PLTW Engineering
Introduction to Engineering Design | Course Outline

Engineers make a world of difference!

Students are introduced to the engineering design process, applying math, science, and engineering standards to identify and design solutions to a variety of real problems. They work both individually and in collaborative teams to develop and document design solutions using engineering notebooks and 3D modeling software.

Are you ready to design the future?

Introduction to Engineering Design (IED) is a high school engineering course in the PLTW Engineering Program. In IED, students explore engineering tools and apply a common approach to the solution of engineering problems, an engineering design process. Utilizing the activity-project-problem-based (APB) teaching and learning pedagogy, students progress from completing structured activities to solving open-ended projects and problems that require them to plan, document, communicate, and develop other professional skills.

Through both individual and collaborative team activities, projects, and problems, students apply systems thinking and consider various aspects of engineering design including material selection, human-centered design, manufacturability, assemblability and sustainability. Students develop skills in technical representation and documentation especially through 3D computer modeling using a Computer Aided Design (CAD) application. As part of the design process, students produce precise 3D-printed engineering prototypes using an additive manufacturing process. Student-developed testing protocols drive decision-making and iterative design improvements.

To inform design and problem solutions addressed in IED, students apply computational methods to inform design by developing algorithms, performing statistical analyses, and developing mathematical models. Students build competency in professional engineering practices including project management, peer review, and environmental impact analysis as part of a collaborative design team. Ethical issues related to professional practice and product development are also presented.

Unit 1	Design and Problem Solving
Unit 2	Assembly Design
Unit 3	Thoughtful Product Design
Unit 4	Making Things Move

Unit 1: Design and Problem Solving

Unit 1 provides an overview of the engineering design process and helps students develop an understanding of the purpose and practice of modeling in engineering communication. Students are introduced to modeling methods and practice modeling skills important to the design of mechanical systems including technical sketching, 3D solid modeling and technical drawing using Computer-Aided Design (CAD), statistical analysis, and prototyping. Emphasis is placed on building CAD skills applied throughout the course. In addition, students learn statistical techniques to evaluate design solutions and apply statistics to inform the design of a game.

Design Basics

Lesson 1.1	Design Basics
Lesson 1.2	Visualization and Solid Modeling
Lesson 1.3	CAD Fundamentals
Lesson 1.4	Product Improvement

Lesson 1.1 Design Basics
In Lesson 1.1 students review and apply an engineering design process to collaboratively design a carnival game. As part of the design process, students practice the art of brainstorming and begin to develop skills in graphically representing ideas through concept sketching. Students also develop and test a solution and improve the design through iteration. In addition, students learn statistical techniques to evaluate design solutions and apply statistics to inform design decisions related to their game design.

Lesson 1.2 Visualization and Solid Modeling
Lesson 1.2 focuses on building student spatial visualization skills. The role of modeling as a means to represent and communicate ideas, designs, and problem solutions is emphasized. Students are introduced to technical sketching and practice sketching isometric views and orthographic projections to represent three-dimensional objects. As part of the design process, students develop basic 3D solid models of simple designs and produce technical drawings using CAD. The lesson culminates in a design project in which students design and prototype a product using additive manufacturing (3D printing).

Lesson 1.3 CAD Fundamentals
Lesson 1.3 focuses on building CAD skills to develop 3D models and technical drawings. Students learn the importance of precision measurement and use dial calipers to make precise measurements, as they come to understand the concepts of precision and accuracy and their implication on engineering design and manufacturing. Students apply statistics to quantify the precision and accuracy of measurements and of measuring tools. Multiple CAD topics are introduced, and students apply the engineering design process and their new CAD skills to design and 3D print a protective case for a product.

Lesson 1.4 Product Improvement
Students work within teams to apply the design process and the skills and knowledge gained in this unit to evaluate and improve the design of a consumer product to meet stakeholder needs. Students will learn effective presentation techniques and present their solutions to an audience.

Unit 2: Assembly Design

Unit 2 emphasizes the design of systems of components. Students are introduced to the concept of reverse engineering and how to investigate and document the design of multi-component systems. Students learn various techniques used to connect components in a system, how systems are designed to allow desired interaction between components, and how to identify and select the materials from which products are made. They are also introduced to methods to improve the manufacturability of a product and reduce production costs. Students learn to apply two methods to create 3D assembly models in CAD and apply those techniques to design and document assemblies.

Assembly Design

Lesson 2.1	Put it Together
Lesson 2.2	Take it Apart
Lesson 2.3	A Material World
Lesson 2.4	Fix It

Lesson 2.1 Put it Together
Students continue to build skills in CAD. Methods to physically join parts into an assembly (including mechanical fasteners and adhesives as well as press fits and hinges) are presented. Interference and clearance fits are introduced, and students learn to apply tolerances to achieve desired fits between interacting parts. CAD assembly modeling is introduced, and students learn to create simple bottom-up assemblies that realistically simulate physical assemblies. Assemblies are documented in CAD with assembly drawings. Students are challenged to iterate on an earlier design project to incorporate skills and knowledge that they have learned in this lesson.

Lesson 2.2 Take it Apart
Lesson 2.2 exposes students to the application of engineering principles and practices to reverse engineer a consumer product. Reverse engineering involves disassembling and analyzing a product or system in order to understand and document the visual, functional, and/or structural aspects of its design. In this lesson, students assess all three aspects of a product's design. Students are introduced to a second method of CAD assembly modeling, top-down modeling and use it to model the consumer product they have reverse-engineered.
Students will also conduct a case study of a common consumer product to identify ways to improve the manufacturability and ease of assembly of the product. Then they apply the design process again to design and prototype (3D print) an integrated accessory for the reversed engineered product and present the design.

Lesson 2.3 A Material World
Students investigate a variety of materials through experimentation to identify properties that determine material selection. The types of materials investigated include wood, metals, ceramics, plastics, and composites. Properties investigated may include density, conductivity, strength, flexibility, hardness, and so on. Students are then tasked with selecting materials to serve specific purposes. They learn how to assign specific materials to CAD model components and to differentiate between assigning the physical properties of a material to a part and only changing the visual appearance of the part. Finally, students work on a team to imagine the future through research of innovative materials and brainstorm a new consumer product composed of one or more advanced material.

Lesson 2.4 Fix It
Students work collaboratively to reverse engineer and troubleshoot a non-working multi-component mechanical device then re-design the device, produce working drawings, and produce new parts to correct the design and produce a working physical model.

Unit 3: Thoughtful Product Design

Unit 3 introduces students to a broader interpretation of the word design to include universal principles that contribute to successful product design. Students are exposed to design principles (other than the visual design principles presented in Unit 2) that can impact the appeal, usability, safety, and sustainability of a product. Design topics that are introduced or reinforced include product life-cycle, sustainability, manufacturability, human-centered design, and systems thinking.

Thoughtful Product Design	
Lesson 3.1	Responsible Design
Lesson 3.2	More Than Parts
Lesson 3.3	Solve a Problem

Lesson 3.1 Responsible Design
Lesson 3.1 begins with students reverse engineering a multi-material consumer product, then identifying and researching the component materials and the material properties that likely contribute to their selection for use in the product. Students are introduced to life cycle analysis and the principles of sustainable development then compare the life cycle of common competing products. The importance of identifying measurable design criteria to define a successful solution and that can be used to evaluate a potential solution is emphasized in this lesson.

Lesson 3.2 More Than Parts
Students are introduced to the concept of human-centered design as they are led through a design experience focused on user needs, perceptions and behaviors and the design trade-offs necessary in every design process. Students also apply systems thinking to engineering design and consider the ethical implications of engineering decisions. A modern CAD feature, generative design is introduced as a tool to optimize design solutions.
Students use the output from a generative design algorithm to explore and select a design alternative. Finally in pairs, students identify a product and apply human-centered design principles and systems thinking to design a product as they practice collaboration and communication skills. Final products are presented through a short commercial.

Lesson 3.3 Solve a Problem
In teams, students act as an engineering consultant group to solve a problem from a list of problems gathered from school and/or community stakeholders. As part of the design process, the team applies the engineering design process to develop a sustainable solution that includes consideration of material choices and the life cycle of the design solution. As part of the design process students meet with the client to understand user needs, develop effective design criteria to inform the design and create a project design brief. Students also practice important project management skills including developing a task and delivery schedule to manage and monitor project work and periodically reporting out on project process.

Unit 4: Making Things Move

Unit 4 focuses on familiarizing students with basic engineering knowledge related to simple mechanical and electrical systems and the use of mathematical models to represent design ideas and to inform design decisions. Students will apply their new knowledge in the design of an electromechanical solution. Students also learn advanced CAD skills to support the design, documentation, and communication of engineering solutions.

Making Things Move

Lesson 4.1	You've Got to Move It
Lesson 4.2	May the Force Be With You
Lesson 4.3	Automating Motion
Lesson 4.4	Make It Move

Lesson 4.1 You've Got to Move It

Students begin the lesson by reverse engineering a mechanical device to identify simple machines and mechanisms that influence motion and contribute to the function of the device. Students identify different types of motion (rotary, oscillating, linear, reciprocating, and so on) and investigate mechanisms that cause motion (including cams, gears, pulleys, chain and sprockets) and later use these mechanisms to create, transform and control motion to solve a problem. Students take a deep dive into how cams transform motion and use motion graphs to design a cam to create a desired motion. They practice CAD skills by developing models of the mechanisms they investigate and simulating motion in the CAD environment. To support efficient CAD modeling, students also learn to use mathematical functions to represent relationships in dimensional properties of a modeled object within the 3D environment.

Lesson 4.2 May the Force Be With You

In lesson 4.2 students investigate forces that resist motion. First students study spring forces and develop a mathematical model to determine the relationship between spring displacement and force for a given spring. Students then use a spring scale to study the force of friction and consider ways to reduce friction, especially in machine design. Finally, students apply their knowledge of mechanisms, springs and friction to design an automaton to create a desired motion with minimal frictional resistance. As part of the automata design process, each student creates a CAD assembly model of their design, CAD technical drawings, and a physical working model of their design.

Lesson 4.3 Automating Motion

In lesson 4.3 students learn about simple electrical circuits and how to transform electrical power to motion using a motor. Students design and install a circuit to run a hobby motor to power their previously designed automaton. Students build a simple variable resistor as part of their circuit and develop a mathematical model to inform the design of a motor speed control mechanism. Students then revise their physical automaton to incorporate the new electrical system and demonstrate their use of the resulting electromechanical system to control the automaton motion.

Lesson 4.4 Make It Move

In the final lesson of Unit 4, students collaborate to develop an electromechanical system to solve a problem. To solve the problem, team members work closely together to apply the knowledge and skills they have gained in this course and create a public display to present the solution.

PLTW Engineering Standards Connection
Introduction to Engineering and Design

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 Introduction to Engineering and Design connects to standards in the following:

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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.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑

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.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
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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.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
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Writing

Text Types and Purposes

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.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
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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.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
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CCSS.ELA-LITERACY.CCRA.W.5

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

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
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Common Core State Standards for English Language Arts Anchor Standards

CCSS.ELA-LITERACY.CCRA.W.6

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

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
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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.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
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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.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
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CCSS.ELA-LITERACY.CCRA.W.9

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

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
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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.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
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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.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
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CCSS.ELA-LITERACY.CCRA.SL.2

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

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
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Common Core State Standards for English Language Arts Anchor Standards

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.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
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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.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
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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.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
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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.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
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CCSS.ELA-LITERACY.CCRA.L.2

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

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
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Vocabulary Acquistion and Use

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 considering a word or phrase important to comprehension or expression.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
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Common Core State Standards for English Language Arts

Reading Informational Text

Key Ideas nad Details

CCSS.ELA-LITERACY.RI.9-10.1

Cite strong and thorough textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑

CCSS.ELA-LITERACY.RI.9-10.4

Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings; analyze the cumulative impact of specific word choices on meaning and tone (e.g., how the language of a court opinion differs from that of a newspaper).

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
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CCSS.ELA-LITERACY.RI.9-10.8

Delineate and evaluate the argument and specific claims in a text, assessing whether the reasoning is valid and the evidence is relevant and sufficient; identify false statements and fallacious reasoning.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
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Writing

Research to Build and Present Knowledge

CCSS.ELA-LITERACY.W.9-10.9.B

Apply grades 9–10 Reading standards to literary nonfiction (e.g., “Delineate and evaluate the argument and specific claims in a text, assessing whether the reasoning is valid and the evidence is relevant and sufficient; identify false statements and fallacious reasoning”).

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
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Speaking and Listening

Comprehension and Collaboration

CCSS.ELA-LITERACY.SL.9-10.1

Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 9–10 topics, texts, and issues, building on others’ ideas and expressing their own clearly and persuasively.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
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Common Core State Standards for English Language Arts

CCSS.ELA-LITERACY.SL.9-10.1.A

Come to discussions prepared, having read and researched material under study; explicitly draw on that preparation by referring to evidence from texts and other research on the topic or issue to stimulate a thoughtful, well-reasoned exchange of ideas.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
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CCSS.ELA-LITERACY.SL.9-10.1.B

Work with peers to set rules for collegial discussions and decision-making (e.g., informal consensus, taking votes on key issues, presentation of alternate views), clear goals and deadlines, and individual roles as needed.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
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CCSS.ELA-LITERACY.SL.9-10.1.C

Propel conversations by posing and responding to questions that relate the current discussion to broader themes or larger ideas; actively incorporate others into the discussion; and clarify, verify, or challenge ideas and conclusions.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
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CCSS.ELA-LITERACY.SL.9-10.1.D

Respond thoughtfully to diverse perspectives, summarize points of agreement and disagreement, and, when warranted, qualify or justify their own views and understanding and make new connections in light of the evidence and reasoning presented.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
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CCSS.ELA-LITERACY.SL.9-10.2

Integrate multiple sources of information presented in diverse media or formats (e.g., visually, quantitatively, orally) evaluating the credibility and accuracy of each source.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
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CCSS.ELA-LITERACY.SL.9-10.4

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

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
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CCSS.ELA-LITERACY.SL.9-10.5

Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
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Common Core State Standards for English Language Arts

CCSS.ELA-LITERACY.SL.9-10.6

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

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☐	☐	☐	☑	☑	☐	☐	☑	☑	☑	☑	☑	☐	☑	☑

Language

Conventions of Standard English

CCSS.ELA-LITERACY.L.9-10.1

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

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑

CCSS.ELA-LITERACY.L.9-10.2

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

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑

CCSS.ELA-LITERACY.L.9-10.2.C

Spell correctly.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑

CCSS.ELA-LITERACY.L.9-10.6

Acquire and use accurately 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 considering a word or phrase important to comprehension or expression.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑

Science and Technical Subjects

Key Ideas and Details

CCSS.ELA-LITERACY.RST.9-10.1

Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☑	☑	☑	☐	☑	☑	☑	☐	☑	☑	☐	☑	☑	☑	☐

Common Core State Standards for English Language Arts

CCSS.ELA-LITERACY.RST.9-10.2

Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☑	☑	☑	☐	☑	☑	☑	☐	☑	☑	☑	☑	☑	☑	☐

CCSS.ELA-LITERACY.RST.9-10.3

Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑

CCSS.ELA-LITERACY.RST.9-10.4

Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9–10 texts and topics.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☑	☑	☑	☐	☑	☑	☑	☐	☑	☑	☑	☑	☑	☑	☐

CCSS.ELA-LITERACY.RST.9-10.5

Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., force, friction, reaction force, energy).

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☑	☑	☑	☐	☑	☑	☑	☐	☑	☑	☐	☑	☑	☑	☐

CCSS.ELA-LITERACY.RST.9-10.7

Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☑	☑	☑	☐	☑	☑	☑	☐	☑	☑	☐	☑	☑	☑	☐

CCSS.ELA-LITERACY.RST.9-10.10

By the end of grade 10, read and comprehend science/technical texts in the grades 9–10 text complexity band independently and proficiently.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑

Writing History/Social Studies, Science and Technical Subjects

Text Types and Purposes

CCSS.ELA-LITERACY.WHST.9-10.1

Write arguments focused on discipline-specific content.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑

Common Core State Standards for English Language Arts

CCSS.ELA-LITERACY.WHST.9-10.1.A

Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☐	☐	☐	☑	☐	☐	☑	☑	☐	☐	☑	☐	☑	☐	☑

CCSS.ELA-LITERACY.WHST.9-10.1.D

Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☑	☐	☐	☐	☐	☑	☑	☐	☑	☐	☐	☐	☐	☐	☑

CCSS.ELA-LITERACY.WHST.9-10.1.E

Provide a concluding statement or section that follows from or supports the argument presented.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑

CCSS.ELA-LITERACY.WHST.9-10.2

Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☐	☑	☐	☐	☐	☐	☑	☐	☐	☐	☐	☐	☑	☐	☐

CCSS.ELA-LITERACY.WHST.9-10.2.A

Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☑	☐	☐	☐	☐	☑	☑	☑	☑	☐	☐	☐	☐	☑	☑

CCSS.ELA-LITERACY.WHST.9-10.2.B

Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑

CCSS.ELA-LITERACY.WHST.9-10.2.D

Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑

CCSS.ELA-LITERACY.WHST.9-10.2.E

Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☑	☐	☐	☑	☑	☑	☑	☐	☑	☐	☐	☐	☐	☐	☑

CCSS.ELA-LITERACY.WHST.9-10.2.F

Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☑	☐	☐	☑	☑	☑	☑	☐	☑	☐	☐	☐	☐	☐	☑

CCSS.ELA-LITERACY.WHST.9-10.4

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

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☑	☐	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑

CCSS.ELA-LITERACY.WHST.9-10.5

Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☐	☐	☐	☑	☐	☐	☐	☑	☐	☐	☑	☐	☐	☐	☑

CCSS.ELA-LITERACY.WHST.9-10.6

Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☑	☑	☐	☑	☑	☑	☑	☐	☐	☐	☑

CCSS.ELA-LITERACY.WHST.9-10.7

Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☑	☐	☑	☐	☑	☐	☑	☐	☑	☐	☑

CCSS.ELA-LITERACY.WHST.9-10.8

Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☐	☐	☐	☑	☑	☐	☑	☑	☑	☐	☑	☐	☑	☐	☑

Common Core State Standards for English Language Arts

CCSS.ELA-LITERACY.WHST.9-10.9

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

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑

CCSS.ELA-LITERACY.WHST.9-10.10

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

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑

Common Core State 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.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☑	☑	☑	☐	☑	☐	☑	☐	☐	☑	☐	☑	☑	☑	☑

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

Define appropriate quantities for the purpose of descriptive modeling.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☑	☑	☑	☐	☑	☑	☑	☑	☑	☑	☐	☑	☑	☑	☑

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

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

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☑	☐	☑	☐	☑	☐	☑	☐	☐	☑	☐	☑	☑	☑	☑

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.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☑	☐	☐	☐	☐	☑	☑	☑	☑	☑	☐	☑	☑	☑	☐

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

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

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☑	☐	☐	☐	☐	☑	☑	☑	☑	☑	☐	☑	☑	☑	☐

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.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☑	☑	☑	☐	☐	☑	☑	☑	☑	☑	☐	☑	☑	☑	☐

Common Core State Standards for Mathematics

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.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☑	☐	☐	☐	☐	☐	☑	☐	☐	☐	☐	☑	☑	☑	☐

CCSS.MATH.CONTENT.HSA.CED.A.3

Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or non- viable options in a modeling context. For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☑	☐	☑	☑	☑	☑	☐	☑	☐	☑	☑	☑	☑	☑	☑

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.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☐	☑	☐	☐	☐	☐	☑	☐	☐	☐	☐	☑	☑	☑	☐

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.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☑	☐	☐	☐	☐	☑	☐	☐	☐

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.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☑	☑	☐	☐	☐	☐	☑	☐	☐	☐	☐	☑	☑	☑	☐

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).

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	☑	☑	☑	☐

Common Core State Standards for Mathematics

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 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).

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐	☐

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.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐	☐

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.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☑	☑	☐

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.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☑	☑	☐

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.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☑	☑	☐

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.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☑	☑	☐

Common Core State Standards for Mathematics

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

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

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☑	☑	☐

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.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☑	☑	☐

Linear, Quadratic, and Exponential Models

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

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.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
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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).

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☑	☑	☐

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.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
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Geometric Measurement and Dimension

Explain Volume Formulas and Use Them to Solve Problems

CCSS.MATH.CONTENT.HSG.GMD.A.3

Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
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Common Core State Standards for Mathematics

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.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
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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).

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
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Apply Geometric Concepts In Modeling Situations

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).

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
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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).

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
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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).

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
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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.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
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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).

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
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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.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
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CCSS.MATH.CONTENT.HSS.ID.B.6

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

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
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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.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☑	☑	☐

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

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

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☑	☑	☐

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.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
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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.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
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Common Core State Standards for Mathematics

Next Generation Science Standards

Motion and Stability: Forces and Interactions

HS.PS2.1

Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
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HS.PS2.6

Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
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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.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
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Earth and Human Activity

HS.ESS3.4

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

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
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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.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
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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.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
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Next Generation Science Standards

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.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
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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.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
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Disciplinary Core Ideas

PS2.A Motion and Stability: Forces and Interactions - Forces and Motion

Newton’s second law accurately predicts changes in the motion of macroscopic objects. (HS-PS2-1)

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
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PS3.A Energy - Definitions of Energy

“Electrical energy” may mean energy stored in a battery or energy transmitted by electric currents. (secondary to HS-PS2-5)

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
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At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy. (HSPS3-2), (HS-PS3-3)

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
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PS3.B Energy - Conservation of Energy and Energy Transfer

Mathematical expressions, which quantify how the stored energy in a system depends on its configuration (e.g., relative positions of charged particles, compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation of energy to be used to predict and describe system behavior. (HS-PS3-1)

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
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Next Generation Science Standards

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. (secondary to HS-PS2-3)

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
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ETS1.B Engineering Design - Developing Possible Solutions

When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (HS-ETS1-3)

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
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ETS1.C Engineering Design - Optimizing the Design Solution

Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed. (secondary to HS-PS1-6)

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
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ESS3.A Earth and Human Activity - Natural Resources

All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors. (HS-ESS3-2)

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
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ESS3.C Earth and Human Activity - Human Impacts on Earth Systems

The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources. (HS-ESS3-3)

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
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Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation. (HS-ESS3-4)

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
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ESS3.D Earth and Human Activity - Global Climate Change

Though the magnitudes of human impacts are greater than they have ever been, so too are human abilities to model, predict, and manage current and future impacts. (HS-ESS3-5)

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
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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.

- Ask questions:
  - that arise from careful observation of phenomena, or unexpected results, to clarify and/or seek additional information
  - that arise from examining models or a theory, to clarify and/or seek additional information and relationships
  - to determine relationships, including quantitative relationships, between independent and dependent variables
  - to clarify and refine a model, an explanation, or an engineering problem

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
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- Evaluate a question to determine if it is testable and relevant.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
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- 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.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
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- 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.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
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- 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.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
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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.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
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• 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.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
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• 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.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
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• Develop a complex model that allows for manipulation and testing of a proposed process or system.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
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• Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
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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. Consider possible confounding variables or effects and evaluate the investigation's design to ensure variables are controlled.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
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• 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.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
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• Plan and conduct an investigation or test a design solution in a safe and ethical manner including considerations of environmental, social, and personal impacts.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
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- 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.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☑	☑	☐

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.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑

- 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.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☑	☑	☑	☐	☑	☐	☐	☐	☐	☑	☐	☑	☑	☑	☐

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

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☑	☐	☑	☐	☑	☐	☑	☑	☐	☑	☐	☑	☐	☑	☐

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

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☑	☐	☑	☐	☑	☐	☑	☐	☐	☐	☐	☑	☑	☑	☐

- 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.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☐	☐	☐	☑	☐	☐	☐	☑	☐	☐	☑	☐	☐	☐	☑

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.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑

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

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑

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

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☑	☑	☑	☐	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑

• 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.)

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

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.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☑	☐	☑	☐	☑	☐	☑	☐	☑	☑	☑	☑	☑	☑	☐

• 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.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☑	☑	☐

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

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☐	☐	☐	☑	☐	☐	☐	☑	☐	☐	☑	☐	☐	☐	☑

• 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.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑

Next Generation Science Standards

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.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑

• 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.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

• Construct, use, and/or present an oral and written argument or counterarguments based on data and evidence.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑

• 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.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑

• 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).

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑

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.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐

• 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.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑

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

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☑	☑	☑	☐	☑	☐	☑	☐	☑	☐	☑

Crosscutting Concepts

Patterns

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

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☑	☐	☐	☑	☑	☑	☐	☑	☑	☑	☑	☐	☑	☑	☑

Mathematical representations are needed to identify some patterns.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑

Scale, Proportion, and Quantity

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).

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☑	☐	☐	☐	☐	☑	☐	☑	☑	☑	☐

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.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☑	☐	☐	☐	☐	☑	☑	☐	☑	☑	☑	☑	☑	☑	☑

Systems can be designed to do specific tasks.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	☑	☑	☑	☑

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.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☑	☐	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐

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.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☑	☐	☐	☐	☐	☑	☑	☐	☑	☑	☑	☑	☑	☑	☑

Next Generation Science Standards

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.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☑	☐	☐	☐	☐	☑	☑	☐	☑	☑	☑	☑	☑	☑	☑

Structure and Function

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

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☑	☑	☐	☐	☑	☐	☑	☑	☑	☑

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.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☑	☑	☑	☐	☑	☐	☑	☑	☑	☑

Standards for Technological and Engineering Literacy

STEL 1 Nature and Characteristics of Technology and Engineering

STEL-1O

Assess how similarities and differences among scientific, mathematics, engineering, and technological knowledge and skills contributed to the design of a product or system.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☑	☑	☐	☐	☐	☐	☐	☑	☑	☑

STEL-1O

Assess how similarities and differences among scientific, mathematics, engineering, and technological knowledge and skills contributed to the design of a product or system.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☑	☑	☐	☐	☐	☐	☐	☑	☑	☑

STEL-1Q

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

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐

STEL-1Q

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

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐

STEL-1R

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

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☑	☐	☐	☑	☑	☑	☑	☑	☑	☐	☑	☐	☐	☐	☐

STEL-1R

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

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☑	☐	☐	☑	☑	☑	☑	☑	☑	☐	☑	☐	☐	☐	☐

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.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☐	☐	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑

Standards for Technological and Engineering Literacy

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.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☐	☐	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑

STEL-2U

Diagnose a flawed system embedded within a larger technological, social, or environmental system.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☑	☐	☐	☑	☐	☐	☐	☐	☐	☐

STEL-2U

Diagnose a flawed system embedded within a larger technological, social, or environmental system.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☑	☐	☐	☑	☐	☐	☐	☐	☐	☐

STEL-2W

Select resources that involve tradeoffs between competing values, such as availability, cost, desirability, and waste while solving problems.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☐	☐	☐	☑	☐	☑	☑	☑	☑	☐	☑	☐	☐	☐	☐

STEL-2W

Select resources that involve tradeoffs between competing values, such as availability, cost, desirability, and waste while solving problems.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐	☐	☐	☐

STEL-2X

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

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☐	☐	☐	☑	☐	☑	☐	☐	☑	☑	☑	☐	☐	☐	☐

STEL-2Y

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

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐

STEL-2Z

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

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☐	☐	☑	☑	☐	☐	☐	☐	☐

Standards for Technological and Engineering Literacy

STEL 4 Impacts of Technology

STEL-4P

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

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☐	☐	☐	☑	☐	☐	☐	☐	☑	☑	☐	☐	☐	☐	☐

STEL-4Q

Critique whether existing or proposed technologies use resources sustainably.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☑	☑	☑	☑	☐	☑	☐	☐	☐	☐	☑	☐	☑	☑	☑

STEL-4Q

Critique whether existing or proposed technologies use resources sustainably.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐

STEL-4R

Assess a technology that minimizes resource use and resulting waste to achieve a goal.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☐	☐	☐	☑	☐	☑	☑	☐	☐	☐	☑	☐	☐	☐	☐

STEL-4R

Assess a technology that minimizes resource use and resulting waste to achieve a goal.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐

STEL-4S

Develop a solution to a technological problem that has the least negative environmental and social impact.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☑	☐	☐	☑	☑	☑	☑	☑	☐	☑	☑	☑	☐	☐	☐

STEL-4S

Develop a solution to a technological problem that has the least negative environmental and social impact.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☐	☐	☐	☑	☐	☐	☐	☐	☑	☐	☑	☐	☐	☐	☐

STEL-4T

Evaluate how technologies alter human health and capabilities.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☑	☑	☐	☑	☐	☑	☑	☐	☐	☐	☐

STEL-4T

Evaluate how technologies alter human health and capabilities.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐	☐	☐	☐

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.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☑	☑	☐	☑	☑	☑	☐	☐	☐	☐

STEL-5H

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

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐	☐	☐	☐

STEL-5I

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

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☑	☐	☐	☑	☐	☑	☐	☑	☐	☑	☑	☑	☐	☐	☐

STEL-5J

Design an appropriate technology for use in a different culture.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☑	☑	☑	☑	☑	☑	☐	☐	☑	☐	☑	☑	☑	☑	☑

STEL 6 History of Technology

STEL-6F

Relate how technological development has been evolutionary, often the result of a series of refinements to basic inventions or technological knowledge.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☑	☐	☑	☑	☐	☑	☐	☐	☐	☐	☑	☑	☑	☑	☑

STEL-6G

Verify that the evolution of civilization has been directly affected by, and has in turn affected, the development and use of tools, materials and processes.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑

STEL-6H

Evaluate how technology has been a powerful force in reshaping the social, cultural, political, and economic landscapes throughout history.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☐	☐	☐	☑	☑	☑	☐	☐	☐	☑	☐	☐	☐	☐	☐

STEL-6J

Investigate the widespread changes that have resulted from the Information Age, which has placed emphasis on the processing and exchange of information.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☑	☐	☐	☐	☐	☐	☐	☐	☑	☐	☑	☐	☐	☐	☐

STEL 7 Design in Technology and Engineering Education

STEL-7W

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

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☑	☑	☑	☑	☐	☑	☐	☐	☐	☐	☑	☐	☑	☑	☑

STEL-7X

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

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☐	☐	☐	☑	☐	☑	☑	☐	☐	☐	☑	☐	☐	☐	☐

STEL-7Y

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

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☑	☐	☐	☑	☑	☑	☑	☑	☐	☑	☑	☑	☐	☐	☐

STEL-7Z

Apply principles of human-centered design.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☑	☑	☐	☑	☐	☑	☑	☐	☐	☐	☐

STEL-7AA

Illustrate principles, elements and factors of design.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☑	☑	☐	☑	☑	☑	☐	☐	☐	☐

STEL-7BB

Implement the best possible solution to a design.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☑	☐	☐	☑	☐	☑	☐	☑	☐	☑	☑	☑	☐	☐	☐

Standards for Technological and Engineering Literacy

STEL-7CC

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

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☑	☑	☑	☑	☑	☑	☐	☐	☑	☐	☑	☑	☑	☑	☑

STEL-7DD

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

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☑	☐	☑	☑	☐	☑	☐	☐	☐	☐	☑	☑	☑	☑	☑

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.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑

STEL-8O

Develop a device or system for the marketplace.

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☐	☐	☐	☑	☑	☑	☐	☐	☐	☑	☐	☐	☐	☐	☐

STEL-8Q

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

1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	4.3	4.4
☑	☐	☐	☐	☐	☐	☐	☐	☑	☐	☑	☐	☐	☐	☐

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