 4 ☑ Component 5

CCSS.ELA-LITERACY.CCRA.SL.2

Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally.

- ☑ Component 0 ☑ Component 1 ☑ Component 2
- ☑ Component 3 ☑ Component 4 ☑ Component 5

CCSS.ELA-LITERACY.CCRA.SL.3

Evaluate a speaker's point of view, reasoning, and use of evidence and rhetoric.

- ☑ Component 0 ☑ Component 1 ☑ Component 2
- ☑ Component 3 ☑ Component 4 ☑ Component 5

Presentation of Knowledge and Ideas

CCSS.ELA-LITERACY.CCRA.SL.4

Present information, findings, and supporting evidence such that listeners can follow the line of reasoning and the organization, development, and style are appropriate to task, purpose, and audience.

- ☑ Component 0 ☑ Component 1 ☑ Component 2
- ☑ Component 3 ☑ Component 4 ☑ Component 5

CCSS.ELA-LITERACY.CCRA.SL.5

Make strategic use of digital media and visual displays of data to express information and enhance understanding of presentations.

- ☑ Component 0 ☑ Component 1 ☑ Component 2
- ☑ Component 3 ☑ Component 4 ☑ Component 5

CCSS.ELA-LITERACY.CCRA.SL.6

Adapt speech to a variety of contexts and communicative tasks, demonstrating command of formal English when indicated or appropriate.

- ☑ Component 0 ☑ Component 1 ☑ Component 2
- ☑ Component 3 ☑ Component 4 ☑ Component 5

Common Core State Standards for English Language Arts Anchor Standards

Language

Conventions of Standard English

CCSS.ELA-LITERACY.CCRA.L.1

Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.

- ☑ Component 0 ☑ Component 1 ☑ Component 2
- ☑ Component 3 ☑ Component 4 ☑ Component 5

CCSS.ELA-LITERACY.CCRA.L.2

Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing.

- ☑ Component 0 ☑ Component 1 ☑ Component 2
- ☑ Component 3 ☑ Component 4 ☑ Component 5

Knowledge of Language

CCSS.ELA-LITERACY.CCRA.L.3

Apply knowledge of language to understand how language functions in different contexts, to make effective choices for meaning or style, and to comprehend more fully when reading or listening.

- ☑ Component 0 ☑ Component 1 ☑ Component 2
- ☑ Component 3 ☑ Component 4 ☑ Component 5

Vocabulary Acquisition and Use

CCSS.ELA-LITERACY.CCRA.L.4

Determine or clarify the meaning of unknown and multiple-meaning words and phrases by using context clues, analyzing meaningful word parts, and consulting general and specialized reference materials, as appropriate.

- ☑ Component 0 ☑ Component 1 ☑ Component 2
- ☑ Component 3 ☑ Component 4 ☑ Component 5

CCSS.ELA-LITERACY.CCRA.L.5

Demonstrate understanding of word relationships and nuances in word meanings.

- ☑ Component 0 ☑ Component 1 ☑ Component 2
- ☑ Component 3 ☑ Component 4 ☑ Component 5

Common Core State Standards for English Language Arts Anchor Standards

CCSS.ELA-LITERACY.CCRA.L.6

Acquire and use accurately a range of general academic and domain-specific words and phrases sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when encountering an unknown term important to comprehension or expression.

- ☑ Component 0
- ☑ Component 1
- ☑ Component 2
- ☑ Component 3
- ☑ Component 4
- ☑ Component 5

Common Core Standards for Mathematics

Quantities

Reason Quantitatively and Use Units to Solve Problems

CCSS.MATH.CONTENT.HSN.Q.A.1

Use units as a way to understand problems and to guide the solution of multistep problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.

- [x] Component 0
- [x] Component 1
- [x] Component 2
- [x] Component 3
- [x] Component 4
- [ ] Component 5

CCSS.MATH.CONTENT.HSN.Q.A.2

Define appropriate quantities for the purpose of descriptive modeling.

- [x] Component 0
- [x] Component 1
- [x] Component 2
- [x] Component 3
- [x] Component 4
- [ ] Component 5

CCSS.MATH.CONTENT.HSN.Q.A.3

Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

- [x] Component 0
- [x] Component 1
- [x] Component 2
- [x] Component 3
- [x] Component 4
- [ ] Component 5

Seeing Structure in Expressions

Interpret the Structure of Expressions

CCSS.MATH.CONTENT.HSA.SSE.A.1

Interpret expressions that represent a quantity in terms of its context.

- [x] Component 0
- [x] Component 1
- [x] Component 2
- [x] Component 3
- [ ] Component 4
- [x] Component 5

CCSS.MATH.CONTENT.HSA.SSE.A.1.A

Interpret parts of an expression, such as terms, factors, and coefficients.

- [x] Component 0
- [x] Component 1
- [x] Component 2
- [x] Component 3
- [ ] Component 4
- [ ] Component 5

Write Expressions in Equivalent Forms to Solve Problems

CCSS.MATH.CONTENT.HSA.SSE.B.3

Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.

- [ ] Component 0
- [ ] Component 1
- [x] Component 2
- [x] Component 3
- [ ] Component 4
- [ ] Component 5

Arithmetic with Polynomials and Rational Expressions

Perform Arithmetic Operations on Polynomials

CCSS.MATH.CONTENT.HSA.APR.A.1

Understand that polynomials form a system analogous to the integers, namely, they are closed under the operations of addition, subtraction, and multiplication; add, subtract, and multiply polynomials.

- [ ] Component 0
- [ ] Component 1
- [x] Component 2
- [ ] Component 3
- [ ] Component 4
- [ ] Component 5

Creating Equations

Create Equations That Describe Numbers Or Relationships

CCSS.MATH.CONTENT.HSA.CED.A.1

Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.

- [ ] Component 0
- [ ] Component 1
- [x] Component 2
- [x] Component 3
- [ ] Component 4
- [ ] Component 5

CCSS.MATH.CONTENT.HSA.CED.A.2

Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.

- [ ] Component 0
- [ ] Component 1
- [x] Component 2
- [x] Component 3
- [ ] Component 4
- [ ] Component 5

CCSS.MATH.CONTENT.HSA.CED.A.4

Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. For example, rearrange Ohm’s law V = IR to highlight resistance R.

- [ ] Component 0
- [ ] Component 1
- [x] Component 2
- [x] Component 3
- [ ] Component 4
- [ ] Component 5

Reasoning with Equations and Inequalities

Understand Solving Equations as a Process of Reasoning and Explain the Reasoning

CCSS.MATH.CONTENT.HSA.REI.A.1

Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method.

- [ ] Component 0
- [ ] Component 1
- [ ] Component 2
- [ ] Component 3
- [ ] Component 4
- [x] Component 5

CCSS.MATH.CONTENT.HSA.REI.A.2

Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise.

☐ Component 0 ☐ Component 1 ☐ Component 2

☐ Component 3 ☐ Component 4 ☑ Component 5

Solve Equations and Inequalities in One Variable

CCSS.MATH.CONTENT.HSA.REI.B.3

Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.

☐ Component 0 ☐ Component 1 ☑ Component 2

☑ Component 3 ☐ Component 4 ☐ Component 5

CCSS.MATH.CONTENT.HSA.REI.B.4

Solve quadratic equations in one variable.

☐ Component 0 ☐ Component 1 ☑ Component 2

☐ Component 3 ☐ Component 4 ☐ Component 5

Solve Systems of Equations

CCSS.MATH.CONTENT.HSA.REI.C.6

Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.

☐ Component 0 ☐ Component 1 ☐ Component 2

☑ Component 3 ☐ Component 4 ☐ Component 5

Represent and Solve Equations and Inequalities Graphically

CCSS.MATH.CONTENT.HSA.REI.D.10

Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line).

☐ Component 0 ☑ Component 1 ☑ Component 2

☑ Component 3 ☐ Component 4 ☐ Component 5

CCSS.MATH.CONTENT.HSA.REI.D.11

Explain why the x-coordinates of the points where the graphs of the equations $y = f(x)$ and $y = g(x)$ intersect are the solutions of the equation $f(x) = g(x)$; find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where $f(x)$ and/or $g(x)$ are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.

☐ Component 0 ☐ Component 1 ☑ Component 2

☐ Component 3 ☐ Component 4 ☐ Component 5

CCSS.MATH.CONTENT.HSA.REI.D.12

Graph the solutions to a linear inequality in two variables as a half- plane (excluding the boundary in the case of a strict inequality), and graph the solution set to a system of linear inequalities in two variables as the intersection of the corresponding half-planes.

- ☐ Component 0 ☐ Component 1 ☐ Component 2
- ☑ Component 3 ☐ Component 4 ☐ Component 5

Interpreting Functions

Understand the Concept of a Function and Use Function Notation

CCSS.MATH.CONTENT.HSF.IF.A.1

Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then f(x) denotes the output of f corresponding to the input x. The graph of f is the graph of the equation y = f(x).

- ☐ Component 0 ☑ Component 1 ☑ Component 2
- ☑ Component 3 ☐ Component 4 ☐ Component 5

CCSS.MATH.CONTENT.HSF.IF.A.2

Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.

- ☐ Component 0 ☐ Component 1 ☐ Component 2
- ☑ Component 3 ☐ Component 4 ☐ Component 5

Interpret Functions That Arise in Applications in Terms of the Context

CCSS.MATH.CONTENT.HSF.IF.B.4

For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.

- ☐ Component 0 ☑ Component 1 ☐ Component 2
- ☑ Component 3 ☐ Component 4 ☐ Component 5

CCSS.MATH.CONTENT.HSF.IF.B.5

Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. For example, if the function h(n) gives the number of person-hours it takes to assemble n engines in a factory, then the positive integers would be an appropriate domain for the function.

- ☐ Component 0 ☑ Component 1 ☐ Component 2
- ☑ Component 3 ☐ Component 4 ☑ Component 5

CCSS.MATH.CONTENT.HSF.IF.B.6

Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.

- [ ] Component 0
- [ ] Component 1
- [ ] Component 2
- [x] Component 3
- [ ] Component 4
- [ ] Component 5

Analyze Functions Using Different Representations

CCSS.MATH.CONTENT.HSF.IF.C.7

Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.

- [ ] Component 0
- [ ] Component 1
- [x] Component 2
- [ ] Component 3
- [ ] Component 4
- [ ] Component 5

CCSS.MATH.CONTENT.HSF.IF.C.7.A

Graph linear and quadratic functions and show intercepts, maxima, and minima.

- [ ] Component 0
- [ ] Component 1
- [x] Component 2
- [x] Component 3
- [ ] Component 4
- [ ] Component 5

CCSS.MATH.CONTENT.HSF.IF.C.8

Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.

- [ ] Component 0
- [ ] Component 1
- [x] Component 2
- [ ] Component 3
- [ ] Component 4
- [ ] Component 5

Building Functions

Build a Function That Models a Relationship Between Two Quantities

CCSS.MATH.CONTENT.HSF.BF.A.1

Write a function that describes a relationship between two quantities.

- [ ] Component 0
- [ ] Component 1
- [x] Component 2
- [x] Component 3
- [ ] Component 4
- [ ] Component 5

CCSS.MATH.CONTENT.HSF.BF.A.1.B

Combine standard function types using arithmetic operations. For example, build a function that models the temperature of a cooling body by adding a constant function to a decaying exponential, and relate these functions to the model.

- [ ] Component 0
- [ ] Component 1
- [x] Component 2
- [ ] Component 3
- [ ] Component 4
- [ ] Component 5

CCSS.MATH.CONTENT.HSF.BF.A.1.C

(+) Compose functions. For example, if T(y) is the temperature in the atmosphere as a function of height, and h(t) is the height of a weather balloon as a function of time, then T(h(t)) is the temperature at the location of the weather balloon as a function of time.

- ☐ Component 0
- ☐ Component 1
- ☑ Component 2
- ☐ Component 3
- ☐ Component 4
- ☐ Component 5

CCSS.MATH.CONTENT.HSF.BF.A.2

Write arithmetic and geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms.

- ☐ Component 0
- ☐ Component 1
- ☐ Component 2
- ☑ Component 3
- ☐ Component 4
- ☐ Component 5

Linear, Quadratic, and Exponential Models

Construct and Compare Linear, Quadratic, and Exponential Models and Solve Problems

CCSS.MATH.CONTENT.HSF.LE.A.1

Distinguish between situations that can be modeled with linear functions and with exponential functions.

- ☐ Component 0
- ☑ Component 1
- ☑ Component 2
- ☑ Component 3
- ☐ Component 4
- ☐ Component 5

CCSS.MATH.CONTENT.HSF.LE.A.1.B

Recognize situations in which one quantity changes at a constant rate per unit interval relative to another.

- ☐ Component 0
- ☑ Component 1
- ☑ Component 2
- ☑ Component 3
- ☐ Component 4
- ☐ Component 5

CCSS.MATH.CONTENT.HSF.LE.A.1.C

Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another.

- ☐ Component 0
- ☑ Component 1
- ☑ Component 2
- ☑ Component 3
- ☐ Component 4
- ☐ Component 5

CCSS.MATH.CONTENT.HSF.LE.A.2

Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table).

- ☐ Component 0
- ☐ Component 1
- ☐ Component 2
- ☑ Component 3
- ☐ Component 4
- ☐ Component 5

CCSS.MATH.CONTENT.HSF.LE.A.3

Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly, quadratically, or (more generally) as a polynomial function.

- [ ] Component 0 - [x] Component 1 - [x] Component 2
- [x] Component 3 - [ ] Component 4 - [ ] Component 5

Interpret Expressions for Functions in Terms of the Situation They Model

CCSS.MATH.CONTENT.HSF.LE.B.5

Interpret the parameters in a linear or exponential function in terms of a context.

- [ ] Component 0 - [x] Component 1 - [x] Component 2
- [ ] Component 3 - [ ] Component 4 - [ ] Component 5

Congruence

Experiment with Transformations in the Plane

CCSS.MATH.CONTENT.HSG.CO.A.1

Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc.

- [ ] Component 0 - [ ] Component 1 - [x] Component 2
- [ ] Component 3 - [ ] Component 4 - [ ] Component 5

CCSS.MATH.CONTENT.HSG.CO.A.4

Develop definitions of rotations, reflections, and translations in terms of angles, circles, perpendicular lines, parallel lines, and line segments.

- [ ] Component 0 - [ ] Component 1 - [x] Component 2
- [ ] Component 3 - [ ] Component 4 - [ ] Component 5

CCSS.MATH.CONTENT.HSG.CO.A.5

Given a geometric figure and a rotation, reflection, or translation, draw the transformed figure using, e.g., graph paper, tracing paper, or geometry software. Specify a sequence of transformations that will carry a given figure onto another.

- [ ] Component 0 - [ ] Component 1 - [x] Component 2
- [ ] Component 3 - [ ] Component 4 - [ ] Component 5

Make Geometric Constructions

CCSS.MATH.CONTENT.HSG.CO.D.12

Make formal geometric constructions with a variety of tools and methods (compass and straightedge, string, reflective devices, paper folding, dynamic geometric software, etc.). Copying a segment; copying an angle; bisecting a segment; bisecting an angle; constructing perpendicular lines, including the perpendicular bisector of a line segment; and constructing a line parallel to a given line through a point not on the line.

- ☐ Component 0 ☐ Component 1 ☑ Component 2
- ☐ Component 3 ☐ Component 4 ☐ Component 5

Geometric Measurement and Dimension

Visualize Relationships Between Two-Dimensional and Three-Dimensional Objects

CCSS.MATH.CONTENT.HSG.GMD.B.4

Identify the shapes of two-dimensional cross-sections of three- dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects.

- ☐ Component 0 ☐ Component 1 ☑ Component 2
- ☐ Component 3 ☐ Component 4 ☐ Component 5

Modeling with Geometry

Apply Geometric Concepts in Modeling Situations

CCSS.MATH.CONTENT.HSG.MG.A.1

Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).

- ☐ Component 0 ☐ Component 1 ☑ Component 2
- ☐ Component 3 ☐ Component 4 ☐ Component 5

CCSS.MATH.CONTENT.HSG.MG.A.2

Apply concepts of density based on area and volume in modeling situations (e.g., persons per square mile, BTUs per cubic foot).

- ☐ Component 0 ☐ Component 1 ☑ Component 2
- ☐ Component 3 ☐ Component 4 ☐ Component 5

CCSS.MATH.CONTENT.HSG.MG.A.3

Apply geometric methods to solve design problems (e.g., designing an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios).

- ☐ Component 0 ☐ Component 1 ☑ Component 2
- ☐ Component 3 ☐ Component 4 ☐ Component 5

Interpreting Categorical and Quantitative Data

Summarize, Represent, and Interpret Data on a Single Count or Measurement Variable

CCSS.MATH.CONTENT.HSS.ID.A.1

Represent data with plots on the real number line (dot plots, histograms, and box plots).

- [x] Component 0
- [x] Component 1
- [ ] Component 2
- [x] Component 3
- [x] Component 4
- [x] Component 5

CCSS.MATH.CONTENT.HSS.ID.A.2

Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets.

- [x] Component 0
- [x] Component 1
- [ ] Component 2
- [x] Component 3
- [x] Component 4
- [x] Component 5

CCSS.MATH.CONTENT.HSS.ID.A.3

Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers).

- [x] Component 0
- [x] Component 1
- [ ] Component 2
- [x] Component 3
- [x] Component 4
- [x] Component 5

CCSS.MATH.CONTENT.HSS.ID.A.4

Use the mean and standard deviation of a data set to fit it to a normal distribution and to estimate population percentages. Recognize that there are data sets for which such a procedure is not appropriate. Use calculators, spreadsheets, and tables to estimate areas under the normal curve.

- [x] Component 0
- [x] Component 1
- [ ] Component 2
- [x] Component 3
- [x] Component 4
- [x] Component 5

CCSS.MATH.CONTENT.HSS.ID.B.5

Summarize categorical data for two categories in two-way frequency tables. Interpret relative frequencies in the context of the data (including joint, marginal, and conditional relative frequencies). Recognize possible associations and trends in the data.

- [x] Component 0
- [ ] Component 1
- [ ] Component 2
- [x] Component 3
- [x] Component 4
- [x] Component 5

CCSS.MATH.CONTENT.HSS.ID.B.6

Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.

- [x] Component 0
- [x] Component 1
- [ ] Component 2
- [x] Component 3
- [x] Component 4
- [x] Component 5

CCSS.MATH.CONTENT.HSS.ID.B.6.A

Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models.

- [x] Component 0
- [ ] Component 1
- [ ] Component 2
- [x] Component 3
- [ ] Component 4
- [x] Component 5

CCSS.MATH.CONTENT.HSS.ID.B.6.B

Informally assess the fit of a function by plotting and analyzing residuals.

- [x] Component 0
- [x] Component 1
- [ ] Component 2
- [x] Component 3
- [x] Component 4
- [x] Component 5

CCSS.MATH.CONTENT.HSS.ID.B.6.C

Fit a linear function for a scatter plot that suggests a linear association.

- [x] Component 0
- [x] Component 1
- [ ] Component 2
- [x] Component 3
- [x] Component 4
- [x] Component 5

Interpret Linear Models

CCSS.MATH.CONTENT.HSS.ID.C.7

Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.

- [x] Component 0
- [ ] Component 1
- [x] Component 2
- [x] Component 3
- [x] Component 4
- [ ] Component 5

CCSS.MATH.CONTENT.HSS.ID.C.8

Compute (using technology) and interpret the correlation coefficient of a linear fit.

- [x] Component 0
- [ ] Component 1
- [ ] Component 2
- [x] Component 3
- [ ] Component 4
- [ ] Component 5

CCSS.MATH.CONTENT.HSS.ID.C.9

Distinguish between correlation and causation.

- [x] Component 0
- [x] Component 1
- [ ] Component 2
- [x] Component 3
- [x] Component 4
- [ ] Component 5

Common Core Standards for Mathematics

Making Inferences and Justifying Conclusions

Understand and Evaluate Random Processes Underlying Statistical Experiments

CCSS.MATH.CONTENT.HSS.IC.A.1

Understand statistics as a process for making inferences about population parameters based on a random sample from that population.

☑ Component 0 ☑ Component 1 ☐ Component 2

☑ Component 3 ☑ Component 4 ☐ Component 5

CCSS.MATH.CONTENT.HSS.IC.A.2

Decide if a specified model is consistent with results from a given data-generating process, e.g., using simulation. For example, a model says a spinning coin falls heads up with probability 0.5. Would a result of 5 tails in a row cause you to question the model?

☑ Component 0 ☐ Component 1 ☐ Component 2

☐ Component 3 ☑ Component 4 ☐ Component 5

Make inferences and Justify Conclusions From Sample Surveys, Experiments, and Observational Studies

CCSS.MATH.CONTENT.HSS.IC.B.3

Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each.

☑ Component 0 ☑ Component 1 ☐ Component 2

☑ Component 3 ☑ Component 4 ☑ Component 5

CCSS.MATH.CONTENT.HSS.IC.B.4

Use data from a sample survey to estimate a population mean or proportion; develop a margin of error through the use of simulation models for random sampling.

☐ Component 0 ☑ Component 1 ☐ Component 2

☑ Component 3 ☑ Component 4 ☑ Component 5

CCSS.MATH.CONTENT.HSS.IC.B.5

Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant.

☑ Component 0 ☐ Component 1 ☐ Component 2

☑ Component 3 ☐ Component 4 ☑ Component 5

CCSS.MATH.CONTENT.HSS.IC.B.6

Evaluate reports based on data.

☑ Component 0 ☑ Component 1 ☐ Component 2

☑ Component 3 ☑ Component 4 ☑ Component 5

Using Probability to Make Decisions

Use Probability to Evaluate Outcomes of Decisions

CCSS.MATH.CONTENT.HSS.MD.B.5

(+) Weigh the possible outcomes of a decision by assigning probabilities to payoff values and finding expected values.

- [ ] Component 0 - [x] Component 1 - [ ] Component 2
- [x] Component 3 - [x] Component 4 - [x] Component 5

CCSS.MATH.CONTENT.HSS.MD.B.5.A

Find the expected payoff for a game of chance. For example, find the expected winnings from a state lottery ticket or a game at a fast- food restaurant.

- [ ] Component 0 - [ ] Component 1 - [ ] Component 2
- [x] Component 3 - [x] Component 4 - [ ] Component 5

CCSS.MATH.CONTENT.HSS.MD.B.5.B

Evaluate and compare strategies on the basis of expected values. For example, compare a high-deductible versus a low-deductible automobile insurance policy using various, but reasonable, chances of having a minor or a major accident.

- [ ] Component 0 - [x] Component 1 - [ ] Component 2
- [x] Component 3 - [x] Component 4 - [x] Component 5

CCSS.MATH.CONTENT.HSS.MD.B.6

(+) Use probabilities to make fair decisions (e.g., drawing by lots, using a random number generator).

- [ ] Component 0 - [x] Component 1 - [ ] Component 2
- [x] Component 3 - [x] Component 4 - [x] Component 5

CCSS.MATH.CONTENT.HSS.MD.B.7

(+) Analyze decisions and strategies using probability concepts (e.g., product testing, medical testing, pulling a hockey goalie at the end of a game).

- [ ] Component 0 - [x] Component 1 - [ ] Component 2
- [x] Component 3 - [x] Component 4 - [ ] Component 5

Next Generation Science Standards

Energy

HS.PS3.3

Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.

- ☐ Component 0 ☐ Component 1 ☐ Component 2
- ☑ Component 3 ☐ Component 4 ☐ Component 5

Earth and Human Activity

HS.ESS3.1

Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.

- ☐ Component 0 ☑ Component 1 ☐ Component 2
- ☐ Component 3 ☐ Component 4 ☐ Component 5

HS.ESS3.2

Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.

- ☑ Component 0 ☑ Component 1 ☐ Component 2
- ☐ Component 3 ☐ Component 4 ☐ Component 5

HS.ESS3.3

Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.

- ☐ Component 0 ☐ Component 1 ☑ Component 2
- ☑ Component 3 ☐ Component 4 ☐ Component 5

HS.ESS3.4

Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

- ☐ Component 0 ☐ Component 1 ☑ Component 2
- ☑ Component 3 ☐ Component 4 ☐ Component 5

HS.ESS3.5

Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.

- ☐ Component 0 ☑ Component 1 ☐ Component 2
- ☐ Component 3 ☐ Component 4 ☐ Component 5

Engineering Design

HS.ETS1.1

Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.

- [x] Component 0
- [x] Component 1
- [x] Component 2
- [x] Component 3
- [x] Component 4
- [x] Component 5

HS.ETS1.2

Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

- [x] Component 0
- [x] Component 1
- [x] Component 2
- [x] Component 3
- [x] Component 4
- [x] Component 5

HS.ETS1.3

Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

- [x] Component 0
- [x] Component 1
- [x] Component 2
- [x] Component 3
- [x] Component 4
- [x] Component 5

HS.ETS1.4

Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

- [ ] Component 0
- [x] Component 1
- [x] Component 2
- [x] Component 3
- [ ] Component 4
- [ ] Component 5

Disciplinary Core Ideas

ETS1.A Engineering Design - Defining and Delimiting Engineering Problems

• Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them.

- [x] Component 0
- [x] Component 1
- [x] Component 2
- [x] Component 3
- [x] Component 4
- [x] Component 5

• Humanity faces major global challenges today, such as the need for supplies of clean water and food or for energy sources that minimize pollution, which can be addressed through engineering. These global challenges also may have manifestations in local communities.

- [x] Component 0
- [x] Component 1
- [x] Component 2
- [x] Component 3
- [x] Component 4
- [x] Component 5

Science and Engineering Practices

Practice 1 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.

• Evaluate a question to determine if it is testable and relevant.

- [x] Component 0
- [x] Component 1
- [x] Component 2
- [x] Component 3
- [x] Component 4
- [ ] Component 5

• 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.

- [ ] Component 0
- [x] Component 1
- [x] Component 2
- [x] Component 3
- [x] Component 4
- [ ] Component 5

• Ask and/or evaluate questions that challenge the premise(s) of an argument, the interpretation of a data set, or the suitability of a design.

- [ ] Component 0
- [x] Component 1
- [x] Component 2
- [x] Component 3
- [x] Component 4
- [ ] Component 5

• 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.

- [ ] Component 0
- [x] Component 1
- [x] Component 2
- [x] Component 3
- [x] Component 4
- [ ] Component 5

Practice 2 Developing and Using Models
Modeling in 9-12 builds on K-8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.

• 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.

- [ ] Component 0
- [x] Component 1
- [x] Component 2
- [x] Component 3
- [x] Component 4
- [ ] Component 5

- Design a test of a model to ascertain its reliability.

  ☐ Component 0 ☑ Component 1 ☑ Component 2

  ☑ Component 3 ☑ Component 4 ☐ Component 5

- Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system.

  ☐ Component 0 ☑ Component 1 ☑ Component 2

  ☑ Component 3 ☑ Component 4 ☐ Component 5

- Develop and/or use multiple types of models to provide mechanistic accounts and/or predict phenomena, and move flexibly between model types based on merits and limitations.

  ☐ Component 0 ☑ Component 1 ☑ Component 2

  ☑ Component 3 ☑ Component 4 ☐ Component 5

- Develop a complex model that allows for manipulation and testing of a proposed process or system.

  ☐ Component 0 ☑ Component 1 ☑ Component 2

  ☑ Component 3 ☑ Component 4 ☐ Component 5

- Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.

  ☐ Component 0 ☑ Component 1 ☑ Component 2

  ☑ Component 3 ☑ Component 4 ☐ Component 5

Practice 3 Planning and Carrying Out Investigations
Planning and carrying out investigations in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.

- Plan an investigation or test a design individually and collaboratively to produce data to serve as the basis for evidence as part of building and revising models, supporting explanations for phenomena, or testing solutions to problems.

  ☑ Component 0 ☑ Component 1 ☑ Component 2

  ☑ Component 3 ☑ Component 4 ☐ Component 5

- Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly.

  ☑ Component 0 ☑ Component 1 ☑ Component 2

  ☑ Component 3 ☑ Component 4 ☐ Component 5

- Plan and conduct an investigation or test a design solution in a safe and ethical manner including considerations of environmental, social, and personal impacts.

  ☑ Component 0 ☑ Component 1 ☑ Component 2
  ☑ Component 3 ☑ Component 4 ☐ Component 5

- Select appropriate tools to collect, record, analyze, and evaluate data. Make directional hypotheses that specify what happens to a dependent variable when an independent variable is manipulated.

  ☐ Component 0 ☑ Component 1 ☑ Component 2
  ☑ Component 3 ☑ Component 4 ☐ Component 5

Practice 4 Analyzing and Interpreting Data
Analyzing data in 9-12 builds on K-8 experiences 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.

- Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.

  ☐ Component 0 ☐ Component 1 ☑ Component 2
  ☑ Component 3 ☑ Component 4 ☐ Component 5

- 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.

  ☐ Component 0 ☐ Component 1 ☑ Component 2
  ☑ Component 3 ☑ Component 4 ☑ Component 5

- Consider limitations of data analysis (e.g., measurement error, sample selection) when analyzing and interpreting data.

  ☐ Component 0 ☐ Component 1 ☑ Component 2
  ☑ Component 3 ☑ Component 4 ☑ Component 5

- Compare and contrast various types of data sets (e.g., self-generated, archival) to examine consistency of measurements and observations.

  ☐ Component 0 ☐ Component 1 ☑ Component 2
  ☑ Component 3 ☑ Component 4 ☑ Component 5

- Evaluate the impact of new data on a working explanation and/or model of a proposed process or system.

  ☐ Component 0 ☐ Component 1 ☑ Component 2
  ☑ Component 3 ☑ Component 4 ☑ Component 5

• Analyze data to identify design features or characteristics of the components of a proposed process or system to optimize it relative to criteria for success.

☐ Component 0 ☐ Component 1 ☑ Component 2

☑ Component 3 ☑ Component 4 ☑ Component 5

Practice 5 Using Mathematics and Computational Thinking
Mathematical and computational thinking in 9- 12 builds on K-8 experiences 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.

• Create and/or revise a computational model or simulation of a phenomenon, designed device, process, or system.

☐ Component 0 ☐ Component 1 ☑ Component 2

☑ Component 3 ☐ Component 4 ☐ Component 5

• Use mathematical, computational, and/or algorithmic representations of phenomena or design solutions to describe and/or support claims and/or explanations.

☐ Component 0 ☐ Component 1 ☑ Component 2

☑ Component 3 ☐ Component 4 ☐ Component 5

• Apply techniques of algebra and functions to represent and solve scientific and engineering problems.

☐ Component 0 ☐ Component 1 ☑ Component 2

☑ Component 3 ☐ Component 4 ☐ Component 5

• Use simple limit cases to test mathematical expressions, computer programs, algorithms, or simulations of a process or system to see if a model “makes sense” by comparing the outcomes with what is known about the real world.

☐ Component 0 ☐ Component 1 ☑ Component 2

☑ Component 3 ☐ Component 4 ☐ Component 5

• Apply ratios, rates, percentages, and unit conversions in the context of complicated measurement problems involving quantities with derived or compound units (such as mg/mL, kg/m3, acre-feet, etc.)

☐ Component 0 ☐ Component 1 ☑ Component 2

☑ Component 3 ☐ Component 4 ☐ Component 5

Practice 6 Constructing Explanations and Designing Solutions
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 ideas, principles, and theories.

- Make a quantitative and/or qualitative claim regarding the relationship between dependent and independent variables.

  ☐ Component 0 ☐ Component 1 ☑ Component 2

  ☑ Component 3 ☐ Component 4 ☐ Component 5

- 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) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.

  ☐ Component 0 ☑ Component 1 ☑ Component 2

  ☑ Component 3 ☑ Component 4 ☐ Component 5

- Apply scientific ideas, principles, and/or evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects.

  ☐ Component 0 ☑ Component 1 ☑ Component 2

  ☑ Component 3 ☑ Component 4 ☐ Component 5

- Apply scientific reasoning, theory, and/or models to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion.

  ☐ Component 0 ☑ Component 1 ☑ Component 2

  ☑ Component 3 ☑ Component 4 ☐ Component 5

- Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.

  ☑ Component 0 ☑ Component 1 ☑ Component 2

  ☑ Component 3 ☑ Component 4 ☑ Component 5

Practice 7 Engaging in Argument from Evidence
Engaging in argument from evidence in 9-12 builds on 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(s). Arguments may also come from current scientific or historical episodes in science.

- 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.

  ☑ Component 0 ☑ Component 1 ☑ Component 2

  ☑ Component 3 ☑ Component 4 ☑ Component 5

- Evaluate the claims, evidence, and/or reasoning behind currently accepted explanations or solutions to determine the merits of arguments.

  ☑ Component 0 ☑ Component 1 ☑ Component 2

  ☑ Component 3 ☑ Component 4 ☑ Component 5

- Respectfully provide and/or receive critiques on scientific arguments by probing reasoning and evidence, challenging ideas and conclusions, responding thoughtfully to diverse perspectives, and determining additional information required to resolve contradictions.

  ☑ Component 0 ☑ Component 1 ☑ Component 2

  ☑ Component 3 ☑ Component 4 ☑ Component 5

- Construct, use, and/or present an oral and written argument or counter-arguments based on data and evidence.

  ☑ Component 0 ☑ Component 1 ☑ Component 2

  ☑ Component 3 ☑ Component 4 ☑ Component 5

- Make and defend a claim based on evidence about the natural world or the effectiveness of a design solution that reflects scientific knowledge and student-generated evidence.

  ☑ Component 0 ☑ Component 1 ☑ Component 2

  ☑ Component 3 ☑ Component 4 ☑ Component 5

- 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).

  ☑ Component 0 ☑ Component 1 ☑ Component 2

  ☑ Component 3 ☑ Component 4 ☑ Component 5

Practice 8 Obtaining, Evaluating, and Communicating Information
Obtaining, evaluating, and communicating information in 9-12 builds on K-8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs.

- Critically read scientific literature adapted for classroom use to determine the central ideas or conclusions and/or to obtain scientific and/or technical information to summarize complex evidence, concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.

  ☑ Component 0 ☑ Component 1 ☑ Component 2

  ☑ Component 3 ☑ Component 4 ☑ Component 5

- Compare, integrate and evaluate sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a scientific question or solve a problem.

  ☑ Component 0 ☑ Component 1 ☑ Component 2
  ☑ Component 3 ☑ Component 4 ☑ Component 5

- Gather, read, and evaluate scientific and/or technical information from multiple authoritative sources, assessing the evidence and usefulness of each source.

  ☑ Component 0 ☑ Component 1 ☐ Component 2
  ☐ Component 3 ☐ Component 4 ☐ Component 5

- Evaluate the validity and reliability of and/or synthesize multiple claims, methods, and/or designs that appear in scientific and technical texts or media reports, verifying the data when possible.

  ☑ Component 0 ☑ Component 1 ☑ Component 2
  ☑ Component 3 ☑ Component 4 ☑ Component 5

Crosscutting Concepts

Patterns

- Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them.

  ☐ Component 0 ☑ Component 1 ☑ Component 2
  ☑ Component 3 ☐ Component 4 ☐ Component 5

- Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.

  ☐ Component 0 ☑ Component 1 ☑ Component 2
  ☑ Component 3 ☐ Component 4 ☐ Component 5

- Classifications or explanations used at one scale may fail or need revision when information from smaller or larger scales is introduced; thus requiring improved investigations and experiments.

  ☐ Component 0 ☑ Component 1 ☑ Component 2
  ☑ Component 3 ☐ Component 4 ☐ Component 5

- Patterns of performance of designed systems can be analyzed and interpreted to reengineer and improve the system.

  ☐ Component 0 ☑ Component 1 ☑ Component 2
  ☑ Component 3 ☐ Component 4 ☐ Component 5

- Mathematical representations are needed to identify some patterns.

  ☐ Component 0 ☑ Component 1 ☑ Component 2
  ☑ Component 3 ☐ Component 4 ☐ Component 5

- Empirical evidence is needed to identify patterns.

  ☐ Component 0 ☑ Component 1 ☑ Component 2
  ☑ Component 3 ☐ Component 4 ☐ Component 5

Cause and Effect: Mechanism and Prediction

- Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering.

  ☐ Component 0 ☐ Component 1 ☐ Component 2
  ☑ Component 3 ☑ Component 4 ☑ Component 5

- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

  ☐ Component 0 ☑ Component 1 ☑ Component 2
  ☑ Component 3 ☑ Component 4 ☑ Component 5

- Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system.

  ☐ Component 0 ☑ Component 1 ☑ Component 2
  ☑ Component 3 ☑ Component 4 ☑ Component 5

- Systems can be designed to cause a desired effect.

  ☐ Component 0 ☑ Component 1 ☑ Component 2
  ☑ Component 3 ☑ Component 4 ☑ Component 5

- Changes in systems may have various causes that may not have equal effects.

  ☐ Component 0 ☑ Component 1 ☑ Component 2
  ☑ Component 3 ☑ Component 4 ☑ Component 5

Scale, Proportion, and Quantity

- In considering phenomena, it is critical to recognize what is relevant at different size, time, and energy scales, and to recognize proportional relationships between different quantities as scales change.

  ☐ Component 0 ☐ Component 1 ☑ Component 2
  ☑ Component 3 ☐ Component 4 ☐ Component 5

- The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs.

  ☐ Component 0 ☐ Component 1 ☑ Component 2

  ☑ Component 3 ☐ Component 4 ☐ Component 5

- Some systems can only be studied indirectly as they are too small, too large, too fast, or too slow to observe directly.

  ☐ Component 0 ☐ Component 1 ☑ Component 2

  ☑ Component 3 ☐ Component 4 ☐ Component 5

- Patterns observable at one scale may not be observable or exist at other scales.

  ☐ Component 0 ☐ Component 1 ☑ Component 2

  ☑ Component 3 ☐ Component 4 ☐ Component 5

- Using the concept of orders of magnitude allows one to understand how a model at one scale relates to a model at another scale.

  ☐ Component 0 ☐ Component 1 ☑ Component 2

  ☑ Component 3 ☐ Component 4 ☐ Component 5

- Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth).

  ☐ Component 0 ☐ Component 1 ☑ Component 2

  ☑ Component 3 ☐ Component 4 ☐ Component 5

Systems and System Models

- A system is an organized group of related objects or components; models can be used for understanding and predicting the behavior of systems.

  ☐ Component 0 ☐ Component 1 ☐ Component 2

  ☑ Component 3 ☐ Component 4 ☐ Component 5

- Systems can be designed to do specific tasks.

  ☑ Component 0 ☑ Component 1 ☑ Component 2

  ☑ Component 3 ☑ Component 4 ☑ Component 5

- When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models.

  ☐ Component 0 ☐ Component 1 ☐ Component 2

  ☑ Component 3 ☐ Component 4 ☐ Component 5

• Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales.

☐ Component 0 ☐ Component 1 ☐ Component 2

☑ Component 3 ☐ Component 4 ☐ Component 5

• Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models.

☐ Component 0 ☐ Component 1 ☐ Component 2

☑ Component 3 ☐ Component 4 ☐ Component 5

Energy and Matter: Flows, Cycles, and Conservation

• Tracking energy and matter flows, into, out of, and within systems helps one understand their system's behavior.

☐ Component 0 ☐ Component 1 ☑ Component 2

☐ Component 3 ☐ Component 4 ☐ Component 5

• The total amount of energy and matter in closed systems is conserved.

☐ Component 0 ☐ Component 1 ☑ Component 2

☐ Component 3 ☐ Component 4 ☐ Component 5

• Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system.

☐ Component 0 ☐ Component 1 ☑ Component 2

☐ Component 3 ☐ Component 4 ☐ Component 5

• Energy cannot be created or destroyed—only moves between one place and another place, between objects and/or fields, or between systems.

☐ Component 0 ☐ Component 1 ☑ Component 2

☐ Component 3 ☐ Component 4 ☐ Component 5

• Energy drives the cycling of matter within and between systems.

☐ Component 0 ☐ Component 1 ☑ Component 2

☐ Component 3 ☐ Component 4 ☐ Component 5

Next Generation Science Standards

Structure and Function

- The way an object is shaped or structured determines many of its properties and functions.

  ☐ Component 0 ☐ Component 1 ☑ Component 2

  ☐ Component 3 ☐ Component 4 ☐ Component 5

- Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem.

  ☐ Component 0 ☐ Component 1 ☑ Component 2

  ☐ Component 3 ☐ Component 4 ☐ Component 5

- The functions and properties of natural and designed objects and systems can be inferred from their overall structure, the way their components are shaped and used, and the molecular substructures of its various materials.

  ☐ Component 0 ☐ Component 1 ☑ Component 2

  ☐ Component 3 ☐ Component 4 ☐ Component 5

Stability and Change

- For both designed and natural systems, conditions that affect stability and factors that control rates of change are critical elements to consider and understand.

  ☐ Component 0 ☐ Component 1 ☑ Component 2

  ☐ Component 3 ☐ Component 4 ☐ Component 5

- Much of science deals with constructing explanations of how things change and how they remain stable.

  ☐ Component 0 ☑ Component 1 ☐ Component 2

  ☐ Component 3 ☐ Component 4 ☐ Component 5

- Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible.

  ☐ Component 0 ☐ Component 1 ☑ Component 2

  ☐ Component 3 ☐ Component 4 ☐ Component 5

- Feedback (negative or positive) can stabilize or destabilize a system.

  ☐ Component 0 ☐ Component 1 ☑ Component 2

  ☐ Component 3 ☐ Component 4 ☐ Component 5

Next Generation Science Standards

- Systems can be designed for greater or lesser stability.
  - ☐ Component 0 ☐ Component 1 ☑ Component 2
  - ☐ Component 3 ☐ Component 4 ☐ Component 5

STEL 1 Nature and Characteristics of Technology and Engineering

STEL-1N

Explain how the world around them guides technological development and engineering design.

- [x] Component 0
- [ ] Component 1
- [ ] Component 2
- [ ] Component 3
- [ ] Component 4
- [ ] Component 5

STEL-1Q

Conduct research to inform intentional inventions and innovations that address specific needs and wants.

- [x] Component 0
- [x] Component 1
- [ ] Component 2
- [ ] Component 3
- [ ] Component 4
- [ ] Component 5

STEL-1R

Develop a plan that incorporates knowledge from science, mathematics, and other disciplines to design or improve a technological product or system.

- [ ] Component 0
- [ ] Component 1
- [ ] Component 2
- [x] Component 3
- [ ] Component 4
- [ ] Component 5

STEL 2 Core Concepts of Technology and Engineering

STEL-2T

Demonstrate the use of conceptual, graphical, virtual, mathematical, and physical modeling to identify conflicting considerations before the entire system is developed and to aid in design decision making.

- [x] Component 0
- [ ] Component 1
- [ ] Component 2
- [x] Component 3
- [ ] Component 4
- [ ] Component 5

STEL-2X

Cite examples of the criteria and constraints of a product or system and how they affect final design.

- [x] Component 0
- [x] Component 1
- [x] Component 2
- [x] Component 3
- [ ] Component 4
- [ ] Component 5

STEL-2Y

Implement quality control as a planned process to ensure that a product, service, or system meets established criteria.

- [ ] Component 0
- [ ] Component 1
- [x] Component 2
- [ ] Component 3
- [ ] Component 4
- [ ] Component 5

STEL-2Z

Use management processes in planning, organizing, and controlling work.

- [x] Component 0
- [x] Component 1
- [x] Component 2
- [x] Component 3
- [x] Component 4
- [x] Component 5

STEL 3 Integration of Knowledge, Technologies, and Practices

STEL-3I

Evaluate how technology enhances opportunities for new products and services through globalization.

- [ ] Component 0
- [ ] Component 1
- [x] Component 2
- [ ] Component 3
- [ ] Component 4
- [ ] Component 5

STEL 4 Impacts of Technology

STEL-4P

Evaluate ways that technology can impact individuals, society, and the environment.

- [ ] Component 0
- [x] Component 1
- [ ] Component 2
- [ ] Component 3
- [ ] Component 4
- [ ] Component 5

STEL-4Q

Critique whether existing or proposed technologies use resources sustainably.

- [ ] Component 0
- [x] Component 1
- [ ] Component 2
- [ ] Component 3
- [ ] Component 4
- [ ] Component 5

STEL 5 Influence of Society on Technological Development

STEL-5H

Evaluate a technological innovation that arose from a specific society’s unique need or want.

- [ ] Component 0
- [ ] Component 1
- [x] Component 2
- [x] Component 3
- [ ] Component 4
- [ ] Component 5

STEL-5I

Evaluate a technological innovation that was met with societal resistance impacting its development.

- [ ] Component 0
- [ ] Component 1
- [x] Component 2
- [x] Component 3
- [ ] Component 4
- [ ] Component 5

STEL 7 Design in Technology and Engineering Education

STEL-7W

Determine the best approach by evaluating the purpose of the design.

- [x] Component 0
- [ ] Component 1
- [x] Component 2
- [x] Component 3
- [ ] Component 4
- [ ] Component 5

STEL-7X

Document trade-offs in the technology and engineering design process to produce the optimal design.

- [ ] Component 0
- [ ] Component 1
- [x] Component 2
- [x] Component 3
- [ ] Component 4
- [ ] Component 5

STEL-7Y

Optimize a design by addressing desired qualities within criteria and constraints.

- [ ] Component 0
- [ ] Component 1
- [x] Component 2
- [x] Component 3
- [ ] Component 4
- [ ] Component 5

STEL-7BB

Implement the best possible solution to a design.

- [x] Component 0
- [ ] Component 1
- [ ] Component 2
- [ ] Component 3
- [ ] Component 4
- [x] Component 5

STEL-7CC

Apply a broad range of design skills to their design process.

- [x] Component 0
- [ ] Component 1
- [ ] Component 2
- [ ] Component 3
- [x] Component 4
- [x] Component 5

STEL-7DD

Apply a broad range of making skills to their design process.

- [ ] Component 0
- [ ] Component 1
- [ ] Component 2
- [ ] Component 3
- [x] Component 4
- [x] Component 5

STEL 8 Applying, Maintaining, and Assessing Technological Products and Systems

STEL-8N

Use various approaches to communicate processes and procedures for using, maintaining, and assessing technological products and systems.

- [ ] Component 0
- [ ] Component 1
- [ ] Component 2
- [ ] Component 3
- [x] Component 4
- [x] Component 5

Standards for Technological and Engineering Literacy

STEL-8Q

Synthesize data and analyze trends to make decisions about technological products, systems, or processes.

- ☐ Component 0
- ☐ Component 1
- ☐ Component 2
- ☑ Component 3
- ☐ Component 4
- ☐ Component 5

References

International Technology and Engineering Educators Association. (2020). *Standards for technological and engineering literacy: The role of technology and engineering in STEM education*. Retrieved from https://www.iteea.org/STEL.aspx

National Governors Association Center for Best Practices, & Council of Chief State School Officers. (2010). *Common Core State Standards*. Washington, DC: National Governors Association Center for Best Practices, Council of Chief State School Officers. Retrieved from http://www.corestandards.org/read-the-standards/

Next Generation Science Standards: For States, By States. (2019). *Read the Standards*. Retrieved from https://www.nextgenscience.org/search-standards