SAN LEANDRO UNIFIED SCHOOL DISTRICT
COURSE PROPOSAL: Course of Study
SECTION A. COVER PAGE

1. **Course Title: Advanced Product Design and Invention**	7. **Action** ▢New Course ▢ Course Revision ▢ Title Change Only
2. Date Submitted:	8. **Grade Level**(s) ▢ 6 ▢9 ▢11 ▢ 7 ▢10 ▢12 ▢ 8
3. Transcript Title/Abbreviation(s)	**9. Prerequisites** (Please list.) ▢ Required Introduction to Product Design and Innovation ▢ Recommended
4. Transcript Course Code/Course Number :	**10. Seeking Program Distinction?** ▢ YES (Check one below.) ▢NO ▢Honors ▢ AP ▢Other
5. Subject Area College-Preparatory Elective ("g") / Interdisciplinary	11. **Is this a CTE course?** ▢ YES ▢ NO **If YES, complete Section C**
6. **Department** Career Technical Education	12. **Previously approved by UC?** ▢ YES ▢ NO ▢ NA for 6th-8th Year approved Year removed
13. UC ELIGIBILITY **Already eligible?** ▢ NA for 6th-8th ▢**YES** ▢**NO** **a**▢ **b**▢ **c**▢ **d**▢ **e**▢ **f**▢ **g**▢ **Proposing eligibility?**▢ NA for 6th-8th ▢**YES** ▢**NO** **a**▢ **b**▢ **c**▢ **d**▢ **e**▢ **f**▢ **g**▢ Please mark one for approved eligibility or proposed eligibility.	14. **Unit Value/Course Credit/Length of Course** ▢ 0.5 (semester or half-year ▢ 1.0 (one year equivalent) ▢ 2.0 (two-year equivalent) ▢ Other
15. School Contact and Course Developer Name: Eduardo Nava Phone: (510) 877-0947 Email: enava@slusd.us Position: Educator	
	DISTRICT OFFICE USE ONLY **Date approved by Board Curriculum Committee 1/15/19**

16. Approval Signatures: Department Chair / Principal:	Approval Date: 1/10/19	Date approved by Board

SECTION B. COURSE CONTENT

17. Course Description

Want to be the next great entrepreneur?

In this class, students take the skills they developed in Introduction to Product Design and Innovation and create three products of increasing complexity over the course of the year. Students create a project plan (Gantt charts) to manage tasks and milestones and attempt to deliver products on schedule.

Students can produce any product they want subject to the approval of the instructor. The products selection process requires students to pick products that they care about but are also a stretch for them from a design, tool or skill perspective. Students build into their plan mastery in those areas. They are required to provide a plan to increase their capability either through working with an expert or taking online courses.

Students will be required to increase capability in shop tools, Computer Assisted Design (CAD), Computer Aided Manufacturing (CAM), programming, planning, design thinking and business case analysis.

Students produce two products in the first semester and learn how to manage tasks and deadlines on relatively simple products. The third projects lasts the entire second semester and ends with a functioning prototype that has been through several iterative cycles.

The class is highly collaborative and project based.

18. Course Goals and/or Major Student Outcomes

CHANGING THE WAY STUDENTS SEE THE WORLD

1. **Learn to see how problems serve as opportunities to create things that improve their world.**
2. **User Centric Design- Understand the principles of how to target the design of a product for a specific user or group and learn to target how it is used in society.**
3. **Become informed consumers of products who understand the process and economics of bringing a product to market.**

CREATIVITY

1. **Create product definitions based on creative brainstorming techniques and deep research into customer needs, competitive markets and cost analysis.**
2. **Use a constructive (additive) initial design process where the emphasis is upon finding opportunities to creative solutions to real world opportunities (problems).**

PROBLEM SOLVING SKILLS

1. **Collaborate with outside content experts.**
2. **Learn how to problem solve solutions to create, improve, and troubleshoot designs.**

3. **Use iterative process throughout the entire design process - product definition and prototyping.**
4. **Develop problem solving skills including the principle their first instinct is not necessarily the best design solution.**

USING TOOLS

1. **Master the use of modern collaboration tools including shared documentation (word processing, presentation and spreadsheet.**
2. **Increase knowledge of industry standard CAD software to create dimensionally accurate models.**
3. **Increase the ability to build more complex electronic circuits including amplifiers, transistors, motors, solid state relays, digital and analog sensors, and other components that are determined in satisfying requirements for student created products.**
4. **Learn how to write and debug software required by the specific design of student created projects (mostly java and python).**
5. **Increase skills necessary to work in a shop environment that includes traditional shop tools in addition to modern prototyping tools such as 3D printers, CNC routers and CNC laser cutters.**

MARKETING AND CREATING DOCUMENTS

1. **Produce documents that describe their product.**
2. **Create marketing plans in both traditional forms and more recent "crowd-sourcing" techniques (such as Kickstarter).**
3. **Create websites to build "living" portfolios of their work as well as "push" communication to their followers via social media.**
4. **Use spreadsheets to create BOMs (bill of material) to enumerate every specific object that is included in a product including estimated manufacturing cost and mark-up to wholesale price.**
5. **Create an oral presentation, product "pitch," to potential businesses and clients that may be interested in their product. - (includes the creation and use of media as part of the presentation).**

PROJECT PLANNING

1. **Backward plan projects using milestones and tasks.**
2. **Use Gantt charts to create a schedule and manage the process to keep projects on schedule. Projects increase in complexity over the course of the year.**
3. **Manage resources, modify specifications and freeze designs to hit major milestones.**

19. Course Objectives (standards)

See Exhibit A

https://www.cde.ca.gov/ci/ct/sf/documents/manproddev.pdf

CTE Pathway: Product Innovation and Design Pathway

Product Innovation and Design Pathway
The Product Innovation and Design pathway provides students with an understanding of the design and manufacturing technologies common to careers in the fields of product design and manufacturing. Representative topics include the product design and development process, the principles of design, computer aided design, fabrication and manufacturing processes, sustainability, and the principles of business, entrepreneurship, and global design

D4.0 Apply various two-dimensional (2-D) graphic and/or three-dimensional (3-D) modeling techniques to development concept.
D4.1 Create a preliminary design of a product concept utilizing drawing, computer software (graphic or CAD), and/or conceptual model fabrication techniques.
D4.2 Identify materials, mechanisms, technologies, and other requirements (e.g., safety, manufacturing, sustainability) the concept may require.
D4.3 Analyze and assess the strengths and weaknesses in the design, function, ergonomics, features, and benefits and identify possible resolutions for improvement.

D5.0 Develop the concept into a well-defined product for prototyping.
D5.1 Produce technical drawings and other specifications required for the prototyping or manufacturing of the product.
D5.2 Recognize the safety issues related to the reliability, functionality, and use of the product.
D5.3 Communicate and collaborate with fabricators, manufacturers, engineers, technologists, or other industry experts to review requirements and specifications and to validate the design.
D6.0 Produce a prototype of a product.
D6.1 Build a looks-like, works-like prototype of the model using the appropriate fabrication, manufacturing, or reproduction techniques or technologies.
D6.2 Assess the outcome of the prototype product and analyze any issues that need redesigning or refining related to function, construction, or other factors.
D6.3 Resolve and/or redesign issues with a prototype.
D7.0 Evaluate the prototype to determine if it meets the requirements and objectives.
D7.1 Create a performance criteria and a quality standard to measure and evaluate a prototype.
D7.2 Test the functionality and other features of the prototype against the performance criteria and quality standard and evaluate the results.
D7.3 Identify any redesigning or additional corrections required to improve the overall quality, look, and performance of the prototype model.
D8.0 Understand and apply basic business and entrepreneurial principles and identify potential markets and/or other business opportunities for distribution of the product.
D8.1 Apply research methodologies to identify potential investors or business opportunities to market the product.
D8.2 Create a marketing plan for the product that includes target consumer, price, product name, brand, and product positioning in the retail market .
D9.0 Produce a package design concept for a product or line of products.
D9.1 Understand physical packaging construction and materials used; e. g., chipboard, cardboard, PVC, plastic blisters, etc. as it relates to protecting the product, costs, and logistic requirements.
D9.2 Understand and apply packaging graphic strategies that effectively communicate and influence the purchasing of the product.
D9.3 Create a packaging concept utilizing drawing computer software (graphic or CAD).
D9.4 Produce a physical package with graphics for the product.
D10.0 Produce a presentation of the product, product line, system design, or service.
D10.1 Create a presentation of the design solution (e.g., product, product line, system design, or service) that effectively communicates its features and benefits.
D10.2 Integrate into the presentation a marketing plan that may include an advertisement, promotion, and packaging/retail strategy using one or more visual communication tools (e.g., graphics, multimedia).
Manufacturing

20. Course Outline

See Exhibit B

21. Instructional Materials:
Board approved required text

Supplementary materials

AutoDesk CAD Software, AutoDesk INC, students.autodesk.com

Title: Conceptual Physics
Edition: 11th
Publication Date: 2011
Publisher: Addison-Wesley
Author(s): Paul G. Hewitt

Title: 100 Things Every Designer Needs to Know about People
Edition: 1st
Publication Date: 2011
Publisher: New Riders
Author(s): Susan Weinschenk

22. Instructional Methods and/or Strategies (Key Assignments)

1) Students use needfinding skills learned in Product Design 1 to identify a product that can be prototyped and tested within **five (5) weeks**.
2) Students use needfinding skills learned in Product Design 1 to identify a product that can be prototyped and tested within **eight (8) weeks**.
3) Students use needfinding skills learned in Product Design 1 to identify a product that can be prototyped and tested within **twenty-one (21) weeks**.

23. Assessment Methods and/or Tools

Grades will be calculated on a straight point basis. Projects will be based on a scale of 1 to 100 points depending on the assignment or project. Daily work and participation grades will be based on completion of the Engineering Notebook and Portfolio. Weekly quizzes, cumulative unit exams and a National PLTW Assessment will be given during the semester. All students must maintain an Engineering Notebook and Portfolio to pass the class. They will be checked periodically throughout semester.

24. Grading Policy

Grading will follow the San Leandro Unified School District's policy.
All grades letter and percentage will be as follows:

100+ - 89% / Excellent
88 - 79% / Above Average
78 - 69% / Average
68 - 60%/ Below Average
Below 60%/ Failure
Grading is weighted as follows:
Class Participation & Professionalism 30%

Project Assignments 60%
Project Book 10%

SECTION C

25. Context for Course (optional)

REQUIRED FOR CTE COURSES

NOTE: In order to understand the context for a new course, sometimes it is helpful to understand the broader educational program and/or reform efforts of the school. How does this course fit into broader departmental and/or pathway structure? How does it fit into the overall school restructuring plans? Is the course intended to be a core course or supplemental? What are the student/school/community needs met by this course?

We are revising our Advanced Manufacturing and Engineering program and creating a Product Development Pathway. This course is designed to create a student centered learning environment where students can take ownership of their projects and a learn by doing model. This course fits well with the Project based learning strategy implemented in our district. This is a core course in the Product Development pathway and a prerequisite for the capstone course.

This course gives students exposure to entrepreneurial and technological practices that are disrupting local business practices. Giving our students and community the most uptodate practices.

26. History of Course Development (optional)

REQUIRED FOR CTE COURSES

NOTE: Likewise, it is sometimes helpful know the origins of a course and who was involved in its development. Was this course modeled after another course at another school? If so, is that course UC approved? How does the course being submitted differ from the course after which it was modeled? Has this course received any special recognitions, designations or awards? Has it been articulated to local community colleges or universities?

This course was modeled after the Product Design 2 course at Novato High School, California. That course is UC approved. It was slightly modified to generalize the software utilized and to encompass the PLTW Principles of Engineering Course.

Exhibit A

Course Objectives (Standards):

Engineering Design and Development (EDD)

Common Core State Standards for English Language Arts

Component 0

AS.R.1 - Reading

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. AS.R.2 - Reading

Determine central ideas or themes of a text and analyze their development; summarize the key supporting details and ideas. AS.R.4 - Reading

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. AS.R.10 - Reading

Read and comprehend complex literary and informational texts independently and proficiently. AS.W.1 - Writing

Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence. AS.W.2 - Writing

Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content. AS.W.4 - Writing

Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. AS.W.5 - Writing

Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach. AS.W.6 - Writing

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Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others. AS.W.7 - Writing

Conduct short as well as more sustained research projects based on focused questions, demonstrating understanding of the subject under investigation. AS.W.8 - Writing

Gather relevant information from multiple print and digital sources, assess the credibility and accuracy of each source, and integrate the information while avoiding plagiarism. AS.W.9 - Writing

Draw evidence from literary or informational texts to support analysis, reflection, and research. AS.W.10 - Writing

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. AS.SL.1 - Speaking and Listening

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. AS.SL.2 - Speaking and Listening

Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally. AS.SL.3 - Speaking and Listening

Evaluate a speaker's point of view, reasoning, and use of evidence and rhetoric. AS.SL.4 - Speaking and Listening

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. AS.SL.5 - Speaking and Listening

Make strategic use of digital media and visual displays of data to express information and enhance understanding of presentations. AS.SL.6 - Speaking and Listening

Adapt speech to a variety of contexts and communicative tasks, demonstrating command of formal English when indicated or appropriate. AS.L.1 - Language

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Demonstrate command of the conventions of standard English grammar and usage when writing or speaking. AS.L.2 - Language

Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing. AS.L.3 - Language

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. AS.L.4 - Language

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. AS.L.5 - Language

Demonstrate understanding of word relationships and nuances in word meanings. AS.L.6 - Language

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.

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Engineering Design and Development (EDD)

Common Core State Standards for English Language Arts

Component 1

AS.R.1 - Reading

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. AS.R.2 - Reading

Determine central ideas or themes of a text and analyze their development; summarize the key supporting details and ideas. AS.R.4 - Reading

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. AS.R.6 - Reading

Assess how point of view or purpose shapes the content and style of a text. AS.R.7 - Reading

Integrate and evaluate content presented in diverse formats and media, including visually and quantitatively, as well as in words. AS.R.8 - Reading

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. AS.R.9 - Reading

Analyze how two or more texts address similar themes or topics in order to build knowledge or to compare the approaches the authors take. AS.R.10 - Reading

Read and comprehend complex literary and informational texts independently and proficiently. AS.W.1 - Writing

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Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence. AS.W.2 - Writing

Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content. AS.W.3 - Writing

Write narratives to develop real or imagined experiences or events using effective technique, well-chosen details, and well-structured event sequences. AS.W.4 - Writing

Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. AS.W.5 - Writing

Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach. AS.W.6 - Writing

Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others. AS.W.7 - Writing

Conduct short as well as more sustained research projects based on focused questions, demonstrating understanding of the subject under investigation. AS.W.8 - Writing

Gather relevant information from multiple print and digital sources, assess the credibility and accuracy of each source, and integrate the information while avoiding plagiarism. AS.W.9 - Writing

Draw evidence from literary or informational texts to support analysis, reflection, and research. AS.W.10 - Writing

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. AS.SL.1 - Speaking and Listening

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. AS.SL.2 - Speaking and Listening

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Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally. AS.SL.3 - Speaking and Listening

Evaluate a speaker's point of view, reasoning, and use of evidence and rhetoric. AS.SL.4 - Speaking and Listening

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. AS.SL.5 - Speaking and Listening

Make strategic use of digital media and visual displays of data to express information and enhance understanding of presentations. AS.SL.6 - Speaking and Listening

Adapt speech to a variety of contexts and communicative tasks, demonstrating command of formal English when indicated or appropriate. AS.L.1 - Language

Demonstrate command of the conventions of standard English grammar and usage when writing or speaking. AS.L.2 - Language

Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing. AS.L.3 - Language

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. AS.L.4 - Language

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. AS.L.5 - Language

Demonstrate understanding of word relationships and nuances in word meanings. AS.L.6 - Language

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.

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PLTW Standards and Alignment

Engineering Design and Development (EDD)

Common Core State Standards for English Language Arts

Component 2

AS.R.1 - Reading

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. AS.R.2 - Reading

Determine central ideas or themes of a text and analyze their development; summarize the key supporting details and ideas. AS.R.4 - Reading

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. AS.R.6 - Reading

Assess how point of view or purpose shapes the content and style of a text. AS.R.7 - Reading

Integrate and evaluate content presented in diverse formats and media, including visually and quantitatively, as well as in words. AS.R.8 - Reading

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. AS.R.9 - Reading

Analyze how two or more texts address similar themes or topics in order to build knowledge or to compare the approaches the authors take. AS.R.10 - Reading

Read and comprehend complex literary and informational texts independently and proficiently. AS.W.1 - Writing

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PLTW Standards and Alignment

Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence. AS.W.2 - Writing

Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content. AS.W.3 - Writing

Write narratives to develop real or imagined experiences or events using effective technique, well-chosen details, and well-structured event sequences. AS.W.4 - Writing

Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. AS.W.5 - Writing

Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach. AS.W.6 - Writing

Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others. AS.W.7 - Writing

Conduct short as well as more sustained research projects based on focused questions, demonstrating understanding of the subject under investigation. AS.W.8 - Writing

Gather relevant information from multiple print and digital sources, assess the credibility and accuracy of each source, and integrate the information while avoiding plagiarism. AS.W.9 - Writing

Draw evidence from literary or informational texts to support analysis, reflection, and research. AS.W.10 - Writing

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. AS.SL.1 - Speaking and Listening

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. AS.SL.2 - Speaking and Listening

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Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally. AS.SL.3 - Speaking and Listening

Evaluate a speaker's point of view, reasoning, and use of evidence and rhetoric. AS.SL.4 - Speaking and Listening

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. AS.SL.5 - Speaking and Listening

Make strategic use of digital media and visual displays of data to express information and enhance understanding of presentations. AS.SL.6 - Speaking and Listening

Adapt speech to a variety of contexts and communicative tasks, demonstrating command of formal English when indicated or appropriate. AS.L.1 - Language

Demonstrate command of the conventions of standard English grammar and usage when writing or speaking. AS.L.2 - Language

Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing. AS.L.3 - Language

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. AS.L.4 - Language

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. AS.L.5 - Language

Demonstrate understanding of word relationships and nuances in word meanings. AS.L.6 - Language

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.

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PLTW Standards and Alignment

Engineering Design and Development (EDD)

Common Core State Standards for English Language Arts

Component 3

AS.R.1 - Reading

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. AS.R.4 - Reading

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. AS.R.7 - Reading

Integrate and evaluate content presented in diverse formats and media, including visually and quantitatively, as well as in words. AS.R.10 - Reading

Read and comprehend complex literary and informational texts independently and proficiently. AS.W.1 - Writing

Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence. AS.W.2 - Writing

Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content. AS.W.3 - Writing

Write narratives to develop real or imagined experiences or events using effective technique, well-chosen details, and well-structured event sequences. AS.W.4 - Writing

Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. AS.W.5 - Writing

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Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach. AS.W.6 - Writing

Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others. AS.W.7 - Writing

Conduct short as well as more sustained research projects based on focused questions, demonstrating understanding of the subject under investigation. AS.W.8 - Writing

Gather relevant information from multiple print and digital sources, assess the credibility and accuracy of each source, and integrate the information while avoiding plagiarism. AS.W.9 - Writing

Draw evidence from literary or informational texts to support analysis, reflection, and research. AS.W.10 - Writing

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. AS.SL.1 - Speaking and Listening

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. AS.SL.2 - Speaking and Listening

Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally. AS.SL.3 - Speaking and Listening

Evaluate a speaker's point of view, reasoning, and use of evidence and rhetoric. AS.SL.4 - Speaking and Listening

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. AS.SL.5 - Speaking and Listening

Make strategic use of digital media and visual displays of data to express information and enhance understanding of presentations. AS.SL.6 - Speaking and Listening

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

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AS.L.1 - Language

Demonstrate command of the conventions of standard English grammar and usage when writing or speaking. AS.L.2 - Language

Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing. AS.L.3 - Language

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. AS.L.4 - Language

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. AS.L.5 - Language

Demonstrate understanding of word relationships and nuances in word meanings. AS.L.6 - Language

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.

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PLTW Standards and Alignment

Engineering Design and Development (EDD)

Common Core State Standards for English Language Arts

Component 4

AS.R.1 - Reading

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. AS.R.2 - Reading

Determine central ideas or themes of a text and analyze their development; summarize the key supporting details and ideas. AS.R.4 - Reading

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. AS.R.6 - Reading

Assess how point of view or purpose shapes the content and style of a text. AS.R.7 - Reading

Integrate and evaluate content presented in diverse formats and media, including visually and quantitatively, as well as in words. AS.R.8 - Reading

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. AS.R.9 - Reading

Analyze how two or more texts address similar themes or topics in order to build knowledge or to compare the approaches the authors take. AS.R.10 - Reading

Read and comprehend complex literary and informational texts independently and proficiently. AS.W.1 - Writing

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

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AS.W.2 - Writing

Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content. AS.W.3 - Writing

Write narratives to develop real or imagined experiences or events using effective technique, well-chosen details, and well-structured event sequences. AS.W.4 - Writing

Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. AS.W.5 - Writing

Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach. AS.W.6 - Writing

Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others. AS.W.7 - Writing

Conduct short as well as more sustained research projects based on focused questions, demonstrating understanding of the subject under investigation. AS.W.8 - Writing

Gather relevant information from multiple print and digital sources, assess the credibility and accuracy of each source, and integrate the information while avoiding plagiarism. AS.W.9 - Writing

Draw evidence from literary or informational texts to support analysis, reflection, and research. AS.W.10 - Writing

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. AS.SL.1 - Speaking and Listening

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. AS.SL.2 - Speaking and Listening

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Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally. AS.SL.3 - Speaking and Listening

Evaluate a speaker's point of view, reasoning, and use of evidence and rhetoric. AS.SL.4 - Speaking and Listening

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. AS.SL.5 - Speaking and Listening

Make strategic use of digital media and visual displays of data to express information and enhance understanding of presentations. AS.SL.6 - Speaking and Listening

Adapt speech to a variety of contexts and communicative tasks, demonstrating command of formal English when indicated or appropriate. AS.L.1 - Language

Demonstrate command of the conventions of standard English grammar and usage when writing or speaking. AS.L.2 - Language

Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing. AS.L.3 - Language

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. AS.L.4 - Language

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. AS.L.5 - Language

Demonstrate understanding of word relationships and nuances in word meanings. AS.L.6 - Language

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.

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PLTW Standards and Alignment

Engineering Design and Development (EDD)

Common Core State Standards for English Language Arts

Component 5

AS.R.1 - Reading

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. AS.R.2 - Reading

Determine central ideas or themes of a text and analyze their development; summarize the key supporting details and ideas. AS.R.4 - Reading

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. AS.R.6 - Reading

Assess how point of view or purpose shapes the content and style of a text. AS.R.7 - Reading

Integrate and evaluate content presented in diverse formats and media, including visually and quantitatively, as well as in words. AS.R.8 - Reading

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. AS.R.9 - Reading

Analyze how two or more texts address similar themes or topics in order to build knowledge or to compare the approaches the authors take. AS.R.10 - Reading

Read and comprehend complex literary and informational texts independently and proficiently. AS.W.1 - Writing

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

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AS.W.2 - Writing

Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content. AS.W.3 - Writing

Write narratives to develop real or imagined experiences or events using effective technique, well-chosen details, and well-structured event sequences. AS.W.4 - Writing

Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. AS.W.5 - Writing

Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach. AS.W.6 - Writing

Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others. AS.W.7 - Writing

Conduct short as well as more sustained research projects based on focused questions, demonstrating understanding of the subject under investigation. AS.W.8 - Writing

Gather relevant information from multiple print and digital sources, assess the credibility and accuracy of each source, and integrate the information while avoiding plagiarism. AS.W.9 - Writing

Draw evidence from literary or informational texts to support analysis, reflection, and research. AS.W.10 - Writing

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. AS.SL.1 - Speaking and Listening

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. AS.SL.2 - Speaking and Listening

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Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally. AS.SL.3 - Speaking and Listening

Evaluate a speaker's point of view, reasoning, and use of evidence and rhetoric. AS.SL.4 - Speaking and Listening

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. AS.SL.5 - Speaking and Listening

Make strategic use of digital media and visual displays of data to express information and enhance understanding of presentations. AS.SL.6 - Speaking and Listening

Adapt speech to a variety of contexts and communicative tasks, demonstrating command of formal English when indicated or appropriate. AS.L.1 - Language

Demonstrate command of the conventions of standard English grammar and usage when writing or speaking. AS.L.2 - Language

Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing. AS.L.3 - Language

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. AS.L.4 - Language

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. AS.L.5 - Language

Demonstrate understanding of word relationships and nuances in word meanings. AS.L.6 - Language

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.

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PLTW Standards and Alignment

Engineering Design and Development (EDD)

Common Core State Standards for Mathematics

Component 0

N.Q.1 - Quantities

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. N.Q.2 - Quantities

Define appropriate quantities for the purpose of descriptive modeling. N.Q.3 - Quantities

Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. A.SSE.1 - Seeing Structure in Expressions

Interpret expressions that represent a quantity in terms of its context. A.SSE.1.a - Seeing Structure in Expressions

Interpret parts of an expression, such as terms, factors, and coefficients. S.ID.1 - Interpreting Categorical and Quantitative Data

Represent data with plots on the real number line (dot plots, histograms, and box plots). S.ID.2 - Interpreting Categorical and Quantitative Data

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. S.ID.3 - Interpreting Categorical and Quantitative Data

Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers). S.ID.4 - Interpreting Categorical and Quantitative Data

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. S.ID.5 - Interpreting Categorical and Quantitative Data

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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. S.ID.6 - Interpreting Categorical and Quantitative Data

Represent data on two quantitative variables on a scatter plot, and describe how the variables are related. S.ID.6.a - Interpreting Categorical and Quantitative Data

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. S.ID.6.b - Interpreting Categorical and Quantitative Data

Informally assess the fit of a function by plotting and analyzing residuals. S.ID.6.c - Interpreting Categorical and Quantitative Data

Fit a linear function for a scatter plot that suggests a linear association. S.ID.7 - Interpreting Categorical and Quantitative Data

Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data. S.ID.8 - Interpreting Categorical and Quantitative Data

Compute (using technology) and interpret the correlation coefficient of a linear fit. S.ID.9 - Interpreting Categorical and Quantitative Data

Distinguish between correlation and causation. S.IC.1 - Making Inferences and Justifying Conclusions

Understand statistics as a process for making inferences about population parameters based on a random sample from that population. S.IC.2 - Making Inferences and Justifying Conclusions

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? S.IC.3 - Making Inferences and Justifying Conclusions

Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each. S.IC.5 - Making Inferences and Justifying Conclusions

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

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S.IC.6 - Making Inferences and Justifying Conclusions

Evaluate reports based on data.

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Engineering Design and Development (EDD)

Common Core State Standards for Mathematics

Component 1

N.Q.1 - Quantities

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. N.Q.2 - Quantities

Define appropriate quantities for the purpose of descriptive modeling. N.Q.3 - Quantities

Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. A.SSE.1 - Seeing Structure in Expressions

Interpret expressions that represent a quantity in terms of its context. A.SSE.1.a - Seeing Structure in Expressions

Interpret parts of an expression, such as terms, factors, and coefficients. A.REI.10 - Reasoning with Equations and Inequalities

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). F.IF.1 - Interpreting Functions

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). F.IF.4 - Interpreting Functions

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.

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F.IF.5 - Interpreting Functions

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. F.LE.1 - Linear, Quadratic, and Exponential Models

Distinguish between situations that can be modeled with linear functions and with exponential functions. F.LE.1.b - Linear, Quadratic, and Exponential Models

Recognize situations in which one quantity changes at a constant rate per unit interval relative to another. F.LE.1.c - Linear, Quadratic, and Exponential Models

Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another. F.LE.3 - Linear, Quadratic, and Exponential Models

Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly, quadratically, or (more generally) as a polynomial function. F.LE.5 - Linear, Quadratic, and Exponential Models

Interpret the parameters in a linear or exponential function in terms of a context. S.ID.1 - Interpreting Categorical and Quantitative Data

Represent data with plots on the real number line (dot plots, histograms, and box plots). S.ID.2 - Interpreting Categorical and Quantitative Data

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. S.ID.3 - Interpreting Categorical and Quantitative Data

Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers). S.ID.4 - Interpreting Categorical and Quantitative Data

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. S.ID.6 - Interpreting Categorical and Quantitative Data

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

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S.ID.6.b - Interpreting Categorical and Quantitative Data

Informally assess the fit of a function by plotting and analyzing residuals. S.ID.6.c - Interpreting Categorical and Quantitative Data

Fit a linear function for a scatter plot that suggests a linear association. S.ID.9 - Interpreting Categorical and Quantitative Data

Distinguish between correlation and causation. S.IC.1 - Making Inferences and Justifying Conclusions

Understand statistics as a process for making inferences about population parameters based on a random sample from that population. S.IC.3 - Making Inferences and Justifying Conclusions

Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each. S.IC.4 - Making Inferences and Justifying Conclusions

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. S.IC.6 - Making Inferences and Justifying Conclusions

Evaluate reports based on data. S.MD.5 - Using Probability to Make Decisions

(+) Weigh the possible outcomes of a decision by assigning probabilities to payoff values and finding expected values. S.MD.5.b - Using Probability to Make Decisions

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. S.MD.6 - Using Probability to Make Decisions

(+) Use probabilities to make fair decisions (e.g., drawing by lots, using a random number generator). S.MD.7 - Using Probability to Make Decisions

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

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Engineering Design and Development (EDD)

Common Core State Standards for Mathematics

Component 2

N.Q.1 - Quantities

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. N.Q.2 - Quantities

Define appropriate quantities for the purpose of descriptive modeling. N.Q.3 - Quantities

Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. A.SSE.1 - Seeing Structure in Expressions

Interpret expressions that represent a quantity in terms of its context. A.SSE.1.a - Seeing Structure in Expressions

Interpret parts of an expression, such as terms, factors, and coefficients. A.SSE.3 - Seeing Structure in Expressions

Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. A.APR.1 - Arithmetic with Polynomials and Rational Expressions

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. A.CED.1 - Creating Equations

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. A.CED.2 - Creating Equations

Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. A.CED.4 - Creating Equations

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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. A.REI.3 - Reasoning with Equations and Inequalities

Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters. A.REI.4 - Reasoning with Equations and Inequalities

Solve quadratic equations in one variable. A.REI.10 - Reasoning with Equations and Inequalities

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). A.REI.11 - Reasoning with Equations and Inequalities

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. F.IF.1 - Interpreting Functions

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). F.IF.7 - Interpreting Functions

Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. F.IF.7.a - Interpreting Functions

Graph linear and quadratic functions and show intercepts, maxima, and minima. F.IF.8 - Interpreting Functions

Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function. F.BF.1 - Building Functions

Write a function that describes a relationship between two quantities. F.BF.1.b - Building Functions

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.

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F.BF.1.c - Building Functions

(+) 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. F.LE.1 - Linear, Quadratic, and Exponential Models

Distinguish between situations that can be modeled with linear functions and with exponential functions. F.LE.1.b - Linear, Quadratic, and Exponential Models

Recognize situations in which one quantity changes at a constant rate per unit interval relative to another. F.LE.1.c - Linear, Quadratic, and Exponential Models

Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another. F.LE.3 - Linear, Quadratic, and Exponential Models

Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly, quadratically, or (more generally) as a polynomial function. F.LE.5 - Linear, Quadratic, and Exponential Models

Interpret the parameters in a linear or exponential function in terms of a context. G.CO.1 - Congruence

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. G.CO.4 - Congruence

Develop definitions of rotations, reflections, and translations in terms of angles, circles, perpendicular lines, parallel lines, and line segments. G.CO.5 - Congruence

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. G.CO.12 - Congruence

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

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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. G.GMD.4 - Geometric Measurement and Dimension

Identify the shapes of two-dimensional cross-sections of three-dimensional objects, and identify three-dimensional objects generated by rotations of two- dimensional objects. G.MG.1 - Modeling with Geometry

Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder). G.MG.2 - Modeling with Geometry

Apply concepts of density based on area and volume in modeling situations (e.g., persons per square mile, BTUs per cubic foot). G.MG.3 - Modeling with Geometry

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). S.ID.7 - Interpreting Categorical and Quantitative Data

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

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PLTW Standards and Alignment

Engineering Design and Development (EDD)

Common Core State Standards for Mathematics

Component 3

N.Q.1 - Quantities

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. N.Q.2 - Quantities

Define appropriate quantities for the purpose of descriptive modeling. N.Q.3 - Quantities

Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. A.SSE.1 - Seeing Structure in Expressions

Interpret expressions that represent a quantity in terms of its context. A.SSE.1.a - Seeing Structure in Expressions

Interpret parts of an expression, such as terms, factors, and coefficients. A.SSE.3 - Seeing Structure in Expressions

Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. A.CED.1 - Creating Equations

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. A.CED.2 - Creating Equations

Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. A.CED.4 - Creating Equations

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. A.REI.3 - Reasoning with Equations and Inequalities

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

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A.REI.6 - Reasoning with Equations and Inequalities

Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables. A.REI.10 - Reasoning with Equations and Inequalities

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). A.REI.12 - Reasoning with Equations and Inequalities

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. F.IF.1 - Interpreting Functions

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). F.IF.2 - Interpreting Functions

Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context. F.IF.4 - Interpreting Functions

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. F.IF.5 - Interpreting Functions

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. F.IF.6 - Interpreting Functions

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.

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F.IF.7.a - Interpreting Functions

Graph linear and quadratic functions and show intercepts, maxima, and minima. F.BF.1 - Building Functions

Write a function that describes a relationship between two quantities. F.BF.2 - Building Functions

Write arithmetic and geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms. F.LE.1 - Linear, Quadratic, and Exponential Models

Distinguish between situations that can be modeled with linear functions and with exponential functions. F.LE.1.b - Linear, Quadratic, and Exponential Models

Recognize situations in which one quantity changes at a constant rate per unit interval relative to another. F.LE.1.c - Linear, Quadratic, and Exponential Models

Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another. F.LE.2 - Linear, Quadratic, and Exponential Models

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). F.LE.3 - Linear, Quadratic, and Exponential Models

Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly, quadratically, or (more generally) as a polynomial function. S.ID.1 - Interpreting Categorical and Quantitative Data

Represent data with plots on the real number line (dot plots, histograms, and box plots). S.ID.2 - Interpreting Categorical and Quantitative Data

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. S.ID.3 - Interpreting Categorical and Quantitative Data

Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers). S.ID.4 - Interpreting Categorical and Quantitative Data

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

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data sets for which such a procedure is not appropriate. Use calculators, spreadsheets, and tables to estimate areas under the normal curve. S.ID.5 - Interpreting Categorical and Quantitative Data

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. S.ID.6 - Interpreting Categorical and Quantitative Data

Represent data on two quantitative variables on a scatter plot, and describe how the variables are related. S.ID.6.a - Interpreting Categorical and Quantitative Data

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. S.ID.6.b - Interpreting Categorical and Quantitative Data

Informally assess the fit of a function by plotting and analyzing residuals. S.ID.6.c - Interpreting Categorical and Quantitative Data

Fit a linear function for a scatter plot that suggests a linear association. S.ID.7 - Interpreting Categorical and Quantitative Data

Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data. S.ID.8 - Interpreting Categorical and Quantitative Data

Compute (using technology) and interpret the correlation coefficient of a linear fit. S.ID.9 - Interpreting Categorical and Quantitative Data

Distinguish between correlation and causation. S.IC.1 - Making Inferences and Justifying Conclusions

Understand statistics as a process for making inferences about population parameters based on a random sample from that population. S.IC.3 - Making Inferences and Justifying Conclusions

Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each. S.IC.4 - Making Inferences and Justifying Conclusions

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. S.IC.5 - Making Inferences and Justifying Conclusions

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Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant. S.IC.6 - Making Inferences and Justifying Conclusions

Evaluate reports based on data. S.MD.5 - Using Probability to Make Decisions

(+) Weigh the possible outcomes of a decision by assigning probabilities to payoff values and finding expected values. S.MD.5.a - Using Probability to Make Decisions

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. S.MD.5.b - Using Probability to Make Decisions

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. S.MD.6 - Using Probability to Make Decisions

(+) Use probabilities to make fair decisions (e.g., drawing by lots, using a random number generator). S.MD.7 - Using Probability to Make Decisions

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

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PLTW Standards and Alignment

Engineering Design and Development (EDD)

Common Core State Standards for Mathematics

Component 4

N.Q.1 - Quantities

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. N.Q.2 - Quantities

Define appropriate quantities for the purpose of descriptive modeling. N.Q.3 - Quantities

Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. S.ID.1 - Interpreting Categorical and Quantitative Data

Represent data with plots on the real number line (dot plots, histograms, and box plots). S.ID.2 - Interpreting Categorical and Quantitative Data

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. S.ID.3 - Interpreting Categorical and Quantitative Data

Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers). S.ID.4 - Interpreting Categorical and Quantitative Data

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. S.ID.5 - Interpreting Categorical and Quantitative Data

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.

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S.ID.6 - Interpreting Categorical and Quantitative Data

Represent data on two quantitative variables on a scatter plot, and describe how the variables are related. S.ID.6.b - Interpreting Categorical and Quantitative Data

Informally assess the fit of a function by plotting and analyzing residuals. S.ID.6.c - Interpreting Categorical and Quantitative Data

Fit a linear function for a scatter plot that suggests a linear association. S.ID.7 - Interpreting Categorical and Quantitative Data

Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data. S.ID.9 - Interpreting Categorical and Quantitative Data

Distinguish between correlation and causation. S.IC.1 - Making Inferences and Justifying Conclusions

Understand statistics as a process for making inferences about population parameters based on a random sample from that population. S.IC.2 - Making Inferences and Justifying Conclusions

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? S.IC.3 - Making Inferences and Justifying Conclusions

Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each. S.IC.4 - Making Inferences and Justifying Conclusions

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. S.IC.6 - Making Inferences and Justifying Conclusions

Evaluate reports based on data. S.MD.5 - Using Probability to Make Decisions

(+) Weigh the possible outcomes of a decision by assigning probabilities to payoff values and finding expected values. S.MD.5.a - Using Probability to Make Decisions

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. S.MD.5.b - Using Probability to Make Decisions

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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. S.MD.6 - Using Probability to Make Decisions

(+) Use probabilities to make fair decisions (e.g., drawing by lots, using a random number generator). S.MD.7 - Using Probability to Make Decisions

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

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Engineering Design and Development (EDD)

Common Core State Standards for Mathematics

Component 5

A.SSE.1 - Seeing Structure in Expressions

Interpret expressions that represent a quantity in terms of its context. A.REI.1 - Reasoning with Equations and Inequalities

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. A.REI.2 - Reasoning with Equations and Inequalities

Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise. F.IF.5 - Interpreting Functions

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. S.ID.1 - Interpreting Categorical and Quantitative Data

Represent data with plots on the real number line (dot plots, histograms, and box plots). S.ID.2 - Interpreting Categorical and Quantitative Data

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. S.ID.3 - Interpreting Categorical and Quantitative Data

Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers). S.ID.4 - Interpreting Categorical and Quantitative Data

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.

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S.ID.5 - Interpreting Categorical and Quantitative Data

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. S.ID.6 - Interpreting Categorical and Quantitative Data

Represent data on two quantitative variables on a scatter plot, and describe how the variables are related. S.ID.6.a - Interpreting Categorical and Quantitative Data

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. S.ID.6.b - Interpreting Categorical and Quantitative Data

Informally assess the fit of a function by plotting and analyzing residuals. S.ID.6.c - Interpreting Categorical and Quantitative Data

Fit a linear function for a scatter plot that suggests a linear association. S.IC.3 - Making Inferences and Justifying Conclusions

Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each. S.IC.4 - Making Inferences and Justifying Conclusions

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. S.IC.5 - Making Inferences and Justifying Conclusions

Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant. S.IC.6 - Making Inferences and Justifying Conclusions

Evaluate reports based on data. S.MD.5 - Using Probability to Make Decisions

(+) Weigh the possible outcomes of a decision by assigning probabilities to payoff values and finding expected values. S.MD.5.b - Using Probability to Make Decisions

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. S.MD.6 - Using Probability to Make Decisions

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Engineering Design and Development (EDD)

Next Generation Science Standards

Component 0

HS.ESS3.2 - Earth and Human Activity

Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios. HS.ETS1.1 - Engineering Design

Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. HS.ETS1.2 - Engineering Design

Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. HS.ETS1.3 - Engineering Design

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. DCI - 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) DCI - ETS1.A - Engineering Design - Defining and Delimiting Engineering Problems

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. (HS-ETS1-1) Science and Engineering Practice - Asking questions and defining problems Evaluate a question to determine if it is testable and relevant. Science and Engineering Practice - Planning and Carrying Out Investigations

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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. Science and Engineering Practice - Planning and Carrying Out Investigations

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. Science and Engineering Practice - Planning and Carrying Out Investigations

Plan and conduct an investigation or test a design solution in a safe and ethical manner including considerations of environmental, social, and personal impacts. Science and Engineering Practice - Constructing Explanations and Designing Solutions

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. Science and Engineering Practice - Engaging in Argument from Evidence

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. Science and Engineering Practice - Engaging in Argument from Evidence

Evaluate the claims, evidence, and/or reasoning behind currently accepted explanations or solutions to determine the merits of arguments. Science and Engineering Practice - Engaging in Argument from Evidence

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. Science and Engineering Practice - Engaging in Argument from Evidence

Construct, use, and/or present an oral and written argument or counter- arguments based on data and evidence. Science and Engineering Practice - Engaging in Argument from Evidence

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. Science and Engineering Practice - Engaging in Argument from Evidence

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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). Science and Engineering Practice - Obtaining, Evaluating, and Communicating Information

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. Science and Engineering Practice - Obtaining, Evaluating, and Communicating Information

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. Science and Engineering Practice - Obtaining, Evaluating, and Communicating Information

Gather, read, and evaluate scientific and/or technical information from multiple authoritative sources, assessing the evidence and usefulness of each source. Science and Engineering Practice - Obtaining, Evaluating, and Communicating Information

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. - Communicate scientific and/or technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (i.e., orally, graphically, textually, mathematically). Crosscutting Concepts - Systems and System Models

Systems can be designed to do specific tasks.

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Engineering Design and Development (EDD)

Next Generation Science Standards

Component 1

HS.ESS3.1 - Earth and Human Activity

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. HS.ESS3.2 - Earth and Human Activity

Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios. HS.ESS3.5 - Earth and Human Activity

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. HS.ETS1.1 - Engineering Design

Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. HS.ETS1.2 - Engineering Design

Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. HS.ETS1.3 - Engineering Design

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. HS.ETS1.4 - Engineering Design

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. DCI - 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

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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) DCI - ETS1.A - Engineering Design - Defining and Delimiting Engineering Problems

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. (HS-ETS1-1) Science and Engineering Practice - Asking questions and defining problems Evaluate a question to determine if it is testable and relevant. Science and Engineering Practice - Asking questions and defining problems

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. Science and Engineering Practice - Asking questions and defining problems

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. Science and Engineering Practice - Asking questions and defining problems

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. Science and Engineering Practice - Developing and Using Models

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. Science and Engineering Practice - Developing and Using Models

Design a test of a model to ascertain its reliability. Science and Engineering Practice - Developing and Using Models

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. Science and Engineering Practice - Developing and Using Models

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. Science and Engineering Practice - Developing and Using Models

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

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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. Science and Engineering Practice - Planning and Carrying Out Investigations

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. Science and Engineering Practice - Planning and Carrying Out Investigations

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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. Science and Engineering Practice - Constructing Explanations and Designing Solutions 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. Science and Engineering Practice - Constructing Explanations and Designing Solutions

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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. Science and Engineering Practice - Constructing Explanations and Designing Solutions

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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. Science and Engineering Practice - Engaging in Argument from Evidence

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. Science and Engineering Practice - Engaging in Argument from Evidence

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Crosscutting Concepts - Patterns

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

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. Crosscutting Concepts - Patterns

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. Crosscutting Concepts - Patterns

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

Mathematical representations are needed to identify some patterns. Crosscutting Concepts - Patterns

Empirical evidence is needed to identify patterns. Crosscutting Concepts - Cause and Effect: Mechanism and Prediction

Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. Crosscutting Concepts - Cause and Effect: Mechanism and Prediction

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. Crosscutting Concepts - Cause and Effect: Mechanism and Prediction

Systems can be designed to cause a desired effect. Crosscutting Concepts - Cause and Effect: Mechanism and Prediction

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PLTW Standards and Alignment

Changes in systems may have various causes that may not have equal effects. Crosscutting Concepts - Systems and System Models

Systems can be designed to do specific tasks. Crosscutting Concepts - Stability and Change

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

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PLTW Standards and Alignment

Engineering Design and Development (EDD)

Next Generation Science Standards

Component 2

HS.ESS3.3 - Earth and Human Activity

Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity. HS.ESS3.4 - Earth and Human Activity

Evaluate or refine a technological solution that reduces impacts of human activities on natural systems. HS.ETS1.1 - Engineering Design

Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. HS.ETS1.2 - Engineering Design

Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. HS.ETS1.3 - Engineering Design

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. HS.ETS1.4 - Engineering Design

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. DCI - 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) DCI - ETS1.A - Engineering Design - Defining and Delimiting Engineering Problems

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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. (HS-ETS1-1) Science and Engineering Practice - Asking questions and defining problems Evaluate a question to determine if it is testable and relevant. Science and Engineering Practice - Asking questions and defining problems

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. Science and Engineering Practice - Asking questions and defining problems

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. Science and Engineering Practice - Asking questions and defining problems

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. Science and Engineering Practice - Developing and Using Models

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. Science and Engineering Practice - Developing and Using Models

Design a test of a model to ascertain its reliability. Science and Engineering Practice - Developing and Using Models

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. Science and Engineering Practice - Developing and Using Models

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. Science and Engineering Practice - Developing and Using Models

Develop a complex model that allows for manipulation and testing of a proposed process or system. Science and Engineering Practice - Developing and Using Models

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

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Science and Engineering Practice - Planning and Carrying Out Investigations

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. Science and Engineering Practice - Planning and Carrying Out Investigations

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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. Science and Engineering Practice - Planning and Carrying Out Investigations

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. Science and Engineering Practice - Analyzing and Interpreting 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. Science and Engineering Practice - Analyzing and Interpreting Data

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. Science and Engineering Practice - Analyzing and Interpreting Data

Consider limitations of data analysis (e.g., measurement error, sample selection) when analyzing and interpreting data. Science and Engineering Practice - Analyzing and Interpreting Data

Compare and contrast various types of data sets (e.g., self-generated, archival) to examine consistency of measurements and observations. Science and Engineering Practice - Analyzing and Interpreting Data

Evaluate the impact of new data on a working explanation and/or model of a proposed process or system. Science and Engineering Practice - Analyzing and Interpreting Data

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.

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Science and Engineering Practice - Using Mathematics and Computational Thinking

Create and/or revise a computational model or simulation of a phenomenon, designed device, process, or system. Science and Engineering Practice - Using Mathematics and Computational Thinking

Use mathematical, computational, and/or algorithmic representations of phenomena or design solutions to describe and/or support claims and/or explanations. Science and Engineering Practice - Using Mathematics and Computational Thinking

Apply techniques of algebra and functions to represent and solve scientific and engineering problems. Science and Engineering Practice - Using Mathematics and Computational Thinking 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. Science and Engineering Practice - Using Mathematics and Computational Thinking 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.) Science and Engineering Practice - Constructing Explanations and Designing Solutions Make a quantitative and/or qualitative claim regarding the relationship between dependent and independent variables. Science and Engineering Practice - Constructing Explanations and Designing Solutions 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. Science and Engineering Practice - Constructing Explanations and Designing Solutions

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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.

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Communicate scientific and/or technical information or ideas (e.g., about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (i.e., orally, graphically, textually, mathematically).

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

Mathematical representations are needed to identify some patterns. Crosscutting Concepts - Patterns

Empirical evidence is needed to identify patterns. Crosscutting Concepts - Cause and Effect: Mechanism and Prediction

Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. Crosscutting Concepts - Cause and Effect: Mechanism and Prediction

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. Crosscutting Concepts - Cause and Effect: Mechanism and Prediction

Systems can be designed to cause a desired effect. Crosscutting Concepts - Cause and Effect: Mechanism and Prediction

Changes in systems may have various causes that may not have equal effects. Crosscutting Concepts - 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. Crosscutting Concepts - Scale, Proportion, and Quantity

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

Some systems can only be studied indirectly as they are too small, too large, too fast, or too slow to observe directly. Crosscutting Concepts - Scale, Proportion, and Quantity

Patterns observable at one scale may not be observable or exist at other scales. Crosscutting Concepts - Scale, Proportion, and Quantity

Using the concept of orders of magnitude allows one to understand how a model at one scale relates to a model at another scale. Crosscutting Concepts - 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). Crosscutting Concepts - Systems and System Models

Systems can be designed to do specific tasks. Crosscutting Concepts - 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. Crosscutting Concepts - Energy and Matter: Flows, Cycles, and Conservation The total amount of energy and matter in closed systems is conserved. Crosscutting Concepts - Energy and Matter: Flows, Cycles, and Conservation

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. Crosscutting Concepts - Energy and Matter: Flows, Cycles, and Conservation

Energy cannot be created or destroyed—only moves between one place and another place, between objects and/or fields, or between systems. Crosscutting Concepts - Energy and Matter: Flows, Cycles, and Conservation

Energy drives the cycling of matter within and between systems. Crosscutting Concepts - Structure and Function

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

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.

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Crosscutting Concepts - Structure and Function

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. Crosscutting Concepts - 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. Crosscutting Concepts - Stability and Change

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

Feedback (negative or positive) can stabilize or destabilize a system. Crosscutting Concepts - Stability and Change

Systems can be designed for greater or lesser stability.

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PLTW Standards and Alignment

Engineering Design and Development (EDD)

Next Generation Science Standards

Component 3

HS.PS3.3 - Energy

Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy. HS.ESS3.3 - Earth and Human Activity

Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity. HS.ESS3.4 - Earth and Human Activity

Evaluate or refine a technological solution that reduces impacts of human activities on natural systems. HS.ETS1.1 - Engineering Design

Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. HS.ETS1.2 - Engineering Design

Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. HS.ETS1.3 - Engineering Design

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. HS.ETS1.4 - Engineering Design

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. DCI - 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)

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DCI - ETS1.A - Engineering Design - Defining and Delimiting Engineering Problems

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. (HS-ETS1-1) Science and Engineering Practice - Asking questions and defining problems Evaluate a question to determine if it is testable and relevant. Science and Engineering Practice - Asking questions and defining problems

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. Science and Engineering Practice - Asking questions and defining problems

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. Science and Engineering Practice - Asking questions and defining problems

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. Science and Engineering Practice - Developing and Using Models

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. Science and Engineering Practice - Developing and Using Models

Design a test of a model to ascertain its reliability. Science and Engineering Practice - Developing and Using Models

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. Science and Engineering Practice - Developing and Using Models

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. Science and Engineering Practice - Developing and Using Models

Develop a complex model that allows for manipulation and testing of a proposed process or system. Science and Engineering Practice - Developing and Using Models

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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. Science and Engineering Practice - Planning and Carrying Out Investigations

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. Science and Engineering Practice - Planning and Carrying Out Investigations

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. Science and Engineering Practice - Planning and Carrying Out Investigations

Plan and conduct an investigation or test a design solution in a safe and ethical manner including considerations of environmental, social, and personal impacts. Science and Engineering Practice - Planning and Carrying Out Investigations

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. Science and Engineering Practice - Analyzing and Interpreting 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. Science and Engineering Practice - Analyzing and Interpreting Data

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. Science and Engineering Practice - Analyzing and Interpreting Data

Consider limitations of data analysis (e.g., measurement error, sample selection) when analyzing and interpreting data. Science and Engineering Practice - Analyzing and Interpreting Data

Compare and contrast various types of data sets (e.g., self-generated, archival) to examine consistency of measurements and observations. Science and Engineering Practice - Analyzing and Interpreting Data

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

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Science and Engineering Practice - Analyzing and Interpreting Data

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. Science and Engineering Practice - Using Mathematics and Computational Thinking

Create and/or revise a computational model or simulation of a phenomenon, designed device, process, or system. Science and Engineering Practice - Using Mathematics and Computational Thinking

Use mathematical, computational, and/or algorithmic representations of phenomena or design solutions to describe and/or support claims and/or explanations. Science and Engineering Practice - Using Mathematics and Computational Thinking

Apply techniques of algebra and functions to represent and solve scientific and engineering problems. Science and Engineering Practice - Using Mathematics and Computational Thinking 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. Science and Engineering Practice - Using Mathematics and Computational Thinking 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.) Science and Engineering Practice - Constructing Explanations and Designing Solutions Make a quantitative and/or qualitative claim regarding the relationship between dependent and independent variables. Science and Engineering Practice - Constructing Explanations and Designing Solutions 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. Science and Engineering Practice - Constructing Explanations and Designing Solutions

Apply scientific ideas, principles, and/or evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects. Science and Engineering Practice - Constructing Explanations and Designing Solutions

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.

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Science and Engineering Practice - Constructing Explanations and Designing Solutions

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. Science and Engineering Practice - Engaging in Argument from Evidence

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. Science and Engineering Practice - Engaging in Argument from Evidence

Evaluate the claims, evidence, and/or reasoning behind currently accepted explanations or solutions to determine the merits of arguments. Science and Engineering Practice - Engaging in Argument from Evidence

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. Science and Engineering Practice - Engaging in Argument from Evidence

Construct, use, and/or present an oral and written argument or counter- arguments based on data and evidence. Science and Engineering Practice - Engaging in Argument from Evidence

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. Science and Engineering Practice - Engaging in Argument from Evidence

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).

Science and Engineering Practice - Obtaining, Evaluating, and Communicating Information

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. Science and Engineering Practice - Obtaining, Evaluating, and Communicating Information

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.

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Science and Engineering Practice - Obtaining, Evaluating, and Communicating Information

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. Communicate scientific and/or technical information or ideas (e.g., about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (i.e., orally, graphically, textually, mathematically).

Crosscutting Concepts - Patterns

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

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. Crosscutting Concepts - Patterns

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. Crosscutting Concepts - Patterns

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

Mathematical representations are needed to identify some patterns. Crosscutting Concepts - Patterns

Empirical evidence is needed to identify patterns. Crosscutting Concepts - 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. Crosscutting Concepts - Cause and Effect: Mechanism and Prediction

Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. Crosscutting Concepts - Cause and Effect: Mechanism and Prediction

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. Crosscutting Concepts - Cause and Effect: Mechanism and Prediction

Systems can be designed to cause a desired effect.

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Crosscutting Concepts - Cause and Effect: Mechanism and Prediction

Changes in systems may have various causes that may not have equal effects. Crosscutting Concepts - 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. Crosscutting Concepts - Scale, Proportion, and Quantity

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

Some systems can only be studied indirectly as they are too small, too large, too fast, or too slow to observe directly. Crosscutting Concepts - Scale, Proportion, and Quantity

Patterns observable at one scale may not be observable or exist at other scales. Crosscutting Concepts - Scale, Proportion, and Quantity

Using the concept of orders of magnitude allows one to understand how a model at one scale relates to a model at another scale. Crosscutting Concepts - 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). Crosscutting Concepts - 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. Crosscutting Concepts - Systems and System Models

Systems can be designed to do specific tasks. Crosscutting Concepts - Systems and System Models

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. Crosscutting Concepts - Systems and System Models

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. Crosscutting Concepts - Systems and System Models

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.

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PLTW Standards and Alignment

Engineering Design and Development (EDD)

Next Generation Science Standards

Component 4

HS.ETS1.1 - Engineering Design

Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. HS.ETS1.2 - Engineering Design

Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. HS.ETS1.3 - Engineering Design

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. DCI - 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) DCI - ETS1.A - Engineering Design - Defining and Delimiting Engineering Problems

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. (HS-ETS1-1) Science and Engineering Practice - Asking questions and defining problems Evaluate a question to determine if it is testable and relevant. Science and Engineering Practice - Asking questions and defining problems

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. Science and Engineering Practice - Asking questions and defining problems

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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. Science and Engineering Practice - Asking questions and defining problems

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. Science and Engineering Practice - Developing and Using Models

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. Science and Engineering Practice - Developing and Using Models

Design a test of a model to ascertain its reliability. Science and Engineering Practice - Developing and Using Models

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. Science and Engineering Practice - Developing and Using Models

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. Science and Engineering Practice - Developing and Using Models

Develop a complex model that allows for manipulation and testing of a proposed process or system. Science and Engineering Practice - Developing and Using Models

Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems. Science and Engineering Practice - Planning and Carrying Out Investigations

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. Science and Engineering Practice - Planning and Carrying Out Investigations

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. Science and Engineering Practice - Planning and Carrying Out Investigations

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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. Science and Engineering Practice - Planning and Carrying Out Investigations

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. Science and Engineering Practice - Analyzing and Interpreting 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. Science and Engineering Practice - Analyzing and Interpreting Data

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. Science and Engineering Practice - Analyzing and Interpreting Data

Consider limitations of data analysis (e.g., measurement error, sample selection) when analyzing and interpreting data. Science and Engineering Practice - Analyzing and Interpreting Data

Compare and contrast various types of data sets (e.g., self-generated, archival) to examine consistency of measurements and observations. Science and Engineering Practice - Analyzing and Interpreting Data

Evaluate the impact of new data on a working explanation and/or model of a proposed process or system. Science and Engineering Practice - Analyzing and Interpreting Data

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. Science and Engineering Practice - Constructing Explanations and Designing Solutions 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. Science and Engineering Practice - Constructing Explanations and Designing Solutions

Apply scientific ideas, principles, and/or evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects. Science and Engineering Practice - Constructing Explanations and Designing Solutions

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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. Science and Engineering Practice - Constructing Explanations and Designing Solutions

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. Science and Engineering Practice - Engaging in Argument from Evidence

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. Science and Engineering Practice - Engaging in Argument from Evidence

Evaluate the claims, evidence, and/or reasoning behind currently accepted explanations or solutions to determine the merits of arguments. Science and Engineering Practice - Engaging in Argument from Evidence

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. Science and Engineering Practice - Engaging in Argument from Evidence

Construct, use, and/or present an oral and written argument or counter- arguments based on data and evidence. Science and Engineering Practice - Engaging in Argument from Evidence

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. Science and Engineering Practice - Engaging in Argument from Evidence

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). Science and Engineering Practice - Obtaining, Evaluating, and Communicating Information

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. Science and Engineering Practice - Obtaining, Evaluating, and Communicating Information

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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. Science and Engineering Practice - Obtaining, Evaluating, and Communicating Information

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. Communicate scientific and/or technical information or ideas (e.g., about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (i.e., orally, graphically, textually, mathematically).

Crosscutting Concepts - 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. Crosscutting Concepts - Cause and Effect: Mechanism and Prediction

Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. Crosscutting Concepts - Cause and Effect: Mechanism and Prediction

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. Crosscutting Concepts - Cause and Effect: Mechanism and Prediction

Systems can be designed to cause a desired effect. Crosscutting Concepts - Cause and Effect: Mechanism and Prediction

Changes in systems may have various causes that may not have equal effects. Crosscutting Concepts - Systems and System Models

Systems can be designed to do specific tasks.

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PLTW Standards and Alignment

Engineering Design and Development (EDD)

Next Generation Science Standards

Component 5

HS.ETS1.1 - Engineering Design

Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. HS.ETS1.2 - Engineering Design

Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. HS.ETS1.3 - Engineering Design

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. DCI - 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) DCI - ETS1.A - Engineering Design - Defining and Delimiting Engineering Problems

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. (HS-ETS1-1) Science and Engineering Practice - Analyzing and Interpreting Data

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. Science and Engineering Practice - Analyzing and Interpreting Data

Consider limitations of data analysis (e.g., measurement error, sample selection) when analyzing and interpreting data. Science and Engineering Practice - Analyzing and Interpreting Data

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Compare and contrast various types of data sets (e.g., self-generated, archival) to examine consistency of measurements and observations. Science and Engineering Practice - Analyzing and Interpreting Data

Evaluate the impact of new data on a working explanation and/or model of a proposed process or system. Science and Engineering Practice - Analyzing and Interpreting Data

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. Science and Engineering Practice - Constructing Explanations and Designing Solutions

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. Science and Engineering Practice - Engaging in Argument from Evidence

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. Science and Engineering Practice - Engaging in Argument from Evidence

Evaluate the claims, evidence, and/or reasoning behind currently accepted explanations or solutions to determine the merits of arguments. Science and Engineering Practice - Engaging in Argument from Evidence

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. Science and Engineering Practice - Engaging in Argument from Evidence

Construct, use, and/or present an oral and written argument or counter- arguments based on data and evidence. Science and Engineering Practice - Engaging in Argument from Evidence

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. Science and Engineering Practice - Engaging in Argument from Evidence

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). Science and Engineering Practice - Obtaining, Evaluating, and Communicating Information

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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. Science and Engineering Practice - Obtaining, Evaluating, and Communicating Information

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. Science and Engineering Practice - Obtaining, Evaluating, and Communicating Information

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. Communicate scientific and/or technical information or ideas (e.g., about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (i.e., orally, graphically, textually, mathematically).

Crosscutting Concepts - 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. Crosscutting Concepts - Cause and Effect: Mechanism and Prediction

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Changes in systems may have various causes that may not have equal effects. Crosscutting Concepts - Systems and System Models

Systems can be designed to do specific tasks.

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PLTW Standards and Alignment

Engineering Design and Development (EDD)

Standards for Technological Literacy

Component 0

1.9-12.J Students will develop an understanding of the characteristics and scope of technology.

J. The nature and development of technological knowledge and processes are functions of the setting. 1.9-12.K Students will develop an understanding of the characteristics and scope of technology.

K. The rate of technological development and diffusion is increasing rapidly. 1.9-12.L Students will develop an understanding of the characteristics and scope of technology.

L. Inventions and innovations are the results of the specific, goal-directed research. 1.9-12.M Students will develop an understanding of the characteristics and scope of technology.

M. Most development of technologies these days is driven by the profit motive and the market. 2.9-12.W Students will develop an understanding of the core concepts of technology.

W. Systems thinking applies logic and creativity with appropriate compromises in complex real-life problems. 2.9-12.X Students will develop an understanding of the core concepts of technology.

X. Systems, which are the building blocks of technology, are embedded within larger technological, social, and environmental systems. 2.9-12.Y Students will develop an understanding of the core concepts of technology.

Y. The stability of a technological system is influenced by all of the components in the system, especially those in the feedback loop. 2.9-12.Z Students will develop an understanding of the core concepts of technology. Z. Selecting resources involves trade-offs between competing values, such as availability, cost, desirability, and waste. 2.9-12.AA Students will develop an understanding of the core concepts of technology.

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PLTW Standards and Alignment

AA. Requirements involve the identification of the criteria and constraints of a product or system and the determination of how they affect the final design and development. 2.9-12.BB Students will develop an understanding of the core concepts of technology.

BB. Optimization is an ongoing process or methodology of designing or making a product and is dependent on criteria and constraints. 2.9-12.CC Students will develop an understanding of the core concepts of technology.

CC. New technologies create new processes. 2.9-12.DD Students will develop an understanding of the core concepts of technology.

DD. Quality control is a planned process to ensure that a product, service, or system meets established criteria. 2.9-12.EE Students will develop an understanding of the core concepts of technology. EE. Management is the process of planning, organizing, and controlling work. 2.9-12.FF Students will develop an understanding of the core concepts of technology.

FF. Complex systems have many layers of controls and feedback loops to provide information. 3.9-12.G Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.

G. Technology transfer occurs when a new user applies an existing innovation developed for one purpose in a different function. 3.9-12.H Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.

H. Technological innovation often results when ideas, knowledge, or skills are shared within a technology, among technologies, or across other fields. 3.9-12.I Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.

I. Technological ideas are sometimes protected through the process of patenting. 3.9-12.J Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.

J. Technological progress promotes the advancement of science and mathematics. 4.9-12.H Students will develop an understanding of the cultural, social, economic, and political effects of technology.

H. Changes caused by the use of technology can range from gradual to rapid and from subtle to obvious. 4.9-12.I Students will develop an understanding of the cultural, social, economic, and political effects of technology.

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PLTW Standards and Alignment

I. Making decisions about the use of technology involves weighing the trade-offs between the positive and negative effects. 4.9-12.J Students will develop an understanding of the cultural, social, economic, and political effects of technology.

J. Ethical considerations are important in the development, selection, and use of technologies. 4.9-12.K Students will develop an understanding of the cultural, social, economic, and political effects of technology.

K. The transfer of a technology from one society to another can cause cultural, social, economic, and political changes affecting both societies to varying degrees. 5.9-12.G Students will develop an understanding of the cultural, social, economic, and political effects of technology.

G. Humans can devise technologies to conserve water, soil, and energy through such techniques as reusing, reducing, and recycling. 5.9-12.H Students will develop an understanding of the cultural, social, economic, and political effects of technology.

H. When new technologies are developed to reduce the use of resources, considerations of trade-offs are important. 5.9-12.I Students will develop an understanding of the cultural, social, economic, and political effects of technology.

I. With the aid of technology, various aspects of the environment can be monitored to provide information for decision-making. 5.9-12.J Students will develop an understanding of the cultural, social, economic, and political effects of technology.

J. The alignment of technological processes with natural processes maximizes performance and reduces negative impacts on the environment. 5.9-12.K Students will develop an understanding of the cultural, social, economic, and political effects of technology.

K. Humans devise technologies to reduce the negative consequences of other technologies. 5.9-12.L Students will develop an understanding of the cultural, social, economic, and political effects of technology.

L. Decisions regarding the implementation of technologies involve the weighing of trade-offs between predicted positive and negative effects on the environment. 6.9-12.H Students will develop an understanding of the role of society in the development and use of technology.

H. Different cultures develop their own technologies to satisfy their individual and shared needs, wants, and values.

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PLTW Standards and Alignment

6.9-12.I Students will develop an understanding of the role of society in the development and use of technology.

I. The decision whether to develop a technology is influenced by societal opinions and demands, in addition to corporate cultures. 6.9-12.J Students will develop an understanding of the role of society in the development and use of technology.

J. A number of different factors, such as advertising, the strength of the economy, the goals of a company, and the latest fads contribute to shaping the design of and demand for various technologies. 7.9-12.G Students will develop an understanding of the influence of technology on history.

G. Most technological development has been evolutionary, the result of a series of refinements to a basic invention. 8.9-12.H Students will develop an understanding of the attributes of design.

H. The design process includes defining a problem, brainstorming, researching and generating ideas, identifying criteria and specifying constraints, exploring possibilities, selecting an approach, developing a design proposal, making a model or prototype. 8.9-12.I Students will develop an understanding of the attributes of design.

I. Design problems are seldom presented in a clearly defined form. 8.9-12.J Students will develop an understanding of the attributes of design.

J. The design needs to be continually checked and critiqued, and the ideas of the design must be redefined and improved. 8.9-12.K Students will develop an understanding of the attributes of design.

K. Requirements of a design, such as criteria, constraints, and efficiency, sometimes compete with each other. 9.9-12.I Students will develop an understanding of engineering design.

I. Established design principles are used to evaluate existing designs, to collect data, and to guide the design process. 9.9-12.J Students will develop an understanding of engineering design.

J. Engineering design is influenced by personal characteristics, such as creativity, resourcefulness, and the ability to visualize and think abstractly. 9.9-12.K Students will develop an understanding of engineering design.

K. A prototype is a working model used to test a design concept by making actual observations and necessary adjustments. 9.9-12.L Students will develop an understanding of engineering design.

L. The process of engineering design takes into account a number of factors.

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PLTW Standards and Alignment

10.9-12.I Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.

I. Research and development is a specific problem-solving approach that is used intensively in business and industry to prepare devices and systems for the marketplace. 10.9-12.J Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.

J. Technological problems must be researched before they can be solved. 10.9-12.K Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.

K. Not all problems are technological, and not every problem can be solved using technology. 10.9-12.L Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.

L. Many technological problems require a multidisciplinary approach. 11.9-12.M Students will develop the abilities to apply the design process.

M. Identify the design problem to solve and decide whether or not to address it. 11.9-12.N Students will develop the abilities to apply the design process.

N. Identify criteria and constraints and determine how these will affect the design process. 11.9-12.O Students will develop the abilities to apply the design process.

O. Refine a design by using prototypes and modeling to ensure quality, efficiency, and productivity of the final product. 11.9-12.P Students will develop the abilities to apply the design process.

P. Evaluate the design solution using conceptual, physical, and mathematical models at various intervals of the design process in order to check for proper design and to note areas where improvements are needed. 11.9-12.Q Students will develop the abilities to apply the design process.

Q. Develop and produce a product or system using a design process. 11.9-12.R Students will develop the abilities to apply the design process.

R. Evaluate final solutions and communicate observation, processes, and results of the entire design process, using verbal, graphic, quantitative, virtual, and written means, in addition to three-dimensional models. 12.9-12.L Students will develop the abilities to use and maintain technological products and systems.

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PLTW Standards and Alignment

L. Document processes and procedures and communicate them to different audiences using appropriate oral and written techniques. 12.9-12.M Students will develop the abilities to use and maintain technological products and systems.

M. Diagnose a system that is malfunctioning and use tools, materials, machines, and knowledge to repair it. 12.9-12.N Students will develop the abilities to use and maintain technological products and systems.

N. Troubleshoot, analyze, and maintain systems to ensure safe and proper function and precision. 12.9-12.O Students will develop the abilities to use and maintain technological products and systems.

O. Operate systems so that they function in the way they were designed. 12.9-12.P Students will develop the abilities to use and maintain technological products and systems.

P. Use computers and calculators to access, retrieve, organize, process, maintain, interpret, and evaluate data and information in order to communicate. 13.9-12.J Students will develop the abilities to assess the impact of products and systems.

J. Collect information and evaluate its quality. 13.9-12.K Students will develop the abilities to assess the impact of products and systems.

K. Synthesize data, analyze trends, and draw conclusions regarding the effect of technology on the individual, society, and environment. 13.9-12.L Students will develop the abilities to assess the impact of products and systems.

L. Use assessment techniques, such as trend analysis and experimentation, to make decisions about the future development of technology. 13.9-12.M Students will develop the abilities to assess the impact of products and systems.

M. Design forecasting techniques to evaluate the results of altering natural systems. 17.9-12.N Students will develop an understanding of and be able to select and use information and communication technologies.

N. Information and communication systems can be used to inform, persuade, entertain, control, manage, and educate.

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PLTW Standards and Alignment

17.9-12.P Students will develop an understanding of and be able to select and use information and communication technologies.

P. There are many ways to communicate information, such as graphic and electronic means.
17.9-12.Q Students will develop an understanding of and be able to select and use information and communication technologies.

Q. Technological knowledge and processes are communicated using symbols, measurement, conventions, icons, graphic images, and languages that incorporate a variety of visual, auditory, and tactile stimuli.

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PLTW Standards and Alignment

Engineering Design and Development (EDD)

Standards for Technological Literacy

Component 1

1.9-12.J Students will develop an understanding of the characteristics and scope of technology.

J. The nature and development of technological knowledge and processes are functions of the setting. 1.9-12.K Students will develop an understanding of the characteristics and scope of technology.

K. The rate of technological development and diffusion is increasing rapidly. 1.9-12.L Students will develop an understanding of the characteristics and scope of technology.

L. Inventions and innovations are the results of the specific, goal-directed research. 1.9-12.M Students will develop an understanding of the characteristics and scope of technology.

M. Most development of technologies these days is driven by the profit motive and the market. 2.9-12.W Students will develop an understanding of the core concepts of technology.

W. Systems thinking applies logic and creativity with appropriate compromises in complex real-life problems. 2.9-12.X Students will develop an understanding of the core concepts of technology.

X. Systems, which are the building blocks of technology, are embedded within larger technological, social, and environmental systems. 2.9-12.Y Students will develop an understanding of the core concepts of technology.

Y. The stability of a technological system is influenced by all of the components in the system, especially those in the feedback loop. 2.9-12.Z Students will develop an understanding of the core concepts of technology. Z. Selecting resources involves trade-offs between competing values, such as availability, cost, desirability, and waste. 2.9-12.AA Students will develop an understanding of the core concepts of technology.

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PLTW Standards and Alignment

AA. Requirements involve the identification of the criteria and constraints of a product or system and the determination of how they affect the final design and development. 2.9-12.EE Students will develop an understanding of the core concepts of technology. EE. Management is the process of planning, organizing, and controlling work. 3.9-12.G Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.

G. Technology transfer occurs when a new user applies an existing innovation developed for one purpose in a different function. 3.9-12.H Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.

H. Technological innovation often results when ideas, knowledge, or skills are shared within a technology, among technologies, or across other fields. 3.9-12.I Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.

I. Technological ideas are sometimes protected through the process of patenting. 3.9-12.J Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.

J. Technological progress promotes the advancement of science and mathematics. 4.9-12.H Students will develop an understanding of the cultural, social, economic, and political effects of technology.

H. Changes caused by the use of technology can range from gradual to rapid and from subtle to obvious. 4.9-12.I Students will develop an understanding of the cultural, social, economic, and political effects of technology.

I. Making decisions about the use of technology involves weighing the trade-offs between the positive and negative effects. 4.9-12.J Students will develop an understanding of the cultural, social, economic, and political effects of technology.

J. Ethical considerations are important in the development, selection, and use of technologies. 4.9-12.K Students will develop an understanding of the cultural, social, economic, and political effects of technology.

K. The transfer of a technology from one society to another can cause cultural, social, economic, and political changes affecting both societies to varying degrees. 5.9-12.G Students will develop an understanding of the cultural, social, economic, and political effects of technology.

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G. Humans can devise technologies to conserve water, soil, and energy through such techniques as reusing, reducing, and recycling. 5.9-12.H Students will develop an understanding of the cultural, social, economic, and political effects of technology.

H. When new technologies are developed to reduce the use of resources, considerations of trade-offs are important. 5.9-12.I Students will develop an understanding of the cultural, social, economic, and political effects of technology.

I. With the aid of technology, various aspects of the environment can be monitored to provide information for decision-making. 5.9-12.J Students will develop an understanding of the cultural, social, economic, and political effects of technology.

J. The alignment of technological processes with natural processes maximizes performance and reduces negative impacts on the environment. 5.9-12.K Students will develop an understanding of the cultural, social, economic, and political effects of technology.

K. Humans devise technologies to reduce the negative consequences of other technologies. 5.9-12.L Students will develop an understanding of the cultural, social, economic, and political effects of technology.

L. Decisions regarding the implementation of technologies involve the weighing of trade-offs between predicted positive and negative effects on the environment. 6.9-12.H Students will develop an understanding of the role of society in the development and use of technology.

H. Different cultures develop their own technologies to satisfy their individual and shared needs, wants, and values. 6.9-12.I Students will develop an understanding of the role of society in the development and use of technology.

I. The decision whether to develop a technology is influenced by societal opinions and demands, in addition to corporate cultures. 6.9-12.J Students will develop an understanding of the role of society in the development and use of technology.

J. A number of different factors, such as advertising, the strength of the economy, the goals of a company, and the latest fads contribute to shaping the design of and demand for various technologies. 7.9-12.G Students will develop an understanding of the influence of technology on history.

G. Most technological development has been evolutionary, the result of a series of refinements to a basic invention.

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7.9-12.H Students will develop an understanding of the influence of technology on history.

H. The evolution of civilization has been directly affected by, and has in turn affected, the development and use of tools and materials. 7.9-12.I Students will develop an understanding of the influence of technology on history.

I. Throughout history, technology has been a powerful force in reshaping the social, cultural, political, and economic landscape. 7.9-12.J Students will develop an understanding of the influence of technology on history.

J. Early in the history of technology, the development of many tools and machines was based not on scientific knowledge but on technological know-how. 8.9-12.H Students will develop an understanding of the attributes of design.

H. The design process includes defining a problem, brainstorming, researching and generating ideas, identifying criteria and specifying constraints, exploring possibilities, selecting an approach, developing a design proposal, making a model or prototype. 8.9-12.I Students will develop an understanding of the attributes of design.

I. Design problems are seldom presented in a clearly defined form. 8.9-12.J Students will develop an understanding of the attributes of design.

J. The design needs to be continually checked and critiqued, and the ideas of the design must be redefined and improved. 8.9-12.K Students will develop an understanding of the attributes of design.

K. Requirements of a design, such as criteria, constraints, and efficiency, sometimes compete with each other. 9.9-12.I Students will develop an understanding of engineering design.

I. Established design principles are used to evaluate existing designs, to collect data, and to guide the design process. 9.9-12.J Students will develop an understanding of engineering design.

J. Engineering design is influenced by personal characteristics, such as creativity, resourcefulness, and the ability to visualize and think abstractly. 9.9-12.K Students will develop an understanding of engineering design.

K. A prototype is a working model used to test a design concept by making actual observations and necessary adjustments. 9.9-12.L Students will develop an understanding of engineering design.

L. The process of engineering design takes into account a number of factors.

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PLTW Standards and Alignment

10.9-12.I Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.

I. Research and development is a specific problem-solving approach that is used intensively in business and industry to prepare devices and systems for the marketplace. 10.9-12.J Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.

J. Technological problems must be researched before they can be solved. 10.9-12.K Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.

K. Not all problems are technological, and not every problem can be solved using technology. 10.9-12.L Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.

L. Many technological problems require a multidisciplinary approach. 11.9-12.M Students will develop the abilities to apply the design process.

M. Identify the design problem to solve and decide whether or not to address it. 11.9-12.N Students will develop the abilities to apply the design process.

N. Identify criteria and constraints and determine how these will affect the design process. 13.9-12.J Students will develop the abilities to assess the impact of products and systems.

J. Collect information and evaluate its quality. 13.9-12.K Students will develop the abilities to assess the impact of products and systems.

K. Synthesize data, analyze trends, and draw conclusions regarding the effect of technology on the individual, society, and environment. 13.9-12.L Students will develop the abilities to assess the impact of products and systems.

L. Use assessment techniques, such as trend analysis and experimentation, to make decisions about the future development of technology. 17.9-12.N Students will develop an understanding of and be able to select and use information and communication technologies.

N. Information and communication systems can be used to inform, persuade, entertain, control, manage, and educate.

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PLTW Standards and Alignment

17.9-12.P Students will develop an understanding of and be able to select and use information and communication technologies.

P. There are many ways to communicate information, such as graphic and electronic means.
17.9-12.Q Students will develop an understanding of and be able to select and use information and communication technologies.

Q. Technological knowledge and processes are communicated using symbols,measurement, conventions, icons, graphic images, and languages that incorporate a variety of visual, auditory, and tactile stimuli.

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PLTW Standards and Alignment

Engineering Design and Development (EDD)

Standards for Technological Literacy

Component 2

1.9-12.J Students will develop an understanding of the characteristics and scope of technology.

J. The nature and development of technological knowledge and processes are functions of the setting. 1.9-12.L Students will develop an understanding of the characteristics and scope of technology.

L. Inventions and innovations are the results of the specific, goal-directed research.

1.9-12.M Students will develop an understanding of the characteristics and scope of technology.

M. Most development of technologies these days is driven by the profit motive and the market. 2.9-12.W Students will develop an understanding of the core concepts of technology.

W. Systems thinking applies logic and creativity with appropriate compromises in complex real-life problems. 2.9-12.X Students will develop an understanding of the core concepts of technology.

X. Systems, which are the building blocks of technology, are embedded within larger technological, social, and environmental systems. 2.9-12.Y Students will develop an understanding of the core concepts of technology.

Y. The stability of a technological system is influenced by all of the components in the system, especially those in the feedback loop. 2.9-12.Z Students will develop an understanding of the core concepts of technology. Z. Selecting resources involves trade-offs between competing values, such as availability, cost, desirability, and waste. 2.9-12.AA Students will develop an understanding of the core concepts of technology. AA. Requirements involve the identification of the criteria and constraints of a product or system and the determination of how they affect the final design and development. 2.9-12.BB Students will develop an understanding of the core concepts of technology.

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PLTW Standards and Alignment

BB. Optimization is an ongoing process or methodology of designing or making a product and is dependent on criteria and constraints. 2.9-12.CC Students will develop an understanding of the core concepts of technology.

CC. New technologies create new processes. 2.9-12.EE Students will develop an understanding of the core concepts of technology. EE. Management is the process of planning, organizing, and controlling work. 2.9-12.FF Students will develop an understanding of the core concepts of technology.

FF. Complex systems have many layers of controls and feedback loops to provide information. 3.9-12.G Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.

G. Technology transfer occurs when a new user applies an existing innovation developed for one purpose in a different function. 3.9-12.H Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.

H. Technological innovation often results when ideas, knowledge, or skills are shared within a technology, among technologies, or across other fields. 3.9-12.I Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.

I. Technological ideas are sometimes protected through the process of patenting. 3.9-12.J Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.

J. Technological progress promotes the advancement of science and mathematics. 4.9-12.I Students will develop an understanding of the cultural, social, economic, and political effects of technology.

I. Making decisions about the use of technology involves weighing the trade-offs between the positive and negative effects. 4.9-12.J Students will develop an understanding of the cultural, social, economic, and political effects of technology.

J. Ethical considerations are important in the development, selection, and use of technologies. 4.9-12.K Students will develop an understanding of the cultural, social, economic, and political effects of technology.

K. The transfer of a technology from one society to another can cause cultural, social,economic, and political changes affecting both societies to varying degrees. 5.9-12.G Students will develop an understanding of the cultural, social, economic, and political effects of technology.

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G. Humans can devise technologies to conserve water, soil, and energy through such techniques as reusing, reducing, and recycling. 5.9-12.H Students will develop an understanding of the cultural, social, economic, and political effects of technology.

H. When new technologies are developed to reduce the use of resources, considerations of trade-offs are important. 5.9-12.I Students will develop an understanding of the cultural, social, economic, and political effects of technology.

I. With the aid of technology, various aspects of the environment can be monitored to provide information for decision-making. 5.9-12.J Students will develop an understanding of the cultural, social, economic, and political effects of technology.

J. The alignment of technological processes with natural processes maximizes performance and reduces negative impacts on the environment. 5.9-12.K Students will develop an understanding of the cultural, social, economic, and political effects of technology.

K. Humans devise technologies to reduce the negative consequences of other technologies. 5.9-12.L Students will develop an understanding of the cultural, social, economic, and political effects of technology.

L. Decisions regarding the implementation of technologies involve the weighing of trade-offs between predicted positive and negative effects on the environment. 6.9-12.I Students will develop an understanding of the role of society in the development and use of technology.

I. The decision whether to develop a technology is influenced by societal opinions and demands, in addition to corporate cultures. 6.9-12.J Students will develop an understanding of the role of society in the development and use of technology.

J. A number of different factors, such as advertising, the strength of the economy, the goals of a company, and the latest fads contribute to shaping the design of and demand for various technologies. 7.9-12.G Students will develop an understanding of the influence of technology on history.

G. Most technological development has been evolutionary, the result of a series of refinements to a basic invention. 7.9-12.H Students will develop an understanding of the influence of technology on history.

H. The evolution of civilization has been directly affected by, and has in turn affected, the development and use of tools and materials.

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PLTW Standards and Alignment

8.9-12.H Students will develop an understanding of the attributes of design.

H. The design process includes defining a problem, brainstorming, researching and generating ideas, identifying criteria and specifying constraints, exploring possibilities, selecting an approach, developing a design proposal, making a model or prototype. 8.9-12.I Students will develop an understanding of the attributes of design.

I. Design problems are seldom presented in a clearly defined form. 8.9-12.J Students will develop an understanding of the attributes of design.

J. The design needs to be continually checked and critiqued, and the ideas of the design must be redefined and improved. 8.9-12.K Students will develop an understanding of the attributes of design.

K. Requirements of a design, such as criteria, constraints, and efficiency, sometimes compete with each other. 9.9-12.I Students will develop an understanding of engineering design.

I. Established design principles are used to evaluate existing designs, to collect data, and to guide the design process. 9.9-12.J Students will develop an understanding of engineering design.

J. Engineering design is influenced by personal characteristics, such as creativity, resourcefulness, and the ability to visualize and think abstractly. 9.9-12.K Students will develop an understanding of engineering design.

K. A prototype is a working model used to test a design concept by making actual observations and necessary adjustments. 9.9-12.L Students will develop an understanding of engineering design.

L. The process of engineering design takes into account a number of factors. 10.9-12.I Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.

I. Research and development is a specific problem-solving approach that is used intensively in business and industry to prepare devices and systems for the marketplace. 10.9-12.J Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.

J. Technological problems must be researched before they can be solved. 10.9-12.K Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.

K. Not all problems are technological, and not every problem can be solved using technology.

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10.9-12.L Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.

L. Many technological problems require a multidisciplinary approach. 11.9-12.M Students will develop the abilities to apply the design process.

M. Identify the design problem to solve and decide whether or not to address it. 11.9-12.N Students will develop the abilities to apply the design process.

N. Identify criteria and constraints and determine how these will affect the design process. 11.9-12.O Students will develop the abilities to apply the design process.

O. Refine a design by using prototypes and modeling to ensure quality, efficiency, and productivity of the final product. 11.9-12.P Students will develop the abilities to apply the design process.

P. Evaluate the design solution using conceptual, physical, and mathematical models at various intervals of the design process in order to check for proper design and to note areas where improvements are needed. 11.9-12.Q Students will develop the abilities to apply the design process.

Q. Develop and produce a product or system using a design process. 11.9-12.R Students will develop the abilities to apply the design process.

R. Evaluate final solutions and communicate observation, processes, and results of the entire design process, using verbal, graphic, quantitative, virtual, and written means, in addition to three-dimensional models. 12.9-12.L Students will develop the abilities to use and maintain technological products and systems.

L. Document processes and procedures and communicate them to different audiences using appropriate oral and written techniques. 12.9-12.M Students will develop the abilities to use and maintain technological products and systems.

M. Diagnose a system that is malfunctioning and use tools, materials, machines, and knowledge to repair it. 12.9-12.N Students will develop the abilities to use and maintain technological products and systems.

N. Troubleshoot, analyze, and maintain systems to ensure safe and proper function and precision. 12.9-12.O Students will develop the abilities to use and maintain technological products and systems.

O. Operate systems so that they function in the way they were designed.

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PLTW Standards and Alignment

12.9-12.P Students will develop the abilities to use and maintain technological products and systems.

P. Use computers and calculators to access, retrieve, organize, process, maintain, interpret, and evaluate data and information in order to communicate. 13.9-12.J Students will develop the abilities to assess the impact of products and systems.

J. Collect information and evaluate its quality. 13.9-12.K Students will develop the abilities to assess the impact of products and systems.

K. Synthesize data, analyze trends, and draw conclusions regarding the effect of technology on the individual, society, and environment. 13.9-12.L Students will develop the abilities to assess the impact of products and systems.

L. Use assessment techniques, such as trend analysis and experimentation, to make decisions about the future development of technology. 13.9-12.M Students will develop the abilities to assess the impact of products and systems.

M. Design forecasting techniques to evaluate the results of altering natural systems. 16.9-12.J Students will develop an understanding of and be able to select and use energy and power technologies.

J. Energy cannot be created nor destroyed; however, it can be converted from one form to another. 16.9-12.K Students will develop an understanding of and be able to select and use energy and power technologies.

K. Energy can be grouped into major forms: thermal, radiant, electrical, mechanical, chemical, nuclear, and others. 16.9-12.L Students will develop an understanding of and be able to select and use energy and power technologies.

L. It is impossible to build an engine to perform work that does not exhaust thermal energy to the surroundings. 16.9-12.M Students will develop an understanding of and be able to select and use energy and power technologies.

M. Energy resources can be renewable or nonrenewable. 16.9-12.N Students will develop an understanding of and be able to select and use energy and power technologies.

N. Power systems must have a source of energy, a process, and loads.

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PLTW Standards and Alignment

19.6-8.F Students will develop an understanding of and be able to select and use manufacturing technologies.

F. Manufacturing systems use mechanical processes that change the form of materials through the processes of separating, forming, combining, and conditioning them.

19.6-8.G Students will develop an understanding of and be able to select and use manufacturing technologies.

G. Manufactured goods may be classified as durable and non-durable. 19.9-12.L Students will develop an understanding of and be able to select and use manufacturing technologies.

L. Servicing keeps products in good operating condition. 20.9-12.J Students will develop an understanding of and be able to select and use construction technologies.

J. Infrastructure is the underlying base or basic framework of a system. 20.9-12.K Students will develop an understanding of and be able to select and use construction technologies.

K. Structures are constructed using a variety of processes and procedures. 20.9-12.L Students will develop an understanding of and be able to select and use construction technologies.

L. The design of structures includes a number of requirements. 20.9-12.M Students will develop an understanding of and be able to select and use construction technologies.

M. Structures require maintenance, alteration, or renovation periodically to improve them or to alter their intended use. 20.9-12.N Students will develop an understanding of and be able to select and use construction technologies.

N. Structures can include prefabricated materials.

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PLTW Standards and Alignment

Engineering Design and Development (EDD)

Standards for Technological Literacy

Component 3

2.9-12.W Students will develop an understanding of the core concepts of technology.

W. Systems thinking applies logic and creativity with appropriate compromises in complex real-life problems. 2.9-12.X Students will develop an understanding of the core concepts of technology.

X. Systems, which are the building blocks of technology, are embedded within larger technological, social, and environmental systems. 2.9-12.Y Students will develop an understanding of the core concepts of technology.

Y. The stability of a technological system is influenced by all of the components in the system, especially those in the feedback loop. 2.9-12.Z Students will develop an understanding of the core concepts of technology. Z. Selecting resources involves trade-offs between competing values, such as availability, cost, desirability, and waste. 2.9-12.AA Students will develop an understanding of the core concepts of technology. AA. Requirements involve the identification of the criteria and constraints of a product or system and the determination of how they affect the final design and development. 2.9-12.BB Students will develop an understanding of the core concepts of technology.

BB. Optimization is an ongoing process or methodology of designing or making a product and is dependent on criteria and constraints. 2.9-12.CC Students will develop an understanding of the core concepts of technology.

CC. New technologies create new processes. 2.9-12.DD Students will develop an understanding of the core concepts of technology.

DD. Quality control is a planned process to ensure that a product, service, or system meets established criteria. 2.9-12.EE Students will develop an understanding of the core concepts of technology. EE. Management is the process of planning, organizing, and controlling work. 2.9-12.FF Students will develop an understanding of the core concepts of technology.

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PLTW Standards and Alignment

FF. Complex systems have many layers of controls and feedback loops to provide information. 4.9-12.J Students will develop an understanding of the cultural, social, economic, and political effects of technology.

J. Ethical considerations are important in the development, selection, and use of technologies. 5.9-12.H Students will develop an understanding of the cultural, social, economic, and political effects of technology.

H. When new technologies are developed to reduce the use of resources, considerations of trade-offs are important. 5.9-12.K Students will develop an understanding of the cultural, social, economic, and political effects of technology.

K. Humans devise technologies to reduce the negative consequences of other technologies. 5.9-12.L Students will develop an understanding of the cultural, social, economic, and political effects of technology.

L. Decisions regarding the implementation of technologies involve the weighing of trade-offs between predicted positive and negative effects on the environment. 6.9-12.H Students will develop an understanding of the role of society in the development and use of technology.

H. Different cultures develop their own technologies to satisfy their individual and shared needs, wants, and values. 6.9-12.I Students will develop an understanding of the role of society in the development and use of technology.

I. The decision whether to develop a technology is influenced by societal opinions and demands, in addition to corporate cultures. 6.9-12.J Students will develop an understanding of the role of society in the development and use of technology.

J. A number of different factors, such as advertising, the strength of the economy, the goals of a company, and the latest fads contribute to shaping the design of and demand for various technologies. 8.9-12.H Students will develop an understanding of the attributes of design.

H. The design process includes defining a problem, brainstorming, researching and generating ideas, identifying criteria and specifying constraints, exploring possibilities, selecting an approach, developing a design proposal, making a model or prototype. 8.9-12.I Students will develop an understanding of the attributes of design.

I. Design problems are seldom presented in a clearly defined form. 8.9-12.J Students will develop an understanding of the attributes of design.

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PLTW Standards and Alignment

J. The design needs to be continually checked and critiqued, and the ideas of the design must be redefined and improved. 8.9-12.K Students will develop an understanding of the attributes of design.

K. Requirements of a design, such as criteria, constraints, and efficiency, sometimes compete with each other. 9.9-12.I Students will develop an understanding of engineering design.

I. Established design principles are used to evaluate existing designs, to collect data, and to guide the design process. 9.9-12.J Students will develop an understanding of engineering design.

J. Engineering design is influenced by personal characteristics, such as creativity, resourcefulness, and the ability to visualize and think abstractly. 9.9-12.K Students will develop an understanding of engineering design.

K. A prototype is a working model used to test a design concept by making actual observations and necessary adjustments. 9.9-12.L Students will develop an understanding of engineering design.

L. The process of engineering design takes into account a number of factors. 10.9-12.I Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.

I. Research and development is a specific problem-solving approach that is used intensively in business and industry to prepare devices and systems for the marketplace. 10.9-12.J Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.

J. Technological problems must be researched before they can be solved. 10.9-12.K Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.

K. Not all problems are technological, and not every problem can be solved using technology. 10.9-12.L Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.

L. Many technological problems require a multidisciplinary approach. 11.9-12.P Students will develop the abilities to apply the design process.

P. Evaluate the design solution using conceptual, physical, and mathematical models at various intervals of the design process in order to check for proper design and to note areas where improvements are needed.

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PLTW Standards and Alignment

11.9-12.Q Students will develop the abilities to apply the design process.

Q. Develop and produce a product or system using a design process. 11.9-12.R Students will develop the abilities to apply the design process.

R. Evaluate final solutions and communicate observation, processes, and results of the entire design process, using verbal, graphic, quantitative, virtual, and written means, in addition to three-dimensional models. 12.9-12.L Students will develop the abilities to use and maintain technological products and systems.

L. Document processes and procedures and communicate them to different audiences using appropriate oral and written techniques. 12.9-12.M Students will develop the abilities to use and maintain technological products and systems.

M. Diagnose a system that is malfunctioning and use tools, materials, machines, and knowledge to repair it. 12.9-12.N Students will develop the abilities to use and maintain technological products and systems.

N. Troubleshoot, analyze, and maintain systems to ensure safe and proper function and precision. 12.9-12.O Students will develop the abilities to use and maintain technological products and systems.

O. Operate systems so that they function in the way they were designed. 12.9-12.P Students will develop the abilities to use and maintain technological products and systems.

P. Use computers and calculators to access, retrieve, organize, process, maintain, interpret, and evaluate data and information in order to communicate. 13.9-12.J Students will develop the abilities to assess the impact of products and systems.

J. Collect information and evaluate its quality. 13.9-12.K Students will develop the abilities to assess the impact of products and systems.

K. Synthesize data, analyze trends, and draw conclusions regarding the effect of technology on the individual, society, and environment. 13.9-12.L Students will develop the abilities to assess the impact of products and systems.

L. Use assessment techniques, such as trend analysis and experimentation, to make decisions about the future development of technology. 13.9-12.M Students will develop the abilities to assess the impact of products and systems.

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PLTW Standards and Alignment

M. Design forecasting techniques to evaluate the results of altering natural systems. 16.9-12.J Students will develop an understanding of and be able to select and use energy and power technologies.

J. Energy cannot be created nor destroyed; however, it can be converted from one form to another. 16.9-12.K Students will develop an understanding of and be able to select and use energy and power technologies.

K. Energy can be grouped into major forms: thermal, radiant, electrical, mechanical, chemical, nuclear, and others. 16.9-12.L Students will develop an understanding of and be able to select and use energy and power technologies.

L. It is impossible to build an engine to perform work that does not exhaust thermal energy to the surroundings. 16.9-12.M Students will develop an understanding of and be able to select and use energy and power technologies.

M. Energy resources can be renewable or nonrenewable. 16.9-12.N Students will develop an understanding of and be able to select and use energy and power technologies.

N. Power systems must have a source of energy, a process, and loads. 17.9-12.M Students will develop an understanding of and be able to select and use information and communication technologies.

M. Information and communication systems allow information to be transferred from human to human, human to machine, machine to human, and machine to machine. 17.9-12.P Students will develop an understanding of and be able to select and use information and communication technologies.

P. There are many ways to communicate information, such as graphic and electronic means. 19.9-12.P Students will develop an understanding of and be able to select and use manufacturing technologies.

P. The interchangeability of parts increases the effectiveness of manufacturing processes. 20.9-12.J Students will develop an understanding of and be able to select and use construction technologies.

J. Infrastructure is the underlying base or basic framework of a system. 20.9-12.K Students will develop an understanding of and be able to select and use construction technologies.

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PLTW Standards and Alignment

K. Structures are constructed using a variety of processes and procedures. 20.9-12.L Students will develop an understanding of and be able to select and use construction technologies.

L. The design of structures includes a number of requirements. 20.9-12.M Students will develop an understanding of and be able to select and use construction technologies.

M. Structures require maintenance, alteration, or renovation periodically to improve them or to alter their intended use. 20.9-12.N Students will develop an understanding of and be able to select and use construction technologies.

N. Structures can include prefabricated materials.

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PLTW Standards and Alignment

Engineering Design and Development (EDD)

Standards for Technological Literacy

Component 4

1.9-12.J Students will develop an understanding of the characteristics and scope of technology.

J. The nature and development of technological knowledge and processes are functions of the setting. 1.9-12.K Students will develop an understanding of the characteristics and scope of technology.

K. The rate of technological development and diffusion is increasing rapidly. 1.9-12.L Students will develop an understanding of the characteristics and scope of technology.

L. Inventions and innovations are the results of the specific, goal-directed research. 1.9-12.M Students will develop an understanding of the characteristics and scope of technology.

M. Most development of technologies these days is driven by the profit motive and the market. 2.9-12.W Students will develop an understanding of the core concepts of technology.

W. Systems thinking applies logic and creativity with appropriate compromises in complex real-life problems. 2.9-12.X Students will develop an understanding of the core concepts of technology.

X. Systems, which are the building blocks of technology, are embedded within larger technological, social, and environmental systems. 2.9-12.Y Students will develop an understanding of the core concepts of technology.

Y. The stability of a technological system is influenced by all of the components in the system, especially those in the feedback loop. 2.9-12.Z Students will develop an understanding of the core concepts of technology. Z. Selecting resources involves trade-offs between competing values, such as availability, cost, desirability, and waste. 2.9-12.AA Students will develop an understanding of the core concepts of technology.

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PLTW Standards and Alignment

AA. Requirements involve the identification of the criteria and constraints of a product or system and the determination of how they affect the final design and development. 2.9-12.BB Students will develop an understanding of the core concepts of technology.

BB. Optimization is an ongoing process or methodology of designing or making a product and is dependent on criteria and constraints. 2.9-12.CC Students will develop an understanding of the core concepts of technology.

CC. New technologies create new processes. 2.9-12.DD Students will develop an understanding of the core concepts of technology.

DD. Quality control is a planned process to ensure that a product, service, or system meets established criteria. 2.9-12.EE Students will develop an understanding of the core concepts of technology. EE. Management is the process of planning, organizing, and controlling work. 2.9-12.FF Students will develop an understanding of the core concepts of technology.

FF. Complex systems have many layers of controls and feedback loops to provide information. 3.9-12.G Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.

G. Technology transfer occurs when a new user applies an existing innovation developed for one purpose in a different function. 3.9-12.H Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.

H. Technological innovation often results when ideas, knowledge, or skills are shared within a technology, among technologies, or across other fields. 3.9-12.I Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.

I. Technological ideas are sometimes protected through the process of patenting. 3.9-12.J Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.

J. Technological progress promotes the advancement of science and mathematics. 4.9-12.H Students will develop an understanding of the cultural, social, economic, and political effects of technology.

H. Changes caused by the use of technology can range from gradual to rapid and from subtle to obvious. 4.9-12.I Students will develop an understanding of the cultural, social, economic, and political effects of technology.

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PLTW Standards and Alignment

I. Making decisions about the use of technology involves weighing the trade-offs between the positive and negative effects. 4.9-12.J Students will develop an understanding of the cultural, social, economic, and political effects of technology.

J. Ethical considerations are important in the development, selection, and use of technologies. 4.9-12.K Students will develop an understanding of the cultural, social, economic, and political effects of technology.

K. The transfer of a technology from one society to another can cause cultural, social, economic, and political changes affecting both societies to varying degrees. 5.9-12.G Students will develop an understanding of the cultural, social, economic, and political effects of technology.

G. Humans can devise technologies to conserve water, soil, and energy through such techniques as reusing, reducing, and recycling. 5.9-12.H Students will develop an understanding of the cultural, social, economic, and political effects of technology.

H. When new technologies are developed to reduce the use of resources, considerations of trade-offs are important. 5.9-12.I Students will develop an understanding of the cultural, social, economic, and political effects of technology.

I. With the aid of technology, various aspects of the environment can be monitored to provide information for decision-making. 5.9-12.J Students will develop an understanding of the cultural, social, economic, and political effects of technology.

J. The alignment of technological processes with natural processes maximizes performance and reduces negative impacts on the environment. 5.9-12.K Students will develop an understanding of the cultural, social, economic, and political effects of technology.

K. Humans devise technologies to reduce the negative consequences of other technologies. 5.9-12.L Students will develop an understanding of the cultural, social, economic, and political effects of technology.

L. Decisions regarding the implementation of technologies involve the weighing of trade-offs between predicted positive and negative effects on the environment. 6.9-12.H Students will develop an understanding of the role of society in the development and use of technology.

H. Different cultures develop their own technologies to satisfy their individual and shared needs, wants, and values.

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PLTW Standards and Alignment

6.9-12.I Students will develop an understanding of the role of society in the development and use of technology.

I. The decision whether to develop a technology is influenced by societal opinions and demands, in addition to corporate cultures. 6.9-12.J Students will develop an understanding of the role of society in the development and use of technology.

J. A number of different factors, such as advertising, the strength of the economy, the goals of a company, and the latest fads contribute to shaping the design of and demand for various technologies. 7.9-12.G Students will develop an understanding of the influence of technology on history.

G. Most technological development has been evolutionary, the result of a series of refinements to a basic invention. 7.9-12.H Students will develop an understanding of the influence of technology on history.

H. The evolution of civilization has been directly affected by, and has in turn affected, the development and use of tools and materials. 7.9-12.I Students will develop an understanding of the influence of technology on history.

I. Throughout history, technology has been a powerful force in reshaping the social, cultural, political, and economic landscape. 8.9-12.H Students will develop an understanding of the attributes of design.

H. The design process includes defining a problem, brainstorming, researching and generating ideas, identifying criteria and specifying constraints, exploring possibilities, selecting an approach, developing a design proposal, making a model or prototype. 8.9-12.I Students will develop an understanding of the attributes of design.

I. Design problems are seldom presented in a clearly defined form. 8.9-12.J Students will develop an understanding of the attributes of design.

J. The design needs to be continually checked and critiqued, and the ideas of the design must be redefined and improved. 8.9-12.K Students will develop an understanding of the attributes of design.

K. Requirements of a design, such as criteria, constraints, and efficiency, sometimes compete with each other. 9.9-12.I Students will develop an understanding of engineering design.

I. Established design principles are used to evaluate existing designs, to collect data, and to guide the design process.

9.9-12.J Students will develop an understanding of engineering design.

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PLTW Standards and Alignment

J. Engineering design is influenced by personal characteristics, such as creativity, resourcefulness, and the ability to visualize and think abstractly. 9.9-12.K Students will develop an understanding of engineering design.

K. A prototype is a working model used to test a design concept by making actual observations and necessary adjustments. 9.9-12.L Students will develop an understanding of engineering design.

L. The process of engineering design takes into account a number of factors. 10.9-12.I Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.

I. Research and development is a specific problem-solving approach that is used intensively in business and industry to prepare devices and systems for the marketplace. 10.9-12.J Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.

J. Technological problems must be researched before they can be solved. 10.9-12.K Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.

K. Not all problems are technological, and not every problem can be solved using technology. 10.9-12.L Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.

L. Many technological problems require a multidisciplinary approach. 11.9-12.M Students will develop the abilities to apply the design process.

M. Identify the design problem to solve and decide whether or not to address it. 11.9-12.N Students will develop the abilities to apply the design process.

N. Identify criteria and constraints and determine how these will affect the design process. 11.9-12.O Students will develop the abilities to apply the design process.

O. Refine a design by using prototypes and modeling to ensure quality, efficiency, and productivity of the final product. 11.9-12.P Students will develop the abilities to apply the design process.

P. Evaluate the design solution using conceptual, physical, and mathematical models at various intervals of the design process in order to check for proper design and to note areas where improvements are needed.

11.9-12.Q Students will develop the abilities to apply the design process.

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PLTW Standards and Alignment

Q. Develop and produce a product or system using a design process. 11.9-12.R Students will develop the abilities to apply the design process.

R. Evaluate final solutions and communicate observation, processes, and results of the entire design process, using verbal, graphic, quantitative, virtual, and written means, in addition to three-dimensional models. 12.9-12.L Students will develop the abilities to use and maintain technological products and systems.

L. Document processes and procedures and communicate them to different audiences using appropriate oral and written techniques. 12.9-12.M Students will develop the abilities to use and maintain technological products and systems.

M. Diagnose a system that is malfunctioning and use tools, materials, machines, and knowledge to repair it. 12.9-12.N Students will develop the abilities to use and maintain technological products and systems.

N. Troubleshoot, analyze, and maintain systems to ensure safe and proper function and precision. 12.9-12.O Students will develop the abilities to use and maintain technological products and systems.

O. Operate systems so that they function in the way they were designed. 12.9-12.P Students will develop the abilities to use and maintain technological products and systems.

P. Use computers and calculators to access, retrieve, organize, process, maintain, interpret, and evaluate data and information in order to communicate. 13.9-12.J Students will develop the abilities to assess the impact of products and systems.

J. Collect information and evaluate its quality. 13.9-12.K Students will develop the abilities to assess the impact of products and systems.

K. Synthesize data, analyze trends, and draw conclusions regarding the effect of technology on the individual, society, and environment. 13.9-12.L Students will develop the abilities to assess the impact of products and systems.

L. Use assessment techniques, such as trend analysis and experimentation, to make decisions about the future development of technology. 13.9-12.M Students will develop the abilities to assess the impact of products and systems.

M. Design forecasting techniques to evaluate the results of altering natural systems.

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PLTW Standards and Alignment

17.9-12.N Students will develop an understanding of and be able to select and use information and communication technologies.

N. Information and communication systems can be used to inform, persuade, entertain, control, manage, and educate. 17.9-12.P Students will develop an understanding of and be able to select and use information and communication technologies.

P. There are many ways to communicate information, such as graphic and electronic means. 19.9-12.P Students will develop an understanding of and be able to select and use manufacturing technologies.

P. The interchangeability of parts increases the effectiveness of manufacturing processes. 19.9-12.Q Students will develop an understanding of and be able to select and use manufacturing technologies.

Q. Chemical technologies provide a means for humans to alter or modify materials and to produce chemical products. 19.9-12.R Students will develop an understanding of and be able to select and use manufacturing technologies.

R. Marketing involves establishing a product's identity, conducting research on its potential, advertising it, distributing it, and selling it. 20.9-12.K Students will develop an understanding of and be able to select and use construction technologies.

K. Structures are constructed using a variety of processes and procedures. 20.9-12.L Students will develop an understanding of and be able to select and use construction technologies.

L. The design of structures includes a number of requirements. 20.9-12.M Students will develop an understanding of and be able to select and use construction technologies.

M. Structures require maintenance, alteration, or renovation periodically to improve them or to alter their intended use. 20.9-12.N Students will develop an understanding of and be able to select and use construction technologies.

N. Structures can include prefabricated materials.

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PLTW Standards and Alignment

Engineering Design and Development (EDD)

Standards for Technological Literacy

Component 5

1.9-12.L Students will develop an understanding of the characteristics and scope of technology.

L. Inventions and innovations are the results of the specific, goal-directed research.

1.9-12.M Students will develop an understanding of the characteristics and scope of technology.

M. Most development of technologies these days is driven by the profit motive and the market. 2.9-12.W Students will develop an understanding of the core concepts of technology.

W. Systems thinking applies logic and creativity with appropriate compromises in complex real-life problems. 2.9-12.Z Students will develop an understanding of the core concepts of technology. Z. Selecting resources involves trade-offs between competing values, such as availability, cost, desirability, and waste. 2.9-12.AA Students will develop an understanding of the core concepts of technology. AA. Requirements involve the identification of the criteria and constraints of a product or system and the determination of how they affect the final design and development. 2.9-12.BB Students will develop an understanding of the core concepts of technology.

BB. Optimization is an ongoing process or methodology of designing or making a product and is dependent on criteria and constraints. 2.9-12.EE Students will develop an understanding of the core concepts of technology. EE. Management is the process of planning, organizing, and controlling work. 3.9-12.H Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.

H. Technological innovation often results when ideas, knowledge, or skills are shared within a technology, among technologies, or across other fields. 3.9-12.I Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.

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PLTW Standards and Alignment

I. Technological ideas are sometimes protected through the process of patenting. 3.9-12.J Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.

J. Technological progress promotes the advancement of science and mathematics. 4.9-12.I Students will develop an understanding of the cultural, social, economic, and political effects of technology.

I. Making decisions about the use of technology involves weighing the trade-offs between the positive and negative effects. 4.9-12.J Students will develop an understanding of the cultural, social, economic, and political effects of technology.

J. Ethical considerations are important in the development, selection, and use of technologies. 4.9-12.K Students will develop an understanding of the cultural, social, economic, and political effects of technology.

K. The transfer of a technology from one society to another can cause cultural, social, economic, and political changes affecting both societies to varying degrees.

5.9-12.L Students will develop an understanding of the cultural, social, economic, and political effects of technology.

L. Decisions regarding the implementation of technologies involve the weighing of trade-offs between predicted positive and negative effects on the environment. 6.9-12.I Students will develop an understanding of the role of society in the development and use of technology.

I. The decision whether to develop a technology is influenced by societal opinions and demands, in addition to corporate cultures. 6.9-12.J Students will develop an understanding of the role of society in the development and use of technology.

J. A number of different factors, such as advertising, the strength of the economy, the goals of a company, and the latest fads contribute to shaping the design of and demand for various technologies. 7.9-12.G Students will develop an understanding of the influence of technology on history.

G. Most technological development has been evolutionary, the result of a series of refinements to a basic invention. 7.9-12.I Students will develop an understanding of the influence of technology on history.

I. Throughout history, technology has been a powerful force in reshaping the social, cultural, political, and economic landscape. 8.9-12.H Students will develop an understanding of the attributes of design.

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H. The design process includes defining a problem, brainstorming, researching and generating ideas, identifying criteria and specifying constraints, exploring possibilities, selecting an approach, developing a design proposal, making a model or prototype. 8.9-12.I Students will develop an understanding of the attributes of design.

I. Design problems are seldom presented in a clearly defined form. 8.9-12.J Students will develop an understanding of the attributes of design.

J. The design needs to be continually checked and critiqued, and the ideas of the design must be redefined and improved. 8.9-12.K Students will develop an understanding of the attributes of design.

K. Requirements of a design, such as criteria, constraints, and efficiency, sometimes compete with each other. 9.9-12.I Students will develop an understanding of engineering design.

I. Established design principles are used to evaluate existing designs, to collect data, and to guide the design process. 9.9-12.J Students will develop an understanding of engineering design.

J. Engineering design is influenced by personal characteristics, such as creativity, resourcefulness, and the ability to visualize and think abstractly. 9.9-12.K Students will develop an understanding of engineering design.

K. A prototype is a working model used to test a design concept by making actual observations and necessary adjustments. 9.9-12.L Students will develop an understanding of engineering design.

L. The process of engineering design takes into account a number of factors. 10.9-12.I Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.

I. Research and development is a specific problem-solving approach that is used intensively in business and industry to prepare devices and systems for the marketplace. 10.9-12.J Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.

J. Technological problems must be researched before they can be solved. 10.9-12.K Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.

K. Not all problems are technological, and not every problem can be solved using technology.

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10.9-12.L Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.

L. Many technological problems require a multidisciplinary approach. 11.9-12.M Students will develop the abilities to apply the design process.

M. Identify the design problem to solve and decide whether or not to address it. 11.9-12.N Students will develop the abilities to apply the design process.

N. Identify criteria and constraints and determine how these will affect the design process. 11.9-12.O Students will develop the abilities to apply the design process.

O. Refine a design by using prototypes and modeling to ensure quality, efficiency, and productivity of the final product. 11.9-12.P Students will develop the abilities to apply the design process.

P. Evaluate the design solution using conceptual, physical, and mathematical models at various intervals of the design process in order to check for proper design and to note areas where improvements are needed. 11.9-12.Q Students will develop the abilities to apply the design process.

Q. Develop and produce a product or system using a design process. 11.9-12.R Students will develop the abilities to apply the design process.

R. Evaluate final solutions and communicate observation, processes, and results of the entire design process, using verbal, graphic, quantitative, virtual, and written means, in addition to three-dimensional models. 12.9-12.L Students will develop the abilities to use and maintain technological products and systems.

L. Document processes and procedures and communicate them to different audiences using appropriate oral and written techniques. 12.9-12.M Students will develop the abilities to use and maintain technological products and systems.

M. Diagnose a system that is malfunctioning and use tools, materials, machines, and knowledge to repair it. 12.9-12.N Students will develop the abilities to use and maintain technological products and systems.

N. Troubleshoot, analyze, and maintain systems to ensure safe and proper function and precision. 12.9-12.O Students will develop the abilities to use and maintain technological products and systems.

O. Operate systems so that they function in the way they were designed.

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12.9-12.P Students will develop the abilities to use and maintain technological products and systems.

P. Use computers and calculators to access, retrieve, organize, process, maintain, interpret, and evaluate data and information in order to communicate. 13.9-12.J Students will develop the abilities to assess the impact of products and systems.

J. Collect information and evaluate its quality. 13.9-12.K Students will develop the abilities to assess the impact of products and systems.

K. Synthesize data, analyze trends, and draw conclusions regarding the effect of technology on the individual, society, and environment. 13.9-12.L Students will develop the abilities to assess the impact of products and systems.

L. Use assessment techniques, such as trend analysis and experimentation, to make decisions about the future development of technology. 13.9-12.M Students will develop the abilities to assess the impact of products and systems.

M. Design forecasting techniques to evaluate the results of altering natural systems. 17.9-12.N Students will develop an understanding of and be able to select and use information and communication technologies.

N. Information and communication systems can be used to inform, persuade, entertain, control, manage, and educate. 17.9-12.P Students will develop an understanding of and be able to select and use information and communication technologies.

P. There are many ways to communicate information, such as graphic and electronic means. 20.9-12.J Students will develop an understanding of and be able to select and use construction technologies.

J. Infrastructure is the underlying base or basic framework of a system. 20.9-12.K Students will develop an understanding of and be able to select and use construction technologies.

K. Structures are constructed using a variety of processes and procedures. 20.9-12.L Students will develop an understanding of and be able to select and use construction technologies.

L. The design of structures includes a number of requirements. 20.9-12.M Students will develop an understanding of and be able to select and use construction technologies.

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M. Structures require maintenance, alteration, or renovation periodically to improve them or to alter their intended use. 20.9-12.N Students will develop an understanding of and be able to select and use construction technologies.

N. Structures can include prefabricated materials.

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Exhibit B

Course Outline:

Unit 1: Product #1.

- Students use needfinding skills learned in Product Design 1 to identify a product that can be prototyped and tested within **five (5) weeks**.
- Students create a plan to deliver their product on schedule.
- Students identify experts to help identify and solve challenges associated with their design. For example, students designing a product that requires computer control of high current motors will work with their experts to design a functional circuit for a specified motor.
- Working with the instructor, students will build learning or mastering skills into their product plan. This includes everything from video tutorials to online courses from sources such as EdX, coursera, MIT open course and others.
- Students meet regularly to compare progress against plan and techniques to bring over budget and late projects back into plan.
- Students create a final product pitch that incorporates aesthetic presentation, clear written and spoken communications and market analysis.

Unit 2: Product #2.

- Students use needfinding skills learned in Product Design 1 to identify a product that can be prototyped and tested within **eight (8) weeks**.
- Students follow the same process as unit 1 except that it is 60% longer.

At end of Unit , Students will produce or be able to:

- Define tasks and milestones for a relative short-term project.
- More masterfully use tools depending on their individual projects. This can include programming, woodworking, welding, 3D printing, laser cutting, CAD (computer aided design), CAM computer aided manufacturing, electronics and other necessary for the design of the prototype.

Unit 3: Product #3.

- Students use needfinding skills learned in Product Design 1 to identify a product that can be prototyped and tested within **twenty-one (21) weeks**.
- Students follow the same process as unit 1 except that it is significantly longer and requires great management and skills to produce a relatively complex product prototype.

At end of Unit, Students will produce or be able to:

- Define tasks and milestones for a relative **long-term** project.
- More masterfully use tools depending on their individual projects. This can include programming, woodworking, welding, 3D printing, laser cutting, CAD (computer aided design), CAM computer aided manufacturing, electronics and other necessary for the design of the prototype.
- Manage multiple user testing group to define a potentially marketable product.